

Configuration Space

Lozano-Pérez 1981, 1983

Lozano-Pérez & Wesley 1979

Cspace

Space of possible configurations of the robot.

Dimension = degrees of freedom of the robot

C obstacle

Constraints imposed on the robot's motions by obstacle's in the robot's workspace.

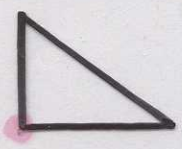
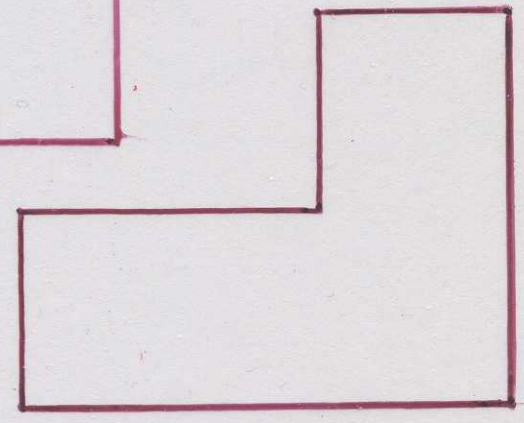
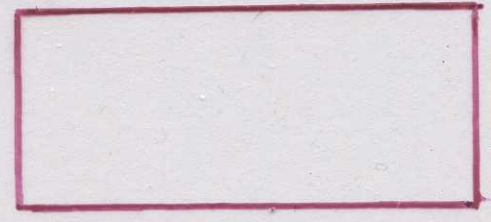
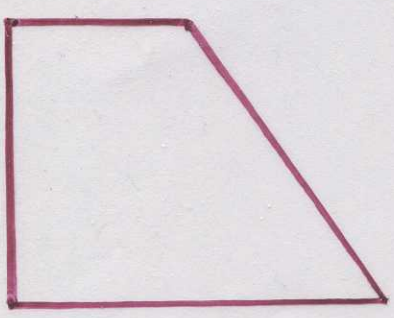
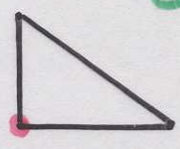
Free Space

Possible configurations of the robot which are collision free.

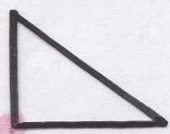
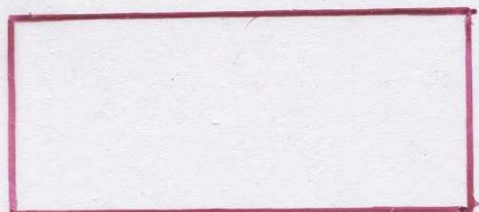
General Idea:

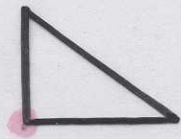
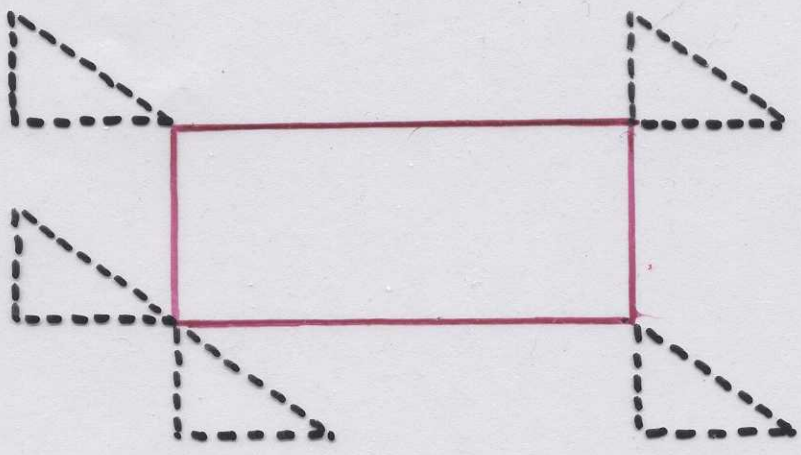
- Construct configuration space obstacles.
- Search the free space for a path from the start to the goal configurations.

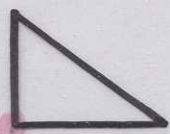
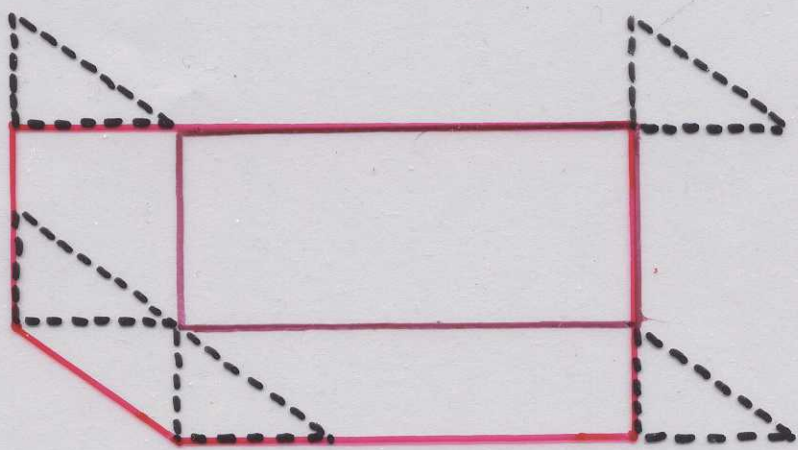
Goal

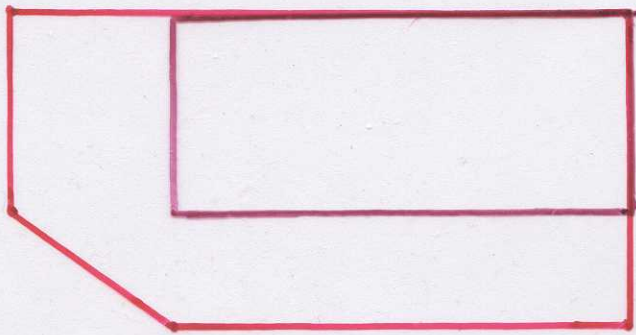


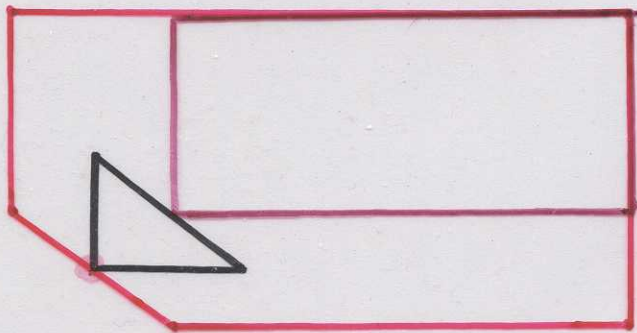
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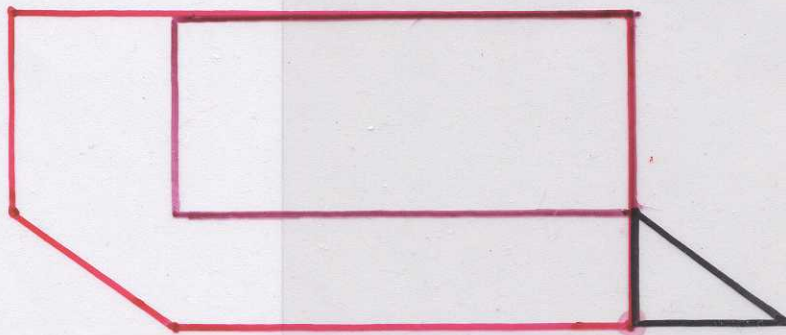




