UIT2201: Lecture 2

- **Lecture Outline:**
  1. The Pervasive Computer
  2. Examples of Uses / Computer Applications
  3. Simple and also Difficult
  4. Similar and also Different
  5. Algorithms

- **Readings: [SG] Ch. 1 & Lecture Notes (esp Ch. 1-1 to 1.2)**

Recurrrrrring Principles in CS & IT

RP1: Multiple Levels of Abstraction
(very high to very low)

RP2: One Data, Multiple Views
(thru diff interfaces)

RP3: Define a (small) set of basic primitives
(building blocks)

RP4: Divide & Conquer aka
(Decomposition)

RP5: "The Power of Iteration"
(aka Recursion)

A Computer Revolution…

- **The Pervasive Computer**
  - **Computer are Everywhere**
  - **They are capable of doing things for us**
- **Some examples of what they do**
  - **Email, bank accounts, music-box,**
  - **Game machine, MSN, Facebook, YouTube**
- **Computer applications are**
  - **both *similar* and *different***
  - **both *simple* and *complex***

Example-1: Email (electronic mail)

Scenario:

Professor Preparata (franco@cs.brown.edu) at Brown Univ wants to send email to me (leonghw@comp.nus.edu.sg).

It is Simple:

Prof Preparata's computer takes a string of characters and passes on to my computer.

Everything happens by Magic!

Example-1: Email (electronic mail)

Scenario:

Professor Preparata (franco@cs.brown.edu) at Brown Univ wants to send email to me (leonghw@comp.nus.edu.sg).

It is Complicated:

How does Prof Preparata's computer know what to do with the string of letters?

What does leonghw@comp.nus.edu.sg mean?

Where is that?

Email: … many complicated steps

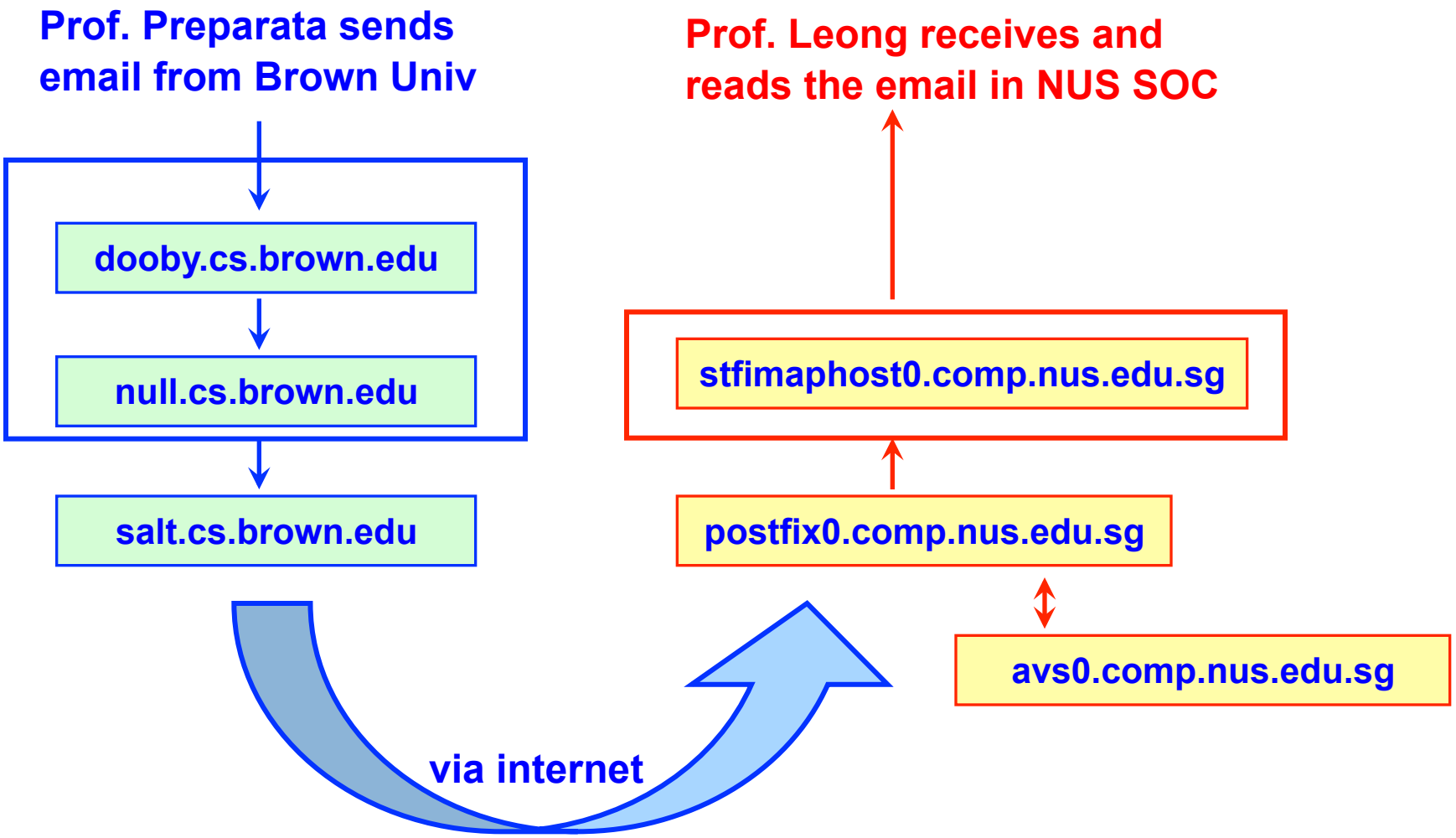
Computer at Brown U
Text Processing.
Detect address to send to,
Get message body, etc

Servers / Routers:
Address ends in ".sg"
send to gateway node,
send to node in SG.

