Teaching machines to learn

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Courtesy: https://www.coursera.org/learn/machine-learning

Why?

- Amazon, Baidu, Google and others spent US$20-40B on AI in 2016
  - R&D + acquisitions
- What for:
  - Tech
  - Financial Services
  - Health care
  - Power grid
  - Logistics
  - Manufacturing
  - Retail
  - Education

http://www.mckinsey.com/business-functions/mckinsey-analytics/our-insights/how-artificial-intelligence-can-deliver-real-value-to-companies

Successes

- Computer Vision - Image/Pattern Recognition
  - Facial recognition
  - Autonomous robots/driving vehicles
  - Early disease detection
- Content/Retail/Ad strategy (recommendation engines)
  - Netflix/Facebook/Amazon etc.
- Malware/Fraud/Spam detection
- Speech Recognition
- Natural Language Processing
- Natural Sciences

Visible successes

- Chat (chatbots pass basic turing test)
- Beat recreational games (chess/go/poker)
- Paint (style-transfer)

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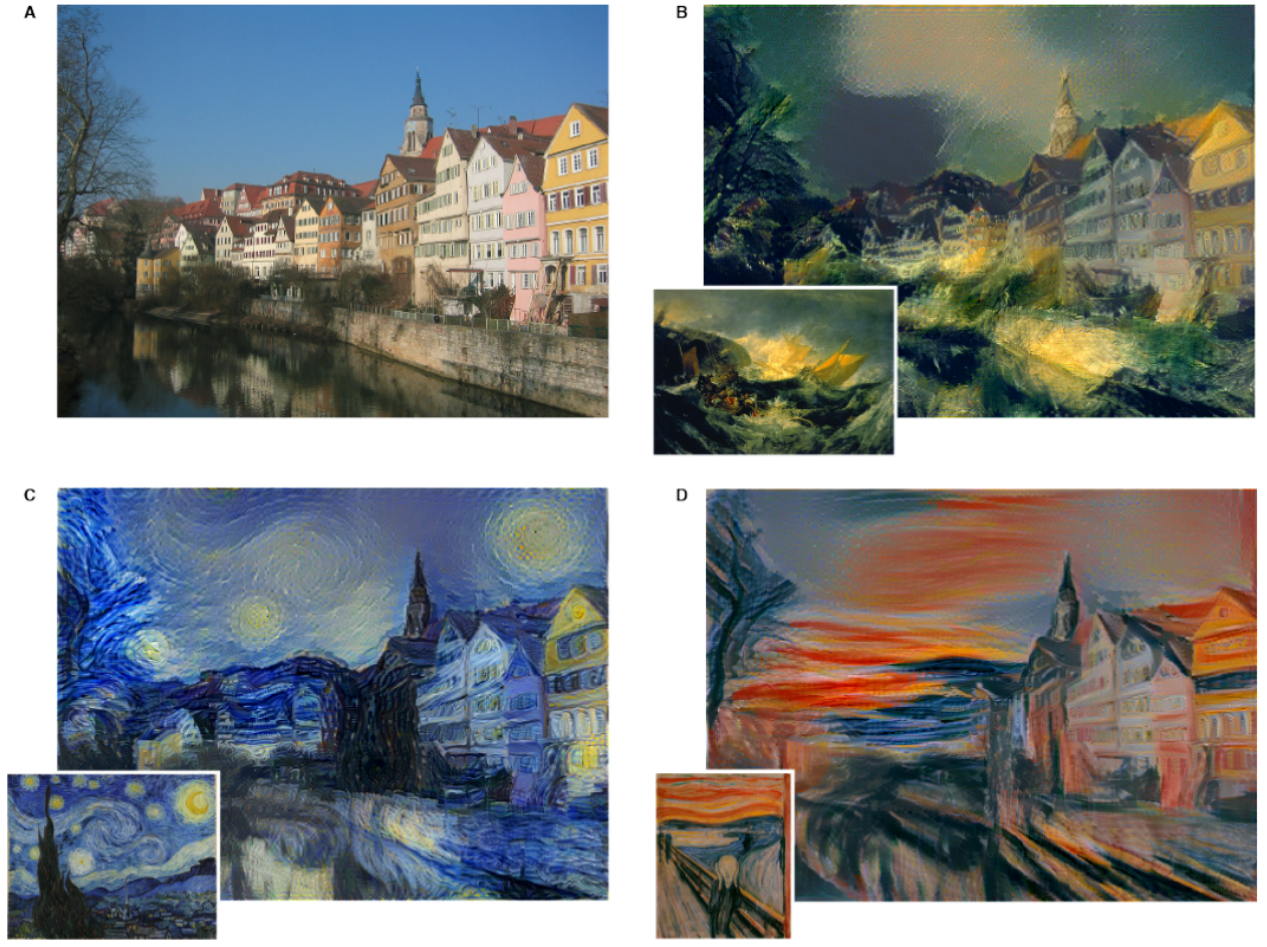

