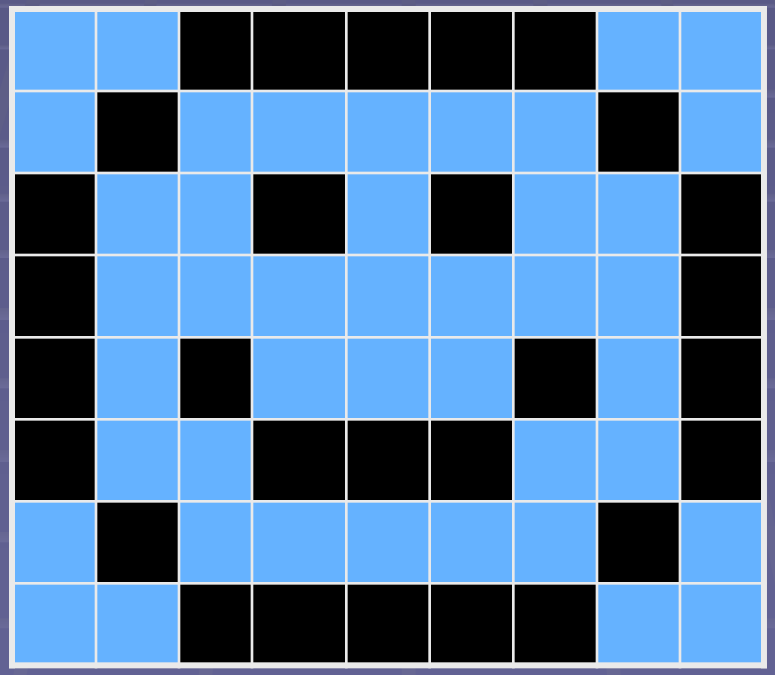
Sample Solutions

Central Europe Regional Contest 2007

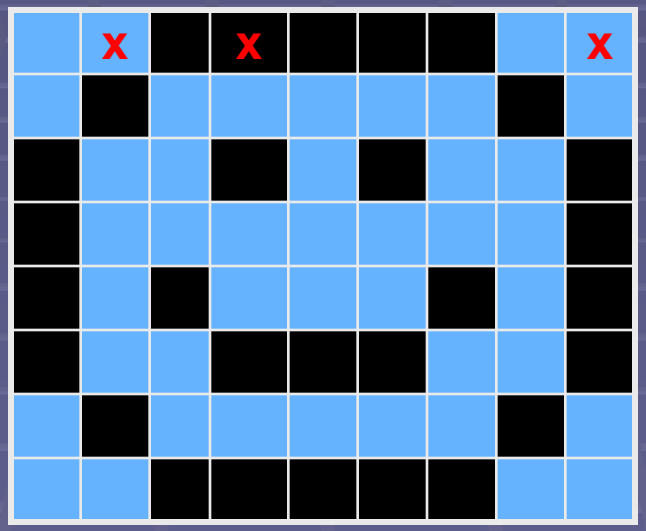
B: Billboard



Billboard – Problem

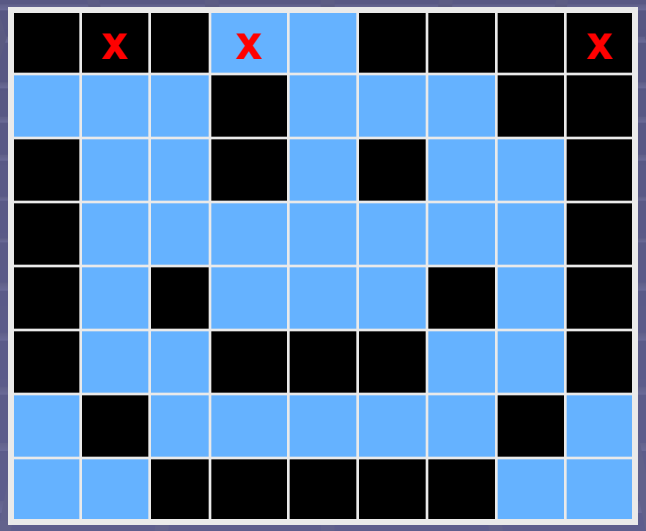
- Test all existing subsets
- 2^{256} possibilities for the 16x16 board
- ☹

Billboard – Main Idea



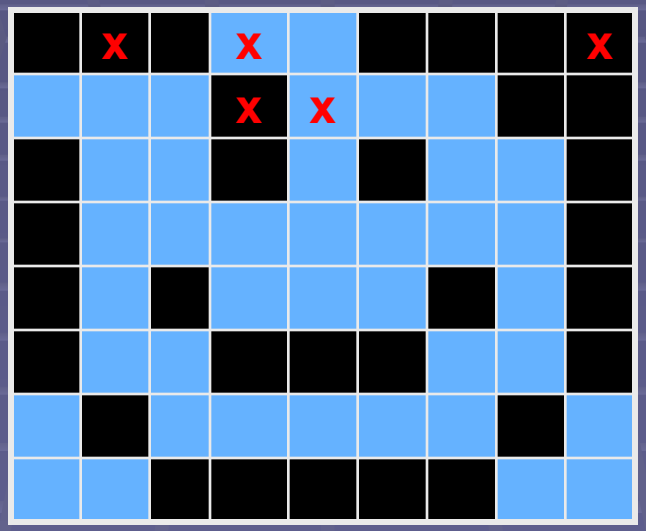
- What if we somehow knew the tapped tiles in the first row?

Billboard – Main Idea



- We can try what happens with the row
- WOW! It is easy to find the second one!

Billboard – Main Idea



- We can try what happens with the row
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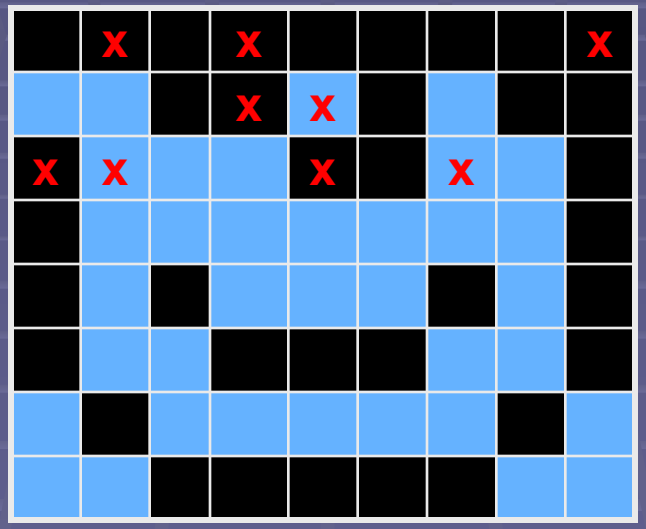
Billboard – Main Idea

