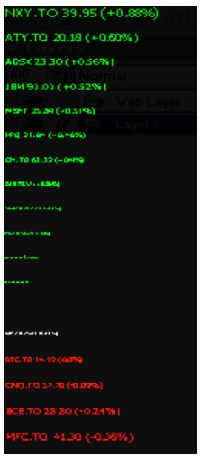
Introduction To Computer Science

In this section you will get an overview of some research areas and higher level courses in Computer Science.

Introduction To Computer Science

- Computer Science is about problem solving

Graphics:
Image curtesy of
Xin Liu



Representing large sets of data
Image from:
Lau, E. (2003) **Stocks**.

Artificial Intelligence
FIFA © Electronic Arts.

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 of research areas: http://www.cpsc.ucalgary.ca/Research/

Calendar (courses):

- http://www.ucalgary.ca/pubs/calendar/current/computer-science.html
- http://www.ucalgary.ca/pubs/calendar/current/software-engineering.html

James Tam

Some Areas Of Study And Research In Computer Science

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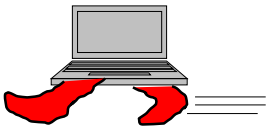
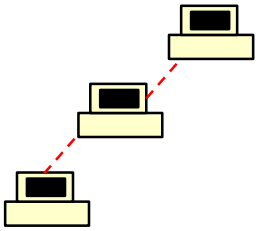
Human-Computer Interaction (HCI)

- Most of Computer Science deals with the 'technical' side of computers such as:



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/ James Tam

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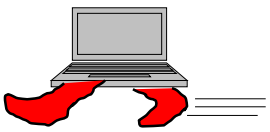

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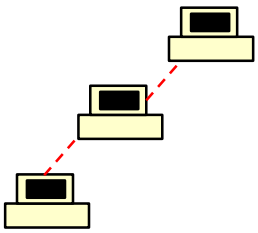

Increase the networking capabilities of computers!!!

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

Human-Computer Interaction

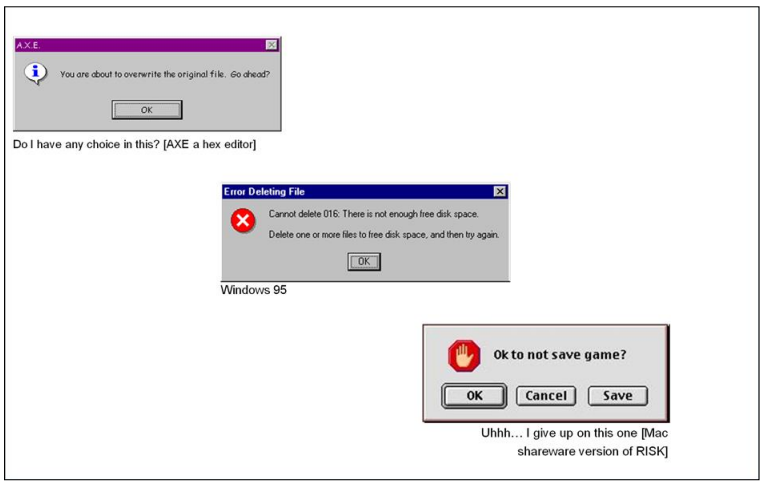
- ...but don't forget about the other side of the relationship.
- No matter how powerful the computer and how well written is the software, if the user can't figure out how it works then the system is useless.
- Software should be written to make it as easy as possible for the user to complete their 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?

Common sense?...come on!

James Tam

Previous Examples

- Cases where designing "user-friendly" technology was not just a matter of commonsense.



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What Is Human-Computer Interaction?

~~Difficult to use~~

Easy to use

Or at least easier to use

James Tam

How Can This Be Done?

- Many techniques have been developed.
  - Some may have already been covered (Usability heuristics from 'Repetition')
- One other technique: simple but effective (user-centered design)
  - Basic principle: getting users involved in the design process from the beginning (rather than building the system and then getting feedback afterwards which is the traditional approach).
  - Many benefits:
    - Cost reduction: The further along the software development process the harder it is to make changes.

