# Puzzled?

## Is a “fun” talk in Beamer possible?

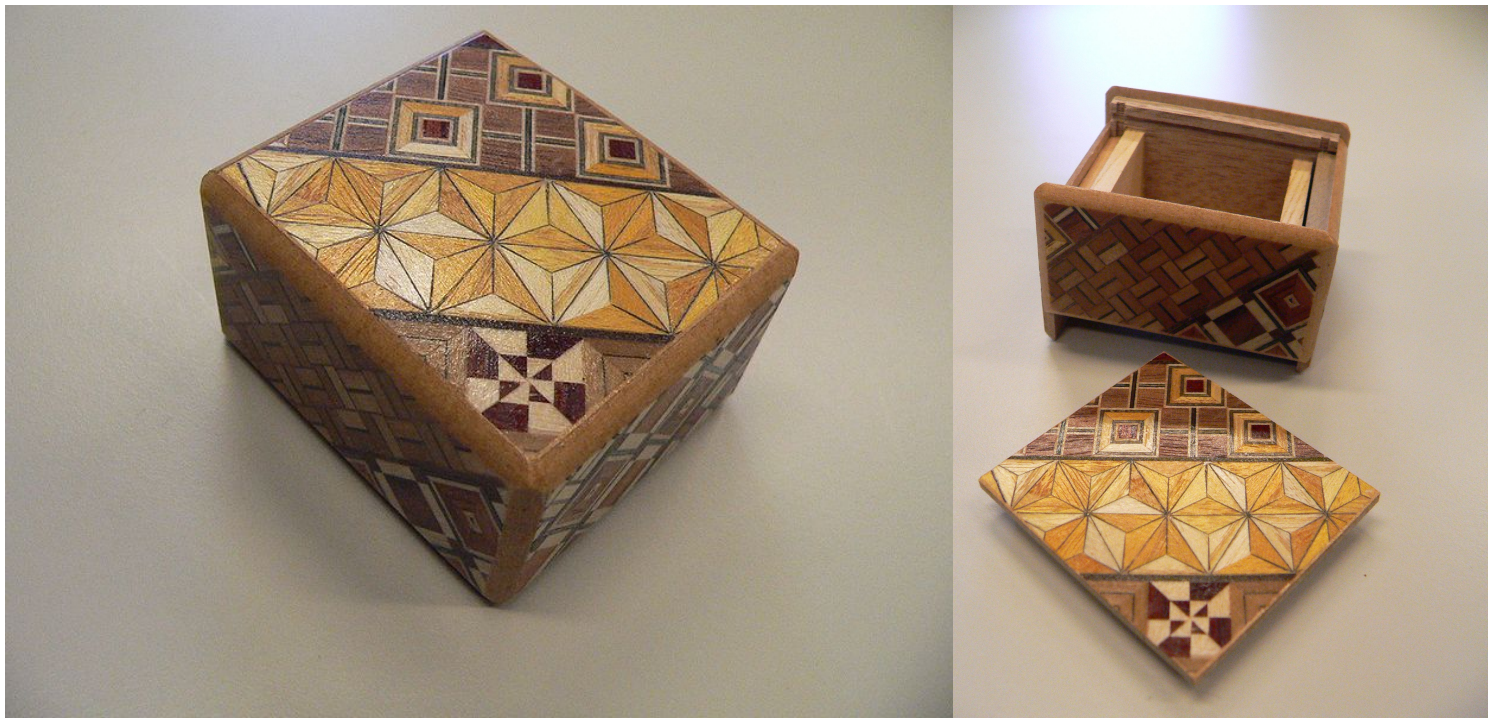
Sho Uemura

# Here's a useless outline

- Some cute puzzles
- Some tricky puzzles
- Four equivalent boring puzzles
- Some annoying puzzles
- An infinite unsolvable puzzle

# Puzzle boxes

- 200 years old (Japan)

