ST. JOSEPH'S
COLLEGE OF ENGINEERING
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DEPARTMENT OF COMPUTER SCIENCE & ENGINEERING

UCEST105 - ALGORITHMIC THINKING WITH PYTHON

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Module 1

Module 1

- PROBLEM-SOLVING STRATEGIES:- Problem-solving strategies defined, Importance of understanding multiple problem-solving strategies, Trial and Error, Heuristics, Means-Ends Analysis, and Backtracking (Working backward).

- THE PROBLEM-SOLVING PROCESS:- Computer as a model of computation, Understanding the problem, Formulating a model, Developing an algorithm, Writing the program, Testing the program, and Evaluating the solution.

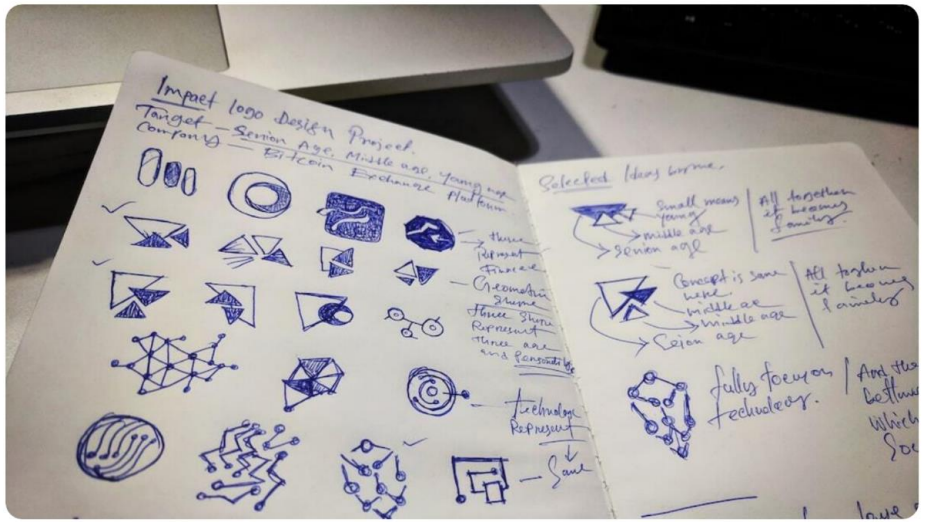
- ESSENTIALS OF PYTHON PROGRAMMING:- Creating and using variables in Python, Numeric and String data types in Python, Using the math module, Using the Python Standard Library for handling basic I/O - print, input, Python operators and their precedence.

Importance of Problem-solving strategies

- **Definition & Overview :** Problem solving strategies encompass various approaches and methods used to address challenges effectively, facilitating decision-making and innovation.

- **Importance across fields**: Different fields, from science to business, benefit immensely from understanding diverse problem-solving strategies and improved outcomes.

- **Enhancing Cognitive Skills:** Learning and Applying various strategies fosters cognitive development, leading to enhanced critical thinking and analytical capabilities.



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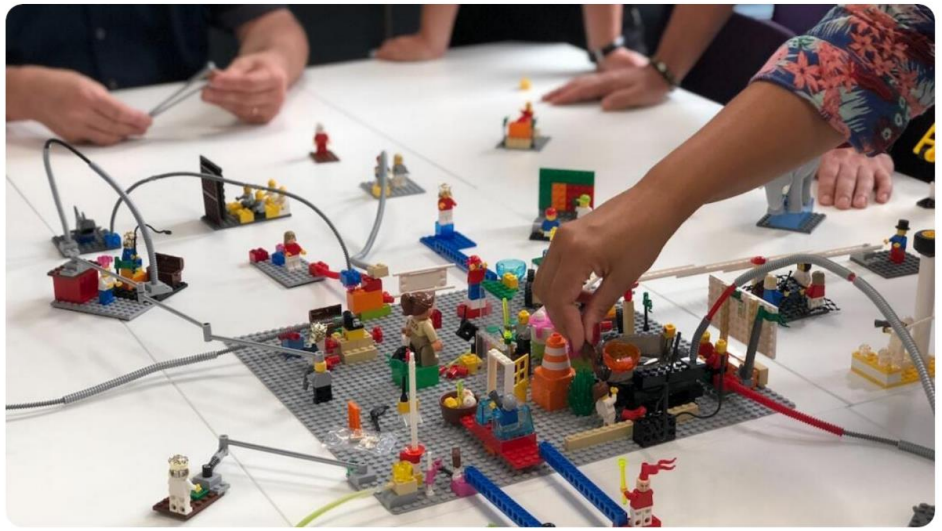
Importance of Problem-solving strategies

