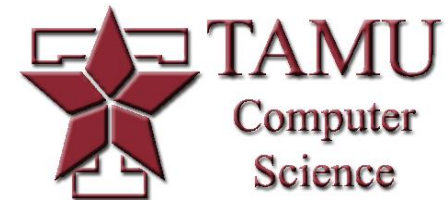
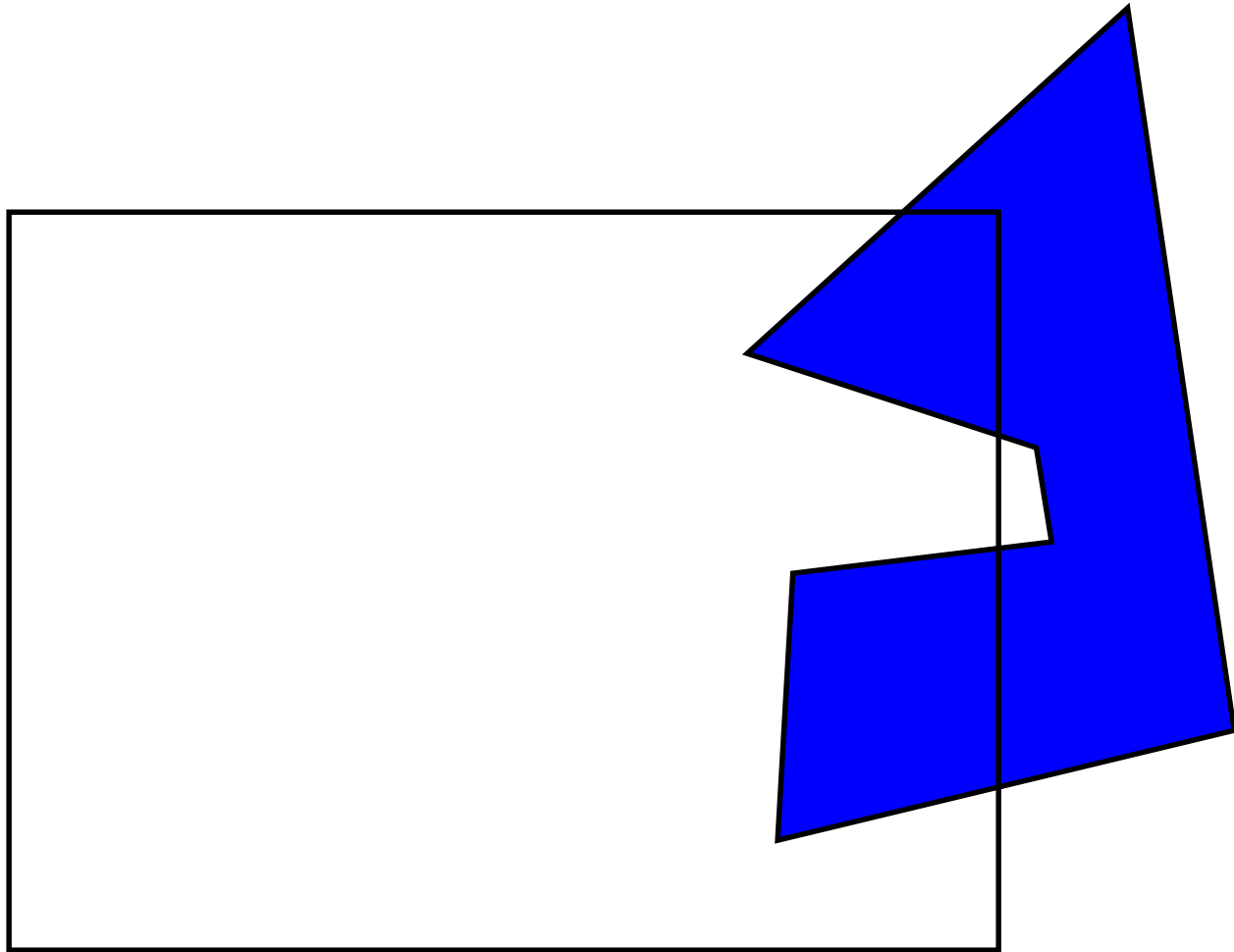


Clipping Polygons

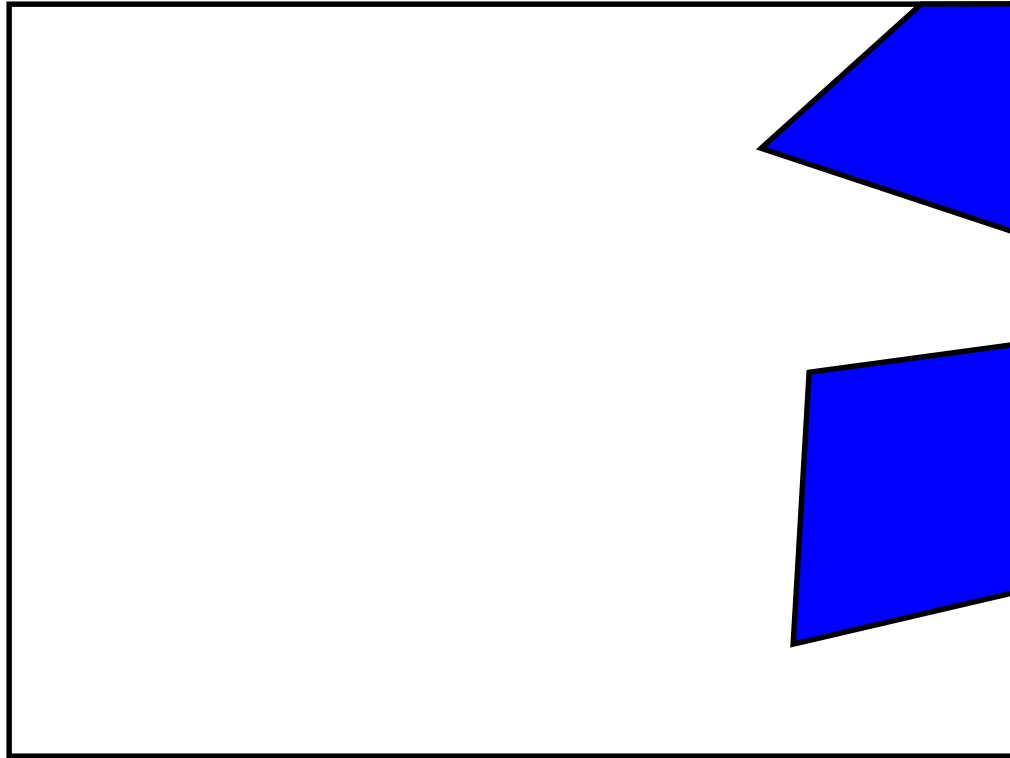
Dr. Scott Schaefer



Clipping Polygons

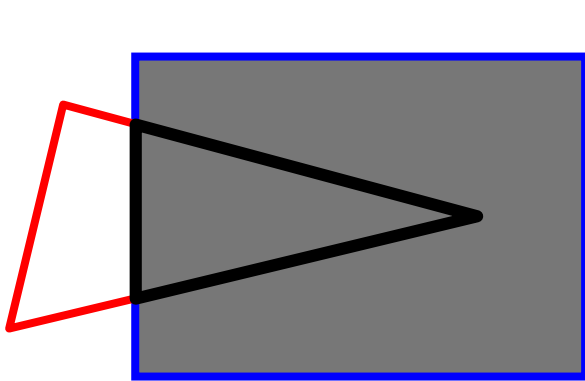


Clipping Polygons

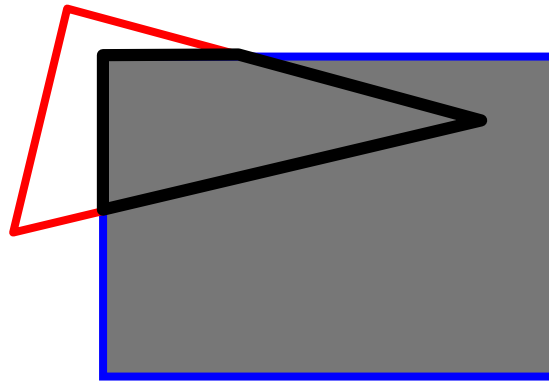


Why Is Polygon Clipping Hard?

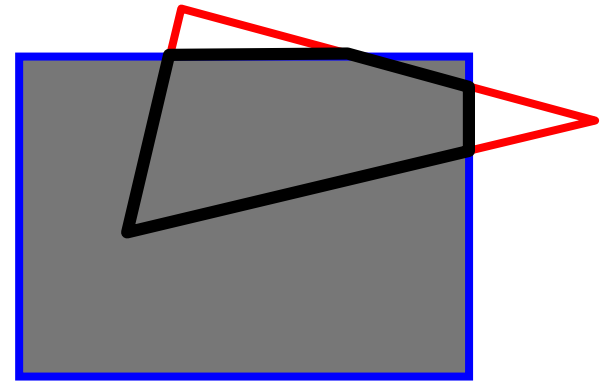
- What happens to a triangle during clipping?
 - possible outcomes:



triangle → triangle



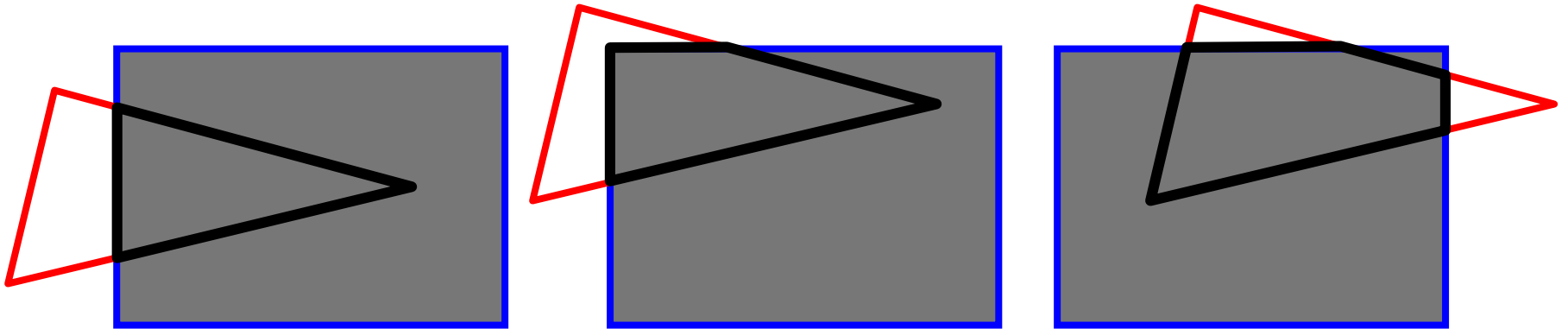
triangle → quad



triangle → 5-gon

Why Is Polygon Clipping Hard?

- What happens to a triangle during clipping?
 - possible outcomes:



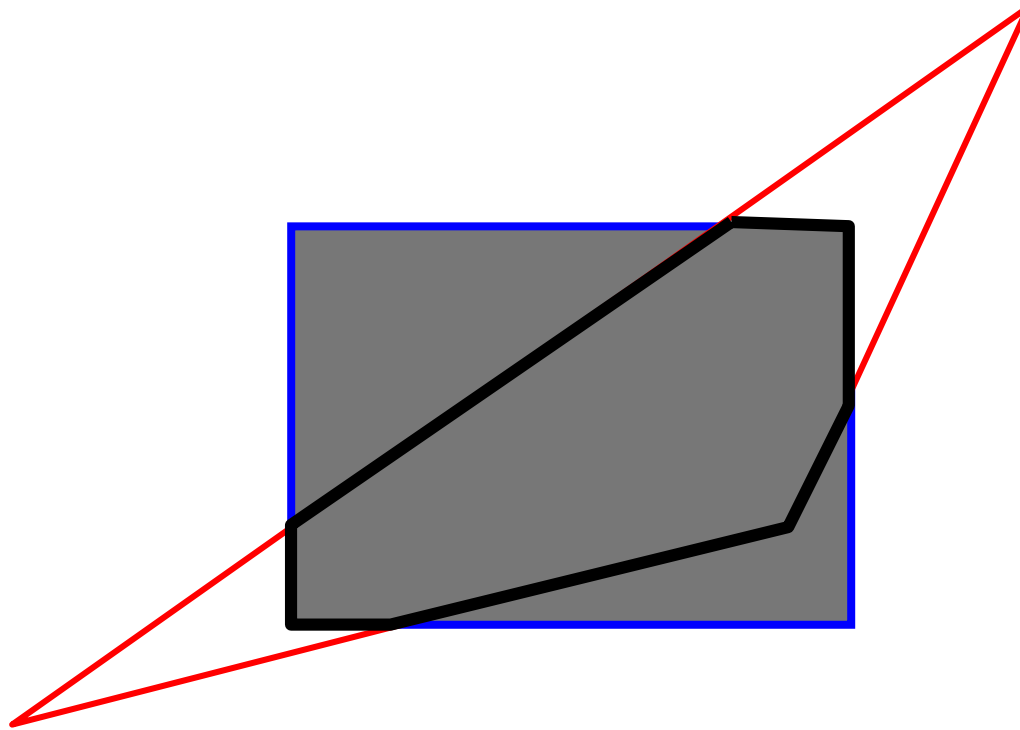
triangle → triangle

triangle → quad

triangle → 5-gon

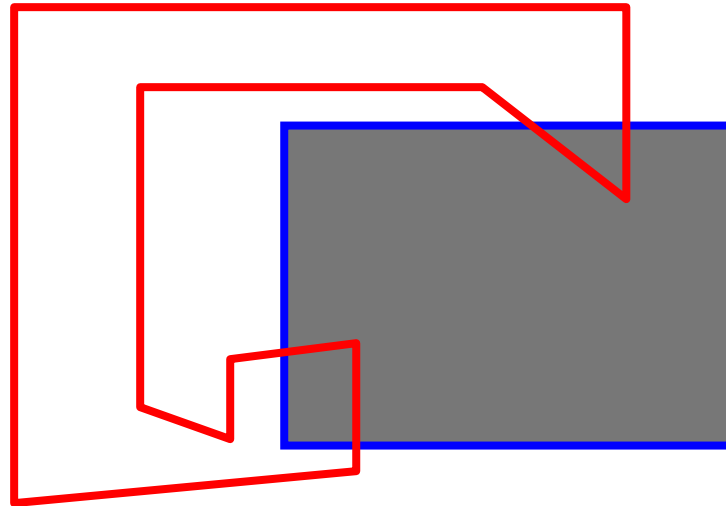
How many sides could a clipped triangle have?

How Many Sides?



7

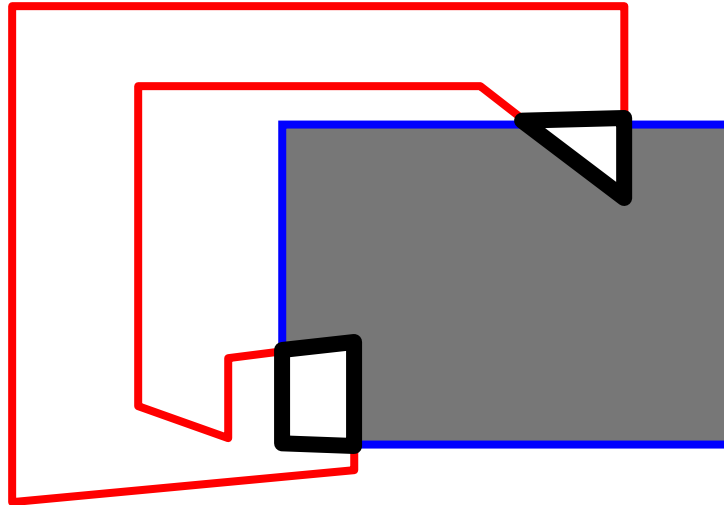
Why Is Polygon Clipping Hard?



Concave polygon \rightarrow Multiple polygons

Why Is Polygon Clipping Hard?

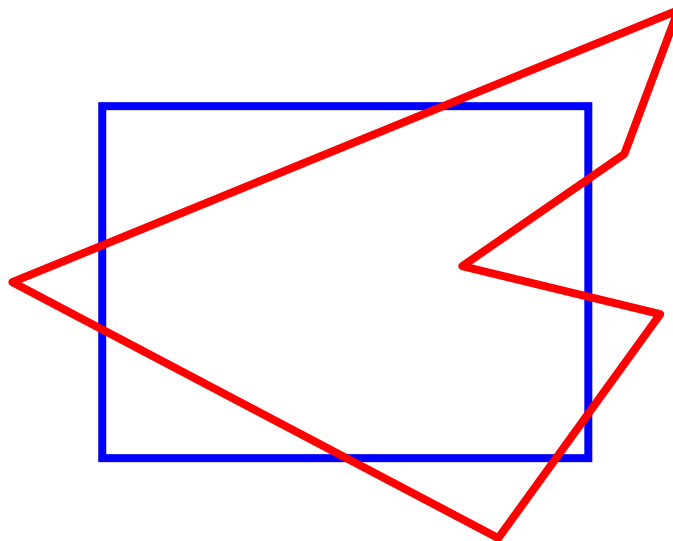
- A really tough case



Sutherland-Hodgman Clipping

■ Basic idea:

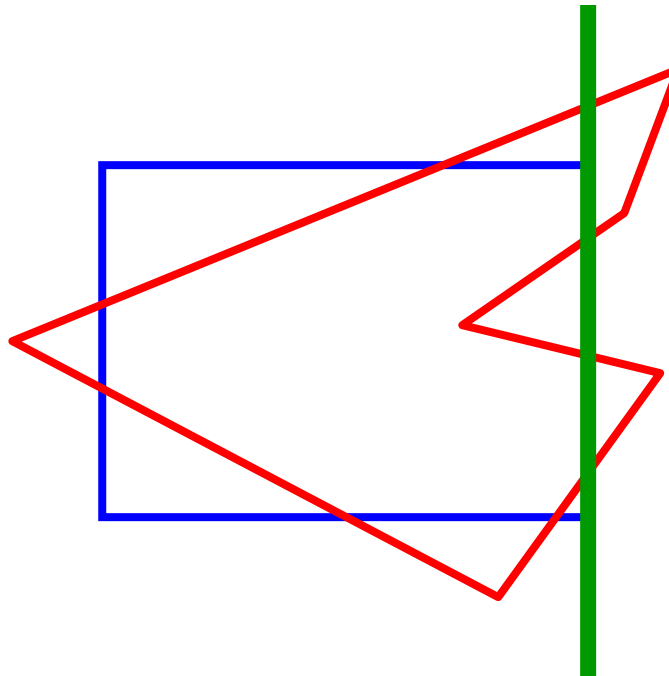
- consider each edge of the view window individually
- clip the polygon against the view window edge's equation



Sutherland-Hodgman Clipping

■ Basic idea:

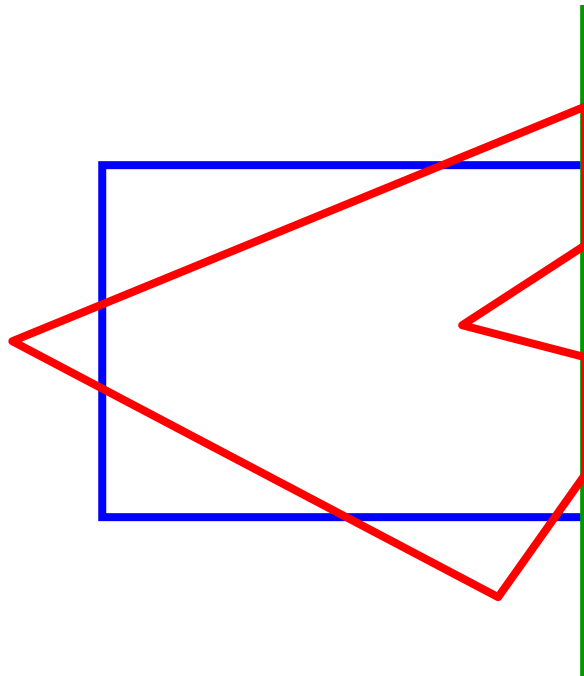
- consider each edge of the view window individually
- clip the polygon against the view window edge's equation



Sutherland-Hodgman Clipping

■ Basic idea:

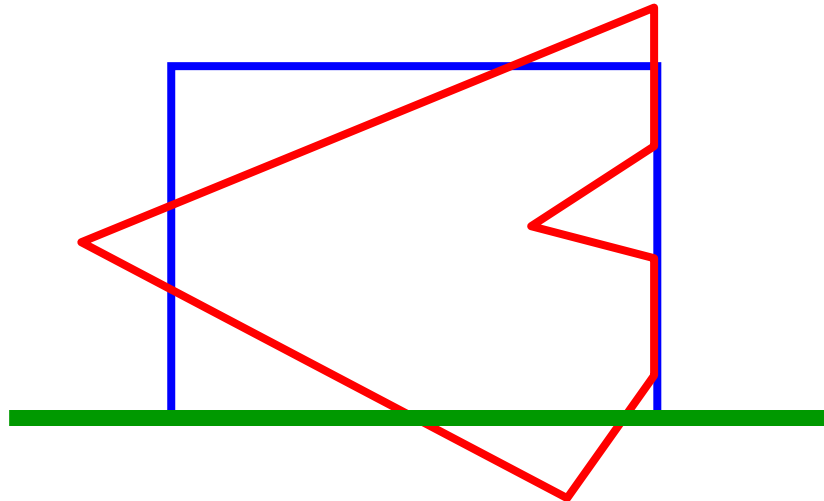
- consider each edge of the view window individually
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Sutherland-Hodgman Clipping

■ Basic idea:

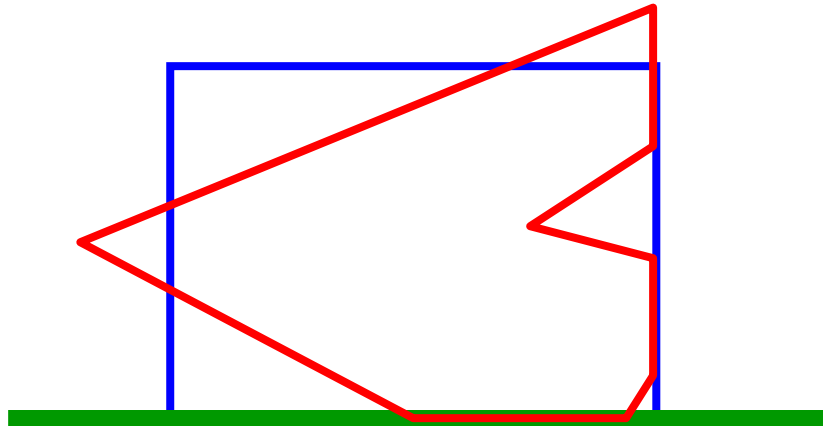
- consider each edge of the view window individually
- clip the polygon against the view window edge's equation



Sutherland-Hodgman Clipping

■ Basic idea:

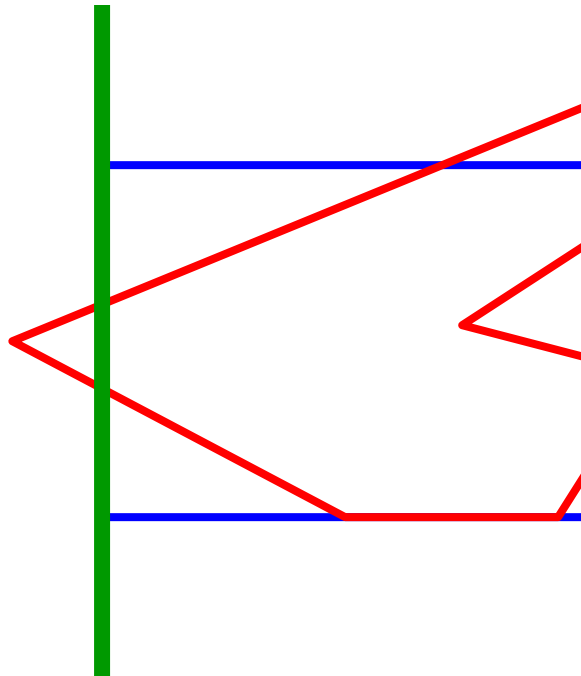
- consider each edge of the view window individually
- clip the polygon against the view window edge's equation



Sutherland-Hodgman Clipping

■ Basic idea:

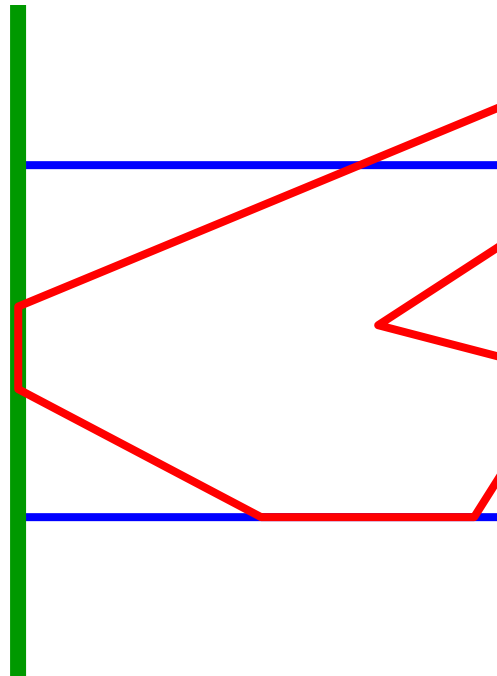
- consider each edge of the view window individually
- clip the polygon against the view window edge's equation



Sutherland-Hodgman Clipping

■ Basic idea:

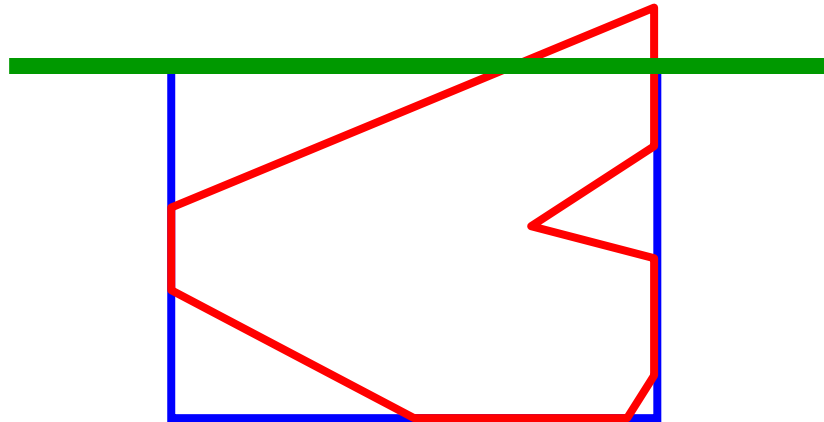
- consider each edge of the view window individually
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Sutherland-Hodgman Clipping

■ Basic idea:

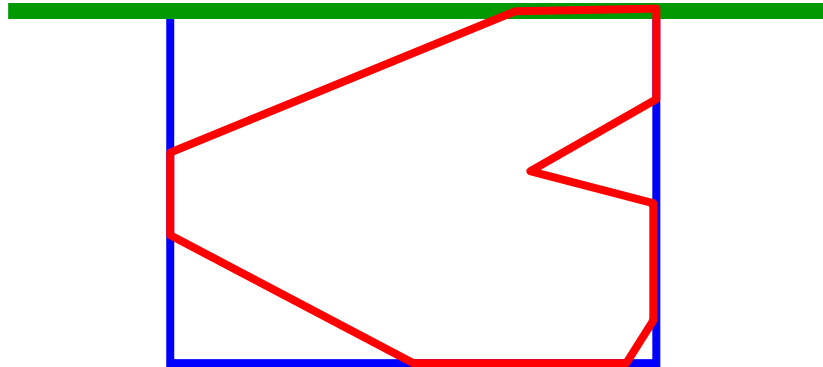
- consider each edge of the view window individually
- clip the polygon against the view window edge's equation



Sutherland-Hodgman Clipping

■ Basic idea:

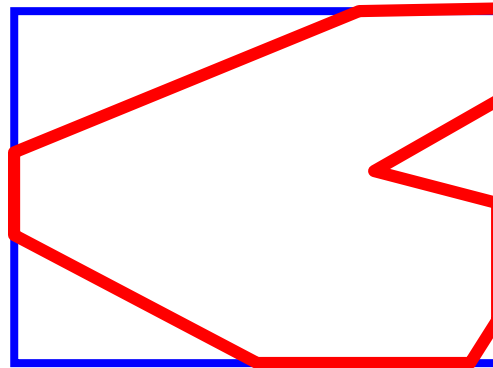
- consider each edge of the view window individually
- clip the polygon against the view window edge's equation



Sutherland-Hodgman Clipping

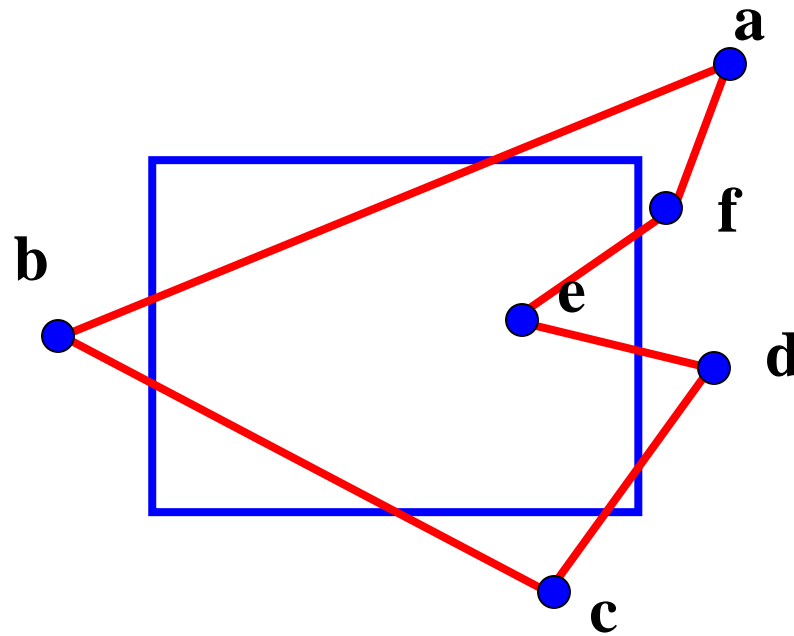
■ Basic idea:

- consider each edge of the view window individually
- clip the polygon against the view window edge's equation
- **after doing all edges, the polygon is fully clipped**



Sutherland-Hodgman Clipping

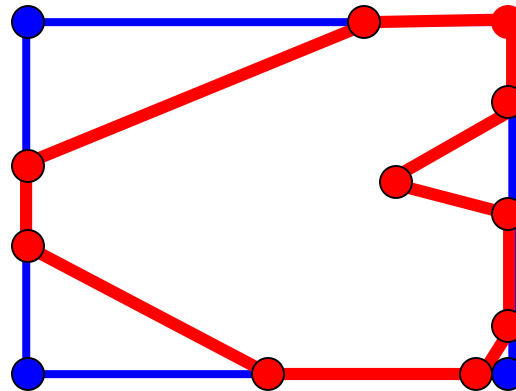
- Input/output for algorithm:
 - input: list of polygon vertices in order
{abcdef}



Sutherland-Hodgman Clipping

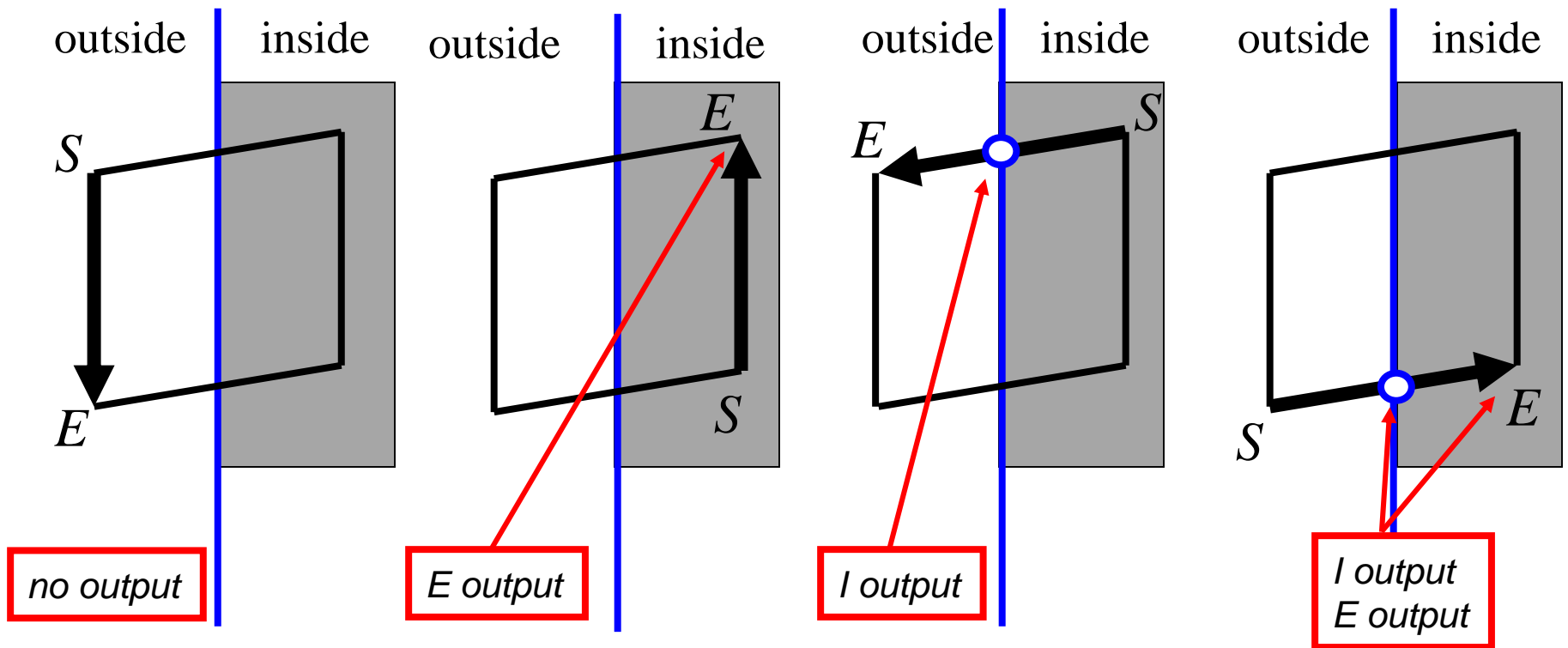
■ Input/output for algorithm:

- input: list of polygon vertices in order
- output: list of clipped polygon vertices consisting of old vertices (maybe) and new vertices (maybe)

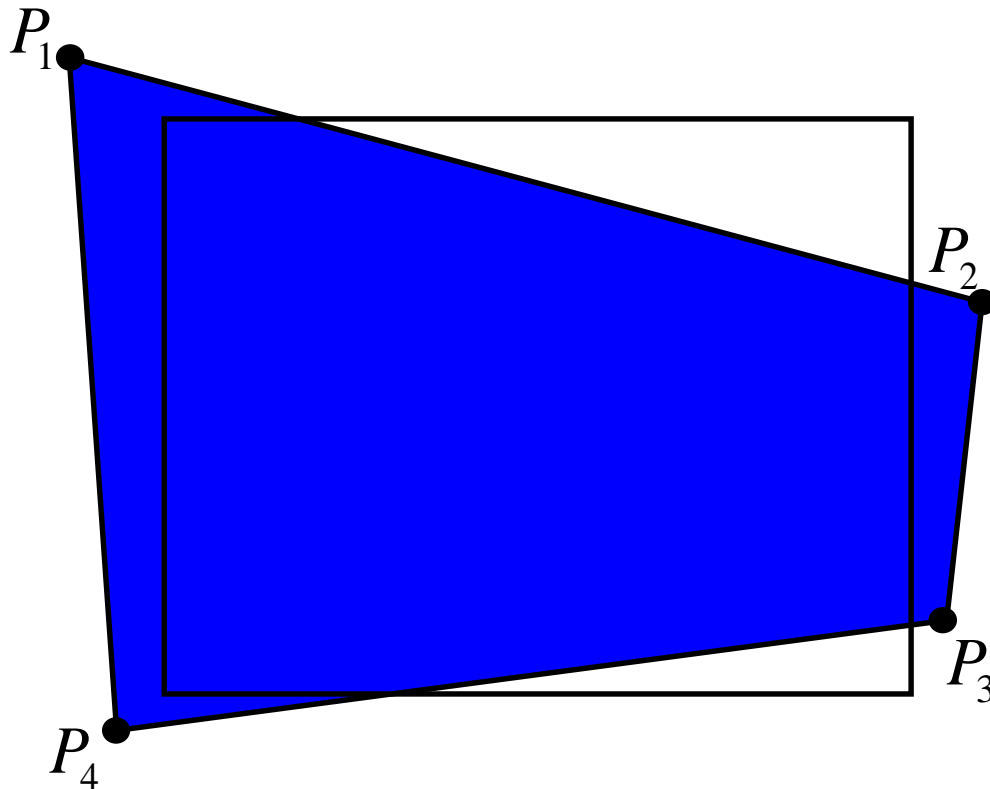
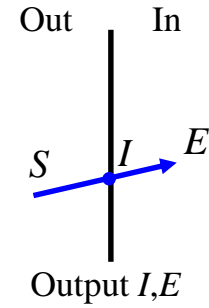
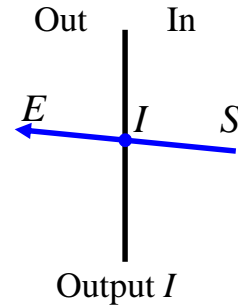
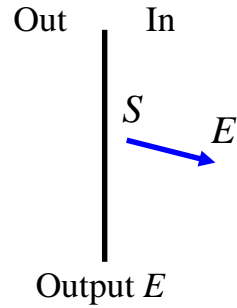
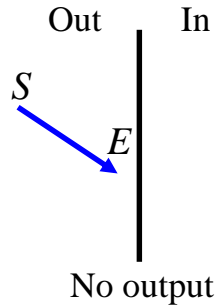


Sutherland-Hodgman Clipping

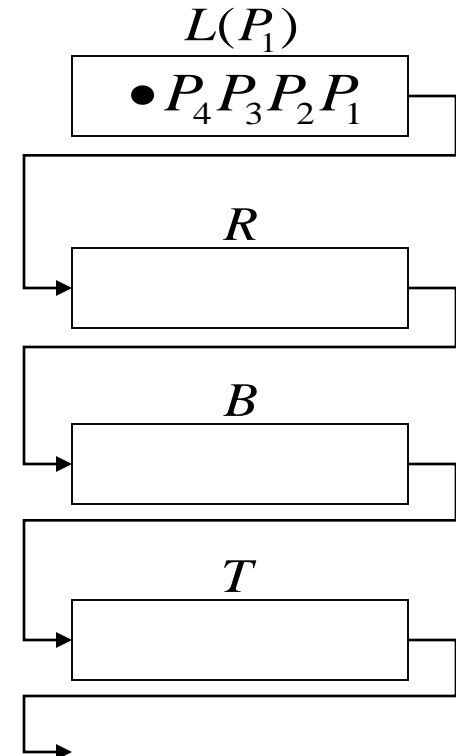
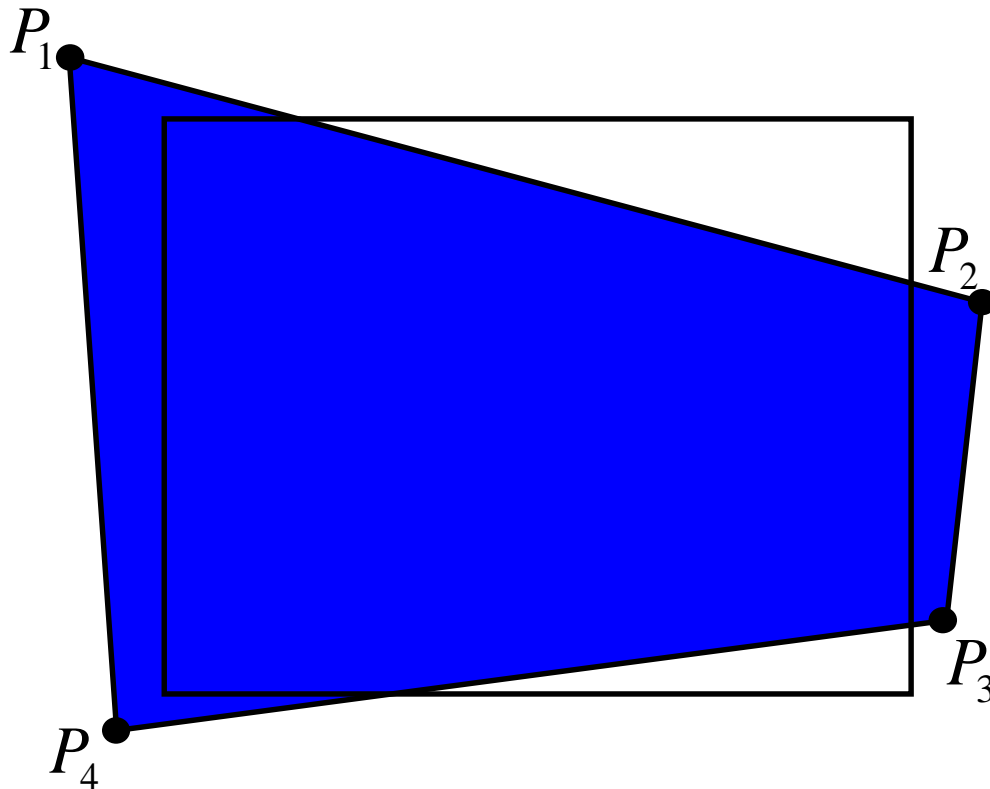
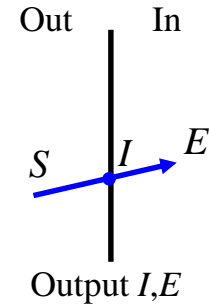
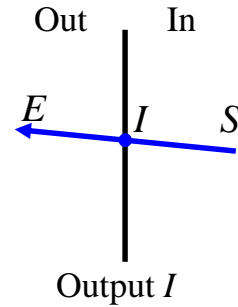
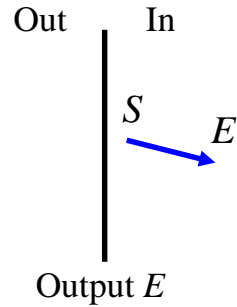
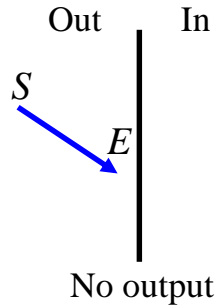
- Edge from S to E takes one of four cases:



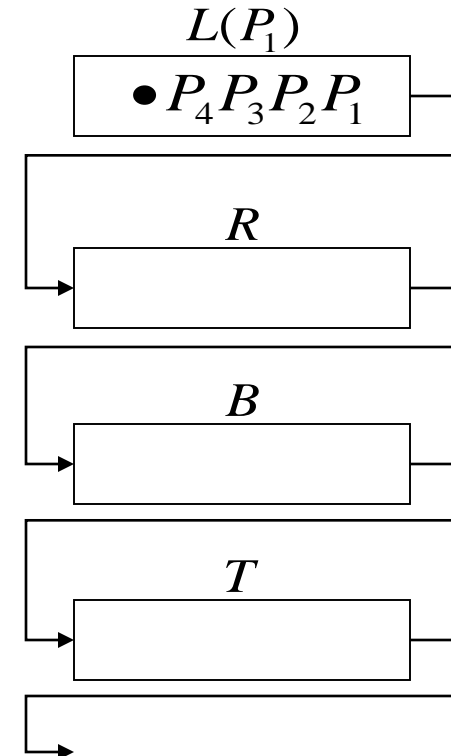
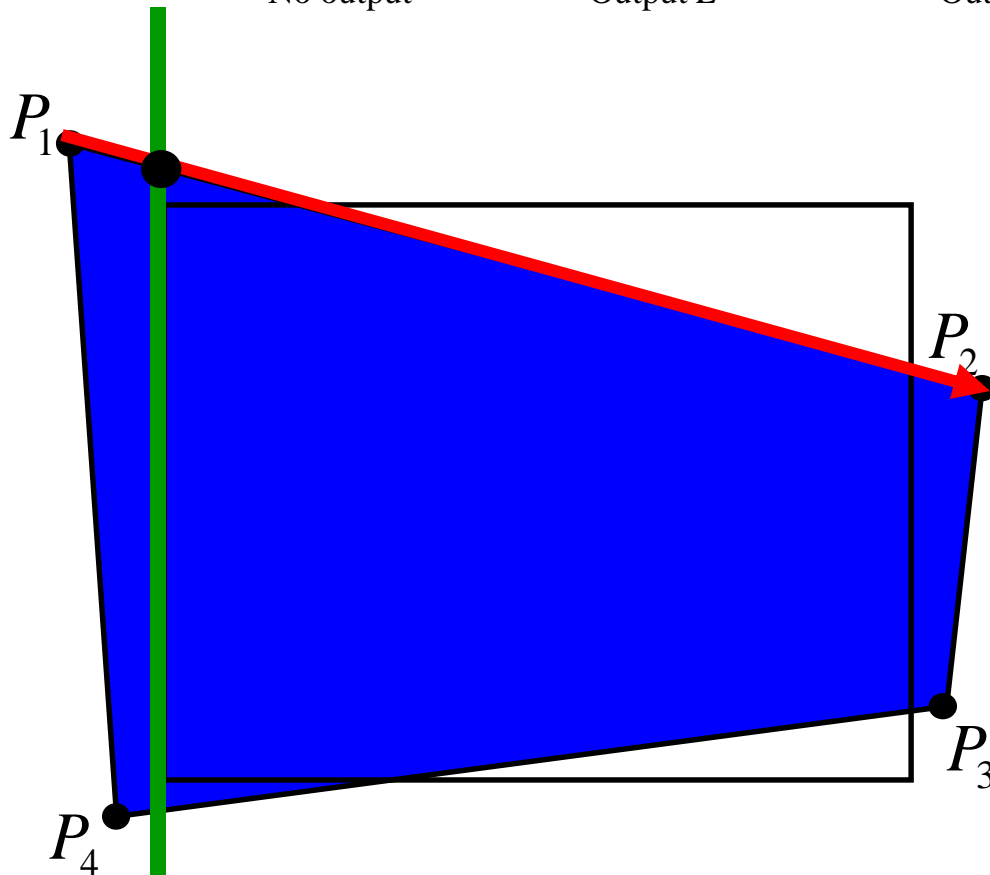
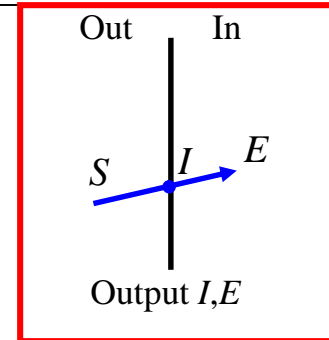
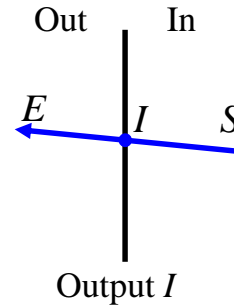
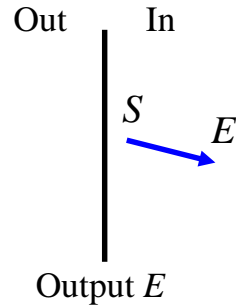
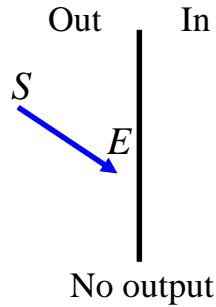
Sutherland-Hodgman Algorithm



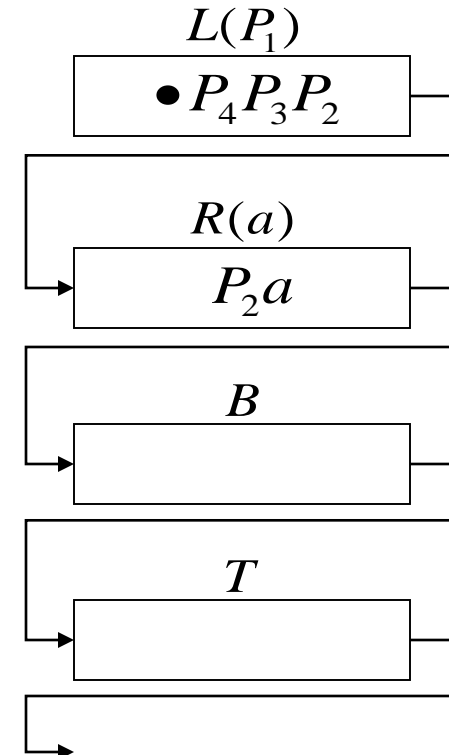
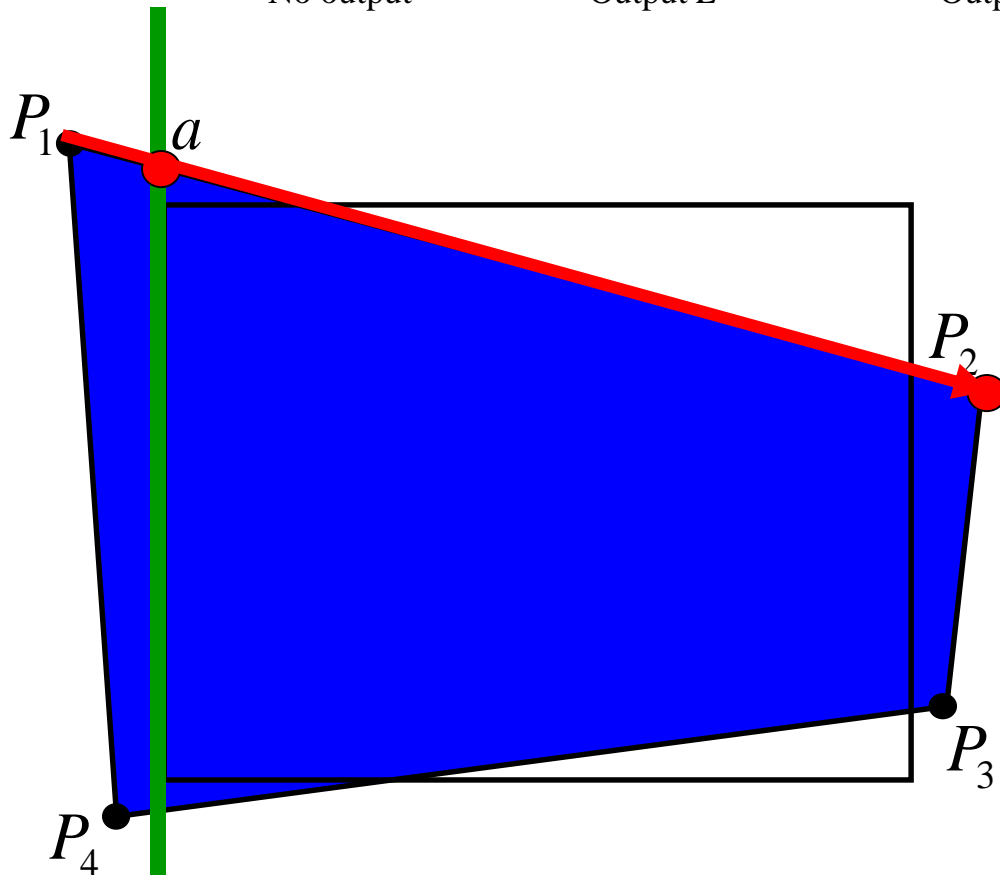
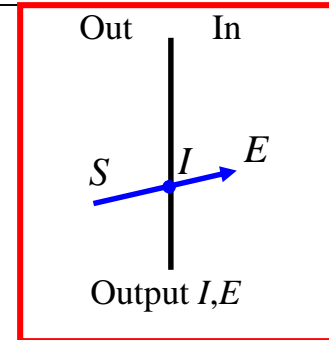
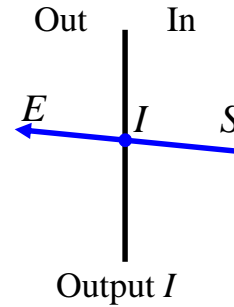
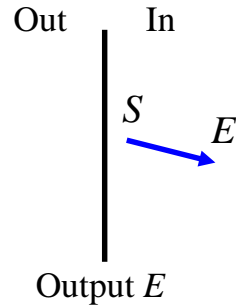
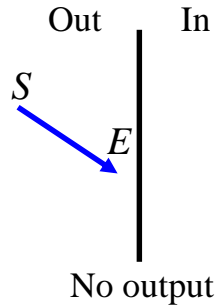
Sutherland-Hodgman Algorithm