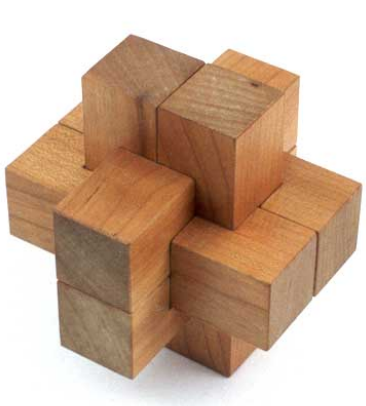


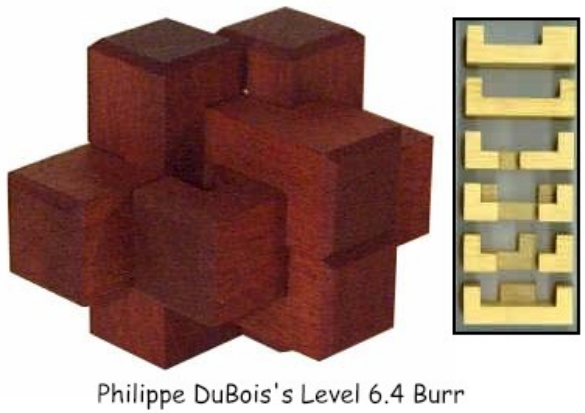
# Art puzzles

- Inspired by puzzle boxes but with a much wider variety of design elements
- Annual competitions:
  `http://www.puzzleworld.org/designcompetition/`

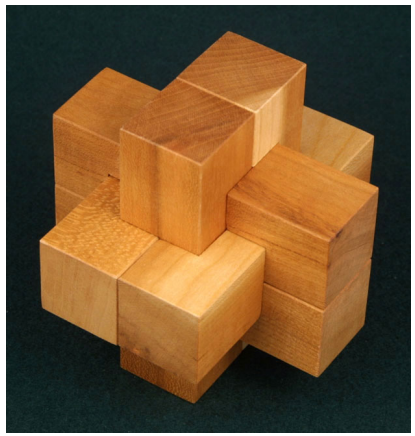
# Six-piece burrs

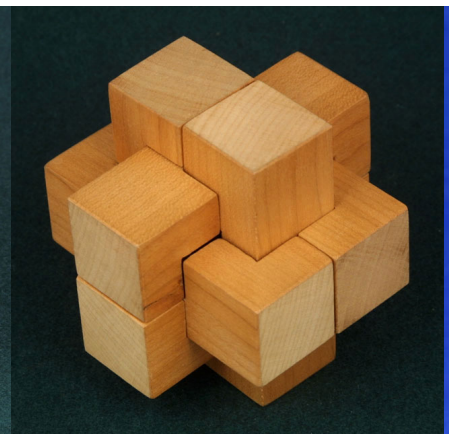
- 200 years old
- Demo: `http://www.research.ibm.com/BurrPuzzles/B6JM9.html`





Philippe DuBois's Level 6.4 Burr



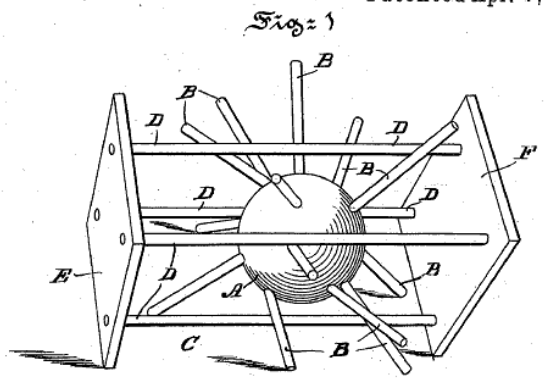


# Disentanglement

- Spatial reasoning puzzles
- These pictures are boring

No. 558,009. Patented Apr. 7, 1896.

