Artificial Intelligence

Agents & Common Sense

Society of Mind (1985)

• Written by Marvin Minsky
  – Pioneer of AI
  – Co-founder of AI lab at MIT
• Collection of ideas about minds
  – Many cross-connections of ideas
Prologue: Agents

• Book tries to explain how minds work
  – How can intelligence emerge from non-intelligence?

• Can build a mind from many little parts
  – Each part mindless by itself

• “Society of Mind”
  – Each mind is made of many smaller processes (agents)

• Agent (or mental agent) NEW DEFINITION!!!
  – By itself can only do some simple thing that needs no mind or thought at all
    • “Everything should be made as simple as possible, but not simpler.” – Albert Einstein
  – When join agents in societies (in special ways), this leads to true intelligence

1.1 Agents of the Mind

• Good theories of mind must span at least three different scales of time
  – Slow
    • For the billion years of brain evolution/adaptation
  – Fast
    • For the fleeting weeks/months of infancy and childhood
  – In-between
    • For the centuries of growth of our ideas through history

• To explain the mind, we must show how minds are built from mindless stuff
  – Using parts simpler than what we would consider “smart” (i.e., agents)
1.1 Agents of the Mind

• What could those simpler parts (agents) be?
• Many questions to answer:
  – Function
    • How do agents work?
  – Embodiment
    • What are they made of?
  – Interaction
    • How do they communicate?
  – Origins
    • Where do the first agents come from?
  – Heredity
    • Are we all born with the same agents?
  – Learning
    • How do we make new agents and change old ones?

1.1 Agents of the Mind

• More questions to answer:
  – Character
    • What are the most important kinds of agents?
  – Authority
    • What happens when agents disagree?
  – Competence
    • How can groups of agents do what separate agents cannot do?
  – Intention
    • How could such networks want or wish?
  – Selfness
    • What gives them unity or personality?
  – Meaning
    • How could they understand anything?
1.1 Agents of the Mind

• Even more questions to answer:
  – Sensibility
    • How could they have feelings and emotions?
  – Awareness
    • How could they be conscious or self-aware
• How could a theory of mind explain so many things, when each question is too hard to answer by itself
  – Difficult when we address each one in isolation
• If see mind as “society of agents”, each answer will illuminate the rest
  – Must consider connections

1.2 The Mind and The Brain

• How do things work?
• Every living thing was found to be composed of “smaller things”
  – Plants to cells to chemicals to …
• Inspired new ideas about how machines could do what only minds had done previously
  – Beginnings of neural networks
  – Possibility for “agents of the mind”
1.3 The Society of Mind

• What kinds of smaller entities cooperate inside your mind to do a task?

• Think about: “Pick up a cup of tea”
  – Grasping agents want to keep hold of cup
  – Balancing agents want to keep tea from spilling out
  – Thirst agents want you to drink the tea
  – Moving agents want to get cup to lips
  – Could be at least a hundred processes (agents)
  – Yet none of these agents consume your mind

• Agents “depend on one another”
  – If each does own little job, bigger job (drinking tea) gets down by all of them communicating and working together

1.3 The Society of Mind

• Involves more machinery than anyone can understand all at once

• Hence, let’s examine an ordinary activity and break it into smaller parts to see how each relate to one another
1.4 The World of Blocks

- Imagine child playing with blocks and likes to watch tower grow as new blocks placed on top
- Goal: **Build a tower of blocks**
- Imagine child’s mind contains many mental agents
- BUILDER agent in control
  - Specialty is making towers from blocks
- But building a tower **too complicated** for any single, simple agent (as BUILDER)
  - BUILDER agent must ask for help from several other agents

1.4 The World of Blocks

- But even “finding another block” and “placing it on the tower” is too big a job for any single ADD agent
  - Therefore calls on other agents, and so forth…

```
  BUILDER
    /
   /
  BEGIN
  /
ADD
  /
FIND
  /
SEE
  /
GRASP
  /
MOVE
  /
RELEASE
```

- END
1.4 The World of Blocks

- **SEE** must recognize blocks
  - Different color, size, place, backgrounds, shades, etc.
- **MOVE** must guide arm and hand in space
  - Not hitting anything
- **FIND** must determine which blocks are still available to use
  - “don’t grab the top block and put it back”
  - Must understand the visual scene

