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Silicon to Software™

2021 EDA Summer Camp

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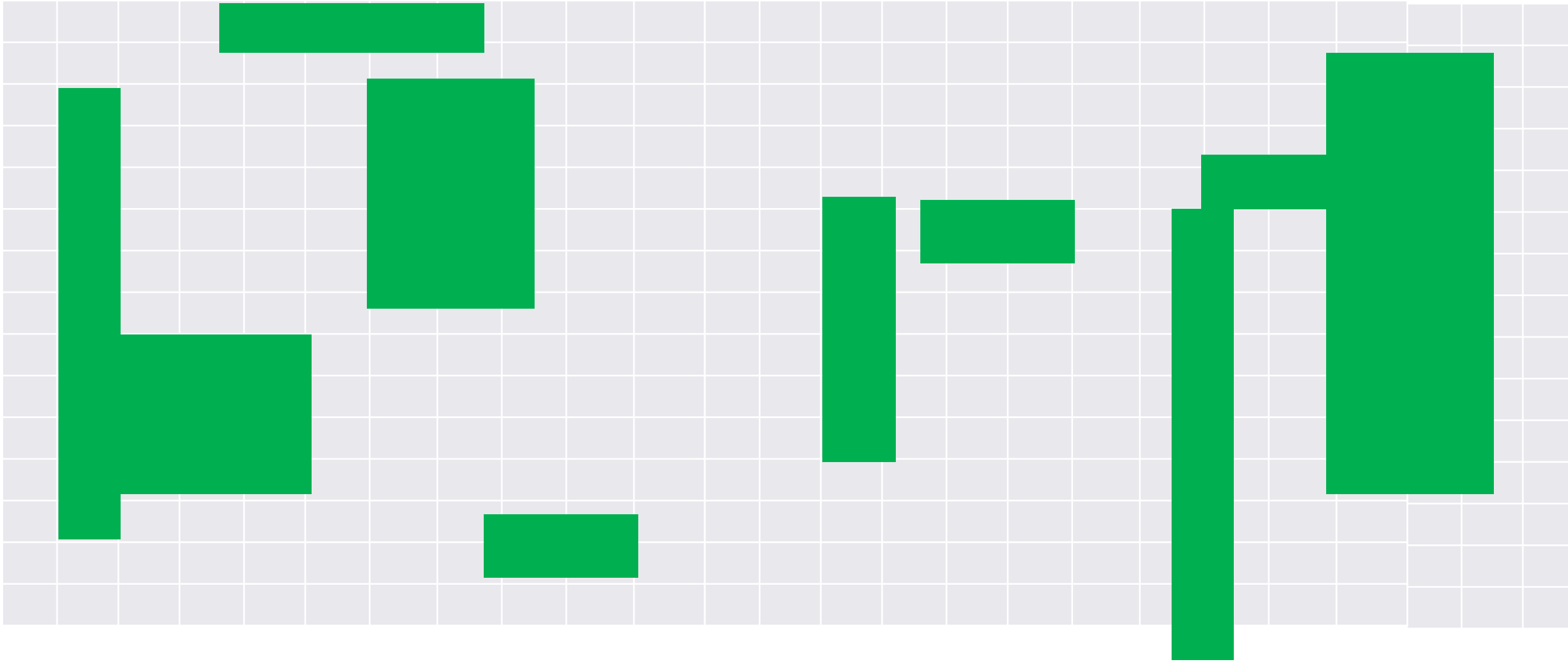
2021 August

Problem Formulation

- Given a set of n rectangles on 2D-plane and an integer k (1<=k<=n), output **exactly k rectilinear polygons** such that each rectangle is contained by one polygon.

- The result is evaluated by the total area of the polygons. The smaller of the total area of output polygons, the better.

Sample Test Case (10 Rectangles)



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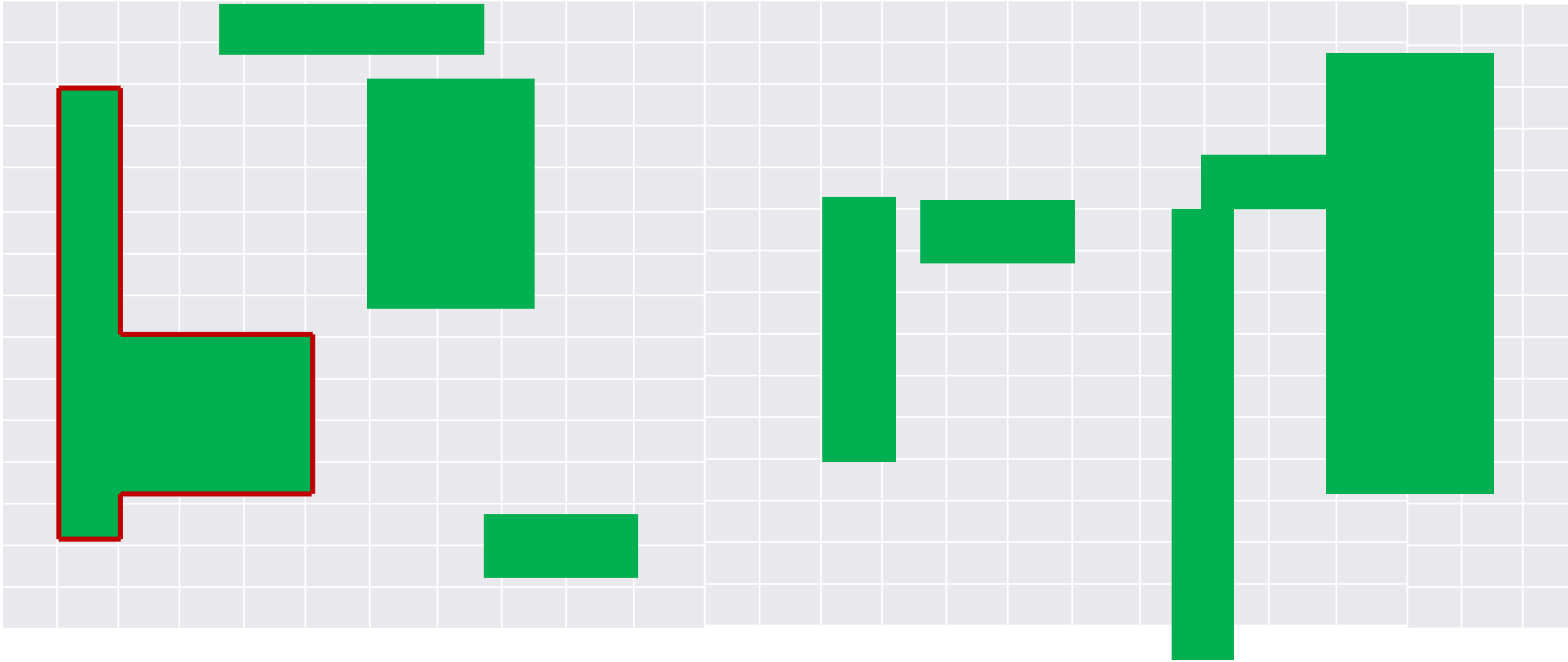
Sample Test Case (10 Rectangles)



