Machine Learning:
Past, Present and Future

Michael Soltys

March 14, 2022 @ CSUCI

Sabbatical Presentation

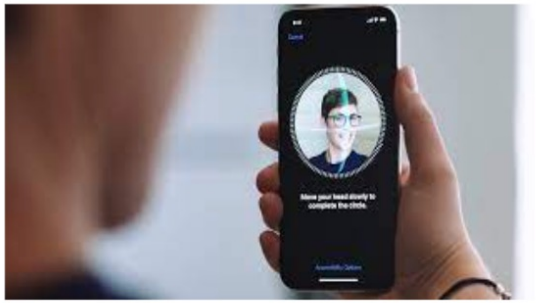
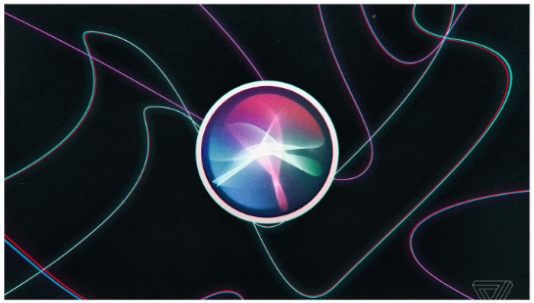


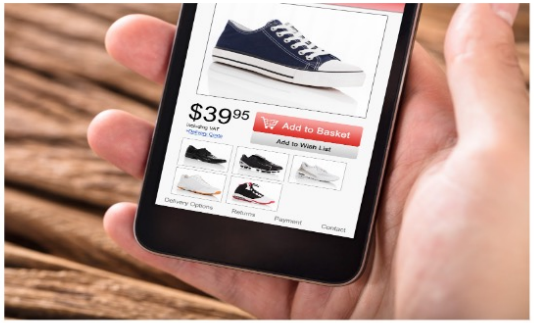
Image Recognition



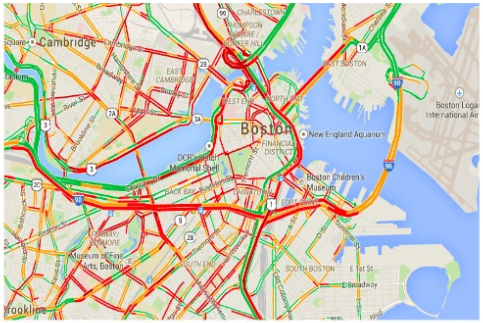
Speech Recognition

Fraud Detection

Self-Driving Cars



Product Recommendation



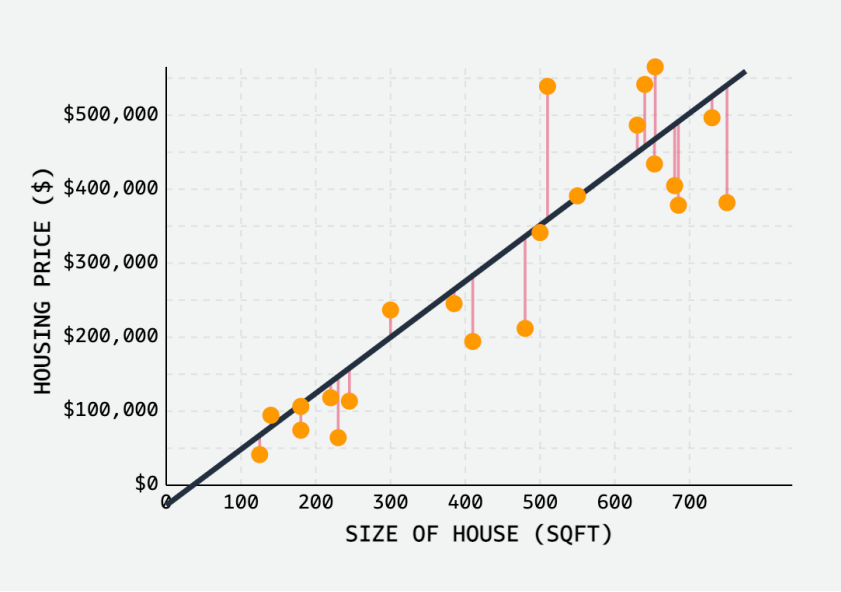
Traffic Prediction

What is ML?