Fig. 1

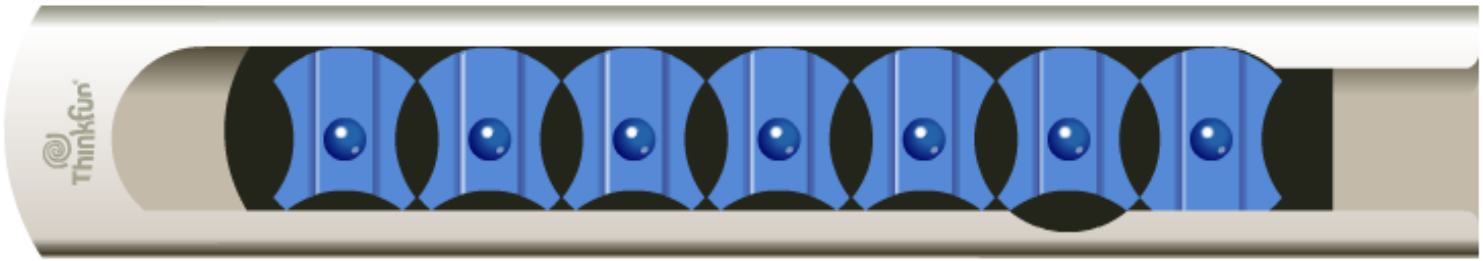


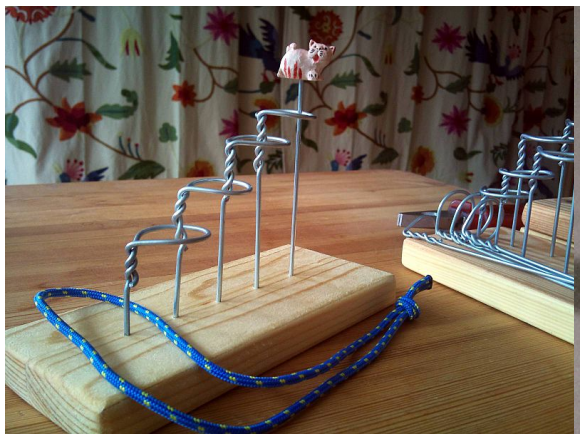
# Chinese rings

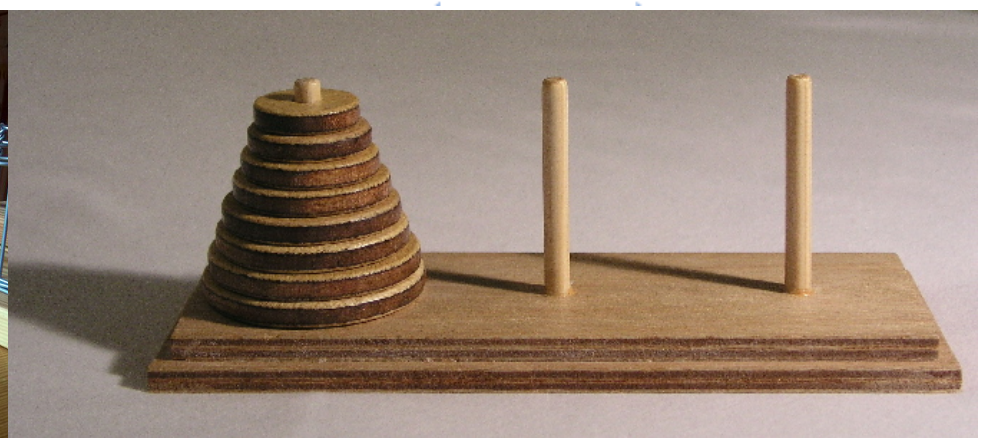
- 2000 years old (China)
- Design enforces these rules:
  - Can only manipulate rings up to the first ring on the handle, or the one after it
  - Cannot manipulate a ring if the previous ring is off the handle

# Equivalent puzzles

- Equivalent to staircase puzzle and Spinout; similar to Tower of Hanoi
  - Spinout demo: `http://www.puzzles.com/products/SpinOut/PlayOnline.htm`

