ACM ICPC Manila 2017

Solution Sketches

Jared Asuncion

Problem A: Statistricks

- Easy problem
- Take smallest and divide the last.

Jared Asuncion

Problem A: Statistricks

- Ceiling division.
  - `((a + b - 1) / b)`
  - `(a / b) + (a % b != 0 ? 1 : 0)`
  - `int(Math.ceil((double) a / b))`
    - Don’t do this!

Kyle See

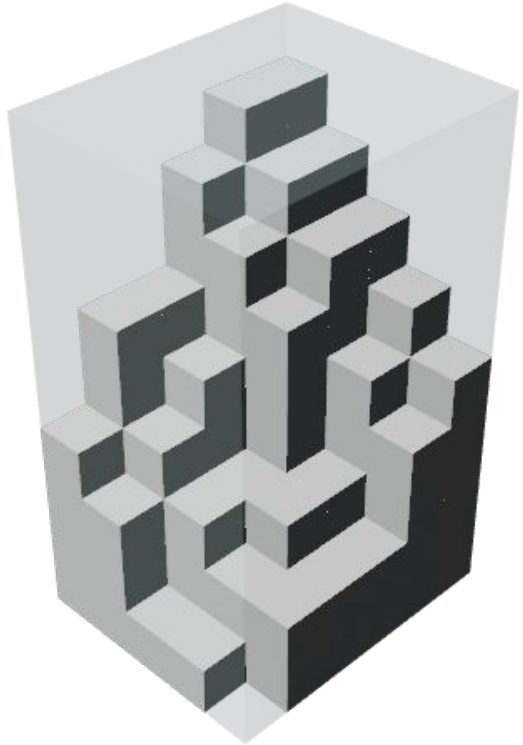
Problem F: Yumamma II

- BFS
- Style 1: BFS with custom checking
- Style 2: Reduce to (r-1)(c-1) grid and normal BFS
  - Shrink Yumamma to 1×1
  - Expand obstacle to 2×2
- Be careful with diagonal moves!
- O(rc)

Karl Pilario

Problem H: Aqua Man's Aqua Room

- Grid doesn't matter
  - Flatten
- Precompute volume per height
- On query: binary search
- O((rc + q) log rc)
- O(rc + q log rc)



Karl Pilario

Problem H: Aqua Man's Aqua Room

- Offline approach: Sort, then two pointers
- O((rc + q) log (rc + q))

Kevin Atienza

Problem L: Frickin’ Heck

- Odd positions determine some type 1 moves.
  - Sweep from left to right.
  - Detect if impossible this way.
- All cells are now even, so possible.
- Improve: Turn 3 “frick” moves into 2 “heck” moves.
  - Be greedy here, left to right
- O(n)

Tim Dumol

Problem G: Win

- Make a graph:
  - Add source “**S**” and sink “**T**”
  - Edges: **S** → **W, W** → **I, I** → **N, N** → **T**
  - 1 capacity at each node
- Set of moves ↔ network flow
- Max score = max flow
- Extract moves from flow

Kyle See

Problem E: Agents of Shield

- Reduce to complete graph with $\leq 2k+1$ nodes
  - Merge headquarters
  - Dijkstra from special nodes
- $(2k+1)3^k$ states:
  - $2k+1$ locations
  - 3 states per soap: initial/picked/dropped
- $O((2k+1)^2 3^k) = O(k^2 3^k)$ DP

Jared Asuncion

Problem J: Bato Bato Split

- **cx + ey = d**
  - $x + y \leq n$
  - $x, y > 0$
  - Handle last move properly!
- Attempt: Try all x. O(n).

Jared Asuncion

Problem J: Bato Bato Split

- **cx + ey = d**
  - x + y ≤ n
  - x, y > 0
  - Handle last move properly!
- Attempt: Try all x. O(n). **TLE.**
- Gotcha: “Impossible” must be answered quickly!

Jared Asuncion

Problem J: Bato Bato Split

- Diophantine cx + ey = d.
- Impossible if **gcd(c,e)** doesn’t divide d.

Jared Asuncion

Problem J: Bato Bato Split

- Otherwise, find x, y such that cx + ey = d.
  - **Extended Euclidean gcd**
- All solutions are now (x - qe’, y + qc’) for all q
- Select q to minimize x, check if x + y ≤ n.
- Do the same with y.
- If both fail, impossible.