- ML is data-driven (as opposed to rule-driven) computation
- It is a subfield of AI (Artificial Intelligence)

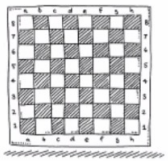
Example: Linear Regression

- https://mlu-explain.github.io/linear-regression/



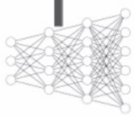
1950 — *Alan Turing proposed The Turing Test*

1952 — *Arthur Samuel wrote the first computer learning program: the game of checkers.*

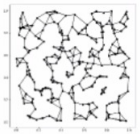


1956 — *The Dartmouth Summer Research Project on AI.*

1957 — *Frank Rosenblatt designed the first neural network for computers: the perceptron.*



1967 — *The "nearest neighbor" algorithm is created, allowing computers to use basic pattern recognition.*



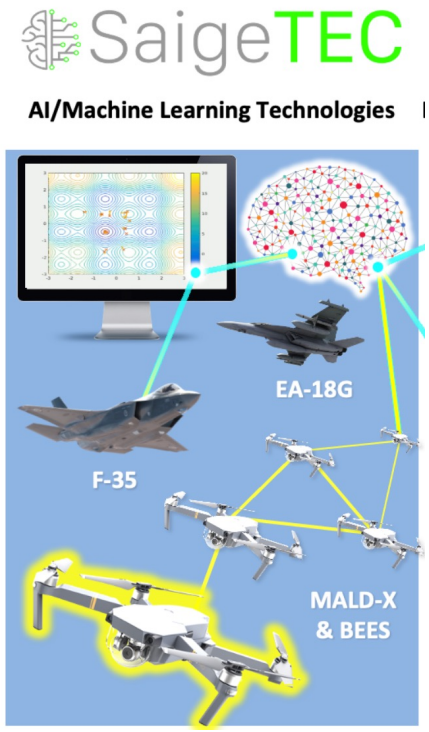
1979 — *Stanford University students invent the "Stanford Cart," which can navigate obstacles in a room on its own.*

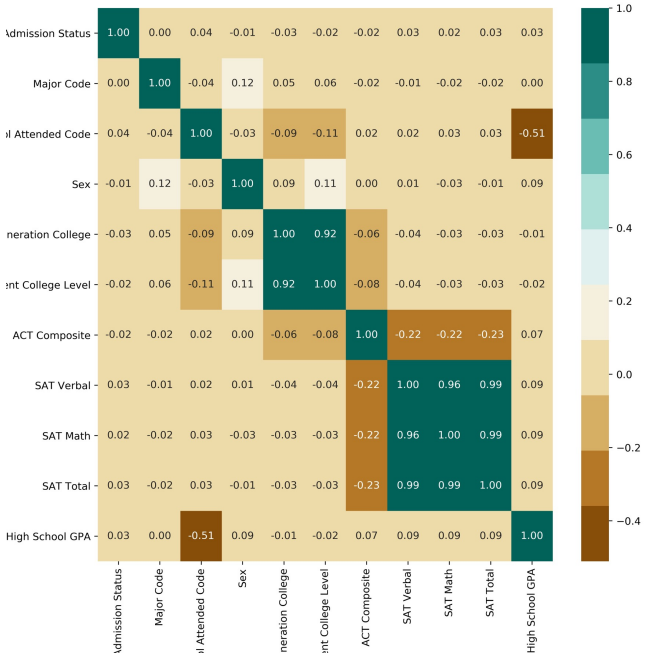
1996 — *IBM's Deep Blue, a chess-playing computer program, defeated the reigning chess world champion*

2011 — *IBM's Watson computer beat two champions on Jeopardy.*

2012 — *Google Brain is developed, a neural network able to discover and categorize objects.*