https://research.googleblog.com/2016/10/supercharging-style-transfer.html

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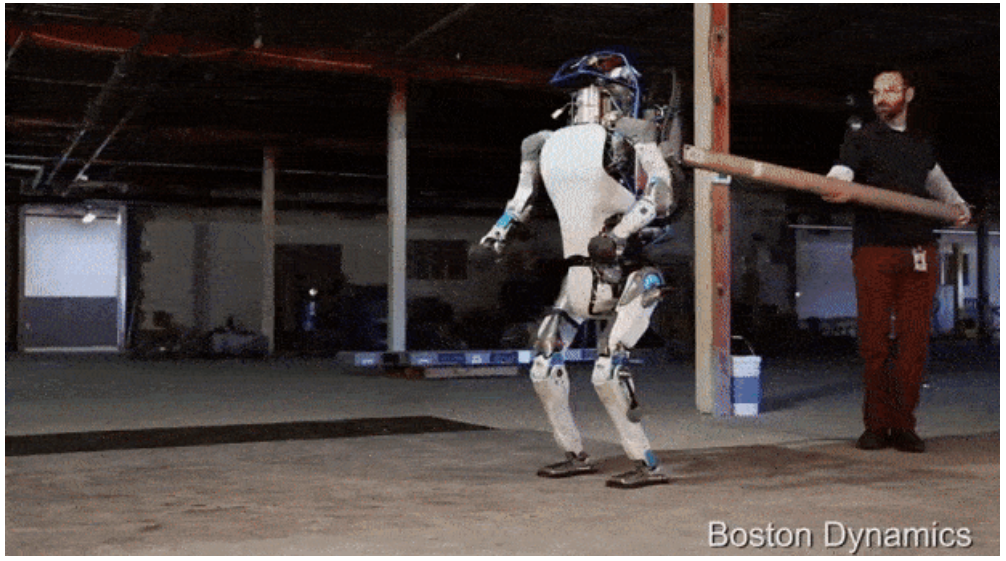

