Sudoku Solver Manual

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Introduction

This is one of many Sudoku programs available online. Some are better, some are worse though most, if not all, will help you learn how to play. Some will teach you advanced strategies for solving Sudoku puzzles, as this one will try to do. You can, of course, decide to use the program to solve your puzzles for you instead of using it as a tool to learn more about Sudoku. It's pretty good at that too.

You may download the program from www.dadler.net/sudoku. The setup program on the webpage will install Sudoku Solver along with the .Net runtime (if needed). Once installed, Sudoku Solver automatically checks for updates, offering to download and install them for you when they are available.

Introduction to Sudoku

Sudoku takes many forms; one of the most common is based on a 9 by 9 grid of squares. Squares are referred to by their row and column number. For instance, the first square in the puzzle (at the upper left of the grid) is row 1, column 1 (or in shorthand, r1c1). The middle square in the puzzle is at r5c5. The grid below shows the numbering scheme, with column numbers running across the top and row numbers running down the left side:

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

The puzzle is further subdivided into 9 boxes made up of 9 squares in a 3 by 3 grid. The boxes are numbered 1 (from the upper left corner) to 9 (the lower right corner). Box 1 is made up of the following 9 squares (spanning from r1c1 to r3c3):

r1c1	r1c2	r1c3
r2c1	r2c2	r2c3
r3c1	r3c2	r3c3

Boxes within the Sudoku puzzle run from left to right, then from top to bottom. Box 3 starts at r1c7 (ends at r3c9), box 4 at r4c1 (ends at r6c3), and box 9 at r7c7 (ends at r9c9).

Within a Sudoku puzzle, any single row, column or box is also known as a house. The key rule to solving Sudoku puzzles is that each house (row, column and box) must have exactly one occurrence of the digits 1 through 9. A digit may not be omitted, nor may a digit be repeated within a house. We'll refer to this as the House Rules.

Sudoku Puzzles

A Sudoku puzzle is presented with somewhere between 17[1] and 80 of the 81 squares filled in with digits. To solve the puzzle, you must deduce the placement of the digits in every blank square. Most Sudoku players agree that a Sudoku puzzle must have one and *only one* solution; that is, if there is more than one value possible for a blank square, then the puzzle is not a valid Sudoku. Without this precondition, many of the deductive solving techniques employed on more difficult puzzles would fail.

These simple rules allow for a very, very broad set of puzzles ranging in difficulty from simple to insanely difficult. In general, a "good Sudoku" puzzle is one that may be solved through logic and deduction; no guessing is required. There is often debate as to where the line between logic and guess work lies; this guide will explain how Sudoku Solver does things. From there, you can learn more by using Sudoku Solver, working on puzzles, reading other sources on Sudoku puzzles and deciding what works best for you.

Sudoku Solver

Sudoku Solver is a Windows-based program (for those that care, it is written in C# and requires the .Net runtime v3 or later). Sudoku Solver will help you download, create, validate and solve 9x9 Sudoku puzzles. Most of the features in Sudoku Solver are dedicated to helping you find logic-based solutions to Sudoku puzzles, though if you like it can easily and quickly provide you with the solution for any valid 9x9 Sudoku puzzle without further ado.

The idea behind this manual is to teach you how to use Sudoku Solver first to solve puzzles, then to download, generate, validate and finally create your own.

[1] As of this writing, there are no known examples of valid Sudoku puzzles that start with fewer than 17 squares filled in.

This manual is meant to serve as an introduction to Sudoku and Sudoku Solver. Sudoku Solver also uses a special version of this manual as its help file (accessible from the Help menu or by pressing F1).

Solving Tutorial

Sudoku Solver implements a variety of logical / deductive techniques to solve Sudoku puzzles. The simplest of these is brute force solving, also called Trial & Error, Adriane's Thread or Recursion (my preferred moniker). Recursion, while tedious and error-prone for people, is very fast when implemented properly on computers; it can solve the most difficult 9x9 Sudoku puzzles in mere fractions of a second. If the puzzle has a solution, Recursion will find it. A handy trick, but not very interesting insofar as learning techniques that will help you to solve puzzles on your own.

This section will take you through Sudoku Solver's toolkit of techniques, from the simplest to the most complex, with an eye towards teaching you how to use these techniques on your own.

Solving With Singletons

For our first example, a simple sample is called for. Here is a text representation of a very easy Sudoku puzzle:

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

In this puzzle, there are 41 squares given and 40 blanks; the blank squares are represented by periods (.). To make the boxes easier to see, they are marked off by "+-|" characters. You'll see this shorthand text format used elsewhere in this document (it also happens to be one of a few common formats used to post Sudoku puzzles on Internet boards).

This puzzle is a very easy puzzle to solve because there are squares where only a *single value is possible* from the outset. Such squares are said to be singletons, and there are two types of singletons: open and hidden. How does one find singletons? One way is to use Sudoku Solver; it displays puzzles with data designed to help you solve the puzzle. Sudoku Solver refers to this data as hints (or hint values); they're also called pencil marks, or PMs for short. Again, using a text representation, here is the PM grid for this puzzle:

```
67    369 2    | 346 5  34   | 8    1   467
4     368 136  | 7   2  123  | 9    5   6
167   5   167  | 46  8  9    | 26   47  3
-------------+-------------+-------------
8     2   5    | 1   4  7    | 3    6   9
9     7   4    | 8   3  6    | 1    2   5
3     1   6    | 2   9  5    | 4    8   7
-------------+-------------+-------------
2     36  367  | 5   1  34   | 36   9   468
1567  36  9    | 34  47 8    | 1356 345 2
15    4   8    | 39  6  23   | 7    35  1
```

Just as with the puzzle representation, PMs are laid out in a 9x9 grid with "+-|" used to separate the boxes from one another. Instead of a single digit or period for each square, PMs show the squares with one or more digits. Any square that was given in the puzzle will show up as a single digit (or singleton) in the PMs. For instance, looking at box 1, r1c3 = 2, r2c1 = 4 and r3c2 = 5 which matches up with the given numbers for box 1 in the puzzle.

The squares with multiple digits shown are squares where given digits have restricted the possible digits down to those listed. Restrictions on a square come from the other squares in

the same house. Every square in a puzzle has 20 squares that influence it (those in the same row, column or box, i.e. the same houses).

Looking at r1c1, the squares that affect its possible digits are those in box 1, row 1 and column 1. Row 1 contains 1, 2, 5 and 8. Column 1 contains 2, 3, 4 and 9 (remember that rows and columns are separate houses, so it is ok if they contain the same digit – a 2 in this case). Box 1 contains 2, 4 and 5. Combining these into a single list shows that the 3 houses affecting r1c1 contain 1, 2, 3, 4, 5, 8 and 9, leaving only 6 and 7 as possible values for r1c1. Thus, the PM grid for the puzzle shows "67" for r1c1 (commonly shown as r1c1 = 67).

Returning to the PM squares with singletons… there are other singletons appearing in the PM; singletons in squares that were not given in the original puzzle. For instance, look at box 4: r4c1 = 8. This was not given as an 8 in the original puzzle. Why is it a singleton in the PMs?

The answer also lies in the House Rules: each house must contain exactly one of the digits 1 – 9. Looking first at box 4 in the original puzzle, we can see that 1, 2, 3, 5, 7 and 9 were given, leaving only 4, 6 and 8 available to fill out the 3 open squares in this box. Next, looking at row 5 (the second row in box 5), we can see that it already has an 8 (in box 5 at r5c4); this means we cannot put an 8 in r5c3 (row 5 can only have a single 8). Similarly, row 6 has its 8 in box 6 (r6c8). This means there is only square in box 4 which may contain an 8, and it is r4c1. Furthermore, if we examine box 4, row 4 and column 1, we'd find that every digit other than 8 is already in use (notice that r2c1 = 4 and r4c8 = 6).

This leads to an open singleton 8 in r4c1. Open singletons occur when PMs show one and only one possible value for a square. Finding singletons is the fundamental step to solving Sudoku puzzles, and open singletons are the easiest ones to spot (especially when you are viewing PMs or hint grids). Box 4 has two more open singletons (r5c3=4 and r6c3=6). Look at

the houses adjoining these squares and make sure you understand why these are open singletons.

Hidden singletons also occur. These are found in squares that, while they may have multiple digits possible according to the House Rules, closer examination will show a square with multiple possible digits is the only square in a house that has one particular digit. For instance, looking at r2c2, we can see that r2c2=368. However, notice that rows 1 and 3 (commonly shown as r13) already contain an 8 (r1c7=8 and r3c5=8). These 8's mean that r13 (that's rows 1 and 3, not row 13) in box 1 cannot contain an 8. Also notice that there cannot be an 8 in column 3 (see if you can figure out why this is so). Interestingly enough, if you look at every PM square in box 1, you will notice that only one of these contains an 8, and that is r2c2. This means r2c2=8, and this 8 is said to be a hidden singleton (because there are other *possible* digits not eliminated by the basic PM logic). Thus, we know that r2c2=8.

Understanding how to find open and hidden singles will let you solve many Sudoku puzzles. As you find the singletons, put them into your Sudoku grid (and if you are using PMs make sure that you also cancel them[2] from other squares in the same row, column and box). Repeat these steps until the puzzle is solved. Any puzzle rated from Easy to Hard by Sudoku Solver's rating technique may be solved using nothing more than singletons.

At the time of this writing, this also includes virtually every Easy and Moderate puzzle on WebSudoku.com, and many of the Hard puzzles as well. It also lets you solve every 1 – 4 star puzzle from UClick's Daily Sudoku Puzzles[3], as well as many of their 5-star puzzles. Start with the easier puzzles, and as you master those, work your way up. Sudoku Solver can also give

[2] When you place a digit into Sudoku Solver's grid, it automatically updates the hint digits for you on the screen. More on this later when we examine how to use the features of Sudoku Solver.

[3] UClick serves up puzzles for the Internet version of many publications across the nation. This particular link takes you to those used by the Seattle Times, Sacramento Bee and others.

you its own puzzle difficulty rankings, which while subjective, will give you a common measurement you may apply to puzzles from all sorts of sites.

Patterns - When Singletons Are Not Enough

Finding singletons will not always solve Sudoku puzzles, as you may already know. For instance, let's look at Hard Puzzle #10,297,404,648 from WebSudoku.com:

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

If you find all of the hidden and open singletons in this puzzle, you will be stuck here:

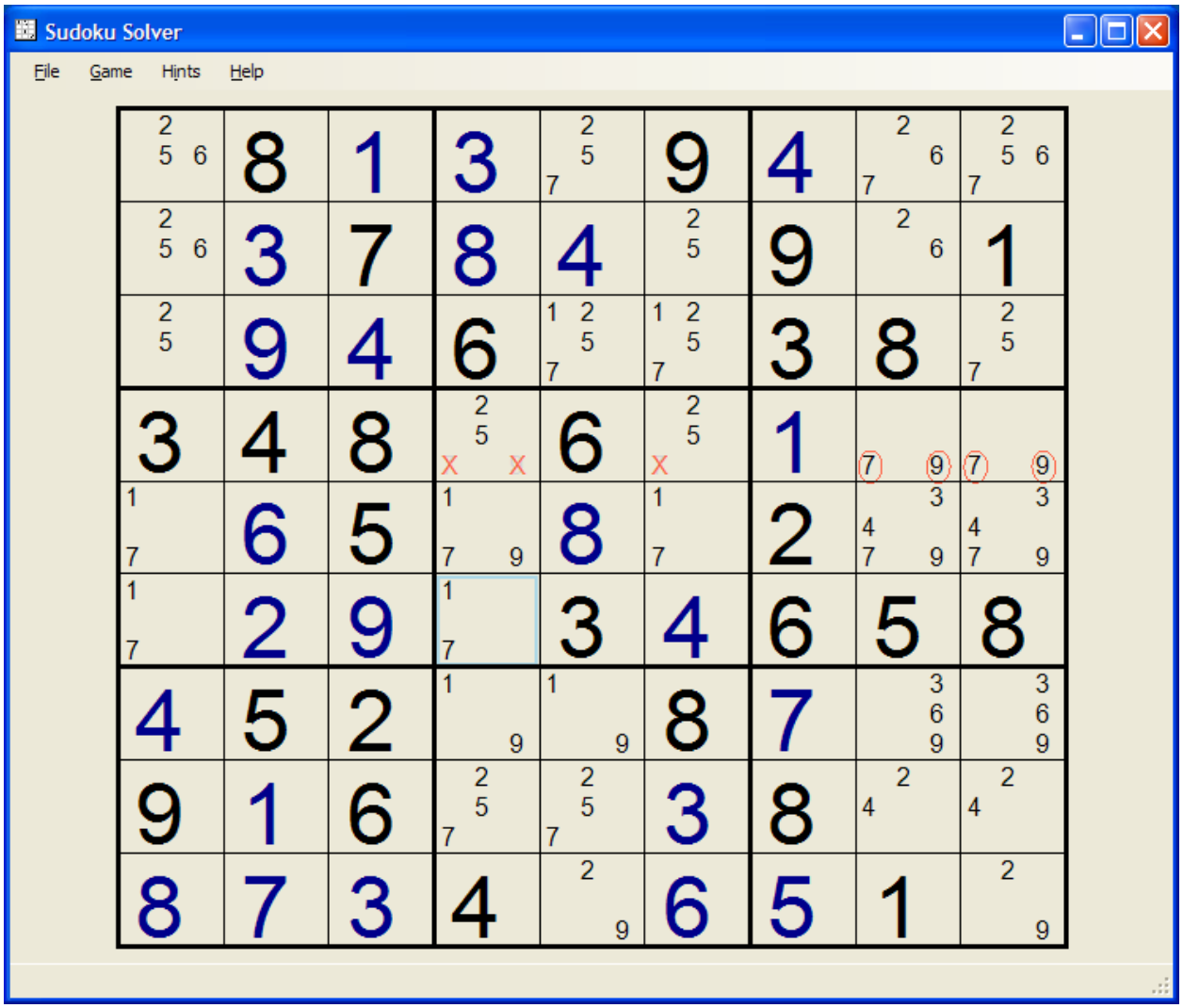
```
256 8 1 | 3    257  9    | 4 267  2567
256 3 7 | 8    4    25   | 9 26   1
25  9 4 | 6    1257 1257 | 3 8    257
--------+----------------+-----------
3   4 8 | 2579 6    257  | 1 79   79
17  6 5 | 179  8    17   | 2 3479 3479
17  2 9 | 17   3    4    | 6 5    8
--------+----------------+-----------
4   5 2 | 19   19   8    | 7 369  369
9   1 6 | 257  257  3    | 8 24   24
8   7 3 | 4    29   6    | 5 1    29
```

Substantial progress, but still several squares left to be solved; as I said earlier, singletons will solve many (but not all) of WebSudoku's Hard puzzles[4]. It's time for a new technique: Open Patterns.

[4] As a point of reference, Sudoku Solver rates this puzzle as Evil.

Open Patterns

At this point, it is worth progressing beyond PMs to snapshots of Sudoku Solver's window (with the hint data):



Sudoku Solver's displays are very easy to customize; this window has the given digits shown in black and the "solved" ones (in this case, those that were found to be singletons) in dark purple[5]. The boxes are made more visible by using slightly bolder lines around their

[5] You might have noticed the light bluish highlight around the edges of r6c4; it will also appear in other screenshots. We'll discuss this in a later section.

borders. Notice the light red X's and O's in boxes 5 and 6. These are highlighting a solving technique known as a Pattern, more specifically an Open Pattern.

Patterns are a solving technique that also takes advantage of the House Rules. Patterns apply within a house. A pattern involves *n* digits across *n* squares in a house. The simplest pattern is 2 values in 2 squares. What we see in box 6 is an open pattern of 2 – in this case a 7, 9 in r4c8 and r4c9. When a pattern is found, then the digits used to create the pattern *cannot be used in any other squares within the house*. In this case, it means that no squares in row 4 other than r4c8 and r4c9 can contain a 7 or a 9 if this is to be a valid Sudoku. This lets us eliminate 7 and 9 from r4c46 (shorthand notation for eliminations of this sort would be: r4c46<>79).

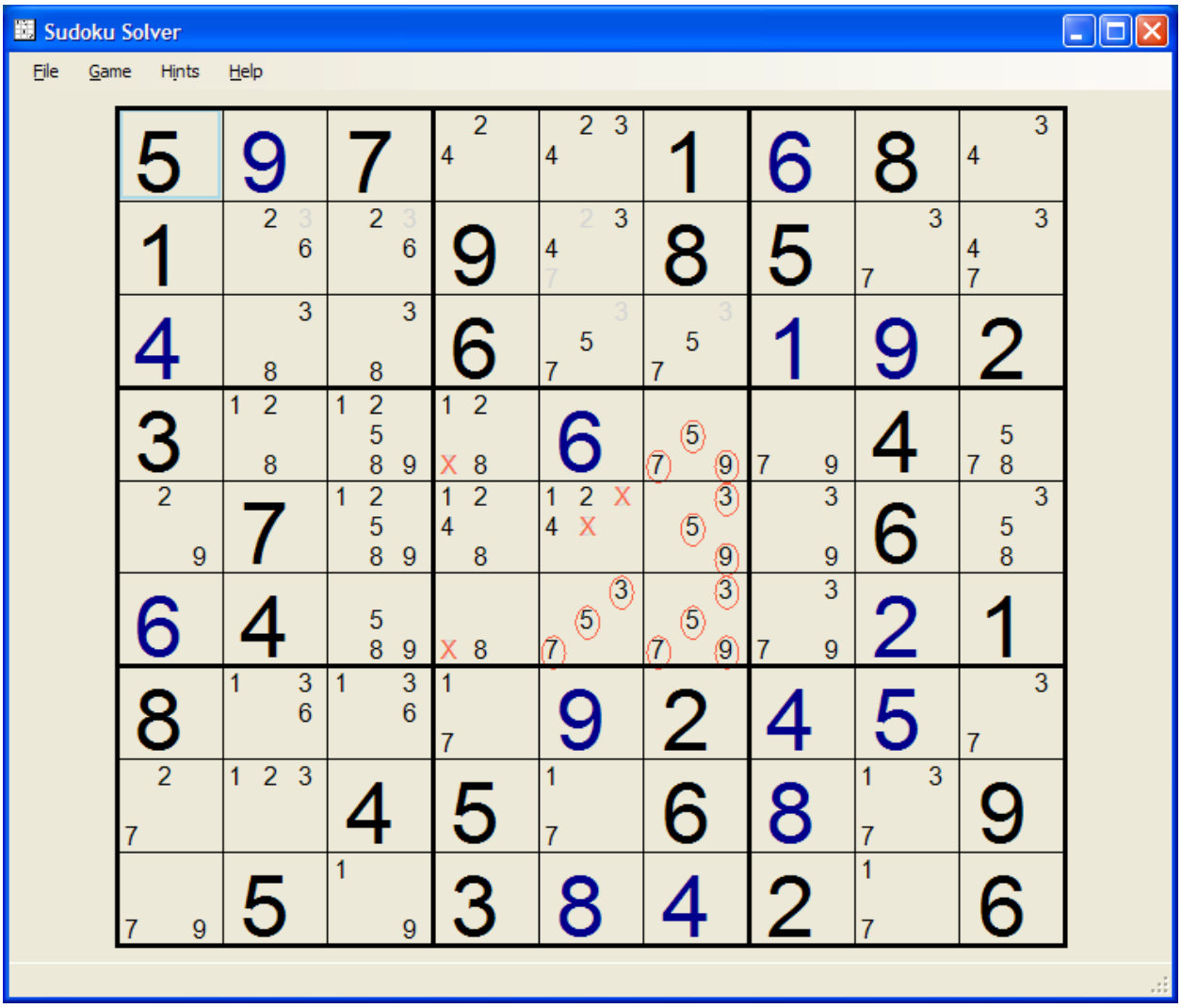
To understand Patterns in a bit more depth, recall that the House Rules tell us each digit can appear once and only once in a house. Since 7 and 9 appear as the only possible digits for r4c8 and r4c9, then one of those two squares must contain a 7 and the other a 9; two separate squares must each have their own, unique digit. At present, it doesn't matter which contains which, only that we know that these two squares will have these two digits. Knowing that lets us eliminate 7 and 9 as possibilities from all other squares in the house (in this case, row 4), again because only r4c8 and r4c9 may contain the digits 7 and 9.

The light red O's highlight the digits that make up the pattern, while the light red X's highlight the digits that the pattern removes from consideration. Open Patterns occur when the pattern digits are the only digits in the involved squares (just as Open Singletons occur when a square contains only a single, possible value). As you might guess, there are also Hidden Patterns, which we'll examine in the next section.

This one Open Pattern creates a single, Hidden Singleton 9 in r5c4. In fact, the pattern converts the puzzle to one that can be completed with singletons (both open and hidden); you'll have to search for them but they are there and singletons will solve the puzzle from here. We'll call this state Singletons to Solve (StS). As noted in the previous section, lots of Sudoku puzzles are StS from the start.

Patterns can occur with 3 digits in 3 squares, 4 digits in 4 squares, and so on. For an example of this, we turn to another Web Sudoku Puzzle[6] (Evil #9,737,105,326), where we can see an example of an Open Quad pattern (after Singletons are solved and a few Open Pairs have been taken care of):

[6] WebSudoku and other internet puzzle sources are directly accessible from Sudoku Solver using the Game / Load from Web menu commands. To load this particular puzzle, load Web Sudoku Evil puzzle #9,737,105,326 by clicking on Game / Load from Web / Load WebSudoku Puzzle…



This pattern is contained in box 5; notice that the O's appear in 4 different squares in the box. Each of these squares contains one or more of the digits 3, 5, 7, 9, creating an Open Quad with those digits. This Open Quad lets us eliminate its digits from all other squares in the house (box 5): r46c4<>7, r5c5<>35 (no squares in box 5 outside of the pattern contain a 9).

It is *very important* to realize that a Pattern larger than 2 *need not have* all digits in all squares; notice that r45c6 and r6c5 have only 3 digits each. What is important is that *exactly* 4 digits are distributed across *exactly* 4 squares within a house (in this case, box 5), whether

or not they appear elsewhere in the house[7]. This would still be an Open Quad if the 4 squares contained 37, 57, 79, 39 or 35, 39, 359, 37 and so on. Alternatively, each square could all contain all four digits (3579). Any of these are a valid Open Quad. The same goes for Triplets and Open 5's (and higher), which can make spotting Quads and larger patterns a little tricky, especially in a puzzle with lots of hint digits showing. Fear not, for there is a shortcut to finding larger Open Patterns: Hidden Patterns.

Hidden Patterns

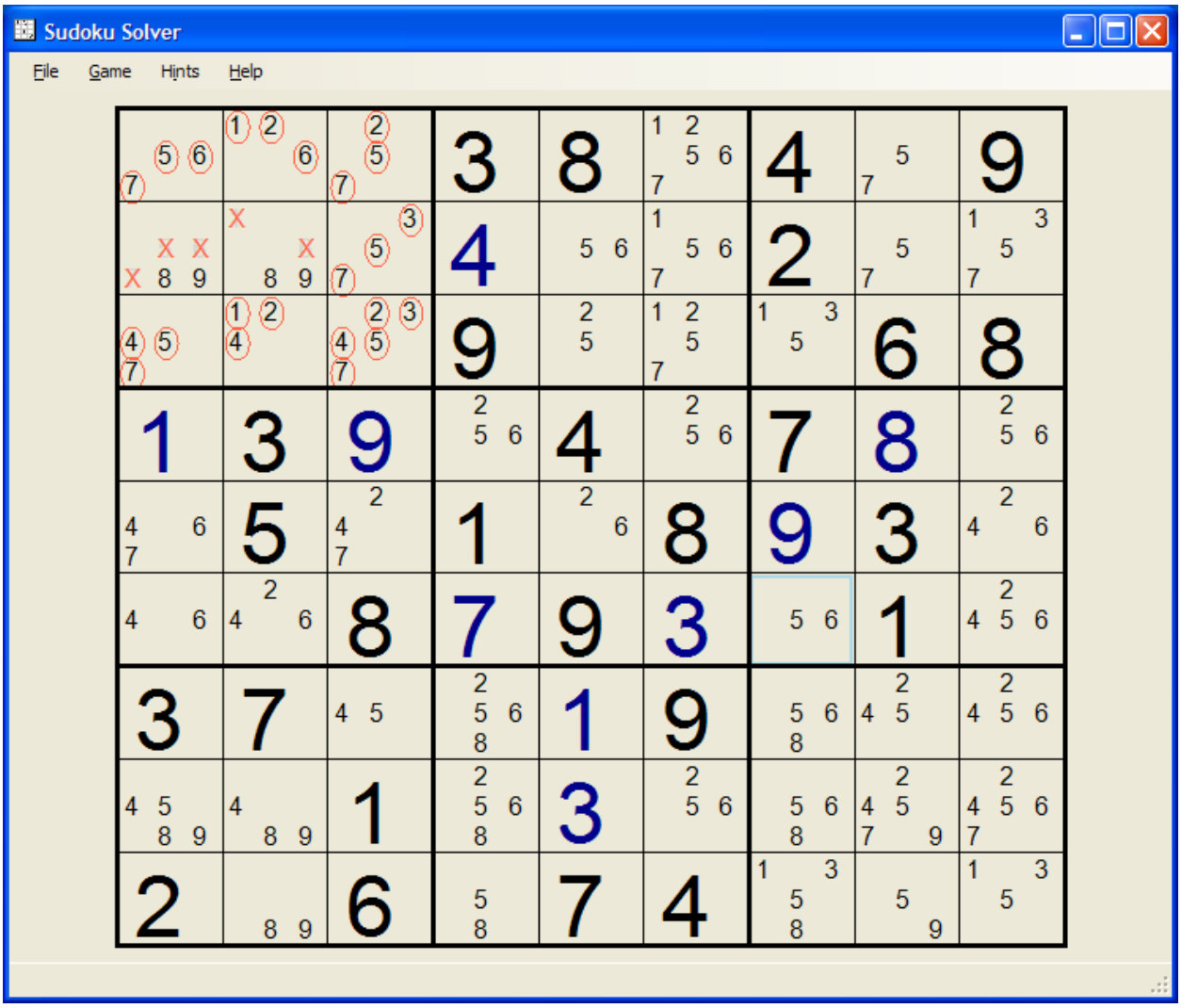
The simplest patterns to see are Open Patterns of 2 (or Open Pairs), as in the first example above. It can be trickier to spot Open Patterns of 3 or 4 (Triples or Quads), but 5 and above are *very* hard to see. Fortunately, an elegant solution exists to ease the burden on your eyes and brain: Hidden Patterns. A Hidden Pattern is really just a shortcut to finding larger Open Patterns. For instance, a Hidden Pair (Pattern of 2) in a house with no solved squares is really just a shortcut for an Open Pattern of 7. An overly-simple[8] formula explains the relationship:

Hidden_Pattern_Size = Number_of_Open_Squares_in_House - Open_Pattern_Size

Here is an example of just such a Hidden Pattern (from Web Sudoku Evil! Puzzle #6,328,269,907, with all initial Singletons resolved to values):

[7] If the digits in this example quad appeared only in these four squares, they would be of no help to us since they would not remove any other digits in the box from consideration. Patterns are only useful when they eliminate hint digits from other squares.