Gateway in SG:
See "comp.nus.edu.sg"
Send to node in NUS-SOC

Computer in NUS-SOC
Stores it away in mail file
in my mailbox
Show its when I access mail

Actual Example:



Detailed email headers: an example

```
Return-Path: <franco@cs.brown.edu>
X-Original-To: leonghw@staffunix-mb.comp.nus.edu.sg
Received: from postfix0.comp.nus.edu.sg (postfix0.comp.nus.edu.sg [192.168.21.67])
          by stfimaphost0.comp.nus.edu.sg (Postfix) with ESMTP id 1A88515C63
          for <leonghw@staffunix-mb.comp.nus.edu.sg>; Thu, 10 Jan 2008 05:30:55 +0800(SGT)
   ...<other intermediate machines @NUS-SOC deleted>...
X-Virus-Scanned: amavisd-new at comp.nus.edu.sg
X-Spam-Flag: NO  ...<other spam-check related stuff deleted>...
Received: from postfix0.comp.nus.edu.sg ([192.168.21.67])
          by localhost (avs0.comp.nus.edu.sg [192.168.20.24]) (amavisd-new, port 10024)
          with ESMTP id K-33z-FlCzIl for <leonghw@comp.nus.edu.sg>;
          Thu, 10 Jan 2008 05:30:47 +0800 (SGT)
Received: from salt.cs.brown.edu (salt.cs.brown.edu [128.148.32.122])
          by postfix0.comp.nus.edu.sg (Postfix) with ESMTP
          for <leonghw@comp.nus.edu.sg>; Thu, 10 Jan 2008 05:30:46 +0800 (SGT)
  ...<other intermediate machines at Brown University deleted>...
Received: by dooby.cs.brown.edu (Postfix, from userid 1069)
          id 5E9C0491C2; Wed,  9 Jan 2008 16:30:45 -0500 (EST)
Date: Wed, 9 Jan 2008 16:30:45 -0500
To: Leong Hon Wai <leonghw@comp.nus.edu.sg>
Cc: "Franco P. Preparata" <franco@cs.brown.edu>
Subject: Re: NUS-Brown...
  ...<other details deleted>...
User-Agent: Mutt/1.5.13 (2006-08-11)
From: franco@cs.brown.edu (Franco P. Preparata)

Hon-Wai,
  <details of email deleted>...  Click [here] for source file.
So long, franco
```