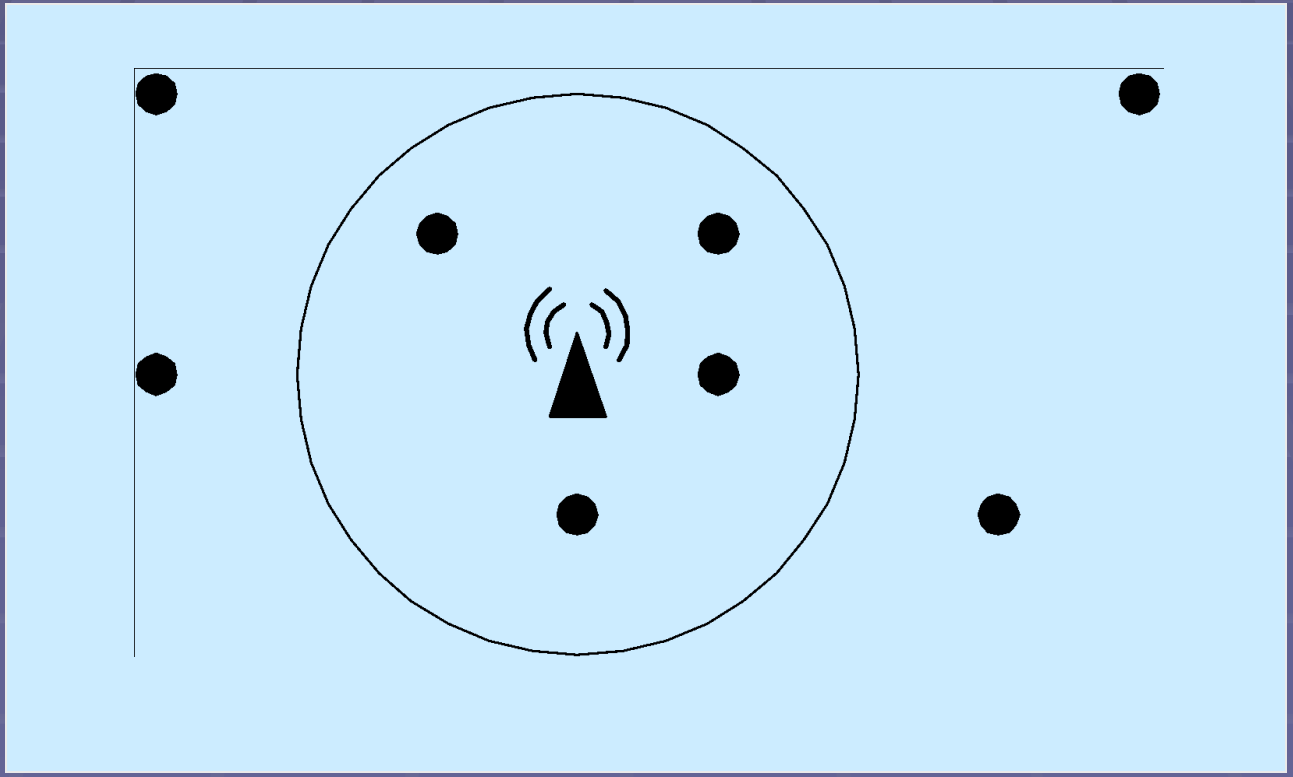


- Let's also do it…
- The third row becomes evident
- … and so on

Billboard – Solution

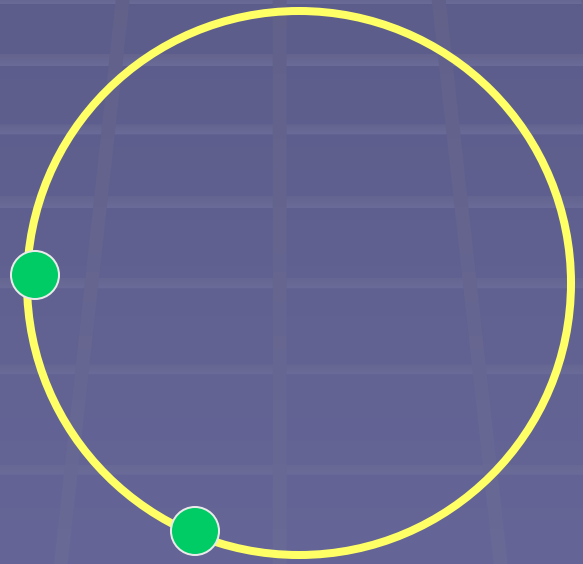
- Ok, but how to find the first row?
- We will try all possibilities!
- Approx. $2^{16} * 16^2$

C: Phone Cell



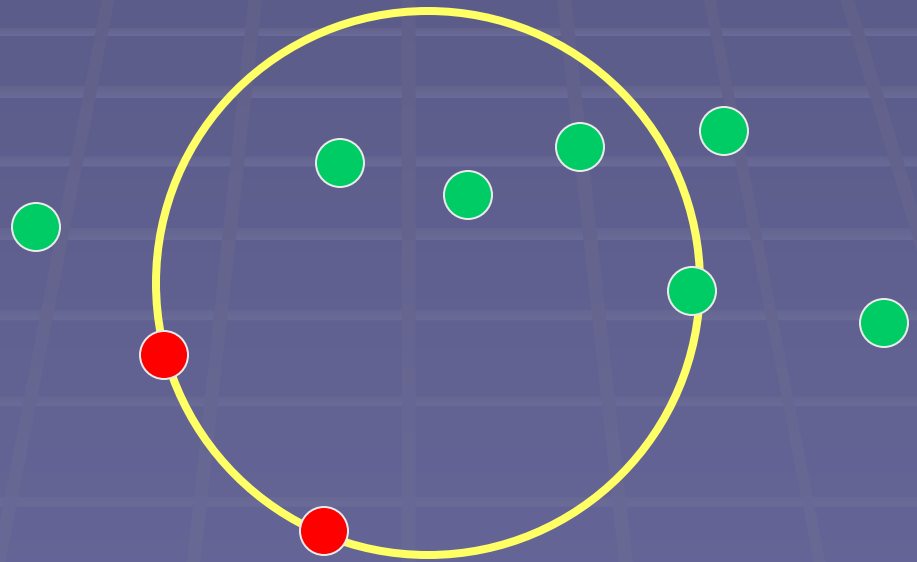
Cell – Problem

- Find a circle that covers most points
- Center may not be in an existing point
- Solution will always touch 2 points



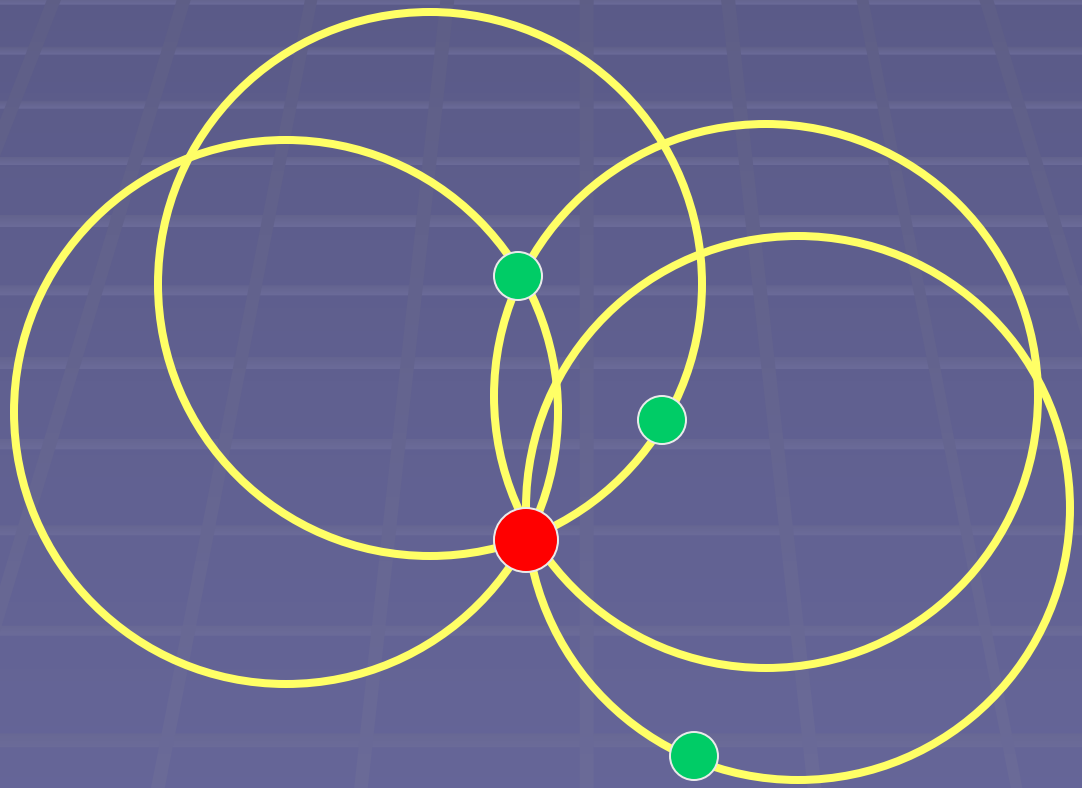
Cell – Simple Solution

- Take all pairs, find a circle
- Then all other points must be tested
- Time: n^3 ☹



Cell –Solution

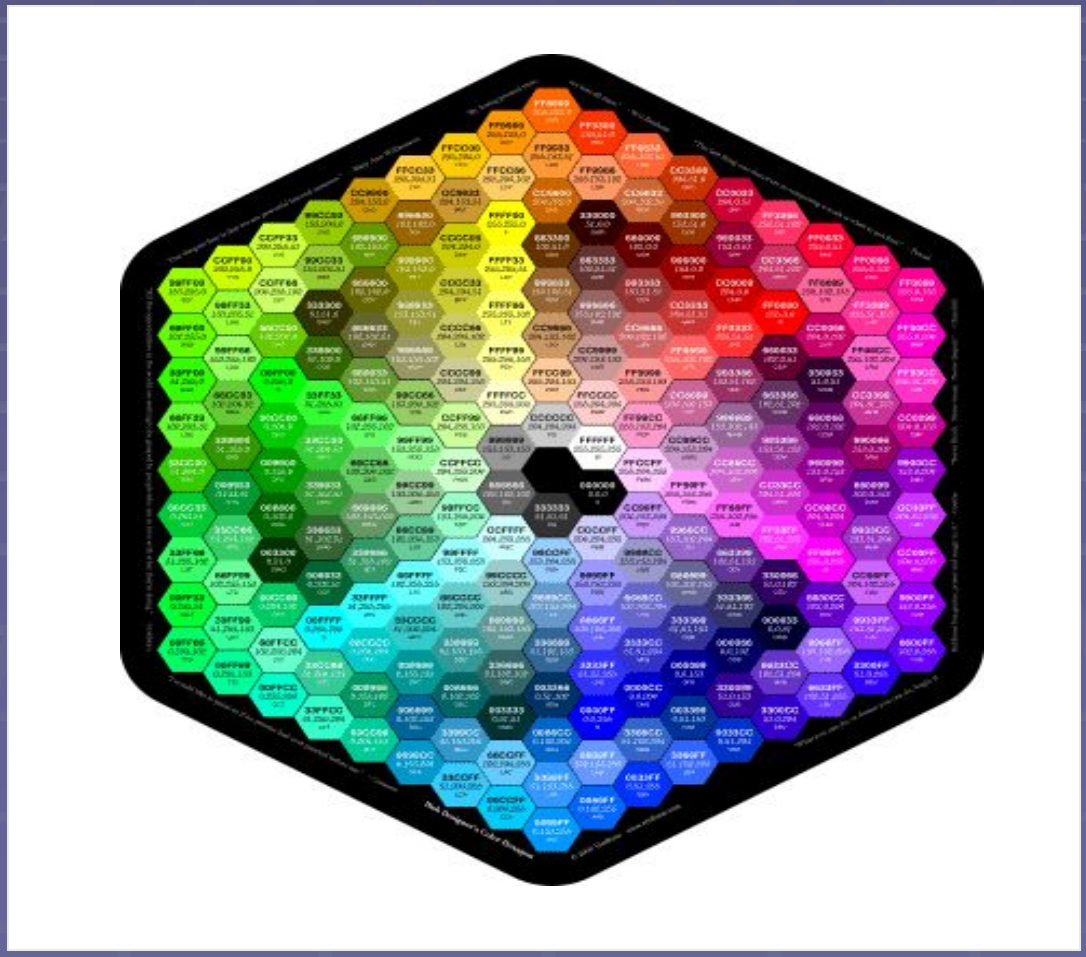
- For each point, use “sweep” technique
- Find „interesting angles“ and sort them



