Project 5: Due next Wed, April 26

http://www.mathcs.emory.edu/~eugene/cs325/p5/

- Questions?

- More:

  http://yann.lecun.com/exdb/mnist/

- Even more on image classification:

  www.image-net.org/

Extra Credit (Optional) Project: AIGym

- https://gym.openai.com/envs/Pong-v0
- https://gym.openai.com/docs
- Mission: “solve” Pong (on average, play with positive score): +10
  - Win consistently at least 5 games: +5
  - Win on average 3 games: +3
- Starting files: p5aigym.zip (in resources on Piazza)

Final: Monday, May 1, 8am

5/1/2017, Monday	**8:00AM - 10:30AM**	**MCS W301**

- Closed book, closed notes.

+ 1 Sheet of Notes
+ Calculator (optional)

Optional Review Session

- Tuesday, April 25, 11:30AM-12:45pm.

  Room: TBA

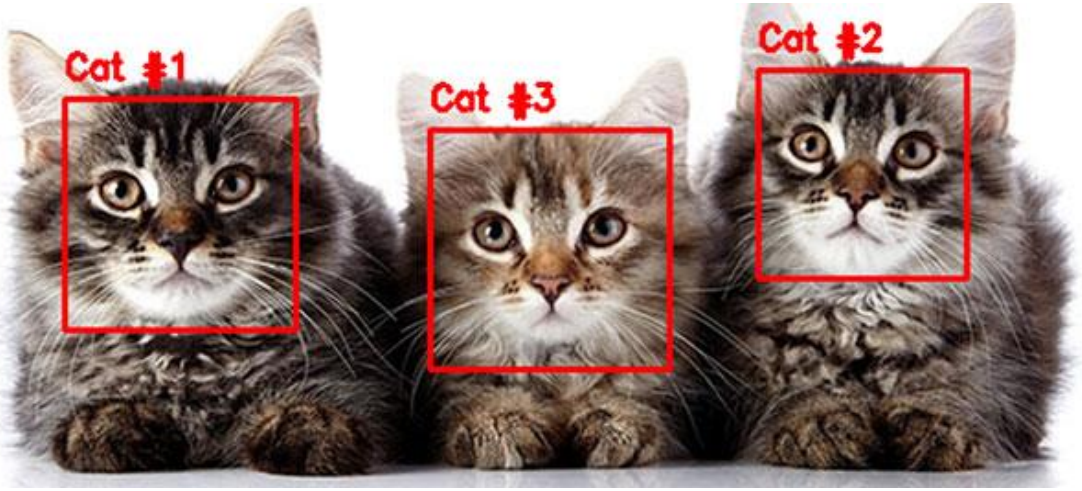
AI: What is possible? (2017)

AI 2017: Object Recognition

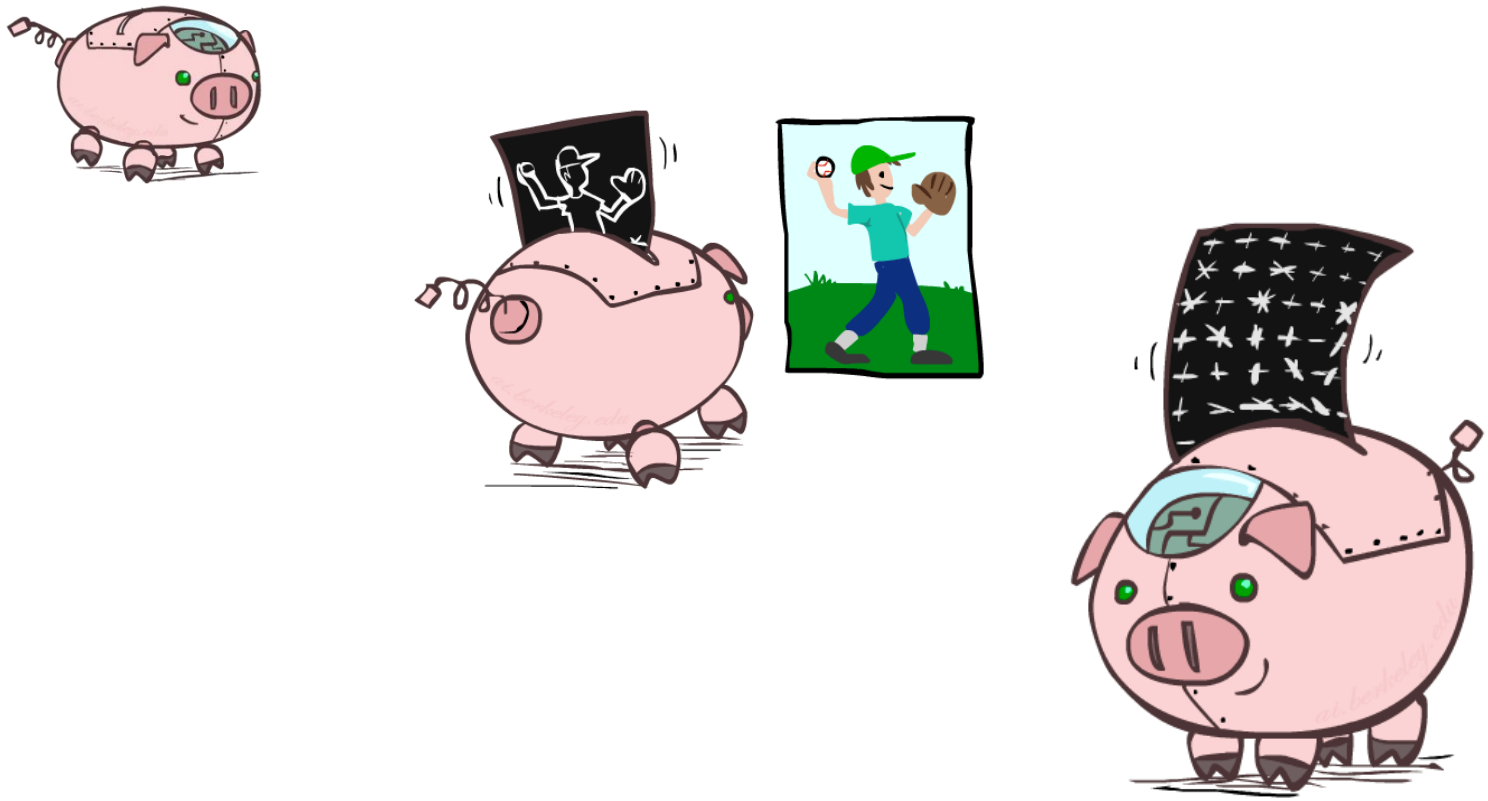
- https://cloud.google.com/vision/

- You can has it, too:

