

More Algorithms without Programming

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Poland

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The Objectives

- 1 Programming contests popularize computer science.
- 2 Programming might be too much for the first step.
- 3 We can first introduce algorithms, and programming afterwards.
- 4 Problems formulated as (mathematical) puzzles, solutions involve algorithmics.

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This is what I presented at IOI Conference in 2010.

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Then it was used at programming camps and popular introductory lectures

- computations kept at a strict minimum
- the solution to be obtained within just a few minutes
- tasks strongly related to programming competitions

Previous Work

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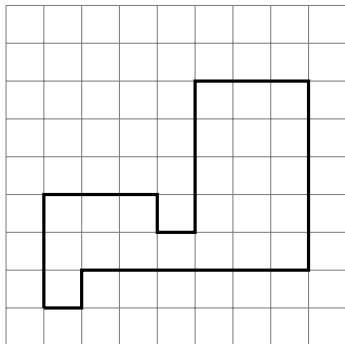
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- Computer Science Unplugged, Algorithms Unplugged

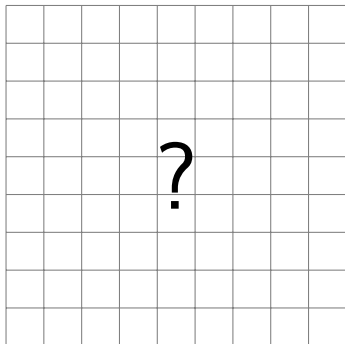
Example 1: Polygon

I own a parcel of a polygonal shape. It has **10** sides and its area equals **23**. All its sides are contained in grid lines. Each two consecutive sides are perpendicular.



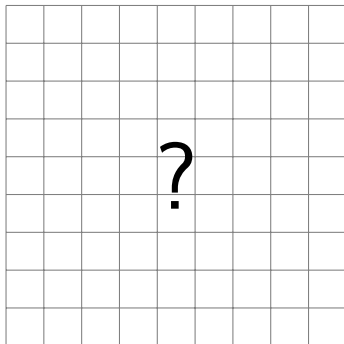
Example 1: Polygon

Can you draw a parcel with
8 sides and area **8**?



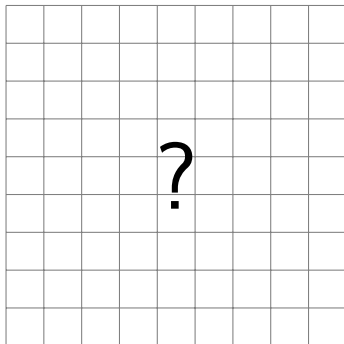
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Can you draw a parcel with
10 sides and area **10**?



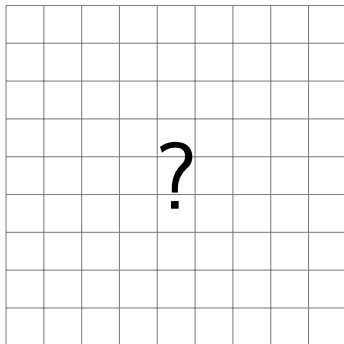
Example 1: Polygon

Can you draw a parcel with
12 sides and area **12**?



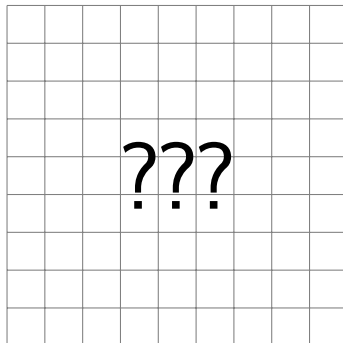
Example 1: Polygon

Can you draw a parcel with
14 sides and area **14**?

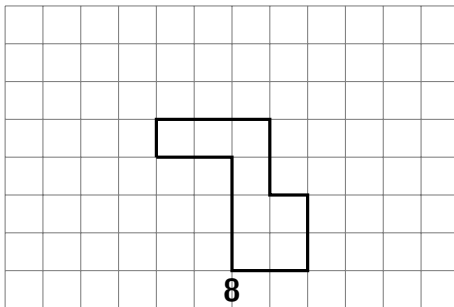


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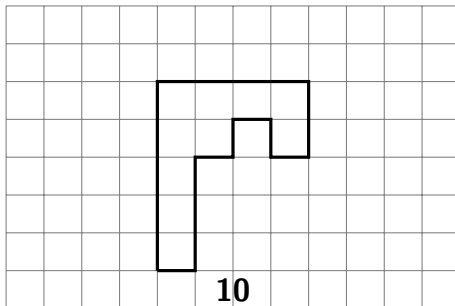
Can you draw a parcel with
13 sides and area **13**?