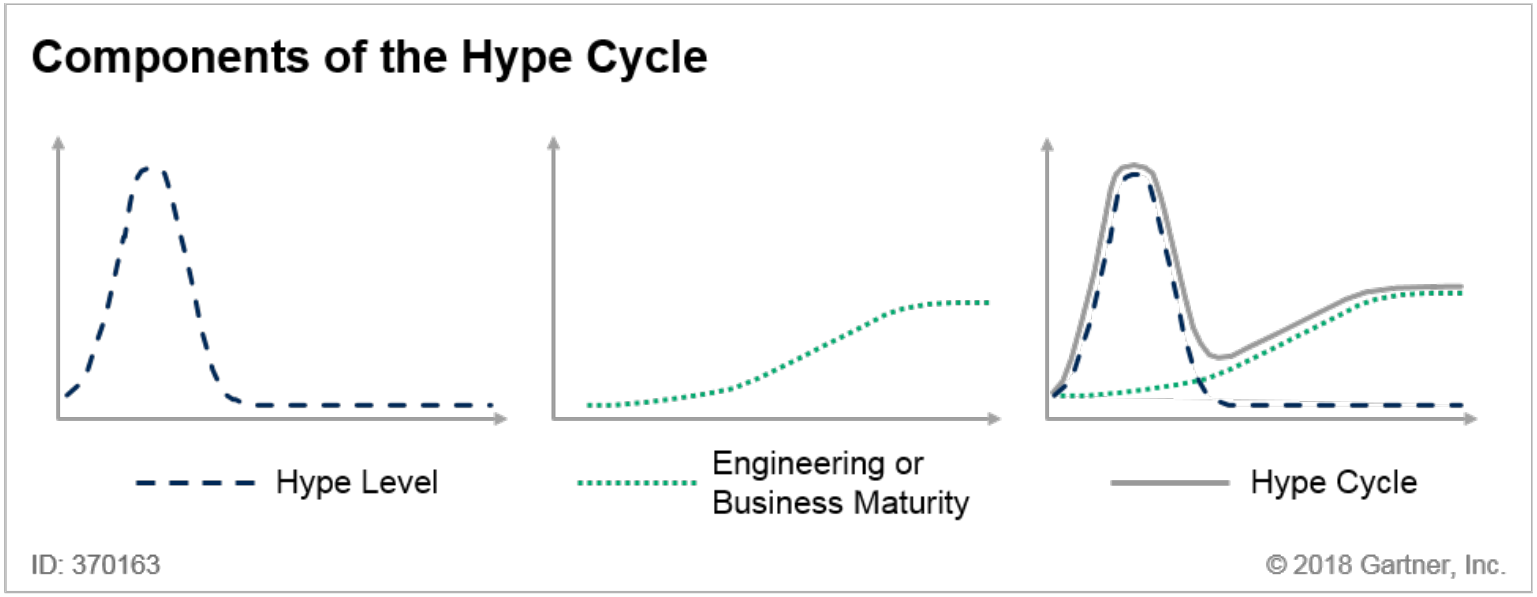
Example



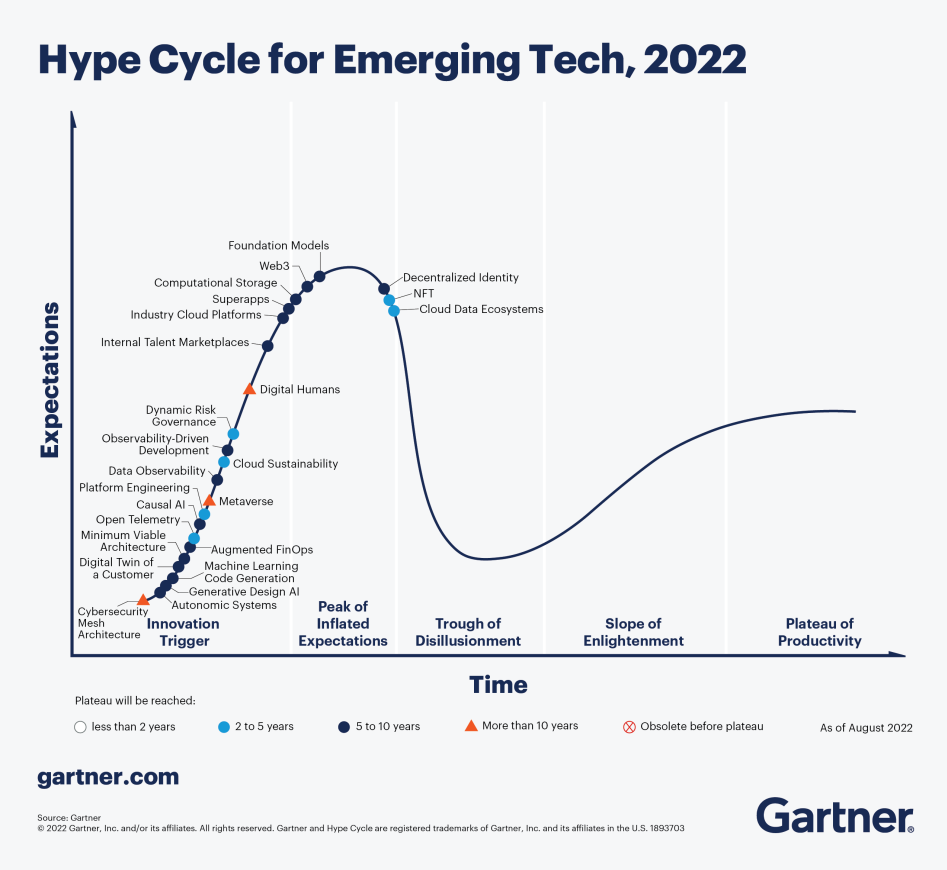


https://github.com/michaelsoltys/sagemaker-enrollment

Gartner Hype Cycle



Where is ML in the hype cycle?



