GEM 1501 Problem Solving With Computers

Lecture 1:

What Problems?

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Overview of this Lecture

- **Administrative matters**
- Course overview
- What problems?
- What computers?
- Problem solving (with and without computers)
- Goals of the course

Administrative Matters

- Course web page `www.comp.nus.edu.sg/~gem1501`
- IVLE (keep checking for announcements)
- Assignments (discussed in labs)
- Discussion forums (IVLE)
- Self-assessments (discussed in labs on demand)
- No tutorials but labs; register, once the system is up
- Be on time for lectures and lab sessions!

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GEM1501

- Goal: Introduction to **problem solving** with **computers**
- Method: Gentle, but principled approach, augmented with practical programming exercises
- Emphasis: Possibilities and limitations of computers

Content of GEM1501

- What problems?
- Algorithms and data
- Programming languages
- **Algorithmic methods**
- Correctness and efficiency
- **Limitations of computers**

Algorithmic Methods

- Divide-and-conquer
- Greedy algorithms
- Dynamic programming
- Traversal/search

Limitations of Computers

- Intractable problems
- NP-complete problems
- Excursion: Public-key encryption
- Undecidable problems

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What Problems?

- Definitions of problems
- Is it really a problem?
- Do I know a solution already?
- If not, I really have to give it a try...

Definitions of Problems

- Etymology
- Three definitions
- Getting closer

Etymology

- Middle English *probleme*, from Middle French, from Latin problema, from Greek problEma,
- Literally: obstacle,
  from Greek *proballein* to throw forward,
  from *pro-* forward + *ballein* to throw

The Devil Does It

- Problem: from Latin problema, from Greek *proballein* to throw forward
- Devil: from Latin diabolus, from Greek diabolos, from *diaballein* to throw across

Three Definitions of "Problem"

`dictionary.com`:

- A misgiving, objection, or complaint: *I have a problem with his cynicism*.
- A situation, matter, or person that presents perplexity or difficulty: was having problems breathing; *considered the main problem to be his boss*.
- A question to be considered, solved, or answered: math problems; the problem of how to arrange transportation.

Definition 1: A misgiving, objection, ...

"A misgiving, objection, or complaint: I have a problem with his cynicism."

- Refers to the subjective perception of a situation
- Often *perception* is the main issue
- Problem solving typically involve "emotional" skill
- Aspects of such problems may or may not be able to be addressed with the help of computers
- `http://www.spouseinfo.homestead.com/index.html`

Definition 2: A situation,... that presents perplexity...

"A situation, matter, or person that presents perplexity or difficulty: was having problems breathing; *considered the main problem to be his boss*."

- refers to practical aspects of daily life
- computers don't solve these problems, but may contribute
- Examples: management tools, spell-checking, pass-times

Not the focus here, but aspects of this type of problems may come up during the course

Definition 3: A question to be considered, solved...

"A question to be considered, solved, or answered: math problems; the problem of how to arrange transportation."

- In math problem example, the teacher "throws forward" problems to the student in order to achieve a didactic objective (computers may be involved as tools)
- Transportation example is a better example for our course

Our Definition of "Problems"

A problem is a technical question in a practical (business, scientific, engineering) domain, whose solution benefits a person or an organization.

Is It Really a Problem?

- "A problem is a gap between what is actual and what is ideal."
- What is "ideal" in a given situation is in the eye of the beholder
- The perception of the "ideal" lies at the heart of all problems, even technical problems

Do I know a solution already?

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What Computers?

- Computers are everywhere!
- What are computers?
- How do they solve problems?

Immersed in Computers

- Computers are ubiquitous
- You are using computers all the time
- Most of the time you don't notice it
- You are not aware of the problem solving

Examples of Ubiquitous Computing

- Spell-checking
- Web-surfing
- Game playing
- Mobile telephony
- ATM banking

Advanced Computer Applications

- Airtraffic control
- Animating "The Matrix" movies
- Controlling nuclear power plants
- Designing computers!

What Are Computers?

- States, realized with electric/magnetic fields
- A "bit" can take two states, let us call them "0" and "1"
- Examples of operations on bits
  - Flipping (from "0" to "1" or vice versa)
  - Zeroing bits (setting a bit to "0")
  - Testing bits (flip a bit if another bit is "1")

How Does It Work?

- Describe problem as "recipe" (algorithm)
- Write the algorithm as a "program" in a programming language
- Translate the program to a form that the computer can execute
- Execute the program

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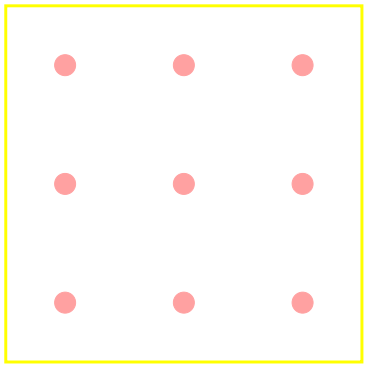
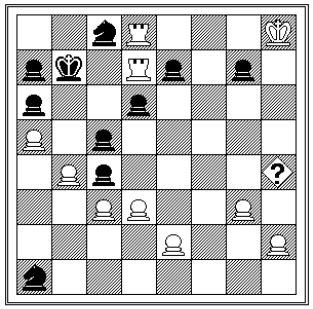
Example 1



Place two more squares to give each pig its own compartment

after Susan Blackmore, *Consciousness*

Example 2



Find the missing piece

from Raymond Smullyan, *The Chess Mysteries of Sherlock Homes* ("retrograde analysis")

Summary "Problem Solving"

- Some problems cannot be solved with computers
- Some problems *should* not be solved with computers

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The Goals of This Course

- Bridge the gap between the nerds and the rest of us
- Learn about the possibilities of computers
- Learn about the limitations of computers
- Learn simple programming skills

The Gap

- Many people know nothing about computers
- Many people know "a lot" (or pretend to do so)
- Bridging this gap is the main aim of this course

Possiblities of Computers

- Get a feeling for what kinds of problems can be solved with computers
- Designing simple algorithms
- Assessing these algorithms

Limitations of Computers

- Get a feeling for problems that are hard for computers
- Find out why some problems cannot be solved with computers
- Find out why some problems cannot be solved at all

Learn Simple Programming Skills

- Appreciation for computer-based problem solving requires doing it!
- Course is for students with **no** programming background
- Simple programming concepts will be introduced **gently**
- The emphasis is on fun!

Assignment

- See `http://www.comp.nus.edu.sg/~gem1501/assignments/01.pdf`
- In brief: Download XEmacs editor
- Learn how to use it!
- Assignment due on 14/1.

Next Week

- Algorithms and Data
  - Control structures
  - Diagrams for algorithms
  - Subroutines, procedures
  - Recursion
  - Data types and data structures