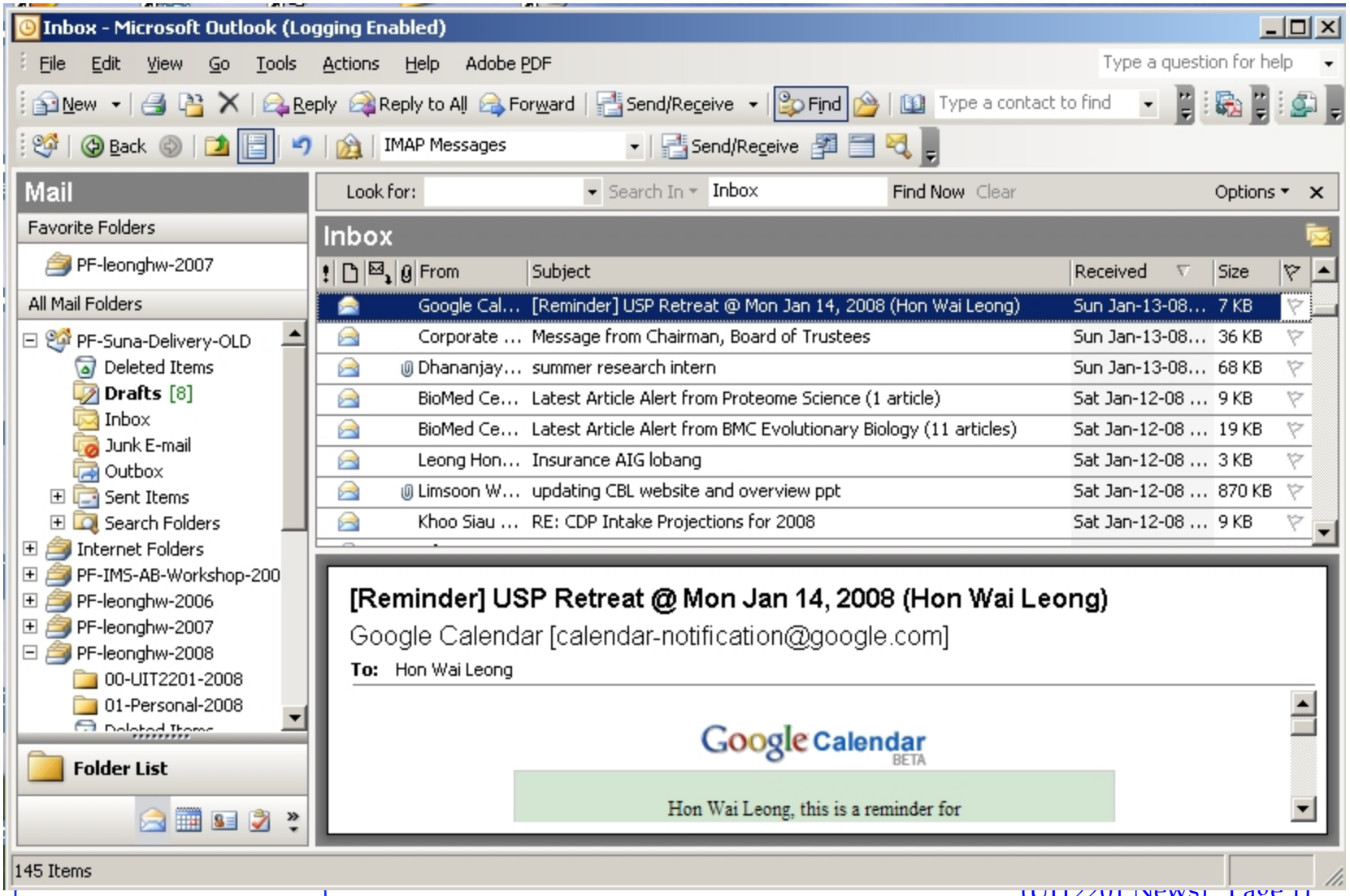
Example-1: Email

- **So, what makes the "Magic" work?**
  - **To do all this work we need**
    - ***various machines to be linked together***
      network using communication lines (the engineering folks)
    - ***Machines need to know what to do with individual messages,***
      detect the addresses, sender, message content etc.
- **Why is it Complicated?**
  - **Huge Volume – things become complex because we need to do this for hundreds of millions of users, sending and receiving tons of mail.**
  - **Communication lines, networks, computers may fail, etc.**

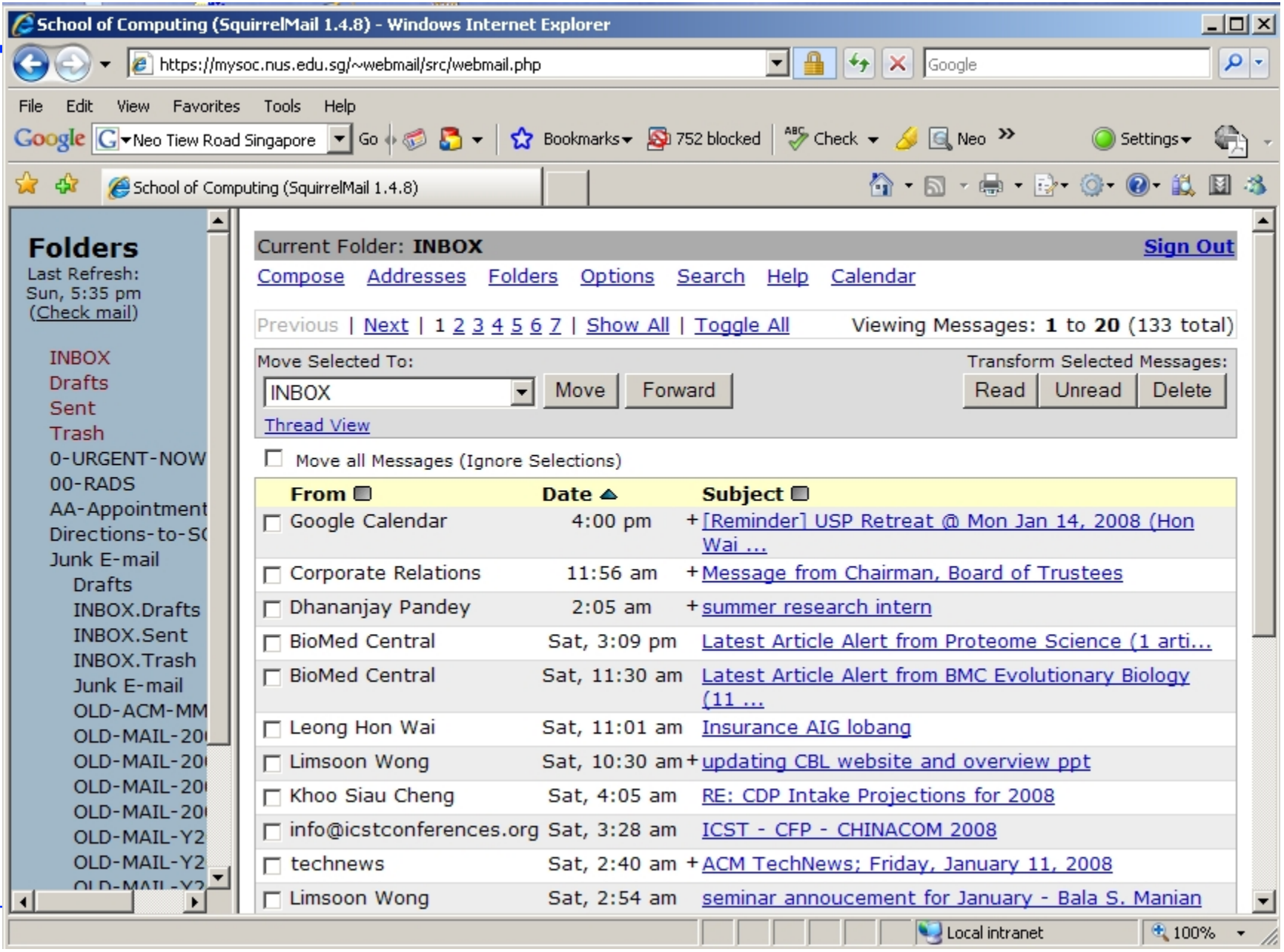
Side Track: One Data, Multiple Views

- Contents of a folder
  - List view, details, icon, tiles, etc
- Powerpoint file,
  - Normal view, outline, slide-sorter, slide-show
- Your email "data" is the same
  - But its appearance is different when using different email-programs (outlook, unix-shells, web-mail [gmail, hotmail, yahoo])