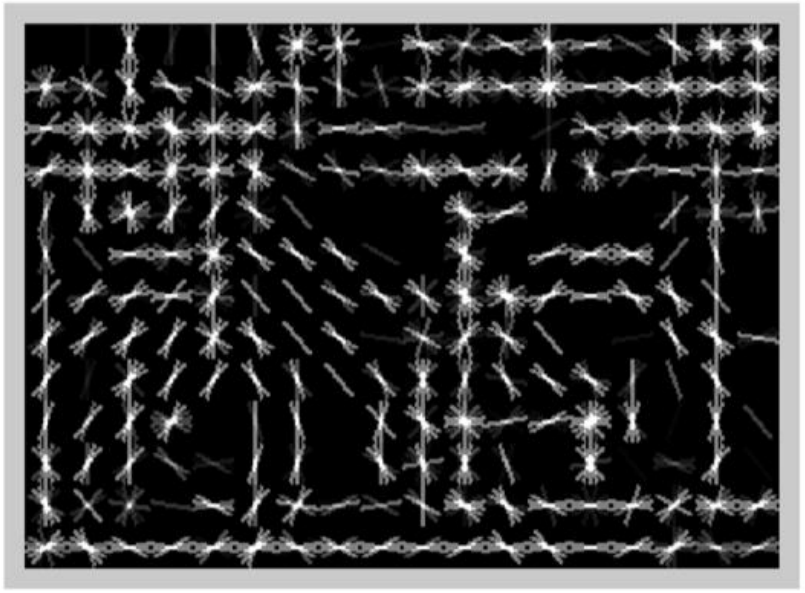
  http://www.pyimagesearch.com/2016/06/20/detecting-cats-in-images-with-opencv/



Object Detection Approach 1: HOG + SVM



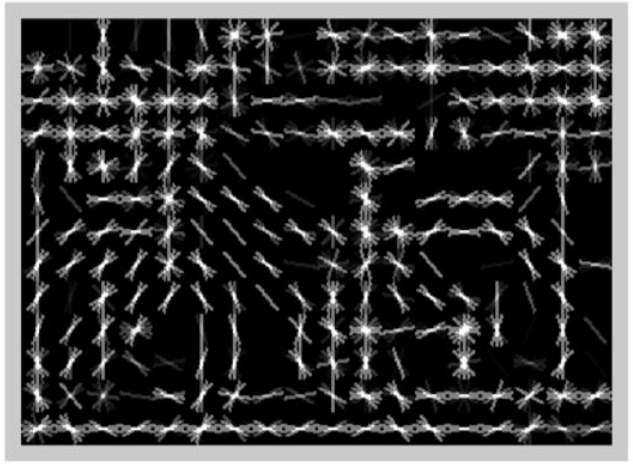
Features and Generalization



[Dalal and Triggs, 20

Features and Generalization

Image



HoG

Training

- Round 1
  - Training set =
    - Positive examples: from labeling
    - Negative examples: random patches

  → preliminary SVM
- Round 2 (“bootstrapping” or “mining hard negatives”)
  - Training set =
    - Positive examples: from labeling
    - Negative examples: patches that have score >= -1