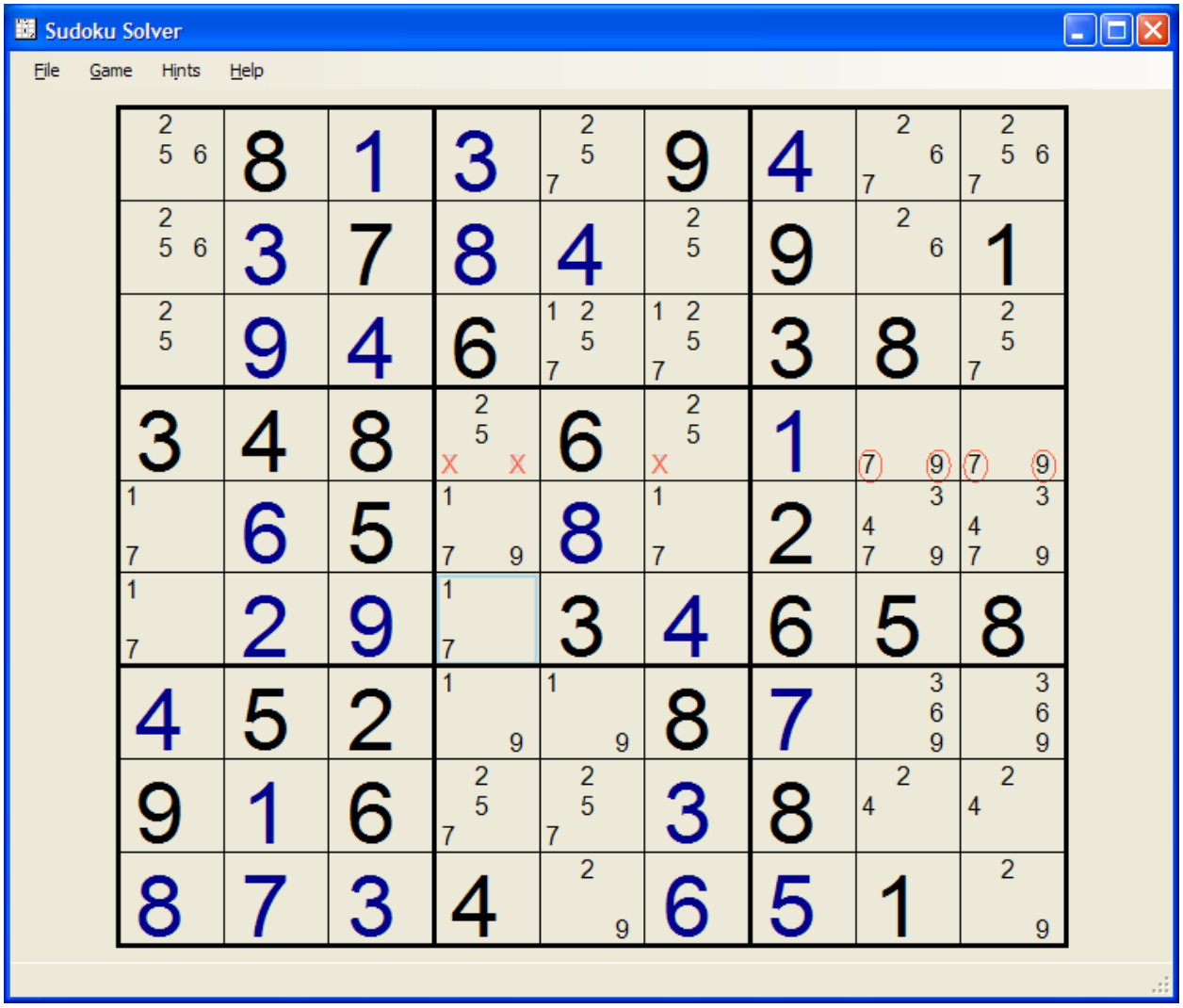
[8] Overly-simple in that it does not cover all known cases of hidden patterns, but does apply in many cases. An example where this fails is seen in this puzzle: .....68.22..8.1.6..8.....4..29.1.....5..9..3.....8.97..3.....8..1.2.4..69.71..... (reveal all initial singletons, and mark off the open pair 5,8 in r8c13; a hidden pair of 1,6 is then seen in box 1).



Notice the flurry of X's and O's in box 1. Sudoku Solver always shows the Open Pattern, but the Hidden Pattern is easy to deduce from there. Open Patterns are always shown by Sudoku Solver because one that's the way I decided to make it work. You'll notice that 6 squares in box 1 contain circled values; all those values are in the range 1 – 7, creating an Open 7. When the squares in box 1 that do not participate in the pattern (r2c12) have their 1 – 7 digits removed (r1c12<>1567), all that remains is 8, 9.

The 8, 9 in r2c12 is the Hidden Pair in box 1. The rule for any Hidden Pattern is: delete all digits within the Hidden Pattern Squares that *are not* part of the Hidden Pattern. If you think

about this, you'll see how the Hidden Pattern of 2 is just the inverse of (or shortcut to) the Open Pattern of 7. In fact, any Open Pattern can be expressed as its inverse Hidden Pattern. The "Hidden Pattern" in box 5 in the first Open Pattern example



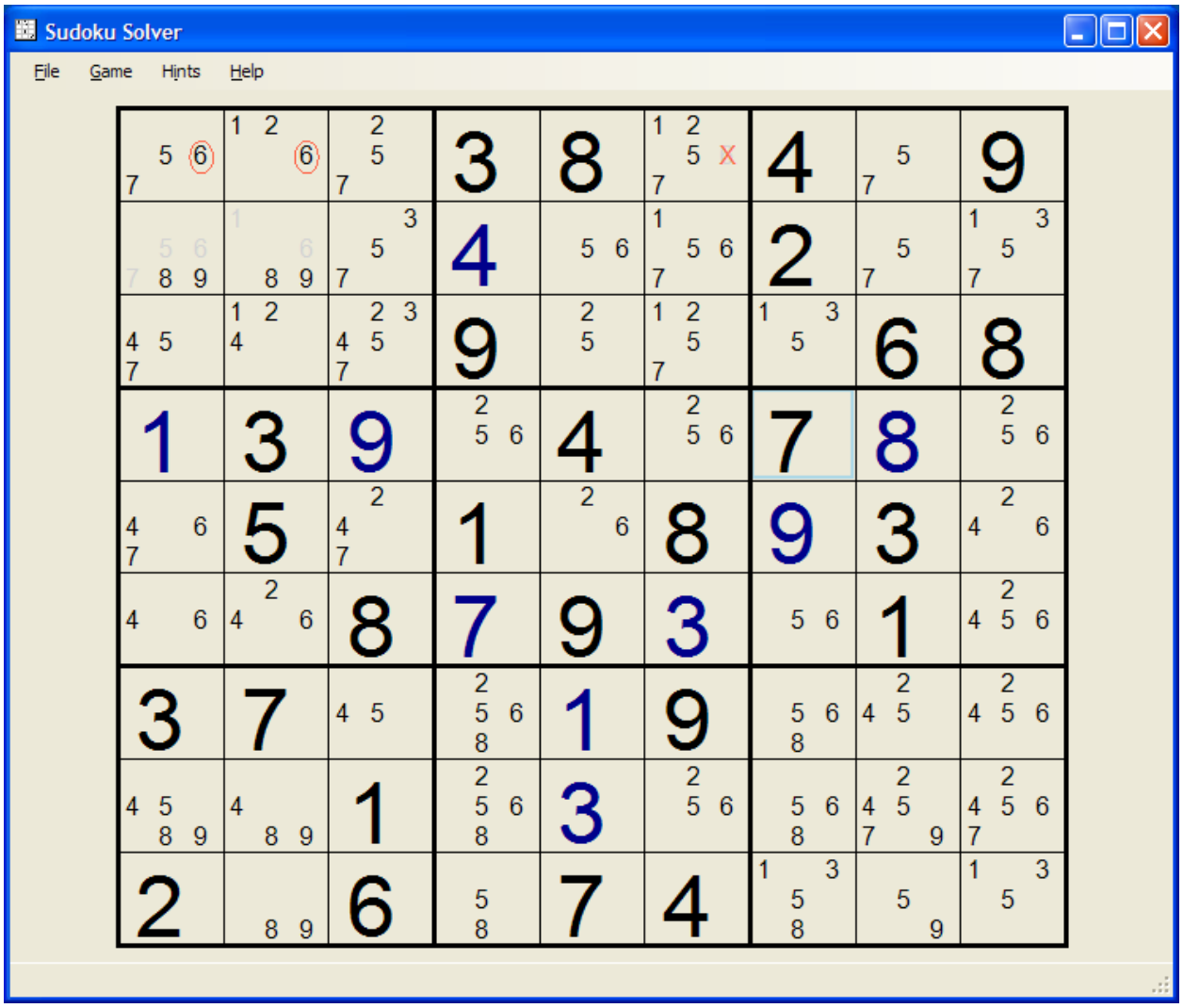
is the 2, 5 in r4c46 (a Hidden Pair). In general, the Pattern is labeled as Hidden or Open based on whichever of these yields the smaller pattern size.

Hidden Patterns are a *very* helpful shortcut when solving puzzles manually; it is often easier to spot the Hidden Pair 8, 9 in box 1 versus finding the Open 7 of 1 – 7. Computers are equally as good at finding one versus the other. To search for Hidden Patterns, examine the

digits available in a House, noting those that appear in only a few squares (e.g. if looking for Hidden Pairs, mark off digits that appear only twice in the house under examination). In the case of Hidden Pairs, if you find two digits appearing in only two squares (as with the 8, 9 in this example) along with other numbers, you've found a Hidden Pair, and can eliminate all other digits within those two squares that are not part of the Hidden Pair. For Hidden Triples, you eliminate all digits within the three pattern squares that are not part of the Hidden Triple, and so on.

Locked Candidates

Locked Candidates occur when a digit is restricted to a particular row or column within a box. They come in two flavors. The first is when a row or column intersection with a box is the only place in the box where a specific digit is found. When that happens, the digit can be eliminated from consideration wherever that row or column extends outside of that box. Let's return to Evil #6,328,269,907, right after the hidden 8, 9 is "exposed" in box 1 to see an example of locked 6's in that same box (note that without the effect of the hidden 8, 9 Pattern, there would not be any locked 6's in box 1):



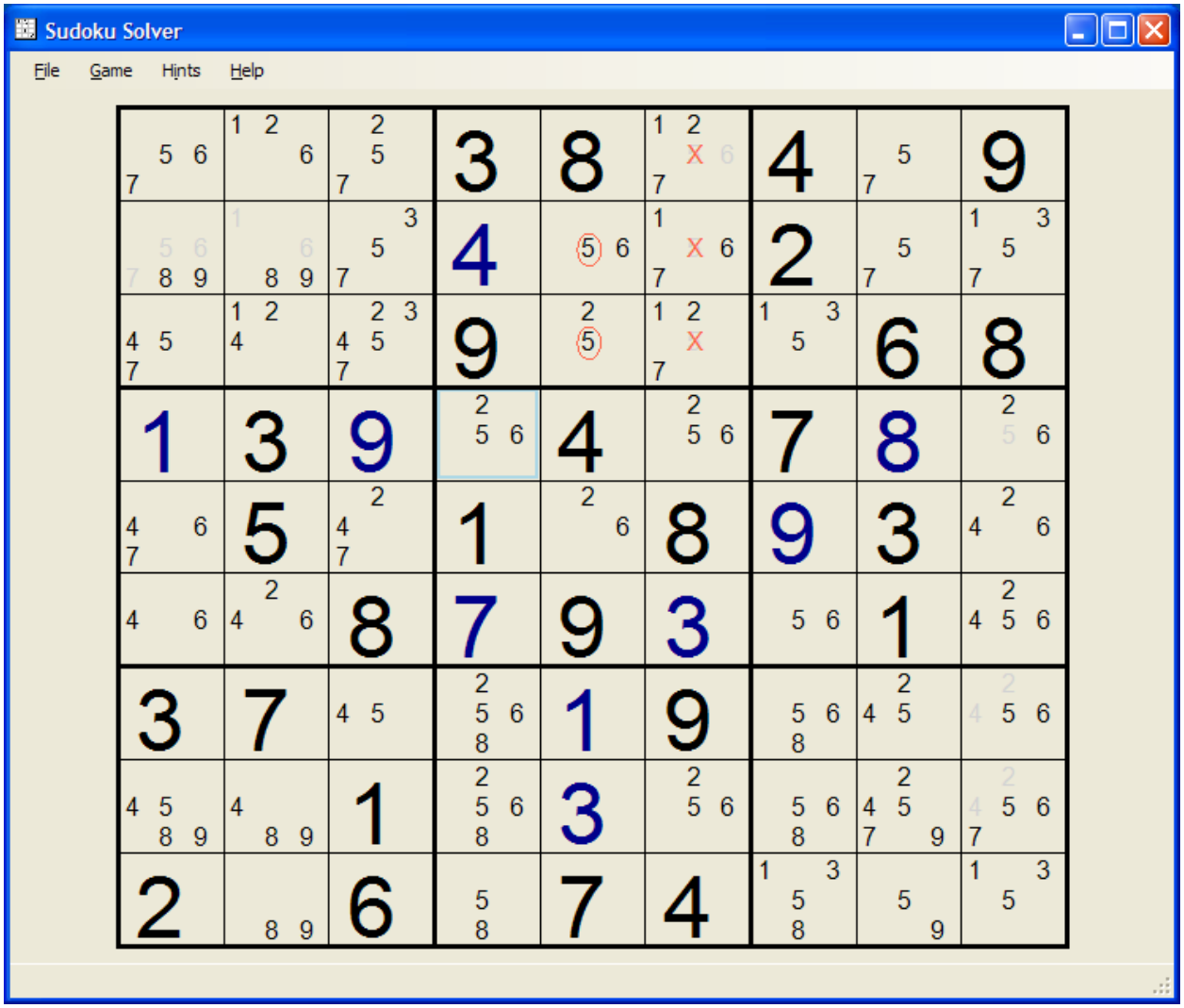
Notice that the 6's in r1c12 are circled. If you look elsewhere in box 1 you'll see that there are no other 6's available. Thus, we know two things:

1. The only place 6's can appear in box 1 is in r1 (more particularly, in r1c12)
2. Since a single 6 must appear somewhere in r1c123, a 6 cannot appear elsewhere in r1 (i.e. not in box 2 or 3, i.e. r1c456789 <> 6).

This is just another application of the House Rules; in this case the Locked Candidates of 6's in r1c12 allows us to state clearly that 6's in row 1 must be in either r1c1 or r1c2, otherwise box 1 would not have a 6. Since they must exist in row 1 of box 1, they cannot exist in row 1 of box 2 or box3.

This same rule applies to columns, as you might notice if you examine the last column of box 6. Notice that 2's occur only in r456c9 and nowhere else in box 6. See if you can figure out what digits that lets you eliminate (hint: look at the same column in box 9).

The second flavor of a Locked Candidate is found when a given row or column within a box is the only place in the entire row or column where a specific digit can be found. When this happens, the digit can be eliminated from consideration in the other rows or columns within that same box. Using the same puzzle as above, after a few other locked candidates have been removed, we find:



The circled 5's in box 2 (r23c5) are the only 5's anywhere in column 5. We can then deduce from the House Rules that:

1. The only place 5's can appear in column 5 is in box 2 (more particularly, in r23c5)
2. Since a single 5 must appear somewhere in r23c5 (which is fully contained within box 2, it cannot appear in the other two columns of box 2 (i.e. not in r123c4 or r123c6).

Using Locked Candidates and Patterns will let you solve all but a very few of the hardest (Evil) puzzles on WebSudoku.com (at least those that I've studied as of this writing). This gives you a very broad set of puzzles from which to choose.

Of course, there are still more techniques that you can apply to solve even more difficult puzzles.

BUG+1

BUG is an acronym for Bivalue Universal Grave (this Google Query will return sites that explain the concept in more detail); it is a situation that, if it occurs in a puzzle then either the puzzle has 0 or 2 solutions. Since we're only dealing with Sudoku puzzles with *exactly* 1 solution, for our purposes any puzzle with a BUG is an invalid puzzle.

What this means is we can use any situation that would result in a BUG as a way to eliminate digits from a square.

A BUG+1 is a situation where you are a single-elimination away from the appearance of a BUG. Let's look at an example grid puzzle:

```
6 3   4 | 8   79   57 | 1 59 2
7 2   1 | 69 3    56 | 4 59 8
9 5   8 | 1   4    2  | 6 3  7
-------+-----------+-------
1 4   6 | 27 27   9  | 3 8  5
3 9   7 | 5   8    4  | 2 1  6
2 8   5 | 3   6    1  | 7 4  9
-------+-----------+-------
8 67  3 | 4   5    67 | 9 2  1
4 16  9 | 26 12   8  | 5 7  3
5 17  2 | 79 179  3  | 8 6  4
```

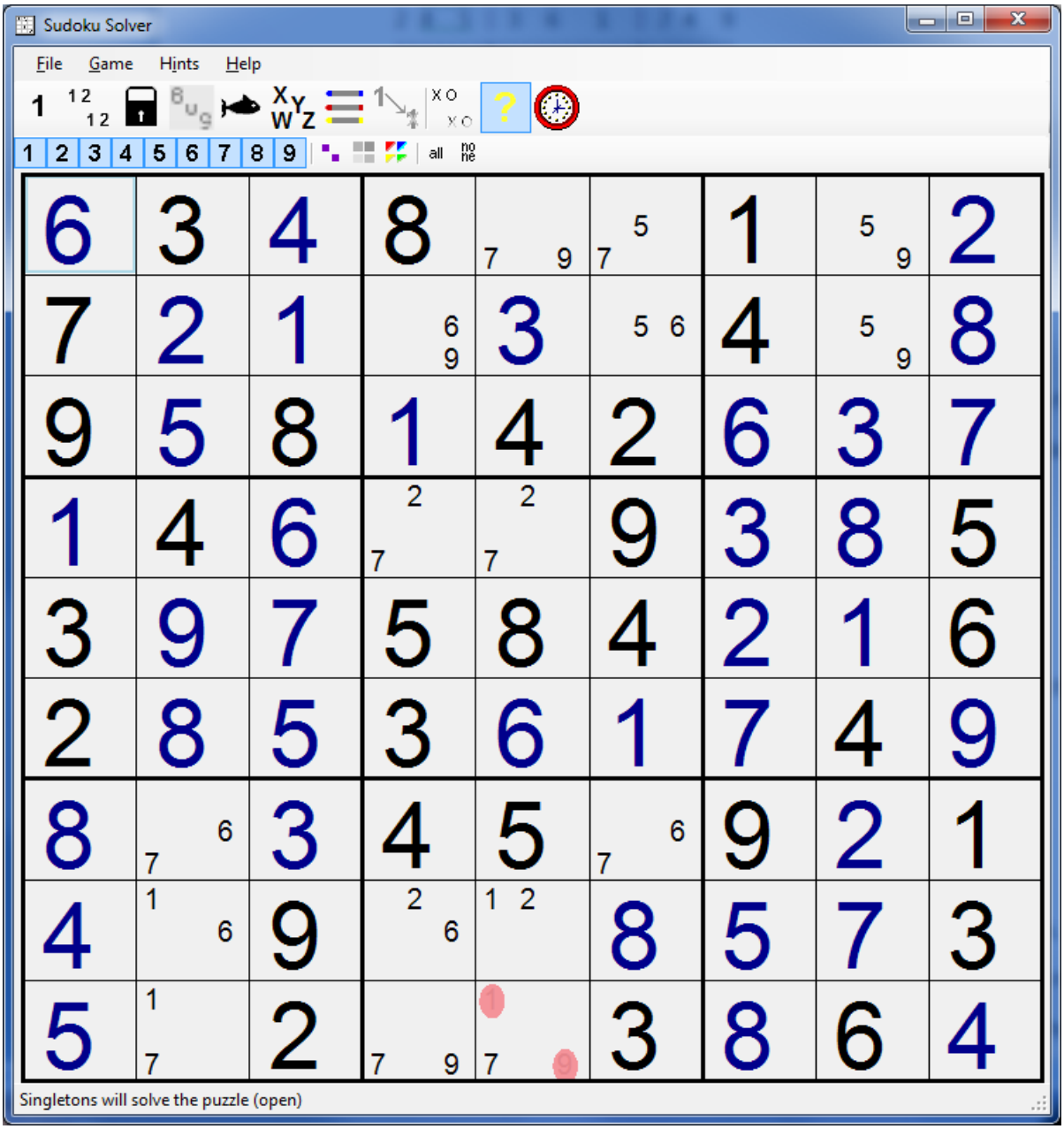
A BUG+1 is possible when all unsolved squares:

1. Contain no hidden singles
2. All but one have 2 hint digits in them
3. There is 1 square with 3 hint digits

With the grid above, all unsolved squares have 2 digits (bi-values) except for r9c5. This makes r9c5 our BUG+1 candidate square. For a BUG+1 elimination, the candidate square must meet the following conditions:

1. Two of the three digits must occur twice in all three houses
2. The third digit must occur *more than* two times in all three houses

The digit that meets these criteria in r9c5 is 7; with r9c5=7, the BUG pattern that would be created if r9c5=1 or 9 is avoided. As Sudoku Solver shows it:



[9]

In my experience, a BUG+1 application always reduces the puzzle to StS. Because they are also fairly easy to spot (versus some of the techniques that follow), it is worth looking for one

[9] Note that the Techniques Toolbar in this puzzle image includes a button for BUG+1 that does not appear in many (if any) other screen shots. When BUG+1 was added to the repertoire, I did not go back and update every other example with the toolbar showing.

whenever the possible criteria are met. Note that not every possible BUG+1 (that meets the possible criteria) will meet the must-have criteria for the candidate square.

Fishy Patterns

Fishy Patterns are patterns that involve a single digit across rows and columns. It does not matter how many other digits are present along with the digit in question, which makes them similar to Locked Candidates (in fact, Locked Candidates are special cases of Fishy Patterns). Fishy Patterns occur when a digit, *d* occurs in exactly *n* rows across *n* columns; when a Fishy Pattern is found, all other occurrences of *d* in the same columns but in different rows may be cancelled. In case this does not yet have you completely confused, Fishy Patterns can also be found in exactly *n* columns across *n* rows (in that case, all other occurrences of *d* in the same rows but different columns may be cancelled).

Fishy Patterns are classified based on their size, *n*. The table below lists values of *n*, and the common names for the Fishy Pattern:

n	Name
2	X-Wing
3	Swordfish
4	Jellyfish
5	Starfish (or Squirmbag – really!)
6	Whale
7	Leviathan

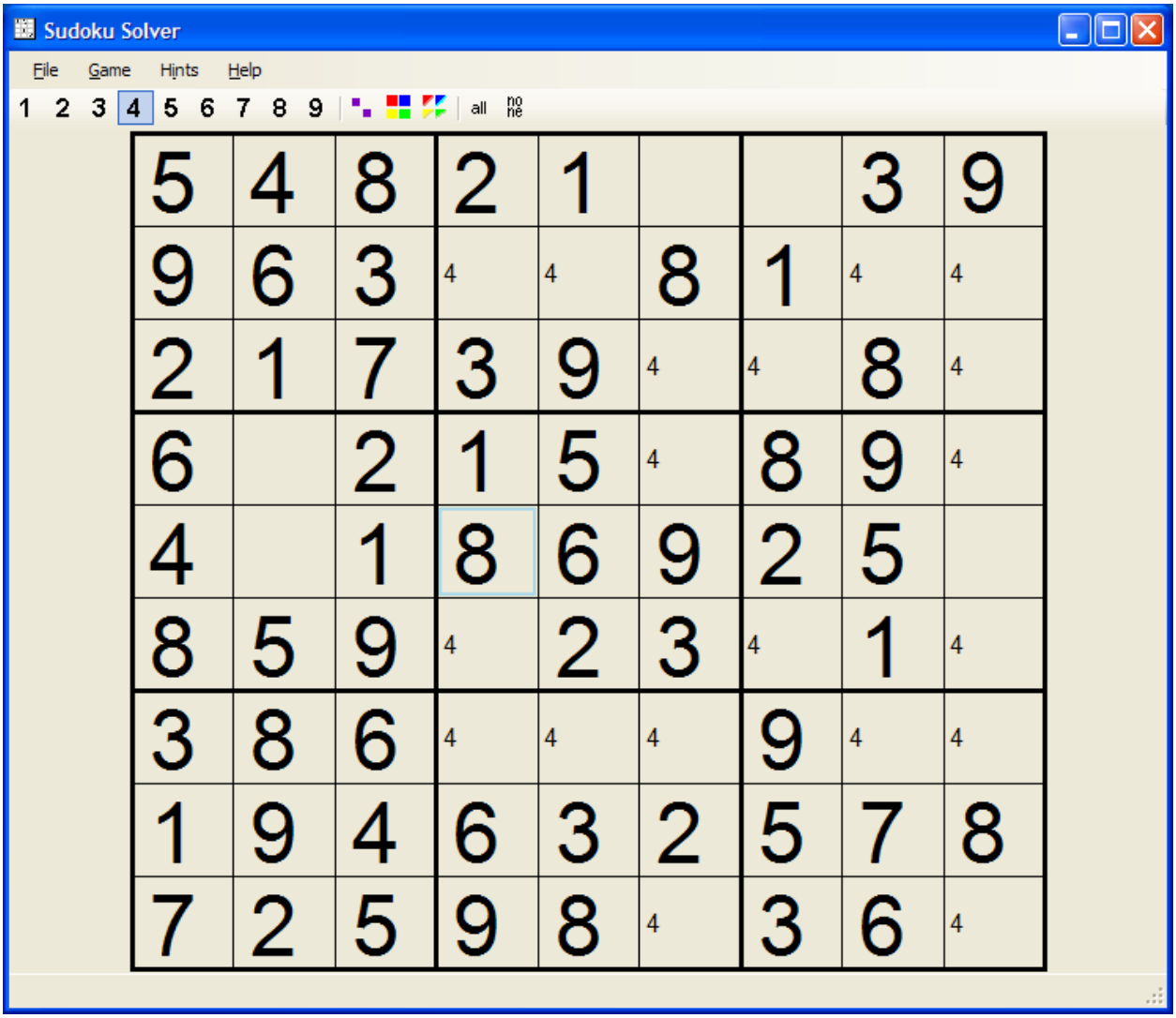
For simplicity, you can also think of *n*=2 as a 2-fish, *n*=3 as a 3-fish, and so on. Fishy patterns are considered a more advanced technique, and are difficult to spot by eye in a crowded puzzle, especially for *n* > 3. In practice, you'll rarely (if ever) find the need for anything larger than a Jellyfish to solve a puzzle.

