CS3331 - Foundations of Computer Science

Course description (course web site)

We live during the computer revolution, which is changing fast everything around us. While programming languages change fast, the basic underlying theory does not. This course covers the basic concepts of the theory of computation. To study computation thoroughly, we need models. Ideally, we would like simple models to solve our problems. This is what the theory of computation is about: computational models and their power, with an impressive array of applications. That includes finite state machines, regular expressions, push-down automata, and context-free grammars. A crucial aspect is studying the limits of computations, which involves investigating all powerful models, such as Turing machines. Some problems are intractable, that is, it takes ages to solve them, others are provably impossible to solve even on an infinitely powerful computer. Computability theory sheds light on these issues of fundamental importance to anyone attempting to understand what computers can do for us.

Topics

- Regular Languages
    - Finite State Machines (FSM)
        - Deterministic (DFSM)
        - Nondeterministic (NDFSM)
    - Regular Expressions
    - Regular Grammars
    - Minimizing DFSM
    - Conversions between DFSM, NDFSM, Reg. Exp., and Reg. Grammars
    - Proving regularity
    - Closure properties
    - Proving nonregularity
        - Pumping theorem
        - Using closure properties
    - Decision Problems
        - Membership, Emptiness, Totality, Finiteness, Equivalence, Minimality
- Context-free Languages

- o Pushdown Automata (PDA)
- o Context-free Grammars (CFG)
- o Conversions
  - PDA ↔ CFG
  - CFG → Chomsky Normal Form
- o Ambiguity
- o Proving context-freeness
- o Closure properties
- o Proving noncontext-freeness
  - Pumping theorem
  - Using closure properties
- o Decision Problems
  - Membership, Emptiness, Finiteness
- Turing Machine and Undecidability
  - o Turing Machines (TM)
  - o Deterministic TM
    - Decidable languages (D)
    - Semidecidable languages (SD)
  - o Multi tape TM
  - o Nondeterministic TM
  - o Universal TM
  - o Halting Problem
  - o D and SD
  - o Enumeration
  - o Reduction
    - Using reduction to prove undecidability
  - o Rice's Theorem
  - o Non-SD languages
  - o Unrestricted Grammars
  - o Non-TM Problems
    - Post Correspondence Problem (PCP)
    - Context-free language problems

Prerequisites

Computer Science 2214: Discrete Structures for Computing or Mathematics 2155: Discrete Structures I or registration in the third or fourth year of an honors program that combines Computer Science and other mathematical science or SE 2251A/B (251A/B) and registration in the third year of the BESc program in Software Engineering.

Unless you have either the prerequisites for this course or written special permission from your Dean to enrol in it, you will be removed from this course and it will be deleted from your record.

This decision may not be appealed. You will receive no adjustment to your fees in the event that you are dropped from a course for failing to have the necessary prerequisites.

Instructor

- Prof. Lucian Ilie, MC378, e-mail: ilie$^{@}$uwo.ca
  - Office hours: Wednesdays, 10:30 - 11:30am and 3:30 - 4:30pm, MC378

Class time

- Tuesdays, 3:30 - 5:30pm, SH-3345
- Wednesdays, 9:30 - 10:30am, NCB-113

Textbook (required)

- Elaine Rich, *Automata, Computability, and Complexity. Theory and Applications,* © Person Prentice Hall (2008), ISBN 978-0-13-228806-4.
  - The textbook is out of print. A free PDF is available from the author's web site. You can find a hard copy from previous students or from AbeBooks.

Tools

- Jflap (You are allowed to use jflap for assignments.)

Evaluation (tentative due dates - check OWL) -- Assignments will be available on **OWL**

- Assignment 1 (10%) -- due Oct. 8
- Assignment 2 (10%) -- due Oct. 15

- Assignment 3 (10%) -- due Nov. 26
- Assignment 4 (10%) -- due Dec. 3
- Midterm Exam (30%) -- (covers Regular and Context-free Languages -- see Topics above) -- **Tuesday, Oct. 22, in class (2 hours); see lecture notes for sample midterm exam**
  - **Review sessions by TAs (in additions to in-class review):**
    - **TBA**
- Final Exam (30%) -- (covers Turing Machines and Undecidability -- see Topics above) -- **TBA; see lecture notes for sample final exam**
  - **Review sessions by TAs (in additions to in-class review):**
    - **TBA**
  - **Final makeup exam: Wednesday, Jan. 8, 2020, TC 357, 11:00am**
- **In order to pass the course you MUST PASS THE EXAMS, that is, your combined grade for the two exams should be at least 50/100.**

TAs

TBA

Assignments

- The assignments will consist of a set of exercises related to the material covered in class. The solutions for the exercises should be neatly written or typed.
- All assignments will be made available on the course web site. The availability of assignments will be announced on class and/or via e-mail. Students are responsible for checking their e-mail on a regular basis.

