CSC340: Requirements Engineering

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http://www.cs.toronto.edu/~sme/CSC340F

About the Course

- Course website
  - www.cs.toronto.edu/~sme/CSC340F/
- Textbooks
  - Fundamentals of Requirements Engineering
  - UML Distilled
- Lecture Notes
  - Available on the course website prior to each lecture
- Coursework
  - Carried out in teams of 3
  - Each team submits one report (per assignment)
  - All team members receive the same grade (exceptions can be negotiated)
  - Involves a practical "real-world" analysis project

Course Objectives

- Examine the state-of-the-art for research & practice in Requirements Engineering.
  - Role of RE in software and systems engineering
  - Current techniques, notations, methods, processes and tools used in RE
- Gain practical experience in selected RE techniques
  - Especially goal-oriented and object-oriented modelling techniques
- Understand the essential nature of RE
  - Breadth of skills needed for RE, and the many disciplines on which it draws
  - Contextual factors & practicalities

Assessment

- 4 team assignments:
  1. Conduct an inspection of an existing specification (10%)
     - Report on defects found, overall quality, and inspection stats
  2. Perform a feasibility study for an information systems project (15%)
     - Write a feasibility report
  3. Perform a requirements analysis for the same project (10%)
     - Produce models that explain the problem
  4. Specify the requirements for the same project (10%)
     - Write a requirements specification
- 2 tests:
  - Midterm test (20%)
  - Final Exam (35%)
    - Must obtain at least 40% on this exam to pass the course.

Course Policies

→ **Assignment Deadlines**
- Are very strict (use a U of T medical certificate if you are seriously ill)
- Assignments are due in the first 10 minutes of a tutorial
- Daily penalties apply to late work

→ **Re-grading**
- Will only be done by the professor (TAs will not re-grade your work)
- The whole report will be re-graded (not just individual sections)
- Your mark may go up or down

→ **Communication**
- TAs and instructor will not answer any queries related to the assignments in the 24 hour period prior to the deadline
- Announcements will appear on the course website. Please check it regularly.

Software-Intensive Systems

→ **Software (on its own) is useless**
- Software is an abstract description of a set of computations
- Software only becomes useful when run on some hardware
  - we sometimes take the hardware for granted
- Software + Hardware = "Computer System"

→ **A Computer System (on its own) is useless**
- Only useful in the context of some human activity that it can support
  - we sometimes take the human context for granted
- A new computer system will change human activities in significant ways
- Software + Hardware + Human Activities = "Software-Intensive System"

→ **'Software' makes many things possible**
- It is complex and adaptable
- It can be rapidly changed on-the-fly
- It turns general-purpose hardware into a huge variety of useful machines

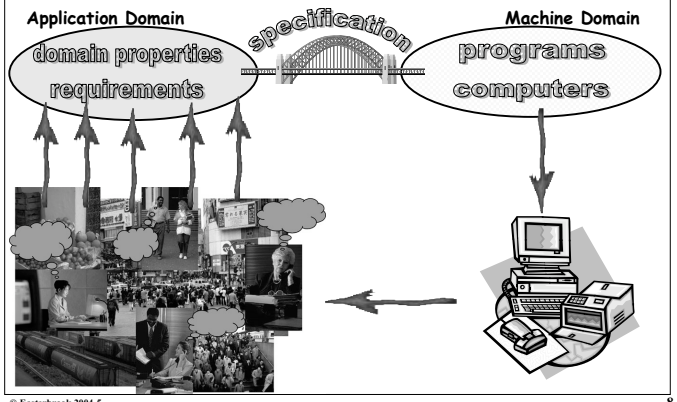
Quality = Fitness for purpose

→ **Software technology is everywhere**
- Affects nearly all aspects of our lives
- But our experience of software technology is often frustrating/disappointing

→ **Software is designed for a purpose**
- If it doesn't work well then either:
  - …the designer didn't have an adequate understanding of the purpose
  - …or we are using the software for a purpose different from the intended one
- Requirements analysis is about identifying this purpose
- Inadequate understanding of the purpose leads to poor quality software

→ **The purpose is found in human activities**
- E.g. Purpose of a banking system comes from the business activities of banks and the needs of their customers
- The purpose is often complex:
  - Many different kinds of people and activities
  - Conflicting interests among them

Where are the challenges?