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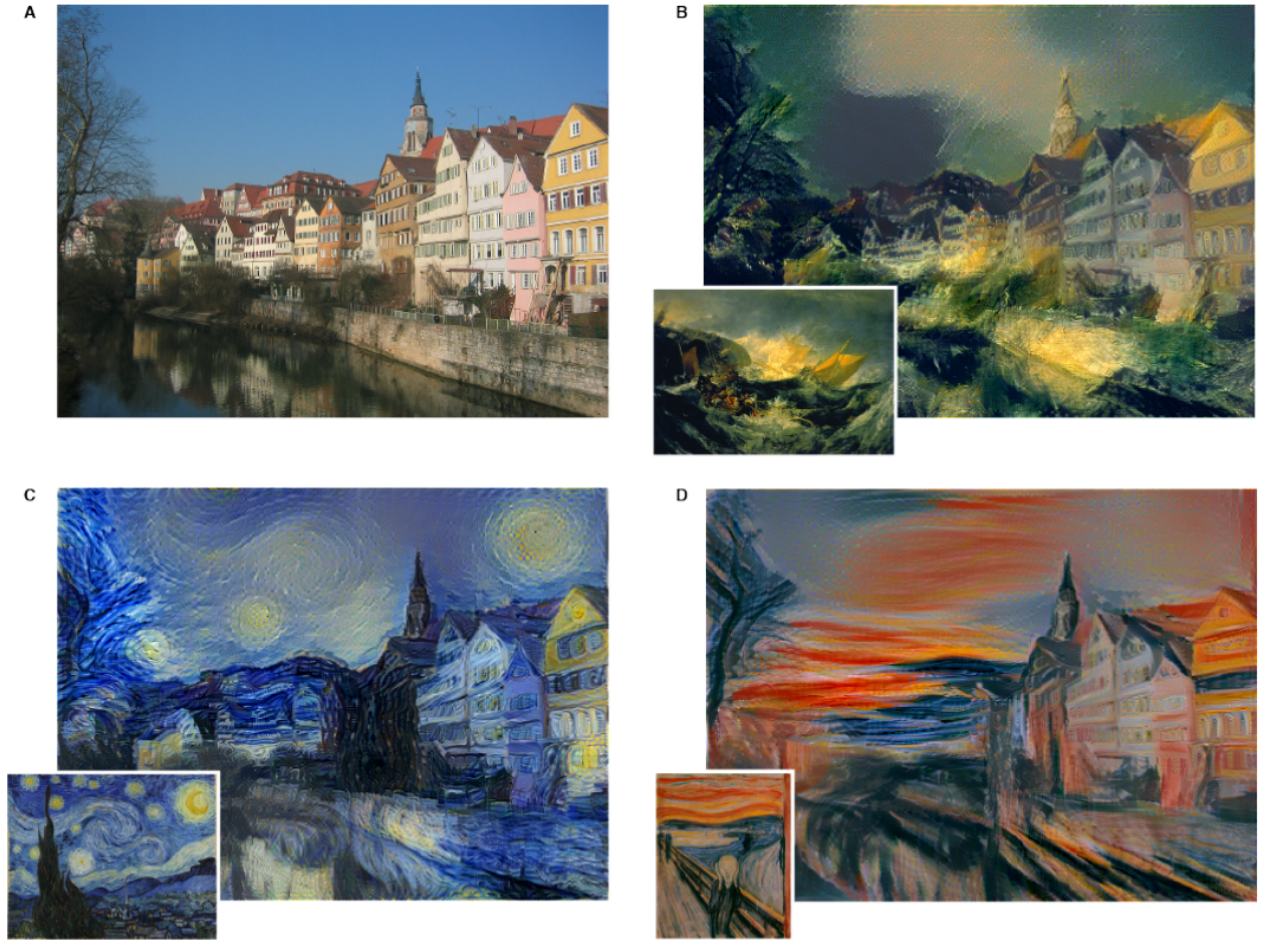
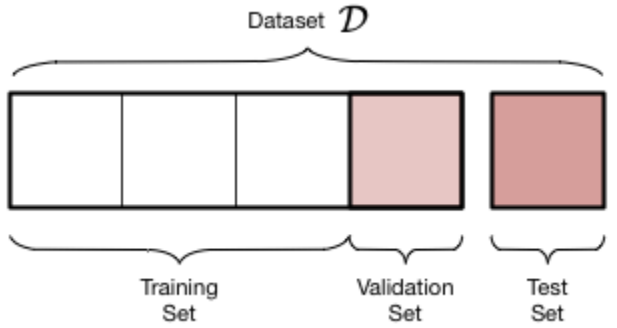


Machine Learning (basics)

- Supervised Learning
  - have a lot of data with labels
  - learn on all the data to predict these labels for new data
  - eg. image classification of a dog
- Unsupervised Learning
  - have a lot of data with no labels
  - learn something useful about the data
  - eg. market segmentation of user clicks on website
- Reinforcement Learning
  - make rational decisions based on a utility function
  - eg. any process with many steps, where you know the target
- To consider: false positives & true negatives

Machine Learning (how-to)