Appeals of Assignment Marks

- Appeals of assignment marks should be addressed to the T.A. first. If you and the T.A. cannot agree, then the T.A. will discuss the situation with the lecturer.
- Appeals must occur within 1 week from the first day that the marked assignments were made available to students. After that 1 week period has gone by, no more appeals will be considered.

Computing Facilities

Each student will be given an account on the Computer Science Department senior undergraduate computing facility, GAUL. In accepting the GAUL account, a student agrees to abide by the department's; Rules of Ethical Conduct.

Adherence to Deadlines

There is no penalty for late submissions up to three days. After that the late work is no longer accepted.

Accommodation and Accessibility

If you are unable to meet a course requirement due to illness or other serious circumstances, you must seek approval for the absence as soon as possible. Approval can be granted either through a self-reporting of absence or via the Dean's Office/Academic Counselling unit of your Home Faculty. If you are a Science student, the Academic Counselling Office of the Faculty of Science is located in NCB 280, and can be contacted at scibmsac@uwo.ca.
For further information, please consult the university's policy on academic consideration for student absences: https://www.uwo.ca/univsec/pdf/academic_policies/appeals/Academic_Consideration_for_absences.pdf.
In case of missed assignments, their weight is moved to the exams as follows: assignments 1 and 2 to midterm and assignments 3 and 4 to final. The midterm exam, if missed, has to be retaken; the weight cannot be moved to the final exam.
If you miss the Final Exam, please contact your faculty's Academic Counselling Office as soon as you are able to do so. They will assess your eligibility to write the Special Exam (the name given by the university to a makeup Final Exam).
You may also be eligible to write the Special Exam if you are in a "Multiple Exam Situation" (see http://www.registrar.uwo.ca/examinations/exam_schedule.html).

Academic Policies

The website for Registrarial Services is http://www.registrar.uwo.ca.
In accordance with policy, http://www.uwo.ca/its/identity/activatenonstudent.html, the centrally administered e-mail account provided to students will be considered the individual's official university e-mail address. It is the responsibility of the account holder to ensure that e-mail received from the University at his/her official university

address is attended to in a timely manner.

No cheat-sheets (or any other sheets), books, or electronic devices are permitted during exams (midterm and final).

Scholastic offences are taken seriously and students are directed to read the appropriate policy, specifically, the definition of what constitutes a Scholastic Offence, at the following Web site: http://www.uwo.ca/univsec/pdf/academic_policies/appeals/scholastic_discipline_undergrad.pdf.

All required papers may be subject to submission for textual similarity review to the commercial plagiarism detection software under license to the University for the detection of plagiarism. All papers submitted for such checking will be included as source documents in the reference database for the purpose of detecting plagiarism of papers subsequently submitted to the system. Use of the service is subject to the licensing agreement, currently between The University of Western Ontario and Turnitin.com (http://www.turnitin.com).

Computer-marked multiple-choice tests and exams may be subject to submission for similarity review by software that will check for unusual coincidences in answer patterns that may indicate cheating.

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Support Services

Please contact the course instructor if you require lecture or printed material in an alternate format or if any other arrangements can make this course more accessible to you. You may also wish to contact Student Accessibility Services (SAS) at 661-2147 if you have any questions regarding accommodations.

The policy on Accommodation for Students with Disabilities can be found here: https://www.uwo.ca/univsec/pdf/academic_policies/appeals/Academic%20Accommodation_disabilities.pdf.

The policy on Accommodation for Religious Holidays can be found here: http://www.uwo.ca/univsec/pdf/academic_policies/appeals/accommodation_religious.pdf.

Students who are in emotional/mental distress should refer to Mental Health@Western (http://www.health.uwo.ca/mental_health) for a complete list of options about how to obtain help.

Additional student-run support services are offered by the USC, http://westernusc.ca/services.