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X-Cycles

From sudokuwiki.com, the puzzle solver's site

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The strategy documentation pages are under going an overhaul. I hope to include detailed documentation on all the strategies used in the solvers. This will appear during the rest of April. Currently I have transferred the existing strategy documents to this new system.

In the X-Wing structure in Figure 1, we have two links with strong inference in rows B and H, which are marked with the solid line. Because there are just two 9s in each row, we know that if one is not a 9, the other must be. A strong link is where:

$\neg A \Rightarrow B$ (if not A, then B)

Weak links are the opposite:

$A \Rightarrow \neg B$ (if A, then not B)

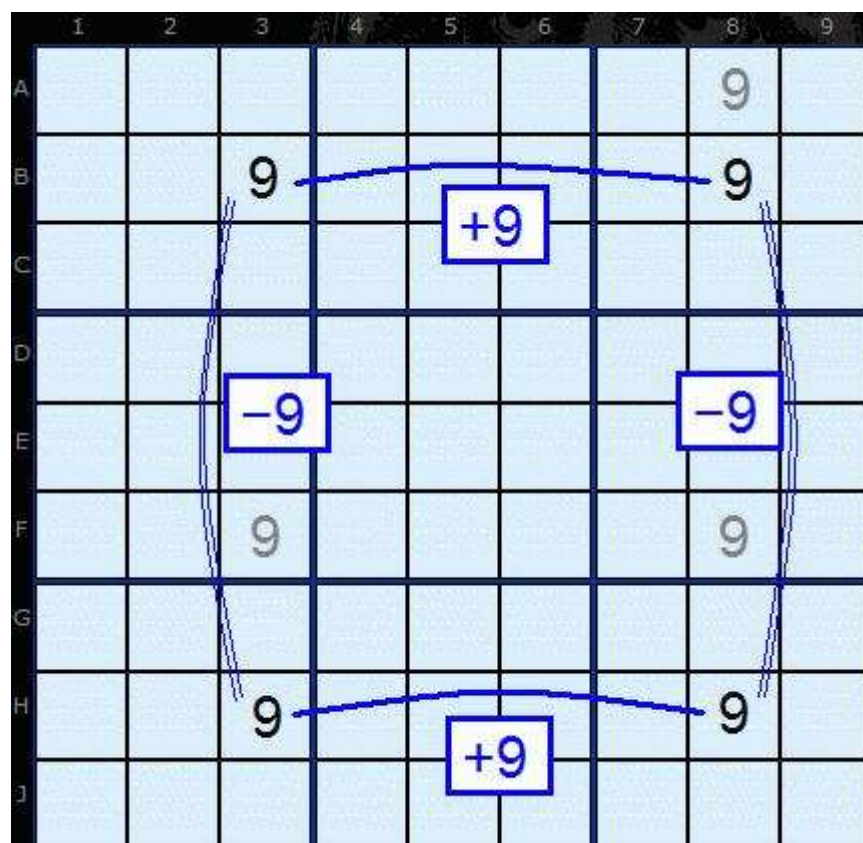


Figure 1: Nice Loop on 9

Our weak links in the X-Wing are in the columns where more than two 9s reside. Pretending one of them is not the solution does not mean that all the others are solutions. Only a pair has this characteristic. I have drawn a weak link with a double thin line and put a -X on that line (in this case, -9) to mark it as a weak link. Strong links are marked with +9.

A "Cycle", as the name implies, is a loop or joined-up chain of single digits with alternating strong and weak links, as the X-Wing in Figure 1 shows.

In Figure 2, we have a 2-2-2-formation Sword-Fish re-drawn to show the strong and weak links. The loop characterises the X-Cycle, and the strong/weak links alternate.

