COMP 409
Logic in Computer Science

Spring 1111

1 Introduction – What is logic

1. History of logic
2. Logic and the foundations of mathematics
3. Logic in computer science

2 Propositional Logic – Syntax

1. Alphabet
2. Well-formed formulas
3. Unique readability

3 Propositional Logic – Semantics

1. Interpretations and satisfaction
2. Validity, satisfiability, and unsatisfiability.
3. Logical implication and material implication
4. Substitution

4 Propositional Logic – Decision Procedures

1. Truth tables
2. Semantic trees
3. Complexity (NP-completeness), graph colorability
4. Horn clauses

5 Propositional Logic – A Formal System

1. Axioms, inference rules, deductions
2. Propositional calculus
3. Monotonicity
4. Soundness
5. Deduction Theorem
6. Consistency and inconsistency
7. Completeness
8. Compactness

6 Propositional Logic – Resolution

1. Literals and clauses
2. Resolution
3. Soundness
4. Completeness
5. Complexity

7 First-Order Logic – Syntax and Semantics

1. Terms and formulas
2. Structures, assignments, and semantics
3. Satisfiability, validity, and logical implication.

8 First-Order Logic – Definability

1. Preservation under isomorphism
2. Elementary equivalence vs. isomorphism
3. Definability: classes of structures, relations, and queries
4. Explicit and implicit definability
5. Compactness and applications to definability

9 First-Order Logic – Normal Forms

1. Prenex normal form
2. Skolem normal form
3. Elimination of function symbols
4. Elimination of equality

10 First-Order Logic – A Formal System

1. Propositional reasoning
2. The Deduction Theorem
3. Subsitutions
4. Axioms
5. Generalization

11 First-Order Logic – Completeness and Consequences

1. Completeness
2. Löwenheim-Skolem Theorem
3. Compactness Theorem

12 First-Order Logic – Undecidability and Incompleteness

1. Recursive enumerability of validity
2. Non-recursive enumerability of satisfiability
3. Decidable quantificational classes
4. Gödel's Incpmleteness Theorem