University of Victoria Engineering

Faculty of Engineering

COURSE OUTLINE

SENG 468: Software System Scalability

Term – Spring 2019 (22722,22723)

Instructor

Zahra Nikdel

E-mail: nikdel@uvic.ca

Office Hours

Days: Mon.
Time: 11 am to 12 pm (or by appointment)
Location: EOW 419

Note: All course emails ***MUST*** have "SEng468:" in the subject line and ***MUST*** be sent from UVic email accounts.
Emails without proper subject lines or sent from off-campus email accounts will likely be dropped by UVic's email spam filters or be automatically redirected to junk email folders.

Course Objectives

The course objectives are to introduce software systems scalability problems and concerns that arise within larger-scale, complex distributed software systems and, particularly, within modern Internet-scale systems. Students will gain understandings of middleware, how it is used to build such systems, how to assess where and why system bottlenecks occur, and identify the best paths to their resolution. Students will gain knowledge of the methods used to model user interactions and how to map these onto the system resource requirements. Students will be introduced to the mathematical models and approaches used to analyze system performance and scalability concerns, including those that commonly arises within modern high-volume system workloads, such as heavy-tailed, long-range dependent, self-similar, non-stationary, and emergent behaviours.
Through the team-based course project students will gain hands-on experience in software system scalability and testing issues, as well as software instrumentation and analysis approaches.

Learning Outcomes

Students successfully completing this course will gain an understanding of:

- The problems that arise when software systems are scaled up to significant numbers of users and/or system events, i.e. into the millions to billions of transactions or serviceable events.
- How to perform the system testing required to identify where and why system bottlenecks are occurring and assess the relative merits of potential solution approaches.
- Why middleware exists, its various forms, and how it is used to construct distributed software systems.
- Engineering design approaches and methods to mitigate consistency, reliability, and scalability issues.
- The applications of queueing networks to the modeling of distributed system performance and capacity and their limitations.
- The engineering principles that underlie the construction of larger-scale software systems and the software engineering challenges inherent in this domain.

- The mathematical approaches used to model modern system workloads and guide performance analyses, including how these can be estimated from collected data sets and the limitations of such models.

From the course project, students will gain practical experience in how to build and debug a larger-scale distributed software system and why this is fundamentally different than building small-scale software systems intended to service only low numbers of users.

Syllabus

The exact pacing and coverage of the syllabus materials will vary with course offerings, as such the listed syllabus denotes a provisional pacing and coverage which may (or may not) change.

- Course introduction
- Discussion of course project details
- Introduction to larger-scale software systems:
    - What and Why
    - Core underlying issues
    - Transparency
    - Basic Distributed Architectures
    - Cloud deployed back-ends
        - VMs and Containers
- Building Blocks of Large-scale Software Systems:
    - Distributed Software Design
        - Design Principals
        - Design Mechanisms
        - Design Methodology
    - Middleware
        - Basic Requirements
        - RESTful and Soap
- Persistence
- Transactions
    - Principals and ACID
    - Concurrency Control
    - Distributed Transactions
- Basics of Distribution and Performance Analysis:
    - Workload Matrix
    - Performance Matrix
    - Rules for addressing bottlenecks
    - Customer behaviour model graph (CBMG)
    - Client/Server interaction diagram (CSID)
    - Example System
- Formal Modeling Approaches and Complexities:
    - Queuing network models
        - Markov models
    - On/Off traffic/workload models
    - Real-world Complications
        - Heavy-tails
        - Long-range dependencies
        - Self-similarity
        - Stationarity and ergodicity
- Mapping onto operational systems and measurements:

- Timestamps
- Fitting distributions
  - Anderson-Darling test
  - Kolmogorov-Smirnov test
  - Chi-squared test
- Testing for stationarity and ergodicity
- Testing for self-similar/bursty workloads
- How much testing is enough?
- Edge networks and their complications

Lectures:

A-Section(s): A01, A02 / CRN 22722,22723
Days: Tues., Wed., Fri.
Time: 1:30 pm - 2:20 pm
Location: MacLaurin Building D110