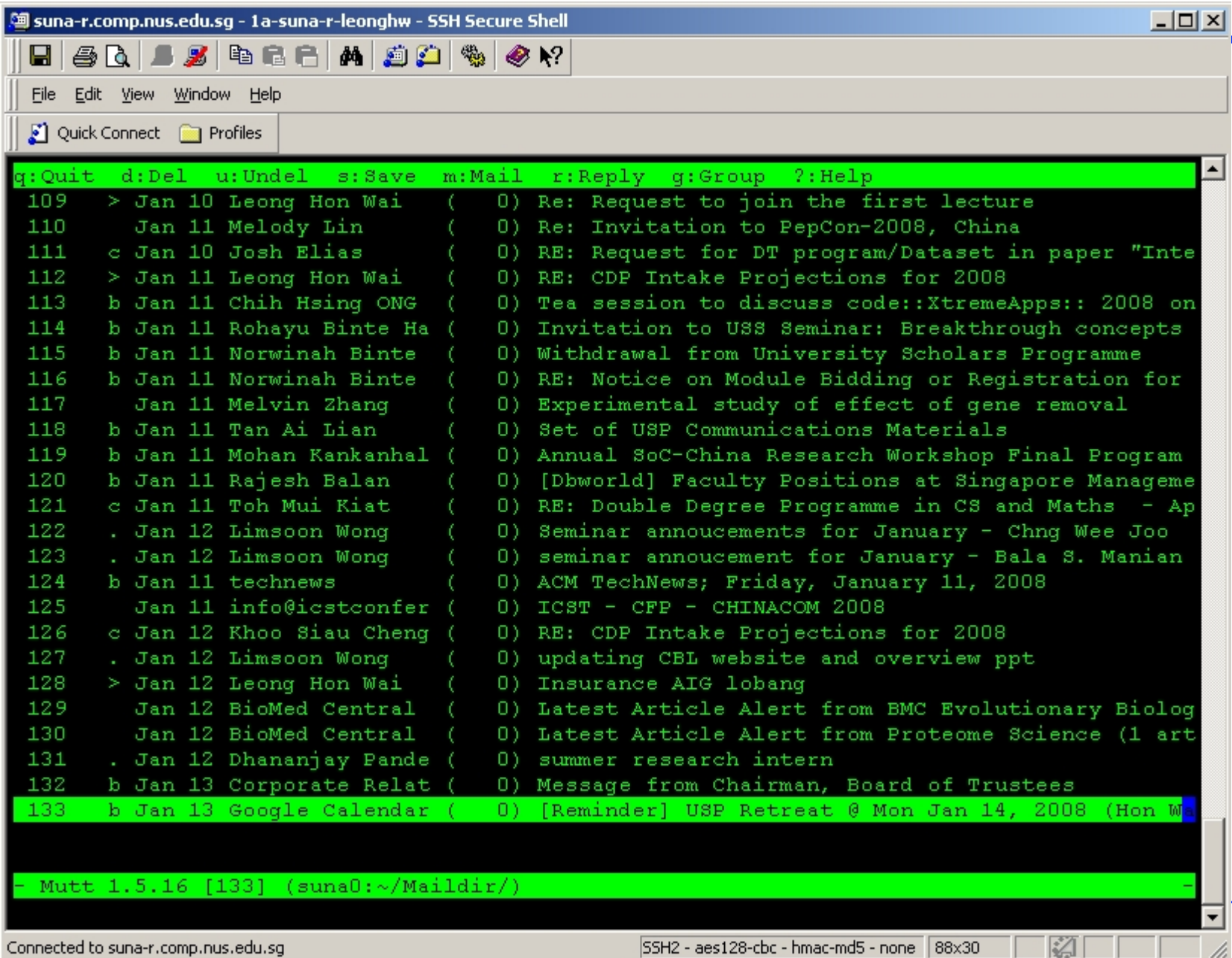
Example: My Mail using Outlook



Example: My Mail using webmail



Example: My Mail using Unix-shell



Example-2: Bank Account & ATM

Scenario: Maintaining Bank Accounts

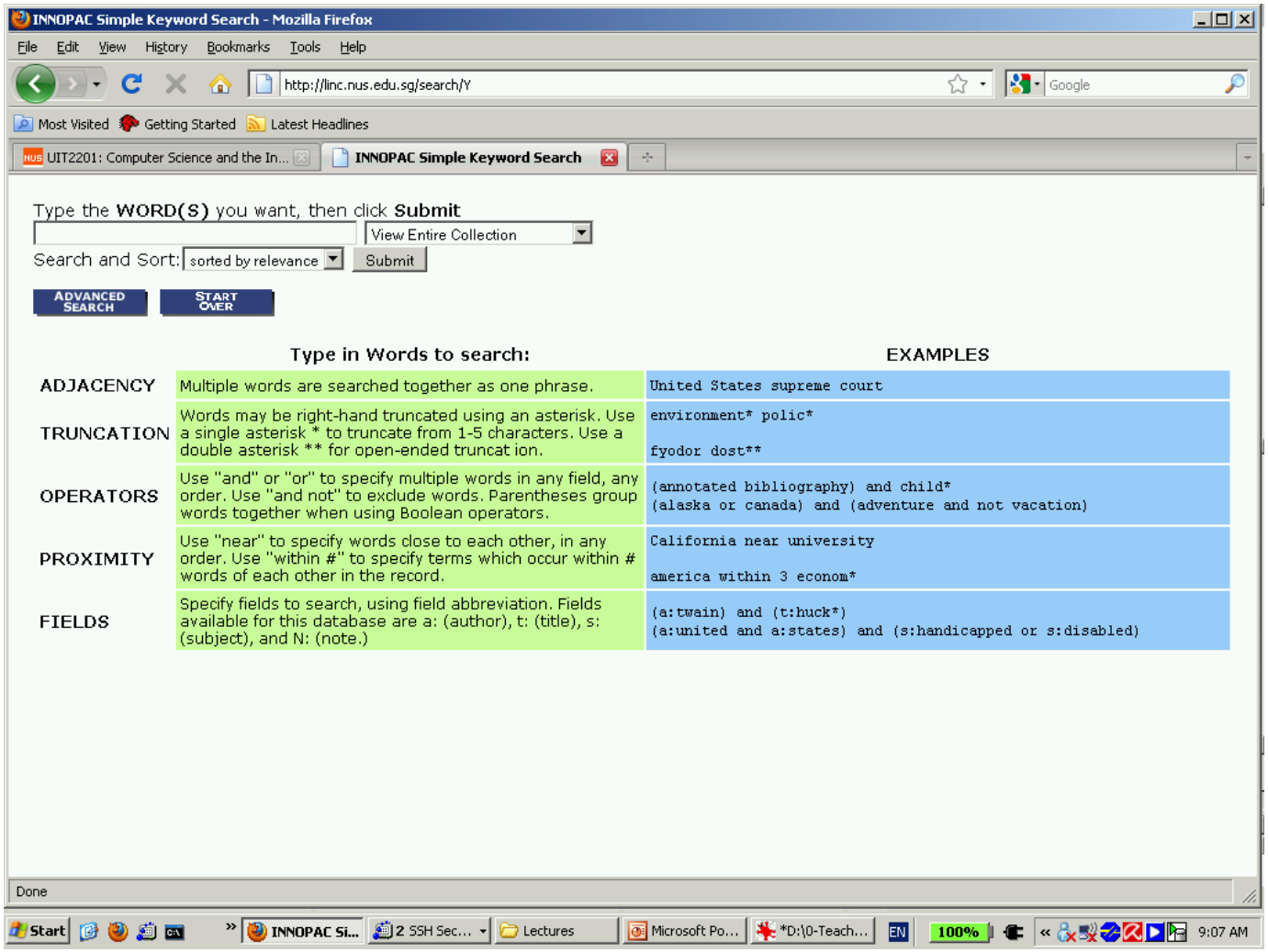
- **Isn't it simple?**
  - **Depositing money is just addition, and**
  - **Withdrawing is just subtraction.**
- **Issues and Complications**
  - **Thousands of customers, at hundreds of branches.**
  - **To do the crediting to the correct account.**
  - **Simultaneous access.**
  - **Information needs to travel from the ATM machine to the computer, and back.**

Example-2: Bank Account

- **Similar to Email in some ways.**
  - **Needs processing, network of computer,**
  - **Use lots of similar hardware and software.**

- **But, also Different:**
  - **Need different kind of buttons on ATM machine,**
  - **Need to do printing on a different kind of paper,**
  - **Need to read the ATM card, count money etc.**

NUS Library Search -- LINC



NUS Course Registration -- CORS

Example-3: LINC, CORS

- **Scenario: LINC (library system)**
  - Store and maintain information on library collection
  - Have a database of items (books),
  - Can search, reserve,
- **Similarities:**
  - Computer, hardware about the same.
- **Differences:**
  - Different interface
  - Different software
  - Difference functionalities
- **CORS --- YOU do the analysis…**

Example-4: MP3 Player

- **MP3 music player**
  - **Similar to LINC database**
    - *You may search, access information in similar way.*
  - **Different**
    - *now your machine interprets the information differently.*
    - *It converts the message into sound: a different interface.*

More Examples: Video Games

Scenario: 3D Walkthrough in Video Games

- **Question: is it similar to what we have seen so far? YES!**
  - **Computer stores info on the 3D structure (scene),**
  - **Project to 2D computer screen**
    - ***works out mathematically the projection from 3D scene to 2D***
  - **Software gets "your position" and "action"**
    - ***and appropriately updates the 2D picture on your screen.***
- **Similarities:**
  - **ATM also shows a different picture**
    - ***for different accounts you access and different operation you want.***
  - **The calculations for 3D walkthrough are very complicated,**
    - ***but is similar to those for other applications.***

Intelligent Computer – Capabilities

- **Common Capabilities**
  - **User Interface**
    - *"the face" of the computer*
  - **Database**
    - *Information store*
    - *Different types of info…*
  - **Database Retrieval**
    - *Fast, diverse*
  - **Data Transmission**
    - *Fast, accurate, secure*
  - **Complex Data Processing**

