

# UIT2201: Lecture 2

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## □ 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

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**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...

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## □ 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)

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## Scenario:

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

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## Scenario:

Professor Preparata ([franco@cs.brown.edu](mailto:franco@cs.brown.edu)) at Brown Univ wants to send email to me ([leonghw@comp.nus.edu.sg](mailto: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](mailto:leonghw@comp.nus.edu.sg) mean?

Where is that?

# Email: ... many complicated steps

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**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.



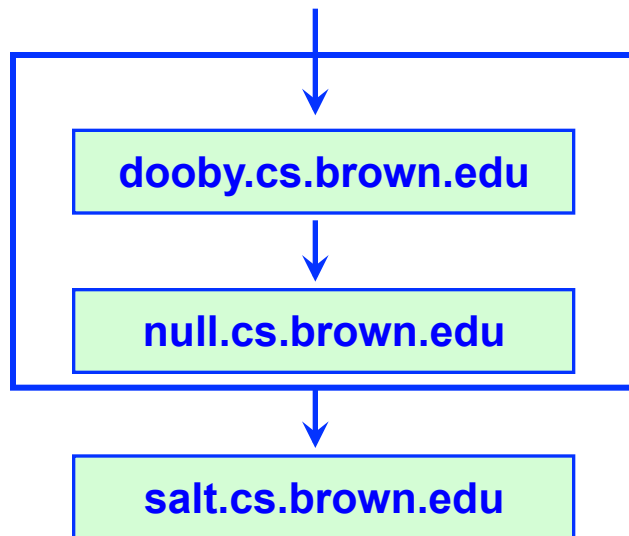
**Computer in NUS-SOC**  
Stores it away in mail file  
in my mailbox  
Show its when I access mail



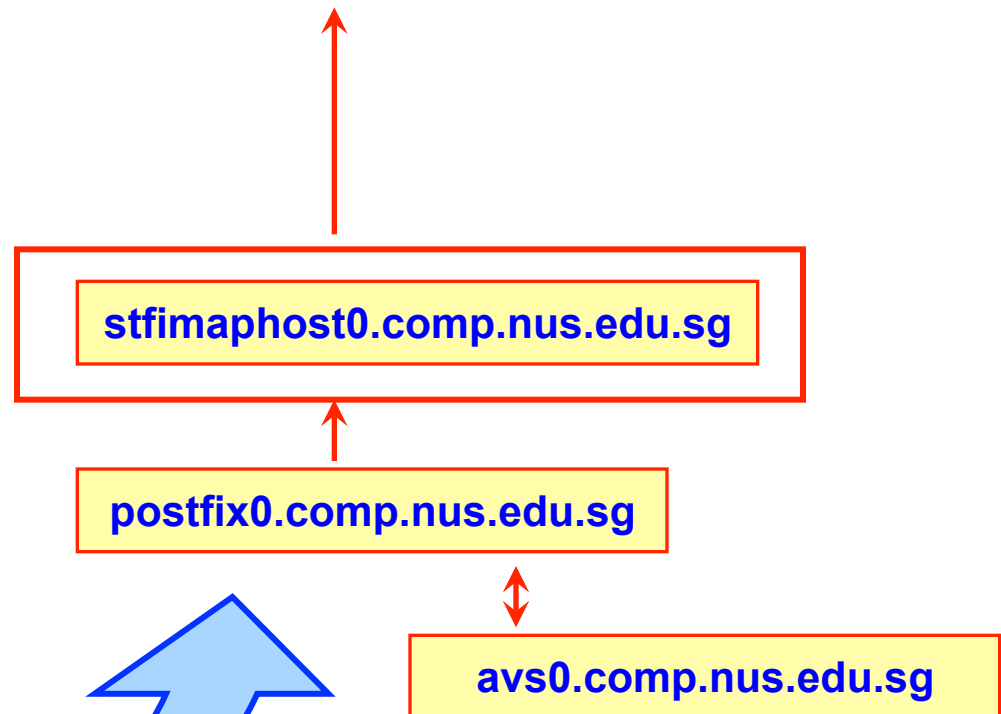
**Gateway in SG:**  
See “comp.nus.edu.sg”  
Send to node in NUS-SOC

# Actual Example:

Prof. Preparata sends  
email from Brown Univ



Prof. Leong receives and  
reads the email in NUS SOC



# 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-F1CzIl 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

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## ❑ 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