Paper sketches

Complete software (from Saul Greenberg mockup)

- Users may also provide many unexpected insights

James Tam

HCI: Higher-Level Courses

- CPSC 481: Human-Computer Interaction I
- CPSC 581: Human-Computer Interaction II
- (Related: Human-Robot Interaction)
  - CPSC 599.65—Robot head-based interaction
  - CPSC 599.62—Advanced topics in human-computer and human-robot interaction
  - CPSC 599.17—Human-robot interaction

James Tam

Computer Graphics

- Concerned with producing and manipulating images using technology

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/

Computer Graphics: Common Misconception

- It’s about *creating* the programs that produce the realistic images and animations (not using existing programs like Photo shop ©).

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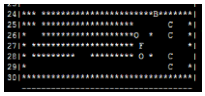
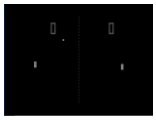
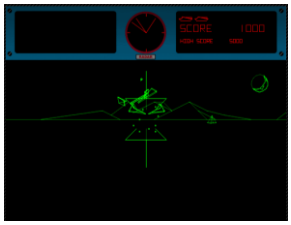
Computer 'Graphics' Have Come A Long Way!



"ASCII games" (Tam)

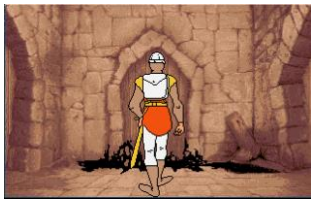


'Pong': re-creation via "Ball 2.7"



'Battlezone': re-creation via http://my.ign.com/atari/battlezone

'Pacman': re-creation via http://www.webpacman.com/pacman.php



Dragon's lair

"'Ultimate' Mortal Kombat" re-creation via http://en.gameslol.net/ultimate-mortal-kombat-3-996.html

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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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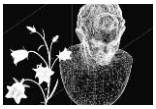
Graphics: Some Areas

- Animations

- Modeling



Xin Liu

- Rendering

Xin Liu

- Image processing

James Tam

James Tam

James Tam

Graphics: Higher-Level Courses

- CPSC 453: Introduction to computer graphics
- CPSC 587: Fundamentals of computer animation
- CPSC 589: Modeling for computer graphics
- CPSC 591: Rendering

James Tam

Artificial Intelligence

- Trying to build technology that appears to be 'intelligent'
- Intelligence: What makes a person smart?
  - Fact retrieval?
  - Creativity?
  - Solving problems?

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

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Artificial Intelligence: Some Areas

- Expert systems
- Neural networks

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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 as 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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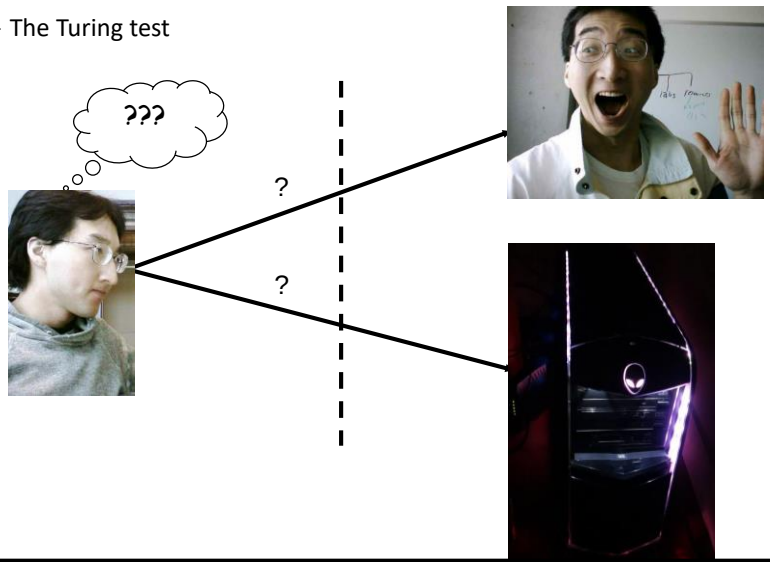
Artificial Intelligence: Mission Accomplished?

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



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Artificial Intelligence: Higher-Level Courses

- CPSC 433: Artificial Intelligence
- CPSC 565: Emergent computing
- CPSC 567: Foundations of multi-agent systems
- CPSC 568: Agent communications

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Computer Vision

- The focus is on interpreting and understanding visual information.

