SudoKoach
by KMR Consulting

Makes solving Sudoku puzzles more fun!

SudoKoach makes solving Sudoku puzzles more fun. It does the tedious work for you, so you can concentrate directly on finding the solution. SudoKoach generates puzzles with six different levels of difficulty, so you don’t have to wait for tomorrow’s newspaper to start solving. You can also enter puzzles from the newspaper, and SudoKoach will help you solve them too, and you can print puzzles to solve later or to give to friends.

SudoKoach doesn’t solve the puzzle for you, it simply figures out which numbers are possible in each unsolved cell. This task is neither difficult nor challenging—if you’ve solved Sudoku puzzles before, you know that it is boring, time-consuming, and error-prone, but absolutely necessary. With SudoKoach, you don’t need to waste your effort on this step. Instead, you can immediately get to the fun part of solving Sudoku puzzles: looking for the relationships among cells that indicate solutions.

SudoKoach also provides tools to help you solve puzzles. You can highlight all unsolved cells in which a particular value is possible. This makes it easier to spot “hidden singles” (groups in which a value is possible in only one cell), pairs, and so forth.

If you get stuck, SudoKoach can give you three levels of hints. A little hint tells you what to look for (e.g. naked single, hidden single, box/line elimination, etc.), but doesn’t give any details on the value or where to look. A medium hint tells you what to look for and what value is involved (e.g. a hidden single with the value 7). And a big hint shows you exactly where the next move is, and explains the logic behind the move. These explanations help you learn the more advanced Sudoku solving strategies, so you can become a better player!
SudoKoach v2.4

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1 Introduction to SudoKoach

Welcome to SudoKoach, the program that makes solving Sudoku puzzles more fun!

- Click here to learn how to use SudoKoach.
- Click here for a discussion of the rules of Sudoku and the logic behind solving puzzles.

Why would I want to use SudoKoach?

SudoKoach takes the tedium out of solving Sudoku puzzles, so you can get to the interesting aspects of the puzzles faster. There are two approaches to solving Sudoku puzzles.

1. The "intuitive" approach, where you stare at the puzzle, looking at the various numbers until you see a move.
2. The "methodical" approach, where you go through the puzzle, cell by cell, computing which numbers are legal in each one.

The intuitive approach is fast and fun until you've made all of the easy moves. Then you'll find yourself looking at the same things over and over, but not seeing any more moves.

With the methodical approach, all moves will eventually become apparent, but the work you must do to get to that point is tedious, time-consuming, and error-prone.

SudoKoach eliminates the tedium by doing the mundane work for you quickly and accurately. But it doesn't solve the puzzle for you: it only takes care of the simple work of figuring out what values are legal in each cell. That lets you spend your time concentrating on the more interesting patterns and relationships in the puzzle, and makes it feasible for you to tackle puzzles that are more difficult.

You'll be amazed at how much faster you can solve Sudoku puzzles when you use SudoKoach, and how much more fun you have solving them.

Why is SudoKoach better than the other Sudoku programs?

There are many other Sudoku programs, but to me they all seem to have shortcomings.

1. Some programs do too much work for you. If the program solves the puzzle for you, or points out too many things on the way to a solution, it isn't as much fun as solving the puzzle yourself.
2. Some programs don't do enough work for you. An "electronic notepad" is an improvement over solving with a pencil and paper (and drowning in the inevitable sea of eraser crumbs), but it makes you do all the tedious work that isn't much fun to do. Solving puzzles quickly becomes boring if most of your efforts require no skill beyond finding a needle in a haystack.
3. Some programs are just clunky to use. If it takes three or more steps to perform a basic task, such as deciding what value should go in a cell, you'll quickly tire of using the program.

SudoKoach does the tedious work for you so that you can get right to the interesting parts of solving the puzzle. But it doesn't solve the puzzle on its own—you've got to find the right answer for each cell. And with SudoKoach, performing basic tasks is easy:

- To choose the answer for a cell, just left-click on the value you want.
- To eliminate a number as a possibility in a cell, just right-click on that number.

SudoKoach Reference Manual

If you prefer having printed documentation, you can download his help file in PDF form from our web site. You can then view or print that file using the free Adobe Acrobat Reader.
1.1 License to use SudoKoach

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You may use the shareware version of this software for up to 30 days without payment of any fees. You may use it on more than one computer simultaneously. You may give copies of the shareware version to others. After 30 days, you must either register the software or discontinue its use. Except for these differences, the license to use the shareware version of the software is identical to the license for the registered version.

Note: the shareware version is identical to the registered version except as described in Limitations in the Shareware Version section.

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*Some states do not allow the exclusion of the limit of liability for consequential or incidental damages, so the above limitation may not apply to you.*

(Geez, lighten up—it's only a game!)

1.3 The Fine Print, Explained

Thank you for your interest in SudoKoach. Please read the warranty disclaimer and license statement immediately preceding this section.
At first glance, the lack of warranty accompanying software these days seems distressing. Chief among the reasons for this are the proliferation of different hardware and software environments, and the existence of computers made by various manufacturers who claim that they are PC compatible. Software authors have no control over the type of hardware and the operating system you have, or other programs you may use; nor can we guarantee that you will use this program correctly. Yet any of these things might cause a malfunction.

However, the best part about shareware is that you have the opportunity to actually use the program before buying it. From a practical point of view, then, there is little for us to warrant, as you've already tried the software on your machine and you know it works. If you do have questions, we provide one year of free technical support to our registered users, and are happy to answer questions from shareware users, too.

1.4 Installing SudoKoach

When you install SudoKoach, the setup program will suggest a folder in which to put it. For most users, this default folder will work just fine, but some users might wish to install SudoKoach in some other folder. Here is how to decide.

**The Default Folder**

The default folder for SudoKoach is `C:\Program Files\SudoKoach`. If it is installed here (or anywhere else in `Program Files`), then SudoKoach will create a new folder in `My Documents` (on Vista, it is just called `Documents`)—this is where it will store your preferences (e.g. the size and position of the SudoKoach window; the colors, cell options; etc.), and any puzzles you save. The advantages of this are:

1. If several different people use this computer and each person has their own user account, then each person can change their own preferences without affecting the preferences for any other user.
2. Each person can save their own puzzles without worrying about whether the names they choose conflict with names that other users have chosen for their saved puzzles.

The only drawback to using the default folder is that if you uninstall SudoKoach, you have to remove the `SudoKoach` folder from `My Documents`.

**Installing to Alternate Locations**

If you choose to install SudoKoach in some folder that is not in `Program Files` (for example, into `C:\SudoKoach`), then all the files created by SudoKoach will be stored in that same folder. This means:

1. If several different people use this computer, any changes made by one user to their preferences will change the preferences for every other user, even if each user has their own separate account. This is because there is actually only one set of preferences, which is shared among all the users.
2. All users will share the same collection of saved puzzles.

The advantage to this choice is that uninstalling SudoKoach is simpler: there is no other folder to remove.

If you install SudoKoach into a folder in your `My Documents` folder, then no other users will be able to use SudoKoach at all.

**Which Location is Best for Me?**

For most users, the default folder will work fine (that is why it is the default). Use an alternate location only if you have a specific reason for doing so (for example, your computer is part of a network and you want other network users to be able to access SudoKoach).

**Creating a Quick Launch Icon on Vista**

When SudoKoach is installed on Windows XP (and earlier versions), the installer gives you the option of
creating a "Quick Launch" icon on the taskbar. However, when installing SudoKoach on Windows Vista, this option is not provided. To create a quick launch icon on a computer using Vista, use the Windows Explorer to locate the SudoKoach application (look in the folder in which you installed SudoKoach). Then right-click on this file and select “Add to Quick Launch.”

1.5 How to Register SudoKoach

To register SudoKoach, just click Order SudoKoach online! on the menu bar. This will take you to our Web site www.KMRConsulting.com where you can place an order with your credit card. If you prefer to register by mail, the web page will let you print a form that you can mail to us with your payment.

The registered version of SudoKoach does not have the annoying "registration reminder" screens. In addition, registered users of SudoKoach are entitled to one year of free technical support, and will automatically receive the next major revision of the program free of charge. Registered users can also download minor updates to SudoKoach from our web site at no charge!
2 The Rules of Sudoku

Despite the fact that Sudoku puzzles contain numbers, no mathematical skill of any kind is needed to solve them.

Sudoku is usually played on a 9x9 grid, like the one shown below:

```
 7 6 3 | 8 1 9  
---+---+---
 7 6 2 | 4  
---+---+---
 4  | 6 3  
---+---+---
 8 2 3 | 9 2  
---+---+---
 5 1  | 7  
```

To solve the puzzle you must fill in the missing numbers so that:

- Each row contains one of each of the digits 1 to 9, and
- Each column contains one of each of the digits 1 to 9, and
- Each 3x3 box (surrounded by the heavier lines) contains one of each of the digits 1 to 9.

Since each row, column and box has only nine cells, there can be no repeated digits.

That’s it—there are no other rules. It is fascinating that so simple a puzzle can be so challenging and so much fun to solve.

2.1 The Logic of Sudoku

Sudoku puzzles are solved with logic, not mathematics or guesswork. For example, consider the 7’s in the puzzle below:
The puzzle starts with four 7's. But there must be exactly one 7 in each row, column, and box, so the solution must have five more 7's in it. Where do they go? The puzzle itself tells us where.

Each 7 that is already in the puzzle prevents another 7 from being placed in the same row, column, or box. The red arrows show the cells that are "covered" or "blocked" by the existing 7's:

This leaves only ten cells available in which the remaining five 7's must go. But by using logic we can figure out exactly where.

- Look at row three (counting down from the top of the puzzle). This row must have exactly one 7 in it, but there is only one cell in the row that isn't blocked by one of the existing 7's. Therefore, the 7 in row three
must go in column nine. Notice that this is also the only cell in box three (counting left to right and then down) that can contain a 7.

- Likewise, row seven only has one cell in which a 7 can be placed.

There are a couple of other moves possible, but let's look at the board again before going any further:

![Sudoku board with highlighted moves](image)

The new 7's block three more cells. This lets us find some more moves.

- The only place in box six that a 7 can appear is the center cell. This cell is also the only place in column eight where a 7 can go.

- The only place in row eight that a 7 can appear is in column five (this will also be the 7 in box eight).

- Once these two 7's are placed, there will be only one cell in row six (column four) where the final 7 can go.

This is the type of logic you need to solve Sudoku puzzles. The strategy used in this example is called a Hidden Single, and is one of the basic strategies that are used in solving all Sudoku puzzles. There are also numerous intermediate and advanced strategies that will help you solve tougher puzzles, and superhuman strategies to help crack the most difficult of puzzles.
Getting Started with SudoKoach

This chapter explains the key things you need to know in order to start having fun solving puzzles with SudoKoach. The reference manual has complete descriptions of all the program’s features. Click the >> button above to see how easy it is to solve Sudoku puzzles with SudoKoach.

3.1 How to Start a Game

SudoKoach can create Sudoku puzzles for you in six different levels of difficulty, or you can enter your own puzzles from books, magazines, newspapers, or wherever.

When you first start SudoKoach, you will see this welcome screen:

With this screen, you can:

- create a new puzzle with any of six different levels of difficulty,
- enter a puzzle you found in a book or a newspaper, or
- return to a puzzle you saved earlier.

When you’re ready for another game, you can perform these same tasks using the controls in the New Puzzles section of the button window:
To create a puzzle, first select the difficulty you want from the list: Easy, Medium, Hard, Expert, Devious, or Sadistic. (Click here for details on what these ratings mean.) Then click the Create button. To create another puzzle with the same difficulty as your last one, just click the Create button again.

To enter a puzzle from some other source into SudoKoach, click the Enter Puzzle button. Then use the mouse to left-click the starting value in each cell of the puzzle that has one. If you make a mistake, click the Undo button to back up. Or, point to the cell containing the mistake and right-click it with the mouse.

When you are finished entering the puzzle, click the Done Entering button. This verifies that the puzzle has exactly one solution. If it does not, the puzzle might have been entered incorrectly—click the Start Over button and try again.

If you saved a puzzle earlier (perhaps because you ran out of time), you can open it and continue working on it. Just click the Open button. Choose the puzzle you want to work on in the window that appears next.

3.2 The SudoKoach Board

After you have started a game, the SudoKoach board will look something like this:
The rows and columns are obvious, and the 3x3 boxes are bordered by heavier lines. Rows are numbered one through nine from top to bottom, and columns are numbered one through nine from left to right. The topmost three boxes are numbered one through three (left to right); beneath those are boxes four through six; beneath those are boxes seven through nine.

When speaking of an individual box, we may refer to its first row, second row, or third row (likewise with columns). This should not be interpreted as a row number of the board. For instance, the first row in box six is row four on the board; the first column in the same box is column seven on the board.

Individual cells are identified by their row and column. For example, cell 2,9 is the last cell in the second row, and cell 7,4 is in the upper left corner of box eight.

The large numbers are the answers in cells that are solved. The small numbers show the values that are legal in each of the remaining cells. SudoKoach computes these possibilities for you so that you don’t have to.

### 3.3 The Button Window

To the right of the SudoKoach board you will see a collection of buttons and controls that looks like this:
These controls give you an easy way to access commonly-used functions. You've already seen how the controls in the **New Puzzles** group allow you to create new puzzles in much the same manner as the **Welcome screen**. Many of the other controls will be described as we go through this tutorial.

All of these functions can also be obtained through the menus, and many have keyboard shortcuts. For simplicity, however, this tutorial does not discuss those methods. See the Reference Manual for complete descriptions.

### 3.4 Making the Board Larger or Smaller

You can make SudoKoach as large or small as you like. To resize the window, move the mouse pointer over any corner of the window. Then press and hold the left mouse button and move the mouse to drag that corner of the window and change its size.

When you resize the window, the board within it gets larger or smaller, and the size of the digits changes appropriately. The larger the window, the larger the numbers will be displayed, making them easier to read.

When you print a puzzle, the size of the printed puzzle is approximately the same as its size on your screen.
If you want the printed puzzle to be larger or smaller, just resize the screen and print it again.

### 3.5 Playing the Game

The two basic things you will do while playing are selecting an answer for a cell, and removing a number as a possibility for a cell.

- To select an answer: just point to the desired number in the cell with the mouse and left-click it. The other possibilities in the cell are removed, and the number you chose is removed as a possibility from all other cells in the same row, column, and box.
- To remove a possibility: just point to it with the mouse and right-click it.

### 3.6 Highlighting Possibilities

SudoKoach provides a very useful tool called **highlighting**. To highlight all of the cells that contain a particular value as a possibility, just click the desired digit in the Highlight section of the button window:

When you've highlighted a value, the corresponding button changes color so you can easily see what is highlighted. For instance, the diagram above shows what you'd see if you highlighted the 5's, and the board might look something like this:
It is now obvious that there is only one 5 in column nine and row seven (and box nine).

When you are finished looking at one value, you can highlight the next value by clicking the Next button (as shown above). You can highlight the previous value by clicking the Previous button. To turn off the highlighting, click the Clear button.

There are several additional highlighting options, but they aren't really needed when you're just beginning (click here if you want to read about them anyway).

3.7 Getting Hints

If you get stuck and can't find any moves, you can get a hint to help you out. There are three types of hints: big, medium, and little, and they can all be obtained with the buttons in the Undo and Hints group of controls:

- A big hint shows a move on the board, and explains why you can make this move. Consider the board below:
In this case, box three has only one cell in which 7 is possible. Because the cell shows other possibilities, this is called a hidden single. Despite those other possibilities, however, the cell must be 7 (the box must contain a 7 somewhere, and this is the only place it can go).

If you click the Yes button, SudoKoach will make the move for you. If you click No, it won't make the move, but the move will remain shown on the board for you to study. If you click Cancel, the move is not made and is erased from the board. Clicking the Explain strategy button will display the Help file with an explanation of the strategy, including examples.

Note: if the hint box is in an inconvenient place, just drag it elsewhere on the screen. In subsequent hints, the box will appear where you last put it.

- A medium hint gives you some details about a move to make, but doesn't tell you where the move is—it is up to you to find the move and make it. For example, in the board above, a medium hint would look like this:

  ![Medium hint example]

Now that you know what to look for, finding the move is a lot easier. As with a big hint, clicking the Explain strategy button will display an explanation of the strategy.

- A little hint just tells you the name of a move:
Finding the move is not as easy as if you knew the number, but easier than not knowing anything about what you're looking for. Once again, you can click the Explain strategy button for an explanation of the strategy.

Each time you get a hint, take a moment to study the move that was pointed out. As your solving skills improve, you will not need as many hints to solve puzzles.

If you find yourself getting a lot of little hints, try checking the Next move: box in the Undo and Hints controls, like this:

This will make SudoKoach tell you what the next move is. This information is updated automatically every time you make a move.

Note: sometimes, it can take quite a while to figure out hints (especially for the composite chain strategy). If a hint takes more than a half second, this box will appear to tell you what is happening:

Just be patient and the hint will eventually appear. If you get tired of waiting for it, you can click the Cancel button.

3.8 Undoing Mistakes

To undo the last move you made, just click the Undo button in the Undo and Hints controls:
Getting Started with SudoKoach

You can undo as many moves as you want, all the way back to the start of the puzzle. If you undo a move and then decide you want to make that move again, just click the **Redo** button.

If you have made a mistake, you can also click **Undo until OK**. This undoes as many moves as needed to eliminate all mistakes that have been made.

It is impossible to choose an illegal number for a cell because SudoKoach only shows the values that are legal in each cell. However, it is entirely possible to make a wrong move by choosing a possibility that is not the answer for that cell. If this happens, the puzzle can no longer be solved, and you will eventually get to a point where some cells have no possibilities left.

You can check at any time whether the puzzle as it currently appears can be solved. Just click the **Check Solution** button:

You will see one of the following answers:

- **This puzzle can be solved.** Everything is correct in the solution so far.

- **This puzzle can no longer be solved!** Something in the solution is wrong. If you want to try and find the problem yourself, use **Undo** to back up a step at a time. If you would rather just undo the error and continue solving, use **Undo until OK**.

If you find yourself checking the solution frequently, just click the **Solution status** checkbox like this:

The **Check Solution** button is replaced by the status itself (either **OK** or **NO SOLUTION!**), which is updated automatically after every move you make.
3.9   Saving, Opening, and Printing Puzzles

To save a puzzle so that you can work on it later, just click the **Save As** button:

You will be asked to enter a filename for the puzzle. Once you have saved a file with a certain name, clicking **Save** will save it again with that same name.

To restore a puzzle that you saved previously, click the **Open** button. The puzzle will be displayed exactly as it was when it was saved. The elapsed time for the puzzle will continue from whatever value it had when the puzzle was saved.

To print the current puzzle on your default printer, just click the **Print** button. Or go to the **File** menu, where you will see the following five options:

- **Print setup** allows you to choose the printer you want to use. Your default printer will be used if you don't explicitly select a different one.
- **Print puzzle with clues** prints the current puzzle and shows the possibilities that are legal for each unsolved cell (just like the **Print** button).
- **Print puzzle, no clues** prints the puzzle, but unsolved cells are blank: the possibilities are not shown.
- **Print answers** prints the answers to the current puzzle.
- **Print blank solving grid** prints an empty Sudoku board: no answers are shown, and every cell shows all nine values as possibilities. This grid is a helpful tool for solving puzzles by hand.

3.10   Learning Sudoku Strategies

There are many strategies you can use to help you solve Sudoku puzzles. However, the basic strategies are the ones that are most often useful in solving puzzles you find in newspapers or magazines. You will need to be able to recognize them before you can solve puzzles without using hints.

While you are learning, hints are an excellent way to see examples of the strategies. Each time you get a hint, take a moment to study the move so you can recognize it when it appears elsewhere in the puzzle. The first two strategies, naked singles and hidden singles, follow logically from the Sudoku rules:

1. **Naked single**: if a cell has only one possibility, then the cell must be that value, even if other cells in the same row, column, or box have the same possibility.

2. **Hidden single**: if only one cell in a row, column, or box can possibly have a certain value, then this cell must be that value even though it has other possibilities.

These strategies are easily learned by studying hints, and they are the only strategies needed to solve SudoKoach "easy" and "medium" puzzles. The only difference between puzzles of these difficulties is that the easy puzzles have more moves than the medium ones, so it is easier to spot moves to make. (Click here for a
3.11 Basic Solving Techniques

SudoKoach makes solving puzzles easier by showing you the possibilities for each unsolved cell. Until you get more experience solving Sudoku puzzles, try using these steps.

1. First look for naked singles (cells with only one possibility) and left-click them to solve those cells.
2. Then highlight the 1's, then the 2's, etc. and look for hidden singles. For example, look at the puzzle below, which has 5’s highlighted:

```
8 9 1 3 6 2 3 6 8 9 2 6 8 9 2 3 9 5 7 3 5 6 7 8 4 1
7 8 9 7 8 9 7 8 9 7 8 9 7 8 9 7 8 9 7 8 9 7 8 9 7 8 9
4 3 6 2 1 5 6 4 8 1 5 6 4 8 1
3 1 6 5 4 9 2 5 1 9 2 5 1 9 2 5 1 9 2 5 1 9 2 5 1 9 2
2 4 1 3 7 8 5 1 2 9 6 1
7 8 9 7 8 9 7 8 9 7 8 9 7 8 9 7 8 9 7 8 9 7 8 9 7 8 9
6 1 2 3 4 5 1 2 3 4 5 1 2 3 4 5 1 2 3 4 5 1 2 3 4 5 1 2
5 2 4 9 8 6 5 2 4 9 8 6 5 2 4 9 8 6 5 2 4 9 8 6 5 2 4
1 9 5 8 3 2 1 9 5 8 3 2 1 9 5 8 3 2 1 9 5 8 3 2 1 9 5 8
```

Look across each row to see if there are any with only one cell that can be 5: row seven is one of these, so left click the 5 in that cell. Now look down each column for the same thing: column nine has only one
cell that can be 5, so left click it. Finally, look at each 3x3 box: after solving the previous two cells, box 4 has only one cell remaining that can be 5, so left click it.

3. When you solve a cell, that number will be eliminated as a possibility in all other cells in the same row, column, and box. Before solving a cell, look at these other cells to see what effect this change will have. (This is much easier if you highlight the value you are about to select.) This will frequently lead you to additional cells that can be solved.

As you become more advanced, there are more tools you can use to look for moves (such as marking chains and coloring), and there are many more strategies you should look for as you go through the board. But you know enough now to get you started.

It's time to start having fun solving Sudoku puzzles!
4 Sudoku Solving Strategies

Introduction

There are numerous strategies for solving Sudoku puzzles:

- the basic strategies are direct applications of the rules of the game;
- the intermediate strategies are simple, logical extensions of the basic strategies;
- the advanced strategies are more difficult (some are quite intricate); and
- the superhuman strategies, which are extremely difficult.

None of these strategies involve any guesswork. “Guesswork” is where you arbitrarily choose one of the possibilities for a cell to see where that leads you. If you happened to choose the wrong value, then you will eventually reach a dead end, such as an unsolved cell with no possibilities. But if you happened to choose right, you are one step closer to solving the puzzle. If you enjoy solving puzzles this way, that’s fine—but if you reach a dead end, undoing your moves in SudoKoach is a lot easier than trying to back up with pencil and paper.

But many people prefer to avoid guesswork whenever possible. In fact, the goal of using strategies to solve Sudoku puzzles is to avoid guesswork altogether. The strategies allow you to say with certainty that a particular number is impossible in a certain cell, and give a logical reason for it. The challenge is deciding which of the many strategies to use, and then applying it properly. SudoKoach can help you with the both parts of this challenge:

1. A little hint tells you what strategy to use next, and a medium hint tells you a little more about what numbers to look for, or where to start looking.

2. The descriptions that follow will help you understand each strategy and learn how to find them in a puzzle.

It will take some practice to learn these strategies, but you don’t need to be an Einstein to do it: most strategies can be mastered by anyone with a little patience.

What is included in the descriptions

The descriptions of the strategies all include some common elements.

- **Overview**: A general overview of how the strategy works. Hopefully this will make the definition easier to understand.
- **Related to**: A list of other strategies that use similar logic. Often, when you’re looking for one strategy in a puzzle, you might find places where the related strategies could also be used.
- **Frequency**: how often this strategy can be used in puzzles. This is described both in general terms (see below for more information), and as an approximate number of puzzles to which the strategy applies. You can use this information to decide which strategies to learn now and which to skip until later. Click here for more information on how to interpret these frequencies.
- **Also known as**: Other names you may see for this strategy.
- **Definition**: A formal definition of the strategy.
- **How to find them**: Tips on how to find places in Sudoku puzzles where the strategy can be applied.
- **Examples**: Sample puzzles that utilize the strategy, including explanations of the logic.

The frequency with which a strategy applies is described with these terms:
### 4.1 Basic Strategies

The basic strategies are direct applications of the rules of the game. You must master these because they are used in solving all Sudoku puzzles. Fortunately, they are quite easy to master.

The basic strategies are:

- Naked Singles
- Hidden Singles

#### 4.1.1 Naked Singles

**Overview**

A **naked single** is a cell that has only one possibility. Finding these is trivial when solving Sudoku puzzles with SudoKoach, but tedious to find when solving them by hand because you have to figure out the possibilities yourself.