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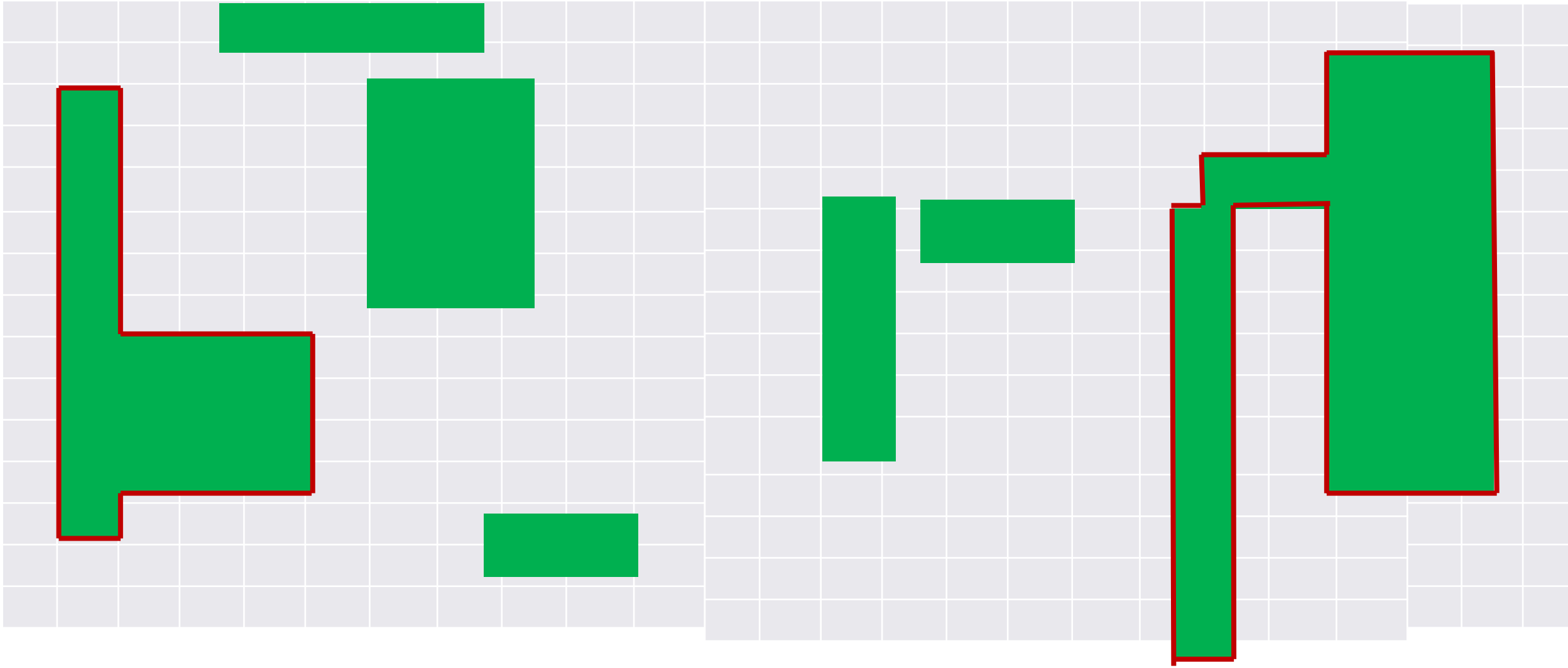
Sample Test Case (10 Rectangles, 7 disjoint polygons)



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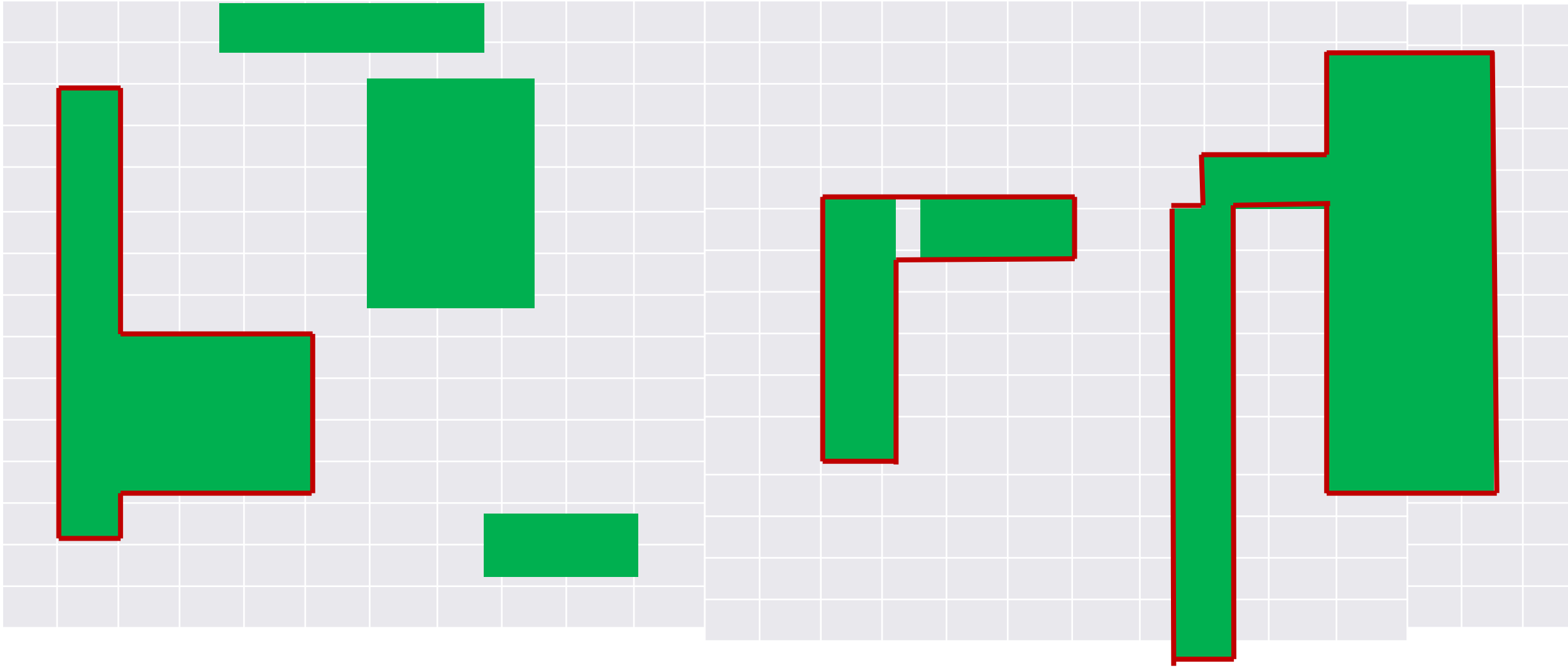
Sample Test Case (10 Rectangles, 6 disjoint polygons)



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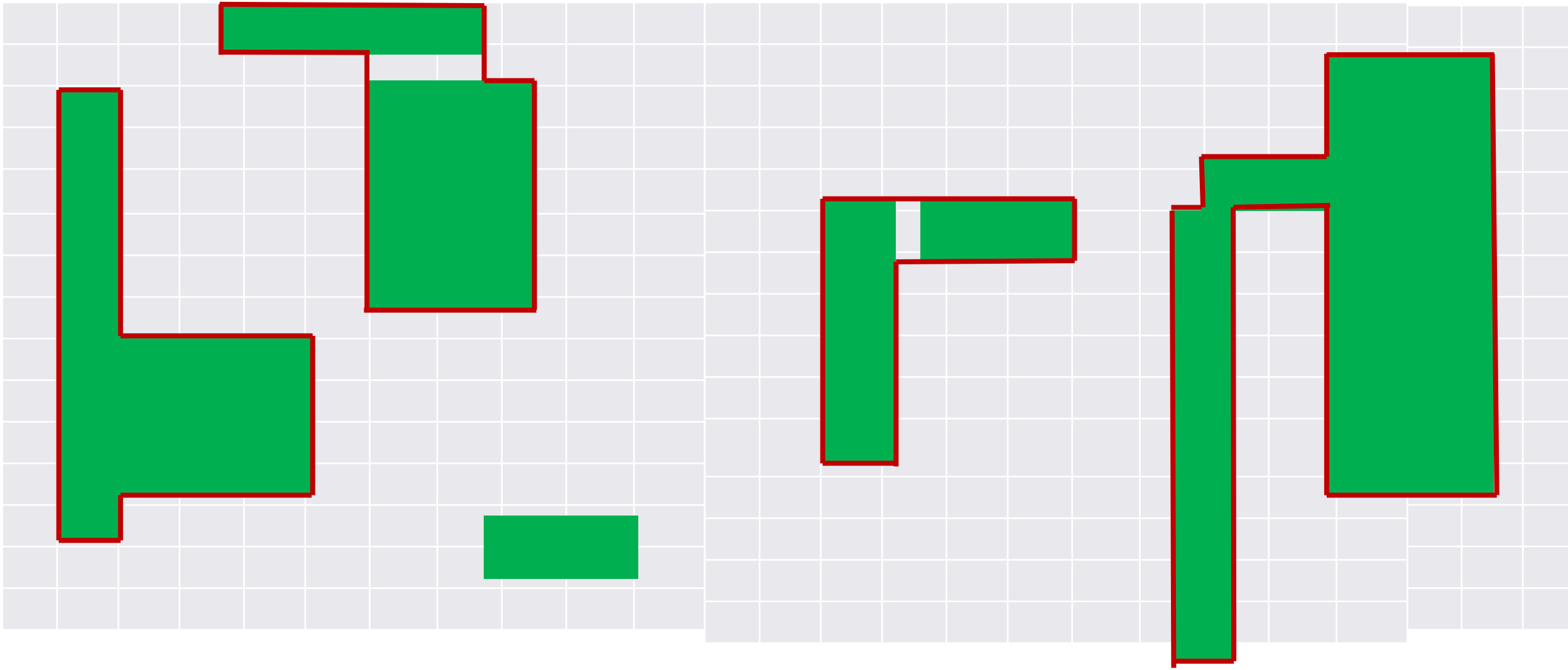
Sample Test Case (5 disjoint polygons)