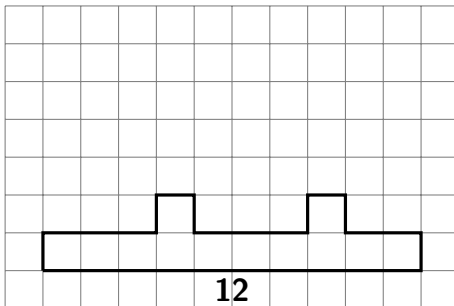
Polygon: Solutions



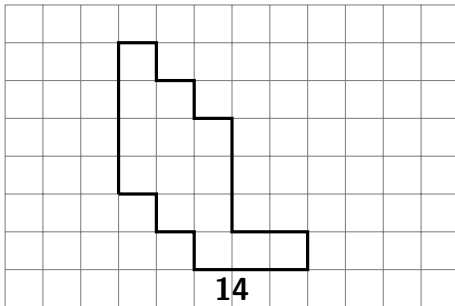
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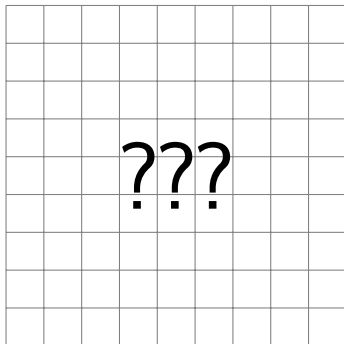


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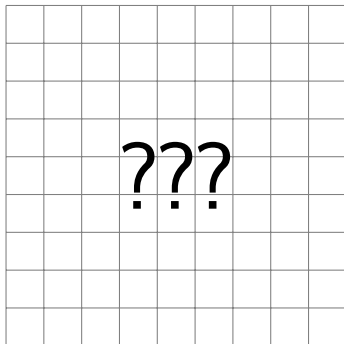
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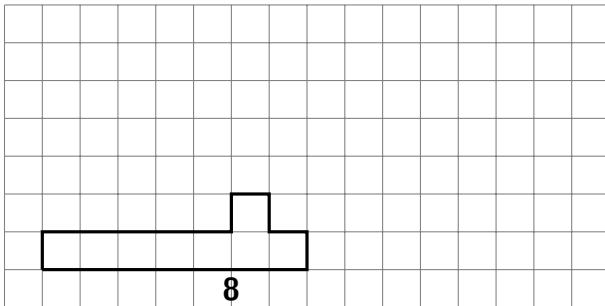


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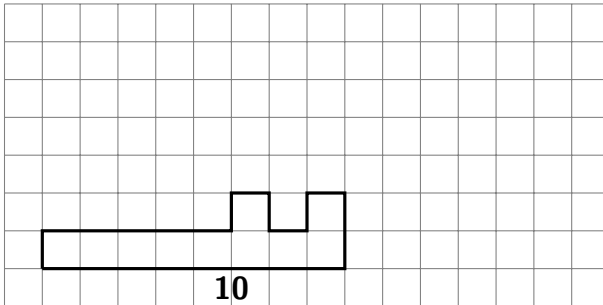
Can you draw a parcel with
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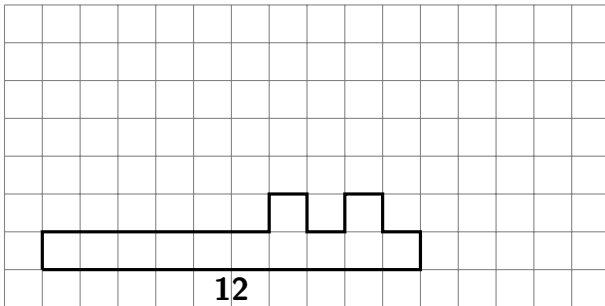
Polygon: Generic Solution



