Lecture 1
Introduction, Motivation & Work Plan

Instructor: Yu Zhen Xie
We all do logic

• If it will rain today, I’d better bring an umbrella.
• If a course teaches useful knowledge, I want to take it. CS2209 teaches useful knowledge. Therefore, I want to take CS2209.
• … …
• How about judicial reasoning?

• We all do logic when we try to clarify reasoning and separate good from bad reasoning.
Natural vs. Logic language

• Natural languages are ambiguous.

• For example, the word “any” can have different meanings depending on the context:
  
  • Any = some  
    – She will be happy if she can solve any question.  
    – She will be happy if she can solve every question.
  
  • Any = all  
    – Any student knows this.  
    – Every student knows this.
What is Logic?

Logic is the Science of Reasoning

- Etymology: Logykos (Greek) - pertaining to reasoning
- Logic: The science of reasoning, proof, thinking, or inference
- Logic: The fundamental science of thoughts and its categories
- Logic: The science or art of reasoning as applied to a department of knowledge
- Logic: The analysis and appraisal of arguments
History of logic

Aristotle (384-322 B.C) developed a general system of logic intended to incorporate the basic principles of good reasoning, and to provide a way to evaluate specific cases of reasoning.
History of logic

• An example of an Aristotelian syllogism:  
  All humans are mortal.  
  Socrates is human.  
  Therefore, Socrates is mortal.

• A syllogism is a kind of logical argument in which one proposition (the conclusion) is inferred from two or more others (the premises) of a specific form.

• This syllogism is an example of good reasoning - constitutes a good argument - because it is truth-preserving.

• If the first two sentences (premises) are true, then the third sentence (conclusion) must also be true.
Why study logic?

• Enjoyable: game, puzzle, ... 
• Analytical thinking 
• **Knowledge representation and reasoning** 
  • **Fundamental to Computer Science**
    – Logic gates, electronic circuits 
    – Database queries 
    – Program analysis 
    – Artificial intelligence 
      • Automated reasoning 
      • Satisfiability (SAT) solver 
      • Answer set programming (ASP), ... 
    – ... ...
Example application: database queries

• Predicates | Microsoft Docs
  https://docs.microsoft.com/en-us/sql/t-sql/queries/predicates

Predicates are used in the search condition of WHERE clauses and HAVING clauses, the join conditions of FROM clauses, and other constructs where a Boolean value is required.
Example application: program analysis

• if (a<b) {
    x = b-a;
    y = a-b;
} else {
    z = b-a;
    t = a-b;
}

• Can we make this program more efficient?

• Compiler optimization!
Example application: program verification

• Consider the following algorithm for finding the max element in an array:

Max(A[1], ..., A[n]):
  m = A[1]
  for i = 2 to n
    if A[i] > m then
      m = A[i]
  return m

• Prove that this algorithm works correctly. What does it mean?

• How about the control system of a vehicle?
Knights and knaves

• On a mystical island, there are two kinds of people: knights and knaves. Knights always tell the truth. Knaves always lie.

• Puzzle 1: You meet two people on the island, Arnold and Bob. Arnold says “Either I am a knave, or Bob is a knight”.

Is Arnold a knight or a knave?
What about Bob?
A fun game

• You see the following cards. Each has a letter on one side and a number on the other.

  B  5  2  J

• Which cards do you need to turn to check that “if a card has a J on it then it has a 5 on the other side”? 
Course contents (tentative)

• Propositional logic and Boolean algebra
• Predicate logic (first-order logic) and basic set theory
• Methods of reasoning (incl. induction)
• Applications of logic to database systems and program verification and automated reasoning in artificial intelligence
• Limitations of logic (intractability and Gödel incompleteness theorem)
# Work plan

## Tentative Quiz (in-class) and Test Schedule

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<th>Due</th>
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<td>Quiz 1</td>
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<td>Quiz 5</td>
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## Work plan

### Tentative Assignment and Exercise Schedule

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Teaching crew & hours

• **Instructor**
  Yu Zhen Xie, PhD
  email: yxie4@uwo.ca
  Office: Middlesex College, Room 327
  Office hours: 4:30-6:30pm on Tuesdays

  Lecture hours: 3:30-4:30pm, 7:00-9:00pm on Wednesdays
  Lecture room: NS 1

• **Teaching Assistants**
  • Andrew Bloch-Hansen
  • Mehdi Samadieh
  • Linxiao Wang
  • Gurjit Randhawa (tutorial session)
  • Zihao Wang (tutorial session)
Get to know and help each other

• **Who are you?**
  • General science
  • Engineering
  • Computer science
  • Math, statistics, ...

• **Questions?**

• **Feedback**
  o Feedback forum
  o Polls
  o Other forms?