Applications of Context for Artificial Intelligence

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Overview

- Basic Problem
- Visual Cues
- Context Filtering
- AlphaGo as example
- Object relationships in Language
- BYU Solution
- Future Applications
- Citations
- Questions

Basic Knowledge Problem

- Ask a robot to bring you a cup
  - It doesn't know how to find, pick up, transport etc.
  - Might break the cup or break itself
  - Must be told how to do all of this
- We consider this knowledge trivial
  - Understand how to hold cups, where cups are located, etc.
  - Humans use this contextual knowledge of objects
  - But robots don't know
  - Must obtain this knowledge somehow

Visual Cues

- When trying to pick up a cup, know what a cup is
  - because know the relative weight of a cup, know how to lift it
- Robots often lack many of these cues
  - even if they can identify objects, often does not have extensive knowledge of these many objects
- Idea of context cues extends beyond physical interactions
  - Humans have lots of general knowledge
  - Implicitly use this knowledge to solve problems

Basic Knowledge Problem

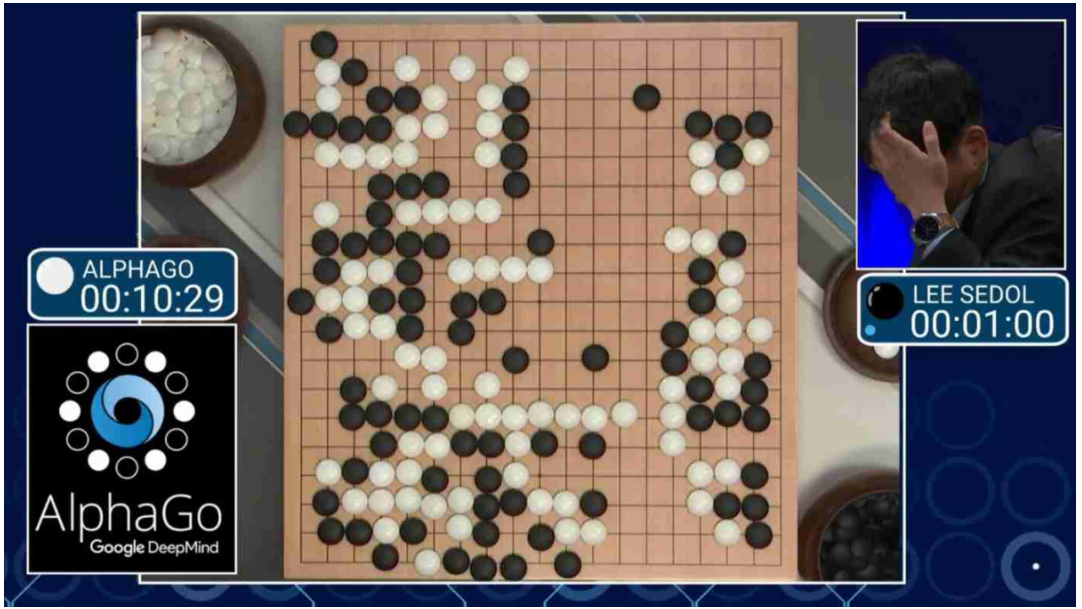
- DARPA Robot Challenge
  - Robots can't open doors or walk really
  - https://youtu.be/g0TaYhjpOfo?t=26s
- What we consider to be basic is actually fairly difficult
  - It's not simple to open a door or walk
- Extends beyond robotics
  - AI will require a similarly extensive amount of knowledge

Context Filtering Problem

- Humans can filter information
  - Humans often have some idea of what is likely to work and what is unlikely to work
  - Understand what information is relevant and what variables should be changed
  - Can use this to filter out poor solutions
  - Because search-space is smaller, humans can experimentally figure out new solutions to new problems
- Machines don't have the knowledge to be capable of filtering
  - Machines don't know what is relevant and what is not
  - Must resort to brute-force search oftentimes
  - Search-space is likely to be intractably large
  - Will never find the solution if it cannot reduce the search-space

Search Space

- AlphaGo
  - 10^761
  - Search space intractable
  - Must reduce search space
- Humans use intuition to reduce search space



Object Relationships Problem

- Humans understand relationships between objects
  - We know how nouns relate to other verbs
  - But the machine does not know these sorts of things
- Machines don't understand relationships between objects
  - You can dethrone a king, but you can't really 'harvest' a king (Christensen)
  - Machine doesn't know that you should not eat a table
  - Machines in unstructured environments perform terribly
  - Infeasible to hand-code this knowledge

Object Relationship Solution

- Researchers at BYU download Wikipedia
  - Teach machine relationships between nouns and verbs
  - Use Wikipedia as a source of up-to-date text
  - Extract noun-verb relationships to find Affordances (set of actions that can be done with an object)
  - Apply math and figure out relationships between words in the text downloaded from Wikipedia
  - So now machine knows how nouns relate to other verbs

Results of the solution

- BYU Researchers improve performance
  - For an unstructured text game where machines have to respond to textual input, improved performance on 12/16 games
  - This improvement was from understanding relationships between objects alone
  - Other improvements could include grammar, speaking conventions, etc

Future Applications

- Basic Knowledge
  - Need machines to be capable of a variety of tasks if integrated in consumer environment
  - Must understand how to not break things
  - Must not break itself
- Context Filtering
  - AI figure out solutions for unseen problems
  - Performance in unstructured environments
- Language, Object Relationships
  - Easy, convenient format to communicate to machines
  - NLP

Citations

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Questions?