Department of Computer Science and Engineering
PES University, Bangalore, India

Lecture Notes
Python for Computational Problem Solving
UE23CS151A

Lecture #2

Problem Solving – Computational and Non-Computational

By,
Prof. Sindhu R Pai,
Anchor, PCPS - 2023
Assistant Professor
Dept. of CSE, PESU

Verified by,
PCPS Team - 2023

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Dr. Shylaja S S (Director, CCBD and CDSAML Research Centers, Former Chairperson, CSE, PES University)
Prof. Chitra G M (Asst. Prof, Dept. of CSE, PCPS Anchor – 2022)

Introduction

A king has three wives and four children. Three of the children are Ram, Lakshman, and Bharat. Compute the name of the fourth child. We do not expect a computational process to answer this problem – instead it would be a guess, not a computation.

Next, let us consider the other problem. Consider a ball at rest, high up somewhere. We wish to compute the distance the ball will travel, when released from rest, over the period starting at the 4th second and ending at the 7th second. We can use the laws of motions to compute this number given a Computing device. This is our notion of computation.

Computing:

The process of utilizing computer technology to complete a task. Computing may involve computer hardware and/or software but must involve some form of a computer system. It is purely a physical phenomenon occurring inside a closed system called a computer. It includes designing, developing, and building hardware and software systems; processing, structuring, and managing various kinds of information; doing scientific research on and with computers; making computer systems behave intelligently; and creating and using communications and entertainment media.

Problem Solving:

Problem: Task/job to be completed

The task or job can be either Computational or Non-Computational.

- Computational: Problem that can be solved by a computer
- Non-Computational: Problem that cannot be solved by a computer

Types of Computational Problems

- Decision Problems
- Counting Problems
- Search Problems
- Sorting Problems
- Optimization problems

This semester as a part of the course, we will be dealing with Computational Problem Solving (CPS)**.** It is evident that in order to solve a problem computationally, we need to understand the Essence of CPS and the processes involved in CPS.

Essence of CPS

- **Representation** - Captures all the relevant aspects of the problem.
- **Algorithm** - A sequence of unambiguous instructions for solving a problem, i.e., for obtaining a required output for any legitimate input in a finite amount of time. The word "algorithm" is derived from the ninth-century Arab mathematician, Al-Khwarizmi.

Phases involved the Process of CPS – Refer to Lecture #9 notes

Analysis, Design, Implementation, Testing

Let us solve an example in order to understand the concept of representation and algorithm.

The Man, Cabbage, Goat and Wolf problem is a River Crossing problem.

A man lives on the east side of a river. He wishes to bring a cabbage, a goat, and awolf to a village on the west side of the river to sell.

However, his boat is big enough to hold himself and either the cabbage, goat, or wolf.In addition, the man cannot leave the goat alone with the cabbage because the goatwill eat the cabbage, and he cannot leave the wolf alone with the goat because the wolf will eat the goat. How does the man solve his problem?

Solution:

There is a simple algorithmic approach for solving this problem by simply trying all possible combinations of items that may be rowed back and forth across the river.

Trying all possible solutions is referred to as a **brute force approach.**

Representation:

There are 4 symbols – **M(Man), C(Cabbage), G(Goat) and W[Wolf].**

There are totally 2^4 States = 16 states

Assume all the items are the East(E) side of the river and they need to reach the West(W) side by following the constraints involved in the problem.

Choose the valid states from the below list of states of each symbol.

[E, E, E, E], [E, E, E, W], [E, E, W, E], [E, E, W, W], [E, W, E, E], [E, W, E, W], [E, W, W, E], [E, W, W, W], [W, E, E, E],

[W, E, E, W], [W, E, W, E], [W, E, W, W], [W, W, E, E], [W, W, E, W], [W, W, W, E], [W, W, W, W]

Algorithm:

Algorithm	
Solution 1	**Solution 2**
Step 1: Start	Step 1: Start
Step 2: Man rows goat	Step 2: Man rows goat
Step 3: Man rows back alone	Step 3: Man rows back alone

Step 4: Man rows cabbage across	Step 4: Man rows wolf across
Step 5: Man takes goat back	Step 5: Man takes goat back
Step 6: Man leaves goat and rows wolf across.	Step 6: Man leaves goat and rows cabbage across.
Step 7: Man rows back alone.	Step 7: Man rows back alone.
Step 8: Man rows goat across.	Step 8: Man rows goat across
Step 9: Stop	Step 9: Stop

In the above example we are not worried about

- Color of the boat
- Name of the man
- Width of the river
- Freshness of cabbage
- Weight of cabbage

Thus, the only information relevant for this problem is where each particular item is at each step in problem solving. Therefore, by the use of **abstraction**, we definea **representation** that captures only this needed information.

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