

## CSCI 4190/6907 — Algorithm Engineering Course Syllabus

### Instructor Information

<b>Instructor:</b>	Dr. Norbert Zeh	<b>Office:</b>	Goldberg 313
<b>E-mail:</b>	nzeh@cs.dal.ca	<b>Office Hours:</b>	T 2:30-4:30 R 9:30-11:30 Chemistry 223
<b>Class Meeting Time:</b>	MWF 14:35-15:25	<b>Room No:</b>	Chemistry 223
<b>Course Homepage:</b>	<a href="http://www.cs.dal.ca/~nzeh/Teaching/AE">http://www.cs.dal.ca/~nzeh/Teaching/AE</a>		
<b>Teaching Assistants:</b>	See webpage		

### Important Dates

1. Reading Week (no classes): February 19–23, 2018
2. Project deadline: Apr 10, 2018
3. Final Withdrawal Date without academic penalty: February 5, 2018
4. Final Withdrawal Date with a grade of W: March 12, 2018

### Course Description

This course gives an introduction to Algorithm Engineering, which focuses on developing efficient algorithms and easy-to-use, well-tested, and high-performance implementations of these algorithms for use in the real world.

Specific aspects of algorithm engineering that will be discussed are modelling, algorithm design, analysis, realistic computer models, implementation aspects, algorithm libraries, and experimental evaluation of algorithms.

### Learning Outcomes

- Understand the iterative nature of algorithm development process.
- Model application problems as formal algorithmic problems.
- Design practically efficient algorithms.
- Understand analysis frameworks focused on predicting the performance of algorithms on realistic data sets.
- Understand computer models that more precisely model modern computer hardware.
- Produce an efficient implementation of an algorithm.
- Formulate falsifiable hypotheses about the algorithm and its inputs that can be tested experimentally.
- Carry out experiments to evaluate the performance of an algorithm implementation.
- Carry out experiments to understand details of the algorithm behaviour and input data.

### Class Format and Course Communication

- The class is organized as a seminar with introductory lectures by the instructor followed by presentations by students.
- Students must ask the instructor permission before recording class lectures.

- Course announcements will be posted to the course mail list, which comprises the instructor's and students' Dal emails. It is the student's responsibility to check their Dal e-mail on a daily basis. To access your Dal e-mail account please see: <https://www.dal.ca/dept/its/o365/services/email.html>.

## Evaluation Criteria

1. Presentation (50%)  
Each student will give a 50-minute presentation that cover one aspect of algorithm engineering. The presentation will be graded based on clarity (20%), coverage of the assigned presentation topic (20%), and effective use of visual aids (10%).
2. Project (50%)  
Each student will complete a project where he or she applies the main steps involved in algorithm engineering (modelling, algorithm design, analysis, implementation, and experiments). The code and the test data are to be submitted and are evaluated based on how they achieve the goals of algorithm engineering (simplicity, reuse, reproducible experiments, ...) (10%). The remaining 40% of the mark are determined based on an evaluation of a 10–15 page project report where the student is required to discuss the problem they addressed, the designed algorithm, the experimental setup including test data, and the results of the experiments.
3. More specific information on evaluation criteria for the presentation and project report can be found on the course webpage.

## Required Texts and Resources

- The text for the course is: Matthias Mller-Hannemann and Stefan Schirra. *Algorithm Engineering: Bridging the Gap Between Algorithm Theory and Practice*. Springer-Verlag, 2010.

## Prerequisites

CSCI 3110

## Project Milestones

<b>Milestone</b>	<b>Deadline</b>
Project selection	Jan 22
Project description	Feb 5
Modelling of problem	Feb 19
Plan for implementation	Mar 5
Plan for experiments	Mar 19
Final report	Apr 10

## Tentative Schedule of Topics

Topic	Tentative dates
Introduction	Jan 8–19
Modelling fundamentals & graph-based models	Jan 22
Modelling: Mixed integer programming, convex programming, constraint programming & algebraic modelling languages	Jan 24
Algorithm design: Simplicity & scalability	Jan 26
Algorithm design: Time-space trade-offs	Jan 29
Algorithm design: Robustness	Jan 31
Algorithm analysis: Worst-case, average-case & amortized analysis; realistic input models	Feb 2
Algorithm analysis: Smoothed analysis	Feb 5
Algorithm analysis: Computational testing, representative operation counts & experimental study of asymptotic performance	Feb 7
Computer models: Memory hierarchies, success stories	Feb 9
Computer models: Parallel computing	Feb 12
Implementation: Correctness & efficiency	Feb 14
Implementation: Flexibility & ease of use; efficiency of implementation; geometric algorithms	Feb 16
Algorithm libraries: Overview, building blocks & design goals; fundamental operations	Feb 26
Algorithm libraries: Advanced number types, basic data structures, graphs & computational geometry	Feb 28
Experiments: Planning, set-up & running experiments	Mar 2
Experiments: Test data generation & test data libraries	Mar 5
Experiments: Evaluating & reporting experimental results	Mar 7
Case studies: Shortest paths & Steiner tree	Mar 9
Case studies: Voronoi diagrams	Mar 12
Project presentations	Mar 21–Apr 9

## Responsible Computing Policy

Usage of all computing resources in the Faculty of Computer Science must be within the Dalhousie Acceptable Use Policies (<http://its.dal.ca/policies/>) and the Faculty of Computer Science Responsible Computing Policy. ([https://www.cs.dal.ca/downloads/fcs\\_policy\\_local.pdf](https://www.cs.dal.ca/downloads/fcs_policy_local.pdf))

## Culture of Respect

Every person has a right to respect and safety. We believe inclusiveness is fundamental to education and learning. Misogyny and other disrespectful behaviour in our classrooms, on our campus, on social media, and in our community is unacceptable. As a community, we must stand for equality and hold ourselves to a higher standard.

