

AlgoHack #3



COMPUTING OPERATIONS

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AlgoHack aims to teach Computer Science and Programming to young people, initiated by Shilpa Sayura Foundation, supported by GOOGLE RISE and Computer Society of Sri Lanka.

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What is an operation?

How do you get 3 from 1 and 2?

$1+2=3$ is a simple adding.

How do you get 1 from 3 and 2?

We have to subtract 2 from 3.

Here, adding and subtracting are operations.

Order of operations

Look at following **expression**. It has two operations.

What is the value of x ?

$$x = 2 + 3 \times 2$$

If we calculate from left to right,

we get $2+3$ as 5 from first operation

Then we get $x=10$ from 5×2 .

What if we calculate from right?

The first operation 3×2 is 6

The second operation $6 + 2$ gives $x = 8$.

What is the correct answer ? 10 or 8.

In math and programming, we have a rule call **order of operations**. When there are several operations in one expression, we want to know which one we do first?

The method is like this.

First Step : **Group symbols** with parenthesis ()

Second Step : Do **Multiplications**, if any

Third Step: Do **Divisions**, if any

Fourth Step : Do **Additions**, if any

Fifth Step : Do **Subtractions**, if any

Using order of operations.

What is the total cost of buying 5 toffees at Rs. 2 and 3 Chocolates at Rs. 4 ?

$$\text{Total} = 5 \times 2 + 3 \times 4$$

We have two multiplications and one adding operation.

The computer does one operation at a time.

We have to group operations.

() tell the computer to separate operations.

$$\text{Total} = ((5 \times 2) + (3 \times 4))$$

We do multiplications first from left to right.

$$\text{First Operation } 5 \times 2 = 10$$

$$\text{Second Operation } 3 \times 4 = 12$$

$$\text{Third Operation is } 10 + 12 = 22$$

How about $12 / 3 + 5 \times 2 - 4$ expression ?

Here we continue moving from left to right and search for multiplications, divisions, adding and subtractions and group them step by step.

$$\text{Total} = 12/3 + (5 \times 2) - 4$$

$$\text{Total} = (12/3) + (5 \times 2) - 4$$

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$$\text{Total} = (((12 / 3) + (5 \times 2)) - 4)$$

Now it's easy to do operations.

First do inner most operations.

Remove () after operation.

$$\text{Total} = ((4 + 10) - 4)$$

$$\text{Total} = (14 - 4)$$

$$\text{Total} = 10$$

Do these computations

$$a = 2 - 4 + 4 \quad b = 4 \times 6 - 2 \quad c = 5 + 3 \times 7 - 4$$

$$d = 4 - 3 + 6 / 2 \quad e = 6 \times 2 + (8 / 4) \quad f = (5 + 3) \times 7 - 4$$

Hint : Group operations first, then , Multiply and divide from left to right. Add and subtract from left to right.

Calculate result for expression result= a - b + c

a	b	c	result
4	2	1	
2	4	2	
2	4	3	

Calculate result for expression result= a x b - c +d

a	b	c	d	result
4	2	6	2	
6	2	4	2	
2	2	6	1	

Why some numbers result negative values like -1 ?

Negative Numbers

A negative number is a **number smaller than zero**.

Zero mean that there is no value.

Think the ground you are standing is zero.

How tall you are from ground ?

That is a positive number.

Now you want to dig a hole to go to Afghanistan.

You dig 2 meters into the ground from zero.

That is a negative number like -2.

Because it is 2m below from zero level.

If you climb to your desk

you will be taller than before from zero.

Do you know place where temperatures below freezing.

Elevators go above and below ground level,

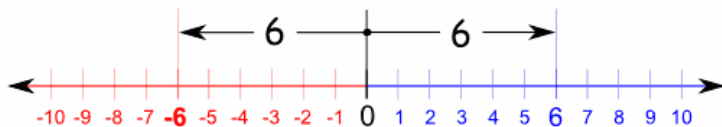
You can walking forward and backward from a point.

Negative numbers are opposites of positive numbers starting from 1 2 3 ...50.

