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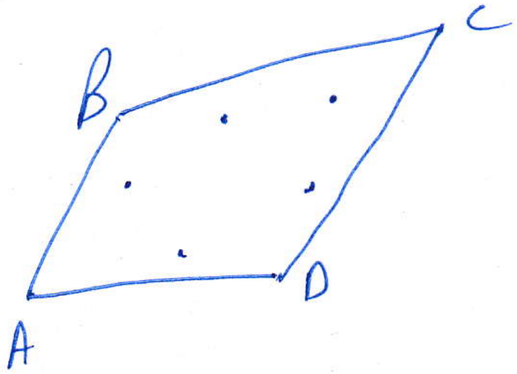
1) The algorithm is INCORRECT

Reason: The points L, T, R, B need not be 4 distinct points. So, there might be a case when L, B both are the same points so we will not get the quadilateral.

Counter example :



A is both L, B.

C is both T, R.

2)

(a) Events in order:

- $\cap(L_3, L_5)$
- $ES(L_1)$
- $\cap(L_5, L_1)$
- $LS(L_2)$
- $LS(L_3)$
- $ES(L_4)$
- $\cap(L_4, L_1)$
- $LS(L_1)$
- $\cap(L_4, L_5)$
- $LS(L_4)$
- $LS(L_5)$

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b) Events in the queue in sequence of their x cordinate.

- $\cap (L_3, L_5)$
- $ES(L_1)$
- $LS(L_2)$
- $LS(L_3)$
- $ES(L_4)$
- $LS(L_1)$
- $LS(L_4)$
- $LS(L_5)$

3a) Order of events.

- Site event (O)
- Site event (P)
- Site event (R)
- Circle event (Fork-in event)

b) Sequence of beach lines

- Before circle event

  O P O R O

- After circle event

  O P R O.

c) $\boxed{\text{Fork-in}}$ event because lines of PO and OR start and infinity and close at a finite point. so 2 lines are MERGING.

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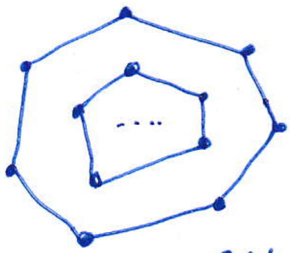
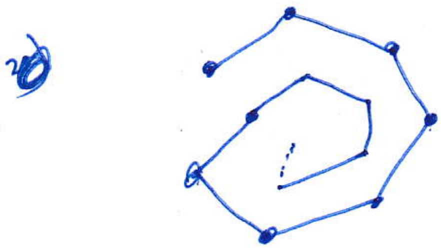
4) We need to calculate the CH (convex hull) of all these points and then the CH of remaining points and so on. Then join the last edge by breaking it.

Pictorially :



1) Calculate CH layer by layer.



2) Break one edge of each CH and join it to the next inner CH and so on.

Time complexity

Option 1) Using $n(\log n)$ to find each CH. [h can be 3 for all)

$= n\log n + (n-h)\log(n-h)$ ....

$= O(n^2 \log n)$

Option 2) Using $(nh.)$ - Jarvis march.

$= nh_1 + (n-h_1)h_2$ ....

$\leq nh_1 + nh_2 +$ ...

$\leq n^2$

$\boxed{\Theta(n^2)}$ ⟶ Better.

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5) • For each edge in Vor(S) check the perpendicular distance of prides on both sides of the edge.

• If ~~the~~ this distance (same for prides on both sides) is less than r then both the prides are marked unsafe.

• Do this process for all edges in Vor(S).

• Prides left unmarked at the end are safe.

Time complexity

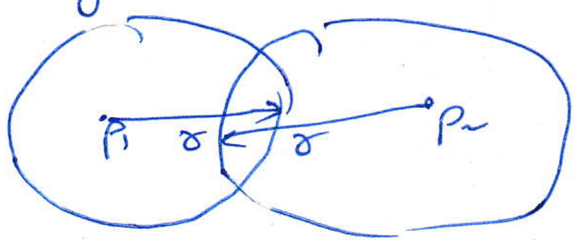
• For each ~~edge~~ edge, calculating distance and comparing with r is a $O(1)$ operation

• There are $O(n)$ edges in Vor(S), so running time $= O(n)$

Proof of correctness

By contradiction

• Assume two prides P_1 and P_2 left unmarked after this process, but are unsafe.



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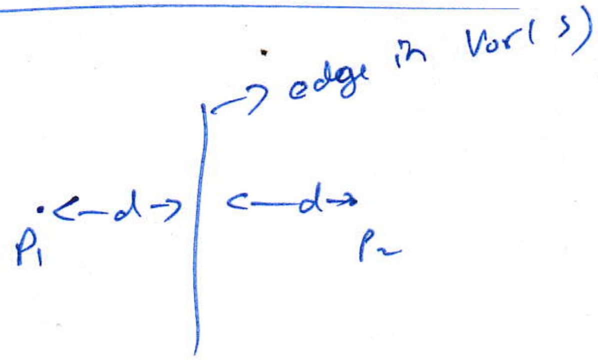
- Distance between P_1 and P_2 = $r + r$ - something
  $< 2r$
- Distance from perpendicular bisector $= \frac{1}{2} \times$ distance between P_1 and P_2. $< r$

  So it must be marked.
- If P_1 and P_2 do not share an edge then there is another pride in between (distances even less).

  ↳ Definitely marked.

Proof that all marked prides are unsafe.



$\Rightarrow d < r$

$\Rightarrow 2d < 2r$

$\Rightarrow$ 2 circles cannot be made without overlapping

$\Rightarrow$ Unsafe.

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6)

a) • Truth assignment in the ABISAT where the condition that all but one clauses are true is satisfied is the succint certificate.

• Verified in $O(n)$ time → n → number of ~~clauses~~. terms. which is polynomial.

• Hence, ABISAT is in NP.

b) CNFSAT ≤ ABISAT

$\phi = C_1 \wedge C_2 \cdots \wedge C_n$ [Instance of CNFSAT]

$\phi' = C_1 \wedge C_2 \cdots \wedge C_n \wedge E$ (Instance of ABISAT)

E = False.

• In this there is a combination of such that $C_1, C_2 \ldots C_n$, all are true.

• So in that combination in ϕ' all but one are true.

• Polynomial time (Obvious)

Hence ABISAT is NP-Complete.