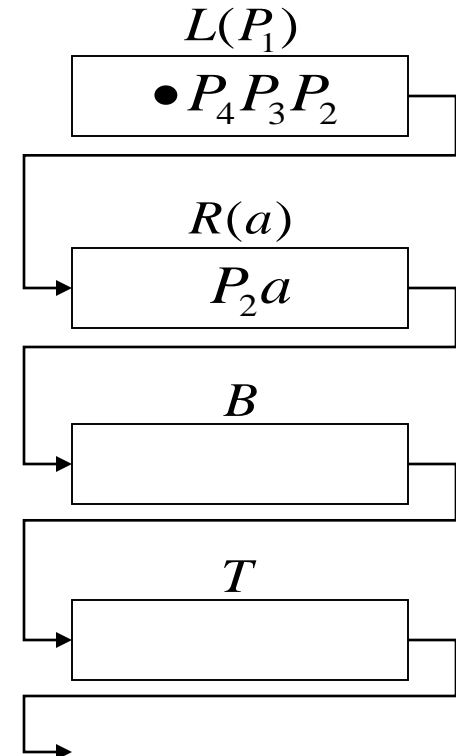
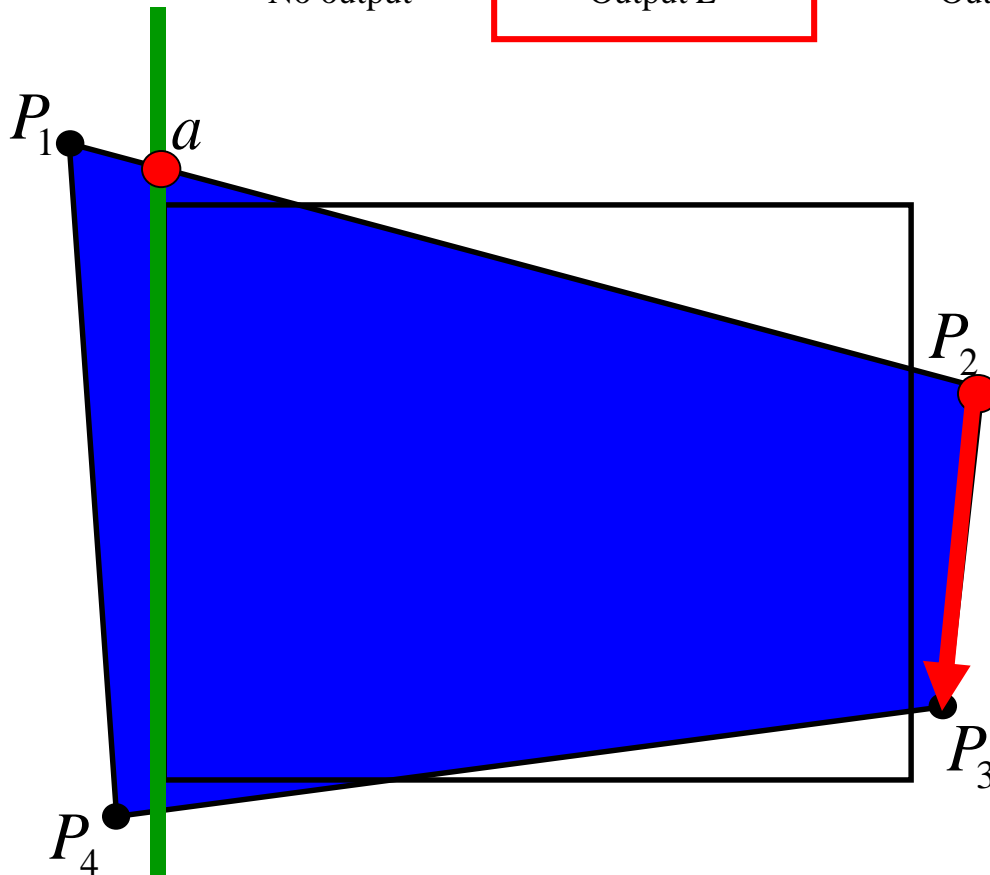
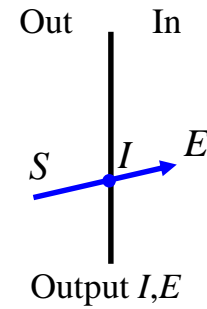
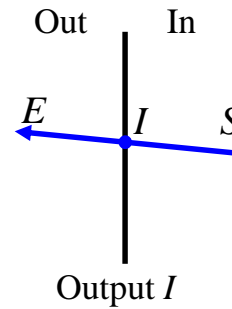
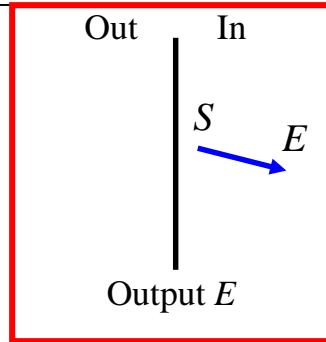
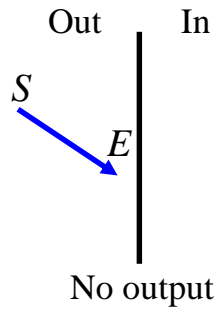
Sutherland-Hodgman Algorithm



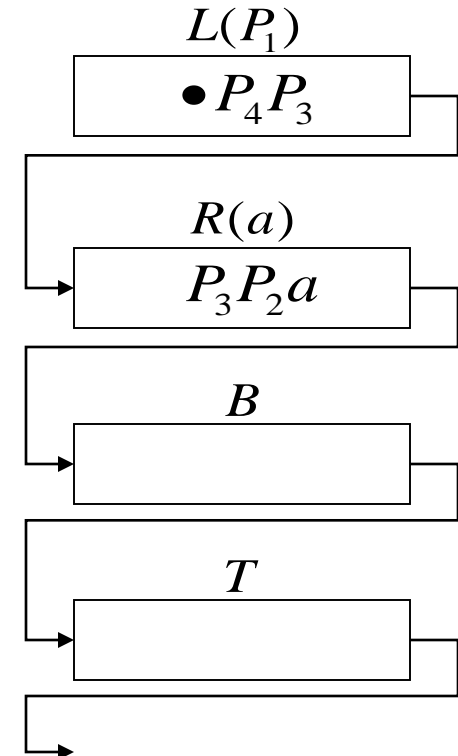
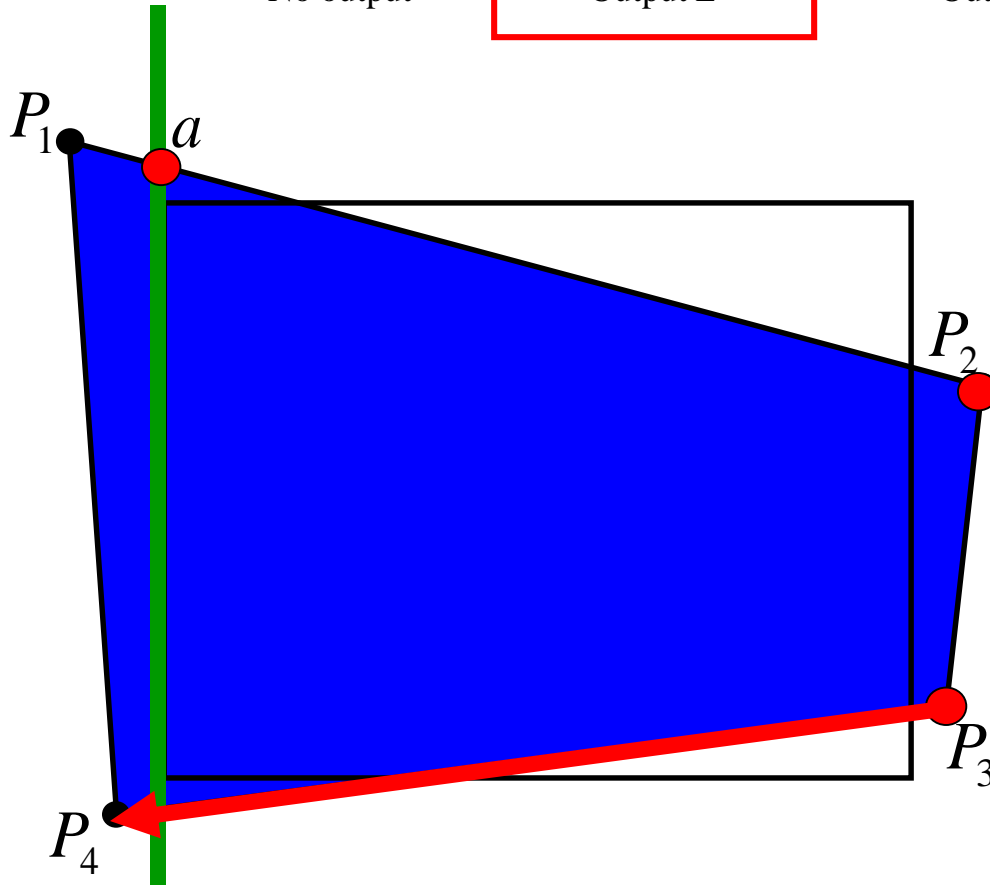
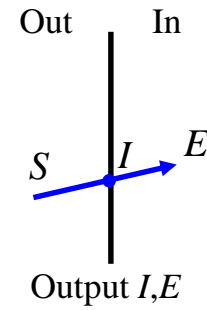
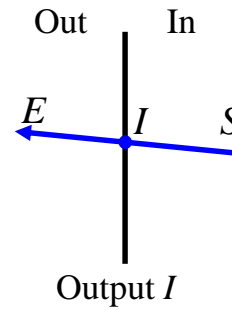
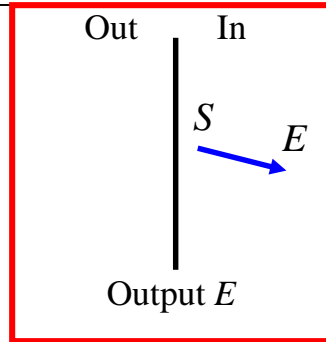
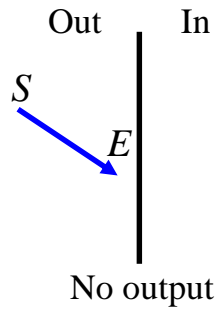
Sutherland-Hodgman Algorithm



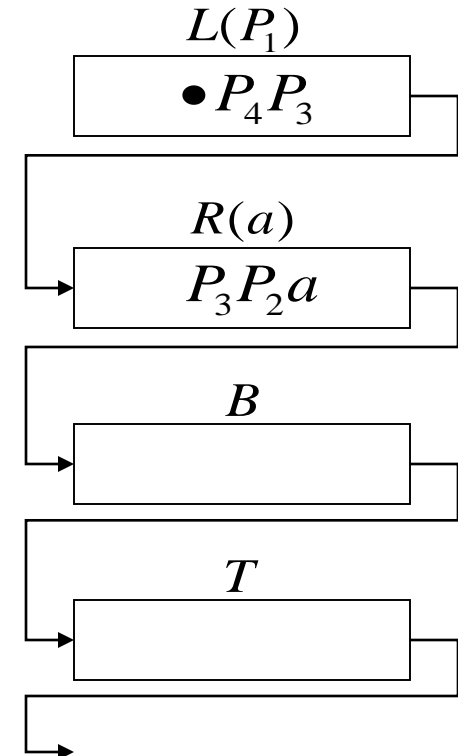
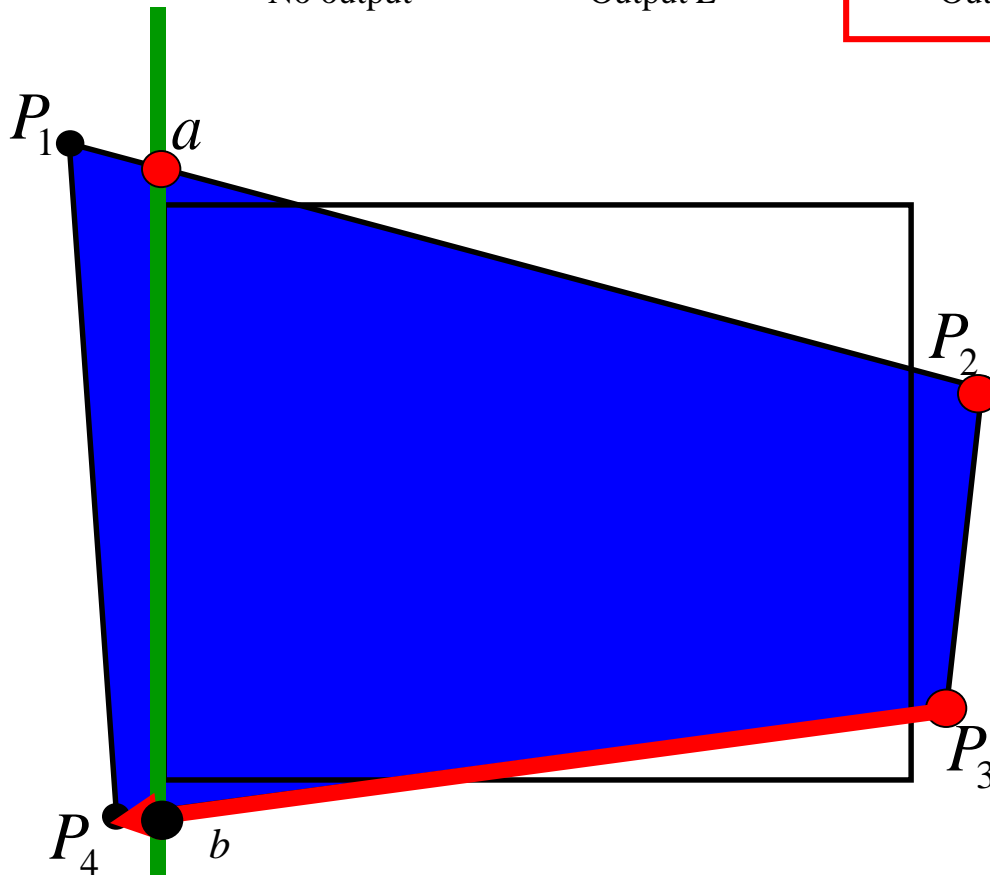
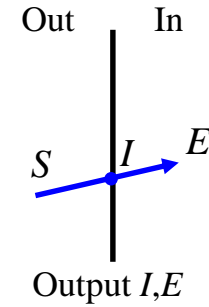
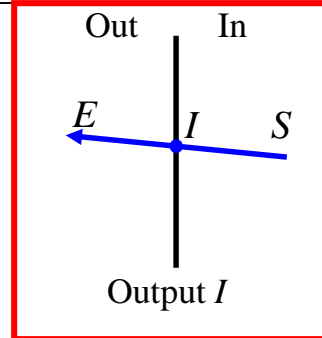
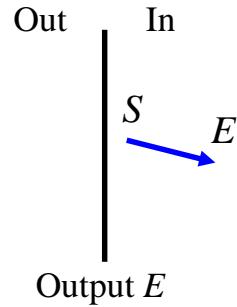
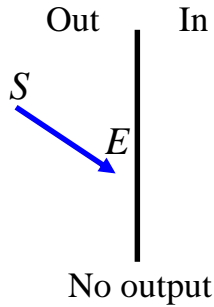
Sutherland-Hodgman Algorithm



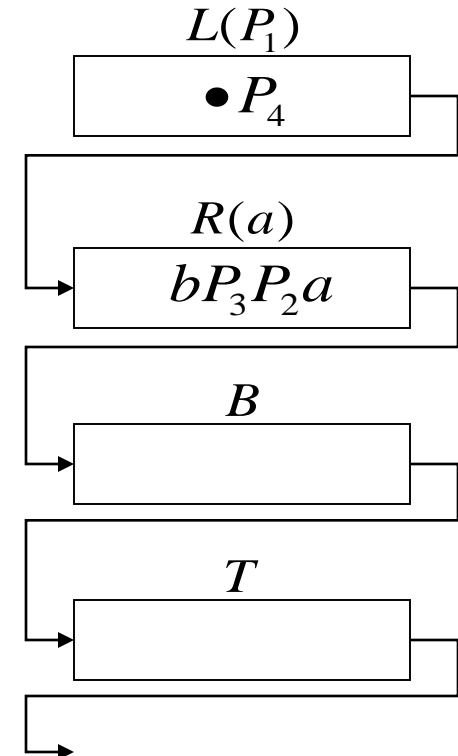
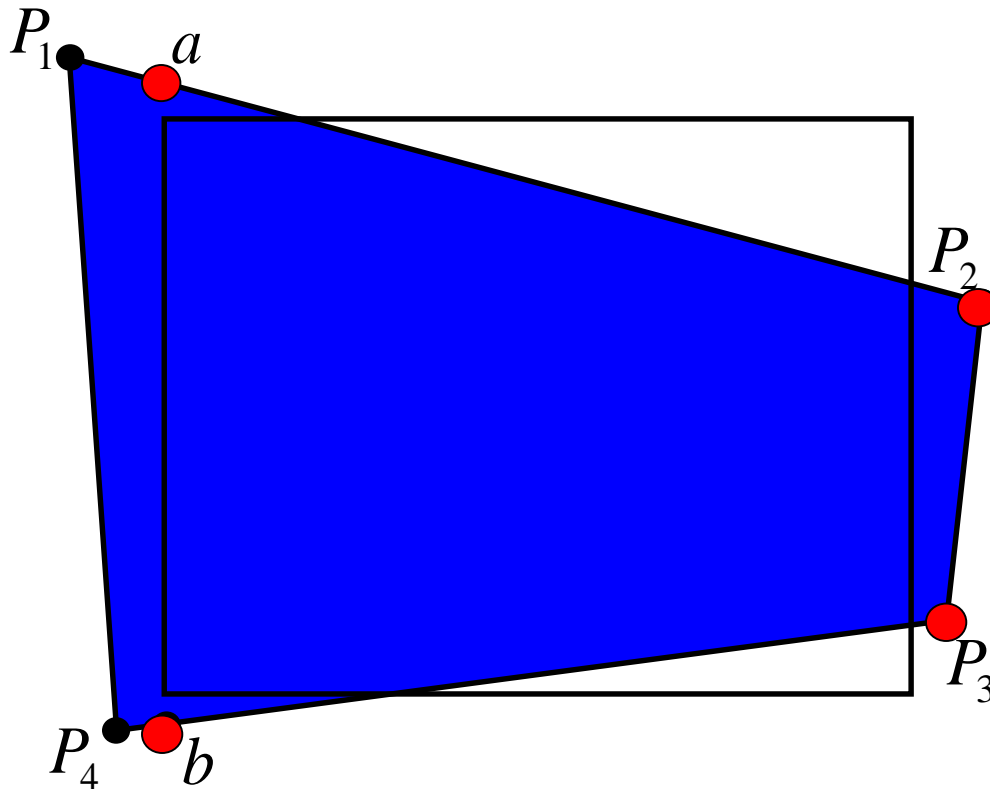
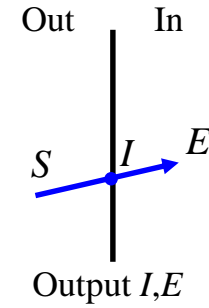
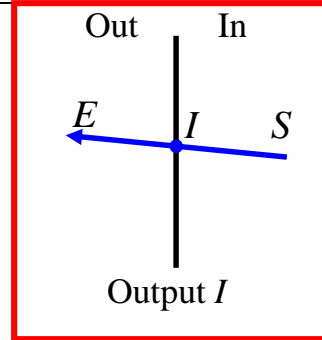
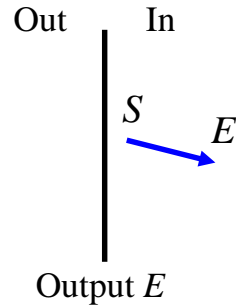
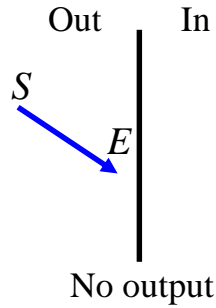
Sutherland-Hodgman Algorithm



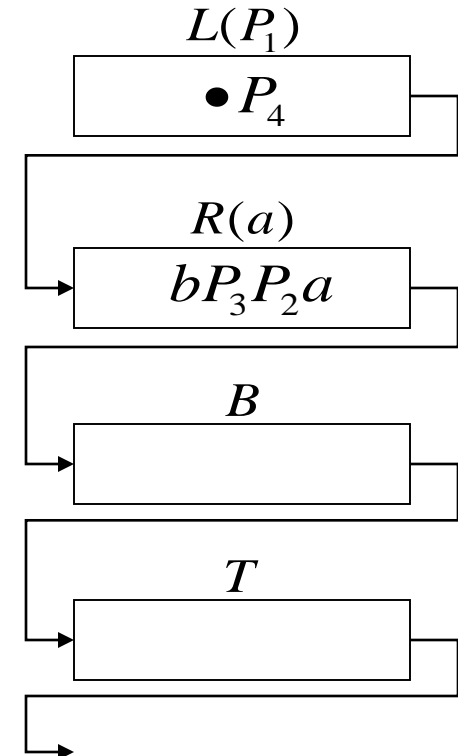
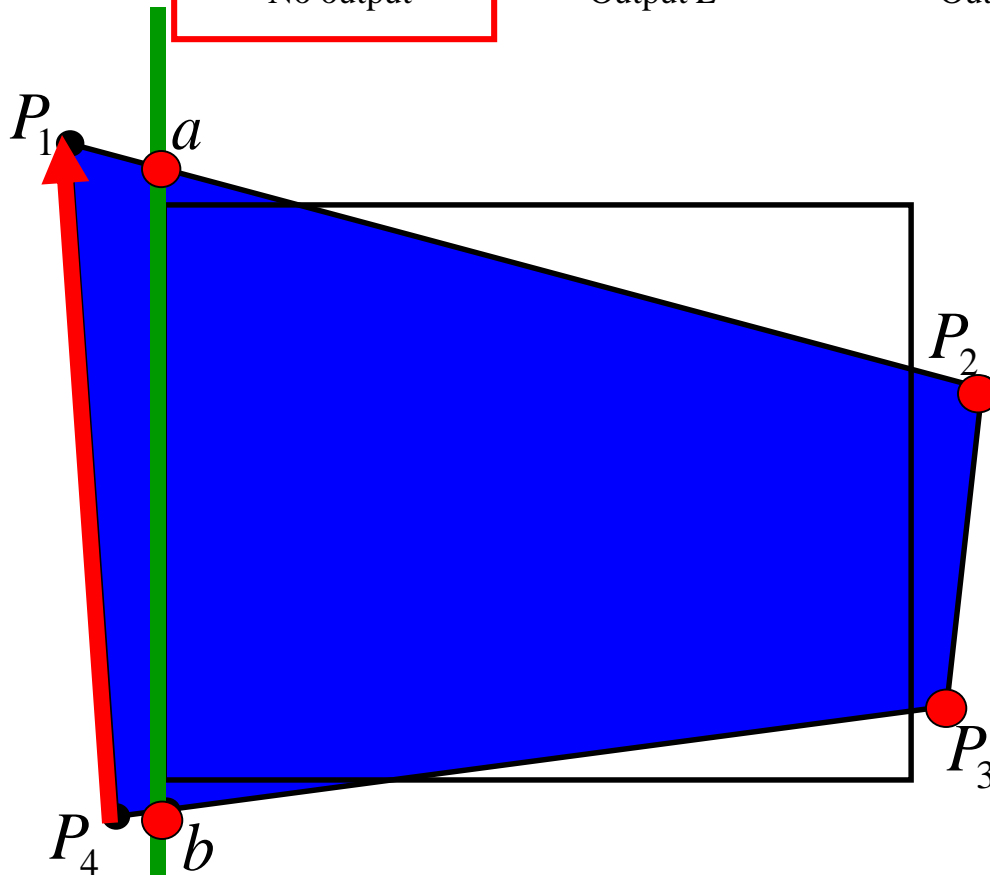
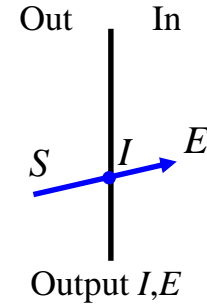
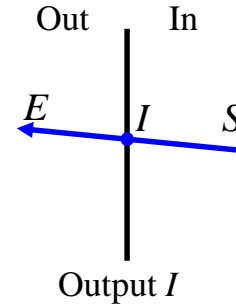
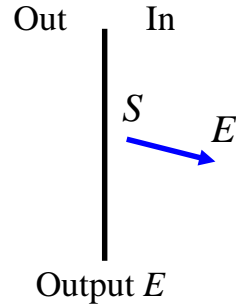
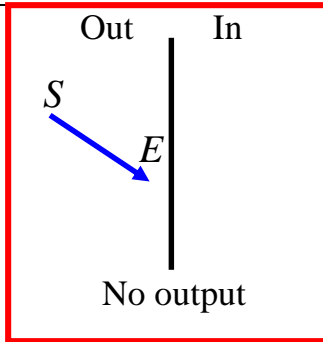
Sutherland-Hodgman Algorithm



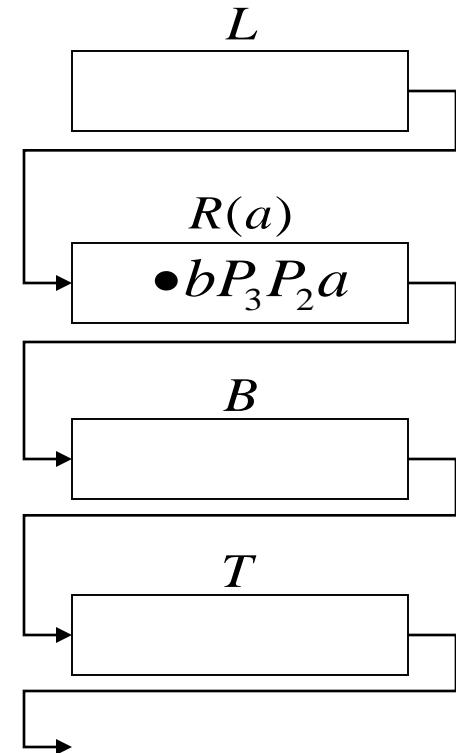
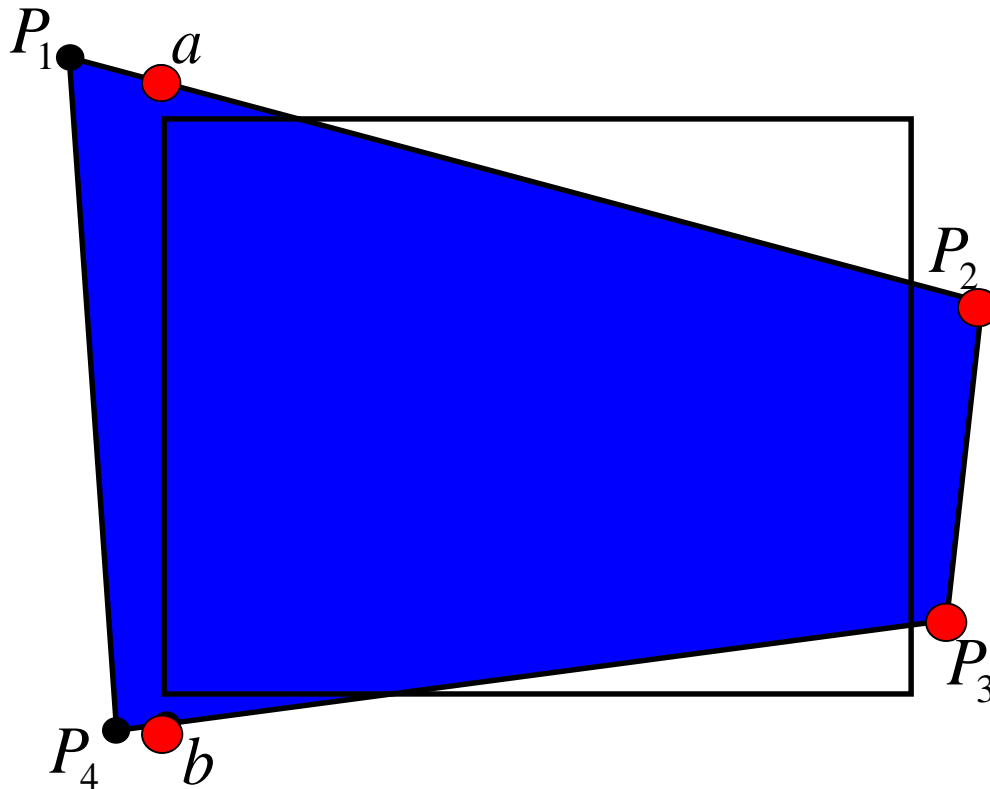
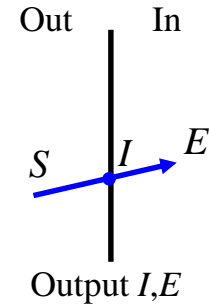
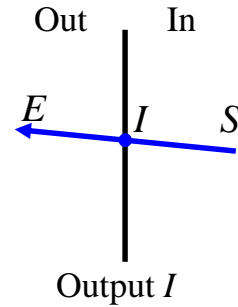
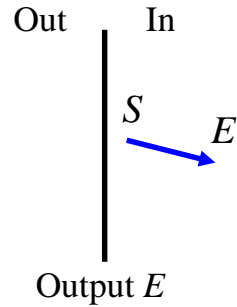
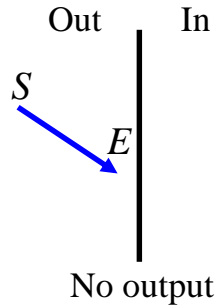
Sutherland-Hodgman Algorithm