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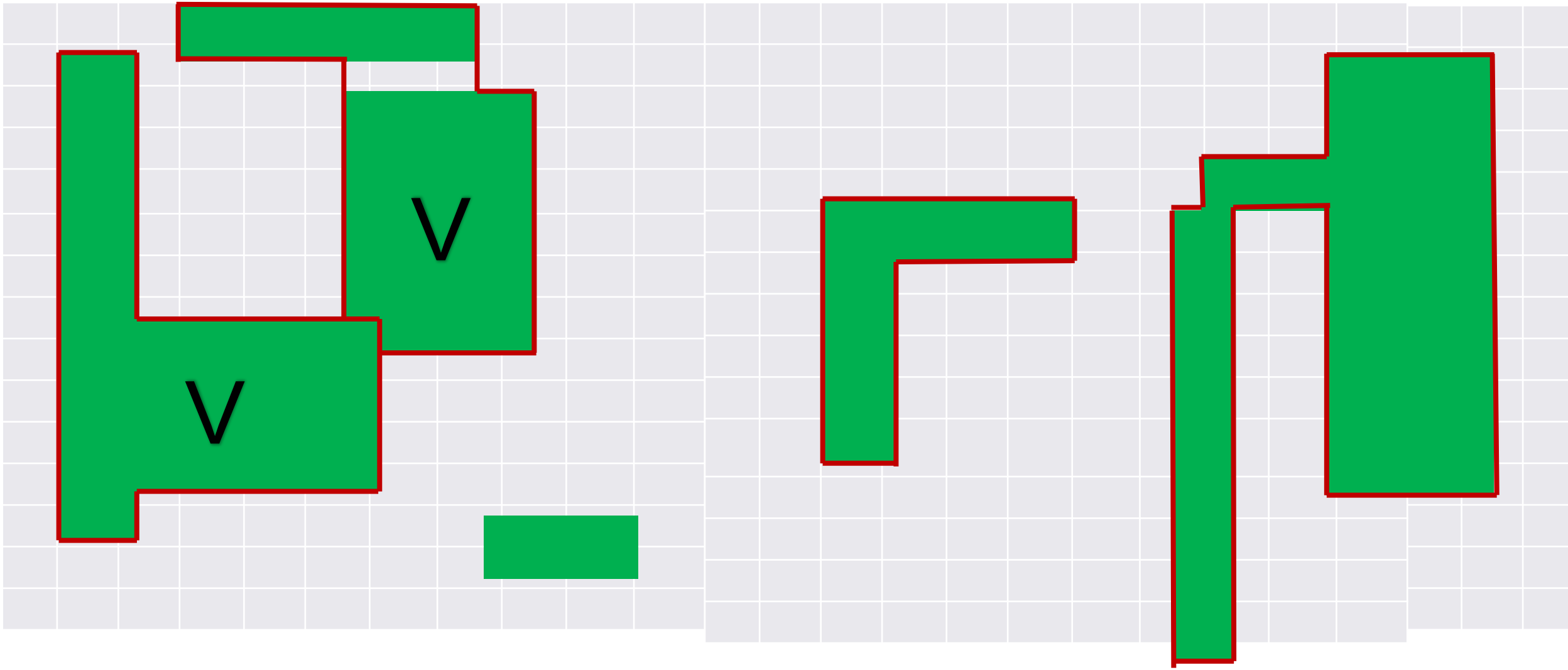
Sample Test Case (4 disjoint polygons ?)



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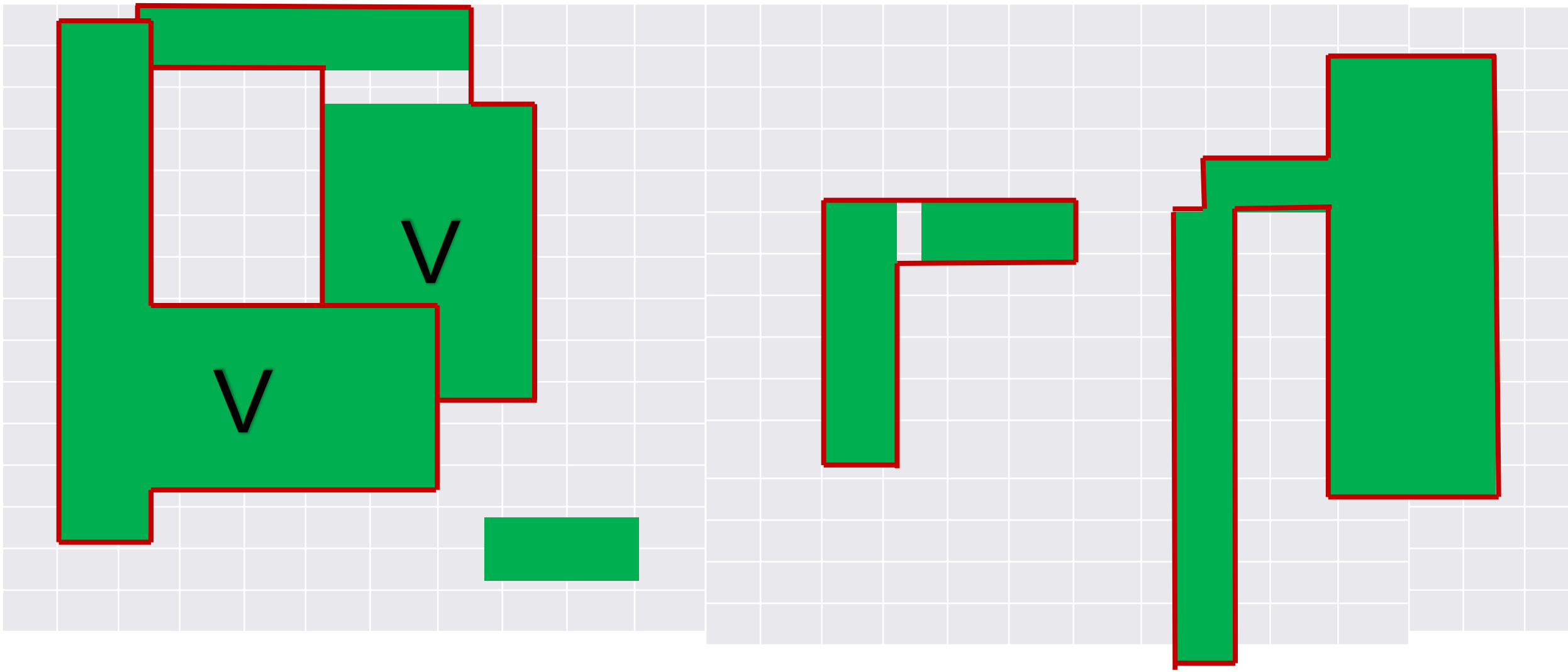
Sample Test Case (4 disjoint polygons ?)