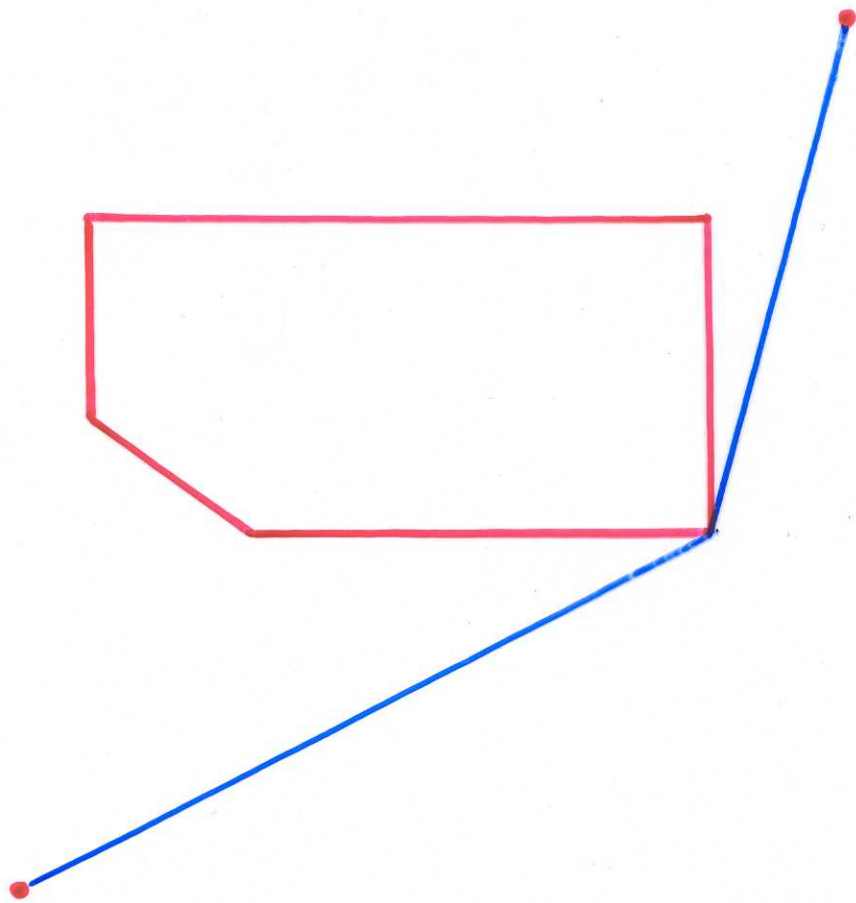






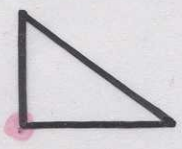
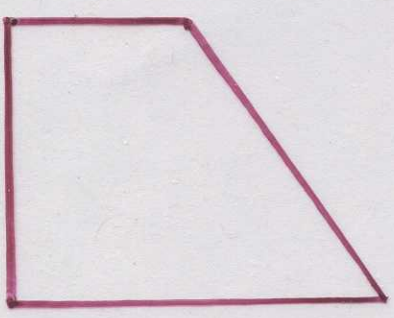
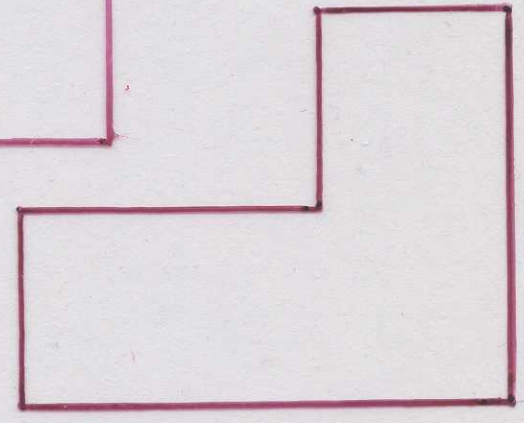
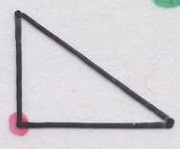


Goal



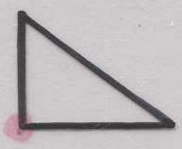
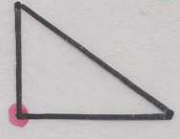
Start