X-Wings

The first example is of a 2-fish or X-Wing. Starting from this puzzle:

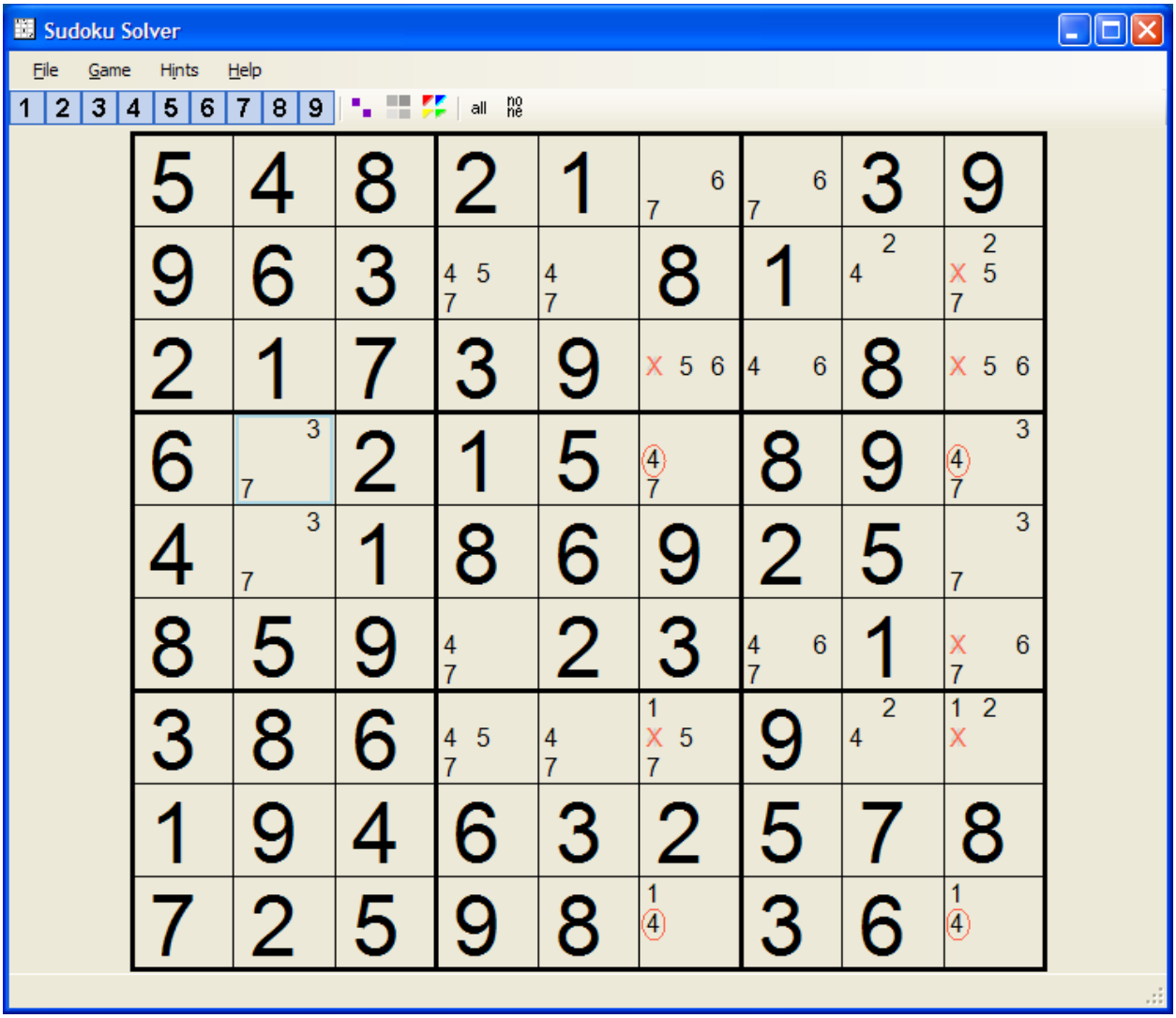
```
 5 4 8 | 2 1 . | . 3 9
 9 6 3 | . . 8 | 1 . .
 2 1 7 | 3 9 . | . 8 .
-------+-------+------
 6 . 2 | 1 5 . | 8 9 .
 4 . 1 | 8 6 9 | 2 5 .
 8 5 9 | . 2 3 | . 1 .
-------+-------+------
 3 8 6 | . . . | 9 . .
 1 9 4 | 6 3 2 | 5 7 8
 7 2 5 | 9 8 . | 3 6 .
```

We will move directly to the Sudoku Solver window to better illustrate the X-Wing:



This shows the hints in filtered mode, so that only 4's are seen[10]. We'll go back to the full view in a moment. Notice that in rows 4 and 9, columns 6 and 9 (r49c69) 4's appears *only* in c69 and nowhere else. This meets the criteria for *n*=2 Fish (or an X-Wing): a digit across 2 rows that appears in only 2 columns of that row. Finding the X-Wing lets us safely remove any 4's occurring in c69 that are *not* in r49. With all the numbers back, this looks like:

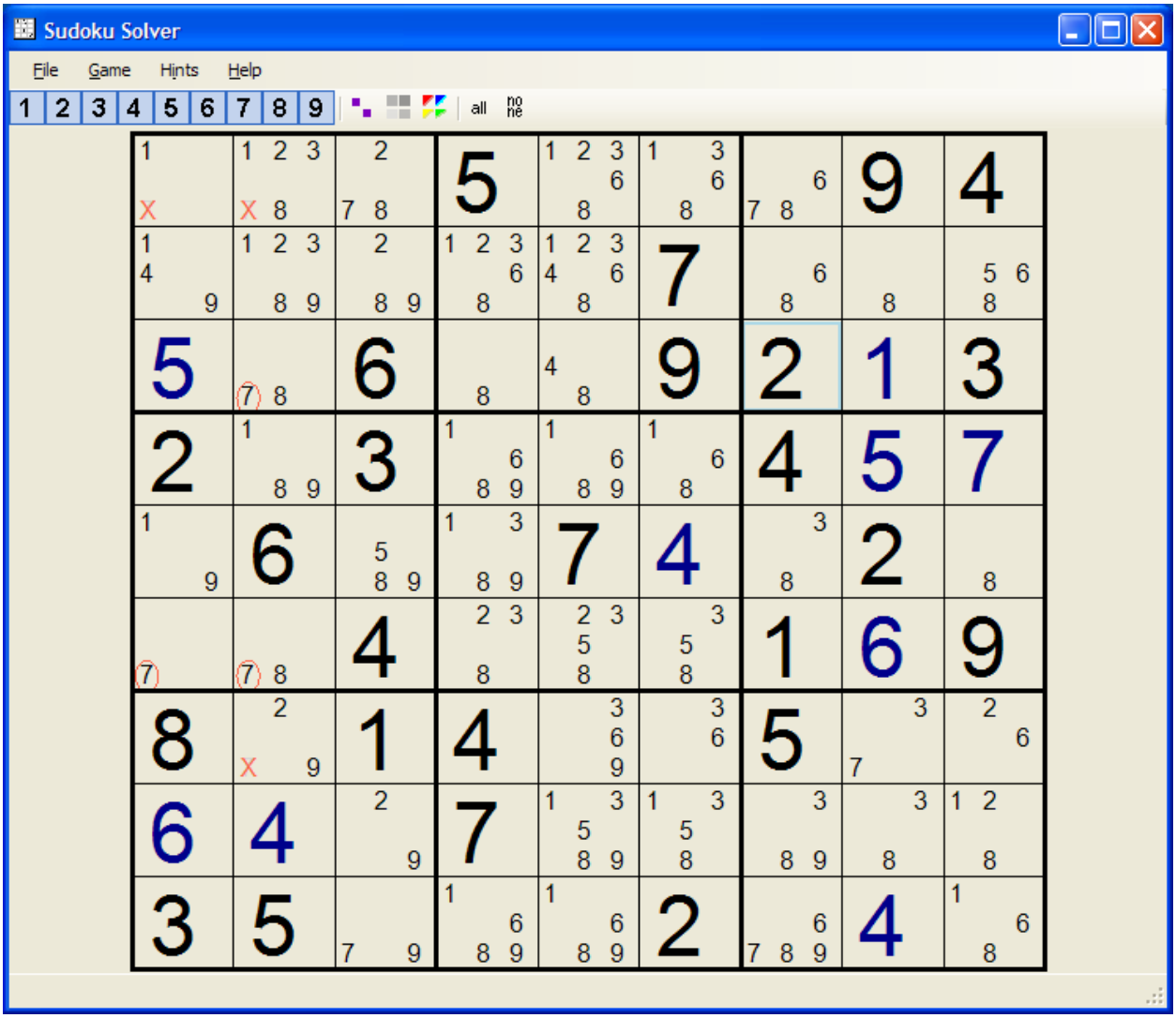
[10] For this example, the Filtering Toolbar is shown; notice that only the 4 button is "pushed", meaning that this is the only hint digit that is shown.



Notice that we're showing all the hint digits again[11]. The circled 4's make up the X-Wing and the X'd 4's are what we are able to cancel due to the X-Wing. X-Wings are a pattern you should be able to spot by eye with practice. X-Wings and all other Fishy Patterns rely on the House Rules. In this particular case, the houses with 4's are r4 and r9. In those two rows, the digit 4 appears in only two columns: c69. Both r4 and r9 *must* have a 4, and there are only two places in these two rows where 4's could possibly occur (c6 or c9). With two possible squares across two possible rows, we know that each row will have a 4 in one of these two squares. Thus, 4's in c69 can only be in r49, and not in any other rows. Got that?

[11] Also notice that the button for every single digit, 1 – 9, is now pressed on the Filtering toolbar.

Note that a Fishy Pattern (including an X-Wing) need not have the digit *d* in every row and column, just across *n* in total. Look at this X-Wing on 7's:



Notice that only three 7's are involved in this X-Wing, making it non-symmetric, but still and X-Wing, which cancels out all 7's in c12 that are not in r36. Non-symmetric X-Wings can

only be found when a Singleton is involved (r6c1 has an Open Singleton 7), but non-symmetric fish appear in the absence of Singletons when $n > 2$ (i.e. Swordfish and above)[12].

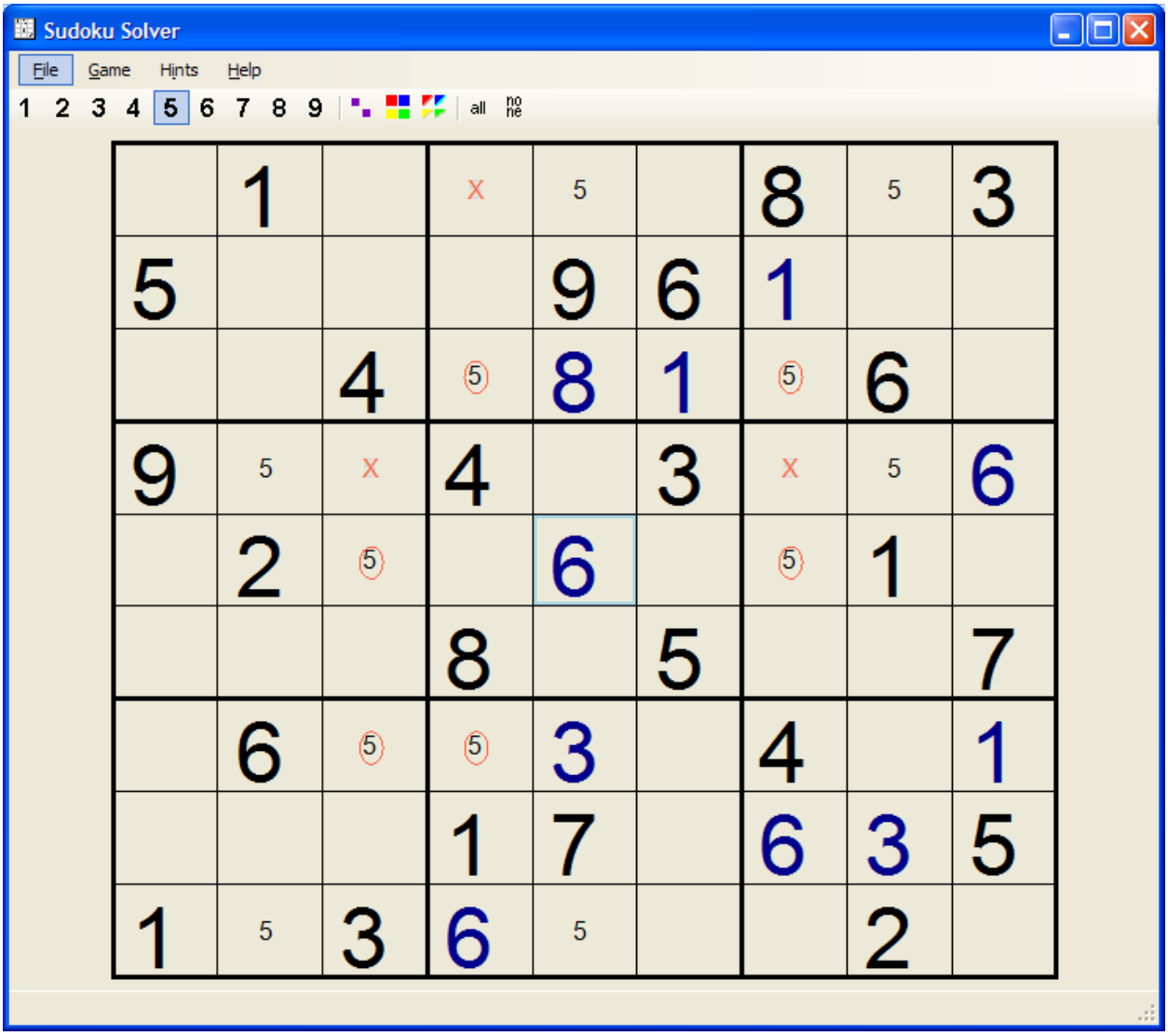
Swordfish

The next example is a Swordfish (or 3-fish). Starting from these PM's:

```
267 1     2679  | 257  45 247  | 8   579 3
5   378   278   | 237  9  6    | 1   47  24
237 379   4     | 2357 8  1    | 579 6   29
----------------+--------------+-----------
9   578   1578  | 4    12 3    | 25  58  6
348 2     58    | 79   6  79   | 35  1   48
346 34    16    | 8    12 5    | 239 49  7
----------------+--------------+-----------
278 6     25789 | 259  3  289  | 4   789 1
248 489   289   | 1    7  2489 | 6   3   5
1   45789 3     | 6    45 489  | 79  2   89
```

Closer examination will show a Swordfish pattern on 5's.

[12] Did you also notice the Open Pair 7, 8 in c2? There are often multiple techniques than may be applied at any point in a puzzle. The order in which you apply them is more a matter of personal taste. Sudoku Solver generally applies this order: Singletons, Patterns, Locked Candidates, Fishy Patterns (there are more techniques, yet to be described).



Notice that while a *total* of 3 rows and columns are used, each individual row (r358) has only two 5's in it; these are the "base rows" for this Swordfish. What is important is that in total 3 columns (c348) are used. Notice that any 5's in c348 and not in one of the base rows is X'd out.

The best way to learn how to recognize Fishy Patterns (as well as every other technique) is to play with the samples from this manual in Sudoku Solver. Just copy the puzzle or PMs to the Windows clipboard and paste them into Sudoku Solver, or download the puzzle from the web as appropriate and try them for yourself! A particularly good source for Swordfish sample

puzzles can be found on the Sudoku.com forum; each line full of numbers in this posting is a complete puzzle (copy from the start of a line up to the # and paste into Sudoku Solver).

XY-Wings

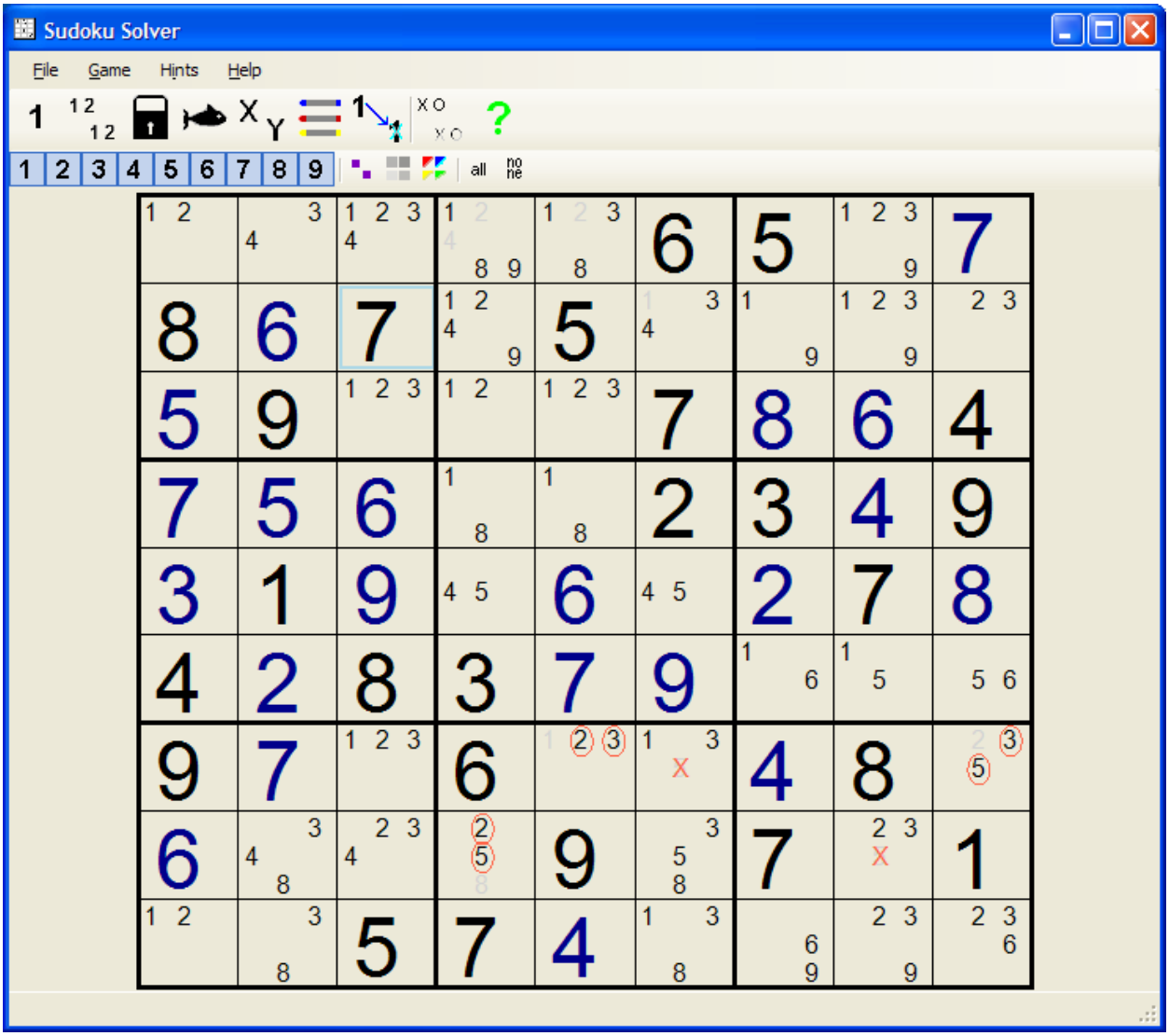
An XY-Wing is an elimination technique that relies on a simple forcing chain. They occur in three squares: the base cell and the two wings, and the wings intersect with candidate squares (from which a value is eliminated). They derive their name from the labels given to the hint digit values: x, y and z. More formally, they occur in three cells where:

- Each cell has exactly two hint values
- Base square values are X and Y
- Wing #1 intersects with the Base square and has the values X and Z
- Wing #2 intersects with the Base square and has the values Y and Z
- The Base and its Wings are *not all* in the same House
- Candidate squares intersect both Wing #1 and #2 and contain the Z value

When these conditions are found, then Z may be eliminated from all candidate squares. Consider the following puzzle PM's:

```
12 34  1234 | 189  138 6   | 5  1239 7
8  6   7    | 1249 5   34  | 19 1239 23
5  9   123  | 12   123 7   | 8  6    4
------------+--------------+------------
7  5   6    | 18   18  2   | 3  4    9
3  1   9    | 45   6   45  | 2  7    8
4  2   8    | 3    7   9   | 16 15   56
------------+--------------+------------
9  7   123  | 6    23  135 | 4  8    35
6  348 234  | 25   9   358 | 7  235  1
12 38  5    | 7    4   138 | 69 239  236
```

If you look closely at r7c5 you'll see the base square of an XY-Wing (X = 2, Y=3) with wings at r8c4 (X = 2, Z=5) and r7c9 (Y=3, Z=5). Moving to the Sudoku Solver screen:



Yes, this screen has another toolbar showing: the Techniques Toolbar (more on that later). Notice that the XY-Wing has eliminated the Z value from two squares: r7c6 and r8c8. The first candidate intersects Wing #1 in box 8 and Wing #2 in row 7. The second candidate intersects Wing #1 in row 8 and Wing #2 in box 9.

Why does this work? Once again it is based on the House Rules and the requirement that there is only one valid solution to the puzzle. The Base (or XY) square must have one of two values, X or Y (in this case, 2 or 3). If the Base = X (or 2) then Wing #1 must be Z (5), because the Base is 2 and there can be only a single 2 in box 8. If Wing #1 (or YZ) is 5, then neither

candidate 1 nor candidate 2 can contain a 5 (Wing #1 provides the 5 for both box 7 and row 8). When the Base = X, it is "forcing" the value to Z in Wing #1.

Similarly, if the Base = Y (or 3) then Wing #2 (YZ) must be 5, because the Base has placed a 3 into row 7. If Wing #2 is 5, then neither candidate 1 nor candidate 2 can contain a 5 (Wing #2 provides the 5 for both row 7 and box 9). When the Base = Y, it is forcing the value to Z in Wing #2.

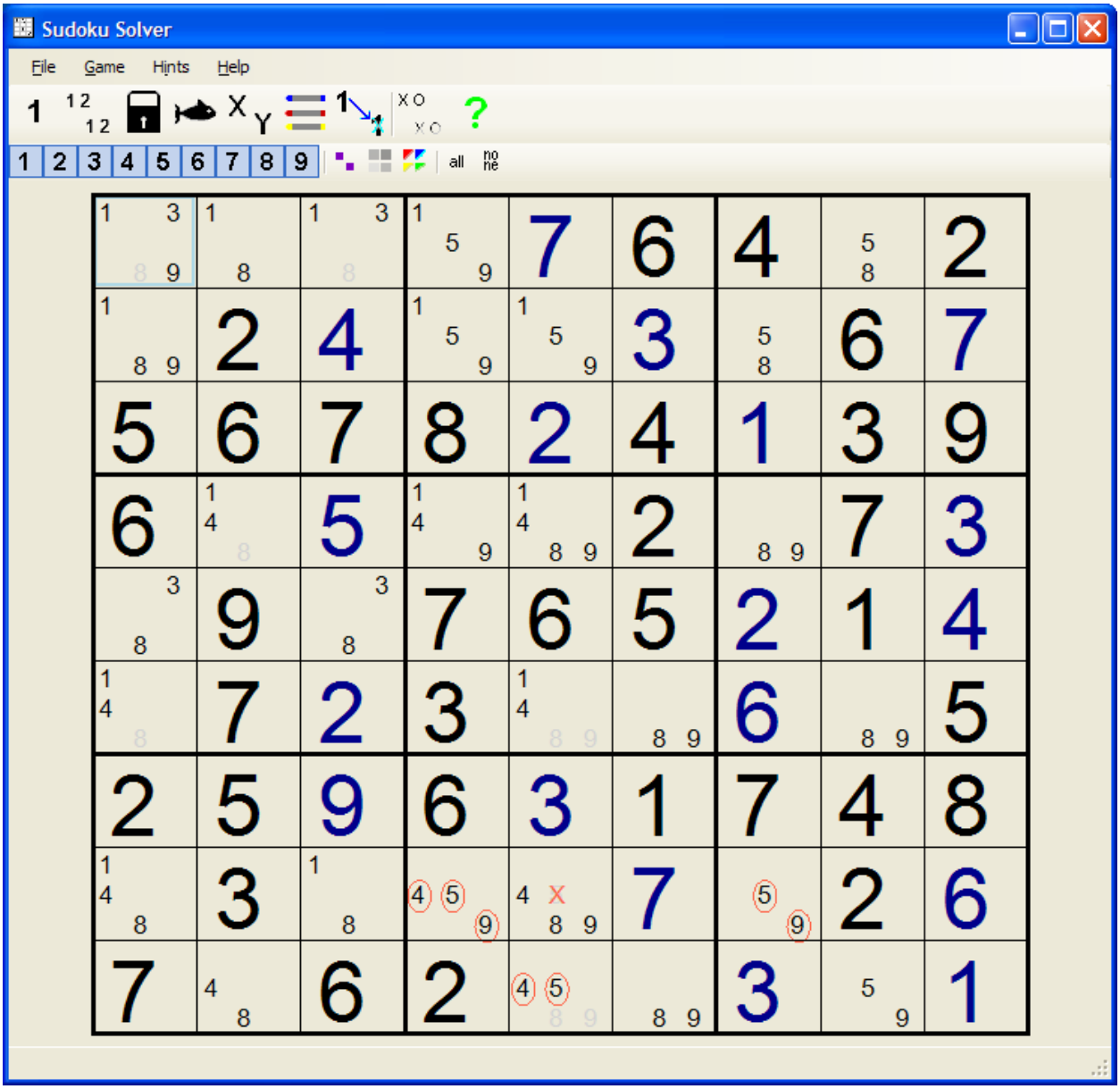
An XY-Wing where the Base and both Wings share a House would actually be a naked triple, hence the "not in the same House" rule for finding an XY-Wing.

XYZ-Wings

Very similar to XY-Wings, except that the base square has all three values (X, Y and Z). Z is still eliminated from candidate squares, and the candidates must intersect with both wings and the base. Here's an example of an XYZ-Wing. Starting from the following PM's:

```
139 18 13 | 159 7    6   | 4  58 2
189 2  4  | 159 159  3   | 58 6  7
5   6  7  | 8   2    4   | 1  3  9
----------+-------------+--------
6   14 5  | 149 1489 2   | 89 7  3
38  9  38 | 7   6    5   | 2  1  4
14  7  2  | 3   14   89  | 6  89 5
----------+-------------+--------
2   5  9  | 6   3    1   | 7  4  8
148 3  18 | 459 4589 7   | 59 2  6
7   48 6  | 2   45   89  | 3  59 1
```

We can see an XYZ-Wing formed in boxes 8 and 9, rows 8 & 9 with r8c4 as the base square and r8c7 and r9c5 as the wings:



The result of this XYZ-Wing is the removal of 5 from r8c5. The House Rules application is similar to that for XY-Wings, except that we make use of the Z value in the Base to also exclude Z from the candidate square, hence the requirement in XYZ-Wings that the Base square align with the target square(s).

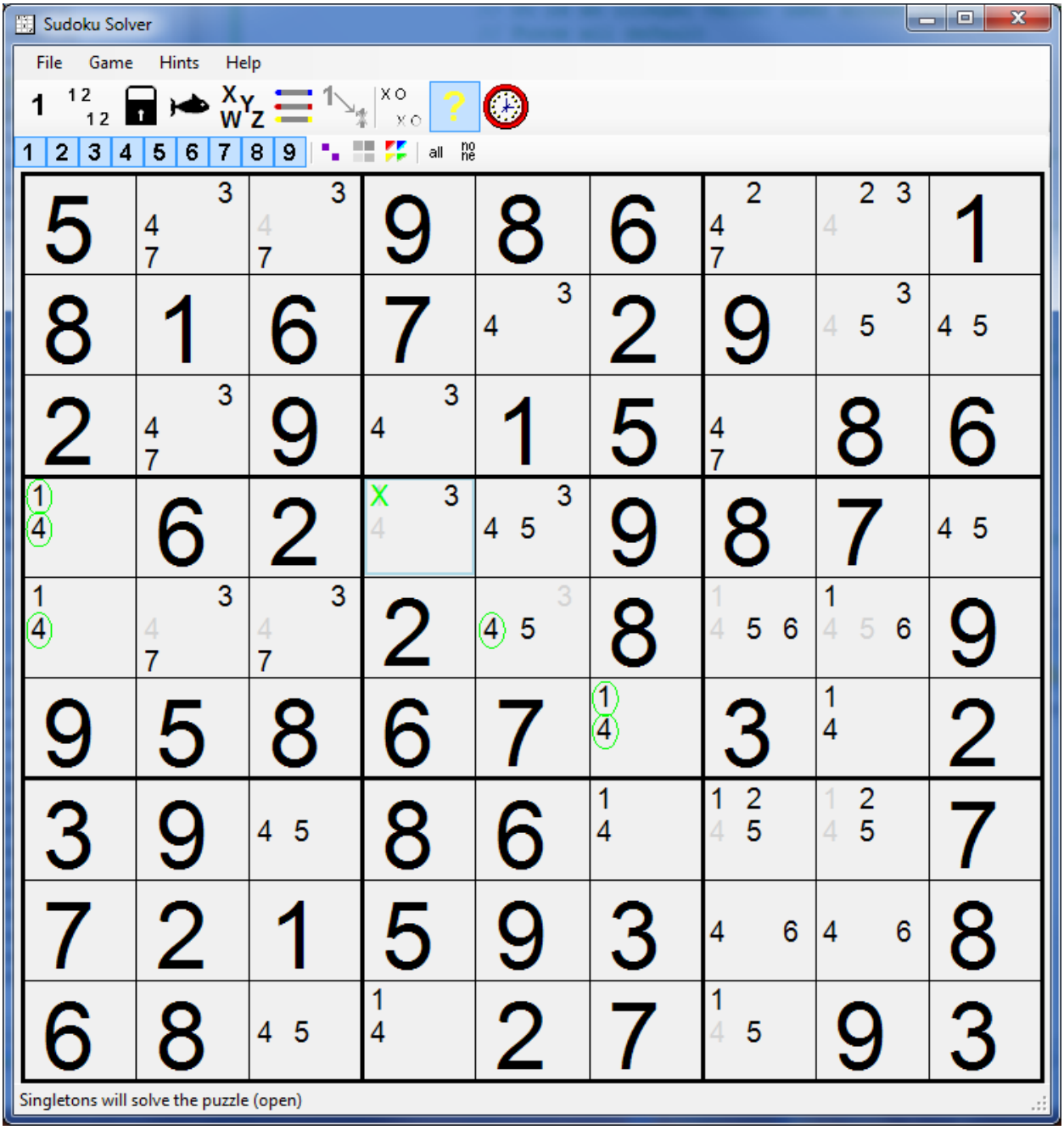
W-Wings

W-Wings are eliminations from two type-1 bi-value squares (see definitions below) that both have the same pair of possible values (X and Y). These two type-1 bi-value squares (let's call these the pincer squares) are linked by a series of bi-value type-2 squares on Y; there must be an even number of links in the series. This sort of linkage is often referred to as a strong link. An even number of links ensure that one of the pincer square values is always X, allowing the elimination of X from any squares seen by both pincers.