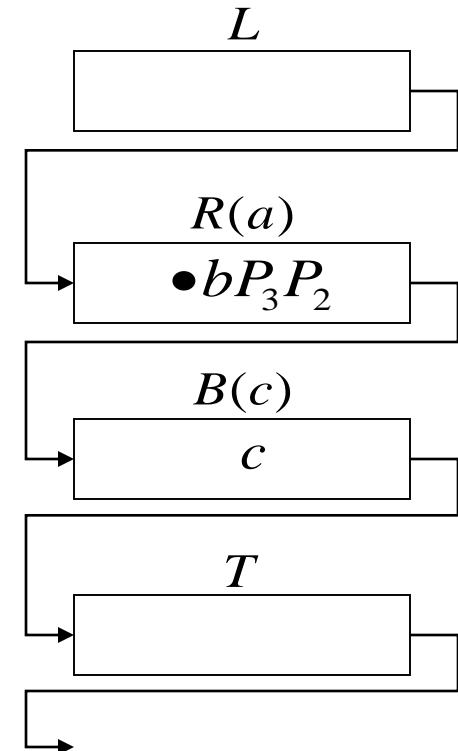
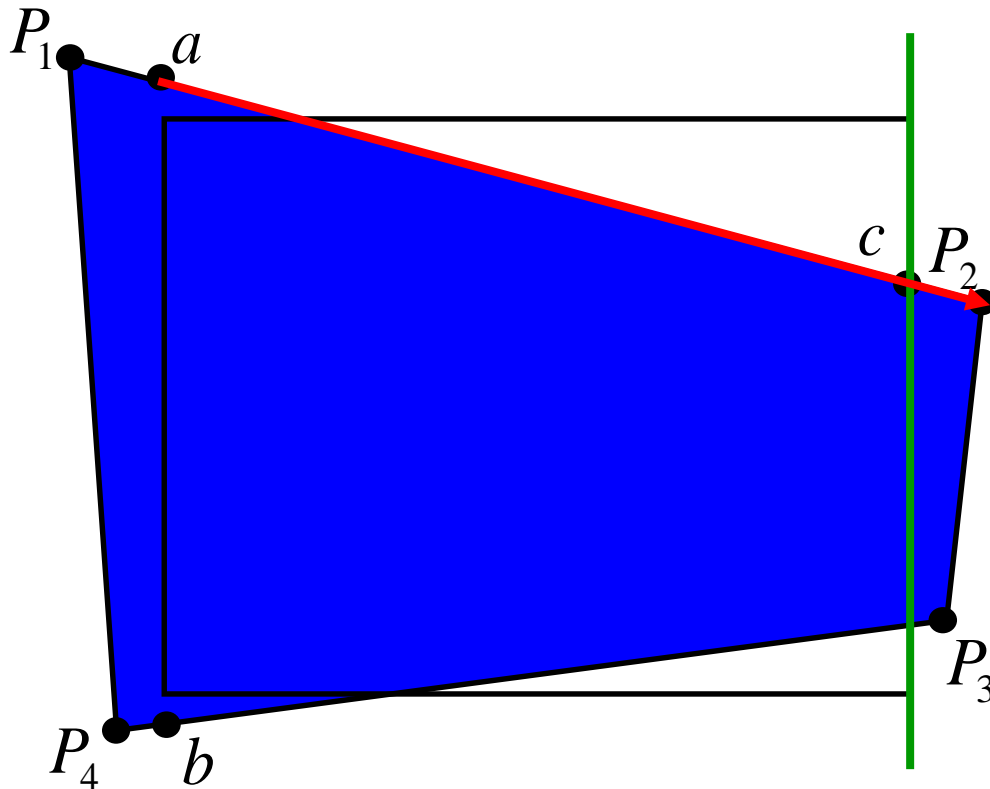
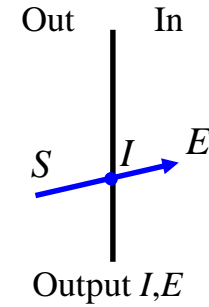
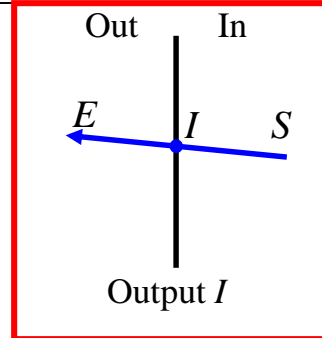
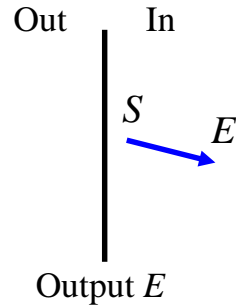
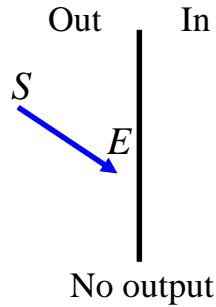
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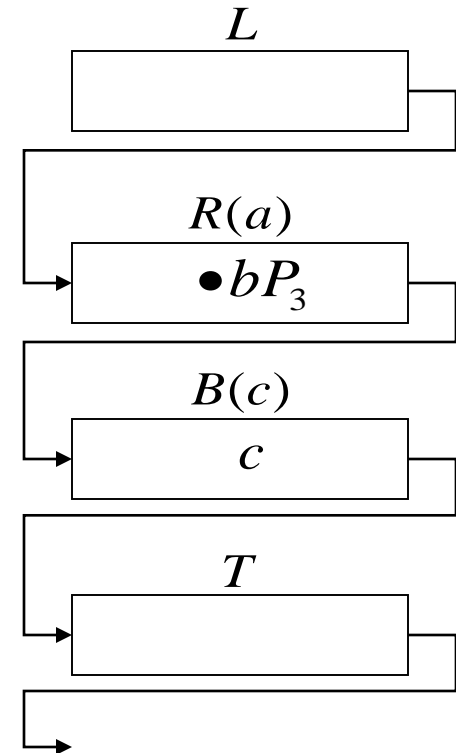
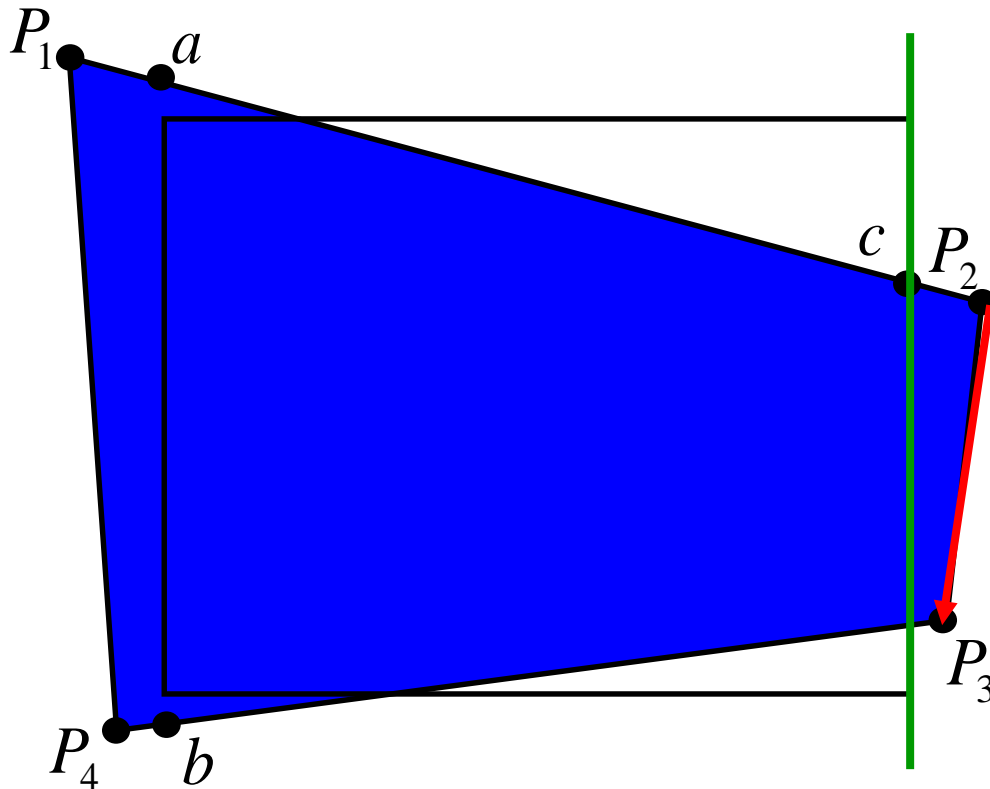
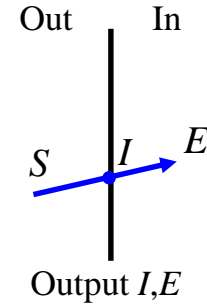
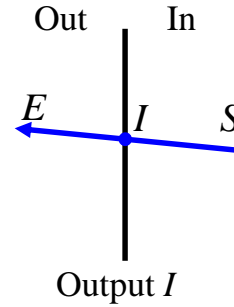
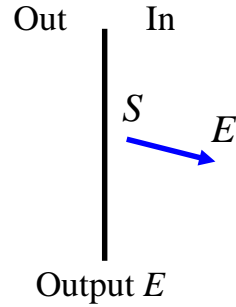
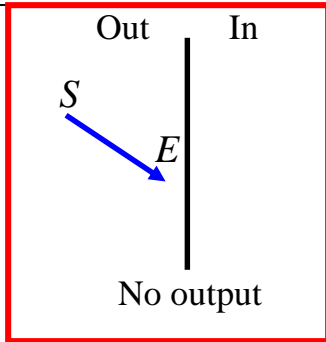
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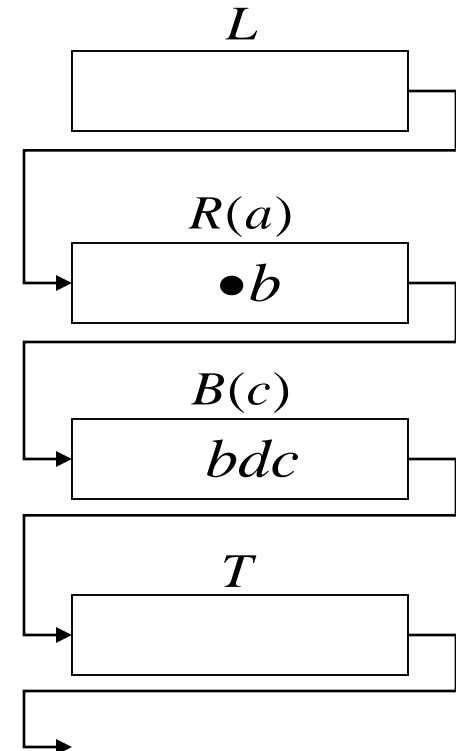
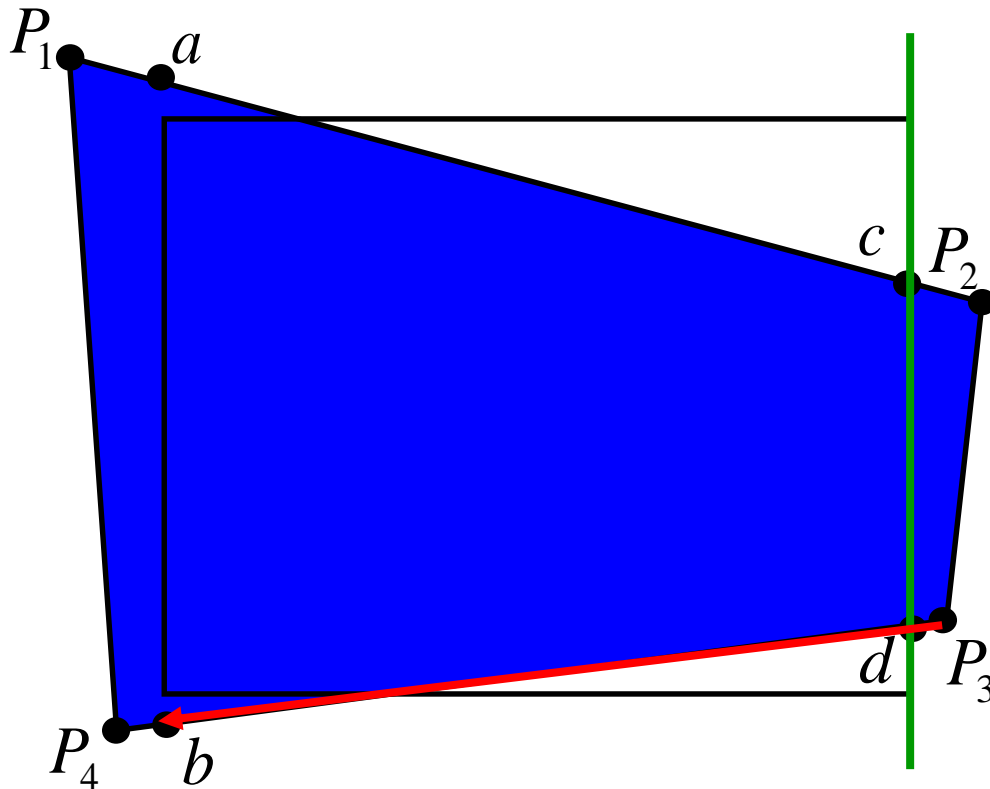
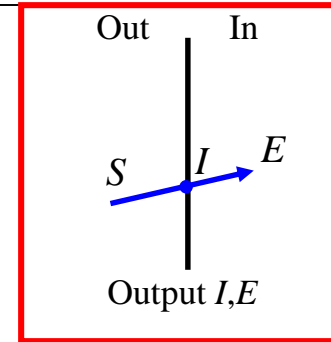
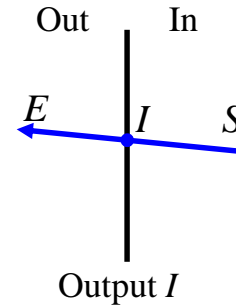
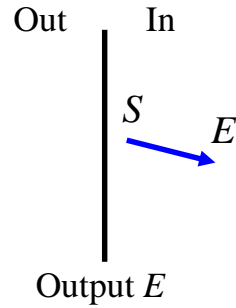
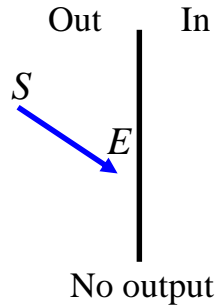
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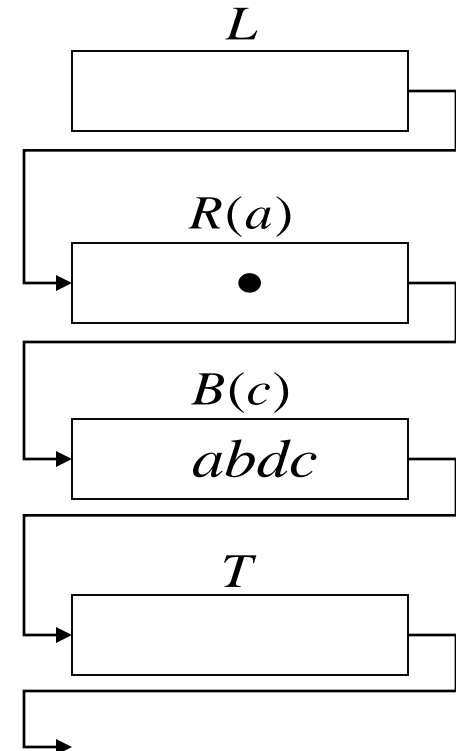
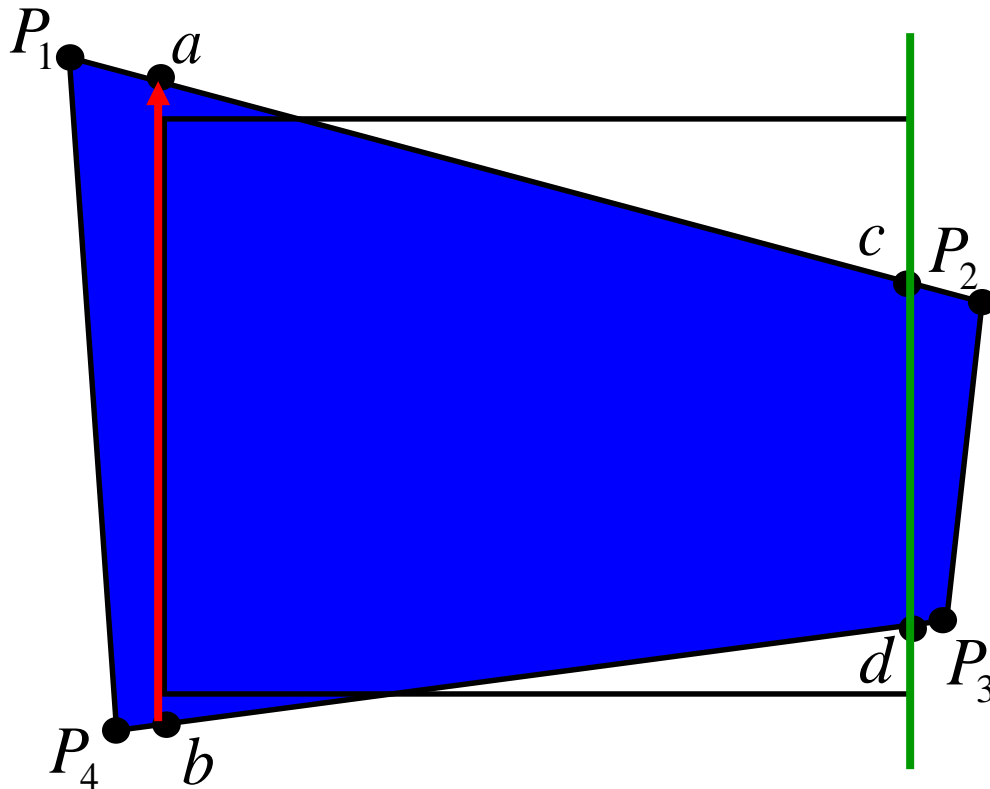
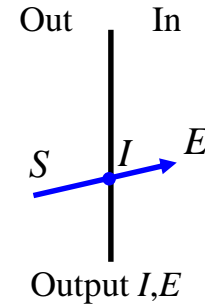
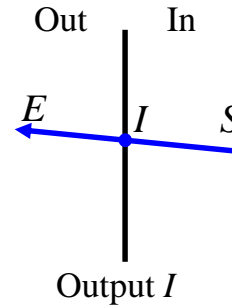
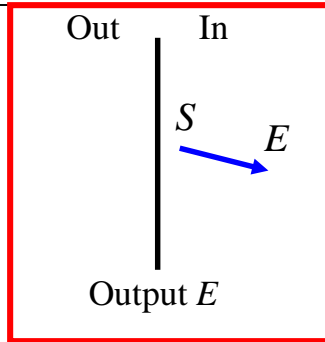
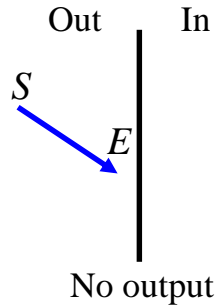
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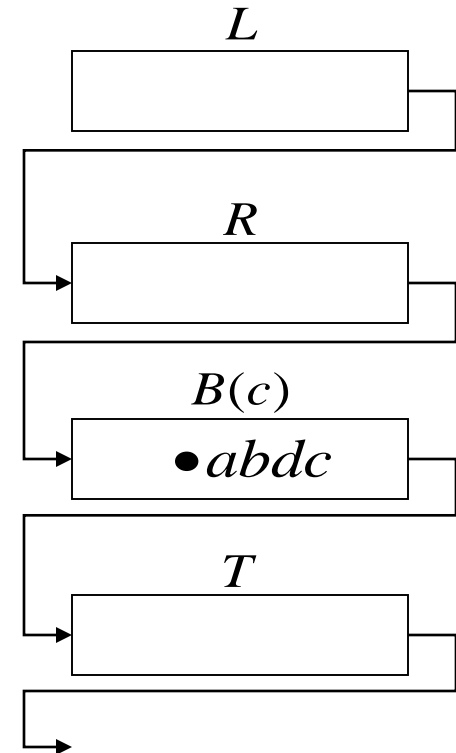
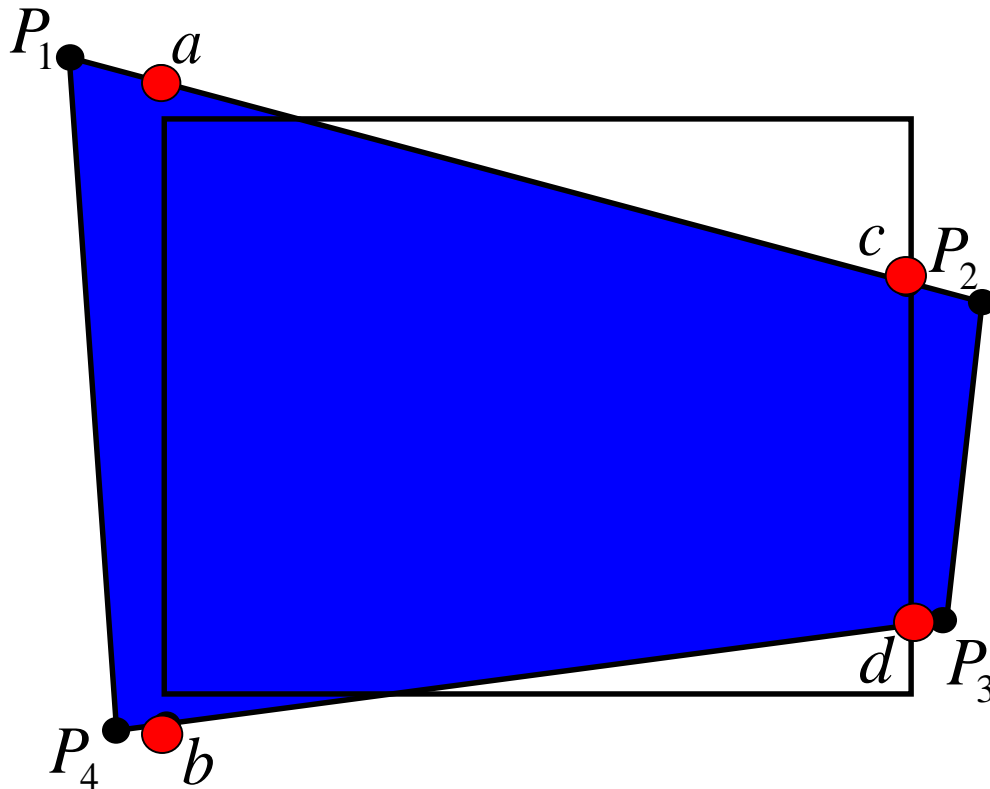
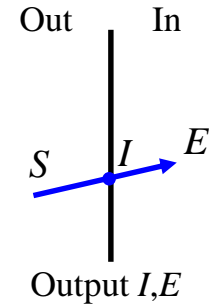
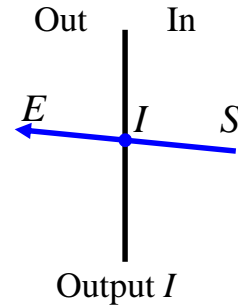
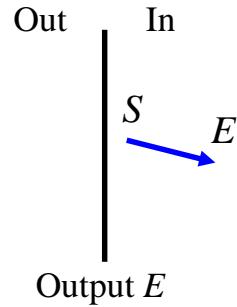
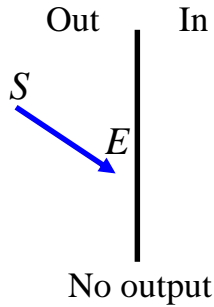
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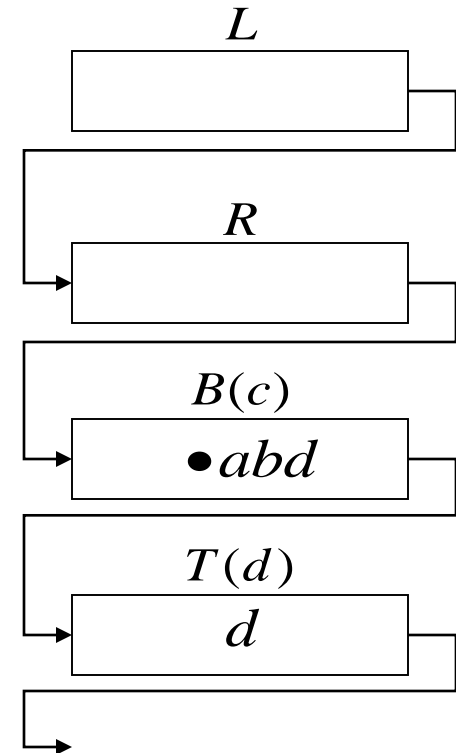
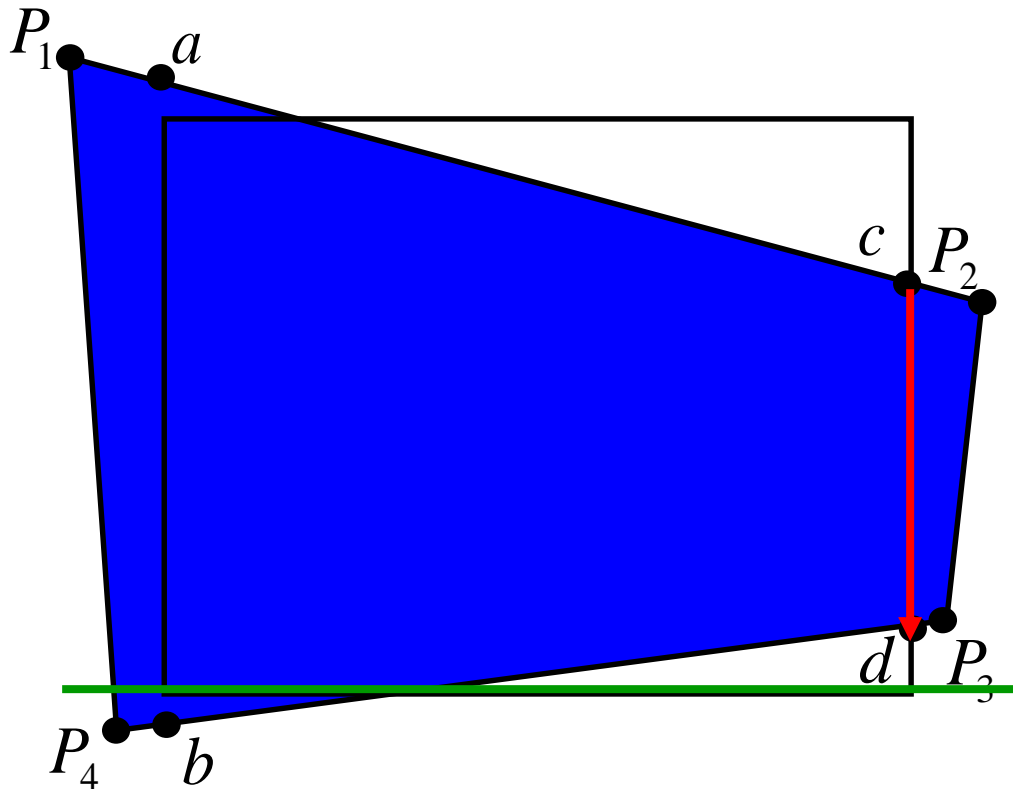
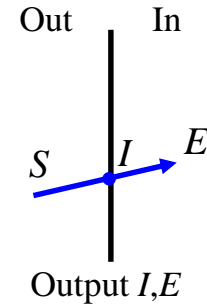
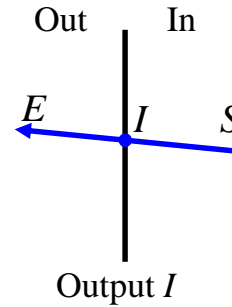
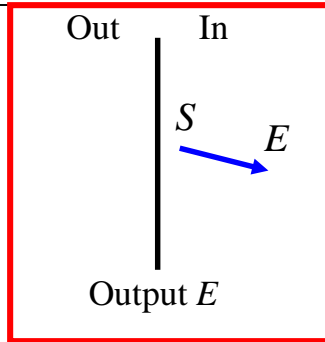
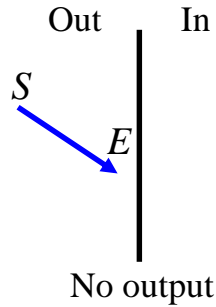
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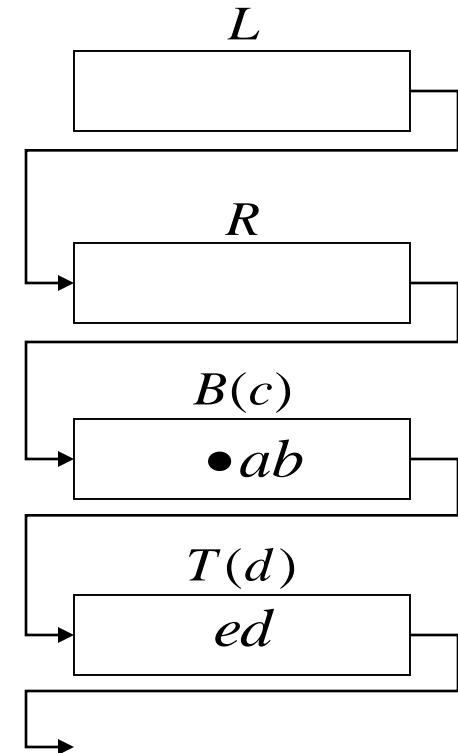
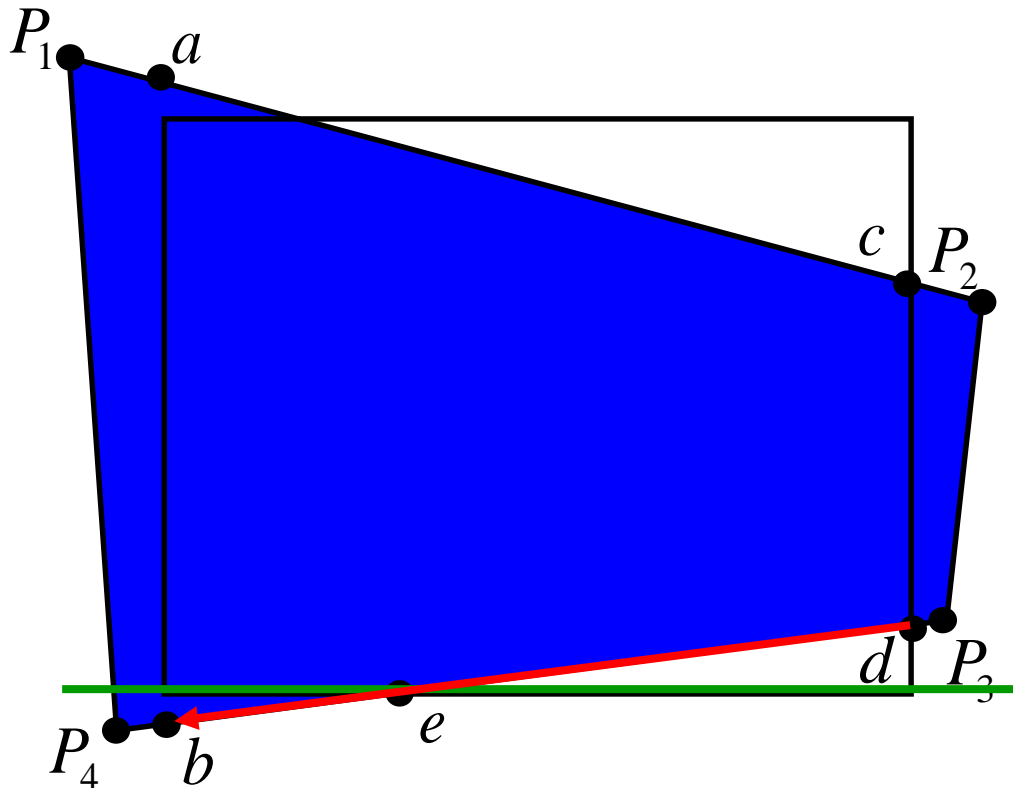
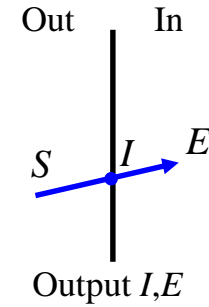
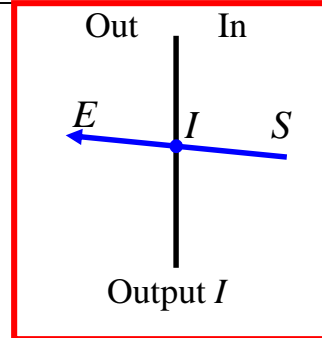
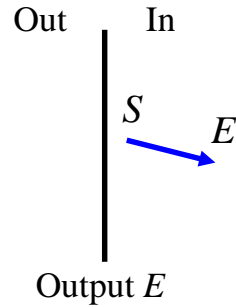
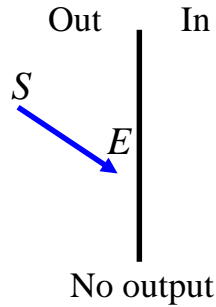
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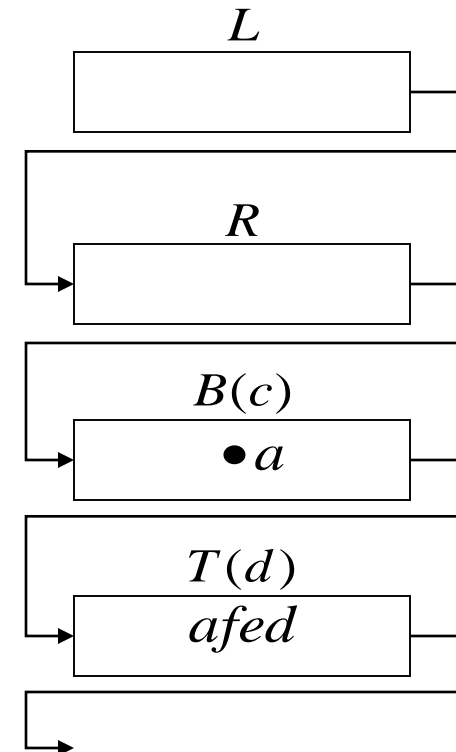
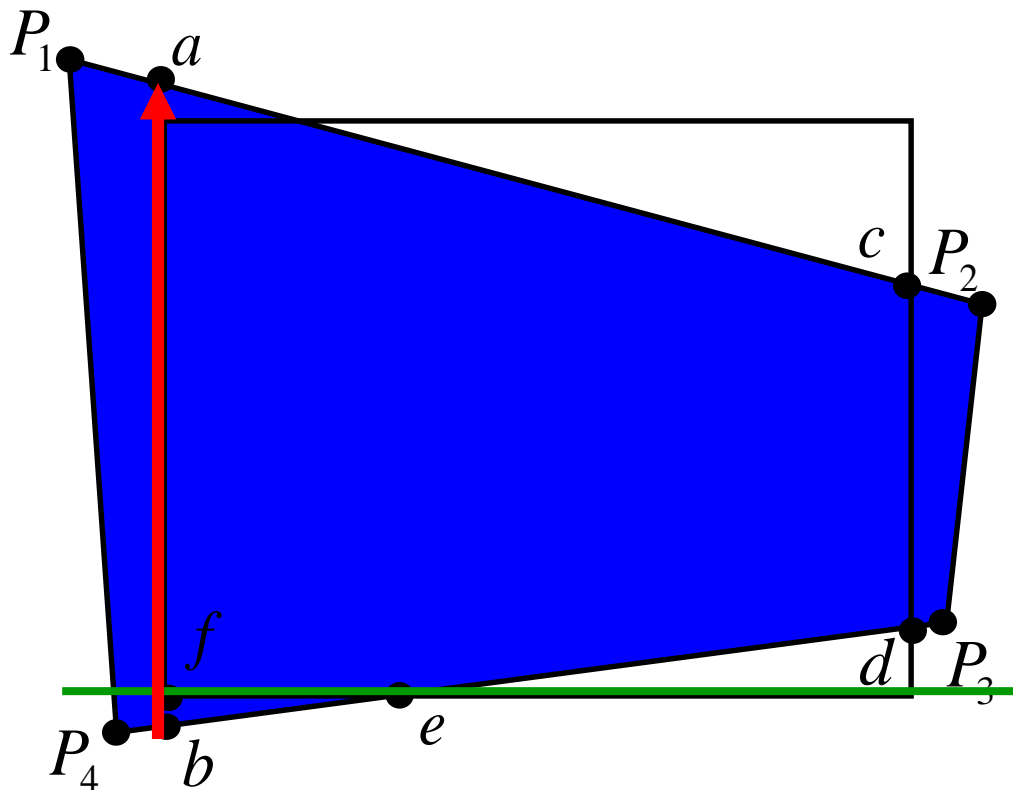
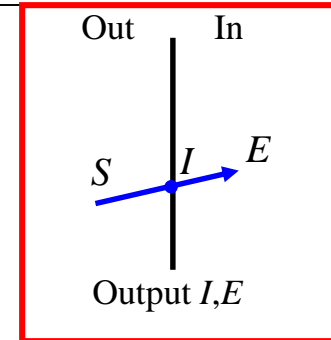
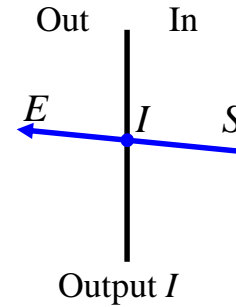
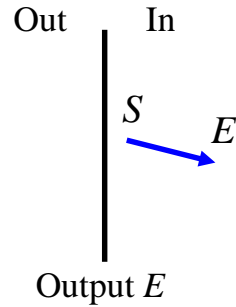
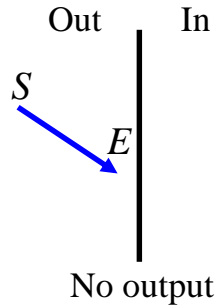
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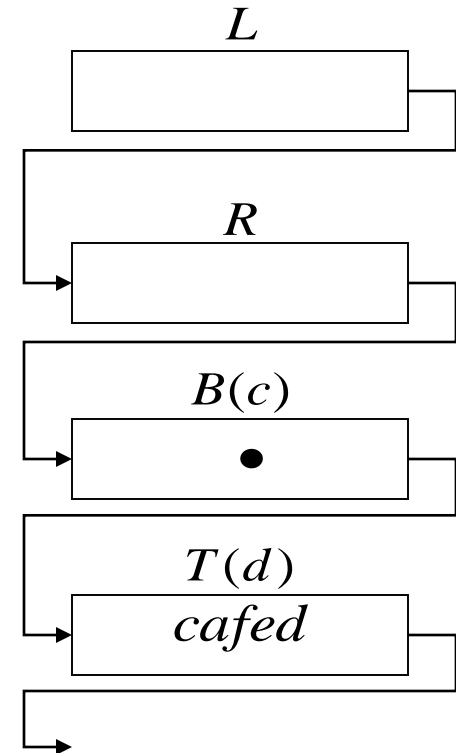
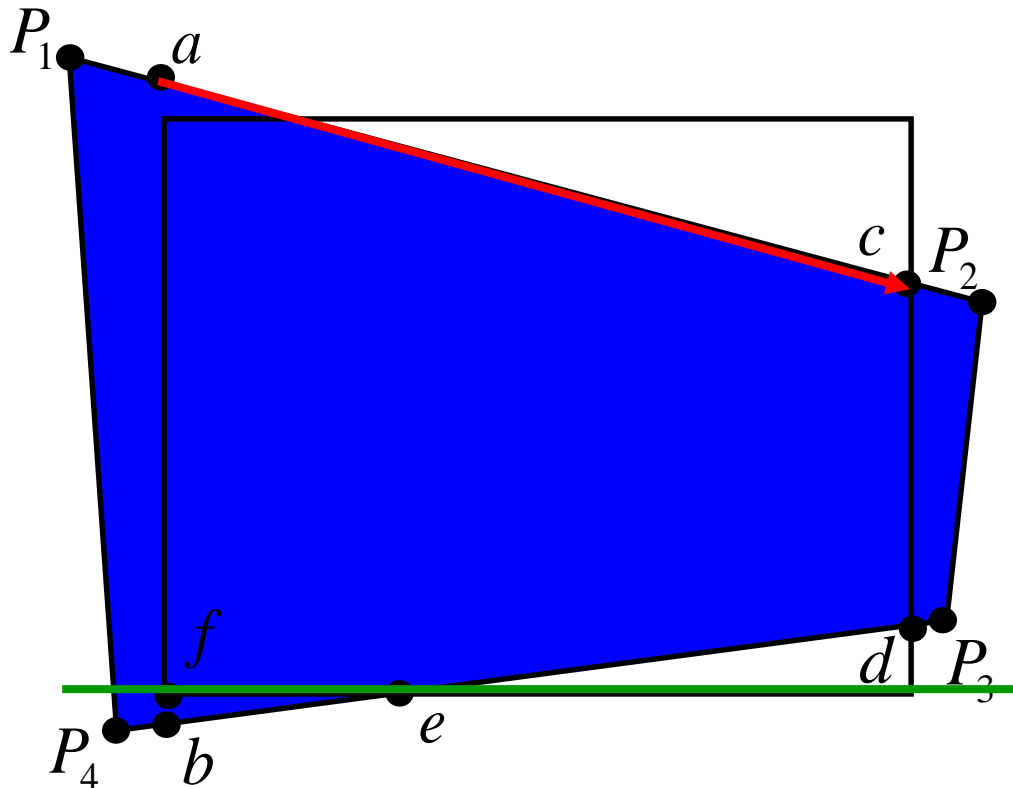
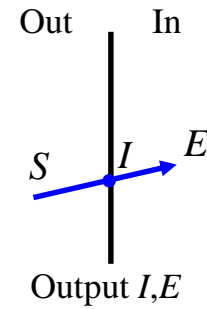
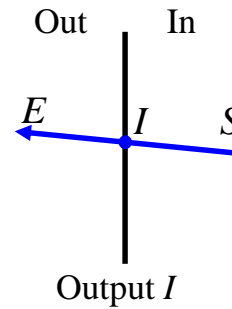
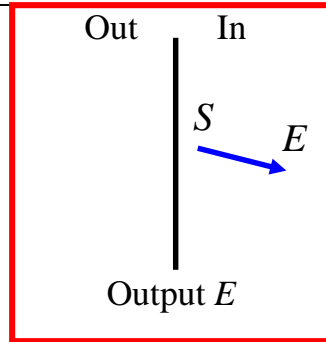
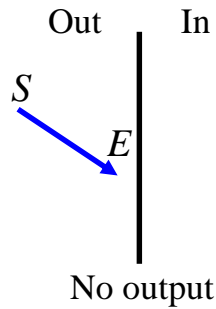
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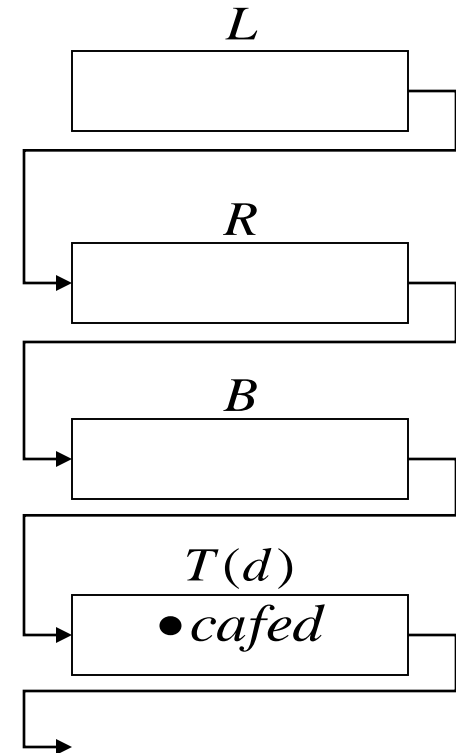
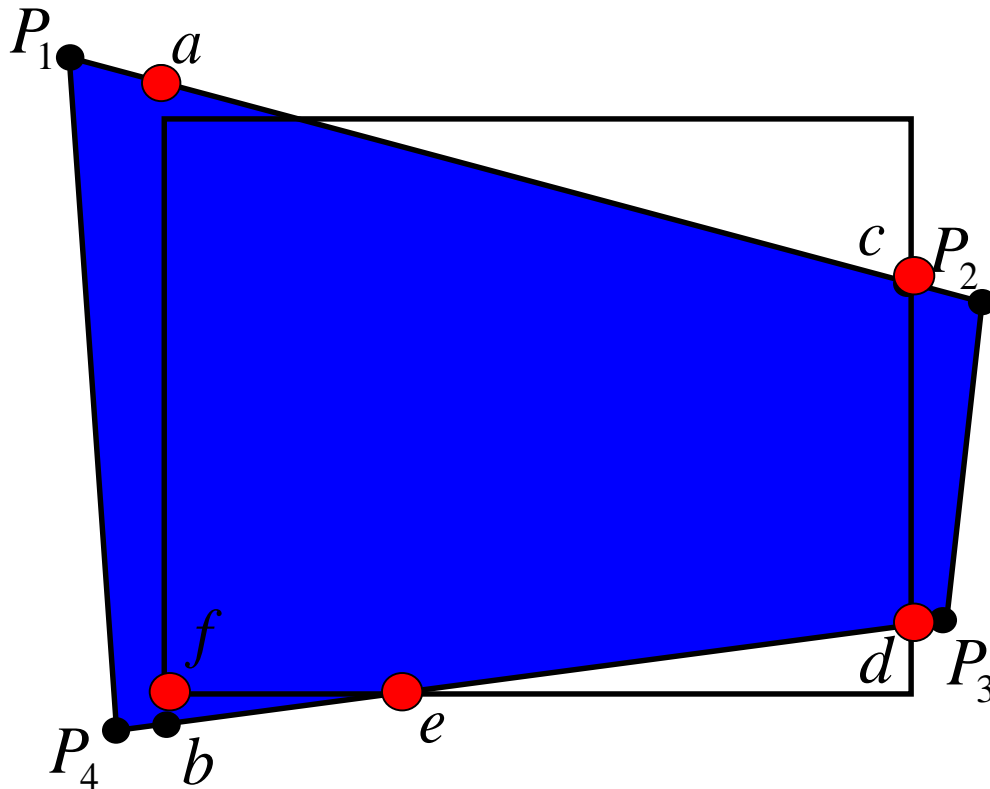
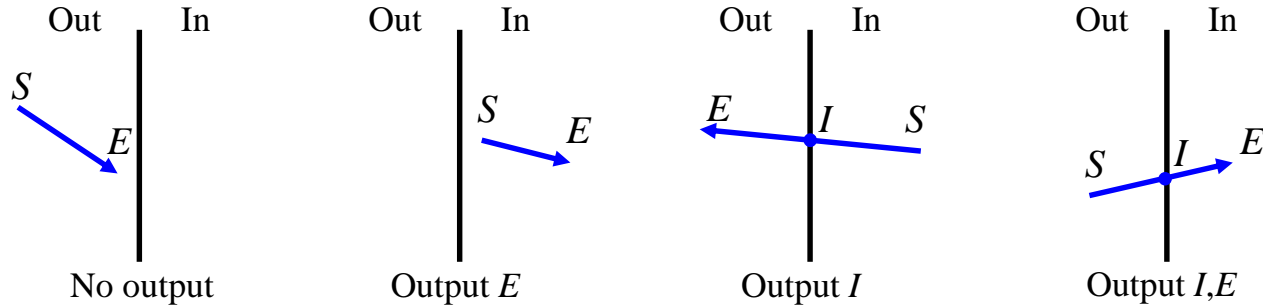
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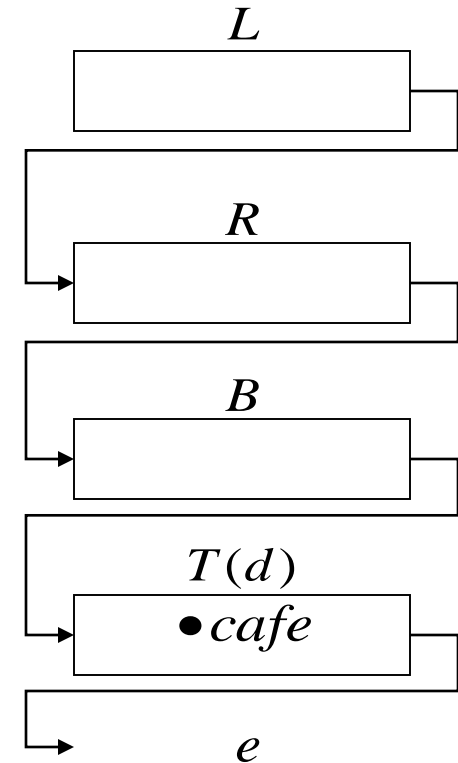
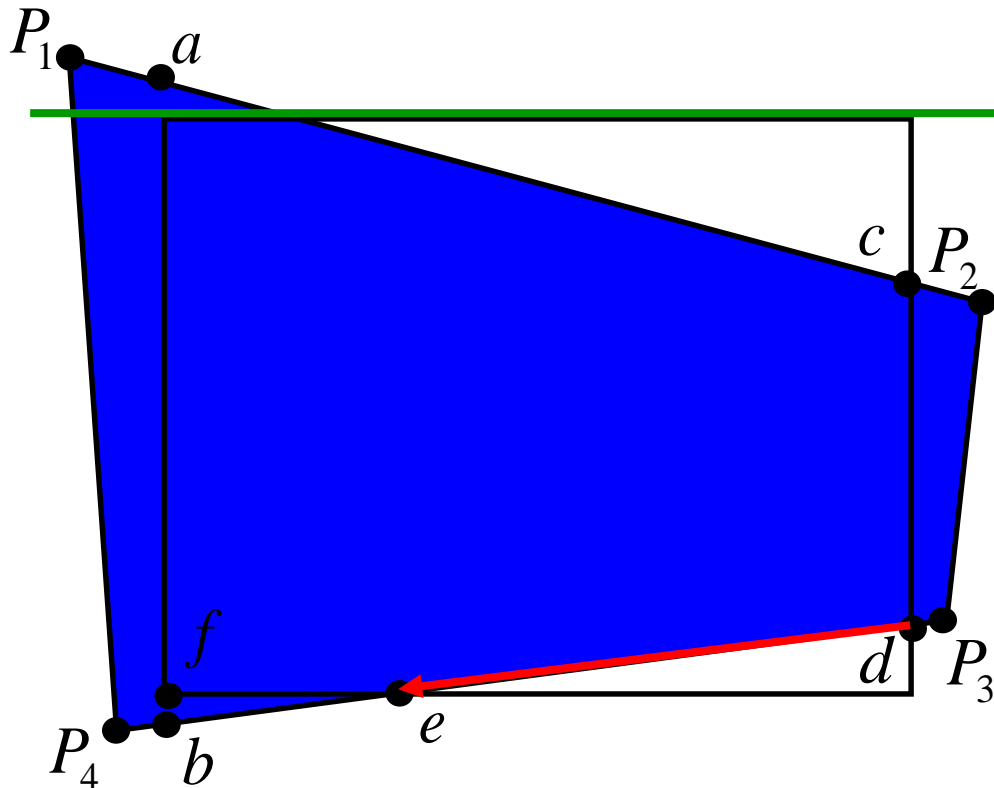
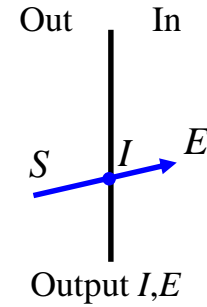
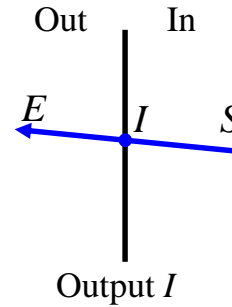
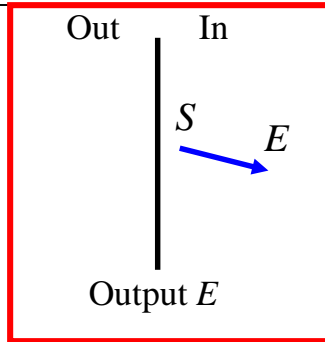
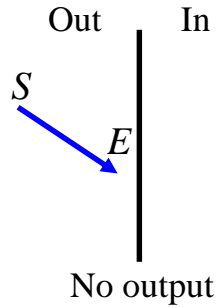
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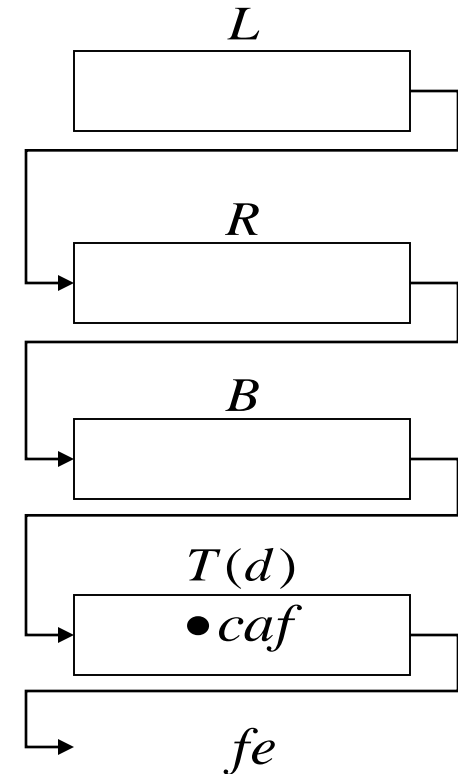
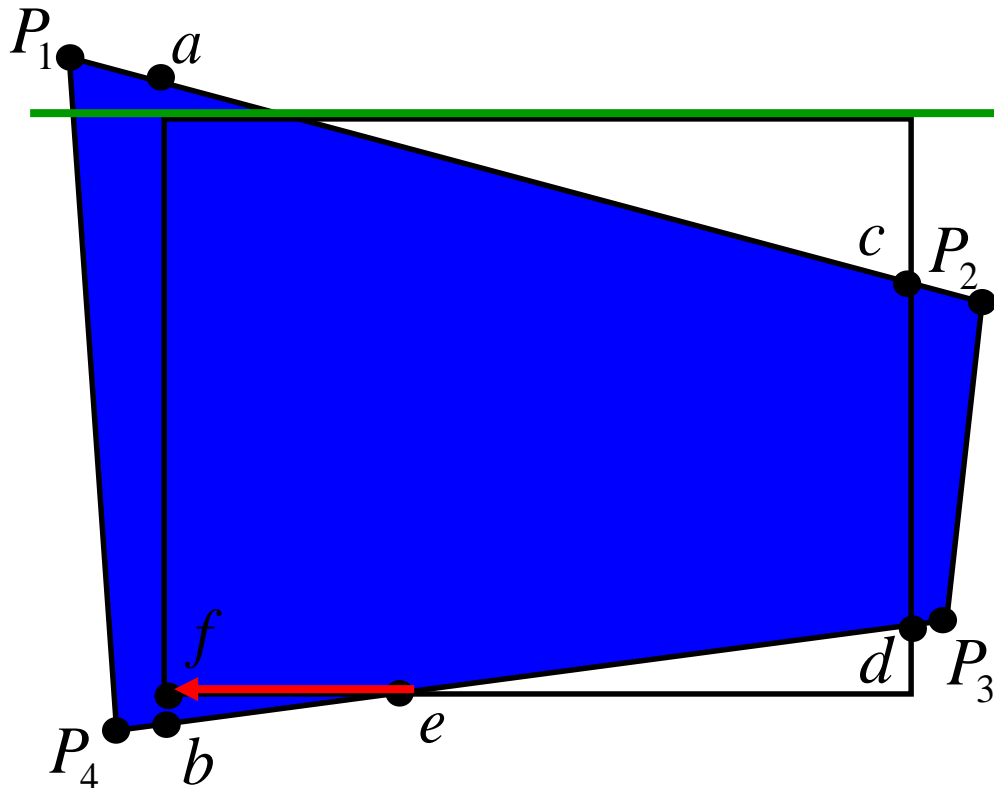
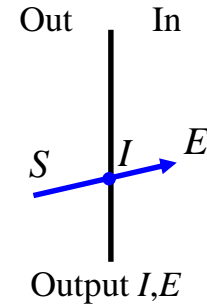
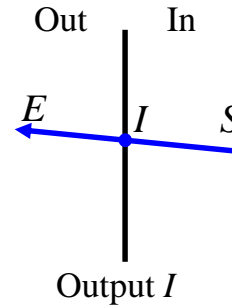
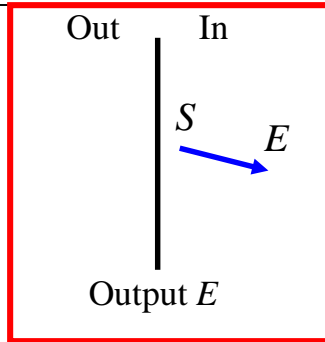
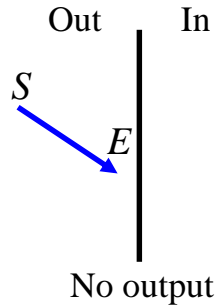
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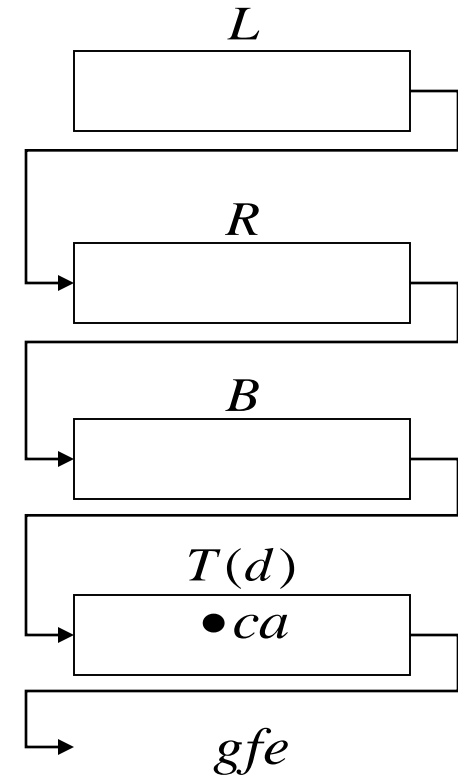
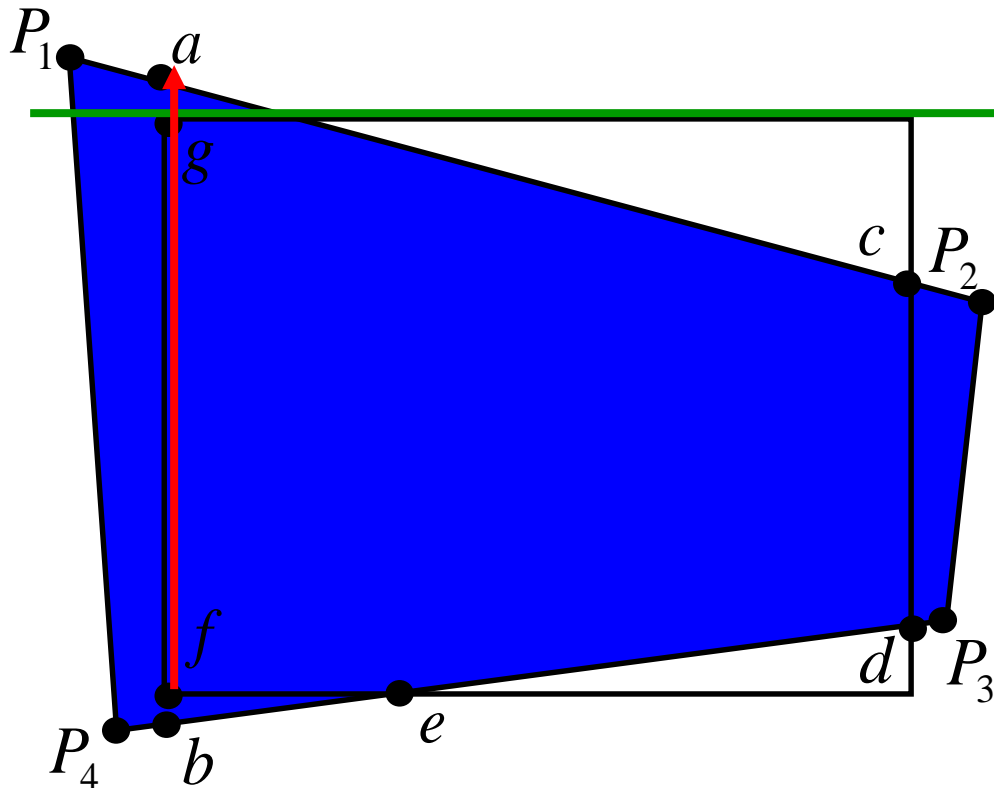
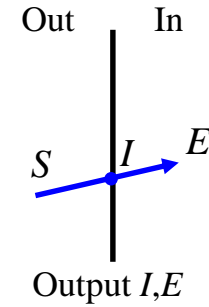
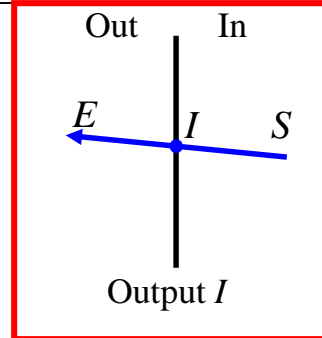
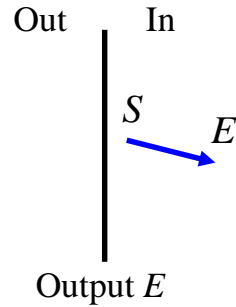
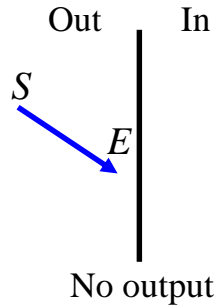
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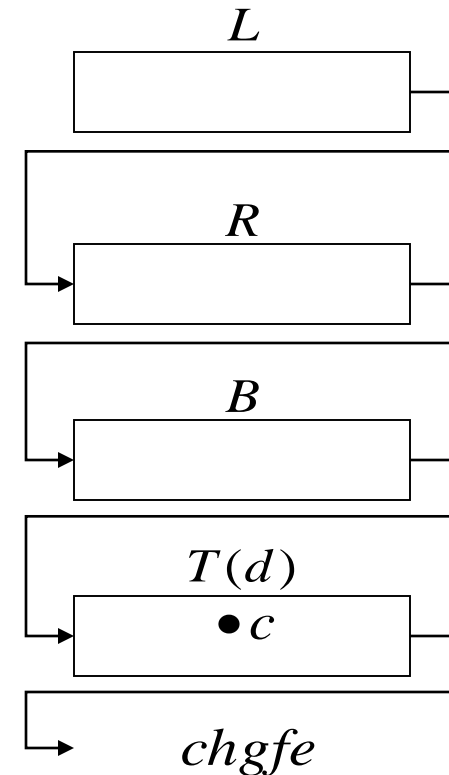
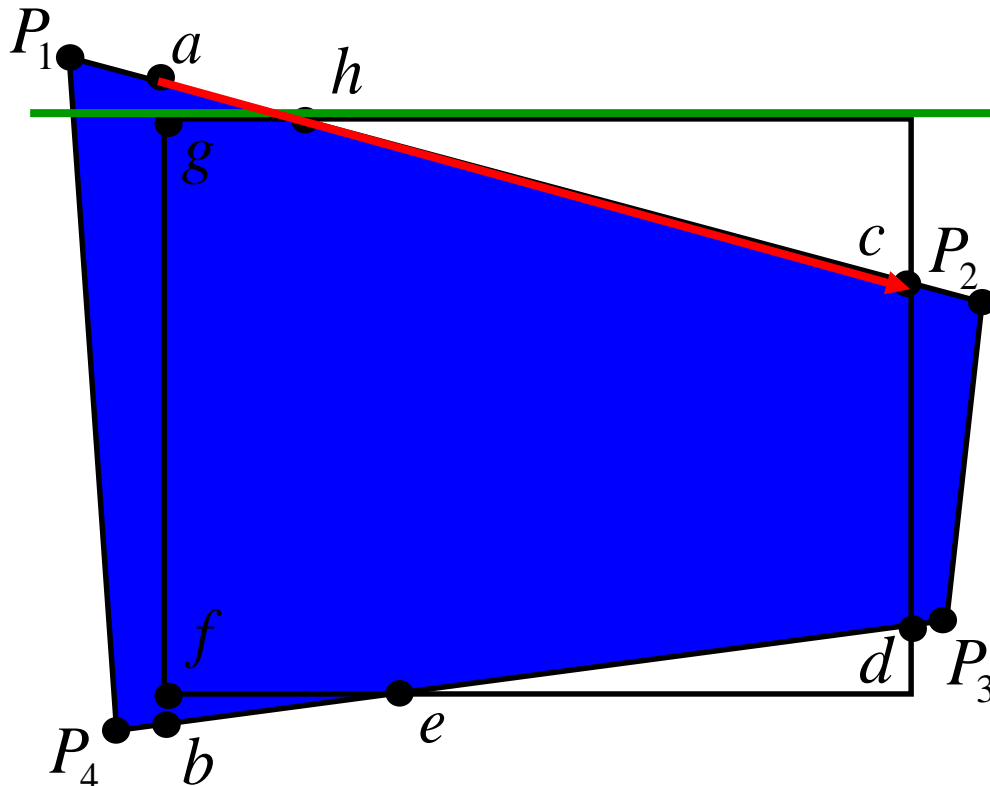
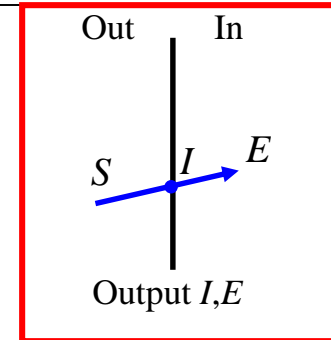
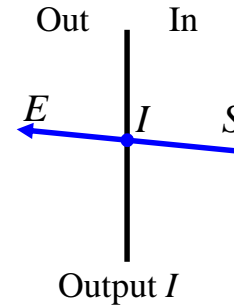
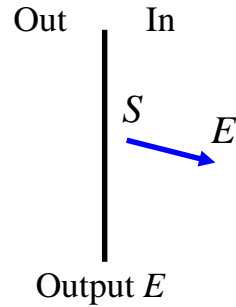
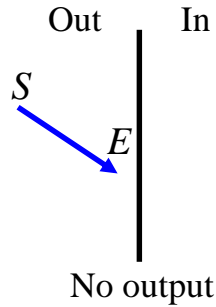
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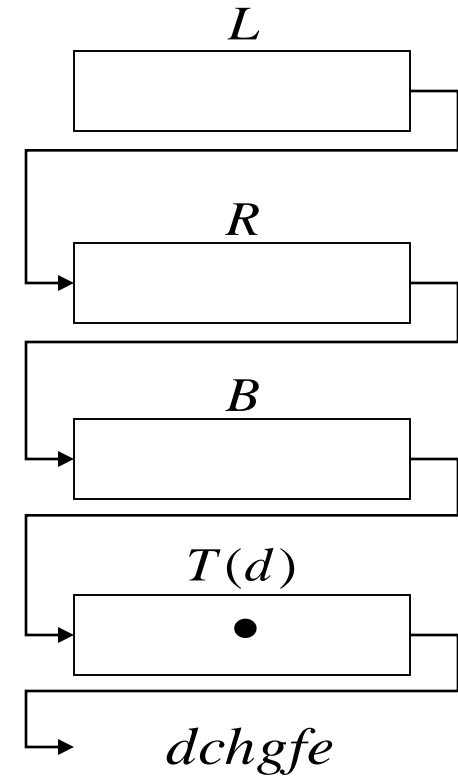
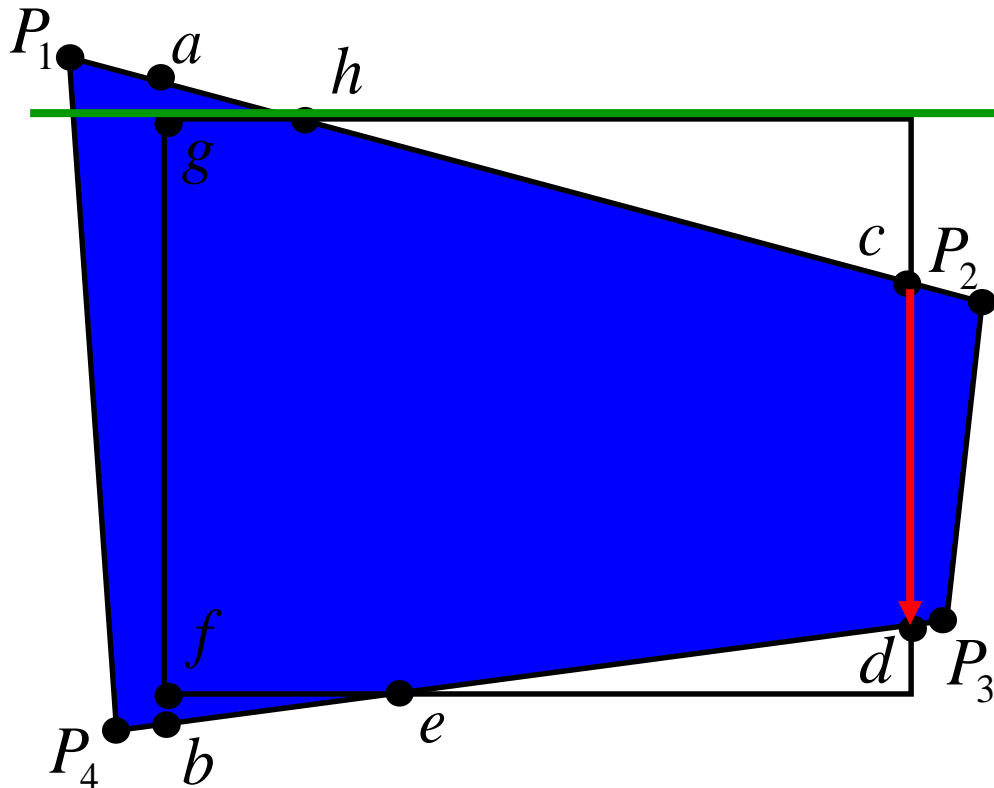
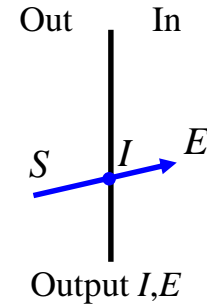
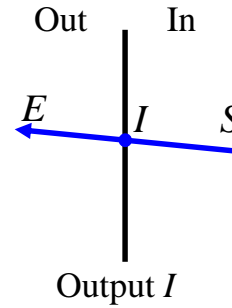
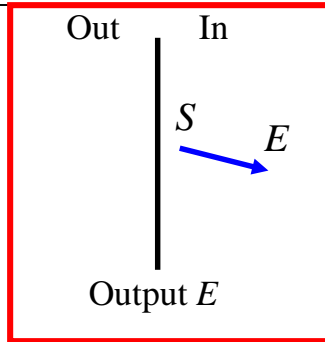
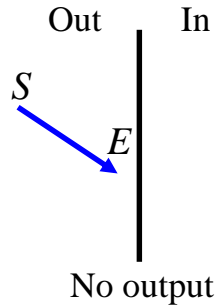
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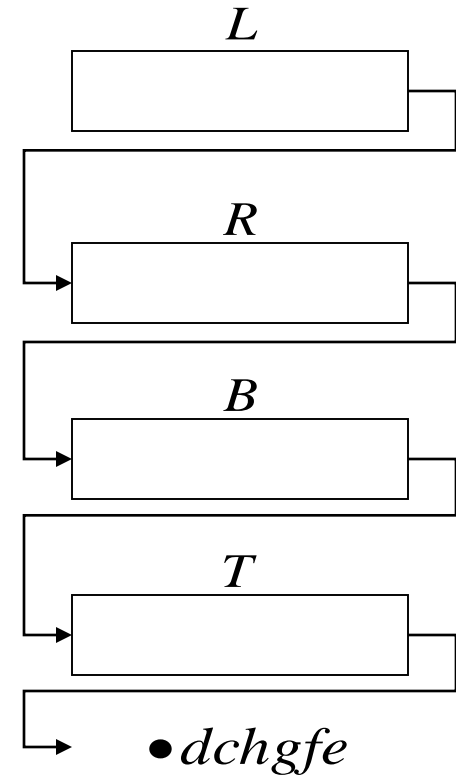
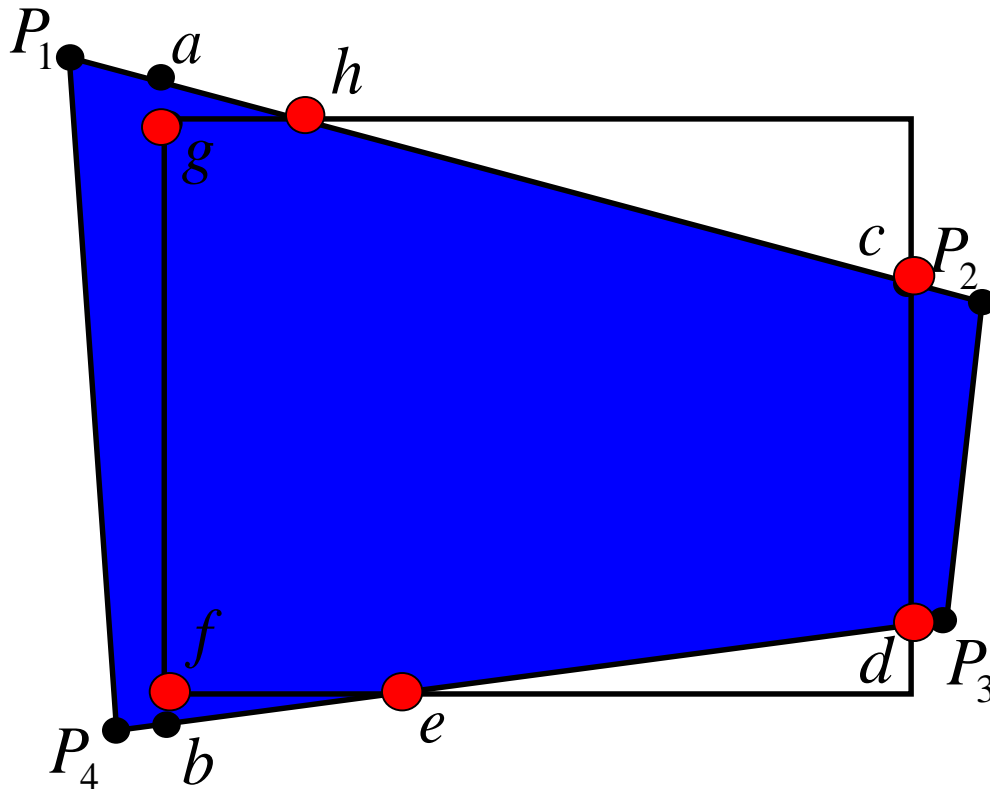
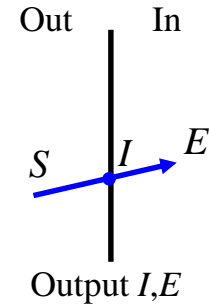
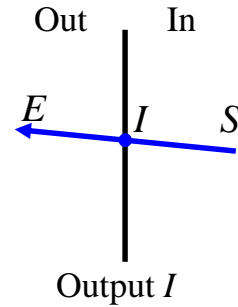
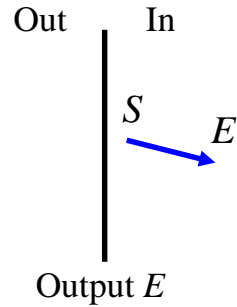
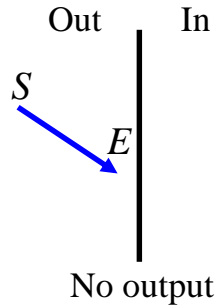
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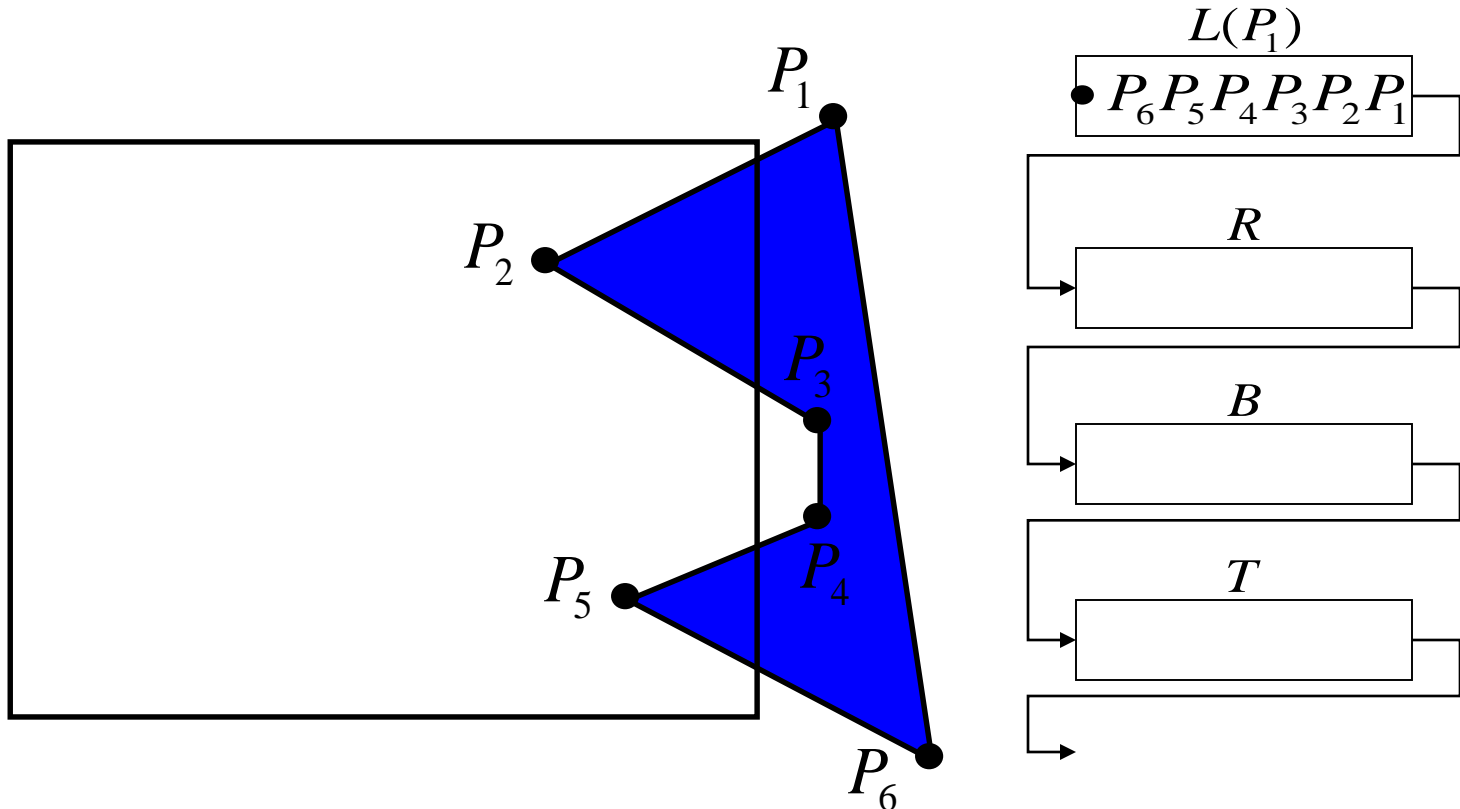
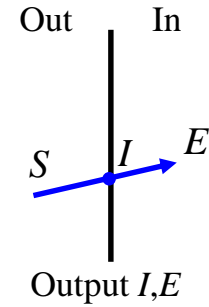
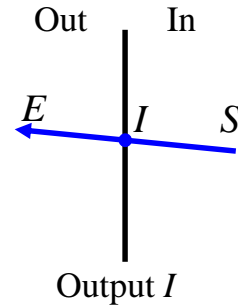
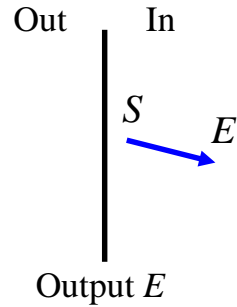
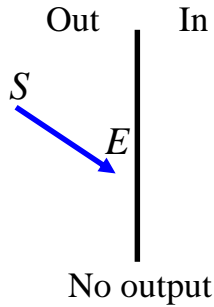
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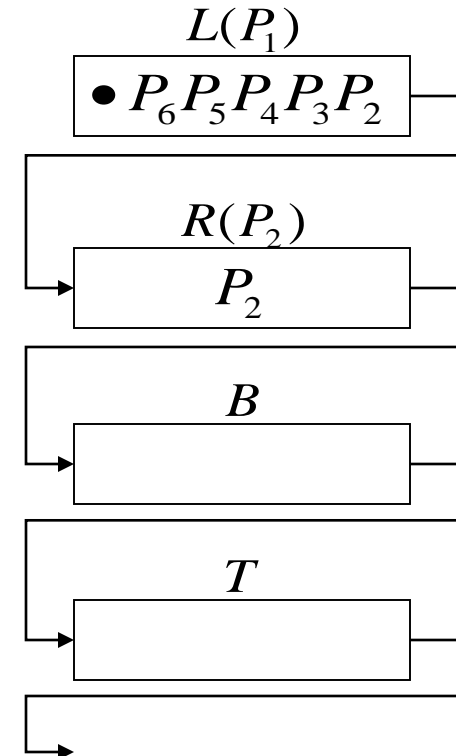
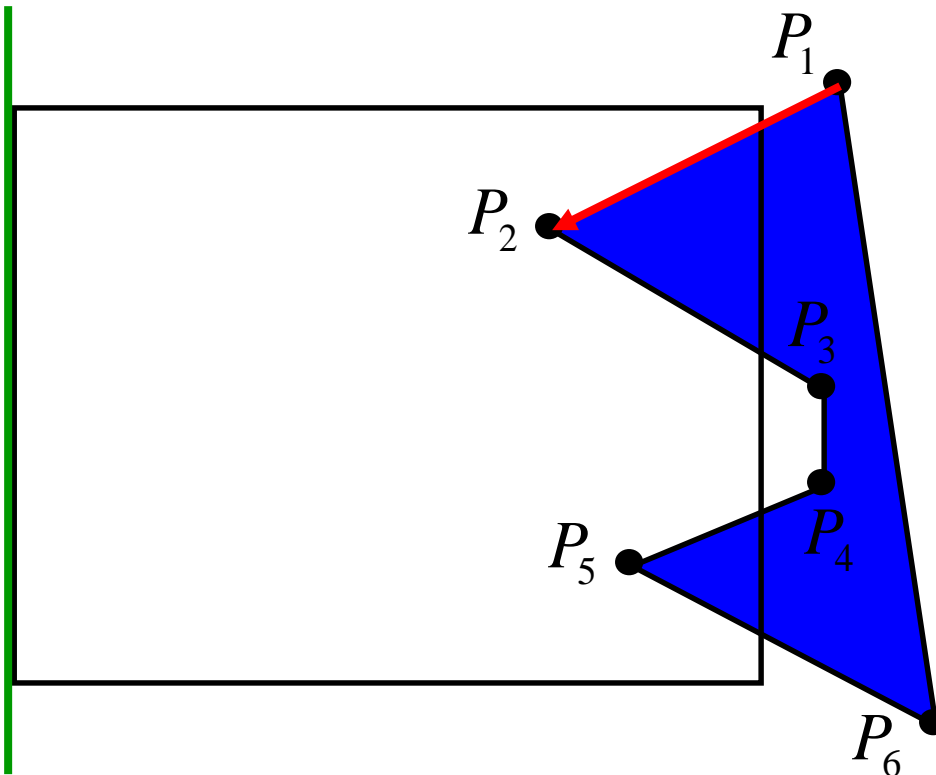
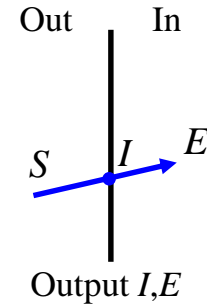
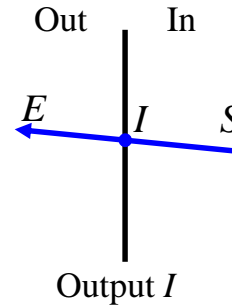
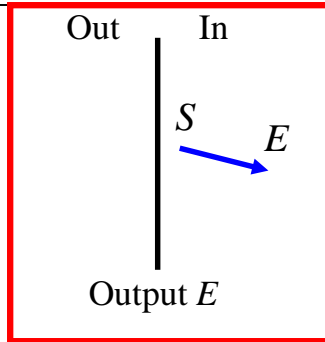
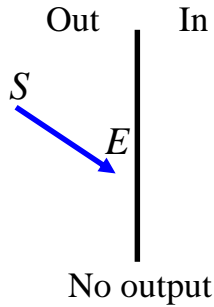
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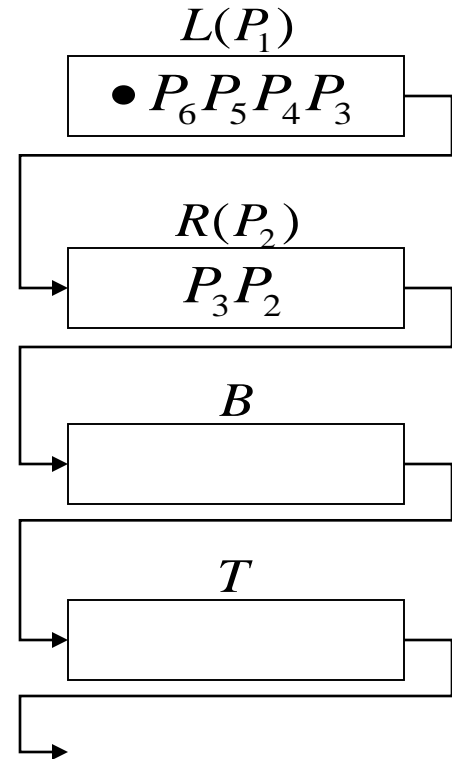
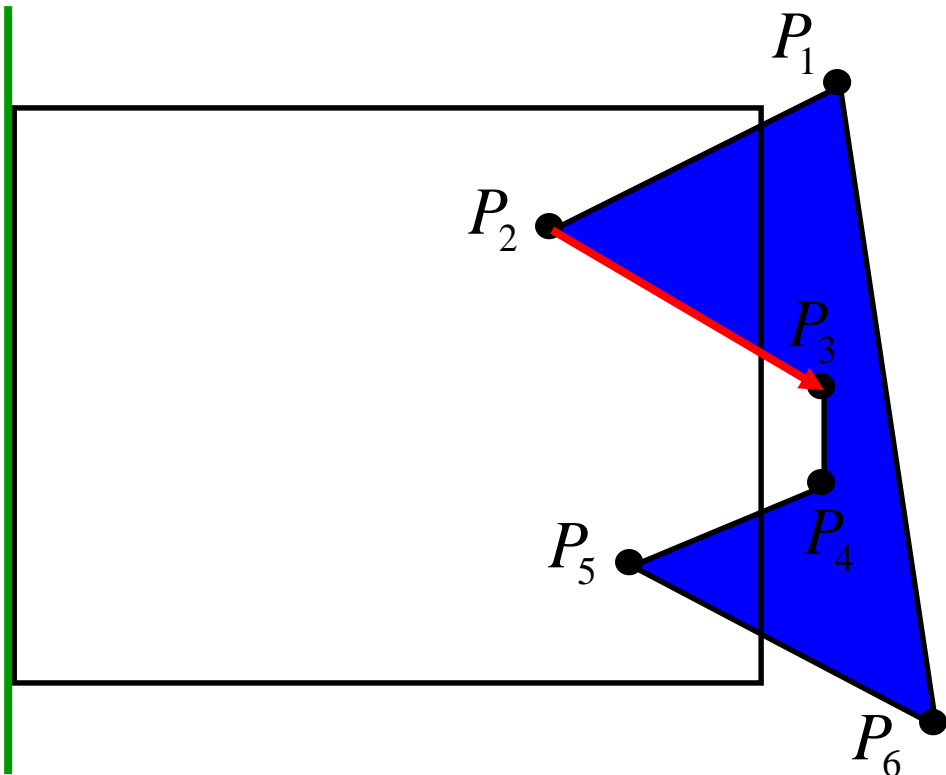
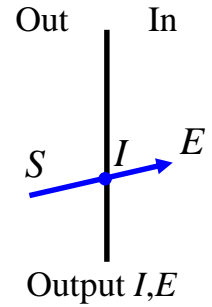
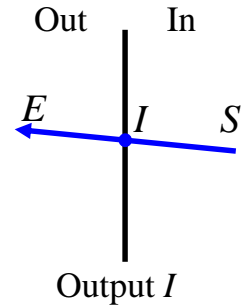
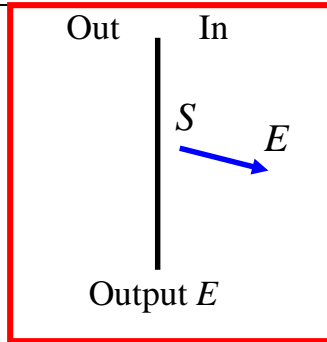
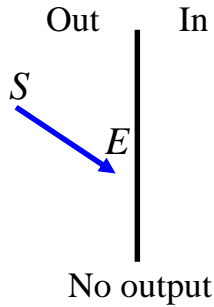
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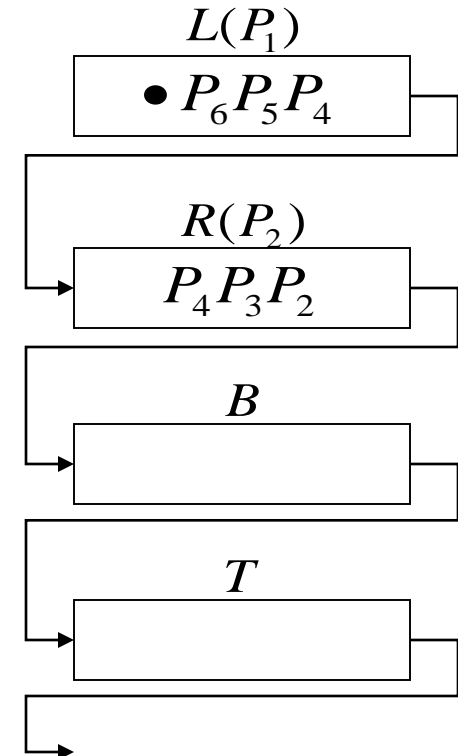
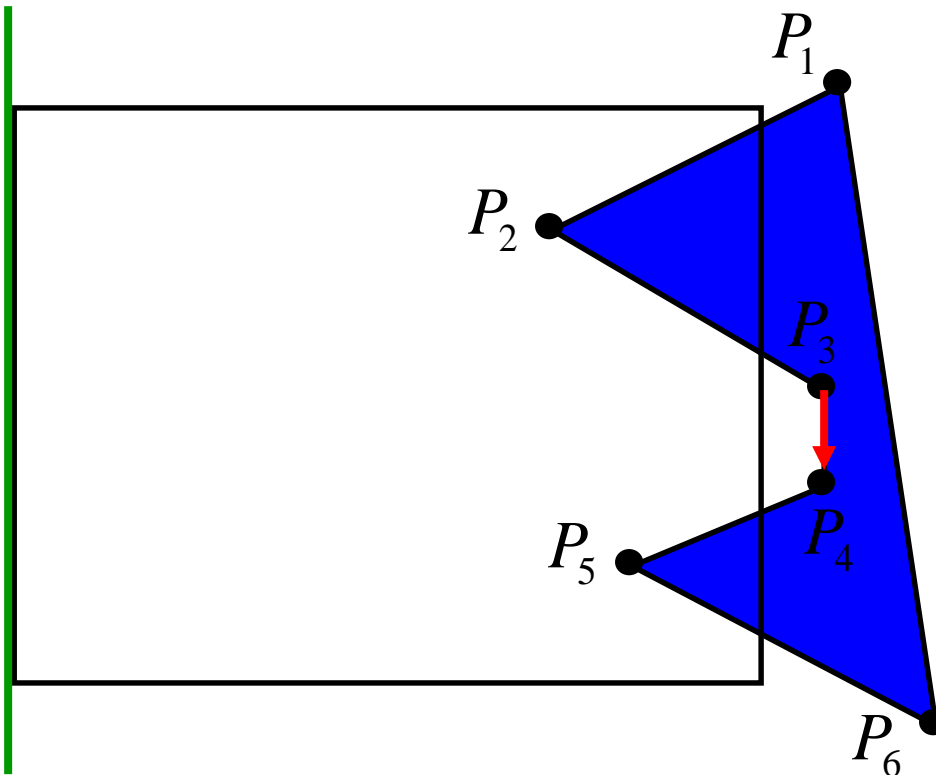
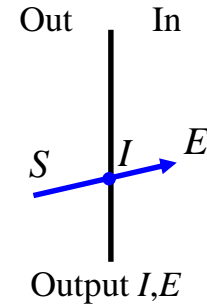
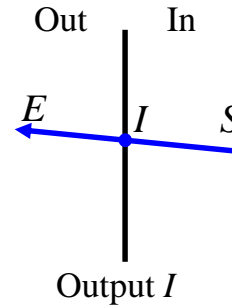
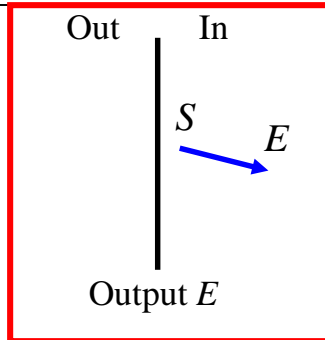
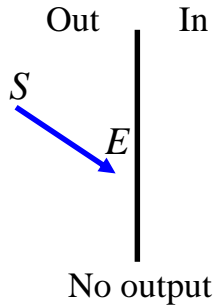
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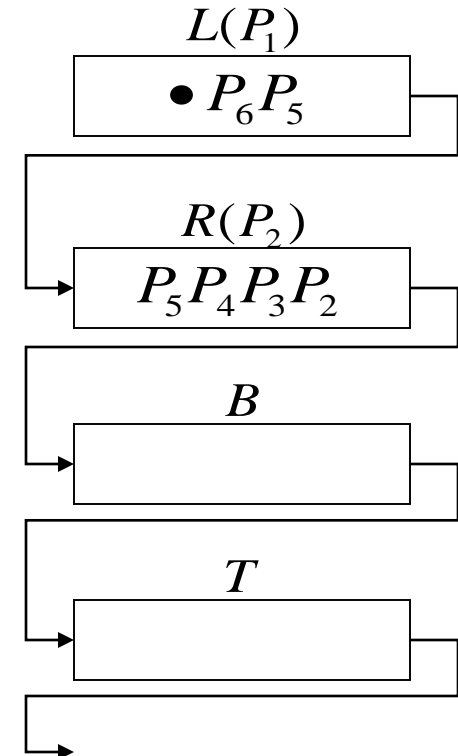
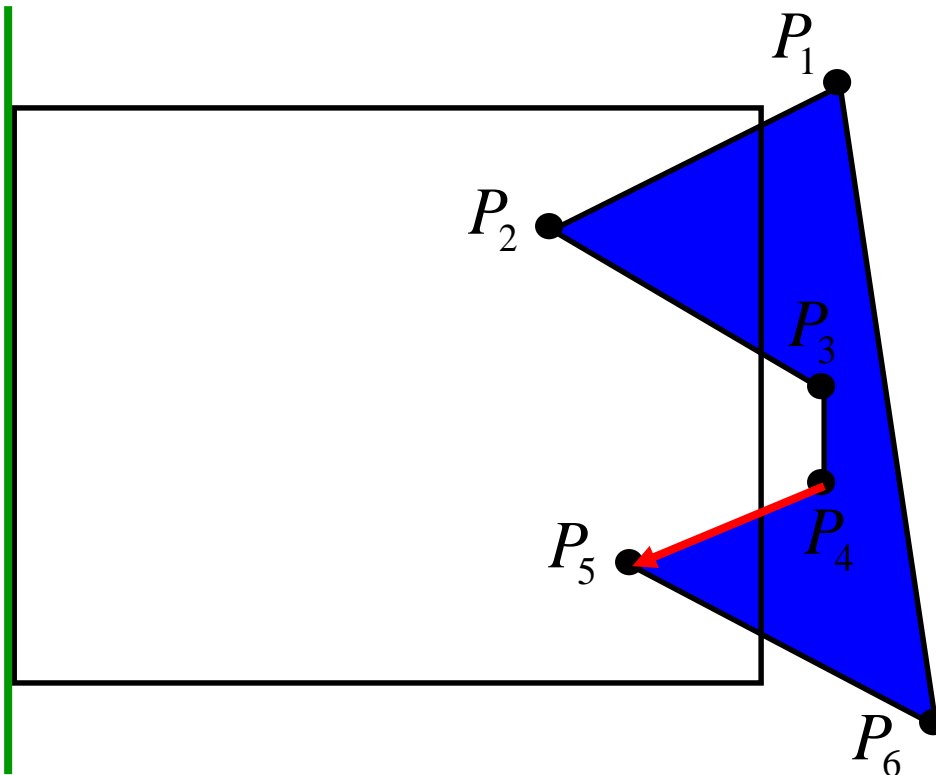
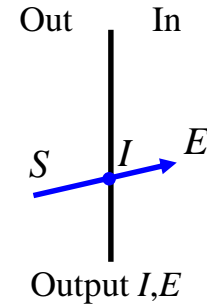
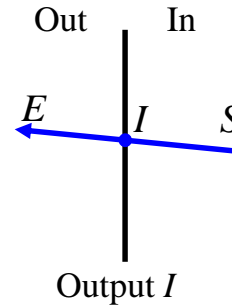
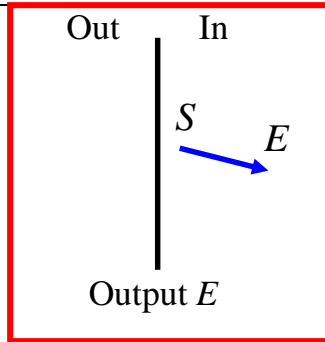
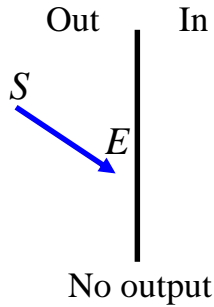
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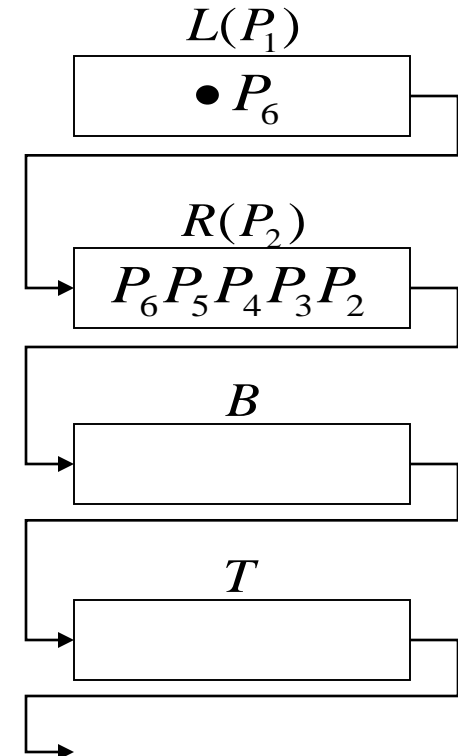
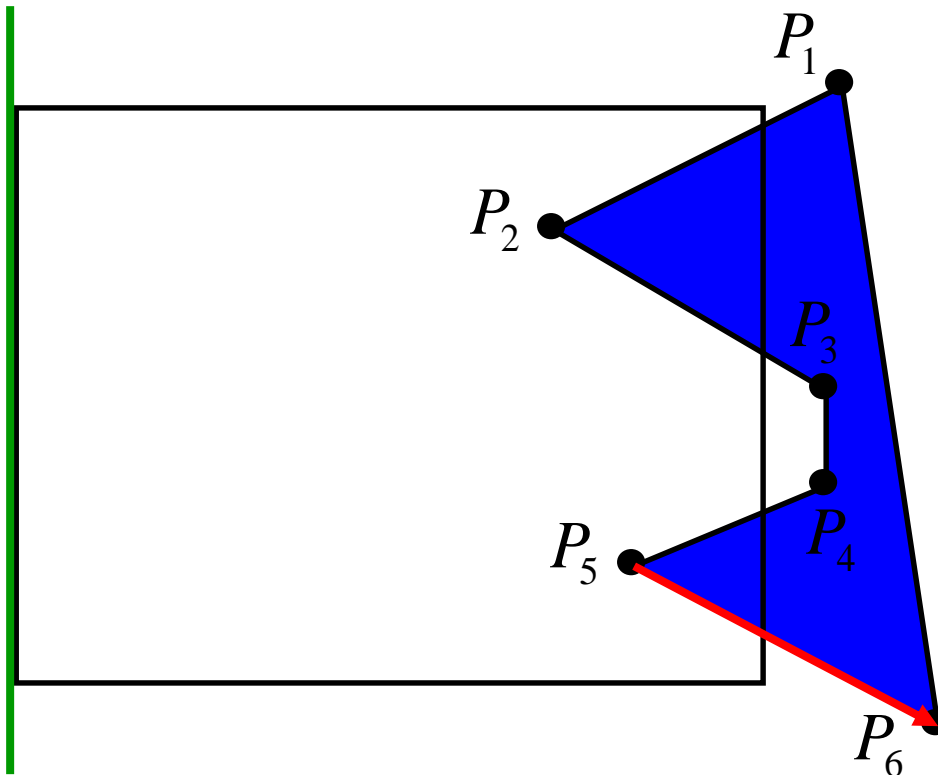
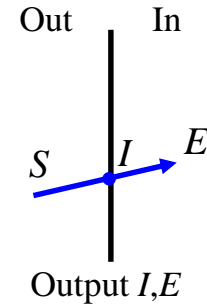
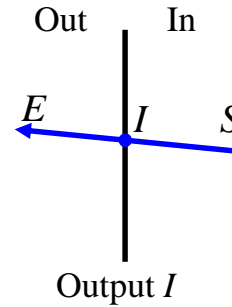
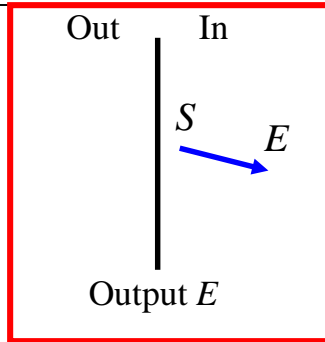
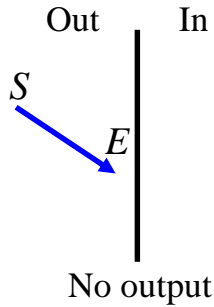
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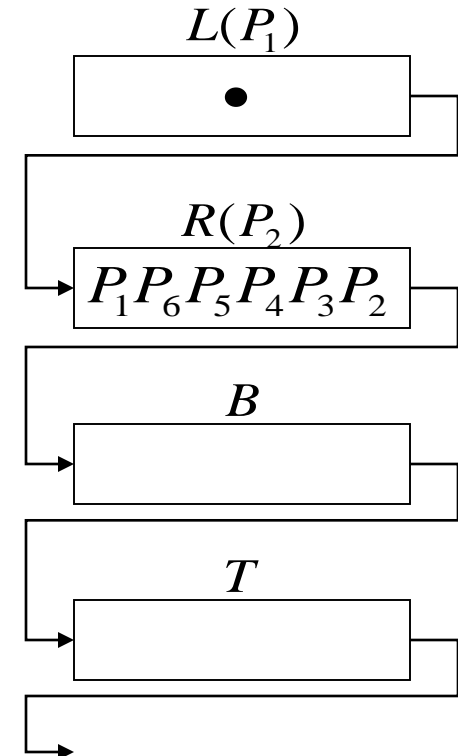
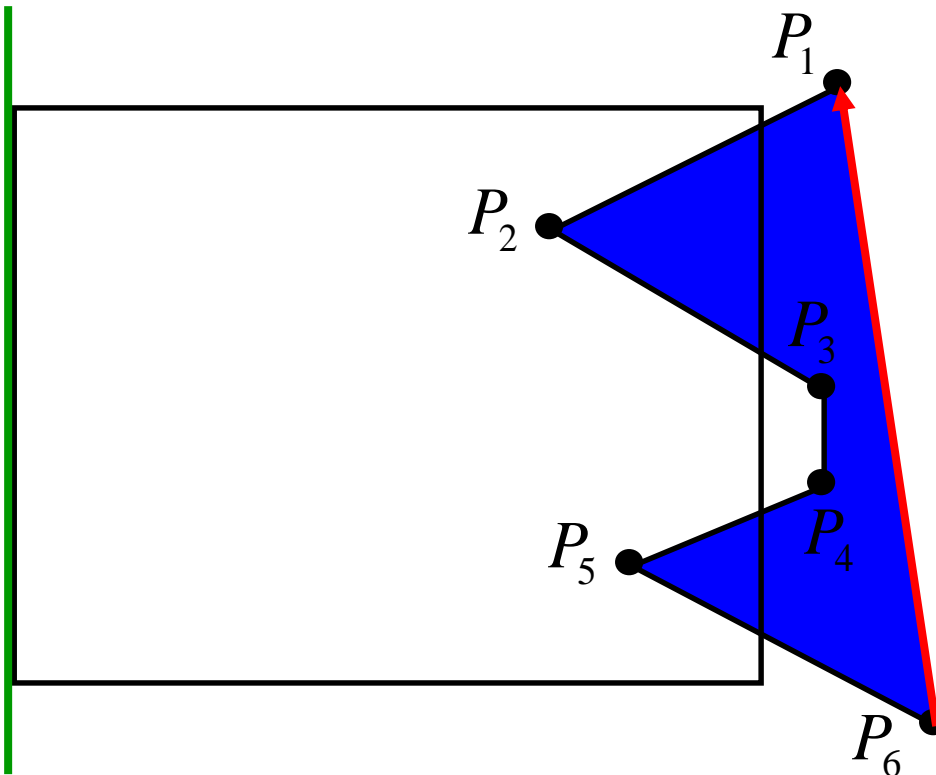
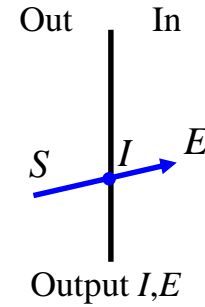
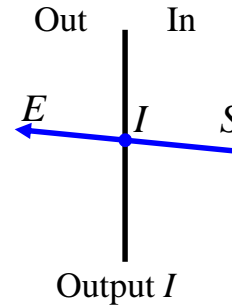
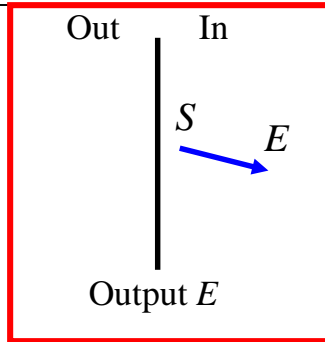
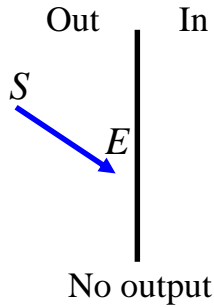
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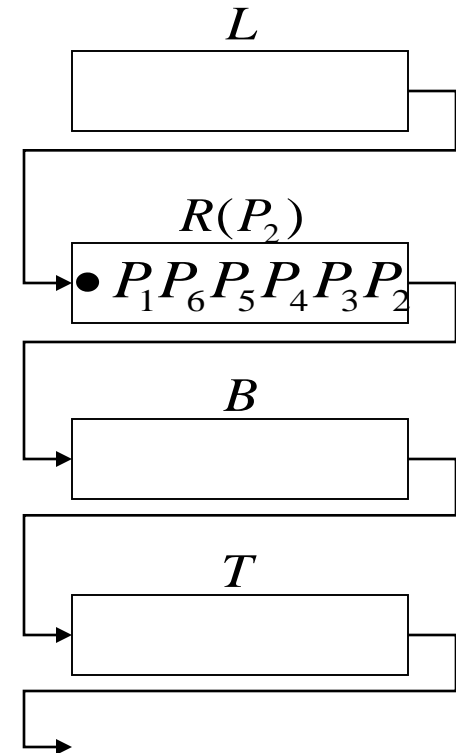
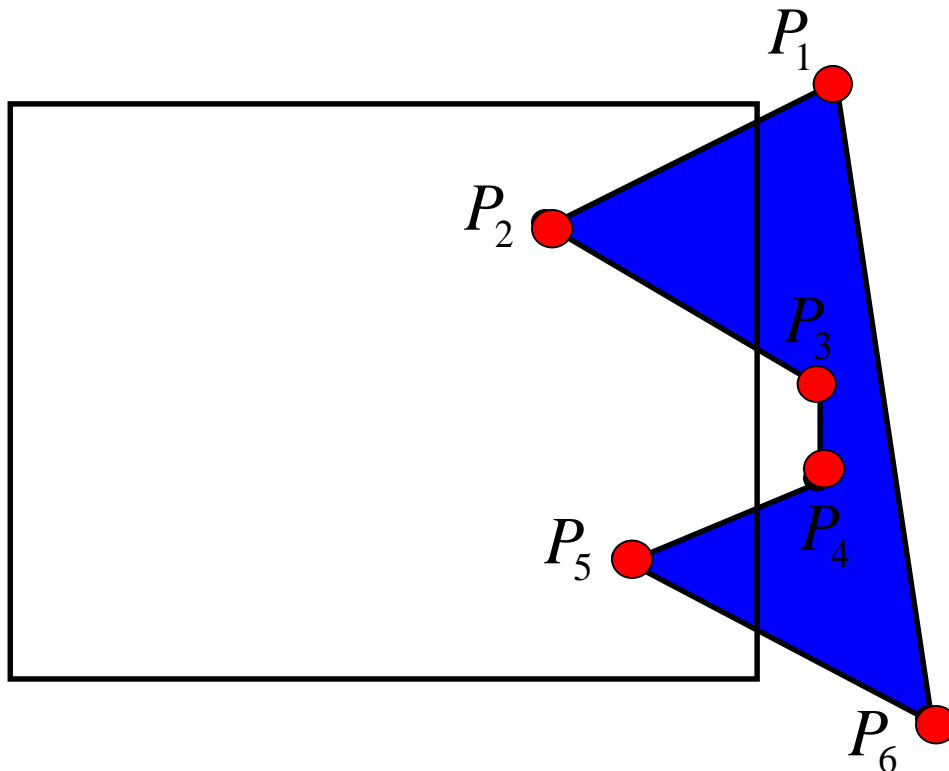
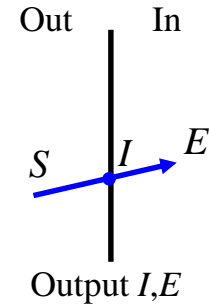
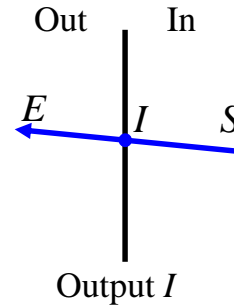
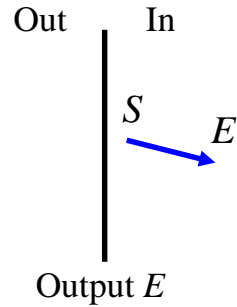
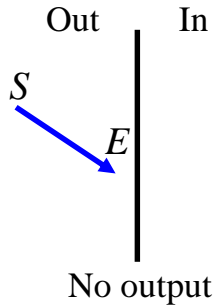
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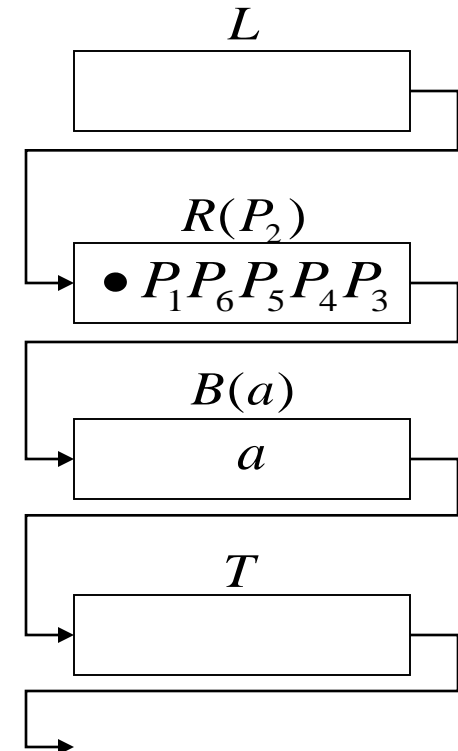
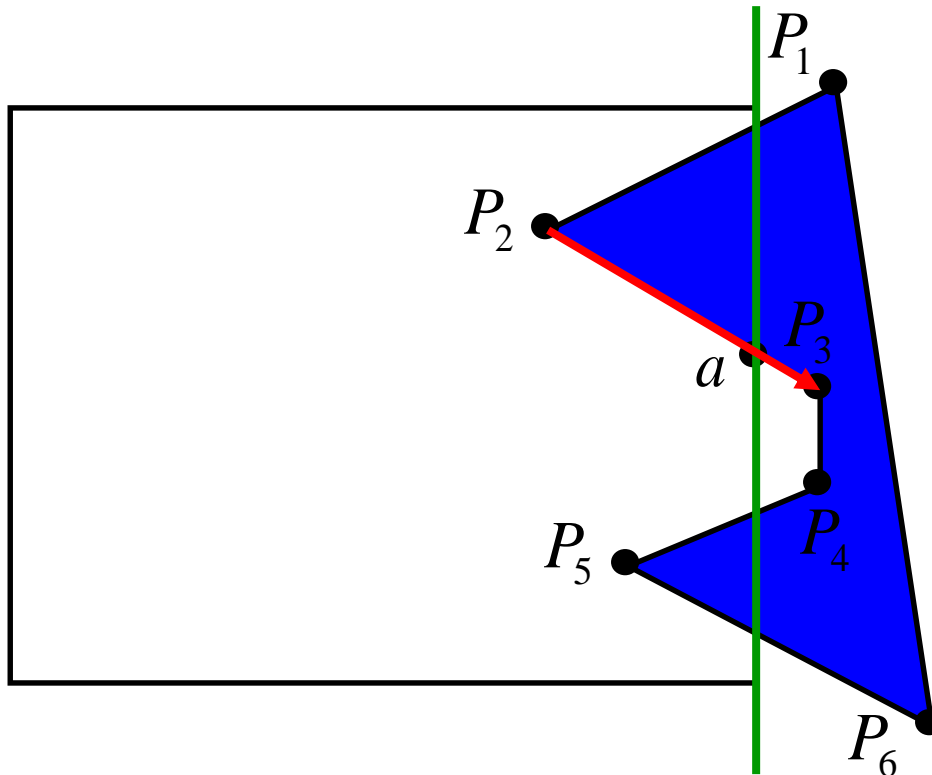
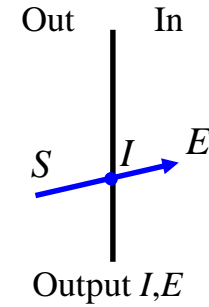
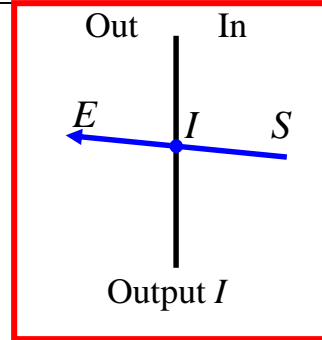
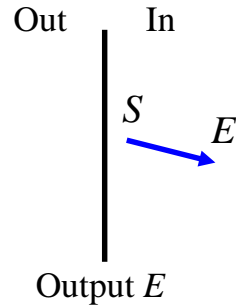
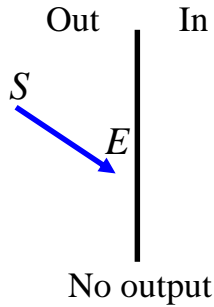
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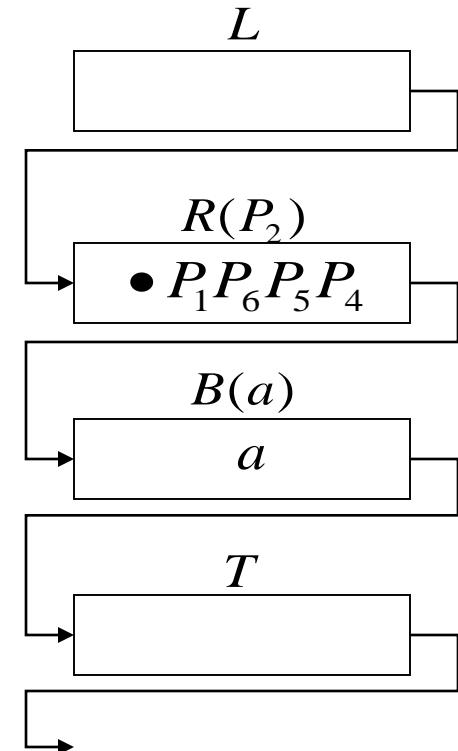
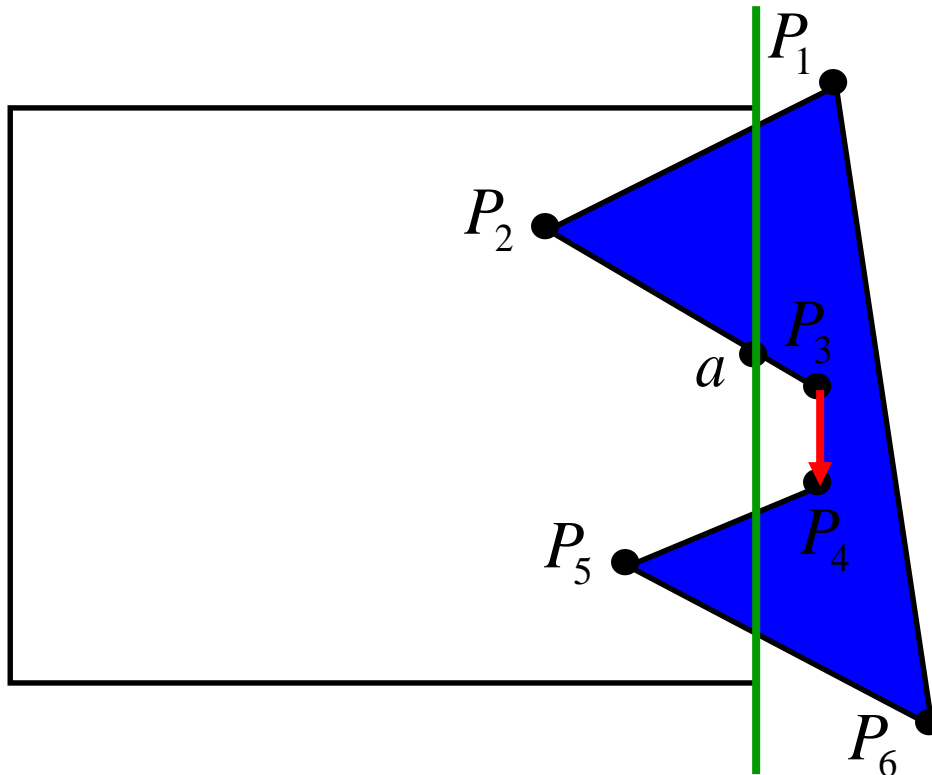
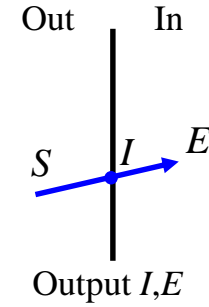
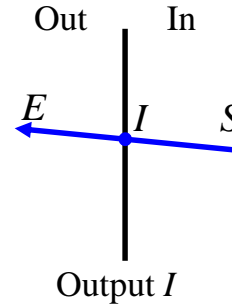
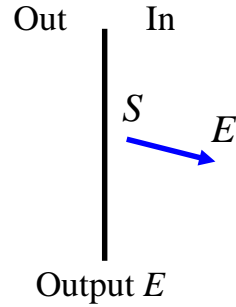
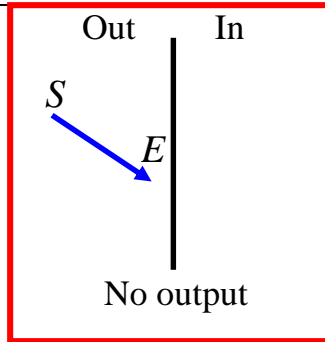
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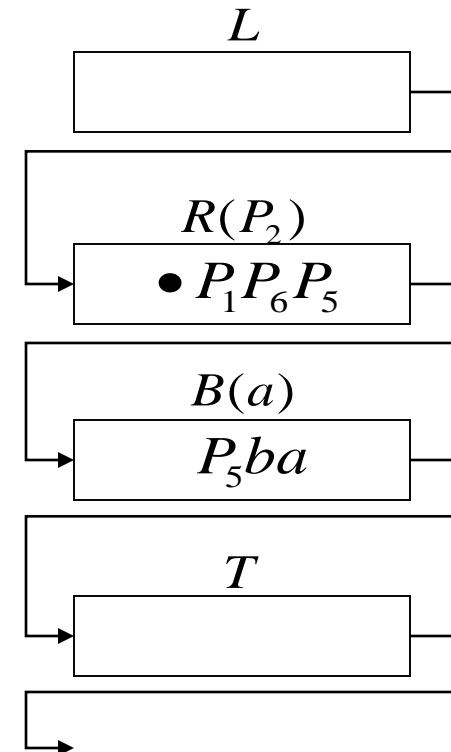
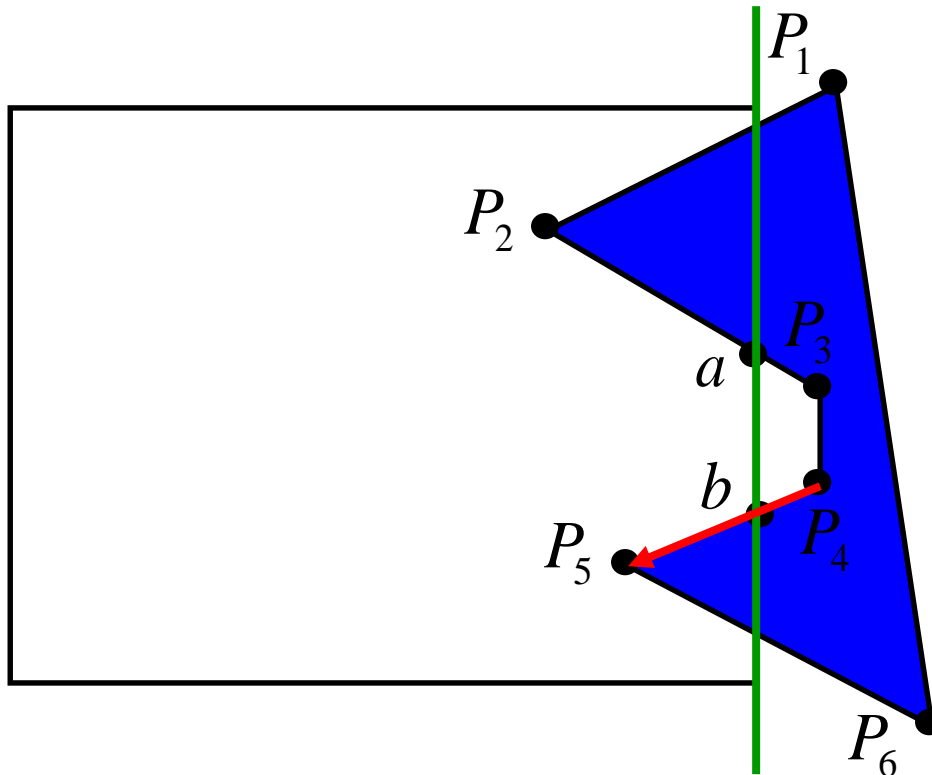
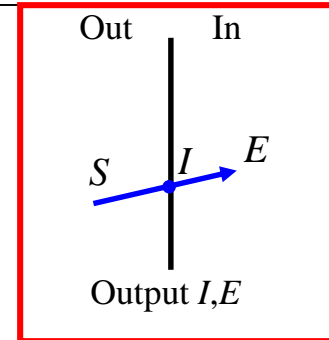
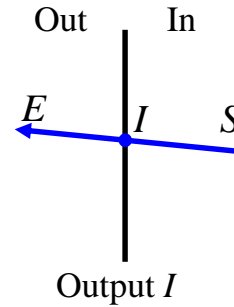
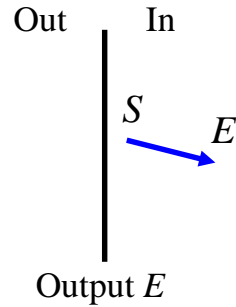
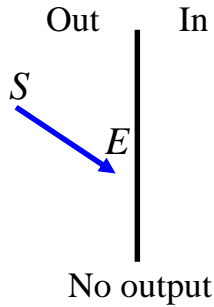
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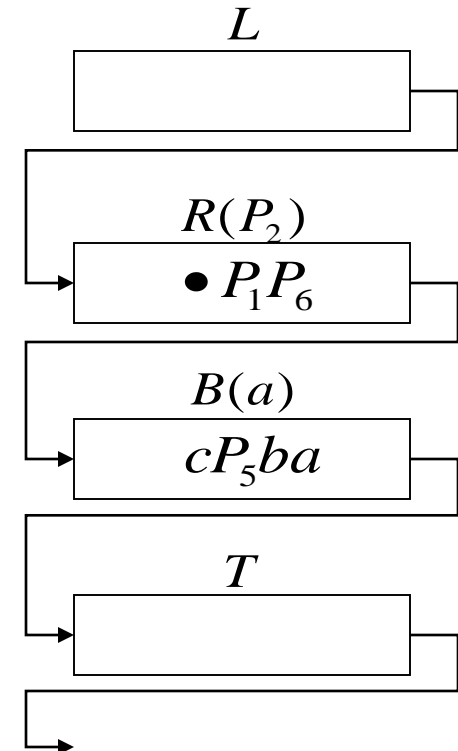
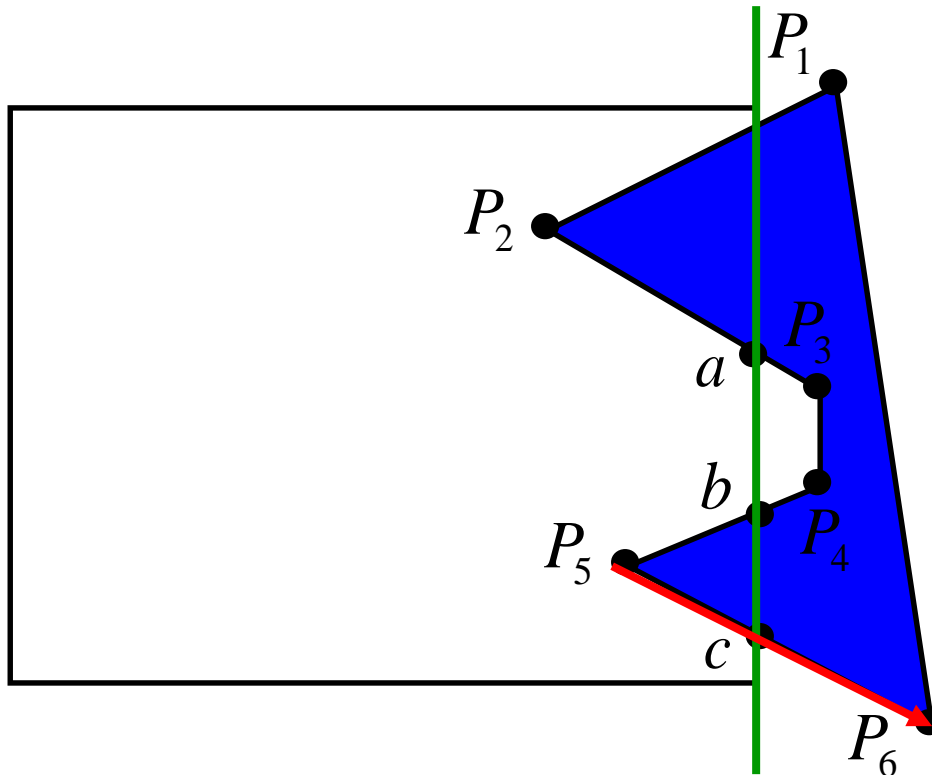
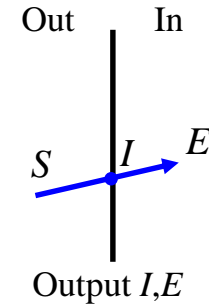
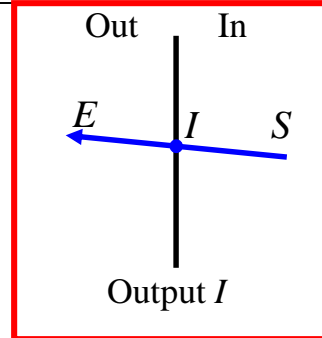
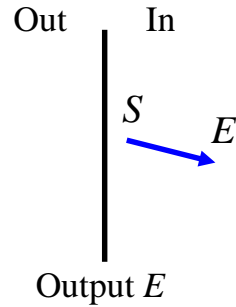
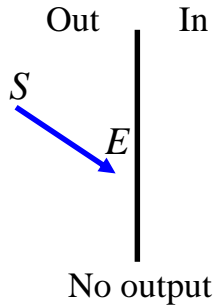
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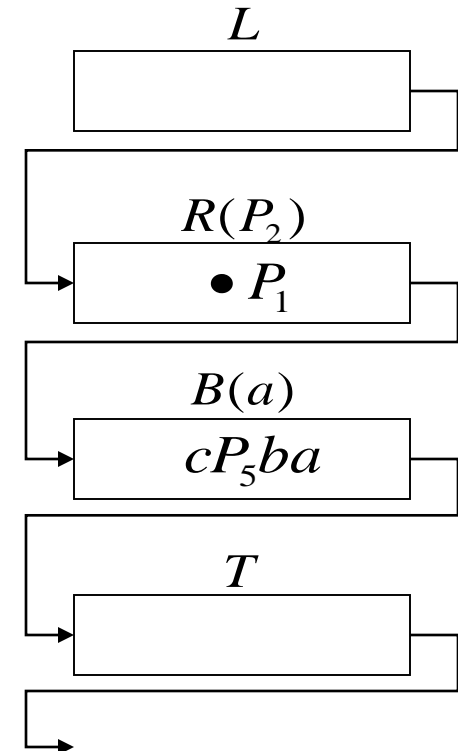
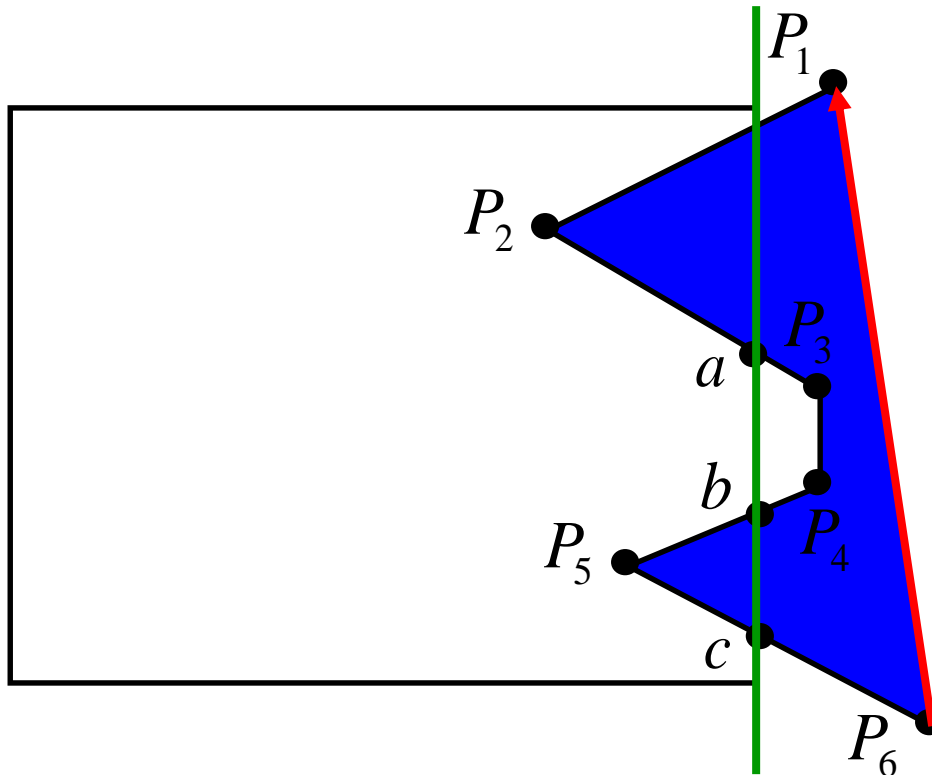
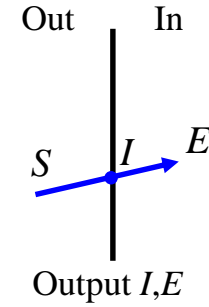
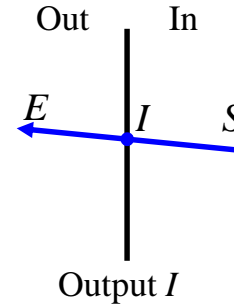
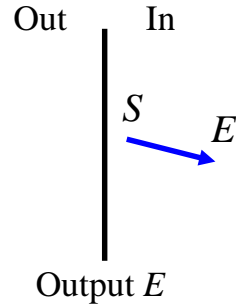
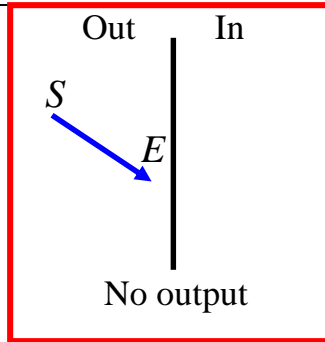
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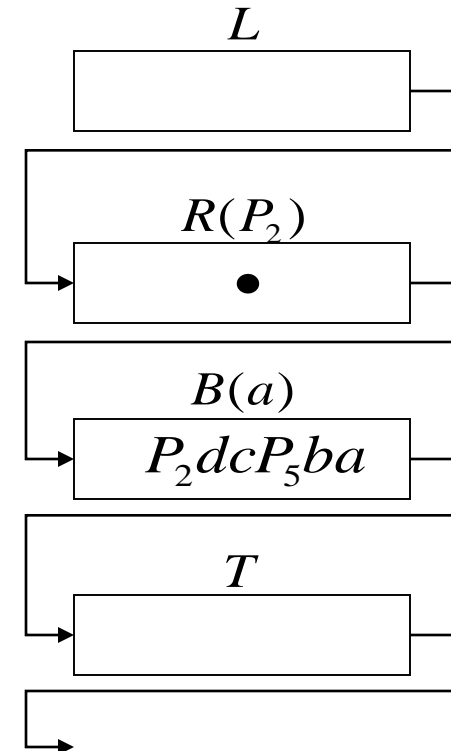
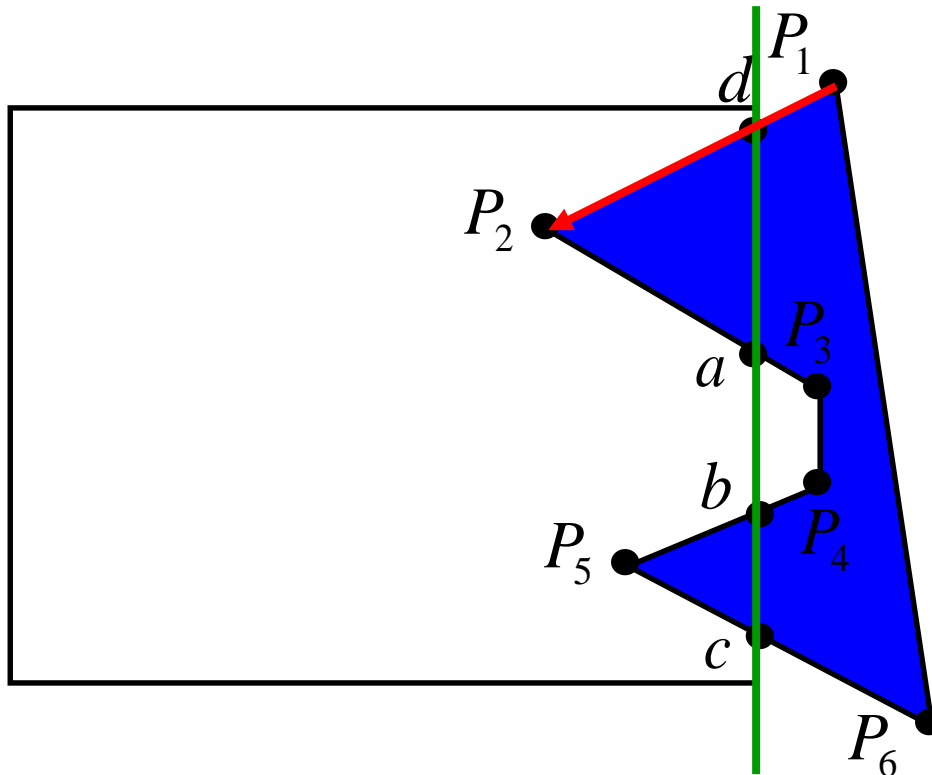
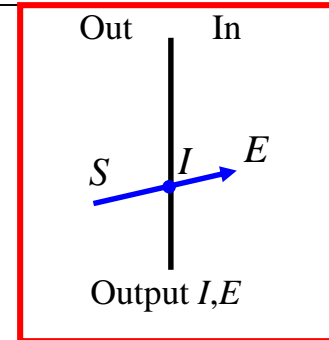
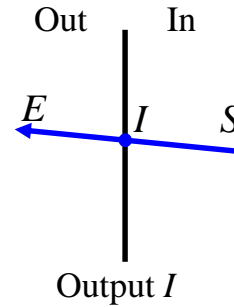
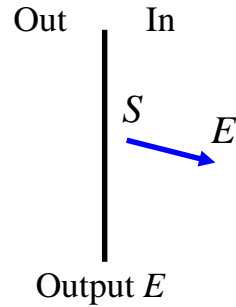
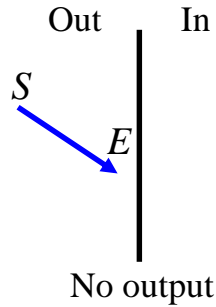
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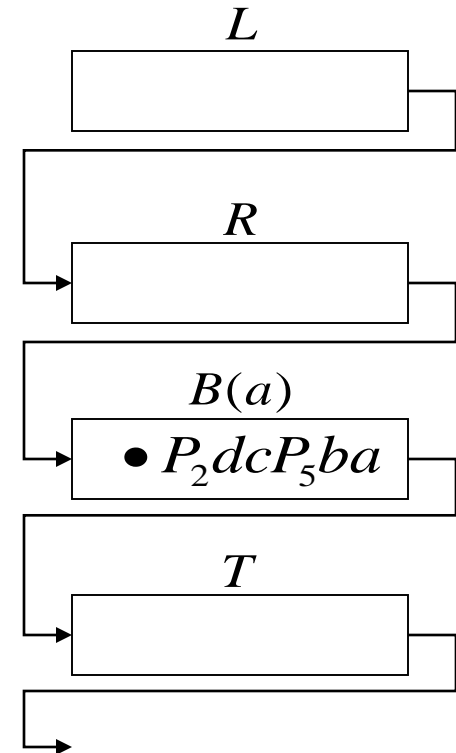
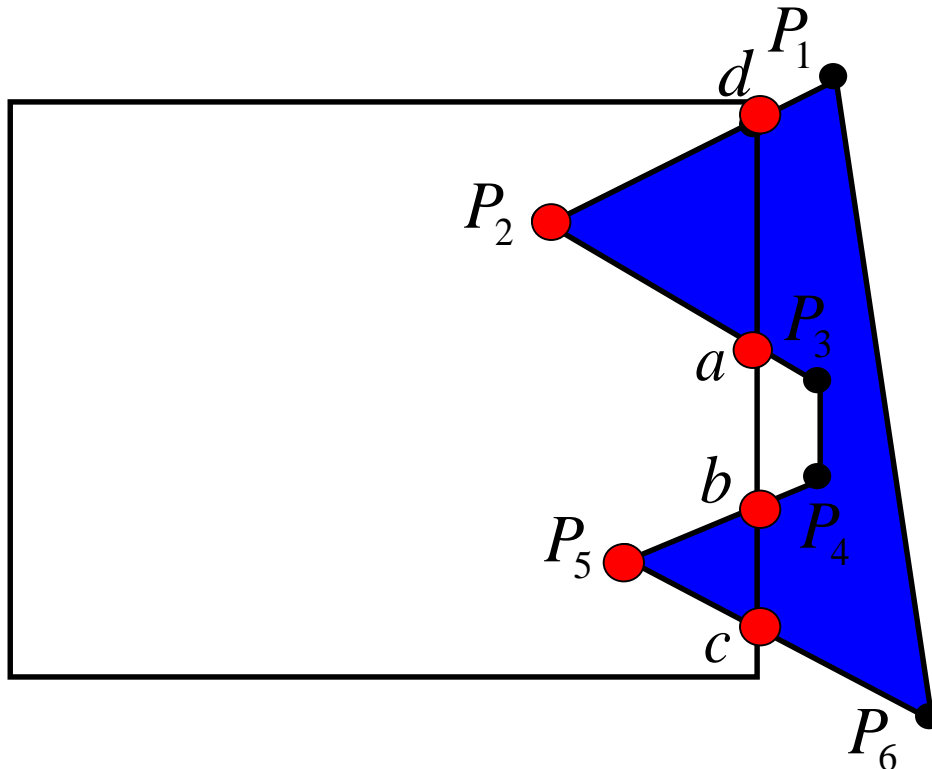
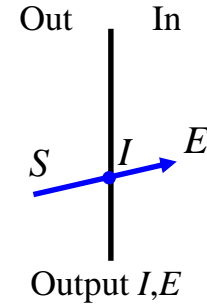
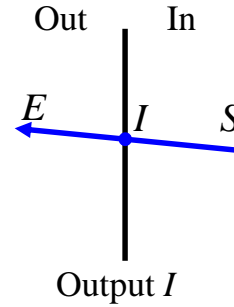
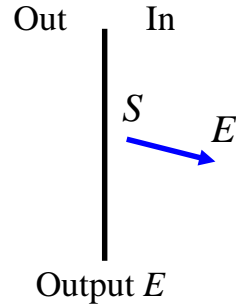
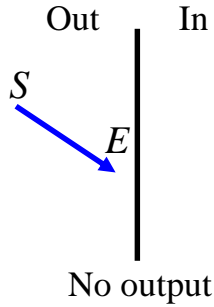
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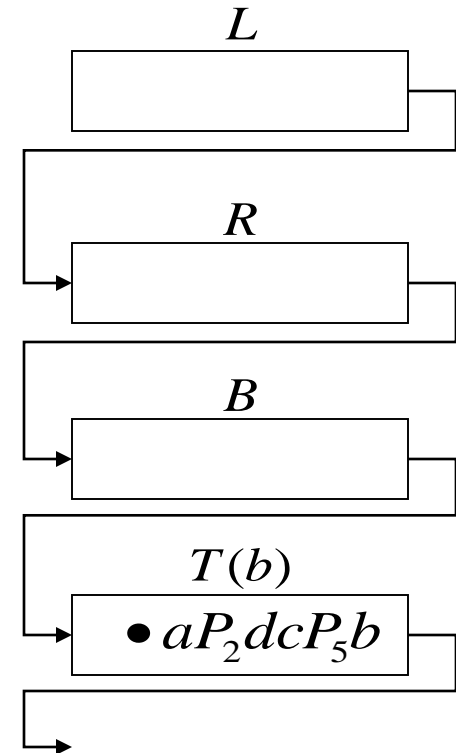
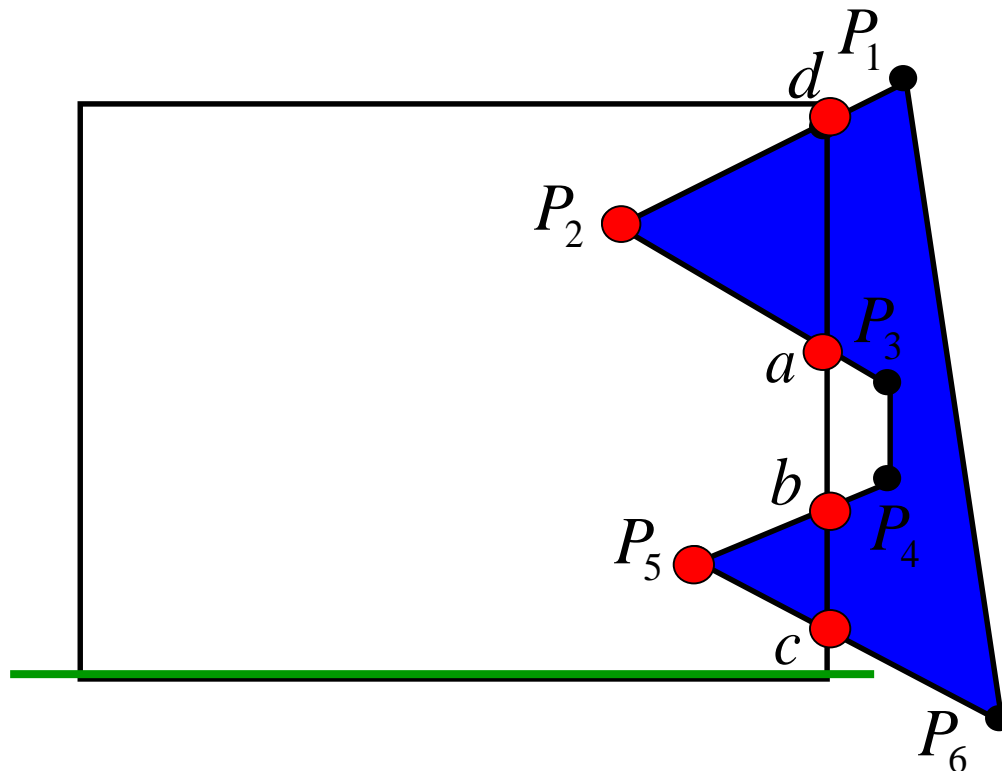
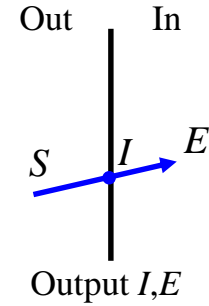
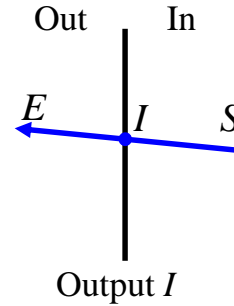
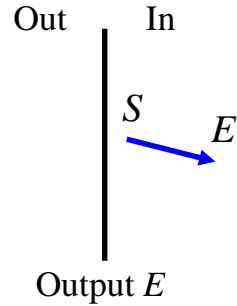
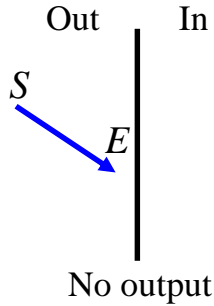
Sutherland-Hodgman Algorithm