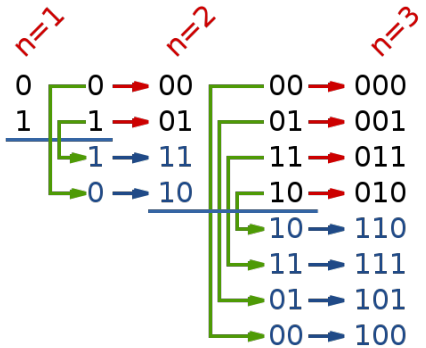


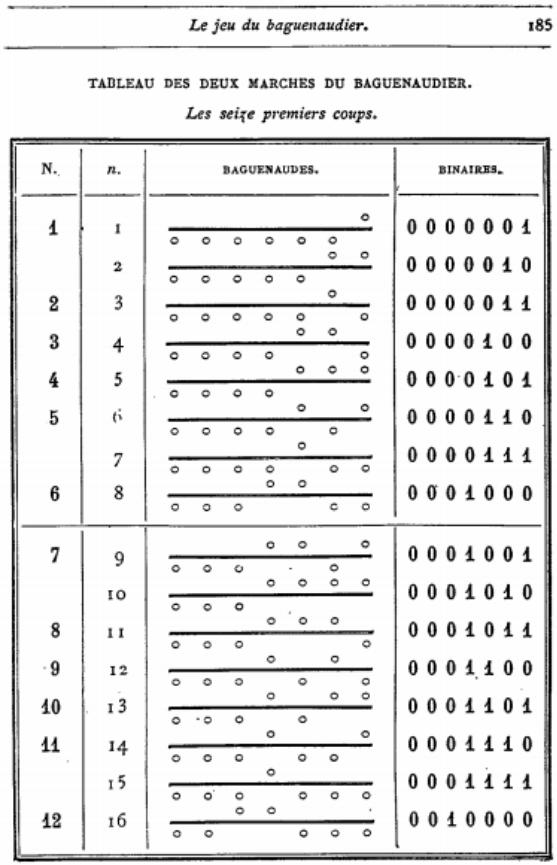





# Recursion and Gray codes

- Puzzle is recursive (to solve the $n$-ring puzzle, first solve the $n-1$-ring puzzle)
- Gray codes: sequences of binary numbers where successive numbers differ by one bit
  - Usually generated recursively: coincidentally this means Gray codes correspond to solutions of Chinese rings puzzle
- Relationship between Chinese rings and binary numbers discovered by Édouard Lucas (inventor of Tower of Hanoi)



*Le jeu du baguenaudier.* 185

TABLEAU DES DEUX MARCHES DU BAGUENAUDIER.