Cell –Solution

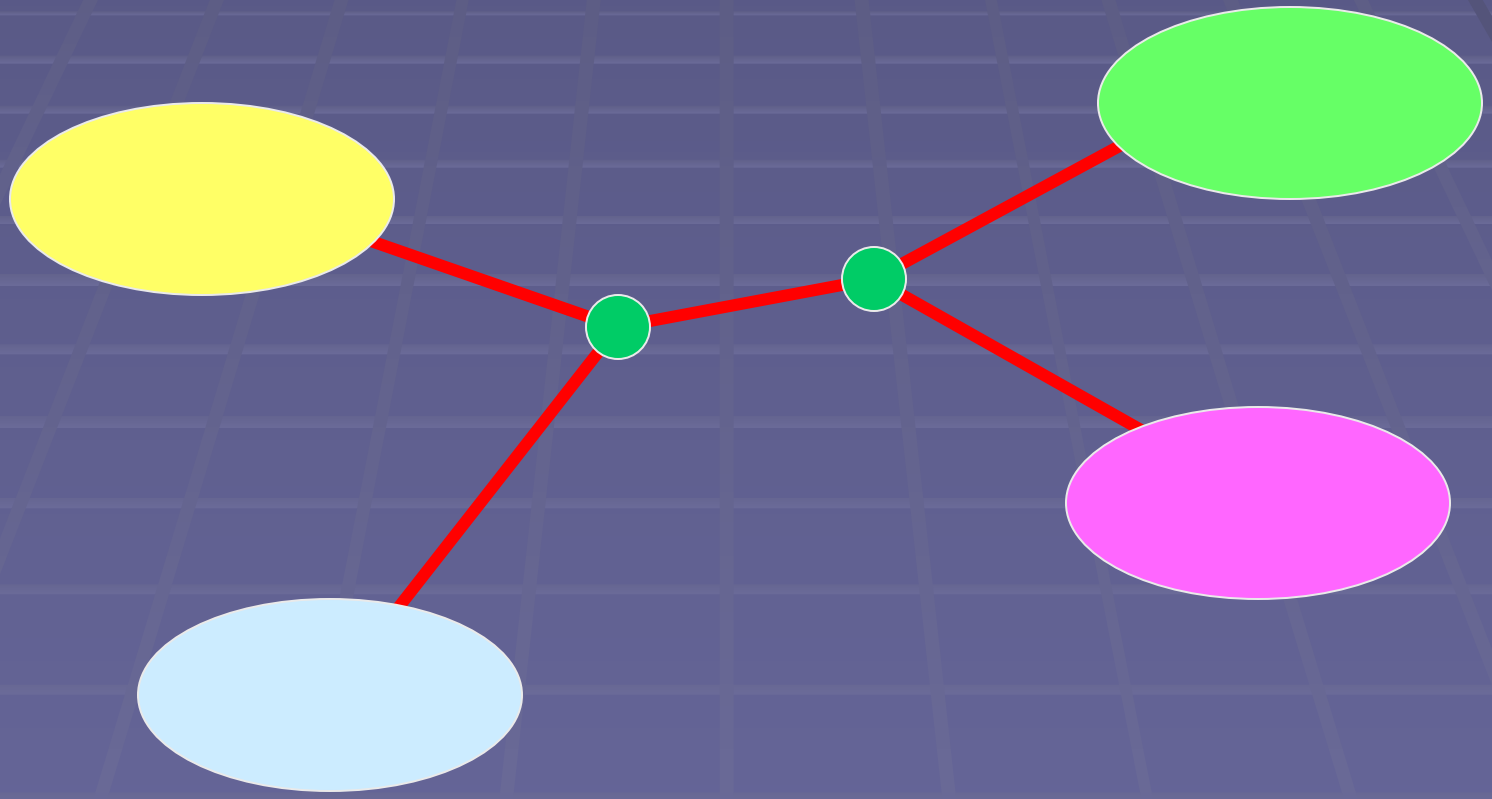
- One sorting for each point
- Time: $n^2 . \log n$
- Carefully with floating point numbers!