Kyle See

Problem D: Weird Keyboard

- Slow: DP on Prefixes and LCS. $O(t^2 * \Sigma s_i)$
- Fast: DP with state
  - Prefix of t
  - Prefix of some s_i
  - “Has taken” flag
- $O(t * \Sigma s_i)$

Kevin Atienza

Problem C: Bananas in Pajamas

- Always YES.
- Insight: Choose bases 4 and 8.
  - Six-bit blocks independent of each other!
- Example:
  - 132 000 232 200 133 101 000 001 (base 4)
  - 36 00 56 40 37 21 00 01 (base 8)

Kevin Atienza

Problem C: Bananas in Pajamas

- Build the number block by block.
- DP: Look at 6-bit blocks and their effects.
- Almost all (x_1,x_2,y_1,y_2) representable.
- Except (0,0,0,1) and related.
  - Just swap “4” and “8” if so!
- Also, need to slightly optimize representation.
  - Greedy works.

Payton Yao

Problem I: Rainbow Dash

- Eulerian Path iff connected and odd degree ≤ 2
  - Already connected
- Compute royal degrees.
- Remove royal edges.
- Connected components.

Payton Yao

Problem I: Rainbow Dash

- Need to fix odd nodes.
  - Can only pair up on same component
  - Odd components must be ≤ 2, otherwise, impossible
- On each component, push to root.
  - “Will use” flag for each edge
  - Push means “push to parent and flip parent edge flag”
  - Bottom-up

Payton Yao

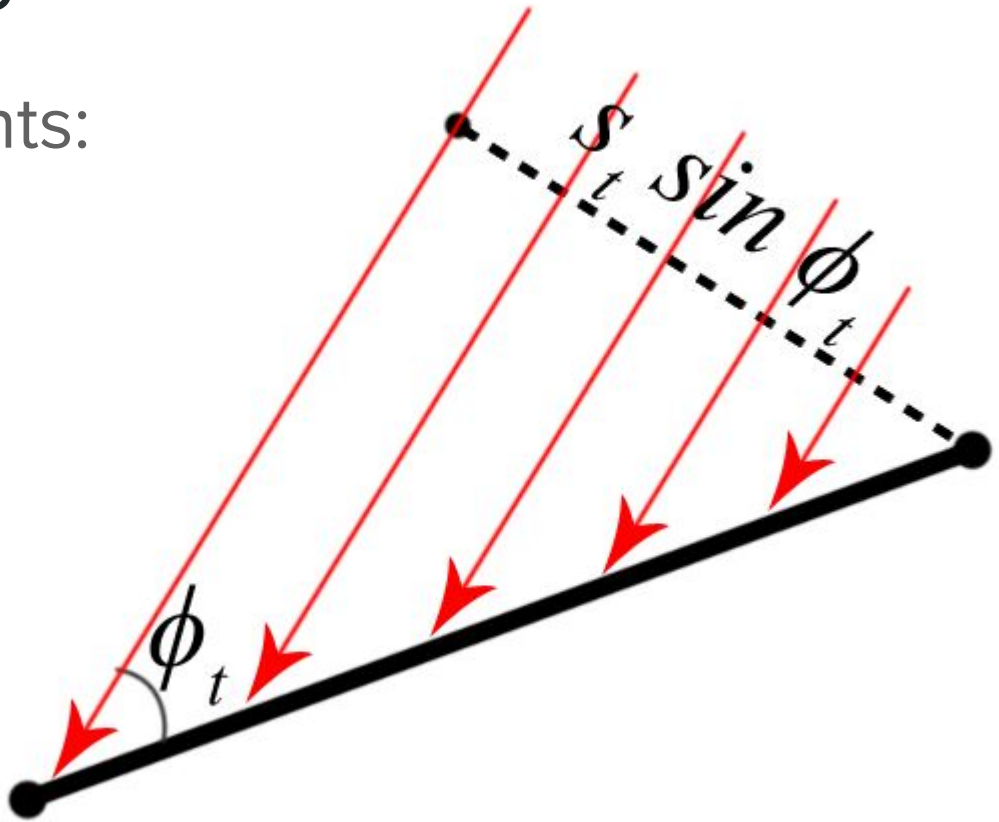
Problem I: Rainbow Dash

- Now all but the roots are even.
- If odd comps. = 0, can now find Eulerian cycle
- If odd comps. = 2, can now find Eulerian path
- O(h)

Kevin Atienza

Problem K: Kebab

- **$s_t \sin \phi_t$** represents:



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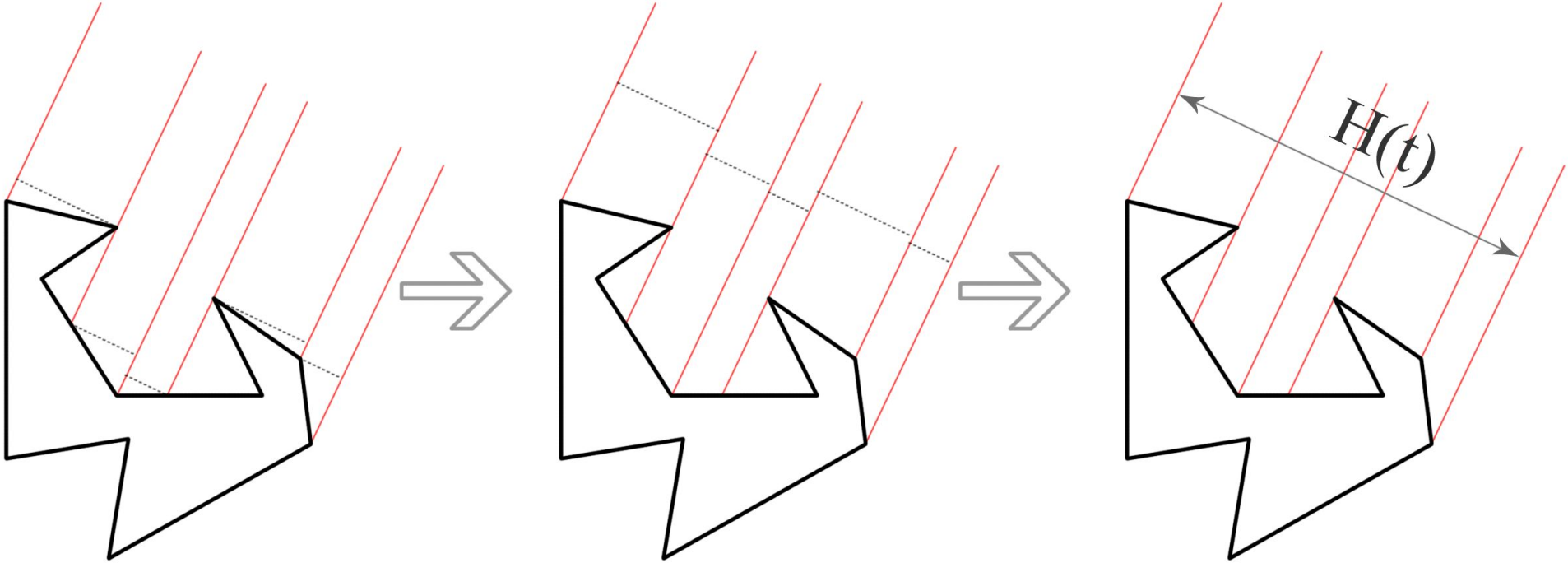
Problem K: Kebab



Kevin Atienza

Problem K: Kebab

- So, H(t) = “width” at time t.
- Thus, **answer(P) = answer(hull(P))**
- We reduce the problem to convex case!

Kevin Atienza

Problem K: Kebab

- If convex, each side is lit half the time
- Hence, answer proportional to perimeter
- Thus, **answer(hull(P))** = **perimeter(hull(P))*C** for some **C**. Just need to find **C**.

Kevin Atienza

Problem K: Kebab

- Unit circle (or almost)
  - Width is 2, hence answer is 2.
  - Perimeter is 2π
- Hence, $C^*(2\pi) = 2 \longrightarrow C = 1/\pi$

Kevin Atienza

Problem K: Kebab

- Cheap solution: Extract $C = 1/\pi$ from sample!