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## □ Contents of a folder

- ❖ List view, details, icon, tiles, etc

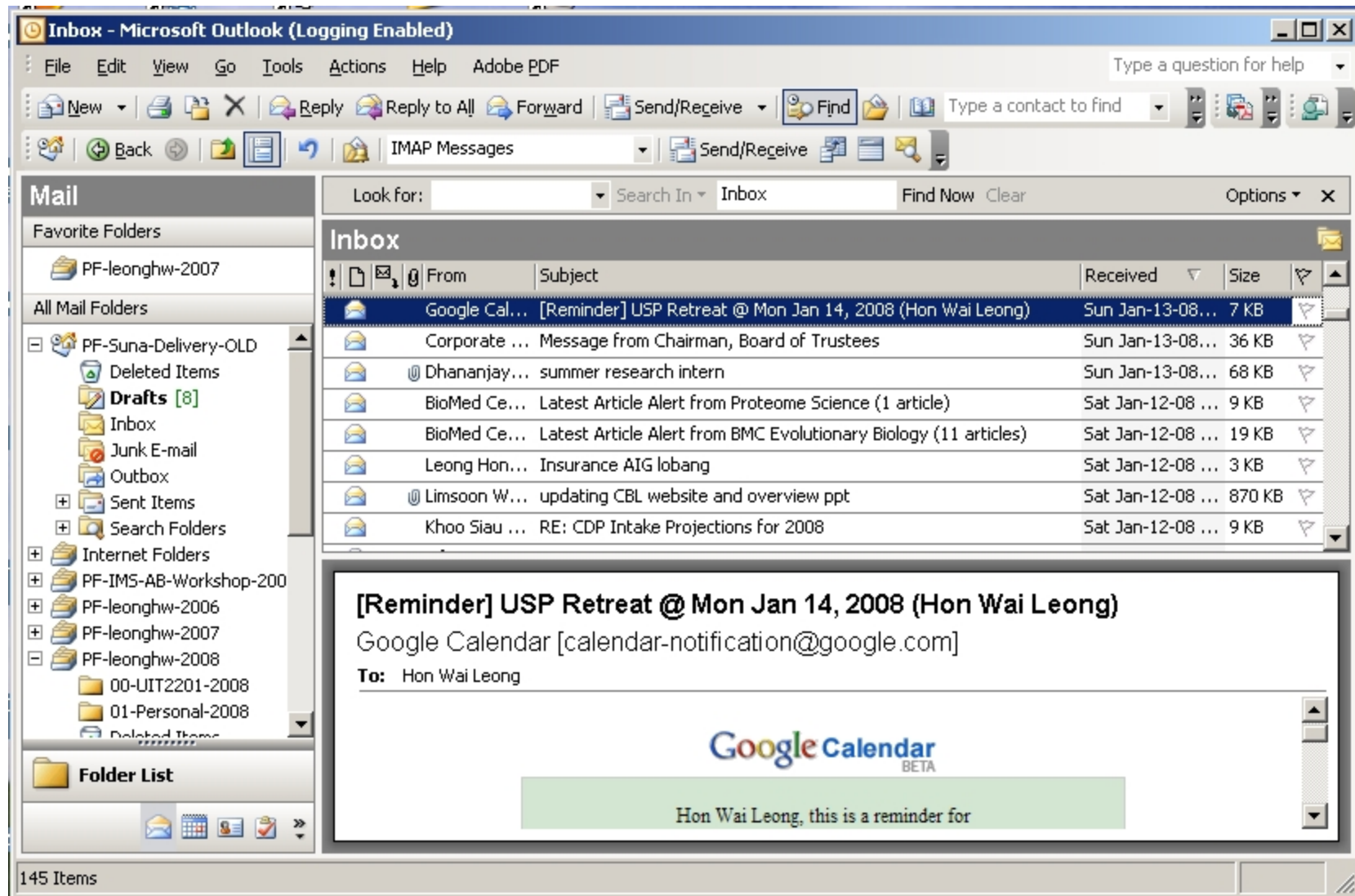
## □ Powerpoint file,

- ❖ 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

School of Computing (SquirrelMail 1.4.8) - Windows Internet Explorer

https://mysoc.nus.edu.sg/~webmail/src/webmail.php

File Edit View Favorites Tools Help

Google G Neo Tiew Road Singapore Go 752 blocked Check Neo Settings

School of Computing (SquirrelMail 1.4.8)

**Folders**  
Last Refresh:  
Sun, 5:35 pm  
(Check mail)

INBOX  
Drafts  
Sent  
Trash  
0-URGENT-NOW  
00-RADS  
AA-Appointment  
Directions-to-S  
Junk E-mail  
Drafts  
INBOX.Drafts  
INBOX.Sent  
INBOX.Trash  
Junk E-mail  
OLD-ACM-MM  
OLD-MAIL-20  
OLD-MAIL-20  
OLD-MAIL-20  
OLD-MAIL-20  
OLD-MAIL-Y2  
OLD-MAIL-Y2  
OLD-MAIL-Y2

Current Folder: **INBOX** [Sign Out](#)

[Compose](#) [Addresses](#) [Folders](#) [Options](#) [Search](#) [Help](#) [Calendar](#)

[Previous](#) | [Next](#) | [1](#) [2](#) [3](#) [4](#) [5](#) [6](#) [7](#) | [Show All](#) | [Toggle All](#) Viewing Messages: **1** to **20** (133 total)