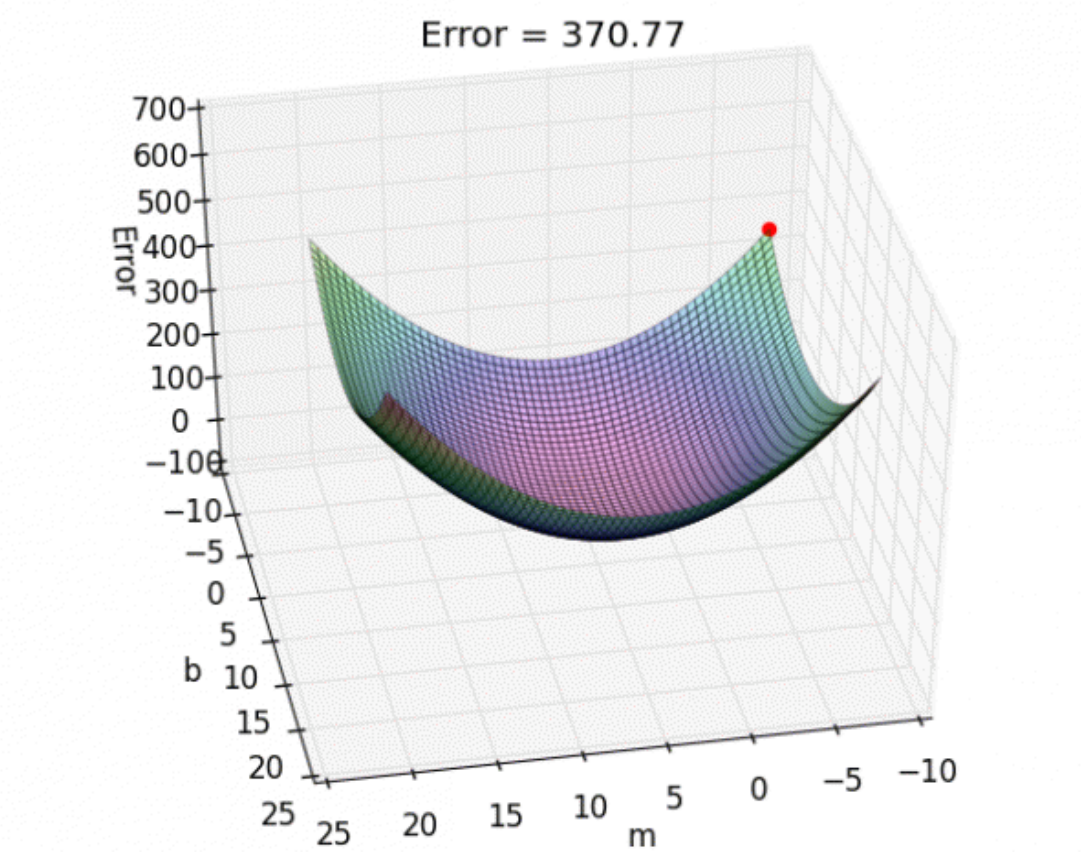
- Get a lot of data: eg. GPL power outage
  - Depends on lots of features: day, time, duration, weather, location etc.
- Ask a question: eg. how long is each outage?
  - classification or regression?
- Split data into:
  - training set (experience)
  - validation set (explore)
  - test set (exam)
- Train-experience
- Tweak hyperparameters on validation set-explore
- Test performance



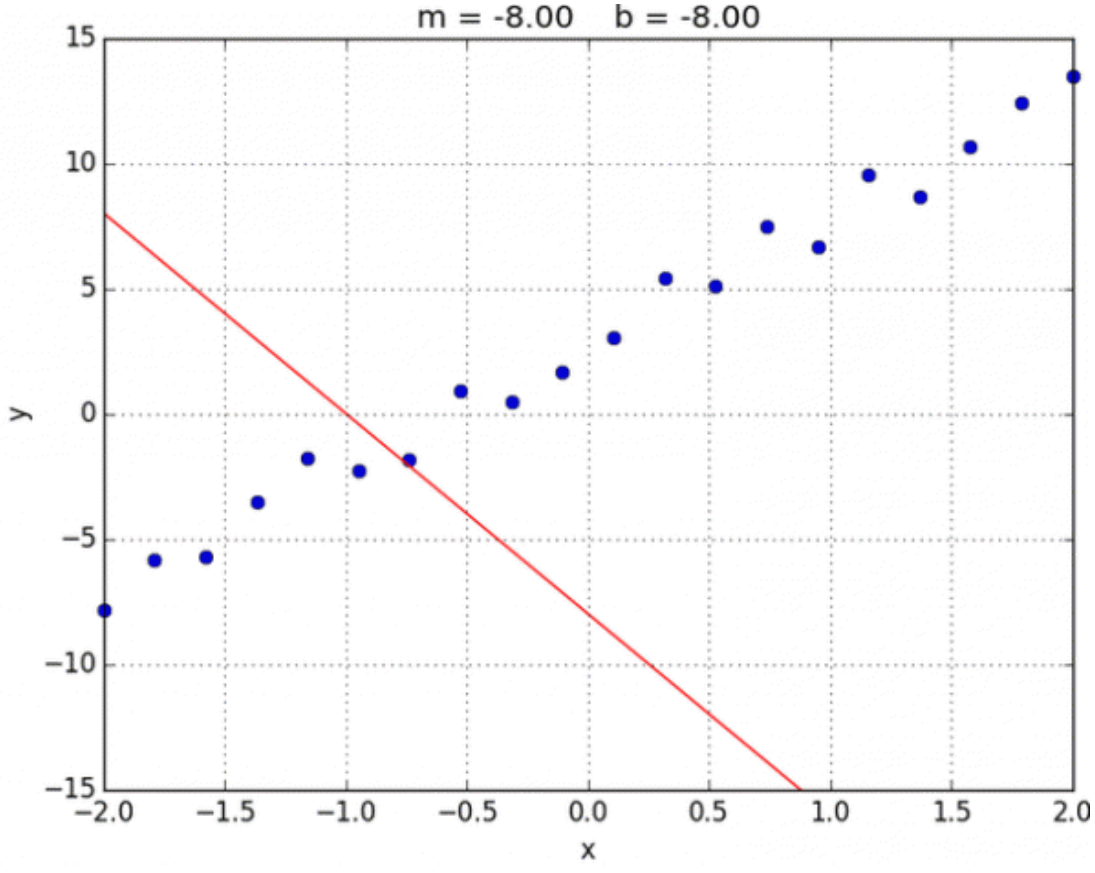
https://am207.github.io/2017/wiki/validation.html

rolling down that hill

- Gradient descent:
  - update model: roll down hill (hyper-hill)