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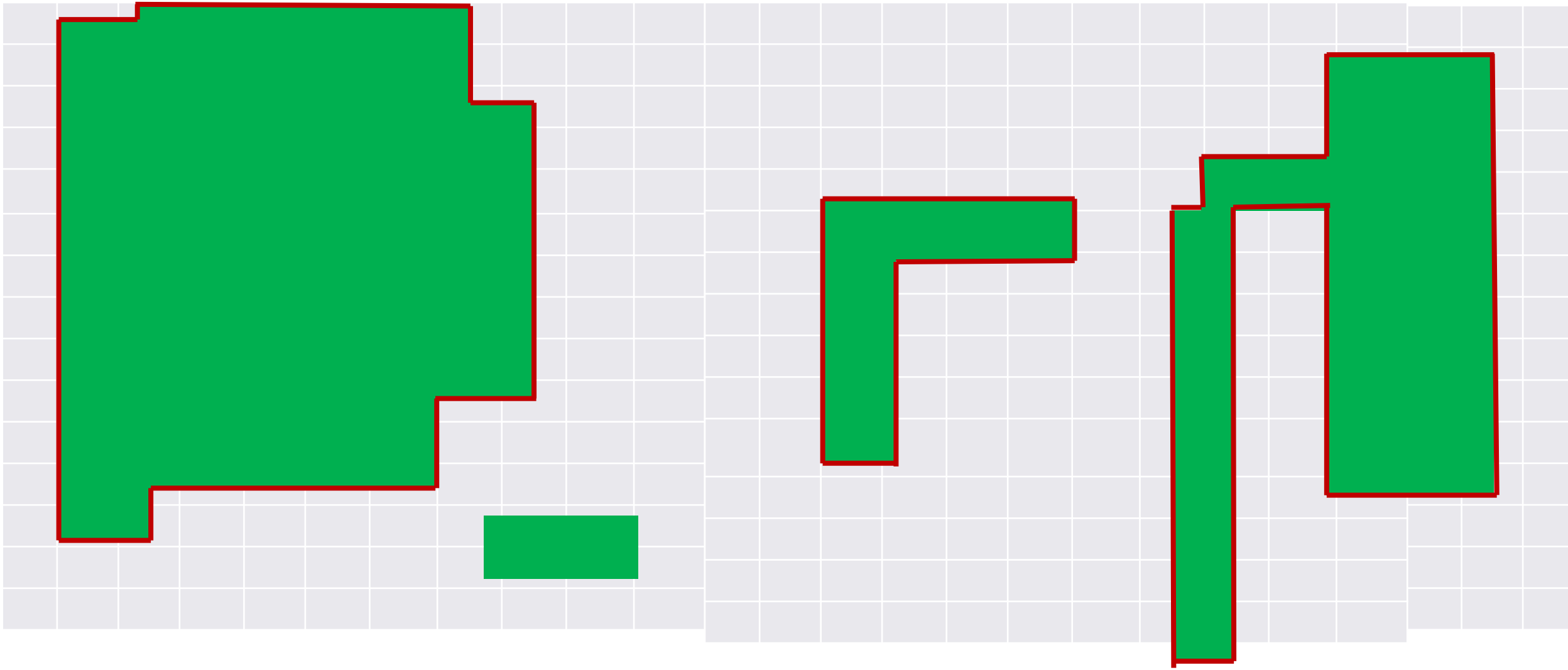
Sample Test Case (4 disjoint polygons ?)



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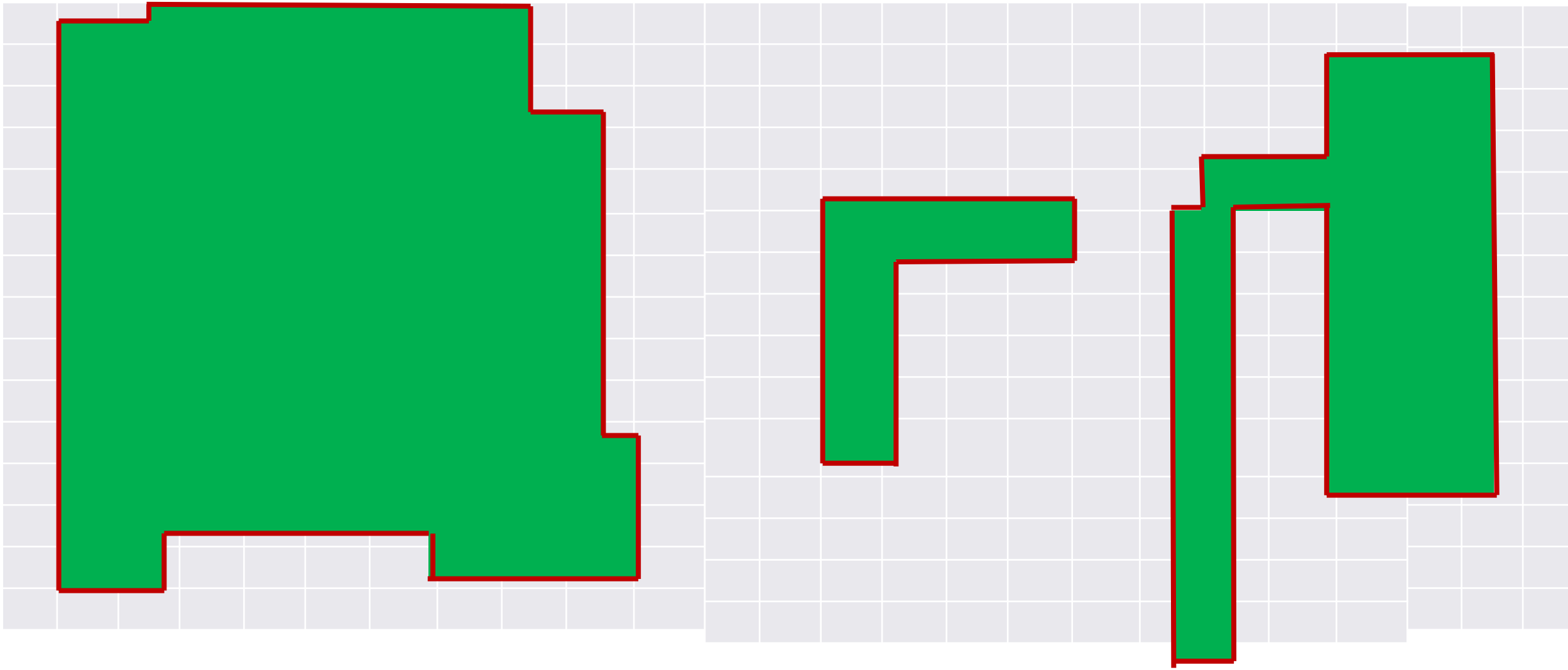
Sample Test Case (3 disjoint polygons ?)



