SOLVING TECHNIQUES

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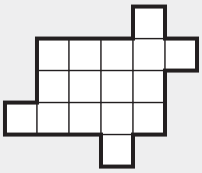
Puzzle solving business is not an exact science. Just like most of the sports it relies on ability, experience and practice. And who knows how world champions solve their puzzles. You can not simply say anything you have to say about puzzles and then expect a newcomer to be the best. Still, this doesn't mean that there are no *facts* on solving puzzles that will make anyone a *better* puzzler (If we are talking about championship level play, "better" will mostly mean "faster"). This effectively distinguishes puzzles from most of the sports.

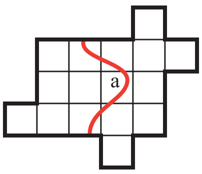
I've written monthly columns on solving techniques in Turkish puzzle magazines for 3 years in a row, always hosting a different puzzle or a different technique. Facts, mentioned above, seem to attract more attention because they can easily be understood, accepted and used immediately on a puzzle. But, half of the techniques presented insights and tips on *how* to solve a puzzle rather than giving facts. This article will give examples from all, thus tying puzzles back to sports again. Whether solving puzzles is a sport or not is another topic.

Facts

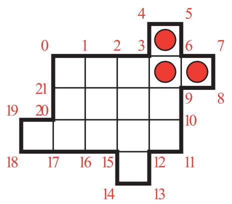
Obvious or not, there are much to discover about puzzles than one might think. Only way to find them is to look for them whether you need them or not. The technique below will hopefully prove useful.



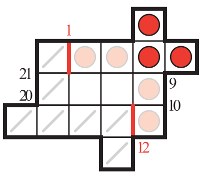
Dissection: Divide the shape into two identical pieces, following the grid lines. Pieces must have the same size and shape, but may be rotated and/or reflected.



Resulting two pieces will be identical; therefore they will have the same area in square units and the same perimeter in unit lines. Since we are dividing the shape into two pieces, we have to draw one line inside the shape, no more. Let's call this common line's length "a" units. So, 22 units of perimeter should be divided evenly between these two pieces to make individual perimeters equal, "11+a" units.



Let's start with an arbitrary intersection point (0) on the border and give all border points a number consecutively. We have to choose two points whose numbers differ by exactly 11, to start and end our line. In the meantime, those three marked cells must clearly be placed in the same piece.



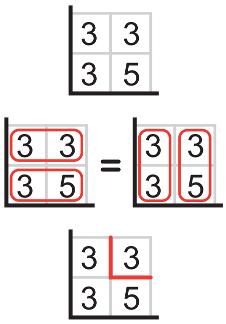
0-11 dual can not be our points because they do not have access to a grid line inside. 4-11 dual can not be either, because 4 doesn't have access similarly. 6 and 17 each has access to inside grid lines, but none of those lines can start or end a full line. We quickly narrowed the list down to three duals. Whenever we give a try to a dual, we will connect all border cells between the points just like in the last figure. Two middle cells left can not be distributed to two groups to make them identical. 1-12 is not the solution. The rest is similarly easy to execute.

Uniqueness

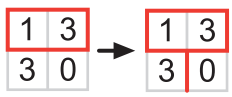
It's usually a safe bet to assume that a puzzle in a championship has a unique, only one, solution. This information will open a lot of back doors and should be studied carefully and thoroughly. Here are two extreme cases.

4	4	6	0	6	3	6	6
1	2	0	0	6	1	0	2
3	2	5	1	1	1	3	1
5	1	5	3	4	0	4	3
2	2	5	6	4	4	0	2
3	3	0	4	5	0	2	6
3	5	4	2	5	1	5	6

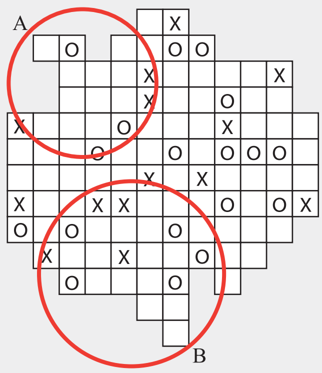
Dominoes: A complete set of 28 dominoes (0-0, 0-1, 0-2, …, 6-6) have been placed in the grid. However, the edges of the dominoes have been removed and the pips have been replaced by numbers. Reconstruct the missing edges.



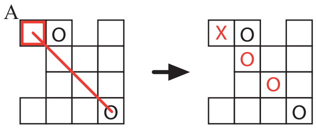
Let's focus on the lower left corner of the grid. Assume that the 3 just above the 5 is connected to the 3 on its left. This will result 3-3 and 3-5 dominoes to be placed. But the fact that these two dominoes can be placed with a different orientation in the same area would verify that the puzzle would have at least two solutions. This contradicts our first assumption, so there must be an edge between the top two 3's. The same logic applies for the vertical 3-5 and we're safe, under circumstances, to draw edges just as shown in the last figure.