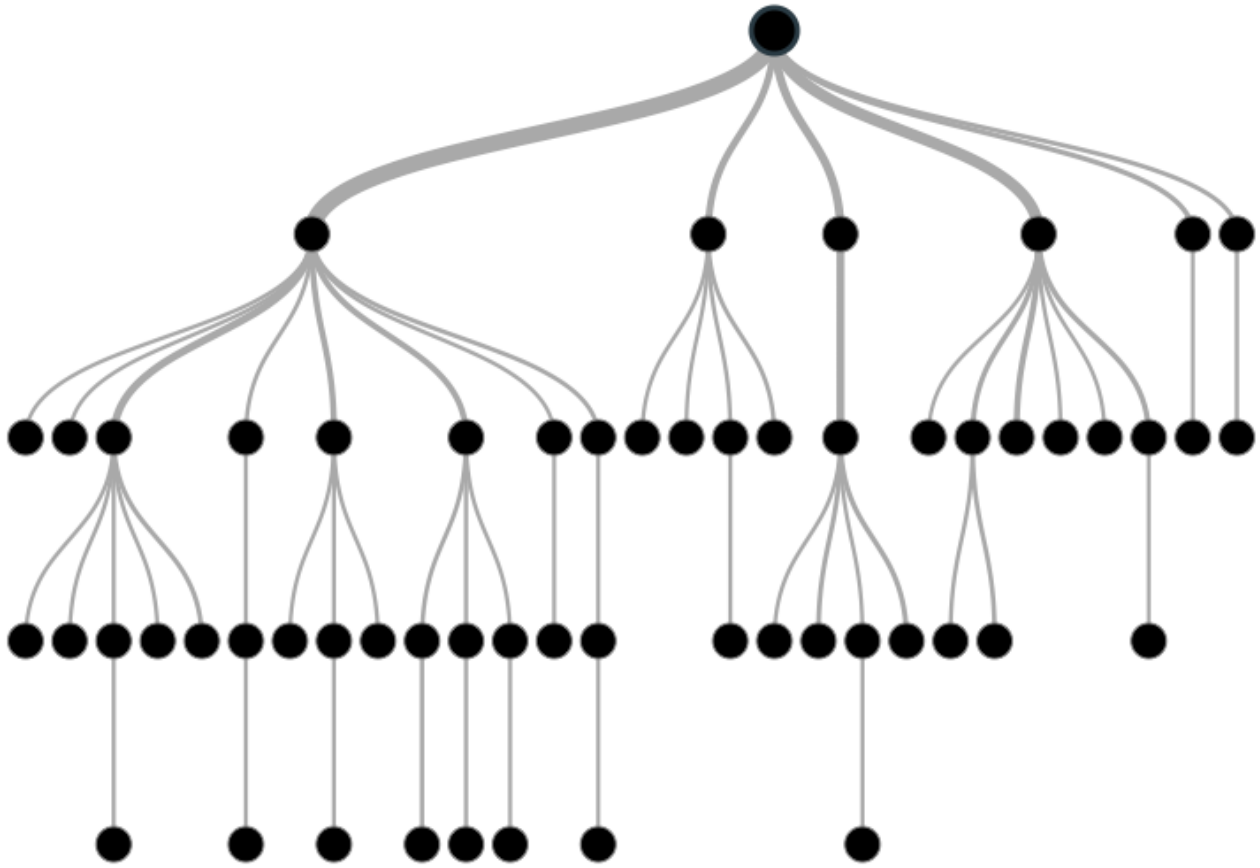


https://alykhantejani.github.io/a-brief-introduction-to-gradient-descent/



Machine Learning (methods)

- Decision Trees
  - Split on features
- To consider (hyperparameters):
  - How to split?
  - How many nodes? How deep?
- Don’t Overfit
- Use a random forest: lots of trees



