cse371/mat371
LOGIC

Professor Anita Wasilewska

GENERAL INFORMATION

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

The course Webpage contains:

Lectures SLIDES for each chapter of the BOOK

Collection of Past Quizzes and Tests

We will not cover all of the chapters of the BOOK
I made LECTURES for all of them accessible for students
for reading and future use

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

Course Goal

The goal of the course is to make student understand the need of, and to learn the formality of logic as scientific field

I will progress relatively slowly, making sure that the pace is appropriate for the undergraduate class

The book is written with students on my mind so that they can read and learn by themselves, even **before** coming to class

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**

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.

Workload

Quizzes and **Tests** problems will be taken from
exercises and problems **solved** in the Book
They wil be very similar to Homework Assignments located
at the end of the chapters of the BOOK
They can be taken from, or can be very similar to problems
included in the Lectures, previous Quizzes, and Tests
as published on the course 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**