**Related to:** naked pairs, naked triples, naked quads

**Frequency:** Very common (every puzzle, or 100%)

**Definition**

A cell with only one possibility must be that value, simply because it cannot be anything else. It makes no difference that the value is shown as a possibility in other cells. Naked singles happen when all other possibilities are blocked by other cells, or eliminated by the use of other strategies.

**How to find them**

Just look at the unsolved cells row by row and see how many possibilities each has. Cells with only one possibility are naked singles.

**Example**

The puzzle below has three naked singles. Can you find them?
- Cell 5,6 can only be a 4.
- Cell 6,7 can only be a 5.
- Cell 9,4 can only be a 4.

Naked singes are easier to find if you highlight all of the cells with one possibility, like this:
When solving Sudoku puzzles by hand, look for naked singles with the "What Can This Cell Be?" technique.

4.1.2 Hidden Singles

**Overview**

A hidden single is a cell that is the only one in a group that can be a particular value.

**Related to:** hidden pairs, hidden triples, hidden quads

**Frequency:** Very common (9 out of 10 puzzles, or 92%)

**Definition**

A hidden single is a number that is only possible in one cell of a row, column or box. It is called "hidden" because the cell will have other possibilities—but if the number cannot appear anywhere else in the row, column, or box, then it must be in this cell regardless of those other possibilities.

**How to find them**

1. Start with the value 1.
2. Look in each row, one by one, to see if there is only one cell in which the value is possible.
3. When you have finished with the rows, look at the columns, then look at the boxes.

4. Repeat the above steps with values 2, 3, etc.

Highlighting is extremely useful in finding hidden singles because it makes it easier to spot the cells that contain a given possibility.

Example

In the puzzle below, the 1’s are highlighted, which identifies two hidden singles:

- Column six (and box five) both have only one cell that can be 1.
- Row seven (and box nine) both have only one cell that can be 1.

This puzzle has eight other hidden singles of different values, but they are harder to spot without highlighting the values.

To find hidden singles when solving a puzzle by hand, use the "Where Can This Number Go" technique.

4.2 Intermediate Strategies

The intermediate strategies are simple logical extensions of the basic strategies. They are:

- Box/line Elimination
- Line/box Elimination
- Naked Pairs
Naked Triples
Hidden Pairs
Hidden Triples
X-Wing
XY-Wing

The basic and intermediate strategies are all that are usually needed to solve Sudoku puzzles in newspapers and magazines.

4.2.1 Box/line Elimination

Overview

Box/line elimination is where the locations of possibilities in a 3x3 box allow you to eliminate possibilities from other cells of the rows or columns that intersect the box.

Related to: line/box elimination

Frequency: Common (1 in 4 puzzles, or 28%)

Definition

If a particular value is possible in only one row within a box, then that value cannot appear in the same row outside of the box. Similarly, if a particular value is possible in only one column within a box, then that value cannot appear in the same column outside of the box.

How to find them

1. Start with box one.
2. Look in the rows of the box, one by one.
3. If there is a value that is possible in that row but not possible in the other two rows of the box, you've got one.
4. Now do the same with the columns of the box.
5. Repeat the above steps with the next box.

The arrangement of values within the box eliminates possibilities elsewhere in the line (i.e. row or column), hence the name box/line elimination.

Example

Consider this puzzle (only the first three rows are shown):

Box/line elimination allows us to remove 1 as a possibility from cells 3,1 and 3,2. Here is the reasoning behind this move:
• In box three, the value 1 can only appear in the third row of the box (outlined in red).
• While we don't know whether cell 3,7 or cell 3,8 will contain the 1, we know that one of them must.
• Because the cells in this row of the box are also in row three of the puzzle, 1 cannot appear anywhere else in row three.
• Therefore, 1 can be eliminated as a possibility in cells 3,1 and 3,2.

With cell 3,1, we're lucky: it now has only one remaining possibility (it is now a naked single) so we can solve it.

### 4.2.2 Line/box Elimination

**Overview**

Line/box elimination is where the values in a line (row or column) allow you to eliminate possibilities from other cells of one of the boxes that intersect the line.

**Related to:** box/line elimination

**Frequency:** Common (1 in 8 puzzles, or 13%)

**Also known as:** pointing pairs, pointing triples, interaction

**Definition**

If a particular value is possible in a row only in cells that are all in the same box, then that value cannot appear elsewhere in that box. Similarly, if a particular value is possible in a column only in cells that are all in the same box, then that value cannot appear elsewhere in that box.

**How to find them**

1. Start with row 1.
2. Look at all of the values possible in the row.
3. If any of the values is possible only in cells that are all in the same box, you've found one.
4. Repeat with the next row.
5. When you're finished looking at rows, repeat with the columns.

The arrangement of values within the line (row or column) eliminates possibilities from other cells of a box that intersects with the line, hence the name line/box elimination.

**Example**

Consider this puzzle (only the first three rows are shown):
We can remove 4 as a possibility from cells 2,5 and 3,5. Here is the justification for this move:

- In row one, the value 4 is possible only in columns four and five.
- While we don't know which of these cells will contain the 4, we know that one of them must.
- Because both of these cells are in box two, and box two can only contain a single 4, we know that 4 cannot appear anywhere else in that box.
- Therefore, 4 can be eliminated as a possibility in cells 2,5 and 3,5.

### 4.2.3 Naked Pairs

**Overview**

A naked pair is two cells in a group that have exactly the same two possibilities. The fact that the two values must appear in these two cells allows you to eliminate the values from all other cells in the group.

**Related to:** naked singles, naked triples, naked quads

**Frequency:** Common (1 in 8 puzzles, or 13%)  

**Definition**

1. If two cells in a group both have exactly the same two possibilities, then these two cells must contain those values. While we don't know which cell will contain which value, we do know that both values must go in these two cells.

2. These two values can be eliminated as possibilities in all other cells of the same group.

**How to find them**

1. Look for cells that have exactly two possibilities.

2. For each one that you find, see if there is another cell with the same two possibilities in the same group.

Highlighting can help you find naked pairs. Choose Only for highlighting, then use the Shift key to highlight 1's and 2's. Now use Next to cycle through all possible combinations, while looking for groups that have exactly two cells highlighted, both in light yellow. You can also highlight cells that contain two possibilities.

**Example**

Consider this puzzle (only rows one through three are shown):
Cells 2,1 and 2,9 both have the same two possibilities: 2 and 3.

- We don't know which of these two cells will be 2 and which will be 3.
- But we do know that one of them must be 2 and the other must be 3, because these are the only two possibilities for these cells.
- Therefore, 2 and 3 cannot appear anywhere else in row two.
- The value 2 can be eliminated as a possibility from cells 2,6 and 2,8; the value 3 can be eliminated from cell 2,4.

If you find a naked pair in a row or column, check whether the two cells are both in the same box. If so, then you can eliminate the two values from all other cells in that box, too.

4.2.4 Naked Triples

**Overview**

A **naked triple** is three cells in the same group whose only possibilities include the same three values. These values can be removed from all other cells in the group.

**Related to:** naked single, naked pair, naked quad

**Frequency:** Uncommon (1 in 50 puzzles, or 2%)

**Definition**

1. There are exactly three possibilities involved.
2. There must be three cells in the same group that have no possibilities other than these three.
3. The values can be eliminated as possibilities from all other cells of the same group.

The wording of #2 is quite precise. What it means is that the three cells do not need to have all three values as possibilities, but only a subset of them. Of course, each cell must have at least two of the possibilities or else the cell would be a naked single. And among the three cells, each possibility must appear at least twice, or it would be a hidden single.

If the possibilities are A, B, and C, then one of the three cells must have A & B, one must have A & C, and one must have B & C. It is acceptable for any (or all) of the cells to have the third possibility as well.

**How to find them**

Naked triples are harder to find than naked pairs because each cell might have only two of the three values as possibilities. Fortunately, though, the cells involved cannot have any other possibilities.

1. Look for a cell with two or three possibilities.
2. Then look for two other cells in the same group whose possibilities include only those values. Remember to look in all groups to which the cell belongs.

Highlighting can help you find naked triples. Choose Only for highlighting, then use the Shift key to highlight 1’s, 2’s, and 3’s. Now use Next to cycle through all possible combinations, while looking for groups that have exactly three highlighted cells, all in light yellow. You can also highlight cells that contain two or three possibilities.

Example 1

The first example illustrates an easy naked triple (only rows one through three are shown):

```
  4  5  6
  7  8  9
  2  3  1
  7  2  3
  9  1  4
  8  5  6

This naked triple is in box one. It involves the values 2, 3, and 9 in cells 2,3; 3,1; and 3,3. We can remove 2, 3, and 9 (shown in red) from all other cells of the box. Here is the reasoning behind this strategy:

- Of these three cells, we don’t know which one will have each value, but we know that all three values will appear somewhere in these three cells.
- Because these three values will be used by the three cells in the triple, the values cannot be possible in other cells of box one.
- Therefore, 2, 3, and 9 can be eliminated as possibilities in cells 1,1 and 2,1.

This example was "easy" because all three cells had each of the three values as possibilities, which makes the pattern easier to spot. But this is not a requirement: each cell only has to contain a subset of the three values. If the three cells contained the values 2 & 3, 3 & 9, and 2 & 9, the same logic would hold. There would be fewer possible arrangements of the three values in the three cells, but all three values would still have to reside somewhere in those cells, and could therefore be eliminated as possibilities in other cells of the group.

Example 2

Here is a naked triple that is more typical. Only rows one through three are shown:

```
  1  2  3
  5  6  7
  9  4  8
  1  2  3
  4  5  6
  8  7  9
  1  2  3
  3  4  5
  9  6  8

In this example, the triple involves the values 3, 4, and 9. It appears in cells 2,2 (containing 3 and 4); 3,1 (containing 3 and 9); and 3,2 (containing 3, 4, and 9). Because each cell contains no values other than 3, 4, and 9, they form a naked triple, so these three values can be removed as possibilities in the other cells of this box.
If you find a naked triple in a row or column, check whether the three cells are all in the same box. If so, then you can eliminate the three values from all other cells in that box, too. Similarly, if you find a naked triple in a box and the three cells are all in the same row or column, you can eliminate the three values from other cells elsewhere in the same row or column.

4.2.5 Hidden Pairs

**Overview**

A **hidden pair** is a pair of values that are possible in only two cells of a row, column, or box. The fact that these two cells must contain these two values allows you to eliminate all other possibilities from the cells.

**Related to:** hidden singles, hidden triples, hidden quads

**Frequency:** Uncommon (1 in 13 puzzles, or 8%)

**Definition**

1. If two values are possible only in the same two cells of a group, then these two cells must contain these values, regardless of the other possibilities the cells have. While we don't know which cell will contain which value, we do know that each of them must contain one of the values.

2. All other possibilities in these two cells can be eliminated.

**How to find them**

1. Start with the rows.
2. In each row, see if you can find a possibility that appears in only two cells.
3. Look at the other possibilities in those cells: if there is one that does not appear elsewhere in the group, you've found a hidden pair.
4. When you're finished with the rows, repeat these steps with the columns, then with the boxes.

Highlighting can help you find hidden pairs. Choose **Any** for highlighting, then use the **Shift** key to highlight 1's and 2's. Now use **Next** to cycle through all possible combinations. Look for groups that have exactly two highlighted cells, each of which contains both possibilities—they will be highlighted in either light green or light yellow.

You must use **Any** for this technique to work, because you only want groups in which the two values appear in exactly two cells.

**Example**

Hidden pairs are harder to find than naked pairs because the other possibilities in the cells "hide" the pair from your view.

Consider this puzzle, of which only rows one through three are shown:
Box two contains a hidden pair: the values 4 and 7 are possible in cells 1,4 and 1,5, but nowhere else in the box. Therefore:

- We don’t know which of these two cells will be 4 and which will be 7.
- But we do know that one of them must be 4 and the other must be 7, because these values cannot appear anywhere else in the box.
- Therefore, these two cells cannot be any other values.
- 1, 2, and 9 can be removed as possibilities from these cells.

After the impossible values have been removed, you will have a naked pair. While this fact cannot result in the elimination of possibilities from other cells in the group you were originally looking at, you can sometimes eliminate possibilities from another group. In this example, after removing our possibilities:

- We have a naked pair in box two.
- But the values 4 and 7 cannot appear anywhere else in box two (our original group)—if they did, we would not have had a hidden pair to begin with.
- However, both the indicated cells are in row one, so if the values 4 or 7 appeared as possibilities elsewhere in row one, they could also be removed (in this particular example, it happens that they don’t).

### 4.2.6 Hidden Triples

**Overview**

A hidden triple is a set of three values that can appear only in three cells of a group. These cells will have other possibilities but they are irrelevant and can be removed.

**Related to:** hidden singles, hidden pairs, hidden quads

**Frequency:** Rare (1 in 200 puzzles, or 0.5%)

**Definition**

1. If three values are possible only in the same three cells of a group, then these three cells must contain these values. While we don’t know which cell will contain which value, we do know that each of them must contain one of the three values.

2. All other possibilities in these three cells can be eliminated.

**How to find them**

Hidden triples are much harder to find than hidden pairs for three reasons:
Each cell can contain other possibilities, which "hide" the triple from view.

Each cell can contain either two or three of the values as possibilities.

There are 84 different sets of three values to consider, which makes looking for hidden triples methodically (e.g. first look for 1,2,3; then 1,2,4; then 1,2,5; etc.) very time-consuming.

To find them:
1. Look for cells in a row, column, or box which share possibilities.
2. If you can find three values that are only possible in three cells of the group, you've found a hidden triple regardless of what other values are possible in those cells.

Highlighting can help you find hidden triples. Choose Any for highlighting, then use the Shift key to highlight 1's, 2's, and 3's. Now use Next to cycle through all possible combinations. Look for groups that have exactly three highlighted cells, each of which contains two or more of the possibilities (if one of the cells contained only one of the possibilities, the other two cells would form a hidden pair).

**Example 1**

Consider this puzzle, of which the first three rows are shown:

![Sudoku Puzzle](image)

Can you find the hidden triple in row two? It's not easy to find these without a lot of experience, but with some patience you can learn. Take a look now for the triple.

Did you find it? If so, fantastic! The values 1, 4, and 9 can appear only in cells 2,1; 2,2; and 2,9 as shown below:

![Sudoku Puzzle](image)

The outlined cells are the ones involved in the triple, the black numbers contained therein are the three possibilities. The red possibilities can all be removed. Here is the reasoning behind this strategy:

- The three cells in the triple must contain the three values that can be found nowhere else in the group (in this case, the row).
- Even though we don't know which cell will end up having each value, we do know that these three cells cannot have any other possible values.
So all other possibilities can be eliminated from these cells.

As with hidden pairs, eliminating the impossible values leaves you with a naked triple. However, this fact is useful only if the three cells are all members of another group (for example, three cells in a row that all happen to be in the same box as well).

4.2.7 X-Wing

Overview

An x-wing is a rectangular arrangement of four cells, all of which are the only cells in their rows (or columns) to have the same value as a possibility. This lets you eliminate that possibility from all other cells in the columns (or rows) involved.

Related to: swordfish, turbofish

Frequency: Uncommon (1 in 20 puzzles, or 5%)

Definition

There are two ways an x-wing can occur:

1. If there are two rows in which a particular value is possible only in the same two columns, you have an x-wing. You don’t know which cell in each row will end up having this value, but you do know that one of the two cells in the first row must be this value, and the other cell in the other row must be also. Therefore, that value cannot appear in any other cells of those two columns.

2. If you have two columns in which a particular value is possible only in the same two rows, you also have an x-wing, though it is flipped on its side. In this case, the value cannot appear anywhere else in those two rows.

How to find them

1. Start with row 1.
2. Look for values that are possible in only two columns of the row.
3. If you find such a value, look for another row in which the same value is possible only in the same columns.
4. If you find one, you can eliminate that value as a possibility from all other cells in those two columns.
5. When you’re done with the rows, start with column 1.
6. Look for values that are possible in only two rows of the column.
7. If you find such a value, look for another column in which the same value is possible only in the same rows.
8. If you find one, you can eliminate that value as a possibility from all other cells in those two rows.

Highlighting the value you’re looking for helps with this search.

Example 1

X-wings are fairly easy to spot with highlighting. Consider this first example:
Here we have an x-wing in rows two and four. In row two, the value 3 is possible only in columns four and seven; in row four, the value 3 is possible only in the same two columns. Highlighting the 3's as we've done here makes this easier to see. Therefore:

- If cell 2,4 is 3, then cells 2,7 and 4,4 cannot be 3 because they are in the same row or column as cell 2,4. The only cell left in row four which can be 3 is cell 4,7.

- Similarly, if cell 2,7 is 3, then cells 2,4 and 4,7 cannot be 3 because they are in the same row or column as cell 2,7. The only cell left in row four which can be 3 is cell 4,4.

- We don't know which of the previous two arrangements will turn out to be true, but we know that one of them must be true.

- In both of these arrangements, there is a 3 in columns four and seven, and these appear in rows two and four.

- Therefore, there cannot be any 3's in columns four and seven outside of these two rows. This means we can remove 3 as a possibility from cells 7,7 and 8,7.

### Example 2

The next example illustrates an x-wing involving two columns:
In column one, the value 3 is possible only in rows one and six; in column seven, the value 3 is possible only in the same two rows. Therefore:

- Row one must have a 3 in either cell 1,1 or 1,7 so we can eliminate 3 as a possibility from cells 1,3 and 1,5.
- Row six must have a 3 in either cell 6,1 or 6,7 so we can eliminate 3 as a possibility from cell 6,4.

### 4.2.8 XY-Wing

**Overview**

An **xy-wing** is a pattern of three cells. Two of the cells in the pattern have a useful property: one or the other of them is guaranteed to be a certain value. This value can therefore be eliminated from any cells that are covered by both of these two cells.

**Related to:** XY-wing chain, XYZ-wing

**Frequency:** Common (1 in 10 puzzles, or 10%)

**Definition**

1. There are exactly three possibilities involved. For convenience, we will call them A, B, and C.
2. The first cell in the pattern is called the **pivot**. It must have exactly two possibilities: A and B.
3. The second and third cells are called the **pincers** (I like to think of these as the tips of a lobster's claw).
Each of the pincers must be covered by the pivot.

4. Both pincers must have exactly two possibilities: A and C for one of them, and B and C for the other.

5. The value C can be removed as a possibility from all cells that are covered by both pincers.

**How to find them**

1. Look for cells that contain two possibilities: every such cell is a potential pivot.

2. For each one that you find, look for two cells covered by the pivot that also contain two possibilities: these will be your pincers. These cells must share one possibility with the pivot and one with each other.

3. Eliminate the shared value as a possibility in all cells that are covered by both pincers.

Highlighting cells with two possibilities helps with this search.

**Example 1**

Here is a puzzle that contains an xy-wing (only rows one through three of the puzzle are shown):

![Sudoku Puzzle](image)

Cell 1,1 (outlined with green) is the pivot. It contains the possibilities 2 & 5.

The pincers (outlined with red) are cells 1,9 and 2,3; they contain the possibilities 4 & 5, and 2 & 4.

The pattern allows us to remove 4 as a possibility from cell 1,3. Here is the reasoning behind this move:

- The pivot (cell 1,1) must be either 2 or 5. We don't know which, but it must be one of these two values.
- If the pivot is 2, then cell 2,3 cannot be 2 because they are in the same box. So if the pivot is 2, cell 2,3 must be 4.
- If the pivot is 5, then cell 1,9 cannot be 5 because they are in the same row. So if the pivot is 5, cell 1,9 must be 4.
- No matter which value the pivot has, one of the pincers will have the value 4. Therefore, 4 can be removed as a possibility from all cells covered by both pincers.

Be careful to look at all of the cells covered by both pincers. There may be more than you think. In this case:

- Cell 2,3 covers all cells in row two, column three, and box one.
- Cell 1,9 covers all cells in row one, column nine, and box three.

There are six cells covered by both pincers:

- Cells 1,1; 1,2; and 1,3 are in both row one and box one
- Cells 2,7; 2,8; and 2,9 are in both row two and box three
• Cell 1,3 is also in both row one and column three
• Cell 2,9 is also in both row two and column nine

Of these six cells, only cell 1,3 contains 4 as a possibility, so that is all we can remove.

Notice that there is no guesswork involved here. We know that the pivot must be one value or the other, and we remove only those possibilities that are eliminated if it attains either of its possible values.

**Example 2**

Here is another xy-wing. Once again, only rows one through three of the puzzle are shown:

<p>| | | | | | | | | | |</p>
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<thead>
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<tbody>
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<td>6</td>
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<td>8</td>
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<td>3</td>
</tr>
</tbody>
</table>

The pivot is cell 2,8 and the pincers are cells 2,3 and 3,9. Here is the reasoning once again:

• The pivot must be either 2 or 6.
• If the pivot is 2, cell 3,9 must be 3.
• If the pivot is 6, cell 2,3 must be 3.

No matter what value the pivot has, either cell 3,9 or cell 2,3 must be 3. We can therefore remove 3 from all cells covered by both 3,9 and 2,3.

See if you can figure out which cells are covered by both pincers.

Your list should include:

• 2,7; 2,8; 2,9 (in both row two and box three)
• 3,1; 3,2; 3,3 (in both row three and box one)

Of these cells, 3 is possible in 2,7; 3,1; and 3,3; we can remove all of these.

**Example 3**

In both of the preceding examples, there were six cells covered by both pincers. This might not always be the case. Look at this puzzle (only rows one through six are shown):
Here, there is no intersection between the box covered by either pincer and the row or column covered by the other one. The only cells that might be affected by this xy-wing are those at the intersections of the rows and columns. Of these two cells, one is the pivot, so in this xy-wing there is only one cell from which we can potentially remove a possibility: 4,3.

4.3 Advanced Strategies

The advanced strategies are more involved than the basic or intermediate strategies. Few of these strategies are likely to be needed to solve puzzles from newspapers (rectangle elimination is one notable exception), but the harder puzzles from some books and web sites depend upon them. They are:

- Rectangle Elimination
- Locked Cell Cycle (type 1)
- Locked Cell Cycle (type 2)
- Naked Quads
- Hidden Quads
- Unique Rectangles (types 1 through 6)
- Avoidable Rectangles (types 1 through 3)
- Swordfish
- Turbofish
- XY-Wing Chain
- XYZ-Wing
- Singles Chain
- Singles Chain Contradiction
- Weak Singles Chain
- Weak Singles Chain Contradiction
- Pairs Chain
- Pairs Chain Contradiction

While these strategies are not as straightforward as the basic ones, most can be mastered with a little practice, and it is very rewarding when you see where to apply one in a difficult puzzle.
4.3.1 Rectangle Elimination

Overview

Suppose the only cells in a 3x3 box in which a particular value is possible all happen to be in one row and one column. If another cell in that same row became this value and another cell in that same column also became this value, there would be no cells left in the box in which the value could appear. This situation is clearly impossible, and rectangle elimination allows you to remove the value as a possibility from such cells.

This strategy is not difficult to spot, and it is common enough to be well worth the effort of mastering it.

Related to: box/line elimination, line/box elimination

Frequency: Common (1 in 7 puzzles, or 14%)

Also known as: empty rectangles (though rectangle elimination is more powerful)

Definition

1. There is a box in which a particular value (we'll call it V) is possible in cells which are not all in one row or column, but which are in exactly one row and one column.
2. V is also possible in another cell (we'll call it A) in the same row, but outside of the box.
3. V is also possible in another cell (we'll call it B) in the same column, but outside of the box.
4. V is also possible in the cell in the same column as A and the same row as B (we'll call this cell C).
5. If cells A and C are locked, then V can be eliminated as a possibility from cell B.
6. If cells B and C are locked, then V can be eliminated as a possibility from cell A.

How to find them

1. Take a look at each box, one by one. Imagine drawing a line across one row of the box, and another line down one column of the box. For the sake of this discussion, we'll call these row X and column Y. Imagine moving the lines to different rows and columns of the box, but always with one line on a row and one on a column. You're looking for a value that is possible only in cells beneath both of these lines—it's no good if all of the possible cells are beneath only one of the lines.

The left diagram above shows one box from a puzzle. The values 1, 8, and 9 are all possible only in cells of one row and one column. The center diagram shows lines drawn over the cells containing 1 (and also 8), and the right diagram shows lines drawn over the cells containing 9. But none of the other possible values work: 2 appears only in column three, 4 appears in two rows and two columns, and 7 appears in two rows and three columns.

2. Now look across row X outside of the box for another cell in which the value appears. This will be the cell A described in the definition.
3. In the same column as cell A, see if there is exactly one other cell in which the value is possible. This will be the cell C described in the definition.

4. In the row that contains cell C, see if the value is also possible in column Y. If so, this is cell B, and you can remove the value as a possibility from this cell.

5. If cell B and C are locked in their row, you can also remove the value as a possibility from cell A.

6. If you cannot construct the rectangle by starting with the row, try building it in the opposite direction. Start by looking for cell A elsewhere in column Y. Look for exactly one other cell in A’s row that contains V (this is cell C), and then look for cell B in row X of the same column as C.

Highlighting the value you’re looking for helps in finding the rectangle.

The diagram below shows rows one through six and columns one through six of a puzzle in which the 5’s have been highlighted. Two solid lines have been drawn in box one over all the cells that might be 5, and have been extended to the edges of the puzzle. These lines mark row X (two) and column Y (one). Now let’s locate the rest of the rectangle—the lines may help you visualize this.