Move Selected To:

Transform Selected Messages:

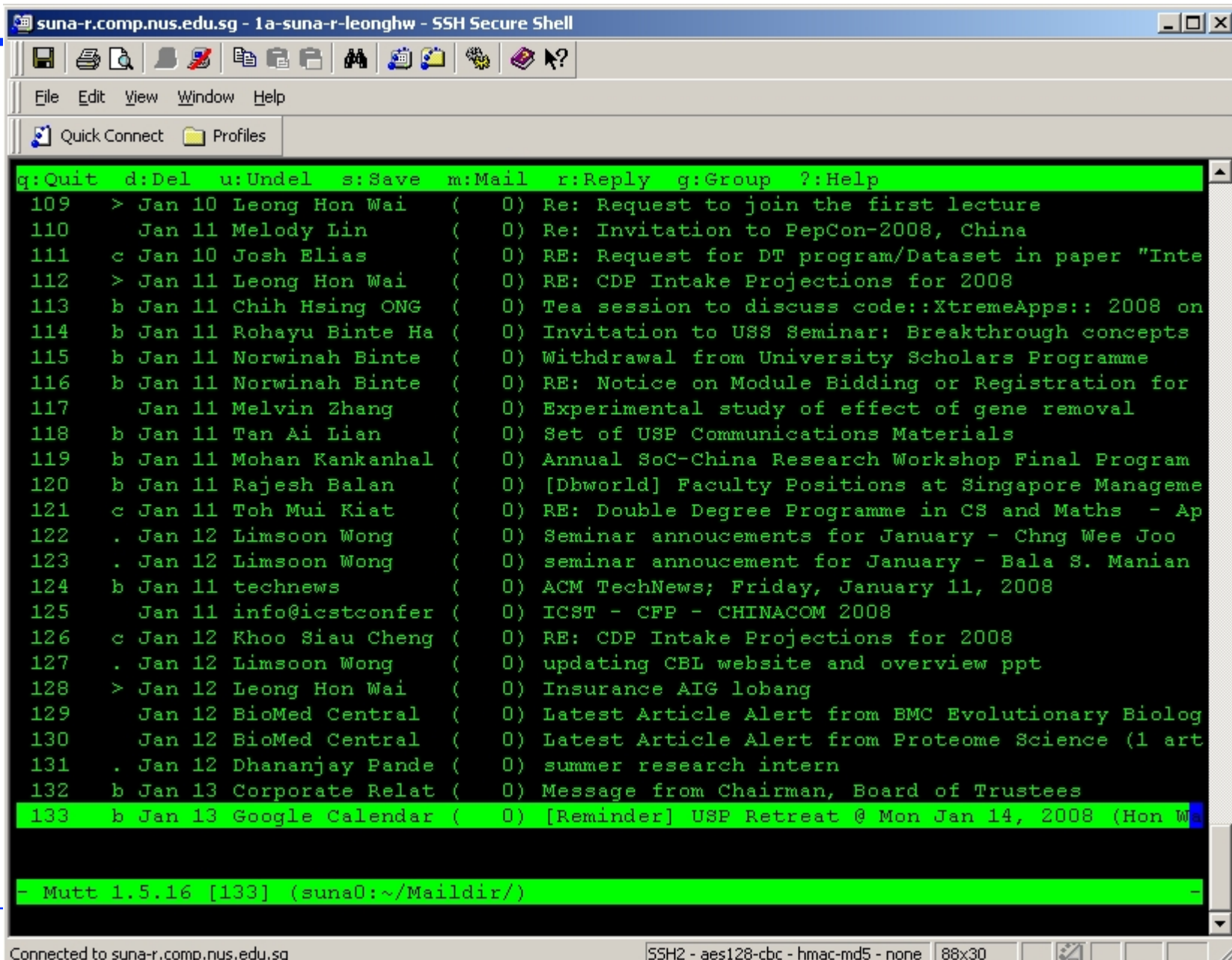
[Thread View](#)

☐ Move all Messages (Ignore Selections)