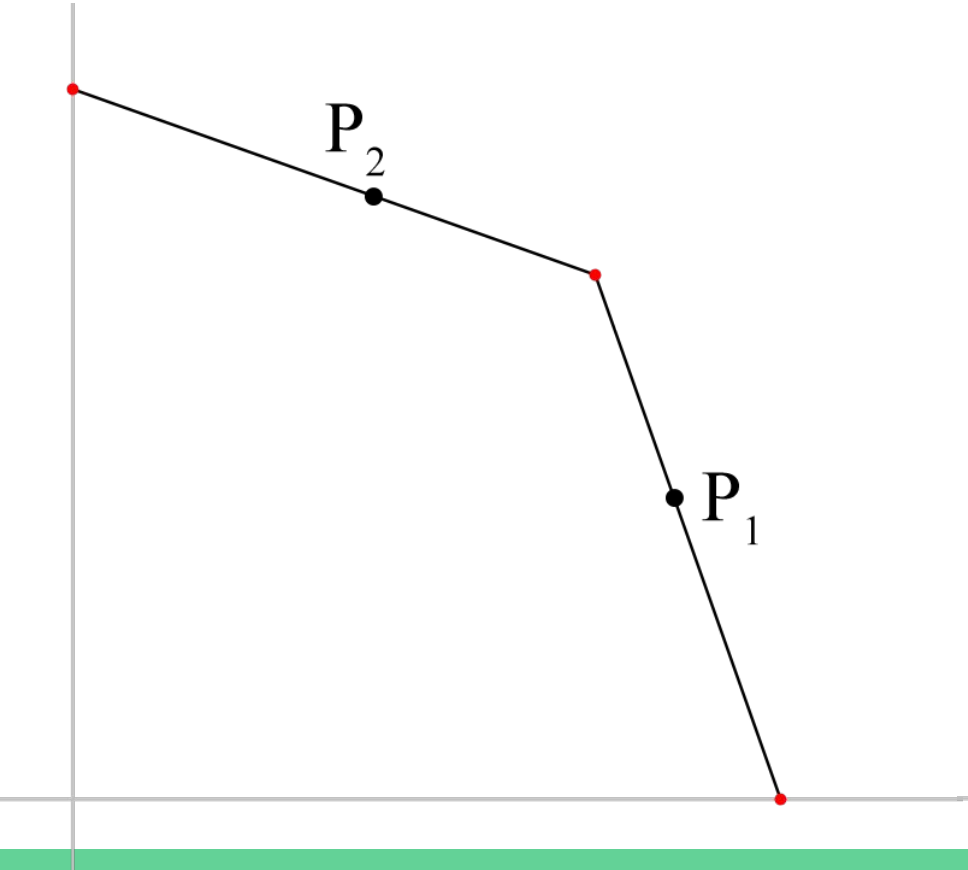
Pablo Manalastas

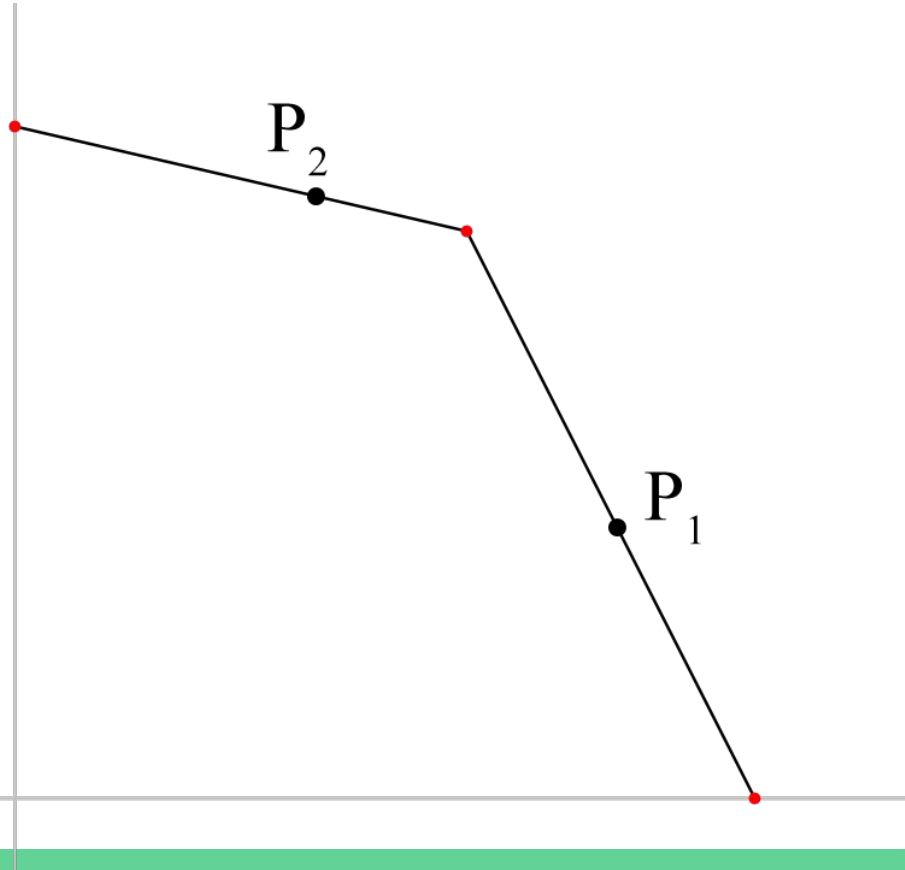
Problem M: Danielrad Cliff

- Reduce: upper-right convex hull
- Gotcha: Not always “flush” with a hull edge!
  - Example: (1,2), (2,1)
  - Example: (10,20), (20,9)