State-of-the-art Results

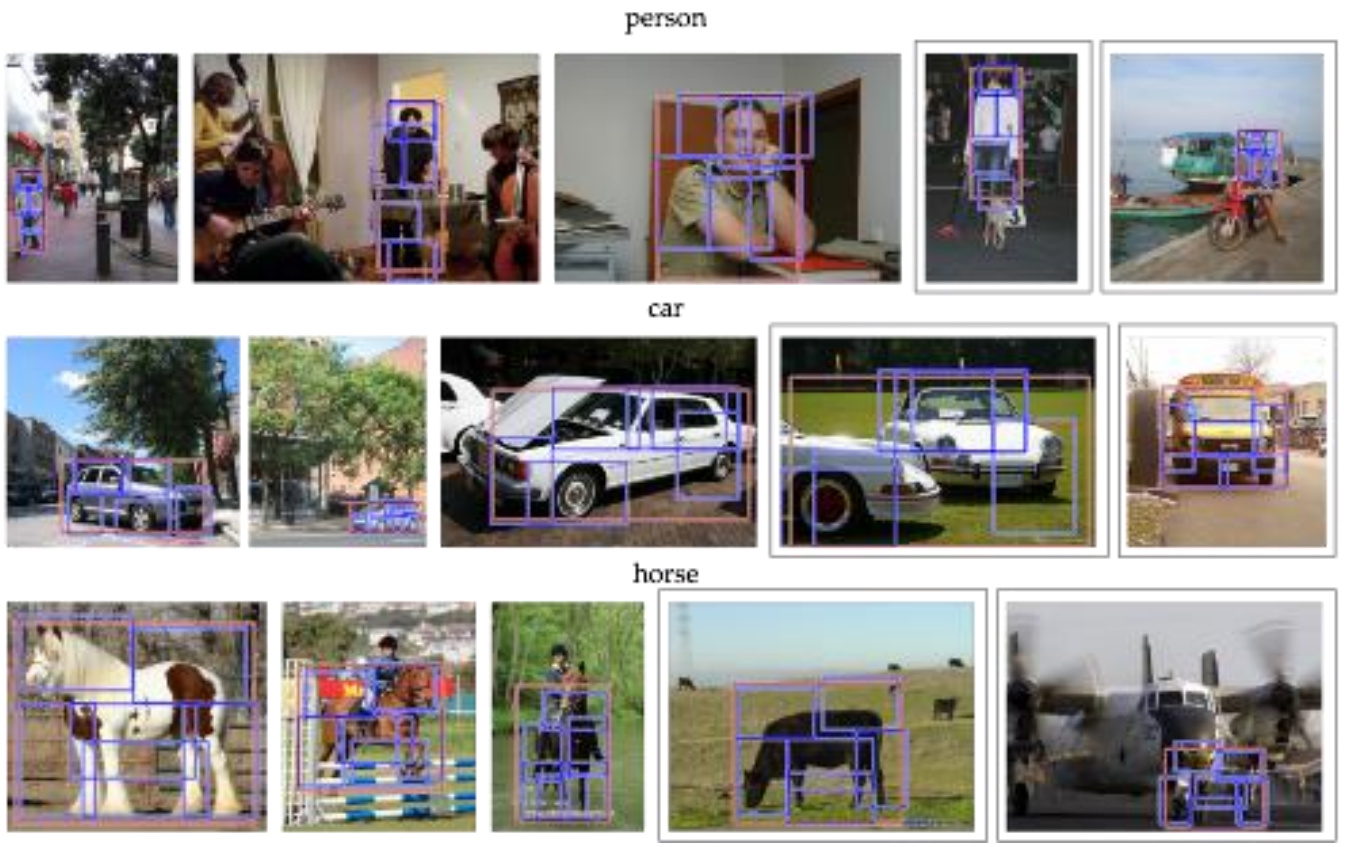
[Girschik, Felzenszwalb, McAll

State-of-the-art Results

person

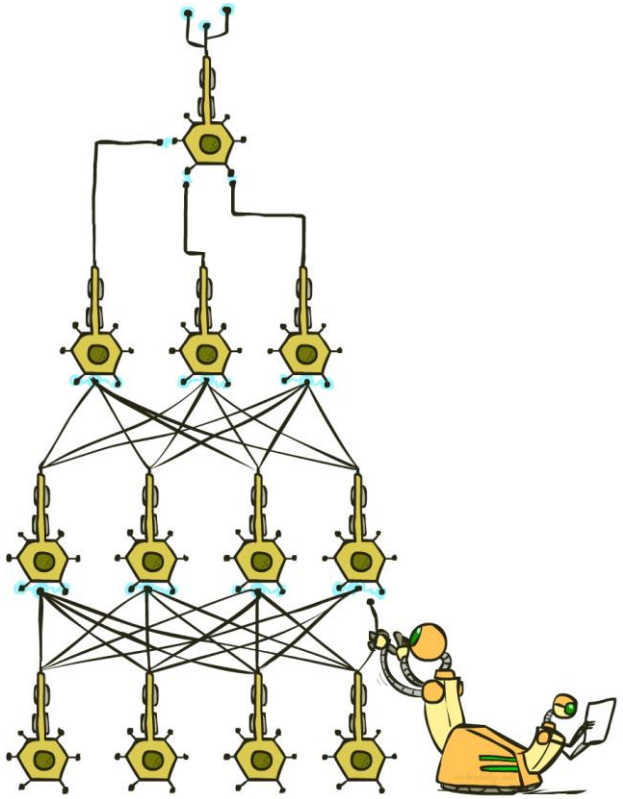
car

horse



[Girschik, Felzenszwalb, McAll

Object Detection Approach 2: Deep Learning



How Many Computers to Identify a Cat?

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How Many Computers to Identify a Cat? 16,000

An image of a cat that a neural network taught itself to recognize.

By JOHN MARKOFF
Published: June 25, 2012

MOUNTAIN VIEW, Calif. — Inside Google's secretive X laboratory, known for inventing self-driving cars and augmented reality glasses, a small group of researchers began working several years ago on a simulation of the human brain.

There Google scientists created one of the largest neural networks for machine learning by connecting 16,000 computer processors, which they turned loose on the Internet to learn on its own.

Presented with 10 million digital images found in YouTube videos, what did Google's brain do? What millions of humans do with YouTube: looked for cats.

