Course Description

Design is a crucial activity in the creation of an information system. It is challenging because of competing goals from multiple stakeholders, and the complexity of issues that can arise. In this course, we focus on design processes resulting in system requirements, as well as high-level architectural design of an information system. A design has to deliver desired functionalities and also meet non-functional qualities such as performance, cost, usability, timeliness, security, privacy, reliability, flexibility, maintainability, and so forth. Increasingly, system design is focused not only on a single isolated system, but on portfolios or families of systems, with more attention to interoperability, sharing, reuse, and evolution.

This course focuses on the design of networked information systems in the face of multiple competing or synergistic goals from many stakeholders. Examples will be taken from settings in e-health, e-learning, e-government, etc. A number of design approaches will be examined, with an emphasis on systematic, model-based approaches. The emphasis of the course is to help students gain an appreciation of the strengths and limitations of various techniques, and of the concept of design itself. These concepts of design are placed within the larger context of contemporary information systems development and software engineering. The significance of design representations (models and notations), methods and tools, and reusable design knowledge will be discussed. Students will work on projects to apply selected design methods and techniques.

Goals and Objectives

The overarching goal of this course is to gain a broad understanding of the concepts, issues, and techniques of system requirements and architectural design, in the context of information systems development, and to practice selected techniques through course projects.

Students having completed this course should be capable of:

- Understanding and articulating the role of stakeholder involvement, interdisciplinary collaboration and specific techniques of requirements elicitation in the requirements discovery, systems analysis and design process (as demonstrated in class discussions and assignments 1 and 3),
- playing a proactive role in the discovery, documentation and validation of system requirements in a variety of contexts (as demonstrated in assignments 1 and 2),
- collaborating effectively in teams working on realistic requirements and system design problems (as demonstrated in assignments 1 and 2),
- determining the scope of a design problem and articulating system context and boundary (as demonstrated in assignment 1),
- applying and evaluating techniques for eliciting, specifying, and communicating system requirements including goals, scenarios, and qualities to a wide range of stakeholders (as demonstrated in assignments 1 and 3),
- applying, evaluating, and discussing techniques and models for creating, documenting, communicating, and evaluating architectural designs based on key system requirements (as demonstrated in assignment 2 and 3 and class presentations),
- systematically identifying, analyzing, explaining, synthesizing, and critiquing concepts, methods, techniques, and problems in the areas of system requirements and architectural design (as demonstrated throughout the course).

Relationship between Course Learning Outcomes and Program Learning Outcomes: The course introduces the conceptual foundations and frameworks that describe how system designers address social needs by negotiating technology and its social context through requirements and design choices (SLO 1). The course design combines practice-oriented systems design perspectives with the underlying theory that articulates and explains those conceptual frameworks, models, and techniques (SLO 4). The discussion of the role of cloud computing in architectural design decisions contributes to SLO 5. In identifying emerging perspectives on the long-term effects of technology choices and the corresponding responsibility of the designers regarding sustainability, the course also aims to contribute to SLO 2.

Class Format

The class will meet for up to 3 hours each week. Each class will normally consist of a lecture, a team activity or guest conversation period, and a discussion period. The lecture portion of the class will introduce the key concepts and may cover material that is not available in published literature. There will normally be a 15 minute break after the lecture. This will often be followed by a team-based activity. The last section of the class will involve discussion of the team-based activity and the readings using questions from class members as a starting point, and sometimes an additional (shorter) lecture. On their own time, students must complete weekly course readings, complete written assignments alone and in teams, present results from teamwork in class, and maintain a blog. Active class participation is built into the course and considered an essential enabler of the learning experience.

Prerequisites

IS&D concentration or INF1003 or permission of instructor. INF1341 is strongly recommended.