Past
Theory and bespoke code

University of Toronto

Geoffrey Hinton was pioneering deep learning (1990-2015)

"All the News That's Fit to Print."

The New York Times.

THE WEATHER. Rain to-day; fair to-morrow.

VOL. LIII...NO. 16,774. NEW YORK, FRIDAY, OCTOBER 9, 1903.—FOURTEEN PAGES. ONE CENT In Greater New York, Elsewhere, Jersey City and Hoboken, Two Cents.

RUSSIAN FLEET AT KOREA?

Report That Ninety Warships Have Arrived at Masam-Pho.

Yesterday Part of Manchuria Should Have Been Evacuated, but No Move Has Been Made by the Russians There.

PARIS, Oct. 8.—Official information received here shows that a formidable Russian fleet, comprising ninety warships of all classes, has left Port Arthur and has arrived at Masan-Pho, Korea, where the Japanese fleet had already arrived. The Russian ships have anchored within the harbor alongside the Japanese ships.

Several brigades of Russian troops have been moved forward to the Korean boundary, and are now stationed on the border.

Diplomatic negotiations between Russia and Japan are still proceeding at Tokio. There do not seem to the evacuation of Manchuria by the Russian troops, but to the status of Korea.

The Temps, in a dispatch from Tokio, gives an interview with Alexander Iswolsky, the Secretary of Foreign Minister Lamsdorff, who, it is stated, spoke on the authority of his chief upon Russo-Japanese relations. M. Iswolsky is quoted as saying:

"Our agents at Tokio have informed us that Japan's entire war debt is prepared for it. We have enough troops in Siberia to resist all the Japanese forces."

TIEN-TSIN, Oct. 8.—A telegram from Yin-Kow, under date of Oct. 6, states that the Russians are taking no steps to evacuate Niu-Chwang.

Reports from the north show that the Russians are holding their positions everywhere.

YOKOHAMA, Oct. 8.—According to all Chinese reports to-day the date fixed for the evacuation of parts of Manchuria by the Russian troops passed without a Russian move toward the evacuation.

In the meantime the negotiations regarding Korea and Manchuria are proceeding at Tokio between the Japanese Cabinet and the Russian Minister, Baron de Rosen. The latter is acting under direct instructions from Admiral Alexieff, Viceroy of the Far East. The prospect of an agreement is considered doubtful, unless Russia makes substantial concessions.

The retreat of the Japanese reserves of the Russian demands is officially denied. The issue so far was officially stated

MAY SUSPEND BALKAN REVOLT.

Report That the Macedonians Will Wait Till the Spring to See If the Reforms Are Carried Out.

[Special Cable—New York Times Service Copyright.]

LONDON, Oct. 8—It is announced from Constantinople through official channels, says the Vienna correspondent of The Times, that the Macedonian insurgents are reported to be preparing a manifesto declaring that, in expectation of the Porte ceasing its efforts to suppress the rising, they have decided to suspend the insurrection until next Spring in order to see whether the reforms are then applied.

The correspondent says all accounts agree in describing the Sultan as cautious and inclined to kick at the proposed European control and surveillance of Turkish methods in Macedonia.

It is important, adds the correspondent, that Europe should not lose sight of the urgent necessity of alleviating the suffering in Macedonia and Bulgaria. The relief organized by the Turks with much blowing of trumpets is a delusion.

LIFE INSURANCE AGENCY SOLD.

R. H. Plant of Georgia Turns His Big Business Over to the New York Life.

Special to The New York Times.

MACON, Ga., Oct. 8—R. H. Plant has sold to the New York Life Insurance Company his general agency. The consideration is not made public, but rumor bankers it is said to be more than $500,000. They say their reason for making such a big figure is that they know that a few years ago Mr. Plant refused an offer of a half million dollars for it.

Mr. Plant's territory embraced the States adjacent to Georgia, and it is said that from the commissions of his business he had the largest income of any insurance agent in the country. It has been variously estimated at from $50,000 to $100,000 per annum, always an signature for controlling the business.

Mr. Plant took charge of the agency twenty-five years ago. Business was small then, and he secured a very valuable contract from the New York.

The company is said to pay the retiring agent $5,000 a year for the contract, which he will always refused to sell. Mr. Plant has made over a million dollars out of the contract, not including the sum just paid by the New York Life.

PRESIDENT GIVEN RESIGNS.