Goal

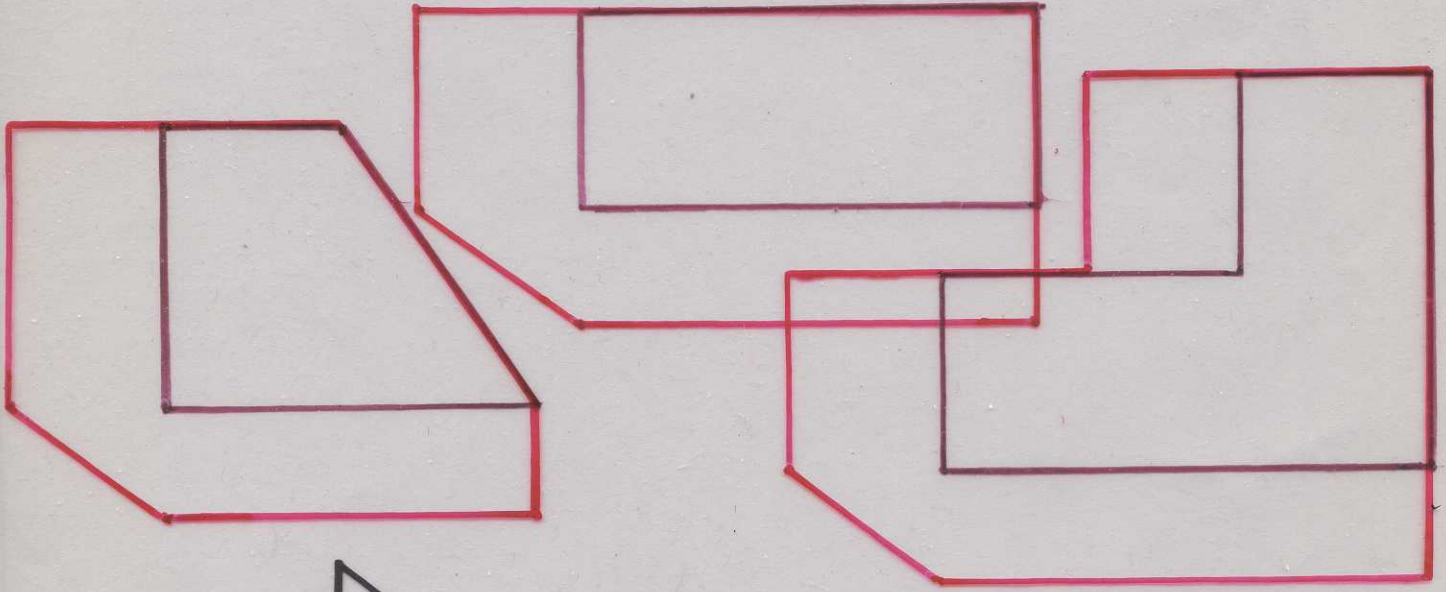


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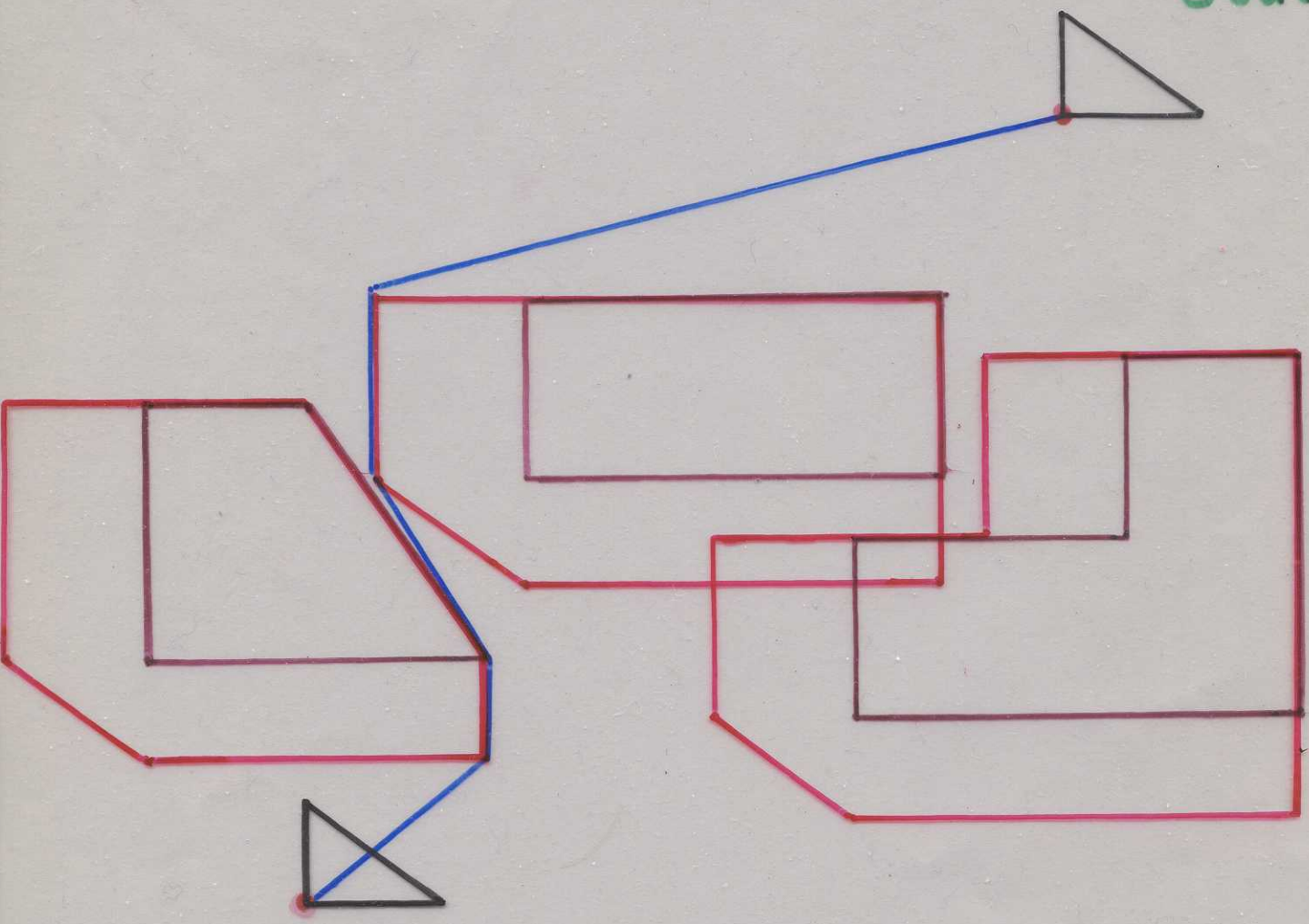


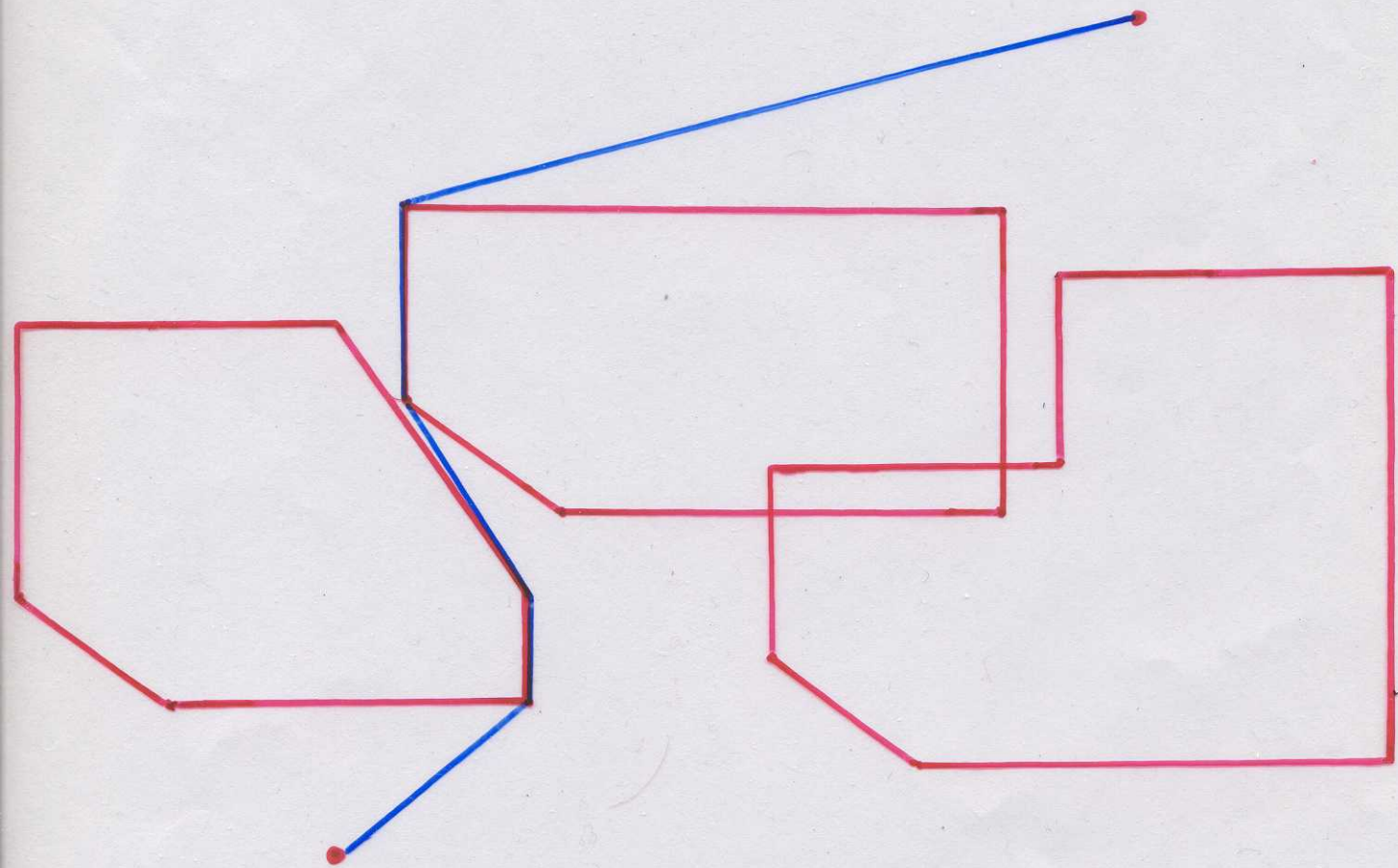
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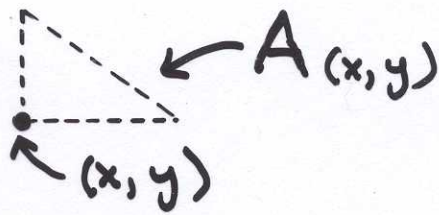
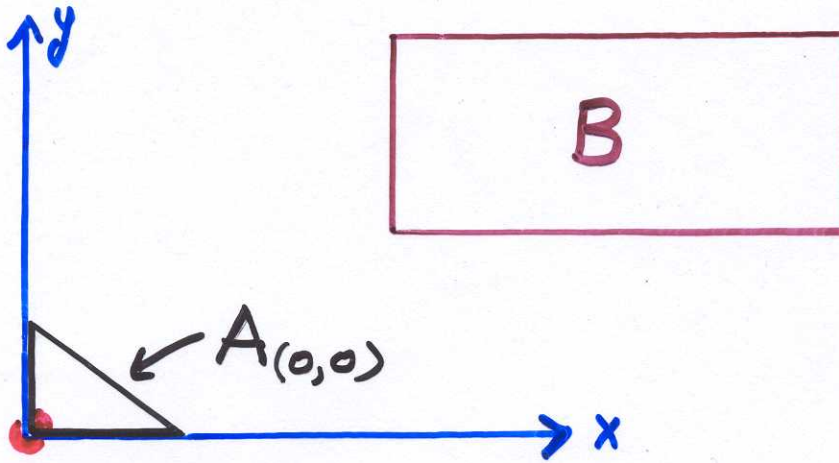


