cse371 math371
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 previous Tests

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

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

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

Class Lectures and VIDEO Lectures

Class Lectures are very detailed and contain more **examples** and **problems** with carefully written detailed **solutions** than the VIDEO Lectures

Class Lectures were developed for each **Chapter** of the Book with 2 - 5 Class Lectures for one **Chapter**

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

Workload

There will be one Midterm, a Practice Final, and a Final

The consistency of your efforts and work is the most important for this course.

None of the grades will be curved.

Records of students points are kept on BRIGHTSPACE

Contact TAs. for information about grading, grades changes, etc....

TESTING

TESTS cover material that was **presented** in class before the dates of respective tests

Consult Weekly STUDY PLAN posted on the course Webpage

PRELIMINARY schedule is posted on the course webpage

Changes will be posted on Brightspace

WE DO NO NOT GIVE MAKE-UP TESTS

Tests

Midterm (100ts)

Midterm will covers material presented in class before the week of the Midterm

Practice Final (15 extra pts)

Practice Final will have Problems only from material covered **after** Midterm

We will correct only one problem and post solutions for you to study and prepare for the **Final**

Tests

Final (100pts)

Final will cover mainly material covered afterMidterm

and including material from

Practice Final

But there will be 1-2 questions from Q1 and the material

covered in Midterm

Extra Credit I may give some extra credit problems on Tests.

TESTS SCHEDULE

This is a PRELIMINARY schedule

Changes, if any, will be posted on BRIGHTSPACE and course Webpage

MIDTERM - Tuesday, **March 5**

Spring Break March 11 - March 17

Practice Final Tuesday, **April 30**

Last Class Thursday, **May 2**

FINAL - during the Finals Period **May 6 - 15**

Tests

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

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

Our actual Tests will have a different content and cover different material depending on what we actually **cover** in class

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

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 Course

The Goals of the Course

The **Main Goals** of course is to make students understand the need of, and the existence of **Logic** as a **scientific** field, to teach not only **intuitive** understanding of different logics, but also to present **symbolic logic** as a **scientific** field

The course progresses **slowly** with the pace is appropriate for students with only cursory knowledge of logic

Students will learn first introductory chapters of the book and then gradually **progress** to more **advanced** chapters and to 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 **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**