



## 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

## 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/>

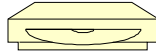
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## Human-Computer Interaction

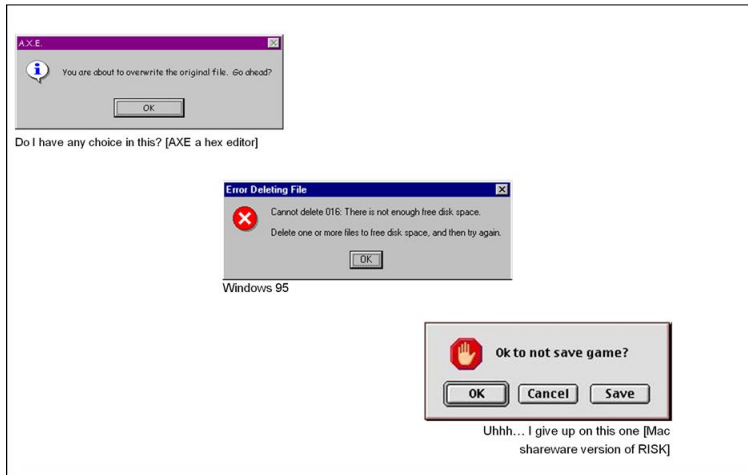
- ...but don't forget about the other side of the relationship.
- No matter how powerful the computer and how well written is the software, if the user can't figure out how it works then the system is useless.
- Software should be written to make it as easy as possible for the user to complete their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

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## 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 ✓

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## How Can This Be Done?

- Many techniques have been developed.
  - Some may have already been covered (heuristics)
- 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



- Users may also provide many unexpected insights

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## 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

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## Computer Graphics

- Concerned with producing and manipulating 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/>

## Computer Graphics: Common Misconception

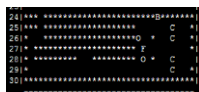
- It's about *creating* the programs that produce the realistic images and animations (not using existing programs like PhotoShop ©).



Images of James courtesy of James Tam

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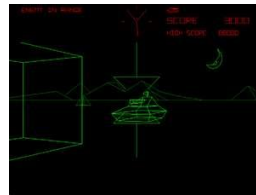
## Computer 'Graphics' Have Come A Long Way!



"ASCII games"



'Pong' [www.world-of-games.co.uk](http://www.world-of-games.co.uk)



'Battlezone' [www.sretroist.com](http://www.sretroist.com)



'Pacman' <http://ostatic.com>



"Dragon's lair" [www.dragons-lair-project.com](http://www.dragons-lair-project.com)



"Mortal Kombat" [www.gnomeslair.com](http://www.gnomeslair.com)

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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.”<sup>1</sup>



<sup>1</sup> From “The Tiger Experience” by Alain Fournier at the University of British Columbia

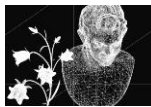
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## Graphics: Some Areas

- Animations



- Modeling



Xin Liu

- Rendering



Xin Liu

- Image processing



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James Tam

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## 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

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## Artificial Intelligence

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



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: Areas We Will Discuss

- Expert systems
- Neural networks

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## Artificial Intelligence: A More Comprehensive List

- |  |  |
|--|--|
| <ul style="list-style-type: none"> <li>• Learning               <ul style="list-style-type: none"> <li>➔ Explanation (discovery, data mining...)</li> <li>➔ No Explanation (neural nets, CBR...)</li> </ul> </li> <li>• Rule-Based Systems               <ul style="list-style-type: none"> <li>➔ Logic Languages (Prolog, Lisp...)</li> <li>➔ Knowledge Bases and Ontologies</li> <li>➔ Inference Engines (Expert systems...)</li> </ul> </li> <li>• Search               <ul style="list-style-type: none"> <li>➔ Game theory, problem spaces</li> </ul> </li> </ul> | <ul style="list-style-type: none"> <li>• Planning</li> <li>• Ability-Based Areas               <ul style="list-style-type: none"> <li>➔ Computer vision</li> <li>➔ Natural Language recognition</li> <li>➔ Natural Language generation</li> <li>➔ Speech recognition</li> <li>➔ Speech generation</li> <li>➔ Robotics</li> </ul> </li> <li>• Robotics</li> <li>• Agents and Multi-Agent Systems</li> </ul> |
|--|--|

