Searching for an axis-parallel shoreline

Elmar Langetepe
University of Bonn

Searching for a shoreline

Searching for a shoreline

- Fundamental search problem

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- Startpoint O,

Searching for a shoreline

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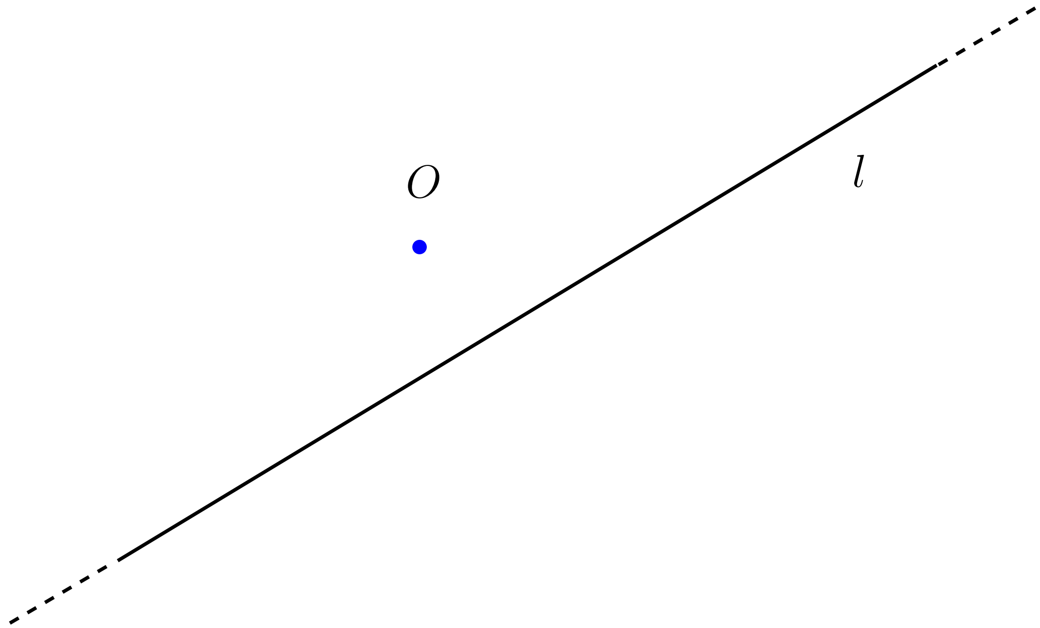
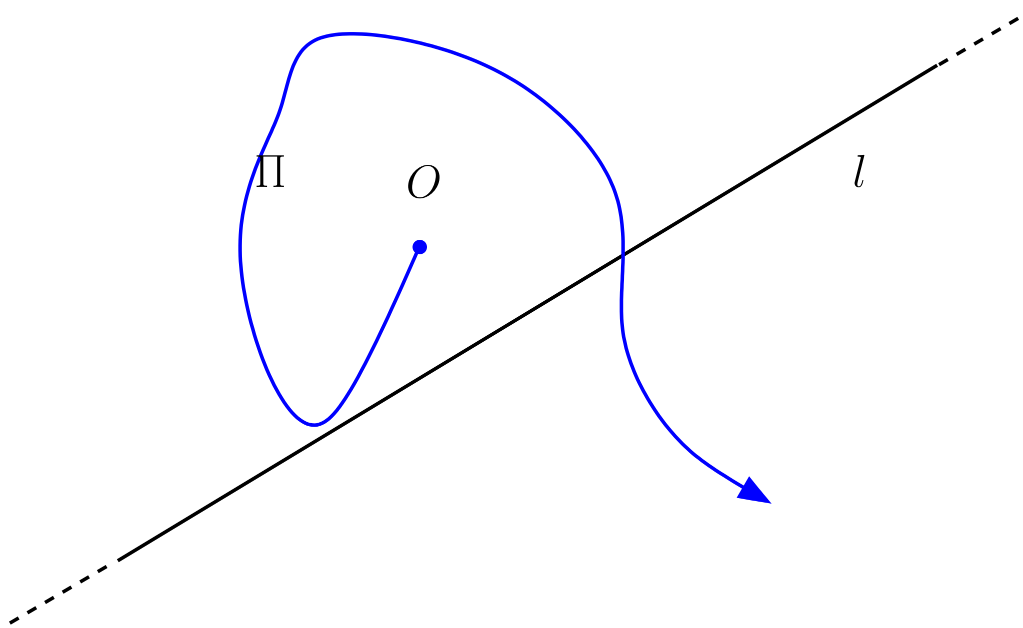
- Startpoint O, unknown line l



Searching for a shoreline

- Fundamental search problem
- Startpoint O, unknown line l
- Agent moves along path Π



Searching for a shoreline

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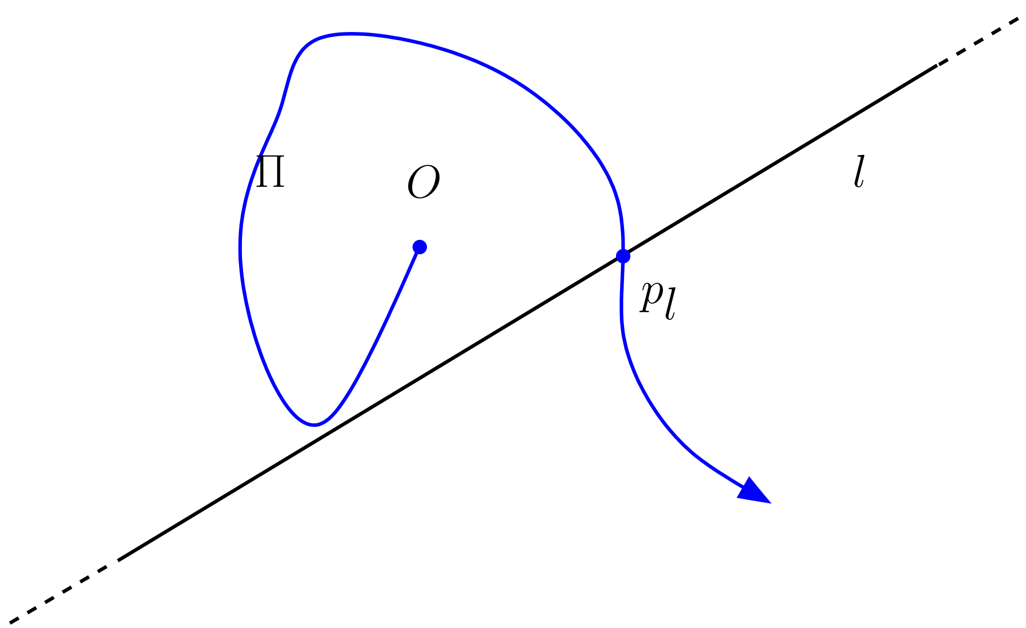
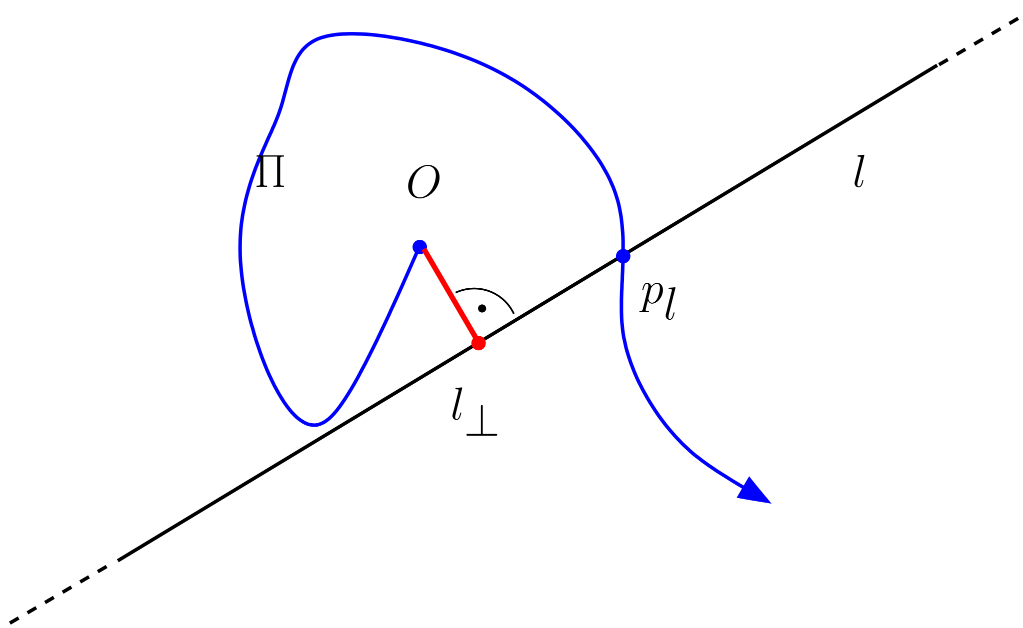
- Find l at p_l,



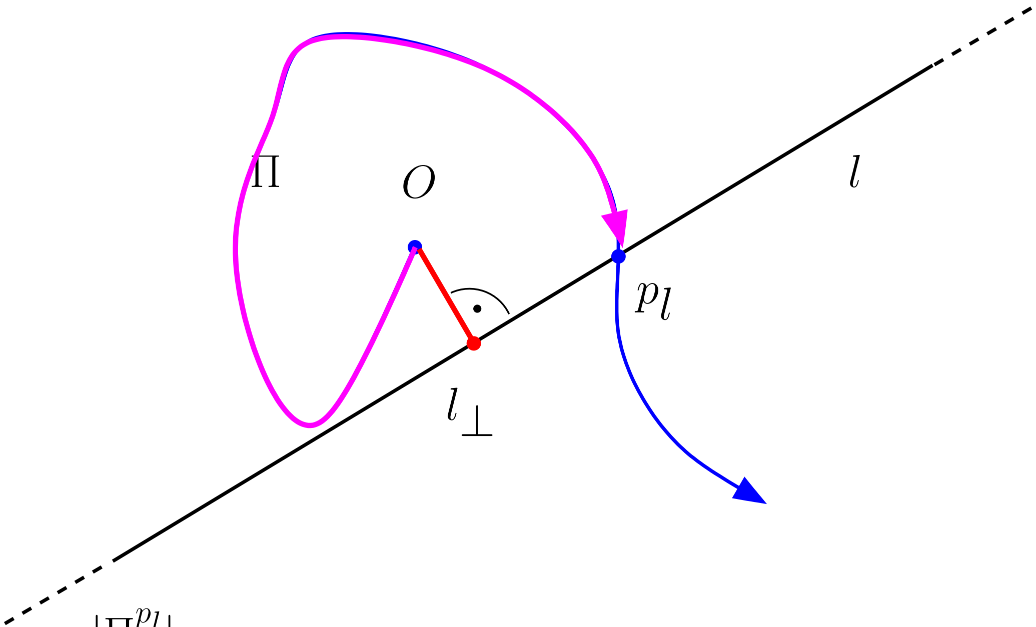
Searching for a shoreline

- Fundamental search problem
- Startpoint O, unknown line l
- Agent moves along path Π
- Find l at p_l, shortest path $|Ol_\perp|$



Searching for a shoreline

- Fundamental search problem
- Startpoint O, unknown line l
- Agent moves along path Π
- Find l at p_l, shortest path $|Ol_\perp|$
- Competitive ratio: Performance $C := \sup_l \frac{|\Pi_O^{p_l}|}{|Ol_\perp|}$



$$\frac{|\Pi_O^{p_l}|}{|Ol_\perp|} \leq C$$

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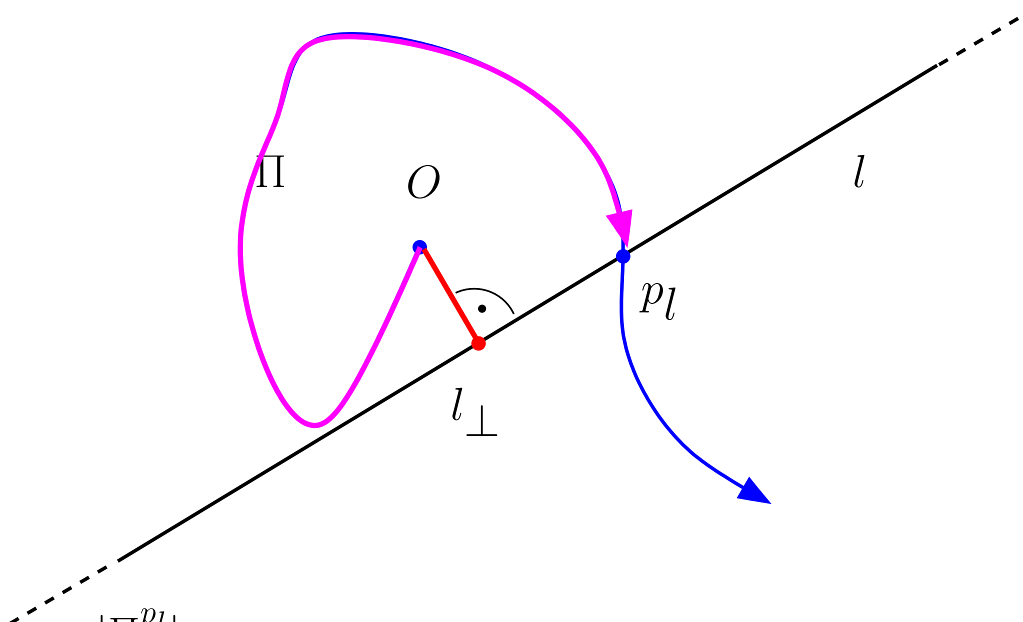

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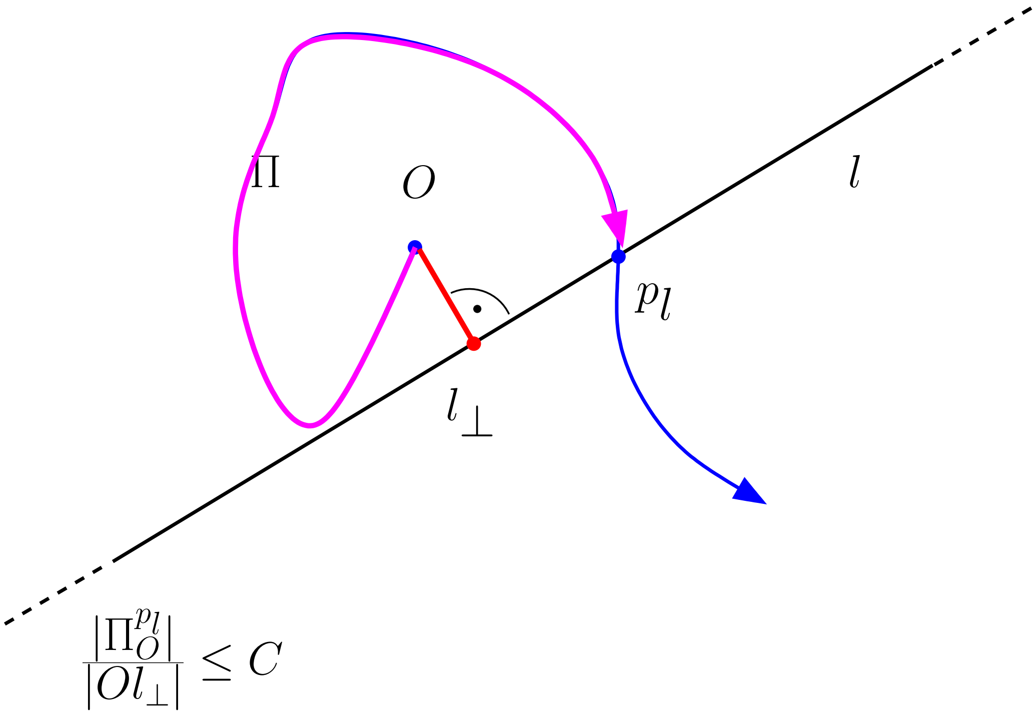
- Shmuel Gal 1980!
  Optimal search path?



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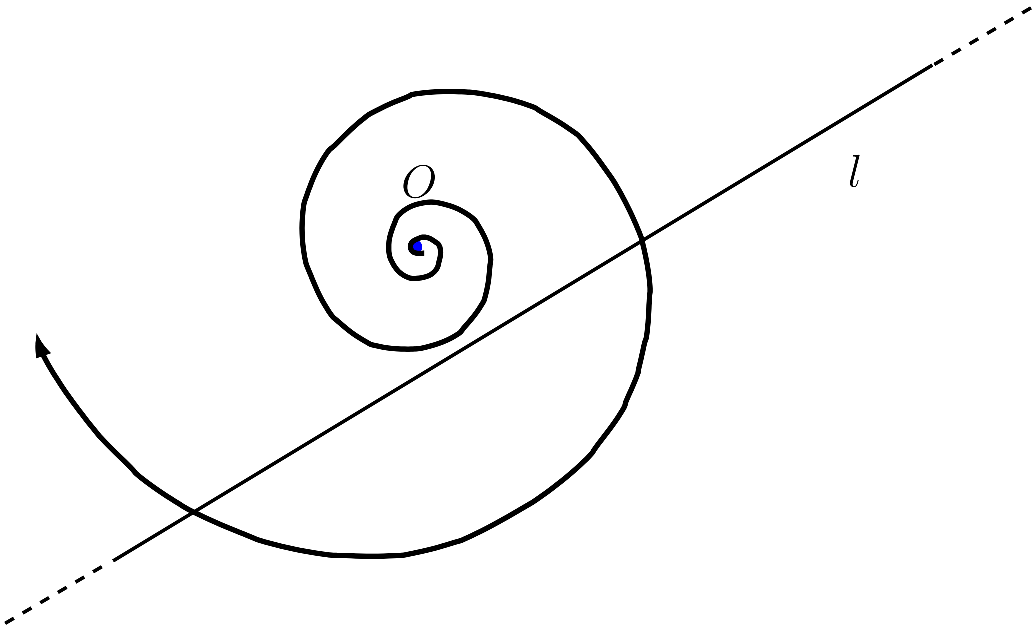
- Spiral conjecture: $13.81113\ldots$



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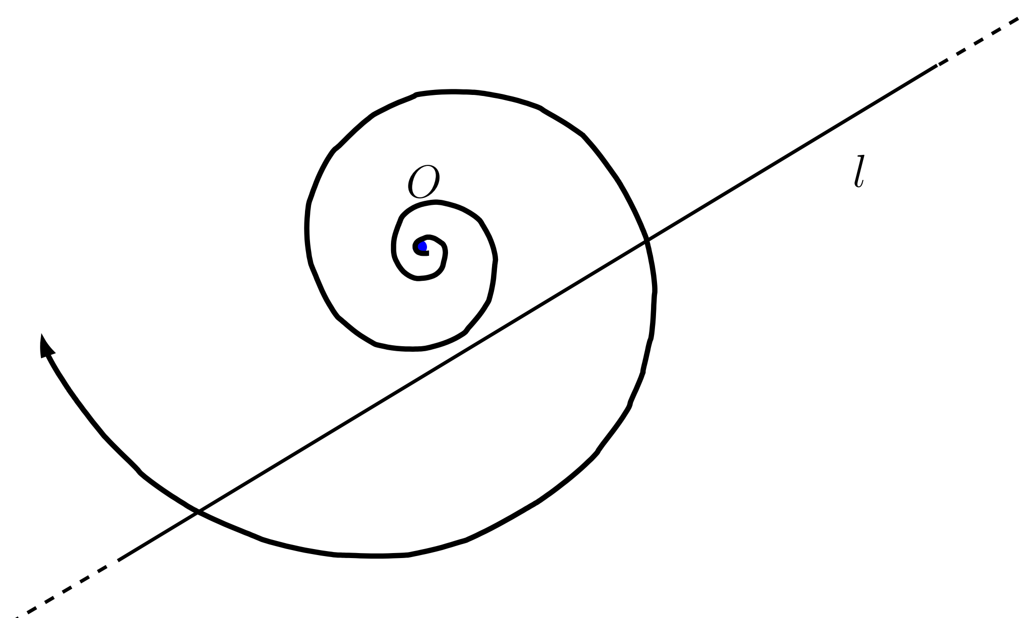
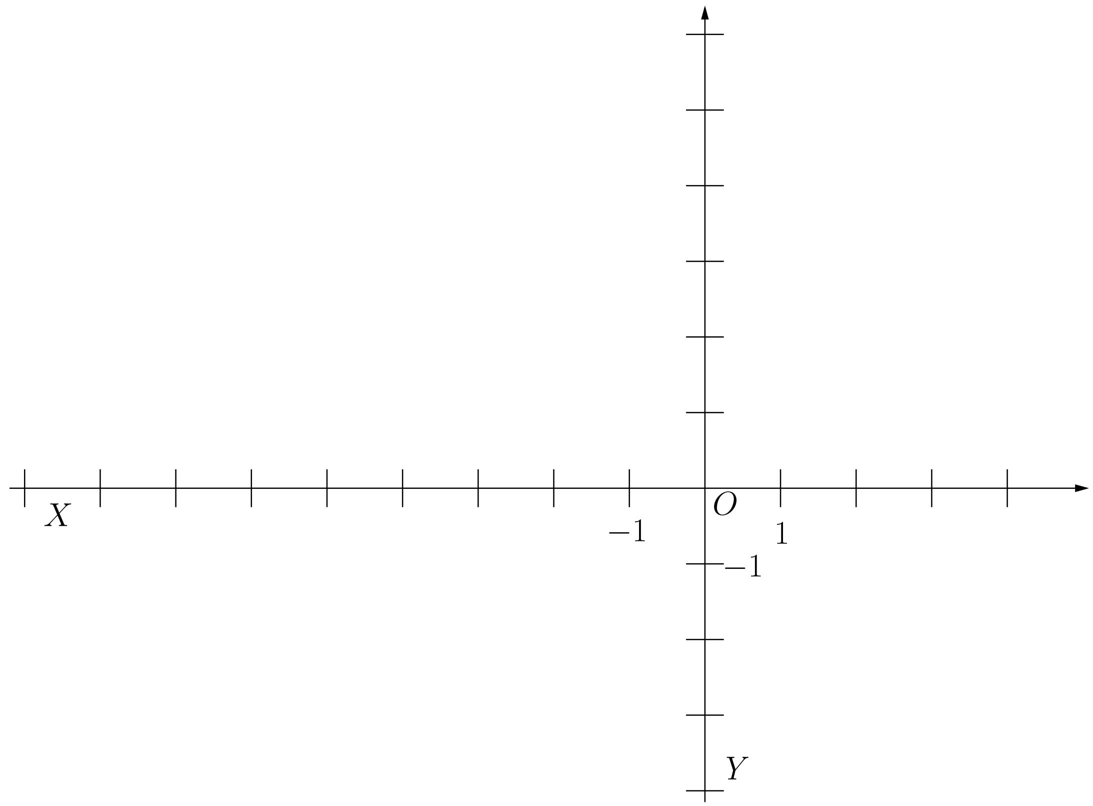
  Optimal search path?
- Spiral conjecture: $13.81113\ldots$
- 30 years old!



