The Mathematician

November copy!

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What is the Pythagorean Theorem?

The Pythagorean theorem is that, in the image 1.1, $A^2 + B^2 = C^2$.

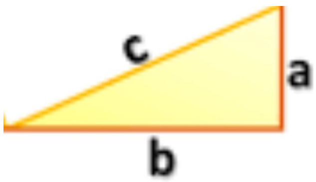

Image 1.1

In order to understand the proof, here are some helpful points:

1. Something^2 is something squared, or something times itself.
2. The triangle above is a right triangle, which means that one of its angles measures 90 degrees.
3. To find the area of a triangle is it's (base * height) /2. In the image above, the area would be (A * B)/2.

The area of the square is calculated by squaring the side.

Now that we got the boring stuff out of the way, how do we actually prove the theorem? Well, look at image 1.2, and see if you can find out.

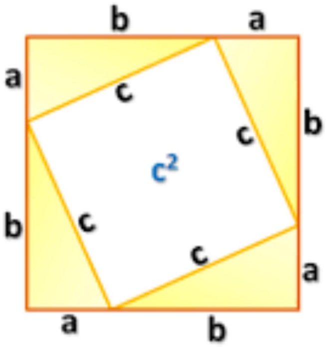

Image 1.2

Did you get it? Well, here is how it works:
The pieces in the previous image can be turned into this:

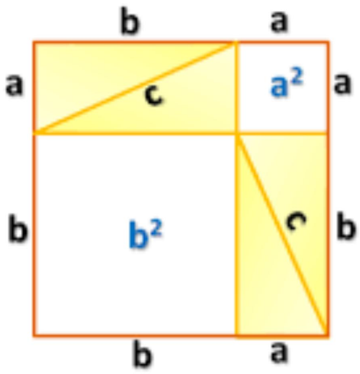

Image 1.3

If you can't see how that worked, draw the image down on paper and try then, or come to the math club on the brown tables for a thorough explanation.
As you can see, the white and shaded areas remain the same, but can now be represented differently. The white part can be represented by C^2 in the image 1.2 and by $A^2 + B^2$ in the image 1.3. So, as the two values are the same, we get $A^2 + B^2 = C^2$. That is how to prove the Pythagorean Theorem.

So we've discovered the Pythagorean Theorem and how to prove it, but how was it found?

Well, a certain Pythagoras of Samos (570-495 B.C.) made the Pythagorean Theorem. It is said that Pythagoras discovered "his theorem" in a palace hall. He studied the stone square tiles when he was bored and imagined right triangles within the tiling. He recognized that the area of the squares on the side lengths were equal to the square on the hypotenuse. From this observation he believed that the same would be true for right triangles of unequal side lengths. Sometime after this experience, he arrived at the proof of his theorem by the deductive method. The following image 1.4 is an example of what the Pythagorean Theorem looks like within square tiles. Although it may not be exactly what Pythagoras saw, this visual depiction gives an idea of how the Pythagorean Theorem can be represented within square tiling.

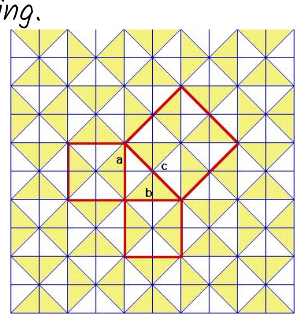

Image 1.4

Primes and Composites

Have you ever heard of prime numbers and composite numbers? These are special types of numbers! We are going to explore them today.

First of all, what are these numbers? Well, a prime number is a number that only has 2 factors: 1 and the number itself. A composite number has more than 2 factors. Let's say we want to find weather 10 is prime or composite. First, we find all of ten's factors. A number divided by its factors never produces a remainder. For example, 10÷2 has no remainder(10÷2=5), so 2 is a factor of 10. Using this method, we can find that 10's factors are 1, 2, 5, and 10. Because 10 has 4 factors, 10 is not prime, but composite.

So that is one way to find primes. However, that is a method that takes a long time. For example, imagine you want to find whether 103 is prime. Using the method above, we would have to try every single number from 1 to 103. That is 103 numbers! That would take a long time There must be a better way. And there is a better way.

Basically, we can notice a fact. We know that 2 is a factor of 4. So, every multiple of 4 must also be a multiple of 2, and every number that has 4 as a factor must have 2 as a factor too. For example, let's try the number 20. 20÷4 is 5 with no remainder, so 4 is a factor of 20. 20÷2 is 10 with no remainder, too, so 4 and 2 are factors of 20.

You can try more numbers, and you will come to the same conclusion: any multiple of 4 is a multiple of 2, and anything that isn't a multiple of 2 isn't a multiple of 4 either. We can extend that. Any multiple of 'x'(x is a variable, so x can represent any number.) must share all it's multiples with x. For example, suppose x is 3. Then, a multiple of x would be 6, and every multiple of 6 is indeed a multiple of 3. Knowing this, why do we have to test 4 if we can test just test 2? Why do we have to test 33 if we can just test 3? Well, we don't. We know that testing by a multiple of something is useless, so we only need to test the numbers that aren't multiples of anything but themselves. These numbers are primes, so we only test primes. A method that uses this fact to find primes is the Sieve of Eratosthenes:

We start with a grid with the numbers from 2-100, like Image 2.1:

	2	3	4	5	6	7	8	9	10
11	12	13	14	15	16	17	18	19	20
21	22	23	24	25	26	27	28	29	30
31	32	33	34	35	36	37	38	39	40
41	42	43	44	45	46	47	48	49	50
51	52	53	54	55	56	57	58	59	60
61	62	63	64	65	66	67	68	69	70
71	72	73	74	75	76	77	78	79	80
81	82	83	84	85	86	87	88	89	90
91	91	93	94	95	96	97	98	99	100

Image 2.1

We start testing with the smallest prime, 2. Since 2 is a prime, we circle 2, then highlight all the multiples of two, because they are all composites.