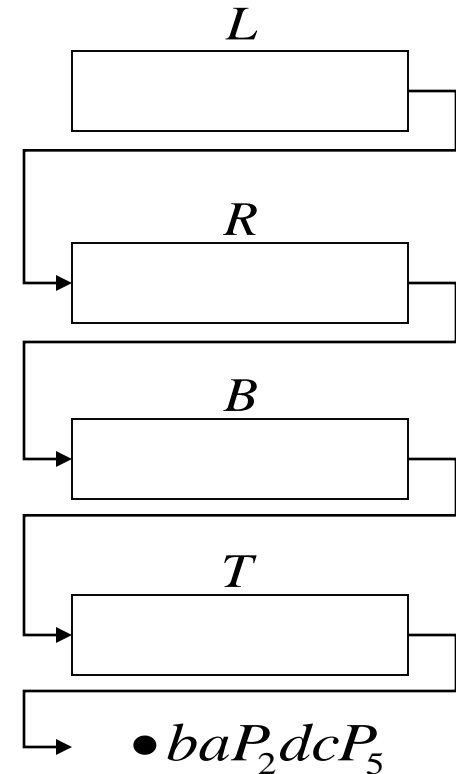
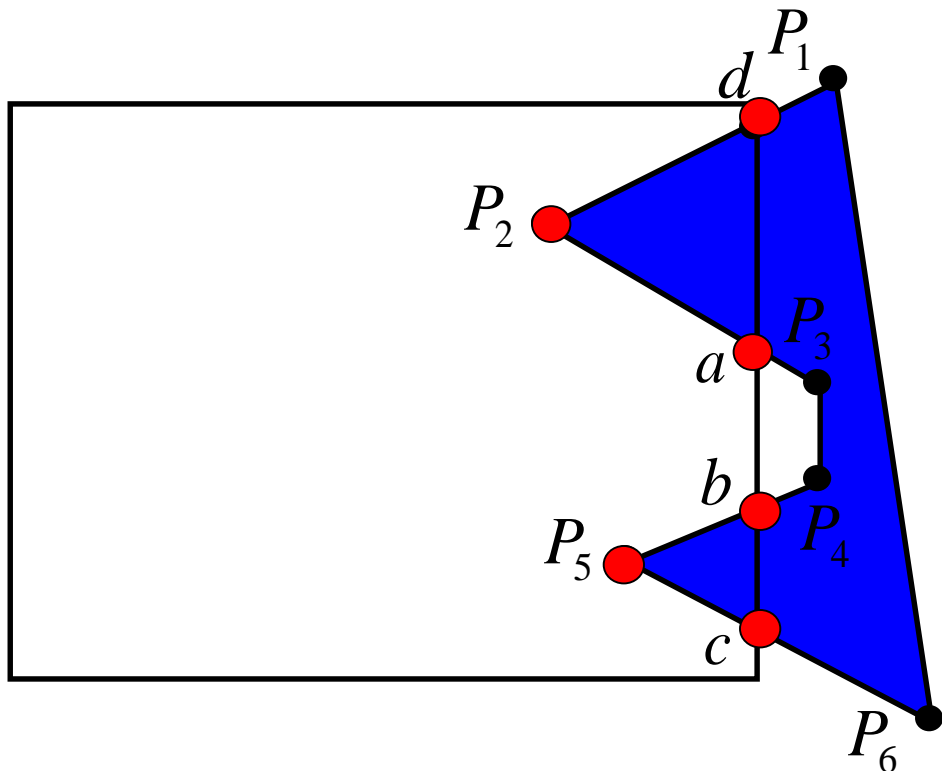
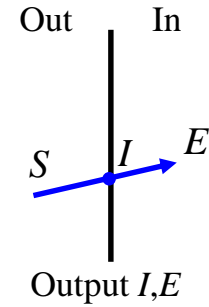
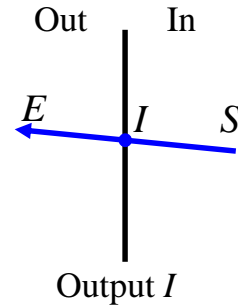
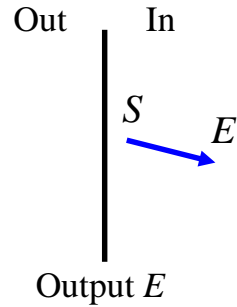
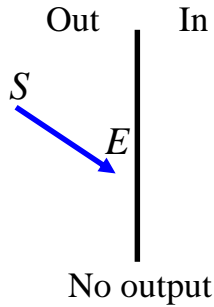
Sutherland-Hodgman Algorithm