Axis-parallel shorelines

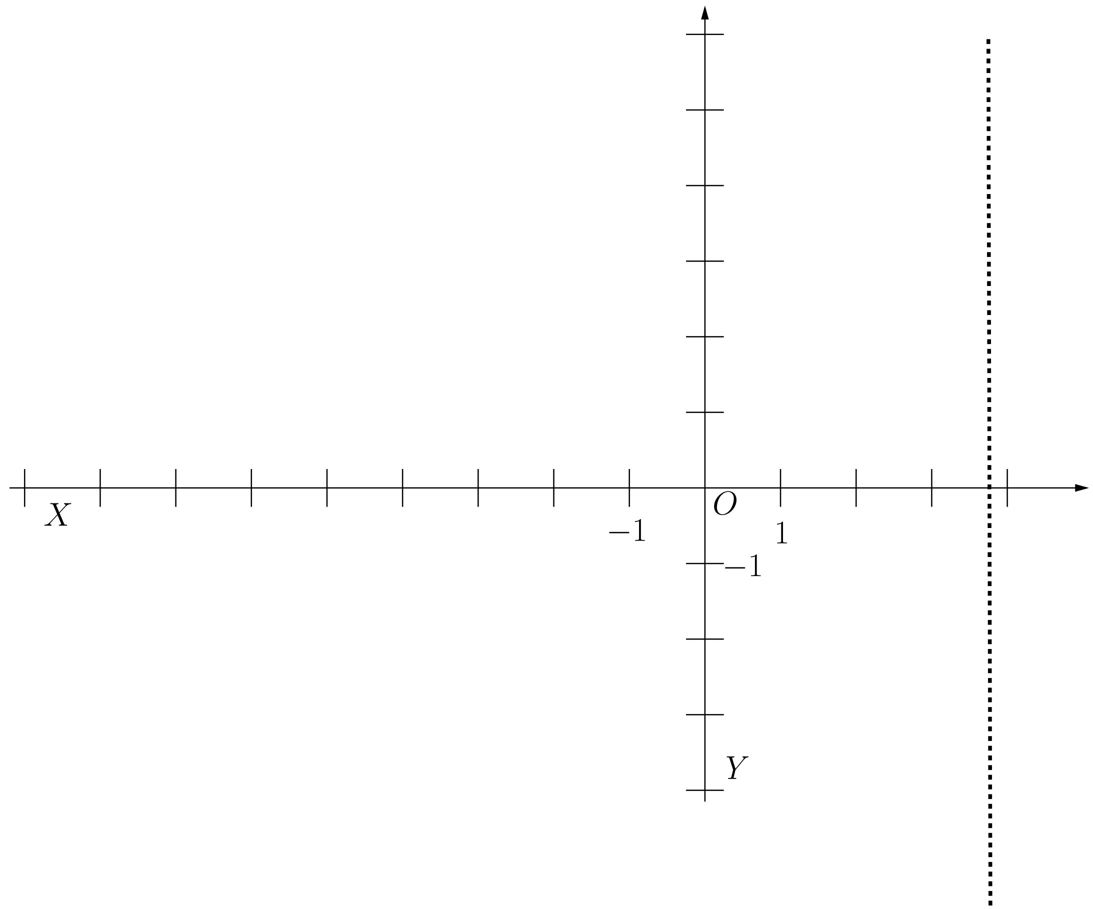
Axis-parallel shorelines

- Subproblem:



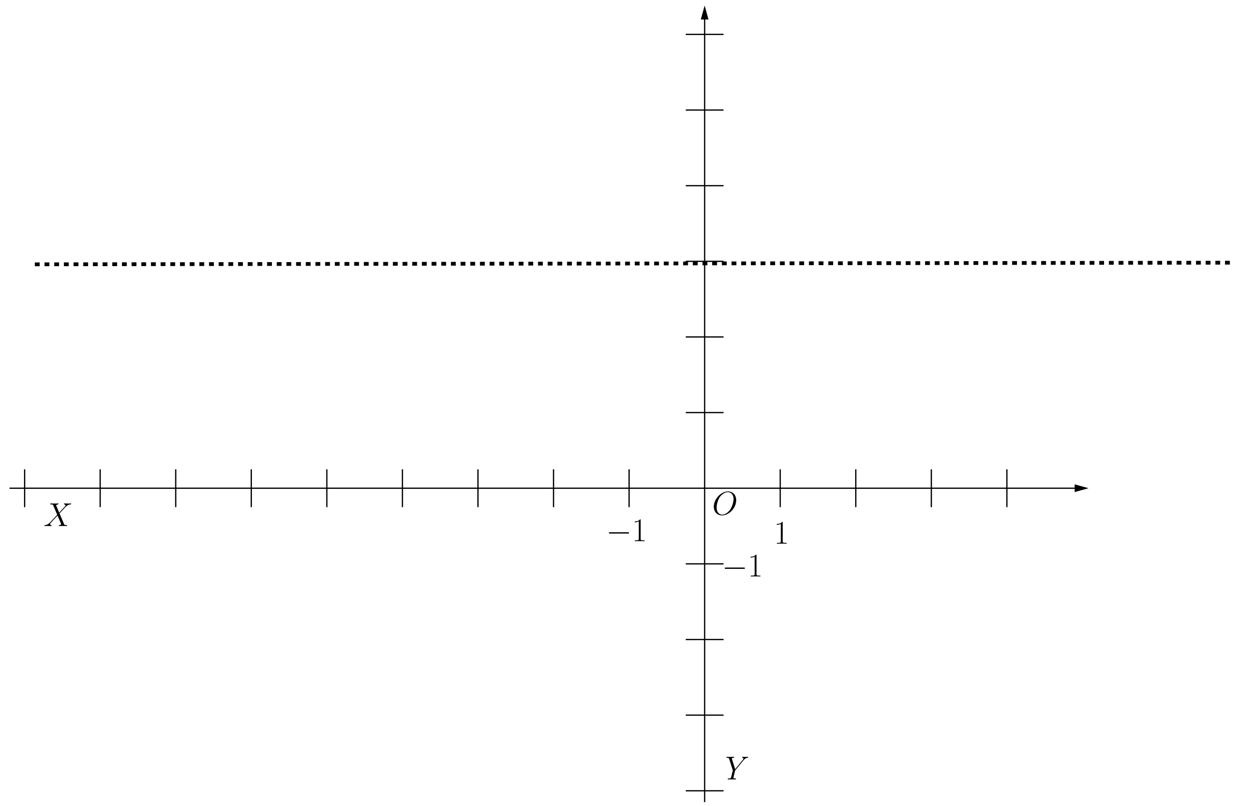
Axis-parallel shorelines

- Subproblem: vertical



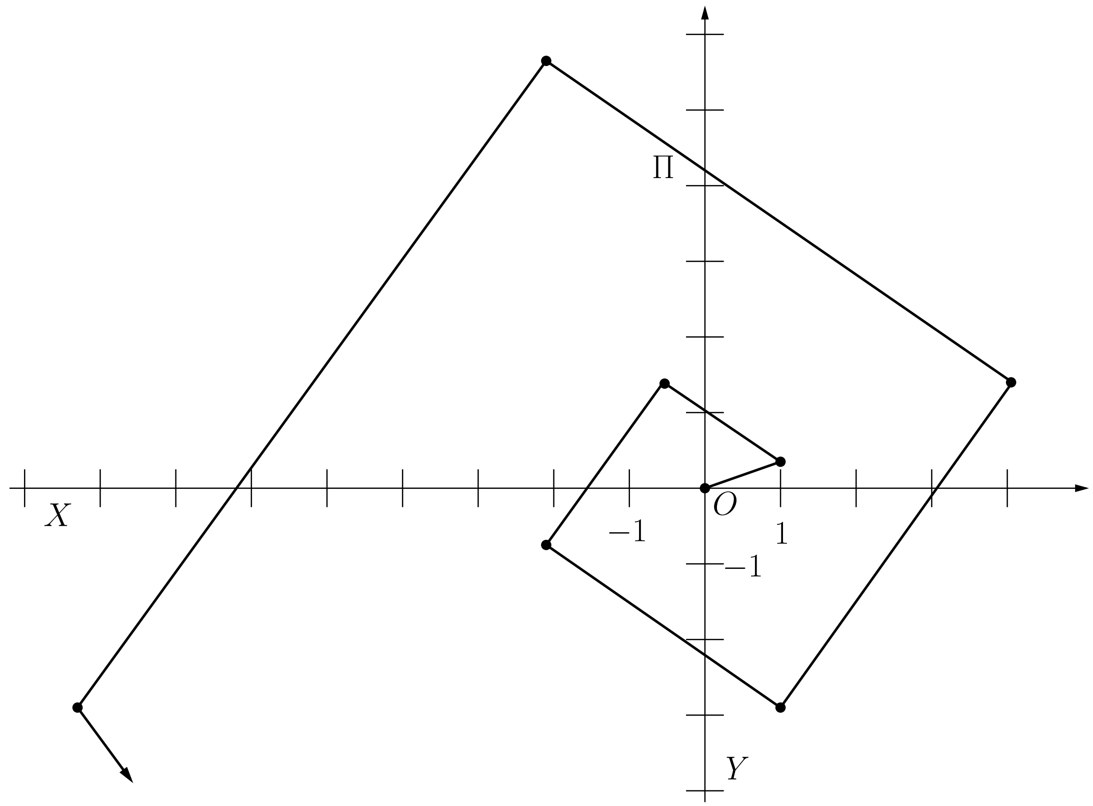
Axis-parallel shorelines

- Subproblem: vertical horizontal



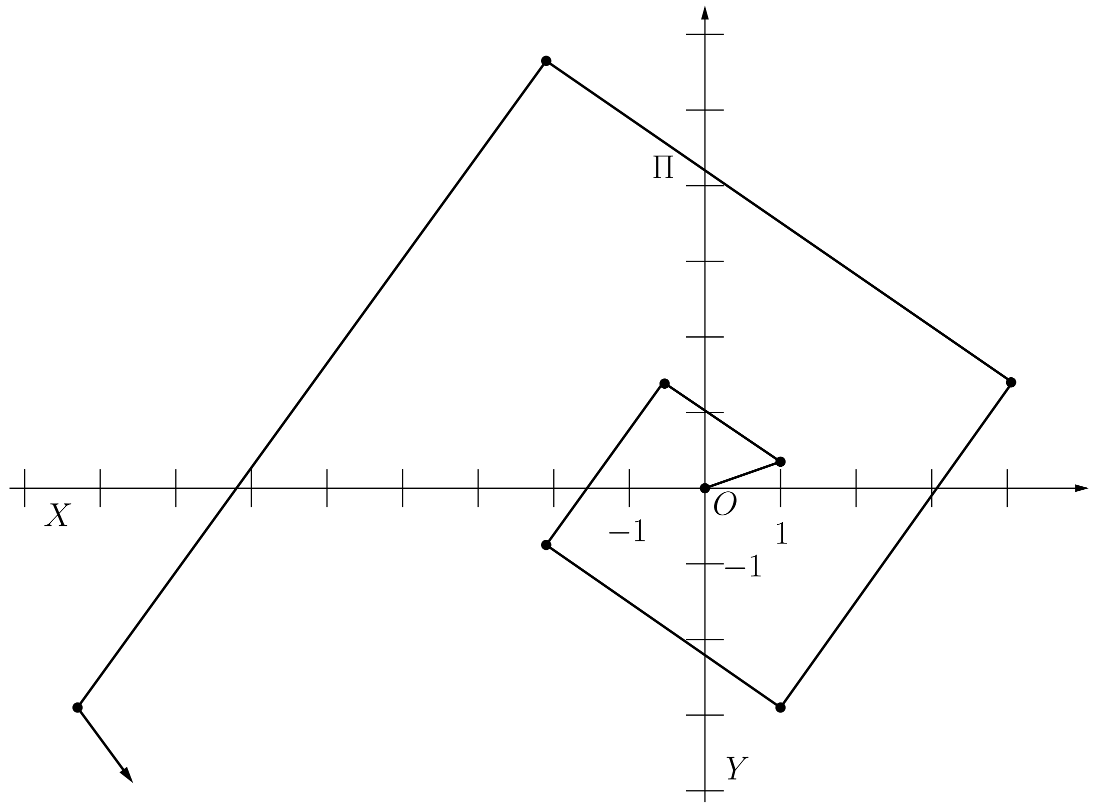
Axis-parallel shorelines

- Subproblem: vertical horizontal
- Jeż, Łopuszański 2009



Axis-parallel shorelines

- Subproblem: vertical horizontal
- Jeż, Łopuszański 2009
- Cyclic, expansion α



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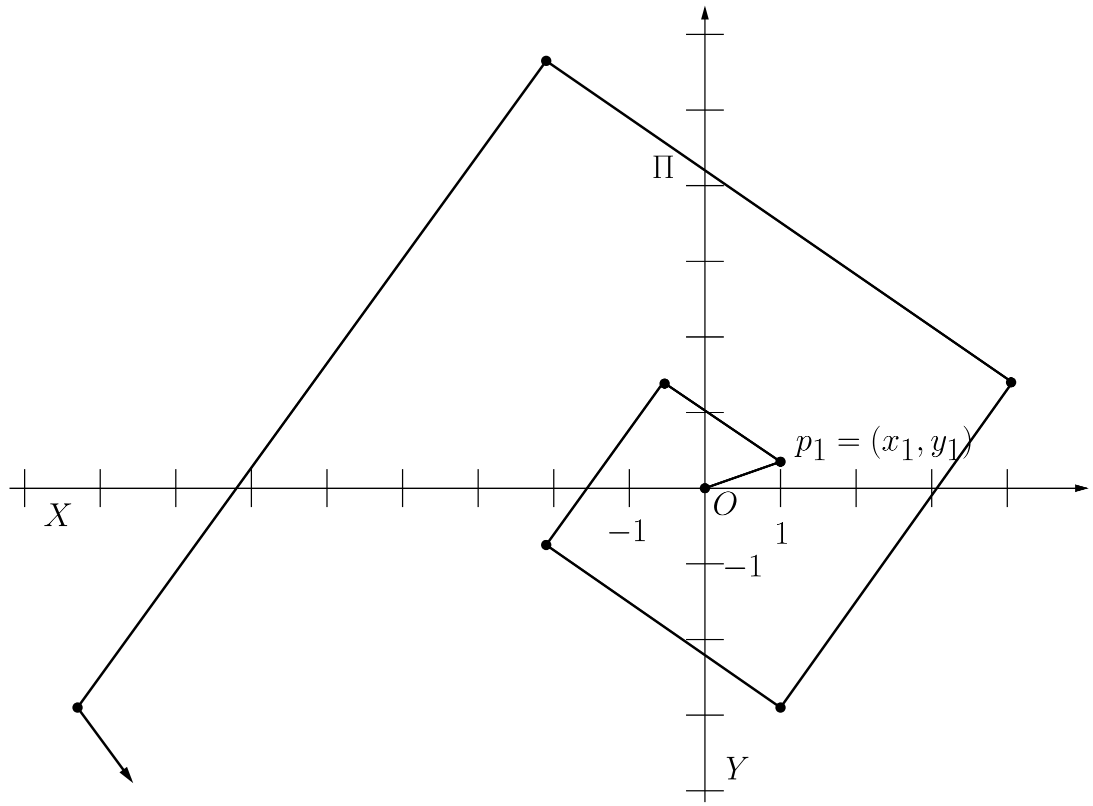

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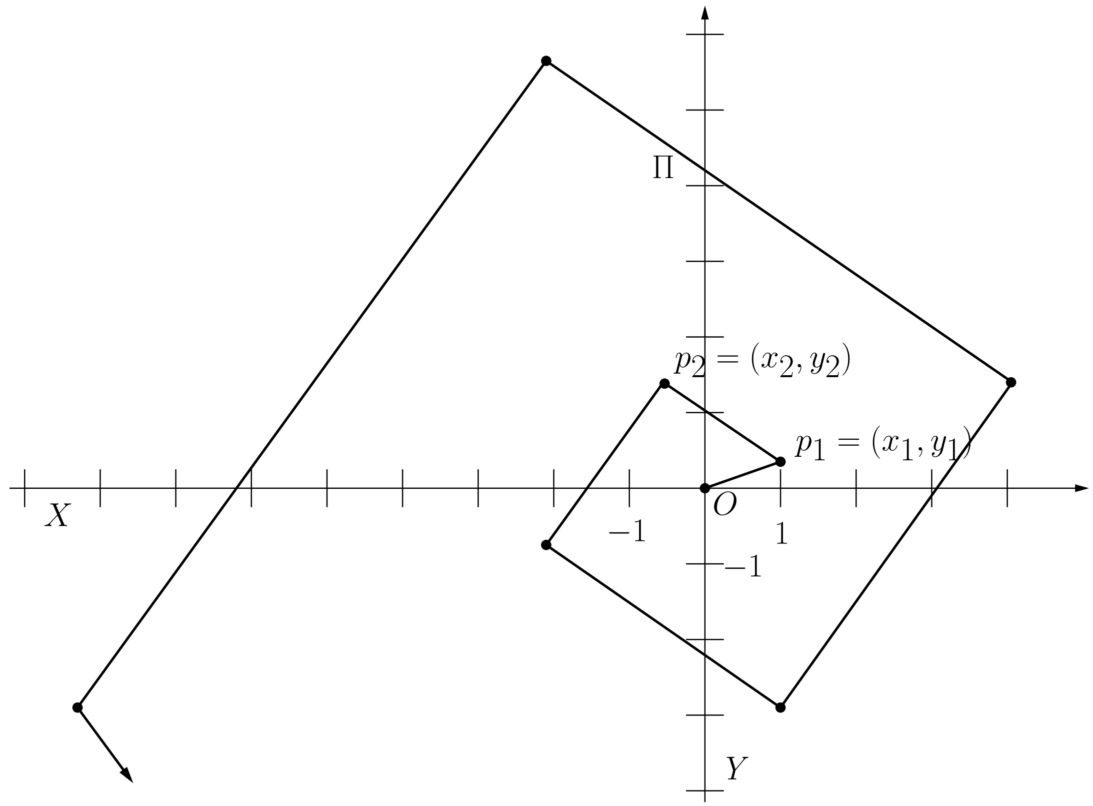

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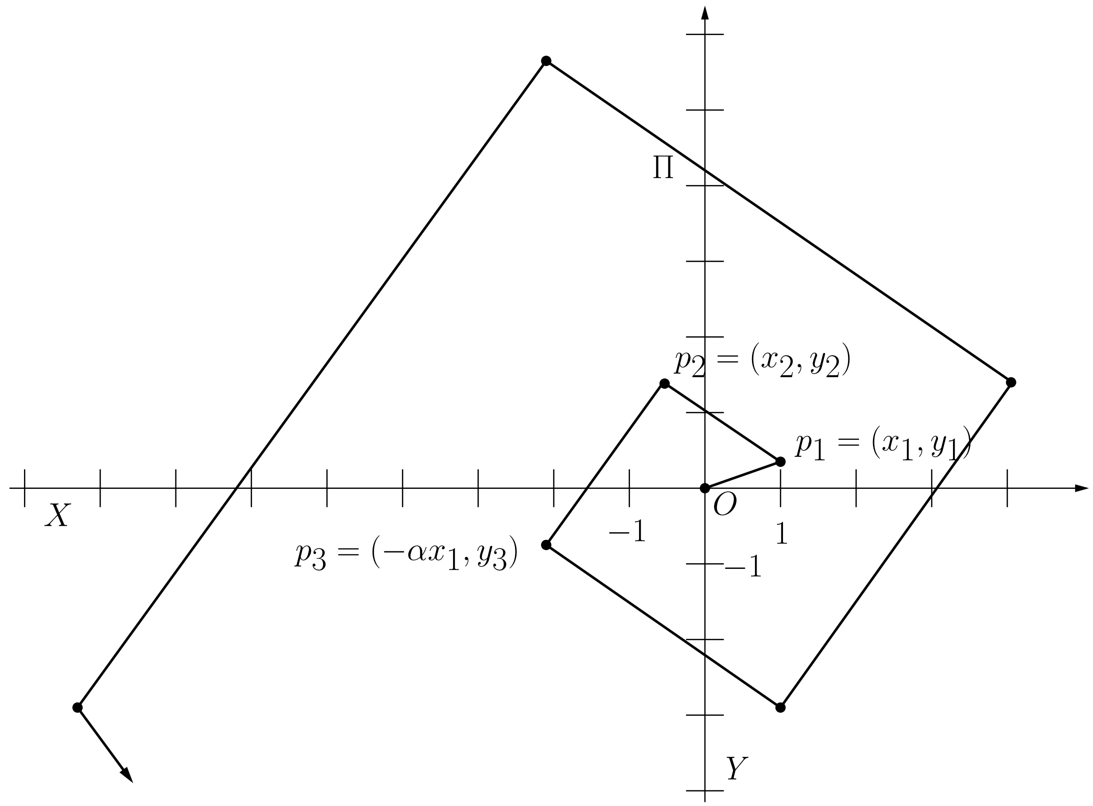