![Sudoku Diagram]

1. Look across row two for another cell in which 5 is possible. This is our cell A, labeled as such in the diagram.

2. Now look down the same column as cell A for another cell in which 5 is possible. We’re hoping that there will only be one such cell, and in this puzzle there is: this is our cell C.

3. Now we look in column one of the row that contains C and find that 5 is possible there.

We have now built a rectangle using row two and column one of the puzzle. The key to this pattern is that cells A and C are locked. The logic below shows how this fact allows us to eliminate 5 as a possibility from cell B:

- If cell B were 5, then cell C would not be 5, because C is in the same row as B.
- But C and A are locked, so if cell C is not 5, then cell A must be 5.
- In that case, all of the cells in box one that can be 5 are covered by either A or B, so 5 cannot appear anywhere in the box. This is clearly impossible.
- Therefore, cell B cannot be 5.
In this example, cells B and C are not locked (due to cell 6,5) so the argument does not work in reverse (if cell A is 5, the C cannot be 5, but this does not force B to be 5: cell 6,5 might be 5 instead).

If B and C were locked, however, the argument would work in reverse, and we could eliminate 5 as a possibility from cell A. This will be illustrated in one of the examples below.

Example 1

This example shows a rectangle elimination on the value 7 starting with box one. Only the first six rows and columns of the puzzle are shown:

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th>3</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>6</td>
<td>6</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>5</td>
<td>6</td>
<td>6</td>
<td>8</td>
<td>5</td>
</tr>
<tr>
<td>8</td>
<td>4</td>
<td>5</td>
<td>7</td>
<td>3</td>
</tr>
<tr>
<td>5</td>
<td>6</td>
<td>9</td>
<td>8</td>
<td>2</td>
</tr>
<tr>
<td>2</td>
<td>3</td>
<td>1</td>
<td>5</td>
<td>4</td>
</tr>
<tr>
<td>7</td>
<td>6</td>
<td>7</td>
<td>7</td>
<td>9</td>
</tr>
</tbody>
</table>

In box one, the value 7 is possible only in row two and column one. Looking across row two, we find cell 2,6 has 7 as a possibility, and there is only one other cell in this column that also can be 7: cell 6,6. The rectangle is completed by cell 6,1 in which 7 is also possible.

We can remove 7 as a possibility from cell 6,1. Here is a recap on the logic behind this move:

- If cell 6,1 were 7, then cell 6,6 could not be 7 because they are in the same row.
- If cell 6,6 is not 7 then cell 2,6 must be 7 because it is the only other cell in column six that can be 7.
- So if cell 6,1 is 7, then cell 2,6 must also be 7. But that leaves no cells in box one which can be 7. This is impossible: box one must contain a 7 somewhere.
- Our original assumption that cell 6,1 was 7 led to a contradiction, so the assumption must be incorrect: cell 6,1 cannot be 7.

Example 2
In box one, the value 7 appears in only two cells. This means that we can look for a rectangle elimination in two different ways.

Let's look for row two and column one. Looking across row two, we find cell 2,6 which is locked with cell 5,6. Cell 5,1 completes the rectangle. Briefly, the logic behind removing 7 as a possibility from cell 5,1 is:

- If cell 5,1 is 7, then cell 5,6 cannot be 7, so cell 2,6 must be 7.
- But if cells 5,1 and 2,6 are 7, then no cells in box one can be 7. This is impossible, so cell 5,1 cannot be 7.

But the astute reader will notice that the cells in box one that can be 7 are also in row three and column three. Indeed, in this particular puzzle we can construct another rectangle in this manner:

- In row three, we find cell 3,8 which is locked with cell 6,8.
- Cell 6,3 completes the rectangle, allowing us to also remove 7 as a possibility from cell 6,3.

Whenever you find a rectangle elimination in which only two cells in a box might be some value, always try to construct two rectangles from it.

**Example 3**
The value 6 appears in box two only in row two and column 6. We construct the rectangle starting with row two, and find cell 2,7 which is locked with cell 6,7. Cell 6,6 completes the rectangle, so we can remove 6 as a possibility from cell 6,6.

But notice that cells 6,6 and 6,7 are also locked on the value 6. That lets us apply our usual logic in the opposite direction around the rectangle:

- If cell 2,7 is 6, then cell 6,7 cannot be 6.
- But then cell 6,6 must be 6 (because 6,6 and 6,7 are locked).
- Cells 2,7 and 6,6 together make 6 impossible in box two.
- This cannot happen, so cell 2,7 must not be 6.

The logic is the same, but it is being applied starting with the first box of the rectangle. This is possible only because cells 6,6 and 6,7 (our B and C cells) are also locked.

### 4.3.2 Locked Cell Cycle (type 1)

**Overview**

When you have a chain of cells, each locked with both of its neighbors on different values, you have a **type 1 locked cell cycle**. The values on which the cells are locked allow you to remove other possibilities from the cells in the cycle.

**Related to:** Pairs chain, locked cell cycle (type 2), pairs cycle
**Frequency:** Uncommon (1 in 55 puzzles, or 1.9%)

**Also known as:** nonrepetitive bilocation cycles

**Definition**

1. There must be a chain of cells such that the first is locked with the second on some value. For convenience, we'll call this value V.
2. The second cell must be locked with the third on some value other than V, which we'll call W.
3. The third must be locked with the next cell on some value other than W.
4. This continues with more cells, each locked with its successor on a different value than it is locked with its predecessor, until we reach a cell that is locked with the original cell in the series on some value other than V.
5. From each cell in the chain, remove all possibilities other than the ones with which it is locked with its neighbors.

**How to find them**

1. Look for a cell with at least two possibilities. For convenience, we'll call this cell S.
2. Look for another cell locked with cell S on one of its possibilities. For convenience, we'll call this value V.
3. Look for a third cell locked with the previous cell on some value other than the one with which the previous cell is locked with its predecessor.
4. Each time you add a cell to the chain, see if the new cell is locked with the starting cell, S, on some value other than V.

**Example 1**

Consider this example (only the first three rows are shown):

```
<table>
<thead>
<tr>
<th>4</th>
<th>1</th>
<th>7</th>
<th>9</th>
<th>7</th>
<th>6</th>
<th>3</th>
<th>3</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>8</td>
<td>8</td>
<td>9</td>
<td>5</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>6</td>
</tr>
<tr>
<td>2</td>
<td>5</td>
<td>1</td>
<td>7</td>
<td>3</td>
<td>1</td>
<td>5</td>
<td>4</td>
<td>2</td>
</tr>
</tbody>
</table>
```

Cell 1,4 is locked with cell 1,5 on the value 8; cell 1,5 is locked with cell 3,5 on the value 7, cell 3,5 is locked with cell 3,4 on the value 5, and cell 3,4 is locked with cell 1,4 on the value 1.

- Each pair of cells is locked on a different value—one or the other of those cells must be that value.
- There are four values involved in the cycle, and four cells in the cycle.
- Therefore, none of these cells can possibly be any value other than the ones on which they are locked with their neighbors.

Let's make this more concrete. We know that either cell 1,4 of 1,5 must be 8, so let's start by assuming that cell 1,4 is 8 and see where that leads us.

- If 1,4 is 8, then cell 3,4 must be 1, so 3,5 must be 5, and 1,5 must be 7.
Now let's see what happens if we assume that cell 1,5 is 8.

- If 1,5 is 8, then 3,5 must be 7, so 3,4 must be 5, and 1,4 must be 1.

Because there are only four cells and the locking involves four different values, these are the only two possible solutions for the cells in this cycle. That means cell 1,5 cannot possibly be 9.

If you're not yet convinced, suppose cell 1,5 was 9.

- 1,5 and 3,5 are locked on 7, so cell 3,5 must be 7.
- But 3,5 and 3,4 are locked on 5, so 3,4 must be 5.
- But 3,4 and 1,4 are locked on 1, so 1,4 must be 1.
- But 1,4 and 1,5 are locked on 8, so cell 1,5 must be 8.

Hmmm ... assuming that cell 1,5 is 9 means that cell 1,5 must be 8.

- This is clearly impossible, so cell 1,5 cannot be 9.

**Example 2**

In the previous example, only one cell had one extra possibility. This is not a requirement for a locked cell cycle—it is possible for many cells to have many extra possibilities. The logic remains the same however: if there are some number of cells in the cycle and they are all locked together on the same number of values, then there are only two possible answers for these cells.

Consider this puzzle (only the first six rows are shown):

```
1 2 3 4 7 6 8 5 1 2 3 3 4 7 6 8 5 1 2 3
5 1 2 1 3 4 5 1 3 6 9 1 2 3 4 9 6 9 8 1 3 4
2 5 1 3 6 9 4 6 9 8 1 3 4 6 9 8 1 3 4
3 5 4 1 2 3 4 6 9 1 2 3 4 6 9 8 1 3 4
2 1 4 3 6 9 8 7 4 1 3 4 5 3 9
```

Cell 2,2 is locked with 2,4 on 3; 2,4 is locked with 2,5 on 4; 2,5 is locked with 4,5 on 1; 4,5 is locked with 4,2 on 9; 4,2 is locked with 5,2 on 4; and 5,2 is locked with 2,2 on 8. There are only two possible outcomes for this cycle:

1. 3-4-1-9-4-8
2. 8-3-4-1-9-4

Therefore, the extra possibilities in cells 2,2; 2,4; 2,5; and 4,5 can be deleted.
**Pairs cycle**

A type one locked cell cycle in which none of the cells have any extra possibilities seems useless—there are no extra possibilities to delete. However, this is not the case, and the pattern is explained along with pairs chains.

### 4.3.3 Locked Cell Cycle (type 2)

**Overview**

When you have a chain of cells, and every cell except for the first is locked with its neighbors on two different values, but the first cell is locked with the second cell and the last cell on the same value, you have a **type 2 locked cell cycle**. The first cell in the chain must be the value on which it is locked with both of its neighbors.

**Related to:** Pairs chain, locked cell cycle (type 1)

**Frequency:** Uncommon (1 in 13 puzzles, or 8%)

**Also known as:** repetitive bilocation cycles

**Definition**

1. There must be a chain of cells such that the first is locked with the second on some value. For convenience, we'll call this value V.
2. The second cell must be locked with the third on some value other than V, which we'll call W.
3. The third must be locked with the next on some value other than W.
4. This continues with more cells, each locked with its predecessor and with its successor on different values, until we reach a cell that is locked with the original cell in the chain on V.

**How to find them**

1. Look for a cell with at least two possibilities. For convenience, we'll call this cell S.
2. Look for another cell locked with cell S on one of its possibilities. For convenience, we'll call this value V.
3. Look for a third cell locked with the previous cell on some value other than the one with which the previous cell is locked with its predecessor.
4. Each time you add a cell to the chain, see if the new cell is locked with the starting cell, S, on V.

**Example 1**

Let's take a look at an example (only rows one through six are shown):
Cell 5,1 is locked with cell 1,1 on 6; cell 1,1 is locked with 1,3 on 9; cell 1,3 is locked with 6,3 on 5; and cell 6,3 is locked with 5,1 on 6.

The difference between a type 1 cycle and this type 2 cycle is the first cell in the chain: it is locked with each of its neighbors with the same value. The logic for solving this clue is therefore different, and works like this:

- If cell 5,1 is not 6, then cells 1,1 and 6,3 must both be 6.
- If cell 1,1 is 6, then 1,3 must be 9.
- If cell 6,3 is 6, then 1,3 must be 5.
- Cell 1,3 cannot be two different values.
- Therefore, cell 5,1 must be 6.

Once we have reached this conclusion, there are lots of possibilities for the remaining cells in the cycle. Cells 5,1; 1,1; 1,3; and 6,3 could be 6-5-9-5; 6-8-9-5; 6-9-6-5; 6-9-8-5; or 6-9-5-8. There is no way to know, so a type 2 locked cell cycle gives us the answer to the first cell in the cycle, but nothing more.

**Example 2**

Here is another example:
Here are the values on which the pairs of cells are locked: 2, 9 and 2, 5 on 6; 2, 5 and 2, 1 on 2; 2, 1 and 8, 1 on 5; 8, 1 and 8, 4 on 8; 8, 4 and 8, 9 on 4; 8, 9 and 2, 9 on 6. Therefore, cell 2, 9 must be 6. Here is the proof:

- If cell 2, 9 were not 6, then
  - cell 2, 5 must be 6; cell 2, 1 must be 2; and cell 8, 1 must be 5;
  - cell 8, 9 must be 6; cell 8, 4 must be 4; and cell 8, 1 must be 8.

Cell 8, 1 cannot be two different values, so the initial assumption that cell 2, 9 was not 6 must be false, therefore cell 2, 9 must be 6.

### 4.3.4 Naked Quads

**Overview**

A **naked quad** is a set of four cells in the same group whose possibilities include only the same four values. These values can be eliminated as possibilities in all other cells of the same group.

**Related to:** naked single, naked pair, naked triple

**Frequency:** Very rare (1 in 3,900 puzzles, or 0.026%)

**Definition**

1. There are exactly four possibilities involved.
2. There must be four cells in the same group that have no possibilities other than these four.

3. The values can be eliminated as possibilities from all other cells of the same group.

The wording of #2 is quite precise. What it means is that the four cells do not need to have all four values as possibilities, but only a subset of them. Of course, each cell must have at least two of the possibilities or else the cell would be a naked single. And among the four cells, each possibility must appear at least twice, or it would be a hidden single.

If the possibilities are A, B, C, and D, then all of the following arrangements of possibilities in four cells would be naked quads:

- ABCD, ABCD, ABCD, ABCD (each cell contains all four possibilities: this is the easiest to spot)
- AB, BC, CD, AD (each cell contains only two of the four possibilities: this is the minimum that you can get away with)
- ABCD, ABC, CD, ACD (dozens of other intermediate arrangements are also possible)

**How to find them**

Like naked triples, naked quads are harder to find than naked pairs because it is not necessary for each cell to have all four values as possibilities. Fortunately, though, the cells involved cannot have any other possibilities.

1. Scan the board for cells that contain two, three, or four possibilities.

2. Now look for three other cells in the group whose possibilities includes only those values. Remember to look in all groups to which the cell belongs.

Highlighting can help you find naked quads. Choose **Only** for highlighting, then use the **Shift** key to highlight 1's, 2's, 3's, and 4's. Now use **Next** to cycle through all possible combinations, while looking for groups that have exactly four highlighted cells.

**Example**

Here is one box from a puzzle:

```
  2 3 3 5
  4 5 5 9
  8 9
  8 9

This box contains a naked quad involving the values 5, 7, 8, and 9. The cells outlined in red are the ones involved in the quad. Like a naked triple, it is not necessary for each cell to contain all four values as possibilities; what is important is that each cell contains a subset of the same four values and no other values. If this is true:

- We don't know which cell will have each value, but we know that all four values will appear somewhere in these four cells.
- Because these four values will be used by the four cells in the quad, the values cannot be possible in other cells of the box.
- Therefore, 5, 7, 8, and 9 can be eliminated as possibilities all other cells in the box.
```
Unlike a naked triple, it is impossible for a naked quad to be part of two different groups at the same time. This is because the quad contains four cells, and the intersection between a line and a box is only three cells.

It is possible for a puzzle to have a naked quintuplet (or larger set). If it does, that group will also have a hidden quad, a hidden triple, a hidden pair, or a hidden single; these will be easier to spot than the naked quintuplet.

4.3.5 Hidden Quads

Overview

A hidden quad is a set of four values that can appear only in four cells of a group. These cells will have other possibilities but they are irrelevant and can be removed.

Related to: hidden singles, hidden pairs, hidden triples

Frequency: Very rare (1 in 47,000 puzzles, or 0.0021%)

Definition

1. If four values are possible only in the same four cells of a group, then these four cells must contain these values. While we don't know which cell will contain which value, we do know that each of them must contain one of the four values.

2. All other possibilities in these four cells can be eliminated.

How to find them

Hidden quads are harder to find than hidden triples, and much harder to find than hidden pairs for three reasons:

- Each cell can contain other possibilities, which "hide" the quad from view.
- Each cell need not contain all four of the values as possibilities; it might contain only two or three of them.
- There are 126 different sets of four values to consider, which makes looking for hidden quads methodically (e.g. first look for 1,2,3,4; then 1,2,3,5; then 1,2,3,6; etc.) very time-consuming.

To find them:

1. Look at one group at a time.
2. Find the cells in which each possibility appears.
3. If you can find four values that can only appear in the same four cells of the group, you've found a hidden quad regardless of what other values are possible in those cells.

Highlighting can help you find hidden quads. Choose Any for highlighting, then use the Shift key to highlight 1's, 2's, 3's, and 4's. Now use Next to cycle through all possible combinations. Look for groups that have exactly four highlighted cells, each of which contains two or more of the possibilities (if one or two of the cells contained only one of the possibilities, the other cells would form a hidden pair or a hidden triple).

Example

Consider this puzzle, of which the first three rows are shown:
Can you find the hidden quad in box three? It's not easy to find these without a lot of experience, but with some patience you can learn. Take a look now for the quad.

Did you find it? If so, fantastic! The values 4, 7, 8, and 9 can appear only in the cells outlined in the figure below:

The outlined cells are the ones involved in the quad, and the black numbers contained therein are the four possibilities. The red numbers are possibilities that can be eliminated, and here is why:

- The four cells in the quad must contain the four values that can be found nowhere else in the group (in this case, the box).
- Even though we don't know which cell will end up having each value, we do know that these four cells cannot have any other possible values.
- We can therefore eliminate all of the other possibilities in those cells.

Unlike a hidden triple, it is impossible for the cells of a hidden quad to belong to more than one group. This is because the quad contains four cells, and the intersection between a line and a box is only three cells.

It is remotely possible for a puzzle to have a hidden quintuplet (or larger set). If it does, that group will also have a naked quad, a naked triple, a naked pair, or a naked single; most of these will be easier to spot than the hidden quintuplet.

### 4.3.6 Unique Rectangles

**Overview**

Unique rectangles are unlike other strategies in that they can only be used on Sudoku puzzles which have only one solution.

While it is possible to create Sudoku puzzles with multiple solutions, they cannot be solved by logic alone: at some point you have to make an arbitrary decision that determines which solution you are heading towards. For this reason, many consider puzzles with multiple solutions to be inferior, or flawed.

With SudoKoach, you can be sure that the puzzle you're working on only has one solution. This is because
Sudoku Koach never generates puzzles with multiple solutions, and it checks puzzles that you enter to ensure that they only have one solution as well. Because of this assurance, you can freely use unique rectangles in solving puzzles in Sudoku Koach.

How about puzzles from books, newspapers, and other sources? The vast majority of them will have exactly one solution, but the only way you can be sure is to enter it into Sudoku Koach. If the puzzle has multiple solutions, you will be told about it.

**Related to:** avoidable rectangles

**Also known as:** gordonian rectangles

**Definition**

There are several different types of unique rectangles, so this definition section will describe the properties that are common to them all. We will then present each of the variations, with examples.

Consider this puzzle:

```
 4 1 2     6 1 3 7 9 5  
3 1 2 7 2 9 5 1 2 6 4
5 9 6 4 2 1 2 8 3
2 3 1 7 4 8 9 5 6
A B 5 3 2 9 4 7 1
9 7 4 5 6 1 8 3 2
1 5 2 3 4 6 2 7
7 4 2 5 6 3 1 8
C D 3 1 7 8 4 5 9
```

The outlined cells (which have been labeled A, B, C, and D) form what is called the **deadly pattern**. This pattern is "deadly" because its existence guarantees that the puzzle has two valid solutions. Here's why:

1. Two cells are in one row, while the other two cells are in another row.
2. Two cells are in one column, while the other two cells are in another column.
3. Two cells are in one box, while the other two cells are in another box.
4. Each cell can only be one of two values (which are called the **deadly values**).
There are only two ways that cells A-B-C-D can be solved: 8-6-6-8 or 6-8-8-6. In each of these cases:

- Rows five and nine will have one 6 and one 8.
- Columns one and two will have one 6 and one 8.
- Boxes four and seven will have one 6 and one 8.

Each of these two solutions is equally valid! Therefore, a puzzle with only one solution cannot contain the deadly pattern. This conclusion is the key to all of the Unique Rectangle strategies.

The cells labeled in the examples below cannot be deadly patterns because they don’t have all of the needed properties:

However, these examples are would be deadly patterns if they all contained the same pair of possibilities, and no others:
There are many ways to exploit the deadly pattern to get closer to a solution, but they all revolve around the same basic idea: you must avoid making moves which create the deadly pattern.

**How to find them**

What we describe here is how to find a potential deadly pattern, because all unique rectangle strategies start with this arrangement of cells.

1. Look for a cell with only two possibilities.
2. Look for another cell in the same row (or column, if you can't find one in the same row) with the same two possibilities (it may have additional possibilities).
3. Now find another row (or column, if that's what you did in step 2) in which the two cells in the same positions include the same two possible values (one or both might have additional possibilities).
4. Ensure that these four cells are contained in exactly two boxes.
5. Consult the descriptions that follow to see which, if any, of the unique rectangle strategies applies in this particular case. The difference is in the number of extra possibilities you've got, and how many cells in the rectangle contain extra possibilities.

### 4.3.6.1 Unique Rectangle (type 1)

**Overview**

If you see something that looks like the deadly pattern, but exactly one of the cells has one or more extra possibilities in it, you've found a type one unique rectangle.

**Related to:** avoidable rectangle (type 1)

**Frequency:** Rare (1 in 130 puzzles, or 0.75%)

**Also known as:** gordonian rectangles

**Definition**

1. A potential deadly pattern in which exactly one cell has extra possibilities will become a deadly pattern only if that cell becomes one of the deadly values.
2. Therefore, we can remove both of the deadly values as possibilities from this cell.
**How to find them**

1. First, find a potential deadly pattern.

2. Ensure that three of these cells have only the deadly values as possibilities, and one cell has one or more extra possibilities.

**Example**

Consider this puzzle (only the first three rows are shown):

```
  4  3  6  1  8  5  7  2  4  5
  4  9  5  9  4  6  1  8  1  8
  2  3  8  4  1  7  6  9  4  5
```

If cell 1,4 were either 4 or 5, then the remaining outlined cells would form a deadly pattern. Therefore, cell 1,4 cannot be either 4 or 5, so we can remove those possibilities from the cell. In this puzzle, there is only one remaining possibility in the cell so we can solve it (though this is not always the case).

Because only one cell in a type one unique rectangle has extra values, we know exactly which cell must break the deadly pattern. What we don't know is which of the other possibilities in that cell will be the correct answer (unless, of course, there is only one of them).

**4.3.6.2 Unique Rectangle (type 2)**

**Overview**

If you see something that looks like the deadly pattern, but two of the cells in the same row or column each contain the same value as an extra possibility, then you've found a type two unique rectangle.

**Related to:** avoidable rectangle (type 2)

**Frequency:** Rare (1 in 540 puzzles, or 0.18%)

**Also known as:** one-sided gordonian rectangles

**Definition**

1. A potential deadly pattern in which two cells in the same row or column have one extra possibility (and it is the same value in both cells) will become a deadly pattern only if both of these cells become one of the deadly values.

2. Therefore, we know that one or the other of these cells must become the extra possibility instead.

3. We don't know which cell this will be, but we do know that it will be one of them so we can remove this value as a possibility from all other cells that are covered by both of these cells.

**How to find them**

1. First, find a potential deadly pattern.
2. Ensure that two of the cells have only the deadly values as possibilities.

3. Ensure that the other two cells are both in the same row or column.

4. Ensure that these cells both have exactly one extra possibility, and it is the same value in both cells.

**Example 1**

Rows one through six of this puzzle contain a type two unique rectangle:

![Sudoku Puzzle](image)

In this case, cells 5,4 and 5,5 each have the same extra possibility: 9. To break the deadly pattern, one of these cells must be 9. The trouble is, we don’t know which cell it will be so we cannot simply solve the cell.

But we can get something out of this: we can eliminate 9 as a possibility in other cells. Here’s how:

1. If cell 5,4 were 9, then no other cells in row five, column four, or box five could be 9.
2. If cell 5,5 were 9, then no other cells in row five, column five, or box five could be 9.

Even though we don’t know which of these cells will be 9, we do know that one of them must, so we can eliminate 9 as a possibility from all other cells that are covered by both cell 5,4 and cell 5,5. In this example, that’s row five and box five. The unsolved cells in these groups are 4,4; 4,5; 4,6; 5,3; 6,4; and 6,6. Of these, the only ones in which 9 is possible are 4,5 and 5,3: we can eliminate 9 from both of these cells.

**Example 2**

![Sudoku Puzzle](image)

Here, the cells that contain the extra value are in different boxes. However, they are still in the same row, so there are cells that are covered by both of them. Arrangements like this are also valid type two unique
Because a type two unique rectangle has two cells with an extra value, we don't know which cell will break the deadly pattern. But there is only one extra possibility, so we know what value will be used to break the pattern. This allows us to eliminate that value as a possibility from all cells covered by both of them.

4.3.6.3 Unique Rectangle (type 3)

Overview

If you see something that looks like the deadly pattern, but two of the cells in the same row or column each contain one or two extra possibilities (but with only two extra values), and there is another cell covered by both of them whose only possibilities are the two extra values, then you've found a type three unique rectangle.

Related to: avoidable rectangle (type 3)

Frequency: Rare (1 in 590 puzzles, or .17%)

Definition

1. Consider a potential deadly pattern in which two of the cells (for convenience, we'll call them cells A and B) in the same row or column each have one or two extra possibilities, for a total of two different values (which we'll call X and Y).