Intelligent Computer – functionalities

- **Can do Email, search, games, etc, etc…**
  - store large amount of information
  - find a particular piece of wanted information
  - move the information quickly
  - produce new information from old information quickly

  - these changes are specified / controlled by

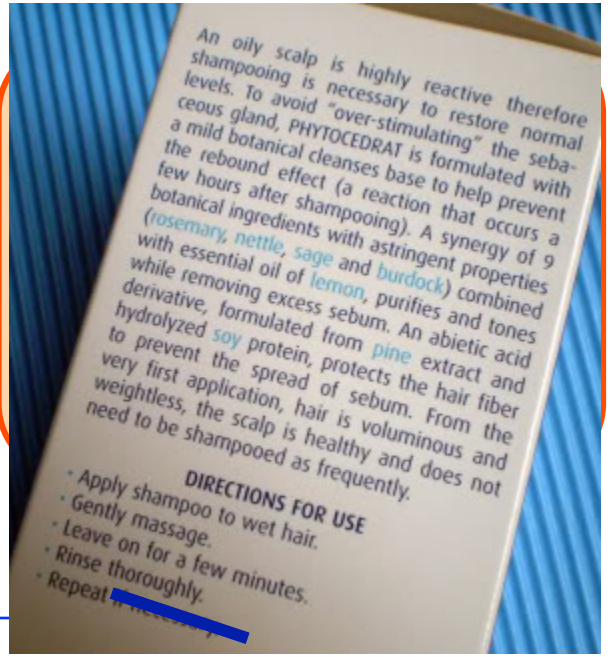
Algorithms

Algorithm

al go rithm [SG3] *A well-ordered collection of unambiguous and effectively computable operations that, when executed, produces a result and halts in a finite amount of time.*

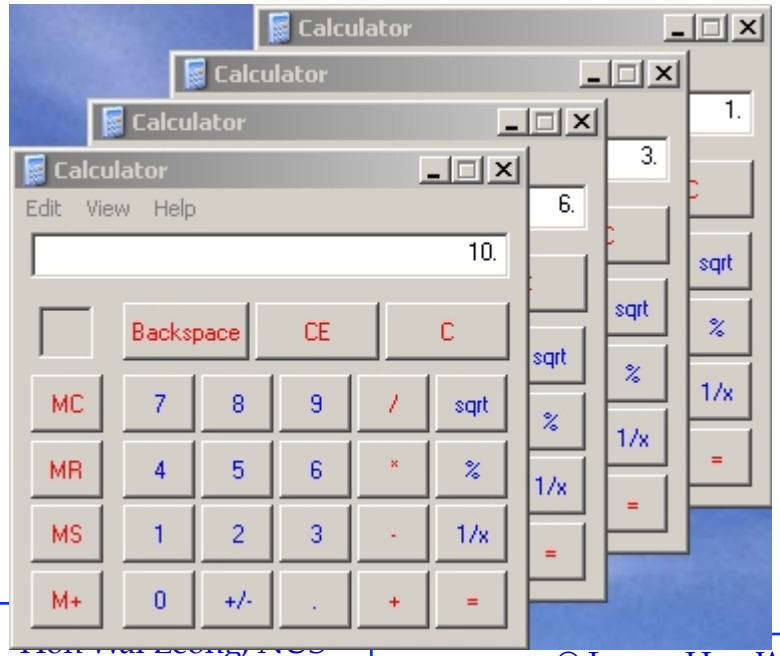
- **Informally:** *an algorithm is an ordered sequence of instructions that is guaranteed to solve a specific problem.*
- **Example of an algorithm (in everyday life):**

Step 1: Wet your hair
Step 2: Lather your hair
Step 3: Rinse your hair
Step 4: Lather your hair
Step 5: Rinse your hair
Step 6: Stop.



Example Problem: Adding 1 to 100

- **Problem: What is 1+2+3….+99+100 ?**
- **Straight-forward "Calculator" Method:**
  - **0+1=1; 1+2=3; 3+3=6; 6+4=10; 10+5=15; 15+6=21; … …**
  - **Repeatedly add "the next number" to "the sum"**
  - **At the beginning, start "the sum" with 0.**



But, humans are error prone.

Method cannot scale…

(Sum 1 to 10,000?)

Expressing Method as an *Algorithm*

- **Straight-forward "Calculator" Method:**
  - **0+1=1; 1+2=3; 3+3=6; 6+4=10; 10+5=15; 15+6=21; … …**
  - **Repeatedly add "the next number" to "the sum"**
  - **At the beginning, start "the sum" with 0.**

- **Now, express the above method as an *Algorithm*!**
  - **Let Sum represent "the sum"**
  - **Let k represent "the next number"**
  - **Question:**
    - ***Where are the steps that are repeated?***
    - ***What changes in-between each repetition?***

Algorithm to Find sum from 1 to 100

- 0+1=1; 1+2=3; 3+3=6; 6+4=10; 10+5=15; 15+6=21; … …
- Repeatedly add "the next number" to "the sum"
- At the beginning, start "the sum" with 0.

```
ALGORITHM Sum-1-to-100;
        sum ← 0
        k ← 1
Repeat: add k to sum
        add 1 to k
        If (k <= 100)?
           then Goto Repeat
           else Goto Finish
Finish: print out the value of sum
```

Iterations

Q: How many iterations? (DIY)