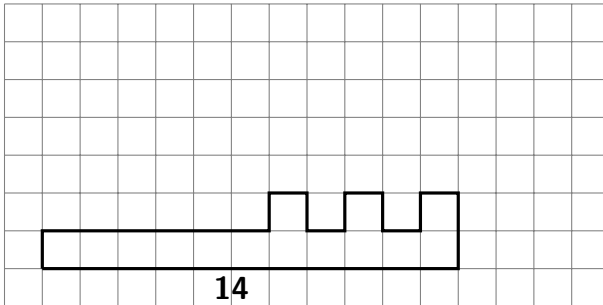
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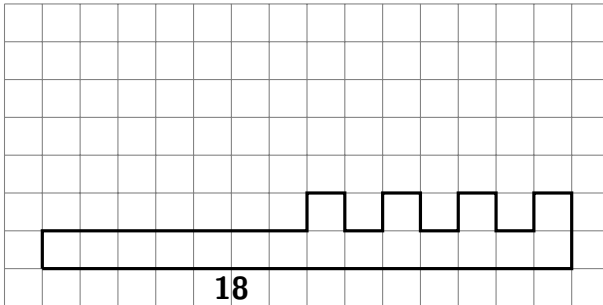
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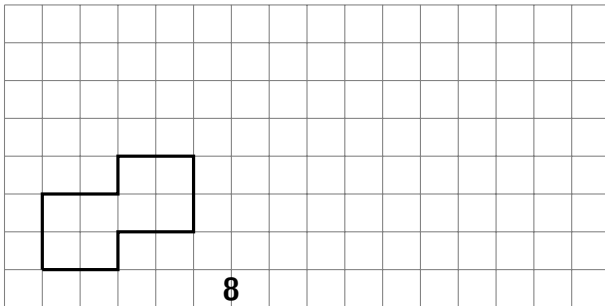
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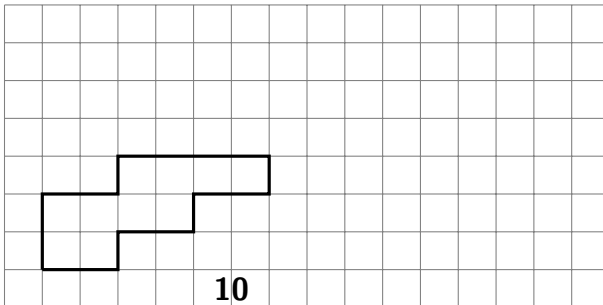
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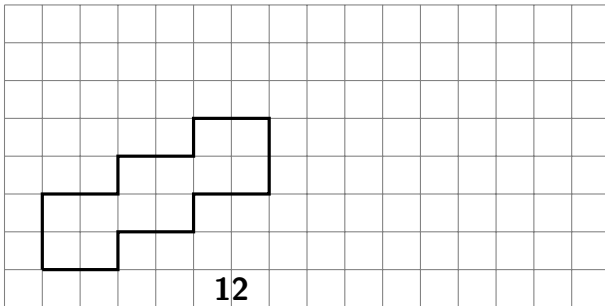
Polygon: Generic Solution Ver. 2



