COMPSCI/SFWRENG 2FA3

Discrete Mathematics with Applications II

Winter 2020

0 Introduction to the Course

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Outline

0 Introduction to the Course (Tuesday).

1. Instructional staff.
2. Who are you?
3. My goals.
4. Learning objectives.
5. Required and recommended resources.
6. Work plan.
7. Marking scheme.
8. Other resources and policy issues.

1 Mathematical Proof (Wednesday).

2 Recursion and Induction (Friday).

Instructor: Dr. William M. Farmer

- Professor, Dept. of Computing and Software.
- B.A., University of Notre Dame.
  M.A., M.S., Ph.D., University of Wisconsin-Madison.
- P.Eng. (Licensed Professional Engineer in Ontario).
- Industrial experience. Research computer scientist for 12 years at The MITRE Corporation in Bedford, MA, USA.
- Teaching: Discrete mathematics, logic, principles of programming, software design, communication skills.
- Research: Logic, mechanized mathematics, formal methods, mathematical knowledge management.
- Software development: In the early 1990s, I developed the IMPS interactive theorem prover with Joshua D. Guttman and F. Javier Thayer at the MITRE Corporation.

My Contact Information

- Office: ITB 163.
- Email: `wmfarmer@mcmaster.ca`.
- Web: http://imps.mcmaster.ca/wmfarmer/.
- Office hours: To see me please send me a note with times.

Please use McMaster e-mail for all correspondence, NOT Avenue email.

Teaching Assistants

Musa Al-hassy	alhassm@mcmaster.ca	Grad TA	T02
Lekhani Ray	rayl1@mcmaster.ca	Grad TA	T04, T05
Akram Elwazani	elwazana@mcmaster.ca	Undergrad TA	T01, T03
Meijing Li	lim147@mcmaster.ca	Undergrad TA	T01, T03
Kumail Naqvi	naqvis8@mcmaster.ca	Undergrad TA	T04
Shyam Shah	shahs1@mcmaster.ca	Undergrad TA	T02, T05

Students

CS C01: 90 Computer Science students (34.6%).

SE C01: 127 Software Engineering students (48.9%).

CS C02: 43 Other students (16.5%).

Total: 260

Who are You?

- I would like to get to know each of you.
- Please complete a bio sheet for yourself using my bio sheet as a model.

William M. Farmer

Preferred name: Bill.

Pronunciation: As expected.

Pronouns: he/him/his.

Hometown: South Bend, Indiana, USA.

Education

- Ph.D., mathematics, Wisconsin-Madison (1984).
- M.S., computer sciences, Wisconsin-Madison (1983).
- M.A., mathematics, Wisconsin-Madison (1980).
- B.A., mathematics, Notre Dame (1978).

Work Experience

- Professor at McMaster University (2005 – present).
- Associate Professor at McMaster University (1999 – 2005).
- Assistant Professor at St. Cloud State University (1997 – 1999).
- Lead Scientist at The MITRE Corporation (1985 – 1997).

Research Interests

- Logic.
- Mechanized mathematics.
- Formal methods.

Personal Information

- *Family.* I am married and have a son and a daughter. I am the oldest of nine children. I have 41 cousins, 20 aunts and uncles, and 20 niblings (nieces and nephews).
- *Sports.* I am an avid basketball player and greatly enjoy hiking and canoeing.
- *Film.* Classics and foreign. Favorite directors are Bergman, Hitchcock, and Kurosawa.
- *Music.* I like all kinds of music. A favorite performer and composer is Mark O'Connor.
- *Reading.* Novels, history, biographies, plays, poetry, mythology, math papers, op-eds.
- *Volunteer work.* I have been a Scout leader for 19 years.
- *Citizenship.* I am a dual American and Canadian citizen.

In 10 years, I hope that I will: Be retired and writing a blog about my interests, insights, and experiences.

Importance of CS/SE 2FA3 (iClicker)

Why do you think this course is a crucial component of an educational program in computer science or software engineering?

A. A proficient understanding of mathematics is needed to communicate ideas about computing.

B. Discrete mathematics and logic are the mathematics underlying computing.

C. Learning to read and write proofs is the most effective way to learn mathematics.

D. Automata and formal languages are a key part of the foundation of computing.

My Goals

- I want to:
  1. Help you lay a foundation on which to build a sophisticated understanding of discrete math and logic.
  2. Help you become proficient at reading and writing mathematical proofs.
  3. Help you gain a solid understanding of the theory of automata and formal languages.
  4. Provide you with opportunities for active learning.
- Will this course be challenging?
  1. Yes, it will take you out of your comfort zone.
  2. You will be expected to learn new things.
  3. You are capable of meeting the challenge.