From	Date	Subject
<input type="checkbox"/> Google Calendar	4:00 pm	+ <a href="#">[Reminder] USP Retreat @ Mon Jan 14, 2008 (Hon Wai ...</a>
<input type="checkbox"/> Corporate Relations	11:56 am	+ <a href="#">Message from Chairman, Board of Trustees</a>
<input type="checkbox"/> Dhananjay Pandey	2:05 am	+ <a href="#">summer research intern</a>
<input type="checkbox"/> BioMed Central	Sat, 3:09 pm	<a href="#">Latest Article Alert from Proteome Science (1 arti...</a>
<input type="checkbox"/> BioMed Central	Sat, 11:30 am	<a href="#">Latest Article Alert from BMC Evolutionary Biology (11 ...</a>
<input type="checkbox"/> Leong Hon Wai	Sat, 11:01 am	<a href="#">Insurance AIG lobang</a>
<input type="checkbox"/> Limsoon Wong	Sat, 10:30 am	+ <a href="#">updating CBL website and overview ppt</a>
<input type="checkbox"/> Khoo Siau Cheng	Sat, 4:05 am	<a href="#">RE: CDP Intake Projections for 2008</a>
<input type="checkbox"/> info@icstconferences.org	Sat, 3:28 am	<a href="#">ICST - CFP - CHINACOM 2008</a>
<input type="checkbox"/> technews	Sat, 2:40 am	+ <a href="#">ACM TechNews; Friday, January 11, 2008</a>
<input type="checkbox"/> Limsoon Wong	Sat, 2:54 am	<a href="#">seminar annoucement for January - Bala S. Manian</a>

Local intranet 100%

# Example: My Mail using Unix-shell



The screenshot shows a terminal window titled "suna-r.comp.nus.edu.sg - 1a-suna-r-leonghw - SSH Secure Shell". The window contains a mail client interface with a menu bar (File, Edit, View, Window, Help) and a toolbar. Below the toolbar is a status bar with "Quick Connect" and "Profiles". The main area displays a list of emails with columns for line number, action, date, sender, and subject. The list is as follows:

Line	Action	Date	Sender	Subject
109	>	Jan 10	Leong Hon Wai	( 0) Re: Request to join the first lecture
110		Jan 11	Melody Lin	( 0) Re: Invitation to PepCon-2008, China
111	c	Jan 10	Josh Elias	( 0) RE: Request for DT program/Dataset in paper "Inte
112	>	Jan 11	Leong Hon Wai	( 0) RE: CDP Intake Projections for 2008
113	b	Jan 11	Chih Hsing ONG	( 0) Tea session to discuss code::XtremeApps:: 2008 on
114	b	Jan 11	Rohayu Binte Ha	( 0) Invitation to USS Seminar: Breakthrough concepts
115	b	Jan 11	Norwinah Binte	( 0) Withdrawal from University Scholars Programme
116	b	Jan 11	Norwinah Binte	( 0) RE: Notice on Module Bidding or Registration for
117		Jan 11	Melvin Zhang	( 0) Experimental study of effect of gene removal
118	b	Jan 11	Tan Ai Lian	( 0) Set of USP Communications Materials
119	b	Jan 11	Mohan Kankanhal	( 0) Annual SoC-China Research Workshop Final Program
120	b	Jan 11	Rajesh Balan	( 0) [Dbworld] Faculty Positions at Singapore Manageme
121	c	Jan 11	Toh Mui Kiat	( 0) RE: Double Degree Programme in CS and Maths - Ap
122	.	Jan 12	Limsoon Wong	( 0) Seminar annoucements for January - Chng Wee Joo
123	.	Jan 12	Limsoon Wong	( 0) seminar annoucement for January - Bala S. Manian
124	b	Jan 11	technews	( 0) ACM TechNews; Friday, January 11, 2008
125		Jan 11	info@icstconfer	( 0) ICST - CFP - CHINACOM 2008
126	c	Jan 12	Khoo Siau Cheng	( 0) RE: CDP Intake Projections for 2008
127	.	Jan 12	Limsoon Wong	( 0) updating CBL website and overview ppt
128	>	Jan 12	Leong Hon Wai	( 0) Insurance AIG lobang
129		Jan 12	BioMed Central	( 0) Latest Article Alert from BMC Evolutionary Biolog
130		Jan 12	BioMed Central	( 0) Latest Article Alert from Proteome Science (1 art
131	.	Jan 12	Dhananjay Pande	( 0) summer research intern
132	b	Jan 13	Corporate Relat	( 0) Message from Chairman, Board of Trustees
133	b	Jan 13	Google Calendar	( 0) [Reminder] USP Retreat @ Mon Jan 14, 2008 (Hon W

At the bottom of the window, a status bar shows "Mutt 1.5.16 [133] (suna0:~/Maildir/)" and "Connected to suna-r.comp.nus.edu.sg". The bottom right corner of the window displays "SSH2 - aes128-cbc - hmac-md5 - none 88x30".

