CS 476/676 : Numeric Computation for Financial Modelling

Winter 2016

Instructor: P.A. Forsyth	Office: DC3631	e-mail: *paforsyt@uwaterloo.ca*
Lecture Times:	MWF	2:30-3:20, MC4040
Office Hours:	Tuesdays TBA DC3631	

Course Web Site: `http://www.student.cs.uwaterloo.ca/~cs476`
My Web Site: `http://www.scicom.uwaterloo.ca/~paforsyt`
TAs: ?????????

Calendar Description: `http://www.ucalendar.uwaterloo.ca/1314/COURSE/course-CS.html#CS476`
Schedule of Classes: `http://www.adm.uwaterloo.ca/infocour/CIR/SA/under.html`
Schedule of Classes: `http://www.adm.uwaterloo.ca/infocour/CIR/SA/grad.html`

Course Description

The interaction of financial models, numerical methods, and computing environments. Basic computational aspects of option pricing and hedging. Numerical methods for stochastic differential equations, strong and weak convergence. Generating correlated random numbers. Time-stepping methods. Finite difference methods for the Black-Scholes equation. Discretization, stability, convergence. Methods for portfolio optimization, effect of data errors on portfolio weights.

Course Objectives

To provide students with an overview of modern numerical algorithms for use in financial applications.

Week of Jan 4	Introduction to Options	First lecture January 4
	Bankers, Bonuses, and Busts	
	Random walks on a lattice	
Week of Jan 11	Ito's Lemma	
	Black-Scholes Eqn	
Week of Jan 18	No arbitrage Lattice	
	Hedging	Assignment 1 out
Week of Jan 25	Monte Carlo methods	
	Risk Neutral World	
Week of Feb 1	Hedging	Assignment 1 in (Feb 1)
	Delta, Gamma, VAR	Assignment 2 out
Week of Feb 8	Generating Normal distributions	
	Correlated random numbers	
Week of Feb 15	No Classes	Reading Week
Week of Feb 22	Finite Difference I	Assignment 2 in (Feb 26)
Week of Feb 29	Finite Difference II	Assignment 3 out
	Positive Coeffs	
Week of Mar 7	Stability	
Week of Mar 14	American Options	
	Linear Complementarity	
	Penalty Methods	
Week of Mar 21	Portfolio Optimization	No class March 25
	Multiperiod Mean Variance	
Week of Mar 28	Optimal Trade Execution	Assignment 3 in (March 28)
Week of April 4	Review	Last lecture April 4

- **Reference Material** Course notes are on sale in the DC copy center. The first 100 pages of the notes are on the course Web site. The notes also have a list of reference books.

- **Background Assumed** You should have taken

  - An introductory course in numerical computation, similar to CS370.
  - An introductory course in statistics.
  - Basic calculus and linear algebra.
  - Ability to program in Matlab

  I will assume you know nothing about finance.

- **Course Accounts** You will need to register in the course to obtain a computing account on the CS student computing environment. You should register in CS476/676 CM476 you can obtain a password by going to see the Math Faculty consultants in MC3011 (you must be registered in the course and have a Watcard). If you have a problem which can't be resolved by the consultants, see Lori Suess in MC3011b. By being on the student environment, you will get a license to use matlab. If you use a research machine, you may not have a license for matlab (depending on your supervisor).

- **Assignments** Must be submitted in class on the due date. Assignments will be posted on the Web page for the course. Check to make sure you are using the most recent version (corrections will be made to the Web posting if necessary).

  Please make a copy of your assignment before you submit it. Although we try to make sure this does not happen, assignments occasionally go astray, or never get picked up after being marked. It is important to have copies of your assignment, since you can use these as aids for the final examination.

- **Assignment Marking.** The assignments will consist of programming problems and analytic work. **IMPORTANT**: most of the marks for the programming problems will be given for your description of your algorithms (i.e. pseudo-code) and explanation of the results. Simply handing in "raw code" will get very few marks.

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

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

  If you believe you have received an unfair mark on an assignment you have up to one week from the date the assignment was handed back to request a remark. Please attach a written explanation to the cover of the assignment stating why you want it remarked and give your assignment to the instructor.

  Assignments will be returned in class. Assignments not picked up at that time must be picked up from the TA or instructor office hours.

  Assignment solutions will be discussed in class. Assignment solutions will not be posted on the Web.

  Assignment marks will be posted on UW-D2L. Notify me immediately if you believe the mark was recorded incorrectly. The marks recorded on D2L are regarded as final two weeks after the assignments are returned.

- **Late Policy** On the due date of an assignment, the work done to date should be submitted in class; further material may be submitted for one-half credit at the start of the next class.

- **Assignment Retention** Unclaimed assignments will be retained for one month after term grades become official in quest. After that time, they will be destroyed in compliance with UW's confidential shredding procedures: `https://uwaterloo.ca/central-stores/confidential-shredding`

- **Class Grade** The course is planned to have three marked assignments and a final examination. The course grade will be made at the discretion of the instructor; the guidelines for this are that the assignments count 50% and the final exam, 50%. All assignments are equally weighted. The final exam will be *aids allowed*, (all course notes and your notes and assignments may be used). You must pass the final examination (i.e. 25/50) in order to pass the course. If you fail the final examination, the final examination mark will be the mark awarded.

- **Graduate Students** To obtain credit for CS676, graduate students will have to complete extra questions on the assignments.

- **Programming Languages** Matlab tutorials can be found on the CS370 Web page: `http://www.student.cs.uwaterloo.ca/~cs370` There are many sources of Matlab information on the Web. There are also many reference books available. You are responsible for getting up to speed on Matlab.

- **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.

- **Final Examination** Students are advised not to make any travel arrangements before the final examination times are posted. Note that in the event that the final examination is postponed, the final examination will be rescheduled for the day following the end of the regular examination schedule. Under no circumstances will alternate examinations be scheduled for students who have made travel arrangements which conflict with the final examination.

  Students must inform the registrar's office if they have a conflict in the final examination schedule, by the date posted on the registrar's web site. Note that there is a precise definition of conflict as defined by the registrar. `https://uwaterloo.ca/registrar/final-examinations`

  The course instructors will then be contacted by the registrar's office to make alternate arrangements. Under no circumstances will the instructor's make alternate arrangements for a final examination unless given instructions by the registrar's office.

- **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/`

- **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` 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 professor, 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` For typical penalties check Guidelines for the Assessment of Penalties, `https://uwaterloo.ca/secretariat/policies-procedures-guidelines/guidelines/guidelines-assessment-penalties`

- **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`

- **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`

- **Disabilities** Note for students with disabilities: The Office for Persons with Disabilities (OPD), located in Needles Hall, Room 1132, 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 the OPD at the beginning of each academic term.