Tutorial:
T01 Tue 11:30 am - 12:20 pm ELW A321
T02 Thurs 12:00 pm - 12:50 pm ELW A321
T03 Wed 2:30 pm - 3:20 pm ELW A321

Required Text

Title: Workload Modeling for Computer Systems Performance Evaluation
Author: Dror G. Feitelson
Publisher: Cambridge University Press
Year: 2014

Optional Text

Title: Performance Evaluation of Computer and Communication Systems
Author: Jean-Yves Le Boudec
Publisher: EPFK
Year: 2009

Assessment:

Course Project	40%	Due Dates: Project milestone due dates are provided on the project course web site http://www.ece.uvic.ca/~seng462. All final project submissions will be due on April 9th @ 5pm
Mid-term	20%	Date: Wed 27th February
Final Exam	40%	

Note:

- Failure to complete and pass the course project will result in a failing grade for the course.
- Failure to pass the final exam will result in a failing grade for the course.

The final grade obtained from the above marking scheme for the purpose of GPA calculation will be based on the percentage-to-grade point conversion table as listed in the current Undergraduate Calendar.

https://web.uvic.ca/calendar2019-01/undergrad/info/regulations/grading.html

There will be no supplemental examination for this course.

https://web.uvic.ca/calendar2019-01/undergrad/info/regulations/exams.html#

Note to students: Students who have issues with the conduct of the course should discuss them with the instructor first. If these discussions do not resolve the issue, then students should feel free to contact the Chair of the Department by email or the Chair's Assistant to set up an appointment.

Accommodation of Religious Observance:
https://web.uvic.ca/calendar2019-01/undergrad/info/regulations/religious-observanc.html

Policy on Inclusivity and Diversity:
https://web.uvic.ca/calendar2019-01/general/policies.html

Standards of Professional Behaviour: You are advised to read the Faculty of Engineering document Standards for Professional Behaviour, which contains important information regarding conduct in courses, labs, and in the general use of facilities.
https://www.uvic.ca/engineering/assets/docs/professional-behaviour.pdf

Cheating, plagiarism and other forms of academic fraud are taken very seriously by both the University and the Department. You should consult the entry in the current Undergraduate Calendar for the UVic policy on academic integrity.
https://web.uvic.ca/calendar2019-01/undergrad/info/regulations/academic-integrity.html

Equality: This course aims to provide equal opportunities and access for all students to enjoy the benefits and privileges of the class and its curriculum and to meet the syllabus requirements. Reasonable and appropriate accommodation will be made available to students with documented disabilities (physical, mental, learning) in order to give them the opportunity to successfully meet the essential requirements of the course. The accommodation will not alter academic standards or learning outcomes, although the student may be allowed to demonstrate knowledge and skills in a different way. It is not necessary for you to reveal your disability and/or confidential medical information to the course instructor. If you believe that you may require accommodation, the course instructor can provide you with information about confidential resources on campus that can assist you in arranging for appropriate accommodation. Alternatively, you may want to contact the Resource Centre for Students with a Disability located in the Campus Services Building.

The University of Victoria is committed to promoting, providing, and protecting a positive, and supportive and safe learning and working environment for all its members.

Course Lecture Notes: Unless otherwise noted, all course materials supplied to students in this course have been prepared by the instructor and are intended for use in this course only. These materials are NOT to be re-circulated digitally, whether by email or by uploading or copying to websites, or to others not enrolled in this course. Violation of this policy may in some cases constitute a breach of academic integrity as defined in the UVic Calendar.

Sexualized Violence Prevention and Response at UVic

UVic takes sexualized violence seriously, and has raised the bar for what is considered acceptable behaviour. We encourage students to learn more about how the university defines sexualized violence and its overall approach by visiting www.uvic.ca/svp. If you or someone you know has been impacted by sexualized violence and needs information, advice, and/or support please contact the sexualized violence resource office in Equity and Human Rights (EQHR). Whether or not you have been directly impacted, if you want to take part in the important prevention work taking place on campus, you can also reach out:

Where: Sexualized violence resource office in EQHR; Sedgewick C119
Phone: 250.721.8021
Email: svpcoordinator@uvic.ca
Web: www.uvic.ca/svp