

On Model-Based vs Model-Blind Approaches to Artificial Intelligence

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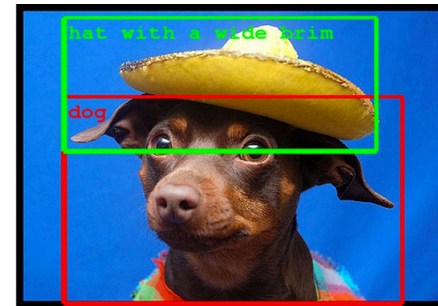
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Motivation

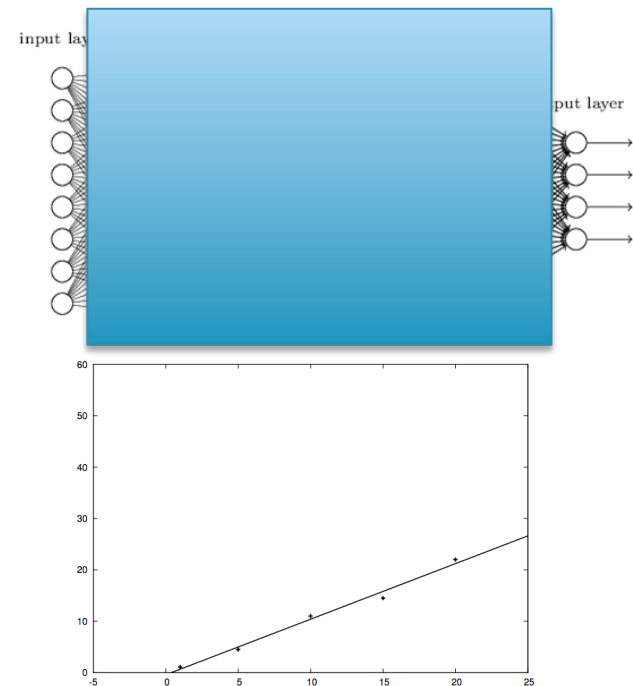
- **Misconceptions:** Driven by recent successes of model-blind approaches:
 - **Stephen Hawking:** “The development of full artificial intelligence could spell the end of the human race”
 - **Elon Musk:** AI is “potentially more dangerous than nukes.”
 - **Students:** ask about super intelligence
 - **AI Researchers:** What? Why?
- **What Just Happened in AI?**
 - Increased & impressive AI applications (self-driving cars, Siri, web translation)
 - Based on technology that existed for more than 50 years
 - AI curriculum almost unchanged
- **Judea Pearl:** “The vision systems of the eagle and the snake outperform everything that we can make in the laboratory, but snakes and eagles cannot build an eyeglass or a telescope or a microscope.”
 - **Paper Title:** Human-Level Intelligence or Animal-Like Abilities?
- **Technical debates are influenced by non-technical dimensions**

What Just Happened in AI?

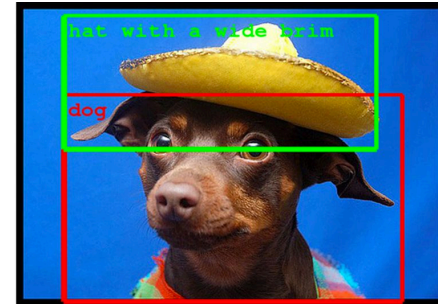
- **Model-Based Approach**
 - Represent & Reason
 - Logic & Probability
- **Model-Blind Approach**
 - Fit Functions to Data
 - Neural Networks
- **Will use “Function-Based”**
 - Input-Output Map, Efficient Evaluation
 - Issue: size
- Deep learning



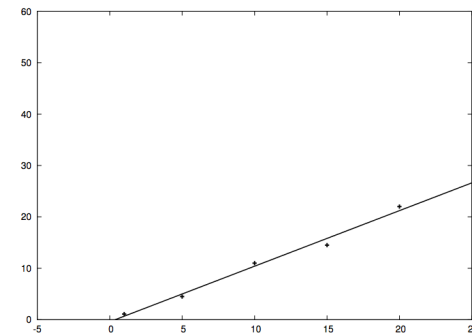
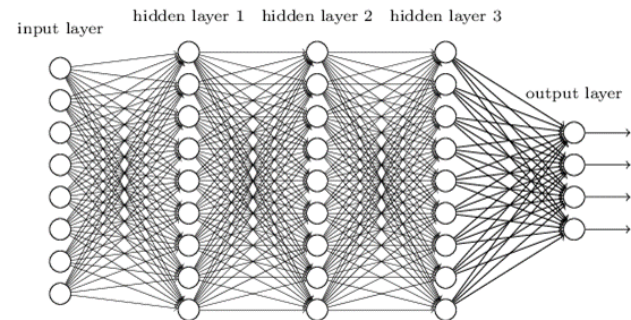
Deep neural network



What Just Happened in AI?