Multimedia

Business Day Live | Google's Brain

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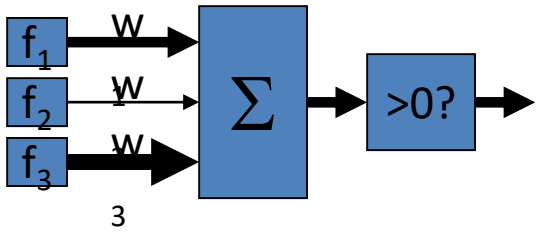
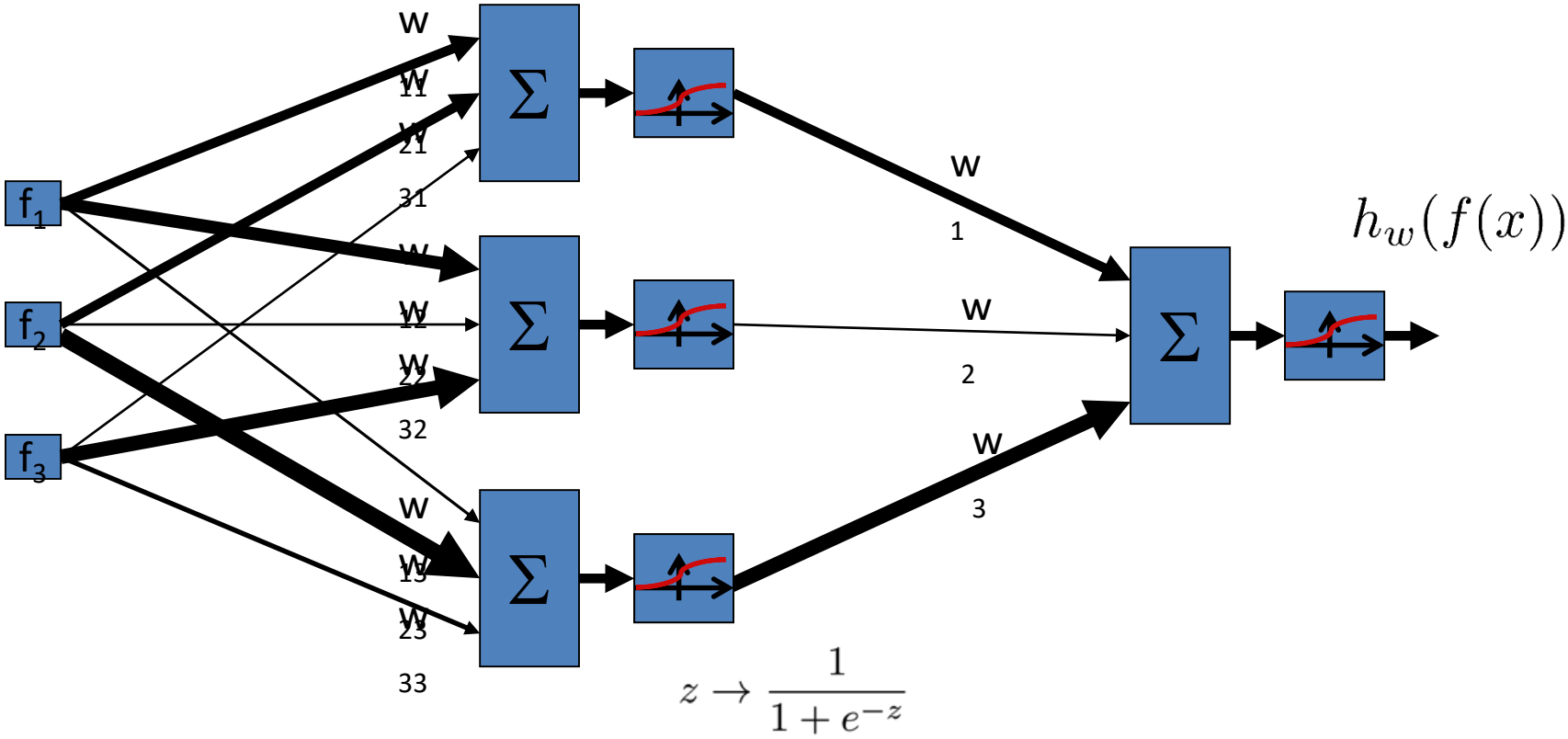
"Google Brain"
[Le, Ng, Dean, et al,