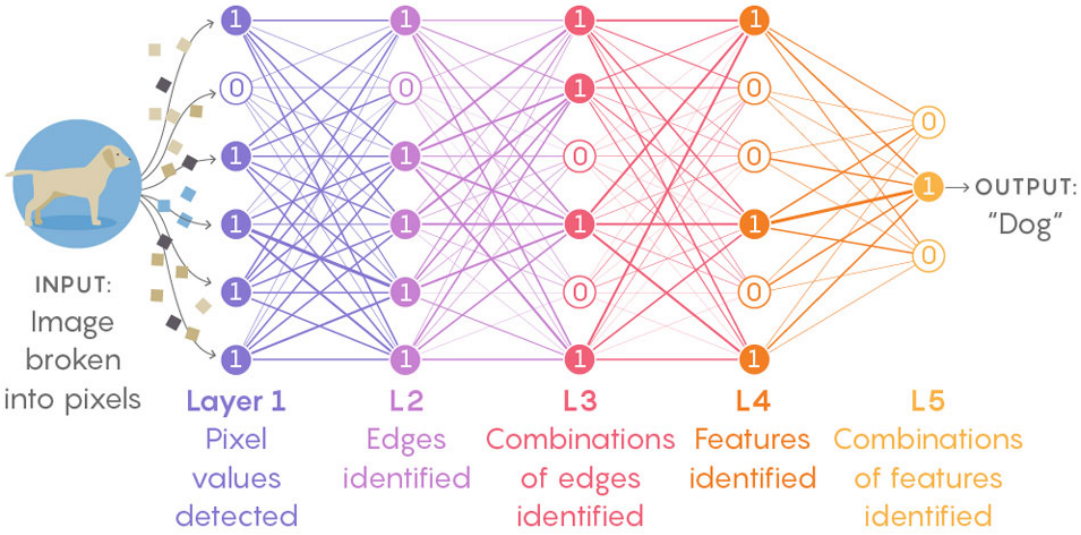
https://www.analyticsvidhya.com/blog/2016/04/complete-tutorial-tree-based-modeling-scratch-in-python/

Machine Learning (methods)

- Logistic Regression:
  - like linear regression but for classification tasks
  - output probability of belonging to class
- Support Vector Machines
  - divides classes based on vectors (lines or hyper-lines)
- Neural Networks (famous)
  - inspired by biology: composed of neurons
  - update weights of neurons at each iteration
  - glorified regression

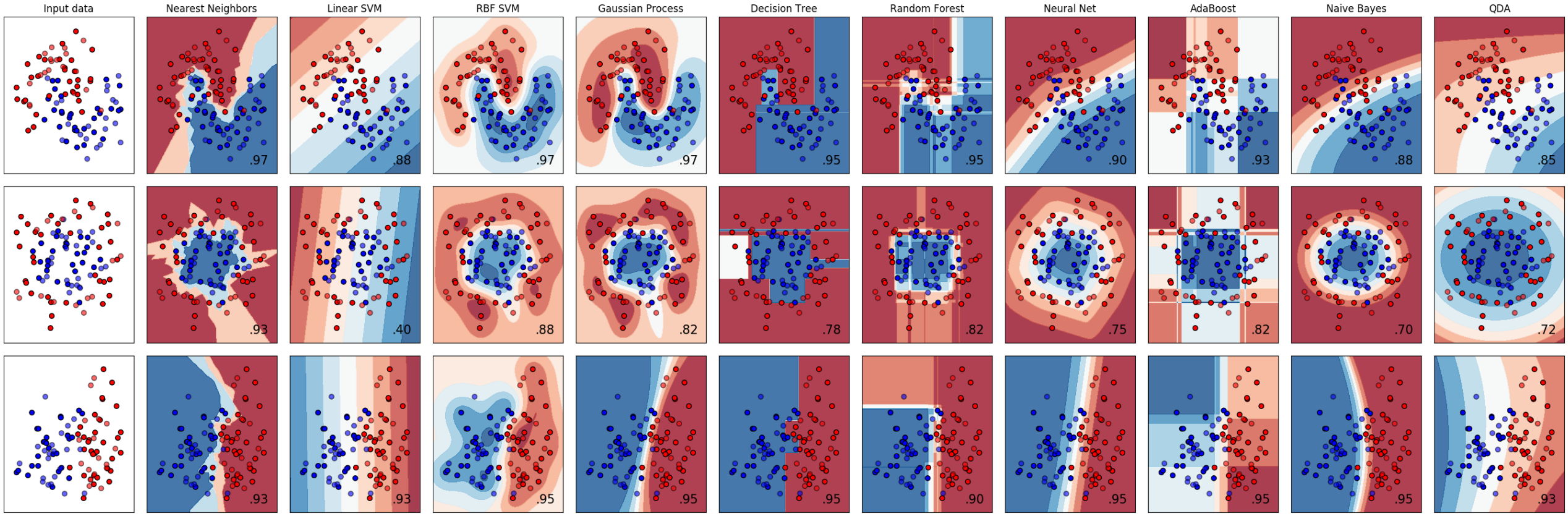
Learning From Experience

Deep neural networks learn by adjusting the strengths of their connections to better convey input signals through multiple layers to neurons associated with the right general concepts.