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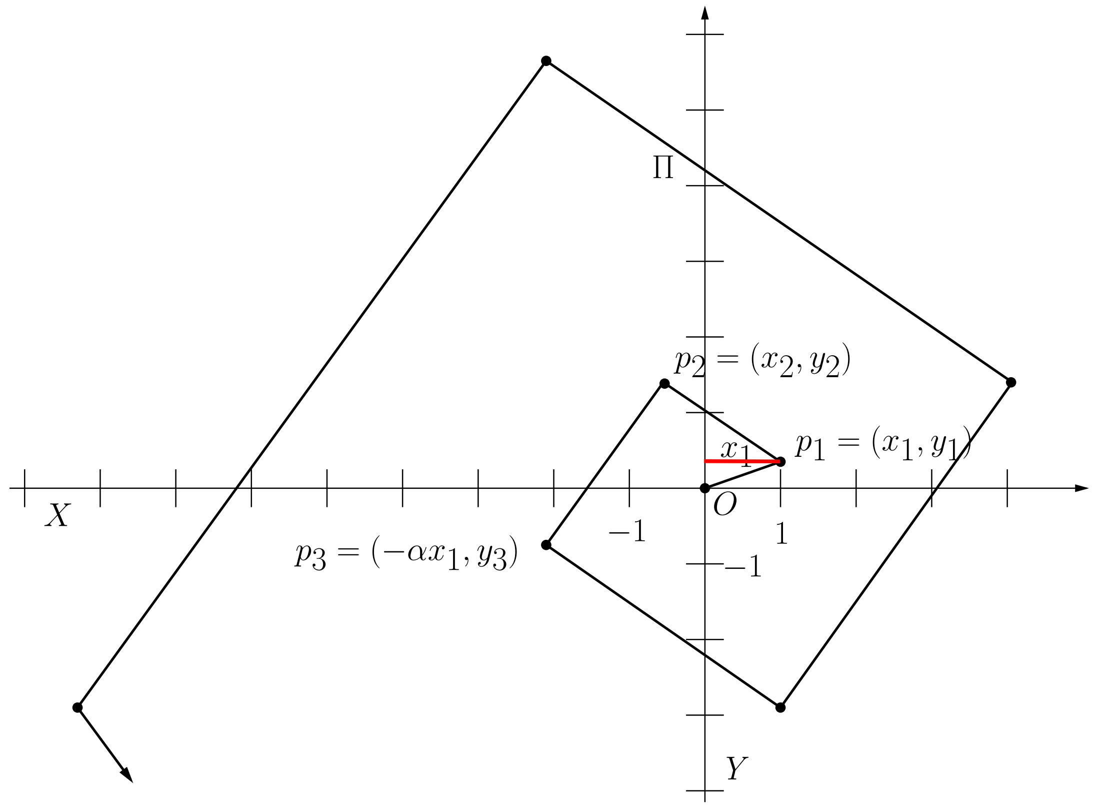

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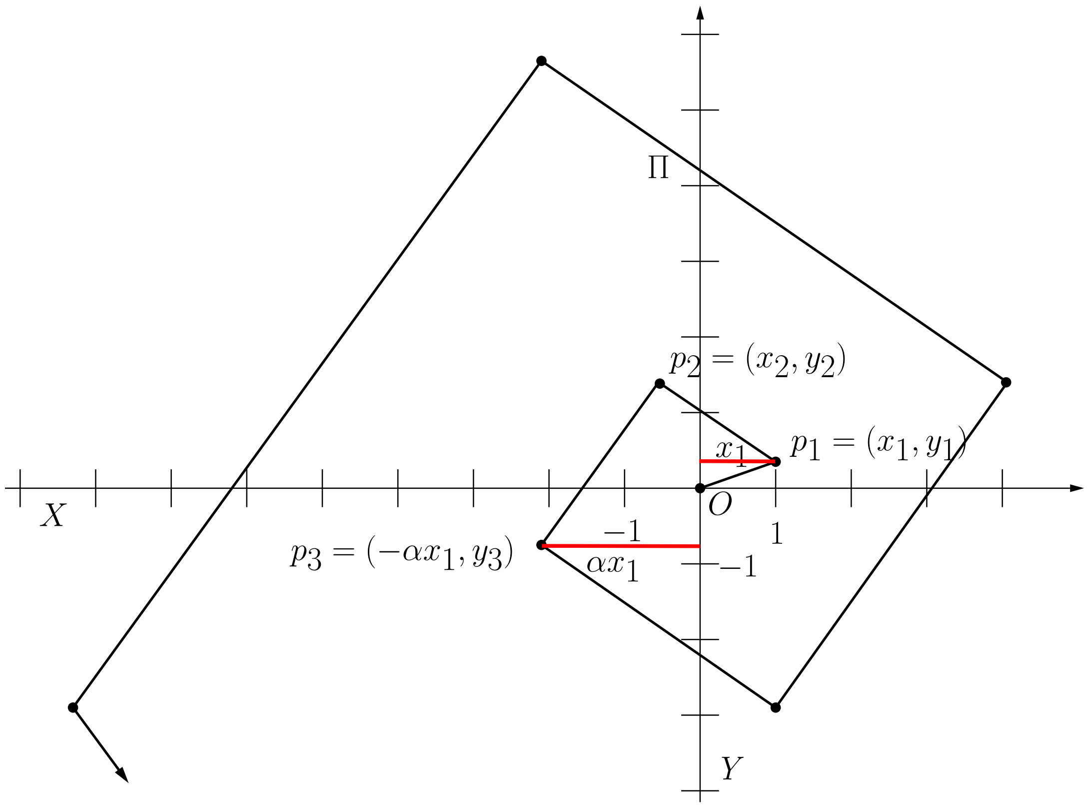

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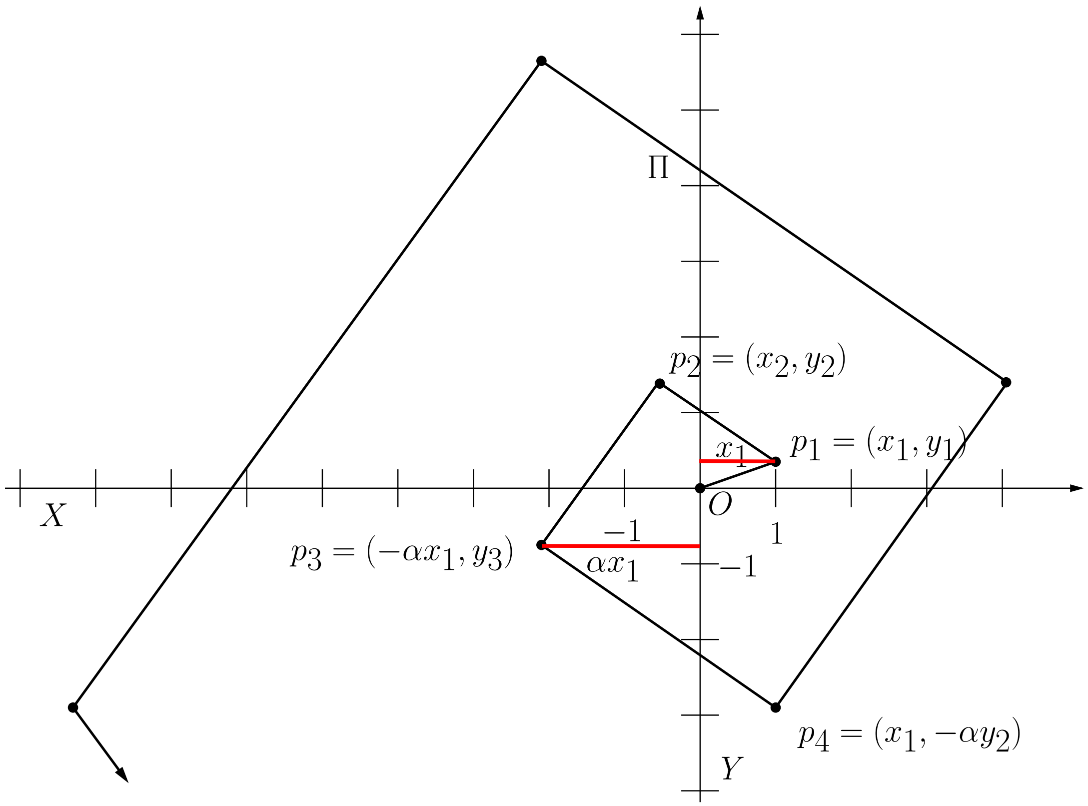

Axis-parallel shorelines

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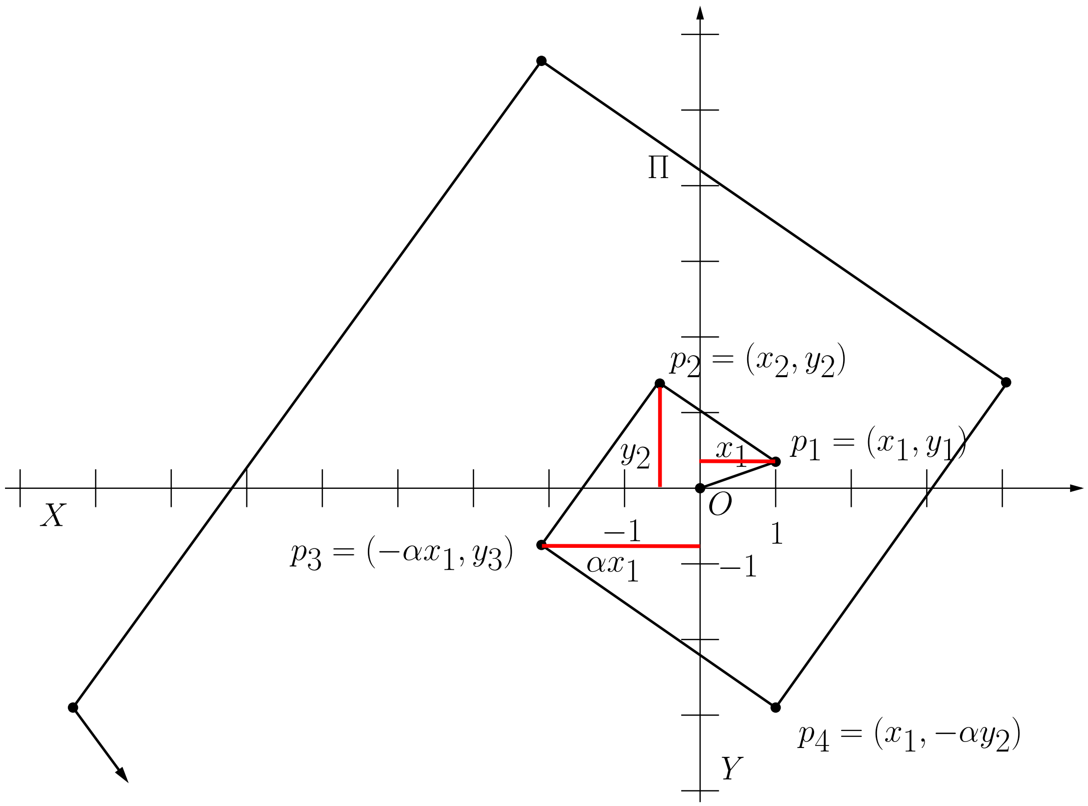
- x_1, αx_1, y_2,



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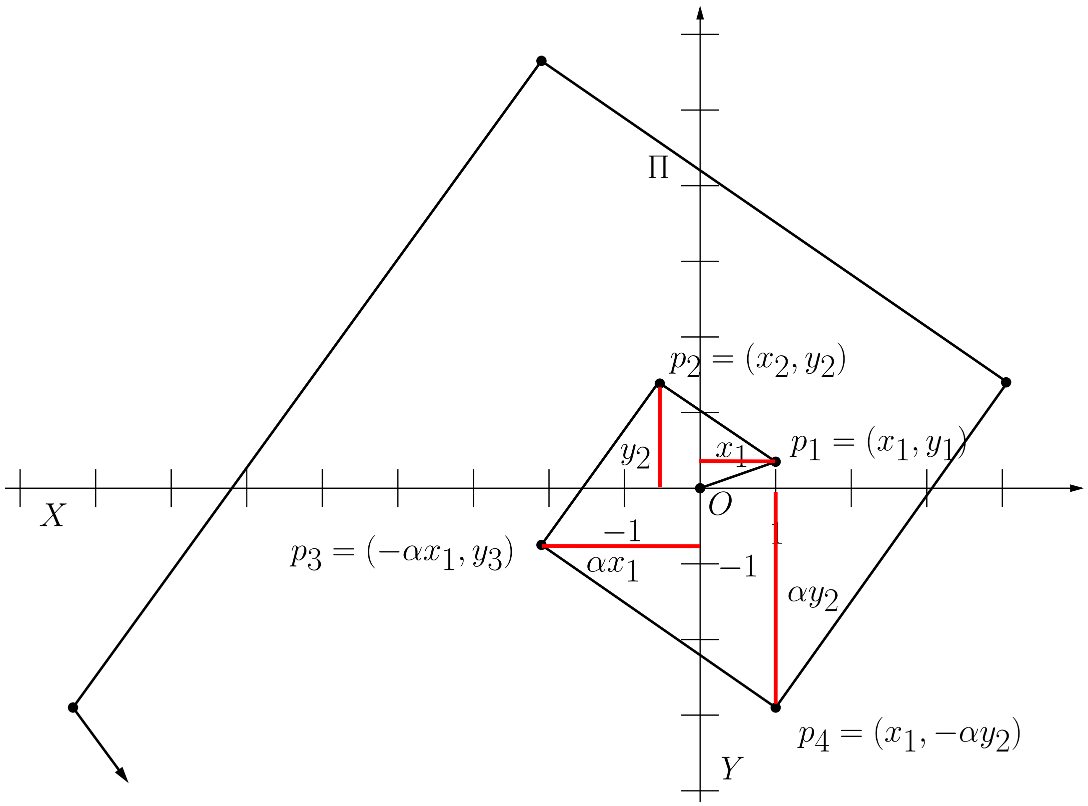

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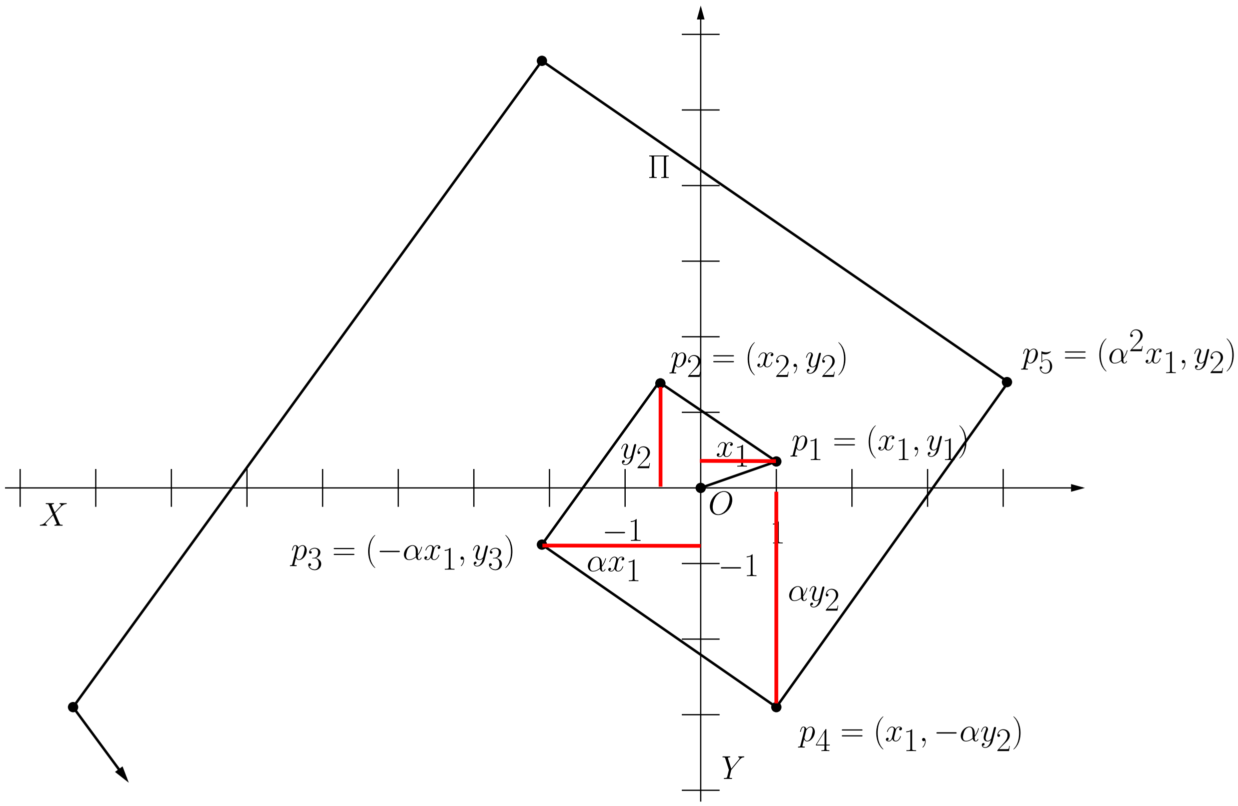

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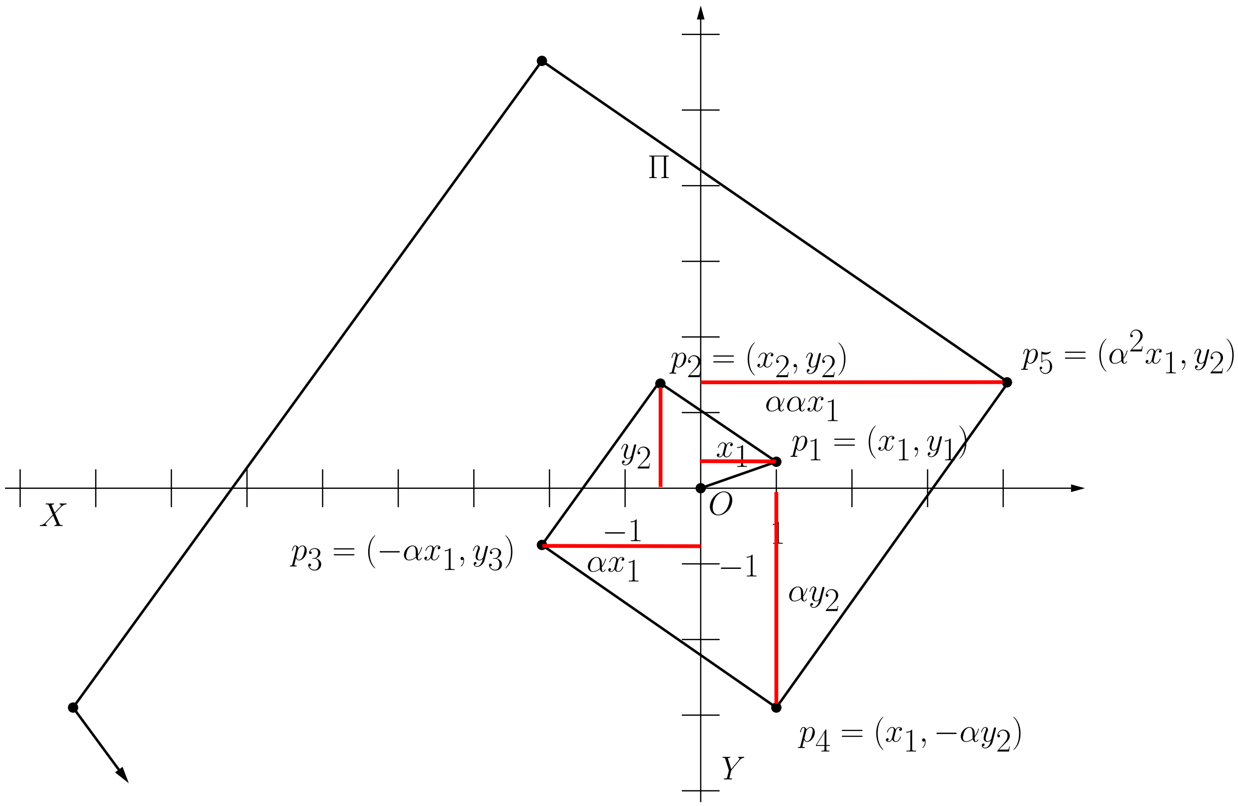

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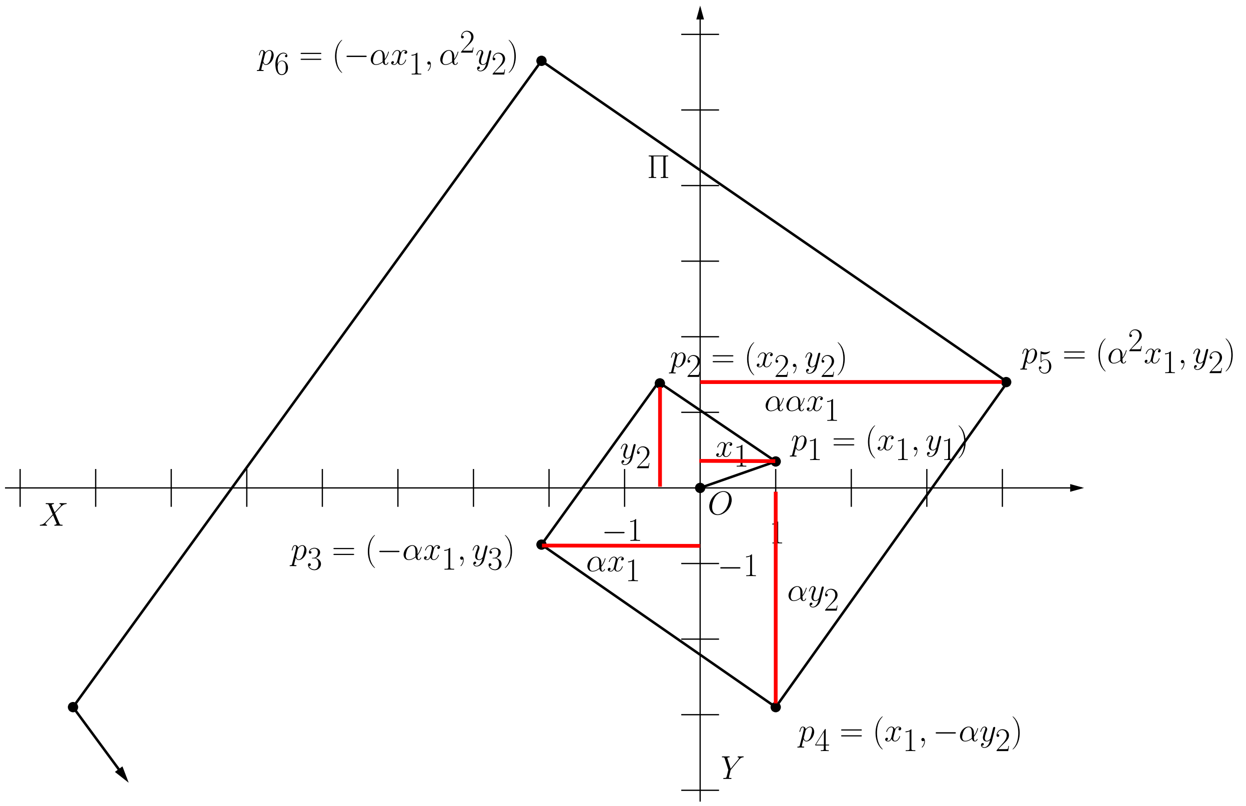