Discrepancies Found in Accounts of Lancaster County (Penn.) Railway and Light Company.

LANCASTER, Penn., Oct. 8.—Rumors which have been current for some time affecting the relations of William B. Given, President of the Lancaster County Railway and Light Company, with that company, culminated to-day in the announcement that Mr. Given has tendered his resignation as

TO EXTRADITE GRAFTERS

Treaties Covering Bribery to be Negotiated at Once.

As Mr. Folk's Request the President Orders Work Begun—The Treaties Will Be Retroactive.

Special to The New York Times.

WASHINGTON, Oct. 8.—Circuit Attorney Folk of St. Louis, whose efforts to secure the punishment of grafters have been partly nullified by the escape of some to Europe recently, called at the White House to-day to urge upon the President the negotiation of extradition treaties to secure their return.

As a result of his visit the President began work on the preparation of treaties with Great Britain and France, making bribery extraditable, and the Attorney General furnished Mr. Folk with an opinion that the treaty with Mexico is retroactive.

Four of the St. Louis boodlers are out of the reach of the law, two in Mexico, one in France, and one in Canada. The fugitives in Mexico reached that country before the new extradition treaty became effective.

Mr. Folk suggested that treaties should soon be made which will cover similar cases in the future. He also raised the point that any one of the statutory boodlers now convicted and awaiting sentence could raise the largest amount of bail that could reasonably be asked and then go to some country where, in the absence of proper treaty arrangements he would be safe from arrest.

The President sent a messenger to the State Department with a summons for Secretary Hay, and when the Secretary appeared informed him of the decision to support Mr. Folk to the utmost.

Mr. Folk said he believed the supplemental treaty recently negotiated with the Mexican Government would permit of the extradition of Charles Steele and Adolph Meyers, and that supplemental treaties should be negotiated with Great Britain and France, so that D. J. Kelley and Ellis Walsworth could also be extradited.

The President suggested that an opinion be obtained from the Attorney General as to whether such provisions would hold in law. In this dictated a letter to Attorney General Knox, which was delivered to Mr. Knox by Mr. Folk.

The Attorney General later in the afternoon rendered an opinion satisfactory to Mr. Folk. He held that the Mexican treaty was retroactive, and that if supplemental treaties with other countries were drafted they would be similarly retroactive.

Armed with this opinion, Mr. Folk returned to St. Louis to-night. While he had said that the reply of the Attorney General, Mr. Bonaparte, directed Secretary Hay to address letters to Ambassador Choate in London and Ambassador Porter in Paris, directing them to begin immediately negotiations for treaties with Great Britain and France, identical with the treaty with Mexico which will add bribery to the list of offenses extraditable under those treaties.

$150,000,000 MORTGAGE FILED.

Given by Lehigh Valley Railroad to the Girard Trust Company for Issue of Bonds.

EASTON, Penn., Oct. 8.—A mortgage for $150,000,000, given by the Lehigh Valley Railroad to the Girard Trust Company of Philadelphia, was filed to-day in the office of the Recorder of Deeds in Northampton County.

This document is for the issue of general consolidated bonds, which may be converted by the Directors. The bonds are to be issued as the Directors may deem expedient, if the company needs, and will eventually supersede all bonds now outstanding. The proceeds will then be a first mortgage on all the Lehigh properties.

MARRIED ON STOLEN MONEY.

Buffalo Bank Messenger Took $5,000, Went to Milwaukee, and Wedded a Fond du Lac Girl.

MILWAUKEE, Oct. 8.—Arthur C. Nagel, who absconded from Buffalo with $5,000 on June 30 and who was arrested on suspicion by Milwaukee detectives, confessed to Inspector Reuse to-day.

The young man worked for a Buffalo bank, and it was his duty to carry large sums of money from one bank to another. No will be held.

Nagel arrived in Milwaukee shortly after leaving Buffalo, and made the acquaintance of Miss Frances McMaster of Fon du Lac, Wis. Two weeks later they were married, the wedding being performed in Chicago. The young couple and a friend of the bride then left for a wedding tour on the Pacific Coast and returned to Milwaukee eleven days ago.

The father of the young man created excitement in police circles and he was watched. His money was evidently getting out, as he began paying some of the notes that were given to find purchased for Detectives then arrested him on many charges. Only $10 of the $5,000 could be found. Nagel said that he had spent the balance.

BUFFALO, Oct. 8.—Nagel was employed as a messenger by the Third National Bank for $12 a week. On June 29 he received $5,000 to deposit in the Bank of Buffalo. He left the bank of the Clearing House. Another bank messenger accompanied Nagel to the door of the attorney couldn't get to the Clearing House.