H: Hexagon



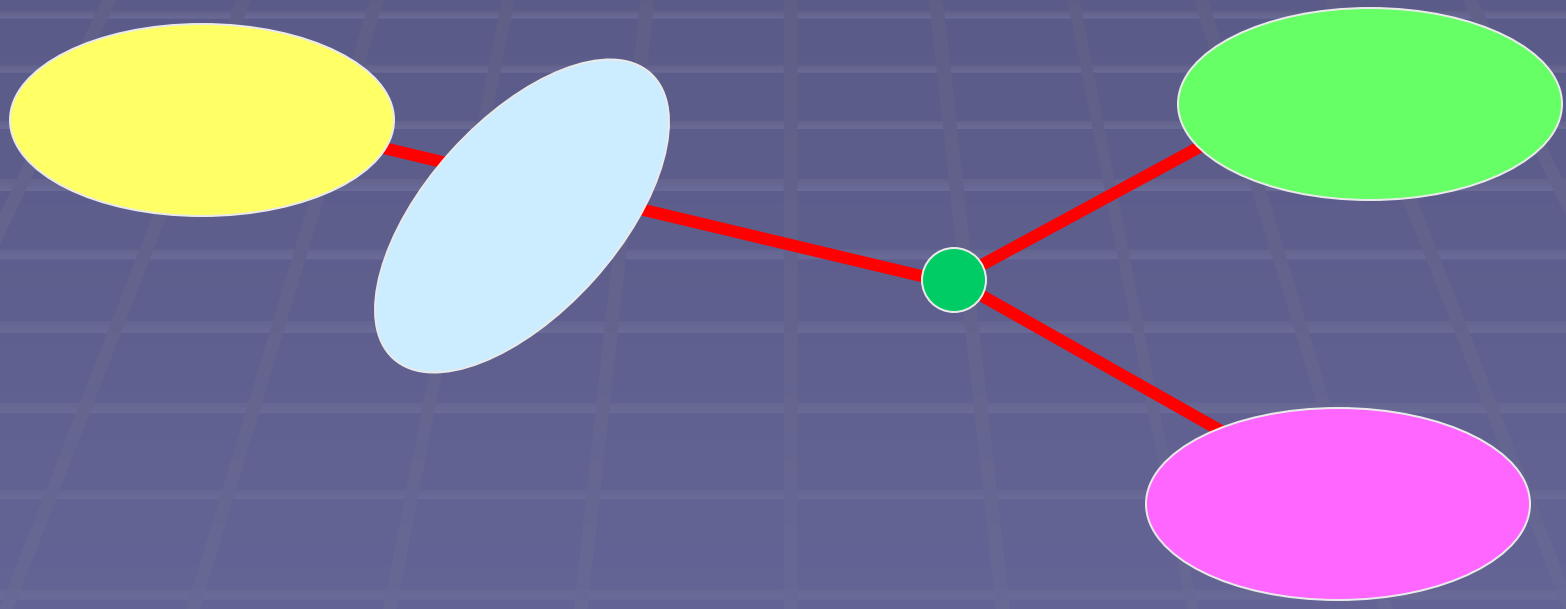
Hexagon – Idea

- All combinations of 2 green points



Hexagon – Solution

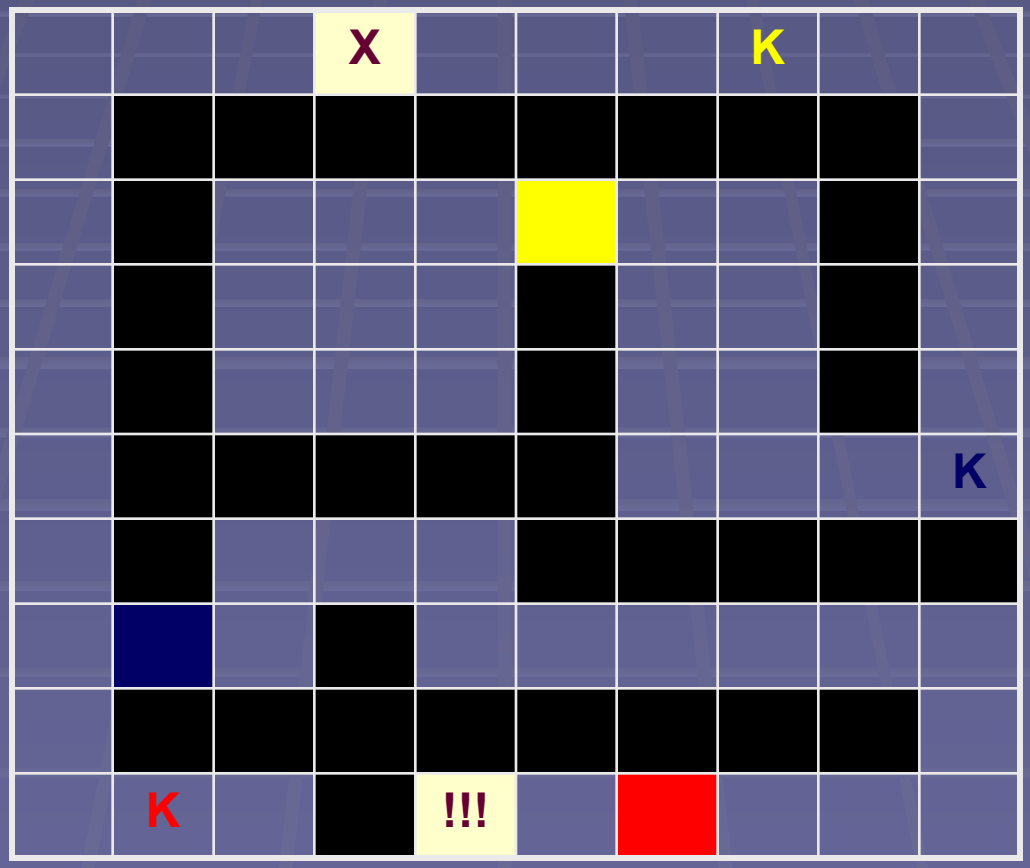
- Handle “special” cases



Hexagon –Solution II

- Dynamic Programming
- For all area subsets (16), find the best solution using each parcel

K: Keys



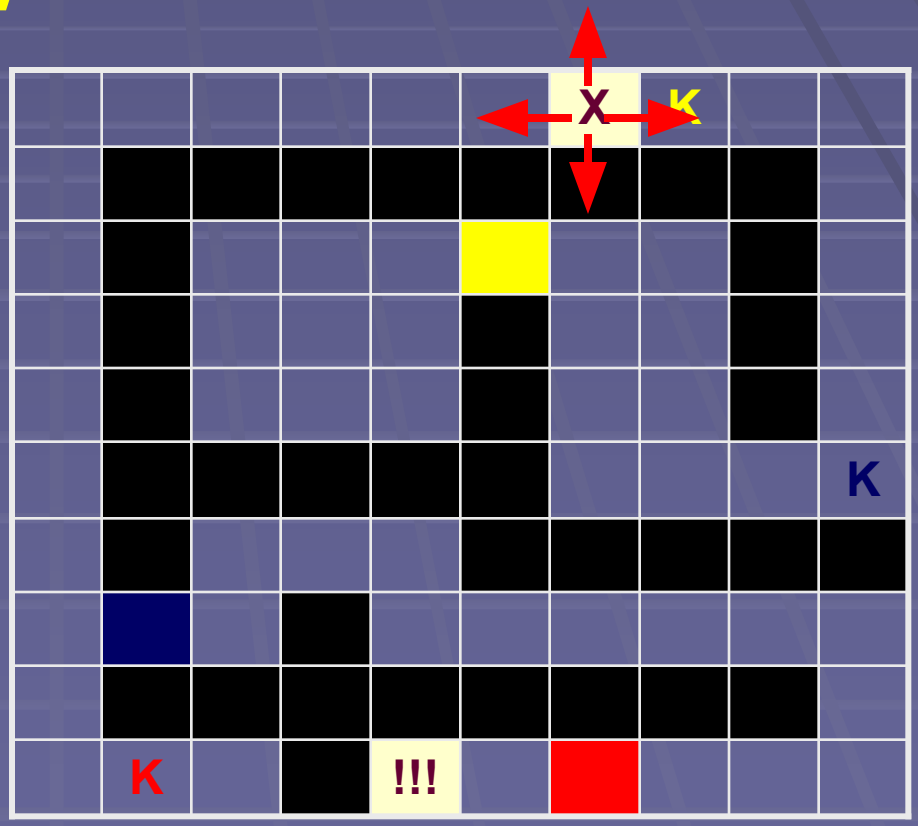
Keys – Idea

- Breadth-First search
- Combination of position and keys (!)

