Computer Science (CS)
vs
Software Engineering (SE)
vs
Computer Engineering (CE): Undergraduate Programs at

Context

- The role of software engineering is evolving in Canada and in the rest of the world.

- Software engineering is growing into a distinct discipline from CS or CE.

- Engineering disciplines have strict professional organizations and laws that govern the qualifications required to practice engineering.
  - Professional engineers are liable for the products they produce.

History

- The term "software engineering" was introduced in 1968 at a NATO conference on the topic.

- U Waterloo admitted its first students to the Bachelor of SE (BSE) degree in 2001.

- SE programs/degrees now offered by many universities in Canada.

Accreditation

- Students who study CS receive an accredited computer science degree.
  - http://www.cips.ca/accreditation
- Students who study CE receive an accredited engineering degree.
  - http://www.peo.on.ca
- Students who study SE receive both a degree that is accredited by both computer science and engineering professional organizations.

- A student with an accredited engineering degree is qualified to apply for a Professional Engineering (P. Eng.) designation.
- It is much harder to become a P. Eng. without an engineering undergraduate degree.
  - This is a bootstrapping problem for universities creating SE programs.

In 10-20 years, we expect:

Computer Engineers ➡
- qualified to build computer hardware and embedded systems
- have P.Eng.'s

Embedded systems are ones with special purposes and include both software and hardware, e.g., cell phones, cars.

Software Engineers ➡
- qualified to build safety-critical systems that include software
- have P. Eng.'s

Safety-critical systems are those where failure of the system can result in death or other significant damage (financial, environmental), e.g., nuclear power plants, subways, autonomous vehicles, stock exchange.

Computer Scientists ➡
- qualified to build any type of software-intensive system

Current Reality in Employment:

Computer Engineers →
- have P.Eng.'s
- qualified to build computer hardware and embedded systems

Software Engineers →
- qualified to get a P. Eng.
- qualified to build software-intensive systems, including safety-critical systems

Computer Scientists →
- qualified to build any type of system that includes software, but not able to certify the system
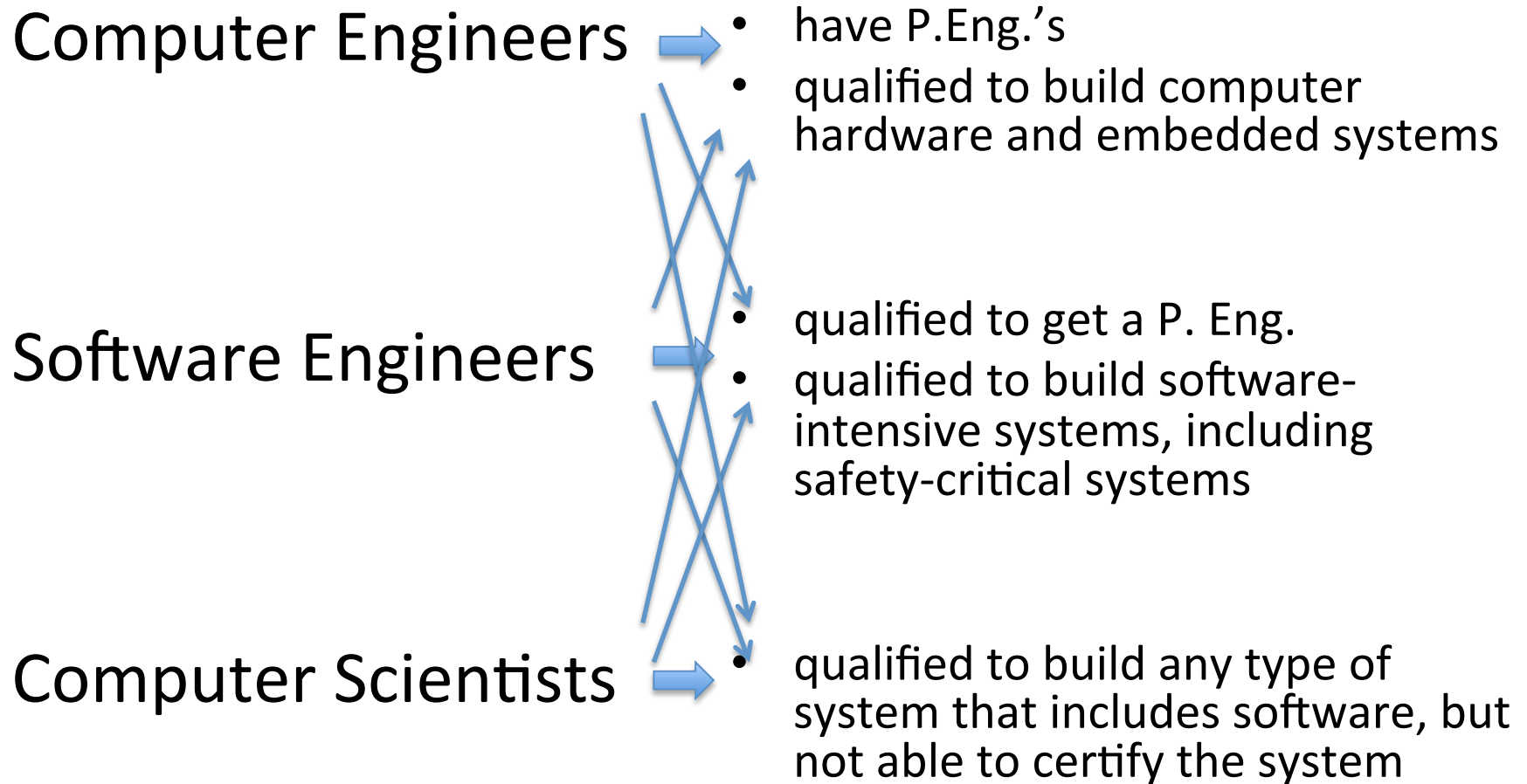
Co-operative Education Programs