The money was not deposited, and on next day, when the Third National had learned, the police were asked to find Nagel. A bonding company settled with the bank.

CANADA'S EMERGENCY TROOPS.

Minister of Defense Says She Will Have Force of 100,000 Men.

OTTAWA, Oct. 8.—Sir Frederick Borden, Minister of Militia and Defense, in the House to-day, on a vote of $1,300,000 for arms and equipment, said that it was intended to have a force of 100,000 men to be called on in the case of an emergency. Of these, 40 per cent. will be enlisted at once, and nearly one-half will be called upon for annual drill. The other 60 per cent. will be supplied with arms and equipments, and will be ready in case of trouble.

All the officers and non-commissioned

DENIAL BY MORGAN & CO.

Statement of Connection With Shipbuilding Trust.

HOW SHARES WERE SOLD

Mr. Untermyer Says There is no Quarrel with Banking Firm—Correspondence on the Underwriting Plan.

"Neither the firm of J. P. Morgan & Co. nor any partner ever had any connection with the formation, organization, or financing of the United States Shipbuilding Company, nor have they ever received or waived any of its securities. As managers of the United States Steel Syndicate, we took the Bethlehem Steel Company stock until a purchaser could be found. It was transferred to the United States Shipbuilding Company at cost, and the preferred and common stock which were received in lieu of interest and earnings of the company were sold as private sale for $7,000, and the proceeds were distributed as part of the profit of the United States Steel Syndicate.

"Any statement that we were parties to any agreement for selling the stock in such manner."

This statement was issued yesterday afternoon by the banking house of J. P. Morgan & Co. as a consequence of Daniel Lay Elsner's testimony that Charles M. Schwab and J. P. Morgan & Co. had arranged for Harris, Gates & Co. to sell Morgan and Schwab holdings in United States Shipbuilding Company securities, aggregating 200,000 shares, ahead of the remainder of the shipyard stocks held in a pool by the brokerage firm.

Mr. Elsner had stated that the matter in question had been given to Mr. Schwab with bonds worth $30,000,000 for the Bethlehem Steel Works, and that Mr. Schwab had informed him that one-fourth of the bonds in stock was to be handed over to the Morgan firm. The sale of the Bethlehem Steel Works to the Shipbuilding Company was announced on Aug. 15, 1903, when about $7,000,000 was paid in the bonds for the Bethlehem stock.

After the formal statement had been issued by the bankers early in the afternoon a number of the firm of J. P. Morgan & Co. were seen in their offices. It was explained that the $7,000,000 mentioned in the statement represented what had been received for the $7,000,000 par value preferred and common stock of the shipbuilding company. When this stock was sold was not disclosed, but the best price was said to indicate a recent sale. It was also explained that J. P. Morgan & Co. had not been a

Mr. Untermyer as President of the Trust Company of the Republic for the benefit of Mr. Gaskins. Why was he that time the company's president. This question was raised by Mr. Untermyer, who had previously objected to the testimony of Mr. Gaskins on the ground that the regime might not be correct, and he now has the privilege of verifying them.

The entire transaction, which was with the Lehigh Valley, is put through the Girard Trust Company, which holds many special securities in Pullman, Baldwin's shipbuilding, &c. The Paris correspondent of J. P. Morgan & Co. in his report Mr. Untermyer submitted, for the purpose of substantiating his statement, that the firm of J. P. Morgan & Co. "in the trust created in respect of said securities," the following extract from a letter written by Col. McCook:

"From letters of prospective parties and large responsibility have requested the organization of the Steel Trust, and the Morgan firm and its associates undertook what, under the circumstances, was considered a difficult task. The Morgan firm and its associates undertook what, under the circumstances, was considered a difficult task. The Morgan firm and its associates undertook what, under the circumstances, was considered a difficult task. The Morgan firm and its associates undertook what, under the circumstances, was considered a difficult task."

A Paris cable dispatch of July 15 from John W. Young, president of the shipyard trust, was among the cable messages viewed in the report of Mr. Untermyer.

HAD ARRANGED SALE.

Mr. Young wired that "we" had arranged "sale $2,000,000 bonds available few days." He added that the balance needed to pay all options would be placed "in good time." Under the name Cable "Morgan" sent a message to "Young, C. Trubee, Paris," in which he said:

"If Paris conditions are good, they may be asked to sell some as underwriters here. If not, they will be asked to take them as we can not have all issues underwritten here."

