CYPRUS INTERNATIONAL UNIVERSITY
ENGINEERING FACULTY

Lecture 1
General Problem-Solving Concepts

CMPE223 / ISYE223
ALGORITHMS AND PROGRAMMING
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Topics

- Problem Solving in Everyday Life
- Types of Problems
- Problem Solving with Computers
- Difficulties with Problem Solving

General Problem-Solving Concepts

- People make decisions every day to solve problems that affect their lives. The problems may be as unimportant as what to watch on television or as important as choosing a new profession.
- If a bad decision is made:
  - *Time* and *resources* are wasted.
- So it's important that people know how to make decisions well.

Six Steps In Problems Solving

1. Identify the problem
2. Understand the problem
3. Identify alternative ways to solve the problem
4. Select the best way to solve the problem
5. List instructions that enable you to solve the problem using the selected solution
6. Evaluate the solution

1. Identify The Problem

- If you don't know what the problem is, you can not solve it.

2. Understand The Problem

- You must understand what is involved in the problem before continuing towards a solution.
- Understanding the *knowledge base* of the person or machine for whom/which you are solving the problem.
- A different set of instructions might have to be used depending on this knowledge base.
  - For example, you would use a more detailed set of instructions to tell someone how to find a restaurant in your city if he/she has limited knowledge of the city than if he/she knows it well.

2. Understand The Problem

- When working with a computer, its knowledge base is the limited instructions the computer can understand in the particular computer language or application you are using to solve the problem.
- Knowing the knowledge base is very important since you can not use any instructions outside this base.
- You can not solve a problem if you do not know the subject. (For example, to solve a calculus problem, you must know calculus.)

3. Identify Alternative Ways

- This list should be as complete as possible.
- You might want to talk to other people to find other solution(s) than those you have identified.
- Alternative solutions must be acceptable ones.

4. Select The Best Way

- Identify and evaluate the pros and cons (advantages and disadvantages) of each possible solution before selecting the best one.
- Select criteria for the evaluation. These criteria will serve as the guidelines for evaluating each solution.

5. List Instructions

- List instructions that enable you to solve the problem using the selected solution.
- These numbered, step-by-step instructions must fall within the knowledge base set up in Step 2.
- No instruction can be used unless the individual or the machine can understand it.

6. Evaluate The Solution

- Check the result to see :
  - if it is correct,
  - if it satisfies the needs of the person with the problem.
- If the result is either incorrect or unsatisfactory, then start the process again.

Example:

The problem: What to do this evening.

1. Identify the problem.
   How do the individuals wish to spend the evening?

2. Understand the problem.
   The knowledge base of the participants must be considered. The only solutions that should be selected are ones everyone involved would know how to do.

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Example (continued)

3. Identify Alternatives

Watch television	Invite friends over	Go to the cinema
Play computer games	Play football	Go to the amusement park

Example (continued)

4. Select the best way to solve the problem.
    a. Cancel alternatives that are not acceptable, such as those that cost too much money or do not interest one of the individuals involved.
    b. Specify the pros and cons of each remaining alternative.
    c. Compare the pros and cons to make the final decision.

Example (continued)

5. Prepare a list of steps (instructions) that will result in a fun evening.

6. Evaluate the solution.

    If nobody is having fun:

        Review the steps to see whether anything can be changed.

        If not then the process must start again.

Types of Problems

- Problems do not always have straightforward solutions.
  - Some problems, such as balancing a checkbook or baking a cake, can be solved with a series of actions. These solutions are called *Algorithmic Solutions*.
    - Once the alternatives have been eliminated, for example, and once one has chosen the best among several methods of balancing the checkbook, the solution can be reached by completing the actions in steps.
- These steps are called the *Algorithm*.

Types of Problems

- The solutions to problems such as how to buy the best stock or whether to expand the company, are not so straightforward.
- These solutions require *reasoning* built on knowledge and *experience*.
  - Such solutions that cannot be reached through a direct set of steps are called *Heuristic Solutions*.

- Usually, most problems require a combination of the two kinds of solutions.

Types of Problems

- The problem solver can use the six steps for both algorithmic and heuristic solutions.
- However, the correctness and appropriateness of heuristic solutions are far less certain.
  - Hence the problem solver needs to follow the six steps more than once, carefully evaluating each possible solution before deciding which is best.

- Furthermore, this same solution may not be correct and satisfactory at another time, so the problem solver may have to re-evaluate and resolve the same problem later.