Goal

Start

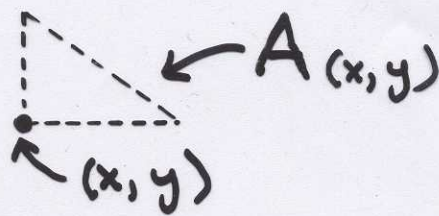
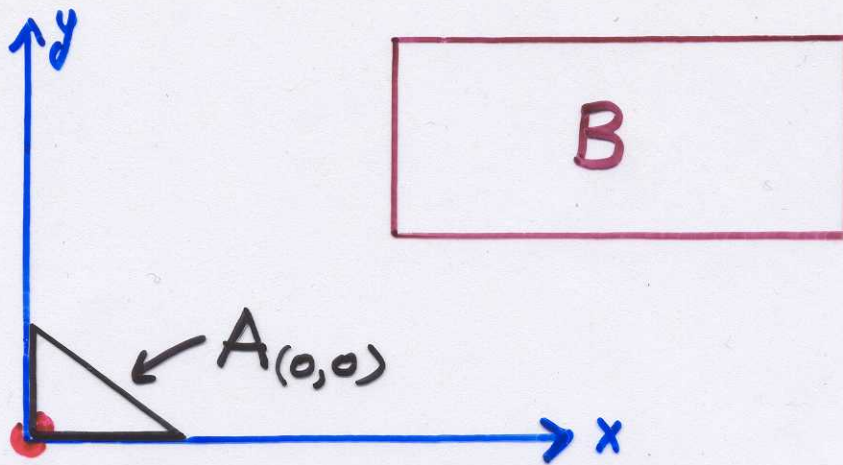






Pick a reference point on A.
That determines a
coordinate frame origin.

moving
object

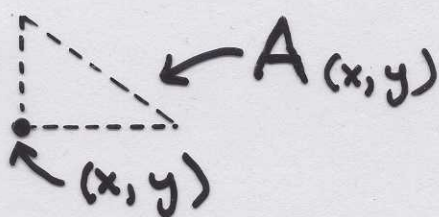
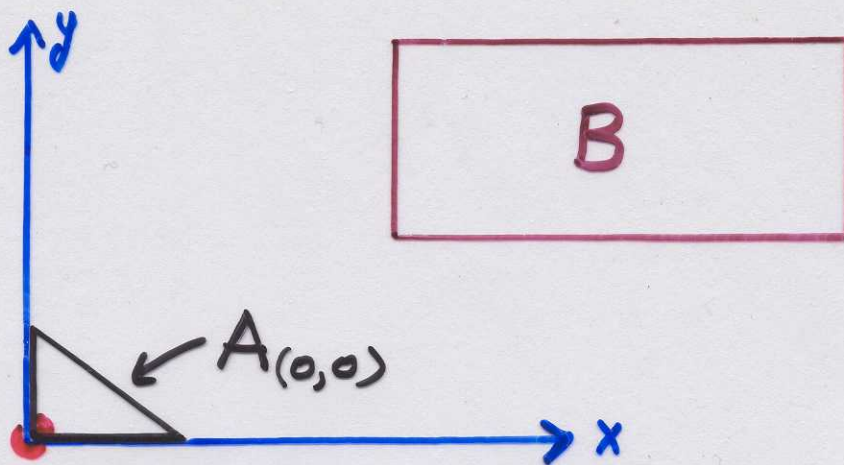


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↑
 moving object

Space obstacle arising from B is:

$$CO_A(B) = \{ (x,y) \mid A_{(x,y)} \cap B \neq \emptyset \}$$

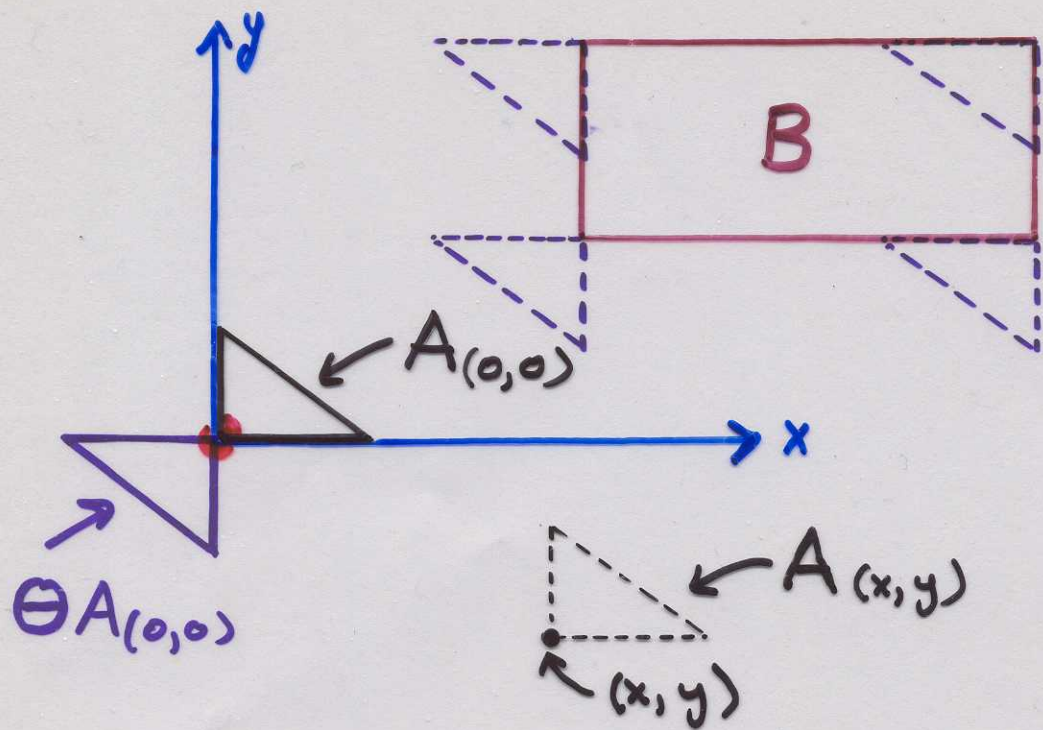


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 CO_A(B) &= \{ (x,y) \mid A_{(x,y)} \cap B \neq \emptyset \} \\
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 &= B \ominus A_{(0,0)}
 \end{aligned}$$

