Deep Learning Limitations and Extensions

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Learning objectives
Where deep learning fails
Future directions
Deep learning thus far

- is data hungry
- is shallow and has limited capacity for transfer
- has no natural way to deal with hierarchical structure
- has struggled with open-ended inference
- is not sufficiently transparent
- has not been well integrated with prior knowledge
- cannot inherently distinguish causation from correlation
- presumes a largely stable world
- works well as an approximation, but often cannot be trusted
- is difficult to engineer

Gary Marcus
Hierarchical structure

◆ Sentences have structure
  ● *The teenager who previously crossed the Atlantic set a record for flying around the world.*

◆ Dialog has structure at many time scales.

◆ As do images, movies, animals, people, companies,…
Common sense

- Who is taller, Prince William or his baby son Prince George?
- Can you make a salad out of a polyester shirt?
- If you stick a pin into a carrot, does it make a hole in the carrot or in the pin?
Instability: who quarterbacked Superbowl 33

Peyton Manning became the first quarterback ever to lead two different teams to multiple Super Bowls. He is also the oldest quarterback ever to play in a Super Bowl at age 39. The past record was held by John Elway, who led the Broncos to victory in Super Bowl XXXIII at age 38 and is currently Denver’s Executive Vice President of Football Operations and General Manager. Quarterback Jeff Dean had jersey number 37 in Champ Bowl XXXIV.
Google translate is very clever

◆ the bat

◆ the bat ate
but still unreliable

- the bat    el murciélago

- the bat ate    el bate comió
What’s hot in ML?

- Solving problems
  - Cancer diagnosis; Game playing with deep-RL
- GANS (Generative Adversarial Networks)
- Why gradient descent does so well (theory!)
- AutoML
- Deep Q-learning Networks (DQN)
- GPT-3 (Transformers)
Why does gradient descent regularize?

AutoML learns network structure

Human built

Learned by RL

https://research.googleblog.com/2017/05/using-machine-learning-to-explore.html
Big open directions (an opinion)

- Multitask learning / domain transfer
- One shot learning
  - “See one do one”
- Integrating deep learning with external data
  - e.g. results of database queries or search
- Learning generalizable “deep structure”
  - Whatever that means?