For more information:
http://pages.cpsc.ucalgary.ca/~boyd/pmwiki/pmwiki.php?n=Main.Research
http://people.ucalgary.ca/~jparker/ (Transferred to Arts)

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Computer Vision: Some Areas

Recognition

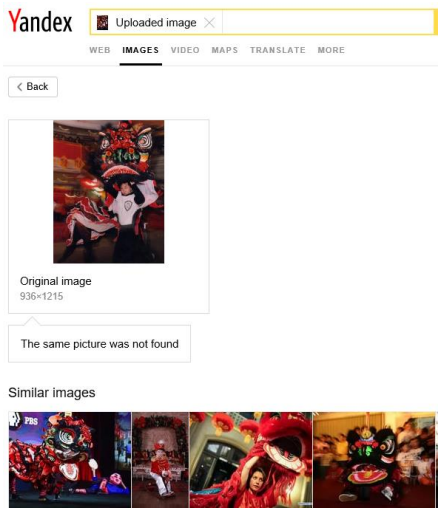
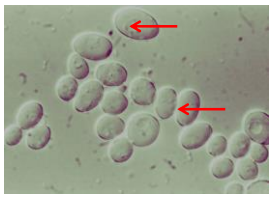


Image-based search engines



Identification of malignant cells: Stanford (Durmus et. al 2015)

Restoration

Removing imperfections such as blurring

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Computer Vision: Higher-Level Courses

- CPSC 535: Introduction to image analysis and computer vision

James Tam

Software Engineering

- 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 is one way: 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

- Agile program development
- Design patterns

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Traditional Software Development "Waterfall"

- (Specifics can vary generally this approach consists of a fixed one way sequence).

1. Gather requirements
2. Design the system
3. Implement and test the system
4. Verify with the user and make some changes
5. Maintain the system

- The entire project is worked on for each step.

Agile Software Development

- Software development is broken into parts rather than working on the entire system at once stage by stage.
- With a particular portion of the program all 5 stages are worked on for several weeks.
  - A representative stakeholder works with the team during this time.
- At the end of that time that part of the project is sufficient to demonstrate to stakeholders.
- Because only a part has been worked on it's easier to go back (iteratively) and make changes based on feedback.

Traditional Waterfall Vs. Agile Development

- 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.

Design Patterns

- A design pattern: a way of creating software that has been shown to be been sound under a number of different contexts.
- Design patterns are a way of documenting successful past approaches
  - Top down design: although not one of the formally recognized designed patterns it shares some similarities to those approaches.

James Tam

Software Engineering: Higher-Level Courses

- Software Engineering 301 Analysis and Design of Large-Scale Software I (required for all CPSC majors)
- Software Engineering 401 Analysis and Design of Large-Scale Software II
- Software Engineering 403 Software Development in Teams and Organizations
- Software Engineering 437 Software Testing
- Software Engineering 471 Software Requirements Engineering
- Software Engineering 511 Software Process and Project Management
- Software Engineering 513 Web-Based Systems
- Software Engineering 515 Agile Software Engineering

James Tam

Software Engineering: Higher-Level Courses (2)

- Software Engineering 521 Software Reliability and Software Quality
- Software Engineering 523 Formal Methods
- Software Engineering 533 Software Performance Evaluation
- Software Engineering 541 Fundamentals of Software Evolution and Reuse

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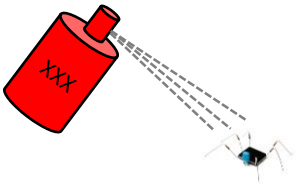
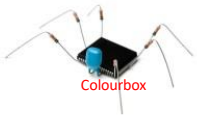
Computer Security

- It can involve 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



Virus software

Spyware

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

James Tam

Some Approaches To Computer Security

- As just demonstrated, understanding 'how things work' is one key component to designing more secure systems.
  - e.g., Creating viruses and other malware in order to create better defenses against them.
- But also the 'human' factor must be considered: some security experts think that many security breaches are due to user actions not technical flaws (social engineering)
  - Sometimes the "weakest line of defense" is not the technology but the person.