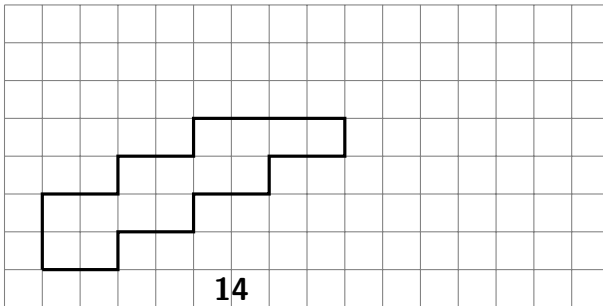
Polygon: Generic Solution Ver. 2



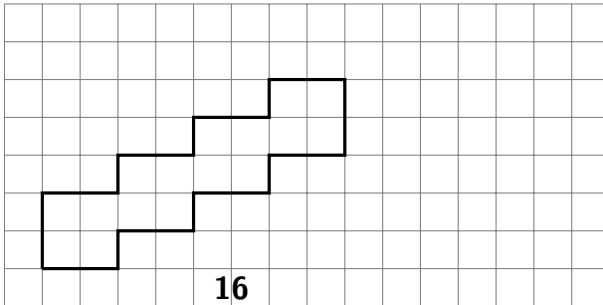
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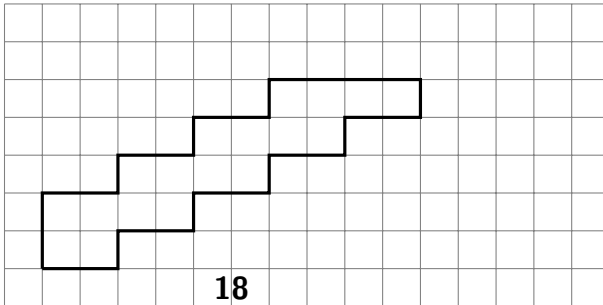
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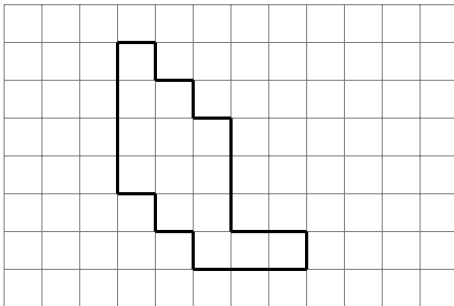


Polygon: No Solution for Odd Number

There is no polygon with **13** sides and area **13**.

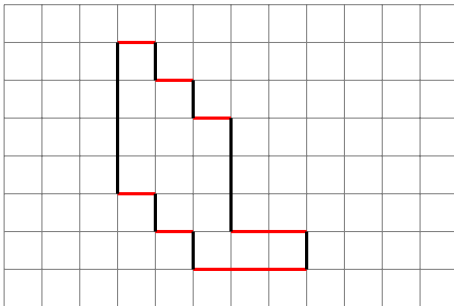
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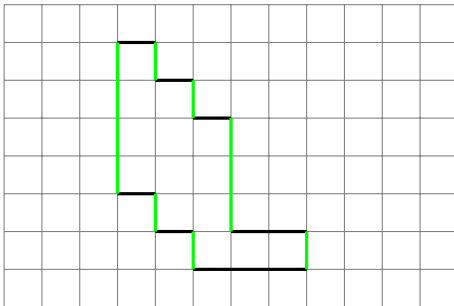
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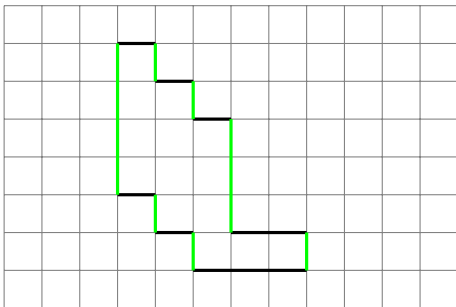
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All even-numbered sides must be vertical and all odd-numbered sides must be horizontal (or *vice versa*).

Polygon: Methodological Comments

- From **trial and error** to **algorithmic thinking**

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- From **intuitive arguments** to **rigorous argument**

Example 2: Palindromes

A palindrome is a word which reads the same from left to right and from right to left, e.g., **noon**, **radar**. Some words may be divided into **even**-length palindromes. For example, the word **aabbbaabbbaa** can be divided into 3 even-length palindromes:

$$\text{aabbbaabbbaa} = \text{aabbba} \mid \text{abba} \mid \text{aa}.$$

What is the smallest number of even-length palindromes in a division of the word:

aabbbaabaabaabbbb?

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Palindromes: Solution

aabbaabaabaabbbb

Palindromes: Solution

aabbbaa | baabaabbbb

Take the longest prefix being a palindrome of even length.

Palindromes: Solution

aabbbaa | baab | aabbbb

Take the longest prefix being a palindrome of even length.
Continue with the rest of the word.

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Continue with the rest of the word.

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However, 3 palindromes are sufficient:

aa | bbaabaabaabb | bb !

Palindromes: Solution

`aabbaabaabaabbbb = aa | bbaabaabaabb | bb`

`aaaaabbbaabbabbabbbb = aa | aaabbaaa | bbabbabb | bb`

`baabbbbaabaabaabbbbb = baab | bbbaabaabaabbb | bb`

`aabbaabaabaabbbbbbbb = aa | bbaabaabaabb | bbbbbbb`

Palindromes: Methodological Comments

- Correct trial and error is better than incorrect greedy.

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- Both presented tasks are based on tasks from actual programming competitions!

Conclusions

- 1 We have given an important application of non-programming tasks.
- 2 We have listed a number of characteristics of a task to fit well for this application.
- 3 We have presented in detail two examples of tasks which satisfy these requirements.

Thank you for your attention!