Zero is neither positive nor negative.

Negative numbers are always written with a negative sign, but positive numbers may be written without a positive sign.

Following is a number line.



Here we can see that the numbers to the left from zero are negative and numbers to the right from zero are positive.

A monkey starts at 0 of the number line.

Monkey jumps 5 steps forward.

Monkey jumps 3 backward.

Monkey jumps 3 backward.

Monkey jumps 3 backward.

What is the position of monkey after each step ?

1	2	3	4	5

Let us play a game.

Draw a long line.

Mark it with with 0 to 25 numbers on the right

Mark it with with 0 to 25 numbers on the left

Toss a dice to get a number between 1-6.

Then toss a coin to get head or tail.

If you get a head you move forward (positive)

If you get a tail you move backward (negative)

How many tosses you needed to go over 25.

Do this game with a friend.

You will understand positive and negative numbers.

Operations with negative numbers

When we add two positive numbers,
We get a positive number.
 $4=1+3$ is an easy example.

Think of a hot air balloon

It has Up, Down and Fly operations.

The positive numbers are hot air.

Negative numbers are sandbags.

When we pump hot air to the balloon, it goes up.

When we add sandbags Balloon goes down.

When we remove sandbags, the balloon goes up.

What happens if we remove hot air.

Will go down ? or Up?

Going Up

Adding hot air puffs= Adding a positive number

Going Down

Adding sandbags = Adding a negative number

Going Up

Subtracting sandbags =Subtracting a negative number

Going Down

Subtracting hot air puffs= Subtracting a positive number

Our balloon starts at height +8, we add two sandbags (down 2), subtract five puffs of hot air (down 5), subtract one sandbag (up 1), then add six puffs of hot air (up 6).
Where will the balloon ends up ?

We can calculate balloon's current height as
 $(+8) + (-2) - (+5) - (-1) + (+6)$

There is an important rule we use in math operations when we meet + and - numbers. N is a number.

+ (- N) becomes - N

+ (+ N) becomes + N

- (+ N) becomes - N

- (- N) becomes + N

So the expression

$(+8) + (-2) - (+5) - (-1) + (+6)$

Becomes $8-2-5+1+6=8$

Numbers with Decimals

We always use numbers with decimals or fractions.

0.5 mean $\frac{1}{2}$, $0.25 = \frac{1}{4}$ so on.

In computers, decimal number operations are handled same ways as whole numbers, however they are stored differently in the memory.

The memory cells store decimal numbers separating whole and decimal part. Therefore a decimal number like 2.5 need more memory than to store 2 like a whole number. Therefore decimal numbers are treated as different **data type**.

This is important when we do mixed number calculations.

We can add a whole number to a whole number and result stored in a **whole number**.

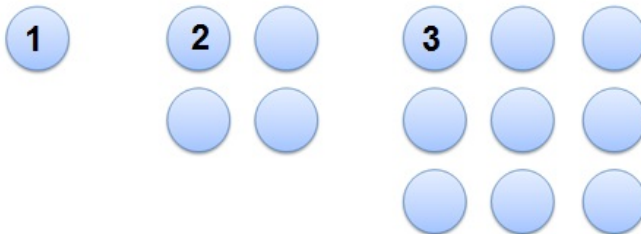
However if we add a whole number to a decimal, the result has a decimal part, so we have to store it as a decimal value.

In python we have **integer** data type for whole numbers including negative numbers.

The data type for numbers with decimals are called **floating point** variables.

Square of a number

square of a number is actually a square.



What would be the shape of squared 4?

A number multiplied by itself we get a squared number.

$$1 \times 1 = 1$$

$$2 \times 2 = 4$$

$$3 \times 3 = 9$$

$$4 \times 4 = 16$$

$$5 \times 5 = 25$$

We say 25 is the **square** of 5
and 5 is the **square root** of 25

Find the square root of 16 from above table.

What's the square of 10 ?

What's the square root of 100?

Write a program to obtain a square of a number.