In Image 2.2, all the multiples of 2 are in light red, and 2 is circled and highlighted in dark red.

	2	3	4	5	6	7	8	9	10
11	12	13	14	15	16	17	18	19	20
21	22	23	24	25	26	27	28	29	30
31	32	33	34	35	36	37	38	39	40
41	42	43	44	45	46	47	48	49	50
51	52	53	54	55	56	57	58	59	60
61	62	63	64	65	66	67	68	69	70
71	72	73	74	75	76	77	78	79	80
81	82	83	84	85	86	87	88	89	90
91	92	93	94	95	96	97	98	99	100

Image 2.2

Next, we try the next smallest prime—3.

	2	3	4	5	6	7	8	9	10
11	12	13	14	15	16	17	18	19	20
21	22	23	24	25	26	27	28	29	30
31	32	33	34	35	36	37	38	39	40
41	42	43	44	45	46	47	48	49	50
51	52	53	54	55	56	57	58	59	60
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91	92	93	94	95	96	97	98	99	100

Image 2.3

We continue this process until we reach the greatest prime. Then, we will know all the primes below 100. Do this yourself! How many primes are below 100, and what are they? Come to the math club to find out, or figure out on your own!

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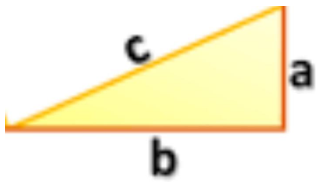

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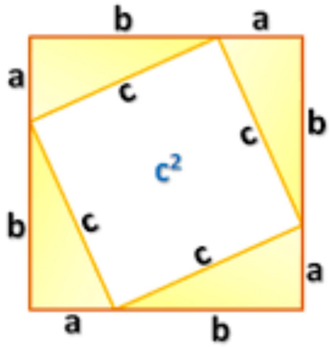

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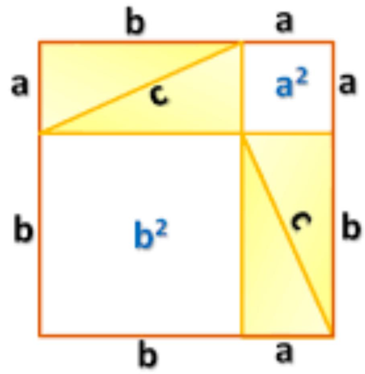

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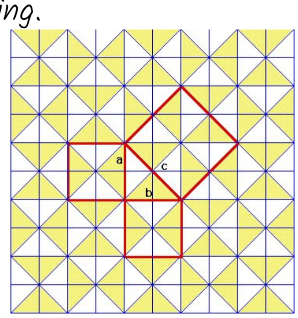

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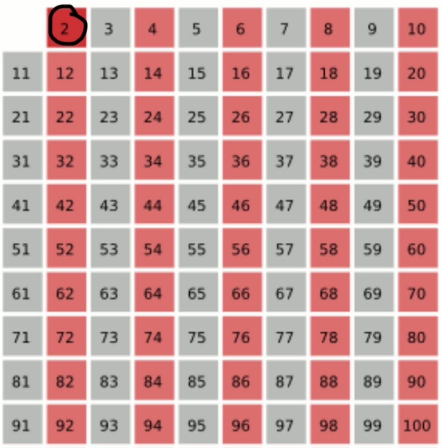

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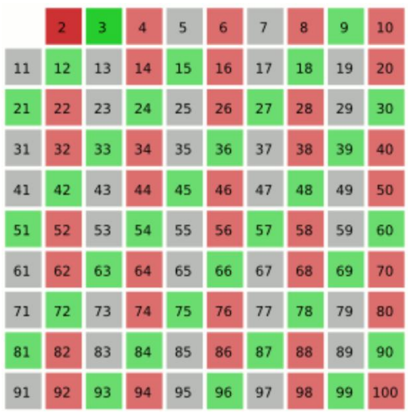

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Game Time!

Today's game is Sudoku! You probably have heard of this game before, but, here are the rules: The 9×9 square, which is the game board) must be filled in with numbers from 1-9 with no repeated numbers in each line, horizontally or vertically. To challenge you more, there are 3×3 squares marked out in the grid, and each of these squares can't have any repeat numbers either. Today's puzzle is below: First, try it yourself. If you need help, or want to check your answers, the solution is in next month's article. In addition, we are talking about sudoku strategies in math club on one of the meetings.

5	3			7				
6			1	9	5			
	9	8					6	
8				6				3
4			8		3			1
7				2				6
	6					2	8	
			4	1	9			5
				8			7	9

Thank you to https://jump.dev/JuMP.jl/stable/tutorials/linear/sudoku/ for the sudoku puzzles. The website was demonstrating how to find the answer to any sudoku using code. Feel free to check it out.

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So what is the club behind all of this? Well, the math club. Math club is a club where people who care about math come together to discuss math topics. We meet every Friday and Wednesday, at the brown tables near the basketball court. Every Friday and Wednesday, we have a meeting about a math topic. Various discussion topics are:

- ➢ *Sudoku strategies*
- ➢ *How is math used in everyday life?*
- ➢ *How do we calculate squares in our head?*
- ➢ *Ultimate-Tic-Tac-Toe*
- ➢ *Paradoxes*
- ➢ *What is Phi?*
- ➢ *What is pi?*

These topics are discussions and not lectures. We will respect everyone's opinions and discuss as a group. Feel free to announce your opinions. In addition, if you have a question on anything in this article, you can ask Brooks Wang.

About the Author

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