Complexity of Purpose

- People and software are closely-coupled
  - Complex modes of interaction
  - Long duration of interaction
  - Mixed-initiative interaction
  - Socially-situated interaction
  - …software systems and human activity shape each other in complex ways
- The problems we'd like software to solve are "wicked"
  - No definitive formulation of the problem
  - No stopping rule (each solution leads to new insights)
  - Solutions are not right or wrong
  - No objective test of how good a solution is (subjective judgment needed)
  - Each problem is unique (no other problem is exactly like it)
  - Each problem can be treated as a symptom of another problem
  - Problems often have strong political, ethical or professional dimensions

Dealing with problem complexity

- Abstraction
  - Ignore detail to see the big picture
  - Treat objects as the same by ignoring certain differences
  - (beware: every abstraction involves choice over what is important)
- Decomposition
  - Partition a problem into independent pieces, to study separately
  - (beware: the parts are rarely independent really)
- Projection
  - Separate different concerns (views) and describe them separately
  - Different from decomposition as it does not partition the problem space
  - (beware: different views will be inconsistent most of the time)
- Modularization
  - Choose structures that are stable over time, to localize change
  - (beware: any structure will make some changes easier and others harder)

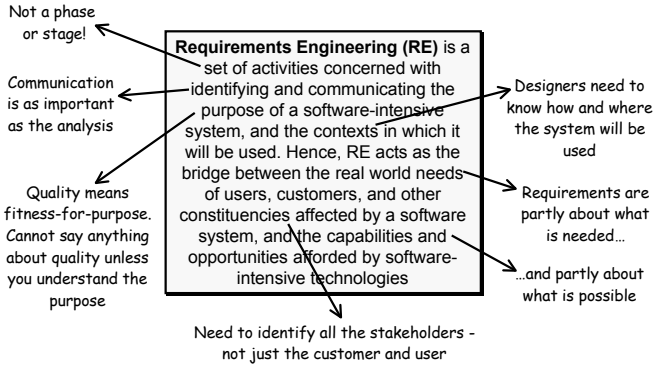
Designing for people

- What is the real goal of software design?
  - Creating new programs, components, algorithms, user interfaces,…?
  - Making human activities more effective, efficient, safe, enjoyable,…?
- How rational is the design process?
  - Hard systems view:
    - Software problems can be decomposed systematically
    - The requirements can be represented formally in a specification
    - This specification can be validated to ensure it is correct
    - A correct program is one that satisfies such a specification
  - Soft systems view:
    - Software development is is embedded in a complex organisational context
    - There are multiple stakeholders with different values and goals
    - Software design is part of an ongoing learning process by the organisation
    - Requirements can never be adequately captured in a specification
    - Participation of users and others throughout development is essential
  - Reconciliation:
    - Hard systems view okay if there is local consensus on the nature of the problem

Which systems are soft?

- Generic software components
  - E.g. Core operating system functions, network services, middleware, …
  - Functionality relatively stable, determined by technical interfaces
  - But note that these systems still affect human activity
    - E.g. concepts of a 'file', a 'URL', etc.
- Control Systems
  - E.g. aircraft flight control, industrial process control, …
  - Most requirements determined by the physical processes to be controlled
  - But note that operator interaction is usually crucial
    - E.g. accidents caused when the system doesn't behave as the operator expected
- Information Systems
  - E.g. office automation, groupware, web services, business support,…
  - These systems cannot be decoupled from the activities they support
  - Design of the software entails design of the human activity
    - The software and the human activities co-evolve

Definition of RE



Cost of getting it wrong

→ Cost of fixing errors

- Typical development process:
  requirements analysis ⇒ software design ⇒ programming ⇒ development testing ⇒ acceptance testing ⇒ operation
- Errors cost more to fix the longer they are undetected
  - E.g. A requirements error found in testing costs 100 times more than a programming error found in testing

→ Causes of project failure

- Survey of US software projects by the Standish group:

	1994	1998
Successful	16%	26%
Challenged	53%	46%
Cancelled	31%	28%

Top 3 success factors:
1) User involvement
2) Executive management support
3) Clear statement of requirements

Top 3 factors leading to failure:
1) Lack of user input
2) Incomplete requirements & specs
3) Changing requirements & specs

What do Requirements Analysts do?

→ Starting point

- Some notion that there is a "problem" that needs solving
  - e.g. dissatisfaction with the current state of affairs
  - e.g. a new business opportunity
  - e.g. a potential saving of cost, time, resource usage, etc.
- A Requirements Analyst is an agent of change

→ The requirements analyst must:

- identify the "problem"/"opportunity"
  - Which problem needs to be solved? (identify problem Boundaries)
  - Where is the problem? (understand the Context/Problem Domain)
  - Whose problem is it? (identify Stakeholders)
  - Why does it need solving? (identify the stakeholders' Goals)
  - How might a software system help? (collect some Scenarios)
  - When does it need solving? (identify Development Constraints)
  - What might prevent us solving it? (identify Feasibility and Risk)
- and become an expert in the problem domain
  - although ignorance is important too -- "the intelligent ignoramus"

Summary

→ This course covers most of requirements engineering:

- Analyzing problem situations
- Studying human activities
- Formulating requirements so that software solutions can be designed

→ This course is different to most CS courses

- It is not about how to solve problems using computers
- It is about how to identify problems worth solving
- The subject matter is human activity:
  - how to understand it
  - how to support it using software technology

→ Your mileage will vary

- Comments from students in previous years vary dramatically:
  - "At last - a course that actually taught me something useful"
  - "This course should be scrapped - it's an embarrassment to CS"