The concept of a RESOLUTION RULE and its applications

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Author	Message
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An example of non-confluence for whip theories, as announced in section 3.3 of the previous post.

Take puzzle #279845 in the random Sudogen0_1M collection of 1,000,000 minimal puzzles

Code:

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

(solve "9817.325.752..19..364.9...8.173...92.43..9.6..9...7...4..1...29.29..8.....9..5..")

***** SudoRules version 13.7wter2 *****
9817.325.752..19..364.9...8.173...92.43..9.6..9...7...4..1...29.29..8.....9..5..
interaction column c7 with block b9 ==> r9c9 <> 6, r8c9 <> 6

nrc-chain[2] c8n8{r6 r9} - r7n8{c7 c3} ==> r6c3 <> 8
interaction column c3 with block b7 ==> r9c1 <> 8
nrc-chain[3] c8n8{r9 r6} - r4c7{n8 n4} - c6n4{r4 r9} ==> r9c8 <> 4
nrczt-whip[2] r1n4{c5 c9} - b9n4{r8c9 .} ==> r8c5 <> 4
nrc-chain[3] r9n2{c5 c6} - r3c6{n2 n5} - r7c6{n5 n6} ==> r9c5 <> 6
nrc-chain[3] r9c3{n6 n8} - r7n8{c3 c7} - b9n6{r7c7 r8c7} ==> r8c1 <> 6
nrczt-whip[3] r1n4{c9 c5} - r9n4{c5 c6} - c4n4{r8 .} ==> r6c9 <> 4
xyzt-chain[4] r7c6{n6 n5} - r3c6{n5 n2} - r9c6{n2 n4} - r8c4{n4 n6} ==> r8c5 <> 6, r7c5 <> 6
nrc-chain[4] b6n7{r5c7 r5c9} - b6n5{r5c9 r6c9} - c3n5{r6 r7} - r7n8{c3 c7} ==> r7c7 <> 7, r5c7 <> 8
naked-pairs-in-a-column c7{r3 r5}{n1 n7} ==> r8c7 <> 7, r8c7 <> 1, r6c7 <> 1
;;; KS1
nrc-chain[4] r9c3{n6 n8} - b9n8{r9c8 r7c7} - r4c7{n8 n4} - c6n4{r4 r9} ==> r9c6 <> 6
interaction row r9 with block b7 ==> r7c3 <> 6
;;; KS2
nrct-chain[5] c6n4{r4 r9} - c6n2{r9 r3} - r3n5{c6 c4} - r8c4{n5 n6} - r7c6{n6 n5} ==> r4c6 <> 5
;;;
nrc-chain[2] r4n5{c5 c1} - b7n5{r8c1 r7c3} ==> r7c5 <> 5
naked-pairs-in-a-row r7{c2 c5}{n3 n7} ==> r7c7 <> 3
xy-chain[3] r7c7{n6 n8} - r4c7{n8 n4} - r4c6{n4 n6} ==> r7c6 <> 6
singles to the end

Consider knowledge state KS1

Code:

```
+-------------------------+-------------------------+-
------------------------+
|9        8        1      |7        46       3
|2        5        46     |
|7        5        2      |468      468      1
|9        34       346    |
|3        6        4      |25       9        25
 |17       17       8      |
+-------------------------+-------------------------+-
------------------------+
|568      1        7      |3        4568     456
|48       9        2      |
|258      4        3      |258      1258     9
|17       6        157    |
|2568     9        58     |24568    124568   7
|348      1348     135    |
+-------------------------+-------------------------+-
------------------------+
|4        37       568    |1        357      56
 |368      2        9      |
|15       2        9      |456      3567     8
|346      1347     1347   |
|16       37       68     |9        2347     246
|5        1378     1347   |
+-------------------------+-------------------------+-
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At knowledge state KS1, we had the potential whip elimination:
nrczt-whip[4] c6n4{r4 r9} - c6n6{r9 r7} - r8c4{n6 n5} - r3n5{c4 .} ==> r4c6 <> 5
In details
nrczt-whip[4] c6n4{r4 r9} - c6n6{r9 r7 r4*} - r8c4{n6 n5 n4#1} - r3n5{c4 . c6*} ==> r4c6 <> 5

Unfortunately, the nrc-chain[4] rule is applied before this whip[4] rule and it deletes the left-linking candidate n6r9c6 in the second cell of this whip[4]. Only a slightly longer nrct-chain[5] can now make the r4c6 <> 5 elimination.
Notice that, if the whip[4] had been applied before the nrc-chain[4], this last chain would still have been applicable.

We have a clear case of non confluence. Notice that if we allow braids, after the nrc-chain[4] is applied and until KS2, we have the replacement braid (as provided by the general proof of confluence for braid resolution theories):
nrczt-braid[4] c6n4{r4 r9} - c6n6{r4 r7} - r8c4{n6 n5 n4#1} - r3n5{c4 . c6*} ==> r4c6 <> 5
The previous z-candidate in cell 2 is now used as a left-linking candidate. (It is nrc-linked to the target).

Does SudoRule find this replacement braid?
;;; idem until KS2
nrczt-braid[4] r7c6{n5 n6} - r3n5{c6 c4} - c6n4{r4 r9} - r8c4{n6 .} ==> r4c6 <> 5
;;;
end unchanged

SudoRules has found another braid, but this is not important, as it has the same length.

After this example, one could wonder whether the difference between the braid and whip theories is only one of adding confluence to the whip theories. But the answer is negative. Most of the braids appear for other reasons than dealing with a deleted candidate.

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Posted: Sat Jan 09, 2010 8:23 am Post subject: quote edit

private mail wrote:

```
Why do you never speak of nrcz chains?
```

nrcz-chains are currently not implemented as a separate pattern in SudoRules, but I sometimes speak of them. In particular, I have mentioned long ago (http://www.sudoku.com/boards/viewtopic.php?t=5591&postdays=0&postorder=asc&start=124) that they subsume Rod Hagglund's "broken wings" (defined here: http://www.sudoku.com/boards/viewtopic.php?t=2666&highlight=): "guardian cells" can be understood as mere additional z-candidates.
nrcz-chains are more general than broken wings:
- there's no need for a closed loop;
- there's no need for all links to be conjugacy links (modulo the guardians): the constraint bears only on even links;
- the length can be odd or even, no matter (this is a consequence of the previous point);
- the number of additional z-candidates in any link is completely irrelevant.

Indeed, ***broken wings, with the proper extensions to Rod Hagglund's definition, could be considered as the 1-digit restriction of nrcz-chains***.

private mail wrote:

> Why do you never speak of nrc or nrcz braids?

Braids (and lassos) are interesting only when the t extension is used.
As nrc and nrcz (or their 2D counterparts) are reversible, ***all the nrc-braids or nrcz-braids are equivalent to nrc or nrcz whips***.

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