cse371/mat371
LOGIC

Professor Anita Wasilewska

LECTURE 0

GENERAL INFORMATION

Course Text Book

Anita Wasilewska

Logics for Computer Science: Classical and Non-Classical

Springer 2018

ISBN 978-3-319-92590-5 ISBN 978-3-319-92591-2 (e-book)

You can get the book in Hard cover, or in Electronic form
Springer also has an option of providing you with chapters of your choice

https://www.springer.com/us/book/9783319925905

The BOOK Goal

I wrote the **Book** with students on my mind so that they can read and learn by themselves, even **before** coming to class

For sure, it is also essential to study after the class.

The **Book** and hence the **course** progresses slowly, making sure that the pace is appropriate for somebody without previous knowledge of formal logic

The **Book** contains hundreds of examples and problems with detailed solutions to facilitate **understanding** of material

Course Goal

The main goal of the course is to teach **intuitive** and **formal** understanding of the classical logic and some non- classical logics

Moreover, the goal of course is also to teach the modern **formal logic** as a scientific subject

You will learn **Formal Logic** basic notions and definitions, Main Theorems, similarities, differences and problems characteristic to different logics; **classical** and **non-classical**

Course Web Page
www3.cs.stonybrook.edu/˜ cse371

The course Webpage contains:

Lecture SLIDES for each chapter of the BOOK

Collection of passed Quizzes and Tests

We will not cover all of the chapters of the BOOK
I made Lectures for all of them accessible for students'
eading and future use

Course Webpage
www3.cs.stonybrook.edu/˜ cse371

The course **Webpage** contains two kind of Lectures:

Class Lectures and VIDEO Lectures

The Class Lectures are very detailed lectures slides

They were developed for each **Chapter** of the Textbook

Usually there are 2 - 5 Class Lectures for one **Chapter**

The **ZOOM Lectures** are based on the Class Lectures

Course Webpage
www3.cs.stonybrook.edu/~ cse371

The Video Lectures are created especially for the
Logic Youtube Channel

The VIDEO Lectures correspond, chapter by chapter to the slides used in the Texbook Chapters VIDEOS

You can use the VIDEO Lectures slides to follow the Chapters VIDEOS as they are exactly the same as slides used in the VIDEOS

Logic Youtube Channel

LOGIC, Theory of Computation CHANNEL
https://www.youtube.com/channel/UCLZp06JC9yit6M_YW3XuvIw

First 4 VIDEOS are for the Theory of Computation, the

LOGIC VIDEOS follow

STUDY PLAN

WEEK 1: February 1 – February 6

ZOOM Lectures: Course Structure and Goals, Introduction, Class Lecture 1

Chapter 1 VIDEO: Introduction: Paradoxes and Puzzles

https://www.youtube.com/watch?v=3xS4RnWqArA&t=1191s

WEEK 2: February 8 – February 13

ZOOM Lectures: Class Lecture 1 (Parts 2, 3, 4, 5)

Chapter 1 VIDEO: Introduction: Paradoxes and Puzzles

https://www.youtube.com/watch?v=3xS4RnWqArA&t=1191s

STUDY PLAN

WEEK 3: February 15 – February 20

ZOOM Lectures: Class Lectures 2: Propositional Language and Semantics

Chapter 2 VIDEO: Introduction to Classical Logic

https://www.youtube.com/watch?v=nqlkWgeGokA&t=3328s

WEEK 4: February 22 – February 27

ZOOM Lectures: Class Lectures 2a: Predicate Language and Semantics, Lecture 2b: Review

Chapter 2 VIDEO: Introduction to Classical Logic

https://www.youtube.com/watch?v=nqlkWgeGokA&t=3328s

TESTING

All QUIZZES and TESTS, including the FINAL Examination will be given as a **TAKE HOME TESTS**

I will design them is a way the **most profitable** for your new way of learning

TAKE HOME TEST POLICY

TAKE HOME TEST means that you take it at home and have access to, and can freely use the BOOK, VIDEOS, Lecture and Video SLIDES and all information posted on the course Webpage

You also will have 1- 2 days to complete the tests- as described in the TESTS SCHEDULE

The TESTS SCHEDULE is designed to give you time to think **deeper** and to work on your tests problems **longer**
It also gives you time to write solution carefully and clear

TAKE HOME TEST POLICY

When you study, follow way the solutions are written in the ClassLectures and posted tests solutions

Clarity and style of your solutions will be part of your grade

All is designed to help you to learn to write properly proper solutions, not only unacceptable scribbled answers

It is also designed to HELP you to study and learn better in the new online environment and to help you your process of learning

TAKE HOME TEST POLICY

Your QUIZZES and TESTS will have the same FORMAT

as those published on the course Webpage

They are there to help you to study and train yourself using their specific format

Your TESTS will be a bit longer as

you will have much more time to complete them

Remember that you always have to write your solutions in

your own words and to **do it** in such way as to make it

VISIBLE to US (and yourself) that you really worked and

that you understood the material

TAKE HOME TEST POLICY

Straightforward COPY of what was **published** and you have

found in the the materials you have access to will **result**

in 0pts for the problem - as in any case of cheating

Workload

There will be two **Quizzes**, one **Midterm** and a **Final**

Each quiz will consist of **3 - 4 questions**

None of the grades will be curved.