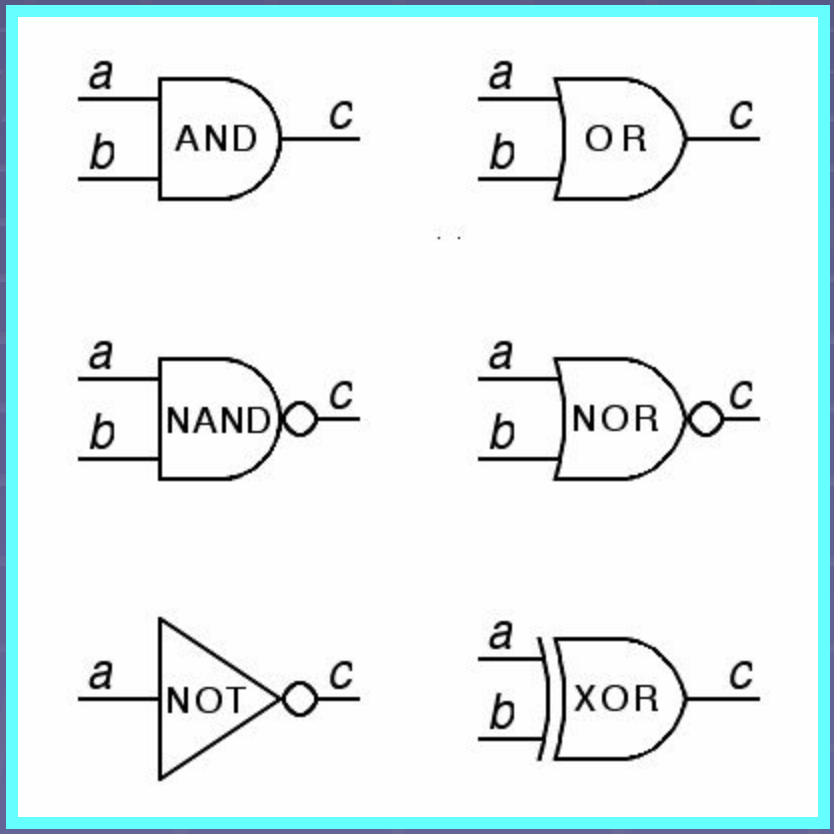
- 4 keys => 16 combinations

Keys – Idea

- Position (1,7) + Red Key
  - (1,8) + Red/Yellow
  - (1,6) + Red



L: Logic



Logic – Problem

- Problem? There is no problem

- “Only” follow the connections
- Compute logical operations

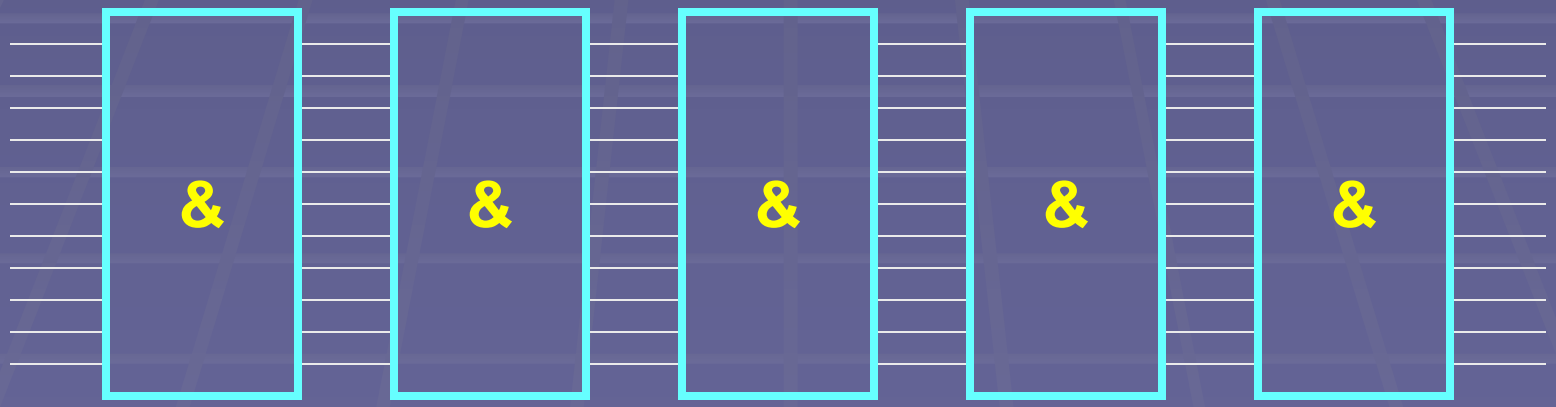
Logic – Potential Pitfalls

- Gates with no input
  - AND □ 1
  - OR □ 0
  - XOR □ 0

Logic – Potential Pitfalls

- Splitting and joining paths

- => We must remember, what has already been computed



N: Numbers

$$10101010100101_{-2} = -10907$$

Numbers – Solution

- TO decimal:
  - Use the formula in the problem statement

$$4257_{-10} = -4000 + 200 - 50 + 7 = -3843$$

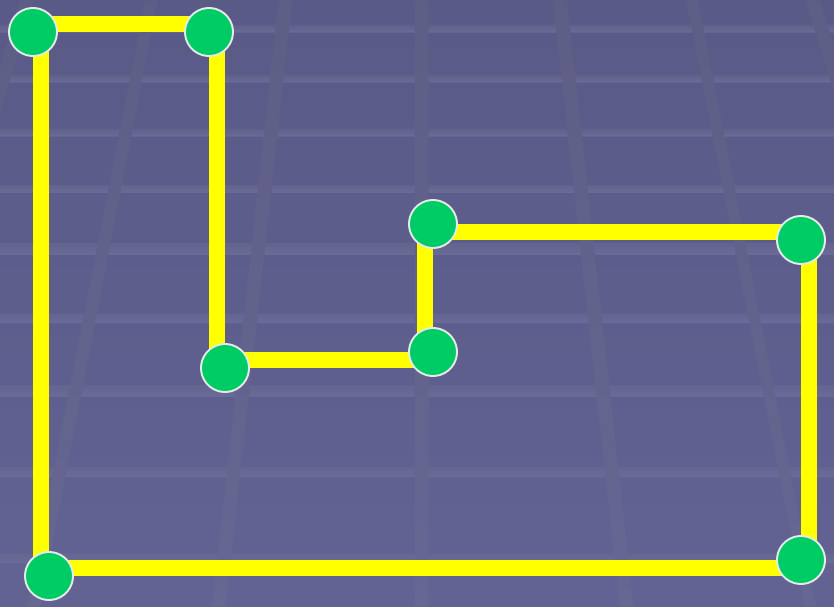
Numbers – Solution

- FROM decimal:
  - Use remainders (modulo)
  - Careful with the negative numbers!

- 4237 mod 10 = 7 -> 423
- -423 mod 10 = 7 -> -43
- 43 mod 10 = 3 -> 4
- -4 mod 10 = 6 -> -1
- 1 mod 10 = 1

