SIE 505: Formal Foundations for Information Science, Spring 2018

School of Computing and Information Science, University of Maine

1 Contact Information

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1.1 How to Contact Me

I'm typically in my office at least Mondays, Wednesday and Fridays, feel free to drop by if my door is open. Directly after class is probably the best time to catch me. Otherwise, email is the quickest way to get hold of me.

2 Objectives and Topics

2.1 Course Objectives

- Introduce students to the basic modes of thinking that underlie information processing: logical, relational, recursive, and quantitative thinking;
- Familiarize students with a variety of mathematical formalism (formal languages, mathematical structures and logical systems) to represent information;
- Equip students with the basic toolset to study more advanced formalism from mathematics and theoretical computer science on their own;
- Enable students to write up their ideas in a well-structured and formal manner.

2.2 Learning Outcomes

The goal of the course is to improve the mathematical and computational literacy of the student. Every student in the course is expected to learn to

- read, comprehend, and explain mathematical formalisms and simple proofs (formal or informal) presented in reference books or scholarly publications;
- present thoughts concisely using standard mathematical notation, structures and algorithms in writing and speaking;
- understand and apply the concept of recursion to define more complex structures and to prove properties about them inductively;
- use sets, functions, relations, sequences, and graphs to represent common problems in an information system;
- write definitions, theorems, and simple proofs in a clear and concise way.

2.3 Covered Topics

We will cover the following topics with a focus on mathematical foundations and on their applications to information systems:

1. Logical thinking:
    - An overview of propositional and predicate logic
    - Uses of logic in mathematics, computer and information sciences
    - Basic strategies to construct logical arguments (proofs): direct proof, proof by contradiction, instantiation, proof by cases
2. Relational thinking through the study of basic discrete mathematical structures:
    - Finite and infinite sets, operations thereon, and ordered structures
    - Functions and relations and their properties
    - Equivalence relations and partially ordered relations
    - Graphs and trees, their traversal and computer representation
3. Recursive thinking:
    - Recursive/inductively defined sets and recursive functions
    - Proof by induction
4. Quantitative thinking:
    - Cardinality and countability of sets
    - Counting with functions and algorithms
5. Algorithmic thinking:
    - Pseudocode
    - Complexity

The intent is to appreciate the various ways information and data can be encoded in discrete forms rather than to provide a comprehensive overview over all kinds of discrete structures.

2.4 Tentative Term Schedule

Week	Topics	Reading Assignment from [Hun17] To Be Completed Beforehand
01/22	Introduction & Expectations, LaTeX	
01/29	Propositional Logic	1.1, 1.2
02/05	Predicate Logic & Logic in Math	1.3, 1.4
02/12	Proofs	1.5
02/19	Graphs & Sets	2.1, 2.2
02/26	no class	
03/05	Functions	2.3
03/12	Spring Recess (no class)	
03/19	Relations, Equivalences, Partial Orders	2.4, 2.5–2.5.3
03/26	Recurrence Relations & Induction (introduction)	3.1, 3.2
04/02	Recursive Definitions, Inductive Proofs	3.3, 3.4
04/09	Recursive Data Structure	3.5
04/16	Counting: Permutations, Combinations	4.1, 4.2
04/23	Counting with Functions and Algorithms	4.3, 4.5
04/30	Algorithms 1, 2	5.1, 5.2
05/07	Final Presentations	

2.5 Tentative Weekly Schedule

This class uses an inverted classroom model with no lectures. Instead, class time is used to address questions, discuss the material and review exercises. Typically, a week will have the following structure:

Day and Time	Activity
Mon 8 am	Weekly writeup with questions due (submit online)
Mon 12-12:50pm	Discussion of readings and questions
Wed 8am	Weekly exercises due (submit online)
Wed 12-12:50am	Presentation and discussion of weekly exercises
Fri 8am	Revised & corrected exercises due (submit online)
Fri 12-12:50pm	Discussion of inquiry problem for next week's reading

3 Course Materials

[**Hunter-2017**] is a very accessible and well organized introduction to the ways of thinking that information systems are build on. It is the only required textbook for the course.

You can additionally look at [**Hein-DiscreteStructures**] and [**Epp-2011**] to get a different perspective at much slower and more detailed pace. [**Velleman-HowToProveIt**] presents a more detailed introduction to logic and proofs. Look at [**Smullyan-MathematicalLogic**] for a more advanced treatise that is only suitable if you already have a background in math or computer science.

Try to figure out which book(s) you can learn best from – often it helps to read multiple versions of the same material to develop a deeper understanding.