# Example-2: Bank Account & ATM

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## 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

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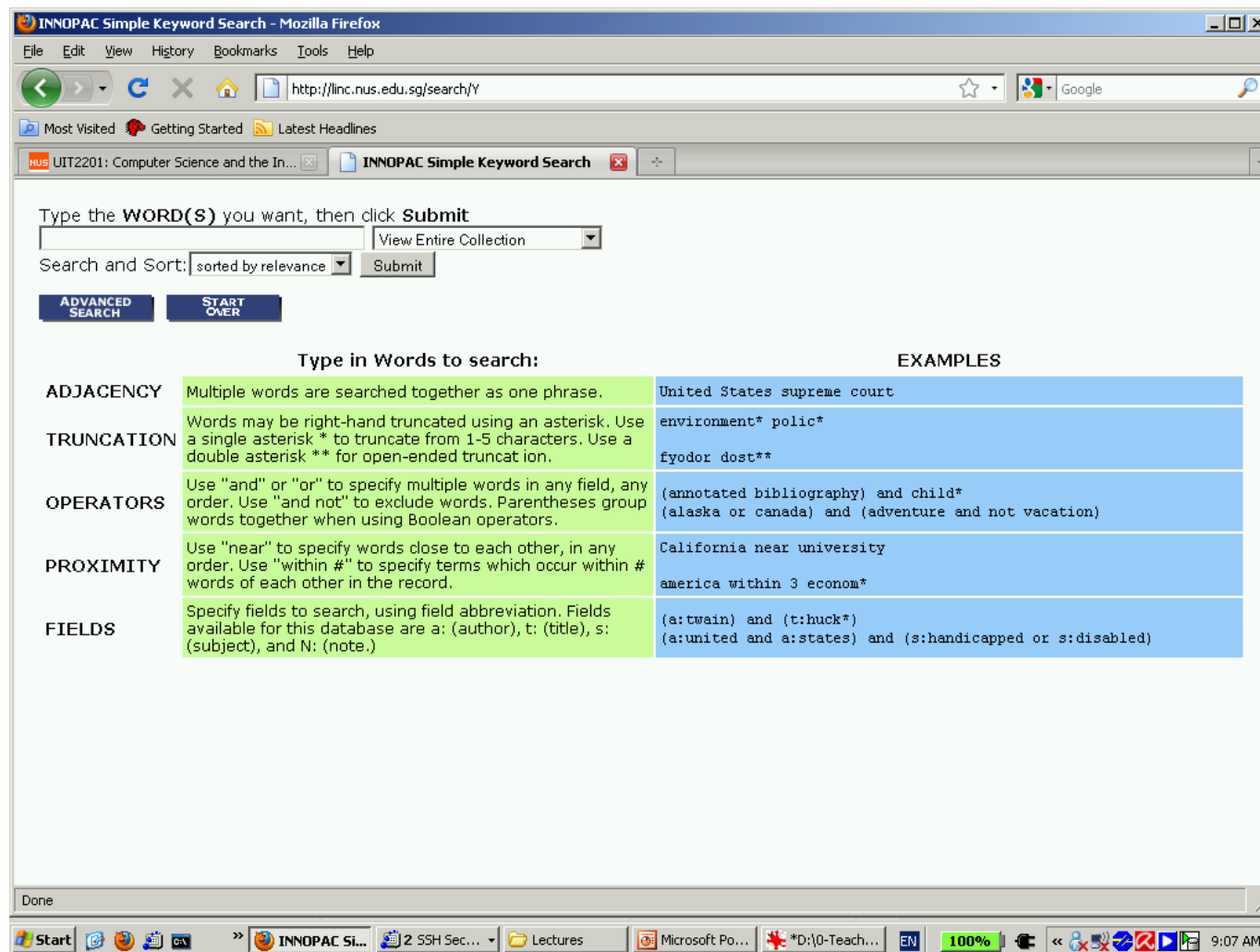
## □ Similar to Email in some ways.

- ❖ Needs processing, network of computer,
- ❖ Use lots of similar hardware and software.