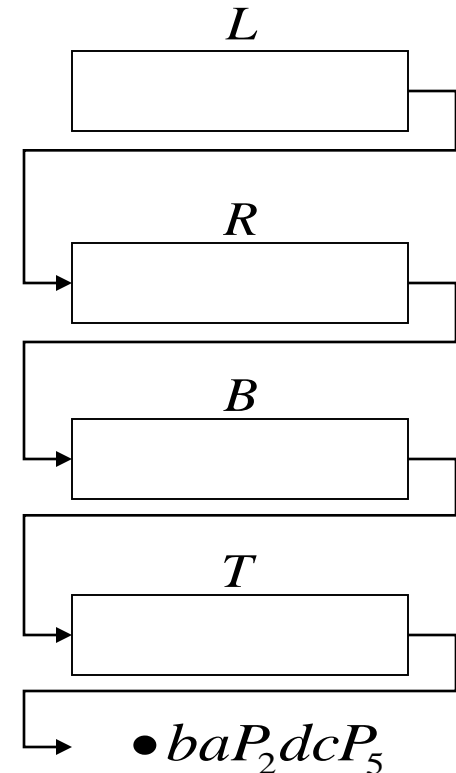
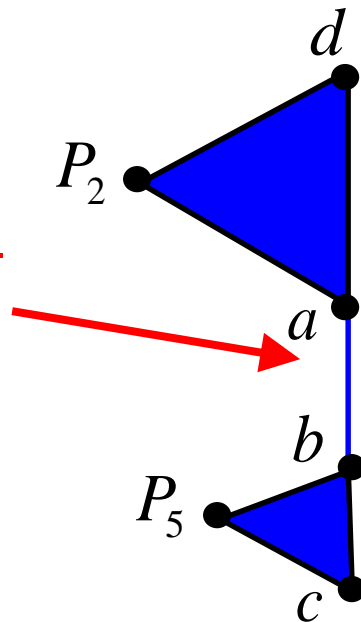
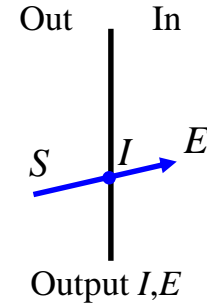
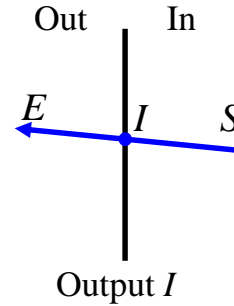
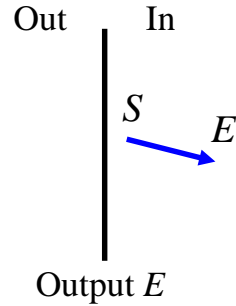
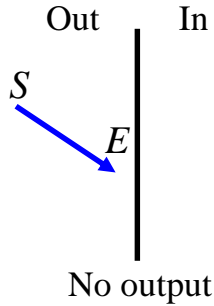
Sutherland-Hodgman Algorithm



Sutherland-Hodgman Algorithm



Sutherland-Hodgman Algorithm



Possible error for non-convex polygons

Sutherland-Hodgman Algorithm

- Easy to pipeline for parallel processing
- Polygon from one boundary does not have to be complete before next boundary starts
- Leads to substantial performance gains

Weiler-Atherton Algorithm

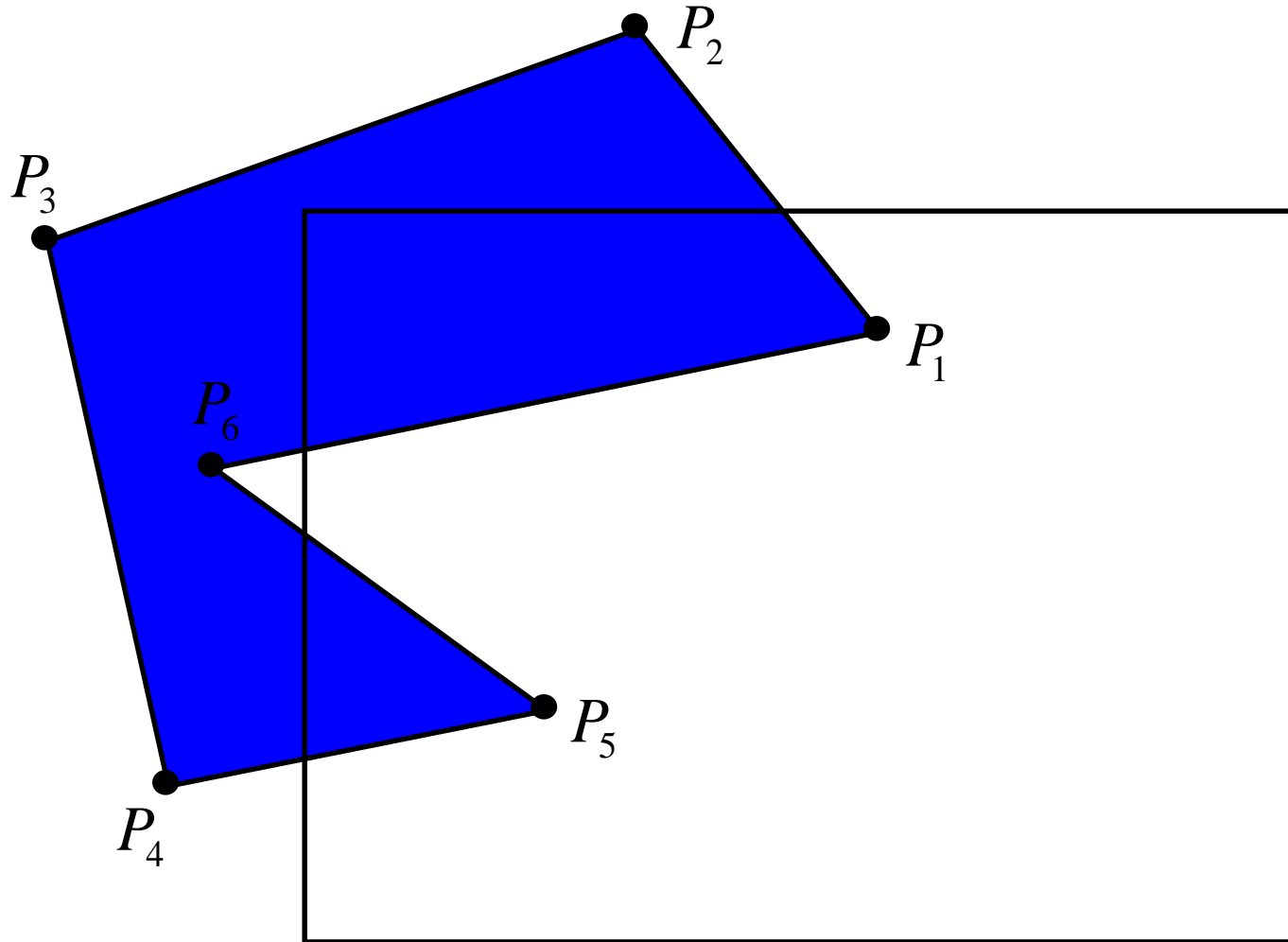
- General polygon vs. polygon clipping
- Handles non-convex shapes

- Not as efficient as Sutherland-Hodgman
- Not easy to parallelize

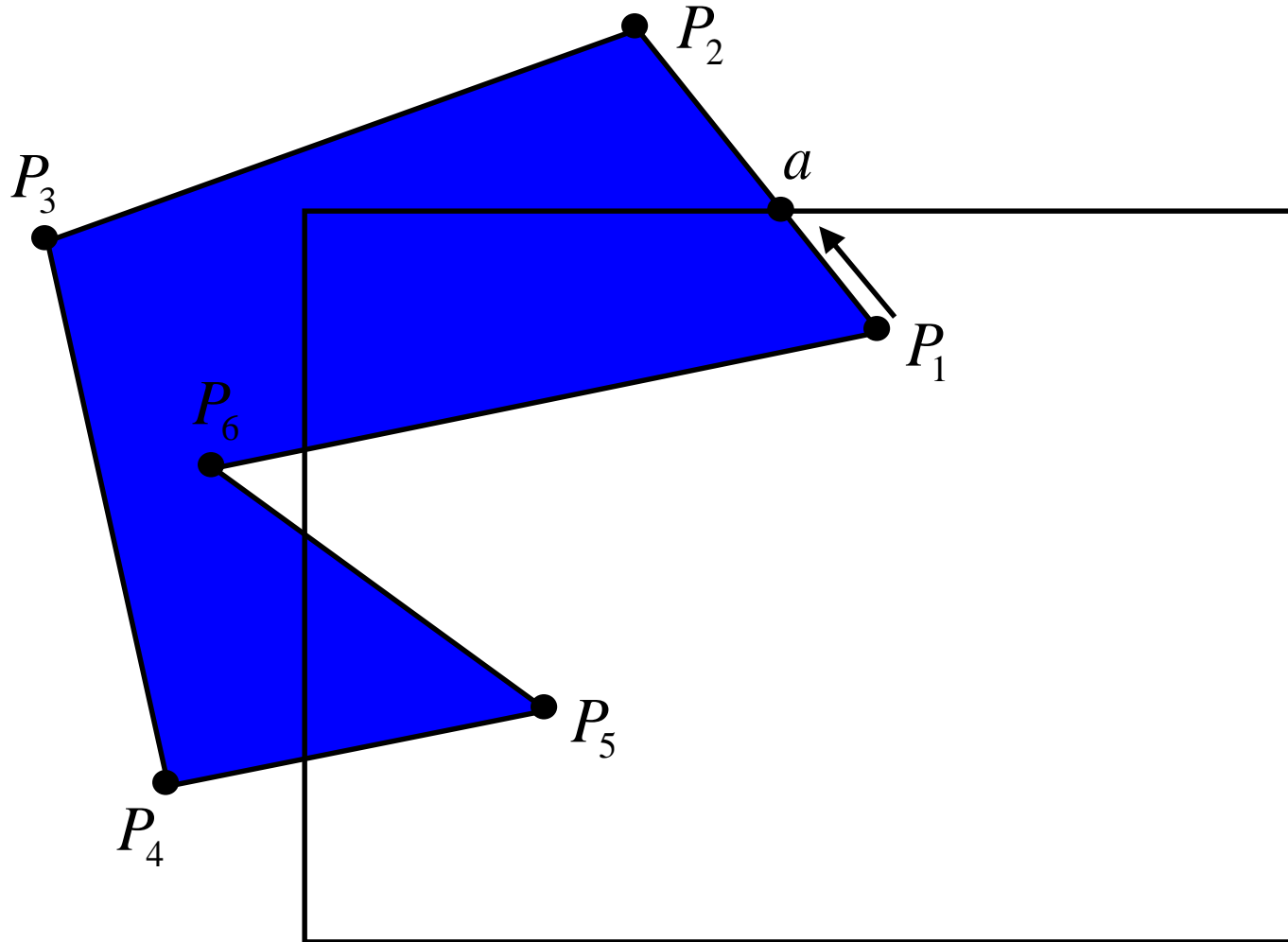
Weiler-Atherton Algorithm

- Process the edges of the polygon in a counterclockwise order until an inside-outside pair of vertices is encountered
- Follow the window boundaries in a counterclockwise direction from the exit-intersection point to another intersection point with the polygon
- Repeat until at a previously processed vertex
- Return to the exit-intersection point and continue processing the polygon edges in a counterclockwise order

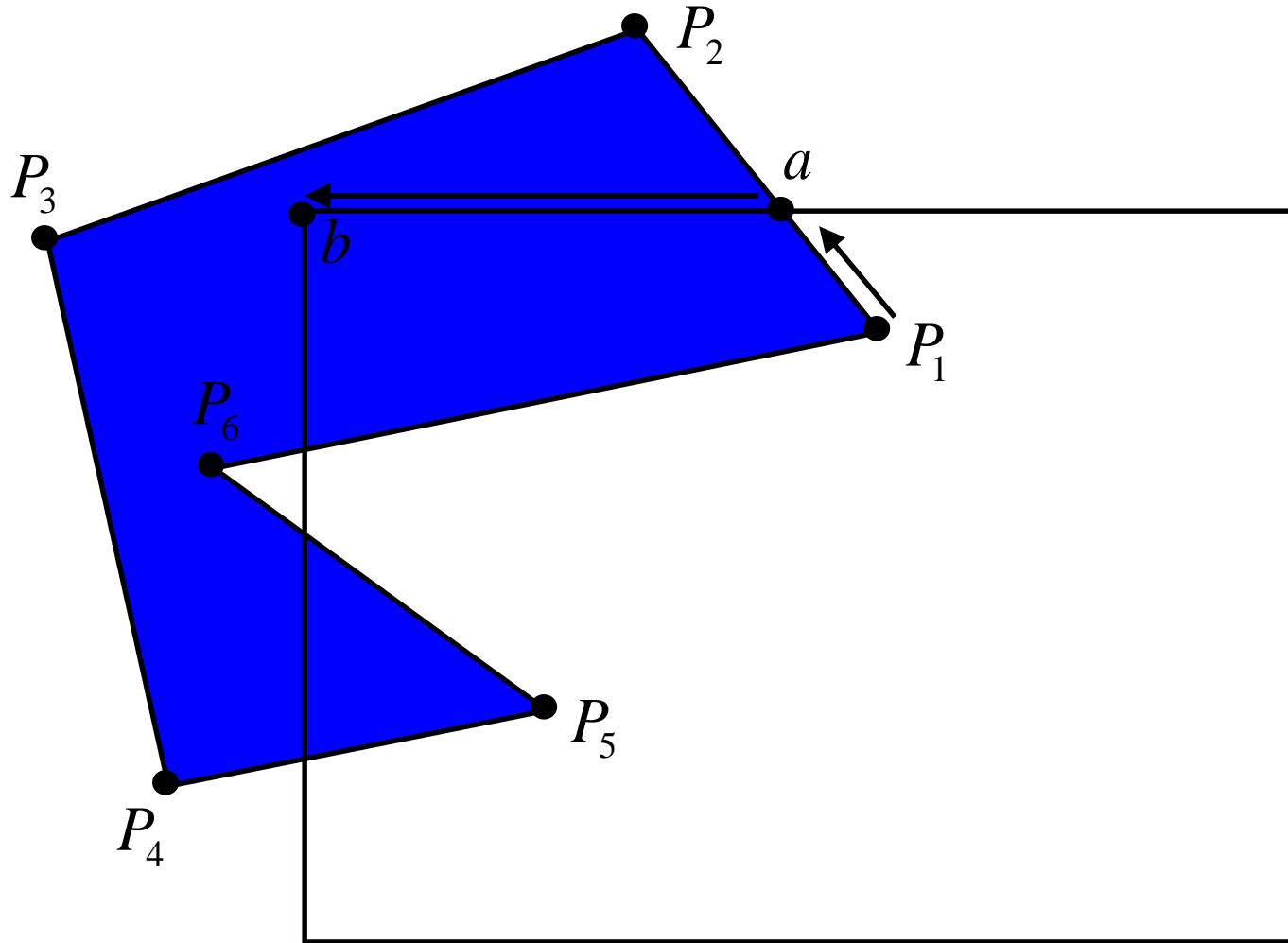
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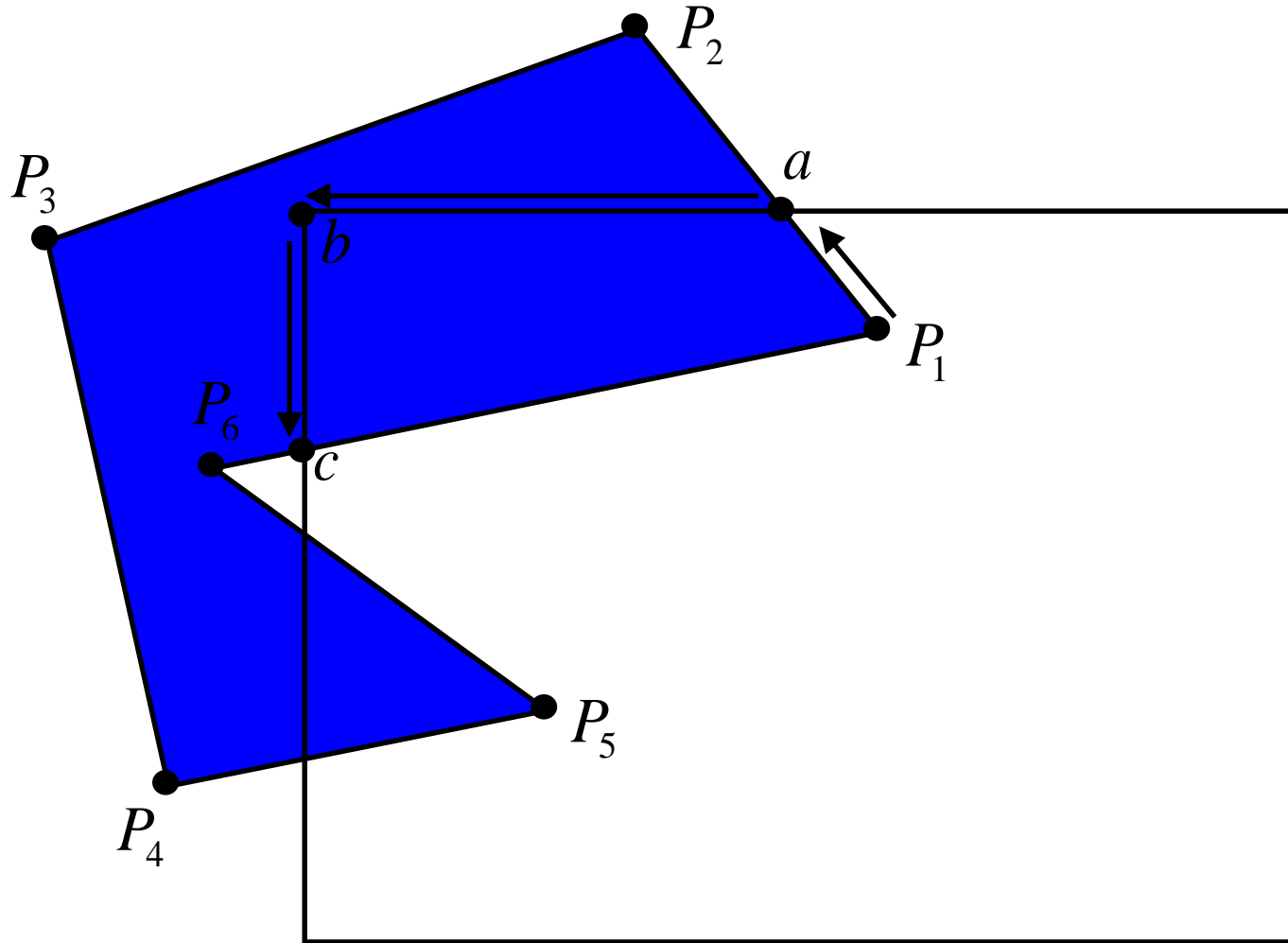
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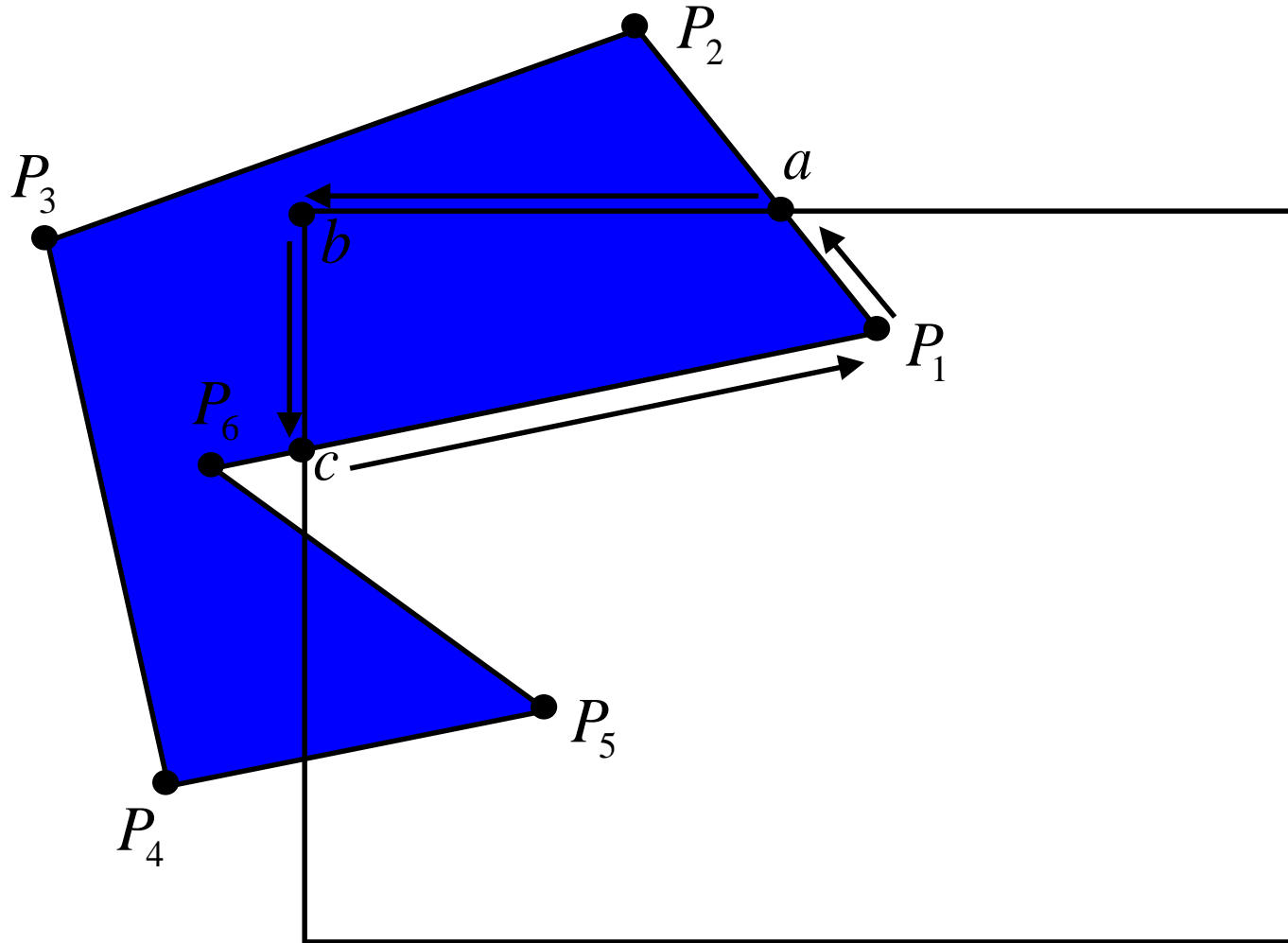
Weiler-Atherton Algorithm



