

Artificial Intelligence Course Wrap Up

Fall 2021

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Status of Logical representations...

“The project of using logical languages to represent commonsense knowledge for AI is almost sixty years old. Though the literature is large, the fraction of commonsense knowledge covered is presumably extremely small, and the impact of this approach on the practical AI technology is small and grows steadily smaller, as AI becomes ever more dominated by corpus-based learning techniques that generate entirely opaque “representations”.

-: *Logical Foundations of Commonsense Reasoning: A Survey*
By Ernest Davis, NYU
Journal of AI Research (JAIR) 59 (2017).

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Status of Logical representations...

“The fact remains, however, that there are many forms of commonsense knowledge for which the *only* epistemically adequate representation known is some form of logical language, and many instance of commonsensical reasoning that can be reasonably characterized or approximated as logical inference, and cannot be carried out in any other known formalism. It therefore seems likely that the study of logical representation of commonsense knowledge will ultimately play an important role in the development of human-level AI.

-: *Logical Foundations of Commonsense Reasoning: A Survey*
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AI – Science, Applications, Technology

- **Science of AI**

Models of intelligent behavior

- **Building AI Applications**

Using the models to build applications (out of a research lab)

- **AI Technology**

Deploying AI products (smart devices)

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The Science of AI

- How do people, organisms, machines
 - Know/believe things?
 - Reason?
 - Solve problems?
 - Use language?
 - See?
 - Hear?
 - Speak?
 - Walk/run/swim?
 - Interact socially?
 - Etc.

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The Science of AI

- How do people, organisms, machines
 - Know/believe things? [Knowledge Representation](#)
 - Reason? [Models for Reasoning](#)
 - Solve problems? [Search, planning, etc.](#)
 - Use language? [Computational Linguistics](#)
 - See? [Computer Vision](#)
 - Hear/Speak? [Computational Neuroscience](#)
 - Walk/run/swim? [Robotics](#)
 - Interact socially? [All of the above?](#)

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The Science of AI

- How do people, organisms, machines
 - Know/believe things? Knowledge Representation
 - Reason? Models for Resoning
 - Solve problems? Search, planning, etc.
 - Use language? Computational Linguistics
 - See? Computer Vision
 - Hear/Speak? Computational Neuroscience
 - Walk/run/swim? Robotics
 - Interact socially? All of the above?
- Logic
Linguistics
Neuroscience
Evolution
Philosophy
Mechanical Engineering
Etc.

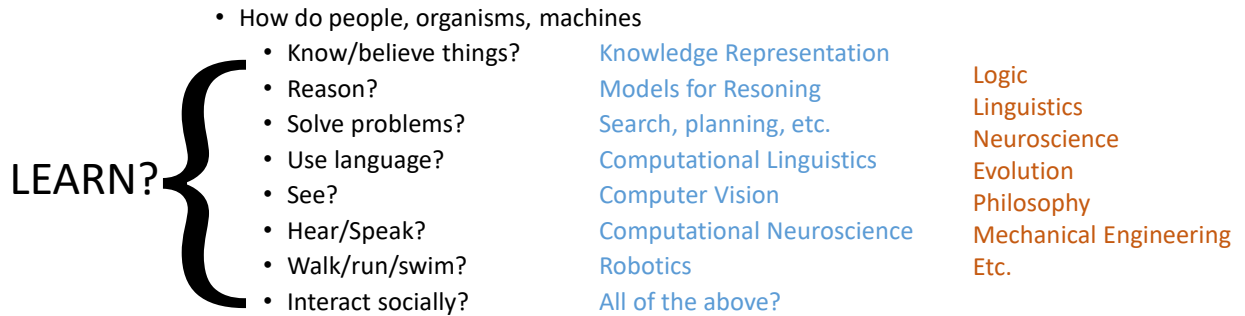
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The Science of AI

- LEARN? {
- How do people, organisms, machines
 - Know/believe things? Knowledge Representation
 - Reason? Models for Resoning
 - Solve problems? Search, planning, etc.
 - Use language? Computational Linguistics
 - See? Computer Vision
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- Logic
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Etc.

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The Science of AI



This is the BIG PUZZLE of AI

Understanding and building models of intelligent behavior.

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The story about AF – Artificial Flight

- How to build a flying machine?
 - Study flying animals like birds
[wings, feathers, muscles, etc. to build machines that emulate birds]
 - Study aerodynamics
[how air flows above and below an air foil, how it provides lift, use wind tunnels to explore shapes of arifoils, etc.]

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Developmental Approach – An alternative

- Machines with their suite of sensors and motors may not be capable of doing things the way people/organisms do.
- Build models for embodied intelligence from “developmental principles”.

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Building AI Applications

- Using the models to build applications from AI research labs
 - Boston Dynamics Spot robots
 - Face recognition
 - Facial recognition
 - Captioning a photograph
 - Understanding objects in a photograph using its caption
 - Robotic surgery

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AI Technology

- People outside of AI/CS using ML
- Autopilot mechanism in cars, trucks, planes, boats
- Robot delivery, vacuums, grocery store monitoring, Amazon's warehouse robots
- Biometric recognition
- Etc.

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AI outside the Lab

- Big Issues
 - Reliability
 - Predictability
 - Social & Ethical Implications
 - Etc.

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What We did...

- Intelligent Agents
- Search
 - Formulation
 - Initial State
 - Goal
 - Transition Model/Operator
 - Path/cost
 - Uninformed/Blind Searches
 - Breadth-First, Depth-First
 - Depth-limited/Iterative Deepening
 - Uniform Cost
 - Informed Search
 - Evaluation function ($f = g + h$)
 - Heuristic Function
 - Greedy/Best First Search
 - A*
 - Local Search
 - Hill Climbing
 - Simulated Annealing
 - Genetic Algorithms
- Game Playing
 - 2-person zero-sum games
 - Minimax & Alpha-Beta Pruning
 - Konane
- Constraint Satisfaction Problems
 - Backtracking Search
 - CSP Inferences
 - Forward Checking
 - Constraint propagation
 - Arc Consistency (AC-3)
 - Variable/Value Ordering
- Knowledge Representation & Reasoning
- Logic
 - Propositional Calculus
 - Syntax – wffs
 - Semantics
 - Entailment
 - Soundness
 - Completeness
 - Inference Rules
 - Resolution
- Logic, contd.
 - First-Order Predicate Calculus
 - Syntax & Semantics
 - Representing knowledge
 - Inference Rules
 - Universal Instantiation
 - Existential Instantiation
 - Generalized Modus Ponens
 - Unification
 - Inference Procedures
 - Forward Chaining
 - Backward Chaining
 - Definite Clause Forms
 - Logic programming – PROLOG
 - Resolution
 - Answer Extraction
- Planning
 - Situation Calculus
 - Fluents
 - Action Schema
 - Axioms
 - Resolution w/ Answer Extraction
 - Frame Axioms
 - STRIPS Representation
 - Planning as Search
 - Forward Search
 - Blind Search
 - Island driven Search
 - Backward Search
 - Partial-Order Planning

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What we didn't...

- Knowledge Representation
- Uncertain Knowledge Representation & Reasoning
 - Probabilistic Reasoning
 - Utility Theory/Decision Making
- Learning
 - Regression & Classification
 - Artificial Neural Networks
 - Support Vector Machines
 - Reinforcement Learning
- Communication, Perception, and Acting
 - Natural Language Processing
 - Computer Vision
 - Robotics
- Philosophical Foundations & Ethics of AI

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