2. This will become a deadly pattern only if cell A is not X or Y and cell B is not X or Y.

3. Therefore, we know that cell A must be X or Y, or cell B must be X or Y, but we don't know which.

4. If there is another cell (let's call it C) that is covered by both A and B, whose possibilities include only X and Y, then C is locked with both cells A and B.

5. If cell A or B turns out to be X, cell C must be Y; if cell A or B turns out to be Y, cell C must be X. We know that one of these cases must be true, but we don't know which.

6. In either case, both values X and Y are used, so neither can appear as possibilities in any cells covered by A, B, and C.

How to find them

1. First, find a potential deadly pattern.

2. Ensure that two of the cells have only the deadly values as possibilities.

3. Ensure that the other two cells are both in the same row or column.

4. Ensure that these cells each have exactly one or two extra possibilities, and that they are exactly two values.

5. Look for another cell in the same row, column, or box as both of these cells, whose possibilities are only the extra possibilities from the first two cells.

Example 1

Here is a type three unique rectangle (only rows one through three are shown):
Here, cells 1,7 and 2,7 each have an extra possibility (shown in green), 7 and 9, and cell 3,9 can only be 7 or 9. This would also be a type three unique rectangle if either cell 1,7 or 2,7 (or both) had both of these extra possibilities.

The rule is that there are two extra values, and two of the cells in the pattern have one or both of them as possibilities.

We are going to remove 7 and 9 as possibilities from cell 3,8. Here’s why we can do this:

- If cells 1,7 and 2,7 were 4 and 8 (or 8 and 4), then the cells outlined in red would be the deadly pattern.
- Therefore, either cell 1,7 is 9, or cell 2,7 is 7. But we don't know which.
- We do know that 7 or 9 will be used though, which will force cell 3,9 to be the other value.
- That means that both 7 and 9 will be used among these three cells, so they cannot be possibilities in any cells covered by all three of these.
- Therefore, we can remove 7 and 9 as possibilities from cell 3,8.

**Example 2**

Here is another example, of which only the first six rows are shown:

In this case, cells 5,7 and 5,9 each have an extra possibility, and they are different: 3 and 6. To break the deadly pattern, either cell 5,7 must be 3, or cell 5,9 must be 6. The trouble is, we don't know which it will be.

But cell 5,3 (outlined in green) can only be 3 or 6, so we can get something out of this. Here’s how:
1. If cell 5,7 were 3, then cell 5,3 would be 6.
2. If cell 5,9 were 6, then cell 5,3 would be 3.
3. We know that one or the other of these must be true, but we don’t know which.
4. Not knowing doesn’t matter: in both cases, the values 3 and 6 will both be used in row five.
5. Therefore, 3 and 6 cannot appear as possibilities in any other cells of row five.
In this example, we can eliminate 3 and 6 from cells 5,1; 5,2; 5,5; 5,6; and 5,8.

4.3.6.4 Unique Rectangle (type 4)

Overview

If you see something that looks like the deadly pattern, and two of the cells in the same row or column each contain one or more extra possibilities, then look at the deadly values themselves. If these two cells of the pattern are the only cells in a group that can contain one of the deadly values, you've found a type four unique rectangle.

Frequency: Rare (1 in 110 puzzles, or 0.9%)

Definition

1. A potential deadly pattern in which two cells have extra possibilities will become a deadly pattern only if both these cells are the deadly values.
2. If these two cells are the only places in the row or column (or box, if they're both in the same box) where one of the deadly values can appear, then one of these cells must be that value.
3. The other cell therefore must not be the other deadly value, or else we'd have a deadly pattern.
4. The other value can therefore be removed as a possibility from both cells.

How to find them

1. First, find a potential deadly pattern.
2. Ensure that two of the cells have only the deadly values as possibilities.
3. Ensure that the other two cells are both in the same row or column, and have extra possibilities.
4. Ensure that these two cells are the only places in the row or column (or box, if they're in the same box) where one of the deadly values can occur.

Example 1

Consider this puzzle (only the first six rows are shown):
The potential deadly pattern is outlined. Cells 2,7 and 2,9 are the only cells in row two that can be 7. This tells us that one of these cells must be 7. But if the other cell were 1, we would get a deadly pattern. Therefore, neither cell can be 1.

In this case, the cells were the only ones in their row that could contain one of the deadly values. Clearly, if the rectangle is flopped on its side, you'll be looking at the column in which these cells reside. But if they happen to lie within the same box, don't forget to look there as well. The next example illustrates this.

**Example 2**

Here is a type four unique rectangle that is flopped on its side:
In this puzzle, cells 8,7 and 9,7 are the only ones in box nine and the only ones in column seven that can contain 9. One of these cells must be 9, but if the other cell were 5 we would have a deadly pattern. Therefore, we can remove 5 as a possibility from both of them.

4.3.6.5 Unique Rectangle (type 5)

**Overview**

If you see something that looks like the deadly pattern, but two of the cells in opposite corners of the rectangle each contain just one extra possibility and they’re the same value, then you’ve found a type five unique rectangle.

**Frequency:** Very rare (1 in 300,000 puzzles, or 0.0003%)

**Definition**

1. A potential deadly pattern in which two cells in opposite corners of the rectangle (for convenience, we’ll call them A and B) each have the same, single extra possibility (which we’ll call X) will become a deadly pattern only if neither of these cells is X.

2. Therefore, either cell A must be X, or cell B must be X, but we don’t know which.

3. One of them must be X, however, so X can therefore be removed as a possibility from all cells covered by both A and B.

**How to find them**
1. First, find a potential deadly pattern.

2. Ensure that two of the cells in opposite corners of the rectangle have only the deadly values as possibilities.

3. Ensure that the other two cells are both have exactly one extra possibility, and it is the same value for both cells.

**Example**

Consider this puzzle (only the first three rows are shown):

```
3 2 1 5 4 3 6 7 4 6 9 3 8 1 3 4
```

Cells 1,1; 1,9; 3,1; and 3,9 form a potential deadly pattern, but cells 1,1 and 3,9 each have a single extra possibility: 3. This allows us to remove 3 as a possibility from cell 1,8. Here's how:

- If cells 1,1 and 3,9 were both 8 (or both 9), we would have the deadly pattern.
- Therefore, at least one of these cells must be 3, but we don't know which one.
- 3 cannot be a possibility in any cell covered by both 1,1 and 3,9, because one or the other of these must be 3.
- We can therefore remove 3 as a possibility from cell 1,8.

It is unfortunate that this strategy appears so rarely in Sudoku puzzles, as it is very easy to spot.

### 4.3.6.6 Unique Rectangle (type 6)

**Overview**

If you see something that looks like the deadly pattern, but the cells in opposite corners each have one or more extra possibilities, and two of the cells in the same row or column are locked on one of the deadly values, you've found a **type six unique rectangle**.

**Frequency:** Uncommon (1 in 75 puzzles, or 1.4%)

**Definition**

1. A potential deadly pattern with corners A, B, C, and D, in which cells A and C (in opposite corners of the rectangle) each have one or more extra possibilities, will become a deadly pattern if cells A and C both become one of the deadly values. This must be avoided.

2. If cells B and C are locked on one of the deadly values V, then cell A cannot have V as a possibility. For if cell A were V, cell B could not be V, which would force cell C to be V, producing the deadly pattern.

3. If cells D and C are locked on one of the deadly values V, then cell A cannot have V as a possibility. For if
cell A were V, cell D could not be V, which would force cell C to be V, producing the deadly pattern.

4. If cells D and A are locked on one of the deadly values V, then cell C cannot have V as a possibility. For if cell C were V, cell D could not be V, which would force cell A to be V, producing the deadly pattern.

5. If cells B and A are locked on one of the deadly values V, then cell C cannot have V as a possibility. For if cell C were V, cell B could not be V, which would force cell A to be V, producing the deadly pattern.

6. The same reasoning holds for the other deadly value.

The assignment of A, B, C, and D to the cells can begin at any corner, and go either clockwise or counter-clockwise around the rectangle.

**How to find them**

1. First, find a potential deadly pattern, with two cells in opposite corners having only the deadly values as possibilities.

2. Ensure that the other two cells each have one or more extra possibilities.

3. If either of the cells with an extra possibility (call it A) is locked with its neighbor on one of the deadly values, then that value can be removed as a possibility from the cell in the opposite corner from A.

4. There are four locking relationships to check for each of the two deadly values.

There is a lot of checking to do with this strategy, and it is important to check everything as soon as the pattern is discovered. The reason for this is that the pattern is destroyed once you delete the first possibility, so it is helpful to know all of the possibilities that can be deleted before you begin to actually get rid of them.

**Example 1**

Here is a simple example:
The outlined cells would be a deadly pattern if cells 1,8 and 4,9 were both 3 or 4. Instead of looking for which extra possibilities these cells ought to be, this strategy looks for which of the deadly values that these cells cannot be. We can remove 3 as a possibility from cell 1,8. Here's why:

- If cell 1,8 is 3, then cell 1,9 cannot be 3.
- But cells 1,9 and 4,9 are locked on the value 3, so if cell 1,9 is not 3, cell 4,9 must be 3.
- Setting cell 1,8 to 3 forces cell 4,9 to be 3. But if these cells are both 3, then we have the deadly pattern.
- Therefore, we can remove 3 as a possibility from cell 1,8.

It is also true that cells 4,8 and 4,9 are locked on the value 3. But all this shows us is that cell 1,8 cannot be 3, which we already know.

**Example 2**

Here is an example where we get more results:
In this puzzle, each cell is locked with both of its neighbors on the value 2. We can therefore show that setting cell 2,4 to 2 forces cell 5,6 to become 2, and setting cell 5,6 to 2 forces cell 2,4 to become 2. Therefore, we can delete 2 as a possibility from each of them.

Here is the logic one more time:

- If cell 2,4 is 2, then cell 2,6 cannot be 2.
- But cell 2,6 is locked with cell 5,6 on 2, so this forces cell 5,6 to be 2.
- That gives us a deadly pattern, so cell 2,4 cannot be 2.
- Similarly, if cell 5,6 were 2, then cell 5,4 could not be 2.
- But cell 5,4 is locked with cell 2,4 on the value 2, so this forces cell 2,4 to become 2.
- That would also give us a deadly pattern, so cell 5,6 cannot be 2.

Note that the deletion of either one of these possibilities breaks the deadly pattern. This is why it is important to look for all of the locking relationships before deleting anything.

You might be thinking, "Once I delete one of these possibilities, doesn't that render the logic for deleting the other one invalid? After all, the rationale for deleting the second value is that it is forced by setting the first one, and the first one isn't there any longer."

This is a good question, but it is easy to answer.

- Before you delete any values, the logic clearly shows that both of them can be deleted.
- Once you delete one of them, the logic justifying the deletion of the other value disappears.
However, the only way that deleting the other value would be wrong is if that value were the answer for its cell.

Setting that cell to this value would prevent its neighbor from becoming that value, but would then force the opposite corner to become the value.

That cannot happen, because that was the first value we deleted.

Therefore, in situations like this, either both corners must be the value, or neither corner is the value.

We know both corners cannot be the value (because this would produce the deadly pattern), so neither corner can be the value, meaning it is OK to delete both possibilities.

**Example 3**

Here is one last example:

In this case, many cells in the rectangle are locked:

- cells 6,4 and 6,5 are locked on 5, so we can remove 5 from cell 7,5;
- cells 6,5 and 7,5 are locked on 5, so we can remove 5 from cell 6,4; and
- cells 7,4 and 7,5 are locked on 9, so we can remove 9 from cell 6,4.

This is marvelous!
4.3.7 Avoidable Rectangles

Overview

The unique rectangle strategies are all based upon the deadly pattern. However, if one of the cells that might have formed a deadly pattern has already been solved, then the pattern is gone. Avoidable rectangles are very similar to unique rectangles, except that two or three of the cells in the deadly pattern have already been solved.

Unlike all other strategies, these ones depend upon cells that have already been solved.

Related to: unique rectangles

Definition

There are several different types of avoidable rectangles, so this definition section will describe the properties that are common to them all. We will then present each of the variations, with examples.

NOTE: Avoidable rectangles depend upon distinguishing cells we have solved from cells that were given initially. It will be easier to apply these strategies if you choose to indicate which cells you've solved, and choose not to hide solved cells. Both of these choices are made in the Edit>Preferences>Cells menu.

To understand avoidable rectangles, we must look at Sudoku through the eyes of the puzzle designer. The first step in creating a Sudoku puzzle is to construct a solution. The next step is to choose cells that will be blank initially.

Consider this solution:

The outlined cells occupy two rows, two columns, and two boxes, and they contain the same two values.
This is a perfectly good solution to this puzzle, but if the 2's and 3's were reversed, we would get another perfectly good solution.

**In order to prevent having two solutions, the puzzle designer must give one or more of these cells as initial values in the puzzle.** This fact is the key to avoidable rectangles.

Now consider this partially solved puzzle (only the first three rows are shown):

```
1 4 6
2 8 3
9 7 5
```

If we place an 8 in the cell labeled B we will get what is called the **avoidable pattern**. This is four cells in two rows, two columns, and two boxes, sharing two values (which are still called the **deadly values**), none of which was given as an initial value. Why must this pattern be avoided? Because otherwise the solution will be wrong! Let’s see why.

If we solved cells A-B-C-D as 4-8-8-4, then we could also solve them 8-4-4-8 and both solutions would be equally good. By "equally good", we mean that either both solutions are correct, or both are wrong.

If the correct solution were 4-8-8-4 (or 8-4-4-8), the puzzle designer would have given us one of these cells as an initial value. None of them were given initially, though, so we know that they cannot contain the avoidable pattern. Therefore, both 4-8-8-4 and 8-4-4-8 are wrong. The only other possibility is for cell B to be 6.

Did you see the crucial difference between these two examples?

- In the first, a puzzle solution contains the rectangle, but the designer will give us one or more of these cells as initial values to the puzzle. This establishes one of the two potential solutions as the correct one for this puzzle, and makes it impossible for the avoidable pattern to occur.

- In the second, we have a rectangle of cells, none of which were given as initial values. If we could solve them as 4-8-8-4, then we could also solve them as 8-4-4-8, and both solutions would be equally good (either way, each row has a 4 and an 8; each column has a 4 and an 8; and each box has a 4 and an 8). If the puzzle has only one solution, 4-8-8-4 and 8-4-4-8 must both be wrong. Therefore, cell B cannot be 8.

If we had solved the cells in this puzzle in a different order, we might have ended up with a deadly pattern in the outlined cells and the unique rectangle strategies would apply. The fact that three of these cells are solved prevents us from using them now. But it doesn’t change the fact that the fourth cell cannot be a value that would lead to multiple solutions.

If one or more of the indicated cells were given as initial values, this would not be an avoidable pattern, and cell 2,7 could be either 6 or 8. The fact that all four were initially blank is what allows us to deduce that those cells must contain more than just two values.

**How to find them**

1. Find a solved cell.
2. Look in the same row for another solved cell.
3. Look in another row at the cells in the same two columns.
4. Ensure that all four cells are in exactly two boxes.

5. Consult the descriptions that follow to see which, if any, of the avoidable rectangle strategies applies in this particular case. The difference is in the number of cells that are solved and the number of extra possibilities involved.

### 4.3.7.1 Avoidable Rectangle (type 1)

#### Overview

If you see something that looks like the avoidable pattern, but three of the cells have been solved by the player and the fourth cell has one or more extra possibilities in it, you've found a **type one avoidable rectangle**.

**Related to:** unique rectangle (type 1)

**Frequency:** Very rare (1 in 3,800 puzzles, or 0.026%)

#### Definition

1. A potential avoidable pattern in which three of the cells have been solved by the player, and the fourth cell has one of the deadly values as a possibility, will become the avoidable pattern only if that cell becomes the deadly value.

2. Therefore, we can remove the deadly value as a possibility from this cell.

#### How to find them

1. First, find a potential avoidable pattern.

2. Ensure that three of these cells are solved, and one of the possibilities for the last cell is the value of the opposite cell.

#### Example 1

Consider this puzzle (only the first three rows are shown):

```
8 6 1 3 5 9 2 4 7
5 7 9 2 4 3 1 6
2 3 4 6 7 9 5 8 8
```

The brown numbers are cells that have been solved by the player, so if cell 3,4 were 6 we would have an avoidable pattern. The puzzle would have two equally good solutions. They must both be wrong, however, because the puzzle has only one solution. Therefore, cell 3,4 cannot be 6, and we can remove this as a possibility from the cell.

Because only one cell in a type one avoidable rectangle has extra values, we know exactly which cell must break the avoidable pattern. What we don't know is which of the other possibilities will be the correct answer (unless, of course, there is only one of them).
Example 2

Here is another example (only the first three rows are shown):

Example 2  

In this puzzle, setting cell 2,7 to 8 would produce the avoidable pattern. Therefore, the cell cannot be 8. In this case, the only other possibility is 6, so that must be the answer.

4.3.7.2  Avoidable Rectangle (type 2)

Overview

If you see something that looks like the avoidable pattern, but two of the cells in the same row or column each contain the same value as an extra possibility, then you've found a type two avoidable rectangle.

Related to: unique rectangle (type 2)

Frequency: Very rare (1 in 52,000 puzzles, or 0.002%)

Definition

1. A potential avoidable pattern in which two cells in the same row or column are solved and the other two cells have one extra possibility (and it is the same value in both cells) will become an avoidable pattern only if both of these cells become one of the deadly values.

2. Therefore, we know that one or the other of these cells must become the extra possibility instead.

3. We don't know which cell this will be, but we do know that it will be one of them so we can remove this value as a possibility from all other cells that are covered by both of these cells.

How to find them

1. First, find a potential avoidable pattern.

2. Ensure that two of the cells are solved.

3. Ensure that the other two cells are both in the same row or column.

4. Ensure that these cells both have exactly two possibilities, and one of them is the value of the cell in the opposite corner of the pattern.

5. Ensure that the other possibility is the same value in both cells.

Example

Only the first six rows of this puzzle are shown:
These four cells will become the avoidable pattern only if cell 2,1 is 4 and cell 2,2 is 6. We know, therefore, that one of these cells must be the other value, 2. We don’t know which cell it will be, but it must be one of them.

Therefore, 2 can be removed from all cells covered by these two. That includes cells 2,4; 2,9; and 3,3.

4.3.7.3 Avoidable Rectangle (type 3)

Overview

If you see something that looks like the avoidable pattern with two cells solved, but two of the cells in the same row or column each contain one extra possibility (and the possibilities are different), and there is another cell covered by both of them whose only possibilities are the two extra values, then you’ve found a type three avoidable rectangle.

Related to: unique rectangle (type 3)

Frequency: Very rare (1 in 38,000 puzzles, or 0.003%)

Definition

1. Consider a potential avoidable pattern containing cells that we’ll call A, B, C, and D, where A is in the opposite corner from C, and B is in the opposite corner from D.

2. Cells A and B are solved.

3. Cells C and D each have at least one extra possibility, and between them there are exactly two extra possibilities (which we’ll call X and Y). Either C has X and D has Y, one of them has X and the other has both X and Y, or both of them have X and Y.

4. This will become an avoidable pattern only if cell C is the same value as A, and cell D is the same value as B.

5. Therefore, we know that cell C must be X or Y, or cell D must be X or Y, but we don't know which.

6. If there is another cell (let’s call it E) that is covered by both C and D, and whose possibilities include only X and Y, then E is locked with both cells C and D.

7. If either cell C or D turns out to be X, cell E must be Y; if either cell C or D turns out to be Y, cell E must
be X. We know that one of these cases must be true, but we don't know which.

8. In either case, both values X and Y are used, so neither can appear as possibilities in any cells covered by C, D, and E.

**How to find them**

1. First, find a potential avoidable pattern.

2. Ensure that two of the cells in the same row or column are solved.

3. Ensure that each of the other two cells has at least one extra possibility.

4. Ensure that the extra possibilities in the other two cells are exactly two values, regardless of how they are distributed among those cells.

5. Look for another cell in the same row, column, or box as both of the cells in step 3, whose possibilities are only the extra two from step 4.

**Example**

Consider this puzzle (only the first three rows are shown):

```
4 6 5 3 2 1 2 3 4
7 8 3 1 2 4 8 7 6
9 2 7 1 6 3 4 5 9
```

The cells in the potential avoidable rectangle are outlined in red.

- If cell 1,1 were 7 and cell 2,1 were 5, we would have the avoidable pattern. Therefore, either cell 1,1 is 4 or 9, or cell 2,1 is 9 (we don't know which).
- But we do know that one of these cells or the other will be a 4 or a 9.
- That will force cell 1,2 (outlined in green) to be the other value.
- Between cells 1,1; 1,2; and 2,1; the values 4 and 9 will both be used.
- Therefore, 4 and 9 can be removed from all cells covered by 1,1; 1,2; and 2,1 (in this example, it turns out that only 4 can be removed).

### 4.3.8 Swordfish

**Overview**

A **swordfish** is an arrangement of cells in three rows and three columns (from six to nine cells in all). Each of these cells must be the only ones in their respective rows (or, their respective columns) in which a specific value is possible. All of the other cells in the same columns of other rows (or, the same rows of other columns) can be eliminated.

**Related to:** x-wing, turbofish
**Frequency:** Rare (1 in 300 puzzles, or 0.33%)

**Definition**

There are two ways a swordfish can occur. The first way looks at rows:

1. There are three rows in which a particular value can only appear in either two or three columns.
2. Among the three rows, only the same three columns are involved.
3. The value can be removed as a possibility from these columns in all other rows.

The second way looks at columns:

1. There are three columns in which a particular value can only appear in either two or three rows.
2. Among the three columns, only three rows are involved.
3. The value can be removed as a possibility from these rows in all other columns.

**How to find them**

1. Start with row one.
2. Look for a value that only appears in only two or three columns.
3. Look for two other rows in which the value also appears in two or three columns, and they are all in the same three columns.
4. If that fails, repeat these steps with the next row.
5. After you've done all the rows, repeat these steps with all of the columns.

As with X-wings, highlighting the value you're looking at helps in finding them.

**Example 1**

The "either two or three" part of definition 1 is what makes swordfish patterns harder to find than x-wings. Consider this puzzle, which illustrates a swordfish that is fairly easy to spot because it has almost all of the nine possible cells. The 2's have been highlighted to make the pattern stand out more clearly:
This swordfish involves rows two, six, and seven. The value 2 can only appear in columns four, seven, and nine of these rows. We can safely remove 2 as a possibility from cells 1,4; 5,4; and 5,7. Here is the justification:

- In rows two, six, and seven, the value 2 can appear only in columns four, seven, and nine.
- There must be a 2 in each of these rows.
- This means that in columns four, seven, and nine, the value 2 must appear in one of the outlined cells.
- Therefore, 2 cannot appear anywhere else in these columns.

**Example 2**

A "complete" swordfish will involve nine cells. This is most unusual. It is more common for some (or even all) of the rows to have only two cells in which the value appears. However, there must be exactly three columns involved in the three rows.

Here is a more typical swordfish:
In this puzzle, the swordfish is flopped on its side, and involves columns one, two, and six. In these columns, the value 4 is possible only in rows three, four, and nine, even though two of these columns only have possibilities in two of these rows. When looking for a swordfish, you must keep in mind that you can't ignore a row (or column) in which a value can appear in only two places.

The logic that justifies eliminating 4 as a possibility from other columns of rows three, four, and nine (the possibilities shown in red above) is not changed by the fact that there are only seven cells involved. Nevertheless, we will repeat the explanation because this particular swordfish is flopped on its side:

- In columns one, two, and six, the value 4 can appear only in rows three, four, and nine. In fact, two of the columns only have appearances of the value 4 in two of these rows, but that doesn’t matter.

- The important thing is that the value 4 cannot appear anywhere else in these columns. This means that each column must have a 4 in one of its outlined cells.

- This means that in rows three, four, and nine the value 4 must appear in one of the outlined cells.

- Therefore, 4 cannot appear anywhere else in these rows.

- We can omit 4 as a possibility from cells 9,3 and 9,4.

4.3.9 Turbofish

Overview

A turbofish is an arrangement of cells in four rows and four columns (from eight to 16 cells in all). Each of these cells must be the only ones in their respective rows (or, their respective columns) in which a specific value
is possible. All of the other cells in the same columns of other rows (or, the same rows of other columns) can be eliminated.

**Related to:** x-wing, swordfish

**Frequency:** Very rare (1 in 7,500 puzzles, or 0.014%)

**Also known as:** jelly-fish

**Definition**

There are two ways a turbofish can occur. The first way looks at rows:

1. There are four rows in which a particular value can only appear in two, three, or four columns.
2. Among the four rows, only the same four columns are involved.
3. The value can be removed as a possibility from these columns in all other rows.

The second way looks at columns:

1. There are four columns in which a particular value can only appear in two, three, or four rows.
2. Among the four columns, only the same four rows are involved.
3. The value can be removed as a possibility from these rows in all other columns.

**How to find them**

1. Start with row one.
2. Look for a value that only appears in two, three, or four columns.
3. Look for three other rows in which the same value also appears in two, three, or four columns, and all four rows share the same four columns.
4. If that fails, repeat these steps with the next row.
5. After you've done all the rows, repeat these steps with all of the columns.

As with X-wings, highlighting the value you're looking at helps in finding them.

**Example 1**

A turbofish is an extension of a swordfish to four rows and four columns, involving up to 16 cells. However, not all 16 cells are required: each row (or column) can have two, three, or four cells.