Problem Solving with Computers

- The term *solution* means the instructions listed during step 5 of problem solving – the instructions that must be followed to produce the best results.

- *Result* mean the outcome or the completed computer- assisted answer.

- *Program* means the set of instruction that make up the solution after they have been coded into a particular computer language.

Problem Solving with Computers

- Computers are built to deal with algorithmic solutions, which are often difficult or very time-consuming for humans.
- People are better than computers at developing heuristic solutions.
  - Solving a complicated calculus problem or alphabetizing 10,000 names is an easy task for the computer, but the problem of how to throw a ball or how to speak a human language is not.

Problem Solving with Computers

- The difficulty lies in the programming.
  - How can problems such as how to throw a ball or speak a human language be solved in a set of steps that the computer can understand?
- The field of computers that deals with heuristic type of problems is called *Artificial Intelligence (AI)*.
- Artificial intelligence enables a computer to build on its knowledge bank. As a result, the computer's problem-solving abilities approach to those of human beings.

Difficulties with Problem Solving

- When solving problems on the computer, one of the most difficult tasks for the problem solver is writing the instructions.

Difficulties with Problem Solving

Which ball has the largest number on it?

7   5   9

Difficulties with Problem Solving

- Almost anyone can immediately tell which is the largest, but many cannot explain the steps they followed to arrive at it.
- Most people will say:

    "I can't explain how I know, I just know it!"

- This explanation is not good enough for the computer.
- The computer is a tool that will perform only tasks that the programmer can explain.

Exercises

- For each of the following tasks, write a set of numbered, step-by-step instructions (a solution) so complete that another person can perform the task without asking questions.
- Define the knowledge base of this person by listing what you expect the person to know in order to follow your directions.

a. Sharpen a Pencil

Knowledge base: Pencil, pencil sharpener, sharp point, turn a handle.

Instructions:
1. Go to a pencil sharpener
2. Put unsharpened end of the pencil in the hole in the side or top of pencil sharpener
3. Turn handle
4. Check to see if the pencil has a sharp point every 5 turns
5. Remove pencil and use it

b. Start a car

Knowledge base: Car, key, door, seat, keyhole, telephone, mechanic.

Instructions:
1. Go to the car
2. Open the car door on the driver's side
3. Sit down in the driver's seat
4. Put the key in the starter keyhole
5. Turn the key until you hear the engine turning over
6. If the engine starts put the car in gear and drive to your destination

b. Start a car (continued)

7. If the car does not start:
    a. Check the gas to see if there is gas in the car.
    b. Try again
    c. If the car still does not start, call a mechanic or a tow truck to tow the car to the mechanic.

c. Get a glass of water

Knowledge base: Water, glass, faucet, kitchen, way to get to kitchen, cupboard.

Instructions:
1. Go to kitchen
2. Get a glass from the cupboard
3. Turn on the faucet
4. Put the glass under the flow of water
5. Fill the glass almost to the top
6. Take the water and the glass back to where you were and drink the water

d. Find an Algorithms & Programming book in the library

Knowledge base: Book, library, book title, way to go to the library, how to search.

Instructions:
1. Go to the library
2. Find the computer books shelf
3. Look for an Algorithms & Programming book
4. If you find take the book, do the required processes to borrow the book
5. If you can not find ask library staff

Try Following Exercises

The knowledge base will differ from student to student; however, the following are the basics.

Exercise : Driving a Car

Knowledge base: car, starting the car, use of the gears, directions, laws and regulations of the state or country in which you are driving.

Instructions:

Exercise : Repairing a Car

Knowledge base: engines, mechanics tools, problem-solving skills, use of manuals, car parts, cars.

Instructions:

Exercise : Building a House

Knowledge base: houses, building materials, contractors, building tools, site development, laws and regulations of the area in which the house will be built.

Instructions:

Exercise : Calculating the cost of using your car for a month

Knowledge base: miles driven, insurance costs, original car cost, price of gas, miles per gallon, average repair costs.

Instructions:

Exercise : Write a solution to the problem of finding the largest number out of three numbers.

Knowledge base:

Instructions:

Exercise : Write a solution to the problem of cooking spaghetti for dinner.

Knowledge base:

Instructions:

References

Sprankle, M., & Hubbard, J. (2008). *Problem solving and programming concepts*. Prentice Hall Press.