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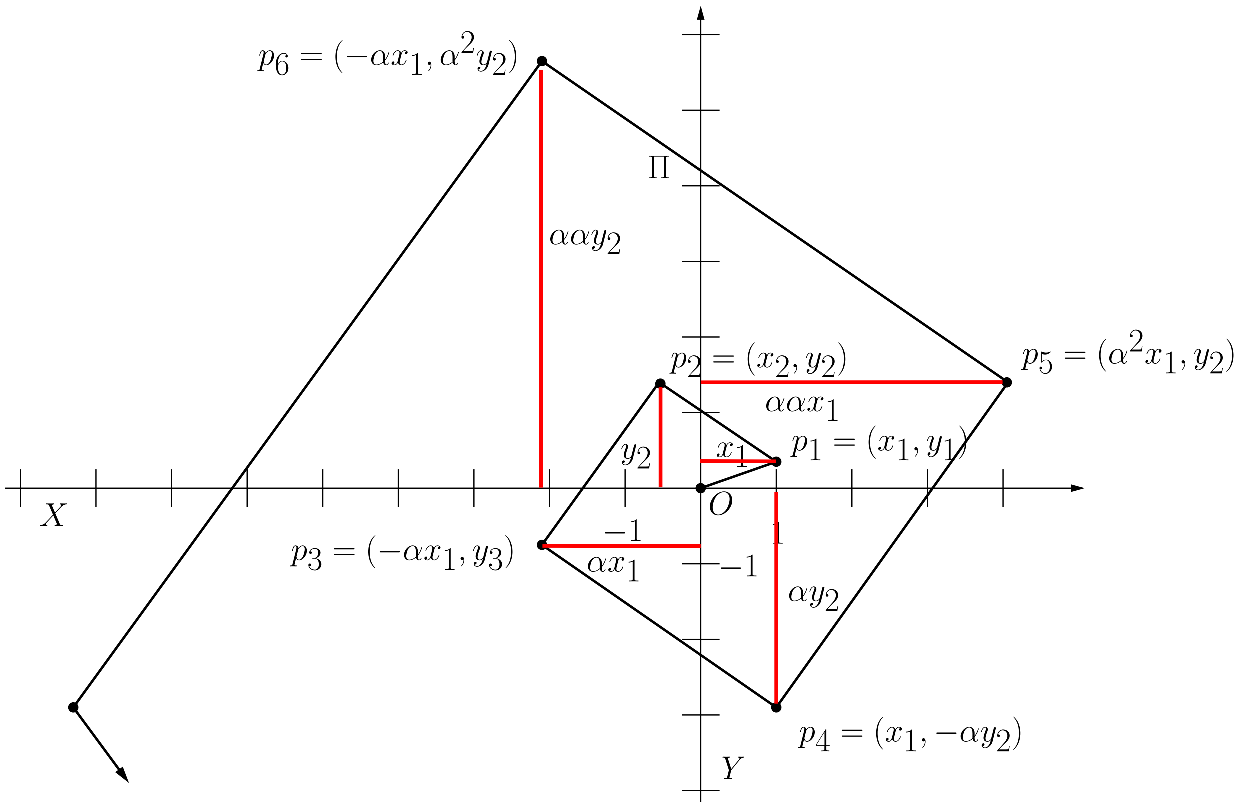

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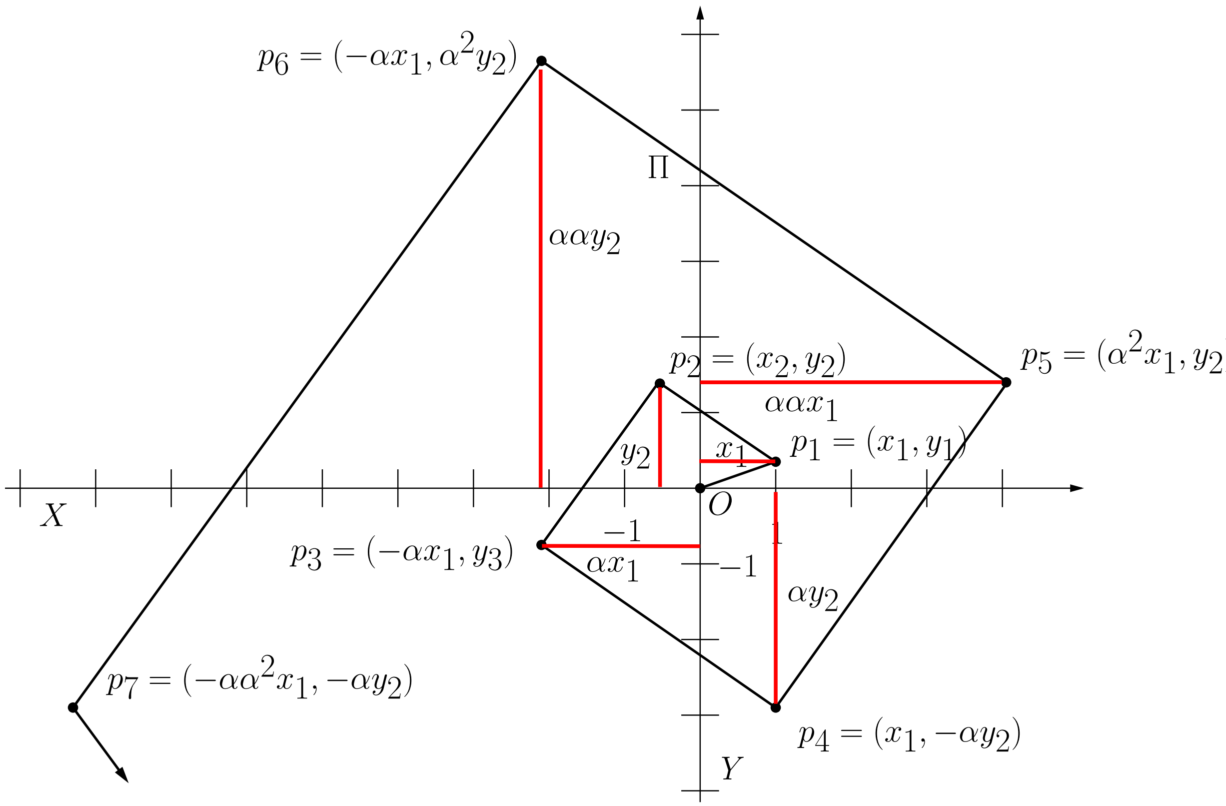

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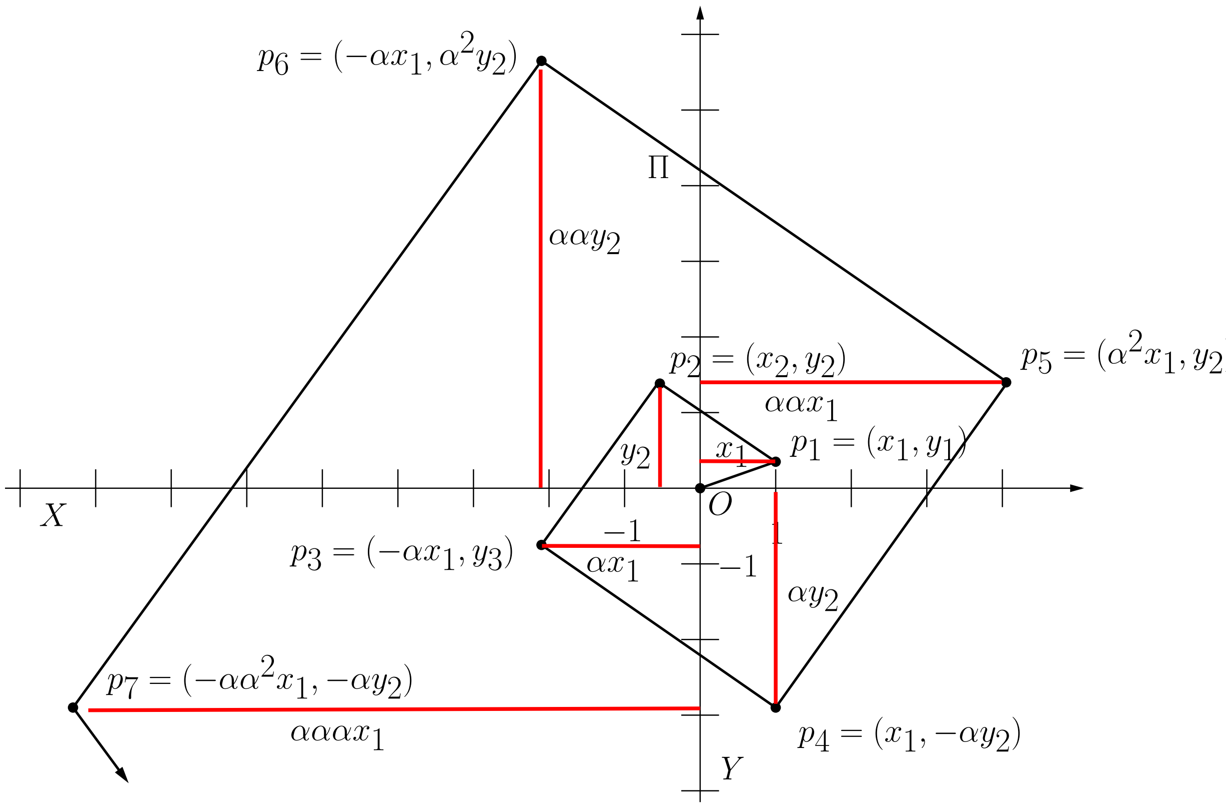

Axis-parallel shorelines

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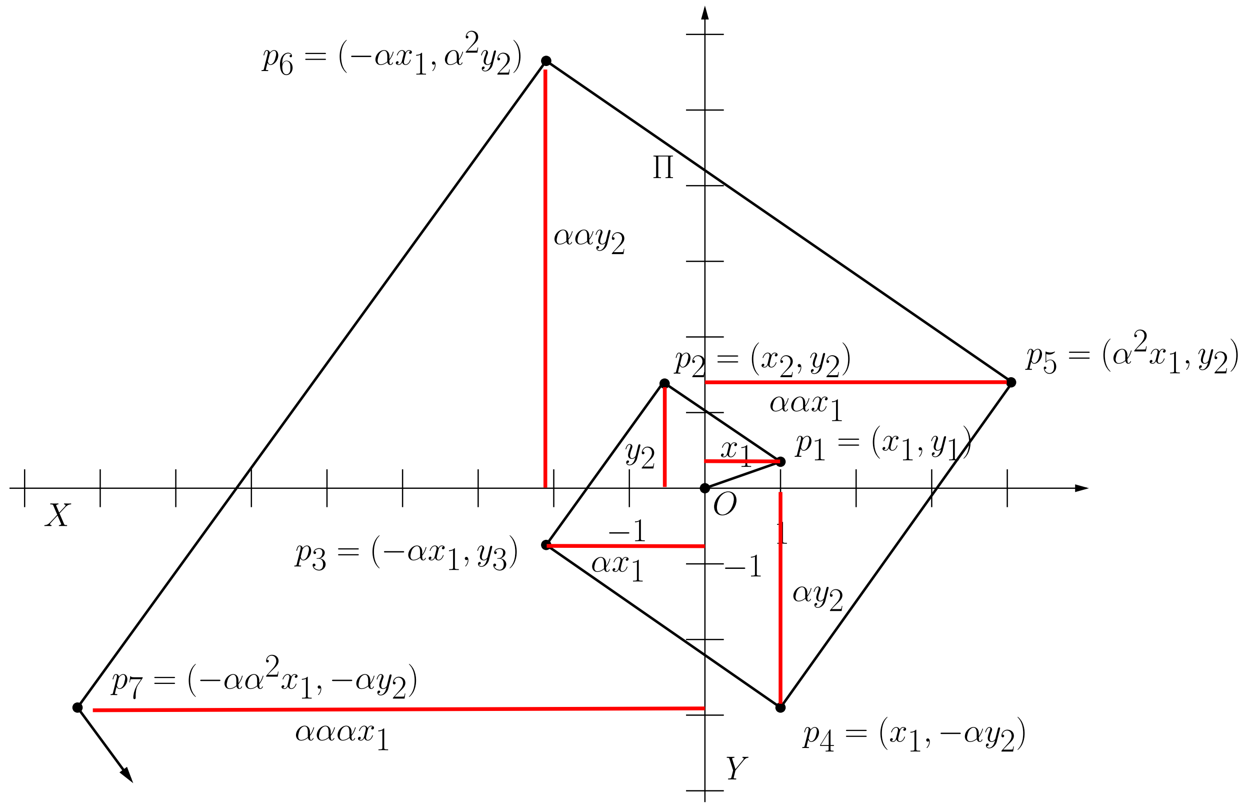
- Cyclic, expansion α
- x_1, αx_1, y_2, αy_2
- Discrete α-spiral



$$x_{2k+1} = -\alpha\, x_{2k-1}, x_{2k} = x_{2k-3}$$
$$y_{2k+1} = y_{2k-2}, y_{2k+2} = -\alpha\, y_{2k}$$

Axis-parallel shorelines

- Subproblem: vertical horizontal
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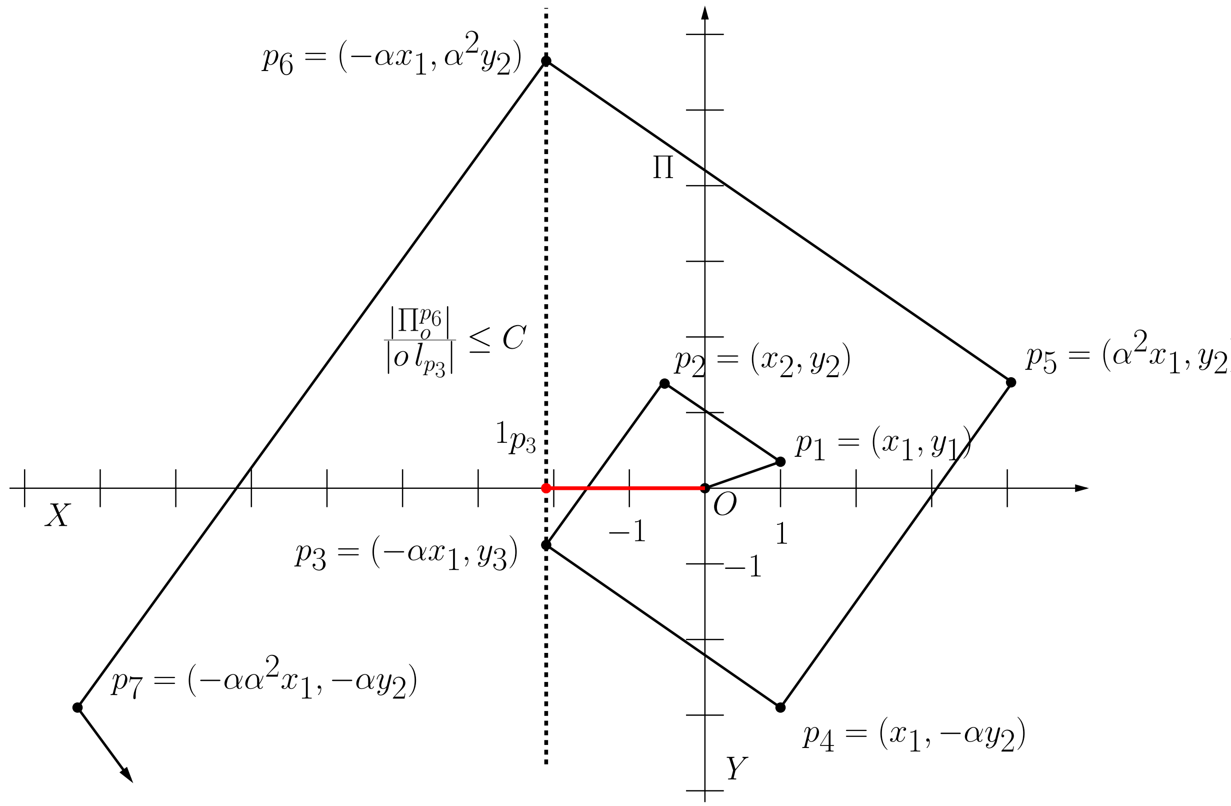
- Worst-case at kinks



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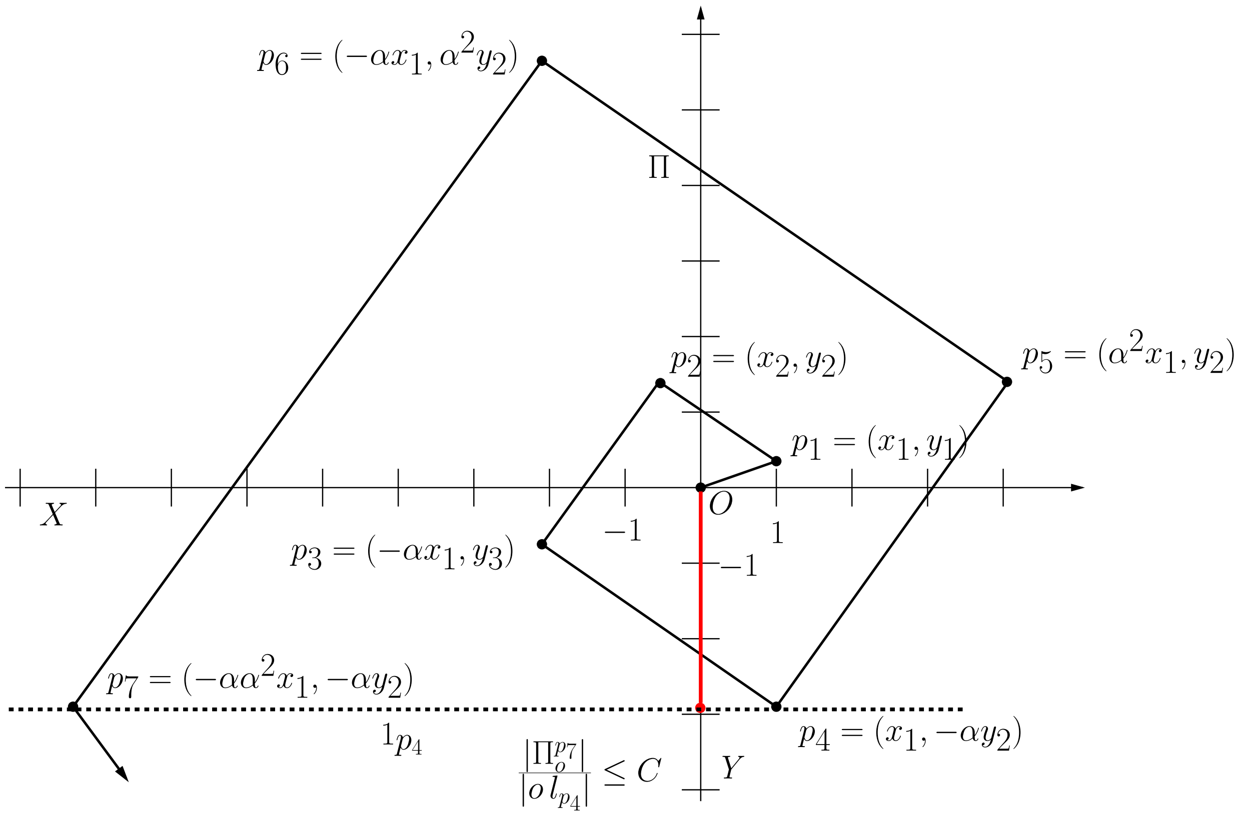