Course Materials

Textbooks/Readings
This course does not have a textbook, but students wishing to have access to a textbook might consider the following books. Selected readings from these books are available on Blackboard.
For **requirements:**

- *The following book is highly recommended as a pragmatic and accessible, yet comprehensive and systematic treatment of requirements and their role in design.*

- *Robertson, Suzanne, and James Robertson (2013) Mastering the Requirements Process—3rd ed., Addison-Wesley. (Referred to as RR in course schedule). [Inforum: 3rd ed. 2-hr reserve; 2nd ed. 2-day reserve] The authors of the book are also the creators of the Volere template, which will be used in A1; the book is a very accessible and comprehensive treatment of the requirements process. Recommended.*

- *Pohl, Klaus (2010). Requirements Engineering: Fundamentals, Principles, and Techniques. Springer (Referred to as Pohl in the course schedule.) A highly systematic and exhaustive treatment from an engineering perspective, with a lot of attention to detail and a comprehensive set of references. Useful as a handbook too.*

For **architectural design** (and software architecture and design processes in general), note that most discussions are aimed at software engineering audiences.

- *The following book is most recommended as a pragmatic and accessible overview and guidance to software architecture and most aligned with the way we will address it in the course. Some of the chapters will be required reading.*
  Cervantes, H., & Kazman, R. (2016). Designing software architectures: a practical approach. Addison-Wesley Professional. [acquisition to Inforum course reserves in process]
  Referred to as CK in the course schedule.

- *Similar to the above, this book is recommended because it is more practice-focused and accessible than the following listings. (Referred to as RW in the course schedule.) Rozanski, B. & Woods, E. (2011). Software Systems Architecture: Working With Stakeholders Using Viewpoints and Perspectives (2nd edition). Addison-Wesley Professional. [Inforum: 2-hr reserve]*

- *The Microsoft Application Architecture Guide, 2nd Edition provides an excellent resource to consult during the second stage of the project. It explains key concepts, guidelines, fundamentals and types of applications, all of which described in general ways that are valid beyond Microsoft technology. It is available online at [https://msdn.microsoft.com/en-us/library/ff650706.aspx](https://msdn.microsoft.com/en-us/library/ff650706.aspx).*

- *The following book is recommended as a thorough in-depth treatment of software architectures.*
  Referred to as BCK in the course schedule

- *This and the following book provide an industry-oriented perspective on systems design in general that you may find useful.*
Syllabus for INF 1342H: System Requirements and Architectural Design

(2004) [Check availability] 005.1 .W624S6 (Referred to as WBD in the course schedule.). Textbook website: www.mhhe.com/whitten


For Object-Oriented Design (and UML), a basis of many concepts and technologies, the following book provides a very comprehensive and practical, detailed coverage.


For Enterprise Architecture (and a well-founded perspective on modelling and communication):


Website/Resources

All course materials will be made available on Blackboard (http://portal.utoronto.ca), and all announcements will be made through Blackboard. Make sure you receive notifications and check in regularly for updates.

Evaluation

The major assignments are focused on a system requirements and design project done in teams of four. (Depending on class size, a few teams may consist of three members.) Each team will design an information service, specifying the requirements for the service and proposing a system architecture designed to address these requirements. The project progresses in iterations.

Additionally, each student will post a short series of blog entries.

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<tr>
<th>Assignments</th>
<th>Weight</th>
<th>Due</th>
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<tr>
<td>Assignment 1: System Design iteration 1 - Service Definition and System Requirements</td>
<td>60% (15% individual, 45% team)</td>
<td>Pitch [3% team]: One slide in PDF submitted on Blackboard by Jan 17 9:00 am. Stand-up pitch in class on Jan 17. Vision [10% team]: Feb 4 Individual requirements [15% individual]: Feb 17 Combined requirements document [20%]: March 3 Team presentation [12%]: Presentation in class in weeks 7 and 8. Slides are due by 9:00 am on the day of the presentation.</td>
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<tr>
<td>Assignment 2: Iteration 2 – Architectural</td>
<td>25% (20% team, 5% individual)</td>
<td>Design presentation [20% team]: Project presentation and discussions of the systems design in weeks 11 and 12. Slides are due by 9:00 AM on the day of the presentation.</td>
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**Design & Requirements**

### Assignment 3: Blog

15% (individual) - You will reflect on the course concepts and the application of requirements and design methods to your project in a series of blog entries.

**Peer assessment** of contributions by team members through confidential self & peer evaluation forms is required for all team work and is considered part of the grade. In team assignments, grades for individual members may differ. For an excellent guide to teamwork, consider [http://bokcenter.harvard.edu/working-groups](http://bokcenter.harvard.edu/working-groups).