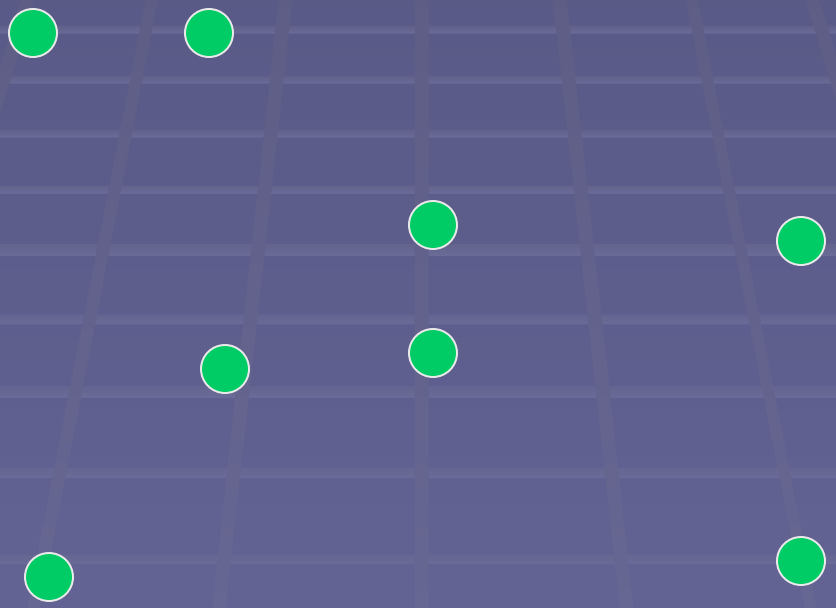
-> 16377

P: Polygon



Polygon – Problem

- Find the order of polygon vertices

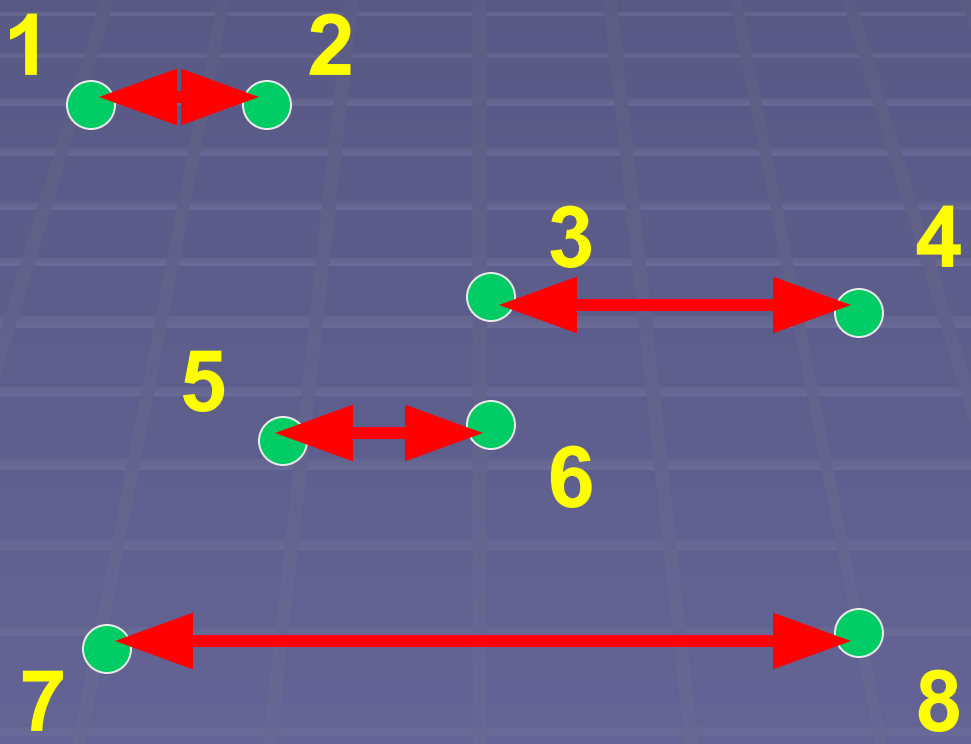


Polygon – Idea

- Sort the vertices by their X coordinate

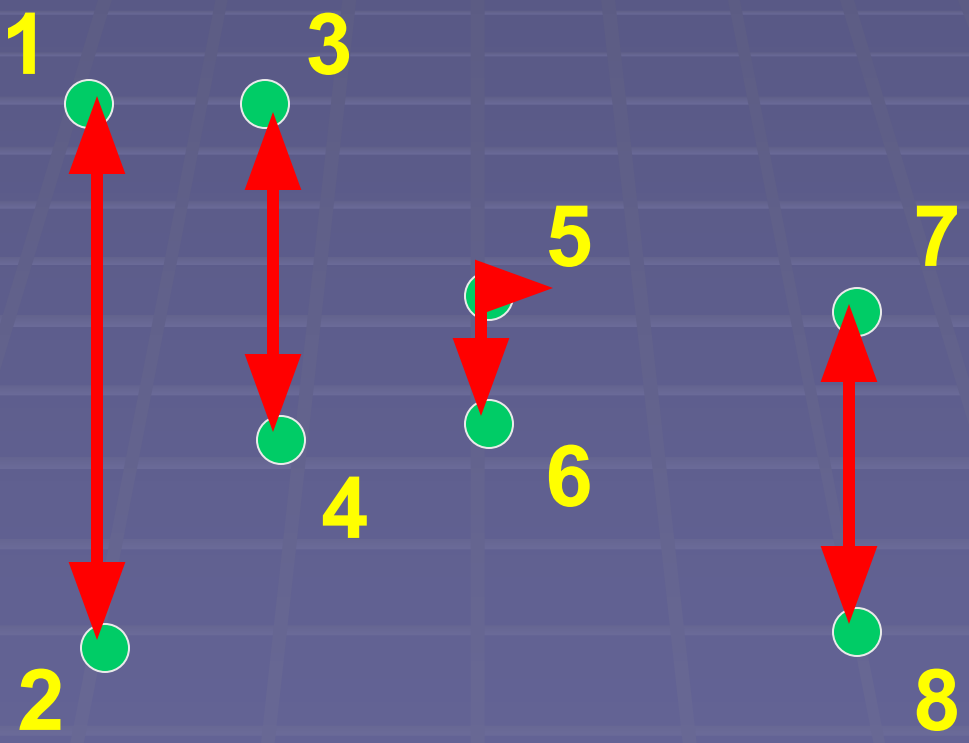
Polygon – Idea

- => Find their horizontal neighbor



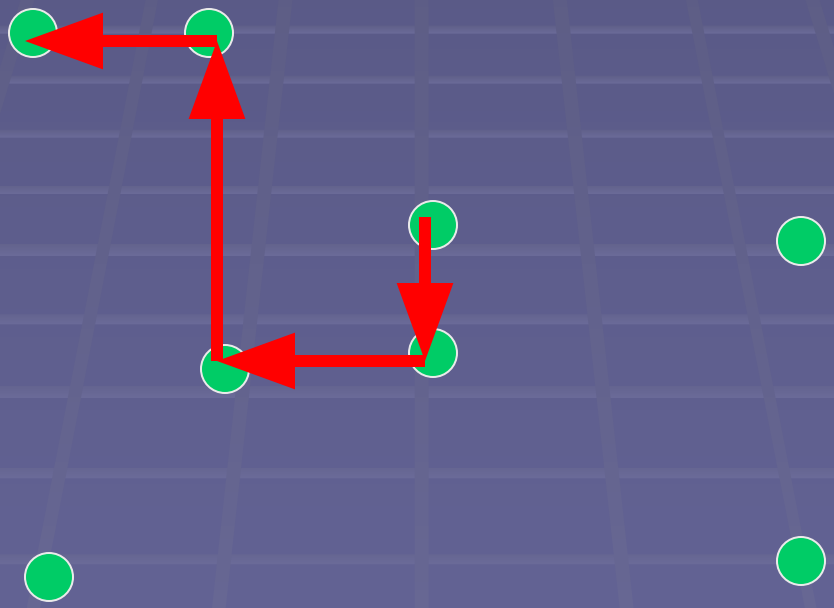
Polygon – Idea

- Sort by Y => vertical neighbor



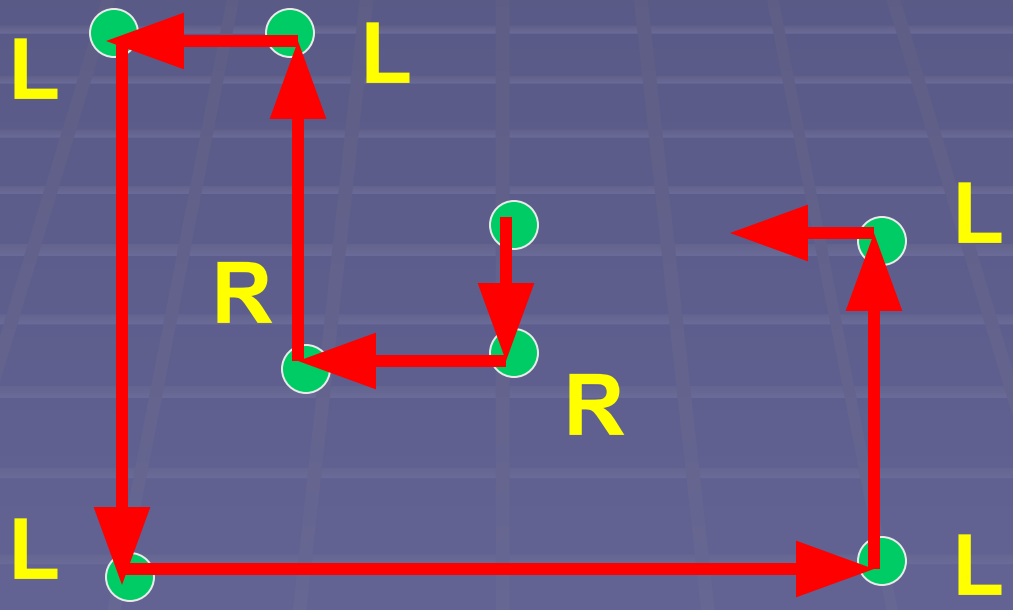
Polygon – Solution

- Now, each vertex knows its neighbors
- Start with the first, and walk around

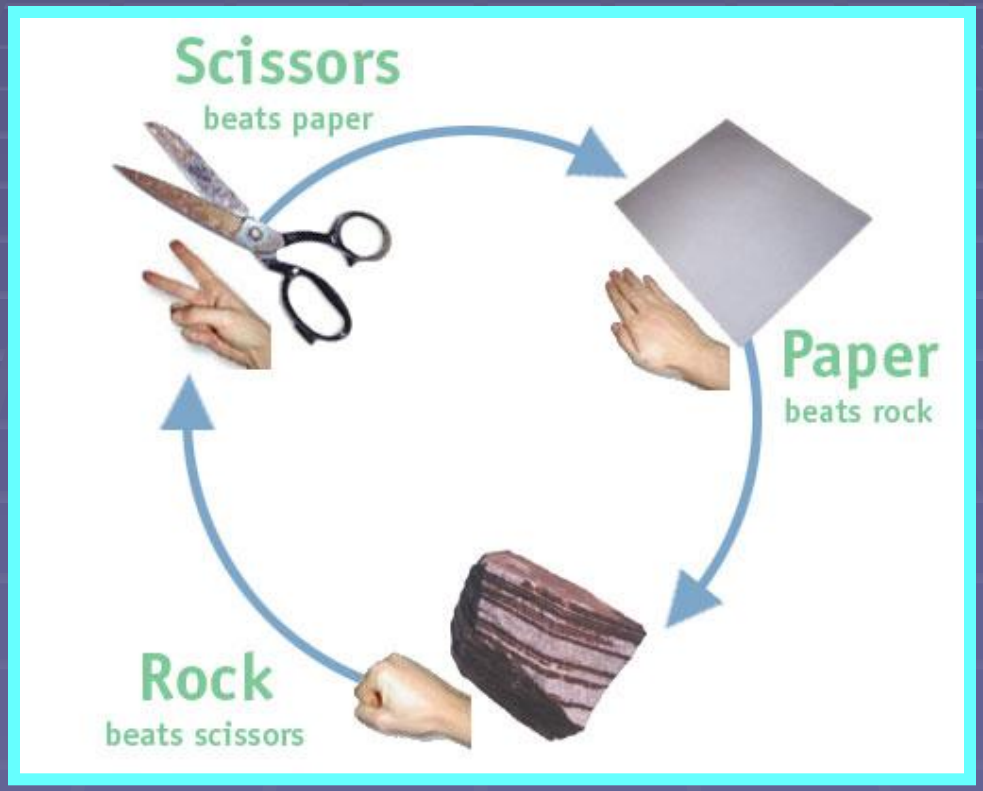


Polygon – Solution

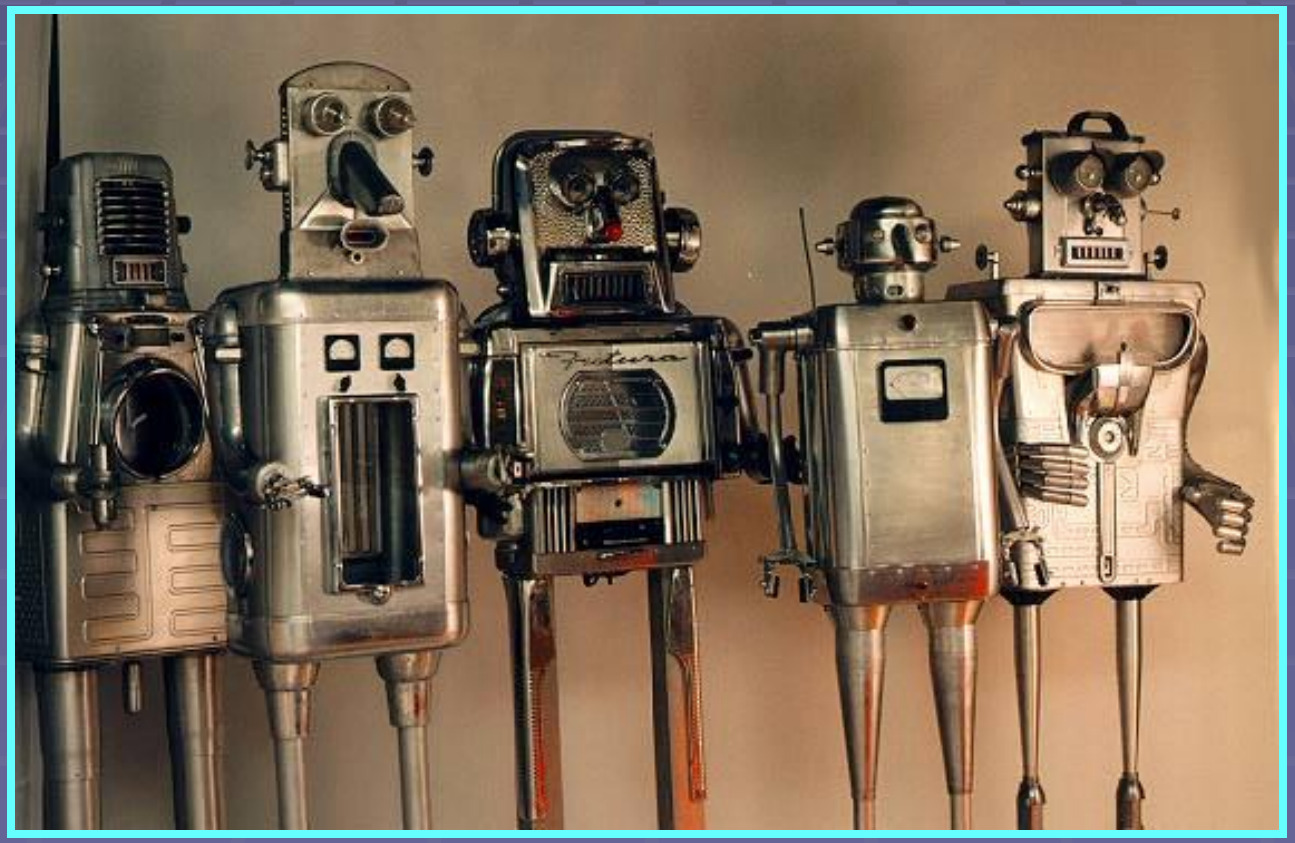
- Count Left / Right turns
- Left > Right ? => counter-clockwise