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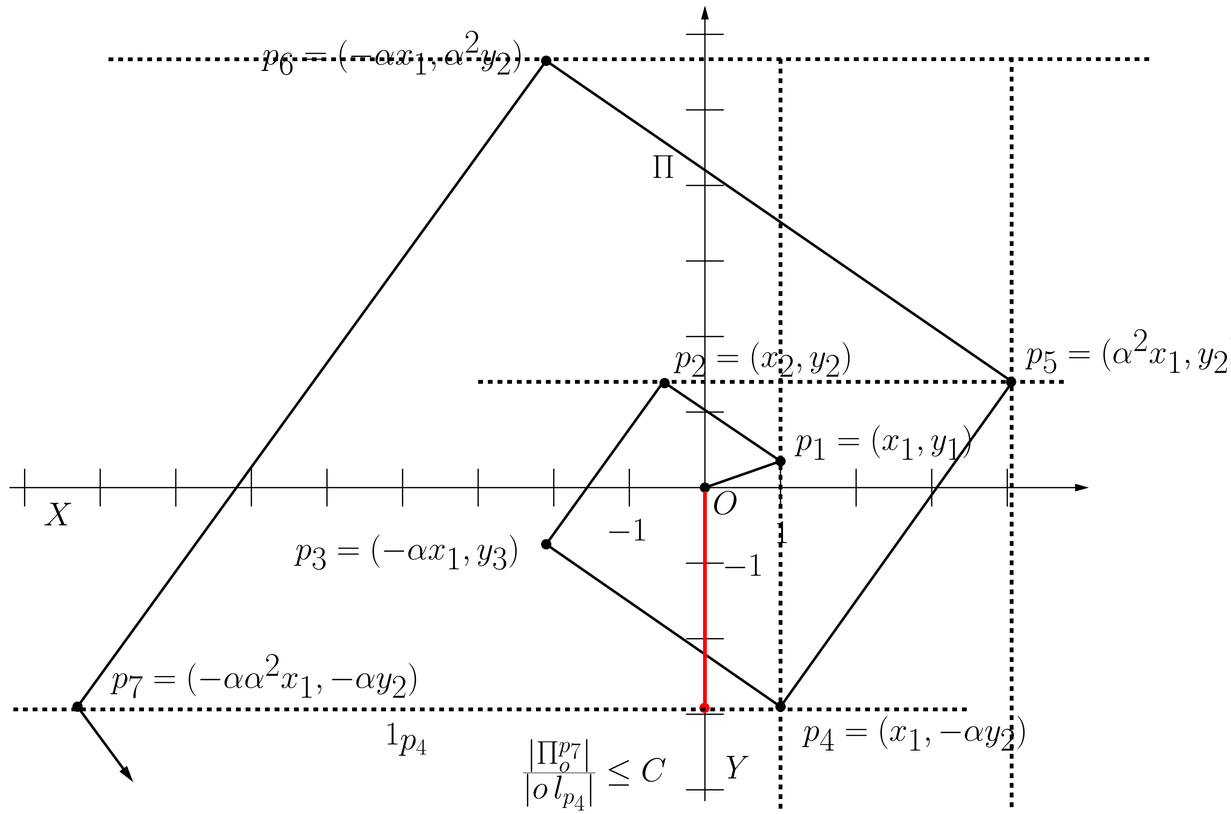

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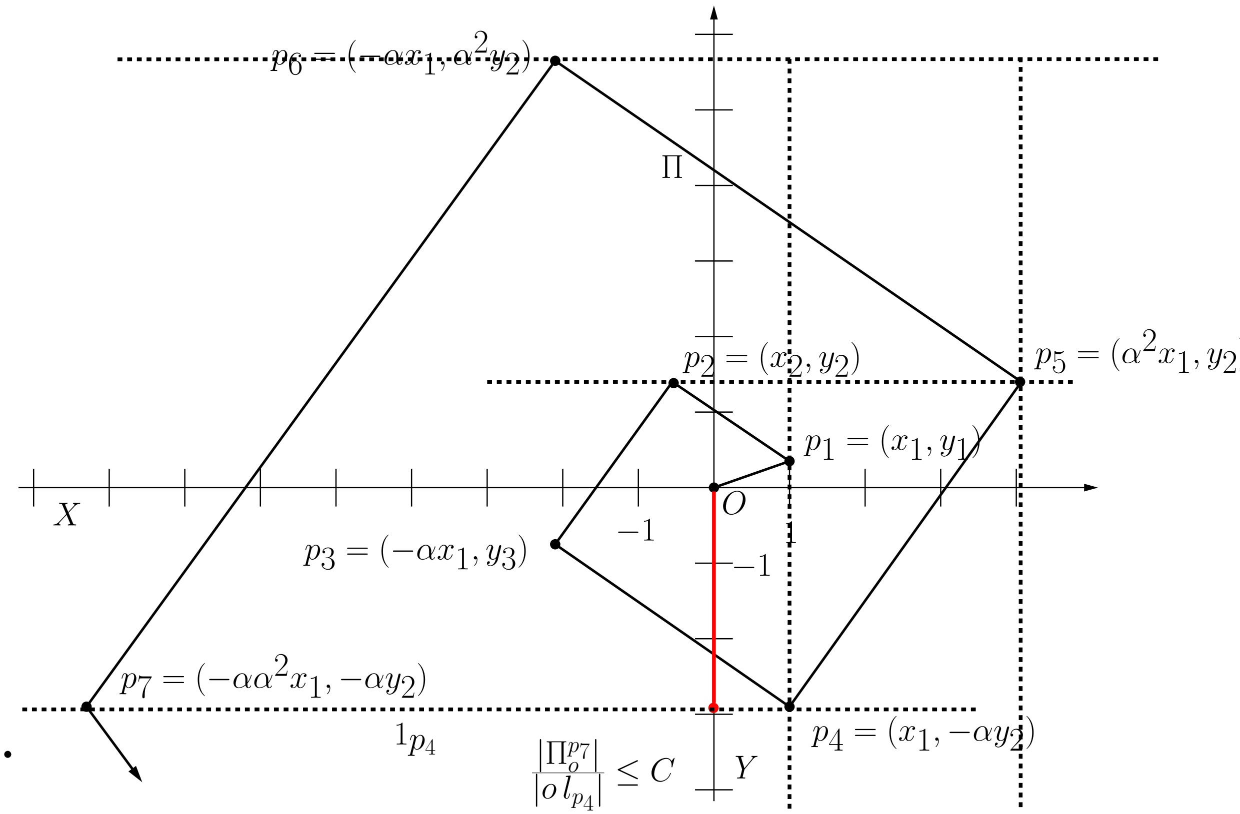
- Worst-case at kinks
- Best α gives $12.54069\ldots$



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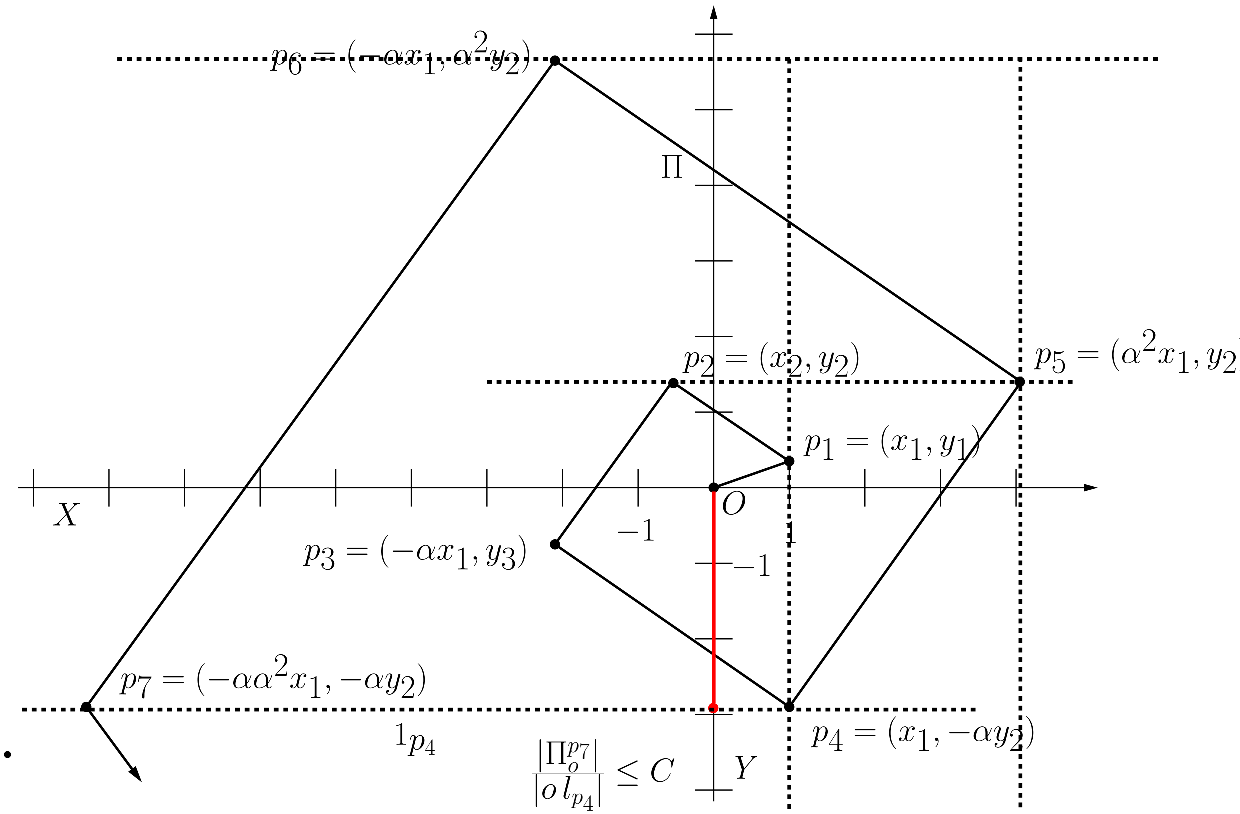

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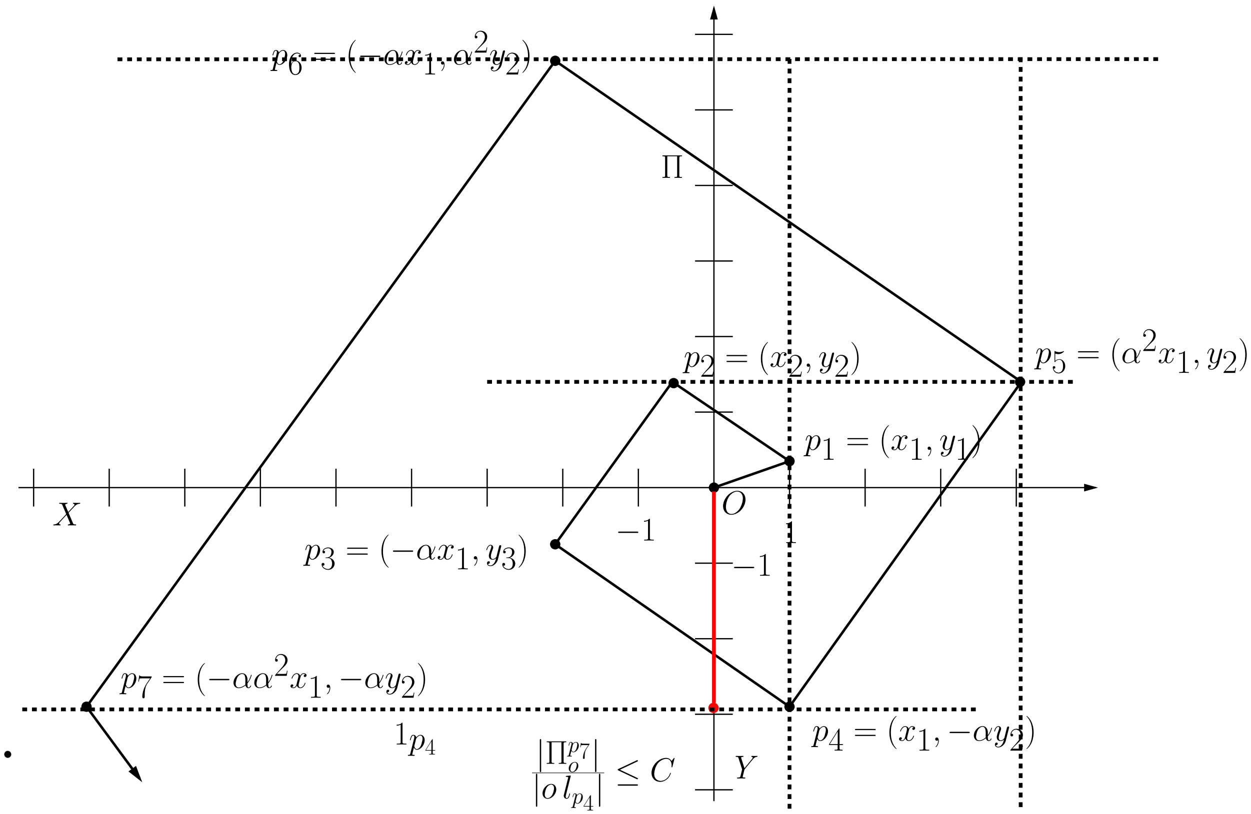
- Answer: No but not bad!



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General cyclic strategies

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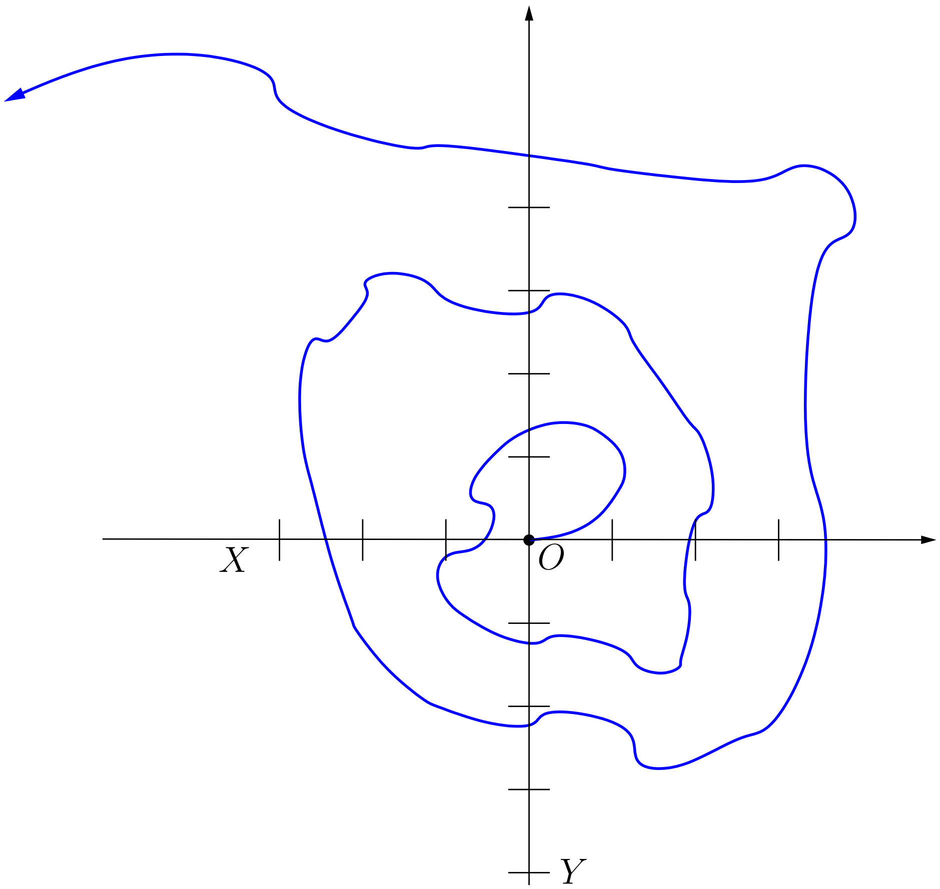
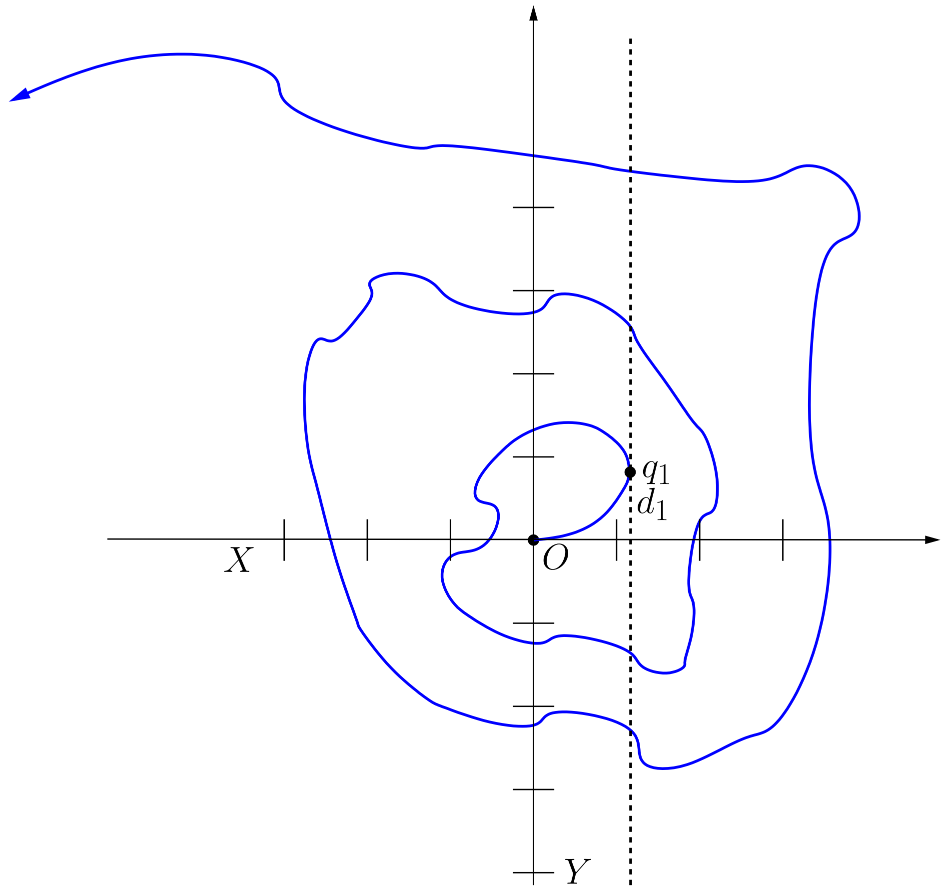


General cyclic strategies

- Cyclic strategy
- Expands directions q_i



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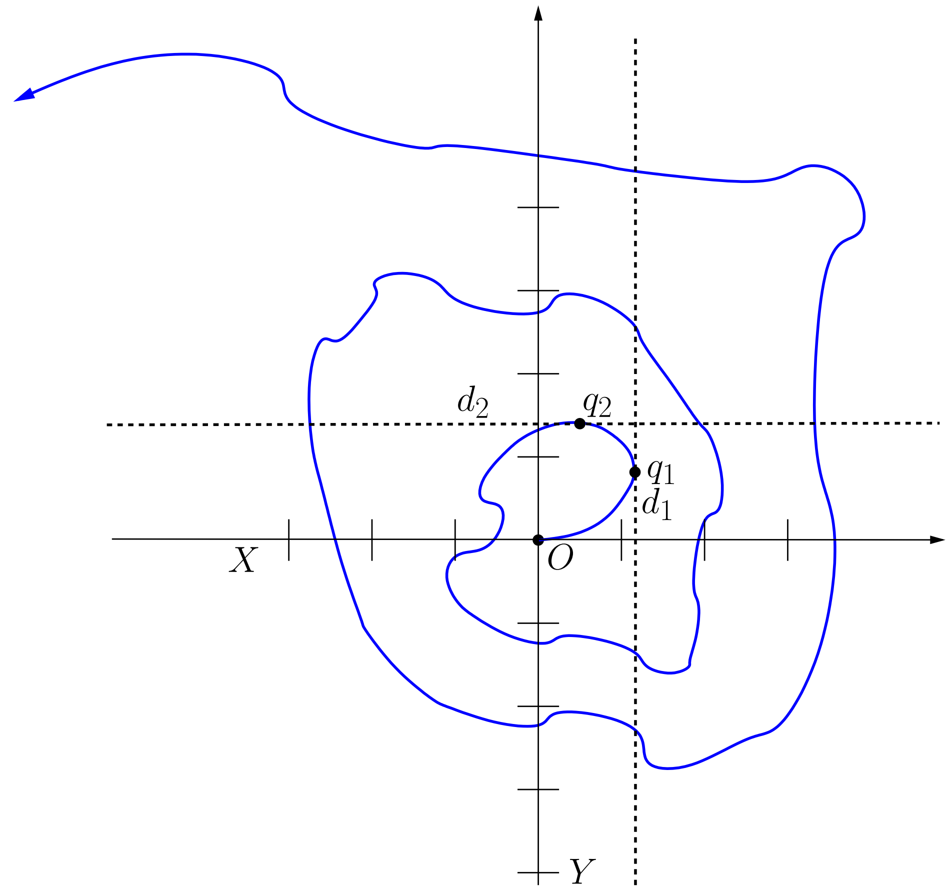

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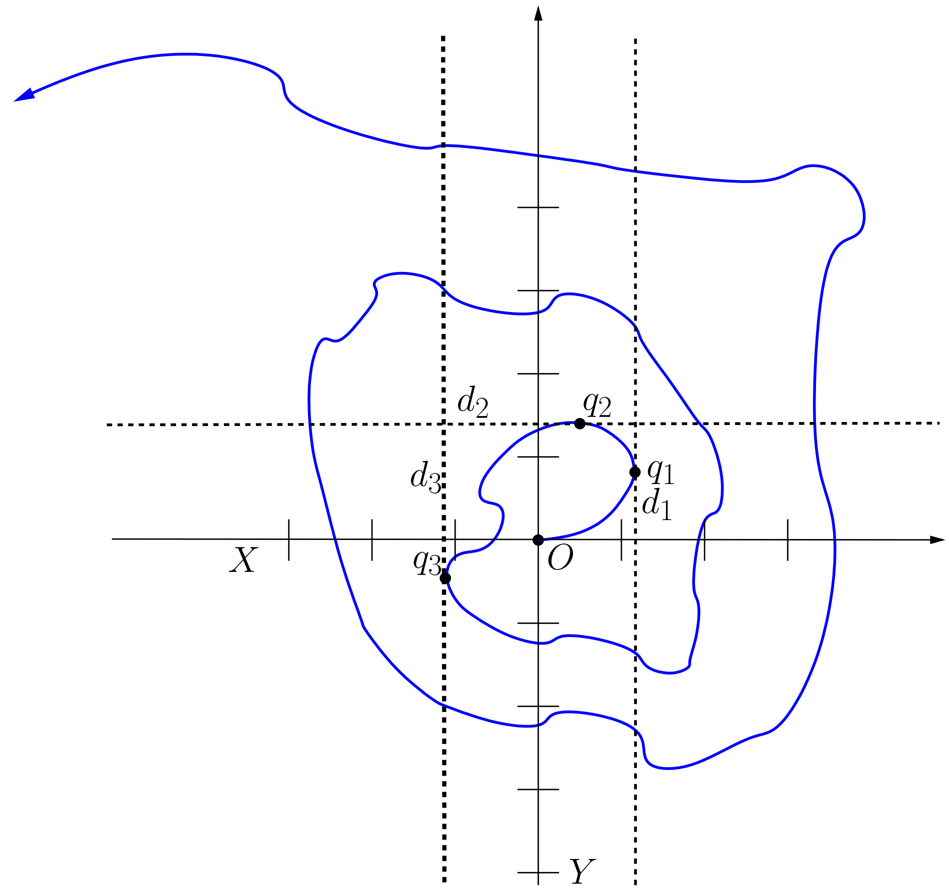