In **Assignment 1**, each team will design an information service, specifying the system requirements for the service. You will use scenario techniques together with goal-modeling techniques to arrive at system requirements. The key objectives of this assignment are to learn about the strengths and limitations of different perspectives and techniques in helping design information systems, leading to system requirements; to reconcile and articulate requirements from these perspectives; and to arrive at a consensus on key requirements expressed in a clear and standards-based requirements structure that can serve as the basis for the subsequent assignment. The topic and project idea is up to each team; early in the term, you will present a short pitch to share the initial idea for the proposed system with the class.

The assignment will proceed in 5 stages, as illustrated above:

- **Pitch**: The pitch is a 2-minute stand-up presentation pitching the project idea to the class in week 2, supported by one slide. This ensures that you share information about the project early, are able to validate assumptions, and can revise the scope and goals as you receive feedback.

- **Vision**: The vision is a short document defining the scope and project more formally to communicate the project’s vision and document a common basis for the individual analysis of requirements, thus ensuring a minimum level of common ground and consistency between the individual draft requirements. In the vision, you will also declare which team members focus on goal models and which team members focus on scenario specifications. (Normally 2+2).

- **Individual requirements**: This is an individual written assignment completed and submitted independently by each team member. You will apply either goal- or scenario-oriented requirements modelling techniques to the project outlined in the vision to discover and document a set of solution-oriented requirements for the system under design.

- **Combined requirements**: The combined requirements specification will be informed by the different perspectives resulting from the individual draft requirements. The team will
reconcile the individual requirements to arrive at a consistent, self-contained requirements specification that drives the design process in assignment 2.

- **Requirements presentation**: This is an in-class team presentation of 15 minutes discussing highlights of the combined requirements document.

The combined requirements document is your starting point for **assignment 2**. As illustrated below, you will explore and present architectural design issues of the information service defined in the combined requirements document that resulted from the first assignment, and use that iteration to revisit and refine the requirements. The individual blog posts will serve as input to the team effort to develop an initial view on the high-level architectural design that is presented to the class in the final weeks.

- **Design presentation**: This is an in-class team presentation of 15 minutes covering the high-level architectural design, key design decisions and open questions, and revisions to requirements if applicable.

- **Final reflections** on the system design experience at the end of the course are integrated in the peer and self-evaluation forms, submitted individually. Discuss major challenges and obstacles, surprising insights, learning experiences, or how you would like to engage in requirements and architecture practices professionally

**Assignment 3: Individual blog**
You will post a short set of contributions to the class blog. Your contributions will (and should) vary in terms of length and topic, but keep your posts focused on the topic and brief (up to 300 words). You are free to add links to materials, tools, articles and so forth, but you must ensure that they relate clearly to the issues at hand and that you add comments and explanation of their relevance. Your blog post must be completed latest by 9am the day when class meets. The blogs will be used to help shape the discussion in each class, and you are encouraged to raise questions in your posts that you would like to see addressed in the class discussion. You are also highly encouraged to read your peer’s blogs and engage in discussions on the blog, and meaningful comments will be considered in the blog grade. The blogs receive a grade at the end of the term.

**Blog post topics**

1. **Week 1 (!) – Introductions**: Shortly present your background (including areas of study & professional interests) and suggest a project idea for the group project. (The idea can be very specific, or more generally characterize an area of particular interest that you would like to consider for the project.)

2. **Week 5 – Architecture**: Find a published diagram describing an information systems’ architecture, post it and discuss it using the questions suggested in BCK chapter 1 as a starting point: “What structure or structures are shown? … What analysis does the
architecture diagram support? Critique it: What questions do you have that the representation does not answer?

3. Week 10 – **An architecturally significant requirement.** Considering the requirements defined for your team project, which one might be particularly significant for the overall architecture of the system? Discuss whether one of the elements of the Smart Decisions game could help to shape the system’s architecture to address this requirement.