- Co-op programs offer students substantial industrial experience through their placements.

- CS offers both co-op and regular programs.

- SE is co-op only.

- CE is co-op only.

- Placement rate for co-op positions is very high (>95%) for all of these programs.

What Do Students Study?

- Computer Science
  - Computation as an abstract medium for problem solving.

- Computer Engineering
  - Computer as a physical, electronic device.

- Software Engineering
  - Design and management of large software systems.

What Do Students Study?

- Computer Science
  - Principles and theory of software
    - Efficiency of data structures
    - What is computable?
  - Many applications
    - Human-computer interface
    - Graphics
    - Artificial Intelligence
    - Security
    - Distributed and Real-time Systems
    - Etc.

What Do Students Study?

- Software Engineering
  - Discipline of software development
    - Efficiency of code
    - How to build large systems
    - How to work in teams of people
  - Applications
  - Embedded systems
  - Hardware
  - Control systems
  - Engineering core
    - Chemistry
    - Physics
    - Engineering Economics

What Do Students Study?

- Computer Engineering
  - Design
    - Circuits (low-level to logic gates)
    - Processors
    - Communication systems
  - Trade-offs of implementing something in software vs hardware
  - Robotics
  - Control systems
  - Embedded systems
  - Engineering core

What Do Students Study?

- Computer Science has an SE option
  - Includes a 3 course sequence of 4th year courses on requirements, design, and testing and maintenance
  - SE students take this same 3 course sequence

Structure of the Programs

- In SE and CE, students have fewer electives (choices of courses) than in CS.

- SE and CE student are grouped as cohorts and take most courses together.

- CS students have more flexibility in choice of courses and therefore take courses with different groups of students.

- There are more CS students than SE students.

Structure of the Programs

- Both CE and SE will have more lab work and group assignments/projects.
  - Labs are scheduled times in a room.
  - Assignments can be done on your own time, likely on your own computer.
- CS allows a student to work individually more often.
- CE and SE have capstone design projects
  - Work in a team over 3 terms to create a substantial system.

Department Organization

- CS students are taught mostly by CS faculty.
  - CS is offered by the David R. Cheriton School of Computer Science, which also offers programs that combine CS with business administration, and financial management.
- CE students are taught mostly by CE faculty.
  - CE is offered by the Department of Electrical and Computer Engineering, which also offers the Electrical Engineering (EE) degree.
- SE students are taught by both CS and CE faculty.
  - In alternate years, SE students graduate with either the Faculty of Math or the Faculty of Engineering.
  - SE research is done by both CS and CE faculty.
- SE students take some of the same courses as CS and CE students.
  - There are only a few courses created specifically for SE students.

Admission Requirements

- Advanced Functions
- Calculus and Vectors
- English
- For SE and CE:
  - Physics and chemistry
- Programming experience is usually required
- Additional Information Form (AIF)
  - Extracurricular activities, community service
- Please see a detailed list of high school course requirements

Admission Requirements

- Admission averages:
  - CS, CE: high 80's (on an upward trend)
  - SE: low 90's
  - Business Admin & CS: high 80's
- It is usually harder to get into SE than CS or CE.
- It is fairly easy to transfer from SE to CS, but not vice versa. (Rarely do students transfer from SE to CE.)

Summary

- Computer Science
  - Allows a deeper study of an aspect of software (e.g., business, health, graphics)
  - Broad range of applications
  - Accredited computer science program
- Computer Engineering
  - More emphasis on hardware and environment that software works within (e.g., networks)
  - Accredited engineering program
- Software Engineering
  - Broader view of large software development
  - Safety-critical systems
  - Accredited computer science and engineering program

Links

- Computer Science
  - https://cs.uwaterloo.ca
- Software Engineering
  - https://uwaterloo.ca/software-engineering/
- Computer Engineering
  - https://uwaterloo.ca/electrical-computer-engineering/
- Comparison of the programs
  - cs.uwaterloo.ca/right-fit
  - https://uwaterloo.ca/software-engineering/future-undergraduate-students/comparing-bse-bcs
- Student Perspective
  - http://aimango.me/post/university-of-waterloo-software-engineering-vs-computer-science