This is better illustrated with an example. Starting from these PM's:

```
5   347 37  | 9   8    6   | 247 23 1
8   1    6  | 7   34   2   | 9    35 45
2   347 9   | 34  1    5   | 47   8  6
------------+--------------+----------
14  6    2  | 13  345  9   | 8    7  45
14  37   37 | 2   45   8   | 56   16 9
9   5    8  | 6   7    14  | 3    14 2
------------+--------------+----------
3   9    45 | 8   6    14  | 125  25 7
7   2    1  | 5   9    3   | 46   46 8
6   8    45 | 14  2    7   | 15   9  3
```

Notice the two bi-value type-1 squares at r4c1=14 and r6c6=14. These will form the pincers of a W-Wing:



The pincers are linked by the 4's in r5c1 and r5c5 (those 4's are circled, as are the two bi-value type-1 pairs). Walking through the mechanics of the W-Wing will demonstrate how the elimination works. If r4c1=4, then r5c1<>4, r5c5=4 and r6c6=1. Since r4c4 are r6c6 are both in box 5, the House Rules dictate that r4c4<>1. If r4c1=1… well in that case we don't need to walk through the chain because r4c4 and r4c1 are in the same row; House Rules dictate that

r4c4r<>1 in this case as well. Because we know that r4c1 must be either 1 or 4, and in either case r4c4<>1, we can safely remove that candidate from consideration.

There can be many different strong-link chains for a single W-Wing. For example, a newer version of Sudoku Solver (one released after this section was written, with logic that stops chain searches sooner) use r4c9 & r6c8 instead of r5c1 & r5c5. There are also longer strong-link chains; however, Sudoku Solver will always use one of the shortest available chains. To better visualize the chains, you may use coloring (on 4's for this example).

The best way to spot W-Wings is to look for identical bi-value type-1 squares that do not overlap. Then see if there are any eliminations that could be made at their intersections (don't forget to check boxes as well as rows and columns). If so, look for a bi-value type-2 chain on the digit not used in the elimination; remember that the chain must have an even number of squares (that guarantees that the pincer squares are always alternate values).

You may want to turn on coloring (see the next section on Color Chains for more on how that works) to help you spot the type-1 bi-value chains.

If you'd like to experiment with W-Wings further, here is a PM set where r6c5 is linked to r8c1 by a 4-square type-2 bi-value chain, eliminating 1 from r6c1:

```
3   8 9    | 1    67 4   | 67 5  2
4   1 5    | 38   2  67  | 9  67 38
67  2 67   | 358  35 9   | 1  4  38
---------+-----------+---------
9   3 4    | 57   15 8   | 2  16 67
8   6 17   | 2    4  3   | 5  17 9
17  5 2    | 9    16 67  | 3  8  4
---------+-----------+---------
2   7 38   | 6    38 1   | 4  9  5
16  4 136  | 37   9  5   | 8  2  67
5   9 68   | 4    78 2   | 67 3  1
```

There has been discussion on the boards about how many strong links are permitted in the chain before it is no longer a W-Wing and is now an XY-Chain. Since the logic and requirements are the same in either case, Sudoku Solver will simply look for the shortest strong link chain and call it a W-Wing regardless of length.

Color Chains & Exclusions

Color Chains are a visual aid to help you see the effect of bi-values. There are two types of bi-values in Sudoku. The first (and simplest) is a square with only two values; we'll call these a type-1 bi-value – they are not the type used to create Color Chains. The second is a house with exactly two occurrences of a single hint digit (type-2 bi-value); these are the bi-values used to create Color Chains[13].

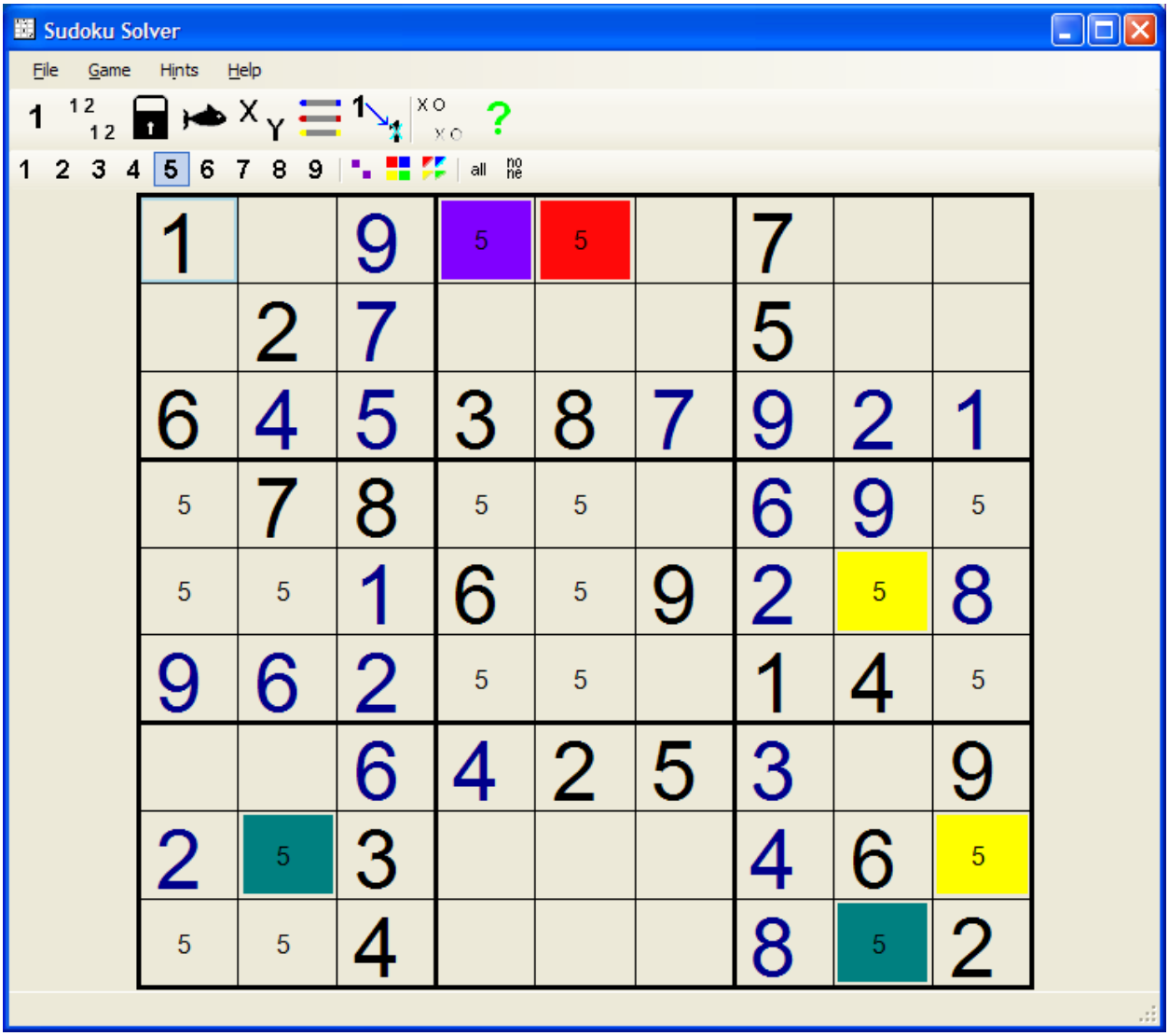
All bi-values have the same interesting property: one or the other of the digits in a bi-value must be part of the puzzle's solution. This is easy to see in a square with only two values; clearly one of them must be part of the solution. Likewise, for a type-2 bi-value, if there are only two occurrences of a digit in a row, column or square, one of them must also be part of the solution (otherwise the House Rules would be violated).

[13] Type-2 bi-values are sometimes called bi-location values (same value in two squares).

Color Chains help you to visualize type-2 bi-values (let's abbreviate these as bv-2) by assigning colors to type-2 squares based on their "chaining". Chaining occurs when a square from one bv-2 pair is shared by another bv-2 pair. Let's examine the following PM's in detail:

```
1   38  9 | 25   456  246  | 7 38  46
38  2   7 | 19   1469 146  | 5 38  46
6   4   5 | 3    8    7    | 9 2   1
----------+----------------+----------
345 7   8 | 125  1345 1234 | 6 9   35
345 35  1 | 6    3457 9    | 2 57  8
9   6   2 | 578  357  38   | 1 4   357
----------+----------------+----------
78  18  6 | 4    2    5    | 3 17  9
2   159 3 | 1789 179  18   | 4 6   57
57  159 4 | 179  36   36   | 8 157 2
```

While it is not easy to see at first, if you load these PM's into Sudoku Solver and filter out all digits except for 5's, you can see that there are 5 bv-2's. Here they are with colors applied:



The 5's in r1 form a stand-alone bv-2 pair. They are not linked with any other squares (and use the paired colors purple and red). The rest of the bv-2 squares are all linked into one longer chain, and they share paired colors yellow and teal; r5c8 + r9c8 form one bv-2 pair. The next is in box 9 and the last one is in row 8. The first two yellow/teal pairs share one common square: r9c8. The last two share r8c9. These shared squares link the bv-2 squares into a single chain.

The colors (which may be configured to suit your tastes), illustrate an important feature of chained/linked bv-2 squares; one of the colors in a pair is true (i.e. part of the solution to the puzzle) and the other is false (not part of the solution).

How does this work? It is easy to see in row 1: either r1c4=5 or r1c5=5. Both cannot be part of the solution but one must be. Looking at the yellow and teal squares, we can see the same logic is in effect. Let's say that r5c8=5. Then its bv-2 pair, r9c8<>5, which means that r8c9=5 (otherwise box 9 would not have a 5). This then forces r8c2<>5.

Color Chains simply help you to visualize this relationship between chained bv-2 squares more easily. The logic behind the linkages is just the House Rules.

Color Chains are show using "paired colors" which may be configured using the Game / Options / Color Pattern Colors dialog. The configuration used for this manual (which is not the default) is:

Notice that the red/purples colors are labeled Pair 1+ and Pair 1-, while yellow/teal are labeled Pair 2+ and Pair 2-. Colored bv-2 chains are frequently called out as a color number (1, 2, 3…) and a sign (+ or -) as a way of representing the state of the chain. In the chained 5's above, r1c4 is color 1+ and r1c5 is 1-. In a like manner, r5c8 and r8c9 are 2+ while r8c2 and r9c8 are 2-. In this terminology, either all of the 1+ squares are true or they are all false, and all of the 1- squares are true or they are all false. If 1+ is false then 1- must be true (and vice-versa). The same goes for any 2+/-, 3+/- squares, and so on.[14]

These basic properties can be exploited to exclude hint digits under the right conditions.

[14] Notice that the Color Pattern Colors dialog shows only 4 pairs. Sudoku Solver can handle many more than 4 pairs, though that is not seen very often. Pairs 5 and higher, if present, will be shown with the same "Overflow" color.

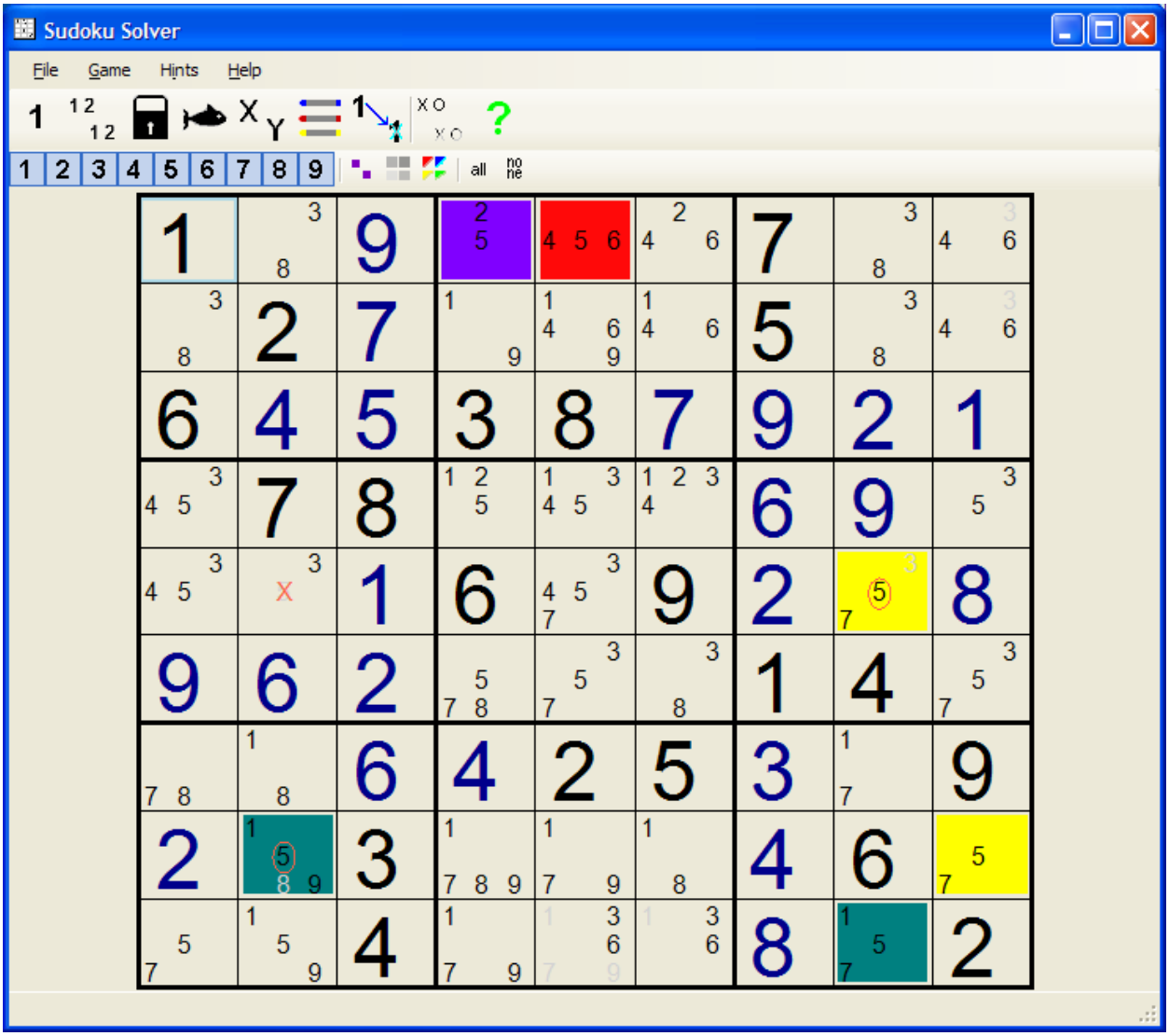
Color Chain Exclusions

Going back to the bv-2 chains on 5's, we can see an example of the simplest type of Color Chain Exclusion:

Color Chain Exclusion Type 1

If a square intersects with both +/- colors in a Color Chain, then the Color Chain digit may be excluded from the intersecting square.

This rule works because we know that one of either the + or – colors must be true. Since one or the other must be true, then none of the squares that intersect with both the + and – colors can also be true (i.e. have the same digit as the Color Chain). Clearly, this is only helpful when intersecting squares that also contain the digit used to create the Color Chain. We have just such as square in r5c2, which intersects with both yellow (color 2+, at r5c8) and teal (color 2-, at r8c2). Thus we can state that r5c2<>5. Sudoku Solver shows this exclusion as:



Notice that all digits are now shown. Color Chain Exclusions are found and applied regardless of the filter settings (just like finding Fishy Patterns); using filters can make it easier for you to see the effects. The Color Chain squares that forced the exclusion are marked with dull red circles, and the excluded digit is X'd out.

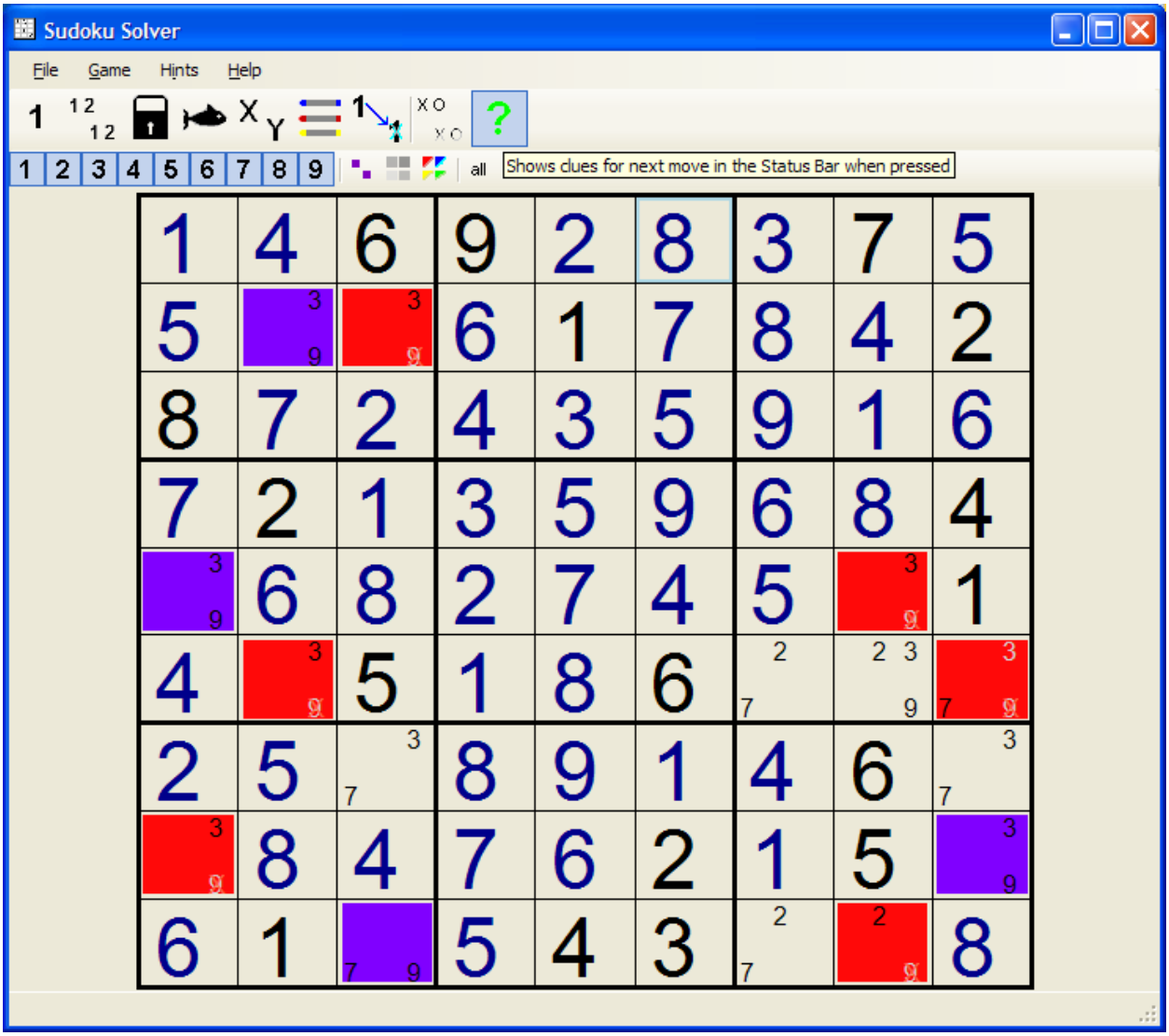
Color Chain Exclusion Type 2

If a single color intersects with itself, then that color is not true and all the Color Chain digits in that color's squares can be excluded.

Yes, this does happen and if it happens in a long chain, it often cracks the puzzle (StS). If a color overlaps itself, then it cannot be true because that would mean that a house would contain two of the same digit. House Rules forbid this, so the only choice is for the color to be false. Consider the following PM grid:

```
1  4  6  | 9 2 8 | 3  7   5
5  39 39 | 6 1 7 | 8  4   2
8  7  2  | 4 3 5 | 9  1   6
---------+-------+----------
7  2  1  | 3 5 9 | 6  8   4
39 6  8  | 2 7 4 | 5  39  1
4  39 5  | 1 8 6 | 27 239 79
---------+-------+----------
2  5  37 | 8 9 1 | 4  6   37
39 8  4  | 7 6 2 | 1  5   39
6  1  79 | 5 4 3 | 27 29  8
```

There is a very nice long +/-1 Color Chain on 9's:



Notice that red (the 1- color) intersects with itself in several places (b6, r6 and c8 to name a few). If red were to be true, all these houses would contain two or more 9's, which clearly cannot be. Because of the all true or all false rule for Color Chains, we can exclude 9 from all of the red squares (it is a little hard to see the dull red X's on top of red). This also reduces the puzzle to StS.

There is a generalization to all other Color Chain Exclusion rules that is worth mentioning here: *if any Color Chain Exclusion excludes another color, then the excluded color is false.* For instance, if a 4+ square intersects with both a 2+ and 2- square (a Type 1 Color Chain

Exclusion), then all 4+ squares are false (the all true / all false rule). As with Type 2 Color Chain Exclusions, hits like this on longer Color Chains will often crack a puzzle.

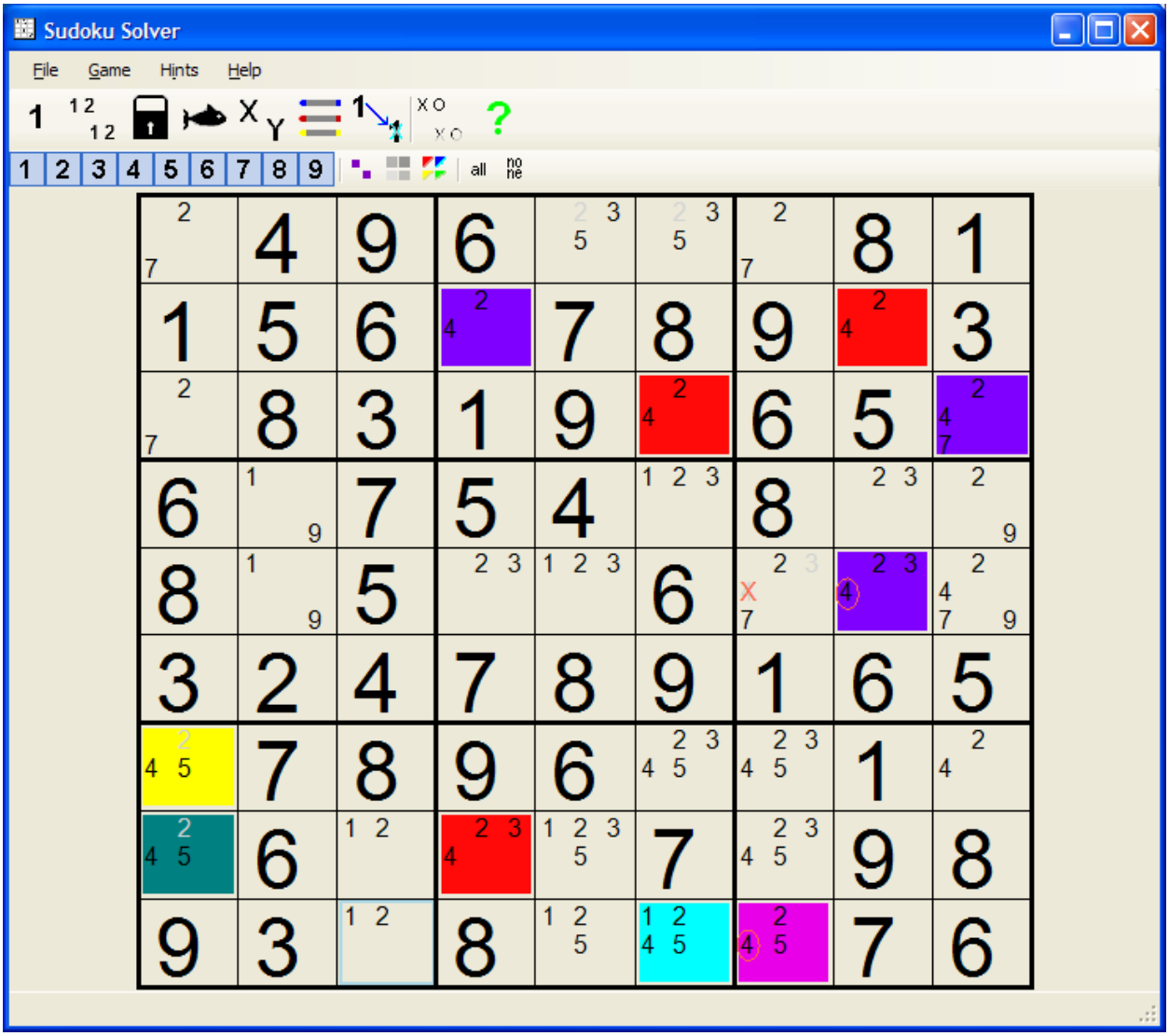
Color Chain Exclusion Type 3

Given two colors (e.g. 2+ and 3-) whose squares intersect, the Color Chain digit can be excluded from any square that intersects with both of their complementary colors (for this example, 2- and 3+).

This is a multi-color exclusion, because it makes use of more than one color to arrive at the exclusion. This rule works because of the all true / all false property of color chains. If 2+ and 3- intersect, we can extend that rule to say that if 2+ is true then 3- must be false, therefore 3+ must be true. Likewise if 3- is true then 2- must be true. The intersection links the fates of the 2/3 colors in a way that we now know that one of 2- or 3+ *must be true*. Let's start with an example PM grid:

```
27 4  9  | 6   35   35   | 27   8   1
1  5  6  | 24  7    8    | 9    24  3
27 8  3  | 1   9    24   | 6    5   247
---------+---------------+--------------
6  19 7  | 5   4    123  | 8    23  29
8  19 5  | 23  123  6    | 247  234 2479
3  2  4  | 7   8    9    | 1    6   5
---------+---------------+--------------
45 7  8  | 9   6    2345 | 2345 1   24
45 6  12 | 234 1235 7    | 2345 9   8
9  3  12 | 8   125  1245 | 245  7   6
```

And move directly to the Sudoku Solver screen with the type 3 exclusion already shown (on 4's):



The overlapping colors in this example are red (r3c6) and aqua (r9c6)[15]. Working from the assigned values in the Color Pattern Colors dialog, these are 1- and 3+, which means we need to look for an intersection of their complements: 1+ and 3-. As with all other Color Chain Exclusions, it is useful only if that intersection contains the colored hint digit, which is a 4 in this example. That overlap occurs in just one square: r5c7, which intersects with 1+ (purple) at r5c8 and 3- (magenta) at r9c7. Thus by the Type 3 rule, we can say r5c7<>4.

[15] Red and aqua also overlap in box 8, but we only need a single overlap to use this technique.