The "two, three, or four" part is what makes turbofish patterns even harder to spot than swordfish. Consider this puzzle:
This is a turbofish in rows one, three, seven, and nine. In these rows, the value 8 can appear only in columns two, four, six, and eight. Just as with a swordfish, it is not necessary for the value 8 to appear in all four columns of every row. When looking for a turbofish, you must keep in mind that you can't ignore a row (or column) in which a value can appear in only two or three places.

This turbofish allows us to remove 8 as a possibility from cells 2,4; 8,6; and 8,8. Here is the justification:

- In rows one, three, seven, and nine, the value 8 can only appear in columns two, four, six, and eight. In fact, each row only has appearances of the value 8 in some of these columns, but that doesn't matter.

- The important thing is that the value 8 cannot appear anywhere else in these rows. So each row must have a 8 in one of its outlined cells.

- Because there are four rows and four columns involved, the value 8 must appear in columns two, four, six, and eight in one of the outlined cells.

- Therefore, 8 cannot appear anywhere else in these columns.

**Example 2**

If the turbofish is flopped on its side, similar logic applies. Here is an example:

```
 9 3 2 1 6
| 4 | 5 | 7 | 8 |
 7 | 8 | 3 | 5 |
 3 | 8 | 7 | 5 |
 5 | 1 | 4 | 3 |
 7 | 8 | 2 | 1 |
 4 | 6 | 9 | 6 |
 6 | 5 | 3 | 7 |
```

This is the puzzle grid with outlined cells where the turbofish applies.
This is a turbofish in columns two, six, seven, and nine. In these columns, the value 5 can appear only in rows three, four, eight, and nine. This turbofish allows us to remove 5 as a possibility from cells 3, 4 and 9, 8. Here is the justification:

- In columns two, six, seven, and nine, the value 5 can only appear in rows three, four, eight, and nine. In fact, each column only has appearances of the value 5 in some of these rows, but that doesn't matter.
- The important thing is that the value 5 cannot appear anywhere else in these columns. So each column must have a 5 in one of its outlined cells.
- This means that the value 5 must appear in rows three, four, eight, and nine in one of the outlined cells.
- Therefore, 5 cannot appear anywhere else in these rows.

4.3.10 XY-Wing Chain

Overview

An xy-wing has two pincers that are covered by a single pivot. The xy-wing chain is a closely related pattern in which the two pincers are connected by a chain of cells which act as the pivot. The result is the same: you can eliminate a value as a possibility from all cells covered by both pincers.

Related to: xy-wing

Frequency: Rare (1 in 600 puzzles, or 0.16%)

Definition
1. There are exactly three possibilities involved. For convenience, we will call them A, B, and C.

2. There are two cells called **pincers**. Each must have exactly two possibilities. One of the pincers must have A and C as possibilities, and the other must have B and C.

3. There is a cell containing A and B as possibilities that covers the first pincer. This is the beginning of the **pivot chain**. This cell covers another cell that also contains only A and B as possibilities. In turn, this cell covers another such cell, and so forth. The last cell in the pivot chain covers the second pincer.

4. The pivot chain has an odd number of cells in it (this is important!).

5. The value C can be removed as a possibility in all cells that are covered by both of the pincers.

**How to find them**

An xy-wing chain is suggested when you have several cells in the puzzle that all contain exactly the same two values.

1. Look for cells that contain two possibilities (which we will call A and B): each is potentially the beginning of the pivot chain.

2. Then look for a covered cell that two possibilities: this will be your first pincer. It must contain one of the possibilities (say, A) plus another possibility we will call C.

3. Now we'll build the pivot chain. Look for a cell covered by the first one that contains exactly the same two values.

4. Repeat this process until you have an odd number of cells in the pivot chain.

5. Look for a cell covered by the last cell in the pivot chain: it will be your second pincer. It must have exactly two possibilities: B and C.

6. If you can't find a second pincer, see if you can extend the pivot chain so you can look for another pincer elsewhere in the puzzle.

7. If that doesn't work, see if you can construct a pivot chain that goes in a different direction.

8. If that doesn't work, start over and look for another cell to begin with.

**Example 1**

An xy-wing chain works exactly like an xy-wing. The only difference is that the pivot is replaced by a pivot chain. Here is why the pivot chain works just as well as a single pivot:

- All the cells in the pivot chain have exactly the same two possibilities.

- Because each cell in the chain covers the next one and has exactly the same two possibilities, if one cell in the chain takes on a certain value, it forces the next cell in the chain to have the other value.

- Because there are an odd number of cells in the chain, assuming a particular value for the first cell forces the last cell in the chain to have the same value.

The logic in an xy-wing had two steps that assumed the pivot was one value, then the other value. This also works with an xy-wing chain: if one end of the pivot chain has a particular value, the other end of the chain must also have the same value. Therefore, both pincers are covered by cells which must have the same value.

Note that the pivot chain forms a bunch of naked pairs. Don't forget to eliminate A and B as possibilities from all other cells in the appropriate groups.

Time for our example. Only rows one through six of this puzzle are shown:
The pivot chain is outlined in green. For your convenience, green lines are used to show how the cells in the chain are connected to each other and to the pincers. The pivot chain cells all contain only the possibilities 4 and 8.

The pincers (outlined in red) are cells 3,2 and 5,8; these contains the possibilities 1 & 8, and 1 & 4.

The pattern allows us to remove the possibility 1 from cell 5,2. Here is the reasoning behind this move:

- The properties of the pivot chain guarantee that the cells on both ends of the chain will have the same value. To see why, suppose that one end of the pivot chain (cell 3,9) is 4. This forces cell 2,7 to be 8 (because they are in the same box), which means that cell 6,7 (the other end of the pivot chain) must also be 4 (because they are in the same column). Likewise, if one end of the pivot chain is 8, the other end must also be 8.
- In this example, either both ends of the pivot chain are 4, or they are both 8.
- If the ends of the pivot chain are 4, then cell 5,8 cannot be 4 because they are in the same box. So if the ends of the pivot chain are 4, cell 5,8 must be 1.
- If the ends of the pivot chain are 8, then cell 3,2 cannot be 8 because they are in the same row. So if the ends of the pivot chain are 8, cell 3,2 must be 1.
- No matter which value the ends of the pivot chain have, one of the pincers will have the value 1. Therefore, 1 can be removed as a possibility in all cells that are covered by both pivots.

In this case, only one cell is covered by the two pincers, so we can remove possibility 1 from cell 5,2.

**Example 2**

This example shows a longer pivot chain (only the first six rows are shown):

![Sudoku Puzzle](image-url)
The ends of the pivot chain will both be either 2 or 3. Each of these values forces one of the pincers to be 9, so we can remove 9 as a possibility from all cells covered by both pincers. In this case, cells 4,6 and 5,3 are affected.

4.3.11 XYZ-Wing

Overview

An xyz-wing is a pattern of three cells which have a useful property: one of the three is guaranteed to be a certain value. This value can therefore be eliminated from any cells that are covered by all three cells in the pattern.

Related to: xy-wing

Frequency: Uncommon (1 in 50 puzzles, or 2%)

Definition

1. There are exactly three possibilities involved. For convenience, we will call them A, B, and C.

2. The first cell is called the pivot. Its possibilities must be A, B, and C. No others are allowed.

3. The second and third cells are called the pincers. Each must be covered by the pivot, and each must have exactly two possibilities. One of the pincers must have A and C as possibilities, and the other must have B and C.

4. The value C can be removed as a possibility in all cells that are covered by the pivot and both of the pincers.

How to find them

1. Start by looking for cells with exactly three possibilities. These are the potential pivots.

2. Then look for a cell that is covered by the pivot and contains two of the three values. This is the first pincer.

3. Look for another cell covered by the pivot and contains a different two of the three values. This is the
4. The value that is common to all three cells can be removed from all other cells that are covered by the pivot and both pincers.

**Example 1**

Here is an example. Only rows one through three of the puzzle are shown:

![Sudoku Grid]

Cell 2,7 (outlined in green) is the pivot. It contains the possibilities 6, 7, and 8.

The pincers (outlined in red) are cells 1,7 and 2,3; these contains the possibilities 7 & 8, and 6 & 7.

The arrangement allows us to remove 7 as a possibility from cell 2,8. Here is the reasoning behind this move:

- The pivot (cell 2,7) must be 6, 7, or 8. We don't know which, but it must be one of these three values.
- If the pivot is 6, then cell 2,3 cannot be 6 because they are in the same row, so it must be 7.
- If the pivot is 8, then cell 1,7 cannot be 8 because they are in the same column, so it must be 7.
- The pivot itself might be 7.
- No matter which value the pivot has, either the pivot or one of the pincers will have the value 7. Therefore, 7 can be removed as a possibility in all cells that are covered by the pivot and both pincers.

Be careful to look at all of the cells covered by all three of these cells. In this case:

- Cell 2,7 covers all of the cells in row two, column seven, and box three.
- Cell 1,7 covers all of the cells in row one, column seven, and box three.
- Cell 2,3 covers all of the cells in row two, column three, and box one.

The cells covered by all three of these are 2,7; 2,8; and 2,9. Therefore, we can remove 7 as a possibility from cell 2,8.

Once again, there is no guesswork involved here. We know that the pivot must be one of three values, and we only remove the possibilities that are eliminated for all of these values.

**Example 2**

Here is another xyz-wing. Only rows one through three are shown:
The pivot is cell 1,1, and the pincers are cells 1,8 and 3,1. Once again:

- The pivot must be 3, 5, or 9.
- The pivot might be 3; if so, cell 1,8 must be 5.
- The pivot might be 9; if so, cell 3,1 must be 5.
- The pivot itself might be 5.
- One of these three cells must be 5, so we can remove the value 5 from all cells covered by all three of them.

There is only one cell covered by all three that has 5 as a possibility: cell 1,2.

### 4.3.12 Singles Chain

**Overview**

A singles chain is a sequence of cells that are all locked together on a particular value in such a way that forces either the first cell or the last cell of the chain to be that value. The value can therefore be removed as a possibility from all cells covered by both ends of the chain.

**Related to:** singles chain contradiction, weak singles chain, pairs chain

**Frequency:** Rare (1 in 200 puzzles, or 0.5%)  

**Definition**

1. The chain begins with a cell that contains a particular possibility. For convenience, we'll call this value A.
2. The cell must be in a group with exactly one other cell containing A as a possibility.
3. The second cell must be in a different group with exactly one other cell containing A as a possibility, and so forth.
4. There must be at least four cells in the chain, and an even number of cells in the chain.
5. The cells in the chain can have other possibilities; they are irrelevant.
6. The value A can be removed as a possibility from all cells covered by both ends of the chain.

**How to find them**

Singles chains are suggested when the puzzle contains a lot of groups that have exactly two cells in which a particular value is possible.

1. Find a cell that has some value as a possibility; let's call it A.
2. Find another cell covered by the first which also has A as a possibility; ensure that these are the only two cells in their group that can be A.

3. Find another cell covered by the previous cell, but which is in a different group than the next previous cell, which also has A as a possibility; ensure that the previous cell and this one are the only two cells in their group that can be A.

4. Continue building the chain in this manner. Each time the chain is an even number of cells in length, see if any of the cells covered by both ends of the chain have A as a possibility.

5. If this fails, see if you can construct the chain differently.

6. If this fails, see if you can start a chain with a different cell.

7. If this fails, try building a chain with a different value.

Singles chains are a lot easier to find if you highlight the possibility that you're looking at. When you've finished with that value, highlight the next one before continuing.

**Example 1**

Only rows one through six of this puzzle are shown, and the 7's are highlighted to help the pattern stand out:

```
 1 6 9
 7 6
 3 6
 7 3 6
 9 7 8 6
 3 6
```

The ends of the chain are outlined in red, and the rest of the chain is outlined in green. The green lines are provided for your convenience in following the chain.

This singles chain runs from cell 3,3 to cell 4,1 and lets us remove the value 7 from cells 5,3 and 6,3. Here is the reasoning behind this move:

- If cell 3,3 is 7, then cells 5,3 and 6,3 cannot be 7.
- If cell 3,3 is not 7, then cell 3,9 must be 7 because it is the only other cell in row three that can be.
- If cell 3,9 is 7, then cell 4,9 must not be 7 because it is in the same column.
- If cell 4,9 is not 7, then cell 4,1 must be 7 because it is the only other cell in row four that can be.
- If cell 4,1 is 7, then cells 5,3 and 6,3 cannot be 7.

To recap, either cell 3,3 or cell 4,1 must be 7. We don't know which, but one of them must be 7. But cells
5,3 and 6,3 are covered by both ends of the chain, so neither one can be 7—we can remove 7 from these cells.

We said that this chain began at cell 3,3 and ended at cell 4,1 but singles chains work in both directions. We could have started at the other end of the chain and achieved the same result. This property is important in singles chain contradictions.

Example 2

Here is a slightly longer singles chain on the value 1 (only rows one through six are shown):

Of the cells covered by both ends of the chain, many are solved, and only one unsolved cell (3,3) contains 1 as a possibility. Here's why we can remove this:

- Cell 2,1 might be 1.
- If cell 2,1 is not 1, then cell 2,4 must be because it is the only other cell in row two that can be.
- If cell 2,4 is 1, then cell 1,5 cannot be because they are in the same box.
- If cell 1,5 is not 1, then cell 6,5 must be because it is the only other cell in column five that can be.
- If cell 6,5 is 1, then cell 5,4 cannot be because they are in the same box.
- If cell 5,4 is not 1, then cell 5,3 must be because it is the only other cell in row five that can be.
- To recap, either cell 2,1 is 1, or cell 5,3 is 1.

We can eliminate 5 as a possibility from all cells covered by both 2,1 and 5,3. In this puzzle, only cell 3,3 is affected.

Example 3

Singles chains can be quite long, as illustrated by this puzzle:
This singles chain is on the value 9. When you highlight a value and find that there are many locked pairs of cells, see if you can construct a singles chain.

In this puzzle:

- If cell 1,8 is 9, then cell 1,5 cannot be 9.
- But if cell 1,8 is not 9, then 3,7 must be 9 and 5,7 cannot be 9.
- This means that cell 5,1 must be 9 and cell 4,2 cannot be 9.
- This forces cell 4,6 to be 9, so cell 7,6 cannot be 9.
- That means cell 7,5 must be 9, so cell 1,5 cannot be 9.
- Either cell 1,8 is 9, or cell 7,5 is 9. Cell 1,5 (which is covered by both of these) therefore cannot be 9.

### 4.3.13 Singles Chain Contradiction

**Overview**

A *singles chain contradiction* is an anomaly or impossible condition you observe while building a singles chain on some value A. If you spot one, every cell in the chain is either set to A or has A removed as a possibility.

**Related to:** singles chain, pairs chain contradiction
**Frequency:** Very rare (1 in 5,700 puzzles, or 0.018%)

**Definition**

1. Start with a singles chain on a particular possibility. For convenience, we'll call this value A.
2. One of the cells covered by both ends of the chain is also locked with the last cell in the chain on the value A.
3. This locked cell can be added to the end of the chain.
4. The chain now has an odd number of cells, so if the first cell is A, the last cell must also be A.
5. This forces two cells in the same group to have the value A.
6. The value A can be removed from the cell on each end of the chain, and from every second cell of the chain. The remaining cells on the chain can be set to A.

**OR:**

1. A singles chain under construction is currently an odd number of cells in length.
2. The first and last cells in the chain are in the same group.
3. This forces two cells in the same group to have the value A.
4. The value A can be removed from the cell on each end of the chain, and from every second cell of the chain. The remaining cells on the chain can be set to A.

**How to find them**

While building a singles chain, when the chain is an odd number of cells in length, check whether the first and last cells are in the same group.

When you have a finished a singles chain, check whether any of the cells covered by both ends of the chain are locked with the last cell.

You can also use coloring to find singles chain contradictions.

**Example**

It is really too bad that these are so rare, because finding one gives you a bunch of moves. Here is an example:
While building a singles chain on the value 7 starting at cell 2,1, we reached cell 3,3. The chain is not complete because it has an odd number of cells, but this fragment exposes a contradiction:

- If cell 2,1 is 7, then cell 2,8 cannot be 7, which forces cell 1,9 to be 7, so cell 8,9 cannot be 7. This in turn forces cell 7,8 to be 7, meaning cell 7,3 cannot be 7, forcing cell 3,3 to be 7.

- To recap, if cell 2,1 is 7, then cell 3,3 must also be 7. But this is impossible because they are both in the same box.

- We can therefore remove 7 as a possibility from cell 2,1.

- But here comes the good part—the cells in the chain are all locked with their neighbors, so if cell 2,1 is not 7 then cell 2,8 must be 7.

- That means cell 1,9 cannot be 7; cell 8,9 must be 7; cell 7,8 cannot be 7; cell 7,3 must be 7; and cell 3,3 cannot be 7. Whew! We eliminated four possibilities and got three answers—that's seven moves—out of this one strategy!

Singles chains work in both directions, so we could have started from either end of the chain and reached the same conclusion.

### 4.3.14 Weak Singles Chain

**Overview**

A weak singles chain is a sequence of cells that are connected together on a particular value in such a way that forces either the first cell or the last cell of the chain to be that value. The value can therefore be removed
as a possibility from all cells covered by both ends of the chain. The difference between this chain and a singles chain is that every other pair of cells in a weak singles chain is only weakly locked.

**Related to:** singles chain

**Frequency:** Uncommon (1 in 60 puzzles, or 1.7%)

**Definition**

Two cells are locked if they are the only ones in a group that might be some value A. This tells us two things:

- If the first cell is A, the other cannot be A.
- If the first cell is not A, the other must be A.

However, consider a group with several cells that might be A. These cells are said to be weakly locked. This gives us less information:

- If one cell is A, the others cannot be A.
- If one cell is not A, one of the others must be A, but we have no idea which one.

Nevertheless, we can exploit this weak locking property. The idea is to construct a chain similar to a singles chain. The difference is that every other pair of cells in the chain is weakly locked; the remaining pairs are locked.

1. The chain begins with a cell that contains a particular possibility. For convenience, we'll call this value A.
2. The cell must be in a group with exactly one other cell containing A as a possibility (they are locked).
3. The second cell must be in a different group with one or more other cells containing A as a possibility (weakly locked).
4. One of these other cells must be in a group with exactly one other cell containing A (they are locked).
5. The next cell in the chain is weakly locked.
6. The next cell in the chain is locked.
7. There must be at least four cells in the chain, and an even number of cells in the chain.
8. The cells in the chain can have other possibilities; they are irrelevant.
9. The value A can be removed as a possibility from all cells covered by both ends of the chain.

**How to find them**

1. Find a cell that has some value as a possibility; let's call it A.
2. Find another cell covered by the first which also has A as a possibility; ensure that these are the only two cells in their group that can be A.
3. Look at all the cells which can be A that are covered by the previous cell but in a different group. Find one that is in another group with exactly one other cell that can be A. These are your third and fourth cells.
4. Continue building the chain in this manner, adding a weakly locked cell and then a locked cell.
5. Each time the chain is an even number of cells in length, see if any of the cells covered by both ends of the chain have A as a possibility.
6. If this fails, try selecting different cells in step 3 for all weakly locked pairs in the chain.
7. If this fails, see if you can start a chain with a different cell.
8. If this fails, try building a chain with a different value.

**Example 1**

Consider this puzzle, in which the 3's have been highlighted:

This chain on the value 3 starts at cell 1,1 and ends at cell 3,8. The chain allows us to remove 3 as a possibility from cell 3,2. Here is the reasoning behind this move:

- Cell 1,1 is either 3, or it is not 3.
- If cell 1,1 is not 3, then cell 6,1 must be 3 because they are locked.
- If cell 6,1 is 3, then none of the other cells in row six can possibly be 3.
- In column eight, there is now only one cell that can be 3: cell 3,8.
- To recap, either cell 1,1 must be 3 or cell 3,8 must be 3. Therefore, no cells that are covered by both of these can possibly be 3.
- We can remove 3 as a possibility from cell 3,2.

**Example 2**

The weak singles chains in the previous example was bidirectional, but this is not always true. Consider another example:
This chain on the value 1 starts at cell 2,1 and ends at cell 1,7:

- If cell 2,1 is 1, then cells 1,2 and 2,8 cannot be 1.
- But if cell 2,1 is not 1, then cell 6,1 must be 1, and none of the rest of the cells in row six can be 1.
- In box five, there is only one cell left that can be 1: cell 5,5. This means that none of the other cells in column 5 can be 1.
- But now there is only one cell in box eight that can be 1: cell 9,4. None of the rest of the cells in row nine can be 1.
- Cell 7,3 is the only one in box seven that can be 1, and that prevents any of the rest of the cells in row seven from being 1.
- Now column seven has only one cell that can be 1: cell 1,7. (Note that cell 5,7 cannot be 1, despite the highlighting, because of cell 5,5 in the third step.)
- But if cell 1,7 is 1, then cells 1,2 and 2,8 cannot be 1.
- To recap, if cell 2,1 is 1, cells 1,2 and 2,8 cannot be 1. But if cell 2,1 is not 1, cell 1,7 is forced to be 1, and that also prevents cells 1,2 and 2,8 from being 1. We can therefore remove these two possibilities.

If we try to follow this chain in the other direction, it does not work:

- If cell 1,7 is 1, then cells 1,2 and 2,8 cannot be 1.
- But if cell 1,7 is not 1, there are two other cells in column seven that might be one, so we can't go any further.
4.3.15 Weak Singles Chain Contradiction

Overview

A **weak singles chain contradiction** is any anomaly or impossible condition you observe while building a weak singles chain. If you spot one, whatever cell you began the chain with can be set to the possibility you were investigating.

**Related to:** weak singles chain

**Frequency:** Very rare (1 in 3,700 puzzles, or 0.027%)

**Definition**

1. The assumption in building a weak singles chain is that the first cell is not a particular value (for convenience, we'll call it V).

2. While building the chain, you will add cells that must be V by virtue of their relationship with the previous cell in the chain. For convenience, we'll refer to these cells as A.

3. Now look at the cells that A covers which also contain V. For convenience, we'll refer to them collectively as B.

4. If two of the B cells are each locked with another cell on the value V, and these two locked cells cover one another, you've got a contradiction.

5. The first cell in the chain can be set to the value V.

**How to find them**

Each time you add a cell (call it A) which must be some value to a weak singles chain, keep track of the cells from which V is removed as a possibility. When you then examine all the cells that are weakly locked with cell A, you will be looking for cells that are strongly locked with another cell. While doing this, simply check whether any of the newly found strongly locked cells cover one another.

**Example 1**

Here is an example (only rows one through six of the puzzle are shown):
A contradiction was found while constructing a weak singles chain on the value 2 starting at cell 1,4. Here is the logic that leads to the contradiction:

- Cell 1,4 is either 2 or it is not 2. If it is 2, then it prevents all other cells that it covers from being 2. The weak singles chain we are trying to construct will show which of these covered cells cannot be 2 if cell 1,4 is not 2. To construct the chain, then, we assume that cell 1,4 is not 2.
- If cell 1,4 is not 2, then cell 3,6 must be 2 because it is the only other cell in box two which can be.
- If cell 3,6 is 2, cells 3,3; 3,9; 4,6 and 6,6 cannot be 2.
- If cell 4,6 is not 2, then cell 6,4 must be 2 because it is the only other cell in box five which can be.
- If cell 4,6 is 2, then cells 6,2 and 6,9 cannot be 2.
- If cell 6,9 is not 2, then cell 2,9 must be 2 because it is the only other cell in column nine that can be.
- But if cell 2,9 is 2, then cells 2,2 and 2,8 cannot be 2.
- If cell 2,2 is not 2, then cell 5,2 must be 2 because it is the only other cell in column 2 that can be.
- And if cell 2,8 is not 2, then cell 5,8 must be 2 because it is the only other cell in column eight that can be.
- Cells 5,2 and 5,8 must both be 2, but this is impossible because they are both in row five.
- This contradiction is unavoidable given our original assumption that cell 1,4 is not 2. Therefore, cell 1,4 must be 2.

**Example 2**

Here is another example:
This chain starts at cell 9,6 and the contradiction allows us to make this cell 7. Here's why:

- If cell 9,6 is not 7, then cell 8,6 must be 7, which prevents any other cells in row eight from being 7.
- Column two has only one cell left that can be 7: cell 4,2. This prevents all other cells in row four from being 7.
- Column three has only one cell left that can be 7: cell 7,3 (cell 6,3 cannot be 7 because of cell 4,2 in the second step; cell 8,3 cannot be 7 because of cell 8,6 in the first step). Cell 7,3 prevents all other cells in row seven from being 7.
- Cell 9,7 is the only one in box nine that can be 7 (cells 7,8 and 7,9 were blocked by cell 7,3, and cells 8,7 and 8,9 were blocked by cell 8,6).
- But if cell 9,7 is 7, then cells 2,7 and 6,7 cannot be 7. This forces cells 2,8 and 6,8 to be 7, which is impossible because they're in the same column.
- The assumption that cell 9,6 was not 7 led to an impossible situation. Therefore, cell 9,6 must be 7.