TESTS SCHEDULE

This is a PRELIMINARY schedule

Changes, if any, will be posted on Blackboard and Webpage

Q1 - posted March 20 **due** March 20

MIDTERM - posted March 27 **due** March 28

Q2 - posted April 22 due April 22

Practice Final - posted posted May 5 due May 6

FINAL - given during the FINALS - to be scheduled by University

Workload

Quizzes and **Tests** problems will be very similar to exercises and problems **solved** in the Book

They can be very similar to some Homework Assignments located at the end of the chapters of the BOOK

They also can be similar to problems included in the Lectures, previous Quizzes, and Tests as published on the Webpage

There also will be some **challenge** problems given as extra credit

Workload

The past **Quizzes** and **Tests** are posted to help you to learn what we covered in class and what you still may not yet fully understand

Our actual Quizzes and Tests may have a different form and cover different material depending on what we actually cover in class

Final grade computation

You can earn up to 200 points + x extra points = 200+x points during the semester

The grade will be determined in the following way:
# of earned points divided by 2 = % grade

The % grade is translated into a letter grade in a standard way as described in the course Syllabus

Final grade computation

The % grade is translated into a letter grade in a standard way i.e.

100 – 95 % is A

94 – 90 is $A-$

89 – 86% is $B+$, 85 – 83 % is B, 82 – 80 % is $B-$

79 – 76 % is $C+$, 75 – 73 % is C, 72 – 70 % is $C-$

69 – 60 % is D range and

F is below 60%

General Goals and Tasks of the Book

The General Goal of the Book

The **General Goal** of the book is to make readers understand the need of, and existence of **Logic** as a **scientific** field

The book teaches not only **intuitive** understanding of different logics, but also teaches modern **symbolic logic** as a **scientific** subject

The book progresses relatively **slowly**, making sure that the pace is appropriate for a reader with only cursory knowledge of logic

Readers can learn introductory chapters by themselves, and then gradually **progress** to more **advanced** chapters and other, more advanced books

Main Tasks of the Book

First Task when one builds a symbolic logic, or foundations of mathematics, or foundations of computer science, is to define formally a proper **symbolic language**

We distinguish and define two kind of languages: **propositional** and **predicate**

They are also called also zero and first order languages, respectively

Main Tasks of the Book

Second Task is to define formally what does it mean that **formulas** of a symbolic language are considered to be **true**, and **always true** i.e. we have to define a notion of a **tautology**

It means that we **define** what is called a **semantics** for a given **language**

The same languages can have different semantics

For example, the languages for classical and intuitionistic logics can be the same, but their the **semantics** are different

Main Tasks of the Book

Third Task is to define a syntactical notion of a **proof** in a **proof system** based on a given **language**

It allows us to find out what can, or cannot be **proved** if certain axioms and rules of inference are assumed

This part of **syntax** is also called a **proof theory**

Main Tasks of the Book

Fourth Task is to investigate the relationship between a **syntactical** notion of a **proof system** based on a given language and a **semantics** for that language

It means we establish **formal** relationship between the **syntax** and a **semantics** for a given **language**

This **relationship** is established by providing answers to the following **two questions**

Main Tasks of the Book

Fourth Task is to pose and answer the following questions

Q1: Is everything one **proves** in a given proof system **tautology** under a given semantics?

The positive answer to the question **Q1** is called **Soundness Theorem** for a given proof system and a given semantics proof system

Such proof system is called a **sound proof system**

Main Tasks of the Book

We write the Soundness Theorem symbolically as follows

Soundness Theorem (with respect to a semantics **M**)
Let S be a proof system and A any formula of its language, then the following holds

$$\text{IF} \quad \vdash_S A \quad \text{THEN} \quad \models_{\mathbf{M}} A$$

Main Tasks of the Book

Q2: Is it also possible to guarantee a **provability** in a **sound** proof system of everything we know to be a **tautology** under a given semantics?

The positive answer to the question **Q2** is called **Completeness Theorem** for a proof system under a given semantics

Such proof system is called **complete** **proof system** with respect to the given semantics

Main Tasks of the Book

We write the Completeness Theorem symbolically as follows

CompletenessTheorem (with respect to a semantics **M**)

Let S be a proof system and A any formula of its language, then the following holds

$$\vdash_S A \quad \text{if and only if} \quad \models_{\mathbf{M}} A$$

Main Tasks of the Book

Fifth Task is to develop proof systems in which a process of finding proofs can be carried fully automatically

These are **automated theorem proving** systems

The book presents various Gentzen Type **automated** theorem proving systems

It also discusses various methods of proving the **Completeness Theorem** for them

The book also provides an introduction to the

Resolution based **automated** theorem proving systems

Main Goals of the Book

The first set of **Main Goals** of the book is to formally define and develop the above FIVE TASKS in case of **Classical** Propositional and Predicate Logic

The second set of **Main Goals** is to develop and discuss the FIVE TASKS for some **Non-Classical** Propositional Logics, namely for some extensional Many Valued logics, for the Intuitionistic logic, and Modal S4, S5 logics

Main Goals of the Book

The third set of **Main Goals** of the book is to formally define and develop the notion of a **formal theory** based on a given **proof system** for a first order **logic**

It discusses notions of a **model** of a theory, its semantical and syntactical **consistency** and **completeness**

The book presents some **Formal Theories** based on classical predicate logic. In particular presents the Peano Arithmetic of Natural Numbers **PA** and discusses and proves the **Gödel Incompleteness Theorems**