## □ But, also Different:

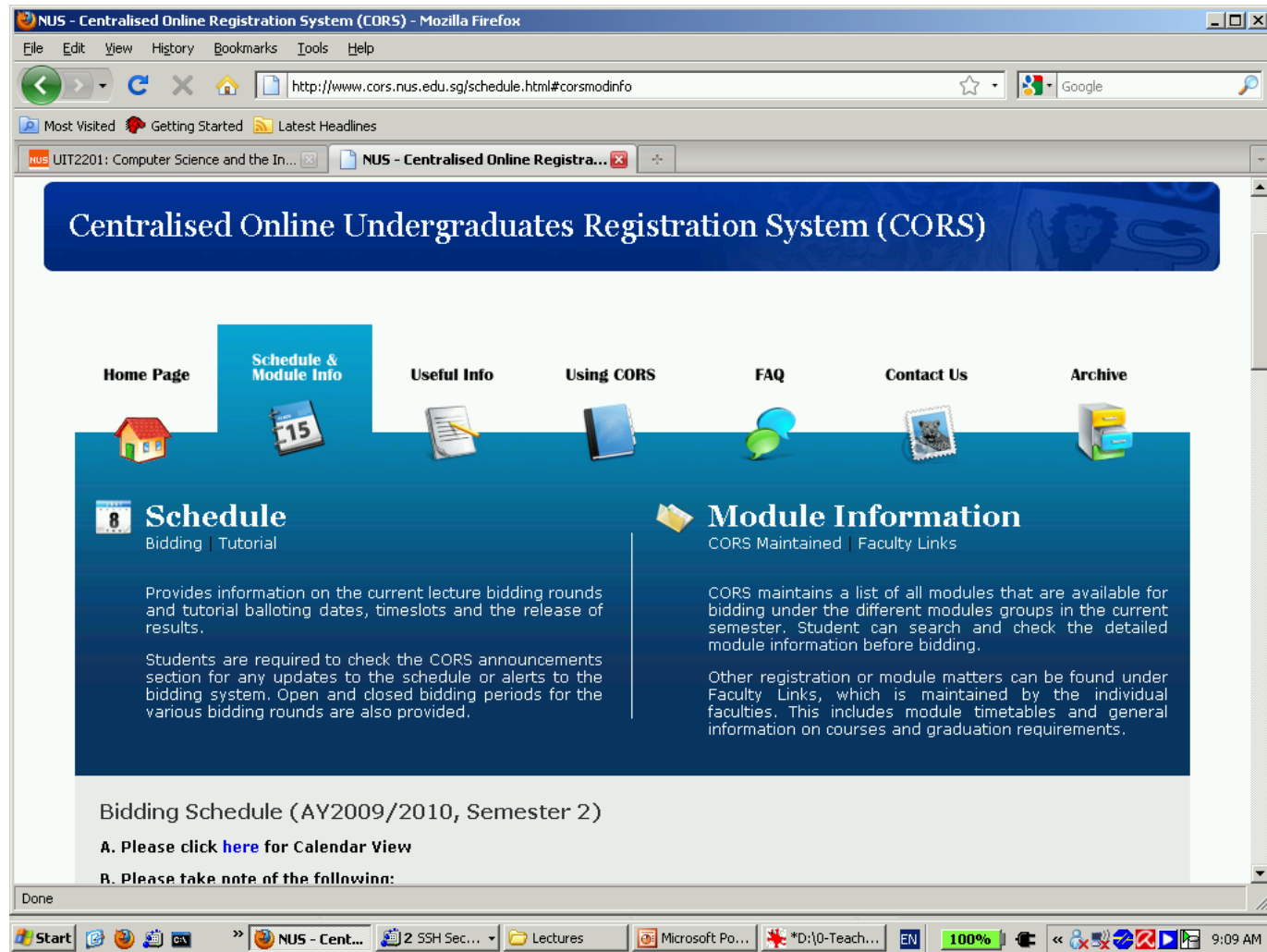
- ❖ Need different kind of buttons on ATM machine,
- ❖ Need to do printing on a different kind of paper,
- ❖ Need to read the ATM card, count money etc.

# NUS Library Search -- LINC





# NUS Course Registration -- CORS



# Example-3: LINC, CORS

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## ❑ **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

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## ❑ 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

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## 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

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## □ 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

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## □ 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