Pablo Manalastas

Problem M: Danielrad Cliff

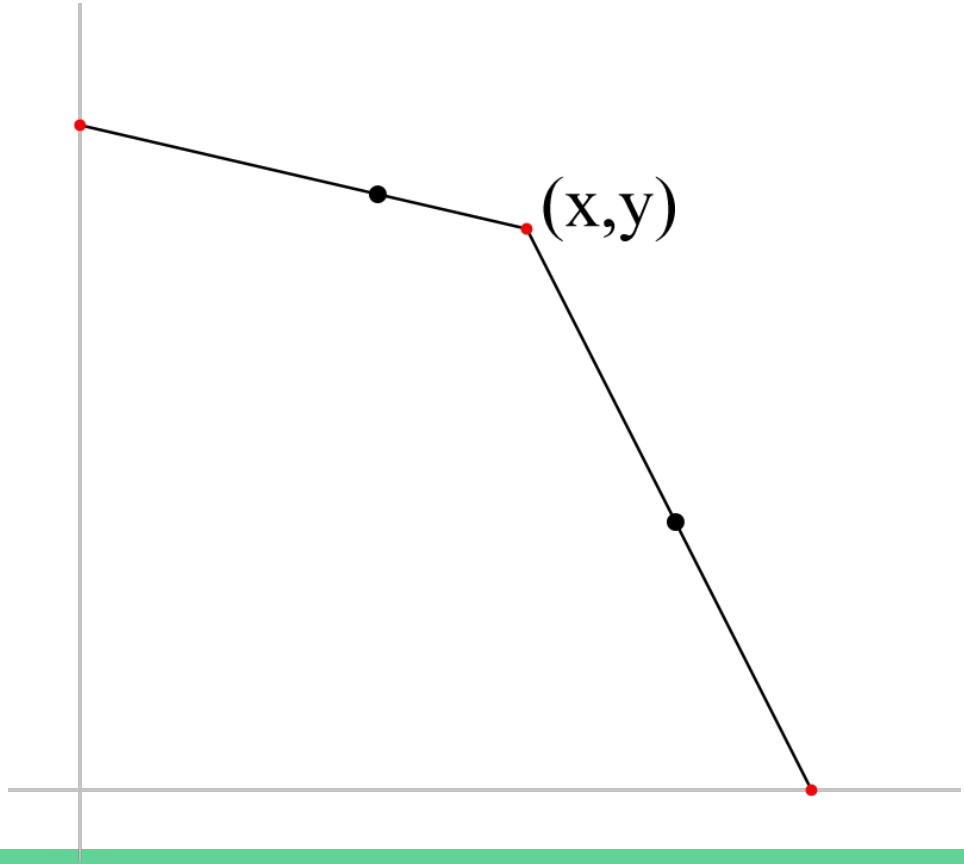




Pablo Manalastas

Problem M: Danielrad Cliff

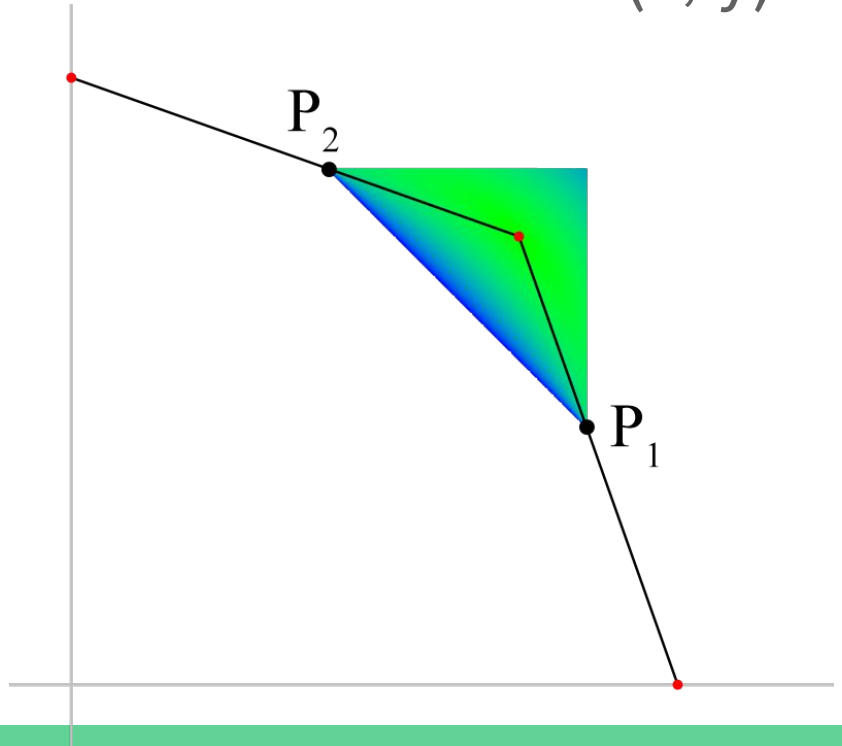
- Reduce to (constrained) two-point case.
- Let f(x, y) = length when middle point is (x, y)