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1.4 The World of Blocks

- Why break things into such small parts?
- Minds, like towers, are made that way
  - Except minds are composed of “processes” instead of “blocks”
- We have found a way to make our tower builder out of parts... but it is far from done
1.5 Common Sense

• Making a tower of blocks may seem insignificant to you, but not so when you were a child

• No one really understands how we learn to do such tasks
  – Can’t remember learning them
  – “Amnesia of infancy”

• All children learn about such things, but we rarely think about them in our later years
  – We regard all of this to be simple “common sense”

1.5 Common Sense

• “Common sense” knowledge
  – Term conceals almost countless different skills
    • Multitudes of life-learned rules and exceptions, dispositions and tendencies, balances and checks
  – Obvious and natural, layered over time
    • Layers becoming increasingly remote
1.6 Agents and Agencies

• Want to explain intelligence as combination of simpler things
  – But must check that **none** of agents is itself intelligent
    • Not a person inside 19th century “chess playing machine”
    • Homunculus!
  – If find agent that is too complicated, replace it *(break it down)* with a sub-society of agents that do simpler things
• So where does “knowing-how-to-build” reside? (Not in any one part)
  – Need to understand how “groups” of agents can accomplish things

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1.6 Agents and Agencies

• Two ways to think about agents
  – If see BUILDER from **outside** (not knowing inside), have impression that “it knows how” to build towers
  – If could see BUILDER from **inside**, you would find no knowledge there
    • Simple process/switches turning other agents on and off
2.1 Components and Connections

- BUILDER is not just a “collection of parts”
  - They are linked to one another by network of interconnections
  - Bureaucracy
- Must know how they are organized
  - How each part interacts with others
  - How local interactions combine to accomplish goal
- Similar with understanding the brain

2.5 Easy Things are Hard

- Minsky and Papert implemented BUILDER at MIT AI lab (1960s)
  - Mechanical hand, television eye, computer
  - Build with children’s building-blocks
  - Took several years for MOVE, SEE, GRASP, and others!
- Implementation
  - Build mechanical hand with touch sensors
  - Interface camera with computer to detect edges of blocks (also the hand)
  - Needed planning programs (recall building the tower from the top-down in the video!)
2.5 Easy Things are Hard

• Found that **everyday problems** are much more complicated than problems/puzzles that adult considers hard

• “Everyday problems involve ordinary *common sense*”

• **We are least aware of what our minds do best!**
  – So cannot trust our offhand judgments about which of the things we do are simple (or complex)!

2.5 Easy Things are Hard

• Minsky: “I like to think that this project gave us glimpses of what happens inside certain parts of children’s minds when they learn to ‘play’ with simple toys”

• This practical experience led to many ideas about “Societies of Mind”
7.1 Intelligence

• Many people insist on having some definition of intelligence
• CRITIC: How can we be sure that things like plants and stones, or storms and streams, are not intelligent in way that we have not yet conceived?
  – Not good to use same word for different things
    • Unless know important ways they are the same
  – Plants and streams don’t seem very good at solving kinds of problems we regard as needing intelligence

7.1 Intelligence

• CRITIC: What’s so special about solving problems? And why don’t you define “intelligence” precisely, so that we can agree on what we’re discussing?
  – Not good idea either
    • An author’s job is using words the ways other people do, not telling them how to use them
  – But, intelligence has the ability to solve hard problems
7.1 Intelligence

• CRITIC: Then you should define what you mean by a “hard” problem. We know it took a lot of human intelligence to build the pyramids – yet little coral reef animals build impressive structure on even larger scales. So don’t you have to consider them intelligent? Isn’t it hard to build gigantic coral reefs?
  – Yes it is hard to build the reefs, but only illusion that animals can “solve” those problems
  – No individual bird discovers a way to fly (exploits evolved solution)
  – Those animals don’t “solve” such problems themselves
    • Only exploit procedures available within gene-built brains

7.1 Intelligence

• CRITIC: Then wouldn’t you be forced to say that evolution itself must be intelligent, since it solved those problems of flying and building reefs and nests?
  – No, people also use the word “intelligence” to emphasize swiftness and efficiency
  – Evolution’s time rate too slow to see as intelligent
  – It is better to try to explain how we use intelligence
    • Not just try to define it

