

LOGICS FOR COMPUTER SCIENCE: Classical and Non-Classical

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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 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 and such proof system is called **sound** with respect to the given semantics

We write it 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

$$\text{IF } \vdash_S A \text{ THEN } \models_M A$$

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

Main Tasks of the Book

We write the **Completeness Theorem** as follows

Completeness Theorem (with respect to a semantics **M**)

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

$$\vdash_S A \text{ if and only if } \models_M A$$

Main Tasks of the Book

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

and to prove the **Completeness Theorem** for them

These are automated theorem proving systems

The book presents and discusses various Gentzen Type automated theorem proving systems and teaches different 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**, or on a given **logic**

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

In particular the book presents some **formal theories** based on **Classical Predicate Logic** and discusses and proves **Gödel Theorems**



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