Autumn 2022
Lecture 4: Nikoli Puzzles, Part 2
Chess scandal update

UNITED STATES DISTRICT COURT
EASTERN DISTRICT OF MISSOURI: EASTERN DIVISION

HANS MOKE NIEMANN,

Plaintiff,

v.

SVEN MAGNUS ØEN CARLSEN A/K/A MAGNUS CARLSEN, PLAY MAGNUS AS D/B/A PLAY MAGNUS GROUP, CHESS.COM, LLC, DANIEL RENSCH A/K/A “DANNY” RENSCH, AND HIKARU NAKAMURA,

Defendants.

CIVIL ACTION NO.

JURY TRIAL DEMANDED

s*** just got real

please do not sue CS64

COMPLAINT

Plaintiff Hans Moke Niemann ("Niemann"), by and through his attorneys Oved & Oved
Nikoli-style logic puzzles are "NP-complete"

- it's easy to verify a solution (polynomial time)
- hard to actually solve a puzzle (exponential time)
- a way to solve any one of the puzzle types efficiently would also let us solve the others

Let's Begin nikoli Puzzles!

A lot of people enjoy solving puzzles every day to escape the pressures of the world. With Nikoli logic puzzles you need just paper, pencil, and an active mind, no expensive programs or training......
Most logic puzzles are NP-complete, not NP-hard

- NP-hard problems can't even have their solutions checked efficiently
- This would of course be undesirable for logic puzzles (solvers like to know when they have things right!)
We are the best in keeping the Nikoli style.

Nikoli has been creating puzzles for 40 years and is surely a one-of-a-kind company in the world.

We have created the world’s largest crossword puzzle that has been verified by the Guinness World Records®, and have coined the puzzle, “Sudoku”, which is now enjoyed in more than 120 different countries.

Human-crafted puzzles will always have a special place in this tech-dominated world we live in today.
Interlude

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This is fairly misleading – "popularized" would be more accurate.

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Interlude

though the original Japanese doesn't make this claim — "the puzzle called (re)named Sudoku"
What does it mean to write the Nikoli style well?

Let's look at...

Kakuro
What does it mean to write the Nikoli style well?

NB: also not originally a Nikoli puzzle ("Cross Sums")
What does it mean to write the Nikoli style well?

*Also note: this is an actual math (arithmetic) puzzle!*

**Kakuro**

Sample

Progressing

Solution
Bold: in puzzle
Italics: about where I stop having the patterns memorized

Nikoli Kakuro often heavily use a small number of common patterns.
Although this is an easy puzzle, Nikoli Kakuro generally heavily use a small number of common patterns.

Bold: in puzzle
Italics: about where I stop having the patterns memorized
Contrast with this Kakuro generator...

Where to begin?
23-in-3 is always 6, 8, 9

8 or 9 can't be part of 10-in-3 (too big)
23-in-3 is always 6, 8, 9

8 or 9 can't be part of 10-in-3 (too big)

4 total left over in the 10-in-2

4-in-2 is always 1, 3
7-in-3 is always 1, 2, 4
We have a 2 and 4 left in the 7-in-3.

The 2 can't go in the 20-in-3 column, since there is no 18-in-2. So the 4 must be there.
We have a 2 and 4 left in the 7-in-3.

The 2 can't go in the 20-in-3 column, since there is no 18-in-2. So the 4 must be there.

And so on. This part was easy for me (an experienced Nikoli Kakuro solver) to fill in. But now what?
Now it's a very different puzzle

Who has all the 27-in-5s memorized? *Not me*

Can fill in candidates for 23-in-3 but it only helps so much.
Now it's a very different puzzle

Who has all the 27-in-5s memorized? Not me

Can fill in candidates for 23-in-3 but it only helps so much

21-in-3 and 22-in-3 have a smaller number of options, but this isn't helping much
A good idea

- Write every possibility for every row/column
- Look at each, one at a time
- See if any numbers are forced by the constraints of just the crossing clues, and if so, fill them in (and update the possibilities)
- Keep looping until the puzzle is done
A good idea that may not work

- Write every possibility for every row/column
- Look at each, one at a time
- See if any numbers are forced by the constraints of just the crossing clues, and if so, fill them in (and update the possibilities)
- Keep looping until the puzzle is done

May not be enough!
What about paint by numbers / nonograms

Example

<table>
<thead>
<tr>
<th>empty Nonogram</th>
<th>solved Nonogram</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 2</td>
<td>0 9 9</td>
</tr>
<tr>
<td>2 2 4 4</td>
<td>2 2 4 4 0</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>9</td>
<td>9</td>
</tr>
<tr>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>2 2</td>
<td>2 2</td>
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<td>2 2</td>
<td>2 2</td>
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<td>6</td>
<td>6</td>
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<td>4</td>
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<td>2</td>
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</tr>
<tr>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

Bummer:

It isn't necessarily sufficient to just keep checking individual rows to see if any cells can be filled in.
Don't get too excited, Mario, it's NP-complete!

Complexity Theory
Bowser wins again
The dreaded "bifurcation"

- AKA "guess and check" – when you're not sure which of two branches to take, try one and be prepared to backtrack

- Many solvers (including me) don't like having to do this. e.g., "I had to bifurcate twice on that tournament puzzle". Why not?
  - Harder for many humans to backtrack (chess, Go, etc. players are good at it, I'm not)
  - Feels less satisfying to have to "guess" instead of finding an intended path
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- Counterpoint: But some solvers might like it! (And may find Nikoli's reliance on common patterns dull)
But isn't guessing the solver's fault?

- "A puzzle should be a battle of wits that the author expects to lose"
  - Dan Katz
But isn't guessing the solver's fault?

- "A puzzle should be a battle of wits that the author expects to lose"
  - Dan Katz

- So what if it's true that the solver didn't have to guess?
  - When things go well, it's because the solver is awesome
  - When things don't go well, it's generally blamed on the puzzle and it's not fun
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- Puzzle authors may need to do some ego management / stroking. Posing an intellectual challenge is inherently stressful and can back the insecure solvers among us into a corner ("oh no! I'm supposed to be smart, and yet I can't solve this!")
stuff below this line rarely shows up even in Sudoku championships