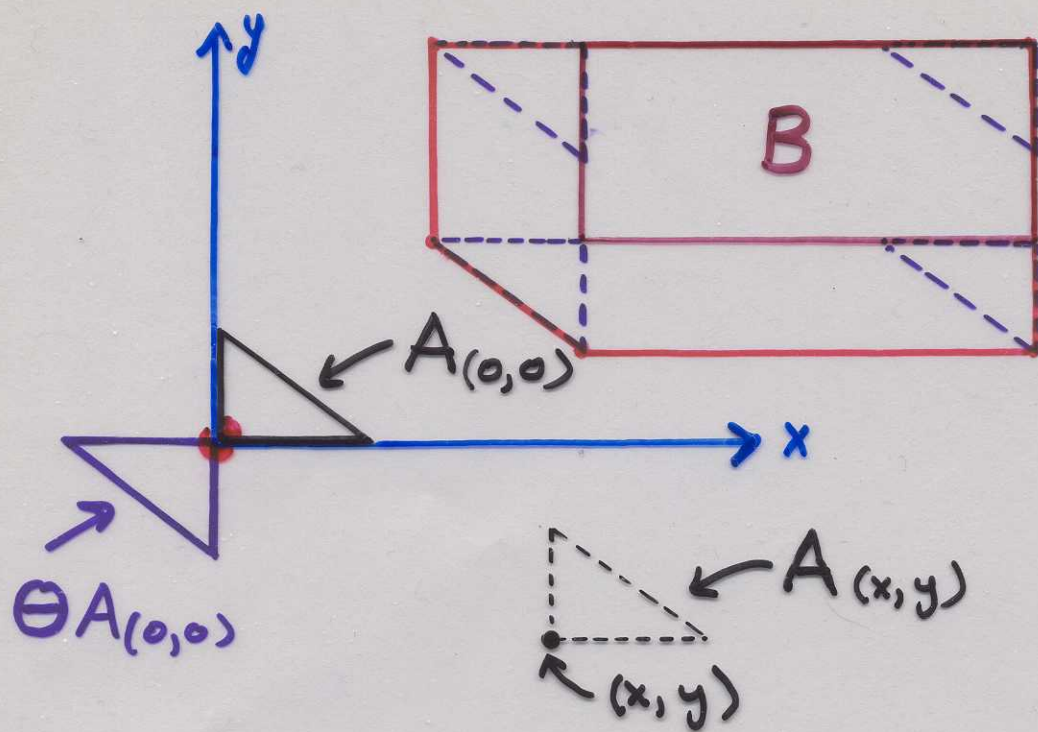


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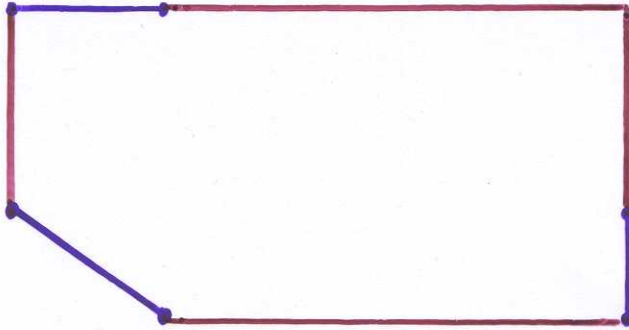
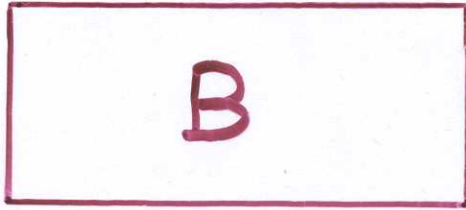


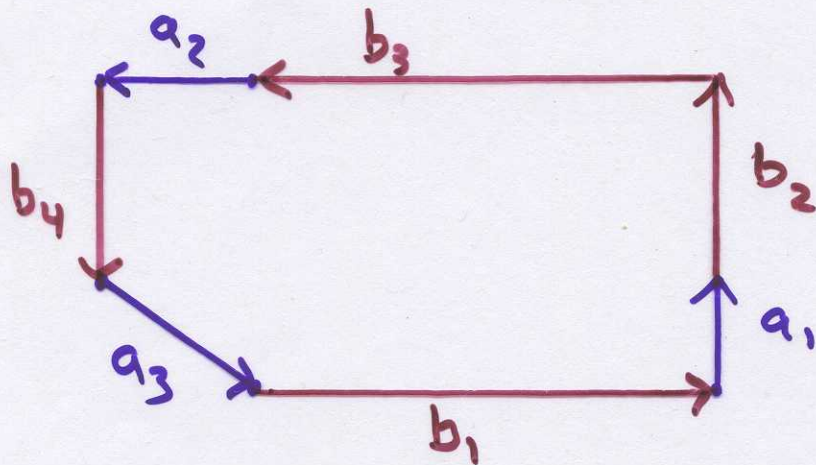
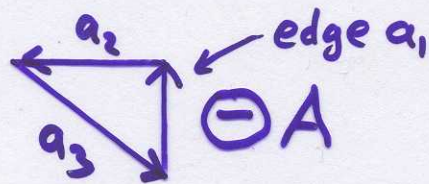
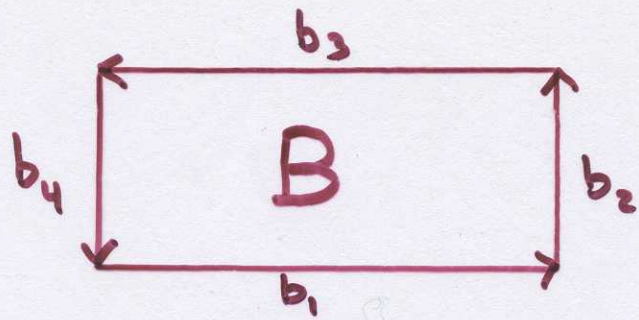
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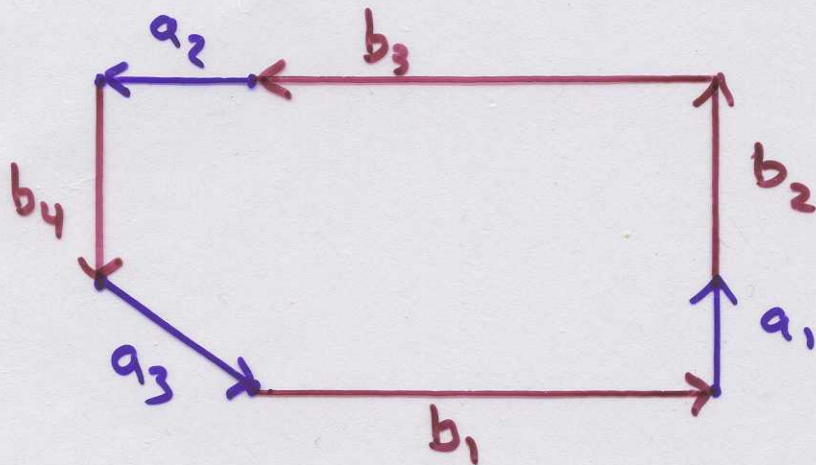
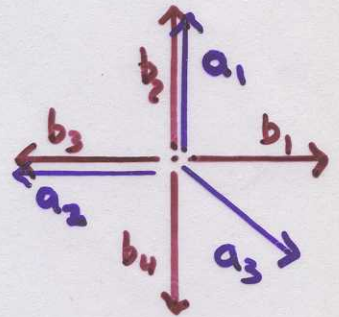
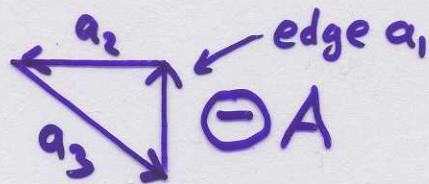
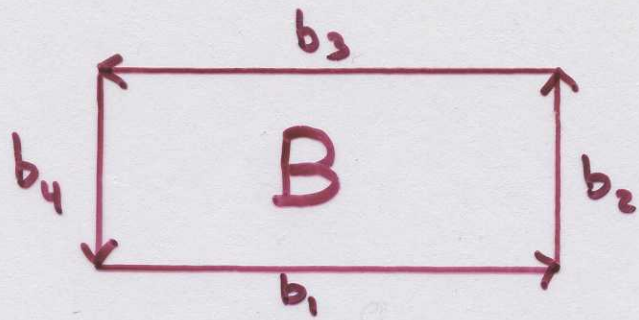




