CSE 579: Knowledge Representation & Reasoning

Week 1: Introductions

Ali Altunkaya
Spring 2023

Outline

1. Introductions
2. Syllabus
3. Course structure
4. Your responsibilities as a student
5. Motivation (Goal of this course)

1. Introductions

Instructor: Ali Altunkaya

Lecturer & PhD Candidate in Computer Science at ASU

Office Hours: Mon-Tue 11:00 - 12:00

Office Location: BYENG M1-38

See Canvas → Syllabus

Communication preference:

– Office Hours is better than email.

– Also I am available after each lecture, 5 minutes, for short questions.

1. Introductions

Teaching Assistant:

See Canvas → Syllabus

2. Course Structure

Hybrid Course: The instructor runs a pre-packaged course developed by Professor Joohyung Lee with all lectures pre-recorded and delivered on-line.

We will meet once a week. I will try to

- Highlight/Review important concepts about the content.
- Explain more about the assignments .
- etc...

Your Responsibilities

Watch Video Lectures: Mandatory, not optional.

- Not like movies, carefully by taking notes, all of them.
- Excellent lectures but difficult content.
- Limited Attention (can watch at most 1 hour in one setting)

Read the recommended texts / books, if you still have time.

2. Course Description

Knowledge Representation and Reasoning (KRR) is one of the fundamental areas in Artificial Intelligence.

KRR is concerned with

- How knowledge can be represented (encoded) in formal languages
- so, computers can manipulate them in automated way
- and make intelligent decisions based on the encoded knowledge

Prerequisites: Programming, Classical Logic, Statistics, Algebra

Software: Clingo

2. Learning Outcomes

By completing this course, you will be able to:

- Discuss the foundations of KRR
- Explain different categories of representation and reasoning tasks
- Assess the tradeoff between representation and reasoning
- Identify which knowledge-based techniques are suitable for which tasks
- Apply KRR systems to challenging real-world problems

2. Course Overview

This course contains 7 modules:

1. Introduction to Knowledge Representation and Reasoning (2 weeks)
2. First Order Logic and Knowledge Representation (2 weeks)
3. Theory of Answer Set Programming (2 weeks)
4. Practice of Answer Set Programming (2 weeks)
5. Reasoning about Actions (2 weeks)
6. KRR with Uncertainty (2 weeks)
7. Ontology Languages (2 weeks)

Modules will be available one-at-a-time, and the next module will be available around the due date of the previous module.

Course Structure

Grading Scheme:

Graded Quizzes (7 total) : 15%

Graded Assignments (3 total) : 15%

Major Project (1) : 30%

Midterm Exam : 20%

Final Exam : 20%

Exams will be taken strictly in-person in this classroom.

Academic Integrity: This is a theoretical CS course, all assignments are individual. There is no team project/assignment.

No late quizzes will be accepted.

Deadlines of Quizzes

There are 7 modules, each module will take 2 weeks = 14 weeks

Midterm exam: 1 week

Deadlines:

Module 1: January 22th Sunday midnight .

Module 2: February 5th Sunday midnight … etc

…….

You need to watch all recorded video lectures, study the slides and other materials in Module 1.

Week 1 Assignments:

- Module 1 Graded Quiz

Motivation

What is the goal of this course?

How can you use it in real-world?

What is intelligence?

Motivation

What is the goal of this course? How can you use it in real-world?

All MDs receive the same education but some are better than others for diagnosing patients:

– They have the same knowledge (facts)

But some MDs are better

– encoding the knowledge (facts) in their brain

– make connections between the knowledge (facts)

– make reasoning, and diagnosing a disease

Two factors of intelligence:

– memory capacity

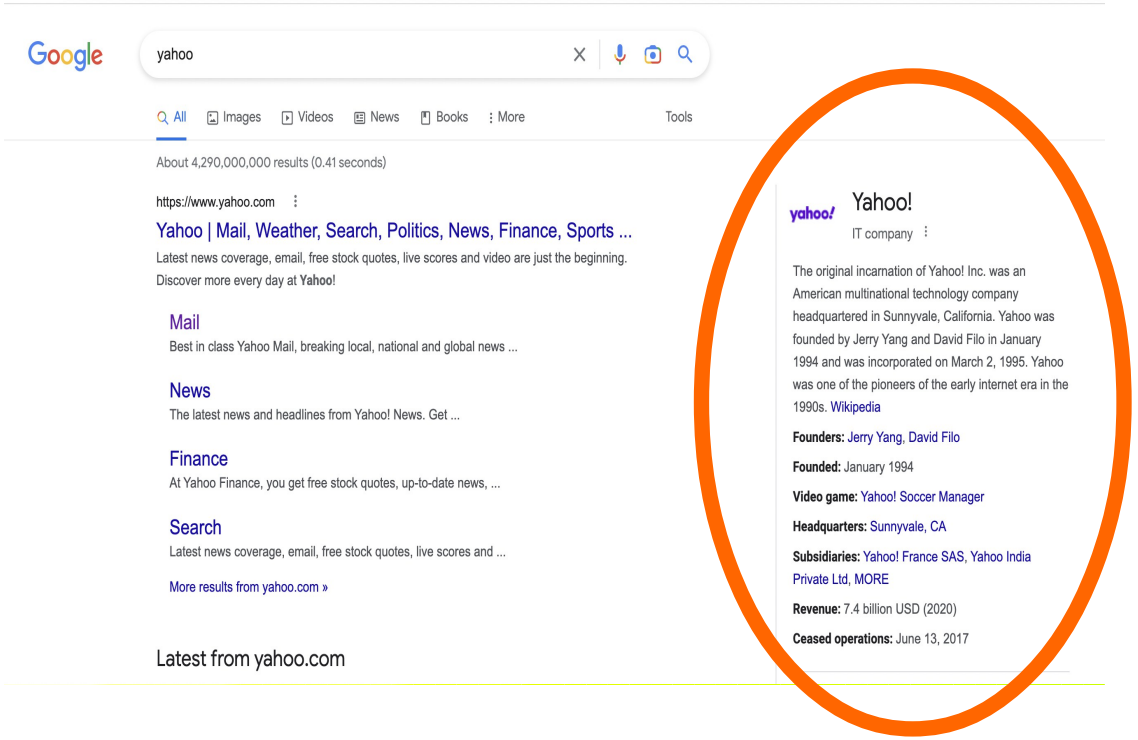
– reasoning

House M.D.

Motivation

What is the goal of this course? How can you use it in real-world?

When you search Google, sometimes you will see a frame on the right. This frame comes from Google's Knowledge Base. Of course they don't have everything in their Knowledge Base (KB). But KB are very important for Semantic Web Mining.



Week 1 Highlights

Introduction to KRR:

– We want to encode knowledge so it can be computed.

– AI: the study of intelligent behavior achieved through comp.

– KR: the study of how to reason (compute) with knowledge in order to decide what to do (use knowledge rather than data)

– Before we can start reasoning with knowledge, we need to represent (encode) it.

– Difference between Learning & Reasoning:

- Learning: learn models/knowledge from data
- Reasoning: manipulate models/knowledge to derive new information

Week 1 Highlights

What is Knowledge? We don't answer this question, but consider representations of knowledge. (all kinds of facts about the world)

- We assume that knowledge can be represented in some symbolic manner and we are going to do some symbol manipulation.

What is representation?

- Symbols standing for things in the world.

What is reasoning?

- A form of calculation over symbols, standing for propositions rather than numbers.

Real world → representational propositional logic

Week 1 Highlights

Why is KRR useful?

- Describing / understanding the behavior of a system (in terms of knowledge).
- Generating the behavior of a system.

In some other areas of AI (such as DL), sometimes we don't understand when/why the system does not work correctly!!!

Week 1 Highlights

Role of Formal Logic

- Formal logic studies these topics: entailment relations, formal languages, truth conditions, semantics and inference.
- All propositions are represented as formulas.

Formal logic gives us a framework to discuss **different kinds of reasoning problems**:

- Deductive reasoning
- Model finding
- Abductive reasoning
- Default reasoning
- Epistemic reasoning

Week 1 Highlights

We will study 3 different formal languages during the course:

1-) Propositional Logic

2-) First Order Logic

3-) Answer Set Theory

Ultimate goal: Encode natural language into a formal language so we can do ….(reasoning)

Week 1 Highlights

Natural Languages: English, French, Indian, Chinese etc.

- High in expressiveness, Low in reasoning computationally

Formal Languages: Fortran, C/C++, Java, Python, Clingo, etc. (introduced by Noam Chomsky in 1950s.)

- Low in expressiveness, High in reasoning computationally

Duality between Expressiveness and Reasoning:

– if a representation (language) is more expressive and then it is difficult to make reasoning

– if a representation (language) is less expressive and then it is easier to make reasoning

Ultimate goal: Encode natural language into a formal language so we can do …. (reasoning)

Thanks

&

Questions