### What we all need to do <sup>1</sup>:

1. **Be Ready to Act:** This starts with promising yourself to speak up to help prevent it from happening again. Whatever it takes, summon your courage to address the issue. Try to approach the issue with open-ended questions like “Why did you say that?” or “How did you develop that belief?”

<sup>1</sup>Source: Speak Up! ©2005 Southern Poverty Law Center. First Printing. This publication was produced by Teaching Tolerance, a project of the Southern Poverty Law Center. Full “Speak Up” document found at: <http://www.dal.ca/dept/dalrespect.html> Revised by Susan Holmes from a document provided April 2015 by Lyndsay Anderson, Manager, Student Dispute Resolution, Dalhousie University 902.494.4140 [lyndsay.anderson@dal.ca](mailto:lyndsay.anderson@dal.ca) [www.dal.ca/think](http://www.dal.ca/think).

2. **Identify the Behaviour:** Use reflective listening and avoid labeling, name-calling, or assigning blame to the person. Focus the conversation on the behaviour, not on the person. For example, “The comment you just made sounded racist, is that what you intended?” is a better approach than “Youre a racist if you make comments like that.”
3. **Appeal to Principles:** This can work well if the person is known to you, like a friend, sibling, or co-worker. For example, “I have always thought of you as a fair-minded person, so it shocks me when I hear you say something like that.”
4. **Set Limits:** You cannot control another persons actions, but you can control what happens in your space. Do not be afraid to ask someone “Please do not tell racist jokes in my presence anymore” or state “This classroom is not a place where I allow homophobia to occur.” After you have set that expectation, make sure you consistently maintain it.
5. **Find or be an Ally:** Seek out like-minded people that support your views, and help support others in their challenges. Leading by example can be a powerful way to inspire others to do the same.
6. **Be Vigilant:** Change can happen slowly, but do not let this deter you. Stay prepared, keep speaking up, and do not let yourself be silenced.

## University Statements

This course is governed by the academic rules and regulations set forth in the University Calendar and the Senate.

<https://academiccalendar.dal.ca/Catalog/ViewCatalog.aspx?pageid=viewcatalog&catalogid=69&chapterid=3457&loaduserredits=False>

### Academic Integrity

At Dalhousie University, we are guided in all of our work by the values of academic integrity: honesty, trust, fairness, responsibility and respect (The Center for Academic Integrity, Duke University, 1999). As a student, you are required to demonstrate these values in all of the work you do. The University provides policies and procedures that every member of the university community is required to follow to ensure academic integrity.

[http://www.dal.ca/dept/university\\_secretariat/academic-integrity.html](http://www.dal.ca/dept/university_secretariat/academic-integrity.html)

### Accessibility

The Advising and Access Services Centre is Dalhousie’s centre of expertise for student accessibility and accommodation. The advising team works with students who request accommodation as a result of: a disability, religious obligation, or any barrier related to any other characteristic protected under Human Rights legislation (NS, NB, PEI, NFLD).

[http://www.dal.ca/campus\\_life/student\\_services/academic-support/accessibility.html](http://www.dal.ca/campus_life/student_services/academic-support/accessibility.html)

### Student Code of Conduct

Everyone at Dalhousie is expected to treat others with dignity and respect. The Code of Student Conduct allows Dalhousie to take disciplinary action if students dont follow this community expectation. When appropriate, violations of the code can be resolved in a reasonable and informal mannerperhaps through a restorative justice process. If an informal resolution cant be reached, or would be inappropriate, procedures exist for formal dispute resolution.

[https://www.dal.ca/campus\\_life/safety-respect/student-rights-and-responsibilities/student-life-policies/code-of-student-conduct.html](https://www.dal.ca/campus_life/safety-respect/student-rights-and-responsibilities/student-life-policies/code-of-student-conduct.html)

### Diversity and Inclusion – Culture of Respect

Every person at Dalhousie has a right to be respected and safe. We believe inclusiveness is fundamental to education. We stand for equality. Dalhousie is strengthened in our diversity. We are a respectful and inclusive community. We are committed to being a place where everyone feels welcome and supported, which is why our Strategic Direction prioritizes fostering a culture of diversity and inclusiveness (Strategic Priority 5.2).

<http://www.dal.ca/cultureofrespect.html>

### Recognition of Mikmaq Territory

Dalhousie University would like to acknowledge that the University is on Traditional Mikmaq Territory. The Elders in Residence program provides students with access to First Nations elders for guidance, counsel and

support. Visit the office in the McCain Building (room 3037) or contact the programs at [elders@dal.ca](mailto:elders@dal.ca) or 902-494-6803 (leave a message).

**Learning and Support Resources**

**General Academic Support — Advising** [http://www.dal.ca/campus\\_life/student\\_services/academic-support/advising.html](http://www.dal.ca/campus_life/student_services/academic-support/advising.html)

**Fair Dealing Guidelines** <https://libraries.dal.ca/services/copyright-office/guidelines/fair-dealing-guidelines.html>

**Dalhousie University Library** <http://libraries.dal.ca>