Algorithm:

- Sort $\ominus A$ & B edges by angle
- Join up in order

$$O(n+m)$$

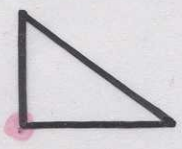
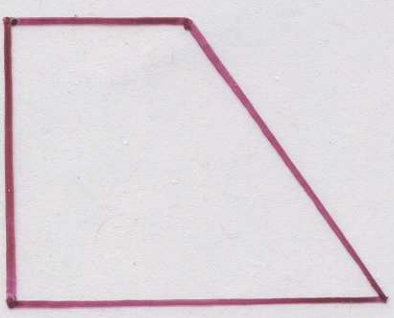
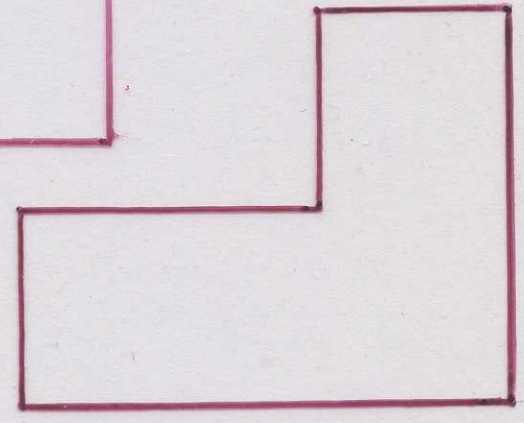
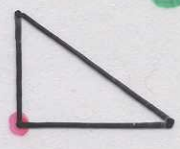


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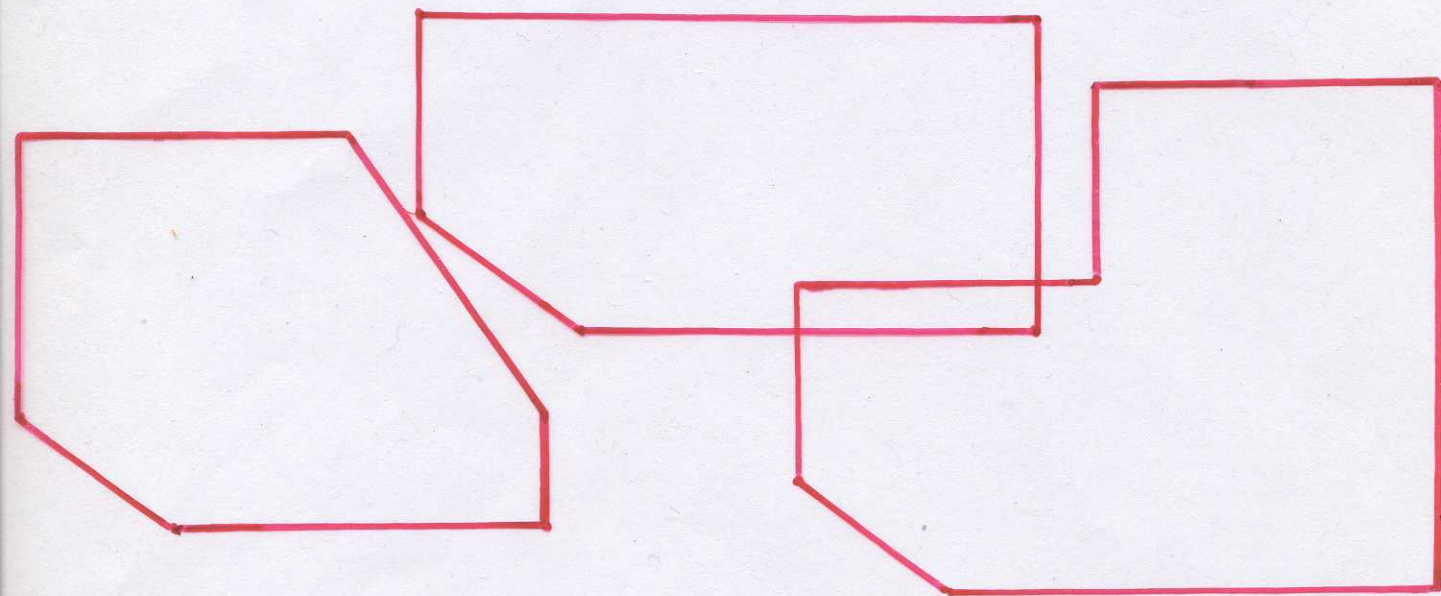
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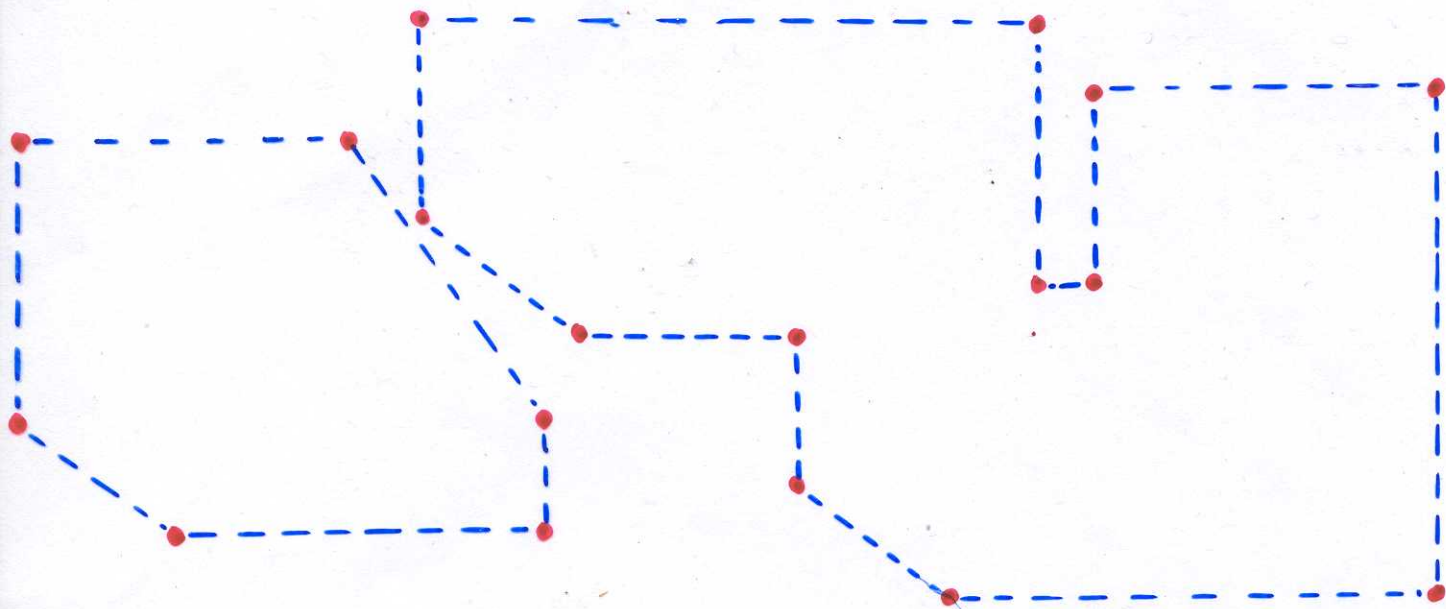
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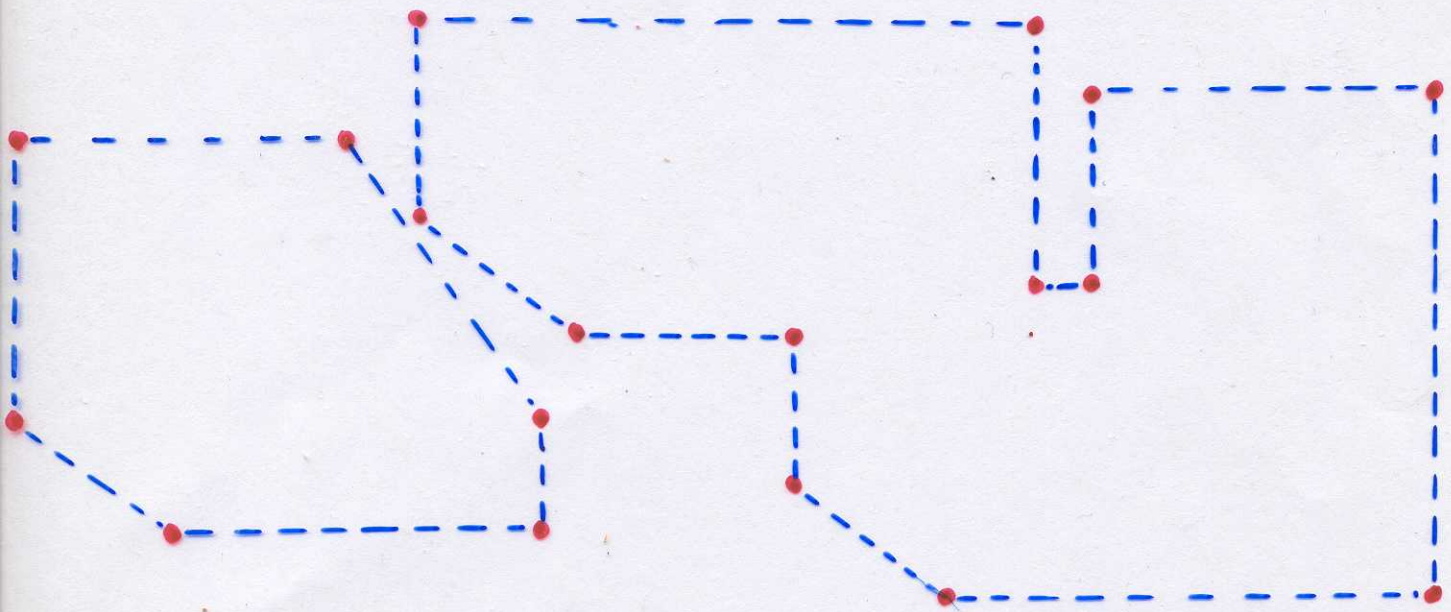
Goal