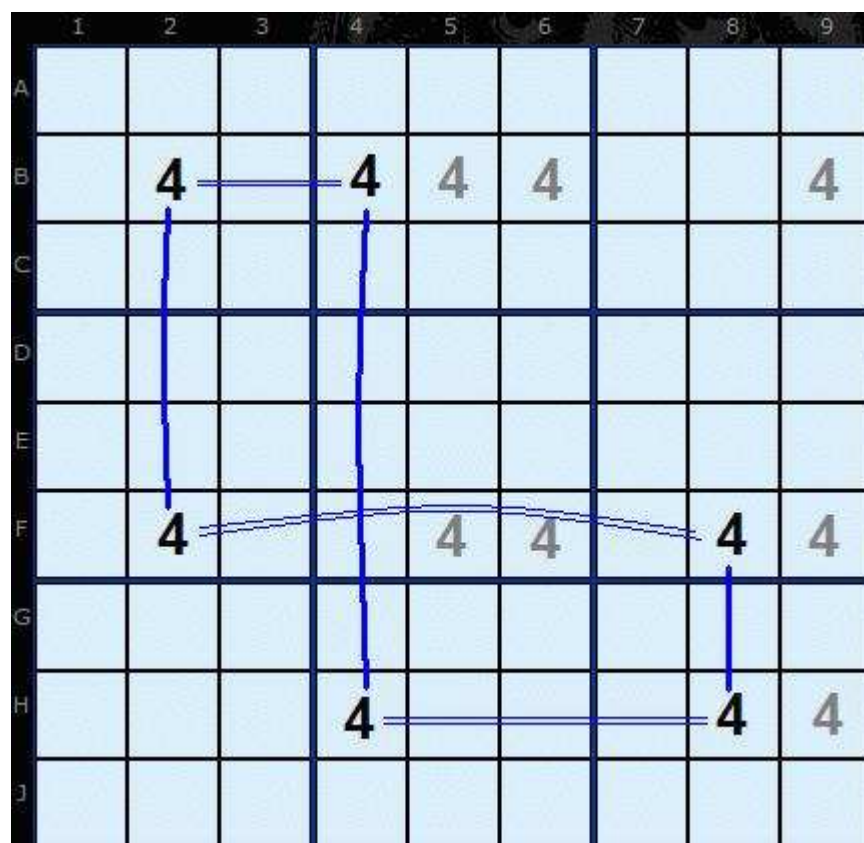


Figure 2: Nice Loop on 4

Nice Loops have evolved a notation which is useful when accompanying a diagram or as part of an explanation. X is, of course, the digit, and we use the row letter and column number notation to identify cells (e.g., B2, F8). The cells in the loop are linked with a dash (hyphen) to indicate a weak link and with an equal sign to indicate a strong link, as in this example:

$x[\text{cell 1}]-x[\text{cell 2}]=x[\text{cell 3}]-x[\text{cell 4}]=$

The 2-2-2 Sword-Fish above can be expressed as:

$4[B2]-4[B4]=4[H4]-4[H8]=4[F8]-4[F2]=$

The only thing not explicit in this notation is that the last cell joins back onto the first cell. Thus, $4[F2]=[B2]$. The beginning of the loop is arbitrary, but it's convenient to use the cell closest to the top left. Note that the loops can be of any length.

Here is the notation for the 8-Cycle in Figure 3:

$$8[B3]=8[B4]-8[C6]=8[D6]-8[F5]=8[F3]-8[B3]=$$

The **yellow** cells are units where other 8s can be eliminated, which in this case correspond to the third column and boxes 2 and 5 - because that's where the weak links are located.

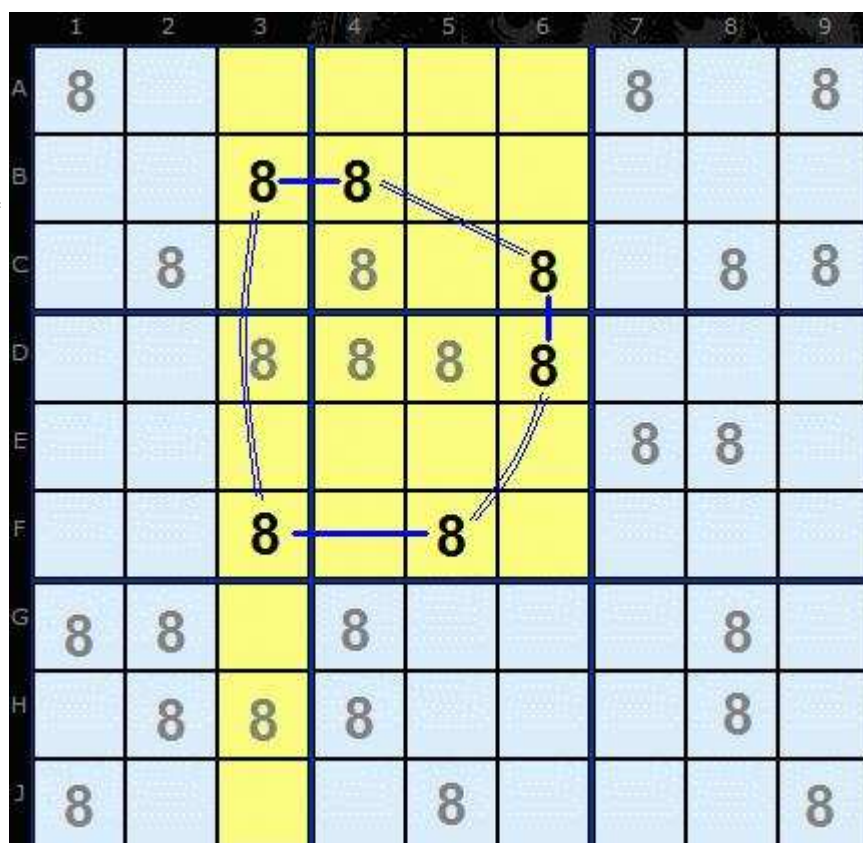


Figure 3: Nice Loop on 8

Nice Loops Rule 1

Nice Loops that alternate all the way round are said to be 'continuous', and they must have an even number of nodes. With a continuous X-Cycle, candidates are not removed from the loop since the loop does not have any flaws. Instead we are looking to eliminate on the units that can be seen by two or more cells that belong to the loop.

Figure 4 is a real-life example of an X-Cycle based on 8. The cells with links are in yellow. We can immediately see that C2/C7 is a weak link across the row because of the 8 in C3. G2/H3 is also a weak across the box because of the third 8 in G3. The last weak link is in box 9, J7/H9. Any other 8s in these units can be removed, which makes it a powerful technique. We end up with a loop containing only strong links - a result identical to a Colouring (Singles Chains) solution.

The output from the solver will contain the following information:

X-CYCLE: 8 taken off G3 (link: G2 / H3)
 X-CYCLE: 8 taken off G9 (link: H9 / J7)
 X-CYCLE: 8 taken off C3 (link: C7 / C2)
 X-CYCLE: 8 taken off C9 (link: C7 / C2)
 X-CYCLE on 8 (Continuous Alternating Nice Loop, length 6):

$$8[C2]=8[G2]-8[H3]=8[H9]-8[J7]=8[C7]-8[C2]=$$



Figure 4: Nice Loop on 8: Load Example or : From the Start

In summary we can see that

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