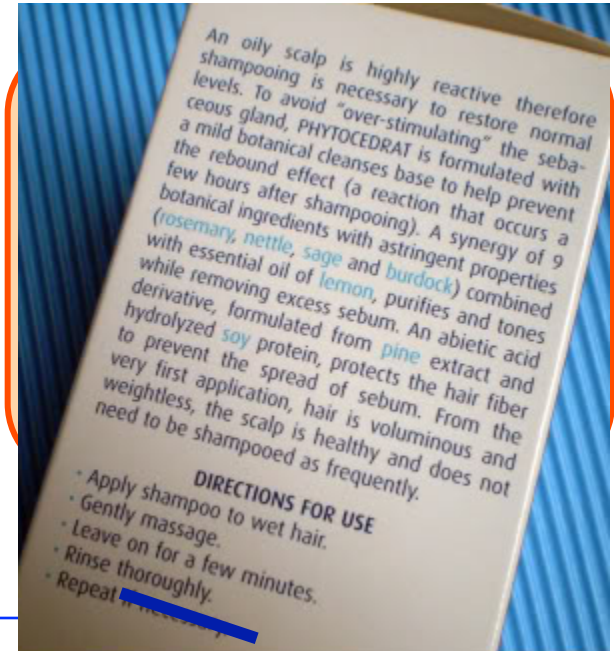
## Algorithms

# Algorithm

**algorithm [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.**

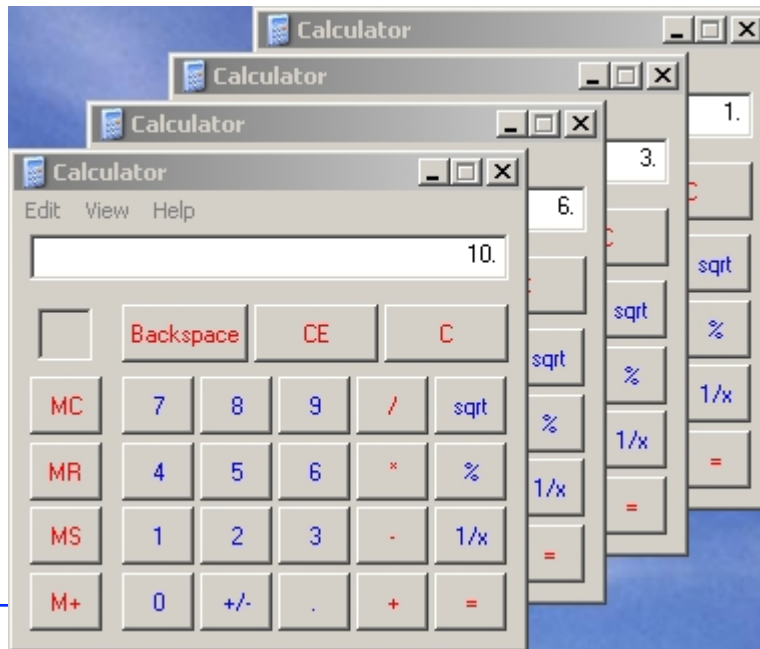


# Example Problem: Adding 1 to 100

❑ **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:

- ❖  $0+1=1; 1+2=3; 3+3=6; 6+4=10; 10+5=15; 15+6=21; \dots$
- ❖ 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  $\leftarrow$  0

k  $\leftarrow$  1

Repeat: add k to sum

add 1 to k

If (k  $\leq$  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;

$\text{sum} \leftarrow 0$

$k \leftarrow 1$

**Repeat:** add  $k$  to  $\text{sum}$

add 1 to  $k$

**If** ( $k \leq 100$ )

**then Goto Repeat**

**else Goto Finish**

**Finish:** print out the value of  $\text{sum}$

1 2 3 4 5 6 7 8 ...

$k$

$\text{sum}$



**DIY: Simulate the running  
of the algorithm...**

# Recurring Principle

## RP5: “The Power of Iteration” (aka Recursion)

### ALGORITHM Sum-1-to-100;

sum  $\leftarrow$  0

k  $\leftarrow$  1

**Repeat:** add k to sum

add 1 to k

**If** (k  $\leq$  100)

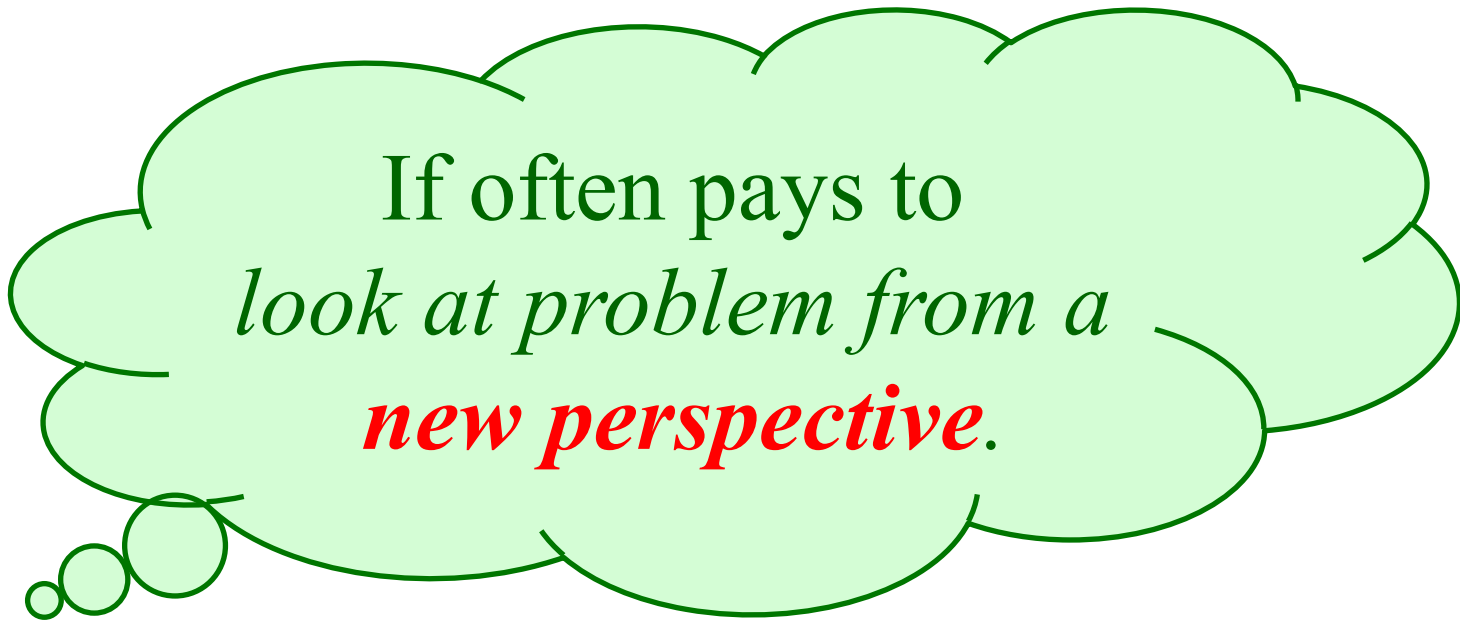
**then** Goto Repeat

**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.**



If often pays to  
*look at problem from a*  
***new perspective.***

# 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://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...)

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## ❑ 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”

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## □ 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....