Start







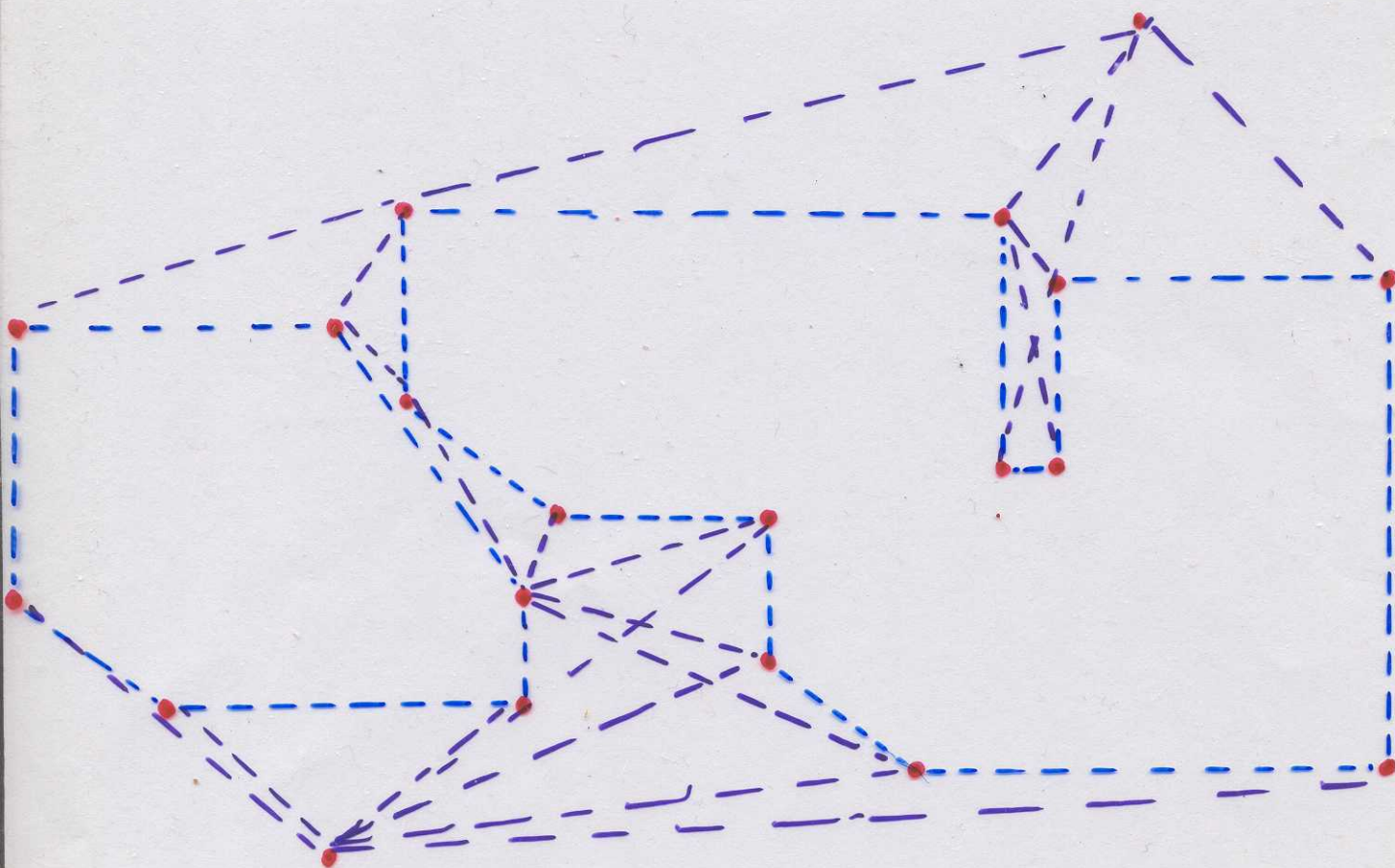
Special Case:

2D, with convex polygonal objects.

- Construct 2D polygonal cspace obstacles.
- Search V graph.

SHAKY 1969

↑
graph of vertices
with visibility edges.



