HKOI Training

$ami \sim wkc$

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Lecture 01
An introduction to problem solving and programming in C

Problem solving - Maths

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- Discover new properties, lemmas, theorems etc.

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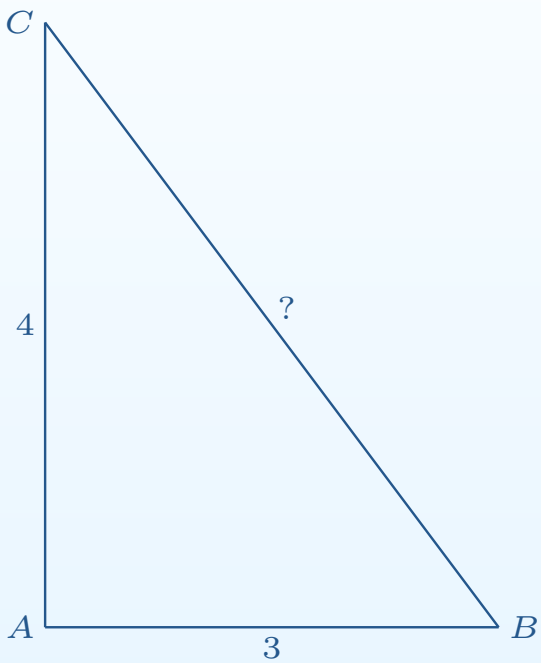
Example - Pythagoras theorem



Find BC if BC is an integer.

Find positive integer solutions to the equation $a^2 + b^2 = c^2$.

Is there any relation between the above two problems?

Theorem (Pythagoras). *If $a^2 + b^2 = c^2$, there is a right triangle with sides a,b,c.*

For each right triangle, sum of square of legs is equal to square of the hypotenuse.

In particular, if a right triangle has integer sides, the sides are a solution to the equation.

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Are they all possible? NO!

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Let's check all of them:

1. putting $b = 3, c = 4$ and $a = BC$, we have
   $BC^2 + 3^2 = 4^2 \iff BC^2 = 16 - 9 = 7 \implies BC = \sqrt{7}$ (?)

2. putting $b = 4, c = 3$ and $a = BC$, we have $BC^2 = -7$, impossible

$\vdots$

Finally, putting $a = 4, b = 3$ and $c = BC$, we have $BC^2 = 25 \implies BC = 5$.

We have the two possible values for BC, $\sqrt{7}$ and 5.

Since $\sqrt{7}$ is not an integer, BC must be 5.[1]

[1] "When you eliminate the impossible, whatever remains–however improbable–must be the truth."

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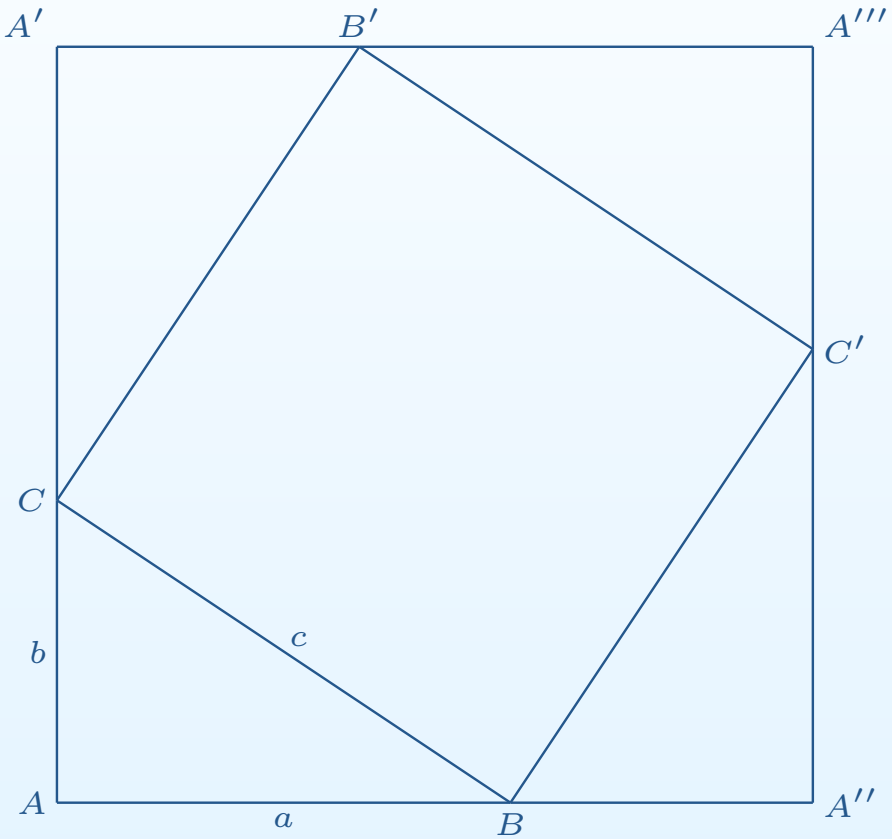

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Proof. Rotate the given right triangle to produce the figure.

Area of the whole figure is $(a+b)^2 = a^2 + 2ab + b^2$

On the other hand, it is the sum of area the smaller square and four triangles.

Area of $\triangle ABC$ is $\frac{1}{2}ab$, so does the other three triangles.

Area of the smaller square is c^2

Hence, $a^2 + 2ab + b^2 = 4\left(\frac{1}{2}ab\right) + c^2 \iff a^2 + b^2 = c^2$. □

Remainder/Modulus

Definition. *Let m, n be two integers with $n \neq 0$,*

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7. $n = 29929 = 173^2$

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Prime checking example, to check whether 1001 is a prime.

1. Set $z = 1$ at first,
2. Starting from 2 to 1000 : if a number divide 1001, change z to 0.
3. If z is 1 then 1001 is a prime, otherwise it is a composite.

Computer can follow the above instruction and do each step one by one repeatedly.

Programming in C

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For those who interested finding square root without calculator, read wiki page

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Programming Language - Computer’s language

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Syntax is the term for Programming Languages' grammar rules and punctuation marks.

C Syntax - Arithmetic

Addition	+
Subtraction	-
Multiplication	*
Quotient	/
Modulus	%
Open Bracket	(
Close Bracket	)

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Therefore, we need to be strict in the rules that first multiplication then addition.

End