- **Cognitive Development:** Understanding multiple strategies promotes cognitive flexibility, allowing individuals to adapt diverse challenges in various contexts.
- **Enhanced Decision making**: Knowledge of various strategies equips individuals to evaluate and select the most effective approaches for a given problem.
- **Real World Applications:** From healthcare to engineering, utilizing diverse strategies enables practical solutions tailored to specific problems.



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Strategies for Problem Solving

- An individual uses various kinds of methods or strategies to solve problems.
- Some strategies when used take a long time but definitely give an answer.
- On the other hand, there are some other strategies which take lesser time but do not always guarantee success.
- These strategies can be mainly classified
  - Trial and error - Continue trying different solutions until problem is solved
  - Algorithm - Step-by-step problem-solving formula
  - Heuristic - General problem-solving framework
  - Means-end analysis
  - Working backward

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Trial and Error

- **Definition & Process**: Involves repeated attempts to solve a problem, where each failure leads to insights that guide subsequent actions until a solution emerges.

- **For example**, say the problem is that your Wi-Fi isn't working.
  - You might try different things until it starts working again, like restarting your modem or your devices until you find or resolve the problem.
  - When one solution isn't successful, you try another until you find what works.
- **Advantages and Disadvantages**: This method is often straightforward and can yield solutions without complex planning; however , it may lead to inefficiencies and waste resources if the approach is not methodical.

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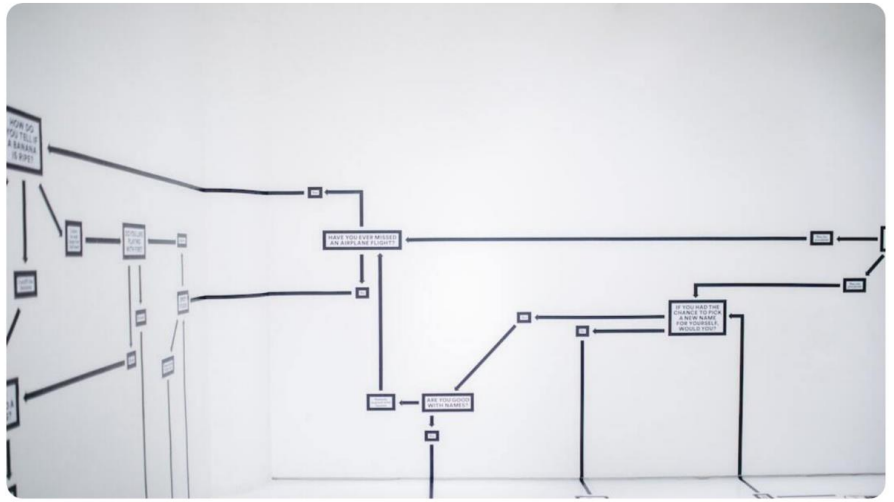
Algorithm

- **Definition**: is a defined series of steps designed to solve a specific problem, characterised by precision, repeatability, and efficiency in execution.

- **Steps involved in algorithmic thinking**: Key steps include problem definition, data gathering, establishing parameters, step by step instruction, creation and analysis of outcomes to refine the approach.

- Algorithms are used frequently in our everyday lives, especially in computer science.
  - Google use algorithms to decide which entries will appear first in your list of results.
  - Facebook also uses algorithms to decide which posts to display on your newsfeed.
  - Can you identify other situations in which algorithms are used?



