CS 335 - Winter 2020: Course Outline (revised)

Computational Methods in Business and Finance

Instructor: Justin W.L. Wan  Office: DC 3625  Email: justin.wan@uwaterloo.ca
Classroom: STC 0020  MW 2:30pm-3:50pm  Office hours: Mondays 10-11:30am

TAs: Andrew Na, Office: DC 3594, Email: andrew.na@uwaterloo.ca
      Thomas Lu, Office: E7 6346, Email: tlu@uwaterloo.ca

CS335 homepage: [http://www.student.cs.uwaterloo.ca/~cs335/](http://www.student.cs.uwaterloo.ca/~cs335/)

- **Course Description:** This course will cover topics such as: Introduction to MATLAB, lattice methods for pricing contingent claims, Monte Carlo techniques for pricing options and evaluating investment strategies, use of optimization software for portfolio optimization, solution of nonlinear equations (yield to maturity, implied volatility), floating point error propagation, and polynomial interpolation. Assignments will involve both theoretical and programming tasks using MATLAB.

- **Course Objectives:** This course will give students in the business related programs in the Mathematics Faculty an introduction to basic computational methods used in business and financial applications.

- **Tentative schedule:**

  Jan 6, 8  Introduction, two state tree
  Jan 9  MATLAB tutorial, MC 2017, 5-7pm
  Jan 13, 15  No arbitrage, random walk on a lattice
  Jan 20, 22  Brownian motion, Ito’s lemma, lattice method
  Jan 27, 29  Dynamic programming, Black-Scholes equation  Assignment 1 due
  Feb 3, 5  Hedging, convergence of numerical scheme, Floating point arithmetic
  Feb 10, 12  Pitfalls of computation, root finding
  Feb 18-21  Reading week
  Feb 24, 26  Bisection, secant, Newton, fixed point  Assignment 2 due
  Feb 27 (Thu)  Midterm, DC 1350, 7-8:50pm
  Mar 2, 4  Convergence theory, Monte Carlo simulation
  Mar 9, 11  Error, complexity, discrete hedging
  Mar 16, 18  Delta hedge simulation, measuring risk, CPPI simulation  Assignment 3 due (March 25, Wed)
  Mar 23, 25  Dynamic rebalancing, higher dimension simulation
  Mar 30, Apr 1  MC vs lattice, other investment strategies  Assignment 4 due (April 10, Fri)

- **Text and References:** The main source of information for the course is the material covered in the class lectures. Details of some of the more mathematical material is available in the form of typeset course notes, which are on sale at W Print in South Campus Hall. There is more material in these notes than we are going to cover in this class. The notes, however, are terse summaries of some of the topics covered in the lectures. It is therefore imperative that you attend the lectures and take notes.
• **Programming Languages:** MATLAB is to be used for the programming assignments. MATLAB tutorials can be found on the CS335 homepage. There are many sources of MATLAB information on the Web. There are also many reference books available. A MATLAB tutorial will be scheduled in the beginning of the term (January 9, Thursday, 5-7pm, MC 2017). The best way to learn MATLAB is to start the assignments early, and see the TAs if you have problems. You should start the assignments as soon as possible, well before the due date, to get familiar with MATLAB. Octave is an acceptable substitute.

• **Assignments:** Assignments will be posted on Crowdmark approximately two weeks before the due dates. Check regularly to make sure you are using the most recent version (corrections will be made to the web posting, if necessary). All assignments must be submitted electronically on Crowdmark by the due date of the assignment.

Students are welcome to discuss the assignment solutions with the instructor and TA after the assignments are returned. However, solutions are not normally posted on the web.

• **Late Policy:** Late assignments submitted (by email to the instructor) within 24 hours of the due deadline will be marked at half credit. You may not hand in part of your assignment on time and part late; if this happens, the entire assignment will be marked as late. Assignments submitted more than 24 hours late will not be marked.

• **Assignment Help:** Students can discuss general concepts and problems with other individuals in class. However, the solution that you submit must be worked through by yourself and written in your own words.

For each assignment, TAs are assigned to handle email queries and office hours which will be posted on the class homepage. Students are encouraged to go to the office hours by the instructor and TA.

• **Marking:** The assignments will consist of programming problems and analytic work. Most of the marks for the programming problems will be given for the description of the algorithm and explanation of the results or output. Simply submitting “raw code” will get very few marks. The results should be presented clearly in the form of table, graph, etc. You will receive no mark if you present results as comments in the code.

Assignment figures and graphs should be carefully thought out to present the data and conclusions in an effective and clear manner. Poor presentation of your work will result in a poor mark.

In all cases, we expect you to explain your algorithms, and describe what you see in detail. You should also submit hard copies of your code, along with documentation. MATLAB has good plotting functions. Create figures with MATLAB to include in your assignments.

• **Assignment/Midterm Marking Appeals:** If you feel your assignment/midterm was marked incorrectly, write an explanation of what you would like reviewed, attach this to your (marked) assignment/midterm, and hand this to the course instructor, who will pass this on the appropriate TA. Reviews of assignment/midterm marking must be submitted within one week from the time the assignments/midterm are returned in class.

• **Course Grade:**

There will be four assignments, a midterm, and no final exam. Each assignment will count 16%, so a total of 64%. The midterm is worth 36%.