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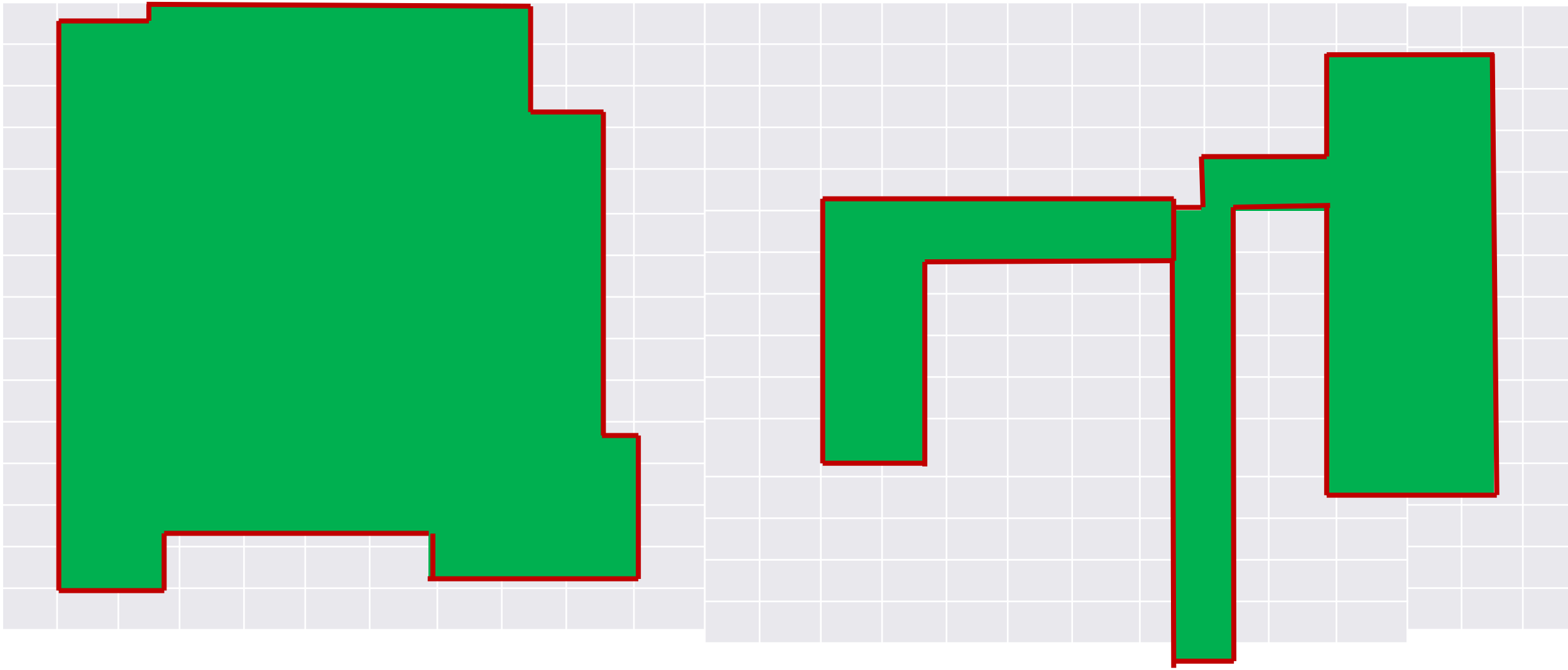
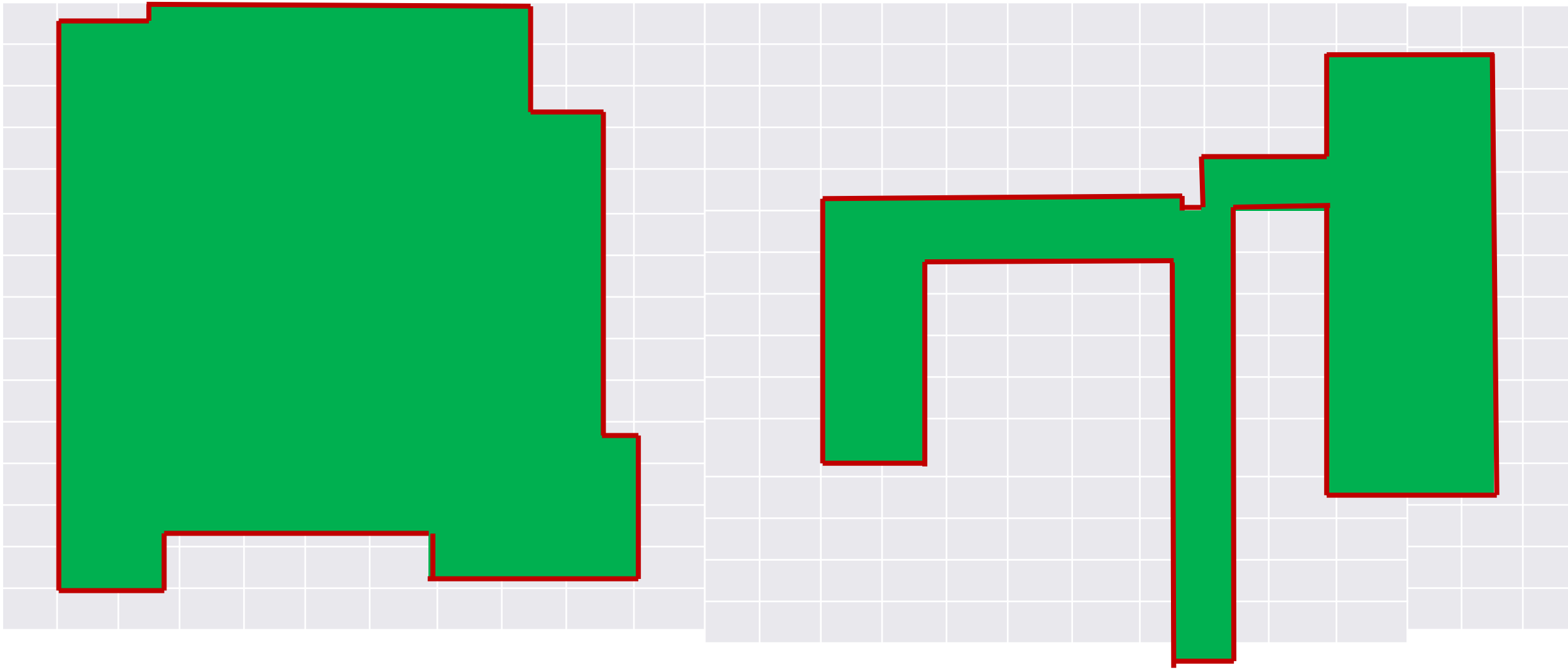
Sample Test Case (2 disjoint polygons ?)



Sample Test Case (2 disjoint polygons ?)



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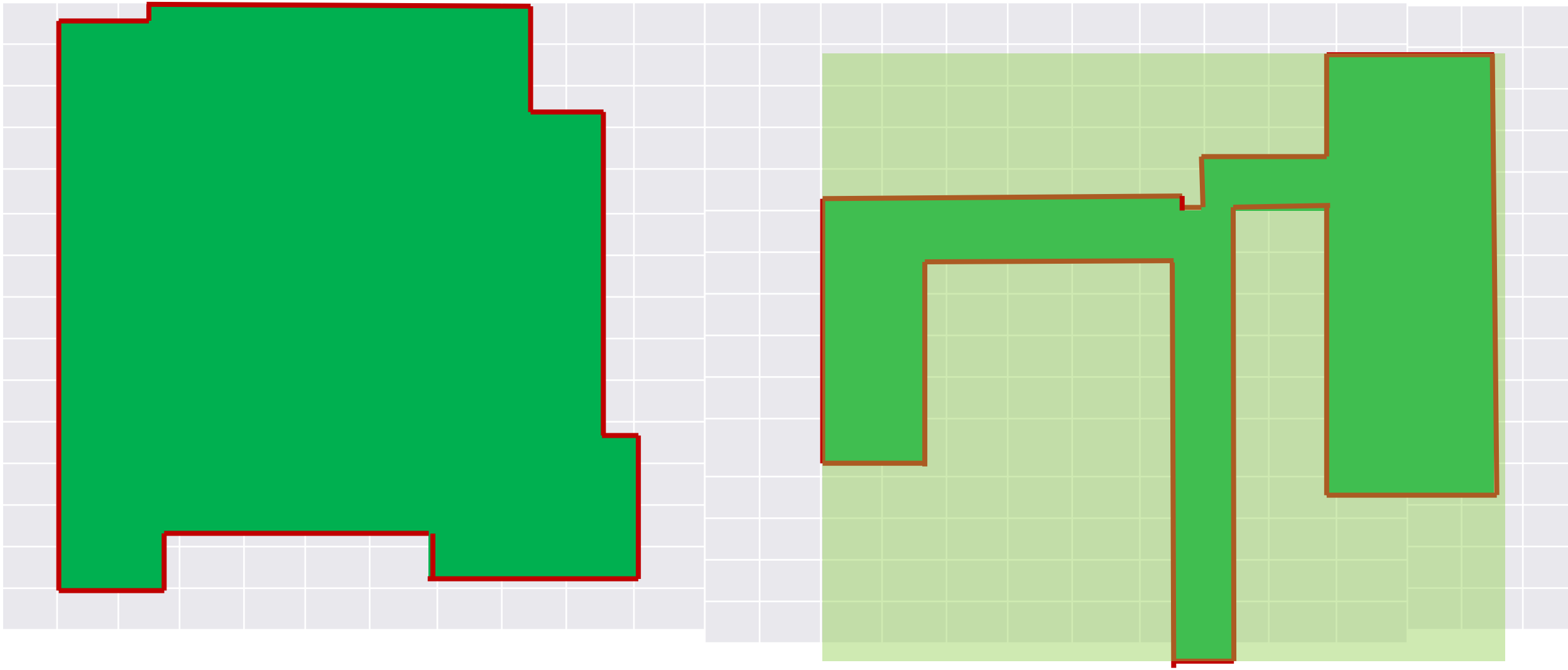
Sample Test Case (2 disjoint polygons ?)