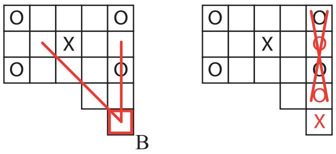
The same argument can be made for the inside of the grid. If you are certain that 1-3 should be there, you can easily put an edge between 3 and 0. This technique, arrived from uniqueness, can also be applied on larger areas, not just 2 by 2 squares. Sometimes, uniqueness can be the only approach to solve a difficult Dominoes puzzle other than mere trial and error.



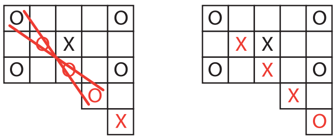
XOXO: Fill in every cell with an X or an O, so that four identical letters never lie on the same row, column or diagonal consecutively.



If this puzzle has a unique solution, the shaded cell in area A should be forced to have a unique letter placed in. Only straight line (with four cells) to force that cell to block a *set* (four consecutive identical letters) is shown on the left figure. The shaded cell must be the end of three consecutive identical letters and fortunately there is an O that tips us off. Therefore we are safe to place XOO to the shown cells.



Area B is a little bit complicated. There are two straight lines (with four cells) that the shaded cell is on. If we apply the same logic given above, on the vertical line, we are then forced to make a set of four O's. Vertical line doesn't force anything.



If we simply try X to be forced on the diagonal line, we're yet again left with a set of four O's. Then, only option left is to put an O at the corner and place three X's that would eventually force it to be an O anyway.

It's a risk to use the uniqueness assumption; but a risk that should be taken. On the other hand, it should also be noted that when a puzzle turns out not to be unique in a competition, it isn't considered flawed or get extracted, unless otherwise stated. As an example, we included a "Nonunique Classics" puzzle part in 2005 Turkish Final. There were 10 puzzles each having either 3 or 4 solutions and every solution brought more points.

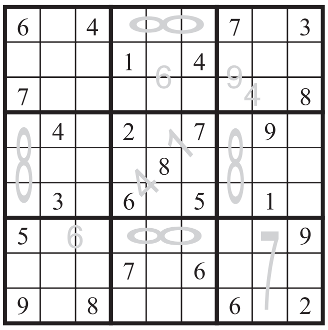
Notation

A usually disregarded approach is to give extensive thought on how to write, how to use your pencil or pen, how to give special notes to yourself and how to mark those notes. I've seen papers clean as day, even from some very fast puzzlers. Dirty doesn't necessarily mean better, but there has to be some kind of notation. *Arrows* is the puzzle where notation helps the solver perhaps the most; it even becomes a solid technique on its own. But, I will give an example on a more popular puzzle.

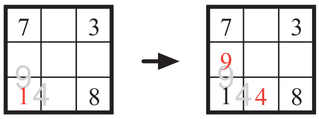
6		4				7		3
			1		4			
7								8
	4		2		7		9	
				8				
	3		6		5		1	
5								9
			7		6			
9		8				6		2

Sudoku: Fill in the grid so that each row, each column and each 3x3 box contains the digits 1 through 9.

I've always had some serious trouble with regular Sudoku. I would usually skip it whenever it comes up, but its recent popularity makes it more likely to pop up just about anywhere. So, I had to find a notation that would help me the most. Notation can change from person to person. I've seen puzzlers using dots on the cells like on a telephone pad; which is mentioned a lot even on the web anyway. It simply didn't help me at all.



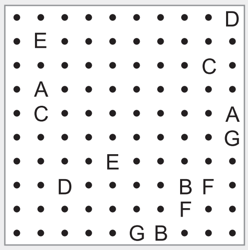
Let's just skip the obvious placements for the above figure. I first start to search each digit one by one; usually starting with all 1's. I prefer to write a digit between the possible cells in a box whenever I reduce the number of possibilities to two (I also write possibilities when there are three cells in a straight line, just writing the digit at the opposite edge of the first cell). For example, a large "8" in the figure above means that digit 8 can only be placed into the two cells that it starts and ends on, in that box. I press my pencil softly to mark those possibilities and never erase them. Sure, it leaves a mess behind, but a mess with a correct solution arrived faster.



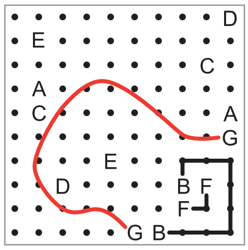
Notation is like an investment to future you. You don't have to remember all those possibilities and whenever you arrive at a new finding, you know what your possibilities are without even looking at other places. Another area to use markings is to show where your trial starts and what writings are trials while using trial and error. You then don't have to erase everything and start over every time. You don't even have to erase your trials in some cases.

Intuition

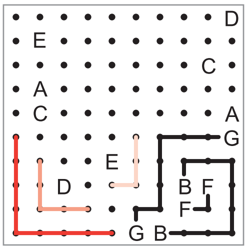
There is no doubt that experience and practice make a puzzler better. More you solve puzzles, more you see things quickly and clearly. And this also is true for completely new or different puzzle types. What I will try to explain here is a little different from experience.