When data is fed into a network, each artificial neuron that fires (labeled "1") transmits signals to certain neurons in the next layer, which are likely to fire if multiple signals are received. The process filters out noise and retains only the most relevant features.

Machine Learning (methods)



http://scikit-learn.org/stable/auto_examples/classification/plot_classifier_comparison.html

How?

- eg. deep neural networks:
  - Lots of hidden layers
  - First few layers understand larger scale features
  - Middle layers understand small scale features
  - Last few layers generalize to the data
- Learn then forget
- You don't think about the things you are best at

https://www.quantamagazine.org/new-theory-cracks-open-the-black-box-of-deep-learning-20170921/

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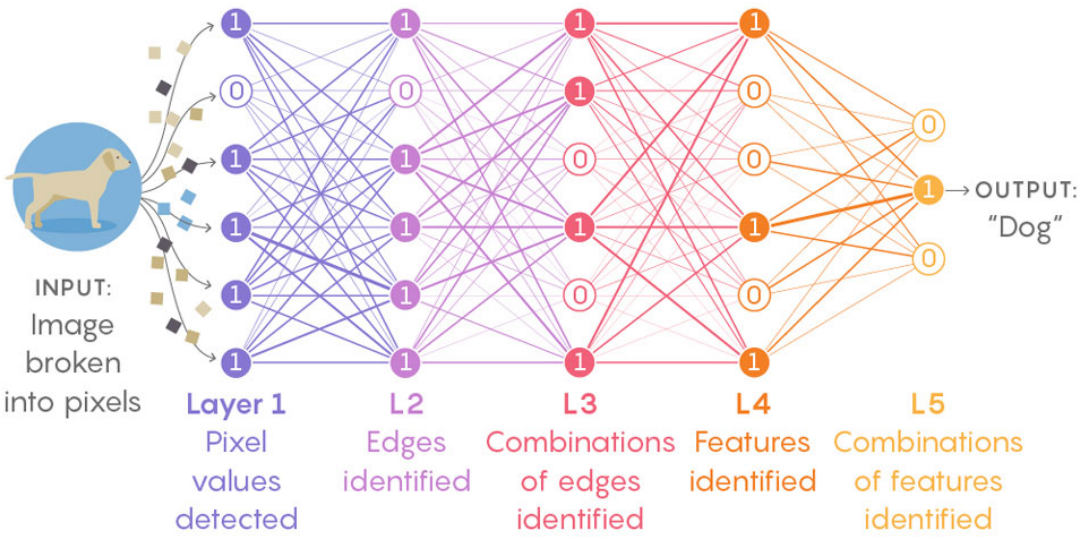

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AI is RL

- Allowing intelligent **agents** to learn
- What is an agent:
  - Takes input
  - References from what it has learned
  - Makes decision (and implements if possible)
- Goal: Make agents that always do the **right** thing (rational)
- To consider:
  - How much to remember?
  - What is the environment like?
  - What does the agent **want**? (Utility function)