On the next day "Morgan" cabled to "Young" that the New York call should be informed promptly whether the Paris underwriters would respond to the call for the first payment, to be made during the next week, that three days after payment message from "Morgan" read as follows:

"Let us immediately know whether you will respond in case we call. This should be arranged to meet demands if necessary, about August and between August."

Finally, it stated that "Doctor Reid, Bankers Trust Company, New York, and Underwriting was legally authorized, and that he himself had sent two banks, discussing the financial situation of the Bethlehem's sum," and "Napoleon." The latter was to take a million and the former what "accommodate her interest." Finally, on Aug. 15, a cable from "Bailey" to "Morgan" said that he had received assurance of the success of the plan. Two days later, passed between the following personal note by cable:

Morgan, New York:

Knox, who underwrites eighty bonds, declines to take more than $2,000 a year. Shall we accept? Have not heard from Underwood. Do bonds run one million per year, and what about bonds?

About this time came a cable dispatch from John W. Young to Lewis Stuart, the former declaring that his commissioners were "all right." Untermyer's examination on July 30 does to had caused it to be known that a leading English banker had said he could get $7,000,000 in twenty-five years. He added: "What is your opinion?" Mr. Young replied that Mr. Alexander is dead, he said the Baring Brothers were the only ones standing to any appreciable but that Mr. Alexander Hospital that he was taken under the French law to keep his agreement. On July

M'LAUGHLIN DECLARES WAR ON M'CARREN

James Shevlin Calls the Senator a Political Acrobat.

EFFECT OF LITTLETON SPEECH

Eight and Perhaps Ten of Brooklyn's Twenty-two Districts Counted as Against Willoughby Street.

With Tammany Hall responding to aggressive warfare for the annihilation of the Hugh McLaughlin organization in Kings County, and with McLaughlin, aided by James Shevlin, John L. Sheu, and Martin W. Littleton, seeking a blow right to exile Senator Patrick H. McCarren from the organization, because of his pro-Tammany prediction, Brooklyn yesterday became the show centre of the Democratic entire politics.

All over the borough the word had gone forth last night that it was War to the Hilts and between McCarren and Willoughby Street, and that all disguises had been thrown off. McCarren, who openly announced on the "Tammany Hall leader of Brooklyn," and he did not make any attempt to deny the title. His Supporters declared that the split between McCarren and McLaughlin had been widening to such an extent by the speech of Shevlin, W. Littleton of the McCarren Club creating the night before that there was no time lose at heading it up than there was hope of patching up the breach between McLaughlin and Charles F. Murphy.

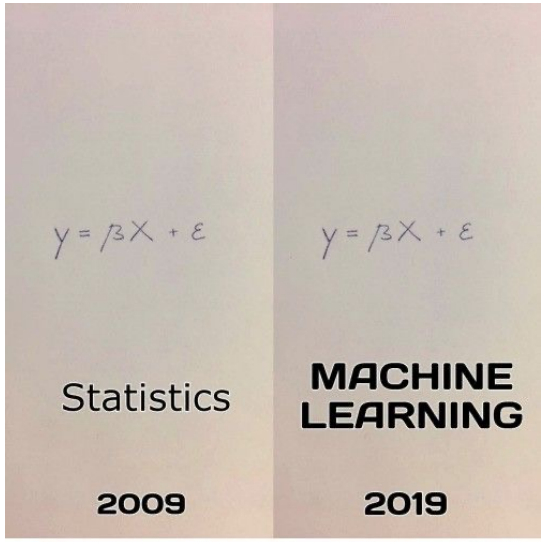
Among the Willoughby Street leaders the whole cause of the trouble is put directly to James Shevlin. McLaughlin is a very old man, and he had been depending strongly on the advice of Shevlin, who is related to the veteran by marriage, and of whom McLaughlin is especially fond. Shevlin generally is credited with having advised the large demands on the Tammany Hall management, together with the sentiment as "grafft" and "Treachery," which McLaughlin hurled against Murphy. Attack together brought about the open break between Tammany and Willoughby Street. McCarren resented this, and from that day McCarren and Shevlin have been at deadly points.