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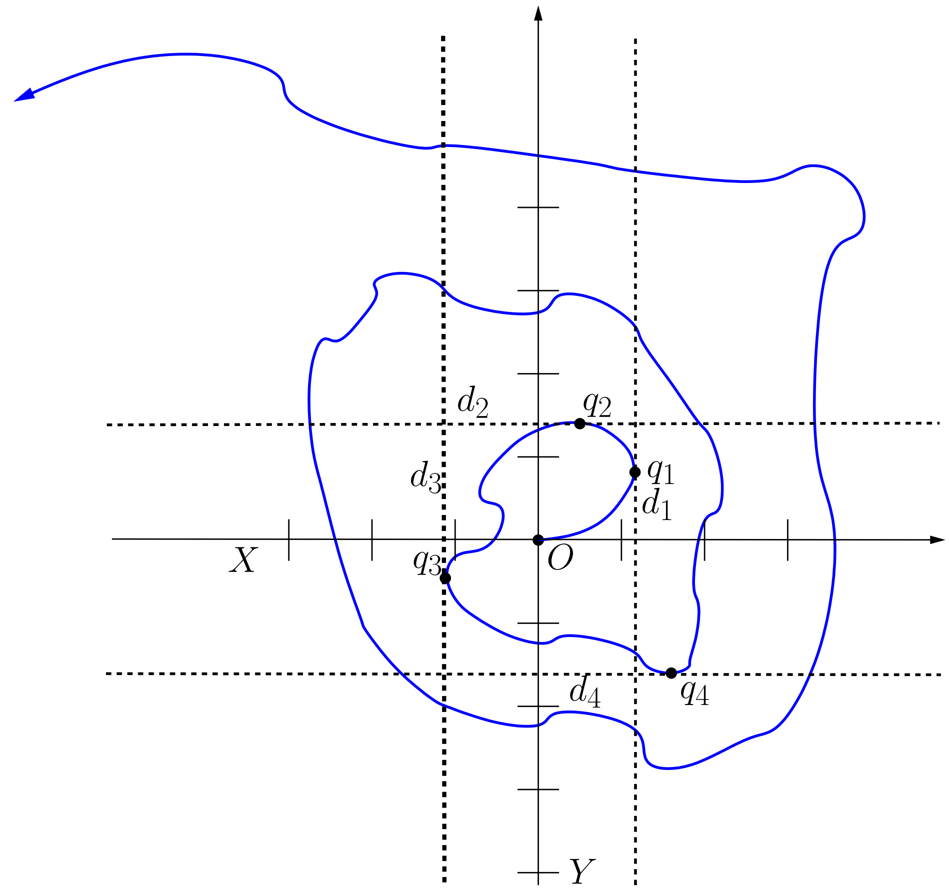

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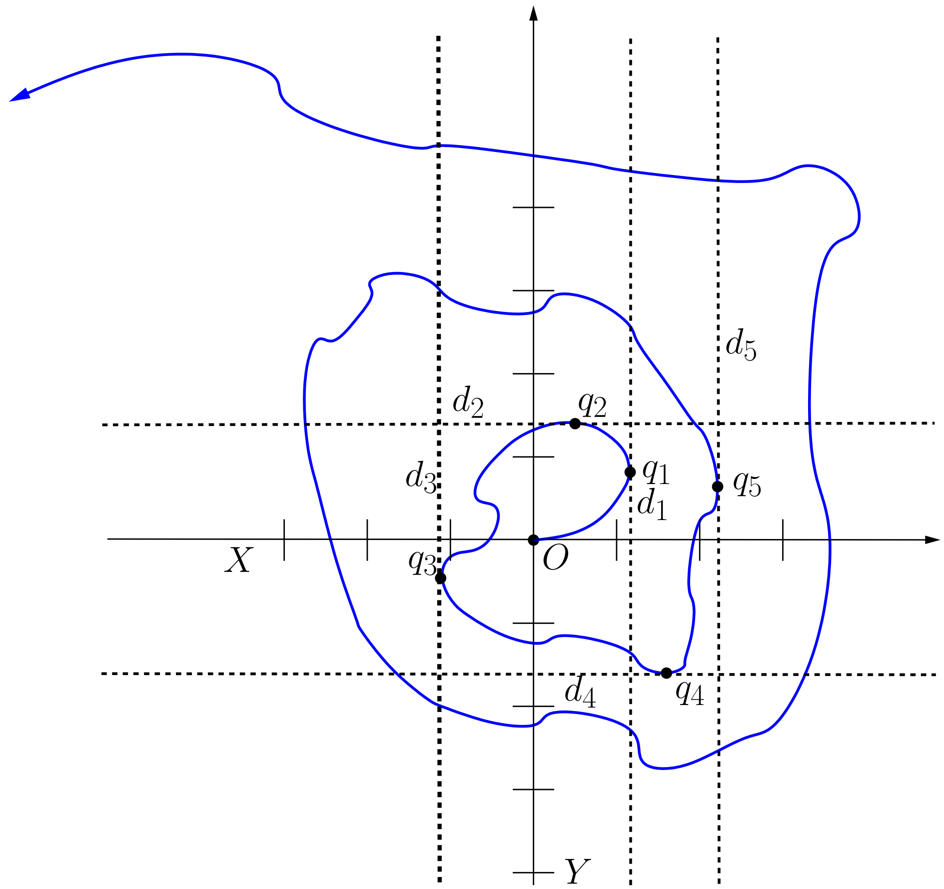

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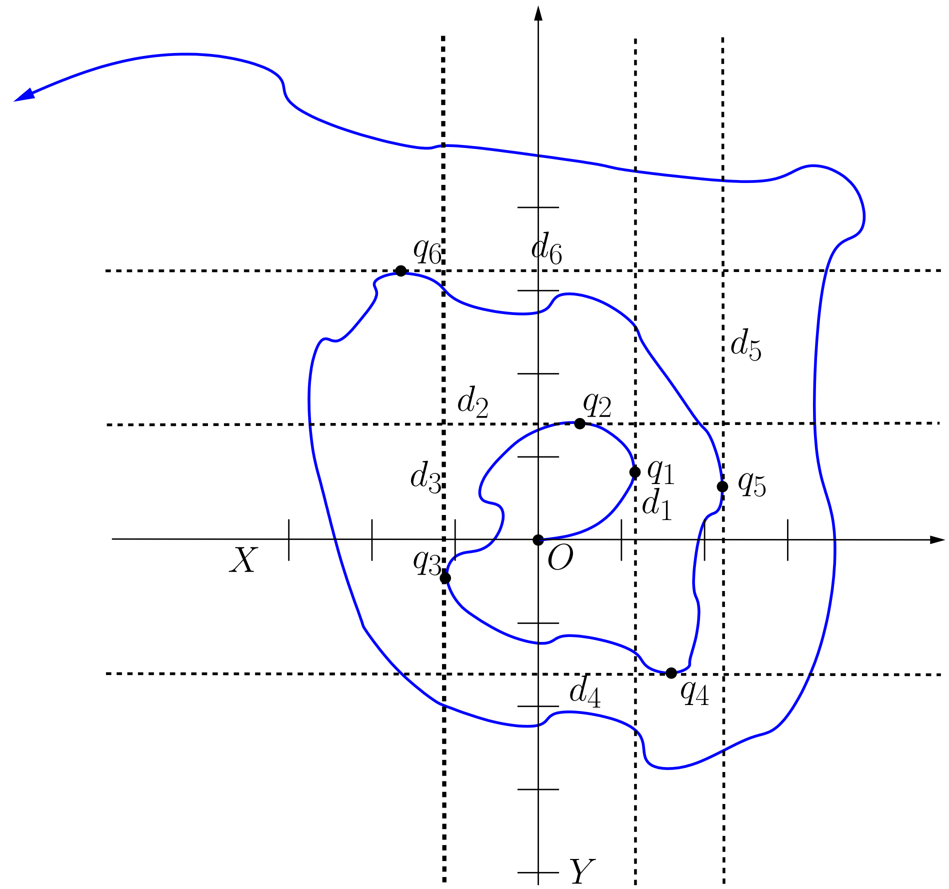

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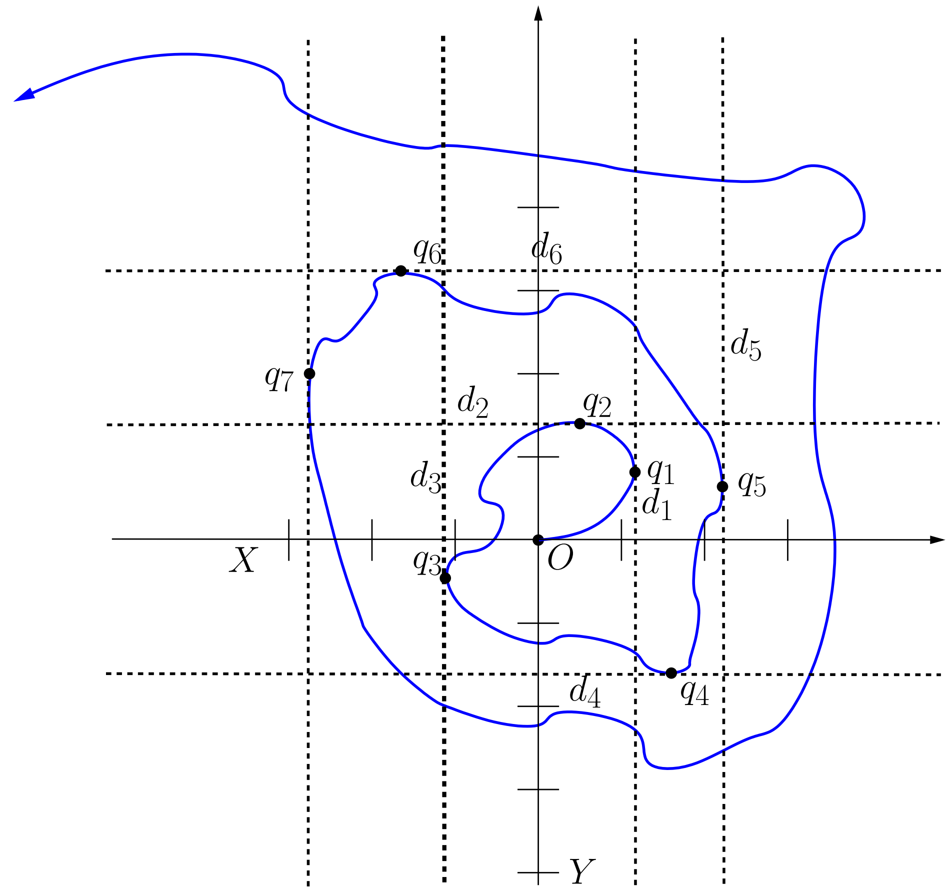

General cyclic strategies

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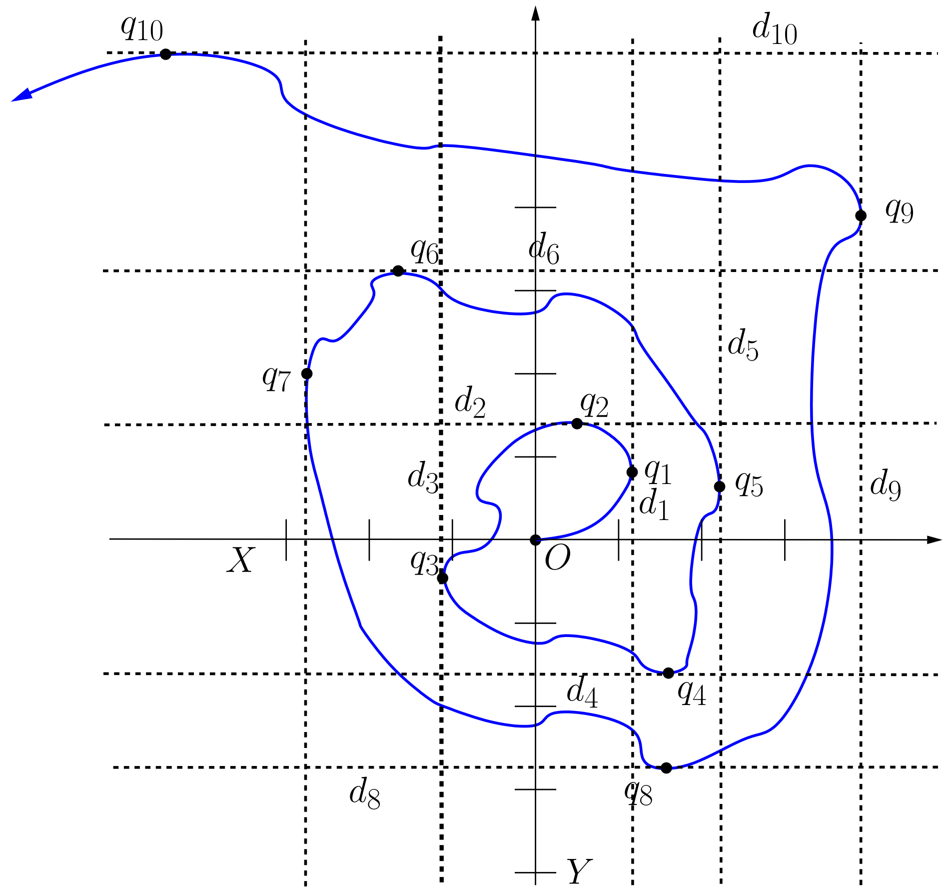
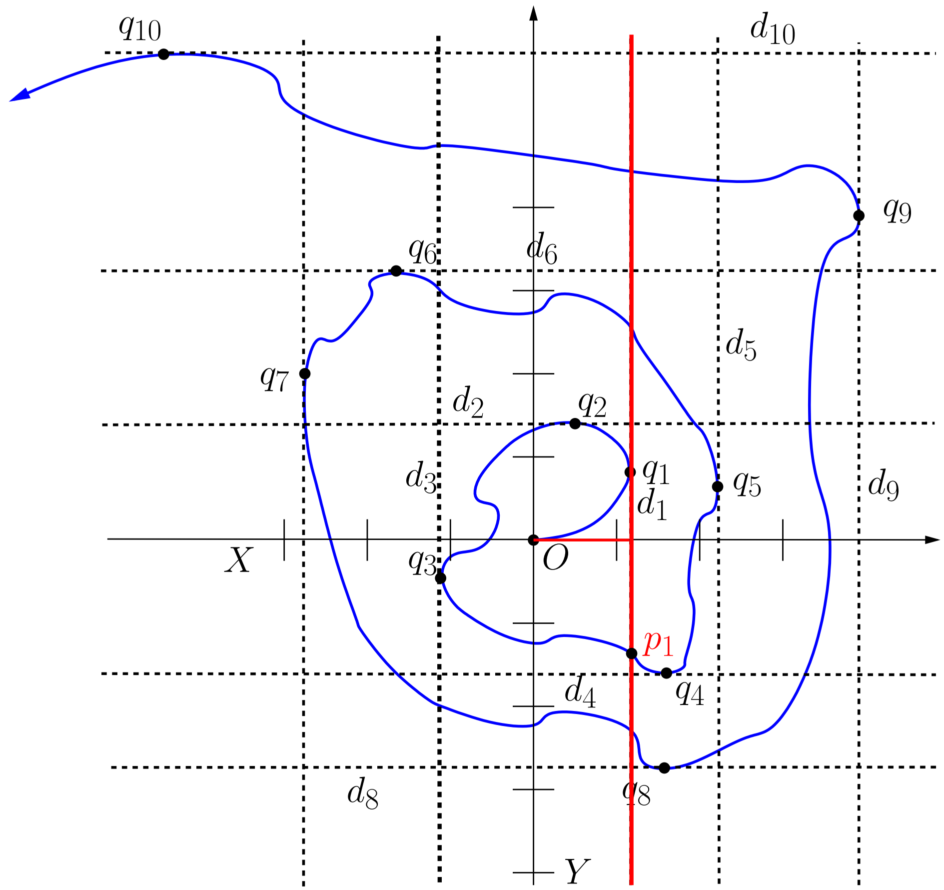


General cyclic strategies

- Cyclic strategy
- Expands directions q_i
- Local worst-cases p_i



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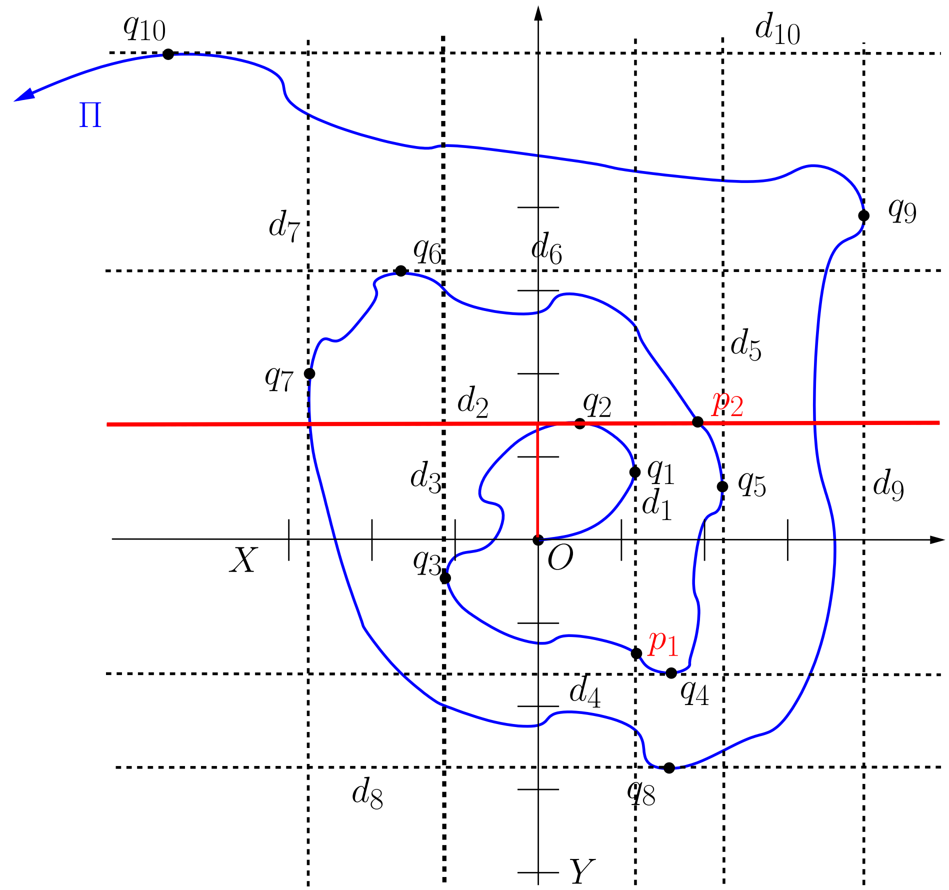

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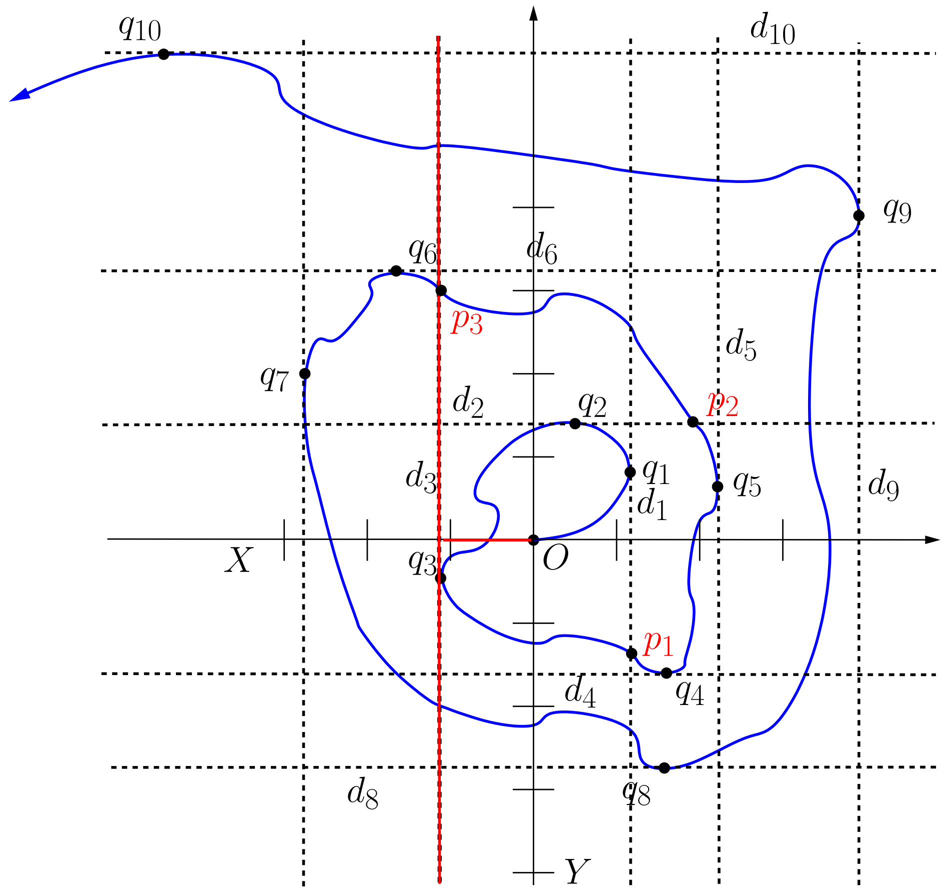