### Guidelines for Assignments

All written assignments for this course must be submitted as one PDF file on Blackboard at the corresponding due date. Blog entries must be posted in the normal manner as text, not as attachments to the post. Where no time is given, the assignments are due at 23:59.

**The required format for written assignments is as follows:**

- **One file in PDF** format (not MS Word or other formats). Where diagrams are used, ensure they are contained in high resolution in the PDF.
- Typed, 1.5 space, 11 point font, one-inch margins, page numbers
- Align paragraphs in a standard way and avoid superfluous indentation.
- No cover page required, but be sure to include your names & student numbers on page 1.
- Use of footnotes/endnotes is permitted.
- Total word count must be indicated at the end of the essay.
- Page layout must be in correct orientation, i.e., pages with content in landscape orientation must be rotated so that the content is right-side up when viewed electronically.
- For large documents, define bookmarks for the start of each main section.
- Text in figures must be legible, with sufficiently high resolution.

Where **self and peer evaluation forms** are required, these are considered part of the assignment, are due at the same time as the assignment, and need to be submitted individually through Blackboard through the appropriate file upload!

All assignments must be written as clearly and cleanly as possible (i.e. watch the typos, grammar, hanging sentences, etc.), in a formal but accessible academic language. The “look and feel” must be professional, and figures and tables should, where possible, be included in the text, not at the end of the document.

Assignments that do not meet a minimum standard (in terms of legibility, formatting, and proofreading) will be returned for re-submission, with late penalties in full effect.

**Referencing**

Students are expected to have taken the "Cite it right" workshop and are encouraged to review the material it covers. Consistent quotation and citation is required and an excellent safeguard against inadvertent plagiarism.

**Images**

“Students can include copyrighted images in their assignments as long as they follow the Canadian Copyright Act’s current exceptions for fair dealing, in that the images must only be used for the purposes of criticism or review, and each image must be accompanied by:

(a) the source; and

(b) the name of the author(s) (if given in the source).
Acceptable Secondary Sources
“As graduate students, you will be expected to use a majority of academic (i.e. peer reviewed) sources when writing your term paper. Students are very much allowed, but not at all limited, to use course readings and other sources referenced in lectures in their own papers. Additional sources and relevant journals that are recommended by the instructor are also acceptable. However, students are strongly encouraged to track down those resources that are best suited to their specific area of interest or inquiry, rather than rely too heavily on those provided in class.

For cutting edge information, news, announcements, etc., popular press articles are of course acceptable. But these should be used to supplement or update rather than replace peer reviewed sources, and should never be used to explain a theoretical concept. They should also come from credible, verifiable sources, who have the credentials (whatever these may be) to back up their claims. Often these articles point to underlying scholarly articles in peer reviewed journals or conferences, students are encouraged to pursue.”

Late Papers
“Unless a formal extension has been negotiated with the instructor in advance of the due date, late assignments (defined here as an assignment submitted after the deadline) will be penalized by one full letter grade per 24 hours (e.g. from A to A-), for a maximum of 72 hours. After that point, late assignments will no longer be accepted. Furthermore, late papers will not receive detailed feedback or comments.”

Extensions
“Extensions on assignments within the term must be negotiated in advance, and require supporting documentation (e.g. doctor’s note). Students must email requests for extensions to the instructor at least 24 hours prior to the due date. Exceptions will only be made in extenuating circumstances. Extensions beyond the end of the term in which a course is taken are subject to the guidelines established by the School of Graduate Studies.”

Grading
Please consult the iSchool’s Grade Interpretation Guidelines and the University Assessment and Grading Practices Policy. These documents will form the basis for grading in the course. The blog will be graded at the end of term.

Ground Rules
“Each student in this course is responsible for keeping up with the course materials, which includes (all) the required course readings, as well as topics, debates, and concepts discussed in class. Students are expected to attend lectures and to take their own lecture notes. You are expected to participate in class discussions, and are encouraged to use your laptops/mobile devices during class to look up relevant information that will contribute to the discussion in a meaningful way. At all times, however, remember to be respectful of the instructor and of your classmates – turn your phone function off, turn off the sound on your computer, and be sure not to browse any websites that may be offensive or illegal, or that might be deemed irrelevant to the task of taking this course. Students should arrive on time and are expected to stay for the
duration. If you miss a class, you are responsible for obtaining any information or materials given in class, either from your classmates or online. Unauthorized recording of the lectures is not permitted.”