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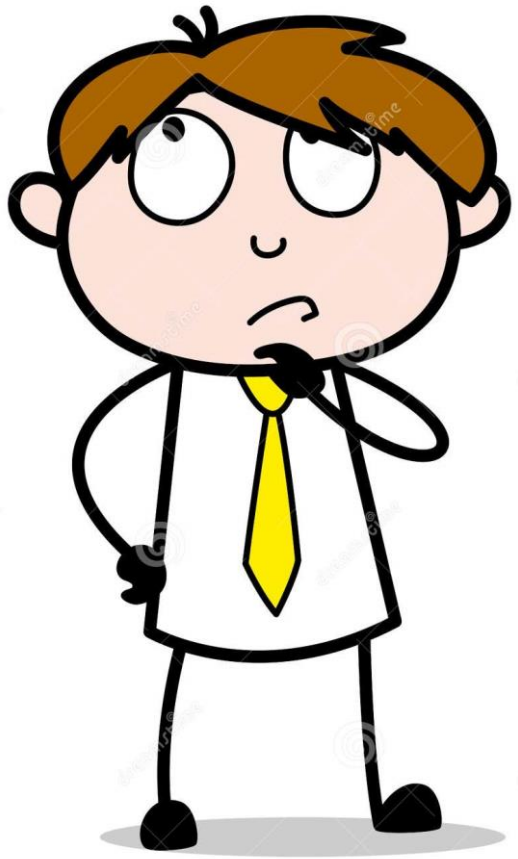
Heuristic Approach

- **Definition**: Heuristics are mental shortcuts or rules thumbs that simplify the decision making process, enabling individuals to draw conclusions and solve the problems more rapidly .

- Different types of heuristics are used in different types of situations, but the impulse to use a heuristic occurs when one of five conditions is met
  - When one is faced with too much information
  - When the time to make a decision is limited
  - When the decision to be made is unimportant
  - When there is access to very little information to use in making the decision
  - When an appropriate heuristic happens to come to mind in the same moment



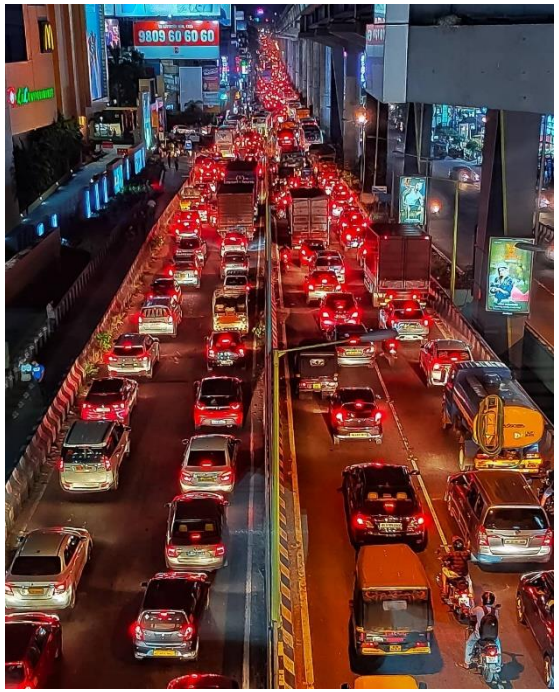
Working backwards

- Working backwards is a useful heuristic in which you begin solving the problem by focusing on the end result. Consider this example

- You live in Kochi and have been invited to a wedding at 4 PM on Saturday in Thiruvananthapuram. Knowing that National Highway 66 (NH 66) tends to get congested, especially on weekends, you need to plan your route and time your departure accordingly. If you want to be at the wedding function by 3:30 PM, and it takes 5 hours to reach Thiruvananthapuram from Kochi without traffic, what time should you leave your house? You can use the working backwards heuristic to plan this.

Working backwards

- Here's how you can approach it:
- **Wedding Start Time**: The wedding is at 4 PM, but you want to arrive by 3:30 PM.
- **Travel Time**: It typically takes 5 hours to drive from Kochi to Thiruvananthapuram without traffic.
- **Traffic Consideration**: Since NH 66 can have heavy traffic, especially on weekends, it's wise to account for possible delays.
- Assuming you want to give yourself an extra hour to account for traffic, the total travel time would be 6 hours.
- **Departure Time Calculation**:
  - If you need to be there by 3:30 PM, and the drive takes 6 hours, you should subtract 6 hours from 3:30 PM.
  - 3:30 PM minus 6 hours is 9:30 AM.
- So, you should leave your house at 9:30 AM to ensure you arrive at the wedding on time, considering potential traffic delays.



