Constraint Programming

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1 Lezione 1 - 18/09/2023

1.1 ACM-IEEE: IS - Intelligent Systems

AI is the study of solutions for problems that are difficult or impractical to solve with traditional methods. The solutions rely on a broad set of:

- general and specialized knowledge representation schemes
- problem solving mechanisms
- learning techniques

12 subareas:

IS/Fundamental ISSUES
IS/Basic Knowledge Representation and Reasoning
IS/Basic Search Strategies
IS/Advanced Search
IS/Advanced Representation and Reasoning
IS/Agents
IS/Basic Machine Learning
IS/Advanced Machine Learning
IS/Reasoning Under Uncertainty
IS/Natural Language Processing
IS/Robotics
IS/Perception and Computer Vision

IS/Fundamental ISSUES

- Overview of AI problems, examples of successful recent AI applications

IS/Basic Knowledge Representation and Reasoning

- Review of propositional and predicate logic
- Resolution and theorem proving

IS/Basic Search Strategies

- Problem spaces (states, goals and operators), problem solving by search
- Factored representation (factoring state into variables)
- Uninoformed search (breadth-first, depth-first, depth-first with iterative deepening)
- Heuristics and informed search (hill-climbing, generic best-first, A*)
- Space and time efficiecy of search
- Constraint satisfaction (backtracking and local search methods)

IS/Advanced Search

- Global constraints
- Large Neighborhood Search
- (Parallelism)

See conferences: ICLP, CP, IJCAI

1.2 Introduction

CP is a declarative programming paradigm suited for modeling and solving complex problems. Problem modeling and solution searching are clearly separated and typically the code is very readable and easy to modify.

You don't have restrictions on the kind of constraints. Solution search is natural to parallelize and search heuristics are crucial.

1.3 The future of xAI

Thanks to the growth of computing resources, the learning capability of artificial intelligence has made the subsymbolic approach very popular. On a larger scale, an exponential phenomenon is complex to handle.

Furthermore, one of the current concerns is the amount of energy required to train the models.

1.3.1 EU AI ACT

In 2024, the EU published the world's first law comprehensively regulating AI. They have developed a set of rules for scenarios that serve as guidelines so that people can develop and use AI.

1. AI definition
2. Forbidden activities: social scoring, remote biometrics, subliminal methods / fragile people
3. Risk based classification of AI:
    - Medical and legal applications and scoring (students, financial, CV) are High Risk

GenAI is not explicitly included in AI Act.

New issues:

- Copyright
- Bulk data retrieval
- Legal liability for generated output
- Embedding into other services (API)

1.3.2 GenAI Risks

Bias: AI learns from unbalanced datasets → this is our society → discriminations

Blackbox:

- Algorithms / training dataset not available
- Can't analyze the trained network (propietary)
- Even if available → trilions of parameters

Improper usage: AI for a specific and unruled task (e.g. fake news)

1.3.3 Explainable AI

Ethical principles to include AI in the decisional chain:

- System's trust
- Compliance to standards/directives
- Bias control
- Incremental improving

How?

- Explainability allows to understand how/why I get that answer
- Transparency and interpretability (access to algorithms and data)
- Logical proof

Creating new AI to explain AI is like creating blackbox to explain blackbox. A solution could be Native Explainability.

1.3.4 Two joining paths

ML	**Symbolic AI**
Learns easily	Knowledge representation
No programming	Programming (e.g. constraints)
Blackbox	Natively explainable
Expensive training	Expensive computation
Syntax level	Semantic level
Probability for next token	Relations on objects
NL expressions patterns	Similar to human deduction
Somehow captures a certain semantica	Can explain ML?

2 Lezione 2 - 20/09/2023