**Accommodations**

Students with diverse learning styles and needs are welcome in this course. If you have a disability or a health consideration that may require accommodations, please feel free to approach me and/or the Accessibility Services Office as soon as possible. The Accessibility Services staff are available by appointment to assess needs, provide referrals and arrange appropriate accommodations. The sooner you let us now your needs, the quicker we can assist you in achieving your learning goals in this course.

**Writing Support**

As stated in the iSchool’s Grade Interpretation Guidelines, “work that is not well written and grammatically correct will not generally be considered eligible for a grade in the A range, regardless of its quality in other respects”. With this in mind, please make use of the writing support provided to graduate students by the SGS Office of English Language and Writing Support. The services are designed to target the needs of both native and non-native speakers and all programs are free. Please consult the current workshop schedule for more information.

**Academic Integrity**

Please consult the University’s site on Academic Integrity. The iSchool has a zero-tolerance policy on plagiarism as defined in section B.I.1.(d) of the University’s Code of Behaviour on Academic Matters. You should acquaint yourself with the Code. Please review the material in Cite it Right and if you require further clarification, consult the site How Not to Plagiarize. Cite it Right covers relevant parts of the U of T Code of Behaviour on Academic Matters (1995). It is expected that all iSchool students take the Cite it Right workshop and the online quiz. Completion of the online Cite it Right quiz should be made prior to the second week of classes. To review and complete the workshop, visit the orientation portion of the iSkills site: uoft.me/iskills.

**Contacting the Instructor**

Prof Christoph Becker is available by email: christoph.becker@utoronto.ca. Usual response time: within 2 working days. Office hours: Tuesday 4.30pm-5.30pm.

**Schedule of Lecture Topics and Readings**

| Week 1: Jan 10 | **Introduction:** systems + requirements + architecture + design = ? |
|               | **Required Reading:** |

*Christoph Becker, iSchool at UToronto*
### Week 2: \( \text{Jan 17} \)

**Stakeholders, context, goals, and "the system"**

**Required Reading:**
  - [http://simplelink.library.utoronto.ca/url_cfm/408290](http://simplelink.library.utoronto.ca/url_cfm/408290)
- RR chapter 4: Business Use Cases
- Review the Volere template and associated examples in detail (see Blackboard)

**Supplementary Sources:**
- RR chapter 3
- ABD chapters 2,3,4
- Larman chapter 1: Object-oriented analysis and design

### Week 3: \( \text{Jan 24} \)

**Scenarios and social modelling**

**Required Reading:**
- Larman chapter 6: “Use cases”
Supplementary Sources:

Week 4: Jan 31

**Scenarios, goals, and quality. Solution-oriented requirements.**

Required Reading:
- Chapter 2 (ps pdf)
- ABD chapter 9: Measurement
- Pohl chapter 13: Fundamentals

Supplementary Sources:
- For i*, see the road map at [http://www.cs.toronto.edu/km/istar/](http://www.cs.toronto.edu/km/istar/)
- Pohl chapter 13: Fundamentals
- Pohl chapter 17: Natural Language Requirements
- Pohl chapter 18: Structuring Natural Language Requirements

Week 5: Feb 7

**From requirements to architecture (and back)**

Required Reading:
- CK chapter 2 (available [online](http://www.cs.toronto.edu/km/istar/))
- RW chapter 5: *The role of the architect*

Recommended reading:
- WBD Chapter 12: System Design
  -or-
  - SJD chapter 9: Moving to Design (p320-334)

Supplementary sources:
• BCK Chapter 1: What is Software Architecture?
• BCK Chapter 2: Why is Software Architecture Important?
• BCK Chapters 3, 4
• Pohl chapter 19: Fundamentals of Conceptual Modelling

Week 6: Feb 14

Elicitation, negotiation and documentation

Required Reading:

Recommended reading:
• Maalej, Walid; Nayebi, Malek Naz; Johann, Timo; Ruhe, Guenther, Toward Data-Driven Requirements Engineering. IEEE Software 33(1), 48-54, Jan.-Feb. 2016.