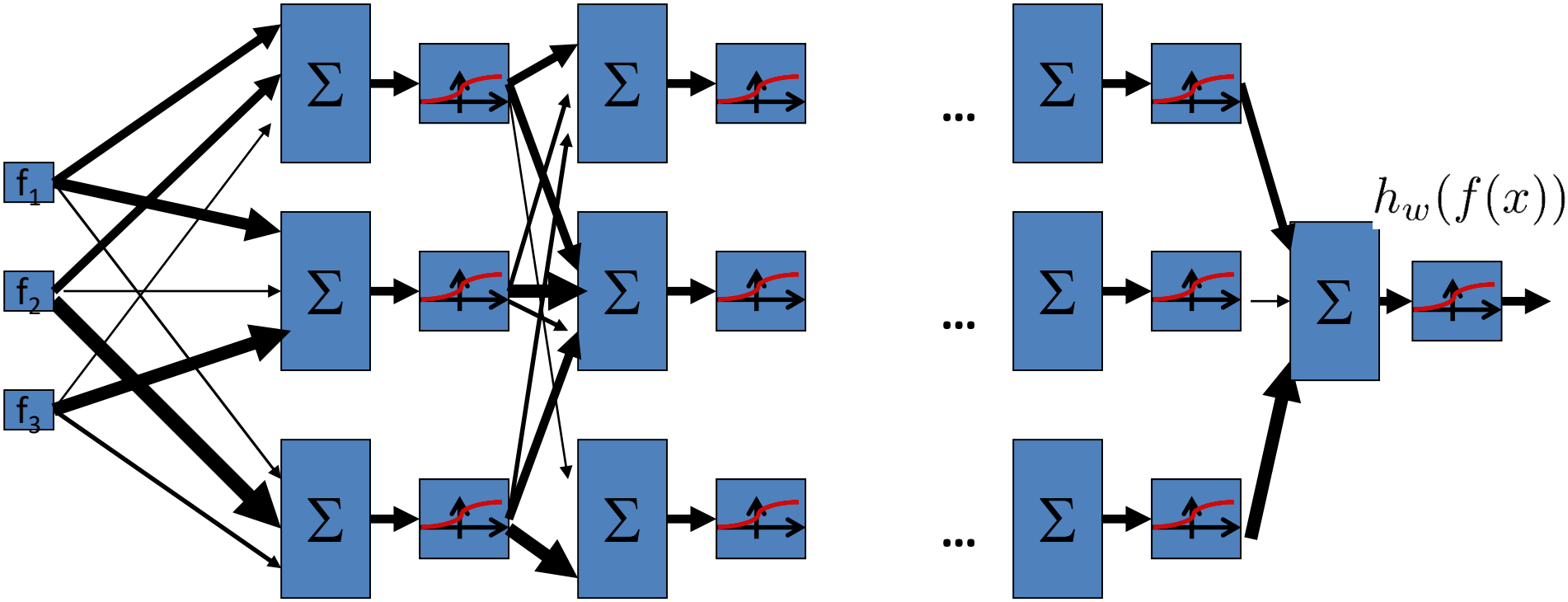
Perceptron



Two-Layer Neural Network



N-Layer Neural Network

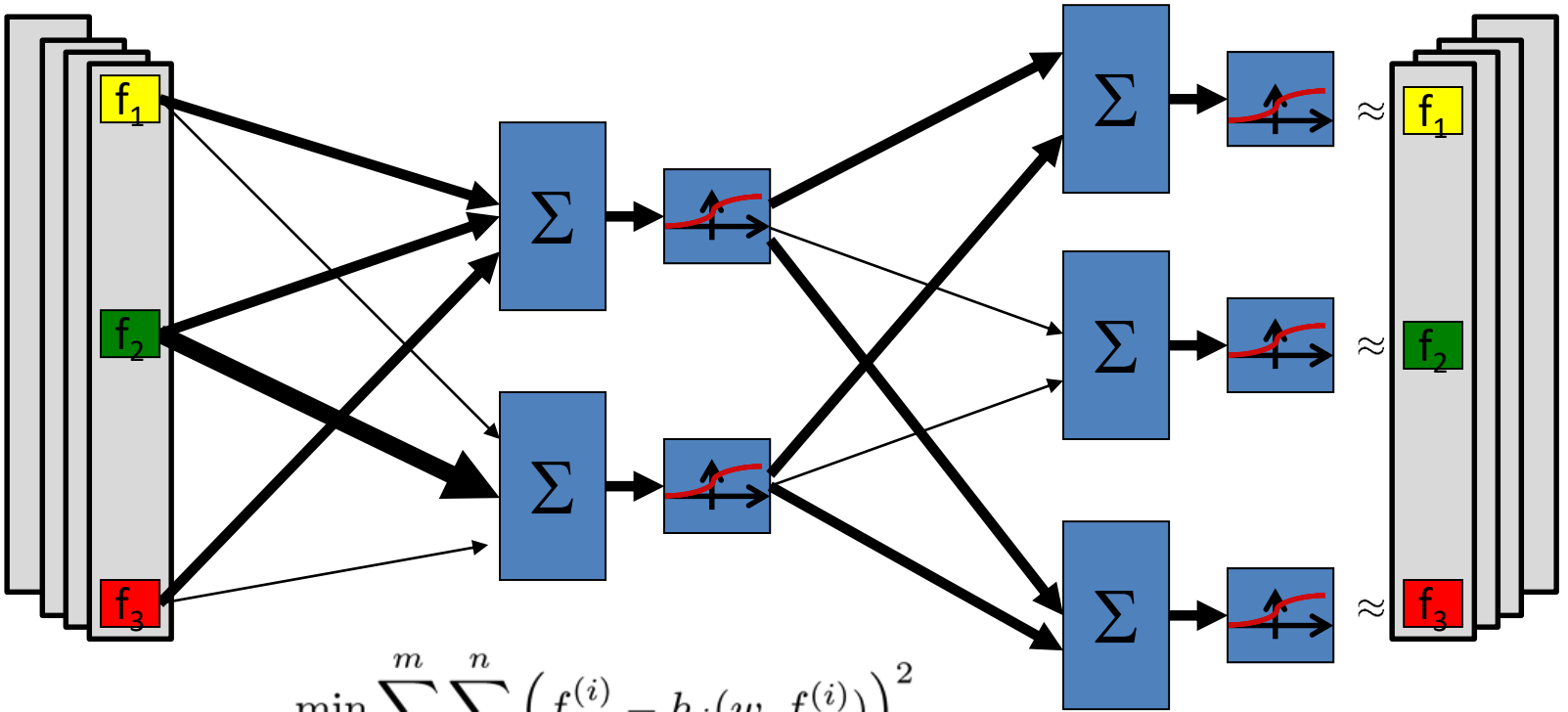


Hill Climbing

- Simple, general idea:
  - Start wherever
  - Repeat: move to the best ne
  - If no neighbors better than c
  - Neighbors = small perturbat
- Property
  - Many local optima

--> How to find a good local optimum?

Auto-Encoder (Crude Idea Sketch)