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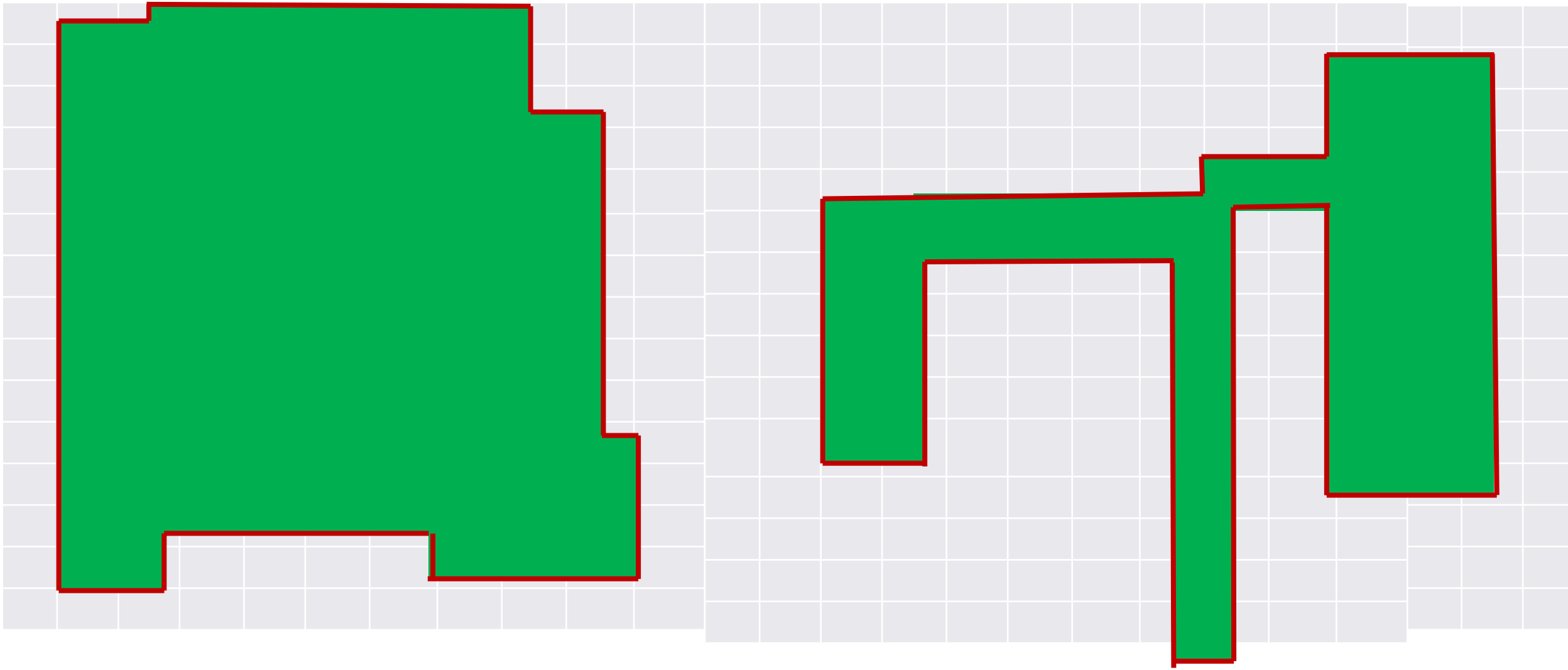
Sample Test Case (2 disjoint polygons)



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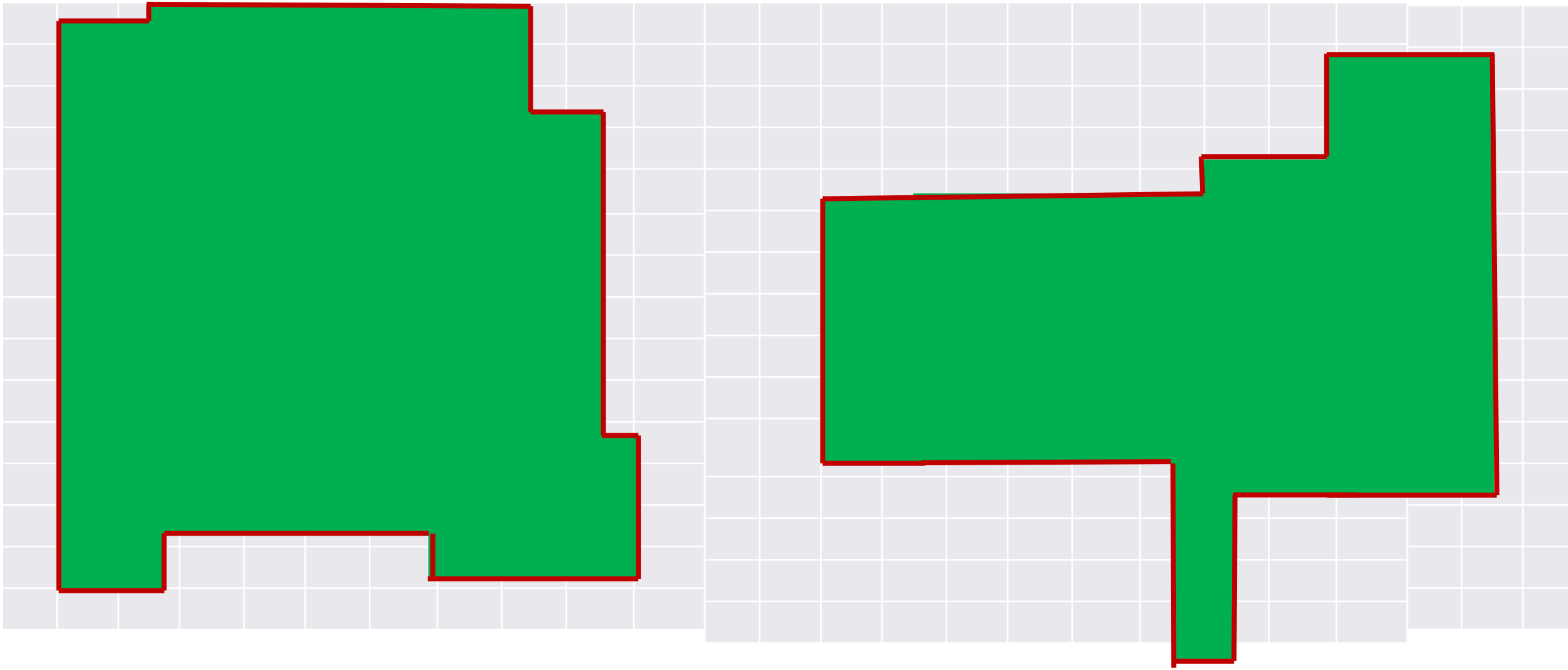
Sample Test Case (2 disjoint polygons)