Supplementary sources:
• Pohl chapters 17,18,19

Feb 21 Reading week
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<tr>
<th>Week 7: Feb 28</th>
<th><strong>Requirements presentations part 1</strong></th>
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<tr>
<td><strong>Required Reading:</strong></td>
<td><em>You can read this in week 7 or 8 depending on when you are presenting:</em></td>
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<td></td>
<td>- Becker, Christoph; Betz, Stefanie; Chitchyan, Ruzanna; Duboc, Leticia; Easterbrook, Steve M.; Penzenstadler, Birgit; Seyff, Norbert; Venters, Colin C., <em>Requirements: The Key to Sustainability</em>. IEEE Software 33(1), 56-65, Jan.-Feb. 2016. <a href="http://dx.doi.org/myaccess.library.utoronto.ca/10.1109/MS.2015.158">http://dx.doi.org/myaccess.library.utoronto.ca/10.1109/MS.2015.158</a></td>
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| Week 8: Mar 7 | **Requirements presentation part 2.**  
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<tr>
<td><strong>The role of requirements in systems design.</strong></td>
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<th>Week 9: Mar 14</th>
<th><strong>Software systems architecture deep dive: Smart Decisions</strong></th>
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<tr>
<td><strong>Required Reading:</strong></td>
<td><em>CK chapter 3</em> is crucial since it gives you the key concepts for the architectural design process and the basis for the game we will spend most of the class on.</td>
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<td>- Review the <em>Smart Decisions</em> Game Cards at <a href="http://smartdecisionsgame.com/">http://smartdecisionsgame.com/</a>. They are quite dense in content and you’ll want to review them before class.</td>
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<tr>
<th>Supplementary Sources:</th>
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<tr>
<td>- BCK Chapter 17: Designing an Architecture</td>
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<td>- The National Institute of Standards and Technology (NIST) (2011). <em>The NIST Definition of Cloud Computing</em>. SP 800-145, <a href="http://dx.doi.org/10.1109/IEEESTD.2011.6129467">available online</a></td>
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<th>Week 10: Mar 21</th>
<th><strong>Architecture design, documentation and evaluation. Quality scenarios.</strong></th>
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| **Required Reading:** | *RW chapter 3: Viewpoints*  
| | - RW chapter 10: Identifying and using scenarios  
| | - Review Rozanski&Wood: Viewpoints and Perspectives Reference Card (see Blackboard): Context View, Functional View, Deployment View  

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<tr>
<th>Supplementary Sources:</th>
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<tr>
<td>- RW chapter 13</td>
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### Syllabus for INF 1342H: System Requirements and Architectural Design

- Rozanski&Wood: Viewpoints and Perspectives Reference Card (see Blackboard) and RW architecture template (see Blackboard)
  - A classic report on how to document architecture, including typical pitfalls and causes for misunderstandings
  - Chapter 6: Guidelines for Modelling
  - Chapters 3: Foundations and 5: A Language for Enterprise Modelling
  - The classic article on multiple viewpoints plus scenarios
  - A detailed technical discussion of architectural styles and patterns
- BCK Chapter 21: Architecture Evaluation
  - Section 11.4: *The Nightingale System: A Case Study in Applying the ATAM*
  - Describes the light-weight architecture evaluation method TARA, which is easier to apply than more formal methods such as ATAM
Statement of Acknowledgement of Traditional Land
We wish to acknowledge this land on which the University of Toronto operates. For thousands of years it has been the traditional land of the Huron-Wendat, the Seneca, and most recently, the Mississaugas of the Credit River. Today, this meeting place is still the home to many Indigenous people from across Turtle Island and we are grateful to have the opportunity to work on this land.

Acknowledgement and citation. Parts of this syllabus build on Prof. Eric Yu's course syllabus for an earlier version of this course. The text in sections Website/Resources, Guidelines for Assignments, Grading, Ground Rules, Students with a Disability or Health Consideration, Writing Support, and Academic Integrity are in quotes because they are taken directly from Prof. Sara Grimes' Research Course Syllabus.