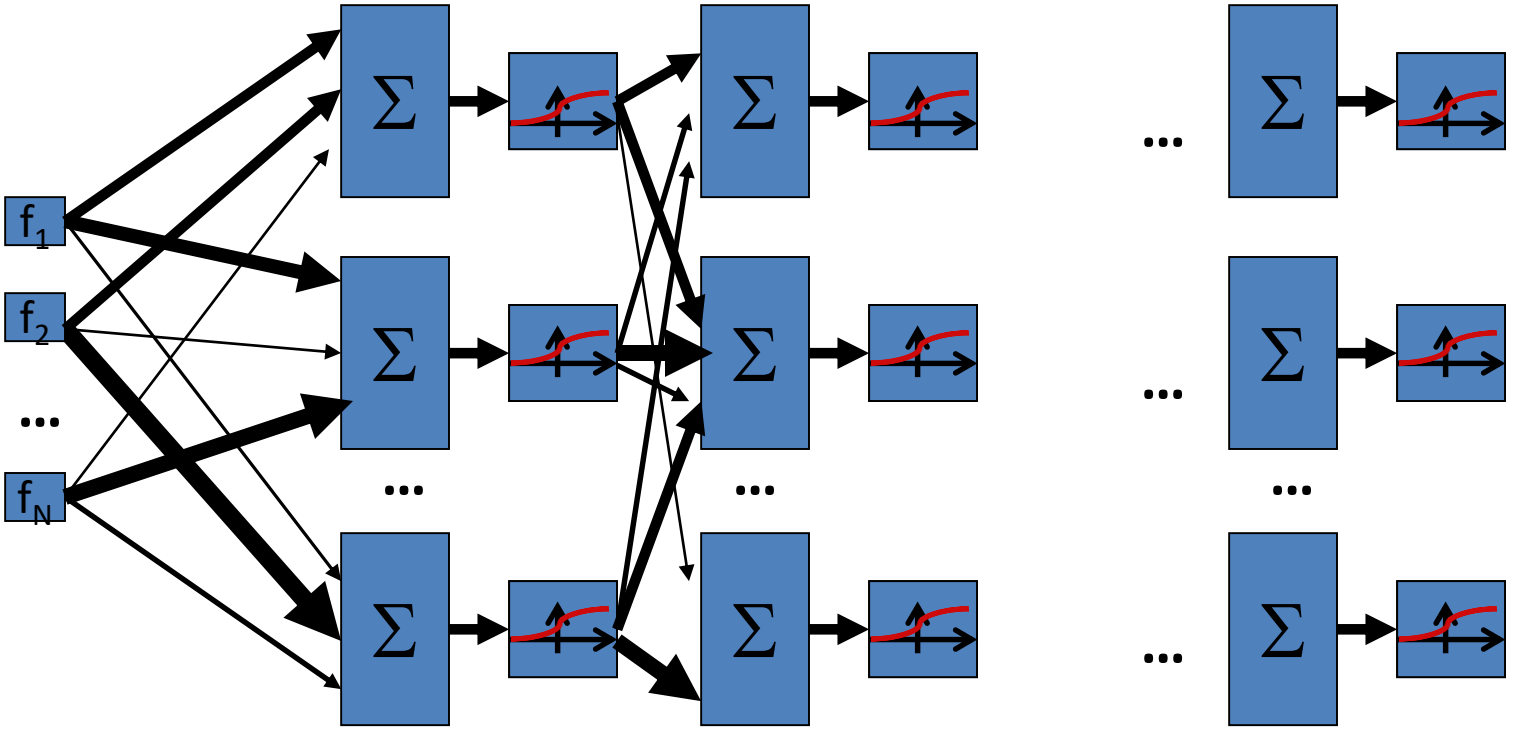


$$\min_{w} \sum_{i=1}^{m} \sum_{j=1}^{n} \left(f_j^{(i)} - h_j(w, f^{(i)}) \right)^2$$

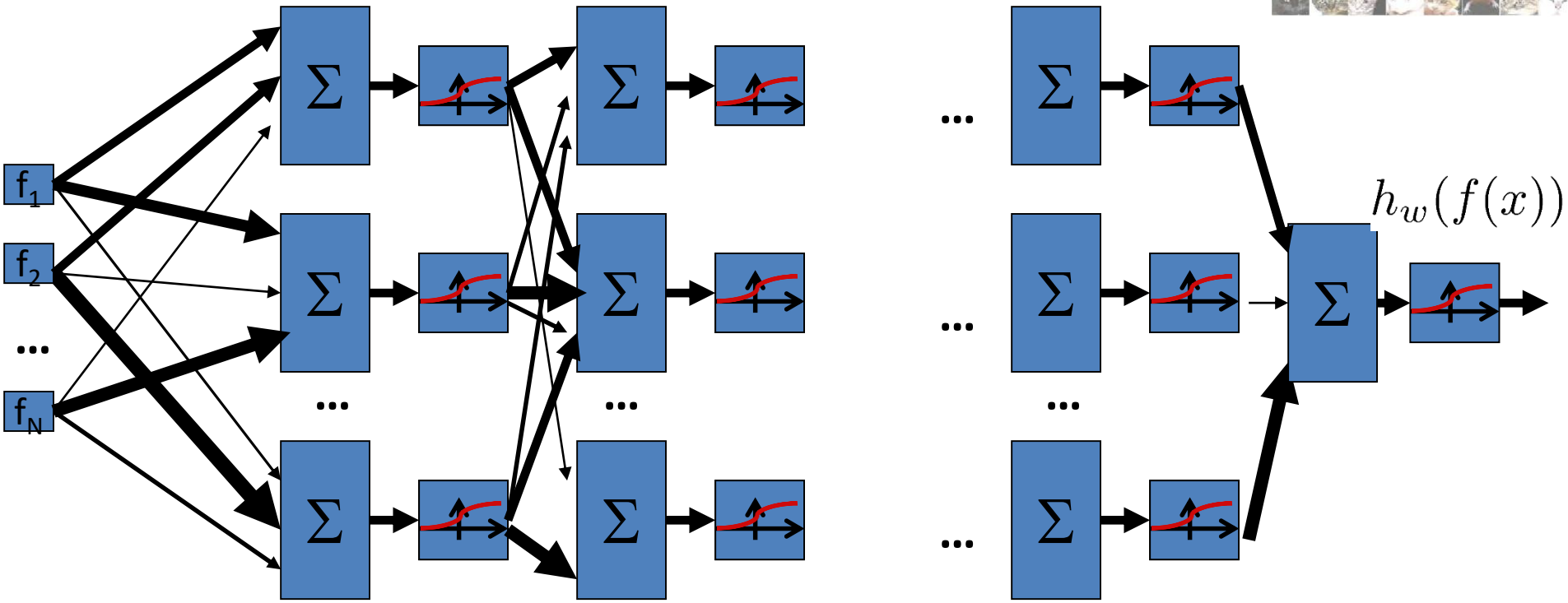
Training Procedure: Stacked Auto-Encoder

- Auto-encoder
  - Layer 1 = “compressed” version of input layer
- Stacked Auto-encoder
  - For every image, make a compressed image (= layer 1 response to image)
  - Learn Layer 2 by using compressed images as input, and as output to be predicted
  - Repeat similarly for Layer 3, 4, etc.
- Some details left out
  - Typically in between layers responses get agglomerated from several neurons (“pooling” / “complex cells”)

Final Result: Trained Neural Network



Final Result: Trained Neural Network



AI 2017: “data” Understanding

- Watson Health, Law:
  https://www.youtube.com/watch?v=yV_6sd32oW0

- JPMorgan: loan agreements:
  https://www.bloomberg.com/news/articles/2017-02-28/jpmorgan-marshals-an-army-of-developers-to-automate-high-finance

- Music?
  https://www.youtube.com/watch?v=LSHZ_b05W7o

AI 2017: Robotics 1

- Uber self-driving car:

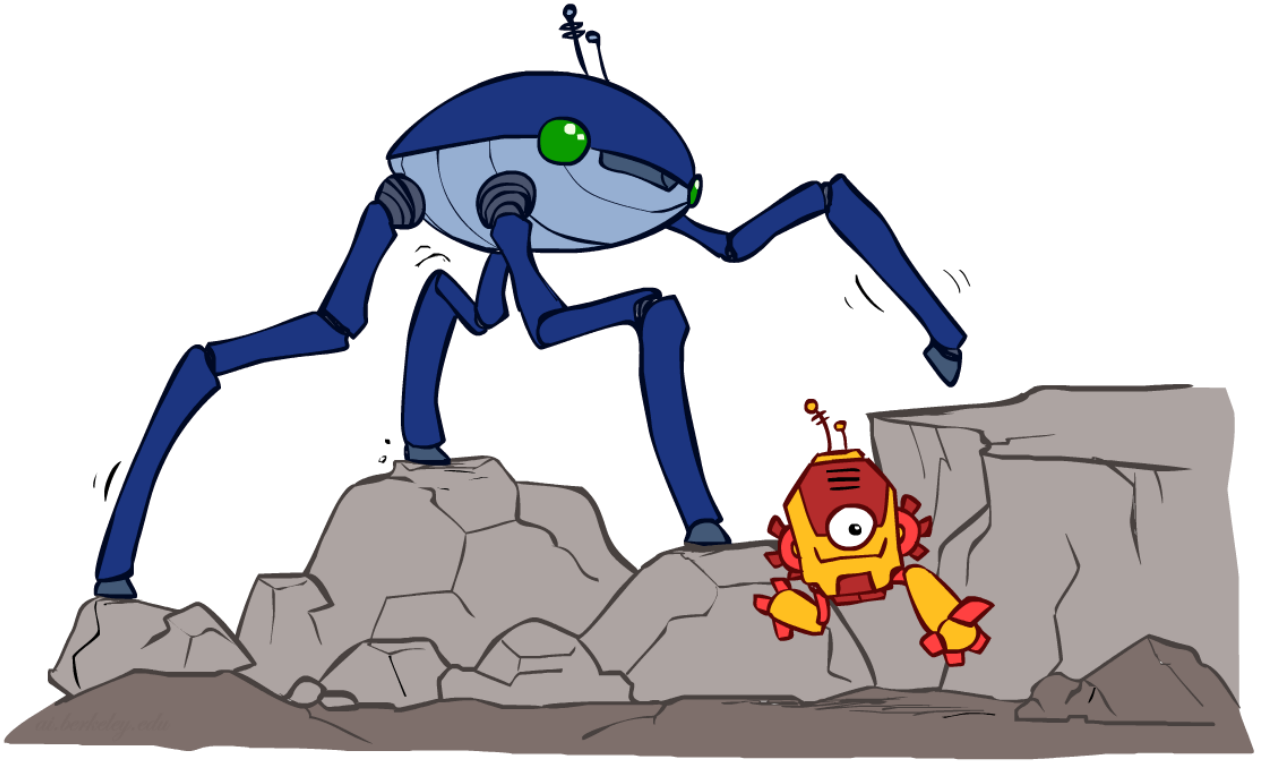
  https://www.youtube.com/watch?v=OKJK3_XIGD4

  https://www.youtube.com/results?q=self+driving+car+crash&sp=EgIIBA%253D%253D

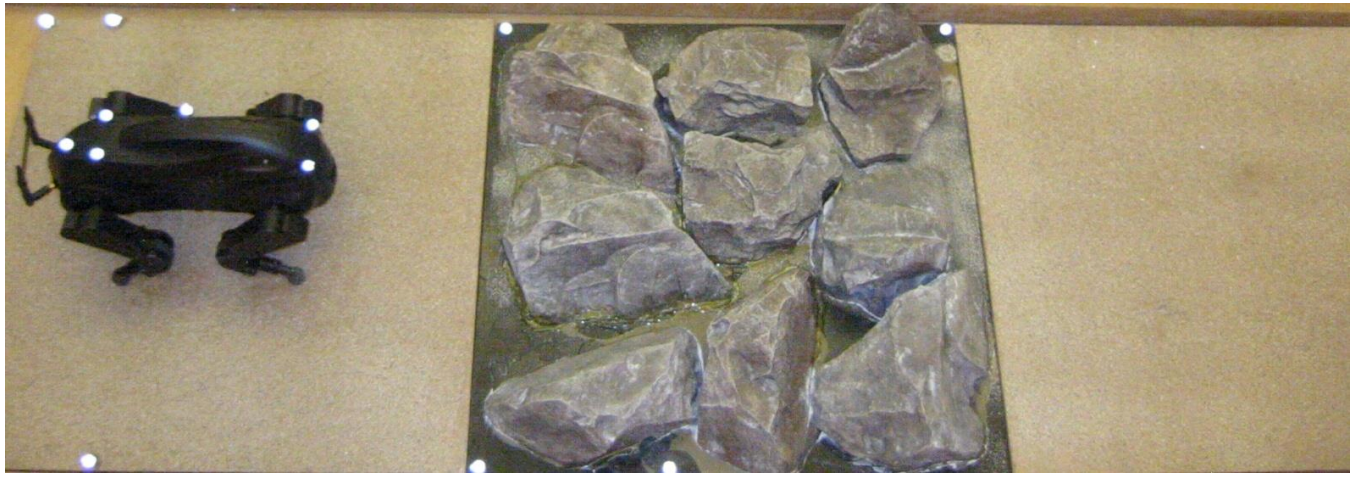
- Hotel receptionist:

  https://www.youtube.com/watch?v=GuXRyUiew88

Legged Locomotion



Quadruped

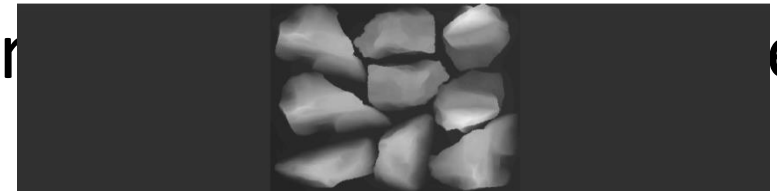


- Low-level control problem: moving a foot into a new location → search with successor function ~ moving the motors
- High-level control problem: where should we place the feet?
  - Reward function R(x) = w . f(s) [25 features]

[Kolter, Abbeel & Ng, 2008]

Experimental setup

- Demonstrate path across the “training terrain”

- Run appr  e reward function
- Receive “testing terrain”---height map.