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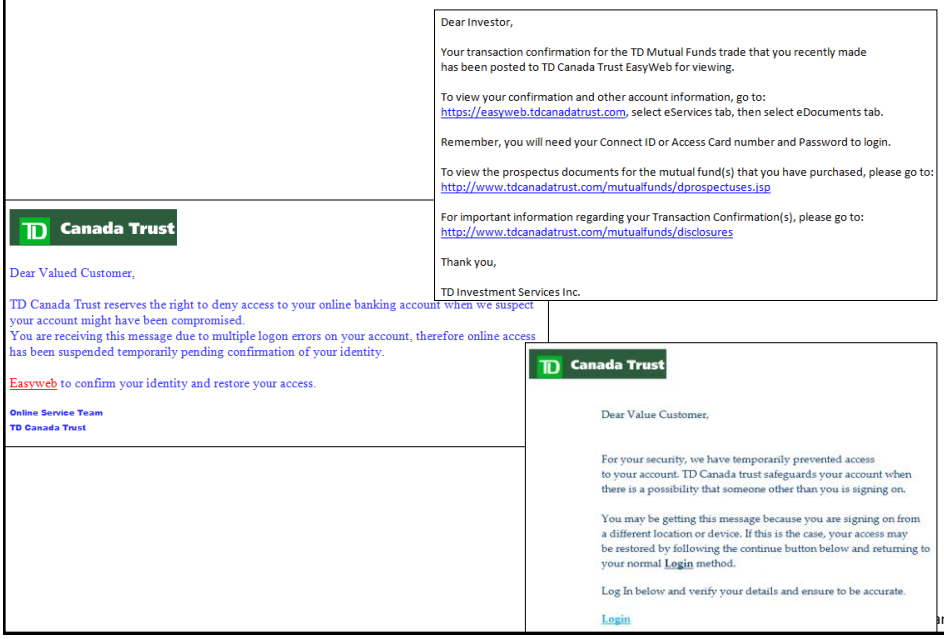
Which Is/Are Fake? Which Is/Are Real?



Dear Investor,

Your transaction confirmation for the TD Mutual Funds trade that you recently made has been posted to TD Canada Trust EasyWeb for viewing.

To view your confirmation and other account information, go to: https://easyweb.tdcanadatrust.com, select eServices tab, then select eDocuments tab.

Remember, you will need your Connect ID or Access Card number and Password to login.

To view the prospectus documents for the mutual fund(s) that you have purchased, please go to: http://www.tdcanadatrust.com/mutualfunds/dprospectuses.jsp

For important information regarding your Transaction Confirmation(s), please go to: http://www.tdcanadatrust.com/mutualfunds/disclosures

Thank you,

TD Investment Services Inc.

TD Canada Trust

Dear Valued Customer,

TD Canada Trust reserves the right to deny access to your online banking account when we suspect your account might have been compromised.
You are receiving this message due to multiple logon errors on your account, therefore online access has been suspended temporarily pending confirmation of your identity.

Easyweb to confirm your identity and restore your access.

Online Service Team
TD Canada Trust

TD Canada Trust

Dear Value Customer,

For your security, we have temporarily prevented access to your account. TD Canada trust safeguards your account when there is a possibility that someone other than you is signing on.

You may be getting this message because you are signing on from a different location or device. If this is the case, your access may be restored by following the continue button below and returning to your normal Login method.

Log In below and verify your details and ensure to be accurate.

Login

Cryptography

- As may have already been described earlier in the semester (depends on the particular assignments), cryptography can play an important role in security.
  - Transmitting and storing sensitive information.
  - Cryptography involves the development of new and better approaches for encoding sensitive data to make unauthorized access harder.

James Tam

Computer Security: Higher-Level Courses

- CPSC 329: Explorations in information security and privacy
- CPSC 418: Introduction to Cryptography
- CPSC 525: Principles of computer security
- CPSC 527: Computer viruses and malware
- CPSC 528: Spam and spyware
- CPSC 530: Information theoretic security

James Tam

Games Development

- 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

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

Areas Covered So Far: How (If At All) Does Games Programming Apply

- Human-Computer Interaction
- Computer Graphics
- Artificial Intelligence
- Computer Vision
- Software Engineering
- Computer Security

James Tam

Computer Games: Higher-Level Courses

- CPSC 585: Games programming
  - Actual 'industry practices' are taught and applied during the semester
    - Sound routines, graphics and more
  - (Lectures have been taught by actual game developers)

James Tam

After This Section You Should Know

- What are some areas of Computer Science
- What does each area entail
- Some of the sub-areas, techniques employed or issues associated with each area of computer science

James Tam

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