4.3.16 Pairs Chain

Overview

A pairs chain is a sequence of cells that all contain exactly two possibilities, though not necessarily the same ones. Each cell in the chain is locked with the next cell on one of its values. The result is a chain in which either the first cell or the last cell must contain a particular value, which can therefore be removed from all cells covered by both ends of the chain.
**Related to:** singles chain, pairs chain contradiction, locked cell cycle, pairs cycle (see below)

**Frequency:** Uncommon (1 in 23 puzzles, or 4.3%)

**Also known as:** XY-chains, remote pairs, forcing chains, dual forcing chains

**Definition**

Unlike a singles chain, a pairs chain does not have to have an even number of cells in it. It does, however, have to have at least four cells (a pairs chain with only three cells in it would either be an xy-wing or would contain naked pairs).

1. A pairs chain is a sequence of cells that all have exactly two possibilities. The first cell in the chain has possibilities A and B, and the last cell in the chain has possibilities A and C.

2. The first cell is locked with the second on the value B, and the last cell is locked with the next-to-last on the value C.

3. Every other cell in the chain is locked with the previous cell on one of its values, and is locked with the next cell in the chain on its other value.

4. The chain is arranged in such a way that either the first cell must be A, or the last cell must be A. Therefore, A can be removed as a possibility from all cells covered by both ends of the chain.

**How to find them**

1. Find a cell that has exactly two possibilities. For convenience, we'll call them A and B.

2. Find another cell that is locked with the first on B.

3. Find a third cell that is locked with the second on the other value in the second cell.

4. Find a fourth cell that is locked with the third on the other value in the third cell.

5. Continue building the chain in this manner.

6. Each time you add a cell that contains two values A and C, and is locked with the previous cell in the chain on C, see if there are any cells covered by both the first and last cells in the chain. If there are, eliminate A as a possibility from all of them.

**Example 1**

This puzzle has a pairs chain in rows one through three:

This chain begins at cell 1,3 and ends at cell 3,6. The value 4 appears in the cells on both ends of the chain, so we can remove 4 from cells 1,4; 1,5; 3,2; and 3,3. Here is the reasoning:

- Either cell 1,3 is 4 or it is 9.
- If cell 1,3 is 9, cell 1,8 cannot be 9 so it must be 6.
• If cell 1,8 is 6, cell 3,8 cannot be 6 so it must be 9.
• If cell 3,8 is 9, cell 3,6 cannot be 9 so it must be 4.

• To recap, either cell 1,3 is 4 or cell 3,6 is 4. We can therefore remove 4 as a possibility from all cells covered by both 1,3 and 3,6.

In this example, we can remove the 4’s from cells 1,4; 1,5; 3,2; and 3,3.

**Example 2**

A singles chain must have an even number of cells in it. Pairs chains do not have this restriction. Here is a pairs chain with an odd number of cells:

![Sudoku Puzzle](image)

This chain is on the value 2. Let's walk through it quickly.

• Either cell 6,6 is 2, or it is 8. If it is 8, then cell 3,6 must be 1 and cell 1,4 must be 8.
• If cell 1,4 is 8, then cell 9,4 must be 4, which forces cell 9,1 to be 2.

• To recap, either cell 6,6 is 2, or cell 9,1 is 2.

• Cells 6,1 and 9,6 are each covered by both ends of the chain, one of which must be 2, so we can remove the value 2 from cells 6,1 and 9,6.

**Pairs Cycle**

The example below shows what looks like a locked cell cycle (type 1). But none of the cells in the chain have any extra possibilities to remove, so it is called a **pairs cycle** instead (it is also known as a **bivalue graph**).
Unlike a pairs chain, the two ends of this chain are locked with each other on some value. The result can be more fruitful than an ordinary pairs chain. Let’s take a closer look (only rows one through six are shown):

Because each cell is locked with two others on each of its two possibilities, there are only two possible answers for these cells:

- Cell 3,1 is 2; cell 3,6 is 7; cell 4,6 is 2; cell 6,4 is 7; cell 6,1 is 8.
- Cell 3,1 is 8; cell 6,1 is 7; cell 6,4 is 2; cell 4,6 is 7; cell 3,6 is 2.

While we don't know which of these arrangements will turn out to be the answer, we can say for certain that:

- Either cell 3,1 or 3,6 must be 2.
- Either cell 3,6 or 4,6 must be 7.
- Either cell 4,6 or 6,4 must be 2.
- Either cell 6,4 or 6,1 must be 7.
- Either cell 6,1 or 3,1 must be 8.

That means that no other cells covered by each of these pairs may contain their common number as a possibility. In general, this could result in a slew of possibilities being removed. In this particular example, however, all we can remove is the 7 from cell 6,3 because we know that either cell 6,1 or 6,4 must be 7.

The pairs cycle is not implemented as a separate strategy in SudoKoach because the pairs chain will find and eliminate all of the possibilities that the pairs cycle would identify. In this example, SudoKoach finds a pairs chain of cells 6,1; 3,1; 3,6; 4,6; and 6,4, and this chain eliminates the 7 in cell 6,3. If the pairs cycle had identified more possibilities to eliminate, then SudoKoach would merely find more pairs chains starting at different places in the cycle, and would eventually eliminate all of the possibilities.

While SudoKoach does not look for pairs cycles, you certainly can. If you are trying to build a pairs chain and notice that the last cell in the chain is locked with the first cell, you may be able to delete more possibilities faster than if you only looked at the cells covered by the ends of the chain.
4.3.17 Pairs Chain Contradiction

**Overview**

A *pairs chain contradiction* is any anomaly or impossible condition you observe while building a pairs chain. This happens when a chain loops back to the group that contains its first cell, and the two cells are forced to be the same value. If you spot one, whatever value you began the chain with can be eliminated as a possibility.

**Related to:** singles chain contradiction, pairs chain

**Frequency:** Rare (1 in 260 puzzles, or 0.38%)

**Definition**

1. Start with a pairs chain on a particular possibility. For convenience, we'll call this value A.
2. One of the cells covered by both ends of the chain is also locked on the value A with the last cell in the chain.
3. This locked cell can be added to the end of the chain.
4. The modified chain has an additional cell, so if the first cell is A, the newly added last cell must also be A.
5. This forces two cells in the same group to have the value A.
6. The value A can be removed from the cell on the beginning of the chain.

OR:

1. A pairs chain is currently under construction.
2. The first and last cells in the chain are in the same group.
3. The chain forces the first and last cells to have the value A.
4. The value A can be removed from the first cell of the chain.

OR:

1. A pairs chain is currently under construction, and the first cell in the chain has the value A.
2. The last cell added to the chain is forced to have a value that conflicts with another cell in the same group that is already on the chain.
3. The value A can be deleted from the first cell in the chain.

**How to find them**

1. When building a pairs chain, check each new cell that is added to the chain.
2. If the last cell and the first cell are in the same group, and assuming that the first cell in the chain is A forces the last cell to have the same value, you've got a pairs chain contradiction.

**Example 1**

Here is an example of this situation:
While building a pairs chain starting at cell 8,6 on the value 1, we've just added cell 9,4 to the chain and found a contradiction. If cell 8,6 is not 1, then it must be 2. But the chain then forces cell 9,4 to be 2. Let's see how:

- If cell 8,6 is 2, then 8,9 must be 4, which forces 8,2 to be 5.
- This forces cell 3,2 to be 2, so 3,4 must be 3, forcing 9,3 to be 2. But this is impossible because cells 8,6 and 9,4 are ... chains, not all pairs chains are bidirectional. Let's see what happens if we try to start at the other end of the chain:

- If cell 9,4 is 2, cell 3,4 must be 3.
- But there are two other cells in row three that can be 2: 3,2 and 3,6. So cell 3,2 is not forced to be 2, and the chain fails.

Traverse the chain in the original direction and every decision is forced. In reverse, this is not so. Thus, the chain is not bidirectional, and we cannot remove 2 from the cells at both ends of the chain.

**Example 2**

Here is an example of the third type of pairs chain contradiction (only the first six rows are shown):
While building a pairs chain from cell 1,4, a cell has been added to the chain that conflicts with another cell already on the chain. Let's follow the chain and see the problem:

- Either cell 1,4 is 1, or it is not 1 (it is 3).
- If cell 1,4 is 3, then cell 1,9 must be 7, and 1,5 must be 1.
- This forces cell 5,5 to be 7, making 5,6 6, which forces cell 4,4 to be 4.
- That means cell 4,8 must be 3, forcing cell 4,9 to be 7.
- But cell 1,9 already has the value 7 from the second step above.
- Therefore, cell 1,4 cannot be 3.

4.4 Superhuman Strategies

The superhuman strategies are extremely complex. A few puzzles from some web sites depend upon them, but if you find a puzzle in a newspaper that needs one of these strategies to be solved, you should consider subscribing to some other newspaper. They are:

- Composite Chain
- Composite Chain Contradiction

When you ask for a hint, SudoKoach will try these strategies to help you solve the puzzle. However, because of their complexity, SudoKoach will not generate a puzzle that requires their use unless you specifically ask for one.

When you have some time to kill, it is fun to try a few of these just to see what they look like. And if you have a lot of time to kill, you might master these techniques! (I haven't.)
4.4.1 Composite Chain & Contradiction

Overview

There are many types of chains: singles chains, weak singles chains, pairs chains. A composite chain is one that has elements of all these types. It may start out as a singles chain, switch to a pairs chain, then switch back to a singles chain, and end as a weak singles chain.

A composite chain contradiction occurs when a contradiction is found in the construction of a composite chain.

Related to: singles chain, singles chain contradiction, weak singles chain, pairs chain, pairs chain contradiction

Frequency:

- Composite chain: Uncommon (1 in 33 puzzles, or 3%)
- Composite chain contradiction: Uncommon (1 in 33 puzzles, or 3%)

Definition

The definition of a composite chain is difficult to express because there are so many ways of forming one. The basic idea is to start with any type of chain, and switch to another type when necessary to continue building the chain. The goal is to get a chain that forces either the cell at one end or the cell at the other end to be a particular value; this value can then be removed as a possibility from all cells covered by both ends of the chain.

If you observe any anomalies during the construction of the composite chain, you have found a composite chain contradiction. The assumption you made for the first cell in the chain can be eliminated as a possibility.

How to find them

1. Start by constructing one type of chain.
2. If you can't finish the chain, see if you can switch to another type.
3. Repeat the previous step as necessary.
4. Don't forget to take time out every now and then to eat and sleep.

Example 1

In principle, it is possible for mere mortal human beings to find composite chains in Sudoku puzzles. In practice, however, it is virtually impossible. Therefore, SudoKoach will not generate a puzzle that requires finding a composite chain or a composite chain contradiction to solve (unless you really, really want one: click here to see how). It is also extremely unlikely that any Sudoku puzzle you find in a newspaper or magazine will require these strategies.

There are some books and web sites, however, where you can find some puzzles that can only be classified as "depraved." If you enter such a puzzle into SudoKoach, it will try these strategies if the puzzle does not yield to any others. If you ask SudoKoach to rate such a puzzle, the rating will be "superhuman."

Here is an example of a composite chain. Only rows one through six of the puzzle are shown:
The result of the chain is that 5 is removed as a possibility from cell 1,3. Here is the reasoning:

- Cell 5,3 is either 5 or 8.
- If cell 5,3 is 8, then cell 4,2 must be 2 (pairs chain).
- If cell 4,2 is 2, then cell 4,4 must be 1 (pairs chain).
- If cell 4,4 is 1, then cell 4,6 must be 5 (pairs chain).
- If cell 4,6 is 5, then cell 1,6 cannot be 5 (weak singles chain).
- If cell 1,6 is not 5, then cell 1,5 must be 5 (singles chain; this is now the only other cell in box 2 that can be 5).

- To recap, either cell 5,3 or cell 1,5 must be 5. Therefore, we can remove 5 as a possibility from cell 1,3.

To assist in following through the strategy, SudoKoach also X's out the values (in purple) that are rendered impossible as the chain is constructed. Even so, it is often difficult to follow the logic of the chain even when it is laid out right in front of you. I find it difficult to imagine anyone doing this by hand. (I certainly can't!)

**Example 2**

Here is an example of a composite chain contradiction:
The result of this is that 3 is removed as a possibility from cell 1,1. Here is the reasoning (I hope I can figure this out for you!):

- Cell 1,1 is either 1 or it is 3.
- If cell 1,1 is 3, then cell 5,1 must be 1 (singles chain).
- If cell 5,1 is 1, then cell 5,9 cannot be 1 (weak singles chain).
- If cell 5,9 is not 1, then cell 8,9 must be 1 (singles chain).
- If cell 8,9 is 1, then cell 9,8 cannot be 1 (singles chain, as 1 is no longer possible in cell 5,8).
- If cell 6,8 is 1, then cell 6,6 cannot be 1 (weak singles chain, or maybe this is a pairs chain), so it must be 4.
- If cell 6,6 is 4, then cell 8,6 cannot be 4 (weak singles chain). This cell can no longer be 1 (from a previous step), so it must be 8.
- If cell 8,6 is 8, then cell 8,2 must be not be 8 (singles chain, or maybe a pairs chain), so it must be 4.
- If cell 8,2 is 4, then cell 4,2 must be 1 (pairs chain).
- However, cell 4,2 cannot be 1 because cell 5,1 became 1 in the third step of the chain.

The contradiction followed from the premise that cell 1,1 was 3. Therefore, cell 1,1 cannot be 3.
4.5 Frequency of Strategies

The frequency with which each strategy is likely to appear in a puzzle was computed by generating over three million puzzles at random and analyzing each one to see what strategies were required to solve it. Because these puzzles were randomly generated (61% of them were "medium"), and the puzzles you find in newspapers and magazines are not randomly generated (they are chosen for their difficulty level), you may encounter some strategies more often than these statistics might lead you to expect.

The table below shows how often each strategy is used in puzzles of varying levels of difficulty generated by SudoKoach.

<table>
<thead>
<tr>
<th>Strategy</th>
<th>Easy</th>
<th>Medium</th>
<th>Hard</th>
<th>Expert</th>
<th>Devious</th>
<th>Sadistic</th>
<th>Super-human</th>
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</tbody>
</table>

Furthermore, the frequency with which each strategy appears depend upon the order in which they are tried. For example, some naked triples would also qualify as XY-wings, but SudoKoach looks for naked triples first because this is the simpler strategy. As new strategies are added to SudoKoach, the frequencies with which other strategies are used will change. The table above lists the strategies in the order in which SudoKoach tries them.

You may want to look at this information when deciding which strategy to master next.
Solving Sudoku Puzzles by Hand

After using SudoKoach for a while, it is natural to begin to rely upon the possibilities that it figures out for you. When you start working on a puzzle in a book or newspaper, you may feel lost without these clues. But remember that in computing these possibilities, SudoKoach doesn't do anything that you can't do yourself.

This chapter describes some approaches for solving puzzles by hand. You may find these techniques helpful for solving puzzles away from your computer.

- Elimination (hidden singles)
- Completion (only one or two cells left)
- What can this cell be? (naked singles)
- Where can this number go? (hidden singles)
- Pure logic

5.1 Elimination

Elimination is a good place to start solving. It is essentially a search for naked singles and hidden singles. The appearance of a number somewhere in a line or box eliminates it as a possibility in all other cells of that line or box. For example, consider this puzzle:

```
4 5 1 2 6
3 9  5
9 3 8 2
6 9
5 7 2 6
4 8 7
3 7 5 8 9
2  1
```

- The 6's in rows five and six prevent a 6 from being placed in either of those rows in box five. But box five must have a 6 somewhere in it, so it must go in row four, and the only cell available is 4,4.

- The 6's in columns eight and nine prevent a 6 from being placed in those columns of box nine. But box nine must have a 6 somewhere in it, so it must go in cell 9,7.

- The 5's in rows two and three prevent a 5 from being placed in either of those rows in box two. But box two must have a 5 somewhere in it, so it must go in row one. There are two possible cells: 1,4 and 1,6. But there is already a 5 in column six, so the 5 must go in cell 1,4.

Of course, this technique does not always lead to the solution of a cell. The 8's in columns five and six mean that the 8 in box two must go in column four. But there are two open cells in that column of box two and at this point either one of them could contain an 8.

Once you have placed a number using this technique, be sure to immediately check that same value in the other direction. For example, after using the third observation in the example above to place a 5 in cell 1,4, check columns four, five, and six. In this case, the 5's in column four and six tell you that there must be a 5 in
cell 5,5 (because it is the only cell in box five which is also in column five).

5.2 Completion

This is an easy strategy to use when you get further along in solving a puzzle. The idea is simple: if you have a row, column, or box with only one unsolved cell, you can solve it by simply filling in the number that is missing from the group. For example, in this puzzle:

```
<table>
<thead>
<tr>
<th>1</th>
<th>8</th>
<th>2</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>7</td>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td>6</td>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
```

it is obvious that the missing cell in box one must contain a 9.

If you find a row, column, or box with two or even three missing numbers, you can sometimes figure them out by using elimination, that is, by seeing if any of the empty cells are in a row, column, or box that already contains any of those numbers. Consider this puzzle:

```
<table>
<thead>
<tr>
<th>7</th>
<th>1</th>
<th>5</th>
<th>6</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>8</td>
<td>3</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>9</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>9</td>
<td>7</td>
<td>2</td>
<td>8</td>
</tr>
<tr>
<td>3</td>
<td>8</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td></td>
<td>8</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>3</td>
<td>7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>8</td>
<td>4</td>
<td>7</td>
<td></td>
</tr>
</tbody>
</table>
```

Column one has three unsolved cells, and the numbers that must go in those cells are 2, 8, and 9. However, box one already contains a 2, so cell 4,1 must be the 2. Row two already contains an 8, so cell 2,1 must be a 9. Similarly, row three already contains a 9, so cell 3,1 must be an 8.

5.3 What Can This Cell Be?

When you can't get any further with elimination and completion, try this technique. It is essentially a search for naked singles. When you use SudoKoach, naked singles are the easiest thing to spot, but when you are solving by hand, they are harder because of the work you have to do. Hence, you probably want to exhaust the previous, easier techniques before resorting to this one.

The technique is very easy, though it is time-consuming and tedious. For each unsolved cell, consider each
of the numbers 1 through 9 and see which ones are eliminated: if the number already appears in the same row, column, or box, then it cannot appear in this cell.

You are looking for cells that only have one possibility (naked singles), so once you find that two numbers are possible in a cell you can move on to the next one.

Better yet, make a note in each unsolved cell of the values that it can be. You've spent the time to figure out what these values are, so you might as well write them down to avoid having to repeat the same work later. If you do this, though, remember that each time you solve a cell you've got to update your notes for all the unsolved cells in the same row, column, or box.

### 5.4 Where Can This Number Go?

This technique is based on the requirement that each row, column, and box must contain each of the numbers 1 through 9. It is another way to look for hidden singles. Look at each row, one by one. For each number that does not already appear in the row, see if it can go in each of the unsolved cells in that row. If there is only one cell in which the value can appear, then it must go there, even if that cell has other possibilities.

When you have finished the rows, look at the columns in the same manner. Then do the same thing with the boxes.

### 5.5 Pure Logic

There are some techniques that rely solely on logic rather than on any mechanical, step-by-step process. Using logic to find answers is more rewarding than blindly following a step-by-step process.

#### Example 1

For a simple example of a logical solution, see if you can place any 5's in this puzzle (only the first three rows are shown):

```
3 5 6 8 1 4
8 1 2 6 9
```

At first glance, it doesn't look like there is enough information to place any 5's. But a little logic makes it clear that cell 1,8 must contain a 5. Here is the reasoning:

1. The 5 in row two means that there cannot be any more 5's elsewhere in row two.
2. There must be a 5 somewhere in box two, but it cannot be in row two, and all the cells in the first row of the box are filled, so the 5 must go in row three. We don't know whether it goes in cell 3,4 or cell 3,6, but it must be one of those two.
3. There must also be a 5 somewhere in box three, but it cannot be in row two (because that row already contains a 5), and it cannot be in row three (because the 5 in box two must be somewhere in that row). Therefore, the 5 in box three must be in row one.
4. In box three, only one cell in row one is open: cell 1,8. Therefore, this cell must contain a 5.

The solution becomes apparent only when you look beyond the obvious, step-by-step methods described earlier. It also helps to realize that even if you don't know exactly where a number must go, knowing that it must go in two or even three specific cells can give you important information that leads to a solution elsewhere.
Example 2

Here's another example. See if you can place any 7's in this puzzle:

\[
\begin{array}{ccc|ccc|ccc}
2 & 9 & & 8 & 4 & & 7 & 1 & 6 \\
1 & 8 & 4 & & 1 & 6 & 5 & & \\
& 1 & 7 & & & & & & 3 \\
9 & 3 & 6 & & & & & & \\
4 & 5 & 6 & & & & & & 9 \\
9 & 7 & & 3 & & 2 & & & \\
\end{array}
\]

Once again, it seems impossible. But logic lets us place a 7 in cell 4,1. Here's how:

1. The 7 in cell 2,7 means that the 7 which must go in box one cannot be in the second row of the box.
2. The 7 which must go in box one must therefore be in cell 1,2 or cell 3,2. We don't know which, but it must be one of those two cells.
3. That means that the 7 which must go in box 4 cannot be in the second column of the box.
4. The 7 in cell 9,3 means that the 7 which must go in box 4 cannot be in the third column of the box.
5. Therefore, the 7 in box four must go in cell 4,1 or cell 5,1.
6. The 7 in cell 5,5 prevents a 7 from being placed in cell 5,1.
7. Therefore, cell 4,1 must contain a 7.

How could anyone find something like this? There is no step-by-step procedure that can expose all solutions of this type. But when applying a technique (elimination, in this example), be on the lookout for places where another technique can also be applied (box/line elimination, in this example). And once again, don't quit just because you can't narrow a number down to a single cell: knowing that it must be in one row or one column gives you useful information that may lead to a solution elsewhere.

Example 3

Let's try another one. Can you place any 1's in this puzzle?
In box seven, it is clear that the 1 must go in either cell 8,2 or cell 8,3. We’re about to find out which. The 1 in cell 1,6 means that the 1 in box one must go in either cell 2,1 or cell 2,3. And in box four, the 1 must clearly go in either cell 4,1 or cell 4,3.

We can’t tell whether the 1’s will be in cells 2,1 and 4,3; or cells 2,3 and 4,1; but in either case there will be a 1 in column one and column three. That means that cell 8,3 of box seven cannot be 1, so cell 8,2 must be 1.

Where can the 1 go in box three? It can’t go in cells 1,7; 2,7; or 3,7 because of cell 9,7. But box six must have its 1 in column nine, which rules out cell 3,9. And we’ve already found that box one must have a 1 in row two, which rules out cell 2,8.

The only cell left in box three that can be 1 is 3,8.

**Example 4**

One final example should be enough. See if you can place a 1 in cell 1,2—it will take several steps.

1. In box seven, the 1 must go in either column one or three.
2. In box four, the 1 must also go in either column one or three.
3. Therefore, the 1 in box one must go in column two.
4. In box three, the 1 must go somewhere in row two.
5. Therefore, the 1 in box one cannot go in row two, but it has to be in column two so it must go in cell 1,2.

This chapter describes how to use all of the features in SudoKoach. It is assumed that the reader is familiar with the rules of Sudoku.

6.1 Levels of Difficulty

There are no standards for rating the difficulty of Sudoku puzzles. Consequently, if you look at puzzles in different newspapers or magazines, you will probably see different rating schemes: four stars, five stars, "easy/medium/hard", etc. Furthermore, a puzzle rated in one publication as "hard" might be rated by another publication as only "medium."

SudoKoach can create puzzles with six different levels of difficulty. The table below explains the characteristics a puzzle in each of these levels will have, including the strategies that SudoKoach needed to solve them.

<table>
<thead>
<tr>
<th>Level</th>
<th>Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Easy</td>
<td>Basic strategies only; 20 or more moves possible at the start</td>
</tr>
<tr>
<td>Medium</td>
<td>Basic strategies only; fewer than 20 moves possible at the start</td>
</tr>
<tr>
<td>Hard</td>
<td>Basic strategies, plus one or two intermediate strategies</td>
</tr>
<tr>
<td>Expert</td>
<td>Basic strategies, plus three or more intermediate strategies</td>
</tr>
<tr>
<td>Devious</td>
<td>Basic and intermediate strategies, plus one or two advanced strategies</td>
</tr>
<tr>
<td>Sadistic</td>
<td>Basic and intermediate strategies, plus three or more advanced strategies</td>
</tr>
</tbody>
</table>

You will quickly find that solving easy and medium puzzles using SudoKoach is so simple that you'll want to move on to the tougher ones. In fact, you might create these easy puzzles only when you want to print one for a friend, or have one to solve by hand.

Note that there are actually two more levels of difficulty:

- **Superhuman**: describes puzzles that require the use of composite chains or composite chain contradictions to be solved. If you really want a superhuman puzzle, hold the Shift key down while you ask for a sadistic puzzle.

- **May the Force be with you**: describes puzzles that SudoKoach cannot solve with its built-in strategies. SudoKoach will not generate a puzzle that cannot solved by logic alone.

Currently, SudoKoach can solve approximately 99.5% of Sudoku puzzles using logic alone!

6.2 The Board

*Rows, columns, and boxes*
The SudoKoach board (and Sudoku puzzles) contain 81 cells arranged in nine rows and nine columns. Rows are numbered 1-9 from top to bottom; columns are numbered 1-9 from left to right.

The heavier lines in the grid mark off nine 3x3 boxes. These are numbered from left to right, and then top to bottom, so boxes one through three are along the top, four through six are in the center, and seven through nine are on the bottom.

