

7 Neural-Symbolic AI Reasoning

1. 课堂讲授学时 Lecture Hours: 16
2. 课堂实验学时 Laboratory Hours: 16
3. 课下研讨学时 Colloquia Hours: 0
4. 学生课下投入学时 Individual Study Hours: 32
5. 学分 Credits: 2
6. 开课学年学期（如果有强制性的要求则必须填，否则可以不填） Occurrence: None
7. 先修课程 Prerequisite(s): Programming-related courses*

*Recommended, not required as prerequisite

8. 课程概要 Course Description:

This intensive course provides an in-depth overview of formal methods and their application in securing software development. Participants will learn mathematical techniques, specification languages, and verification tools to ensure software security throughout the development lifecycle. The course also introduces large language model techniques for generating formal constraints and specifications from natural language requirements, improving efficiency and accuracy. By integrating formal methods and AI-driven approaches into the development process, developers can rigorously specify, develop, and verify software systems, leading to robust and secure applications.

9. 课程预期学习成果 Course Outcomes:

- (1) Understand fundamental concepts of formal logic, including propositional logic and predicate logic, and apply them to problem modeling.
- (2) Develop the ability to construct formal specifications and perform reasoning using techniques such as natural deduction and theorem proving.
- (3) Apply formal verification methods, including model checking and automated reasoning tools, to analyze software systems.
- (4) Utilize LLMs to assist in generating formal specifications and enhancing reasoning processes.
- (5) Integrate neurosymbolic AI approaches to solve complex problems in software security and system verification.

10. 教学内容与学时分配 Course Content, Laboratories and Laboratory Hours（有则填，没有则不填），Colloquia Hours（有则填，没有则不填）：

(1) Foundations of Logic and Reasoning (4 Class Hour)

- Classroom 3 hours
- Practice 1 hour

(2) Predicate Logic and Formal Modeling (4 Class Hour)

- Classroom 2 hours
- Practice 2 hour

(3) Natural Deduction and Theorem Proving (4 Class Hour)

- Classroom 2 hours
- Practice 2 hour

(4) Automated Reasoning and Model Checking (4 Class Hour)

- Classroom 2 hours
- Practice 2 hour

(5) Formal Methods Tools (Isabelle/HOL, PAT) (4 Class Hour)

- Classroom 2 hours
- Practice 2 hour

(6) Non-classical Logic and System Verification (4 Class Hour)

- Classroom 2 hours
- Practice 2 hour

(7) LLM-based Formal Specification and Reasoning (4 Class Hour)

- Classroom 2 hours
- Practice 2 hour

(8) Neurosymbolic AI and LLM Applications (4 Class Hour)

- Classroom 2 hours
- Practice 2 hour

11. 考核与成绩评定 Grading:

Homework: 20%

Inclass Quizzes: 20%

Individual Presentation: 60%

12. 教材，参考书 Text & Reference Book: None

13. 编写教师 Course Lecturer: Zhe Hou

编写教师 Course Lecturer (签字):