Special Case:

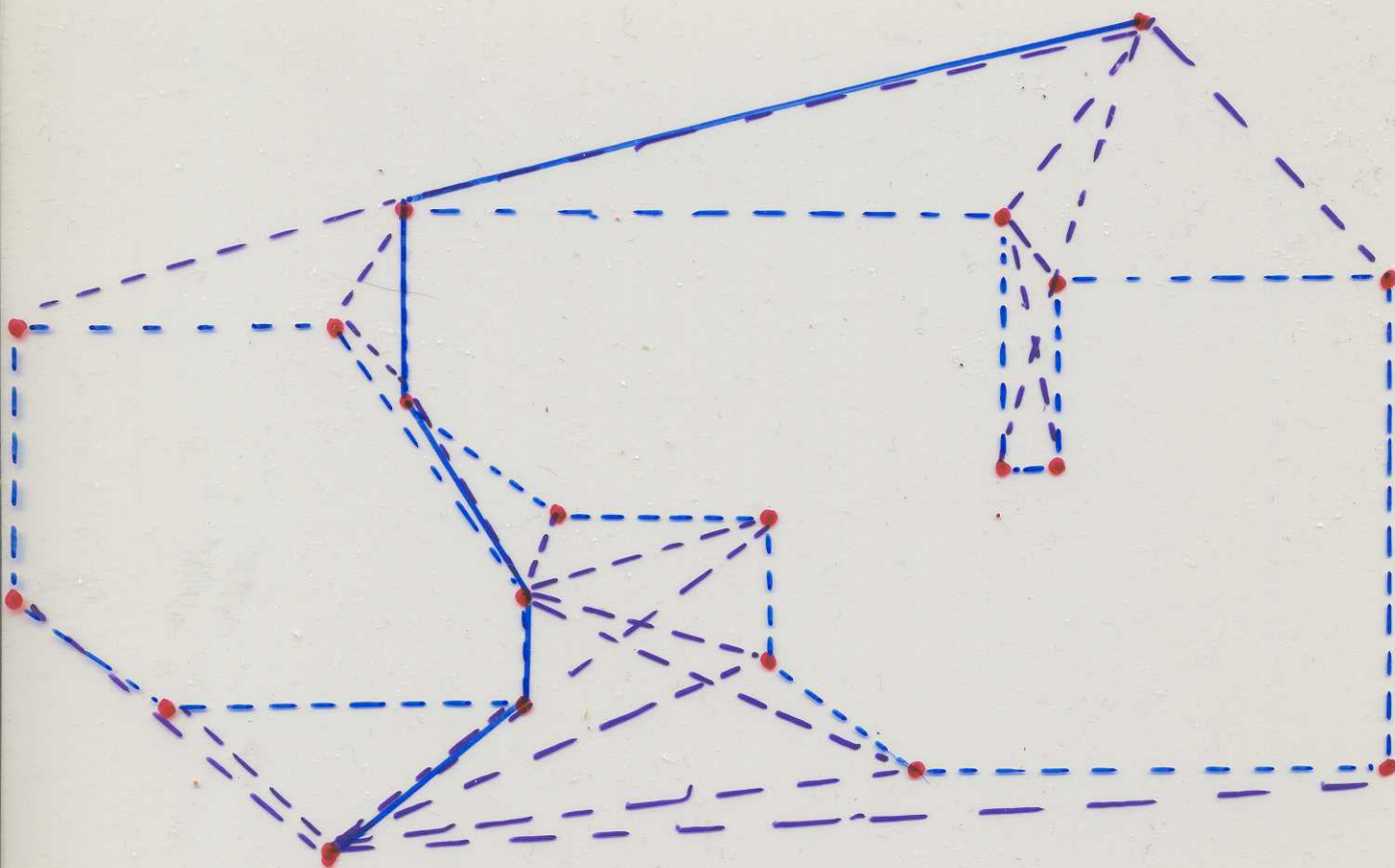
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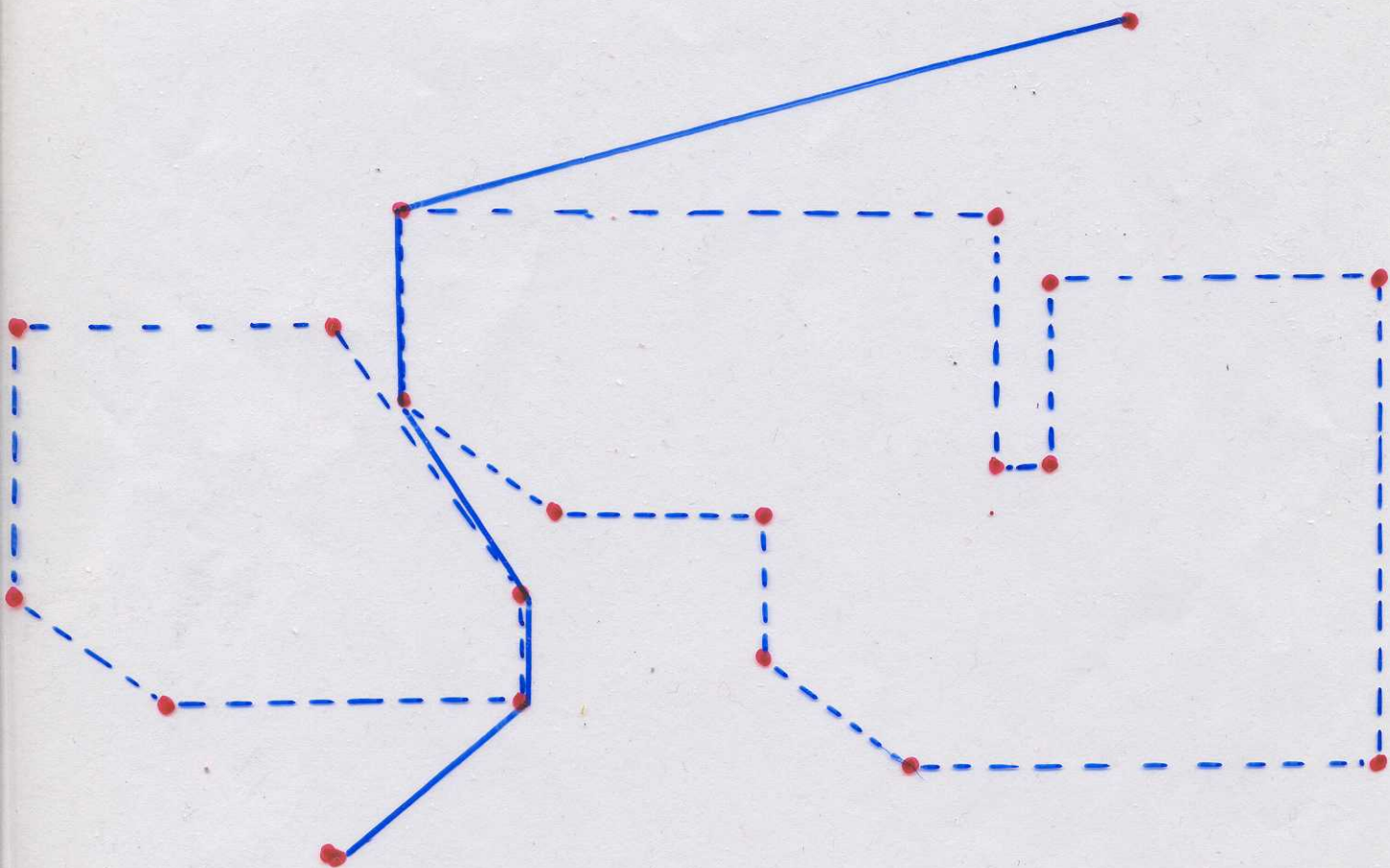
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To reduce clutter, the previous pictures did not include all visibility edges. Here are more:

