Introduction To Computer Science

In this section you will get an overview of some areas of Computer Science.

James Tam

Introduction To Computer Science

•What is Computer Science?

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Introduction To Computer Science

•What is Computer Science?

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Introduction To Computer Science

•Computer Science is about problem solving

Graphics

Interactive displays

Robotics: acceptance of domesticated robots

Artificial Intelligence
FIFA © Electronic Arts.

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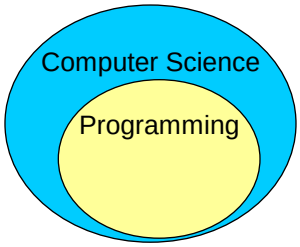
Computer Science Is Not The Same As Computer Programming

•Computer Science does require the creation of computer programs ('programming') but goes beyond that.



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Some Areas Of Study And Research In Computer Science

- Human-Computer Interaction
- Computer Graphics
- Information Visualization
- Databases
- Computer theory
- Computer networking and distributed systems
- Artificial Intelligence
- Computer Vision
- Software Engineering
- Computer Security
- Games programming

This list provides only a brief introduction to the different areas of Computer Science and is far from comprehensive:
For a more updated list: http://www.cpsc.ucalgary.ca/Research/

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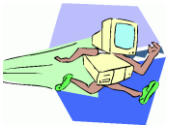
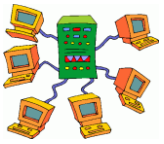
Human-Computer Interaction (HCI)

- Most of Computer Science deals with the 'technical' side of computers.



Run computers faster!

Make computers store more information!!



Increase the networking capabilities of computers!!!

- These technical issues (and others) are all very important but something is still missing...

For more information: http://ilab.cpsc.ucalgary.ca/

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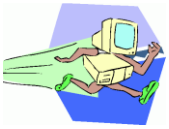

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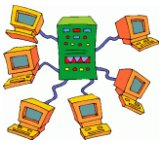

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Human-Computer Interaction

- ...but don't forget about the other side of the relationship.
- No matter how powerful the computer and how well written is the software, if the user of the program can't figure out how it works then the system is useless.
- Software should be written to make it as easy as possible for the user to complete their task. (Don't make it any harder than it has to be).
- This is just common sense and should/is always taken into account when writing software?

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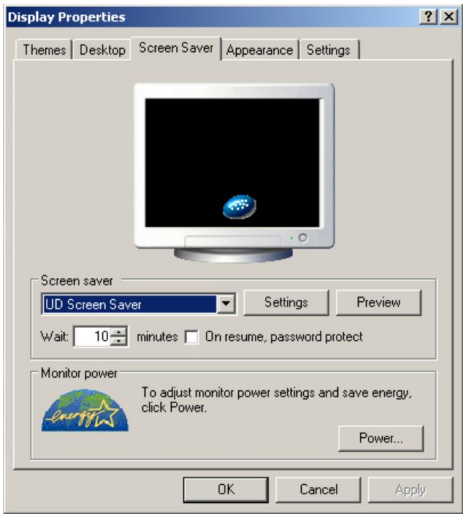
Human-Computer Interaction: Not Just Common Sense Information



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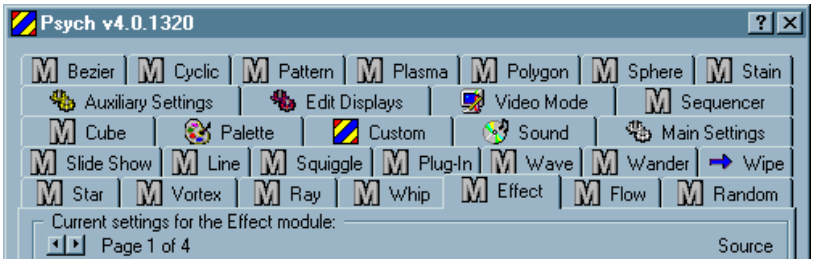
Human-Computer Interaction: Not Just Common Sense Information (2)



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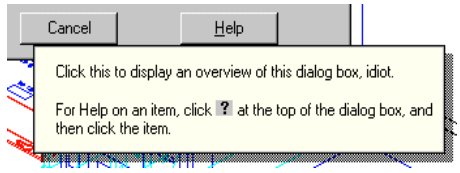
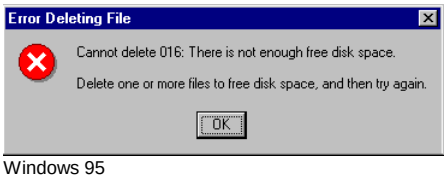
Human-Computer Interaction: Not Just Common Sense Information (3)



AutoCAD Mechanical



Windows 95

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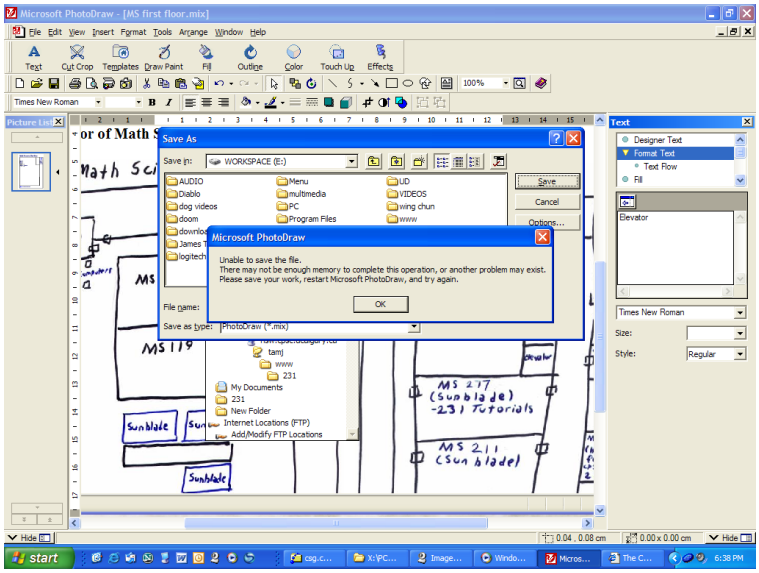
Human-Computer Interaction: Not Just Common Sense Information (4)



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What Is Human-Computer Interaction?

~~Difficult to use~~

Easy to use

Or at least easier to use

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Determining Requirements For Software

- Requirements are typically a list of 'features' or operations that the software performs.
  - E.g., for a word processor it could include saving, printing, spell checking etc.
- While having the proper functionality is important (fulfilling the requirements) it's not sufficient.
  - Although a program might include a particular feature if users cannot find or figure out how to use the feature then it's useless.

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Ways Of Including The 'Human' In The Development Process

- Get in touch with real people who will be potential users of your system.
- Spend time with them discussing how the system might fit in to their work.
- Learn about the user's tasks:
  - Articulate concrete, detailed examples of tasks they currently complete or those that they want to complete (ones that they want to do but can't do

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Computer Graphics

- Concerned with producing images on the computer.

Gran Turismo © Sony

For more information: http://jungle.cpsc.ucalgary.ca/

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Computer Graphics: Issues

•How to make the images look "real"?

From http://klamath.stanford.edu/~aaa/

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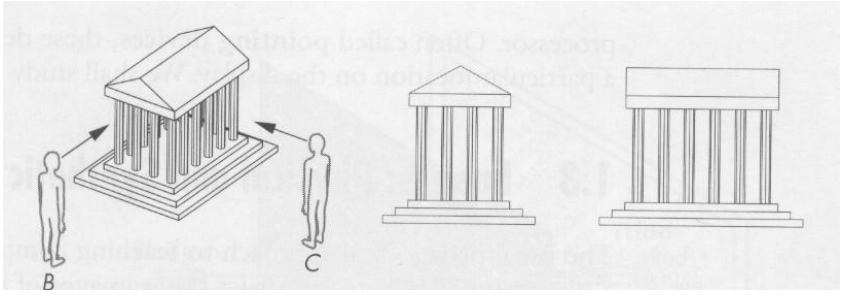
Computer Graphics: Highly Mathematical

•Highly mathematical



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Computer Graphics: Still A Long Way To Go

- "Even though modeling and rendering in computer graphics have been improved tremendously in the past 35 years, we are still not at the point where we can model automatically, a tiger swimming in the river in all it's glorious details." [1]

[1] From "The Tiger Experience" by Alain Fournier at the University of British Columbia

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Artificial Intelligence

- Trying to build technology that appears to be 'intelligent'
- What makes a person smart?

"*We don't truly understand what intelligence is, but we hope we know it when we see it*." – Kenneth Hoganson (Concepts in Computing): Jones and Bartleett 2008)

For more information:
http://pages.cpsc.ucalgary.ca/~jacob/AI/
http://pages.cpsc.ucalgary.ca/~denzinge/
http://pages.cpsc.ucalgary.ca/~kremer

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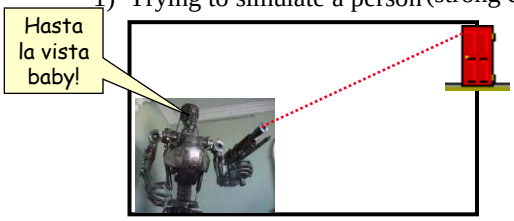
Artificial Intelligence (2)

- Approaches:
  1) Trying to simulate a person (strong equivalence)



  2) Trying to simulate what the person can do

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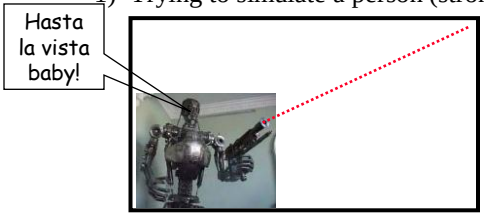
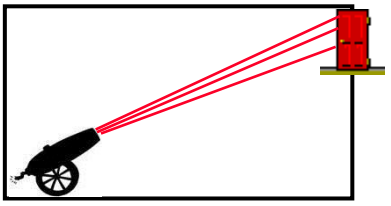
Artificial Intelligence (2)

- Approaches:
  1) Trying to simulate a person (strong equivalence)



  2) Trying to simulate what the person can do (weak equivalence)



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Fields Of Artificial Intelligence

- Machine learning
- Experts systems
- Neural networks
- Fuzzy logic

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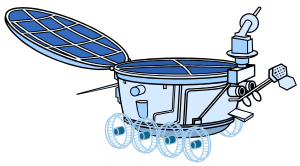
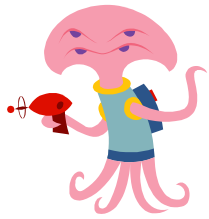
Machine Learning

- The focus is on designing a computer that has the ability to learn and adapt to new situations (rather than just apply a fixed set of rules).



Pre-set rules: terrain

New scenario: life form encountered



Pre-set rules: terrain

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Expert Systems

- The focus is on capturing the knowledge of a human expert as a set of rules stored in a database.
- The expert system can then answer questions, diagnose problems and guide decision making.
- Example applications: medicine, computer repair

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Neural Networks

- The focus is on building structures that function the way that neurons (and their connections in the brain) function.
- (Simplified overview):
  - Neurons take electrical pulses and input and send electrical pulses as output.
  - A required level of input is required before the output is fired.
- This approach has been applied to problems which involve pattern recognition (e.g., visual, voice).

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Fuzzy Logic

- People can make decisions when faced with uncertainty.
- The standard logic of computer programs (true/false) cannot be easily applied when relationships can be applied with only a degree of probability.
  - Standard computer program:
    if X then Y
    e.g., if temperature >= 50 then decrease temperature

- Fuzzy logic is reasoning with probabilities
  - Fuzzy logic programs:
    If close enough to X then Y
    E.g., if temperature is too hot then make temperature less hot

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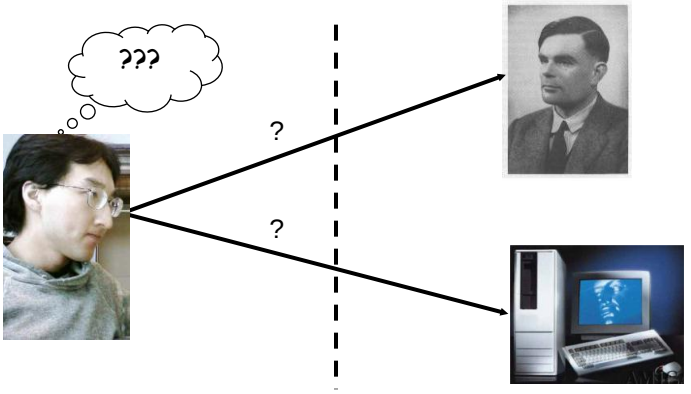
Artificial Intelligence: Mission Accomplished?