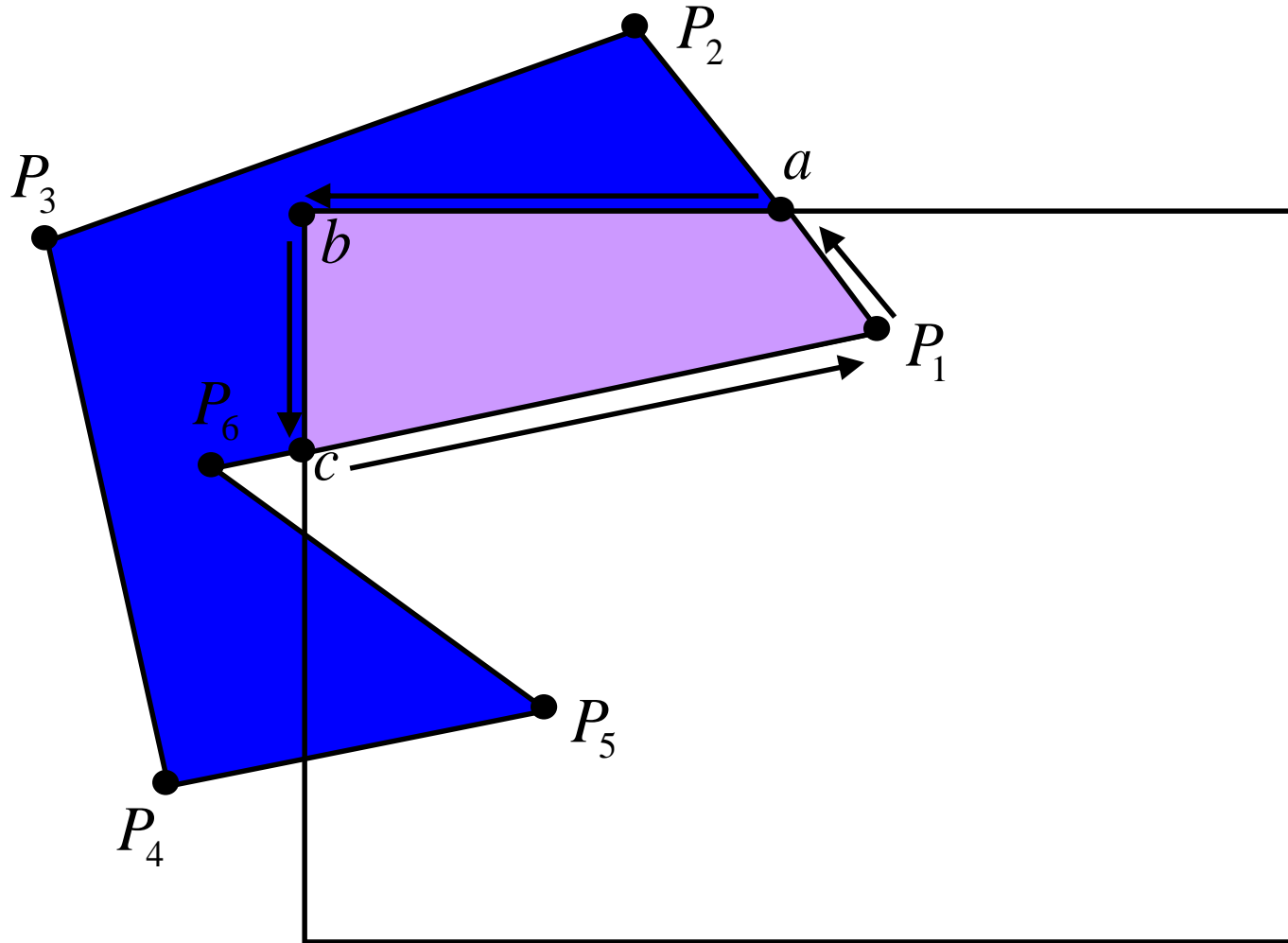
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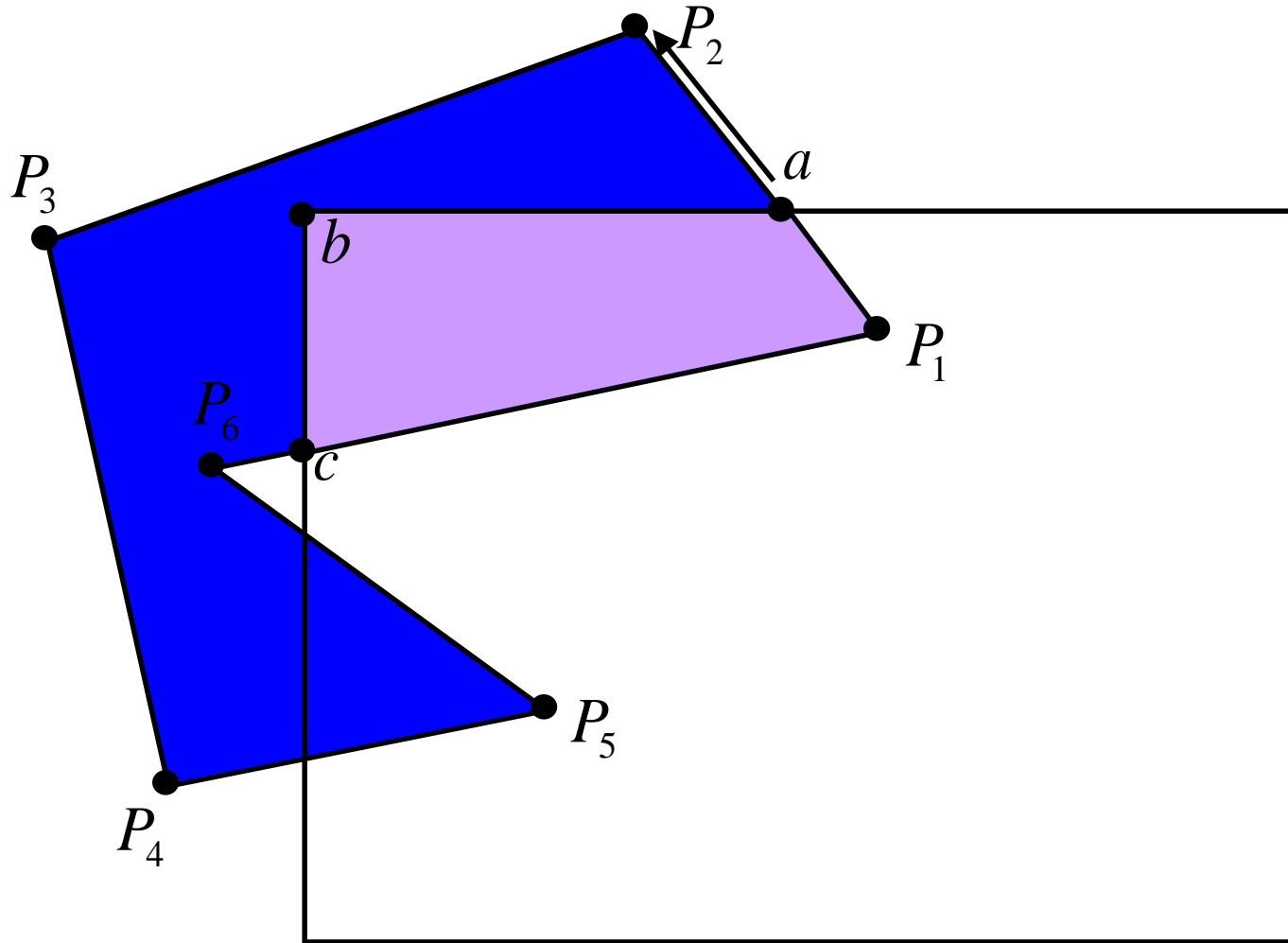
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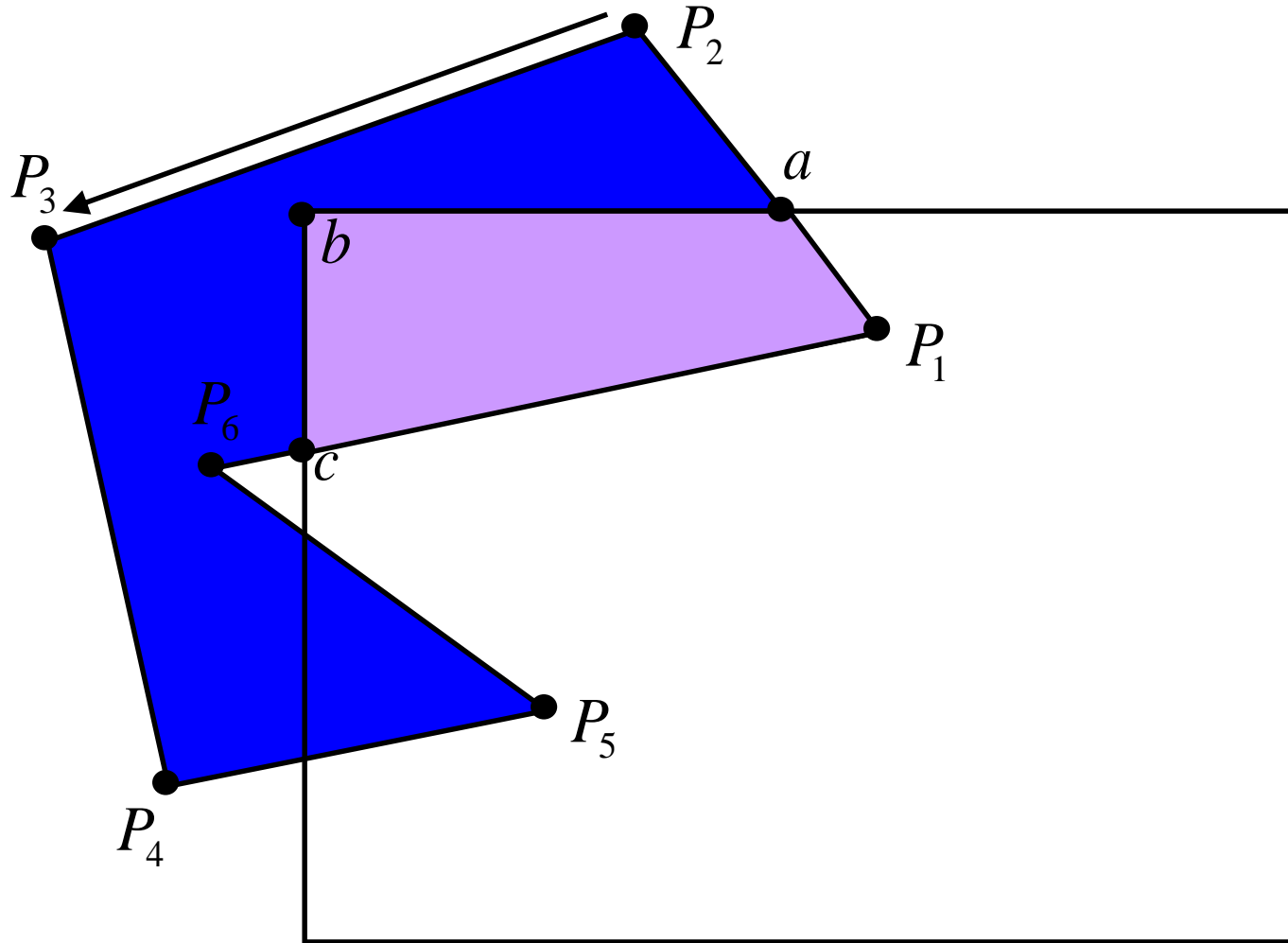
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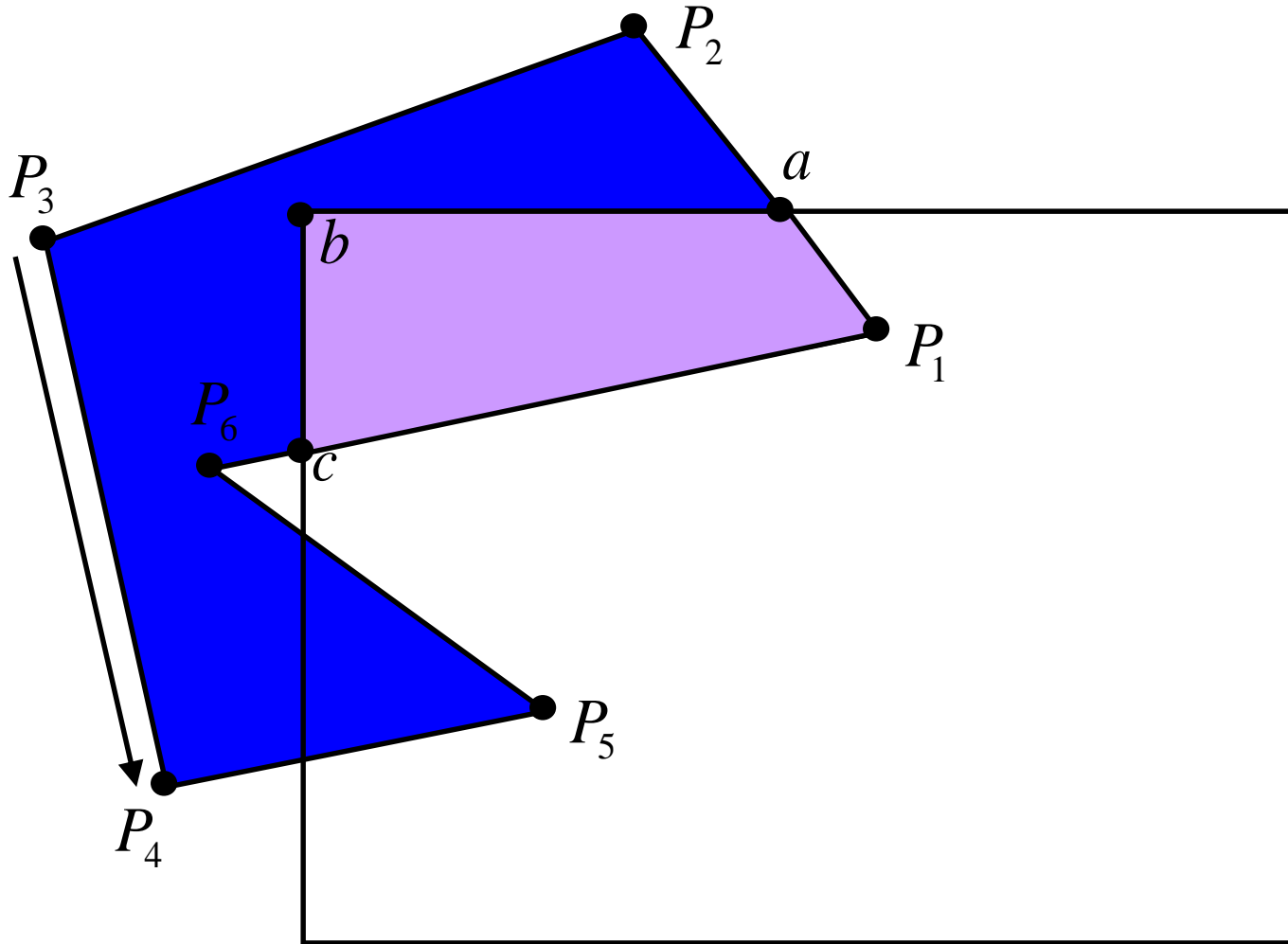
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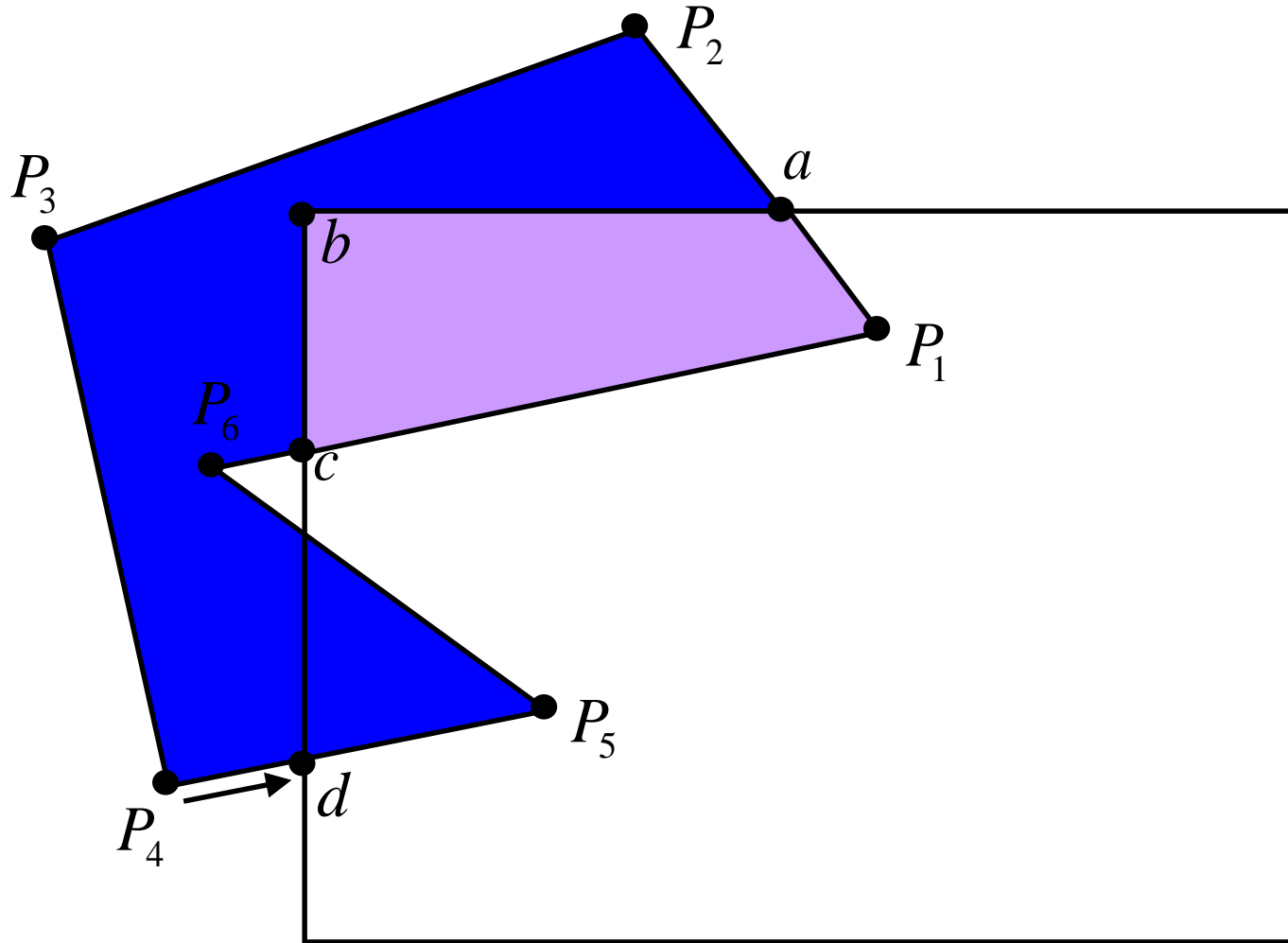
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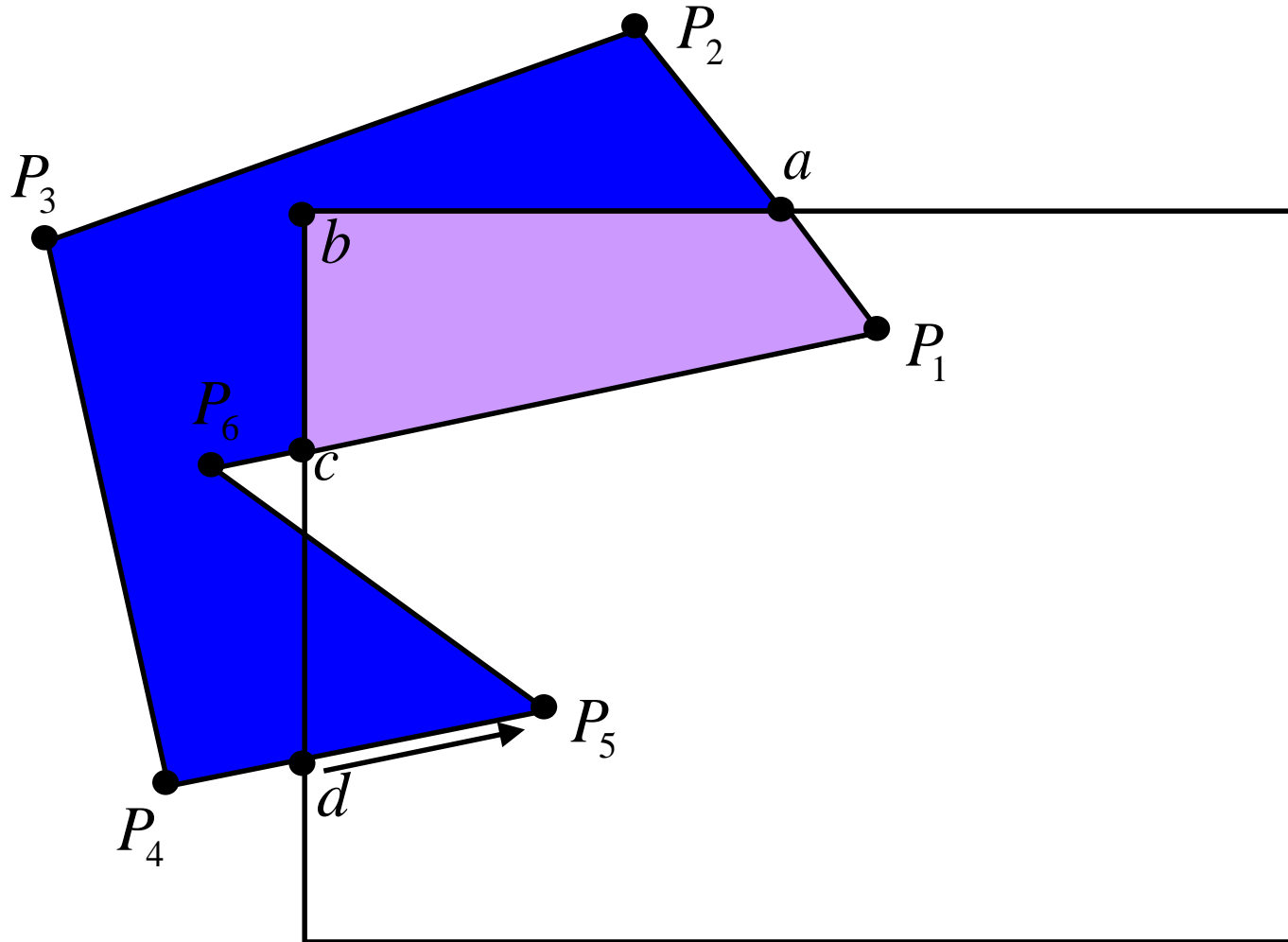
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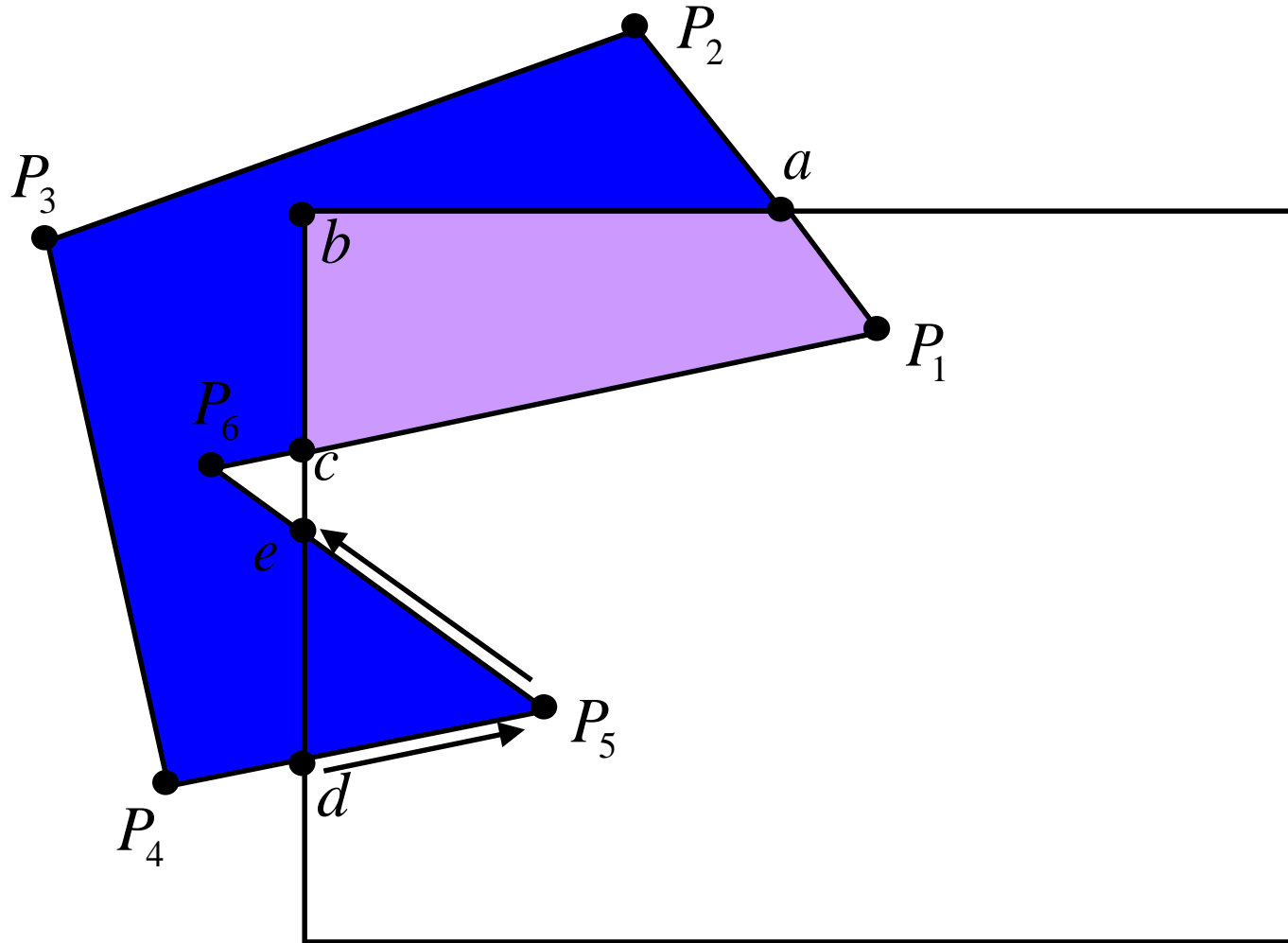
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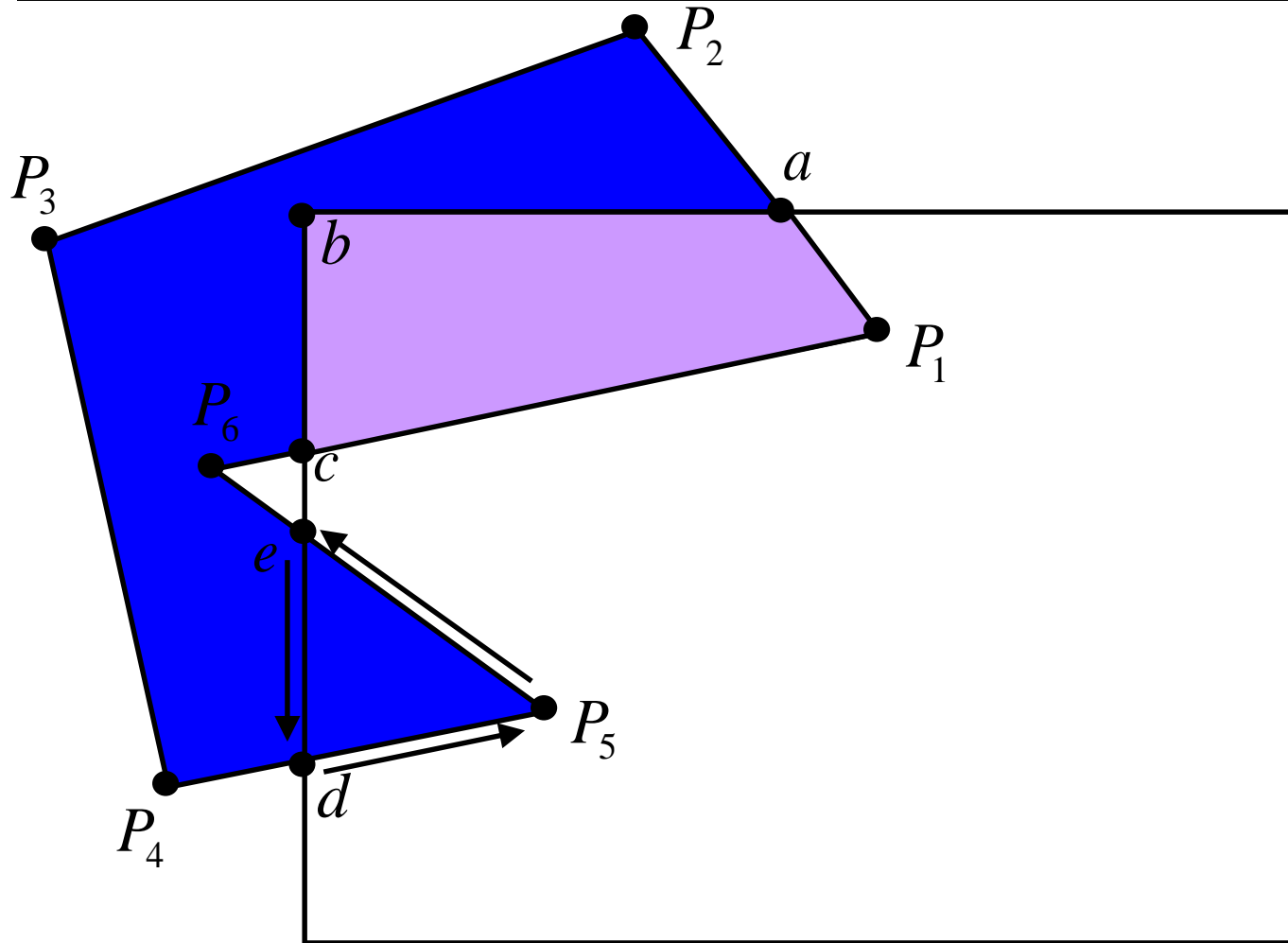
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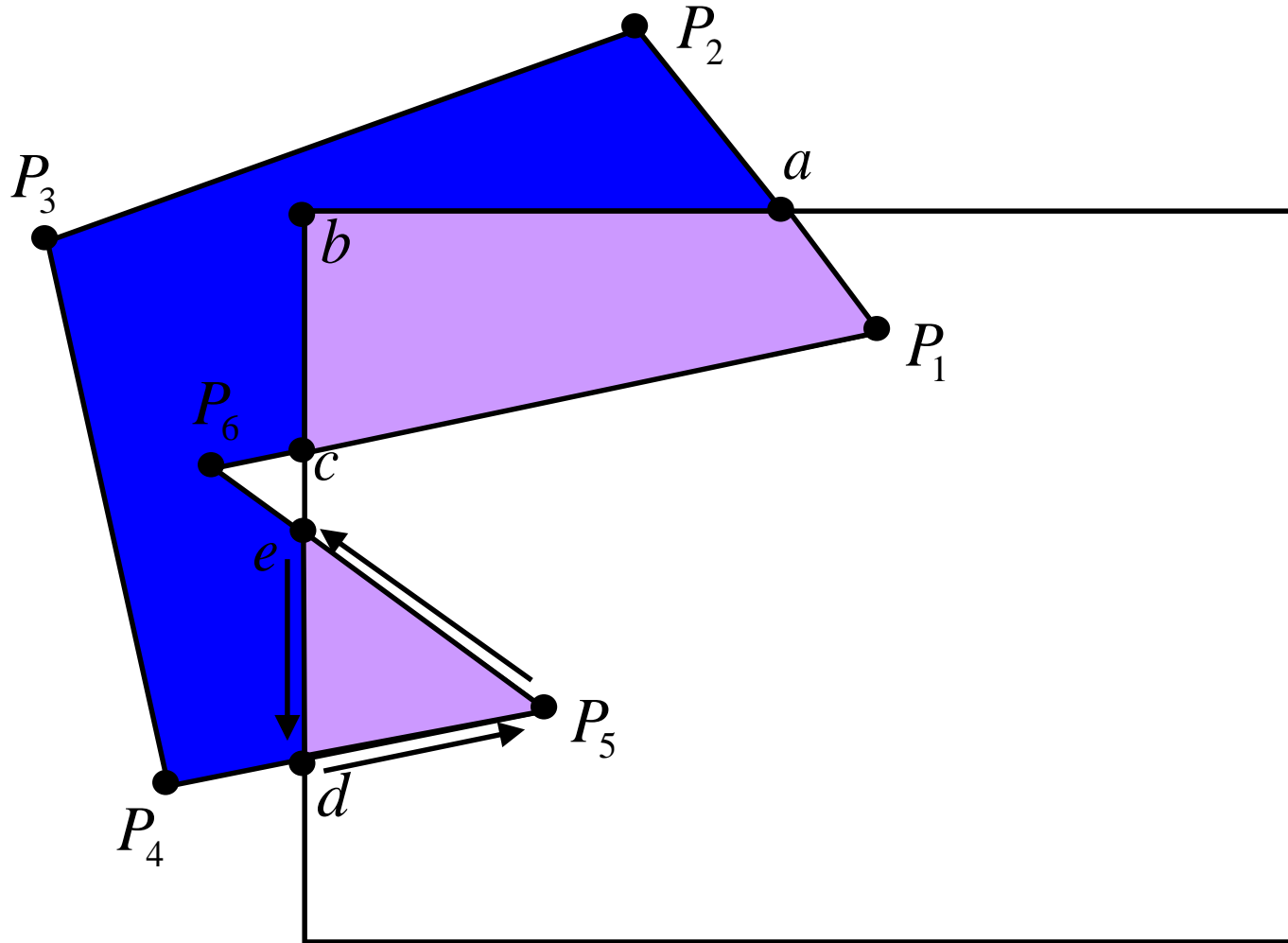
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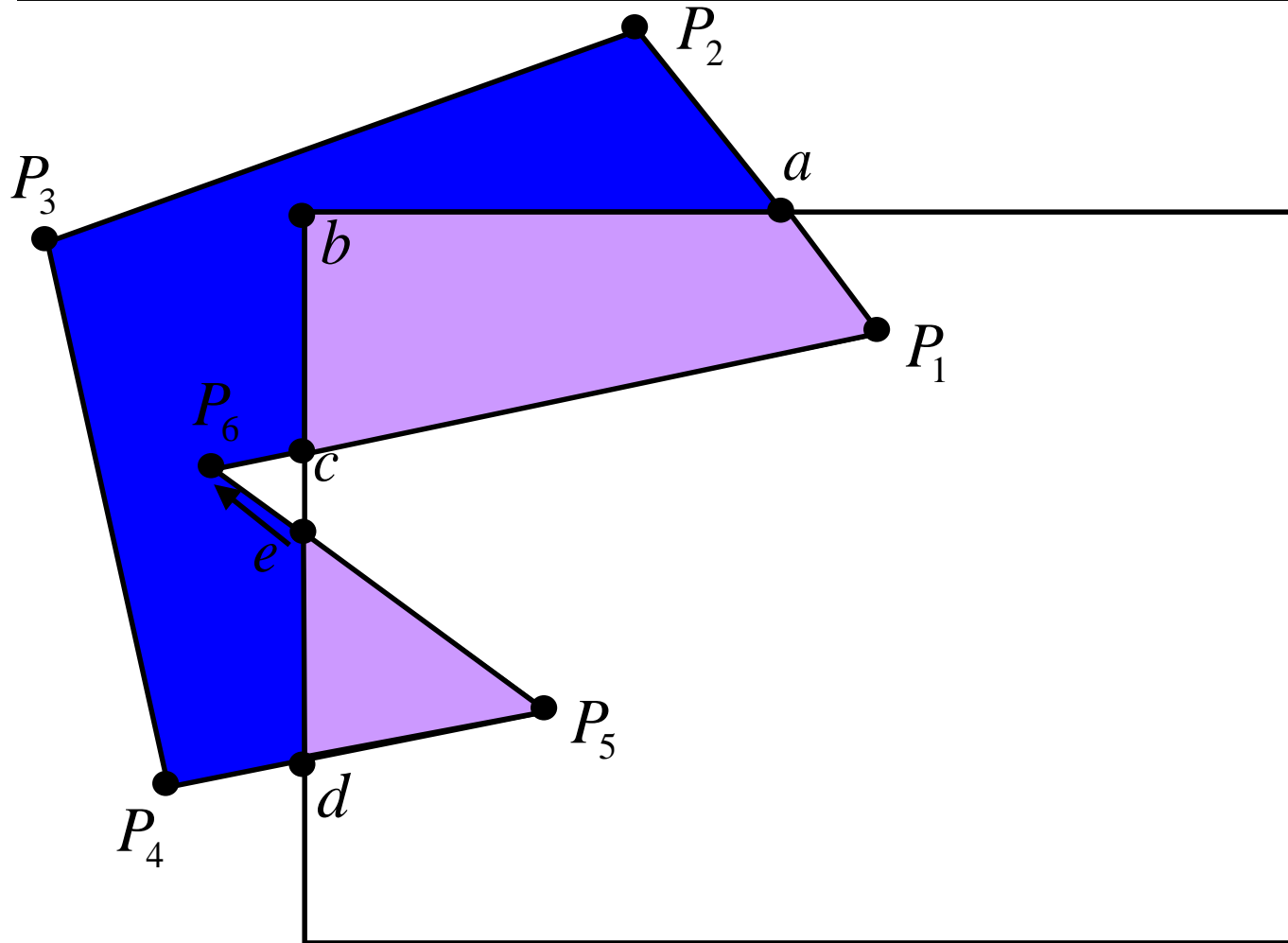
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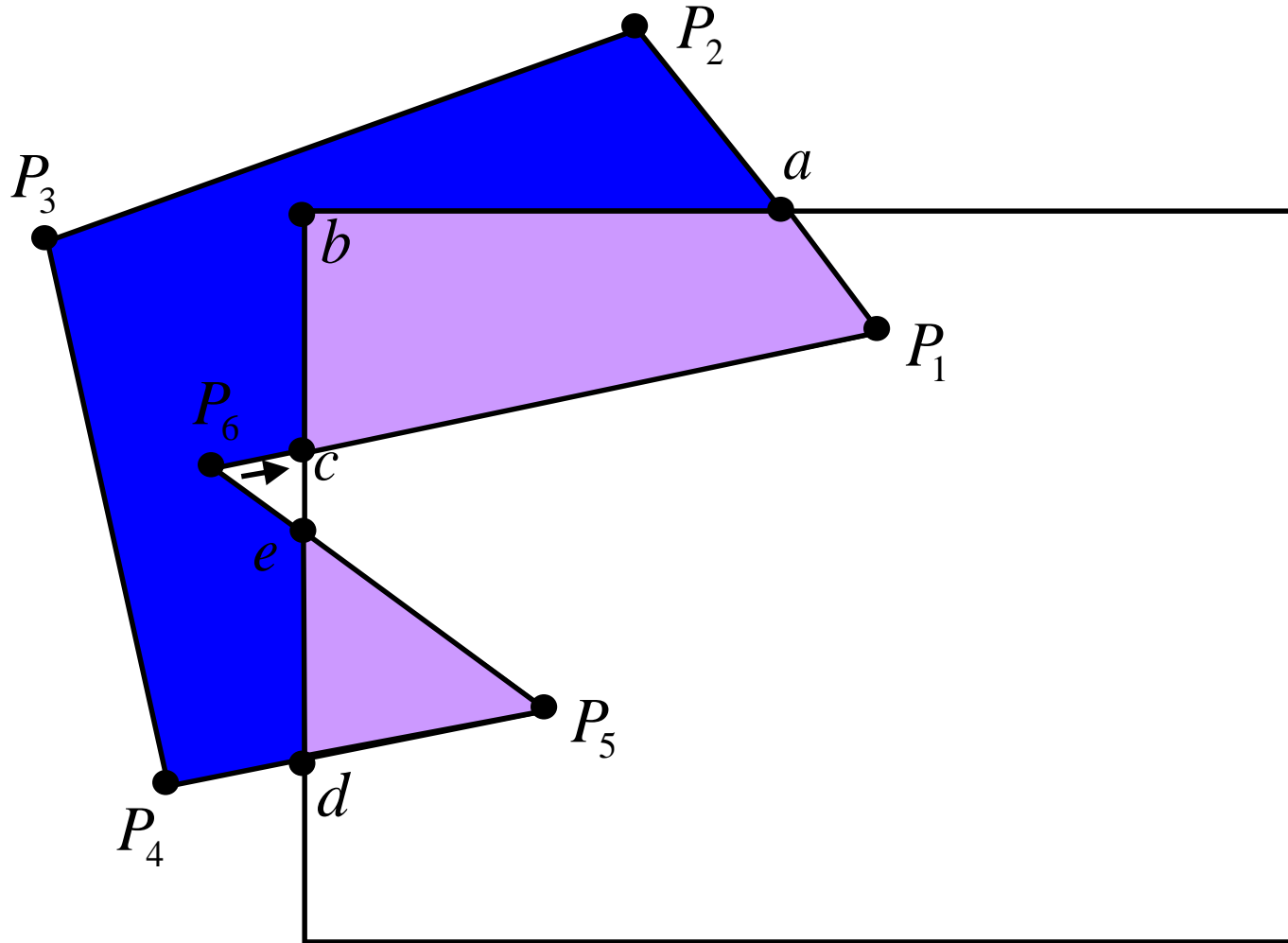
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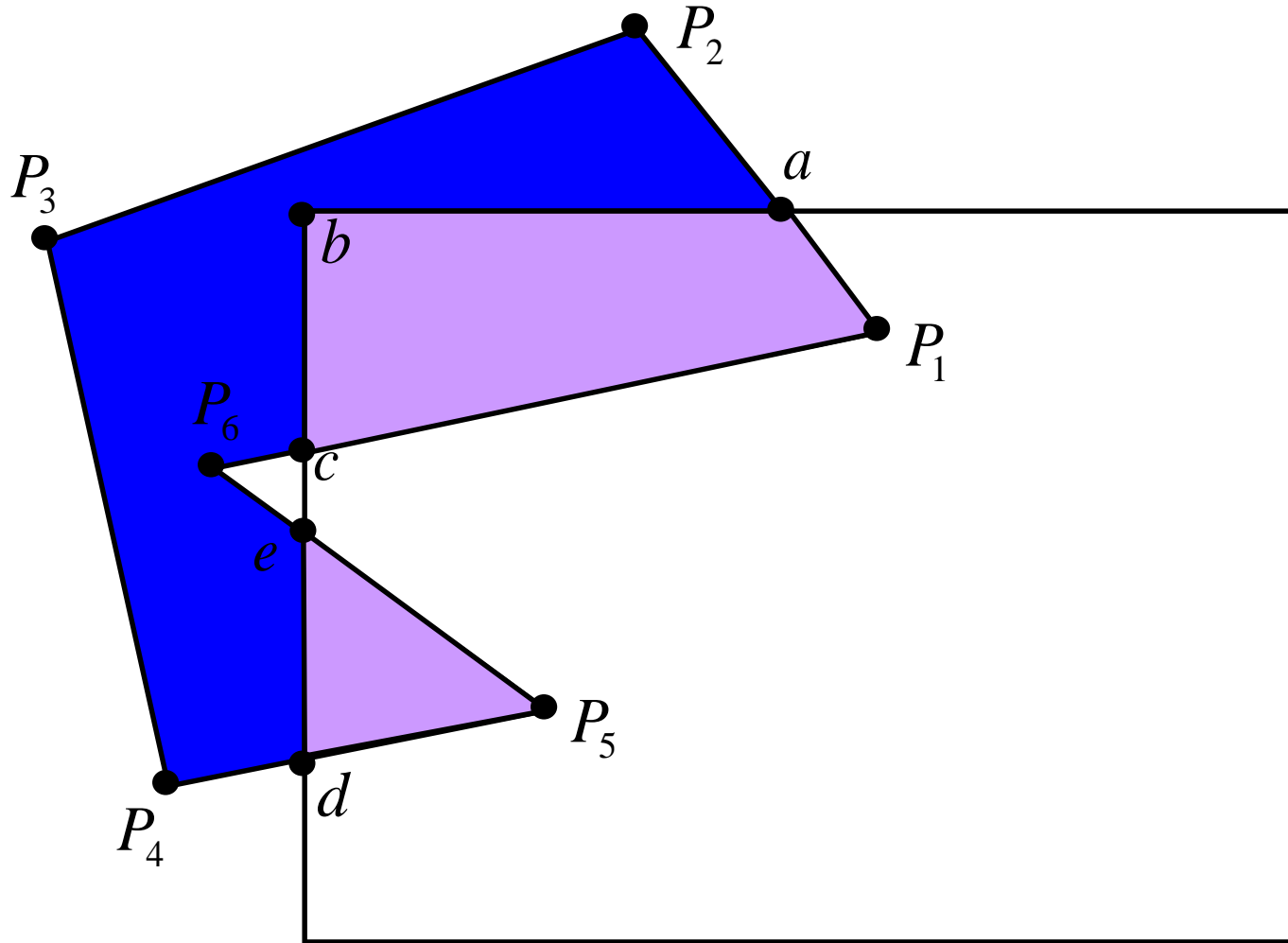
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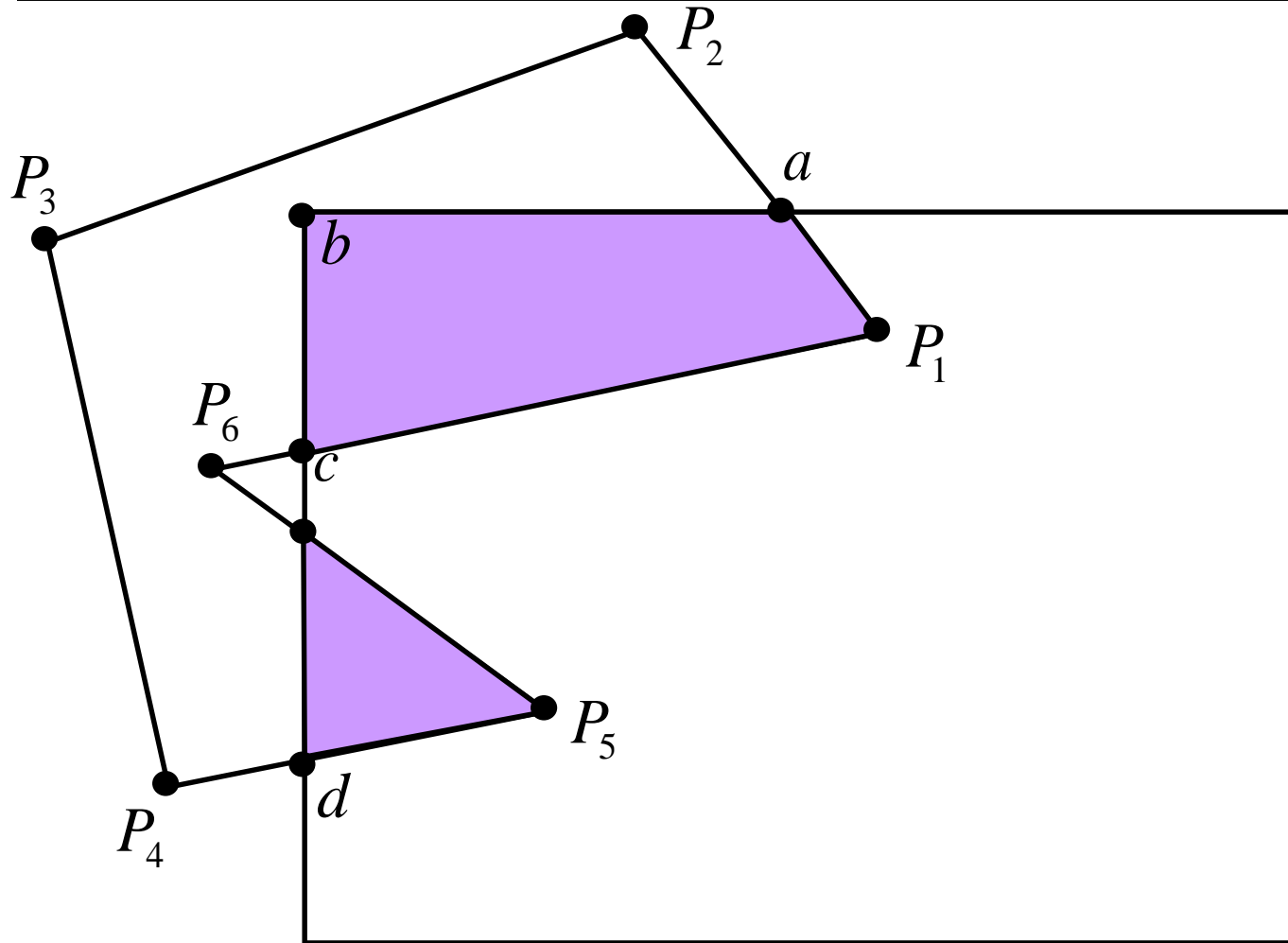
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Weiler-Atherton Algorithm

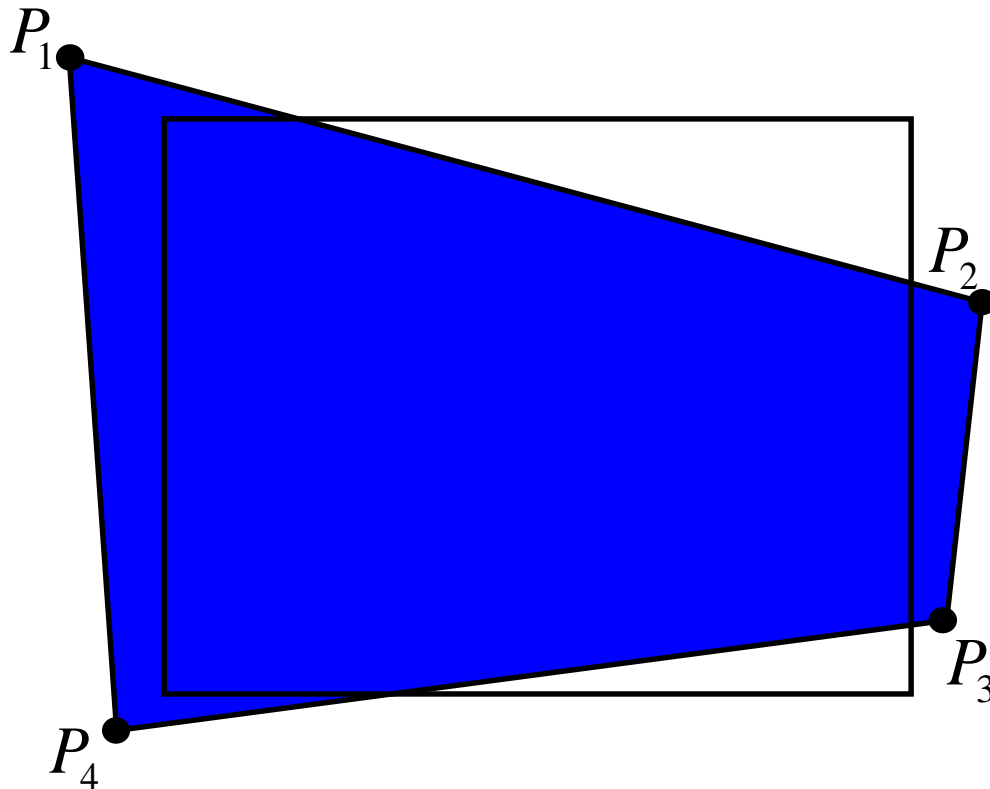
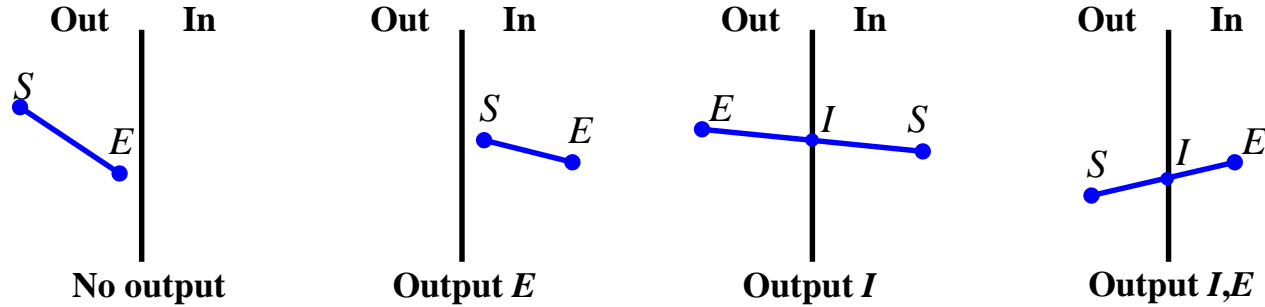


Weiler-Atherton Algorithm

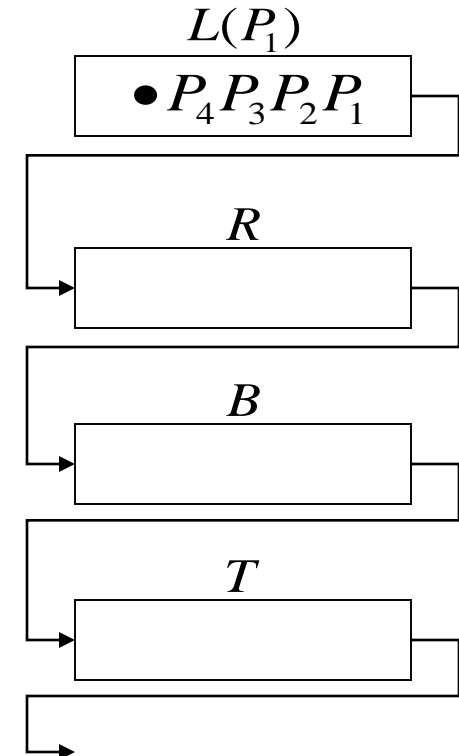
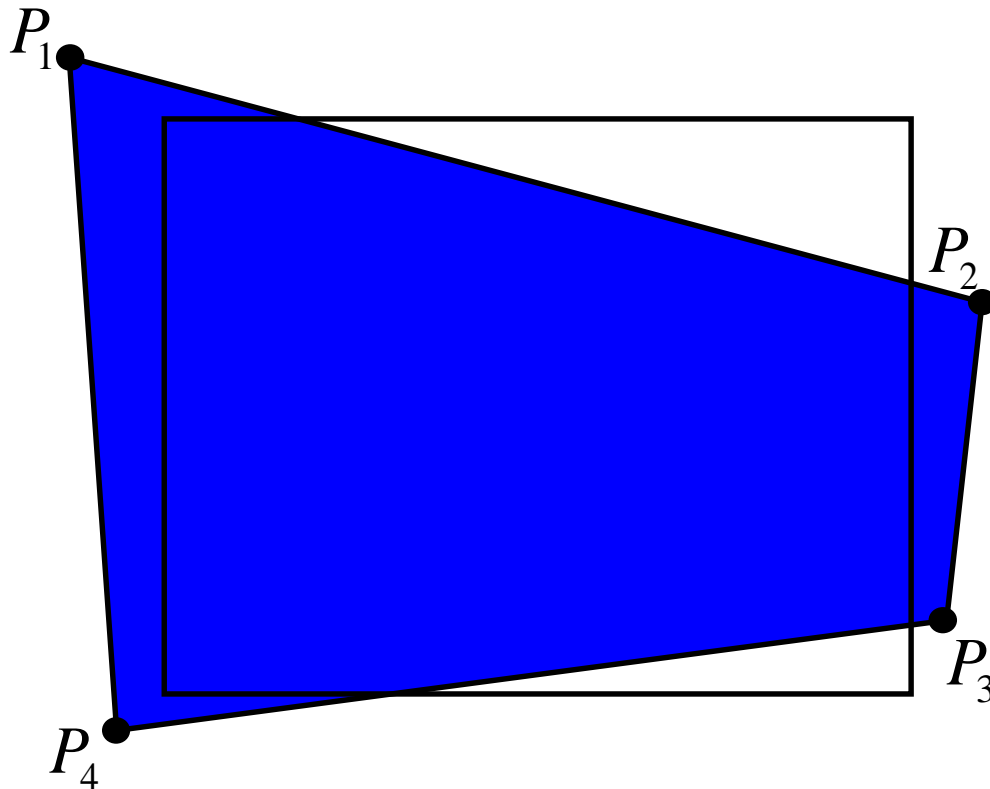
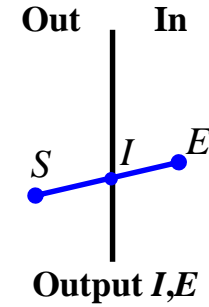
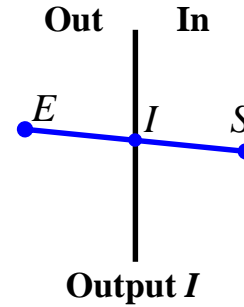
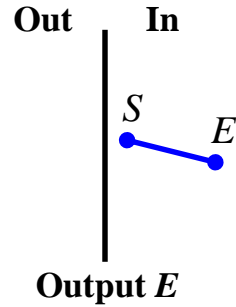
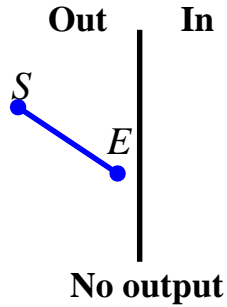




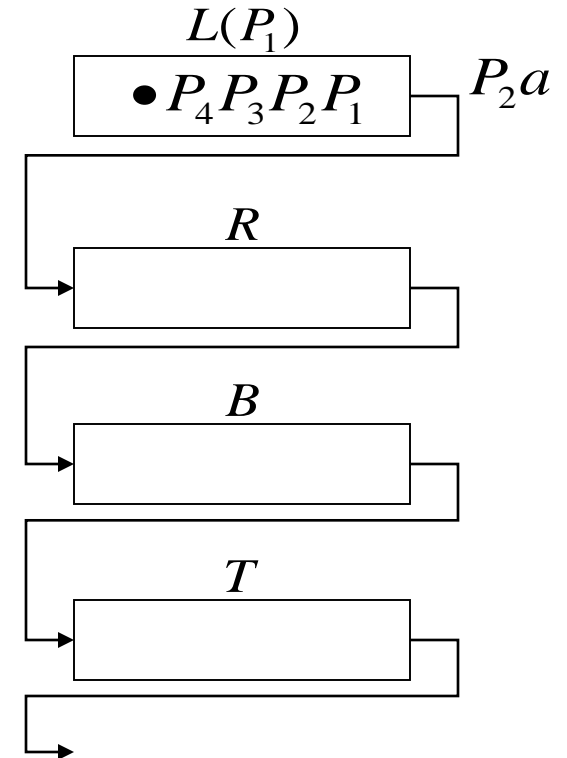
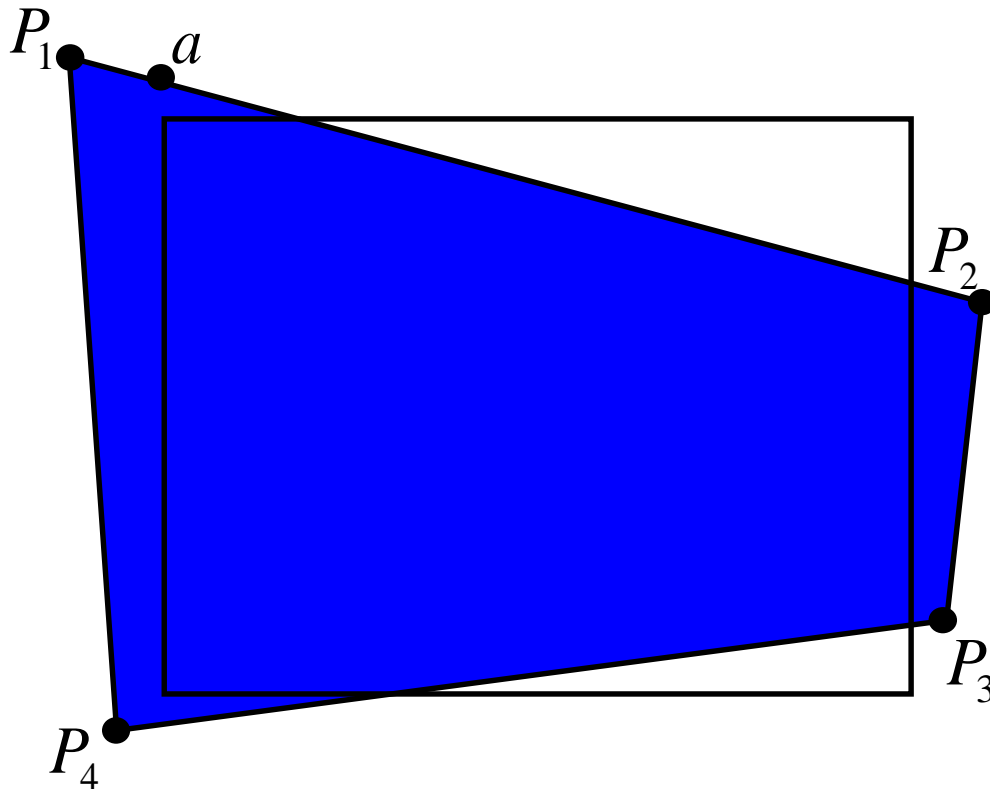
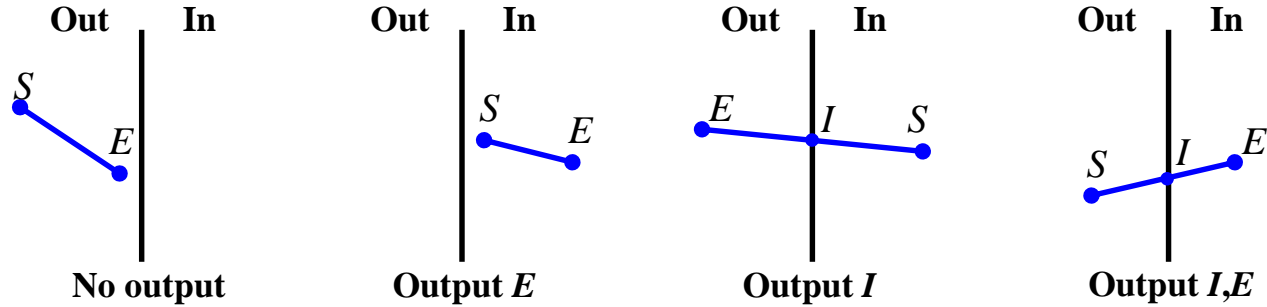
Sutherland-Hodgman Algorithm