When speaking of an individual box, we may refer to its first row, second row, or third row (likewise with columns). This should not be interpreted as a row number of the board. For instance, the first row in box six is row four on the board; the first column in the same box is column seven on the board.

Individual cells are identified by their row and column. For example, cell 2,9 is the last cell in the second row, and cell 7,4 is in the upper left corner of box eight.

Possibilities and answers

Each cell either has one large number or some small ones. The large numbers indicate the answers in cells that are already solved. Small numbers indicate which values are legal in unsolved cells. Legal values are those that do not appear in any other cell in the same row, column, or box.

The two basic actions are eliminating a possibility and solving a cell. These are very easy to do in SudoKoach.
To solve a cell, move the mouse pointer to the correct possibility and left-click it. To eliminate a possibility, right-click it instead. If you make a mistake, you can always undo it by clicking the **Undo** button (or selecting **Undo** from the **Undo/Redo** menu).

6.3 The Button Window

With the controls in the button window, you can create new puzzles, get hints, highlight values, and much more. You can choose whether this window appears to the right of the board, to the left of the board, or is not shown at all. From the **Edit** menu select **Preferences**, then select **Buttons**, and then make your choice.

The controls are separated into several different groups; each is described below.

**New Puzzles**

- To create a new puzzle, choose the desired difficulty from the list next to the **Create** button, and then click **Create**. To create another puzzle of the same difficulty, just click **Create** again.
- To practice, choose the strategy you want to practice from the list next to the **Practice** button, and then click **Practice**. Click **Practice** again to make another puzzle for the same strategy.
- Click **Enter Puzzle** to enter a puzzle you found in a newspaper or magazine.
- **Open** lets you open a puzzle you saved earlier.
- **Save** lets you save a puzzle so you can continue to work on it later.
- **Save As** lets you save a puzzle using a different filename than it was previously saved with.
- **Print** causes the current puzzle to be printed on your default printer.
• **Start Over** starts the current puzzle again.

**Undo and Hints**

- **Undo** undoes your last move. Clicking **Undo** again undoes the next-to-the-last move, and so forth. You can undo moves all the way back to the beginning of the puzzle.

- **Undo until OK** undoes as many moves as necessary to undo all erroneous moves.

- **Redo** redoes the last move you have undone. Clicking **Redo** again redoes the next-to-the-last move, and so forth.

- Click the hint buttons to get a little hint, medium hint, or big hint.

- If **Solution status** is not checked, the **Check Solution** button will be shown. Click the button to see if the puzzle can be solved.

- If **Solution status** is checked, the **Check Solution** button is replaced by the puzzle status: either **OK** or **NO SOLUTION!**.

- If **Next move** is checked, SudoKoach will tell you what kind of move is next in this puzzle. This is updated after each move you make; each update counts as a little hint in the **Score** box.

**Highlight**

The first two buttons select the highlighting style. The choices are:

- **Possibilities**: highlights cells that contain the specified values as possibilities, regardless of how many possibilities there are.

- **# of possibilities**: highlights cells that have the specified number of possibilities, regardless of their values.

For simplicity, the remainder of this section describes the **Possibilities** style of highlighting, though the buttons all work similarly for the **# of possibilities** style.

The number buttons in the next row do double duty: they let you select values and also show you which values have not yet been solved.
To highlight a value, click the button for that value. The button will change color and remain depressed to show you which value or values are highlighted.

To highlight several values, hold the **Shift** key down as you click the buttons.

When you solve all cells that contain a certain value, then its corresponding button will disappear.

To highlight the next value (or values) in sequence, click the **Next** button.

To highlight the previous value (or values) in sequence, click the **Previous** button.

To turn off highlighting for all values, click the **Clear** button.

If **Any** is selected, all cells that contain any of the selected values will be highlighted.

If **All** is selected, only cells that contain all of the selected values will be highlighted.

If **Only** is selected, only cells whose possibilities are all selected are highlighted.

If **2 or More** is selected, only cells that contain two or more (but not all) of the selected values are highlighted.

**Score**

<table>
<thead>
<tr>
<th>Score</th>
<th>Elapsed time: 8:36</th>
<th>Little hints: 0</th>
<th>Moves made: 1</th>
<th>Medium hints: 0</th>
<th>Moves undone: 0</th>
<th>Big hints: 0</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pause Game</td>
<td>Resume Game</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- **Elapsed time** is the time you've spent on this puzzle. This timer is stopped when SudoKoach is minimized.

- **Moves made** is the number of moves, including eliminating possibilities and choosing answers for cells. This also counts moves you have redone with **Redo**.

- **Moves undone** is the number of moves you have undone with **Undo** or **Undo until OK**.

- The three counters on the right count how many hints you have asked for.

- Click **Pause Game** to momentarily stop the game (to answer the phone, for instance). The elapsed time does not change while the game is paused.

- Click **Resume Game** to resume play on a paused game.

### 6.4 The Welcome Screen

When you start SudoKoach, you will see the welcome screen, shown below:
With this screen, you can:

- create a new puzzle with any of six different levels of difficulty,
- enter a puzzle you found in a book or a newspaper, or
- return to a puzzle you saved earlier.

**Creating a new puzzle**

To create a new puzzle, click the button for the level of difficulty that you want. The screen will flash as SudoKoach generates puzzles until it gets one of the proper difficulty.

You will quickly find that easy, medium, and hard puzzles are all pretty easy to solve with SudoKoach, so you might have more fun trying some of the harder puzzles.

Note that there is actually a seventh level of difficulty: Superhuman. These puzzles make use of the superhuman strategies, which are easy for a computer to do but difficult for people to do—this is why SudoKoach normally does not generate superhuman puzzles. If you really want one of these, though, just hold the Shift key down and ask for a sadistic puzzle. (Good luck—you'll need it!)

**Entering a puzzle**

To enter a puzzle that you found elsewhere into SudoKoach, click the Enter a puzzle from a book or newspaper button on the welcome screen, or the Enter button in the button window. This screen will appear:
This screen indicates that SudoKoach is ready to accept your puzzle. Use the mouse to left-click each of the initial values in the puzzle. If you make a mistake, just point to the cell you’d like to fix and right-click the mouse. You can also click the **Undo** button to back up one cell at a time, or you can click the **Start Over** button to begin entering the puzzle again.

When you have finished entering the puzzle, click the **Done Entering** button. SudoKoach will check the puzzle to make sure that it has exactly one solution. If so, you can begin solving it. Otherwise, you will be given the opportunity to double check the puzzle and fix any errors.

If you see this error screen:

![Error Screen]

it means that you have begun trying to solve the puzzle before clicking the **Done Entering** button. SudoKoach won’t let you do this because it has to check the puzzle you’re entering to ensure that it has a solution. If you see this screen, just click **OK**, then click the **Done Entering** button. You can then begin to solve the puzzle.

**Returning to a puzzle you saved earlier**

To continue working on a puzzle you saved earlier, click the **Open a puzzle I saved earlier** button. You can also click the **Open** button in the button window, or select **Open** from the **File** menu. Locate the file name of the desired puzzle in the dialog that appears, and click the **Open** button. The puzzle will be displayed just as it was when you saved it earlier, and you can then continue working on it.

### 6.5 Busy Indicator

When SudoKoach is doing something that may take a long time, the cursor changes from an arrow to an hourglass to indicate that it is busy. If the task takes more than a half second, a **busy indicator** also appears. An example of this indicator is shown below:
The indicator tells you what SudoKoach is doing (creating a new puzzle in this example).

The indicator also has a Cancel button. Some tasks, such as creating a practice puzzle for a rare strategy, might take a very long time. If you start such a task and then decide you'd rather not wait for it to finish, click the Cancel button and the operation will stop.

6.6 Printing Puzzles

SudoKoach offers several ways to print Sudoku puzzles. Most of these are found on the File menu, and the most frequently used ways have keyboard shortcuts.

- **Print setup**: your default printer will be used unless you use this menu entry to select a different one. This also lets you choose printer properties, such as the paper size and orientation.
- **Print puzzle**: (or Ctrl-P on the keyboard) prints the current puzzle to your default printer, or the printer you selected with Print setup. The puzzle is printed approximately the same size as it shows on your screen. To make the puzzle larger or smaller on the printout, just resize SudoKoach on your screen and print it again.
- **Print puzzle, no clues**: (or Ctrl-X on the keyboard) prints the puzzle but does not show the possibilities in the unsolved cells. This is how Sudoku puzzles are usually shown in newspapers, books and magazines. You might choose this style for puzzles you want to give to friends, or puzzles you'd like to solve by hand without SudoKoach's help.
- **Print answers**: prints the answer for the current puzzle. This is printed only half as large as the puzzle on your screen because there is no need on the answer for room to make notes about the possibilities in each cell.
- **Print blank solving grid**: (or Ctrl-G on the keyboard) prints a grid with no cells solved, and possibilities 1-9 showing in each cell. This is useful when you are solving a puzzle by hand, because it makes it easier to keep track of which values are possible in each cell. But you have to be disciplined for it to work: each time a cell is solved, you must cross out that value in the possibilities of cells in the same row, column, and box.

There are two options related to printing that you can change. They are found on the Edit>Preferences>Printer menu.

- **Print puzzles in color**: prints puzzles using the same colors that are shown on your screen. If this option is not selected, puzzles will be printed in black, gray, and white. If you print lots of puzzles, you might save some money by not using your color inks.
- **Print full size**: Normally, the size of a printed puzzle is roughly the same as its size on your screen. If this option is selected, puzzles will be printed as large as the paper in your printer will allow (with a 1/4 inch margin) regardless of their size on your screen. If you have a printer that takes paper much larger than your screen, this is the way to print puzzles that are as large as the paper.
There are several different menus in SudoKoach. This chapter describes what each one does for you. Note that many of these functions are also accessible from the button window and with keyboard shortcuts.

**File**

- **Enter puzzle**: lets you enter a puzzle into SudoKoach. This allows you to use SudoKoach to help you solve puzzles you find in books, newspapers, etc. Click here to see how to enter a puzzle.

- **Create new**: tells SudoKoach to create a new puzzle for you to solve. When you choose this entry, another menu will appear that lists the six difficulty levels of puzzles. Choose whichever one you want. Pressing **Ctrl** and **N** generates another puzzle of the same difficulty as the last one you asked for. Click here for more information about creating puzzles.

- **Open...**: lets you return to a puzzle that you previously saved. In the window that appears, find the file name you used to save the puzzle, and then click the **Open** button. You can then continue working on that puzzle.

- **Save**: lets you save a partially completed puzzle to a file so you can continue to work on it later. If you have already saved the puzzle, this saves it to the same file you used before. Otherwise, you will be asked for a file name as if you had chosen **Save as**.

  Note: **Save** and **Save as** both save the current state of the puzzle plus all of your previous moves. When you continue working on the puzzle later, you will be able to undo moves you made prior to saving it. However, if you had undone some moves and then saved the puzzle, you will not be able to redo those moves after opening the puzzle later.

- **Save as...**: lets you save a partially completed puzzle to a file so you can continue to work on it later. In the window that appears, enter a file name and click the **Save** button.

- **Practice**: lets you practice using specific strategies. Choose a strategy from the menu that appears, and SudoKoach will generate a puzzle whose next move uses that strategy. This is a great way to improve your solving skills. Pressing **Shift** and **P** generates another puzzle using the same strategy most recently practiced. If you choose to practice a strategy that is rare or very rare, SudoKoach will let you know that it might take a while to find a puzzle in which that strategy is used. If you ask for another practice puzzle with the same strategy, this message is not shown.

  NOTE: The puzzles that SudoKoach generates for practice are chosen solely because they use the strategy you've chosen. Once you've found that move, you can continue with the puzzle if you wish, but the remainder of the puzzle could be any level of difficulty from Easy to Superhuman, or even May the Force Be With You.

- **Print setup**: lets you choose which printer you want to use to print puzzles from SudoKoach. You can also change the printer's properties.

- **Print puzzle**: prints the current puzzle on the currently selected printer. If you have not selected a printer with the **Print setup** dialog, your computer's default printer will be used.

- **Print puzzle, no clues**: prints the current puzzle on the currently selected printer. However, the possibilities are not printed in cells which are not yet solved. Puzzles printed in this manner are solved exactly like those you would find in books and newspapers.

- **Print answers**: prints the answers to the current puzzle. Because there is no need to make pencil notations to "solve" the answers, they are printed smaller than regular puzzles.

- **Print blank solving grid**: prints a grid showing all possibilities for all cells. These grids are handy for solving Sudoku puzzles with a pencil. As you write a solution in each cell, cross out that number from the
possibilities in all other cells in the same row, column, and box. The answer to each cell must be one of the possibilities that remain in it.

- **Exit**: exits the SudoKoach program. If you have a puzzle in progress when you do this, you will be asked whether you wish to save it.

**Edit**

- **Copy**: copies the current puzzle to the clipboard. The result is a 9x9 grid of numbers which shows the solution for each cell that is solved, and a 0 for each unsolved cell. Here is an example of a copied puzzle:

```
400050000
008107402
000802001
000000074
053000820
760000000
500706000
906405200
000030005
```

- **Paste**: tries to construct a new puzzle from the data on the clipboard. It is expected that the clipboard will contain 81 digits, but they need not be in a 9x9 grid like the example above. Digits from 1 to 9 are taken as the solution to the next cell. The digit 0 or a dot are taken as unsolved cells. All other characters are ignored. This allows you to import Sudoku puzzles from web sites, emails, and other sources easily, usually with no modification needed to the source itself.

- **Import puzzle**: imports a puzzle from a file. The contents of the file are expected to be as described under **Paste** above.

- **Export puzzle**: exports a puzzle to a file. The result is the same 9x9 grid described under **Copy** above.

- **Preferences**: use these submenus to personalize some aspects of SudoKoach:
  - **Buttons**: lets you choose whether the button window is on the left, the right, or is hidden.
  - **Colors**: lets you modify the colors used for various things in SudoKoach.
  - **Change colors** brings up this screen:

```
Choose the element whose color you want to change and then click the Change Color button.
```
To go back to the default color, click the Default Color button. Click OK when you're done. If you click Cancel, the color won't be changed.

- **Use system colors**: uses your system's default colors for the digits and the background.

- **Cells**: lets you change some behaviors of SudoKoach:
  - **Naked singles**: lets you change the behaviors associated with naked singles.
    - **Highlight naked singles**: if this is checked, cells containing naked singles are outlined in light purple on the board. As your solving skills improve, you may not find it rewarding to hunt for lowly naked singles. If so, check this option so you can get them out of the way more quickly.
    - **Automatically solve naked singles**: when a puzzle is shown that contains a naked single, SudoKoach will solve it for you automatically. If you are showing the solution status and the status is NO SOLUTION, then naked singles will not be automatically solved.
    - **Set delay for automatic solving**: allows you to choose how much time goes by between the display of a puzzle with a naked single and the solving of that cell. You can choose any delay from zero to two seconds. The default is 1/4 second.
  - **Default cell coloring choice**: lets you choose which of the six possible colors is initially selected when you color a cell. You can also specify that the color you used most recently be selected initially.
  - **Show deleted possibilities**: if this is checked, possibilities that you have deleted are shown in light gray, and you can bring them back by right-clicking them. Once a possibility is blocked by a solved cell, it disappears.
  - **Mark cells with no possibilities**: if this is checked, a large X is drawn in cells that have no remaining possibilities. This makes these cells easier to spot.
  - **Hide solved cells**: if checked, nothing will be shown in cells that have been solved. All the information needed to solve the puzzle is shown in the possibilities—you don't really need to see the solved cells. Some people find the solved cells distracting and prefer not to see them. **Note**: the avoidable rectangles strategies are the exception. They depend upon seeing the values in solved cells as well as unsolved ones.
  - **Indicate which cells you solved**: shows the cells that you've solved in a different color than the answers that were given when the puzzle began.

- **Printer**: lets you change printing options:
  - **Print puzzles in color**: if checked, puzzles will be printed using the same colors that are shown on your screen. If not checked, puzzles will be printed using only black, white, and shades of gray. This option helps you to conserve your more expensive color inks.
  - **Print full size**: if checked, puzzles will be printed as large as the paper in your printer allows, regardless of how large the SudoKoach window is on your screen.

- **Strategy list**: lets you change how the list of solving strategies is shown in the Practice drop-down list and the File→Practice menu.
  - **List alphabetically**: makes it easier to find a particular strategy in the list.
  - **List by difficulty**: makes it easier to practice strategies starting with the easiest and moving toward harder ones.

- **Puzzle**: lets you change puzzle options:
Main Menu

- **Allow asymmetric puzzles**: normally, Sudoku puzzles are symmetric, meaning that their initial values are given in pairs on opposite ends of the board (e.g. if cell 1,3 is given initially, cell 9,7 will also be given). Checking this option removes this restriction, and allows SudoKoach to generate puzzles with fewer initial values.

**Undo/Redo**

- **Undo**: undoes the most recent move. Selecting **Undo** again continues to undo moves. You can undo moves all the way back to the beginning of the game.

- **Redo**: redoes the move that you most recently undid. Click **Redo** again to redo the next undone move. You can redo your undone moves all the way to the last move you made. Once you make a different move, however, all undone moves that have not yet been redone are discarded.

- **Undo until OK**: undoes as many moves as needed to eliminate all errors in the puzzle's solution. When finished, this will tell you how many moves were undone.

- **Start over**: erases all of your moves and goes back to the beginning of the puzzle.

**Hint**

- **Little hint**: gives you a little hint. This tells you the simplest strategy that can be applied next.

- **Medium hint**: gives you a medium hint. This tells you the simplest strategy that can be applied next, and the value that is affected.

- **Big hint**: gives you a big hint. A big hint gives you the simplest move to make next.

- **Show answers**: displays the answers to the current puzzle.

- **Solve naked singles now**: when automatic solving (above) is turned off, choosing this entry will solve naked singles until there are no more, but naked singles that appear later in the puzzle will not be solved. Pressing “S” on the keyboard (with no Shift or Ctrl keys) does the same thing. This is handy if you only occasionally want naked singles solved for you.

**Highlight**

Click here to read more about highlighting.

- **Possibilities**: highlights cells that contain the selected number(s) as possibilities, regardless of how many possibilities there are.

- **# of possibilities**: highlights cells that contain the selected number of possibilities, regardless of their values.

- **1 through 9**: selecting one of these menu items causes cells that contain the specified value as possibilities (or, if **# of possibilities** is selected, cells that have the specified number of possibilities) to be highlighted on the board. Use the **Shift** key to highlight multiple values.

- **Next** and **Previous**: These entries change the highlighting to the next (or previous) value, allowing you to cycle through all possibilities more easily.

- **Skip solved #’s**: This entry determines whether numbers that have been solved (or, if **# of possibilities** is selected, numbers for which no cells have that many possibilities) are included when using **Next** and **Previous** to see highlighted possibilities. By default, solved values are skipped.

- **Any, 2 or more, All, and Only**: These entries only apply when **Possibilities** is chosen and two or more values are chosen for highlighting.
If Any is selected, cells which contain any of the chosen values will be highlighted.
If 2 or more is selected, only cells containing two or more of the chosen values will be highlighted.
If All is selected, only those cells that contain all of the chosen values are highlighted.
If Only is selected, cells are highlighted only if every one of their possibilities is one of the chosen values.

In addition, when two or more values are chosen, different colors are used to highlight cells with different properties:
- Light gray: cells that contain only one of the chosen values.
- Light red: cells that contain two or more (but not all) of the chosen values.
- Light green: cells that contain all of the chosen values.
- Light yellow: cells in which every possibility is one of the chosen values.

Clear: This entry turns off all highlighting.

Help
- Help: Displays the help and instructions file that you are looking at now.
- About: Displays the version number of SudoKoach.

Solution ➤: This entry has a submenu that contains three items:
- Check solution: This checks the puzzle to make sure that it can still be solved. This is an easy way to ensure that you're still on the right track.
- Rate Puzzle: If you have entered a puzzle using File→Enter puzzle or by importing or pasting it, selecting this entry will cause SudoKoach to rate the puzzle so you can compare its difficulty to puzzles that SudoKoach might generate.

Strategies Used: Shows a list of the strategies that SudoKoach needed to solve the current puzzle.  
NOTE: If you ask for big hints until the puzzle is solved, every strategy on the list will show up in one of the hints. But if you solve the puzzle in a different order than SudoKoach, you might not need to use some of the strategies listed, or you might use strategies that are not listed. This is not an error, but rather a side effect of the fact that SudoKoach solves puzzles by applying the strategies in a particular order.

Online ➤: This entry has a submenu with two items:
- SudoKoach web site: Takes you to the SudoKoach web site where you can check for updates and other recent developments.
- Update SudoKoach: Allows you to update your copy of SudoKoach when a new version becomes available. There are two choices: Check the Internet for updates checks whether a new version is available. If so, it will be downloaded and installed automatically; just follow the instructions that you see. Click here for more details.

If you run into a problem with the automatic update, you can download the update from our website and then install it manually, following the instructions that come with the download. One of the steps will instruct you to select Decrypt an update that you've downloaded.

6.8 Highlighting Cells

Highlighting is a very useful tool. There are two styles of highlighting:
- **Possibilities**: all cells containing the specified value(s) as possibilities are highlighted, regardless of how many possibilities the cell has. This makes finding hidden singles a breeze, and is also useful for singles chains, coloring, and other strategies.

- **# of possibilities**: all cells containing the specified number of possibilities are highlighted, regardless of the values of the possibilities. This style is helpful when looking for naked pairs, triples, quads, pairs chains, XY-wings, XYZ-wings, and other strategies.

Select the style you want with the Possibilities and # of possibilities entries on the Highlight menu, or with the two buttons in the top row of the Highlight section of the button window, whichever is more convenient:

![Highlight window]

### 6.8.1 Highlighting Possibilities

**Highlighting one possibility**

To highlight all cells that contain a certain possibility, make sure the Possibilities style is selected, and then just click the button for that value in the Highlight section of the button window:

![Highlight possibilities]

In this example, all cells that contain 5 as a possibility will be highlighted.

The button will change color and stay in the down position when you click it—this makes it easy to see which values are highlighted. You can also use the number entries (1 through 9) on the Highlight menu or the number keys on your keyboard to highlight values—use whichever method you find most convenient. But no matter how you highlight values, the buttons illustrated above will always show you which value or values are currently highlighted.

Cells that contain the highlighted value are shown with a gray background, and the value itself is shown in blue, like this:
Hidden singles stand out like a sore thumb this way.

To turn off highlighting for a value, just click its button again (or use the menu or keyboard). Or you can click the Clear button (or use the Clear entry on the Highlight menu, or press "c" on your keyboard). Also, highlighting another value automatically turns off highlighting of the previous value.

To highlight the next value in sequence, just click the Next button (or choose Next from the Highlight menu, or press "n" on the keyboard). Clicking Next when 9’s are highlighted starts over with 1’s. To go backward, click Previous instead.

When a number has been completely solved, its button disappears from the Highlight box:

This makes it easy to see which numbers you don't have to spend any more time searching for. By default, Next and Previous skip past these numbers. You can change this behavior if you wish: just uncheck Skip solved #'s on the Highlight menu.

**Highlighting several possibilities**

You can highlight several values at once with the Shift key. When you highlight a value while holding the Shift key down, any values that are already highlighted will remain so. Different colors are used to indicate cells that contain various combinations of highlighted values. In this example, 4’s, 5’s, and 6’s are highlighted:
Light gray: cells that contain only one of the chosen values.
Light red: cells that contain two or more (but not all) of the chosen values.
Light green: cells that contain all of the chosen values.
Light yellow: cells in which every possibility is one of the chosen values.

These make various combinations easier to spot. For instance, to spot naked pairs, highlight the 1’s and 2’s, and then use Next to highlight all other combinations. If you find a group that contains exactly two light yellow cells, you’ve found a naked pair.

If two or more values are highlighted, Next and Previous go through a cycle that shows all combinations of that number of values. For instance, if 5’s and 6’s are highlighted, Next will move to 5’s and 7’s, then to 5’s and 8’s, then 5’s and 9’s, then to 6’s and 7’s, and so forth. If Next is selected while 8’s and 9’s are highlighted, the cycle will start over with 1’s and 2’s.

You can control which combinations of highlighted values will be shown on the board with the Any, All, Only, and 2 or More settings (on the button window and also on the Highlight menu):
- If Any is selected, cells which contain any of the chosen values will be highlighted. This is the default.
- If 2 or more is selected, only cells containing two or more of the chosen values will be highlighted.
- If All is selected, only those cells that contain all of the chosen values are highlighted.
- If Only is selected, cells are highlighted only if every one of their possibilities is one of the chosen values.

6.8.2 Highlighting # of Possibilities

Highlighting number of possibilities

The # of possibilities style works much the same as the Possibilities style:
- You can highlight a single number.
- You can highlight several numbers with the Shift key.
- Next, Previous, and Clear work the same way.
- The menu entries all work the same way.

The differences are:
- Cells are highlighted if they contain the specified number of possibilities, rather than the specific values.
• The number buttons disappear when there are no cells with that many possibilities.

• The Any, All, Only, and 2 or More modes do not apply and are disabled.

To highlight all cells that contain a certain number of possibilities, make sure the # of possibilities style is selected, and then just click the button for that number in the Highlight section of the button window:

In this example, all cells with two possibilities would be highlighted with a gray background, like this:

```
1 8 2 9 5 3 6 4 3
4 7 4 5 7 3 1 6 8
5 3 7 9 2 3 4 2 5
6 9 7 3 8 7 1
9 6 3 1 4 2 3 5
```

Note that the possibilities themselves are not shown in blue because we're interested in how many values a cell might be rather than the values themselves.