Deep neural network



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Intelligence As a Function

- **Every behavior**, intelligent or not, can be captured by a function:
 - Input: environmental sensing
 - Output: thoughts or actions
- **Key questions:**
 - How complex is this function (how large)?
 - Can we estimate it from data (practically)?

What Just Happened in AI?

- **First development:**
 - Lots of data
 - Increased computational power
 - Improved statistical techniques
- **Second development:**
 - Some cognitive tasks can be approximated by functions of reasonable size **
 - Object recognition and localization in images
 - Some speech and language tasks
- **Third development:** changed measures of success (largely unnoticed)

Measuring Success

- Machine translation
- Speech understanding
- Object recognition and localization

- **What just happened:** “numerous applications that can benefit from improved AI techniques, that still fall short of AI ambitions, yet are good enough to be capitalized on commercially.”

- **Significance of observations:**
 - Forecasting what may happen next
 - Balancing research agendas & attitudes

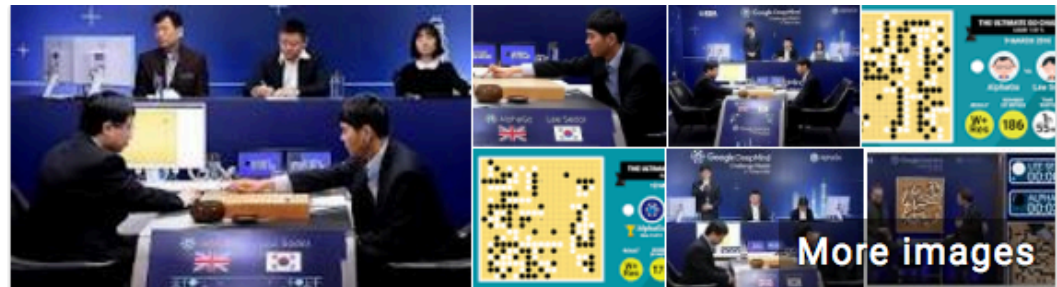
One the Title

- Eagles, snakes & vision
- Cats & navigation
- African parrots & speech
- What about Go?



On Misperceptions

- AlphaGo is not a function (i.e., neural network)
- It uses a set of techniques under development for ~50 years in AI
 - MiniMax for two player games
 - Stochastic search
 - Learning from self play
 - Evaluation functions
 - Reinforcement learning
 - Two neural networks
- Can we build a Go-Function in the future?
 - Focus on pushing thresholds
 - Academic, policy & regulatory challenges



AlphaGo versus Lee Sedol

AlphaGo versus Lee Sedol, or Google DeepMind Challenge Match, was a five-game Go match between 18-time world champion Lee Sedol and AlphaGo, a computer Go program developed by Google DeepMind, played ... [Wikipedia](#)

Dates: Mar 9, 2016 – Mar 15, 2016

Result: AlphaGo won.

Location: [Seoul, South Korea](#)

Game four: Lee Sedol won

Academic Considerations

- We don't have the evidence to justify this
 - We need to know more about “cognitive” functions and their size (e.g., will a Go-Function be small enough)
 - We need to know what happens when we tighten measures of success (i.e., when we seek better approximations)
- History tells us to be cautious:
 - Rule-based systems (aka expert systems)
 - Following period known as “AI Winter”
 - Transition happened when we could “delimit” applications

Bullied-By-Success Phenomena

- **Expert systems era (early 80s):**
“Knowledge is Power”
- **Commonsense reasoning (early 90s):**
Transition from logic to probability in AI
- **Parties:** the successful, the overwhelmed, and industry!
- **Raise awareness:** empower young researchers to do what they think is right

Policy Considerations

- Function-based approaches cannot answer the “Why” question:
 - Why did the medical diagnosis/treatment system recommend surgery?
 - Why did the self-driving car crash into the gym?
 - Why did the image-recognition system falsely recommend an arrest?
 - Why did the speech command mistakenly shut down the power system?
- Responsibility & attribution (heart of legal systems)
- White House Initiative on “Preparing for the Future of AI”:
“Safety” mentioned dozens of times in final report
- Upcoming DARPA program on “Explainable AI”
- Regulatory challenges (trials as in Drug approval?)

Concluding Remarks

- Recent successes of deep learning have revealed something very interesting, yet this seems to be the least pursued today (we have not even established the vocabulary to pursue this)
- What happened recently is mostly due to pushing thresholds (data, computation & statistics), in addition to changing the mode of operation.
- In AI, the key question is not whether we should use model-based or function-based approaches. The key challenges now are:
 - Understanding the reach and limits of function-based approaches
 - Characterizing deep learning progress in ways that facilitate its utilization by researchers outside the deep learning community
 - Integrating the two approaches

Functions Synthesized From Models and Data

Recent talk at the Simons Institute, UC Berkeley

Tractable Learning in Structured Probability Spaces
(Available on YouTube)

Thank You