AlgoHack #1

WHAT IS A PROGRAM ?

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

Let's play Robot Bug game

The Robot can move up, down, left and right only.

Draw arrows for the bug to water all flowers.

Is there more than one path to water the flowers?

How do you find the best path?

Mark Robot's path as a program using up, down, left and right arrow commands like below.

➡➡➡➡➡⬆□□□□⬆➡➡➡⬆ ….

We used 4 symbols in the program.

Do you see that same symbols repeating.

➡➡➡ means move right 5 times

You can write it as ➡5

➡5⬆ □4⬆➡3⬆ …. Complete your code.

OK, now you get two bonus commands.

Now, Robot can move diagonally ↗ **and** ↖

Write a new program to water all flowers.

Count the number of moves. Is it lesser code?

Pattern Robot

Can you create an interesting android phone local pattern

for your mother. Code them with □ ➡ ⬆ ⬇ ↗ and ↖ symbols.

□	□	□
□	□	□
□	□	□

Draw the first letter of your mother's name ?
Program it using 6 arrow commands.
Draw a pattern with squares.
Draw a pattern with triangles.
What happens if you change a symbol?
What happens if you remove that symbol ?
Does it give any error?
An error in a program code is called a bug.

Programs use commands.
Commands have a **Syntax**.
Syntax is a specific way we write **instructions**.
Instructions are like words in english language.
Instructions can contain numbers and symbols.
Run *100 meters* is a command in sports.

How does a program is run?
First we write a program with instructions.
We load the program into the computer memory.
Then we run the program.
The processor **reads** first instruction of the program.
Processor **decode** the instruction.
Processor **run** the instruction.

Processor may take an **input**, do a **calculation** or **comparison** and **output** result.
Then processor **reads next** instruction
Repeat the process for all instructions.
An instruction can be at **multiple** places.
The processor runs **one instruction** at a time.

Draw a diagram to show how a program works?

Algorithm
You come home from school and want to wash your face.

What are the steps you take to wash your face?
Is following steps are in **order**?

Wash face, Apply Soap,Wash face, Dry Face

What will happen if you exchange step 2 and 4 ?
Definitely, Your eyes will irritate.
You have to wash face before and after soap use. Dry the face finally. So you have to **do things in an order** get a good face wash. Its an algorithm to wash face.

Think of Algorithms in your daily life.
Describe one life activity with an Algorithm.
Is this activity happen every time the same way?

Making a cup of tea
Describe the steps of making a cup of tea.

Do all people make tea same way as you do?
Is there a better order of steps for great tasty tea?

Programing is like that.

In Programming
We write instructions, step by step to do something. The steps of the program is our **Algorithm**.

Algorithm is a procedure of doing something with steps or sequence of actions.

There are 2 Rabbits in a forest. They mate every year and give birth to 2 more Rabbits. How many Rabbits will be there in the forest after 3 years?

Three Cup Pyramid
Take three cups.
Make a cup stack keeping one over each other..

Now take a cup by cup and build a pyramid.

Re-build the stack same way.
Does it has an Algorithm?

You are given 4 commands.
CupUp, CupRight, CupLeft, CupUp, CupDown
Write a program to build 3 cup pyramid.
How many steps you need to build 3 cup pyramid?
Can you write an algorithm for a 5 Cup pyramid?

Build a Cup Robot with 8 commands
GoLeft, GoRight, GoUp, GoDown,
TurnLeft, TurnRight, GoForwad, GoBack
Can you get Cup Robot to assemble and disassemble different cup pyramids.
Write a code and test it out with a friend.

River Crossing Problem

Mr. Roko is a circus man.
He carries a tiger, a goat and vegetable sack.
He has to cross a river in a boat to get to city.
The small boat can carry only two at a time.
Mr. Roko can't leave tiger and goat together.
He also can't leave goat and vegetable sack.

Tell Mr. Roko how to take tiger, goat and vegetable sack safely across the river?

Card Algorithms
S**huffle** a card deck.

Take **one card out**
Keep it without looking.

Now take the other cards
one by one and **organise**.

Which card was taken out?
How did you find that?
You took one card. You kept it away.
You processed 51 other cards
You organised them into groups
You organised them into an order.
You found the missing card in the order.

The organising and ordering process gave you an algorithm to find the missing card.

Categorising Data
Shuffle the card deck again.
Mark two places on the desk.
One place for pictures and other for numbers
Take a card.
Is it a picture card? Then place on picture deck.
Is this a number card? Then place on number deck.
Do it until all cards are over.
Count! **Which cards are more ?**

Card Challenge:
Think of a method to categorise cards by suits:
clubs (♣), diamonds (♦), hearts (♥) and spades (♠),
Design an algorithm to do this process.

Let's get into much more card fun.
Now, take 10 cards.
Shuffle it and place on desk.
Order them from small to big as fast as possible.
Easy.. you did fast.
Is it faster to do as a group ?

But computers don't work like that.

You can see many cards at once.
Computers can see one card at a time.
You can think of smart moves.
Computers can't think like human.
Computers do things the way we program them.
Programs provide data and rules to process data.
Computers can process data on given rules only.

But, computers can learn from data and remember. They can use what they learned to make decisions on new data.