4 Expectations and Assessments

I understand that everybody's background will be quite diverse, many of you having little previous experience with logic or discrete mathematics or having had your last mathematical course years ago. While no specific technical background is required, I expect a willingness to work your way through complex and formal material. To properly understand the material, you have to reread it multiple times or to consult additional sources. You will need to extensively engage with the course material outside of class. This being a graduate course, we will go over material fairly quickly. You will have to spent significant time outside the

classroom on the readings and to work on exercises and problem sets. Of course, I'm willing to help and guide you in this process.

4.1 Grading

Your grade for the course will be calculated from the following components:

- Participation: 20%
- Weekly write-up and questions: 10%
- Initial solutions to weekly exercises: 15%
- Corrections to weekly exercises: 15%
- Problem set: 20%
- Topic presentation: 20%

All weekly submissions (weekly write-ups, exercises, revised exercises) should be submitted via: `goo.gl/VcHVeu`.

4.2 Participation

This is essentially an inverted class, thus class attendance and participation are crucial to your learning success. Class attendance and participation in discussions are expected and count towards this portion of your grade. If you are absent due to illness or another important reason, please email me prior to or immediately after your absence.

4.3 Weekly write-ups in preparation for question session

Each Sunday evening, you are expected to submit a short summary of the key terms/concepts from the reading, and a set of 2 or (preferably) more questions to guide Monday's class. This is to demonstrate that you have carefully read the assigned chapter and are familiar with the new concepts and theorems.
The questions should help you bridge any gaps that prevent you from working on the exercises for Wednesday.

4.4 Weekly exercises: Prepared solutions & presentation

Each week, you are given a set of exercises to work on, some of which you are asked to present. We will discuss some of these exercises in Wednesday's class.

4.5 Corrections to weekly exercises

After class, you are expected to correct and improve your solutions. Corrections are due before Friday's class.

4.6 Problem set

There will be a set of 10-15 problems throughout the course, each worth 4 points. You will receive 4 points for a **correct and concise solution** submitted on first attempt, 3 points on second attempt, and 2 points on third attempt. No further attempts are allowed. Unless I give other instructions, solutions must be typeset in LaTeX and submitted in both LaTeX and PDF format. This part is graded out of 80% of the maximum number of possible points. To complete the course, you must score at least 50% points on the problem set.

You may work on the problem sets in pairs. I strongly encourage you to do so as discussing the material with a partner helps improve your understanding.

4.7 Topic presentation

To demonstrate your ability to work through more advanced material on your own, you are asked to present one advanced topic at the end of the semester. Suggested topics from the book are: Graphs Formally (2.6); Estimation of Growth (4.6); or any of the applications in 6.1 to 6.5. You are free to choose a different topic (e.g. something not covered in the book) that interests you, but you must first consult with me to obtain my approval.

5 Academic Honesty

Academic honesty is expected. Plagiarism—one form of academic dishonesty—is the handing in of work not substantially the student's own. It is usually done without reference, but is unacceptable even in the guise of acknowledged copying. It is not cheating, however, to discuss ideas and approaches to a problem, nor is it cheating to seek or accept help with a program or with writing a paper. Indeed, a moderate form of collaboration is encouraged as a useful part of any educational process. Nevertheless, good judgement must be used, and students are expected to present the results of their own thinking and writing. Plagiarism is unacceptable in this course and will result in a failing grade.

6 Students with disabilities

If you have a disability for which you may be requesting an accommodation for, please contact either me or Sara Henry, Director of Disabilities Services, 121 East Annex, 581-2319, as early as possible in the term.

7 Extended disruption

In the event of an extended disruption of normal classroom activities, the format for this course may be modified to enable its completion within its programmed time frame. In that event, you will be provided an addendum to the syllabus that will supersede this version.

8 University Policy on Sexual Discrimination

There is zero tolerance of any kind of sexual discrimination, harassment or misconduct and any such behavior will be reported promptly and appropriate action taken. The University of Maine is committed to making campus a safe place for students. Because of this commitment, if you tell the instructor, TA, or an MLA about an experience of sexual assault, sexual harassment, stalking, relationship abuse (dating violence and domestic violence), sexual misconduct or any form of gender discrimination involving members of the campus, we are required to report this information to the campus Office of Sexual Assault & Violence Prevention or the Office of Equal Opportunity. If you want to talk in confidence to someone about an experience of sexual discrimination, please contact these resources:

- Confidential resources on campus:
  - Counseling Center: 207-581-1392 or
  - Cutler Health Center: 207-581-4000
- Confidential resources off campus:
  - Rape Response Services: 1-800-310-0000 or
  - Spruce Run: 1-800-863-9909

Other resources on campus: The resources listed below can offer support but may have to report the incident to others who can help:

- Office of Sexual Assault & Violence Prevention: 207-581-1406,
- Office of Community Standards: 207-581-1409,
- University of Maine Police: 207-581-4040 or 911.
- See the OSAVP website for a complete list of services at http://www.umaine.edu/osavp/