*Les seize premiers coups.*

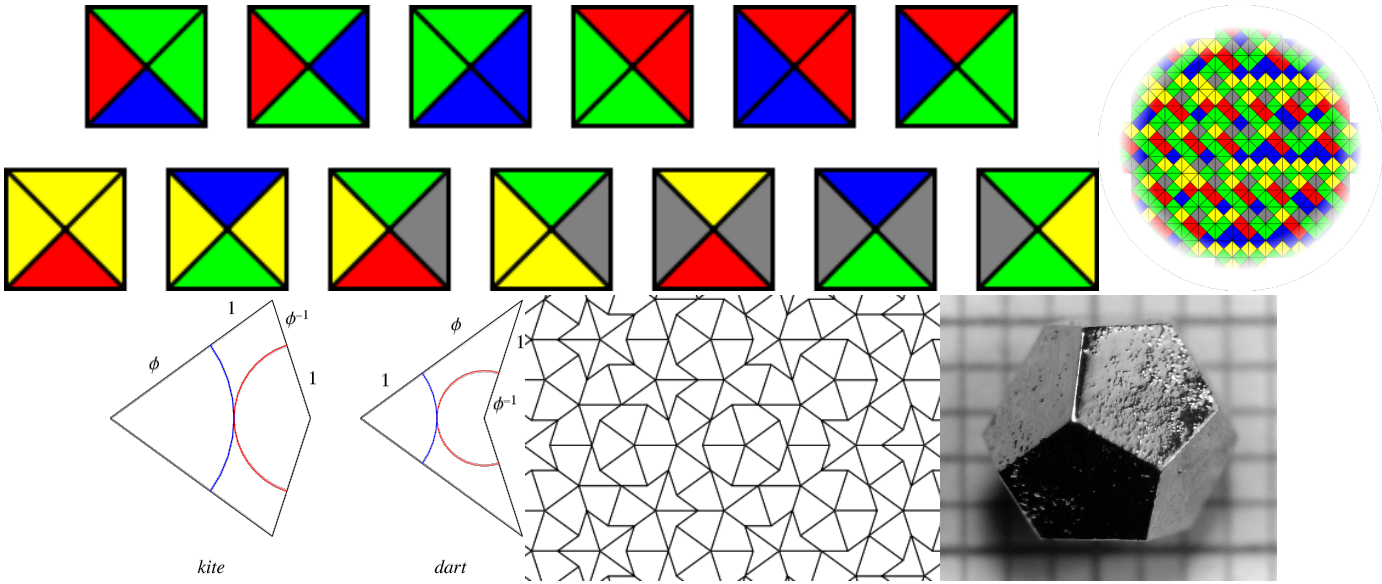
| N. | n. | BAGUENAUDES. | BINAIRES. |
|---|---|---|---|
| 1 | 1 | | 0 0 0 0 0 0 1 |
| | 2 | | 0 0 0 0 0 1 0 |
| 2 | 3 | | 0 0 0 0 0 1 1 |
| 3 | 4 | | 0 0 0 0 1 0 0 |
| 4 | 5 | | 0 0 0 0 1 0 1 |
| 5 | 6 | | 0 0 0 0 1 1 0 |
| | 7 | | 0 0 0 0 1 1 1 |
| 6 | 8 | | 0 0 0 1 0 0 0 |
| 7 | 9 | | 0 0 0 1 0 0 1 |
| | 10 | | 0 0 0 1 0 1 0 |
| 8 | 11 | | 0 0 0 1 0 1 1 |
| 9 | 12 | | 0 0 0 1 1 0 0 |
| 10 | 13 | | 0 0 0 1 1 0 1 |
| 11 | 14 | | 0 0 0 1 1 1 0 |
| | 15 | | 0 0 0 1 1 1 1 |
| 12 | 16 | | 0 0 1 0 0 0 0 |

# Jigsaw puzzles

- Traditional jigsaws are $O(n^2)$ search problems (each edge has a unique match)
  - Boring unless you're the government (DARPA Shredder Challenge)
- Tetravex is hard (many matches $\rightarrow$ nonlocal) — NP-complete
  - "Eternity II" puzzle (16x16 Tetravex puzzle, rotations allowed) remains unsolved (despite $2M prize July 2007—end of 2010)
- "Tetravex tiles" were originally called Wang tiles in formal logic
- Tiling problem: given an finite set of Wang tiles and infinite supply of each can you tile an infinite plane?
  - Undecidable: equivalent to halting problem for a Turing machine

# Aperiodic tiling

- This implies there must exist “aperiodic tile sets” that can tile the plane, but can’t form periodic patterns (otherwise you could search for periodic tilings)
- Below: aperiodic Wang tiles, Penrose tiles
- 2011 Nobel in chemistry awarded for discovery of quasicrystals



# Links

- http://www.research.ibm.com/BurrPuzzles
- http://www.johnrausch.com/PuzzlingWorld/
- http://visualiseur.bnf.fr/CadresFenetre?O=NUMM-3943&I=188&M=tdm
- http://www.tavernpuzzle.com/
- http://www.puzzleworld.org/PuzzleWorld/
- http://www.puzzles.com/products/spinout.htm