Intelligence = The ability to “solve hard problems”, “quickly and efficiently”
7.1 Intelligence

- “Intelligence” is our name for whichever of those processes we don’t yet understand
- Meaning of intelligence changes as we learn more about psychology (and biology)
  - Consider how concept of “the unexplored regions of Africa” disappear as soon as we discover it

7.2 Uncommon Sense

- Computer’s total lack of common sense is another reason people think no machine could have a mind
  - Send us bills and checks for $0.00
  - Don’t mind working in endless loops
  - Others???
7.2 Uncommon Sense

- Some of the earliest computer programs excelled at what people considered to be “expert” skills
  - 1956 program solved hard problems in logic
  - 1961 program solved college-level calculus problems
- Not until 1970s could we build robot programs to see and arrange children’s building-blocks into towers
- Why could we make programs do grown-up things before make them do childish things???
  - Much of “expert” adult thinking is actually simpler than what is involved when ordinary children play!

- Common sense is actually more intricate than most technical expertise
  - The calculus program had no more than 100 “facts”
    - But still enough to solve college-level calculus problems
  - Think of all the different kinds of things a child must know merely to build a house of blocks
    - Knowledge of shapes, colors, space, time, support, balance, …
- To be considered expert, need large amount of knowledge of relatively few varieties
  - Recall the definition of classic Expert Systems
- Common sense involves much larger variety of different “types” of knowledge
  - Requires more complicated management systems
7.2 Uncommon Sense

- Why is it easier to acquire specialized knowledge than common sense knowledge?
  - Each type of knowledge requires a “representation” and a set of skills for using that representation
  - Once investment made, easy for specialist to accumulate further knowledge (if suitable to same representation)
    - For example, relatively easy for doctor/lawyer/architect to learn more knowledge in his/her field
    - Consider if a person had to learn about diseases, law cases, architectural blueprints, etc. (takes longer to learn)

7.4 Problem Solving

- *** Still turns out that it’s harder for a machine to do what people think is easier ***
  - Consider chess vs. building tower from blocks!
### Winograd Schema Challenge

- **Aims to determine how well AI handles common sense reasoning**
- After Eugene Goostman chatbot “passed” a Turing test a few years ago, experts decided that traditional Turing test might not be all that effective in measuring the intelligence of a computer program after all.
- **NEW:** A set of multiple-choice questions where the answers are expected to be fairly obvious to a layperson, but ambiguous for a machine without human-like reasoning or intelligence.
  - Pronoun disambiguation

### Examples

The trophy would not fit in the brown suitcase because it was too big.

*What was too big?*
- (a) the trophy
- (b) the suitcase

The town councilors refused to give the demonstrators a permit because they feared violence.

*Who feared violence?*
- (a) the town councilors
- (b) the demonstrators

I asked Dave to get me my sweater from the other side of the yacht. While he was gone, I rested my arm on the rail over there and suddenly it gave way.

*What was it that gave way?*
- (a) sweater
- (b) yacht
- (c) arm
- (d) rail
Open Mind Common Sense (OMCS)

- AI project started at MIT whose goal is to build and utilize a large Common Sense Knowledge Base
  - Started in 1999
  - Has accumulated more than 1M English facts from over 15,000 contributors

Examples Statements Entered

- Relationships between objects/events
  - “A coat is used for keeping warm”
  - “The sun is very hot”
  - “The last thing you do when you cook dinner is wash your dishes”

- Emotional situations
  - “Spending time with friends causes happiness”
  - “Getting into a car wreck makes one angry”

- Desires/Goals
  - “People want to be respected”
  - “People want good coffee”

But needs to be transformed into a more structured representation to use it computationally
ConceptNet

- **Semantic network** based on OMCS data

Explore online: http://conceptnet.io

In the News…

- “One Genius’ Lonely Crusade to Teach a Computer Common Sense” (2016)
- “Facebook’s AI Chief: Machines Could Learn Common Sense from Video” (2017)
- …
Summary

- Agent definition
- Intelligence definition
- Common Sense knowledge and reasoning