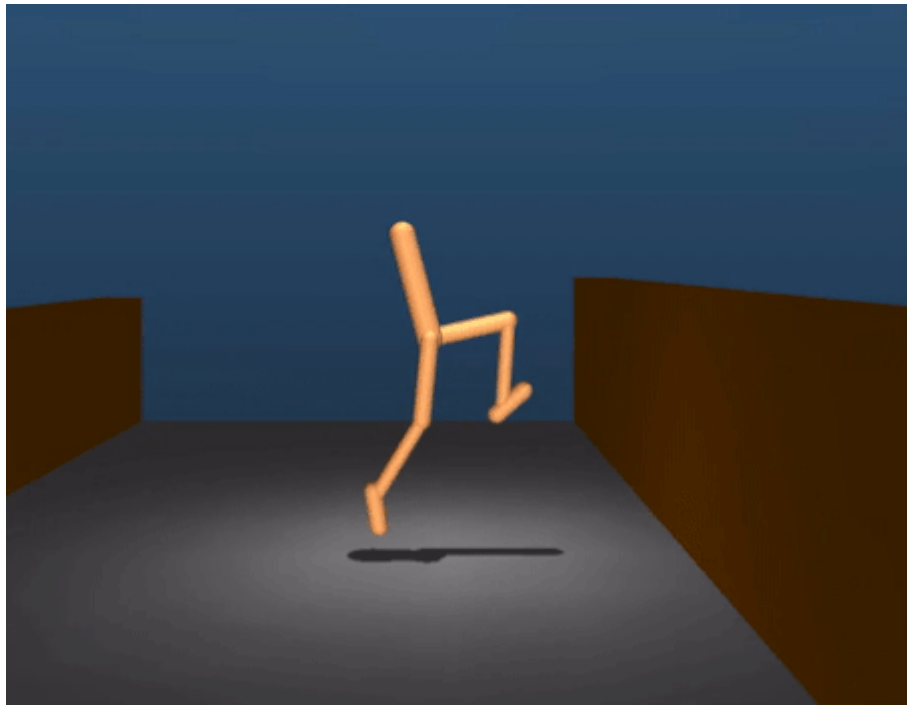
Environments

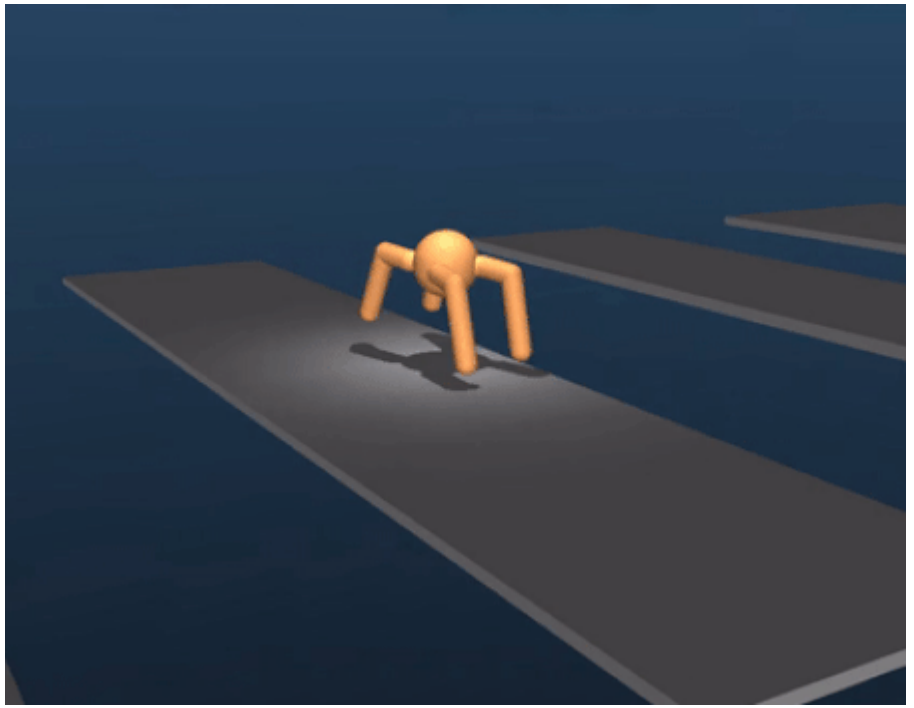
Task Environment	Observable	Agents	Deterministic	Episodic	Static	Discrete
Crossword puzzle	Fully	Single	Deterministic	Sequential	Static	Discrete
Chess with a clock	Fully	Multi	Deterministic	Sequential	Semi	Discrete
Poker	Partially	Multi	Stochastic	Sequential	Static	Discrete
Backgammon	Fully	Multi	Stochastic	Sequential	Static	Discrete
Taxi driving	Partially	Multi	Stochastic	Sequential	Dynamic	Continuous
Medical diagnosis	Partially	Single	Stochastic	Sequential	Dynamic	Continuous
Image analysis	Fully	Single	Deterministic	Episodic	Semi	Continuous
Part-picking robot	Partially	Single	Stochastic	Episodic	Dynamic	Continuous
Refinery controller	Partially	Single	Stochastic	Sequential	Dynamic	Continuous
Interactive English tutor	Partially	Multi	Stochastic	Sequential	Dynamic	Discrete

Figure 2.6 Examples of task environments and their characteristics.

Stuart Russell, Peter Norvig. Artificial Intelligence: A Modern Approach

and it walks!





https://deepmind.com/blog/producing-flexible-behaviours-simulated-environments/

What can you do?

- Explore the vast amount of resources on the internet to learn any one of these techniques.
- Machine Learning frameworks come in handy open-source packages. (w/ tutorials and benchmarks)
- Enjoy the learning!
- P.S. Robots won’t take over anytime soon.