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□ **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?

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## ❑ 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?

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## ❑ Computer Science is NOT *just*

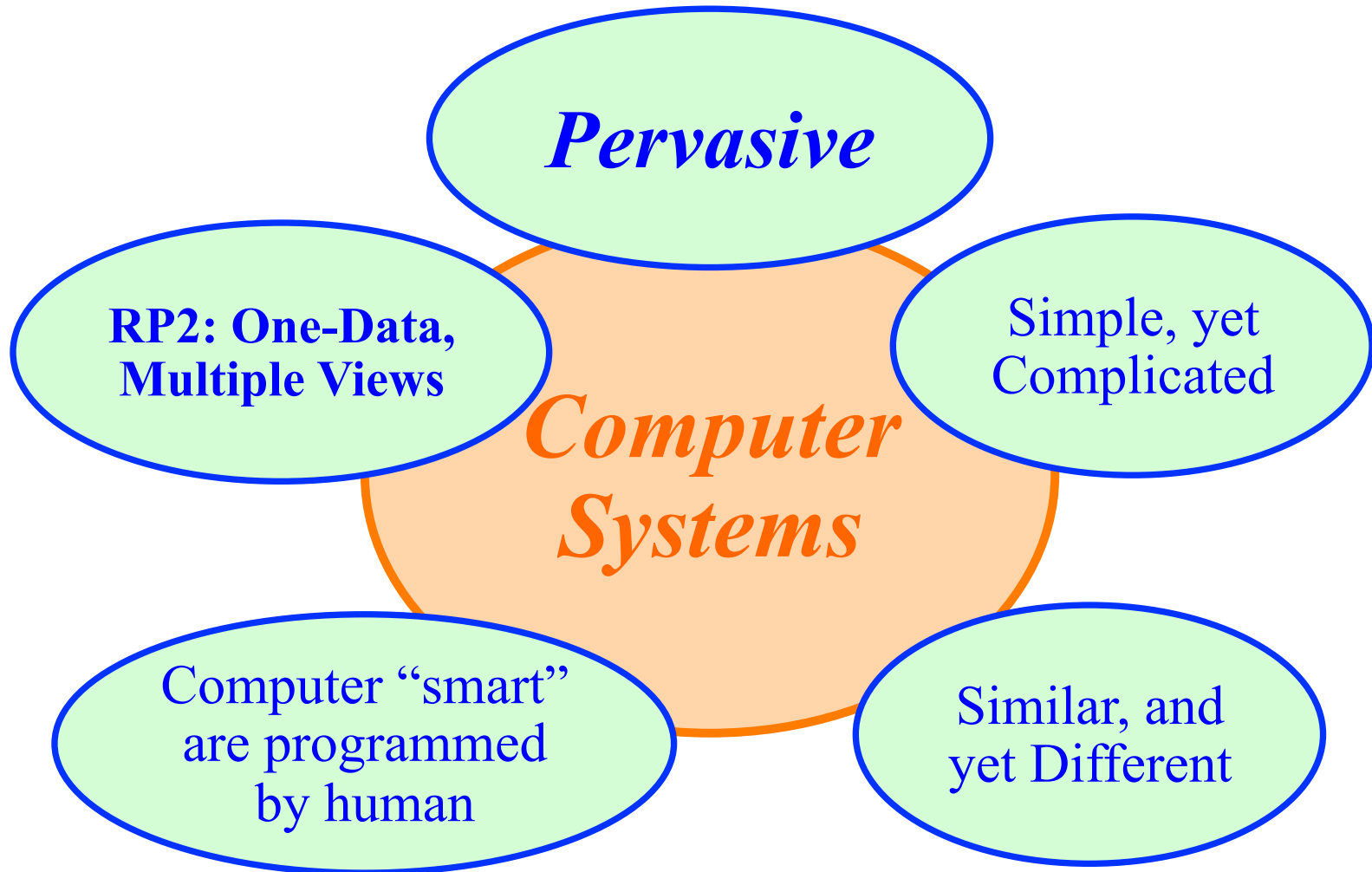
- ❖ the study of computers
- ❖ the study of how to write computer programs
- ❖ the study of the uses and applications of computers and software

## ❑ Computer Science is *the study of algorithms, including*

- ❖ *their formal and mathematical properties,*
- ❖ *their hardware realizations,*
- ❖ *their linguistic realizations,*
- ❖ *their applications*

# Summary

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***The End.***

***Thank you***