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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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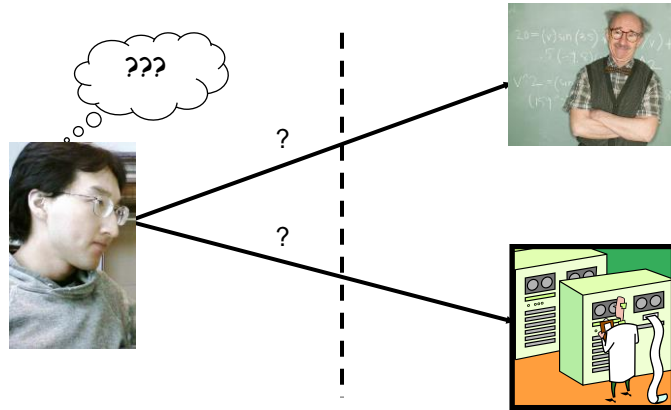
## Neural Networks

- 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?

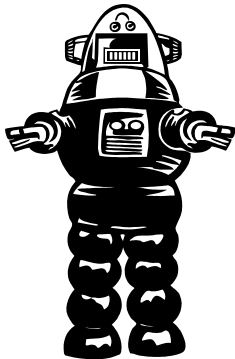
- How do we know we have a "smart machine"?
  - The Turing test



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

- Much work still needs to be done: Turing Test not yet passed



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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/>

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## Computer Vision: Some Areas

- Recognition

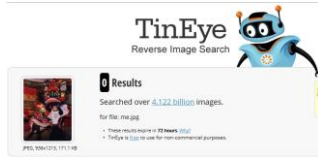
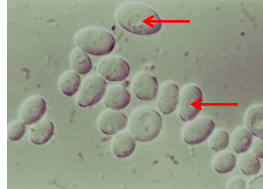


Image-based searches



Identification of malignant cells (mockup)

- Restoration



Removing imperfections such as blurring

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## Computer Vision: Higher-Level Courses

- CPSC 535: Introduction to image analysis and computer vision

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## 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](http://www.cpsc.ucalgary.ca/cpsc_research/areas/evolutionary)

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## Software Engineering (2): Techniques

- Agile development
- Design patterns

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## Agile Programming

- The focus is on reducing risk by producing a new iteration/version 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.
  - Versions are produced less frequently than with the agile approach.
  - Documentation is the way that others understand how the code works.
  - The client may be periodically be asked to “sign-off” on the software.

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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 creating software that has been shown to be 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 design patterns it shares some similarities to those approaches.

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## 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

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## 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



Spyware



Virus software



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

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

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## 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.
  - But this may require more than just standard ‘security workshops’.

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

	<p>Dear Investor,</p> <p>Your transaction confirmation for the TD Mutual Funds trade that you recently made has been posted to TD Canada Trust EasyWeb for viewing.</p> <p>To view your confirmation and other account information, go to: <a href="https://easyweb.tdcanadatrust.com">https://easyweb.tdcanadatrust.com</a>, select eServices tab, then select eDocuments tab.</p> <p>Remember, you will need your Connect ID or Access Card number and Password to login.</p> <p>To view the prospectus documents for the mutual fund(s) that you have purchased, please go to: <a href="http://www.tdcanadatrust.com/mutualfunds/dprospectuses.jsp">http://www.tdcanadatrust.com/mutualfunds/dprospectuses.jsp</a></p> <p>For important information regarding your Transaction Confirmation(s), please go to: <a href="http://www.tdcanadatrust.com/mutualfunds/disclosure">http://www.tdcanadatrust.com/mutualfunds/disclosure</a></p> <p>Thank you,</p> <p>TD Investment Services Inc.</p>
 <p>Dear Valued Customer,</p> <p>TD Canada Trust reserves the right to deny access to your online banking account when we suspect your account might have been compromised.</p> <p>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.</p> <p><a href="#">Easyweb</a> to confirm your identity and restore your access.</p> <p>Online Service Team TD Canada Trust</p>	 <p>Dear Value Customer,</p> <p>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.</p> <p>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 <a href="#">Login</a> method.</p> <p>Log In below and verify your details and ensure to be accurate.</p> <p><a href="#">Login</a></p>

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## 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).

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## 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

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## Games Development

- 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

For more information: [http://www.cpsc.ucalgary.ca/undergrad/courses\\_progression/concentration?conc=game](http://www.cpsc.ucalgary.ca/undergrad/courses_progression/concentration?conc=game)

## 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)

## 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

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