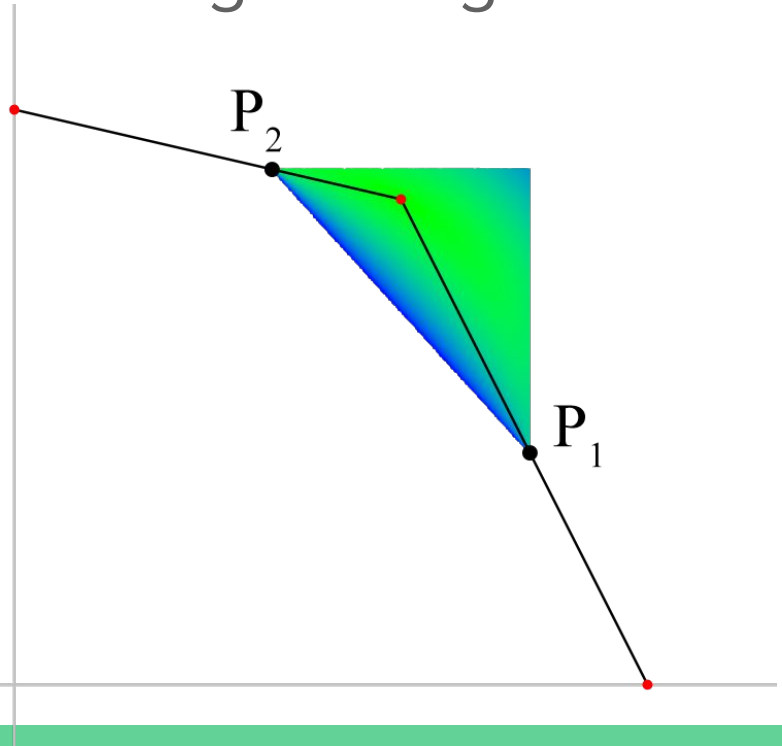


Pablo Manalastas

Problem M: Danielrad Cliff

- Goal: minimize f(x, y) on a triangular region





Pablo Manalastas

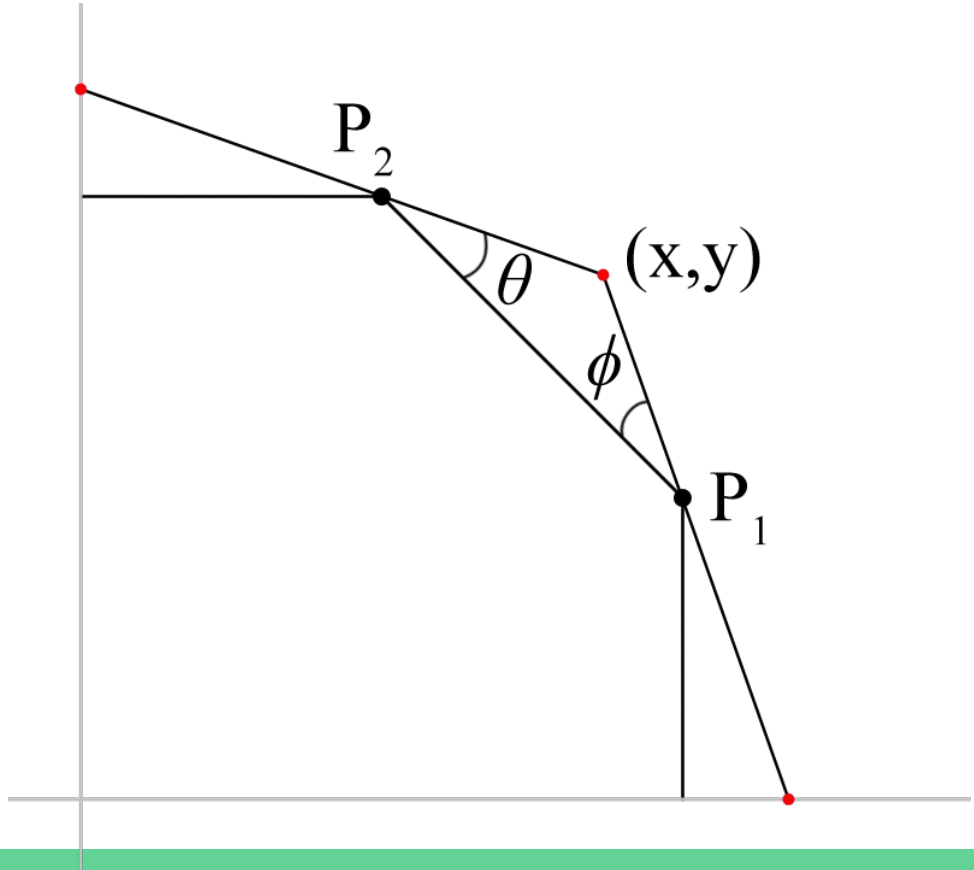
Problem M: Danielrad Cliff

- Goal: minimize f(x, y) on a triangular region
- **Gradient descent** on f(x, y)
- $O(n^2 * (\text{gradient descent}))$

Pablo Manalastas

Problem M: Danielrad Cliff

- Alternatively, minimize F(θ, ϕ).



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Problem M: Danielrad Cliff

- Minimize F(θ, ϕ) on a **rectangular region**

$$F(\theta,\phi) = A \cdot \frac{\sin r}{\sin(a+r-\theta)} + B \cdot \frac{\sin s}{\sin(b+s-\phi)} + C \cdot \frac{\sin\theta + \sin\phi}{\sin(\theta+\phi)}$$

$$c \le \theta \le a$$
$$d \le \phi \le b$$

- This one's convex.

Kevin Atienza

Problem B: Fashionista

- Cyclic gray code with two determined values
- Impossible if either:
  - (j - i) and bitcount(b $\oplus$ a) not same parity
  - (j - i) mod n < bitcount(b $\oplus$ a)
  - (i - j) mod n < bitcount(b $\oplus$ a)
- Otherwise, possible!

Kevin Atienza

Problem B: Fashionista

- Reduce to special case
  - XOR with “a” so arr[i] = 0 and arr[j] = b $\oplus$ a.
  - Rotate so i := 0 and j := j - i.
  - Rearrange bits so target arr[j] = 2^m-1
- Only m, j matters now.

Kevin Atienza

Problem B: Fashionista

- Modified “cyclic gray code” generation.
- Key property: Can rearrange bits.
- Key property: Can insert “reversed” anywhere!

Kevin Atienza

Problem B: Fashionista

```
000   -->   000     000     000     000
001           001     001     001     100
011           011     011     101     110
010           010     111     100     111
                      110     101     110     101
                      111     100     111     001
                      101     110     011     011
                      100     010     010     010
```

Kevin Atienza

Problem B: Fashionista

- You can control when you can introduce a bit.
- Some edge cases.
- $O(n2^n)$

Thank you!

- **A. Statistricks -** Asuncion
- **B. Fashionista -** Atienza
- **C. Bananas in Pajamas -** Atienza
- **D. Weird Keyboard -** See
- **E. Agents of Shield -** See
- **F. Yumamma II -** See
- **G. Win -** Dumol
- **H. Aqua Man's Aqua Room -** Pilario
- **I. Rainbow Dash -** Yao
- **J. Bato Bato Split -** Asuncion
- **K. Kebab -** Atienza
- **L. Frickin' Heck -** Atienza
- **M. Danielrad Cliff -** Manalastas

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