Computers operate on our instructions.
We program one instruction at a time.
Computers are very fast, they can do millions of instructions. But one by one. That's why computers faster than humans when doing calculations and comparisons

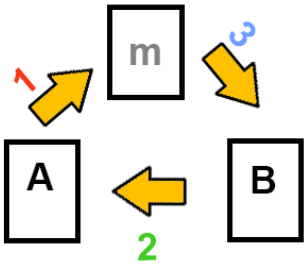
with large number of data.

So how do computers do that?
Place 5 cards randomly on a row

Rules for processing
You can only **open** one card at a time.
You can **compare** two open cards.
You can **exchange** cards.
But, You can **move** one card at a time.
You can **repeat** until all cards are in order.

Computers keep all data in memory.
When exchanging data, a temporary space in memory is used to keep the data that would be overwritten.

How A and B are exchanged ?



First A is placed on temporary space m, then B moved to A and finally A in m is moved to B.

To sort 10 cards, we need 11 memory locations and each exchange need 3 moves.

Organise your 5 cards in order
starting with 1st card and use a swap space.
How many moves you need to sort all cards?
Shuffle the cards and organise again.
How many moves? Is it different each time?

Memory stores data and programs to operate a computer. Memory is a grid of cells like math exercise book. Like lot of squire cells to write numbers and text. Because memory and processor are connected, processor can read data from memory and store results after processing.

How a program runs?
First we load the program into memory.
We know a **program is a list of instructions.**

The processor **reads** each instruction.
It may may do **calculations** with input data.
Or do **comparisons** of input data.
It **store** results **in memory** for future use.
Its **receives signals** from other devices.
Its **sends signals** to other devices.

Write a program with 5 instructions to sort cards.
TakeCard - Takes one card.
StoreInMemory - stores card in memory.
CompareTwoCards - compare two cards. **MoveCard** -

Move a card to new location.
Repeat - The process repeats until ordered.

There is something else …

We have to input all cards to the computer, before starting the ordering process. We can input them from the keyboard. The processor has a keyboard controller. It takes inputs from the keyboard and processor store them in memory.

We give each card a **name** to identify it by program.
We give each card name a **place in memory**.
The place in memory is called **memory address**.
It's like your home address. Your friend's address is different from you.

Once stored, We can get a data from memory address. We use the name in our program to identify data. The name connected to a memory address. Clear, right ?
So you need another instruction to input all data
InputCards - input card set into the memory
Now we can start **Sorting**.
Sorting is arranging some data to an order.
Sorting Small to Big is called **Ascending order**.
Sorting Big to Small is called **Descending order.**

What is the order of A, C, K, R , T ?
What is the order of 7,5, 3, 2, 1, 0 ?

Let's write program to sort cards.

Place 5 cards into memory.
Take a card from memory if first time.
Take another card from memory.
Compare two cards.
Exchange to make order.
Repeat until all 5 cards are sorted.
Record the process and count number of moves.

.

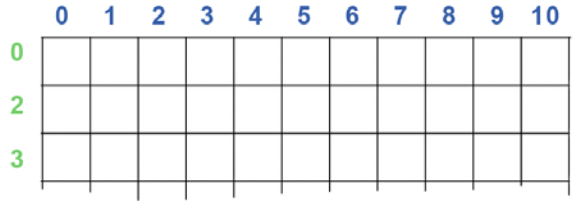
Re-shuffle cards and do another sorting.
Compare number of moves.
Is it different in two occasions? Why ?
Does the number of steps depend on data?
Does it depend on initial order?

The number of processing cycles created by instructions is program is **running time**. In sorting we found that the running time is dependent on initial order of data. How efficient is an algorithm is dependent of time and memory usage in processing.

Jumping Robot
You have a jumping Robot.
You are going to make it jump different places.
You will do it with program instructions.

You need four friends act as a computer.
Input - Input friend will give **inputs**
Processor - You do **calculations**
Memory - Memory friend **store** the data

Display Unit - Display friend **output** results



Create a 10x10 **grid** for the display unit.
Mark each column from 0 to 9 left to right.
Mark each row from 0 to 9 top to bottom.
Each cell has a **column** and **row number**.
We call them **x and y** or **coordinates** of the cell.
Draw a dot in 5,5 cell. It's the most center cell .
Turn any page of your book
Get the last digit of the page number.
Get another number between 0 and 9 same way.
Input two numbers to jump the robot.
Repeat for 10 jumps. Record and connect cells.

How a program will do all this?
Input column to processor
Processor give it to memory x
Input row to the processor
Processor give it to memory y.
Processor get x from memory
Processor get y from memory
Processor send y and y to display
Display mark column x and row y
Do this for 10 jumps

What if you enter a number bigger than 9?
Can you jump the robot?
If you can't, It's called a **bug** in your program
You program will stuck as there is no cell beyond 9.

Hacking Numbers for Robot Jump
What numbers will draw a squire and triangle?
A Sextant has 6 sides, can you draw a one?
Do a competition to create interesting graphic.
Draw them first and get coordinates.

Algorithms process different data same way, but the running time may vary on different data sets.

Write an algorithm for a Robot driven car come to your school from home. Consider drawing a map first, mark routes and give instructions.

You can use algorithms to help describe things that people do every day.
Create an algorithm to plant a bean seed.
Is everyone's algorithm is same?
How can you improve the algorithm ?

An algorithm is a list of steps that you can follow to finish a task. We follow algorithms every day.

Write algorithms for your day.
Making the bed, Making breakfast
Washing face, getting dressed what else?
List their steps.

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