General cyclic strategies

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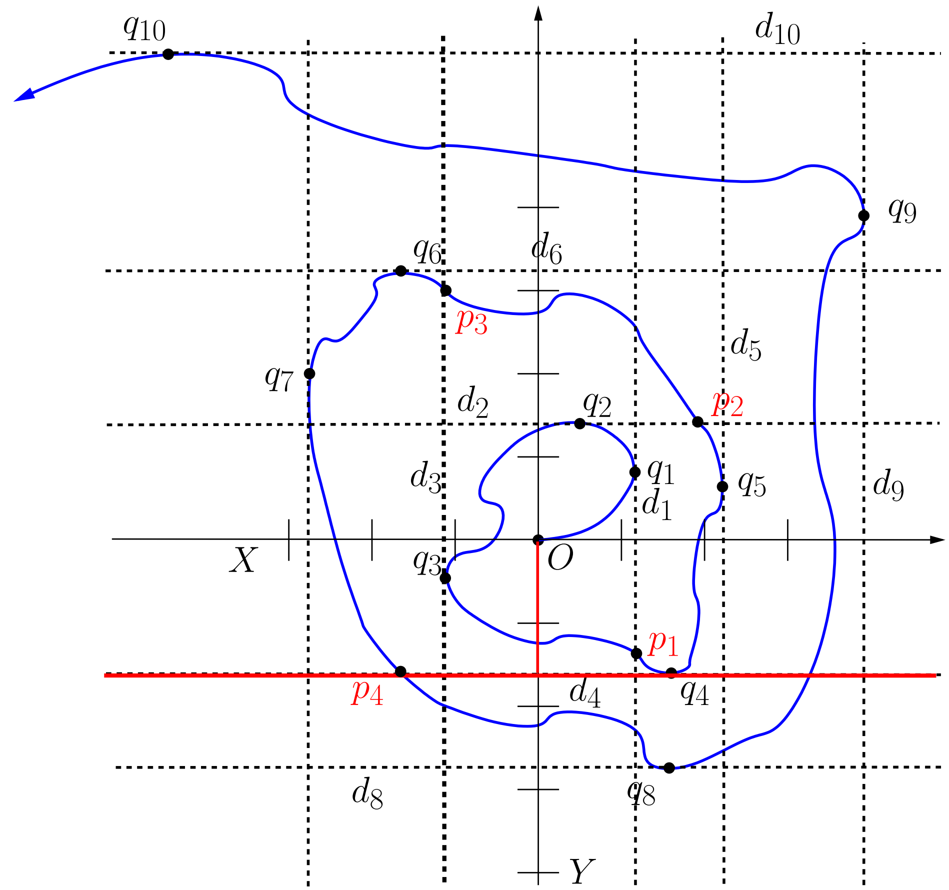

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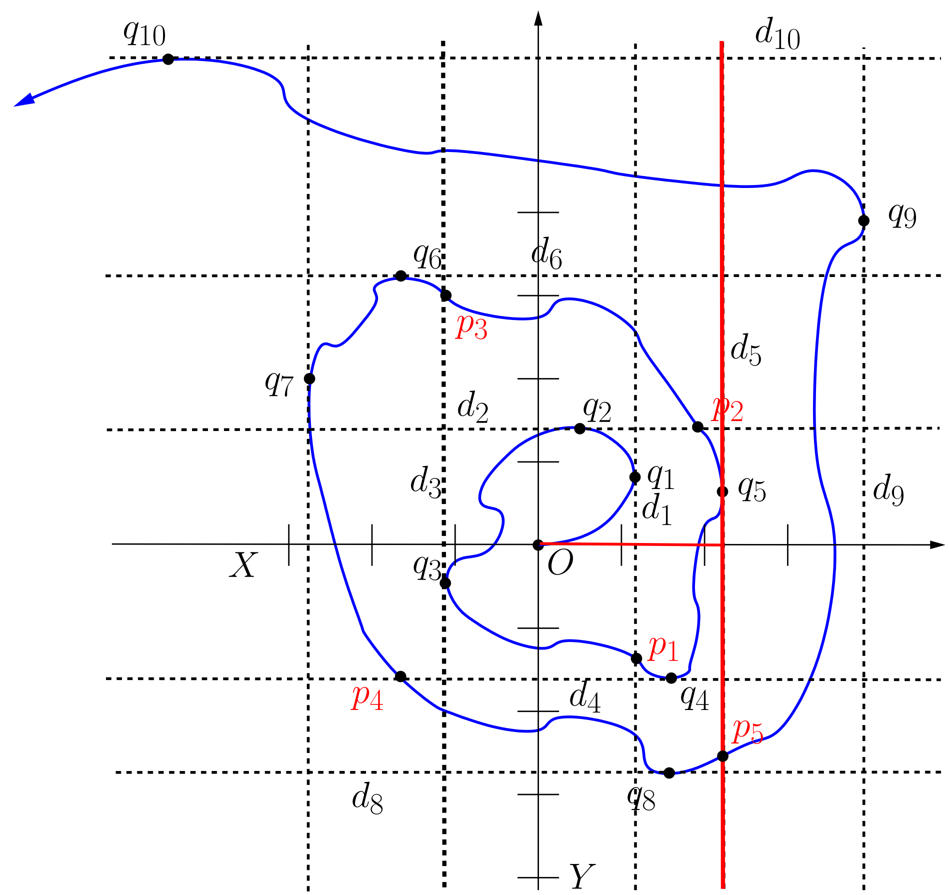

General cyclic strategies

- Cyclic strategy
- Expands directions q_i
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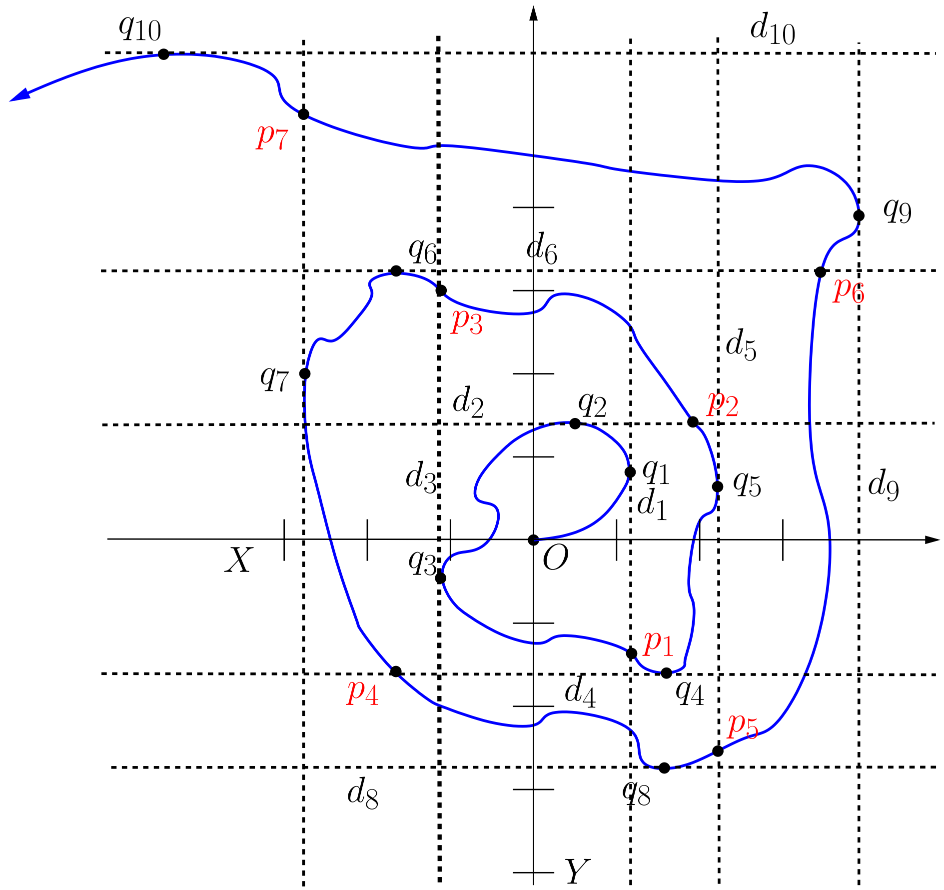
- Two sequences p_i, q_i



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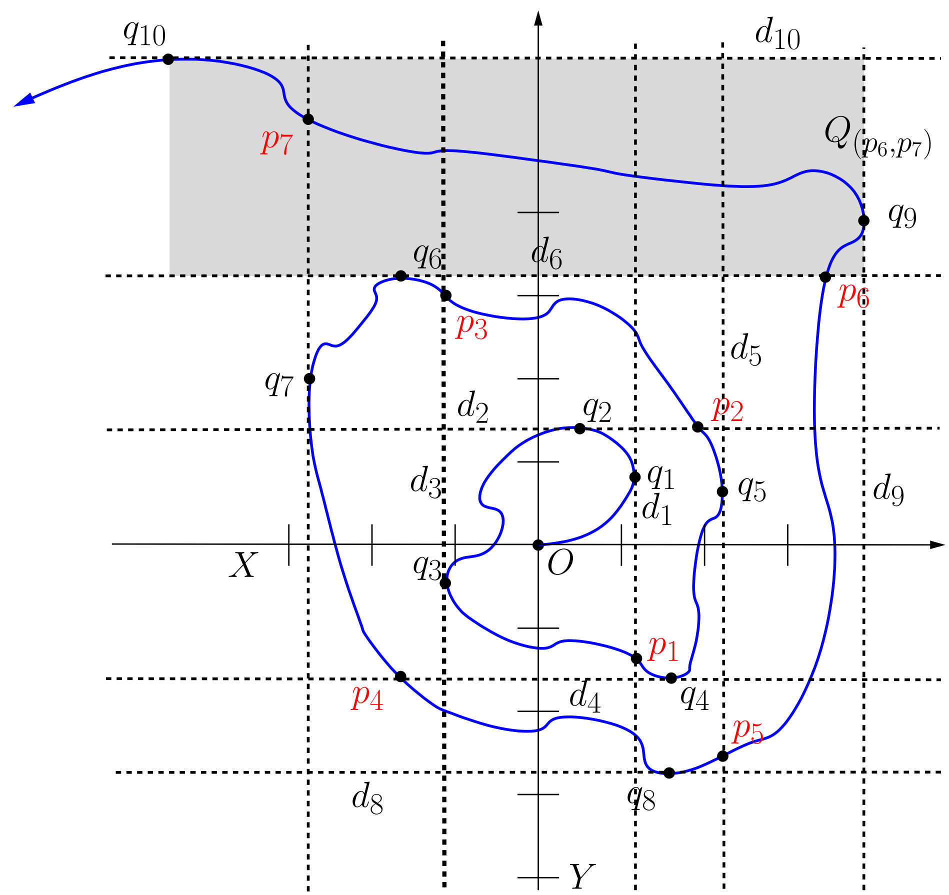

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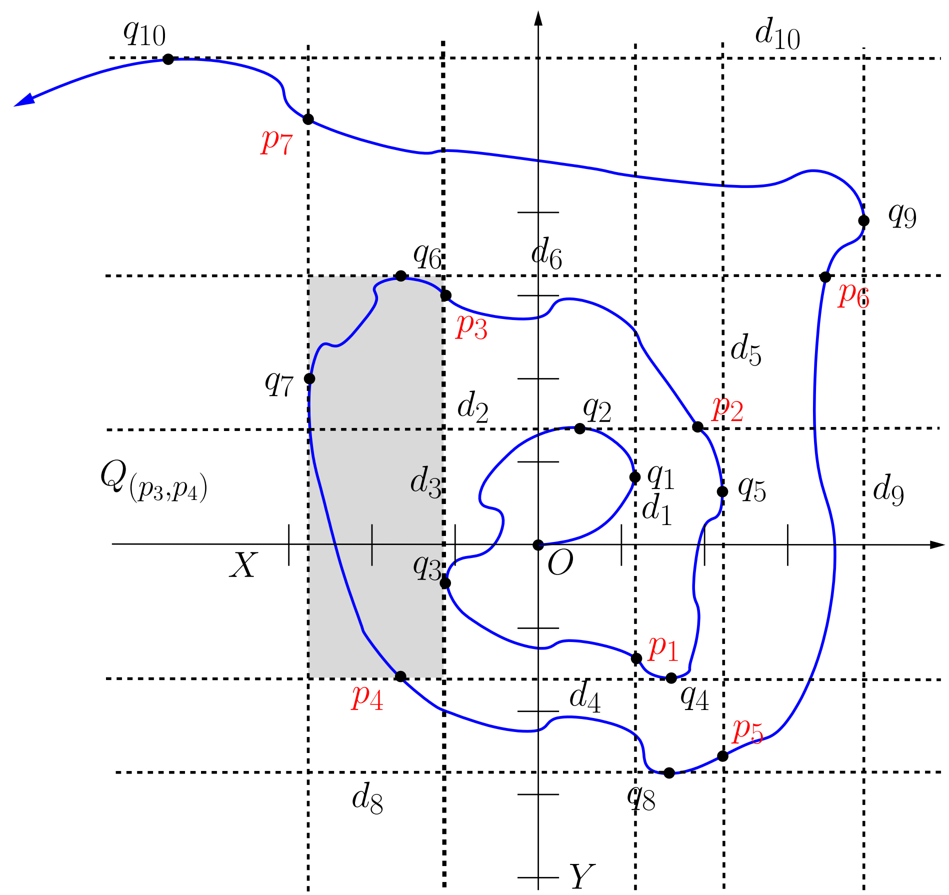

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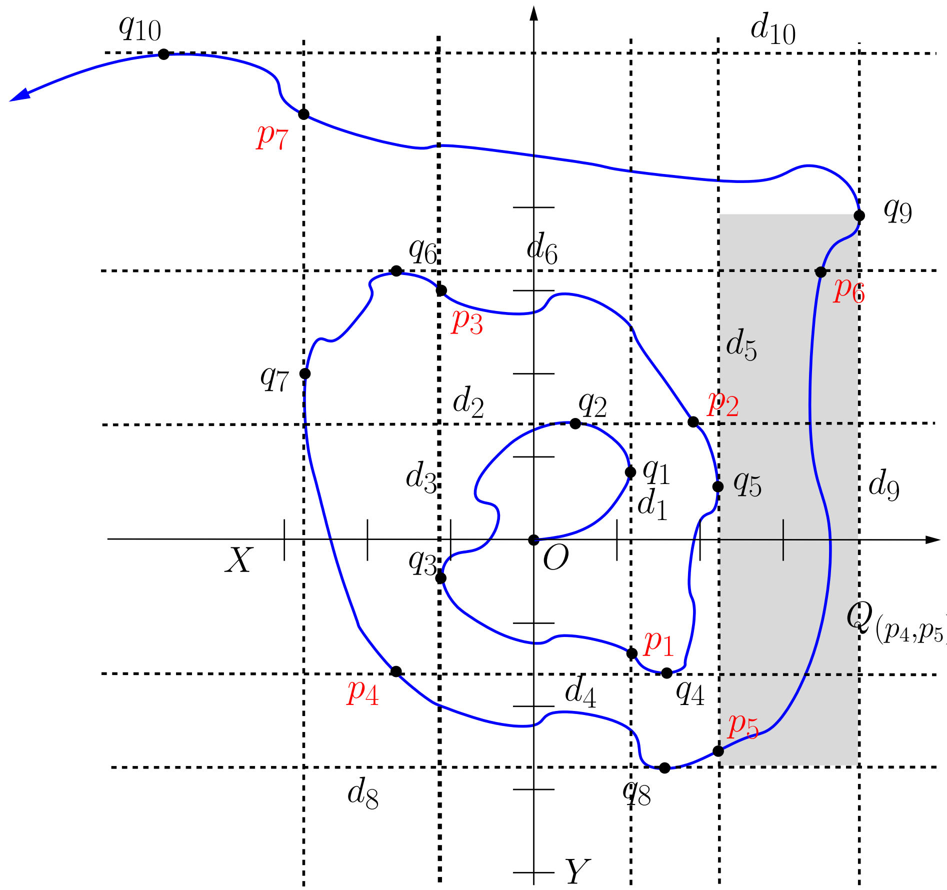

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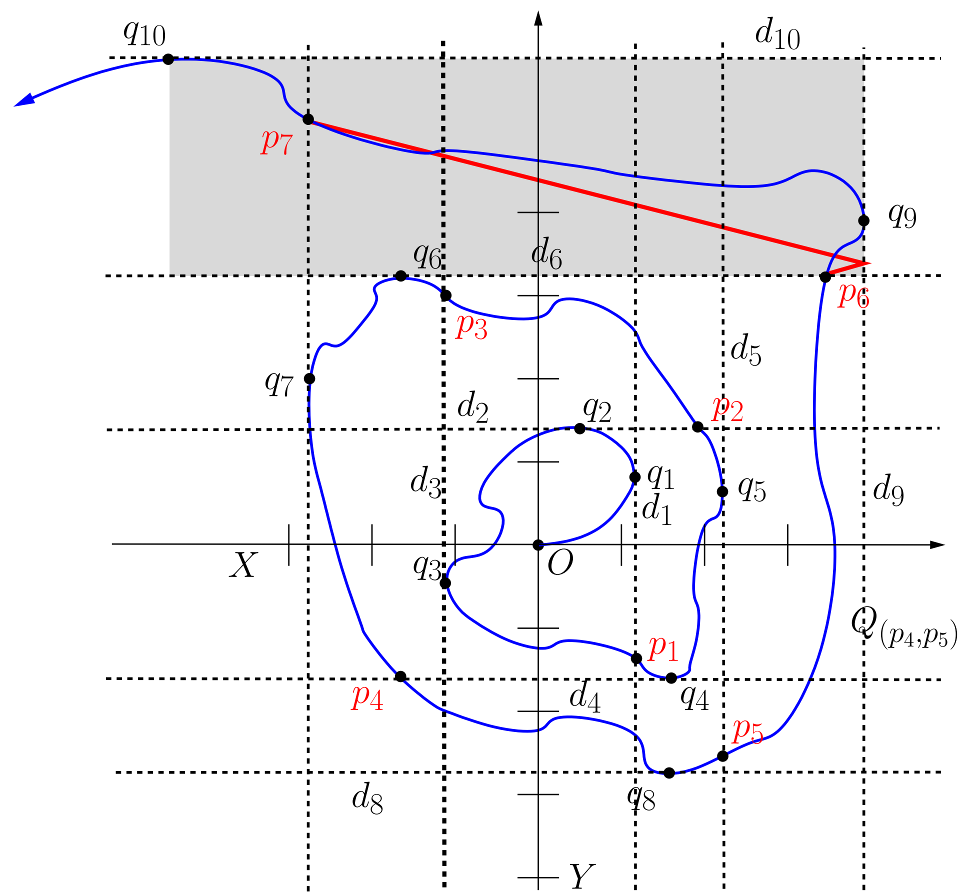

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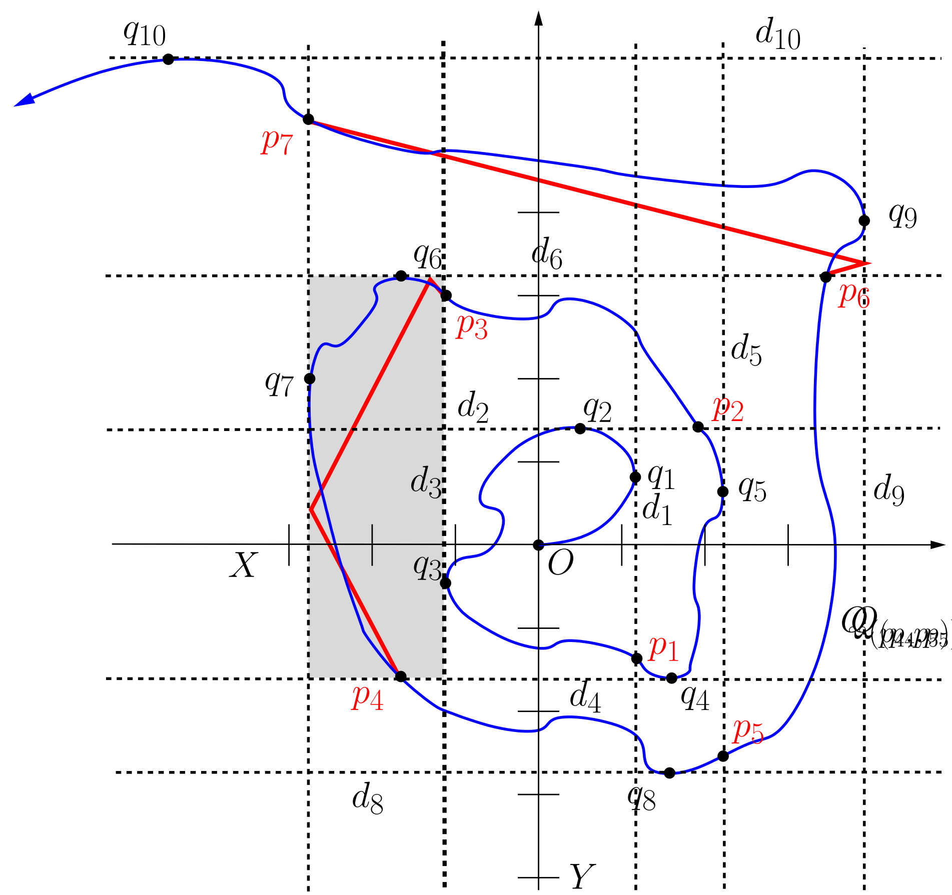

