ROC’DEZ Challenge

Toulouse
Rules

- Solve the puzzle!
- Like the name suggests... no clues!

Questions?
Alright, alright...

Note by [Gerard Butters, Frederick Henle, James Henle, Colleen McGaughey (Smith College, Northampton)]

- Sudoku puzzles are “inelegant”: numeric clues
- Can we have a puzzle without any clue?
- Yes! (sort of)
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4 1 3 2 5 6
1 2 6 5 3 4
6 3 5 4 2 1
5 6 4 3 1 2
2 5 1 6 4 3
3 4 2 1 6 5

- Latin square (rows and columns are permutations of \( \{1, \ldots, N\} \))
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\[
\begin{array}{cccccc}
4 & 1 & 3 & 2 & 5 & 6 \\
1 & 2 & 6 & 5 & 3 & 4 \\
6 & 3 & 5 & 4 & 2 & 1 \\
5 & 6 & 4 & 3 & 1 & 2 \\
2 & 5 & 1 & 6 & 4 & 3 \\
3 & 4 & 2 & 1 & 6 & 5 \\
\end{array}
\]

- Latin square (rows and columns are permutations of \(\{1, \ldots, N\}\))
- Specified regions all add up to the same value (14)
Alright, alright...

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<table>
<thead>
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<th></th>
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- Latin square (rows and columns are permutations of \(\{1, \ldots, N\}\))
- Specified regions all add up to the same value (14)
Solving a puzzle by hand

\[
\text{Sum in each of the } M \text{ regions } V = N \times \left( \frac{N \times (N + 1)}{2} \right) / M
\]

\[N = 6, \quad M = 9 \quad \Rightarrow V = 14\]

3-partitions of 14 in \{1, \ldots, 6\}:

\[
\begin{align*}
&\left\{ 2, 6, 6 \right\} \\
&\left\{ 4, 4, 6 \right\} \\
&\left\{ 4, 5, 5 \right\} \\
&\left\{ 3, 5, 6 \right\}
\end{align*}
\]

only partition consistent with a row/column
Solving a puzzle by hand

- Sum in each of the \( M \) regions \( V = N \times (N \times (N + 1)/2)/M \)
Solving a puzzle by hand

Sum in each of the $M$ regions $V = N \times \left( N \times (N + 1)/2 \right) / M$

- $N = 6, M = 9$ then $V = 14$
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3-partitions of 14 in $\{1, \ldots, 6\}$:
  - $(2, 6, 6)$
  - $(4, 4, 6)$
  - $(4, 5, 5)$
  - $(3, 5, 6)$
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Sum in each of the $M$ regions $V = \frac{N \times (N \times (N + 1)/2)}{M}$

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Challenge

- 1-st Part: Solve these puzzles:

- 2-nd Part: Create new puzzles for $N \geq 4$ and $1 < M < N(N + 1)/2$
  - Criterion: number of solutions (a true puzzle has only one solution)
Rules (1-st part)

- Puzzles on paper and this format:

  - [size of the board]
  - [number of regions]
  - 1 1 1 1
  - 1 2 2 2
  - 1 1 2 2
  - 1 1 1 2

- Solutions by USB stick in this format:

  - [id of the team]
  - [puzzle name]
  - 1 2 3 4
  - 3 1 4 2
  - 1 4 2 3
  - 2 3 1 4

- Score: \( N \times ([10/k]) \) for the \( k \)-th team to solve puzzle of size \( N \)
  - You can run
  - But you can’t tackle or trip someone up (arbitrary point deduction)
  - \(-1\) for a wrong solution
Rules (2-nd part)

- Puzzle in the same format as in the data \([\text{file name} = \text{team id}]\).
- For each class of puzzle (size \(\times\) number of regions):
  - Count only the best (i.e., with fewest solutions) for this class.
  - Score: \(\left\lfloor 100 \cdot \frac{2^N}{k} \right\rfloor\) for a puzzle of size \(N\) with \(k\) solutions.
    - \(-10\) for a puzzle with no solution or equal to those in the data.
After lunch

- Archive `rocdez.zip` with
  - The original note from Northampton folks
  - Data set (`rocdez/data`) [note + challenge instances]
  - A Puzzle class (in C++ and in Python)
    - read/write instances and solutions + a few other things

- You can use whatever method to compute solutions
  - By hand: perhaps the best way to solve the easiest instances first
  - Standard MIP/CP models: should easily solve all puzzles
  - Generating new puzzles is much harder
    - Generating feasible puzzles is hard
    - Generating nice puzzles is extremely hard
Postgrads
  d1 Grégoire, Jean-Thomas, Leonardo
  d2 Azzedine, Margaux, Mohamed
  d3 Clément, Letitia, Yacine

Staff
  p1 Cyril, Julien, Sandra
  p2 Nicolas, Pierre
  p3 Christian, Laurent

Interns (coached by Marie-Jo, Patrick and Nadia)
  s1 Marie-Jo, Alexandre, Florian, Francisco, Maria, Thomas
  s2 Patrick, Nadia, Mikael, Pierre, Pauline, Ulrich

Bon Appétit!
  Well, for those who do not fast
Puzzle class (C++ and Python):

- Read puzzle from file
- Get the value of the sums
- Get the list of shapes coordinates
- Check a solution
- Apply symmetries
  - clock-wise rotation
  - vertical mirror
  - horizontal mirror
  - flip along first/second diagonal
- Compare two puzzles
Some relevant tools (clueless_puzzle.py):

- **factors** \(\langle n \rangle\)
  - all pairs Number of regions × Sum in a \(n\)-puzzle

- **partitions** \(\langle s \rangle, \langle k \rangle, \langle n \rangle, [l]\)
  - all \(k\)-partitions of \(s\) using numbers up to \(n\) on at most \(l\)

- **ascii/tikz** \(\langle file \rangle\)
  - print the puzzle nicely

- **compare** \(\langle file1 \rangle, \langle file2 \rangle\)
  - check if \(file1\), \(file2\) are symmetric puzzles

- **verify** \(\langle solfile \rangle, \langle puzzlefile \rangle\)
  - check that the solution is correct
Go!