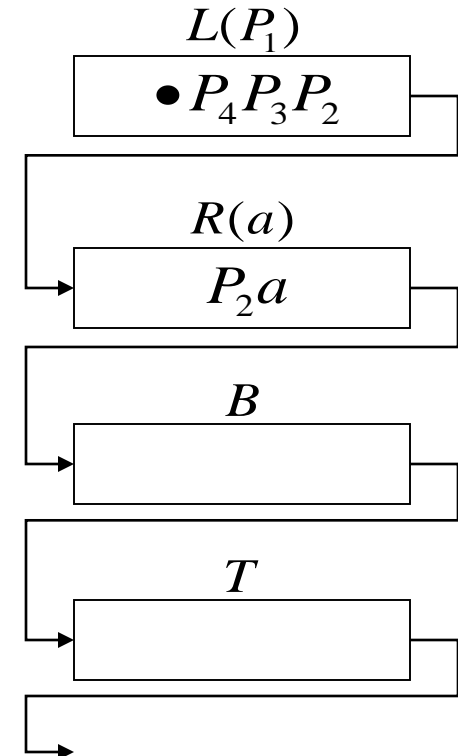
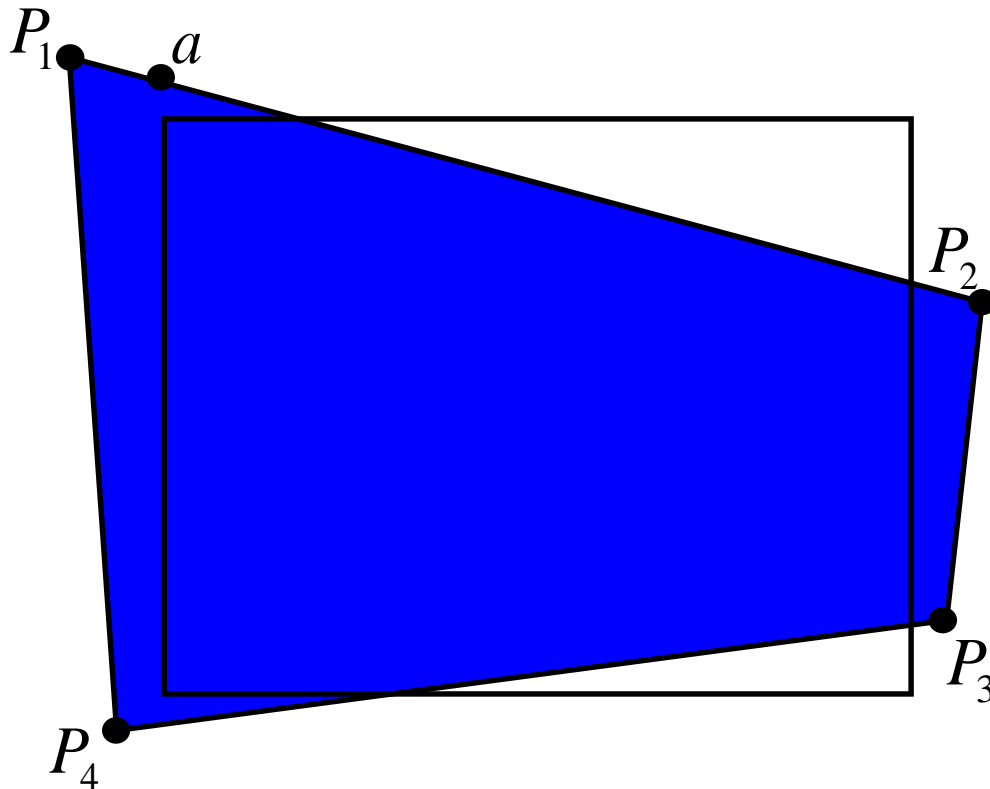
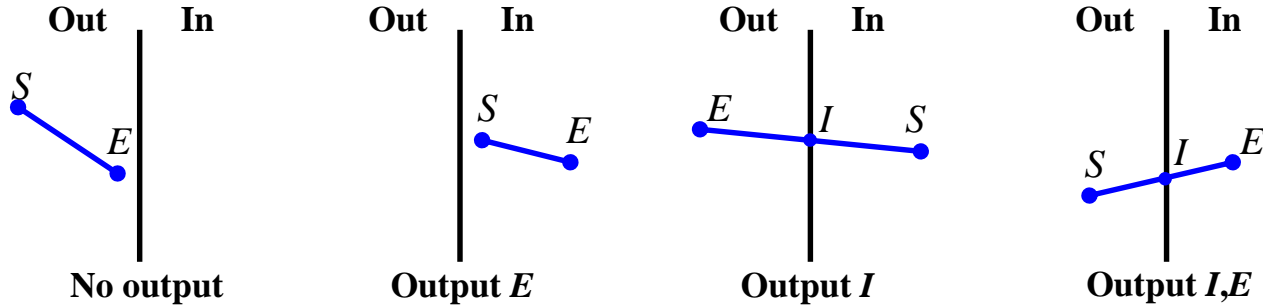
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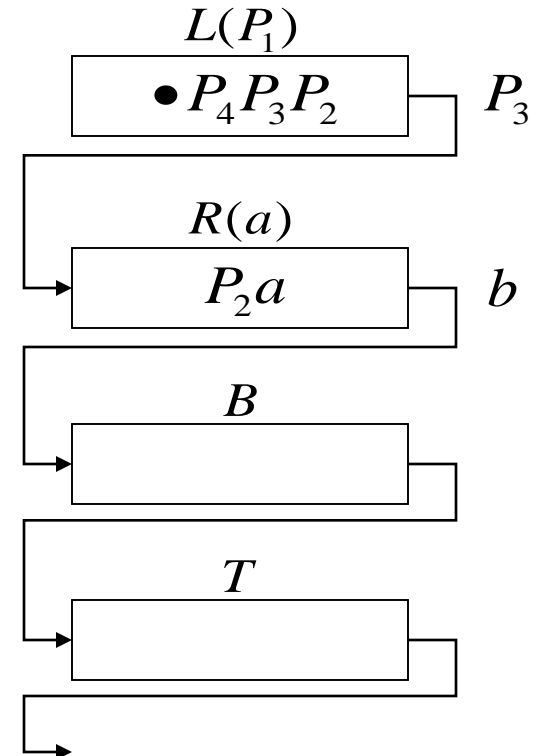
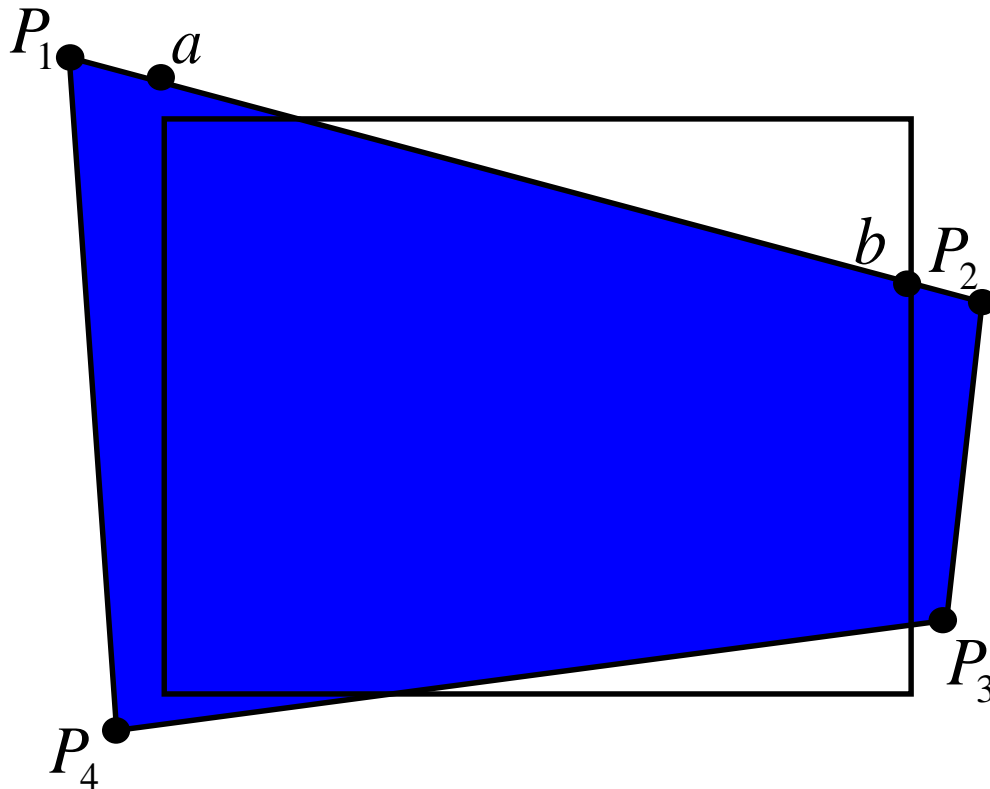
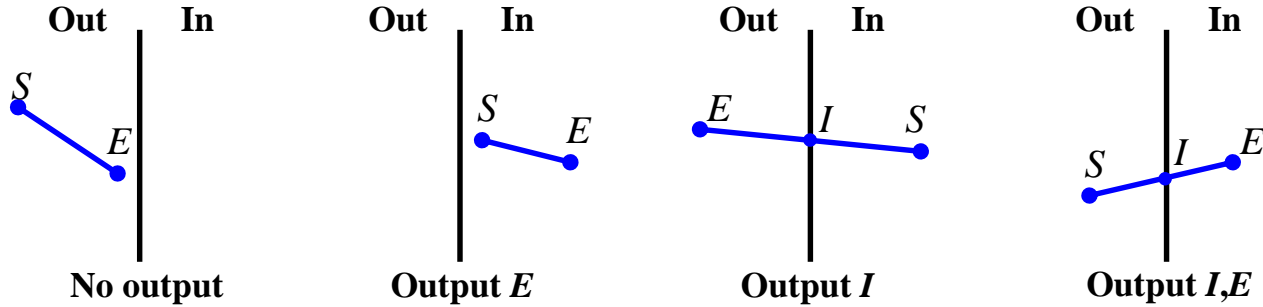
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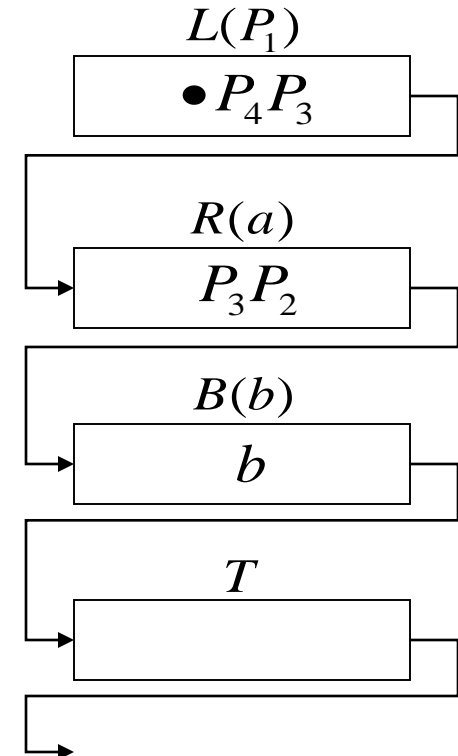
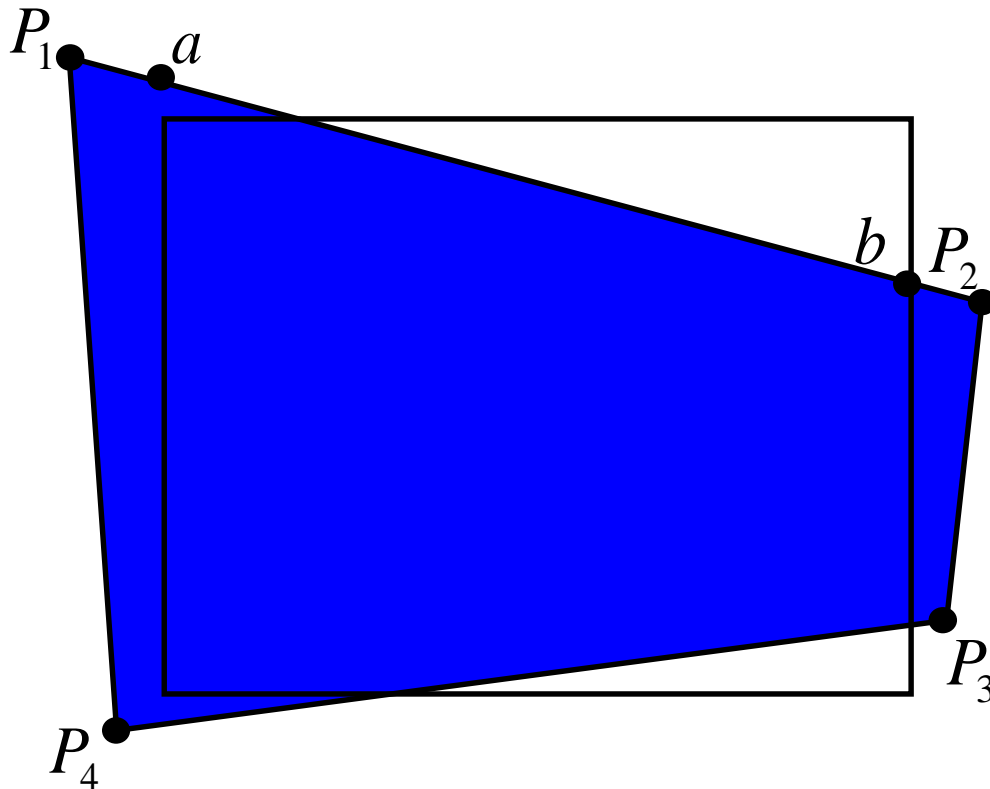
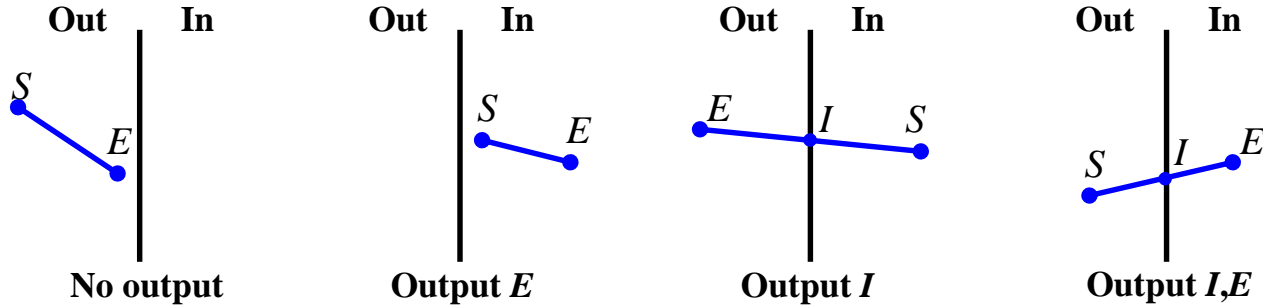
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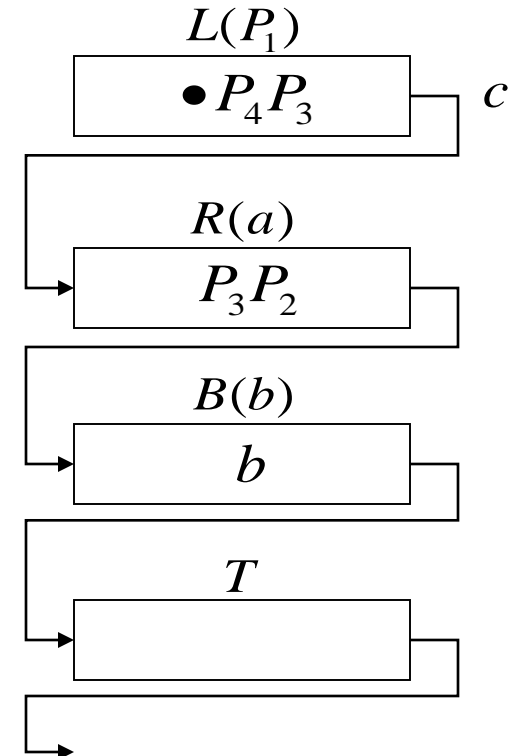
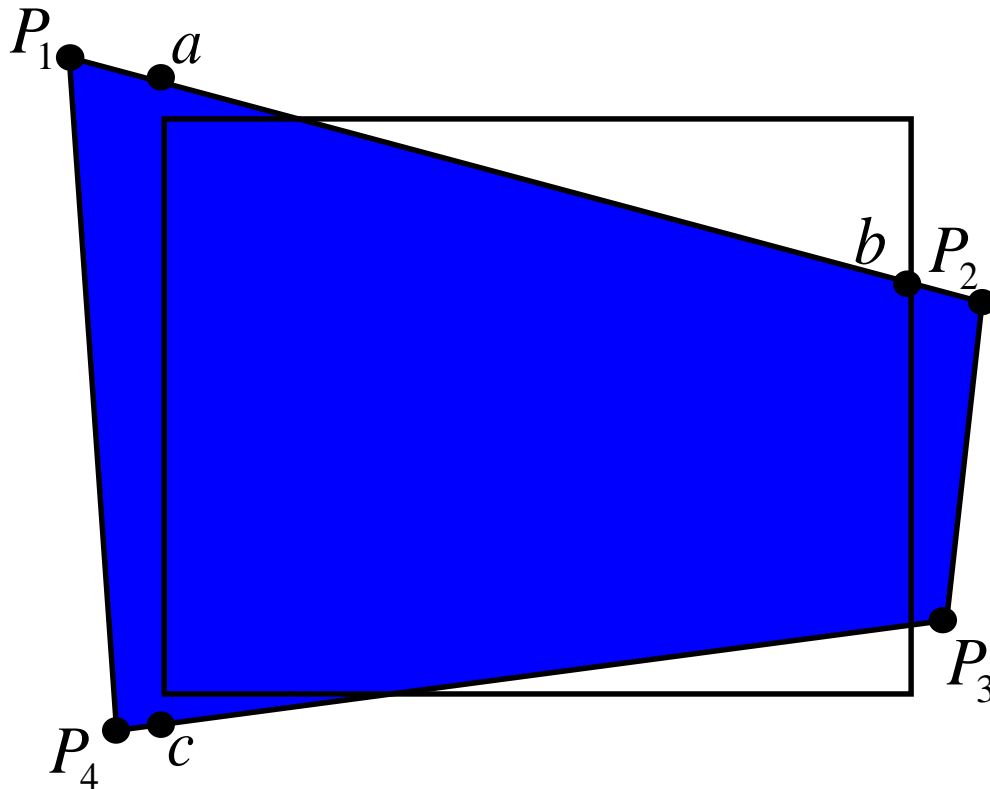
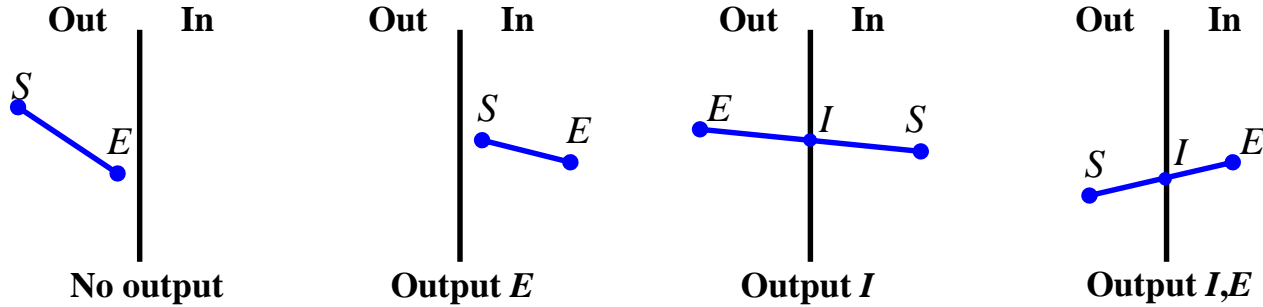
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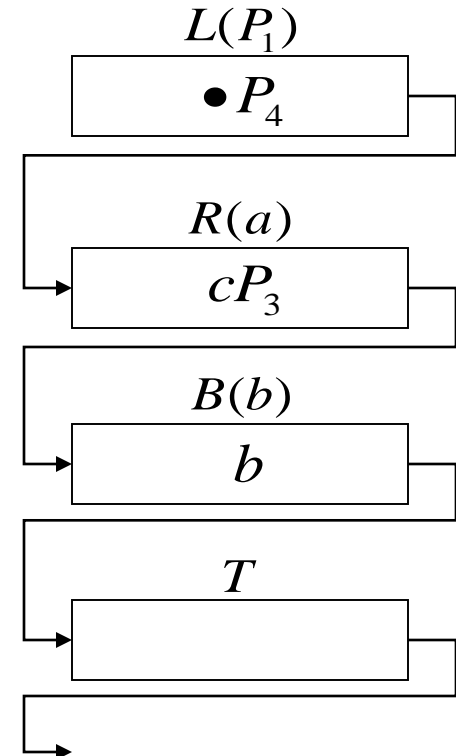
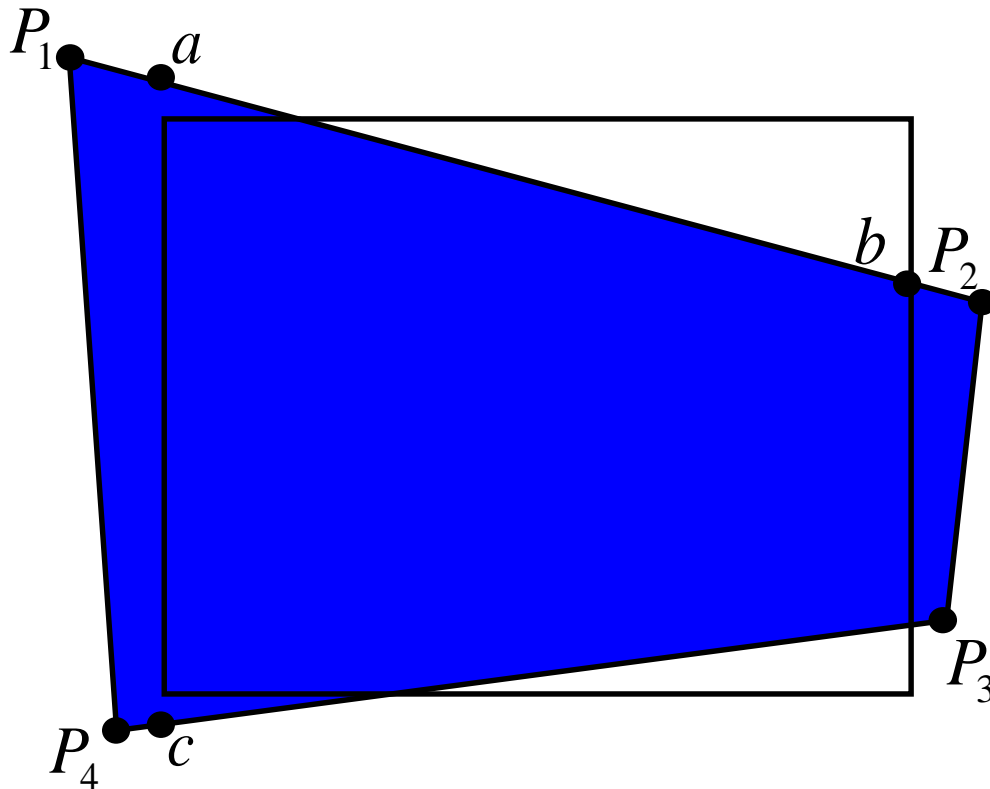
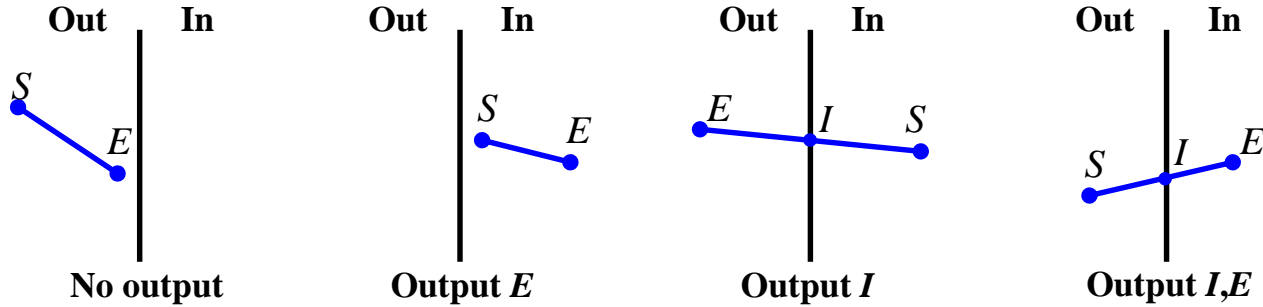
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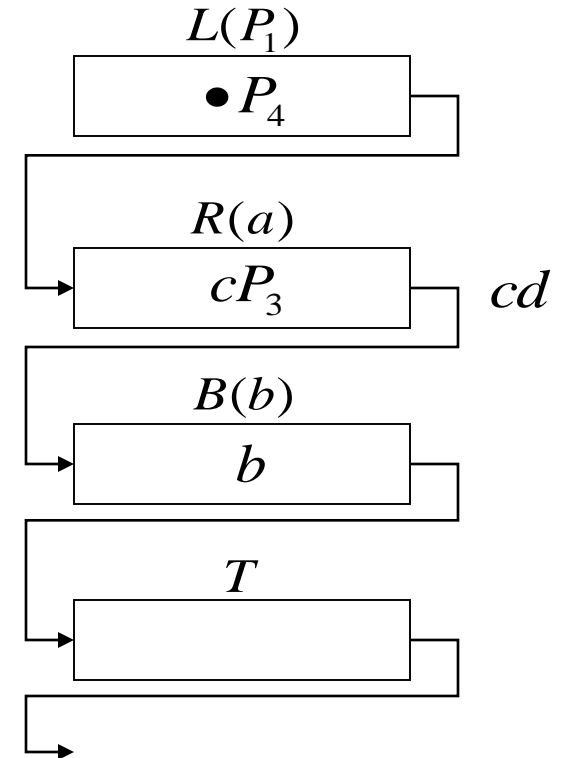
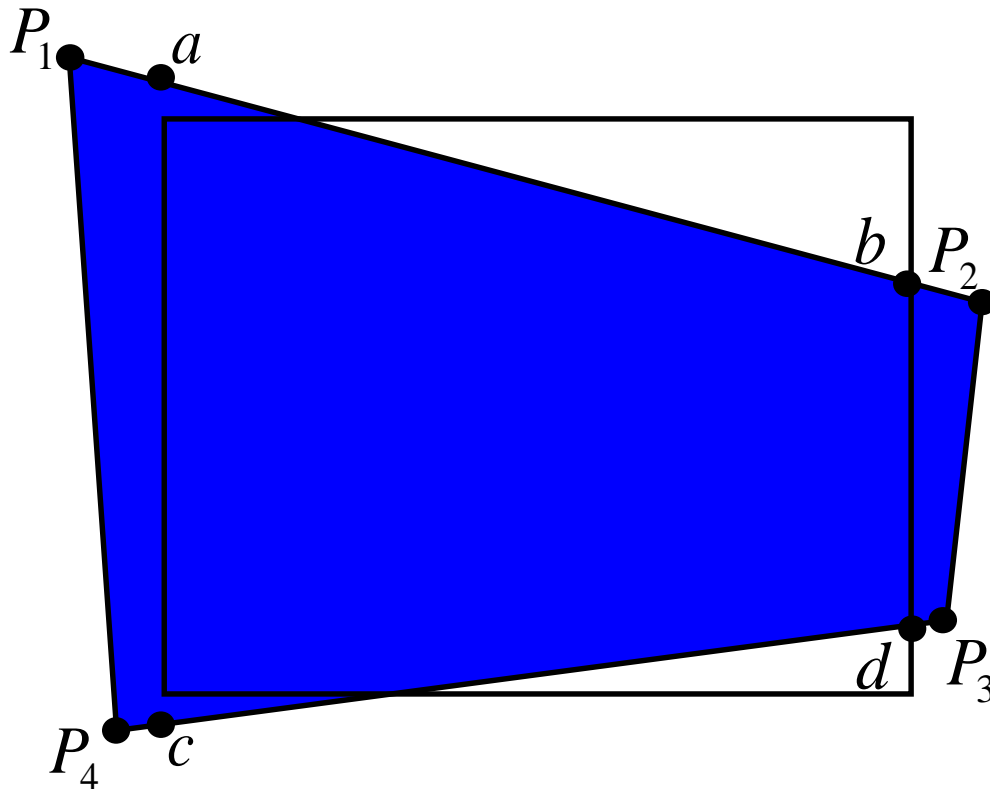
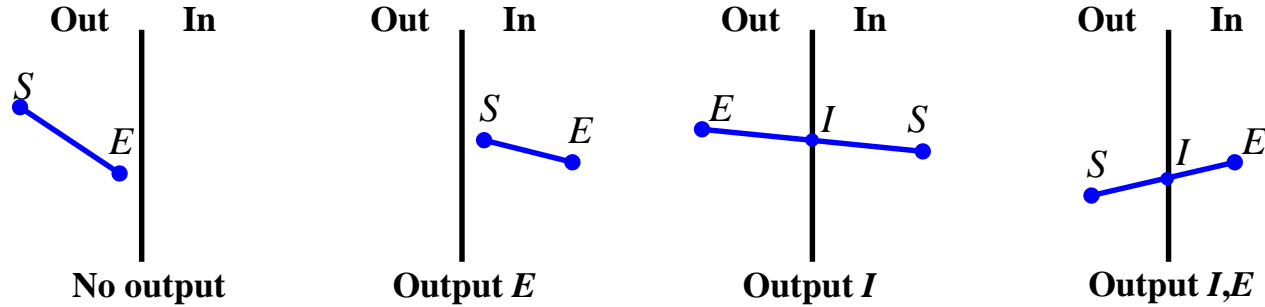
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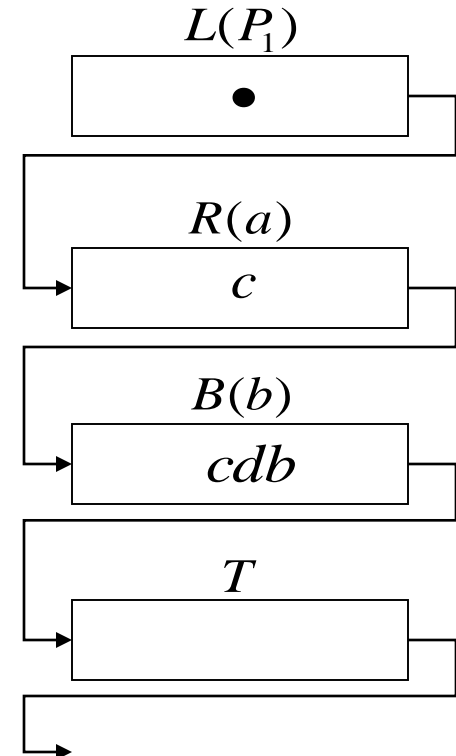
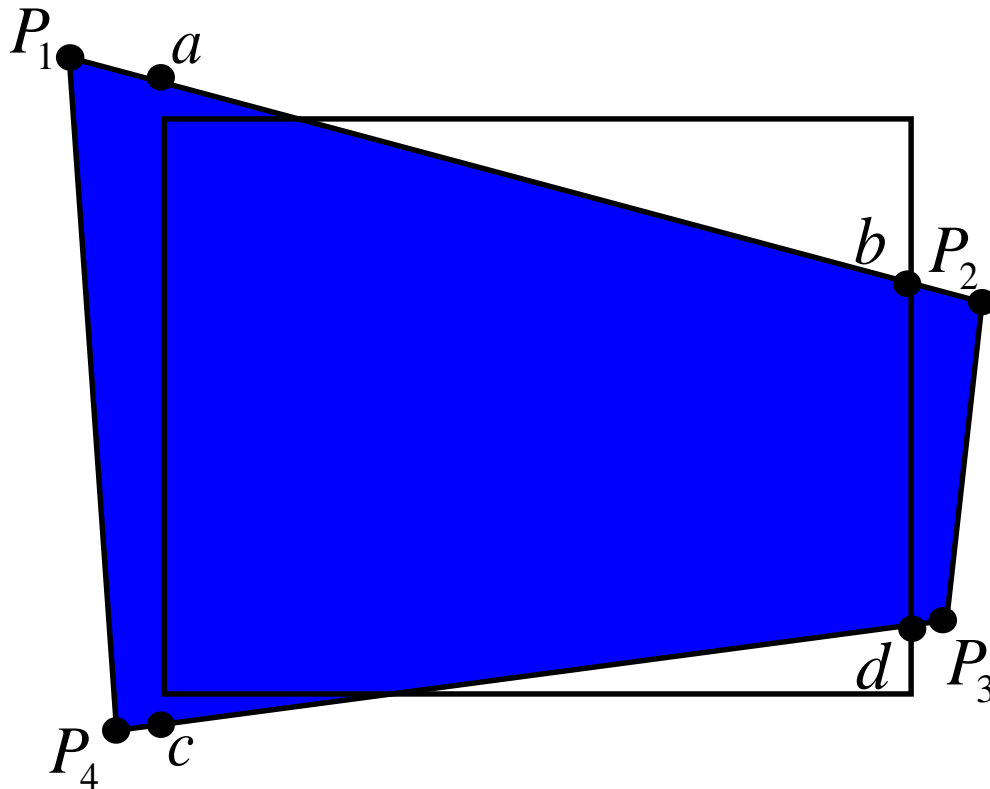
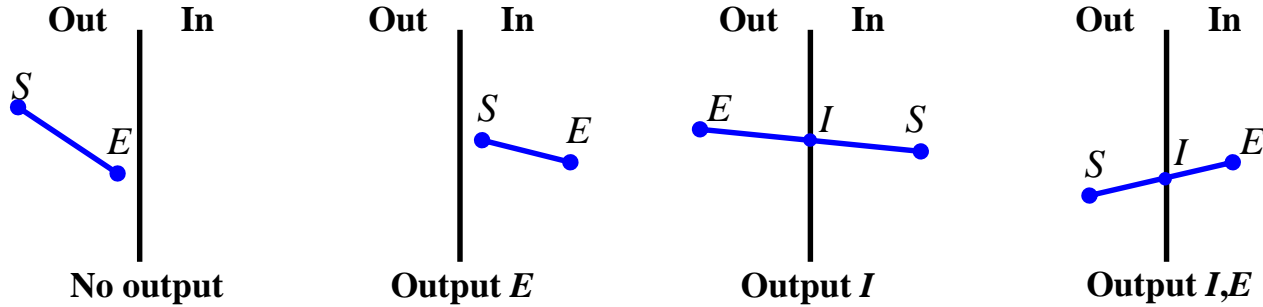
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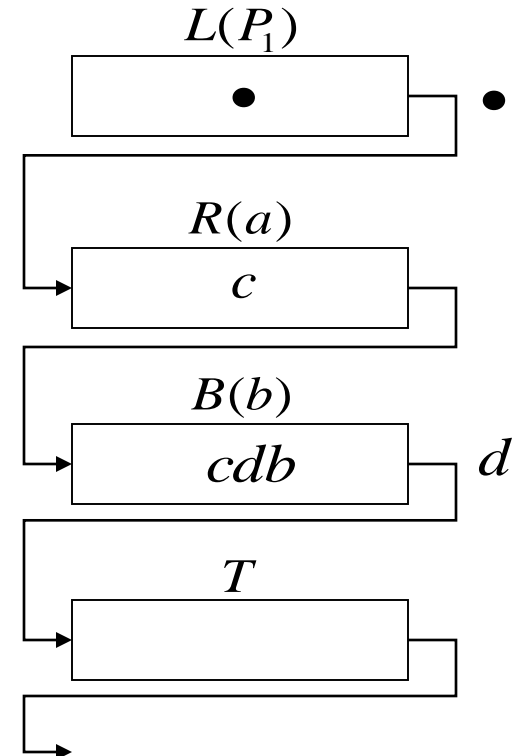
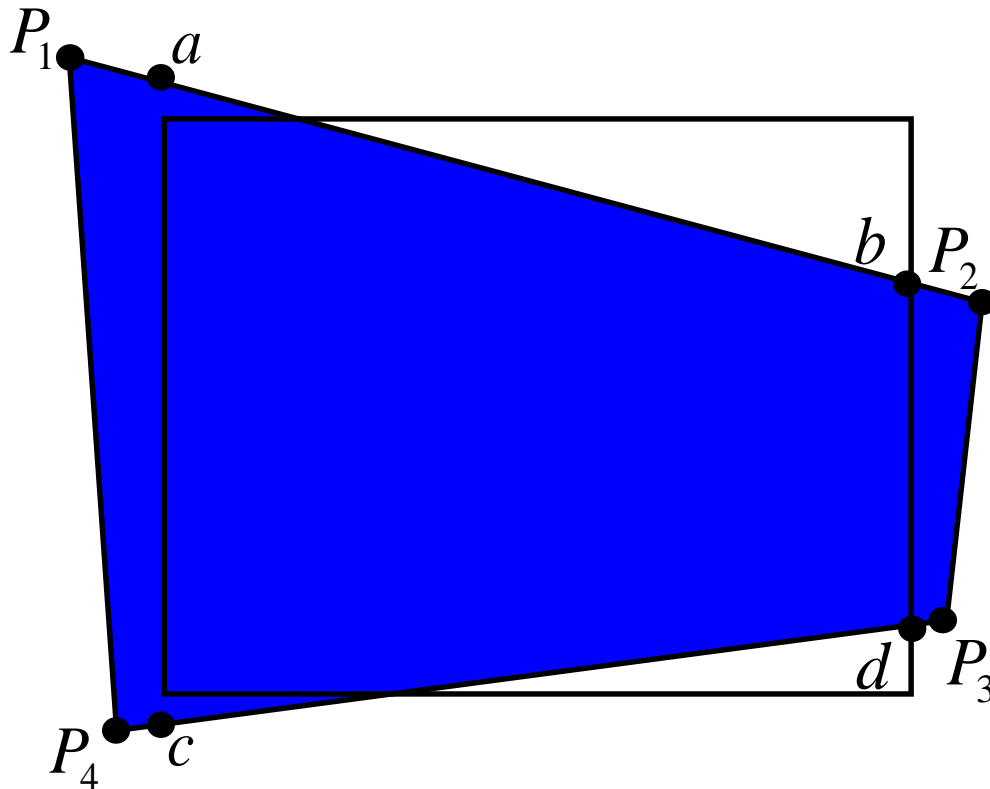
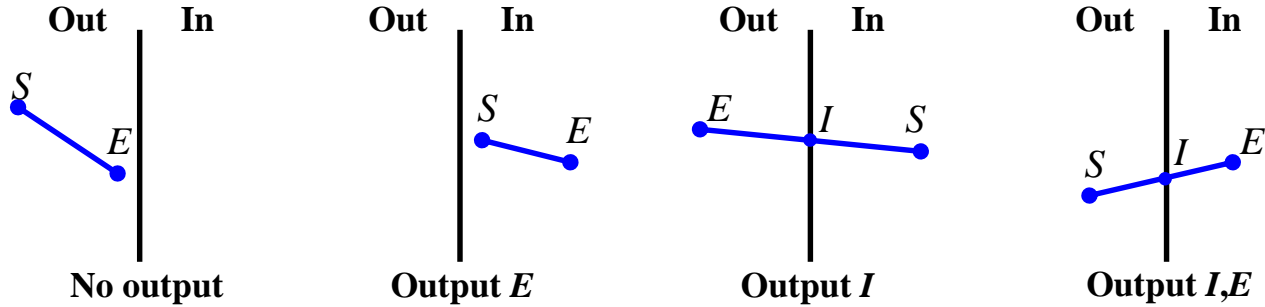
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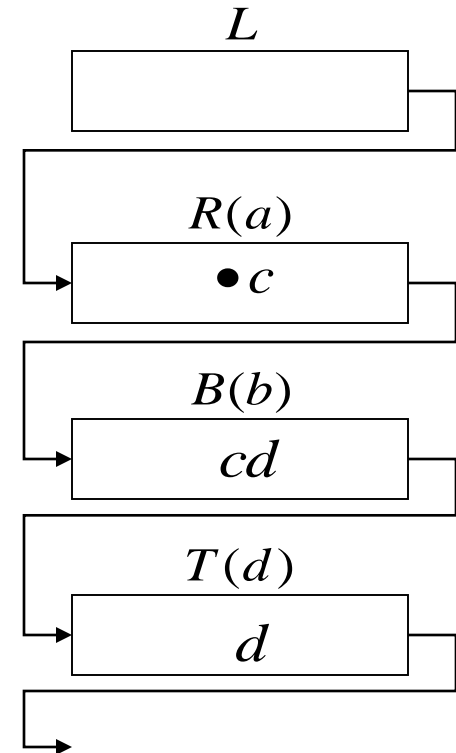
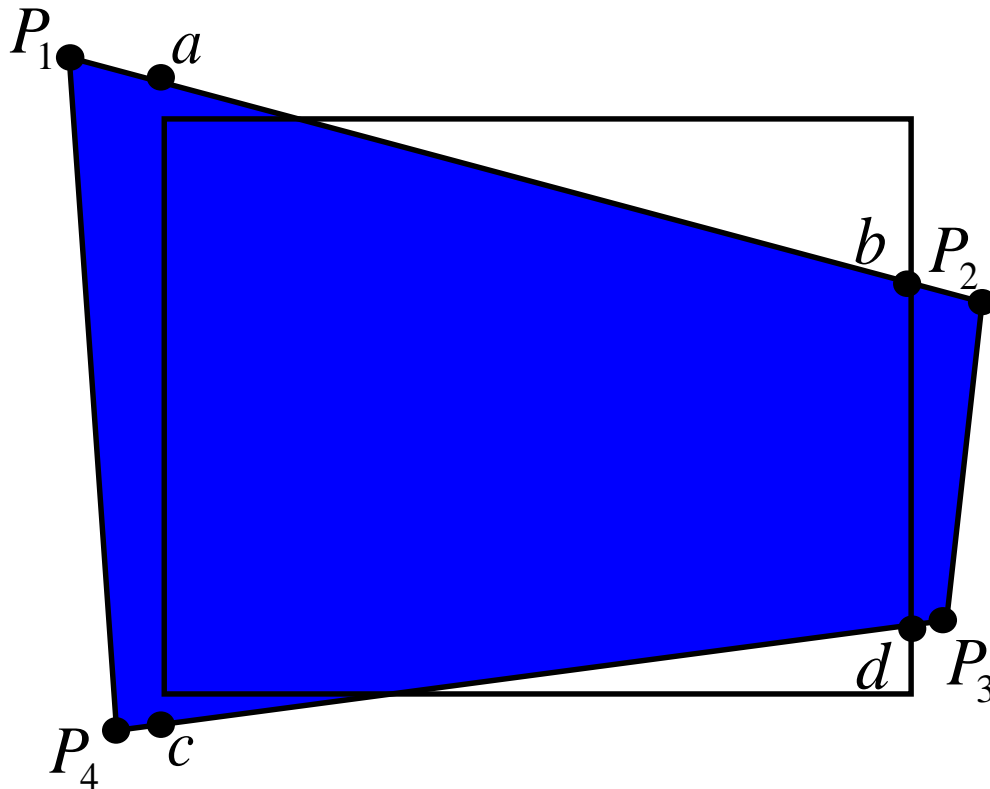
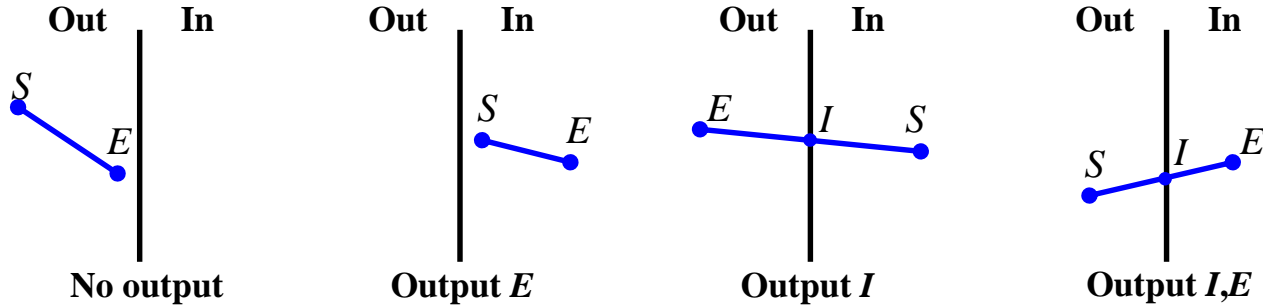
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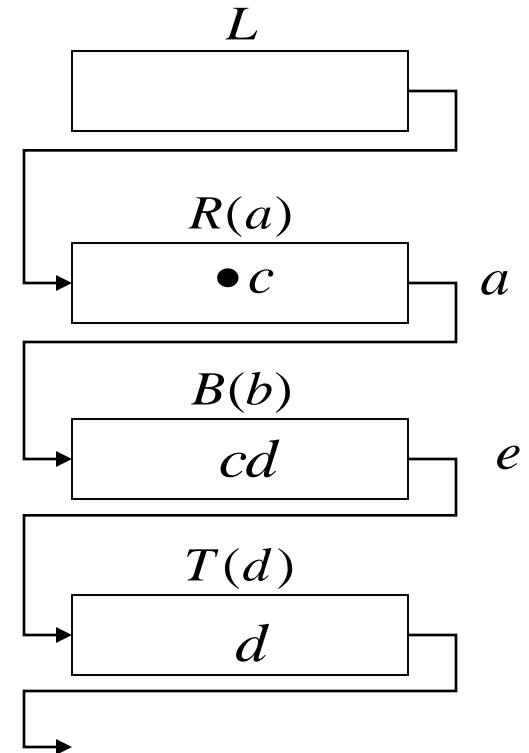
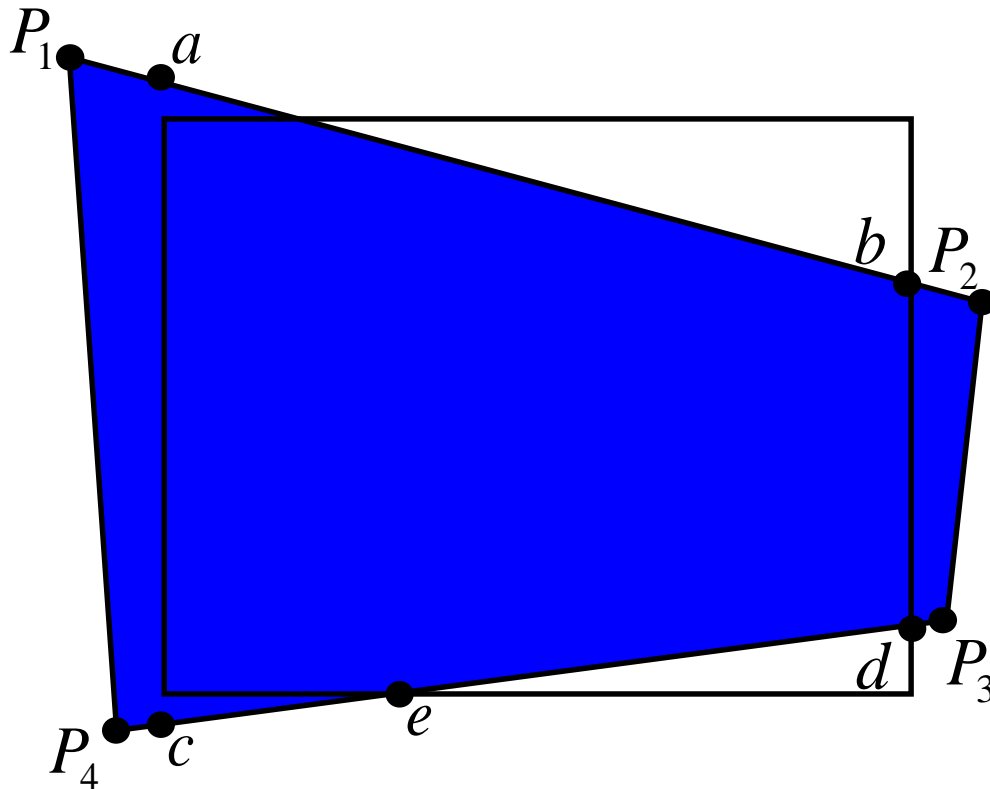
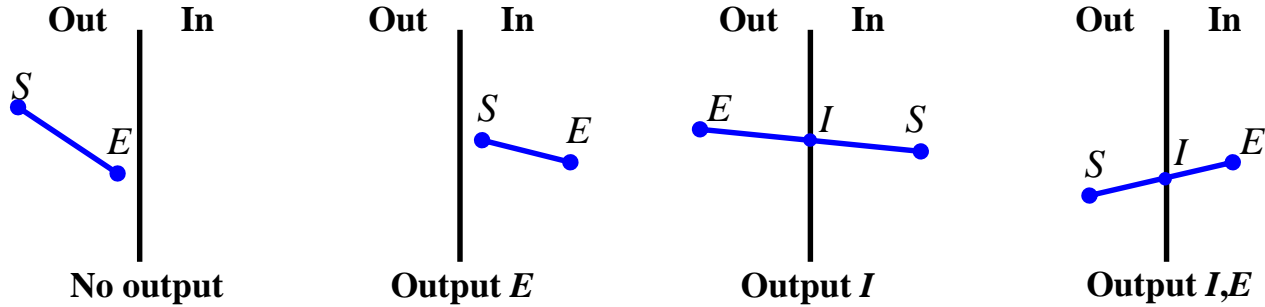
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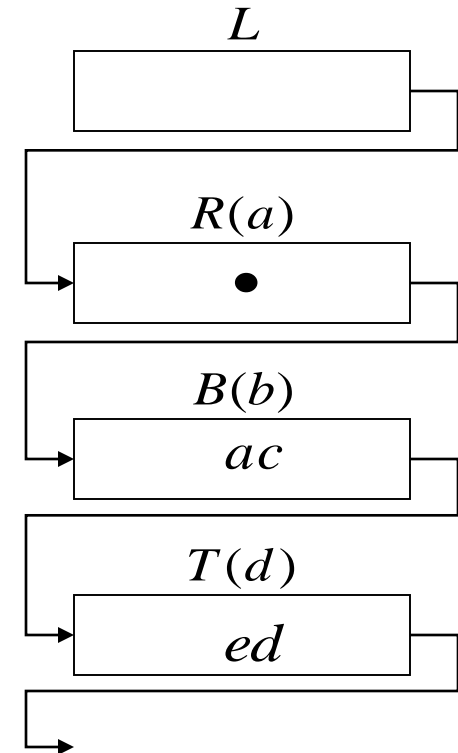
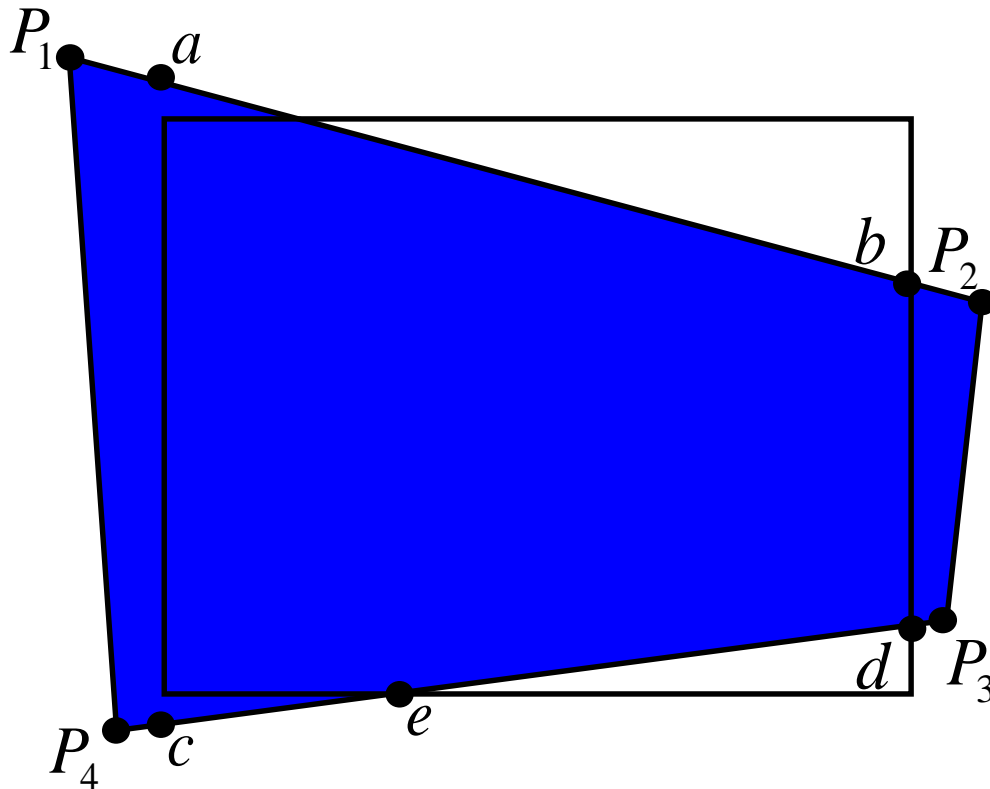
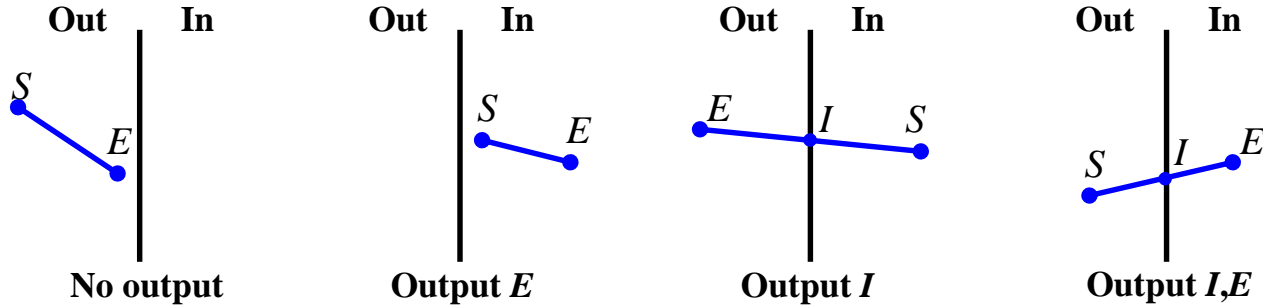
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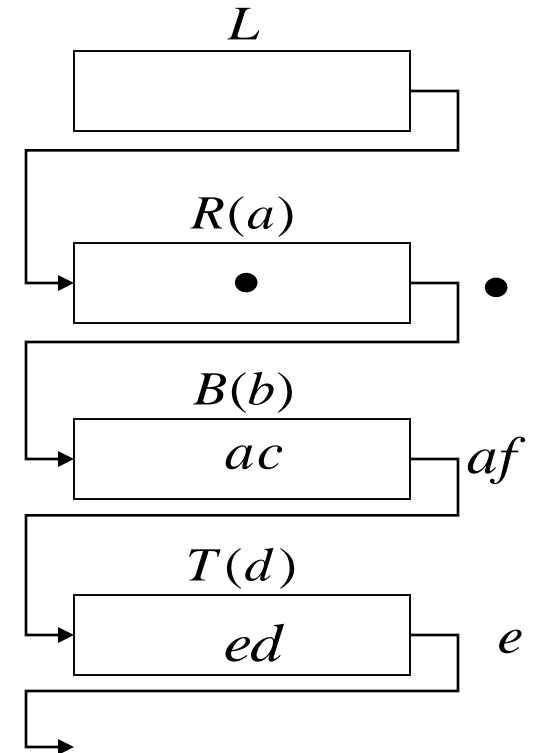
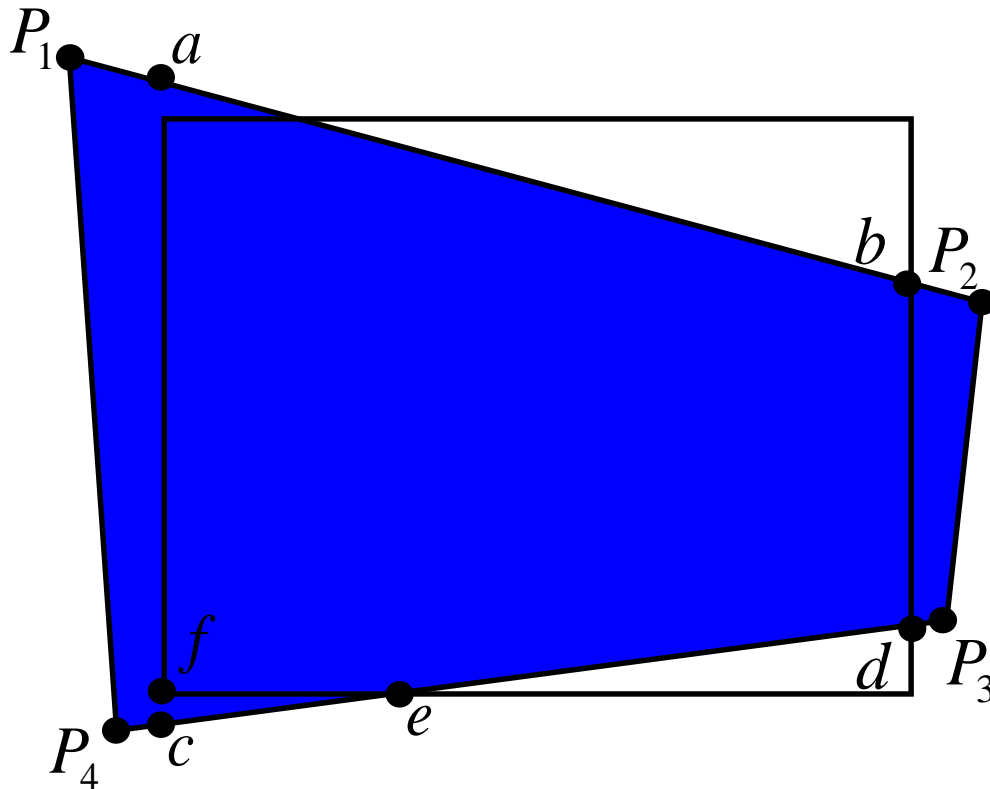
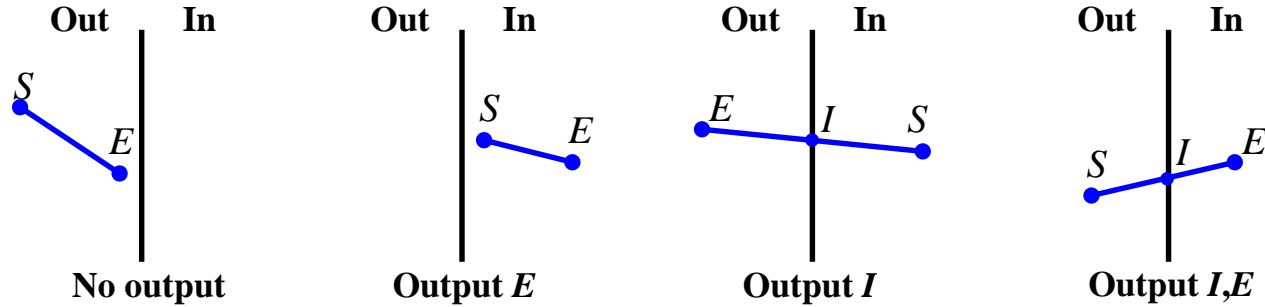
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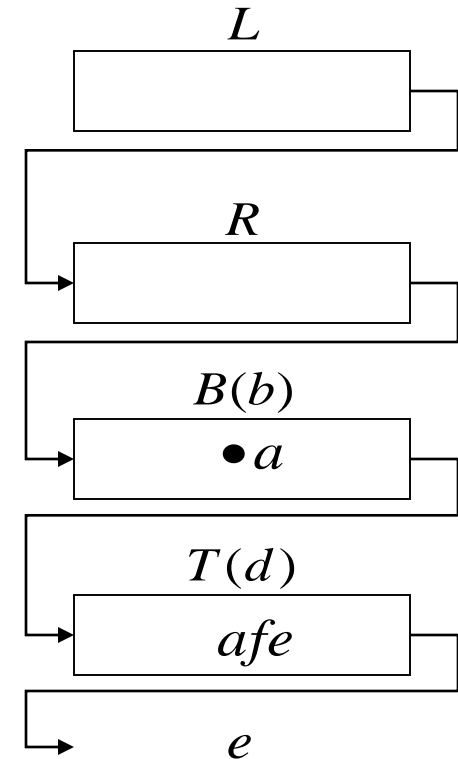
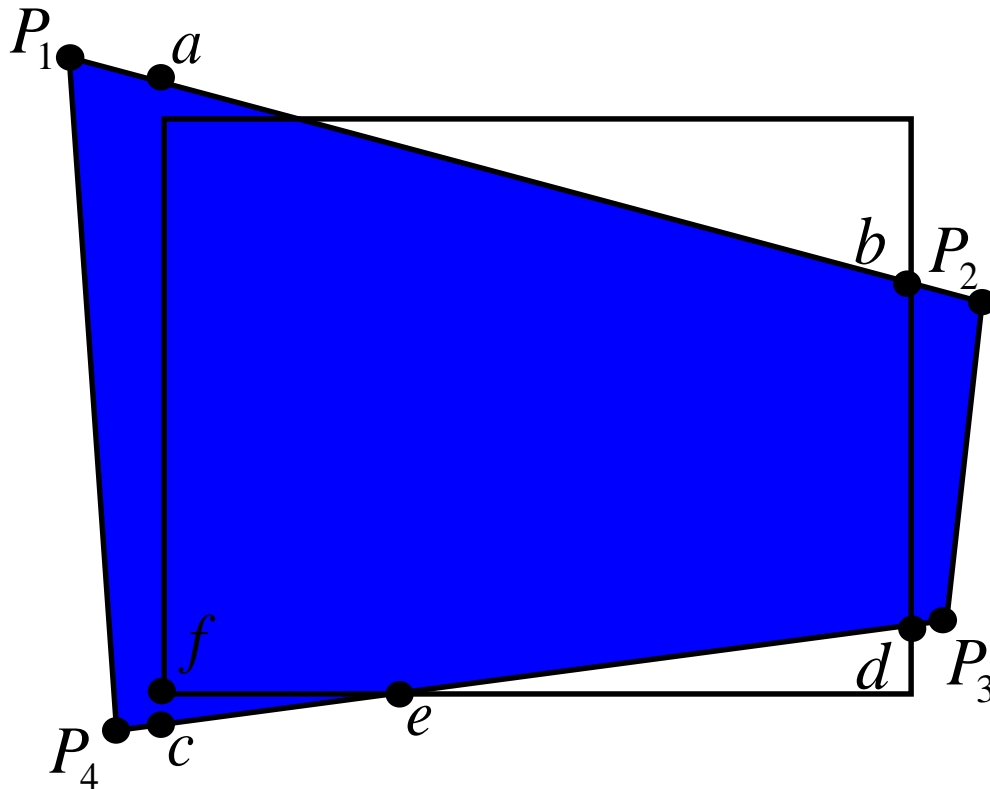
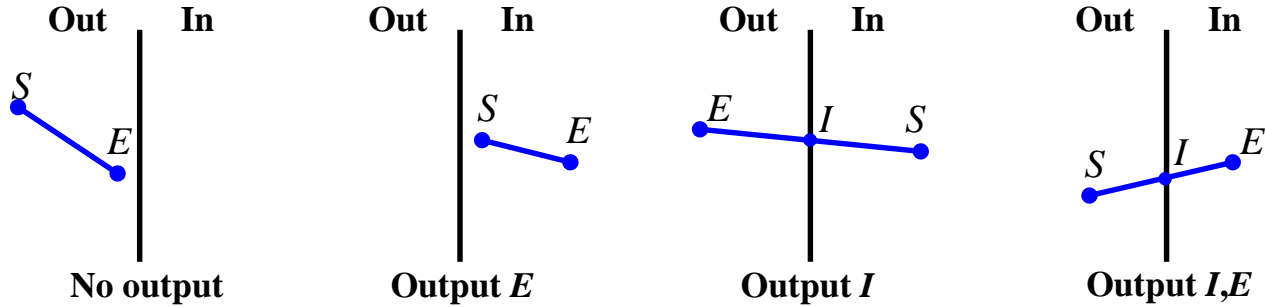
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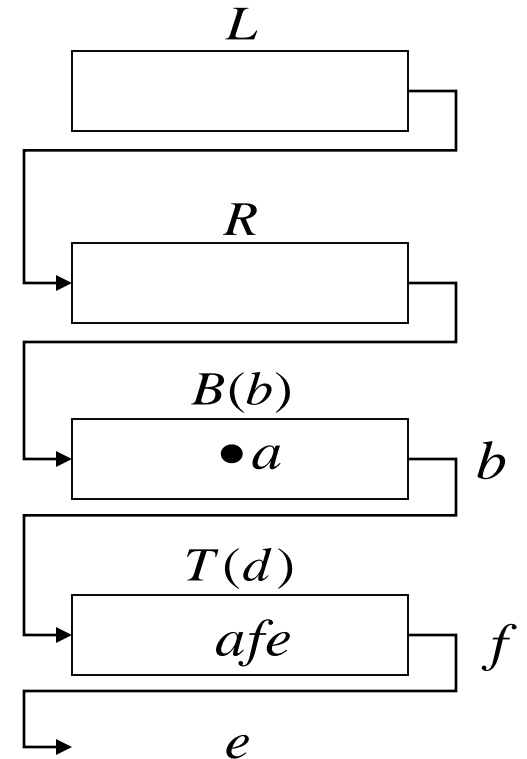
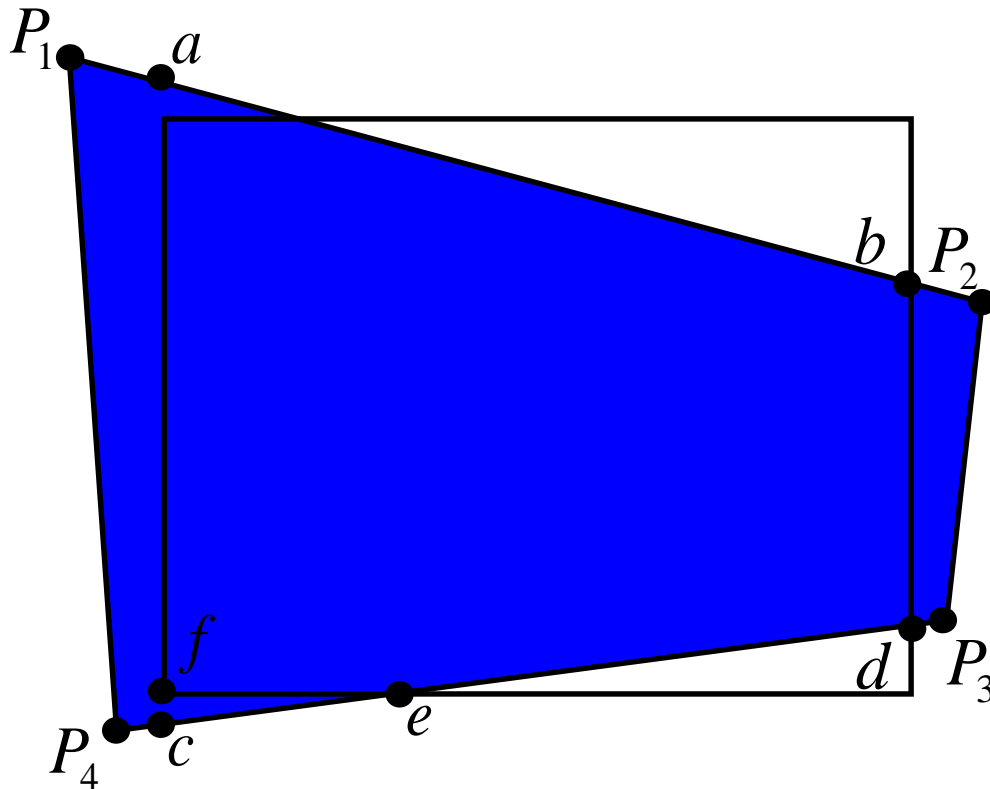
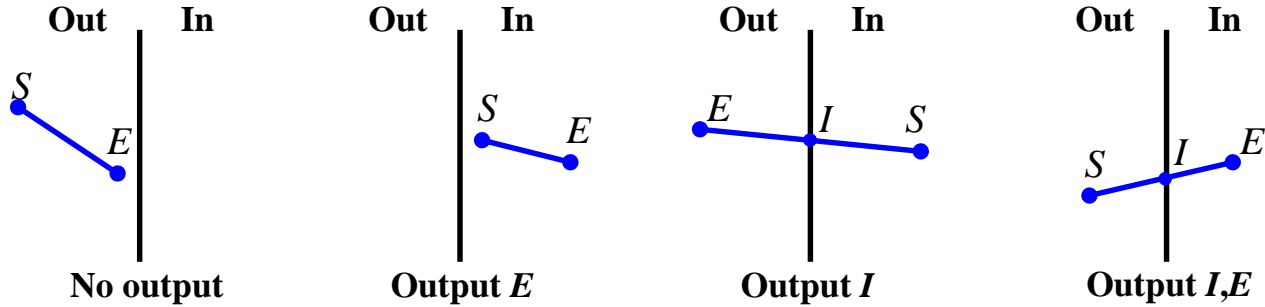
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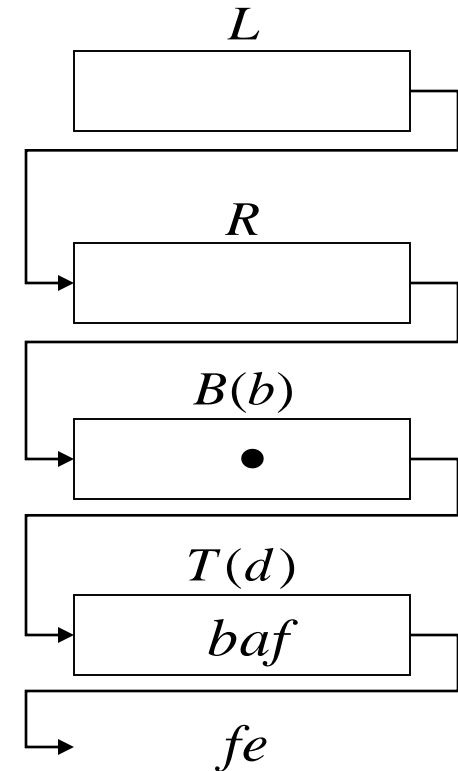
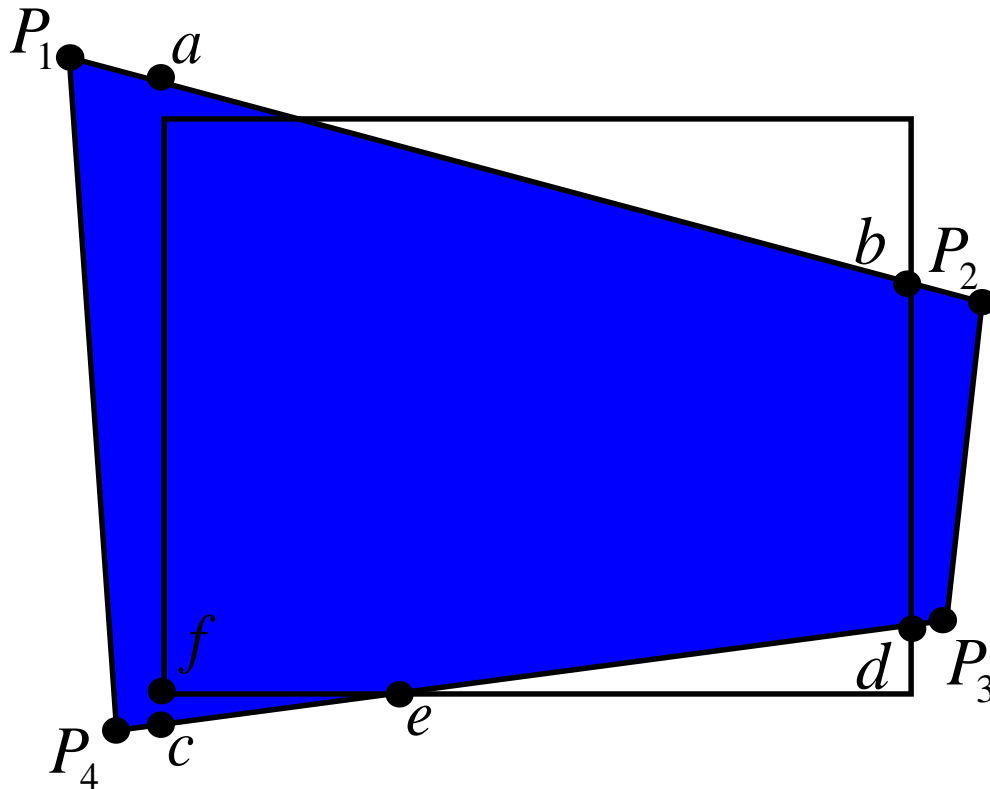
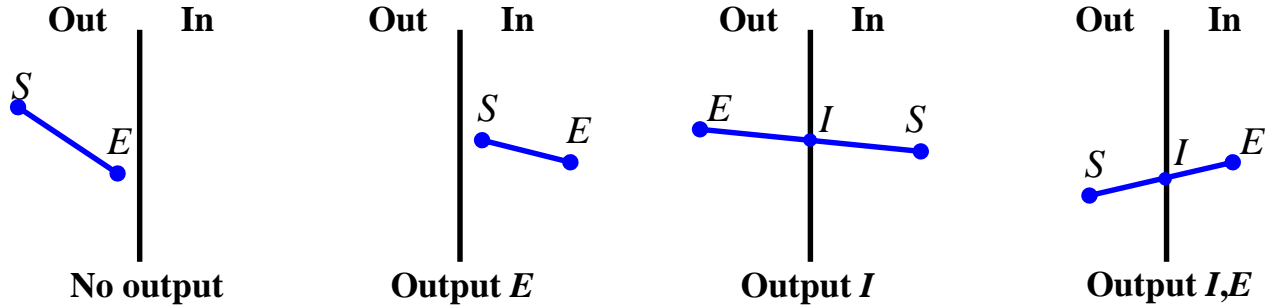
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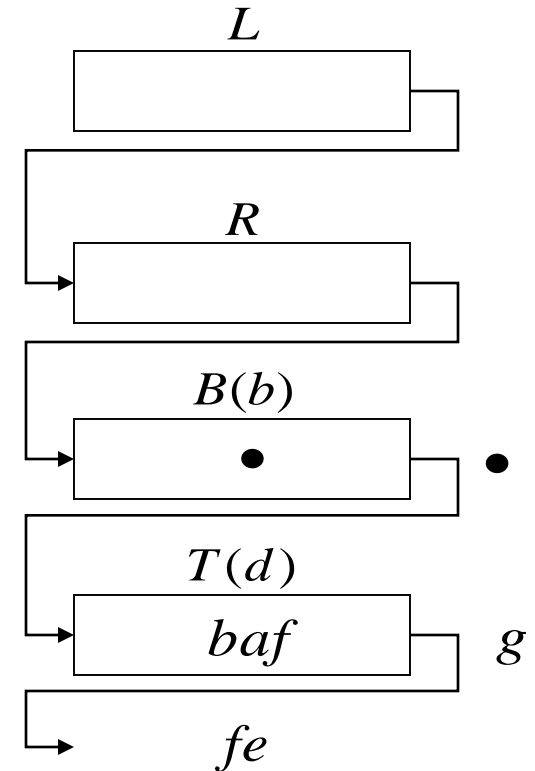
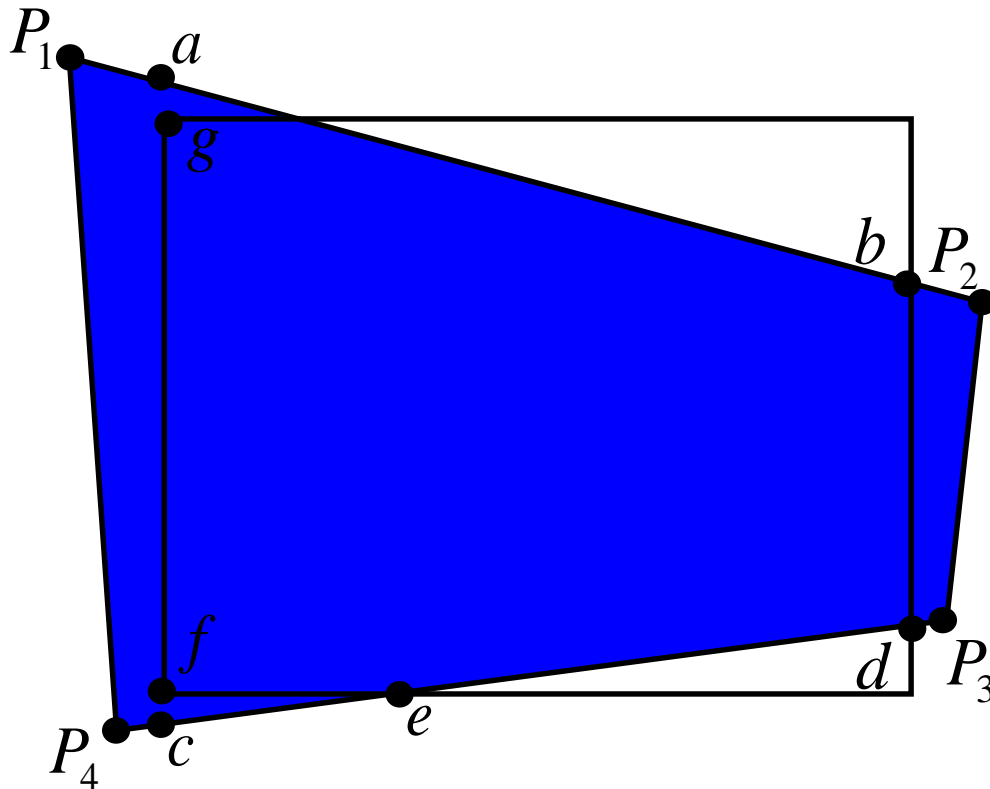
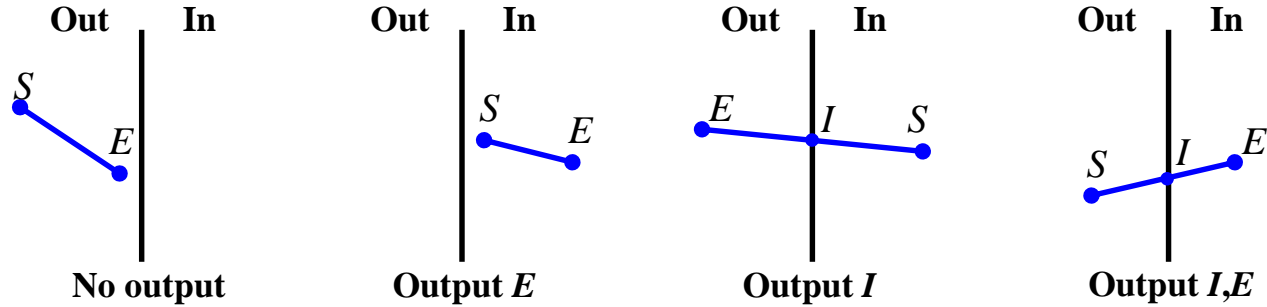
Sutherland-Hodgman Algorithm