In this example, we can see an XY-wing in cells 3,3; 3,4; and 2,6.

To turn off highlighting for a number, click its button again. Also, highlighting another value automatically turns off highlighting of the previous value.

If there are no cells with a particular number of possibilities, then the button for that number disappears from the Highlight box:

**Highlighting several numbers of possibilities**

You can highlight several numbers at once with the Shift key. When you highlight a number while holding
the Shift key down, any numbers that are already highlighted will remain so. In the example below, cells with either two or three possibilities are highlighted:

![Sudoku puzzle grid]

And this makes it easier to see the XYZ-wing in cells 1,7; 2,9; and 2,2.

### 6.9 Marking Chains

Some solving strategies involve chains, or linear sequences of cells that are locked with one another. When you are looking for chains, SudoKoach can help you keep track of the cells you're looking at by drawing lines for you from one cell to another on the board.

To draw lines, you use the mouse and the Shift key. Here are the steps:

1. Move the mouse to point at a cell.
2. Hold the Shift key down.
3. Press and hold the left mouse button down. The cursor changes to a star.
4. Move the mouse to point to another cell and release the mouse button. The line is drawn and the cursor changes back to the usual arrow.
5. Release the Shift key.

The two cells you pointed at are now outlined in red, with a green line between them. To add another cell to the chain, repeat the process, but start by pointing to the cell at either end of the existing chain. You can extend the chain in either direction in this manner.

A cell cannot be on the chain more than once. Attempts to extend the chain to a cell that is already on the chain are ignored. Similarly, you cannot add new cells into the middle of a chain. If you try this, a new chain will be started instead.

To remove a cell from a chain, just point to it with the mouse, hold the Shift key down, and click the right mouse button. To erase the entire chain, point to any cell that is not on the chain, and Shift-right click the mouse. Your chain will also be erased if you ask for a big hint, or start drawing a new chain.

You cannot add cells to or delete cells from a chain that appeared from a big hint. If you want to build a chain when one of these is showing, just delete it (with Shift-right click) and you will be able to draw a new chain.

**Example**

Let's see how drawing chains can be useful. Consider this puzzle:
We are looking for a singles chain involving the value 2, and have therefore highlighted that value. Cell 1,1 might be the beginning of such a chain, so we look for another cell that is locked with it. Cell 1,6 looks good. To remember what we've found so far, we draw a line between these two cells:
Continuing, we look for a cell that is locked with 1,6 on the value 2, but there aren't any. Can the chain be extended from its other end? Yes, cell 7,1 is locked with cell 1,1 so we draw another line:
It is now easy to see that cell 7,4 is locked with cell 7,1 so we draw another line:
Singles chains must have at least four cells, so we can now begin to look for possibilities to eliminate. Are there any cells in which 2 is possible that are covered by both ends of the chain? Yes, cell 8,6 is covered by both 1,6 and 7,4, so we can remove 2 as a possibility from it.

Drawing these lines to mark the chain does not find the chain for us, it merely makes it easier to keep track of what we have found so far. As such, it is not considered to be a hint (even though it looks a lot like some big hints). It is, however, a very useful tool for finding these types of strategies.

6.10 Coloring

Coloring is a very powerful technique. When a particular possibility appears in exactly two cells in many groups, coloring can help you keep track of the locking between these cells. This makes it easier to visualize the consequences of any particular cell either being or not being that possibility.

Coloring a cell involves the mouse and the Ctrl key:

1. Move the mouse to point at a cell.
2. Hold the Ctrl key down.
3. Click the left mouse button, and this window appears:
4. Click one of the six colored buttons.

5. Release the Ctrl key.

To remove the coloring from a cell, point to it with the mouse, hold the Ctrl key down and click the right mouse button. You can also remove the coloring from all cells by clicking the Clear all button in the window above.

Notes on coloring

As with all colors in SudoKoach, you can change these six colors if you wish.

It is recommended that you highlight the value you are investigating. This makes it much easier to spot cells that contain this value.

If you color a cell that is highlighted, the highlighting will no longer be visible. If the coloring is removed from the cell, the highlighting will again become visible.

If you change which values are highlighted, all colored cells will be cleared. Similarly, asking for a big hint clears the coloring on all cells.

Coloring techniques

There are many techniques that use coloring. The next chapters describe several of them. It is worth the effort to learn them!

6.10.1 Contradictions

Technique 1: Looking for contradictions

One of the easiest techniques to understand is searching for contradictions. Consider this puzzle:
There are numerous groups in which the value 3 is a possibility in only two cells. We'll start with one of these cells: 2,2. If this cell were 3, how would that affect where 3's could appear in the other cells? Coloring will make it obvious.

Let's color cell 2,2 green to indicate our assumption that it is 3, and then color all of the cells that it covers red to indicate that they cannot be 3. The board now looks like this:
There is now only one cell left in row three (cell 3,5) that can be 3. Similarly, there is only one cell in column three (cell 8,3) that can be 3. Let's color both of them green, and color all of the cells that they cover red. We now have:
Box eight now has no cells left that can be 3! This is clearly impossible, so the initial assumption that cell 2,2 might be 3 must be incorrect. We can remove 3 as a possibility from cell 2,2.

Note that we did not simply assume that cell 2,2 was 3 and start solving. Coloring allowed us to see the consequences of this assumption before making any moves. But now that we know cell 2,2 cannot be 3, it is clear that cell 3,3 must be 3 because it is the only other cell in box one that can be. We can solve this cell now with complete confidence.

If our original assumption had not led us to a contradiction, that would not prove that the assumption was correct. Consider this puzzle (only the first three rows are shown):

There are only four cells that can be 1, and we have colored them based on the assumption that cell 1,2 is 1. There are no contradictions. But if we assume that cell 1,2 is not 1, we get this coloring:
There are no contradictions with this coloring either! Of course, it cannot be true that both solutions are correct. What makes one of them wrong is that a 1 is placed in a cell which must be some other value, and the coloring does not show that. The apparent lack of a contradiction only indicates that we are not looking at enough information to see the contradiction that is actually there.

Nevertheless, each time a coloring leads to a contradiction, you know for sure that the initial assumption must be incorrect.

6.10.2 Impossible Possibilities

**Technique 2: Impossible possibilities**

Another technique is to color only the cells that are locked on some value. Here is an example:

We have colored all of the cells that are locked with each other on the value 7. For example, in row two cell 2,1 is green and cell 2,2 is red. But cell 2,1 is also locked with cell 5,1, so we color cell 5,1 red (the opposite
color of cell 2,1). We then color cell 4,3 green (opposite of 5,1), so cell 9,3 becomes red, and so forth.

Unlike the previous technique, we are not making any assumptions about which cells actually are 7, we are only marking the pairs for which one must be 7 and the other must not be. Therefore, we do not color any cells that are covered by colored cells but not locked with them.

Now we can say for certain that either all of the red cells are 7, or all of the green cells are 7. Therefore, any cell that is covered by both a red cell and a green cell cannot possibly be 7.

Cell 8,6 is covered by a red cell (6,6) and a green cell (8,2). We know that one of these colored cells must be 7, so we can remove 7 from cell 8,6.

In the Contradictions technique, we were able to say, "If cell X,Y is 3, then these other cells cannot be 3." But with this technique, we can say much more:

- Either all of the green cells are 7 and none of the red ones are, or
- all of the red cells are 7 and none of the green ones are.

The reason this works is that we only colored the cells that are locked.

6.10.3 Overpopulated Groups

**Technique 3: Looking for overpopulated groups**

In this technique, we are trying to find colorings that force a group to have two cells with the same value. Because this situation is not allowed, the coloring tells us which cells must be this value and which ones cannot be.

Here is a puzzle in which we have colored cells that might be 3, but we've only colored the pairs of cells that are locked with one another (only the first six rows are shown):

Because we've only colored cells that are locked, we can say for certain that either all of the green cells are 3, or all the red cells are 3. However, row two tells us that the green cells cannot be 3—if they were, there would be two 3's in the row. Therefore, none of the green cells can be 3, which means that all of the red cells must be 3.

That solves three cells, and removes possibilities from four more cells, which is a lot of results for our
6.10.4 Multiple Chains

**Technique 4: Multiple chains**

A series of cells that are all locked together on a value is called a chain (specifically, a singles chain). Often a puzzle will contain two or more separate chains—coloring multiple chains is a way to find moves that cannot be found with a single chain. Here is an example with the 4's highlighted:

We'll start with cell 2,1 and see how many locked pairs we can color, this time using the light green and dark green colors:
We didn't get very far—there are no more cells locked with any of the green ones. But there are more locked pairs, so let's color them red and pink:
From this coloring, we know:

- Either the light green cells must be 4, or the dark green cells must be 4.
- Either the pink cells are all 4, or the red cells are 4.

But the cell 4,3 (pink) is covered by cell 3,3 (dark green), and cell 9,6 (pink) is covered by cell 9,9 (light green). We can now conclude:

- If the light green cells (including 9,9) are 4, then the pink cells (including 9,6) cannot be 4.
- If the dark green cells (including 3,3) are 4, then the pink cells (including 4,3) cannot be 4.
- Either the light green cells are 4, or the dark green cells are 4.
- Therefore, the pink cells cannot be 4, and the red cell must be 4.

In the Impossible Possibilities technique, you color cells based on some value, V. Then, any cell that is covered by cells of alternate colors cannot possibly be V. With multiple chains, we simply extend this conclusion to like-colored cells that are locked in a chain. We can do this because we are only coloring cells that are locked.

With this technique (and the next one), it is vital to remember which colors go together. That is why SudoKoach uses pairs of colors, one light and one dark. It is easier to remember that light green and dark green go together than it would be to remember that green and blue go together. Of course, if you don't like these colors, you can always change them to whatever you prefer.
6.10.5 Too Much Togetherness

**Technique 5: Too much togetherness**

Suppose you've found a chain of cells locked on some value \( V \) and colored them light blue and dark blue. You then find another chain locked on \( V \) and colored them light green and dark green.

If you can find any group that contains both light blue cells and light green cells, then any cells that are covered by a dark blue cell and a dark green cell cannot possibly be \( V \).

The reasoning is simple:

- If any group contains a light green and a light blue cell, then these colors cannot both be \( V \).
- Therefore, one of the darker colors must be \( V \) (though we don't know which one).
- Any cell covered by both of these darker colors cannot be \( V \).

It is entirely possible that both of the darker colors might be \( V \), but the conclusion is still valid.

Of course, the choice of light/dark in this description is completely arbitrary, and was done only to simplify the explanation. More precisely:

- If any group contains both blue and green cells, then these colors cannot both be \( V \).
- Therefore, one of the opposite blue or green colors must be \( V \) (but we don't know which one).
- Any cells covered by both of these opposite colors cannot possibly be \( V \).

Or, to put it another way, if two colors are together in a group, no cell can be together with their opposite colors (that would be too much togetherness).

Consider this puzzle, in which we have colored cells that are locked on the value 4:
We see that light green and light blue both appear in box six. That means any cell which is covered by a dark green cell and a dark blue cell cannot possibly be 4.

Cells 6,1 and 6,2 are both covered by a dark green cell (5,1) and a dark blue cell (6,4), so we can remove 4 as a possibility. Because light green and light blue cannot both be 4 (they both appear in the same group), either dark green or dark blue must be 4.

6.11 Hints

Hints are useful when you get stuck on a puzzle. Once of the nice features of SudoKoach is that it can give you different levels of hints. When you get stuck, a little hint might be just enough of a clue to get you going again without giving you so much information that you feel like the program is solving the puzzle for you.

You can get a hint by clicking one of the buttons in the button window, by using the Hint menu, or with keyboard shortcuts.

Note: if you ask for a hint and the hint dialog does not appear right away, don't panic—SudoKoach is probably looking for a composite chain, and on some puzzles this can take quite a while (as much as several minutes, depending on how fast your computer is). Just be patient and your hint will eventually appear.

Little Hints

A little hint gives you the name of the simplest strategy that can currently be applied to the puzzle. A little hint looks like this:
Click the OK button to dismiss this window and continue solving the puzzle. If you click the Explain strategy button, an explanation of the strategy will be displayed. This is very helpful when you are learning new strategies.

**Medium Hints**

A medium hint gives you the name of the simplest strategy that can be applied to the puzzle, and the value that will be involved. A medium hint looks like this:

Click the OK button to dismiss this window and continue solving the puzzle. As with little hints, the Explain strategy button causes a description of the strategy to be displayed.

**Big Hints**

A big hint gives you the next move. It tells you the strategy involved, the value to which it applies, the cells that are affected, and explains how the resulting move is justified. It also highlights the board to make the move easier to see and to understand. The exact appearance of a big hint depends on which strategy is involved, but they will look something like this:
Once the hint is showing, you can click one of four buttons:

- **Yes**: SudoKoach will make the move for you. You may then continue solving the puzzle.
- **No**: The move will not be made, but the highlighting will be left on the board. This is handy if you want to study the move in more detail.
- **Cancel**: The move will not be made, and the highlighting will be erased from the board.
- **Explain strategy**: Displays the section of the Help file that explains the strategy used, including examples.

### 6.12 Keyboard Shortcuts

Keyboard shortcuts can save you time by letting you perform common tasks from the keyboard rather than with the mouse. If a menu item has a keyboard shortcut associated with it, the shortcut will appear on the right side of the menu. For example, in this menu:
the shortcut for the **Undo** command is "u" (it doesn't say to shift, so don't), while the shortcut for the **Undo until OK** command is to hold the **Shift** key down and press "u".

Here are the shortcuts implemented in SudoKoach, the equivalent button from the button window (if there is one), the equivalent menu entry, and the function that is performed.

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<td>Hint Big hint</td>
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</tr>
<tr>
<td>C</td>
<td>Clear</td>
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</tr>
<tr>
<td>L</td>
<td>Little Hint</td>
<td>Hint Little hint</td>
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</tr>
<tr>
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<td>Previous</td>
<td>Highlight Previous</td>
<td>Highlight the previous value or combination of values</td>
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<tr>
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</tr>
<tr>
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</tr>
<tr>
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<td>Ctrl+X</td>
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<td>File ▶ Print puzzle, no clues</td>
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<tr>
<td>Shift+P</td>
<td>Practice</td>
<td>File ▶ Practice ▶ (strategy)</td>
<td>Creates a puzzle to let you practice the same strategy you most recently practiced</td>
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<tr>
<td>Shift+R</td>
<td>Help ▶ Solution ▶ Gauge puzzle</td>
<td>Help ▶ Solution ▶ Check solution</td>
<td>Analyzes a puzzle to determine its level of difficulty</td>
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<tr>
<td>Shift+S</td>
<td>Solution status:</td>
<td>Help ▶ Solution ▶ Check solution</td>
<td>See if the puzzle can still be solved</td>
</tr>
<tr>
<td>Shift+T</td>
<td>Help ▶ Solution ▶ Strategies used</td>
<td>Help ▶ Solution ▶ Check solution</td>
<td>Show a list of the strategies used in the current puzzle</td>
</tr>
<tr>
<td>Shift+U</td>
<td>Undo until OK</td>
<td>Undo/Redo ▶ Undo until OK</td>
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<tr>
<td>Shift+V</td>
<td>Start Over</td>
<td>Undo/Redo ▶ Start over</td>
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Note: If you want to use the numeric keypad to highlight possibilities, be sure that the Num Lock mode is on. If it is off, the behavior of the Shift key with the keypad number keys will be incorrect.
7 Technical Support

Registered users are entitled to one year of free technical support. To obtain help, contact us via US mail:

KMR Consulting
5227 Fox Hills Road
Fort Collins, Colorado 80526
USA

or by electronic mail:
support@KMRConsulting.com

or through our web site:
www.KMRConsulting.com

Shareware users with questions are also welcome to contact us.

7.1 Installing Updates

Updates and fixes to SudoKoach are available to registered users from our World Wide Web site www.KMRConsulting.com. The process of installing an update is almost completely automatic. First, make sure that your computer is connected to the Internet. Then go to the Help menu, choose Online, and select Update SudoKoach→Check the Internet for updates. If an update is found, you will be asked whether you want to download it. Once the file has been downloaded, it will be decrypted automatically. You will then be asked whether you want to install the update. If you choose not to, you will be told how to install the update later.

Note: some virus checkers can be set to prevent “unexpected” programs from accessing the Internet. If you’re having trouble downloading an update, this may be the problem.

If you’re having trouble with the automatic download process, you can visit our web site and download the update yourself. Then unpack it according to the instructions on our web site. To complete the installation, follow the instructions in the read_me.txt file.

Note that the shareware version of SudoKoach is not capable of installing these updates.

7.2 How to Resolve Printing Problems

Errors with printing are one of the most common problems people encounter with Windows programs. If you're having problems printing reports from SudoKoach, here are some things that might correct the problem.

1. If your computer has more than one printer installed, make sure you've selected the right printer.

2. Make sure that the printer is turned on and the cable is connected properly. An easy way to test this is to see if other Windows applications will print—for example, start Wordpad, type some text, and then select File→Print. If nothing appears on the printer, or if the printout is garbled, then the problem is in your printer setup or cabling.

3. Make sure you have the latest driver for your printer. Printer manufacturers often provide updated drivers for their products via online services such as AOL and through their own World Wide Web sites. If there is a newer driver available for your printer, download it and install it.

4. If all else fails, give us a call. We'll try to help you solve your problem.
7.3 Limitations in the Shareware Version

The shareware version of SudoKoach is fully functional so you know what you'll get when you purchase a license to use it. There are exactly four differences between the shareware and registered versions.

1. The shareware version stops working after 30 days. Hopefully 30 days is enough time to try it out and decide whether or not you'd like to register it. The registered version works for as long as you want to keep using it.

2. The shareware version shows a registration reminder screen when the program starts and again when it ends telling you how many days of free trial you have left. The registered version does not show these screens.

3. The shareware version includes an extra menu item: "Order SudoKoach online." The registered version omits this item.

4. In the shareware version, the functions that update the program are disabled. The registered version can automatically download and install updates when they become available.

7.4 Revision History

We hope you like SudoKoach, but if you have any ideas on how it might be improved, by all means let us know.

Version 2.4, released 3/8/2019
- Fixed the online update feature to work with my new website host.

Version 2.3 (Released 2/8/2010)
- The timer is paused when SudoKoach is minimized (thanks to John Bailey).
- You can now choose to mark unsolved cells in which there are no possibilities (thanks to John Bailey).
- When opening a saved puzzle, the timer continues from where it was when the puzzle was saved rather than starting from zero.
- International keyboards caused an error message to appear every time SudoKoach started up. You can now prevent this message from being displayed again (thanks to Marjolein Hoekstra).
- The box that appears when you ask for a little or medium hint now contains a button you can click to explain the strategy used in the next move (thanks to Marjolein Hoekstra).
- The list of strategies shown in the File|Practice menu and also in the drop-down list next to the Practice button can now be shown in alphabetic order or in order by difficulty (thanks to Marjolein Hoekstra).
- You can now display the answers to the current puzzle (thanks to R. J. Allen).
- When you double-click a saved puzzle, SudoKoach now reads your preferences properly.

Version 2.2 (Released 7/22/2008)
- (As of 2.2a) Fixed an error that caused printed answers to be incorrect for puzzles that were entered, imported, or pasted.
- You can now highlight cells based on the number of possibilities they contain (thanks to Ron Jackson).
- You can now color cells on the board to help you find moves (thanks to Ron Jackson).
- You can draw lines on the board to help you find chains in the puzzle.
- Added new solving strategies: Avoidable Rectangles (types 1, 2, and 3).
- Added new solving strategies: Locked cell cycle, type 1 and 2.
- Added new solving strategies: Unique Rectangle (type 5) and Unique Rectangle (type 6).
- The definition of Unique Rectangle (type 3) has been broadened to include more cases.
- Singles chain contradictions now result in far more possibilities being removed.
• Naked singles can now be solved automatically so you don't have to waste any time on them (thanks to Wolfgang Junker).
• Automatic solving of naked singles will not happen if the puzzle has no solution (thanks to Ron Jackson).
• You can have the current batch of naked singles solved for you without automatically solving all of them (thanks to Ron Jackson).
• You can choose the color to be used on the highlight buttons (thanks to Wolfgang Junker).
• Highlight buttons stay in the down position when they are selected (thanks to Wolfgang Junker).
• There is a new option to print puzzles full size, regardless of how large the SudoKoach window is on your screen.
• Printing of puzzles has been improved, especially when SudoKoach is full-screen.
• Asymmetric puzzles are now allowed.
• Added a busy indicator with the ability to cancel operations that are taking a long time.
• Highlighting multiple values with Shift and number keys now works on non-US keyboards (thanks to Wolfgang Junker).
• Internal changes that speed up handling of puzzles constructed specifically to confound computer programs (thanks to Wolfgang Junker).

Version 2.1 (Released 6/18/2007)
• You can now choose to print puzzles in black-and-white to save your expensive color ink.
• SudoKoach now stores your preferences and any puzzles you've saved in the My Documents folder (on Vista, it is just called Documents), and other changes for Vista.
• (As of 2.1a) Modified to prevent a failure caused by a bad file distributed by Microsoft through Windows update.
• (As of 2.1b) Fixed a bug that prevented the creation of Superhuman puzzles.

Version 2.0 (Released 2/9/2007)
• If you choose to hide the solved cells, numbers that have been completely solved are now skipped in highlighting sequences (as of version 2.0a).
• Deleted possibilities can now be made visible, and you can undelete them.
• You can now specify that naked singles should be outlined on the board, to save you the time of looking for these uninteresting cells yourself.
• You can customize the colors used by SudoKoach to your liking.
• You can also specify that your system's default colors be used instead of SudoKoach's default colors for the digits and the background.
• There is a new button window with buttons for commonly-used features.
• You can specify that cells you've solved be shown in a different color than cells whose answers were given.
• You can specify that the answers for solved cells be hidden (thanks to Peter Gradeff).
• Some big hints are enhanced with additional coloring.
• Values that have been completely solved are now skipped in highlighting sequences.

Version 1.3 (Released 11/15/2006)
• The Help file is now available in PDF form for easier printing (as of version 1.3a).
• The big hint dialog now has a button you can click to get an explanation of the strategy used in the hint.
• You now have more options for highlighting cells that contain certain possibilities.
• When moving from one highlighted state to the next, you can now choose to skip states in which no cells are highlighted.
• You can now print the answers to the current puzzle (thanks to David Epstein).
• A new strategy has been added: Rectangle Elimination. While this is an advanced strategy, it is fairly easy to learn and occurs frequently.
• A new strategy has been added: Unique Rectangles type 3.
• If you make a mistake while entering a puzzle from a book or newspaper, you can now fix it by right-clicking the erroneous cell (thanks to Tom Wallenhorst).
• You can now get a list of the strategies are needed to solve the current puzzle.
• The composite chain and composite chain contradiction strategies are now classified as superhuman rather than advanced.
• The hidden triple and naked triple strategies have been reclassified as intermediate. This change causes XY-wings contained within one group to be recognized as naked triples, which is an easier strategy to spot.
• The warning about generating a practice puzzle for a rare or very rare strategy is skipped if the previous practice puzzle you requested was for the same strategy.
• The Practice menu now has a keyboard accelerator, **Shift+P**, which automatically goes to the strategy you practiced most recently.
• The Create new puzzle menu also has a keyboard accelerator, **Ctrl+N**, which automatically creates another puzzle with the same difficulty as the last one you created.

**Version 1.2 (Released 9/3/2006)**
• The puzzle difficulty ratings were changed to be more uniform (thanks to Silvio Podcameni).
• A new practice feature allows you to get puzzles that contain the strategies you want to practice solving.
• You can now restart a puzzle with the **Start over** entry on the **Undo/Redo** menu (thanks to Silvio Podcameni).
• A new strategy was added: Weak Singles Chain Contradiction.
• Frequency information was added to the descriptions for the solving strategies.

**Version 1.1 (Released 7/15/2006)**
• The help file is now complete. It includes descriptions of all of the Sudoku solving strategies that are implemented in SudoKoach, and the SudoKoach Reference Manual.
• Several separate menu entries were consolidated. **Undo** and **Redo** are now found under **Undo/Redo**, and the **Solution** and **Online** menus are now found under **Help**.
• There is a new menu option under the **Undo/Redo** menu: **Undo until OK**. If there are any errors in the puzzle, this will undo as many moves as needed to eliminate all of the errors.
• **Save** and **Save as** now save all your prior moves so that when you continue working on the puzzle later, you can undo these moves if you wish. This is particularly helpful for **Undo until OK**.
• You can now generate superhuman puzzles if you really, really want to.
• You now get some feedback when you finish a game, and if you try to exit the program with an unfinished game, you are asked whether you want to save it (thanks to Bill Stratton).
• The big hint dialog is now sized more appropriately for the length of the hint.
• The pairs chain logic was improved: the chain need not be an even number of cells in length.
• The naked triple and naked quad logic was improved. Some triples and quads were not being detected (though the complementary hidden set was).
• The "Enter puzzle" dialog was improved (thanks to Bill Stratton).
• Added a timer to puzzle creation that prevents spending more than 5 seconds on any candidate puzzle.
• The screen is now drawn correctly if your default window background is not white (thanks to Jack Wallenhorst).

**Version 1.0 (Released spring 2006)**
• Initial release.
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