• **Midterm:** The midterm is scheduled on February 27, Thursday, 7:00pm-8:50pm, DC 1350.
• **Plagiarism**: Plagiarism is representing the work of others as your own. Plagiarism on exams includes using unauthorized aids or communicating in any way with others during an examination. Plagiarism on assignments includes copying another student’s solution and submitting it as your own, allowing another student to copy your solution, collaborating excessively with another student, or obtaining solutions from any other source. See the section on Discipline below for typical penalties.

All academic offenses are reported to the Associate Dean for Undergraduate Studies and are recorded in the student’s file. Subsequent academic offenses in the same course or in other courses will lead to more severe penalties, up to and including suspension and expulsion.

We encourage you to discuss general concepts and problems with classmates, tutors, TAs, and instructors. However, the solution that you submit must be worked through by yourself and written in your own words. It is not acceptable to work on an assignment with somebody else and write it up individually. The only exceptions are assignments or projects which the instructor designates as group activities. When discussing course matters, do not take notes, and do not look at another person’s partial solutions, or show them yours.

• **Avoiding Academic Offenses**: Most students are unaware of the line between acceptable and unacceptable academic behaviour, especially when discussing assignments with classmates and using the work of other students. For information on commonly misunderstood academic offenses and how to avoid them, students should refer to the Faculty of Mathematics Cheating and Student Academic Discipline Policy ([http://www.math.uwaterloo.ca/navigation/Current/cheating_policy.shtml](http://www.math.uwaterloo.ca/navigation/Current/cheating_policy.shtml)).

• **Academic Integrity**: In order to maintain a culture of academic integrity, members of the University of Waterloo community are expected to promote honesty, trust, fairness, respect and responsibility ([https://uwaterloo.ca/academic-integrity/](https://uwaterloo.ca/academic-integrity/)).

• **Grievance**: A student who believes that a decision affecting some aspect of his/her university life has been unfair or unreasonable may have grounds for initiating a grievance. Read Policy 70, *Student Petitions and Grievances, Section 4* ([https://uwaterloo.ca/secretariat/policies-procedures-guidelines/policy-70](https://uwaterloo.ca/secretariat/policies-procedures-guidelines/policy-70)). When in doubt, please be certain to contact the department’s administrative assistant who will provide further assistance.

• **Discipline**: A student is expected to know what constitutes academic integrity to avoid committing academic offenses, and to take responsibility for his/her actions. A student who is unsure whether an action constitutes an offense, or who needs help in learning how to avoid offenses (e.g., plagiarism, cheating) or about “rules” for group work/collaboration should seek guidance from the course instructor, academic advisor, or the undergraduate Associate Dean. For information on categories of offenses and types of penalties, students should refer to Policy 71, *Student Discipline* ([https://uwaterloo.ca/secretariat/policies-procedures-guidelines/policy-71](https://uwaterloo.ca/secretariat/policies-procedures-guidelines/policy-71)). For typical penalties, check *Guidelines for the Assessment of Penalties* ([https://uwaterloo.ca/secretariat/policies-procedures-guidelines/guidelines/guidelines-assessment-penalties](https://uwaterloo.ca/secretariat/policies-procedures-guidelines/guidelines/guidelines-assessment-penalties)).

• **Appeals**: A decision made or penalty imposed under Policy 70, *Student Petitions and Grievances* (other than a petition), or Policy 71, *Student Discipline*, may be appealed if there is a ground. A student who believes he/she has a ground for an appeal should refer to Policy 72, *Student Appeals* ([https://uwaterloo.ca/secretariat/policies-procedures-guidelines/policy-72](https://uwaterloo.ca/secretariat/policies-procedures-guidelines/policy-72)).

• **Note for Students with Disabilities**: The AccessAbility Office is located in Needles Hall, Room 1401, collaborates with all academic departments to arrange appropriate accommodations for students with disabilities without compromising the academic integrity of the curriculum. If you require academic
accommodations to lessen the impact of your disability, please register with AccessAbility Services at the beginning of each academic term.

- **Intellectual Property**: Students should be aware that this course contains the intellectual property of their instructor, TA, and/or the University of Waterloo. Intellectual property includes items such as:
  
  - Lecture content, spoken and written (and any audio/video recording thereof);
  - Lecture handouts, presentations, and other materials prepared for the course (e.g. PowerPoint slides);
  - Questions or solution sets from various types of assessments (e.g. assignments, quizzes, tests, final exams); and
  - Work protected by copyright (e.g. any work authored by the instructor or TA or used by the instructor or TA with permission of the copyright owner).

Course materials and the intellectual property contained therein, are used to enhance a student's educational experience. However, sharing this intellectual property without the intellectual property owners permission is a violation of intellectual property rights. For this reason, it is necessary to ask the instructor, TA and/or the University of Waterloo for permission before uploading and sharing the intellectual property of others online (e.g. to an online repository).

Permission from an instructor, TA or the University is also necessary before sharing the intellectual property of others from completed courses with students taking the same/similar courses in subsequent terms/years. In many cases, instructors might be happy to allow distribution of certain materials. However, doing so without expressed permission is considered a violation of intellectual property rights.

Please alert the instructor if you become aware of intellectual property belonging to others (past or present) circulating, either through the student body or online. The intellectual property rights owner deserves to know (and may have already given their consent).