Means-End Analysis

- **Concept:** Means-end analysis is a goal oriented problem-solving technique that focuses on breaking down a problem into smaller, manageable sub-goals to reach the overall objective.

- **Steps Involved**: The process includes identifying your goal, assessing the current situation, determining the means to progress and systematically implementing those means to bridge the gap.

Means-End Analysis

- **Missionary-Cannibal Problem**

- Three missionaries and three cannibals are on one side of a river and need to cross to the other side. The only means of crossing is a boat, and the boat can only hold two people at a time. Your goal is to devise a set of moves that will transport all six of the people across the river, being in mind the following constraint: The number of cannibals can never exceed the number of missionaries in any location. Remember that someone will have to also row that boat back across each time.

Means-End Analysis

- **Steps Using Means-End Analysis:**
- **Identify the Goal:**
  - **Goal:** All missionaries and cannibals must be on the right bank of the river.
- **Current State:**
  - **Initial State:** All 3 missionaries and 3 cannibals are on the left bank.
- **Difference Between Current and Goal State:**
  - All people need to be moved from the left bank to the right bank.
- **Break Down the Problem:**
  - The boat can carry only two people at a time.
  - Cannibals should never outnumber missionaries on either side.

Means-End Analysis

- **Plan and Execute Subgoals:**
- **Subgoal 1:** Move two people across the river.
  - **Action:** Move 2 cannibals (C) across the river.
  - **New State:** Left Bank: 3M, 1C | Right Bank: 0M, 2C
- **Subgoal 2:** Ensure boat returns to the left bank.
  - **Action:** One cannibal (C) returns with the boat.
  - **New State:** Left Bank: 3M, 2C | Right Bank: 0M, 1C
- **Subgoal 3:** Move another two people across the river.
  - **Action:** Move 2 cannibals (C) across the river.
  - **New State:** Left Bank: 3M, 0C | Right Bank: 0M, 3C
- **Subgoal 4:** Ensure boat returns to the left bank.
  - **Action:** One cannibal (C) returns with the boat.
  - **New State:** Left Bank: 3M, 1C | Right Bank: 0M, 2C

Means-End Analysis

- **Plan and Execute Subgoals:**
- **Subgoal 5**: Move missionaries safely across the river.
  - **Action**: Move 2 missionaries (M) across the river.
  - **New State**: Left Bank: 1M, 1C | Right Bank: 2M, 2C
- **Subgoal 6**: Balance numbers on the left and right banks.
  - **Action**: One cannibal (C) and one missionary (M) return.
  - **New State**: Left Bank: 2M, 2C | Right Bank: 1M, 1C
- **Subgoal 7**: Move missionaries safely across the river.
  - **Action**: Move 2 missionaries (M) across the river.
  - **New State**: Left Bank: 0M, 2C | Right Bank: 3M, 1C
- **Subgoal 8**: Ensure boat returns to the left bank.
  - **Action**: One cannibal (C) returns with the boat.
  - **New State**: Left Bank: 1M, 2C | Right Bank: 3M, 0C

Means-End Analysis

- **Plan and Execute Subgoals:**
- **Subgoal 9**: Move the final two cannibals across the river.
  - **Action**: Move 2 cannibals (C) across the river.
  - **New State**: Left Bank: 1M, 0C | Right Bank: 3M, 2C
- **Subgoal 10: Ensure boat returns to the left bank.**
  - **Action**: One cannibal (C) returns with the boat.
  - **New State**: Left Bank: 1M, 1C | Right Bank: 3M, 1C
- **Subgoal 11: Move the final two cannibals across the river.**
  - **Action**: Move 2 cannibals (C) across the river.
  - **New State**: Left Bank: 0M, 0C | Right Bank: 3M, 3C
- **Final Check**:
  - **Goal State**: All 3 missionaries and 3 cannibals are now on the right bank.

References

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Thank You

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