×	1	2	3	4	5	6	7	8	9	10
1	1	2	3	4	5	6	7	8	9	10
2	2	4	6	8	10	12	14	16	18	20
3	3	6	9	12	15	18	21	24	27	30
4	4	8	12	16	20	24	28	32	36	40
5	5	10	15	20	25	30	35	40	45	50
6	6	12	18	24	30	36	42	48	54	60
7	7	14	21	28	35	42	49	56	63	70
8	8	16	24	32	40	48	56	64	72	80
9	9	18	27	36	45	54	63	72	81	90
10	10	20	30	40	50	60	70	80	90	100

1, 4, 9, 16, 25, 36, 49, 81 and 100 are square numbers from 1 to 100. Can you find there square roots?

What happens when a negative number is squared?

Check it in python IDLE

```
2 * 2
```

$-2 * -2$

What do you get ?

We get 4 in both instances.

So, square of any number is a positive number.

Finding square root manually is difficult for all numbers.

so we use a computer. We can find square root of a number using python **math module**.

We use its `math.sqrt()` function.

```
#!/usr/bin/python
import math
n=float(input("Enter number : "))
sqr=(math.sqrt(n))
print (sqr)
```

The float() function is used to convert text to decimal numbers.

Can there be a square root for a negative number?

Any **number** times itself is a positive **number**

We can't get a **negative number** by squaring a positive or negative number.

square roots undo squaring,

So, **negative numbers** can't have **square roots**.

Write a python program to accept four inputs a, b, c, d and calculate output for following expressions.

$p = a + b + c$

$q = a \times b - c + d$

$r = a + b \times c - d$

$t = a - b + c / d$

$s = a \times b + (c / d)$

$u = (a + b) \times c - d$

Tip: convert input numbers with int() function.

There are 10 pieces of cheese cakes.
How do you divide it among 3 friends?
How many pieces shall be left ?

Modulus operator

Python provide modulus operators for you to find the remainder from a integer division.

Type following in python IDLE

5 % 2 7 % 3 10 % 3 int(5/2) int(7/3) int(10/3)

Write a python program

There are **x** number of toffees and **y** number of students in class. Write a program to calculate how many toffees per person (z) and how many left (t).
Enter your results in the table.

X	y	z	t
15	4		
12	6		
3	4		

Explain your outputs.

Comparison Operators

We use comparison operators to compare two values.

The comparison gives a true or false output.

Compare following

Sun and Moon

5 meters rope and 7 meters rope

One cup of tea and one cup of milk

In math and programming we use equal, smaller than and bigger than operators to compare values.

equality check uses `==` symbol like `4==4`

Bigger than check uses `>` symbol `6 > 4`

Smaller than check uses `<` symbol `4 < 6`

Mark which comparisons are true.

<code>6==5</code>	<code>6 > 5</code>	<code>5 > 6</code>	<code>37 < 47</code>	<code>31 > 19</code>
<code>"A"=="B"</code>	<code>K < M</code>	<code>-1 < -2</code>	<code>D+1 > E-1</code>	<code>-3+4==1</code>
<code>dog > cat</code>	<code>2 < 7</code>	<code>-4 > -6</code>	<code>-3-1 < -2</code>	<code>-4+2==2</code>

Explain Why ?

Write 10 comparison operators using `==`, `<` and `>`

You can combine two comparison operators.

`X == Y` mean X is equal to Y

$X \neq Y$ mean X is not equal to Y

$X \geq Y$ mean X is bigger than or equal to Y

$X \leq Y$ mean X is smaller than or equal to Y

Explain the output using python IDLE

`7==7 7!=6 7>=6 7<=8 9>=8 9<=8 8==9`

Python provide turtle **module** for you to draw lines.

Run following code and **explain what happens ?**

```
import turtle
t = turtle.Pen()
t.shape("turtle")
t.left(20)
t.forward(150)
t.left(90)
t.forward(150)
t.left(90)
t.forward(150)
t.left(90)
t.forward(150)
t.left(90)
```

More turtle commands to create interesting graphics.

```
color("blue")
shape("turtle")
goto(x, y)
speed()
penup()
pendown()
```

Draw an interesting Turtle graphics of your choice.



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