Simulating an *Algorithm*

❖ 0+1=1; 1+2=3; 3+3=6; 6+4=10; 10+5=15; 15+6=21; … …

ALGORITHM Sum-1-to-100;

sum ← 0

k ← 1

Repeat: add k to sum

add 1 to k

If (k <= 100)

then Goto Repeat

else Goto Finish

Finish: print out the value of sum

1 2 3 4 5 6 7 8 …

k

sum

DIY: Simulate the running of the algorithm…

Recurring Principle

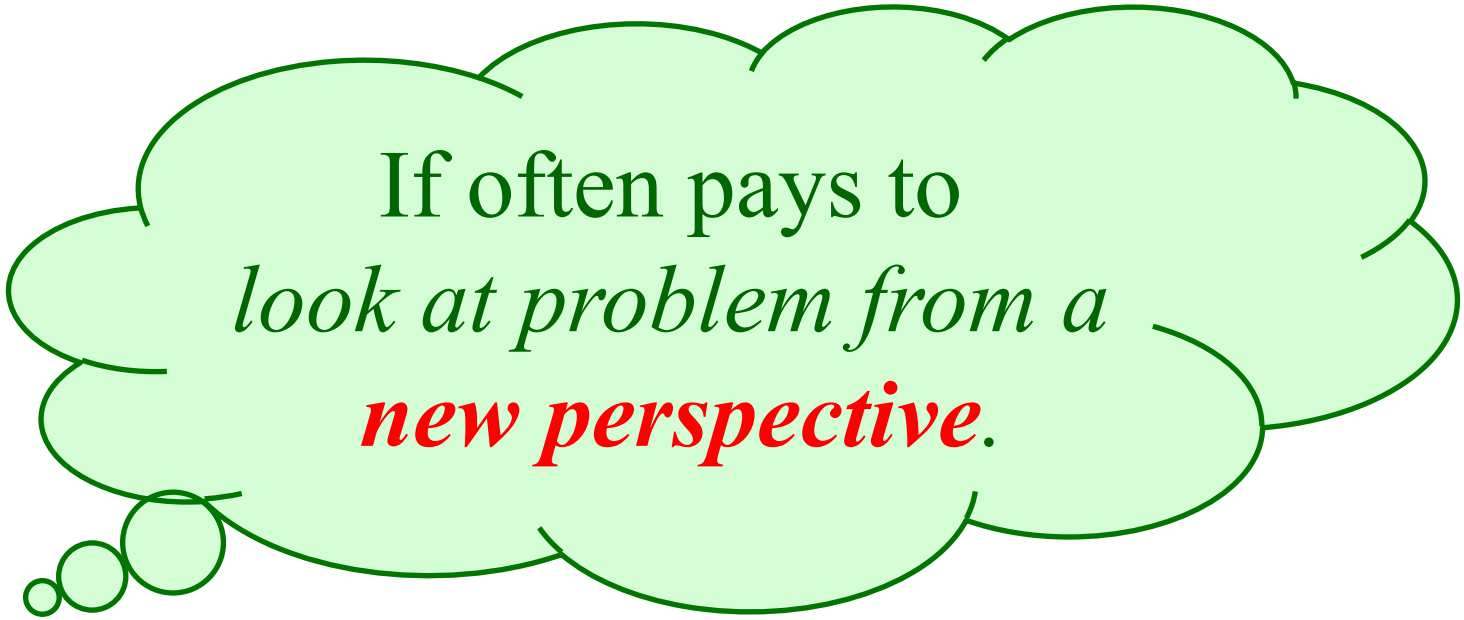
RP5: "The Power of Iteration"
(aka Recursion)

ALGORITHM Sum-1-to-100;

```
        sum ← 0
        k ← 1
Repeat: add k to sum
        add 1 to k
        If (k <= 100)
           then Goto Repeat
           else Goto Finish
Finish: print out the value of sum
```

If you are new to algorithm, go through the algorithm animation SLOWLY.

Make sure you master it.



Problem: Adding 1 to 100 [*Gauss*!]

- **Problem: What is 1+2+3….+99+100 ?**
- **Straight-forward "Calculator" Method:**
  - **0+1=1; 1+2=3; 3+3=6; 6+4=10; 10+5=15; 15+6=21; … …**
  - **Repeatedly add "the next number" to "the sum"**
  - **At the beginning, start "the sum" with 0.**

- **Side Track: Gauss' *Creative* Method**

1 + 100 = 101;
2 + 99 = 101;
3 + 98 = 101;
… … …
50+ 51 = 101;

50 pairs, each sum to 101

$$= \frac{100 \times 101}{2}$$

More about Gauss

Carl Friedrich Gauss

- (30 April 1777 – 23 February 1855)
- Prince of Mathematics
- Contributed to number theory, statistics, analysis, differential geometry, geodesy, geophysics, electrostatics, astronomy & optics.

Links:

- http://en.wikipedia.org/wiki/Carl_Friedrich_Gauss
- http://betterexplained.com/articles/techniques-for-adding-the-numbers-1-to-100/
- http://mathforum.org/library/drmath/view/57919.html
- http://www.jimloy.com/algebra/gauss.htm

Researchers' FUN: 9 steps to Gauss, 12 to Euler.
http://www.comp.nus.edu.sg/~leonghw/genealogy-leonghw.png

Intelligent Computer – How (cont…)

- **You are able to use the computer because**
  - **professionals have already done to hard work to make it look simple from your end.**
- **Complex Software make your life easy:**
  - **Applications such as Word Processing, Email, etc require thousands or millions of lines of code.**
  - **But, they are relatively easy to use.**
- **Source of Computer "Intelligence"**
  - **the variety of algorithms that we can come up with is where the versatility of computers come from.**

Why is the Computer "Intelligent"

- Human Intelligence
  - We invent/design the algorithms
  - We program them into software
- "Programmed" into the computer
  - Capabilities are "programmed into"
  - Why is Google search so "smart"
  - Is Google search "intelligent"?
- Machine Intelligence
  - A different notion, covered later in course.

