Course Information

Introduction to Proofs (AS.110. 301)

Credits: 4.00

Instructor

- Sina Hazratpour
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- Krieger 405
- Office Hours: Wednesdays 3:00pm-4:00pm (*By appointment only*)

Teaching Assistant

- Junyan Zhang
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- Kriger 201
- Office Hours: TBA

Location

- Lectures: Krieger 304
- Lab Section: Maryland 104

Days/Times:

- MW 1:30PM - 2:45PM
- F 1:30PM - 2:20PM
- 08-30-2021 to 12-06-2021

Prerequisites

There are no prerequisites for this course, however, it is expected that you are familiar with the basic high-school algebra. You should be familiar with

basic number systems including natural numbers, integers, rational and real numbers. If not, I recommend reading the chapter 0 of our textbook.

The Structure Of The Course

This course will have two phases.

Phase I: Traditional Lecture Style

The first half of the semester will be taught in the *traditional lecture style*.

Roughly, mathematical proofs have two roles: firstly, to convince oneself and others of validity of mathematical statements , and secondly, to convey mathematical ideas and methods.

In the first few lectures, we will focus on the first role. Starting with propositional logic, we study a formal system of precise rules governing proofs. It will quickly become clear that being explicitly aware of logical operations will not only help convince ourselves of validity of a statement, it will also guide us in search of new proofs and in solving problems. We will then move on to the topics of first order logic to extend our capability of formally encoding more complicated kinds of reasoning in symolic logic.

We will also spend some time learning to read and write mathematical proofs in the style common in mathematical community. We shall cover the basics of logic, sets, functions, equivalence relations, and partially order sets which are essential in all fields of mathematics. Therefore, the content of this course will be essential for your next level maths courses.

Periodically, there will be a lecture where we explore the topics of the previous lectures in a “proof relevant” style by interacting with the computer proof assistant Lean. The Lean codes of these lectures are posted on the course website, so you can fix some of the proof errors (mostly by design) and holes in the arguments with the assistance of Lean.

For the first eight weeks, the format will be that of a traditional lecture course. The following schedule of lectures is aspirational and subject to change.

- An introduction to 301
- Propositional logic
- Natural Deduction, Excluded Middle, and Truth Tables
- Propositions with Lean
- First Order Logic -- Variables, Predicates, and Quantifiers
- First Order Logic -- Natural Deduction
- Proof Strategies
- Sets (part I)
- Sets (part II)
- Sets (part III)
- Sets (part IV)
- Relations
- Functions
- Isomorphisms
- Images and pre-images
- Induction on natural numbers
- Recursion

- Integers
- Rational numebrs
- Real numbers
- Real numbers

Phase II: Inquiry-Based Learning

In the last 4 weeks of the semester, we will change to the “inquiry-based learning” (IBL) style, where the students develop the material on their own with the help of a carefully created guide. The classroom will also be flipped at this stage: the students, not the instructor, will be presenting the material at the blackboard.

In these 4 weeks, we will delve a little deeper into a particular subject: the study of metric spaces. During this period, the students will follow a set of scripts provided by the instructor consisting of definitions, examples, lemmas and theorems, with one important feature: the proofs are missing and have to be provided by the students as their homework assignments. During the class meetings, students will take turns presenting their work at the blackboard while the rest of the class will be tasked with following along and verifying the validity of the statements. Your blackboard presentation is not expected to be completely correct. In fact, both you and your classmates will learn a lot from seeing common mistakes being made and develop skills to detect and avoid them.

Requirements

Problem sets

During the first phase of the course, there will be a problem set assigned due roughly each week on Monday in class. Late homework is rarely accepted

unless you have an exceptionally good excuse for it.

You are allowed and encouraged to discuss the problem sets with other students. Proofs are best enjoyed with others! However, each student must attempt the problems on their own before meeting with other students. You must write up your solutions to the problems on your own and in your own words, and must acknowledge your collaborators by name on your written assignments. Also, remember that if you cannot do the exercises, you will not do well on the exams. Copying from another student or any other source is prohibited. Use of online solution banks is prohibited and will be considered a violation of the ethics code.

Furthermore, you are encouraged to consult with each other and even collaborate on all non-homework all Lean exercises, and help each other debug. Any code that was jointly written must have a citation (idealy, at the beginnnig of your code, as a comment) which indicates who developed which part of the code. Any code excerpted from outside sources must have a citation to the source (in code comments).

It is encouraged, but not required, that you use LaTeX for typesetting your homework assignments. LaTex is a powerful markup language for typing up mathematics and is used in many technical fields. Appendix D of our textbook has a nice introduction to the basic features of LaTeX. I will make homework files available in LaTex format so you can start using it right away. If this is your first time using LaTeX, I recommend that you start by using an online editor (e.g. Overleaf). I included some useful links on the LaTeX page

Exams

There will be a midterm exam worth ten percent of your final grade. The exam is based on the material of the phase I. Please consult the schedule page of this website for the exact time and location of the midterm exam.

Attendance

Since we will cover a lot of ground this semester and much of the material is cumulative, attendance in lectures is strongly encouraged. The class particiapation is particularly important in the second phase and it comprises of 5 percent of your final grade.

Grading Policy

A numerical grade will be assigned based on the following formula:

- Homework (50%)
- Lean workshop (10%)
- Metric spaces workbook (15%)
- Blackboard presentations (10%)
- Class participation (5%)
- Midterm exam (10%)

JHU Ethics Statement

The strength of the university depends on academic and personal integrity. In this course you must be honest and truthful. Ethical violations include cheating on exams, plagiarism, reuse of assignments, improper use of the Internet and electronic devices, unauthorized collaboration, alteration of graded assignments, forgery and falsification, lying, facilitating academic dishonesty, and unfair competition.

Report any violations you witness to the instructor. You may consult the associate dean of student conduct (or designee) by calling the Office of the Dean of Students at 410-516-8208 or via email at integrity@jhu.edu. For more information, see the Homewood Student Affairs site on academic ethics:
https://studentaffairs.jhu.edu/student-life/student-conduct/academic-ethics-undergraduates
or the e-catalog entry on the undergraduate academic ethics board:
http://e-catalog.jhu.edu/undergrad-students/student-life-policies/#UAEB

Disability Accommodations

If you are a student with a disability or believe that you might have a disability that requires special accommodations, please contact Student Disability Services to obtain a letter from a specialist:

385 Garland
(410) 516-4720
studentdisabilityservices@jhu.edu

To arrange for testing accommodation, remind the instructor and provide the letter from the Student Disability Services no later than 7 days before each exam.

Anxiety, Stress and Mental Health

If you are struggling with anxiety, stress, depression or other mental health related concerns, please consider visiting the JHU Counseling Center. If you are concerned about a friend, please encourage that person to seek out their services. The Counseling Center is located at 3003 North Charles Street in Suite S-200 and can be reached at 410-516-8278 and online at http://studentaffairs.jhu.edu/counselingcenter/