

Deep Learning Limitations and Extensions

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Learning objectives
Where deep learning fails
GANS

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?

Gary Marcus

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

球棒



◆ the bat ate

蝙蝠吃了



but still unreliable

◆ the bat

el murciélagos



◆ the bat ate

el bate comió



What's hot in ML?

- ◆ **Solving problems**

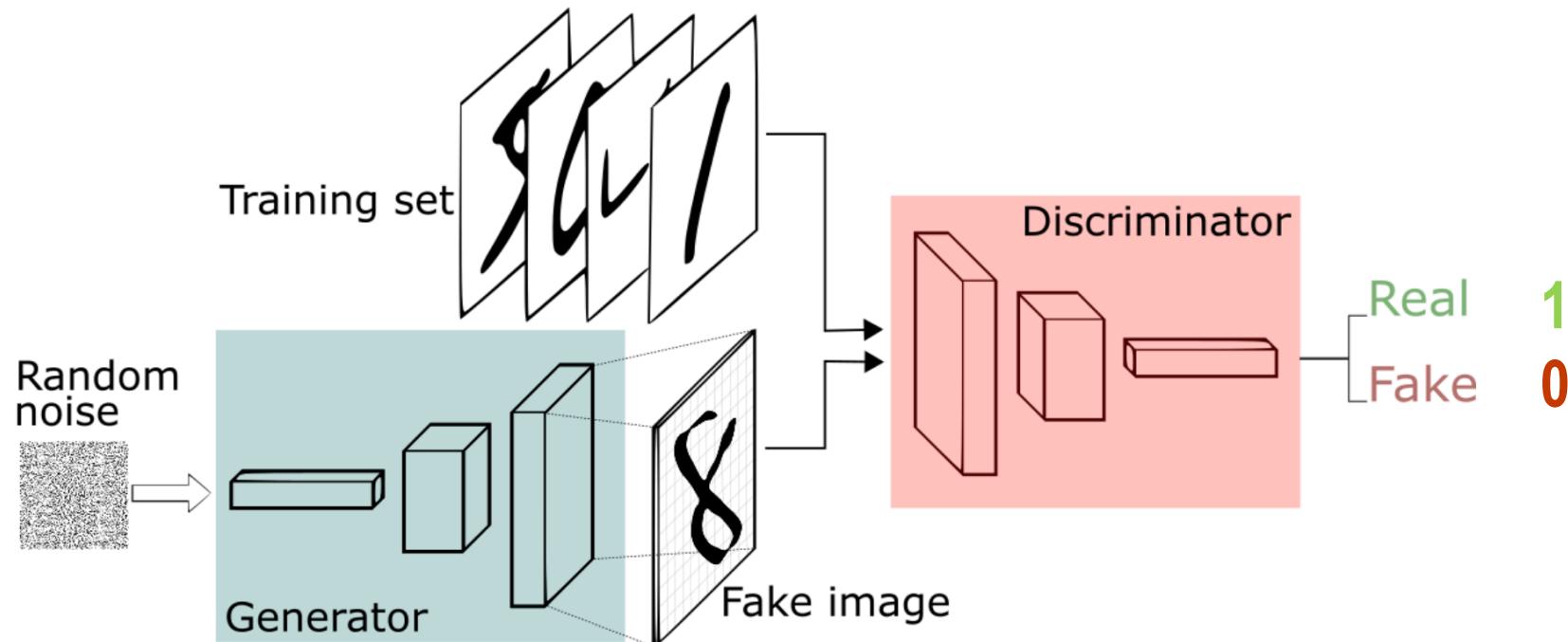
- Cancer diagnosis; Game playing with deep-RL

- ◆ **GANS (Generative Adversarial Networks)**

- ◆ **Why gradient descent does so well (theory!)**

- ◆ **AutoML**

Generative Adversarial Networks: GANS



$$G: \operatorname{argmin} \log(1 - D(G(\text{noise})))$$

[https://medium.freecodecamp.org/
an-intuitive-introduction-to-
generative-adversarial-networks-
gans-7a2264a81394](https://medium.freecodecamp.org/an-intuitive-introduction-to-generative-adversarial-networks-gans-7a2264a81394)

Generative Adversarial Networks

We propose a new framework for estimating generative models via an adversarial process, in which we simultaneously train two models: **a generative model G that captures the data distribution, and a discriminative model D that estimates the probability that a sample came from the training data rather than G .** The training procedure for G is to maximize the probability of D making a mistake. This framework corresponds to a minimax two-player game. In the space of arbitrary functions G and D , **a unique solution exists, with G recovering the training data distribution and D equal to 1/2 everywhere.** In the case where G and D are defined by multilayer perceptrons, the entire system can be trained with backpropagation. There is no need for any Markov chains or unrolled approximate inference networks during either training or generation of samples. Experiments demonstrate the potential of the framework through qualitative and quantitative evaluation of the generated samples.

<https://arxiv.org/abs/1406.2661>

These are ...

Progressive Growing of GANs for improved Quality, Stab...



<https://sites.google.com/view/cvpr2018tutorialongans/>

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?