R: Roshambo

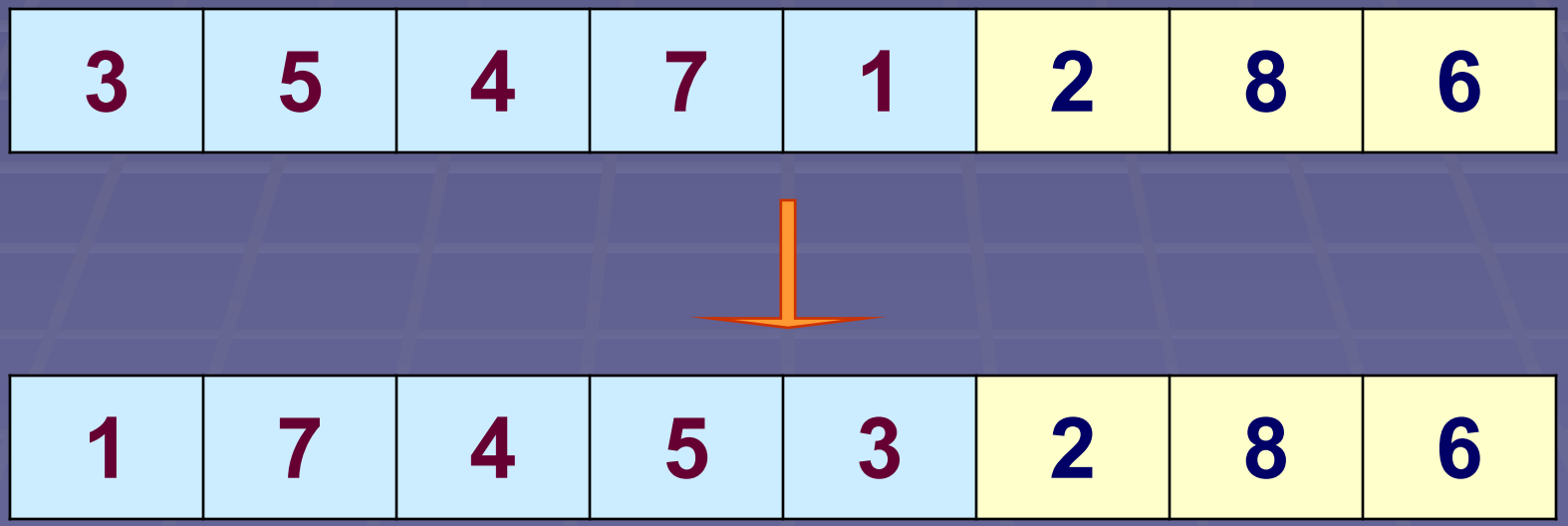


S: Robotic Sort



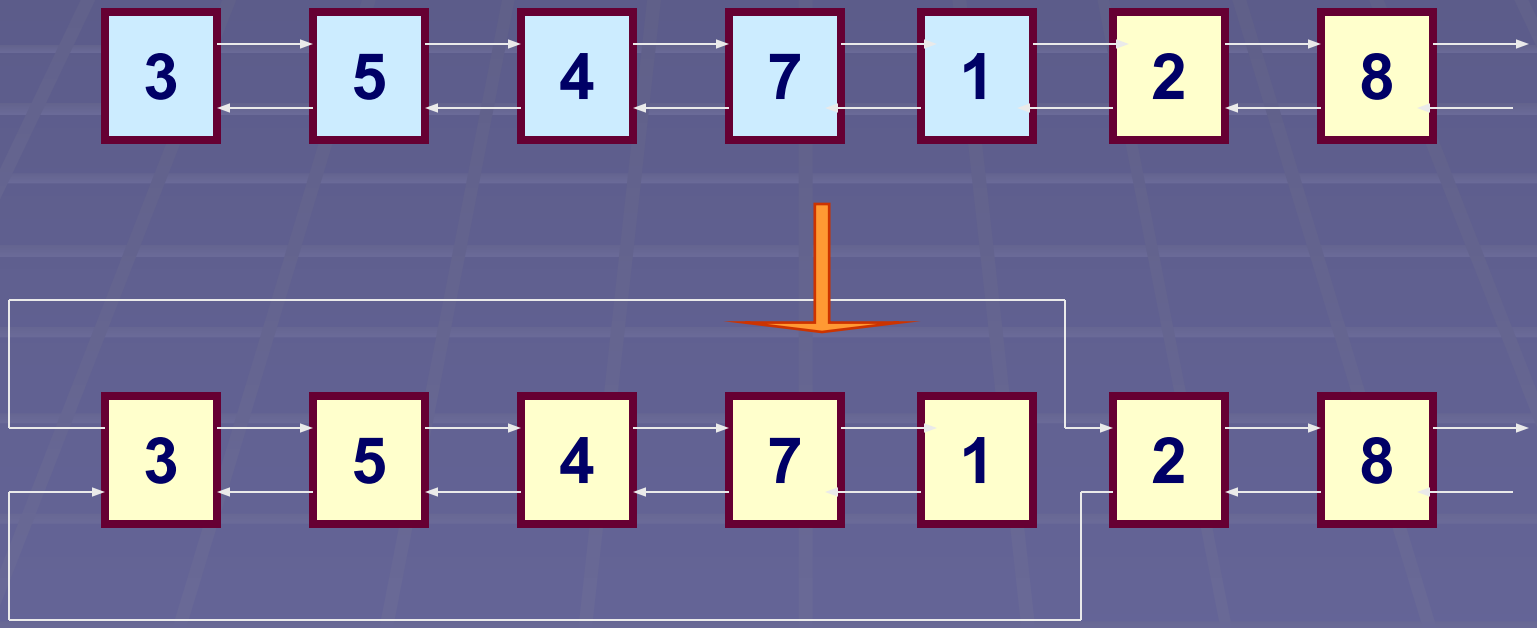
Sort – Problem

- Naive approach – reverse in an array
- Little bit better: remember reversed
- Quadratic time □ $100\ 000^2$ ☹



Sort – Another Approach

- Double-linked list
- Problem finding the „forward direction“



Sort – Solution

- Combined solution: use both
- Linked list + array of reversed

- The array time: O(*rev_before*)
- After SQRT(*n*) steps: reorder

- □ n.SQRT(*n*) time

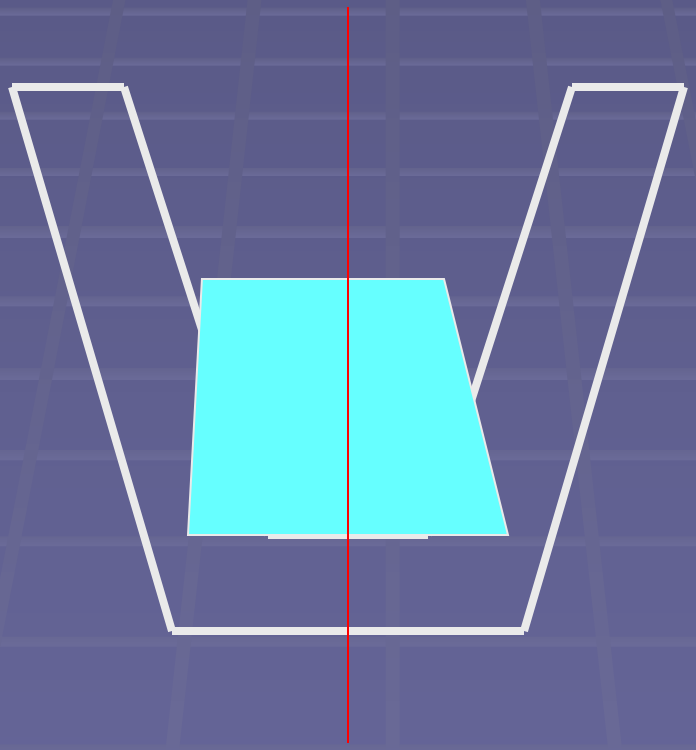
Sort – Solution II

- Other possibilities - ???
  - Heap
  - Interval Trees
  - … ?