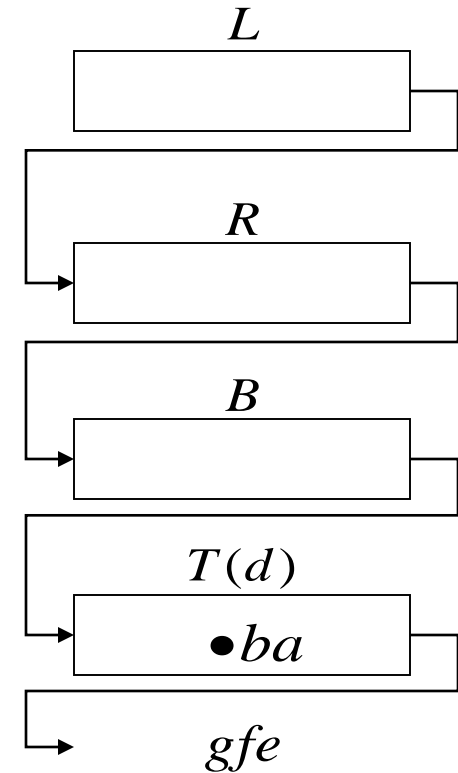
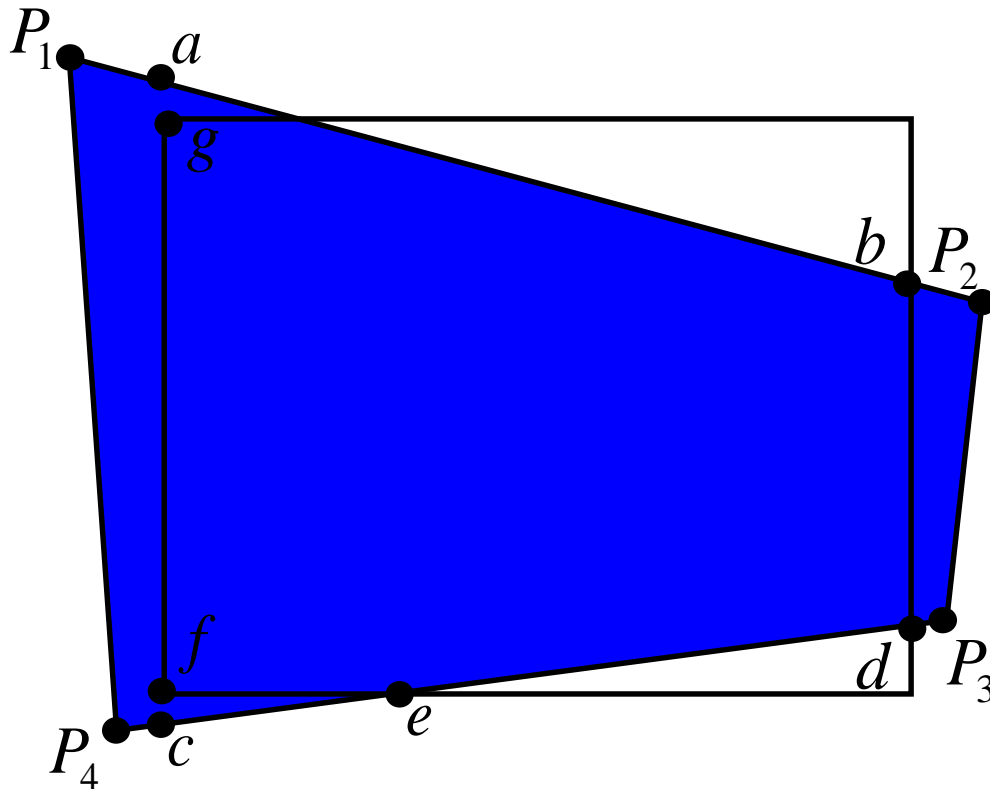
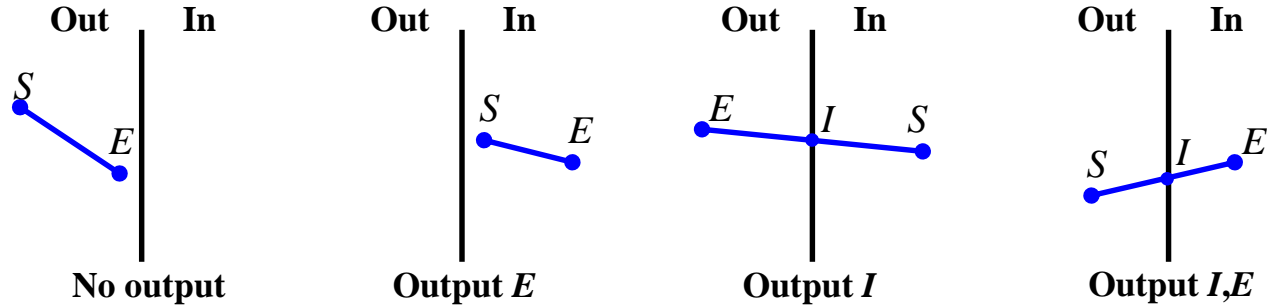
Sutherland-Hodgman Algorithm



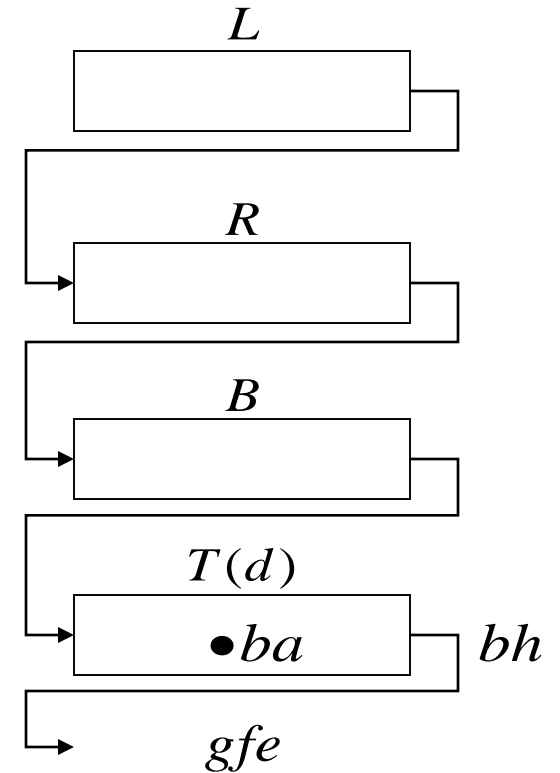
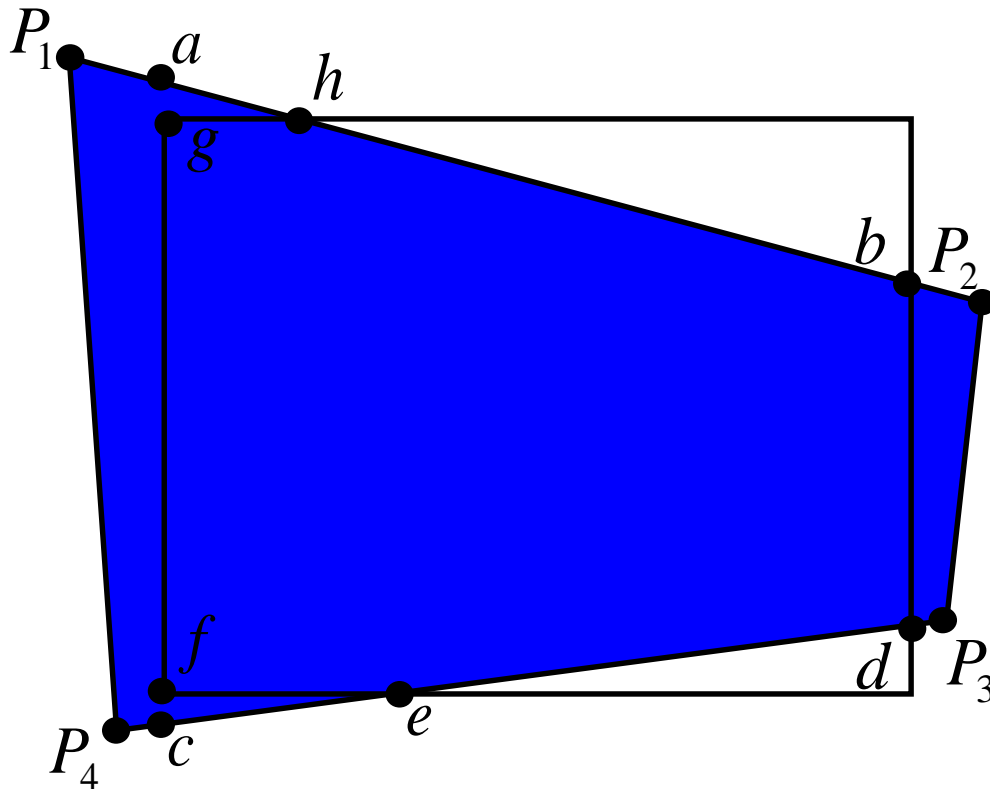
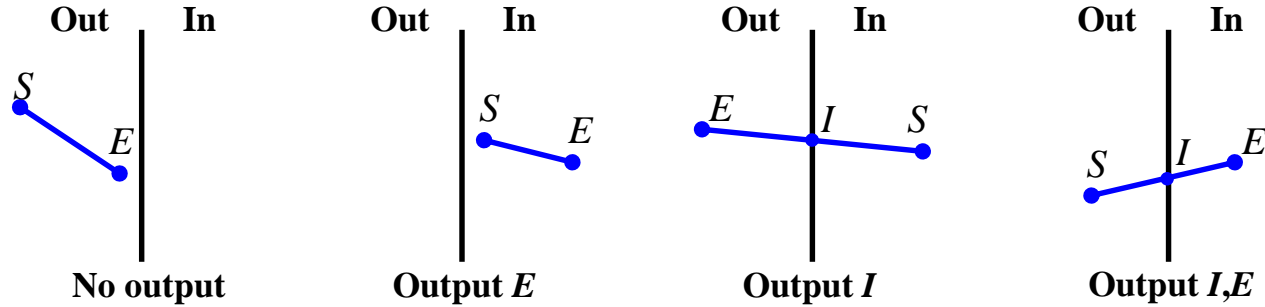
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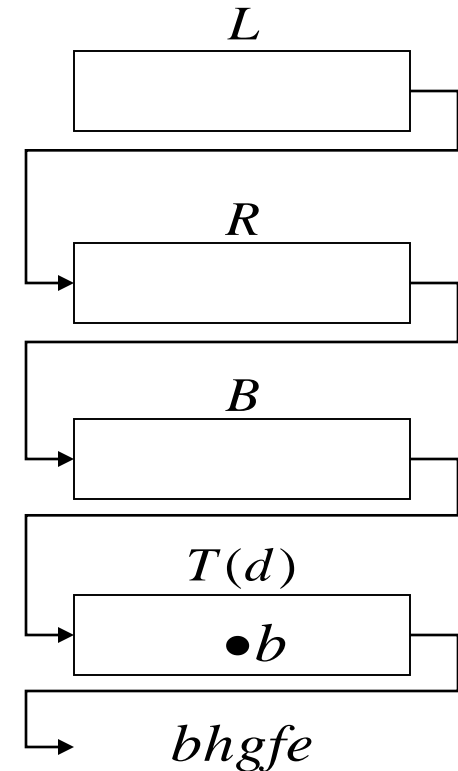
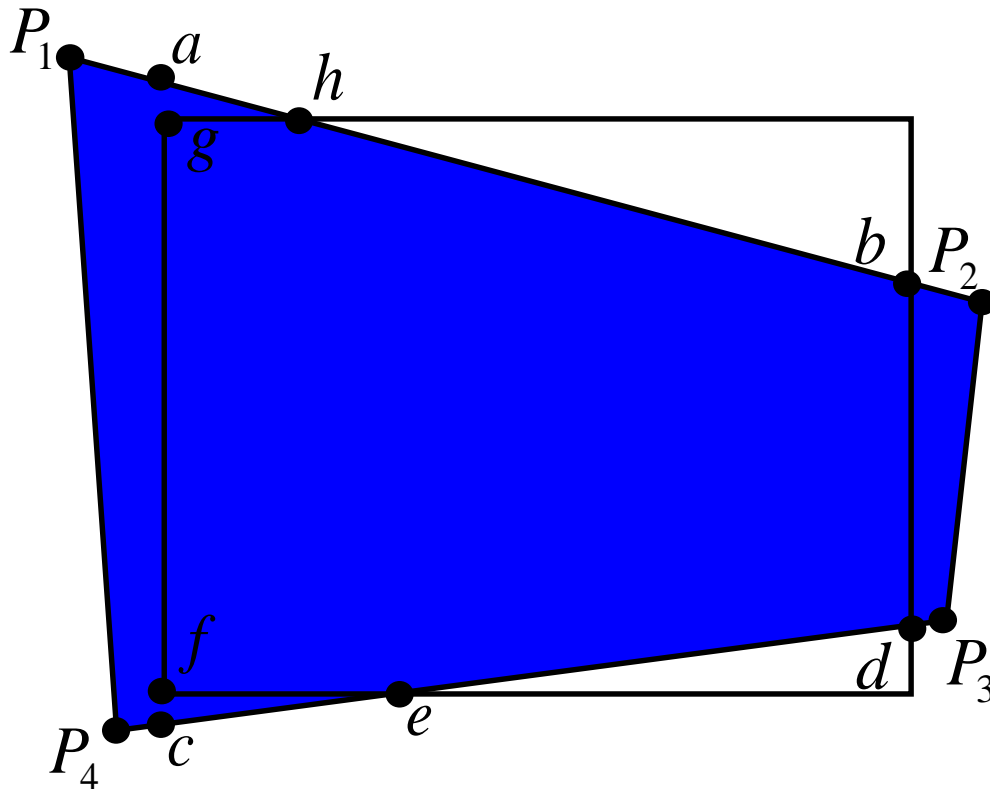
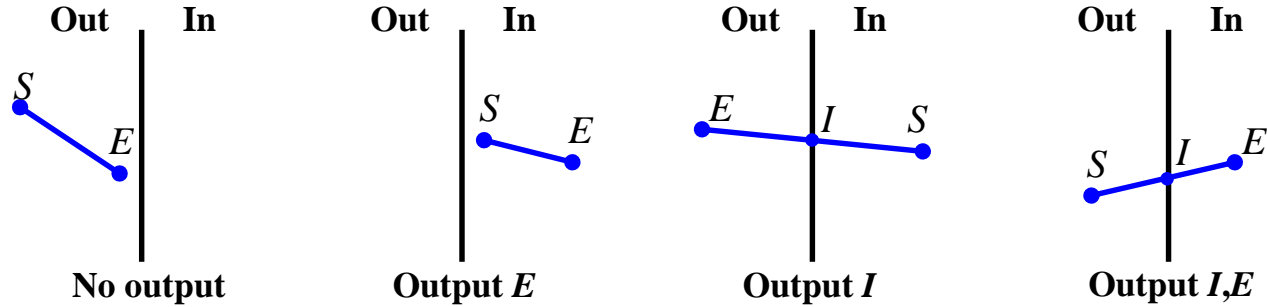
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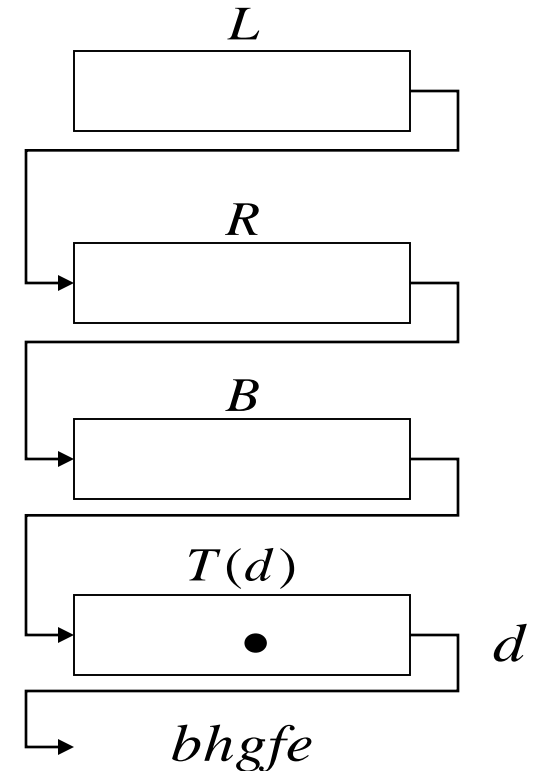
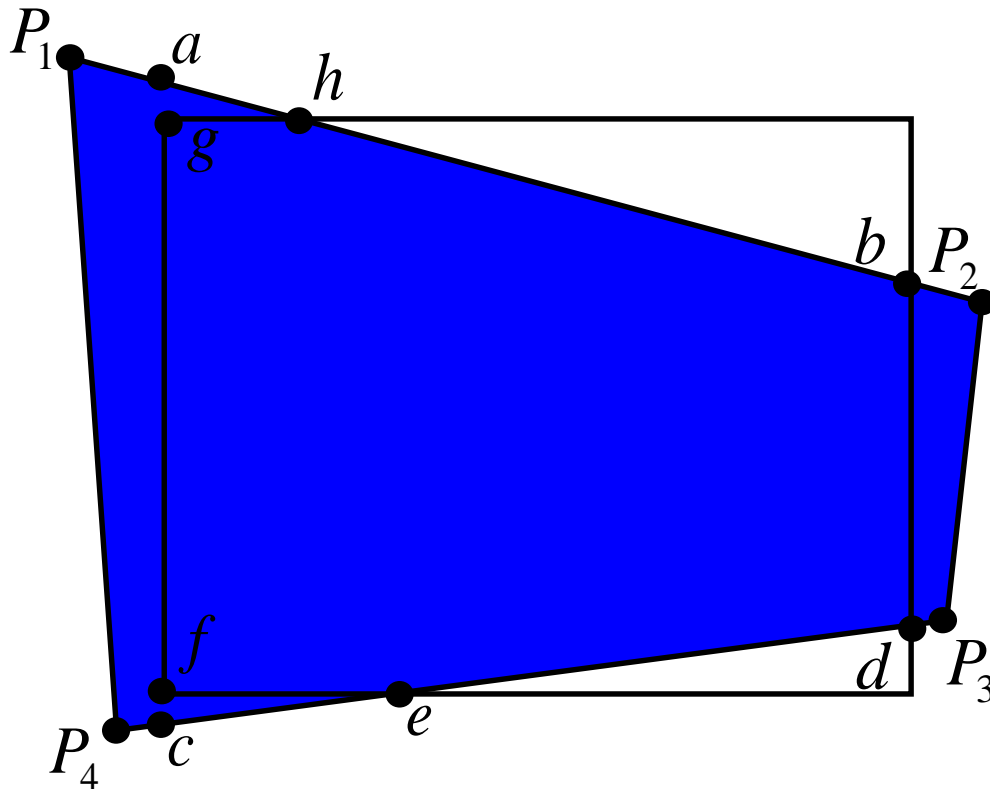
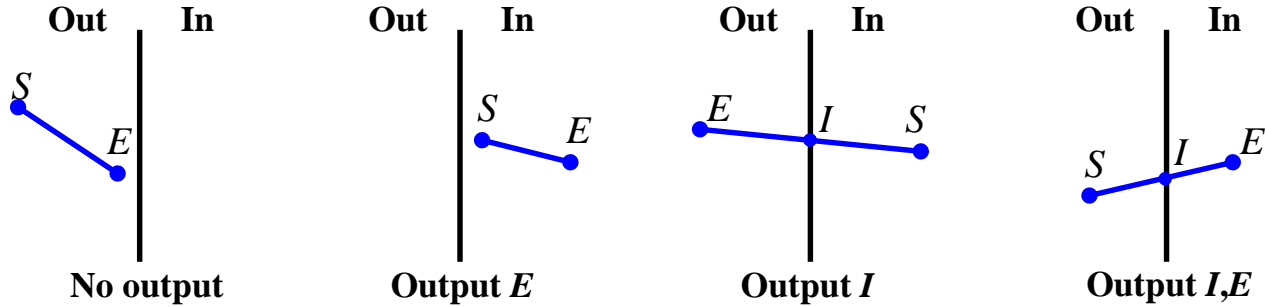
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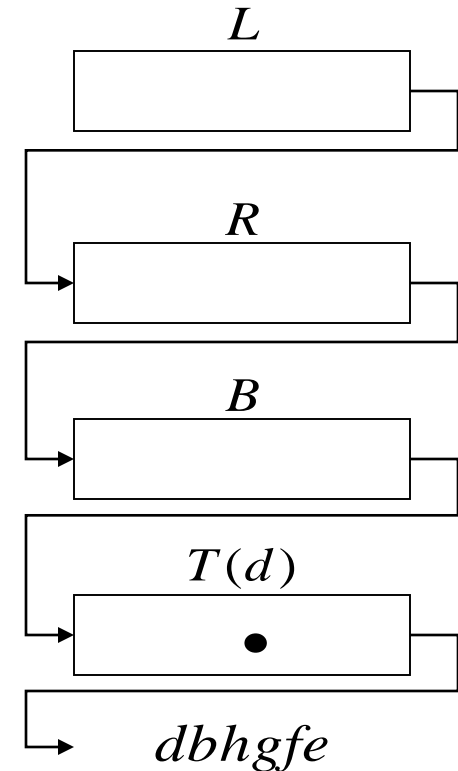
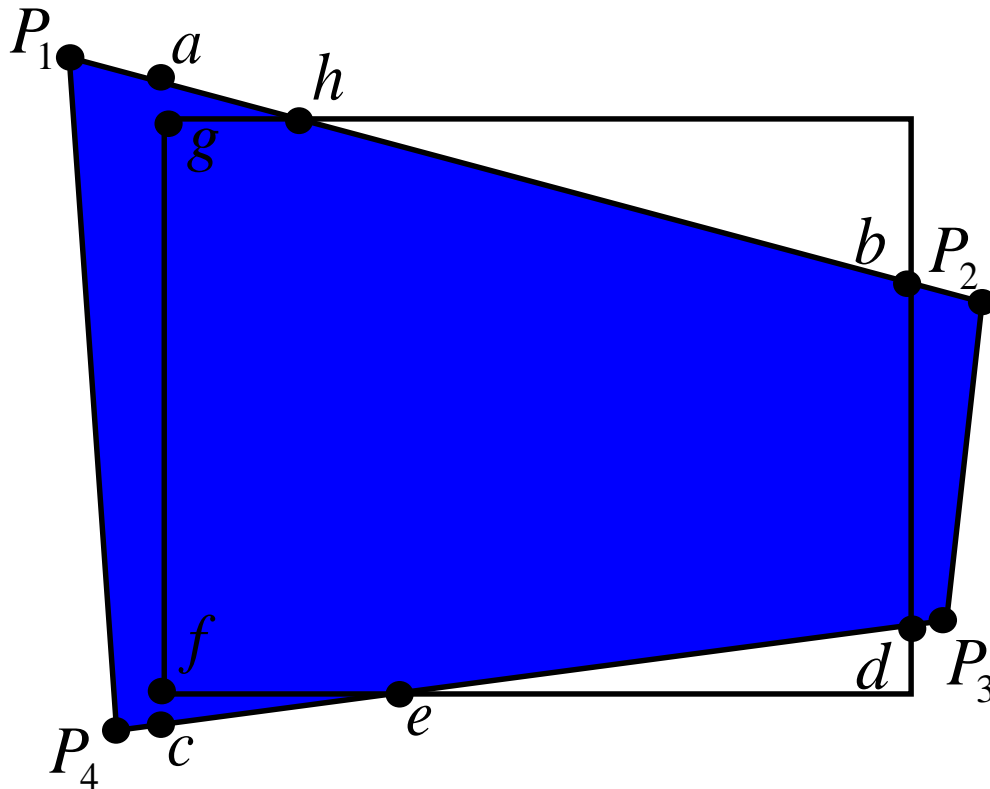
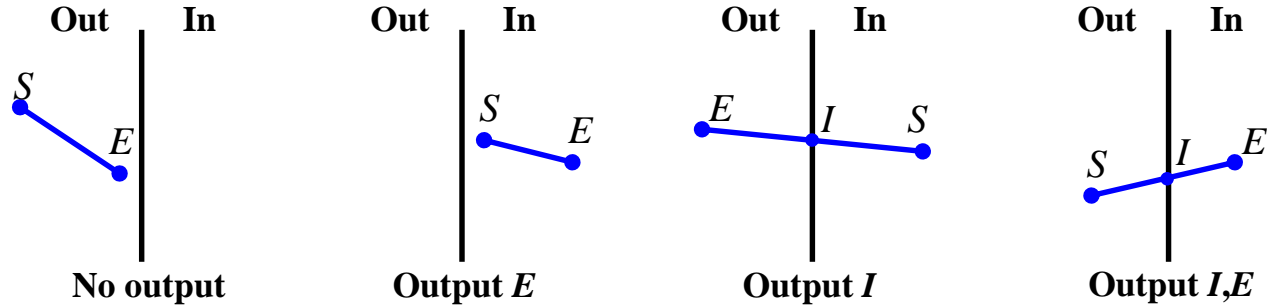
Sutherland-Hodgman Algorithm



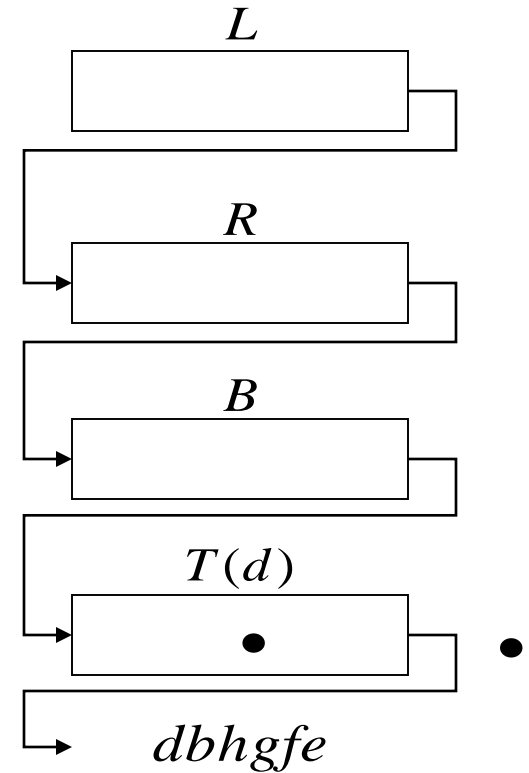
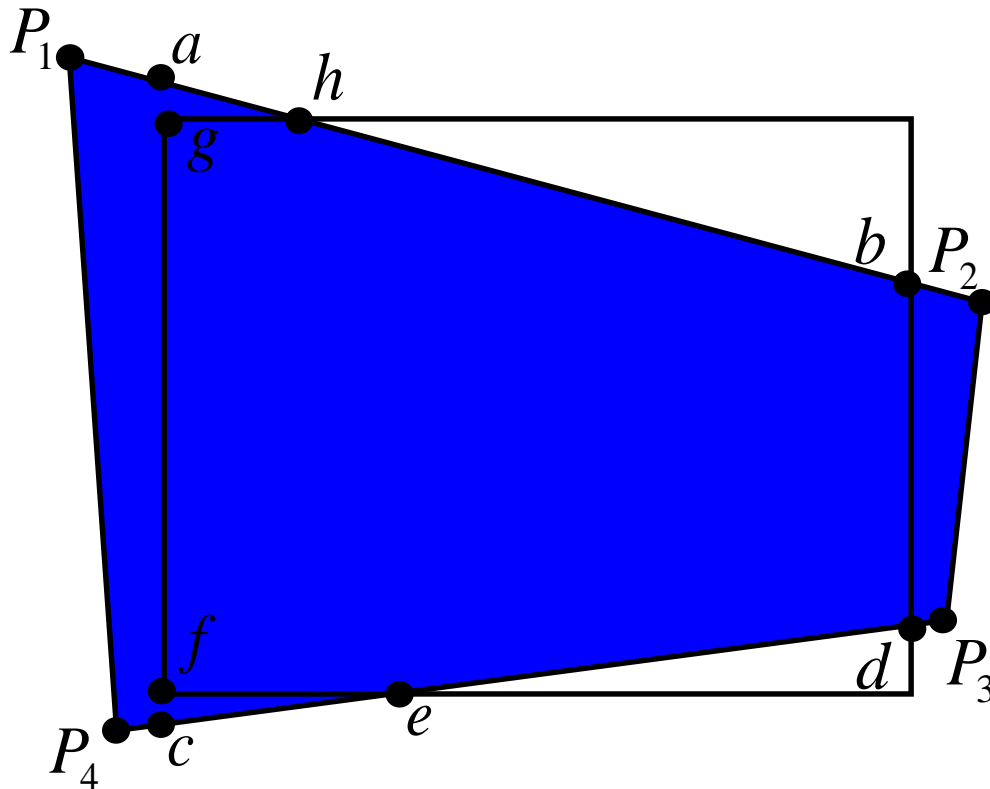
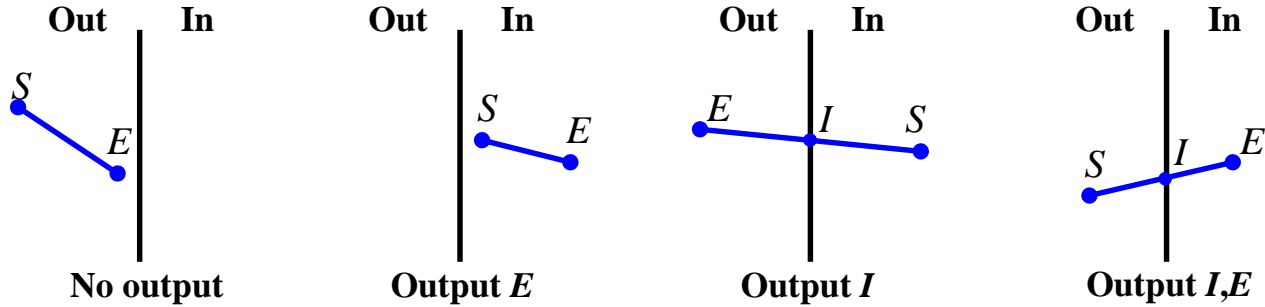
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