Color Chain Exclusion Type 4

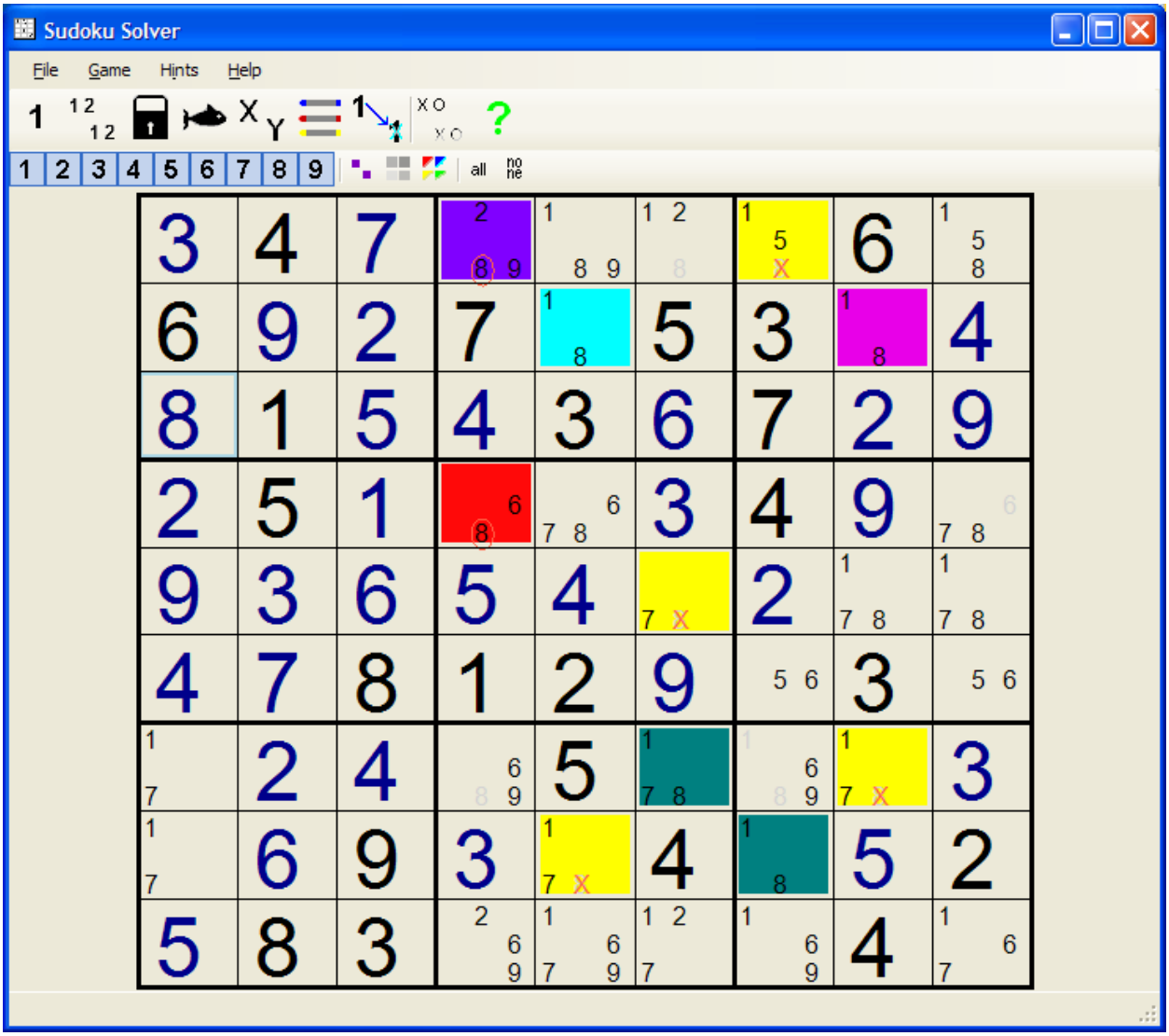
If a color intersects with both the +/- versions of another color, then this color is false.

This is a generalized version of a Color Chain Exclusion Type 1, with the generalization possible only because the intersection is on another colored square. The intersection with the + and – colors *need not be in the same square*; any one or two squares of the same color can satisfy this rule. Here is a PM grid of a partially-solved puzzle from the London Daily Telegraph[16] (on 5-5-2008):

```
3  4 7 | 289 189  12  | 158 6   158
6  9 2 | 7   18   5   | 3   18  4
8  1 5 | 4   3    6   | 7   2   9
-------+--------------+------------
2  5 1 | 68  678  3   | 4   9   78
9  3 6 | 5   4    78  | 2   178 178
4  7 8 | 1   2    9   | 56  3   56
-------+--------------+------------
17 2 4 | 69  5    178 | 69  178 3
17 6 9 | 3   178  4   | 18  5   2
5  8 3 | 269 1679 127 | 169 4   167
```

Moving directly to the Sudoku Solver screen with the type 4 exclusion already shown (on 8's):

[16] Because the Daily Telegraph made their online puzzles a subscription-only service in late 2008, you will not be able to download the original puzzle using Sudoku Solver.



Purple (1+) and red (1-) intersect with yellow (the now-false color) in row 1 and in box 5. The reason this exclusion works is the same reason the Type 1 exclusion works. It is more general because the intersection can happen across two squares, thanks to the chaining effect of colors.

Forcing Chains

Forcing Chains are the most powerful and advanced technique Sudoku Solver offers for cracking tough Sudoku puzzles. They should only be used when all other techniques fail, as they can also be fairly complicated.

As a general rule, you may want to apply the solving techniques in the order they've been presented in this guide: Singles, Patterns, Locked Candidates, BUG+1, Fishy Patterns, XY-Wings, XYZ-Wings, W-Wings, Color Chain Exclusions and, finally Forcing Chains. Sudoku Solver can be configured to offer you clues for your next move, and to change the order in which these solving techniques are applied to discover these clues.

Forcing Chains, for our purposes, consist of a single path (a chain) or multiple paths (a network) through the puzzle that allows the exclusion of one or more hint digits. These paths are found by examining all bi-value squares with a "what-if" analysis: what would happen if the first bi-value was true, then what would happen if the second was true? If both of these paths lead to one or more common hint digit exclusions, then these digits can be safely excluded from the puzzle (since one or the other of the bi-values *must* be true).

This is very much a trial-and-error process, and some consider it little better than recursive solving techniques (like Nishino[17]) or just plain guessing. In the end, it is more a matter of personal taste and what you'd like to do to find a puzzle solution. There are other techniques less general than Forcing Chains that can crack puzzles (e.g. Unique Rectangles, Almost-Locked Sets, Mutant and Finned Fish), some of which find solutions when Sudoku Solver cannot. If you'd like to learn more about these techniques, use your favorite search engine and with one or more of the above terms (and perhaps "Sudoku") and you will find ample reference materials.

Note that all of the examples in this manual showing Forcing Chains are shown with the Find best Forcing Chains option turned off.

[17] There is also a Nishino Contradiction Chain technique that Sudoku Solver employs when no standard Forcing Chains are available.

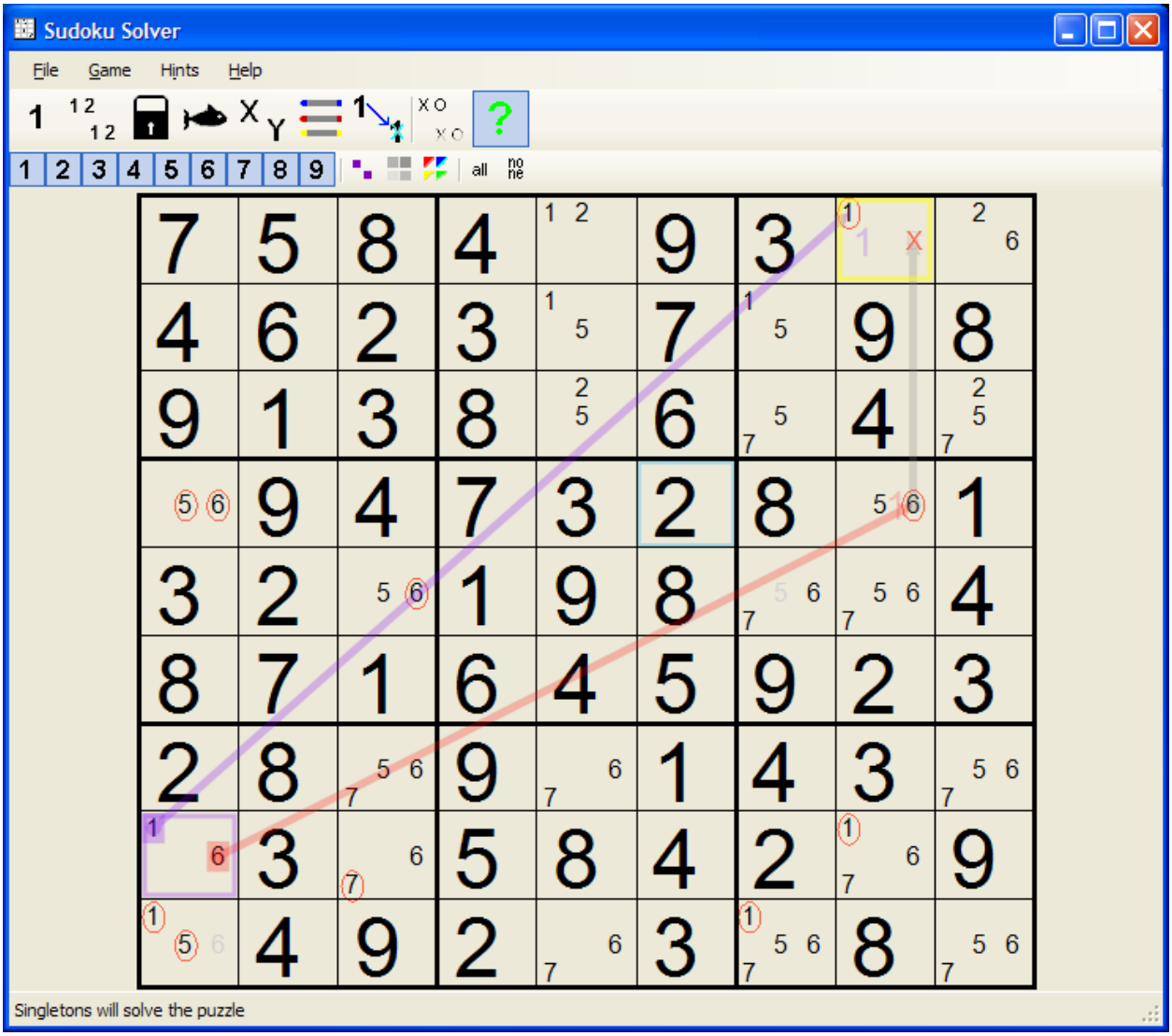
For our Forcing Chain example, we'll turn to a puzzle from Life.com (the Evil puzzle from 3/6/2008[18]). Here are the PM's after all of the above techniques have been applied and no further progress can be made:

```
7   5 8    | 4  12 9  | 3     16   26
4   6 2    | 3  15 7  | 15    9    8
9   1 3    | 8  25 6  | 57    4    257
----------+----------+-------------
56  9 4    | 7  3  2  | 8     56   1
3   2 56   | 1  9  8  | 67    567  4
8   7 1    | 6  4  5  | 9     2    3
----------+----------+-------------
2   8 567  | 9  67 1  | 4     3    567
16  3 67   | 5  8  4  | 2     167  9
15  4 9    | 2  67 3  | 1567  8    567
```

There are many possible ways to crack this puzzle[19]; the one we'll use is a short Forcing Chain from the bi-value square r8c1:

[18] Note that Life.com puzzles are no longer available as of February, 2019)

[19] In fact, a W-Wing will also crack this puzzle to StS; however at the time this example was created, W-Wings were not implemented in Sudoku Solver.



Forcing Chains are show using colors and arrows. The colors used are the 1+ and 1- for arrows (and the starting location – if a bi-value type 2 is used, there are 2 different starting locations), and the "Overflow" color used to illustrate the final, forcing step if it is in a different square. The "Bad Singleton Marks" color is used to highlight squares with exclusions (where the values are "forced"). Here's a description of what has happened:

```
------ First Chain ------
r8c1=1 r1c8=1
------ Second Chain ------
r8c1=6 r4c8=6
------ Cancellations ------
r1c8<>6
------ Chain Ends ------
```

The first chain starts with the assumption that r8c1=1. But how does that force r1c8=1? If you filter out all digits except for 1's and color them, you'll find that every 1 in the puzzle is part of the same +/-1 color chain, and both r8c1 and r1c8 are red. This is a simple bi-value type 2 force based on colors.

The second behaves in a similar manner, only you need to color 6's to see the force effects. Alternatively, you could view things less directly and notice that if r8c1=6 then r4c1=5 (it just so happens that a bi-value type 1 force also exists for this chain), and therefore r4c8=6. In the end, both paths get you to the same result.

How does this tell us that we can safely state r1c8<>6? The first chain excludes it by forcing r1c8=1; if it is 1 then it cannot be 6. The second chain excludes it by placing a 6 in the same house (c8). Since we know that r8c1 must be either 1 or 6 and since either of those values mean r1c8<>6, we can exclude that from the solution.

This is a *very* simple forcing chain (and leaves this puzzle at StS). Forcing Chains get much more complex – branching into Networks, indirectly forcing squares (shown with dashed lines), crisscrossing the puzzle grid. It can take some time to learn how to follow the logic. One may find, after using several Forcing Chains to be to crack a puzzle, that using some other square as a starting point would have cracked the puzzle to StS with fewer chains[20], or

[20] The Find best Forcing Chains option helps to avoid this particular case by searching broadly for all available chains given the puzzle state, but it can take much longer to find each chain.

that some other technique (like Unique Rectangles or perhaps a Mutant Kraken Jellyfish) cracks the puzzle to StS in fewer tries/moves.

The method used to find exclusions with Forcing Chains in Sudoku Solver involves a what-if analysis that applies one of the bi-value digits and then looks for the path (or paths) of Singletons that follow the application of that digit. These paths are followed simultaneously for both bi-values until a common exclusion is found or both paths stop generating Singletons. Sudoku Solver also looks for basic contradictions (i.e. a branch of a chain that leads to an illegal set of values in the grid). Contradiction cases are shown with the illegal values pointing back at the initial spot in the chain (and that initial spot is excluded from the puzzle). These search mechanisms operation in parallel. It is a very thorough search, and it is applied systematically to every type 1 and 2 bi-value pair found on the puzzle grid.

The previously mentioned Find best Forcing Chains option can be turned on to use a more informed (but much slower) search methodology.

Sudoku Solver will allow a form of Nishino (finding contradiction chains) if you enable that feature via the Preferences Dialog.

As you learn more about advanced Sudoku techniques, you may find other definitions of Forcing Chains and how they are implemented. It is all a matter of personal taste in the end.

Some Internet Sudoku Resources

Two sites I have found very useful are the Daily Sudoku Forums and Sudopedia. I may not always agree with their conclusions or definitions, but I always find them to be informative. Alternative (and also free) solvers you might want to check out are Simple Sudoku (which does not support quite as many techniques as Sudoku Solver) and Sudoku Susser (which

supports several additional advanced techniques). As with Forcing Chains, the tool you choose to help you with Sudoku puzzles is all a matter of personal taste. Happy solving!

Using Sudoku Solver

Now that you have seen the techniques that Sudoku Solver can use to solve puzzles and some screen shots, it is time to go into Sudoku Solver's capabilities in more detail. First we'll go over the menus and their operation (including shortcut keys). Next we'll review the toolbars and status bar. We'll conclude by covering any additional information you'd need to know to replicate the examples in the tutorial section.

Definitions

Some terms used throughout this narrative that might otherwise not be defined until after their first appearance:

- Board – also grid. The 9 x 9 Sudoku game board.
- Highlight – a user mark (see the Context Menu documentation) that shows up as an oval or circle around a hint digit.
- Message Window – a separate Sudoku Solver window that shows various messages, such as whether or not a puzzle was loaded or saved, puzzle score/rating, etc. Turned on in the Preferences dialog. Turned off there as well, or simply by closing it.
- X-Out – a user mark (see the Context Menu documentation) that shows up as an "X" over a hint digit (or as a faded hint digit, depending on your Preference settings). Using X-out on a hint digit removes that digit from consideration in the puzzle.

Command Line

The format of the command line is as follows:

```
Sudoku.exe [switch] [filename] [additional_args]
```

The “switch” argument may be one of the following:

- /print – must be followed by filename (see below). Opens filename, prints it to the default printer and exits
- /reg – reset Sudoku Solver’s registry information. For maintenance purposes only; run this if you notice Sudoku Solver files (.SS1 and .SS2) are not opening when you double-click them or do not have the right icon.
- /score – used to create a score table for a batch of puzzles in a text file. Scoring is performed in the background, with no visible UI (so the only way you know it is completed is to check in Task Manager to see if Sudoku.exe is still running). Arguments that follow are:
    - Inputfile: name of the file that contains the puzzle list; must be in the same format as the Sudoku17 text file (one puzzle per line made up of the digits 0-9 and ended by CR, LF). Processing continues in the background until all rows in the file have been scored. This serves as the “filename” argument (see below).
    - Outputfile: name of the file that will contain the score table. Output with one puzzle per row in same order as Inputfile (the file will be created; if it exists then the existing file will be erased). Fields are separated by commas and they are: Row # in Inputfile (origin 1), Hint Count (the same count given by the uniqueness test), Solve Time (in seconds), Level, and the formatted Puzzle Score.
    - Startrow: [optional] the row in Inputfile to start on. Useful for restarting if scoring was interrupted, or to score a newly expanded file (e.g. the latest version of Sudoku17).

The “filename” argument, if provided, is the name of a Sudoku puzzle file to open. If not one of the types defined under File Open then it is assumed to be an .XML file. If “filename” is provided without the /print or /score switch, then this file is opened and displayed. If “filename” contains any blanks, it must be surrounded in quotes (e.g. “c:\documents and settings\user\my documents\sudoku\puzzle.ss1”). It is fine to use quotes even if there are no blanks, but you *must* use quotes if there are blanks in the name.

Menus and Commands

Excluding the Help menu, there are three top-level menus in Sudoku Solver: File, Game and Hints. There is also a context menu, two toolbars and keyboard shortcuts. There are several commands available using your mouse as well. All are documented in the following sections.

File Menu

The file menu has commands for opening, saving and printing puzzles, as well as for closing Sudoku Solver.

Open – (shortcut Ctrl-O)

Opens a Sudoku puzzle file. Three base file types are supported. The default is .SS1 (Sudoku Solver files); these files can contain puzzles and X-out data. Also supported are .SS2 (Sudoku Solver Manual files), SS (Simple Sudoku files – puzzles only) and .XML (Sudoku Solver’s custom XML format – puzzles with X-Out and Highlight data). See the Hints Menu section for more information on X-Outs and Highlights.

Save As

Saves a Sudoku puzzle file without any X-Out or Highlight data. Supported file types for saving are .SS1 and .XML in normal mode and .SS2 in manual mode.

Save As with Marks

Saves a Sudoku puzzle file with X-Out and Highlight data. Supported file types are .SS1 (can only save X-Out data) and .XML (can save both X-Out and Highlight data) in normal mode and .SS2 in manual mode.

Print (shortcut key Ctrl-P)

Prints the current puzzle; allows you to select the printer to be used as well as printer options.

Print Preview

Opens a print preview window that lets you see what the page would look like if printed to the currently selected printer.

Page Setup

Lets you select paper size, margins for the page, printer to use and other options.

Exit (shortcut key Alt-F4)

Exit Sudoku Solver. Any puzzle work in progress is lost. There are no overly-friendly, "are you sure you want to quit?" messages.

Game Menu

The game menu commands help you to create, download, solve and control access to puzzles as well as various Sudoku Solver options (such as colors).

Copy (grid + hints) - (shortcut key Ctrl-C)

Copies the current puzzle and pencil marks (PM's) to the clipboard as text. May be pasted back to Sudoku Solver to restore / reload the puzzle. More commonly, this is used to send

puzzles through e-mail or to post them on Sudoku boards on the Internet. Going back to the example in the tutorial, the puzzle and PMs are copied as:

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


67   369 2   | 346 5  34  | 8   1   467
4    368 136 | 7   2  123 | 9   5   6
167  5   167 | 46  8  9   | 26  47  3
-------------+------------+------------
8    2   5   | 1   4  7   | 3   6   9
9    7   4   | 8   3  6   | 1   2   5
3    1   6   | 2   9  5   | 4   8   7
-------------+------------+------------
2    36  367 | 5   1  34  | 36  9   468
1567 36  9   | 34  47 8   | 1356 345 2
15   4   8   | 39  6  23  | 7   35  1
```

The Copy Grid command is related, and copies only the grid to the clipboard (see below). Note that the puzzle grid format is controlled by your preference settings.

Copy Grid – (shortcut key Ctrl-Shift-C)

Very similar to the Copy command, but copies only the original, unmodified grid to the clipboard *without* PM's. Some programs, such as Sudoku Explainer, are unhappy if PM's are pasted in along with the puzzle; this command makes it easier to copy puzzle data to those programs. Note that the puzzle grid format is controlled by your preference settings.

Copy Hints – (shortcut key Ctrl-Alt-Shift-C)

Very similar to the Copy command, but copies only the PM's (i.e. "hints") to the clipboard. The original grid is omitted.

Paste – (shortcut key Ctrl-V)

Pastes the text from the clipboard into Sudoku Solver; if the clipboard text can be interpreted as valid puzzle data, it will load the puzzle. This is typically used to load puzzles from e-mail or the Internet into Sudoku Solver. The Message Window will tell you if the puzzle (and PM's) were successfully pasted into Sudoku Solver (or not). You may paste just the puzzle, just the PM's or both together. Some rules to keep in mind for pasting:

- Puzzle data is expected to contain exactly 81 numbers. Numbers are the digits 1 – 9 plus 0 (for no value); Sudoku Solver will also treat the following characters as zeros: x.X (lowercase x, period, uppercase X). Puzzle data that uses other characters (e.g. asterisk) for 0 placeholders cannot be pasted successfully into Sudoku Solver; you can try pasting them into another program, such as Notepad, first and changing the offending characters before pasting back to Sudoku Solver.
- PM data is expected to be strings of digits 1-9 separated by just about anything; 81 strings of digits must be found for the PM to be interpreted correctly. There are no placeholders, just numbers and non-numbers. When pasted without puzzle data, every open singleton is treated as a given square for the purposes of initializing the puzzle.
- To paste puzzle data + PM's there must be at least 1 blank line (i.e. nothing other than the ASCII characters CR and LF with at least 2 LF's in the sequence – *not even spaces*) between the puzzle data and PM's, and the PM's must come after the

puzzle data. When both are pasted, the given squares are taken from the puzzle data, and X-Out's are inferred from the PM's.

Paste Template – (shortcut key Ctrl-Shift-V)

Very similar to the Paste command, except it pasts puzzle templates instead of playable puzzles. A template uses "X" or "x" to show where a given value should appear and "0" or "." to show where no given should appear. Used in Puzzle Generation with the Use grid as Template option. Note that the Sudoku grid this creates will have 1's for the given squares, and will not be a valid puzzle. An example of a spiral puzzle template (with 24 spots; it also happens to be symmetric) is:

```
X X . . . . . . .
. . . . . . X X .
X . . . X X . . .
X . . X . . X . .
. X . X . X . X .
. . X . . X . . X
. . . X X . . . X
. X X . . . . . .
. . . . . . . X X
```

Load from Web

Opens a pop-up menu used to load puzzles from several different sources on the Internet. Please note that .Net and Windows security settings will not allow users logged on through the Guest account to access the Internet; sorry, but the only way around that is to use a different Windows account. Note that if you have already saved a Sudoku 17 file, there are no restrictions on Guest account access for those puzzles. Users with Guest accounts will see an error message if they try to load puzzles from the Web.

The first pop-up menu options allow you to quickly load a random puzzle of a given difficulty level from WebSudoku.com. Note that all puzzle downloads are subject to the

maximum web wait time. The remaining options let you load puzzles from a variety of sources. Because each web site has their own methods of setting the difficulty level of their puzzles, Sudoku Solver will rate each puzzle you load to give you a consistent metric. Even WebSudoku (whose puzzles helped form Sudoku Solver's baseline metrics for Easy, Medium, Hard and Evil puzzle ratings) does not always agree with the ratings calculated by Sudoku Solver. Messages about the success or failure of loading the puzzle will appear in the Messages Window; if the load is successful then the puzzle will also be scored.

You may use F5 as a shortcut key for one of the puzzle sources listed below that begin with "Load"; pick which source to launch in the Preferences dialog. The menu items are:

- Level 1 (Easy) – load a random, Easy puzzle from WebSudoku.com
- Level 2 (Medium) – load a random, Medium puzzle from WebSudoku.com
- Level 3 (Hard) – load a random, Hard puzzle from WebSudoku.com
- Level 4 (Evil) – load a random, Evil puzzle from WebSudoku.com
- Load WebSudoku Puzzle – Download a puzzle based on its difficulty level, and if you wish, its puzzle number. Use this command to download specific WebSudoku puzzles (e.g. those used in the Tutorial section). If you check the Save Puzzles checkbox, then instead of a puzzle number this becomes the *number of puzzles to download*. This option lets you download and save a relatively large number of puzzles (saved in your default puzzle directory); the maximum web wait time is applied to each puzzle downloaded (e.g. 30 seconds per puzzle).
- Load UClick Puzzle – Download a puzzle from one of several UClick websites. Select the site and the date for the puzzle; the dates you can select for a site are restricted to the range of Newest to Oldest as listed in the dialog. If any sites are grayed out it means they are unavailable at present. The Newest and Oldest dates

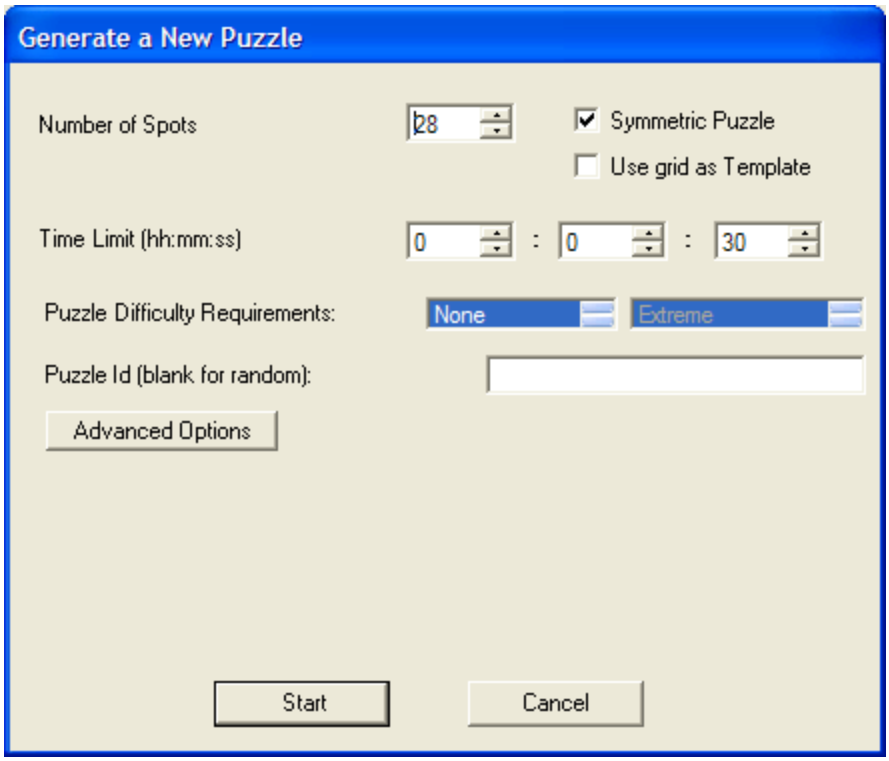
are not always correct; if the puzzle isn't available for a selected date then it simply won't be downloaded. UClick puzzle ratings are only available as part of the puzzle itself, so you can't easily select puzzles based on difficulty. UClick is known to rate puzzles differently for different sites (the LA Times site[21] often has the hardest puzzles).

- Load DailySudoku Puzzle – Download a puzzle based on date from the DailySudoku.com website. Past and future puzzles are available. See the website's archives for a complete list of dates for which puzzles are available; the last time I checked they had daily puzzles dating back to 21 January 2005.
- Load 17 Puzzle - Gordon Royle, from the University of Western Australia, has been collecting 17-spot Sudoku's for many years and maintains the authortative list of more than 49,000 published and unique puzzles on the web. To use this feature you must download and save his Sudoku17 file to your default puzzle directory as Sudoku17.txt. The file is nearly 4 Mb in size. Once you've saved it to your default puzzle directory, the file will be available as the source for 17-spot puzzles. Check his web page now and again, as Gordon adds more puzzles as they are discovered. Happy solving!

Generate Puzzle – (shortcut key Ctrl-E)

Open the Generate Puzzle Dialog, which lets you create random puzzles. If a puzzle is successfully generated, it will be loaded into the grid and the Message Window (if shown) will present information on the puzzle (how many spots, how long it took to find, the puzzle score / difficulty rating). If you cancel the process or a valid Sudoku is not found within the time limit, the puzzle grid is left as it was at the start of the generate process.

[21] It appears the the LA Times stopped using UClick puzzles in January, 2012. Older puzzles will remain available as long as the Times keeps them available.



- Number of Spots is the number of given spots you'd like the puzzle to have; range is from 17 to 80. Generally speaking, generating puzzles with 22 – 23 spots or more can be accomplished in seconds (or a few minutes). Puzzles with 21 or fewer spots can take quite a long time. Puzzles with 24 – 25 or more spots are generated very quickly. When Sudoku Solver starts, it uses the "Default spots for Generate" value from your Preferences. During any single session, changes you make to this value are remembered, but the default value can only be changed in the Preferences Dialog.
- Symmetric Puzzle forces the puzzle to be symmetric; if not checked then the puzzle will be totally random. Virtually all published Sudoku puzzles are symmetric. Note that to date no puzzle with 17 spots has been found that is symmetric (and no puzzle with less than 17 spots has been found).

- Use grid as Template will use the current puzzle grid as a template for the generated puzzle. This means that the puzzle generated will have given spots where the current puzzle grid has given spots. If you use this option, Number of Spots and Symmetric Puzzle are disabled (because the grid determines the count and layout). You can use any puzzle grid (valid or not) as a template; common template grid formats can be entered easily using Paste Template.
- Time limit determines how much time (in hours, minutes and seconds) you want to allocate to the search. There is no guarantee that a puzzle will be found in this amount of time.
- Puzzle Difficulty Requirements – the default is *None* which means the first valid Sudoku puzzle found with the requested number of spots will be returned. Other values force the puzzle returned to meet specific difficulty requirements using the listbox just to the left of this one (shown as *Extreme* in the example above)
    - Same – puzzle must have the same level (*Extreme* in this example)
    - Easier – puzzle must be easier (*Easy* through *Fiendish* in this example); if you select *Easier* and *Easy* as the difficulty level, you will never get a puzzle back (the only level easier that *Easy* is an already solved puzzle).
    - Harder – puzzle must be harder (*Insane* in this example).
    - SameOrHarder – puzzle must be the same level or harder (*Extreme* in this example)
    - SameOrEasier – puzzle must be easier or the same difficulty (*Easy* through *Extreme* in this example)
    - None – as noted above, this disables the difficulty rating tests and the first valid puzzle found with the requested number of spots is returned. This setting also disabled the difficulty level listbox to the right (notice how the

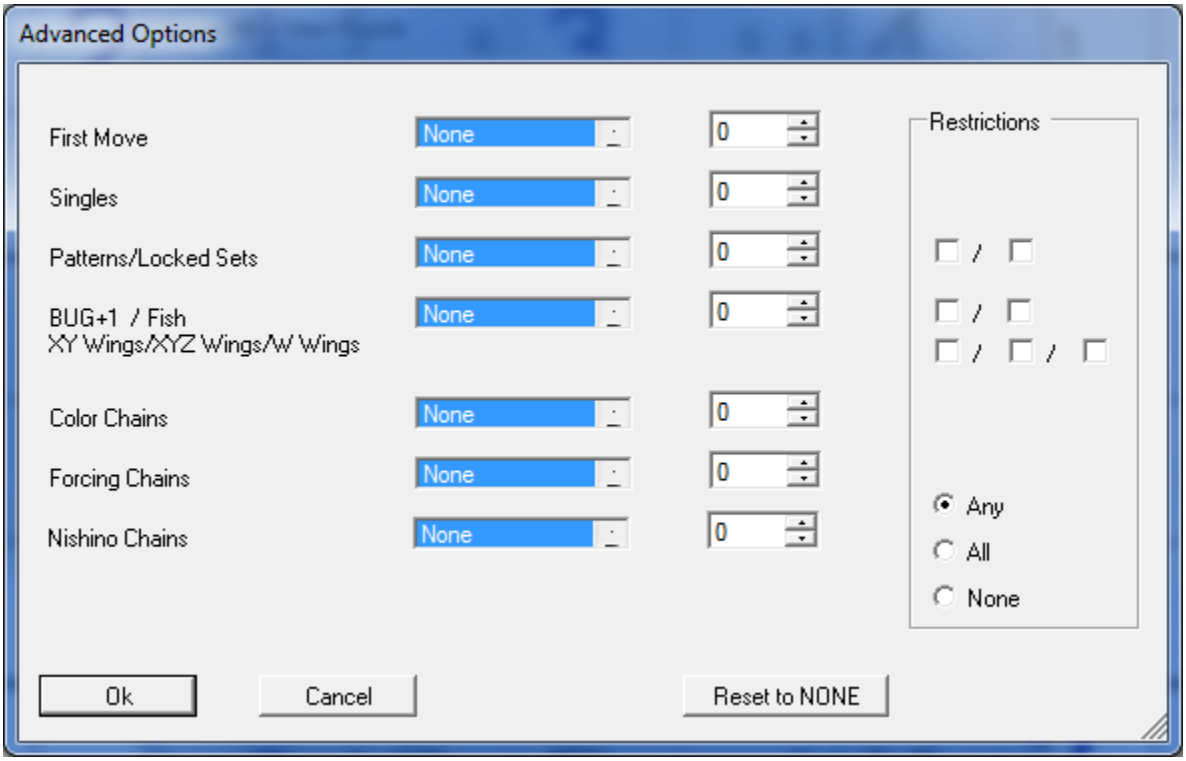
Extreme text appears grey instead of white on the blue selection background).

NOTE: To select an item in this or the next listbox, you must not only scroll until the item is visible, you must also click on it so that it is highlighted (as in the example above).

- *Extreme* – Actually a list of puzzle difficulty levels from Easy to Extreme, depending on your access permission settings for Max Difficulty; this sets the comparison for Puzzle Difficulty Requirements. Sudoku Solver will not allow you to generate a puzzle harder than the Max Difficulty setting using this option. Ok, with one exception – if your Max Difficulty level is Extreme, Sudoku Solver will allow you to select *Insane* as the level (i.e. create a puzzle that Sudoku Solver cannot solve through logic).
- Advanced Options – This button is only available if your access permission settings for Max Difficulty are set at *Extreme*. It brings up a fairly complex selection dialog that allows you to select every element of the ratings list, making puzzle selection quite detailed. If any criteria in the Advanced dialog are used, then use of the simpler "Puzzle Difficulty" settings above is suppressed. *If you can't figure out what the Advanced Dialog settings mean,* ***don't use the dialog!***
- Puzzle Id – Every puzzle returned has a unique id associated with it (listed in the Message Window and part of the puzzle's default file name). If you want to recreate a specific puzzle, enter the id here (you will also need the same settings for Number of Spots, Symmetric, and Puzzle Difficulty). Never use Start From Current Grid if you want to recreate a puzzle based on its id.

- START – starts the search process. A progress bar indicates how much of the allotted time has been used in the search. The search will end as soon as a valid Sudoku puzzle has been found that meets your criteria, or when the time limit has been reached.
- CANCEL – lets you cancel the search at any time.

Advanced Options



This dialog (accessible only from the Generate Puzzle dialog) lets you control the difficulty of the puzzle generated down to a very fine-grained level. You may specify numeric values for each element in the ratings list displayed when a puzzle is scored. For each element, set the first listbox (comparison type) to one of: None, Same, Easier, Harder, SameOrEasier, SameOrHarder (equivalent to: Ignore, Equal To, Less Than, Greater Than, Less Than or Equal To, Greater Than or Equal To). Then set the numeric value (score); the larger the value the greater the difficulty. Each numeric value is pinned between zero and the

maximum score for that item. If the comparison type is None, then the score (and checkboxes – see below) are ignored. For your reference, the First Move values are:

0 = Open single
1 = Hidden single
2 = Pattern
3 = Locked set
4 = BUG+1
5 = Fishy pattern
6 = XY wing
7 = XYZ Wing
8 = W Wing
9 = Color chain exclusion
10 = Forcing chain
11 = Nishio forcing chain

The Restrictions check boxes allow you to split out techniques from score values that combine one or more techniques. Thus there are two checkboxes next to Patterns/Locked Sets (the first for Patterns, the second for Locked Sets) and five next to BUG+1/Fish and XY Wings/XYZ Wings/W Wings (similarly assigned in order, but split across two rows). The three radio buttons (Any, All, None) specify the interpretation of these checkboxes:

- Any: the puzzle must have at least one of the checked techniques.
- All: the puzzle must have all of the checked techniques and none of the unchecked techniques.
- None: the puzzle must not have any of the checked techniques.

The checkboxes are only applied if the comparison type for their particular techniques is something other than None.

The Reset to NONE button resets all of the comparison types to None, effectively disabling the Advanced Options settings.

Type in Puzzle

This allows you to enter a puzzle manually, either to create your own or copy one from an offline source, like a newspaper or Sudoku book. It is also known as "Design Mode." You have the option of starting from a cleared grid or working off the puzzle currently in the grid. If the status bar is showing the next move, then it will also display a message stating you are in Design Mode.

The current square (the one you'll type in) is marked with a yellow highlight. You may change squares by clicking with the mouse or using the arrow keys. Typing 0 "unsets" the square, even if it was a given. The numbers 1 – 9 assign that value to a square; Sudoku Solver will not allow you to enter any number more than once per house. The space bar simply skips over squares.

Entering a value causes the square selection to advance by one. You may also use backspace to move back one square without changing anything. The method of advancing (by box or row) is determined by your Preferences settings.

You may check to see if your grid is unique at any time; this will also tell you how may squares you have set (you must have the message window open to see this information).

To assist with designing your own puzzle, you may press Ctrl-Shift-P to have Sudoku Solver highlight one possible solution for the grid as it exists, even if the current grid is not unique. If the grid is not unique, the highlighted digits may change each time you press Ctrl-Shift-P.

You may download a puzzle from the web while in Design Mode; the puzzle will be available for editing once downloaded.

To exit Design Mode, click on Game / Finished Typing Puzzle (the menu command changes to this once you enter Design Mode). If your puzzle grid is not a unique Sudoku, you will be

warned and offered the chance to return immediately to Design Mode to complete it. If you were in Manual Mode when you entered Design Mode, Manual Mode will be restored.

Manual Mode

Switches Sudoku Solver to Manual Mode. This disables all of the solving logic, creating a computerized "pencil and paper" solver for you to use. This mode is discussed in more detail in the Manual Solving section below. When Sudoku Solver is in Manual Mode, a check mark appears next to this menu item and the Status Bar (if enabled) reports that Manual Mode is in effect. To switch back to normal mode, uncheck this menu item. Sudoku Solver remembers if it was exited while in Manual Mode, and it will restart in the same mode.

Clear the Board – (shortcut Ctrl-N)

Creates a clear, empty board with no "given" values; the same sort of board or grid you see when you first open Sudoku Solver.

Check for Unique – (shortcut Ctrl-U)

Checks the current puzzle grid to see if it is a valid Sudoku (has *exactly* one solution). Results are displayed in the Message Window. Most modern computers can complete this test in fractions of a second (the longest I have seen to date is about 5 seconds for a puzzle with more than 20 million possible moves). This will also tell you how many possible hint values were considered at each step of the solving process (solved via recursion, not logic).

Solve

Places the puzzle's solution into the grid. Sudoku Solver calculates the solution at the time the puzzle is loaded, thus placing this into the grid for you to review is very quick.

Calculate Solve Time – (shortcut Ctrl-Shift-Q)

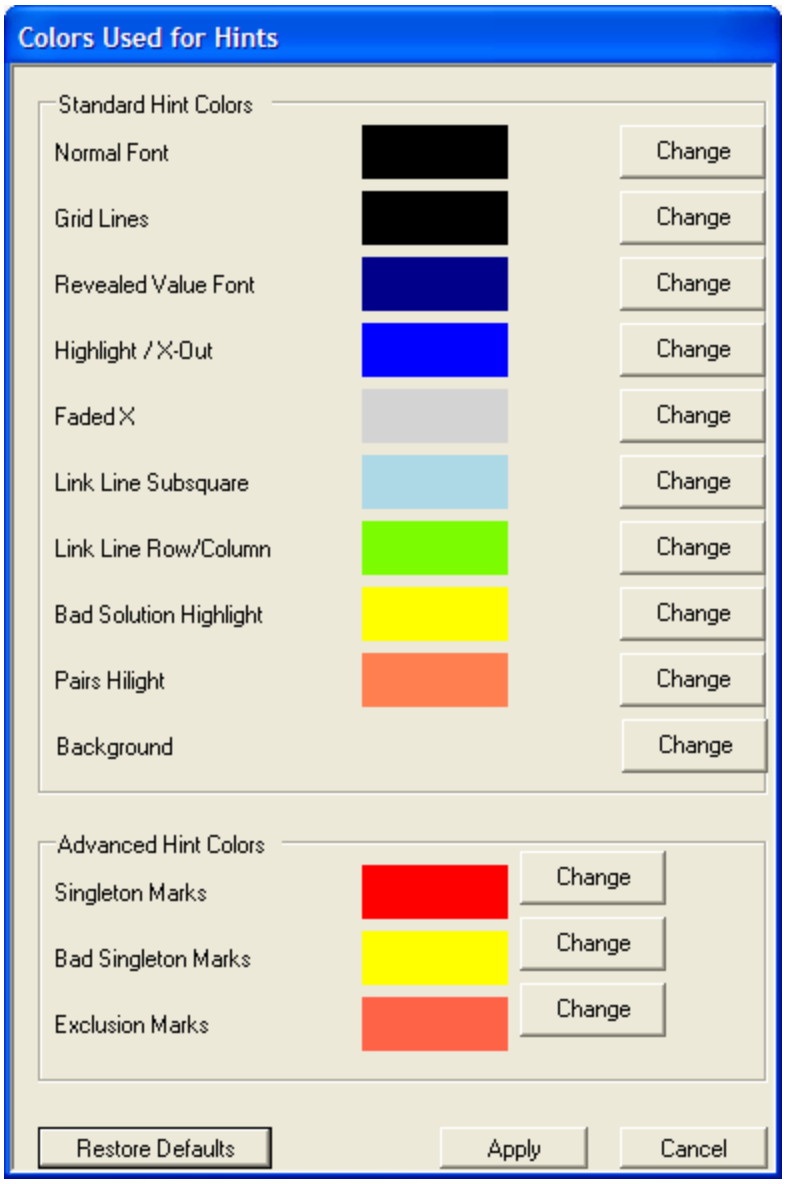
Calculates the average time (in milliseconds) needed to find a solution for the current grid. This is figured by running the solution up to 100 times and taking the average. It can take up to 3 minutes to compute, but often takes 2 – 30 seconds or so, depending on the puzzle complexity. Results are shown in the Message Window. The time required is directly proportional to the total possible number of hint values considered in reaching a solution via recursion. It is rarely related to the grid score.

Options

Opens the Options pop-up menu, which lets you change colors, preferences and access restrictions:

Colors

Lets you set the colors used for puzzle display. Here is an example with the default colors in place:



To change any color, click on the Change button. You'll see the standard Windows "color picker" dialog which lets you choose from several preset colors or click on "Define Custom Colors" to create your own. Your changes are not saved unless you click Apply. You may click on Restore Defaults to reset all these colors to Sudoku Solver's default values (but again, this is not saved unless you click Apply). Note that in the default configuration, there does not appear to be a Background color; this is because the default Background color is the same

color as the surrounding dialog (you are, of course, free to change this to any color you like). Note that changes to the background color also affect some (but not all) other parts of the window (e.g. text shown on the status bar, but not the toolbars). Changes take effect immediately and are saved between sessions.

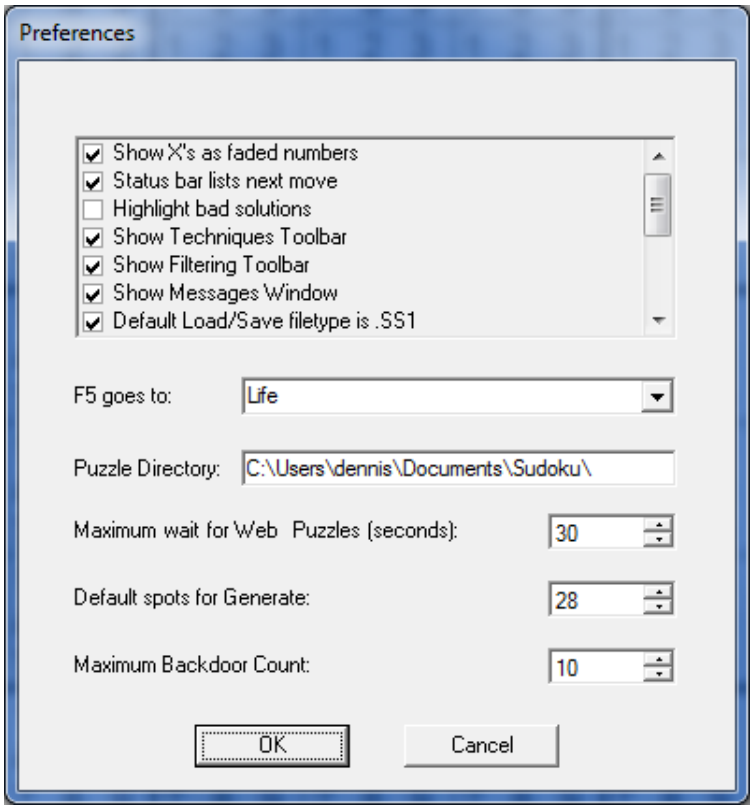
Color Pattern Colors

You first saw this dialog in the Tutorial section. It controls the colors used for Color Chains and Forcing lines. Here is the dialog with its default colors in place:

As with the preceding dialog, you make changes to any individual color with the Change button and restore the default settings with Restore Defaults. None of your changes take effect unless you click Apply. Changes take effect immediately and are saved between sessions. The intensity used to display these colors may be adjusted with the Alpha Slider.

Preferences – (shortcut F2)

Opens the Preferences dialog, where you can choose from several different options / settings. The section of the dialog with the checkmark list is scrollable (depending on the number of options and your screen resolution); not all preference settings are visible in the screen image below. Changes will take effect immediately and are saved between sessions:



Checkbox items

- Show X's as faded numbers: X-outs may be shown as an X over the hint digit, or by simply showing the hint digit in a lighter, faded color (see the Faded X color in the Colors dialog).
- Status bar lists next move: Shows suggested next moves, depending on the level of access granted to hint techniques. You may also set this from the Techniques Toolbar.

- Highlight bad solutions: Serves as a teaching aid for people learning to solve puzzles by using X-outs. Once every square has only zero or one possible hint values remaining, a yellow highlight will be placed around any square which has one or more incorrect X-outs; an incorrect X-out is defined as X'ing out the solution value for a square. Because it is to be used as a teaching aid, bad solutions (i.e. X-outs) are only highlighted once the user is at a point where they have completed their work on the puzzle (versus marking bad X-outs immediately, which encourages more of a trial-and-error approach, square by square).
- Show Techniques Toolbar: display the Techniques toolbar underneath the main menu.
- Show Filtering Toolbar: display the Filtering toolbar underneath the main menu.
- Show Messages Window: Show the messages window, which is used to show puzzle rating/scores, results of loading, generating, running a uniqueness test, and many other tidbits. If you close the Messages Window, the only way to bring it back is using this checkbox. Note that the Messages Window will snap to the left or right side of the main window if it is moved close enough. When the windows are snapped together, the Messages Window will move along with the main window. To unsnap the windows, you must move the Messages Window away from the main window.
- Default Load/Save filetype is .SS1: Previous versions of Sudoku Solver used .XML as the default format for opening and saving puzzle files. This checkbox makes .SS1 the default. The .SS1 format is more compact and is "human readable." The one advantage of .XML files is their ability to save both X-out and Highlight information (when saving with marks).

- Copy Puzzle Board as grid: This option is not visible in the screen image above; when it is checked, text copies of the puzzle board (e.g. using Copy or Save As) will format the given/unknown puzzle data as a text grid. This is the default. When this option is not checked, the given/unknown data is instead formatted as a text string without spaces or other formatting (periods are used in lieu of zeros). The data is the same; it's simply a matter of how it is formatted. This applies to the Copy Command and all variations of Save As commands. It has no effect on Paste or Open. As an example, if this option is checked, then the puzzle board copies to the clipboard as shown in the Copy command. If this option is not checked, then that same grid would instead be copied to the clipboard as:
  ..2.5.81.4..7..9...5..89..3.251.7.6997.836.2531.2.548.2..51..9...9..8..2.48.6.7..
- Use filled ellipse instead of X in Exclusion Marks: This option is not visible in the screen image above; when checked this changes the tomato red X used in Exclusion Marks into tomato red, filled, semi-transparent ellipses. Some people find this makes spotting excluded values easier. The default is to show Exclusion Mark X's as X's. Keep in mind that the color is also configurable.
- Show Exclusion Marks and Groups: This option is not visible in the screen image above; when checked, Exclusion Marks and Groups are shown. This is identical to the Turn Exclusions Marks/Groups On menu item (except no sounds are played when turned on).
- Look for Nishino Contradiction Chains: This option is not visible in the screen image above; when checked this enables searching for Nishino Contradiction Chains if it is unable to find any Forcing Chains. These are akin to forcing chains, except they may start on any hint value in any square (versus only from bi-value squares). Since it starts from a single value, cancellations occur only when contradictions are

discovered. Whether or not Nishino Contradiction chains are enabled (i.e. Sudoku Solver will search for them if no Forcing Chains are found), they will still appear as part of the current grid score as appropriate.

- Find best Forcing Chain (slow): This option is not visible in the screen image above; when checked this turns on logic for finding the "best chain" when looking for Forcing Chains. Normally, the search for Forcing Chains (using the menu or Toolbar commands) simply looks for the first chain forcing one or more values that it can find (searching for shorter chains first). The "best chain" logic examines *all possible chains* for the current grid, scoring them against one another and picking the one deemed best. This is usually very slow… it can take 10 times longer than a standard Forcing Chain search. It can lead to solving the puzzle with fewer chains, but that is not always the case. Your mileage will vary depending on the puzzle.
- Autodial Internet if not connected: This option is not visible in the screen image above; when checked, your Internet Explorer "autodial" connection (if any) will be used to connect to the Internet if you are not already connected. If Sudoku Solver dials a connection, it hangs up as soon as it is completed, so this can lead to lots of dialing and hanging-up if you are downloading puzzles. This only works if one of your dial-up networking connections is set to "Dial whenever a network connection is not present" (see Control Panel, Internet Options on the Connection tab).
- Show Congratulations Message: This option is not visible in the screen image above; when checked, Sudoku Solver will display a congratulatory message when you solve the puzzle; it will also let you know if this a new personal-best time at this puzzle's level of difficulty. It will not display another for the same puzzle unless you reload or reset it.

- Cursor advances thru Box Items: This option is not visible in the screen image above; when checked, Sudoku Solver will move the cursor through the current box (through the current row in the box, then on to the next row) before moving onto the next box (after the end of box 9, the cursor jumps back to the start of box 1). The default (unchecked) is to move through the grid one row at a time (jumping back to the start of row 1 after the end of row 9). This preference applies to Backspace and to typing in puzzles.

Other Preference Items

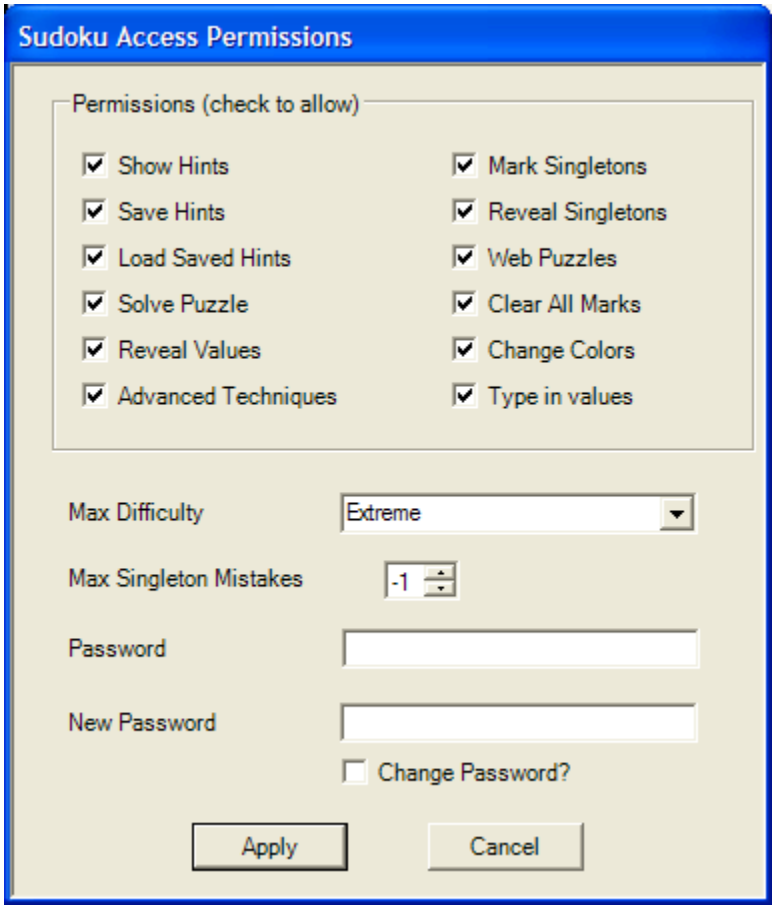
- F5 goes to: F5 is a shortcut key that is assigned to one of the Load from Web sources (e.g. WebSudoku, Playr, UClick, etc). The default is Playr. When F5 is pressed, the dialog to load puzzles from that source will be launched.
- Puzzle Directory: The default directory to use for opening and saving puzzle files. This is also the directory where en masse downloads from WebSudoku are placed, and the directory where the Sudoku17 file is sought.
- Maximum wait for Web Puzzles: Downloading puzzles from the Internet may be subject to all sorts of delays. Your connection speed, the load on the servers and the particular path your request takes on the Internet can all play an unpredictable part. The default value of 30 seconds should be more than enough time. If you find you're consistently "timing out" when loading puzzles from the Internet, try increasing this time. If you feel that your computer is waiting too long or seems to hang, decrease this time. Note that it is not an *exact* limit; it is approximate.
- Default spots for Generate – sets the default value for the number of spots used in Puzzle Generation. The default is 25.

- Maximum Backdoor Count – sets a ceiling on the number of Backdoors that will be displayed. The default is 10.

Press OK to save your changes Cancel to close the dialog without accepting any of the changes you've made.

Restrict Access – (shortcut F3)

This dialog is designed largely for use in educational environments. It allows a teacher or parent fine-grained control over access to specific Sudoku Solver features and capabilities. To that end, these settings may be protected with a password.



Permissions (check to allow)

- Show Hints – if *not* checked then all of Sudoku Solver's puzzle solving or assistance features are turned off. This includes hint digits (or Pencil Marks) and pretty much everything else.
- Save Hints – if checked, then you will be allowed to save puzzles with Highlights and X-Outs using Save As with Marks.
- Load Saved Hints – if checked, then any puzzles saved with hint data (X-Outs and Highlights) will be loaded including their hints. Otherwise, the hint data is ignored when loading the puzzle.
- Reveal Values – if checked then Click to Reveal is allowed, as well as related Context Menu features.
- Advanced Techniques – if checked then all of the Advanced Techniques on the Hints Menu are enabled. This also enables showing Clues about next moves in the Status Bar as well as permitting access to Hint Order for Clues.
- Mark Singletons – enables marking of singletons; if Reveal Singletons is also set then also enables Reveal All Singletons.
- Reveal Singletons – enables revealing of marked singletons; if Mark Singletons is set then also enables Reveal All Singletons.
- Web Puzzles – if checked then the user is allowed to load puzzles from the web.
- Clear All Marks – if checked then Clear All Marks is enabled. Because clearing all marks can cause you to lose work put into a partially solved puzzle, you have the option of disabling the command.
- Change Colors – if checked then the user is allowed to change the colors schemes (general and color chains), though access to Advanced Techniques is also needed to change color chain colors.

- Type in Values – if checked then the user can type values into squares on the grid; note that attempts to type the *wrong* value (i.e. not part of the solution) will result in a "beep" with nothing entered. This can be used as a primitive trial & error solver (keep hitting keys until you get it right).

Other Permissions

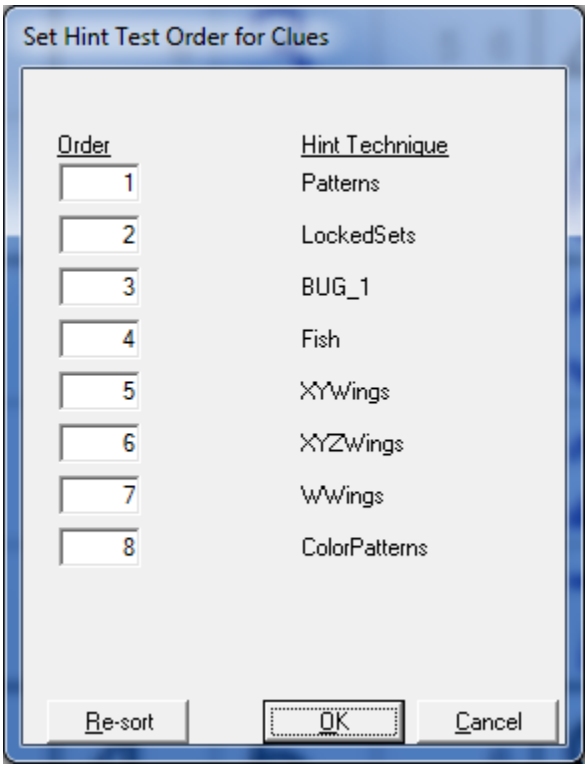
- Max Difficulty – Limits the difficulty of puzzles downloaded from the Internet to the level selected (or easier). Ranges from Easy to Extreme. This is based on the level identified by the website. Sudoku Solver's rating may differ.
- Max Singleton Mistakes – To disable set to -1. Otherwise this is the maximum number of times that Mark Singletons (or related commands like Reveal) can be used with erroneous X-outs present on the grid. Once this limit has been reached, these features will be disabled (with a warning message) until a new puzzle is loaded or all X-outs are cleared from the grid. This number is also used to track typing mistakes; it limits guesswork when using the Direct Entry. Direct Entry remains disabled until you load a new puzzle or the reset and start over. This is designed as a teaching aid, to keep players who are learning more advanced techniques from using Reveal Singletons or Direct Entry as a "cheat." If used, a good starting value is 3 or 4.
- Passwords – The password is initially empty. To create one, type it in the New Password field (what you type will be plainly visible) and check "Change Password?" Once a password is set, you will need to type it into the Password field (characters are obscured while typing); if it does not match the stored password, you cannot apply changes. To change the password, enter the current password in the Password field, the new password in the New Password field, and check Change Password. To delete the password, enter the current password, leave new

password empty and check change. This *is not* a securely-stored password. It is meant only as a barrier to spurious changes.

Press the Apply button to save your changes; this is confirmed once done. Press the Cancel button to exit without making any changes.

Hint Order for Clues - (shortcut F4)

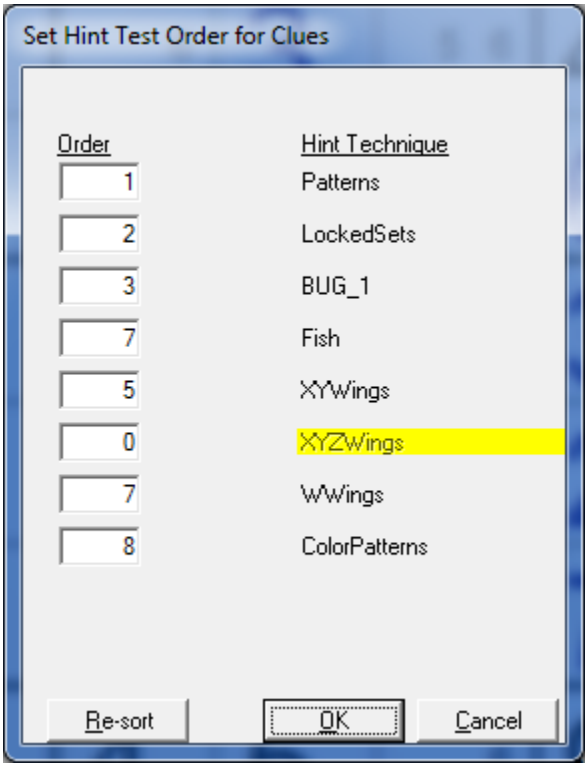
When the status bar is configured to show clues as to the next move (configured in the Preferences Dialog or Toolbar), Sudoku Solver searches for techniques you might apply in a specific order. Singles are always the first technique tried, however the order of the rest is configurable through this dialog (access to this dialog depends on your permissions):



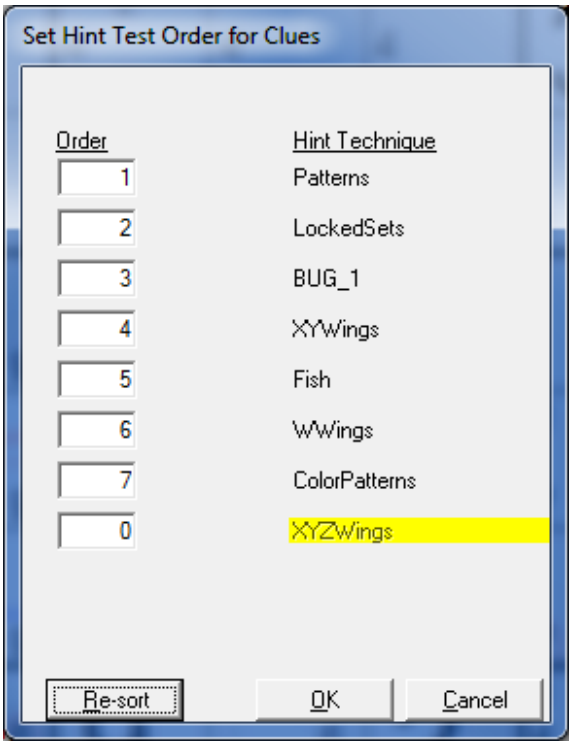
Note that Forcing Chains are not examined for clues. The dialog above shows the default search order (which is identical to the suggested order listed in the tutorial). You may alter the ordering by editing the Order field for each Hint Technique. For example, to look at

LockedSets before Patterns, change the Order for Patterns to 2 and LockedSets to 1 (or just change the Order for Patterns to 3). The Order values must be non-negative integers. Zero will remove that technique from the clues given in the status bar, while positive numbers are used to define the search order. When a technique is removed, the Hint Technique itself is highlighted in the dialog. If an Order value appears more than once, then those techniques appear together in their current order. You may click on Re-Sort to see the effect of your order changes, but these changes are only applied when you click on OK.

For example, to turn off XYZ-Wings and move Fish after XY-Wings, you could enter:



The yellow background highlights techniques you have turned off for status bar hints. After hitting re-sort, you would see:



This information is also used to control the techniques and the order in which they are applied when Ctrl-Shift-M is used.

Hints Menu

This menu contains commands related to solving the current puzzle. Some of these commands may be inaccessible, depending on the state of the grid and the current access permissions. Some of these commands are also accessible from the filter and techniques toolbars. There is also a context menu associated with some of these commands.

Note that whenever a value is placed into a square (be it by revealing it or typing it in) and hints are not disabled, all hint digits (or Pencil Marks) are automatically recalculated and displayed.

Click to Reveal

If available (Reveal Values must be set in access permissions), this command changes the mouse cursor to a plus (+). When you left-click the mouse on an unsolved square, the solution value will be put into that square, and the mouse cursor is restored. This works for a single square at a time. You can also use this feature by holding down both the Ctrl and Shift keys; the mouse cursor is changed to a plus and so long as you hold down both Ctrl and Shift, you can left-click on as many squares as you choose to reveal their values.

Mark Singletons (shortcut key Ctrl-G)

If available (Mark Singletons must be set in access permissions), this command will place red squares around all hint digits that are either open or hidden singletons on the current grid. If there is a bad X-Out on the grid, then this can lead to incorrect singletons, which will be shown instead with a yellow square. You will not be able to mark (or reveal) any more singletons until you find and correct the bad X-outs (Sudoku Solver will not tell you which X-outs are incorrect). If Max Singletons Mistakes is set in access permissions, then after the indicated number of attempts to Mark Singletons with bad X-outs, this feature will be disabled. This is a teaching aid, often used in classrooms to keep students who are learning more advanced techniques from relying too heavily on Sudoku Solver to do their work.

Reveal Marked Singletons (shortcut key Ctrl-Shift-G)

If available (Reveal Singletons must be set in access permissions and there must be one or more singletons marked), this command will place the marked singleton values into each square.

Advanced Techniques

This opens a pop-up menu with a large list of more advanced solving techniques (all of those listed in the Tutorial). Advanced Techniques must be set in access permissions to use this menu.

Reveal Singletons (shortcut key Ctrl-A)

Finds and reveals *all* singletons currently available in the puzzle. Access permissions for Mark Singletons *and* Reveal Marked Singletons must be set. This single command is the equivalent of pressing Ctrl-G and Ctrl-Shift-G once each.

Reveal All Singletons (shortcut key Ctrl-Shift-A)

Finds and reveals *all* singletons in multiple passes, until no more can be found. Access permissions for Mark Singletons *and* Reveal Marked Singletons must be set. This single command is the equivalent of pressing Ctrl-G and Ctrl-Shift-G repeatedly, until no further singletons are found. This command is also available on the Techniques Toolbar.

Reveal Open Singletons (shortcut key Ctrl-B)

Finds and reveals *all open* singletons currently available in the puzzle. Access permissions for Mark Singletons *and* Reveal Marked Singletons must be set. The subtle difference between this and Reveal Singletons is that this command only finds and reveals open singletons; it will not find hidden singletons.

Reveal All Open Singletons (shortcut key Ctrl-Shift-B)

Finds and reveals *all open* singletons in multiple passes, until no more can be found. Access permissions for Mark Singletons *and* Reveal Marked Singletons must be set. The subtle difference between this and Reveal All Singletons is that this command only finds and reveals open singletons; it will not find hidden singletons.

List Backdoors

Finds and lists backdoors; a backdoor is a single X-Out that simplifies the puzzle to Fiendish or easier. Only useful for puzzles rated Extreme or Insane. The backdoor values found will be highlighted (with temp marks) in the main window, and listed in the messages window. The maximum number of backdoors highlighted is controlled via preferences.

Turn Exclusions Marks/Groups On (shortcut key Ctrl-Shift-Z)

When advanced techniques such as Patterns, Locked Candidates and others discussed in the tutorial are used, a sequence of dull-red X's and O's are used to show which hint digits were employed in the technique. The O's are Exclusion Groups – the hint digits in this technique that forced one or more X-Outs to occur. The X's are the Exclusion Marks – the X-outs forced by the technique. This command toggles the display of Exclusion Marks and Groups on or off. If it is on, there will be a checkmark next to the menu item. There is also an audible clue (the System Question Sound, if one is defined) which is played when marks are toggled on. When Exclusion Marks/Groups are off, none of these marks will be shown.

Clear Exclusion Marks/Groups (shortcut key Ctrl-Z)

This command clears the Exclusion Marks/Groups on the grid. It does not disable their display for future techniques. This is also available under Clear Marks.

Patterns (single) (shortcut key Ctrl-Y)

Look through the puzzle grid for a pattern that forces cancellations in a row, column or box. As soon as one is found, mark it and stop. This is also available on the Techniques Toolbar.

Patterns (shortcut key Ctrl-Shift-Y)

Look through the puzzle grid for patterns that force cancellations in a row, column or box. When one is found, mark it and continue. This makes a full pass through the puzzle grid,

marking all patterns it finds in that pass. If there are several, the resulting Exclusion Marks/Groups may be a little hard to decipher.

Locked Candidate (single) (shortcut key Ctrl-X)

Look through the puzzle grid for a locked candidate that forces cancellations in a row, column or box. As soon as one is found, mark it and stop. This is also available on the Techniques Toolbar.

Locked Candidates (shortcut key Ctrl-Shift-X)

Look through the puzzle grid for locked candidates that force cancellations in a row, column or box. When one is found, mark it and continue. This makes a full pass through the puzzle grid, marking all locked candidates it finds in that pass. If there are several, the resulting Exclusion Marks/Groups may be a little hard to decipher.

BUG+1 (shortcut key Ctrl-Shift-U)

Examine the puzzle grid for a BUG+1 pattern. If one is found, mark it. This technique is unavailable if one or more singletons remain to be revealed/set. Insofar as I am aware, a puzzle never has more than one BUG+1 in it, as BUG+1 leaves a puzzle at StS. This is also available on the Techniques Toolbar.

Fishy Patterns (single) (shortcut key Ctrl-F)

Look through the puzzle grid for a fishy pattern that forces cancellations in rows or columns. As soon as one is found, mark it and stop. This is also available on the Techniques Toolbar.

Fishy Patterns (shortcut key Ctrl-Shift-F)

Look through the puzzle grid for fishy patterns that forces cancellations in rows or columns. When one is found, mark it and continue. This makes a full pass through the puzzle

grid, marking all fishy patterns it finds in that pass. If there are several, the resulting Exclusion Marks/Groups may be a little hard to decipher.

XY/Z/W-Wing (single) (shortcut key Ctrl-W)

Look through the puzzle grid for an XY-Wing, XYZ-Wing or W-Wing that forces one or more cancellations; the order used is controlled by the Hint Order for Clues setting. As soon as one is found, mark it and stop. This is also available on the Techniques Toolbar.

XY/Z/W-Wings (shortcut key Ctrl-Shift-W)

Look through the puzzle grid for an XY-Wing, XYZ-Wing or W-Wing that forces one or more cancellations; the order used is controlled by the Hint Order for Clues setting. This makes a full pass through the puzzle grid, marking all XY-Wings, XYZ-Wings and W-Wings it finds in that pass. If there are several, the resulting Exclusion Marks/Groups may be a little hard to decipher.

XY-Wing (single) (shortcut key Ctrl+Alt-X)

Look through the puzzle grid for an XY-Wing that forces one or more cancellations. This will not look for XYZ-Wings or W-Wings.

XYZ-Wing (single) (shortcut key Ctrl+Alt-Z)

Look through the puzzle grid for an XYZ-Wing that forces one or more cancellations. This will not look for XY-Wings or W-Wings.

W-Wing (single) (shortcut key Ctrl+Alt-W)

Look through the puzzle grid for a W-Wing that forces one or more cancellations. This will not look for XY-Wings or XYZ-Wings.

Color Chain Exclusion (single) (shortcut key Ctrl-I)

Look through the puzzle grid for a Color Chain Exclusion that forces one or more cancellations. As soon as one is found, mark it and stop. The color chains involved are also displayed. This is also available on the Techniques Toolbar.

Color Chain Exclusions (shortcut key Ctrl-Shift-I)

Look through the puzzle grid for Color Chain Exclusions that force one or more cancellations. When one is found, mark it and continue. This makes a full pass through the puzzle grid, marking all Color Chain Exclusions it finds in that pass. If there are several, the resulting Exclusion Marks/Groups may be a little hard to decipher. Because multiple chains may be marked, the color chains themselves cannot be displayed.

Forcing Chains (shortcut key Ctrl-Shift-H)

Look through the puzzle grid for Forcing Chains. This technique should only be used when all other techniques fail to produce results. This technique is unavailable if one or more singletons remain to be revealed/set[22]. This command is also available in the Techniques Toolbar.

The goal of a Forcing Chain is to prove that one or more hint digits can be safely excluded from the puzzle. It is technically possible to find Forcing Chains based on squares with more than two values in them; Sudoku Solver won't do that though.

The chains produced by Sudoku Solver are more properly called forcing nets, because they can and do branch into multiple pathways. Because they can be somewhat complex, there are several options that adjust the displayed forcing lines, describe the steps in detail and even let you step through individual lines or sets of lines on the display. Sudoku Solver uses a

[22] Forcing Chains, as explained in the text that follows, track the propagation of singletons in successive waves to show the forcing effects within the chain. Therefore if open singletons remain in the puzzle, discontinuous "chains" could be created. You must find and set all singletons before Forcing Chains may be applied.

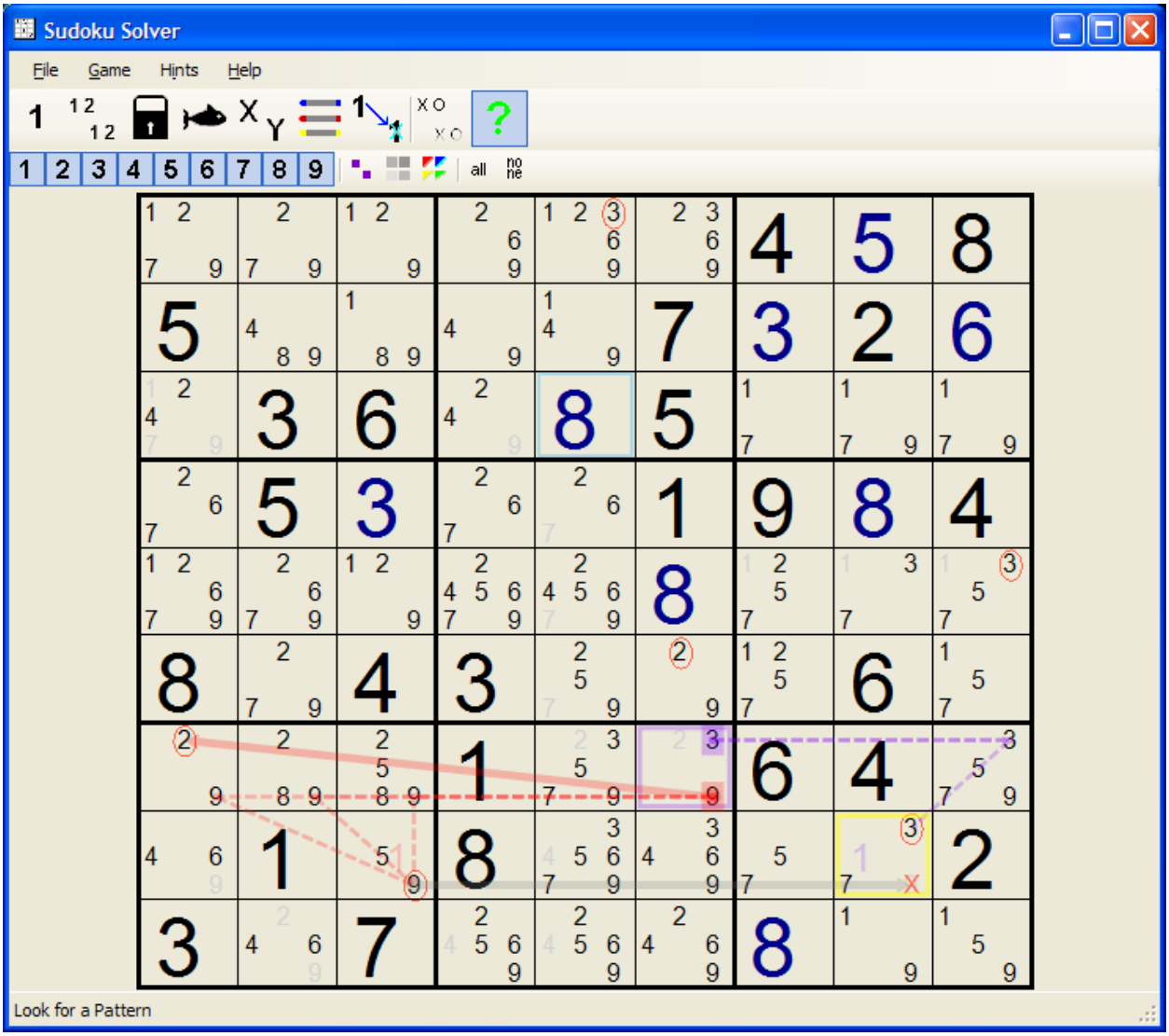
trimming algorithm by default to cut out extraneous lines (those that do not directly contribute to forcing the cancellations). This algorithm is imperfect, especially when examining indirect forcing lines, and extraneous lines will sometimes remain. The chain displayed is still valid; it just has more lines showing than are needed to show the cancellations. More on this as we go through some examples.

Standard Forcing Chains always start from a bi-value (type 1 or 2); they take advantage of the knowledge that one of these bi-values must be part of the solution. The what-if analysis examines how singletons are created in successive waves (or iterations), tracking those waves of singletons and the hint digits eliminated by them (for instance, if a 3 is placed in r2c3, then all other hint digits in r2c3 are eliminated, as well as all 3's in row 2, column 3 and box 1). When the same hint digit is eliminated on both bi-value paths, we know that hint digit may be safely excluded from the puzzle (recall that one of the bi-values must be part of the solution, so any hint digit that would be cancelled under both bi-values cannot be true). Sudoku Solver stops chain progression as soon as it finds at least one hint digit elimination (due to cancellation of a common digit or a contradiction) or once it finds no additional singletons in either chain, whichever comes first. A different, more comprehensive (and *much slower*) search can be enabled in the Preferences dialog. The Preferences dialog may also be used to enable searching for Nishino Contradiction Chains (these are chains starting from any single hint value in any square that yield a contradiction, thus proving that particular hint value cannot be part of the solution). Nishino Contradiction Chains are only used (if enabled) when no Forcing Chains can be found.

Let's look at a puzzle that is loaded with potential Forcing Chains; here's the PM grid:

```
1279  279  129  | 269    12369 2369 | 4    5   8
5     489  189  | 49     149   7    | 3    2   6
24    3    6    | 24     8     5    | 17   179 179
---------------+--------------------+-------------
267   5    3    | 267    26    1    | 9    8   4
12679 2679 129  | 245679 24569 8    | 257  37  357
8     279  4    | 3      259   29   | 1257 6   157
---------------+--------------------+-------------
29    289  2589 | 1      3579  39   | 6    4   3579
46    1    59   | 8      35679 3469 | 57   379 2
3     46   7    | 2569   2569  2469 | 8    19  159
```

If you passed this into Sudoku Solver, you'll find no techniques in its repertoire to apply other than Forcing Chains. Here is the first one it finds:



One thing to note up front: the Status Bar is telling you to look for a Pattern (notice the Techniques Toolbar has the green question mark button pressed); more on that later. Let's get to the chains. The bv-1 at r7c6 is the origin of this chain. Notice there are both dotted and solid purple and red lines, as well as a gray line.

Notice the faint but larger 1's in the squares with force lines and circled values. These represent the iteration step at which this particular force was recorded. It gives you an idea of the order in which the lines were found/drawn. From Sudoku Solver viewpoint, everything in the same iteration happened simultaneously.

Going from the descriptive text (output to the Message Window by pressing Ctrl-Shift-T or from the Hints / Advanced Techniques / Display Message Chain in Window menu command):