So, where are we now….

- SOME problems are simple for a Computer.
  - Finding the books by particular author
  - Computing average height of 1 billion people given the list of their heights.
- But, we are not *THERE* yet…
  - We still do not have working algorithms for all the problems you may want to solve.
- Many "simple things" are HARD for Computer

What are still hard to compute?

- **Image Understanding / Computer Vision**
  - **Face Recognition;** **[Terence Sim, SOC]**
  - **Finding the ball in a soccer video** **[ACMMM-2003]**
- **Natural Language Processing**
- **Navigation or Motion Planning**

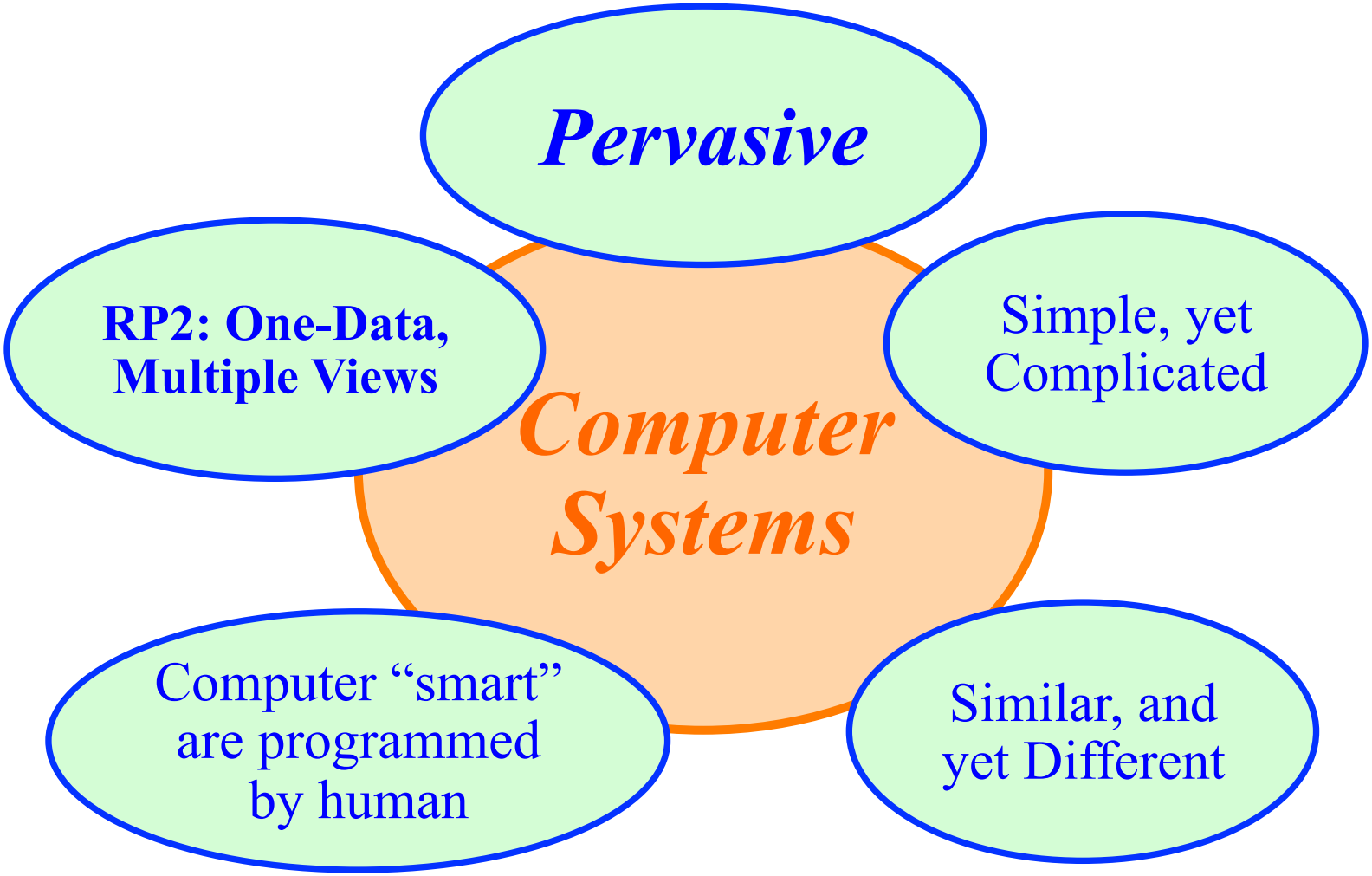
References:

http://en.wikipedia.org/wiki/AI-complete

What is Computer Science?

- **Computer Science is NOT *just***
  - **the study of computers**
  - **the study of how to write computer programs**
  - **the study of the uses and applications of computers and software**
- **Computer Science is *the study of algorithms, including***
  - ***their formal and mathematical properties,***
  - ***their hardware realizations,***
  - ***their linguistic realizations,***
  - ***their applications***

Summary



The End.

Thank you