- How do we know we have a "smart machine"?
  - The Turing test



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An Artificial Intelligence: Won't Be Created In The Foreseeable Future

•Much work still needs to be done

Photo from www.startrek.com © Paramount

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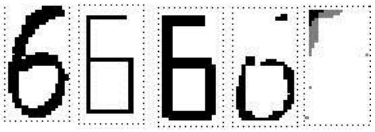
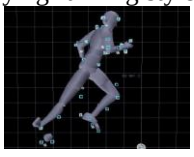
Computer Vision

•The focus is on interpreting and understanding visual information.

- Hand writing recognition: six?



- Analyzing digital video: studying running styles (i.e., not just still images)



For more information:
http://pages.cpsc.ucalgary.ca/~boyd/pmwiki/pmwiki.php?n=Main.Research

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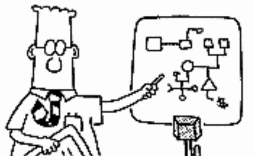
Software Engineering



Dilbert © United Features Syndicate

- Concerned with employing systematic ways of producing good software on time and within budget.
- A typical person can only hold ~7 concepts in their mind at a time.
  - A typical computer program consists of more than 7 'parts'.
- Consequently mechanisms for dealing with this complexity are needed.
  - Top down approach break a large (hard to conceive) problem into smaller more manageable parts.

For more information:
http://www.cpsc.ucalgary.ca/cpsc_research/areas/evolutionary

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Software Engineering (2): Techniques

- Extreme programming
- Agile development
- Design patterns

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Extreme Programming

- The focus is on developing prototypes very quickly with extensive testing and user communication.
- With the traditional approach to software development where specifications (what the software is supposed to do) is determined at the start and fixed throughout the project ("sign offs" may occur).
- With extreme programming specifications can and will change.
  - (It's argued that it's impossible to correctly envision all the issues associated with a large project at the onset).
  - There is however greater risk that the software will run into 'dead ends' and it has to be redesigned.
- Consequently with extreme programming changes occur to the software to adapt to things like changing client requirements.

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Agile Programming

- Related to extreme programming.
- The focus is on reducing risk by producing a new 'iteration' of the software in a short period of time (~1 – 4 weeks).
- The project is then evaluated.
  - The emphasis is on real time and face-to-face communication between developers over written documentation.
  - Everyone associated with the project is brought together: developers, software testers, project managers and end users.
  - Benefit: reduced development time with fewer misunderstandings.
- Contrast with traditional development: formal processes are followed such as heavily documenting program code.

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Agile Programming (2)

- Traditional approaches work well for extremely large projects that require a high degree of reliability.
- Agile programming works well for smaller (although still large) projects where having a shorter development time is crucial.

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Design Patterns

- A design pattern: a way of implementing and part of the software that has been shown to be been sound under a number of different contexts.
- Design patterns are a way of documenting past approaches to a problem that have shown be successful.

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Computer Security

•Involves the creation of malicious software ('malware')

Spam generators

- Purpose: learn about how malicious software is created and distributed.
- Goal: develop countermeasures to protect computer systems

Spyware

Virus software

For more information:
http://icis.cpsc.ucalgary.ca/

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Games Programming

•Pulls together many areas of Computer Science

•The University of Calgary was the first Canadian university to offer this area of study.

<< Warning!!! >>

Blatant advertisement

<< Warning!!! >>

"Scarface: The World is Yours" © Radical Entertainment

Sound byte: © "The Simpsons" Fox

For more information: http://www.cpsc.ucalgary.ca/undergrad/courses_progression/concentration?conc=game

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