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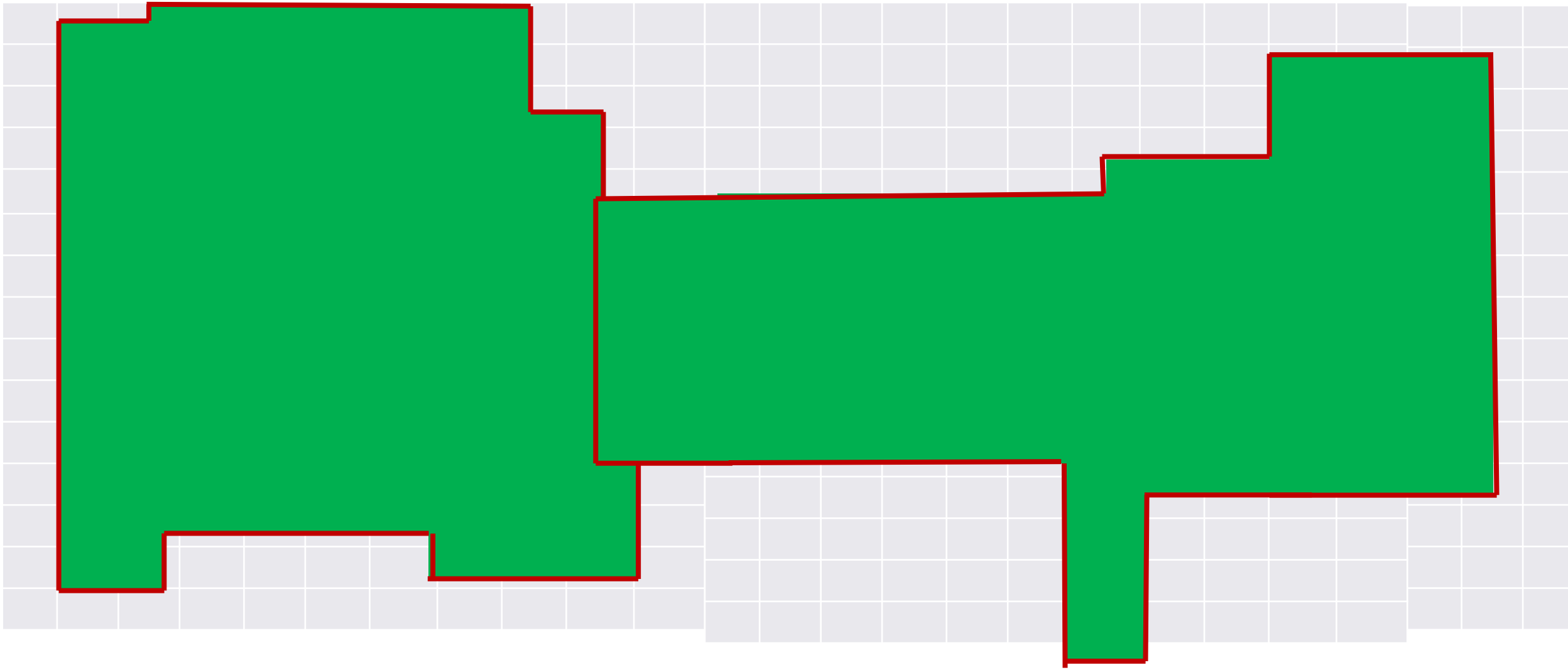
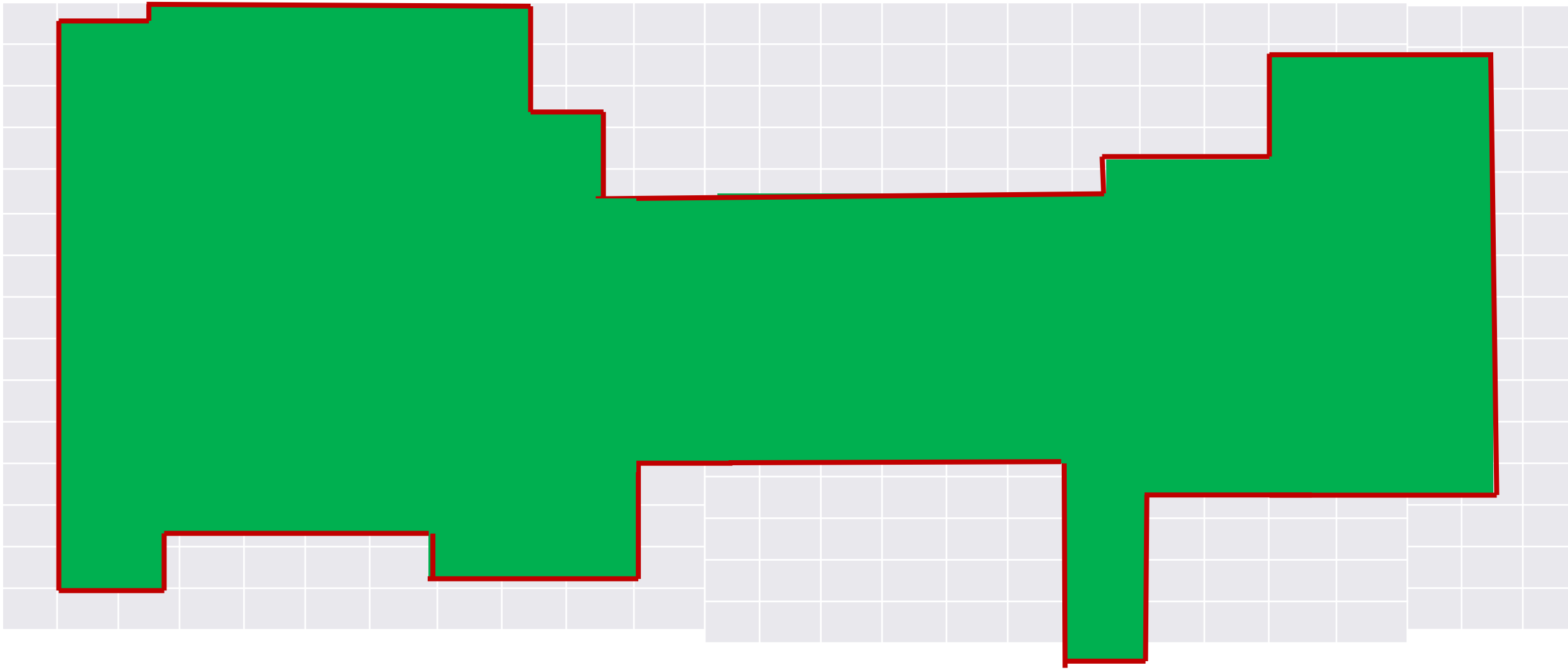
Sample Test Case (1 disjoint polygon)



Sample Test Case (1 polygon)



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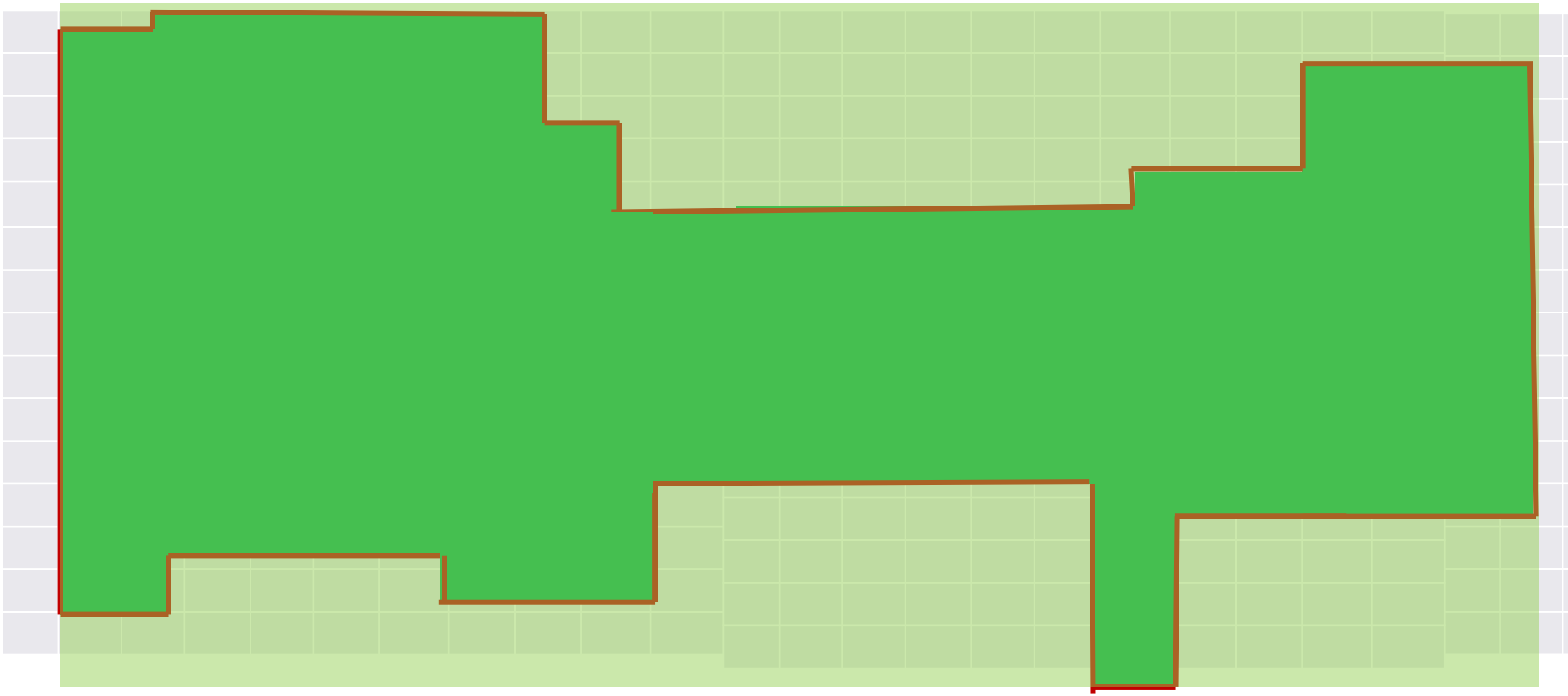
Sample Test Case (1 polygon)



