Problem Solving & Algorithm Design
Problem solving

• The act of finding a solution to a perplexing, distressing, vexing, or unsettled question
How to Solve it

• Written by George Polya in 1945
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  It is written in a mathematical context for mathematical problems
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    With simple wording changes his list of suggestions are applicable to all types of problems
Ask Questions

• To understand a problem
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  ➤ What do I know about the problem?
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  » What do I know about the problem?
  » What is the information that I have to process in order to find the solution?
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  - What does the solution look like?
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  » What is the information that I have to process in order to find the solution?
  » What does the solution look like?
  » What sort of special cases exist?
Ask Questions

• To understand a problem
  » What do I know about the problem?
  » What is the information that I have to process in order to find the solution?
  » What does the solution look like?
  » What sort of special cases exist?
  » How will I recognize that I have found the solution?
Look for Familiar Things

» You should never “reinvent the wheel”
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» In computing, you see certain problems again in different guises
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» You should never “reinvent the wheel”

» In computing, you see certain problems again in different guises

» A good programmer sees a task, or perhaps part of a task (subtask), that has been solved before and plugs in the solution.
Divide and conquer

Break up a large problem into smaller units that can be handled more easily
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» Abstraction plays an important role
Divide and conquer

» Break up a large problem into smaller units that can be handled more easily

» Abstraction plays an important role

» The divide-and-conquer approach can be applied over and over
Abstraction

An explanation, idea or model that removes complex details

This is a key concept

Abstraction will reappear throughout the course
Algorithm

A technical term for a set of instructions for solving a problem or sub-problem
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Desirable Properties

Use a finite amount of time
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Use a finite amount of data, material
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Desirable Properties

Use a finite amount of time
Use a finite amount of data, material
Instructions are unambiguous
Who writes algorithms?
Who writes algorithms?

Anyone who wants to write a set of instructions for solving a problem
An Example Algorithm

How to prepare Hollandaise sauce

Never-Fail Blender Hollandaise

1 cup butter
4 egg yolks
1/4 teaspoon salt
1/4 teaspoon sugar

1/4 teaspoon Tabasco
1/4 teaspoon dry mustard
2 tablespoons lemon juice

Heat butter until bubbling. Combine all other ingredients in blender. With blender turned on, pour butter into yolk mixture in slow stream until all is added. Turn blender off. Keeps well in refrigerator for several days. When reheating, heat over hot, not boiling, water in double boiler. Makes about 1-1/4 cups sauce.
A mixture of English and formatting to make the steps in the algorithm explicit

Put butter in a pot
Turn on burner (low heat)
Put pot on the burner
While (not bubbling)
   Leave pot on the burner
Turn off burner
Put other ingredients in the blender
Turn on blender
While (more butter needed)
   Pour butter into blender in a slow stream
Turn off blender
Developing an Algorithm

- **Implementing** an algorithm involves making it **computer-readable**
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  - Begin with a problem statement
Developing an Algorithm

- **Implementing** an algorithm involves making it **computer-readable**
  - Must be in a suitable form for a computer
- The **methodology** (set of working methods) used to make the plan must
  - Begin with a problem statement
  - Conclude with a plan that can be easily coded