W: Water

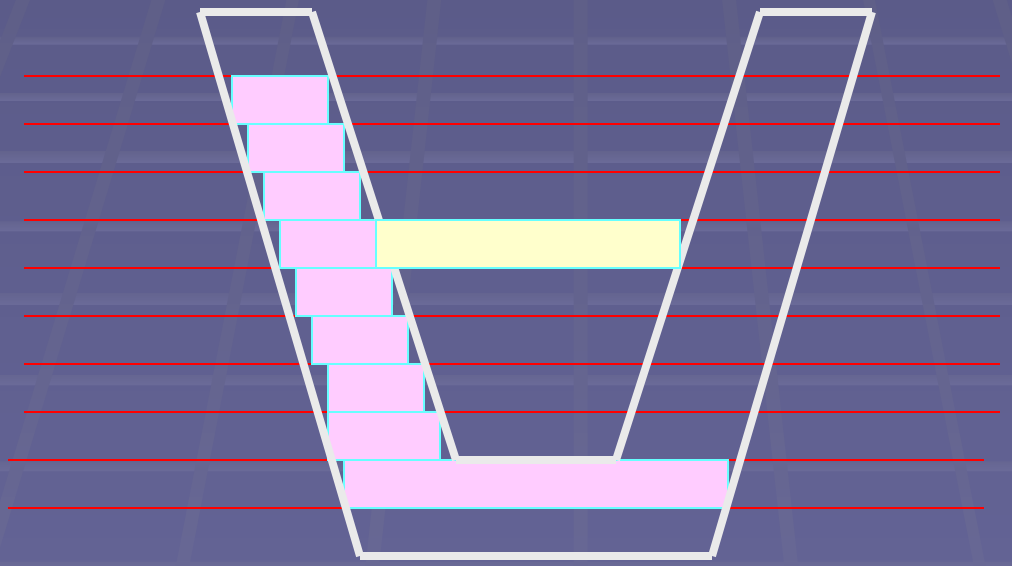
Water – Problem

- Find the Center of Mass
- Amount of water with the lowest center



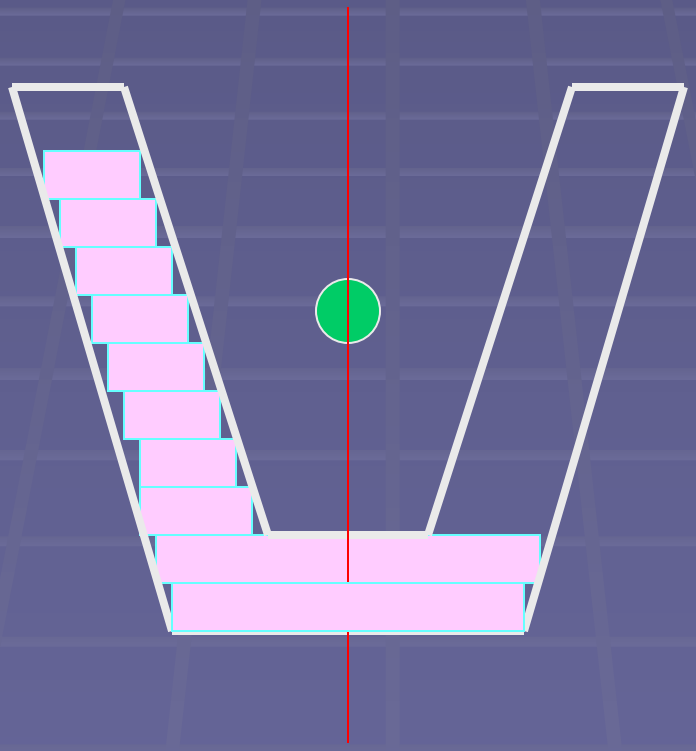
Water – Idea

- Split the glass into horizontal slices
- Volume of one slice: $\pi.r^2.d$



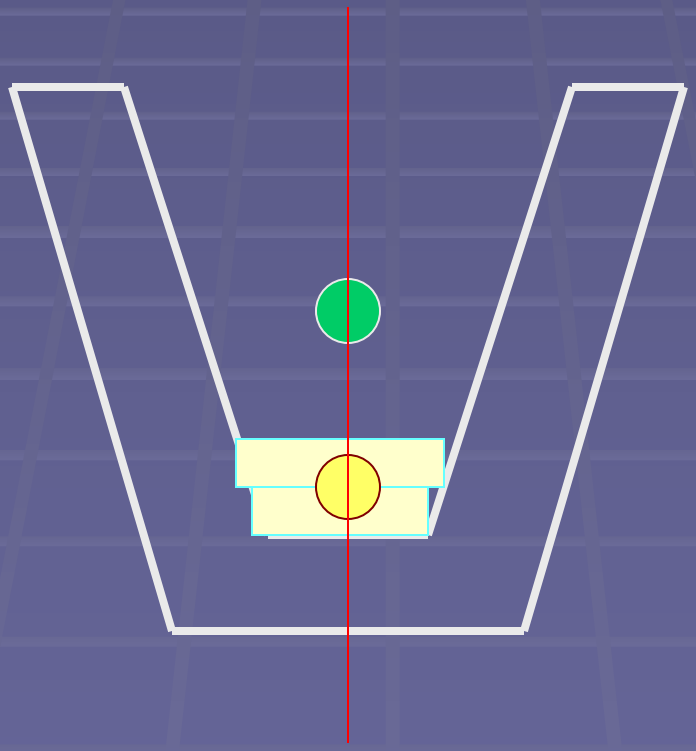
Water – Solution

- Center of Mass of the glass
- Weighted average of all slices



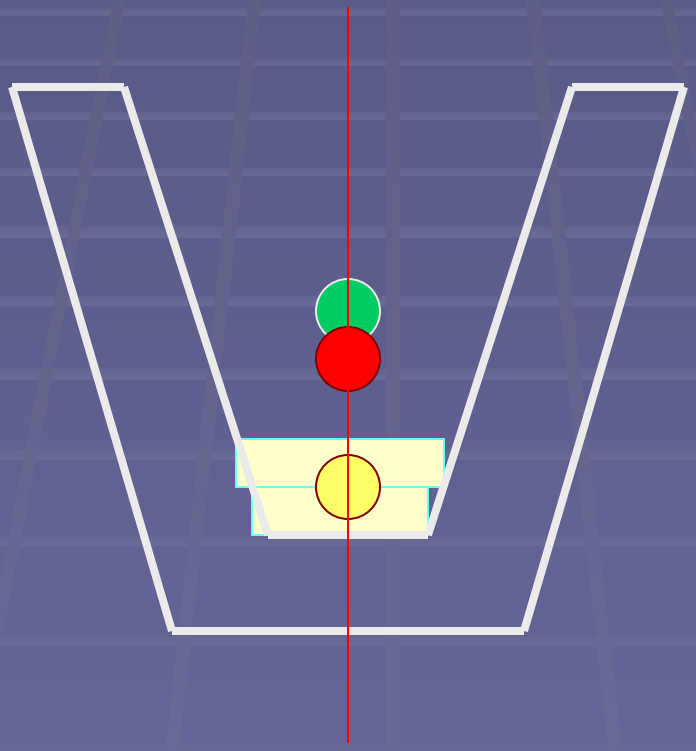
Water – Solution

- Add the water “slowly”
- Center of water mass



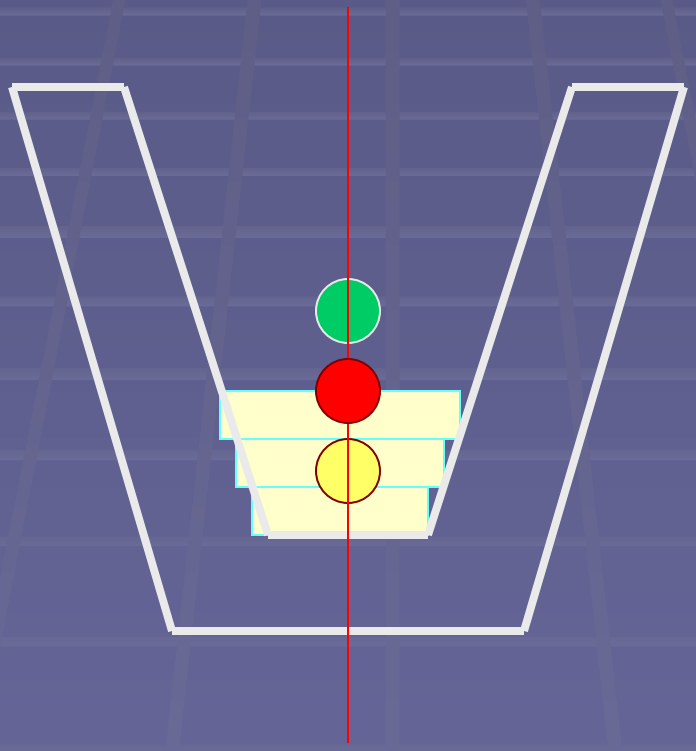
Water – Solution

- Combine both centers (weighted average)



Water – Solution

- Water reached the center ? => END!
- (Linear time needed only)



Statistics

	RT	TL	WA	PE	AC
Billboard	1	11	8	1	22
Cell	5	17	17	1	12
Hexagon	4	7	13	0	4
Keys	1	10	14	3	42
Logic	1	1	31	0	4
Numbers	11	5	65	0	46
Polygon	6	11	24	0	37
Roshambo	6	1	10	16	66
Sort	3	24	0	0	1
Water	1	2	1	0	1