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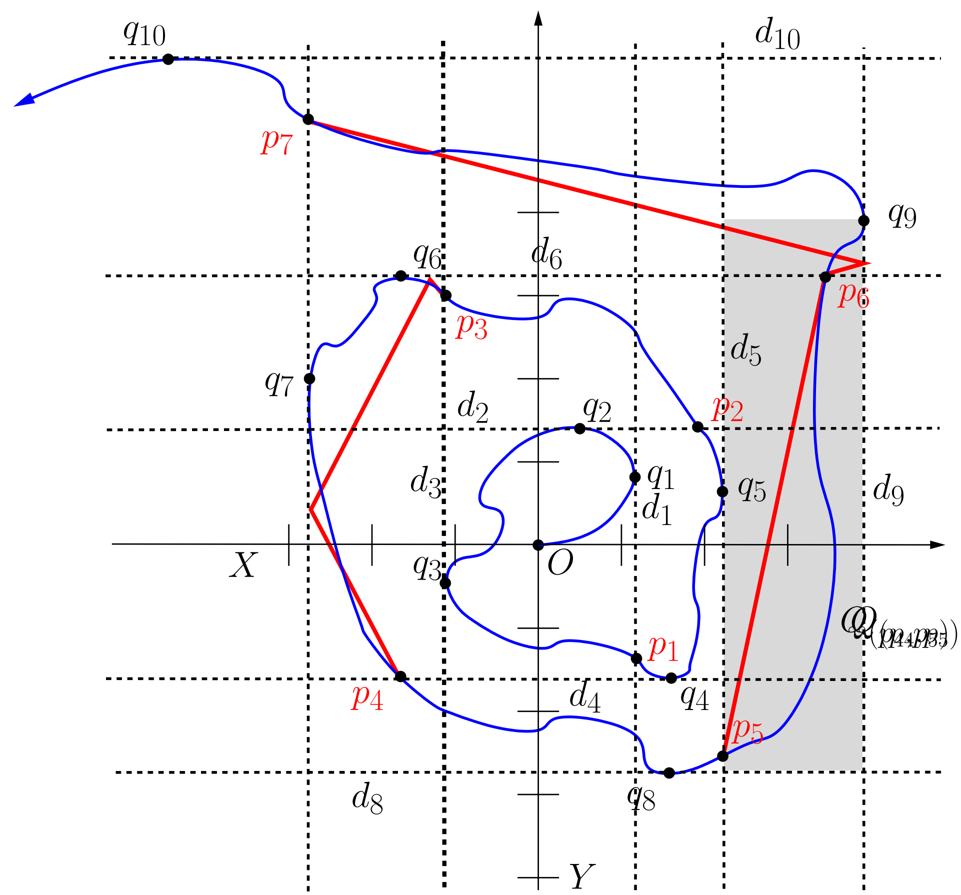

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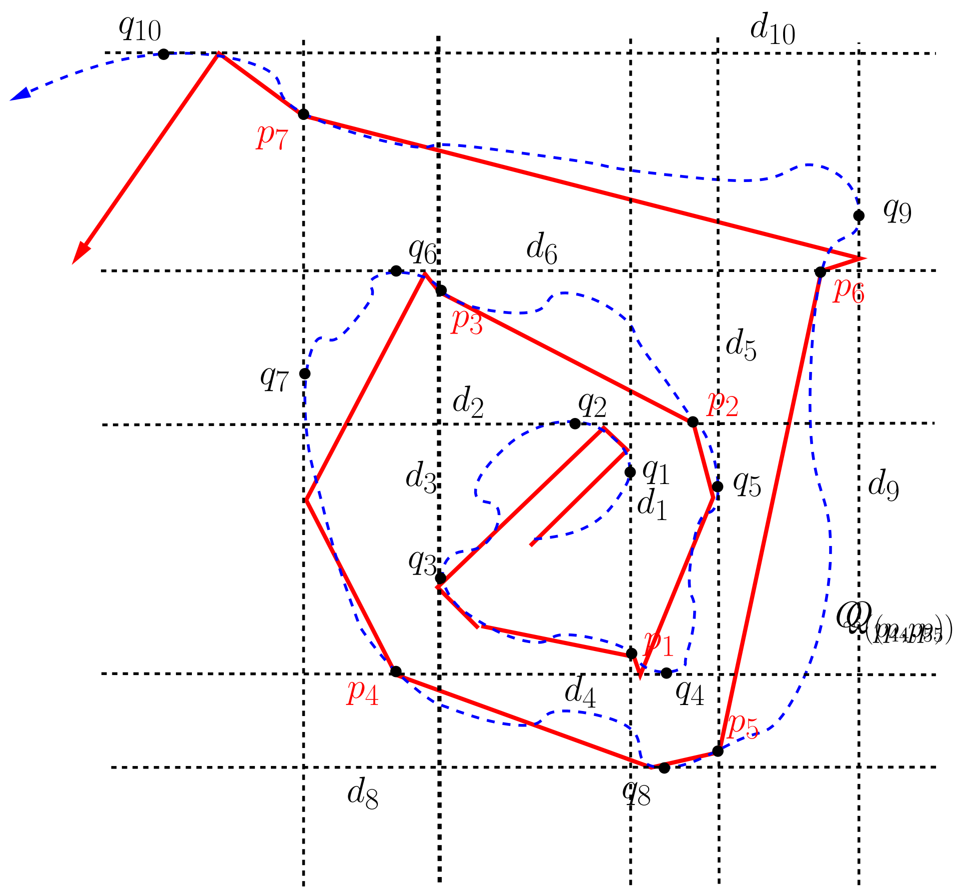

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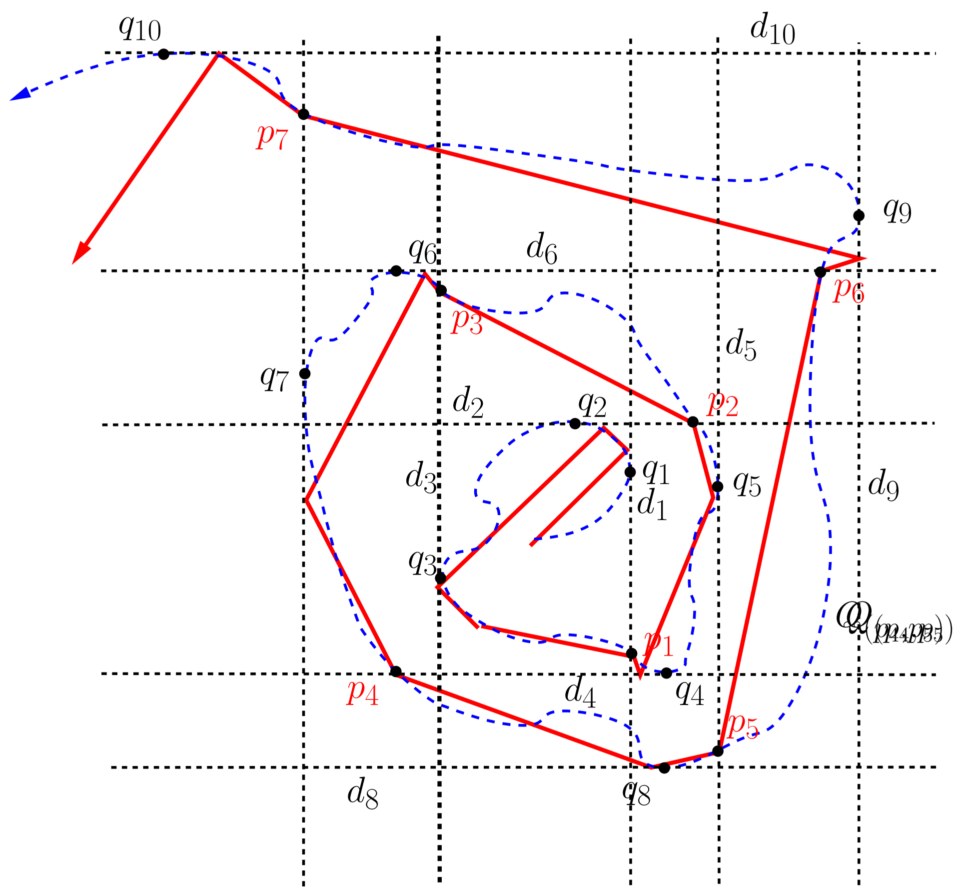

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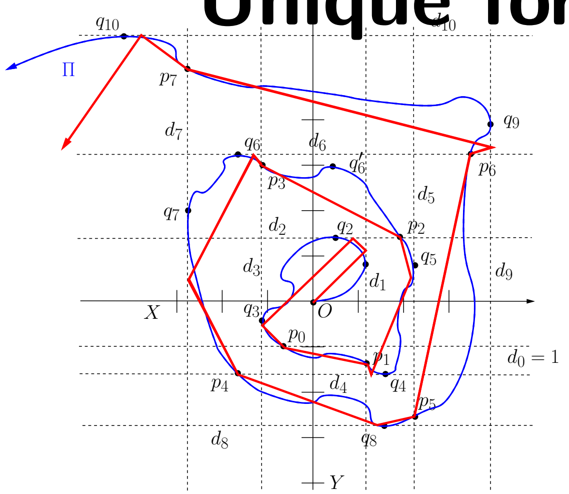
Unique formula! Sketch!



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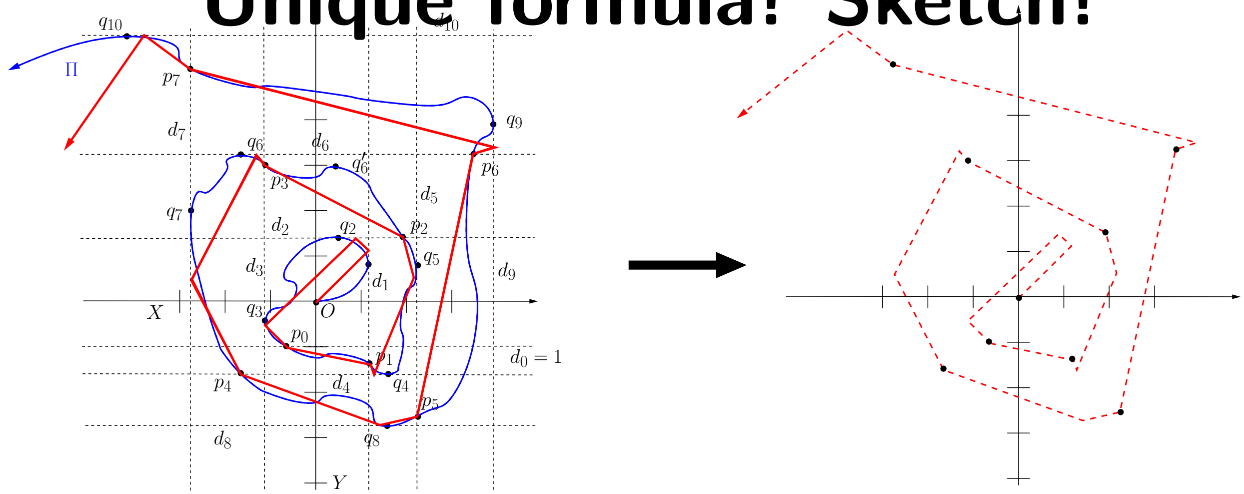

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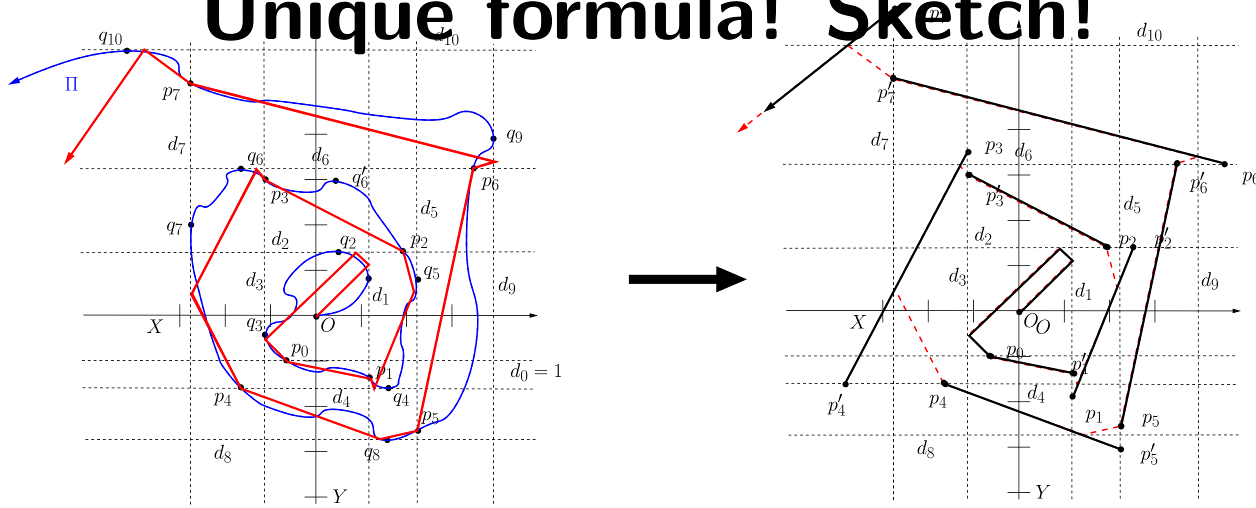

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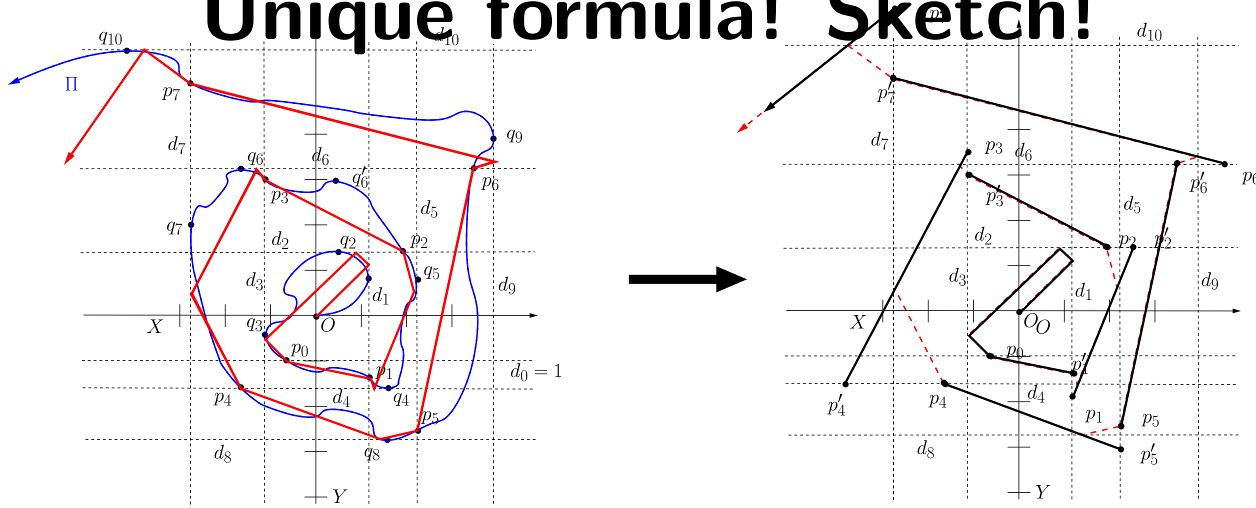

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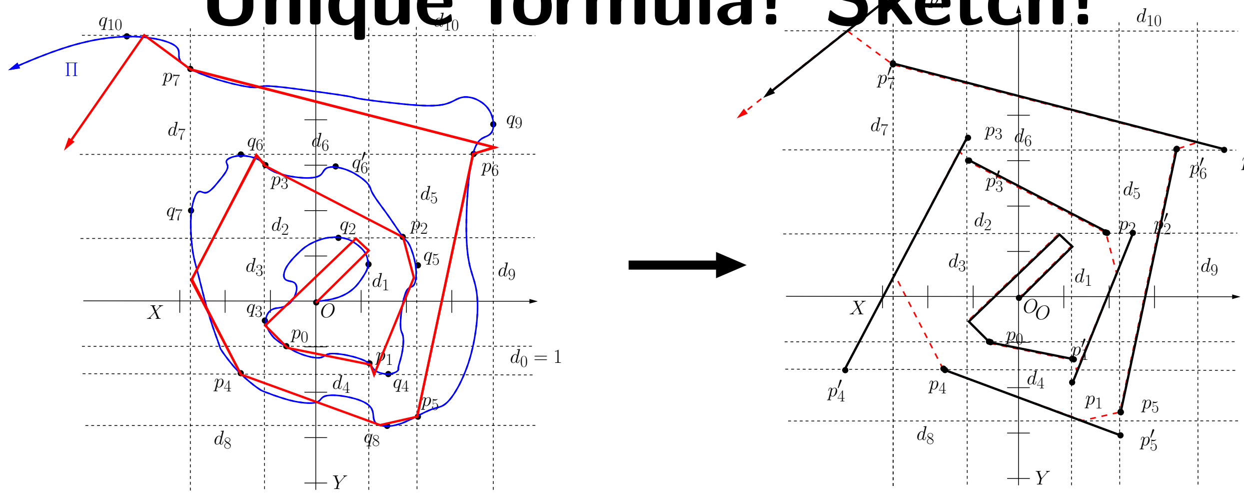

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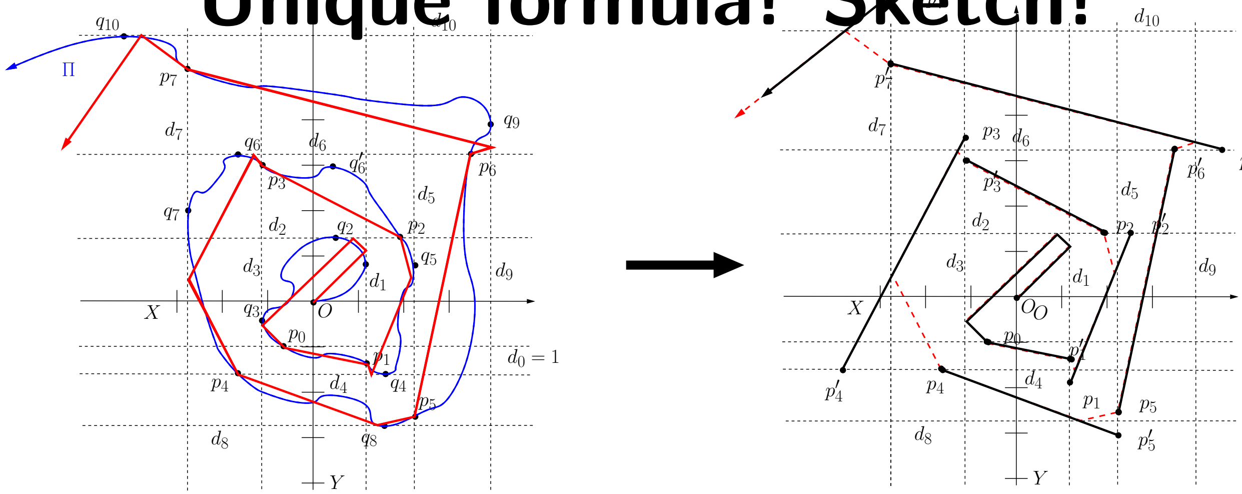

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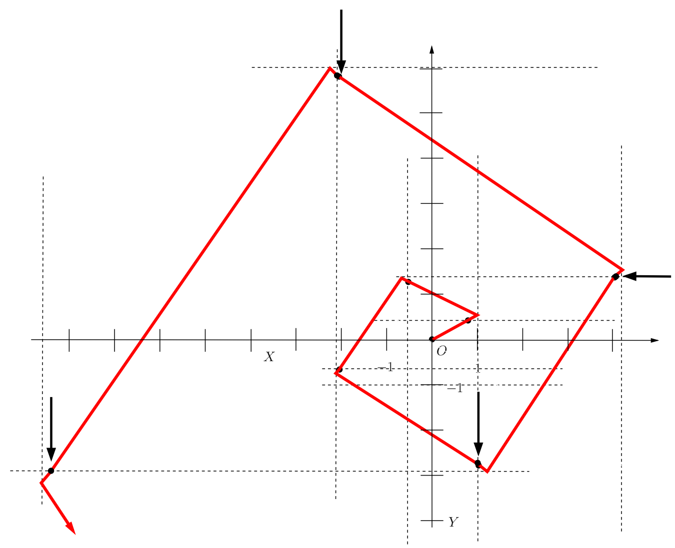

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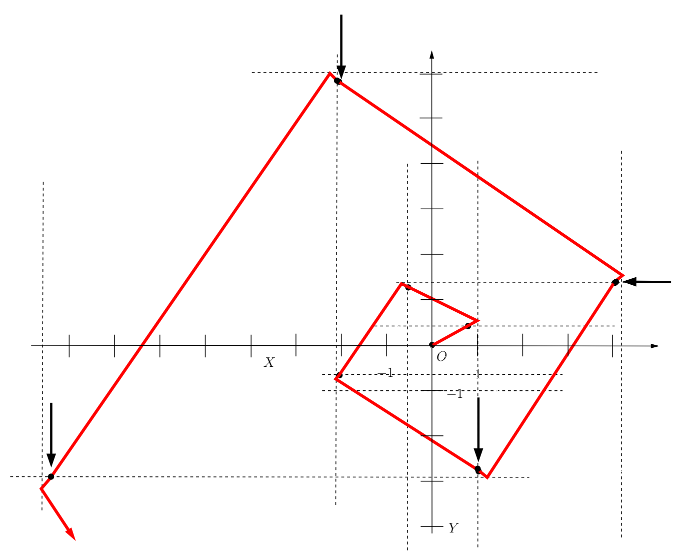

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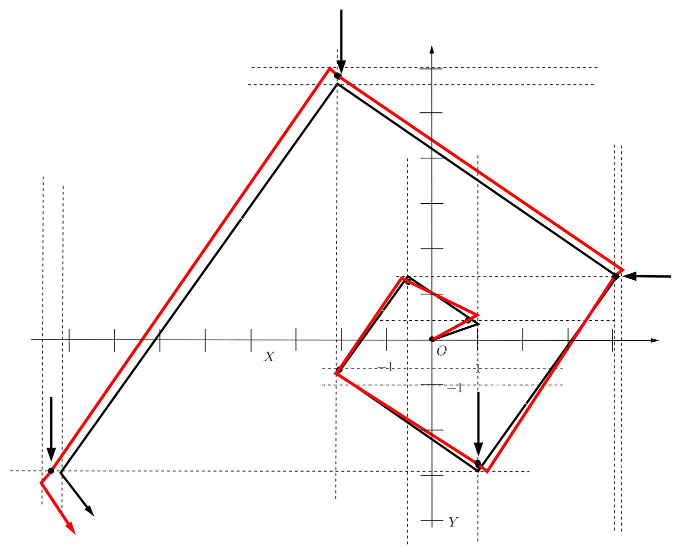

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