[Kolter, Abbeel & Ng, 2008]

Apprenticeship Learning

- Goal: learn reward function from expert demonstration

- Assume $R(s) = w \cdot f(s)$
- Get expert demonstrations $\mathbf{s} = (s_0, s_1, \ldots s_n)$
- Guess initial policy π_0
- Repeat:
  - Find w which make the expert better tha $\{\pi_0, \pi_1, \ldots, \pi_{i-1}\}$

    $$w_i \leftarrow \text{distinguish}\left(\pi^*, \{\pi_0, \pi_1, \ldots, \pi_{i-1}\}\right)$$

  - Solve MDP for new weights w:

    $$\pi_i \leftarrow \text{solve}\left(MDP(w_i)\right)$$

[VIDEO: quad initial.wmv]

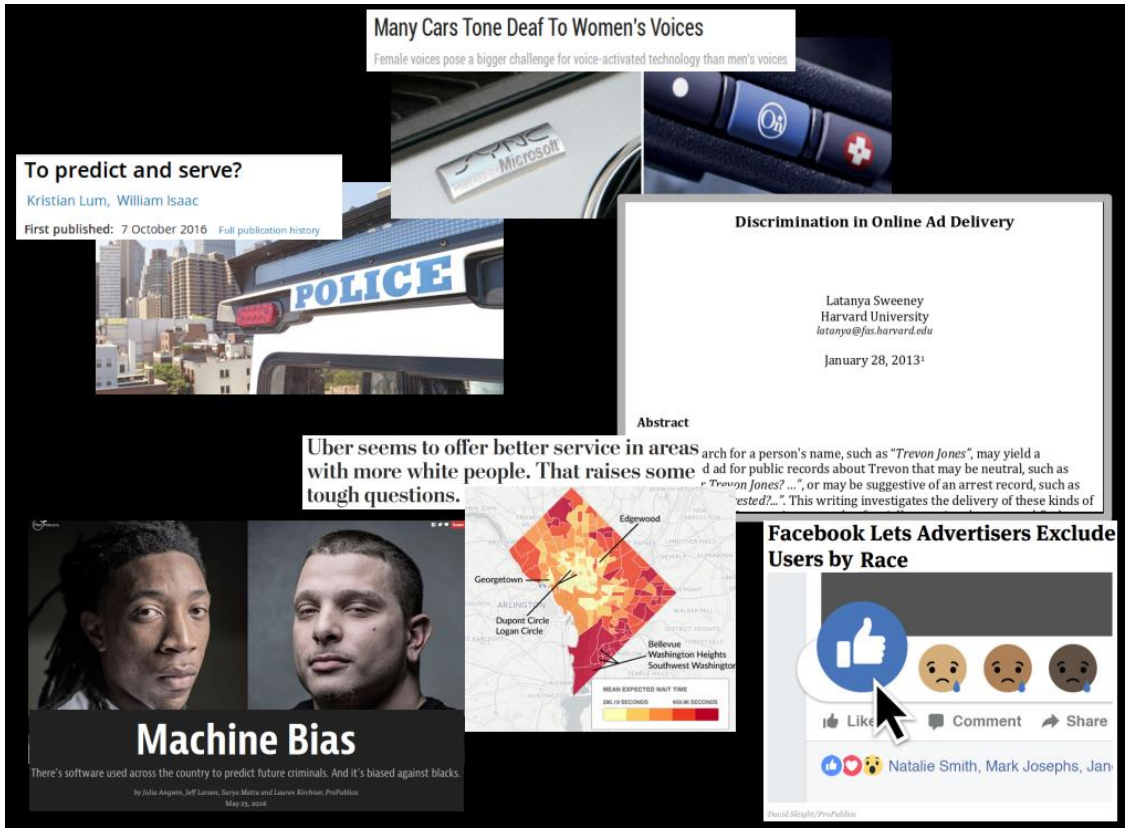
[VIDEO: quad initial.wmv]

AI 2017: Humanoid Robots

- Boston Dynamics: https://www.youtube.com/watch?v=rVlhMGQgDkY
- Fedor 1: https://www.youtube.com/watch?v=oke01g1-H0s
- Fedor 2: https://www.youtube.com/watch?v=gZauGhfv-1w

What can go wrong

- https://nlpers.blogspot.com/2016/11/bias-in-ml-and-teaching-ai.html

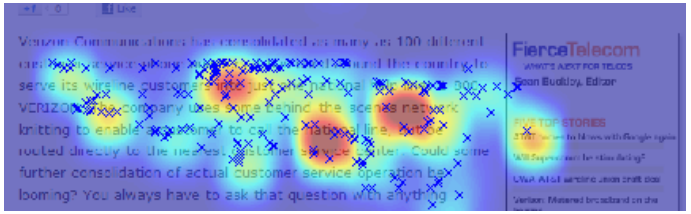


What to Study Next

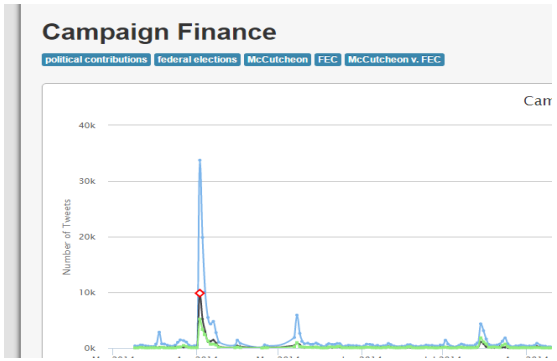
- Applications:
  - Robotics: ?
  - Natural Language Processing: CS571
  - Information Retrieval and Web Search: CS572
- Techniques:
  - Machine Learning (CS534): Every semester
  - “Deep” Learning: Spring 2018? (requires ML + AI)

Summer 2017 -

- Openings in IR Lab for internships in:
  - Automated (Web) Question Answering
- Web search ranking, presentation:
  - Measure attention on pages, images with behavior and visual saliency



- (Web-scale) social media analysis:



- More info:
  - http://ir.mathcs.emory.edu/
  - Email: eugene@mathcs.emory.edu

Fall 2017: AI++

- Will teach AI again in Spring 2017
- Planned changes:
  - Add more intro exercises + labs on Python programming
  - Add final (team) project (AIGym? MindCraft?)
  - **Other suggestions?**

The End.

- **Good luck on your finals preparation**

- **Please help with evaluations. The written comments will help me design a better course for Fall 2017!**