CSC340: Information Systems Analysis and Design

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About the Course

- **Course website**
  - www.cs.toronto.edu/~csc340h/
- **Textbooks**
- **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)
- **Deadlines**
  - Are very strict (use a U of T medical certificate if you are seriously ill)
  - Daily penalties apply to late work

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

A note about terms:
“Systems Analysis” ⊂ “Requirements Engineering”
SA typically refers only to information systems
RE applies to all software-intensive systems
This course is evolving to cover more of RE

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 requirements modelling for the same project (10%)
     - Prepare requirements models
  4. Perform a requirements analysis 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.

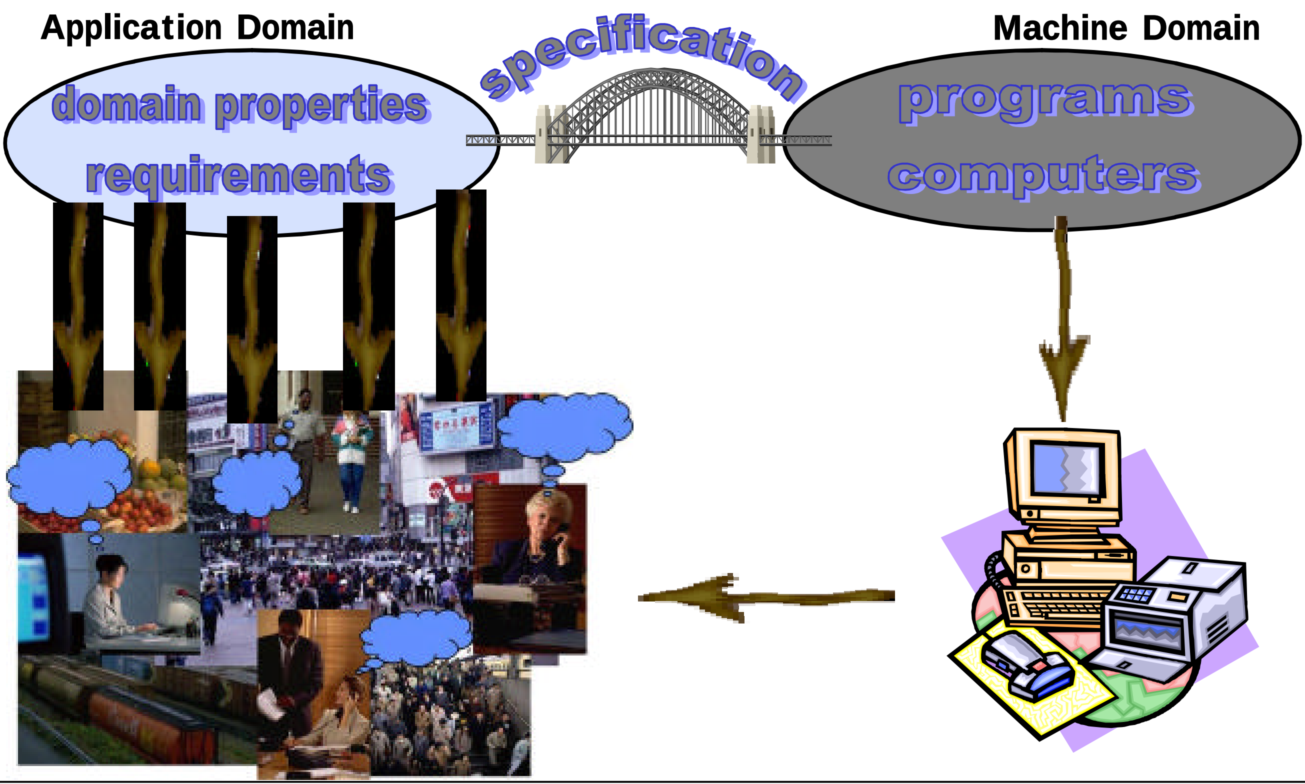
Software-Intensive Systems

- **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 judgement 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

Requirements Engineering (RE) is a set of activities concerned with identifying and communicating the purpose of a software-intensive system, and the contexts in which it will be used. Hence, RE acts as the bridge between the real world needs of users, customers, and other constituencies affected by a software system, and the capabilities and opportunities afforded by software-intensive technologies

Not a phase or stage!

Communication is as important as the analysis

Quality means fitness-for-purpose. Cannot say anything about quality unless you understand the purpose

Designers need to know how and where the system will be used

Requirements are partly about what is needed…

…and partly about what is possible

Need to identify all the stakeholders - not just the customer and user

Cost of getting it wrong

- **Cost of fixing errors**
  - **Typical development process:**
    - requirements analysis Þ software design Þ programming Þ development testing Þ acceptance testing Þ 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"**