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Motivation

- Simplify the problem
- Speed up the run time for the following application engine(s)
- Serve special requirement(s) from Foundry / Manufacture

Input format

1. First line: k (i.e. the number of output polygons)
2. Second line: n (i.e. the number of input rectangles)
3. From the third line to the end of the input file: Each line corresponds to a rectangle. Each rectangle is represented by a sequence of eight integers separated by space:

   x0, y0, x1, y1, x2, y2, x3, y3, where (x0, y0), (x1, y1), (x2, y2), (x3, y3) are the coordinates of the four corners of the rectangles in a clockwise order, and (x0, y0) is the left-bottom corner.

- In the testcase(s), the given rectangles will not have “point touch” scenario.
  That is, the input rectangles will be disjoint (separated) or at least
  line touch or with overlap area (larger than 0).

Input file example

```
1
10
27 48 27 49 28 49 28 48
21 23 21 24 22 24 22 23
32 26 32 27 35 27 35 26
24 30 24 38 25 38 25 30
9 43 9 47 10 47 10 43
14 18 14 29 17 29 17 18
32 43 32 44 35 44 35 43
66 33 66 36 67 36 67 33
15 47 15 48 17 48 17 47
42 43 42 44 44 44 44 43
```

the number of output polygons

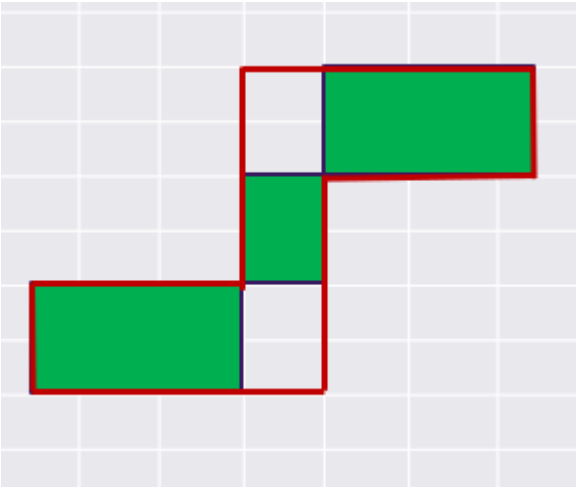
the number of input rectangles

Output format

- Each line corresponds to a polygon. Each polygon of m corners is represented by a sequence of 2m integers separated by space: x0, y0, x1, y1, ..., x_m-1, y_m-1, where (x0, y0), (x1, y1), ..., (x_m-1, y_m-1) are the coordinates of the n corners of the polygon in a clockwise order.

- For every polygon in the output file, evaluator will identify point touch or line crossing as an **illegal** polygon. Then, contestant will get no score for this kind of output.
- Each outputted rectilinear polygon can be either convex or concave, without a hole.

  A 凹 shape polygon is legal.



(Optional) The extended challenging problems

1) To find the largest number (K) of disjoint rectilinear polygons of given n rectangles; and output the ‘K’ non-overlapping rectilinear polygons.

– What is the complexity of your algorithm? Please analyze the algorithm.

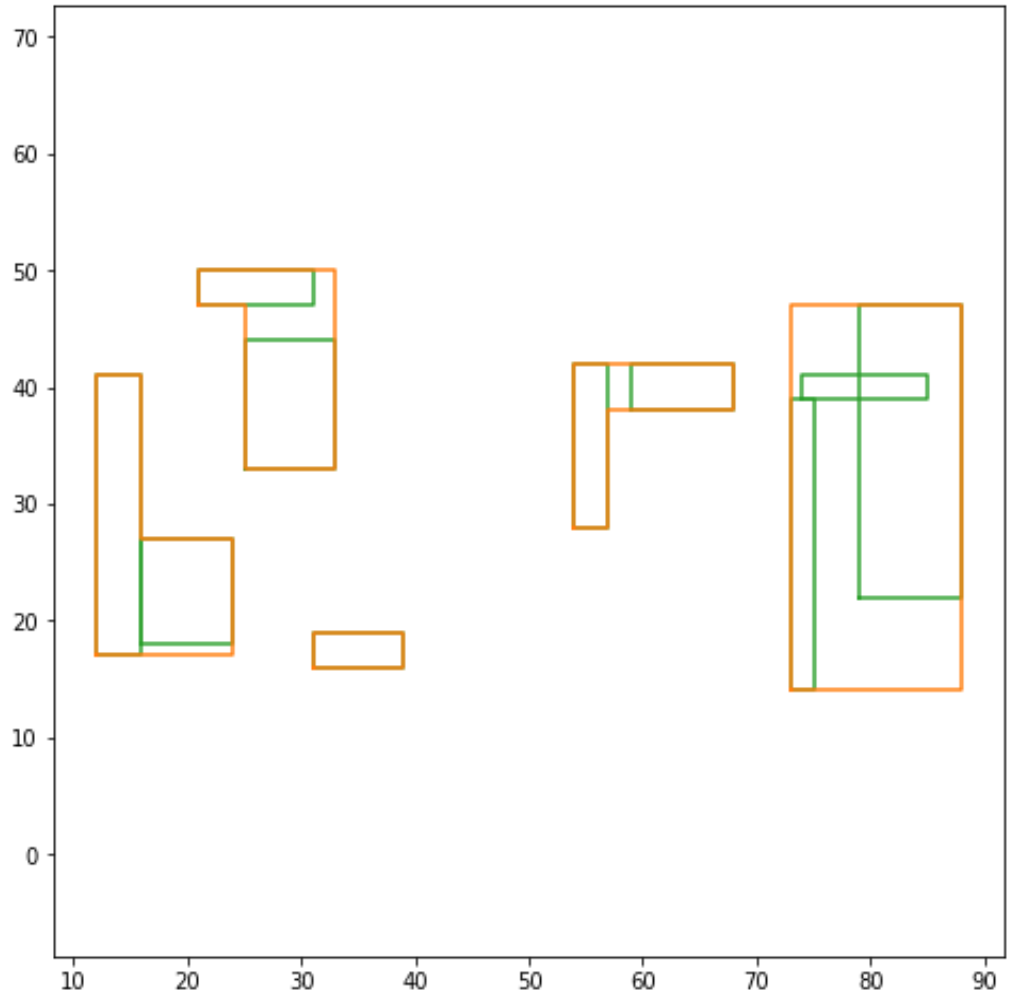
2) Develop a program which can output any k non-overlapping rectilinear polygons

for k = 1, 2, …, K; where K <= n.

GUI

- Debug in visualization
- Verification

display_result (‘input.txt', ’output.txt')



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Evaluation

- The output rectilinear polygons cover all input rectangles
- The smaller the total area of output polygons, the higher score
- 70% programing result
- 30% Oral presentation

➢ Evaluator

Specify the input file and output file name, the evaluator outputs the total area of the polygons for legal solutions.

As for illegal solutions, the evaluator outputs -1.

Test cases

- Public testcases: (5 mins)
  - 10 no overlapping rectangles (with space). k =1, 3, 5.
  - 10 rectangles (3 connected components). k =1, 3.
  - 100 overlapping rectangles. k = 1, 10, 20
  - 1000 nonoverlapping rectangles (with space). k = 1, 10, 20.

- Hidden testcases:

  Hidden Case 1: 100 rectangles, k = 1, 10, 20.

  Hidden Case 2: 1000 rectangles, k = 1, 10, 20.

Import

- Python package: https://pypi.org/project/Shapely/ (Version 3.0 and above)

- Geometry operations:
  - Grow
  - Shrink
  - Clean up the overlap
  - Find a contour of connected rectangles

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Thank You