Escaping the local minimum

By Kenny Friedman

MAS.S63 Integrative Theories of Mind and Cognition

May 9, 2016
I'm just outside town, so I should be there in fifteen minutes.

Actually, it's looking more like six days.

No, wait, thirty seconds.

The author of the Windows file copy dialog visits some friends.
WE MADE A BREAKTHROUGH, SO IT SHOULD BE JUST A FEW YEARS NOW

Actually, it's looking more like six days

No, wait, three hundred years.
WE MADE A BREAKTHROUGH, SO IT SHOULD BE JUST A FEW YEARS NOW

ACTUALLY, IT'S LOOKING MORE LIKE SIX DAYS

NO, WAIT, THREE HUNDRED YEARS.

A RESEARCHER EXPLAINING WHEN WE'LL HAVE GENERAL ARTIFICIAL INTELLIGENCE
Escaping the local minimum

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May 9, 2016
Agenda

Background / The Problem

Vision

3 Examples

Contributions
Agenda

Background / The Problem

Vision

3 Examples

Contributions

For each example:

Define the Problem

Classic Method

Potential Modern Method
Background

Electrical Engineering & Computer Science

Undergraduate, Junior

Taking 2 classes in AI this semester:

MAS.S63 & 6.803
Background

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Undergraduate, Junior

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The Vision

AI has been performing gradient descent for decades

Then the field gets caught in a local minimum

Rarely looks around to see if it is stuck
The Vision

AI has been performing gradient descent for decades

Then the field gets caught in a local minimum

Rarely looks around to see if it is stuck

Take methods from recent success

Apply them to classic models & problems

NNs as a substrate for all previous work in the field
Gradient Descent

1960s

SAINT (Symbolic automatic integrator)

ELIZA (chatterbot)

SHRDLU (NPL, Terry Winograd)
Gradient Descent

"Within a generation ... the problem of creating 'artificial intelligence' will substantially be solved.”
Minsky, 1967

1960s

SAINT (Symbolic automatic integrator)

ELIZA (chatterbot)

SHRDLU (NPL, Terry Winograd)
Gradient Descent

"Within a generation ... the problem of creating 'artificial intelligence' will substantially be solved."
Minsky, 1967

"In from **three to eight years** we will have a machine with the general intelligence of an average human being."
Minsky, 1970

1960s

SAINT (Symbolic automatic integrator)

ELIZA (chatterbot)

SHRDLU (NPL, Terry Winograd)
AI Winter Strikes
Gradient Descent

1980s

Expert Systems

Knowledge Based Systems (Cyc)

“Intelligent Agents”

Deep Thought Wins Redkin Intermediate Prize

Hans Berliner

Since May 1988, Deep Thought (DT), the creation of a team of students at Carnegie Mellon University, has been attracting a lot of notice. In the Fredkin Masters Open, May 28–30, DT tied for second in a field of over 20 masters and ahead of three other computers, including Hitech and ChipTest (the winner of the 1987 North American Computer Championships). In August at the U.S. Open, DT scored 8.5, 3.5 to tie for eighteenth place with Arnold Denker among others. Its performance was marred by hardware and software bugs. However, DT astounded everyone by beating International Master (IM) Igor Ivanov, the perennial winner of the U.S. Grand Prix circuit prize, who is generally regarded to be as almost all potential contenders. The two first place finishers drew with each other. Hitech led the field at the halfway point but lost to DT in round 3 and threw away a winning position against Fidelity in round four (because of a programming bug). The level of play in this tournament was by far the best ever in a computer event, and the winners clearly deserved their top places.

Ten days later, DT achieved the greatest computer success to date. It tied for first with GM Tony Miles in the prestigious Software Toolworks Open in Los Angeles with a score of 6.5, 1.5. Several GMs played in this tournament, including former World Champion Mikhail Tal of the USSR. In the tournament, DT became the
AI Winter Strikes
2010s

Deep Learning

Statistical Models

Voice Recognition Paired with NLP

AI HAS ARRIVED, AND THAT REALLY WORRIES THE WORLD’S BRIGHTEST MINDS
Future?

A Neural Net would predict a third winter any moment

Escape the current local minimum
(of superhuman perception)

Can neural networks become the substrate of all AI systems?
(*What If… Poggio*)
Three Examples

1. Generic Symbol Manipulation / Logic Systems

2. Minsky’s Multiplicity

3. Language / Story Understanding
Generic Symbol Manipulation / Logic Systems

Symbolic Integral Calculus (1960)

Recent Examples of Progress:

NTM

Logic as vectors of real numbers
Minsky’s Multiplicity

Architectures: Leabra, MicroPsi.

How much can emerge solely from NN?

1960: 5 Areas: Search, Pattern-Recognition, Learning, Planning, and Induction

2006

Self-Conscious Thinking
Concerned with relationship between mind and others, including self-appraisal by comparing one’s abilities and goals with those of others.

Self-Reflective Thinking
Concerned with large-scale models of “self”, including the extent and boundaries of one’s physical and cognitive abilities and knowledge.

Reflective Thinking
Reflects on and manages deliberative activity, including assigning credit to inference methods, selecting suitable representations, and so forth.

Deliberative Thinking
Reasons about the situations and events in the external world, e.g., prediction, explanation, planning, diagnosis, generalization.

Learned Reactions
Learned reflexes, scripts, and otherwise automatic, non-deliberative processes acting both on the external world and within the mind.

Innate Reactions
Instinctive reflexes and responses to opportunities and emergencies that occur in the external world or in the mind itself.
Language / Story Understanding

Chomsky, Winston.

Merge operator.

Inner Language Hypothesis,
Strong Story Hypothesis

reflection, cultural bias, personality understanding, question answering, onset detection, trouble anticipation, similarity measurement, similarity based retrieval, question driven interpretation, analogical interpretation, reader aware story telling, persuasion, and summary.

Word2Vec, RNNs, show promise but distance
Contributions

Reviewed AI’s tendency to fall into a local minimum

Provide three examples of prior systems & models that can not be done with deep learning

Suggest that a research focus should be placed on enabling deep learning to prove neural nets can be the right level of abstraction
Thanks
input atoms \( \{P(a), Q(b), P(f(a))\} \)

- **Decomposition giving the terms \( \{a, b, f(a)\} \)**
  - Basic tests and composition of basic tests \( \{P(b), P(X)^{\lor} Q(X), P(X)^{\lor} P(f(X)), \text{etc.}\} \)
  - Application of the "good" tests. The set of "good" tests was learned during the training \( \{P(X)^{\lor} P(f(X))\} \)

- **Building of the output arguments \( \{a, b, f(a), f(b), f(f(a)), \text{etc.}\} \)**
  - Selection of the "good" outputs arguments. The set of "good" outputs arguments is learned during the training \( \{f(f(a)), b\} \)

- **Building of the output atoms \( \{Q(f(f(a)), b)\} \)**