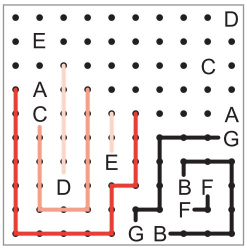
ABC Connection: Connect each identical letter-double with a single line that only travels horizontally and vertically, and doesn't touch other lines. Use all points in the grid.



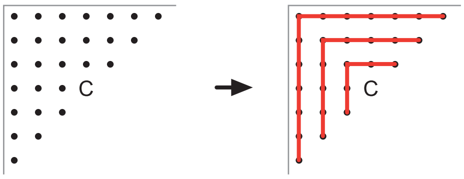
Some basic guidelines can be formed based on topological experiments and uniqueness, but these take you only thus far and will not be mentioned here completely. If a line can be formed by surrounding either the grid border or already formed lines without disturbing any other letter-double, take the opportunity. In fact, the line connecting the G's can be proven to be the only way after connecting F's and B's: Since both G's are at the border of the grid, the line connecting them will divide the grid into two parts. Each part must have exactly two copies of a letter, or not at all. Therefore, there remains only one way to connect two G's.



I remember sitting down and trying to come up with a solid technique to solve ABC Connection. Nothing served well, then I decided to analyze some large number of ABC Connection solutions wherever I find them. Most of them had an apparent property in common: *Corner lines*. Whenever a corner, and a letter surrounded by it, is seen, whether at the corners of the grid or formed later on, there would be one or more surrounding lines that doesn't even reach the mentioned letter, at least not right away. Notice how two lines surround D at lower left.



The same goes for the corner on the left of the lower G and the corner two units above it. After that, just lengthening the corner lines until they hit the target will complete the puzzle. These all come largely from uniqueness actually; but a leap of faith is always a good friend at least diving into the puzzle quickly.



Sometimes, just reminding yourself that a puzzle has a solution and trying to visualize it help you solve the puzzle. Philosophical and psychological effects come into play then. An example would be to pick the longest separating line on a Dissection puzzle, if the shape is tightly packed. It works magically sometimes.

Trial and Error
It's sometimes stated that a puzzle requiring trial and error is not a good puzzle. Then I would argue what "good puzzle" means. A distinctive puzzle or a puzzle that needs to be hard usually has, and sometimes must have, trial and error buried inside. Also, there is no such thing as "This puzzle requires trial and error", because every move in every puzzle is the result of auto trial and error anyway. This requirement can not simply be put as if an algorithm in a computer program.

Making puzzles on a regular basis for several magazines and competitions, I've developed a taste for trial and error. I can quickly get into trials in a systematic manner getting the help of my notation preferences. I usually try the least likely possibility and move on to the most likely one; a habit developed to make puzzles with unique solutions. *That's good*, one would think. Not at all; a bad habit. The actual trick is to try the most likely option first, hence arriving at the solution earlier. We call it "making the puzzle happy" among friends. Why not put a letter into the cell just near a given hint in an *Easy as ABC* puzzle?

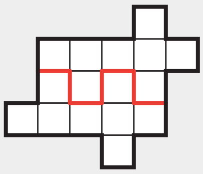
Others
Another approach in trial and error might be to "make the designer happy". Just try the craziest option first, whenever you see fit. The designer must have thought you would try *that* possibility latest. But let's not get into it much, after recommending "making the puzzle happy".

I feel like I'm destined to find a method in *Battleships* just by looking at the given water marks inside. They are there to make the puzzle unique. Why not assume there would be a ship segment on one of those water marks and go from there? The alternate solutions might not be much different from the expected one. Common properties might be extremely helpful.

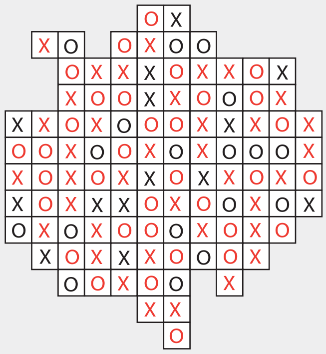
These two cases, and some of the other cases given in this article too, involve an unfortunate paradox. If, by some magical reason, someone finds a generalized method or an insight on these, fake givens might be placed by an aware puzzle designer from then on. I know I do. Then we would have to wait long to come back to equilibrium again.

This article has done its duty if it places *hope* into its reader's heart, *joy* into the soul and an *if* into the mind. The rest is up to the puzzler.

Solutions



4	4	6	0	6	3	6	6
1	2	0	0	6	1	0	2
3	2	5	1	1	1	3	1
5	1	5	3	4	0	4	3
2	2	5	6	4	4	0	2
3	3	0	4	5	0	2	6
3	5	4	2	5	1	5	6



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