```
------ First Chain ------
r7c6=3 [r7c9<>3] r8c8=3
------ Second Chain ------
r7c6=9 r7c1=2
r7c6=9 [r7c1<>9 r7c2<>9 r7c3<>9] r8c3=9
------ Cancellations ------
r8c8<>9
------ Chain Ends ------
```

The first (purple[23]) chain is an example of an indirect force. Because r7c6=3, it means that r7c9<>3 (can't have two 3's in the same row). Given that r7c9<>3, then r8c8=3 must be true (otherwise box 9 would not have a 3).

Something different happens with the second chain; a direct force of r7c1=2 is shown (this is a direct force since r7c6=9 leaves no other value possible for r7c1; direct forces also occur when color chains are involved). However this has no bearing on the puzzle cancellation; this is a trimming artifact. Trimming artifacts occur when an indirect force is involved; there is no automatic cure for this behavior at present[24]. What we do care about is that r7c6=9 "knocks out" all the other 9's in row 7 (r7c123) box 7, leaving the 9 in r8c3 as the only 9 in box 7.

Setting r8c3=9 means there can be no other 9's in r8, and setting r8c8=3 means no other hint digits can be in r8c8, thus allowing us to state that r8c8<>9 (cancelled by both bi-value chains).

Filter Forcing Lines

This pops-up a menu of commands that help you view/review forcing chains:

[23] Remember that you can change the colors used for forcing chains using the color chain colors dialog. Purple and red are simply the colors I used when writing this manual.

[24] You may manually remove forcing lines from the display by using the Space bar in Single Line mode.

- +1 Lines (shortcut key Ctrl-,) – either toggle the purple (+1) lines on and off *or* step forward through lines or iterations (if Single Iterations or Single Lines mode in effect).
- -1 Lines (shortcut key Ctrl-.) – either toggle red (-1) lines on and off *or* step backward through lines or iterations (if Single Iterations or Single Lines mode in effect).
- Indirect Lines (shortcut key Ctrl-H) – if checked, then indirect forcing lines are shown. If not checked, then they are not shown.
- Single Lines (shortcut key Ctrl-S) – If checked then you are in Single Line display mode. This will show each forcing line as a darker line (with all others even fainter than usual). One line at a time out of those displayed is darkened. Step forward or backward through the lines with +1 Lines and -1 Lines. The Space key may be used to toggle the display of any single line on or off (this only affects minimal line mode); the line will appear here with a cross-hatched pattern. Once you exit Single Line mode, the line and its direct predecessors will be excluded from the minimal line set (ergo they will not be shown when displaying minimal lines). Go back to Single Line mode if you wish to restore the line and its predecessors to visibility. *This is a tweak* to the minimal line calculations and, in some circumstances, may render a minimal forcing line display more difficult to understand (e.g. if you remove a line that is important to the forcing chain). You cannot remove the gray force value arrows.
- Single Iterations (shortcut key Ctrl-Shift-S) – If checked then you are in Single Iteration display mode. Shows groups of lines (grouped by iteration) darker, with all others fainter than usual. One iteration set at a time is darkened. Step forward or backward through the iterations with +1 Lines and -1 Lines.

- Toggle All Cancel Points (shortcut key Ctrl-Shift-N). The Cancel Points are the hint digits that this chain X'd out. This command toggles the cancel / X-out state of each value X'd out by this chain. This option is only available when showing minimal lines. Use in concert with Ignore FCP Toggle to reduce your chain to the precise set of values you want cancelled.
- (shortcut key Ctrl-T) – There is no menu command for this, only a shortcut key. This toggles trace-back (minimal) lines. If you press Ctrl-T then *all* forcing lines in the Forcing Chain will be shown. Pressing it again returns you to the minimal set. Ctrl-Shift-T will enumerate whichever set (minimal or full) is currently displayed. Minimal set display is imperfect, and sometimes shows lines that are not technically needed for to force the cancellations. This happens when there is a complex forcing network with multiple branches and indirect forces are involved. The minimal set algorithm finds all forcing lines that touch the back-trace of squares from the cancelled point to the initial point in the chain. Directly affects the chain display in the message window.

Display Chain in Message Window (shortcut key Ctrl-Shift-T)

Enumerates the displayed forcing lines; as noted in the example above, occasionally when indirect forcing lines are involved, more lines may be listed than are needed for the forced cancellations.

Filter Hints

Pops up a menu that allows you to filter the hint digits shown on the grid in various ways.

All On (shortcut key Ctrl-Shift-1)

Show all hint digits (1 through 9).

All Off (shortcut key Ctrl-Shift-0)

Do not show any hint digits; useful when you want to show only one or a few digits and do not want to turn the others off one by one.

1 – 9 (shortcut key Ctrl-1 – Ctrl-9)

Toggle this particular hint digit on or off; the checkmark shows which hint digits are turned on. One way to duplicate the display showing only 4's in the Tutorial's Fishy Pattern example would be to press Ctrl-Shift-0 followed by Ctrl-Shift-4.

Apply Color Patterns

Available only when hints have been filtered down to a single visible digit, this applies colors to show the color chain (or chains) for this digit. Use Clear Color Patterns to remove the color chains.

Highlight Pairs

Highlights squares with two and only two possible hint digits (bi-value type 1). Useful for spotting patterns like Unique Rectangles (which are not implemented in Sudoku Solver).

Clear Marks

Pops up a menu with options to clear different sorts of hint markings from the grid.

All (shortcut key Ctrl-K)

Clears all of the different sorts of marks (listed individually below) from the grid.

Highlights

Clear only highlight marks (or O's) from the grid.

X's

Clears only X's (i.e. marks that remove hint digits from consideration in the solution) from the grid.

Singletons

Clears singleton boxes from the grid.

Link Lines (shortcut key Ctrl-L)

Clears link lines from the grid.

Color Patterns

Clears color patterns from the grid.

Exclusion Marks/Groups (shortcut key Ctrl-Z)

Clears exclusion marks (X's) and groups (O's) from the grid. These are *not* the same as Highlights and X's. This command does the same thing as the Clear Exclusion Marks/Groups command in the Advanced Techniques menu.

Forcing Chain Lines (shortcut key Ctrl-Shift-H)

Clears all forcing chain lines (and associated marks such as exclusion marks/groups and highlights for cancelled squares and initial squares) from the grid.

Temp Marks

Clears temp marks from the grid. Temp Marks are placed using the center mouse button; click places a temp O and Shift-click places a temp X (Alt mouse clicks may also be used; see Using the Mouse). These marks have no impact whatsoever on the puzzle or its solution and are never saved (hence the "temp" designation). This feature may be removed at a future date.

Manual Marks

Clear All

Available only when in Manual Mode. Clears *all* the manual PMs placed on the grid.

Set All

Available only when in Manual Mode, Sets *all* the manual PMs (1-9) in any unsolved square.

Reset Puzzle (shortcut key Ctrl-R)

When a puzzle is first loaded onto the grid, there are given values: squares without hint digits whose value is defined from the outset. Any values found through hint techniques or entered afterwards by typing them in are considered revealed values. This command removes all these revealed values from the grid along with any marks. It also resets the Game Timer and Congratulations message.

Note that if your puzzle was loaded with hint data (e.g. from a file with hints or pasted from the clipboard with PM's) then this command sequence will also remove those hints. To ensure the same initial state, either re-paste or reload the puzzle from its source.

Score Current Grid (shortcut key Ctrl-Shift-E)

Displays Sudoku Solver's scoring/level as calculated for the current grid. This value changes as you work on a puzzle, so it not only gives you a relative rating of puzzle difficulty, it also helps you gauge how much further you have to go.

This scoring is based on Sudoku Solver's suite of solving techniques and is by no means an absolute measure of difficulty.

The score is displayed in the message window, and takes the following form:

Next_Move-a.b.c.d.e.f (difficulty)+x where a – f are numbers (smaller numbers means easier to solve):

- Next_Move: the next, simplest move Sudoku Solver can find; if you are stuck look for this (e.g. Hidden Single or Fishy Pattern) as your next move. This does not mean other moves are not available!
- a: how hard singletons are to find in this puzzle from this point forward.
- b: the difficulty of patterns and locked sets from this point forward.
- c: the difficulty of BUG+1, fishy patterns , XY-wings, XYZ-Wings and W-Wings from this point forward.
- d: the difficulty of color-chain exclusions from this point forward.
- e: the difficulty of forcing chains from this point forward.
- f: the difficulty of Nishino contradiction chains from this point forward.
- difficulty: an overall puzzle rating, ranging from Easy to Insane.
- +x: Sudoku Solver's estimate of the number of techniques needed before the puzzle may be solved solely with singletons. Another way of thinking about this is it is the number of techniques required to reduce the puzzle difficulty to Easy, Medium or Hard.

Each number a – e gives you a sense of the moves Sudoku Solver would use to complete the puzzle. The difficulty ratings are: Easy, Medium, Hard, Evil, Fiendish, Extreme, and Insane. Easy through Hard puzzles require no techniques beyond Singles. Evil requires one or more Patterns and/or Locked Sets. Fiendish requires one or more BUG+1, Fishy Patterns, XY-Wings, XYZ-Wings, W-Wings or Color-Chain exclusions. Extreme puzzles require one or more Forcing Chains and/or Nishino Contradiction Chains. Insane puzzles cannot be solved using the logic techniques in Sudoku Solver, but you can always display the solution, reveal individual squares, or take other intermediate steps (including manual application of logical techniques not found in Sudoku Solver).

Because different web sites rate their puzzles using different metrics, scoring the grid gives you a standard, relative metric you can use to see how any particular puzzle compares to others you have solved.

Reset Alpha to 0

The Alpha Slider in the toolbar allows you to change the intensity of colors displayed for Color Chains and Forcing Lines. This is simply a visibility aid. The default is set in the middle (the zero-point), which leaves all color intensities at their default settings (for the more technically minded, this is an adjustment to the Alpha channel). Because it is tricky to find the zero-point using the slider, this menu option allows you to easily restore the default setting. The Alpha Slider setting is not saved between sessions.

Context Menu

The Context Menu is available when you right-click on any square. It provides some shortcuts to other commands, while providing the only method to access others (like Link Lines). The commands may be grayed out if they are not appropriate for the location you clicked on. The commands are:

Row Value to Reveal

Shows a list of available digits for the row; click on one and it will be revealed in the proper location in the row.

Column Value to Reveal

Shows a list of available digits for the column; click on one and it will be revealed in the proper location in the column.

Box Value to Reveal

Shows a list of available digits for the box; click on one and it will be revealed in the proper location in the box.

Unset (shortcut key Del)

Unsets the square; that is it removes the revealed value. One use for this is if you accidently reveal a value and want to get back to solving the puzzle from where you were (yeah, I know, Undo would be nice).

X-Out

Shows a list of hint digits for the square; click on one to X it out. X'd out hint digits are removed from consideration as part of the puzzle's solution. The appear with an X over them or as faded numbers, depending on your preference.

Highlight

Shows a list of hint digits for the square; click on one to highlight it with an O.

Draw Link Lines

Draws link lines for the square. These highlight the box, row and column houses that contain the square. Very helpful, especially for beginning players, when looking for singles, patterns, and so on.

Forcing Chain

Try to create a Forcing Chain using this square as its starting point.

Value to Force

Try to create a Forcing Chain that X's out this value; it may also X-out many other values in the process. If a Forcing Chain is found, it will display with *only* this value X'd out. Use

Ignore FCP Toggle and/or Toggle All Cancel Points to show other points (if any) that may have also been X'd out.

Ignore FCP Toggle

Forcing Chains can cancel many, many values at once. This lets you toggle the cancellation state of any single Force Cancellation Point (FCP).

Toolbars

Sudoku Solver has two toolbars: the Techniques Toolbar and the Filtering Toolbar. These are made visible using the Preferences dialog. Some or all of these buttons may be disabled, depending on the state of the puzzle and your access settings; disabled buttons appeared grayed out.

Techniques Toolbar

This toolbar appears below the menu and above the Filtering Toolbar (if present) and puzzle grid. It supplies quick and easy access to the most important solving techniques from the Hints menu. A snapshot appears below with the third-to-last button pressed:

The buttons have tooltips (hover the mouse over a button to see the tips).

Singletons

Press to find and reveal all current singletons. Identical to the Reveal All Singletons menu command.

Pattern

Find and mark a pattern, if one is available. Identical to the Patterns menu command.

Locked Candidate

Find and mark a locked candidate set, if one is available. Identical to the Locked Candidate menu command.

BUG+1

Find and mark a BUG+1, if one is available. Identical to the BUG+1 menu command.

Fishy Pattern

Find and mark a fishy pattern, if one is available. Identical to the Fishy Patterns menu command.

XY/Z/W-Wing

Find and mark an XY-Wing, XYZ-Wing or W-Wing, if one is available. Identical to the XY/Z/W-Wing menu command.

Color Chain Exclusions

Find and mark a color chain-based exclusion, if one is available. Identical to the Color Chain Exclusion menu command.

Forcing Chains

Find and mark out a forcing chain, if one is available. Identical to the Forcing Chains menu command.

Clear All Marks

Clears *all* marks from the board; this may cause you to lose work you've put into solving the puzzle. Because of this, it may be disabled in Access Permissions. Identical to the Clear All Marks menu command.

Show Clues in Status Bar

This button is a toggle that you click to turn it on (as shown at the start of this section) or off. When it is on (pressed), the status bar (found beneath the grid) will display informational messages; exactly what is shown depends on your access permissions. You may also set this in the Preferences Dialog.

This toolbar button is different from the others; it has three different states:

1. Off
2. On – standard messages. Button is pressed and question mark remains green.
3. On – detailed messages. Button is pressed and question mark is yellow.

States 1 and 2 are also configurable through the Preferences dialog as noted above. State 3 can only be controlled using this toolbar button. The difference between State 2 and 3 is the level of detail shown when Sudoku Solver tells you what technique to try next. Let's say the next technique was a Pattern – an open triple for the purpose of this example. In State 2 (button pressed, question mark is green), the status bar message would be "Look for a Pattern." In State 3, the status bar message would be, "Look for a Pattern (open triple)." Note that the clue given in State 3 does not mean there are not other, perhaps simpler, instances of this same technique possible at this point in the puzzle. This is just the first instance found by Sudoku Solver. The search techniques used by Sudoku Solver may well differ from your own. The order in which techniques are suggested is configurable.

Game Timer

 This button is a toggle that you click to turn it on or off; it is shown at the start of this section is the "off" state. When it is on, a game timer will be displayed in the title of Sudoku Solver's window; it will count up hours, minutes and seconds until the puzzle has been solved (the time to solve is also output to the Messages Window). The timer only runs when you have a valid, unsolved puzzle. When you load a new puzzle it resets and restarts. The timer will not update if Sudoku Solver is busy (e.g. the mouse cursor is in its wait state – often called the hourglass cursor). In Manual Mode it will run so long as the grid isn't solved (valid or otherwise). Note that once a puzzle has been solved, you can't restart the timer unless you reload or reset the puzzle. If you turn the timer off and then back on again, it will reset to 0. If you minimize Sudoku Solver's window, the timer will pause (it also pauses if you put your computer into a sleep or hibernation state). Trying odd tricks (like toggling into manual mode and back again) will leave the timer running even with an invalid puzzle. This is not meant to be bulletproof; it is meant to as an aide for you to use (or not). The on or off state is saved between Sudoku Solver sessions, so if you exit with the game timer on, it will be on the next time you run the program.

Sudoku Solver also keeps track of your "best time" at each difficulty level whenever the timer is running. New best times will be acknowledged in the Messages Window and, if enabled, with a congratulatory message. You may display your list of best times (or clear it to start afresh) from the Help menu.

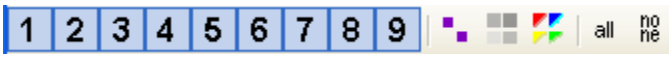
Alpha Slider

 This slider adjusts the intensity of colors displayed for Color Chains and Forcing Chain lines; this has no impact on the puzzle itself, simply on the color intensity, or Alpha Channel value, used to display these items. The default value is zero (0), and the

current setting is not maintained between sessions (always starts as 0). Because precise adjustments are tricky with a slider, the Hints menu provides the Reset Alpha to 0 command.

Filtering Toolbar

This toolbar appears below the menu (and Techniques Toolbar, if present) and above the puzzle grid. It supplies quick and easy access to the most important filtering techniques from the Hints menu. Some or all of these buttons may be disabled, depending on the state of the puzzle and your access permissions; disabled buttons appeared grayed out. A snapshot appears below with the 1 - 9 buttons pressed:



The buttons have tooltips (hover the mouse over a button to see the tips).

1 to 9

1 to 9 These buttons toggle on and off (they are shown above in their "on" state). When on, this hint digit value is shown in the puzzle grid; when off this hint digit value is hidden. Identical to the 1 - 9 menu commands.

Highlight Pairs

This button toggles on and off (it is shown above in its "off" state). When on, all bi-value type 1 squares (i.e. those with two hint digits showing – a "pair") are highlighted with a border (using the Pairs Highlight color). Identical to the Highlight Pairs menu command.

Apply Color Patterns

Available when only a single hint digit is visible on the grid; when pressed it shows the color chains for that digit. Identical to the Apply Color Patterns menu command.

Clear Color Patterns

 Clears any color chains currently shown on the grid. Identical to the Clear Color Patterns menu command.

All On

all Turns on all digits (1 – 9); this is useful if you've had one or more digits filtered out and want to once again see everything. Identical to the All On menu command.

All Off

none Turns off all digits (1 – 9); this is quicker than turning off digits one by one until only one (or two or three) remains. Simply click on All Off then click the individual 1 – 9 buttons for the digits you want to see. Identical to the All Off menu command.

Manual Solving

The normal mode for Sudoku Solver gives you access to a suite of tools and techniques that can assist you in solving Sudoku puzzles. For those times when you would prefer little assistance beyond the electronic equivalent of pencil and paper, Sudoku Solver offers its Manual Mode.

In Manual Mode, no PM's are generated automatically; instead you enter them using the mouse or keyboard. No logic is used to keep you from entering an incorrect PM or solution value for a square. Likewise, virtually all of Sudoku Solver's solving techniques are disabled. A brief summary of the changes follows:

- Mouse: Shift-Left Click toggles PM values on and off; use this by clicking in the spot where the hint value is (toggles it off) or would be (toggles it on). Left Clicking (no Shift, Alt or Ctrl) on a square still selects it. Temp Marks are still available. Right-Click

will still bring up a Context Menu, but with fewer options (see below). All other features listed under Using the Mouse are disabled.

- Virtually all Hint Techniques are disabled. Exceptions are:
    - Filtering is available; it is applied to the PM's you enter on the grid. Be cautioned that Left Click and Shift # (e.g. Shift-1) will still change the PMs even if filtering is not displaying them!
    - Clear Marks works only for Link Lines and Temp Marks.
    - Manual Marks / Clear All and Set All is available (not available in normal mode).
    - Reveal Singletons is available in a restricted form. If you use the toolbar button, Reveal All Singletons, or Reveal All Open Singletons, then Sudoku Solver will reveal all squares where you have only a single PM value present. It is essentially Reveal All Open Singletons for the PMs you have placed on the board.
- Keyboard entry of solution values using the 1-9 keys operates the same, though there is no error checking to make sure your entry is logical or correct.
- Shift 1 – 9 may be used in the currently selected square in lieu of Shift-Left Click to toggle the appropriate PM value on or off.
- Del – still removes or unsets solution values you've placed on the grid.
- Keyboard commands for hint techniques other than those listed above are disabled. Keyboard commands for non-hint related commands (e.g. Ctrl-O for File Open, Ctrl-P for Print, Ctrl-Shift-R for Refresh, etc.) are not affected.
- Context Menus are restricted to Draw Link Lines and Unset.
- Save As With Marks will save your manual PM's instead of X-outs and Highlights. The file type used for Manual Mode puzzles is .SS2. Save As will also save an .SS2 file,

though without any PMs. When an .SS2 file is opened, if Sudoku Solver is not currently in Manual Mode, it will be switched into Manual Mode.

- Copy and Paste will copy and paste your manual PM's instead of those generated by a combination of logic and X-outs. Note that copying PM's to the clipboard in Manual Mode and pasting them back in Normal Mode will work fine *if all of your PM's are correct*; if your PM's are incomplete then Sudoku Solver will treat them as incorrect X-outs. And yes, you can cheat by copying a puzzle in normal mode, switch to Manual Mode and then paste the puzzle + PM's, but then why bother with Manual Mode in the first place?
- The Status Bar will not show its usual set of clues. Instead it reminds you that Sudoku Solver is in Manual Mode and how to return to normal mode. The only clue it provides is when you successfully complete the puzzle; if your solution is correct it will display "Puzzle solved."

Using the Mouse

Left-clicking will move the current square highlight (see Entering Values Directly) to the square on which you click. Right-clicking on a square opens a Context Menu for that square. Other click options that are supported are:

- Shift Left-Click: Toggle the X-Out state for the hint digit under the mouse pointer. Shortcut for Context Menu X-Out.
- Ctrl-Shift Left-Click: When you hold Ctrl+Shift the mouse pointer changes to a plus (+). Clicking on any unsolved square will reveal that squares value (a.k.a. Click to Reveal).
- Shift Right-Click: Toggle the Highlight state for the hint digit under the mouse pointer. Shortcut for Context Menu Highlight.

- Middle-Click (only available on 3-button mice) *or* Alt-Right-Click: Toggle a temp mark circle on the hint digit under the mouse cursor. Temp marks are not used by Sudoku Solver per se; they available as marks you can place on the grid without affecting any solving techniques.
- Shift Middle-Click (only available on 3-button mice) *or* Alt-Left-Click: Toggle a temp mark X on the hint digit under the mouse cursor. Temp marks are not used by Sudoku Solver per se; they available as marks you can place on the grid without affecting any solving techniques.

Keyboard Commands

Most keyboard commands are shortcuts and appear in the menus along with the command they run; a few are not and are listed here below. They are grouped by their shift-state (Ctrl-Shift keys, Ctrl keys, Normal keys). Some work at all times, others only work in solving or typing (design) mode.

Ctrl-Shift Keys

- M: "Magic" solver key. When pressed, it applies all techniques *other than* *Forcing Chains* iteratively until the puzzle is solved or it can go no further. This set of techniques is sometimes called the "Simple Sudoku Tool Set" or SSTS (although as of Sudoku Solver version 6.11.2.1, this tool set may be expanded to include BUG+1, *XYZ-Wings* *and* *W-Wings*, depending on the Hint Order for Clues setting). The count of iterations for each key press is shown in the message window. Pressing this key will solve any puzzle rated Fiendish when Hint Order for Clues is configured to use all available techniques. The Status Window will list the number of passes required to solve the puzzle (think of this as the number if distinct techniques, other than finding singletons, used to find the solution). If there are techniques you want to

practice finding and applying on your own, just remove them via the Hint Order for Clues dialog, and neither the Status Bar nor the Magic Solver Key will find/enumerate them, while still finding/enumerating the other techniques. This is a shortcut to get past these baseline techniques, allowing you to work on a specific technique or set of techniques. If you simply want to see the solution to the puzzle, it's much simpler to simple use Solve.

- P: Pick a solution; used to highlight a possible solution when typing in a puzzle.
- R: Refresh the window. There is a strange bug with Sudoku Solver and the .Net runtime under Windows Vista (and later) when Forcing Chains are displayed; sometimes the forcing lines do not show up. You can minimize and restore the window, or press this key to update the window.

Ctrl Keys

- D: Show 10 best "back doors". A back door is a value that, when removed (or X'd out) from the grid, simplifies the puzzle. This can be slow because every current hint digit in grid must be considered and scored. The 10 best results will be marked with a Temp Mark circle and listed (by row + column) with the resulting puzzle score in the Messages Window. Note that 10 is the default value; you may set any value you wish in the Preferences Dialog.
- T: Toggle minimal traceback vs. show all Forcing Lines.

Normal Keys

- Arrow keys: Moves the active square highlight (light blue outline) up, down, left or right when typing in a puzzle or solving a puzzle.
- Backspace: Skips back to the previous square without changing anything typing in a puzzle or solving a puzzle.

- Del: Unset a non-given value in a square (i.e. restores it to the “not solved” state).
- F5: Shortcut for loading a puzzle from your preferred web source.
- Space: Skips over a square without changing it when typing in a puzzle. When single-stepping through a forcing chain, toggles the suppress bit for a forcing line. Suppressing a line cuts it and all of its predecessors out of minimal line calculations.
- 0: Removes an entered or given digit when typing in a puzzle.
- 1 – 9: Used to enter digits when typing in a puzzle or solving a puzzle.

Entering Values Directly

Sudoku Solver allows you to directly enter values for any square, as long as that has not been turned off in Access Permissions. If you look closely at the board you will notice a light blue highlight around the border of one square. This highlight may be moved with the arrow keys, backspace or by left-clicking on a square with the mouse.

This is the current square highlight; it shows you which square is ready to accept a number if you type one (1 – 9). You may only enter values if the square is unsolved. If you try to enter a value that is not correct, Sudoku Solver will “beep” and do nothing. So if you like, you can use this as a primitive trial & error solving technique (this can be limited using Max Singleton Mistakes value). A more common use is to enter a deduced value without resorting to directly revealing it.

You can remove an entered value by using either unset from Context Menu or by pressing the Del key.

Change Log

Version	Description
6.15.1.1	Released 20 February 2019. Deprecated Chicago Tribune puzzles; they changed their location and format. Suggest that you use Generate Puzzle to create new puzzles of the desired difficulty.
6.15.1.0	Released 18 February 2019. Fix for error when a deprecated puzzle source was saved for use with the F5 key (thanks, Sue!). Deprecated Life.com puzzles (RR.com stopped serving these).
6.15.0.1	Released 10 June 2017. Fixed some typos in the manual and one in the Hints/Filter Hints menu.
6.15.0.0	Released 9 June 2017. Added Alpha slider to toolbar, along with Reset Alpha to 0 in the Hints menu. Most of the screen shots in this manual do not yet show the Alpha slider. Removed non-working Web Puzzle sites (SudoPuzz, Playr and MSNBC-UClick). If you have saved SudoPuzz or Playr as the site to use with F5, you will be prompted to change that setting. Fixed a bug with UClick puzzles where an exception could occur when changing between UClick puzzle sources.
6.14.3.0	Released 9 September 2013. Updated the Load from Web feature to display an error message if you are using a Guest account; previously you'd simply see an error message in the Messages Window. Revised 9/13/13 try even for Guests, but show an error dialog on failure (for all Web access, not just Load From Web).
6.14.2.0	(unreleased documentation change) - the Hint Orders for Clues dialogs and text were out of synch; fixed that.
6.14.2.0	Released 28 February 2013. Hidden Patterns were, on occasion, not reported in the Status Bar (when detailed messages are enabled) due to a bug; now they are properly reported in all cases.
6.14.1.0	Released 20 January 2013. Added Show Exclusion Marks and Groups to the Preferences dialog, and updated documentation.
6.14.0.0	Released 15 December 2012. First version compiled under VS 2012 (Any CPU option); also upgraded to Net 3.0. Fixed some dialog typos.
6.13.1.0	Not released. Fixed bug in Hint Orders for Clues that failed to display disabled techniques if two or more techniques were disabled and Resort was pressed. Updated an incorrect dialog image in the documentation; see Hint Orders for Clues, the last image.
6.13.0.0	Released 11 September 2012. Added BUG+1 support. Several changes throughout this document and in program features (e.g. Techniques Toolbar, Advanced Generate Options, Hint Orders for Clues) as part of this update. Note that if you have changed the default hint order for clues, you may need to redo that after upgrading to this version (sorry).
6.12.2.1	Released 8 August 2012. Found cases where Forcing Chains were still not correctly displayed, despite previous fixes. Perhaps this will finally fix it.
6.12.2.0	Released 5 August 2012. Enhanced the Value to Force feature. Instead of showing the cancellation of the desired value and everything else that is also cancelled (which is often a very large, complex Forcing Chain), it now shows

the chain reduced down to just those forcing lines/points needed to cancel this single point.

6.12.1.2 Not released. Miscellaneous code clean-up and minor bug fixes.

6.12.1.1 Released 31 July 2012. Added List Backdoors to the documentation, and added Maximum Backdoor Count to the Preferences dialog (saved along with other preferences)

6.12.1.0 Released 28 July 2012. Fixed minor bug in how scoring information is copied; this bug caused the Magic Solver to report 0 passes completed. Changed Pattern searching to always find the smallest pattern first (previously it found the first pattern in its search order, regardless of size); this *could* have minor side effects on scoring (none found so far). Updated the documentation and help files.

6.12.0.1 Released 22 July 2012. Fixed bug introduced in 6.12.0 that ignored bad X-Outs entered when using the mouse or context menu to X-Out a hint value. Fixed very subtle bug introduced in 6.11.3.1 (forcing line display) where a single click on the Forcing Chains Toolbar Button could simulate several, sequential button clicks. More code cleanup too.

6.12.0 Released 20 July 2012. Big code changes for follow-on work to previous version; almost all of this work is internal cleanup. Includes some bug fixes, mostly related to the clean-up work. Visible fixes: Advanced Puzzle Generation conditions were not reported correctly in some cases (the generation was correct, but the message window text was iffy). Exceptions thrown during puzzle generation should've included more information on the puzzle state; this is now output correctly to the messages window. The Hint Order for Clues dialog will not be accessible unless your permissions include Advanced Techniques. The Status Bar will not show clues about a next move unless your permissions include Advanced Techniques. The manual and help file were edited, both to correct errors and document these changes.

6.11.3.1 Not released. Added logic to W-Wing code that improves the speed of searching for the shortest strong-link chain. Also changed the XY/Z/W-Wing menu and toolbar button to apply these techniques according to the Hint Order for Clues setting. Screen updates that involve more than 1 or 2 squares are now much smoother (less flicker). Finally found a fix for forcing line display that could do away with the need for Ctrl-Shift-R (*seems* to be working). Several other internal housekeeping changes.

6.11.3 Released 28 June 2012. Fixed bug in Direct Entry where, after deleting a value with Del then re-entering it, the menus and toolbar buttons would not update properly; this could also happen when entering any value. Also compiling executable for release in Any CPU mode (which means it runs as 64-bit application on 64-bit machines).

6.11.2.1 Released 24 June 2012. Reworked Ctrl-M so it uses the same code as the scoring algorithm to work its magic. As a beneficial side-effect, Ctrl-M will now run the techniques as per Hint Order for Clues (which means it may now include XYZ-Wings and W-Wings in its repertoire). Documented issues with Guest account and downloading puzzles.

6.11.2 Released 11 June 2012. MSNBC changed their URL for puzzles; recently noticed it was not working and updated the URL list. Adjusted some scoring constants

to improve the tracking of W-Wings (part of the score that also includes Fishy Patterns, XY-Wings, XYZ-Wings and Color Chains). Added a new source for web puzzles: Daily SuDoku.

6.11.1 Released 9 June 2012. Fixed subtle bug in W-Wing code that left behind traces of a longer strong-link chain after finding a shorter one. Cleaned up some of the new code while debugging.

6.11.0 Released 6 June 2012. Added W-Wing support. Not all images in the documentation have the updated XY+XYZ+W-Wings toolbar button image, in fact it is likely that only W-Wing examples use the updated Techniques Toolbar. Added Advanced Hints menu items for finding individual XY-Wings, XYZ-Wings and W-Wings (vs. the previous all-at-once behavior); no toolbar item for these. Renamed XY-Wing menu item to XY/Z/W-Wing). Many other changes needed (e.g. scoring needs to account for W-Wings, as does puzzle generation). Note that the default order in Hint Order for Clues will put W-Wings between XYZ-Wings and Color Chains. However if you've run versions of Sudoku Solver prior to version 6.11.0, your hint ordering for Color Chains will have W-Wings in their place. Sorry, but it was the only way to get the default order right. Best if you check your Hint Order settings after your upgrade from version 6.10.4.

6.10.4 Released 17 May 2012. Updated Hint Order for Clues feature to support adding new techniques later, and changed orders to positive integers (suppress technique with 0). Added highlighting for suppressed techniques.

6.10.3 Not released. Added information as to what sort of Singletons remain to the Status Bar Clue when the puzzle is solvable through singletons (open or hidden); previously even when detailed clues were enabled, Sudoku Solver would not describe the sorts of singletons remaining. Fixed some edge conditions in the low-level color chain code.

6.10.1 Released 28 April 2012. Change log started. Added the *Hint Order for Clues* feature (accessed from Game/Preferences menu or with F4). The EXE and Setup files are now signed with the DAdler.Net key (see http://www.dadler.net/sudoku for a link describing how to install the key on your computer, or just download the PDF file).