Mission

- The mission of the course is to:
  1. Teach students to read and write traditional-style (informal) proofs.
  2. Provide students a foundational understanding of recursion, induction, and predicate logic.
  3. Introduce students to the theory of automata and formal languages.
- These goals are best achieved by active learning!
  1. Engaging in interactive discussion.
  2. Solving problems.

Major Topics

1. Mathematical proof.
   1 lecture.
2. Recursion and induction.
   3 lectures.
3. Predicate logic.
   4 lectures.
4. Finite automata and regular expressions.
   5 lectures.
5. Push-down automata and context-free languages.
   6 lectures.
6. Turing machines and computability.
   4 lectures.

Models (iClicker)

Do you know what a model of a set of formulas is?

A. Yes.

B. No.

Logical Consequence (iClicker)

Do you know the meaning of "logical consequence"?

A. Yes.

B. No.

Axiomatic Theories (iClicker)

Do you know what an axiomatic theory is?

A. Yes.

B. No.

Lambda Notation (iClicker)

Do you know what lambda notation is?

A. Yes.

B. No.

Learning Objectives (Knowledge)

Students should know and understand:

1. Mathematical proof.
2. Recursion and induction.
3. Predicate logic.
4. Finite automata and regular expressions.
5. Push-down automata and context-free languages.
6. Turing machines and computability.

Learning Objectives (Skills)

Students should be able to:

1. Write traditional-style proofs using LaTeX.
2. Prove statements by different forms of induction.
3. Formulate axiomatic theories.
4. Construct finite automata, pushdown automata, and Turing machines.
5. Construct regular sets and context-free grammars.

Required and Recommended Resources

- Textbook 1: R. Hammock, Book of Proof, Second Edition, Richard Hammock, 2016. ISBN-13: 978-0989472111. **Recommended.**
- Textbook 2: Dexter C. Kozen, Automata and Computability [abbreviated AC], Springer, 1997. ISBN-13: 978-0387949079. **Required.**
- Equipment: An iClicker+ remote. **Required.**
- Course web site: All course materials will be available on Avenue to Learn at

  http://avenue.mcmaster.ca/.

  Required.
- Collaborative software: Discord. **Required.**

Work Plan per Week

- Lectures: Presentation of the course material.
  - 1-hour lectures on Tuesday and Wednesday given by the Instructor.
- Discussion session: Interactive discussion.
  - 1-hour discussion session on Friday lead by the Instructor.
- Tutorial: Second look at material and problem solving.
  - 1-hour tutorial lead by the TAs.
- Homework: 5 hours outside of class.
- Assessment: What has been learned.
  - Weekly assignments produced using LaTeX.
  - Two midterm tests (on Wed, Feb 5, and Wed, Mar 11).
  - Final exam.

LaTeX (iClicker)

Have you used the LaTeX document preparation system before?

A. Yes.

B. No.

Class Participation

- Clicker questions in lectures.
  - Students will answer clicker questions in the lectures.
- Discussion session questions.
  - Students selected from a randomized list will be asked questions about the material covered during the week
- Meaningfuls and memorables (M&Ms).
  - Students will submit a short paragraph via Discord at the end of each week.
  - M&Ms start next week.
- Bio sheet.
  - Students must submit a bio sheet using the Instructor's as a model.

Marking Scheme

Class participation	
a. Clicker questions	4%
b. Discussion session questions	4%
c. Meaningfuls and memorables (M&Ms)	4%
d. Bio sheet	1%
Assignments	20%
Midterm test 1	12%
Midterm test 2	15%
Final exam	40%
Total	**100%**
Course review session bonus	1%

Other Resources and Policy Issues

1. Midterm course review.
2. End-of-term course evaluation.
3. Clickers.
4. Academic dishonesty.
5. Discrimination.
6. Missed work.
7. Academic accommodation.
8. Course modifications.
9. Course schedule.
10. Assignments and M&Ms may not be submitted late nor may midterms be taken later without prior approval.
11. Cell phones are not allowed during lectures, discussion sessions, and tutorials unless approved by the instructor.
12. No electronic devices may be used during exams.
13. Use McMaster email for all correspondence, NOT Avenue.