In demanding that the entire Democratic party ticket be supported, Senator McCarren has the backing of several of the twenty-two district leaders in the Kings County organization. Congressman George H. Lindsay's organization in the Fifteenth District, of which he is the leader, already has indorsed the entire ticket, as of course has the organization in Senator McCarren's Thirteenth District. Colonel Hasbrouck's Nineteenth District has taken similar action. The Tenth District, of which McCarren's law partner, Coolidge Hagerty, is the leader, will follow suit regardless, as will John Greenhut's Twenty-first

1903 NYT weeks before Wright brothers flew for first time:

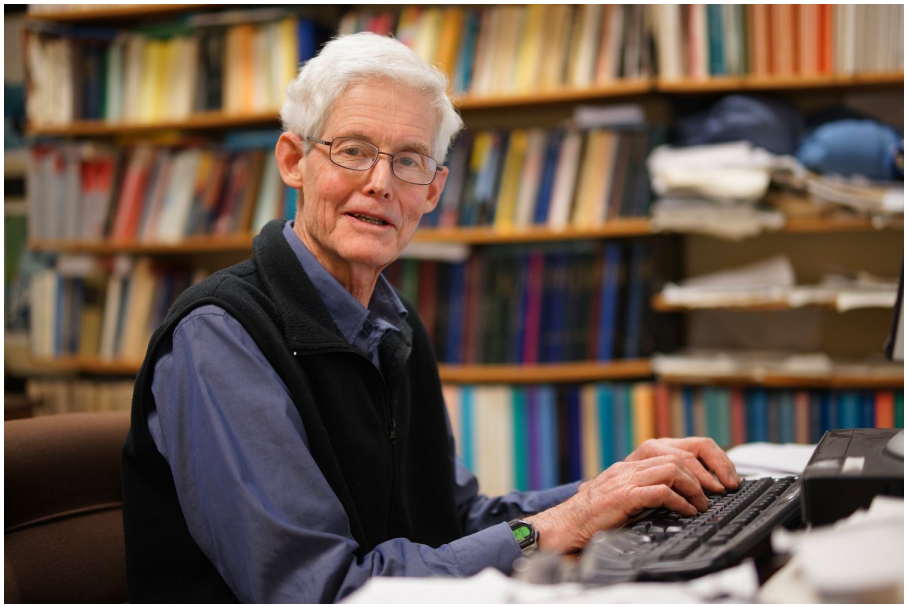
man will not fly for 10 million years

Mathematics

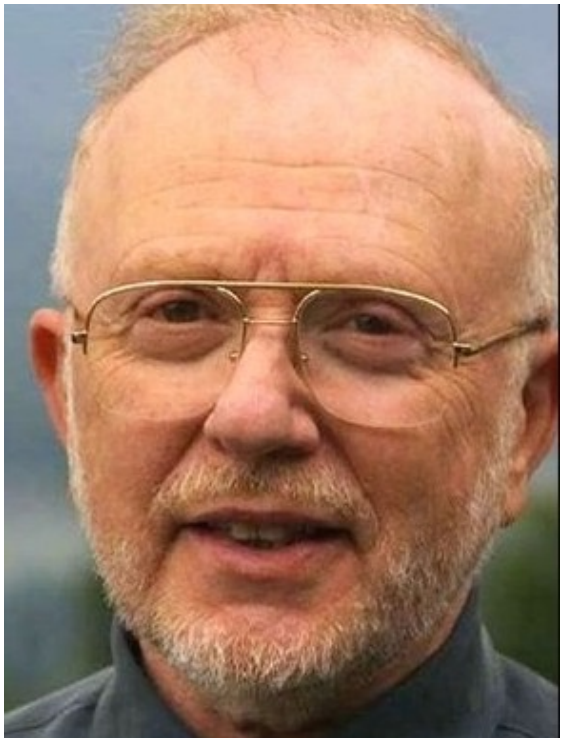


#10yearchallenge

Stephen Cook

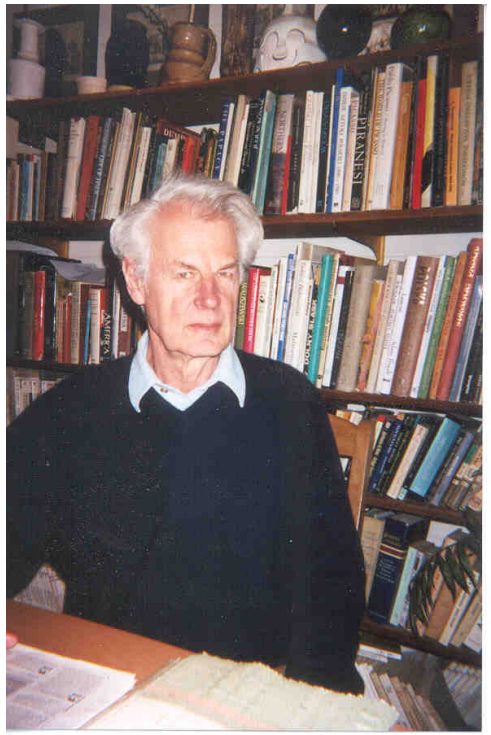


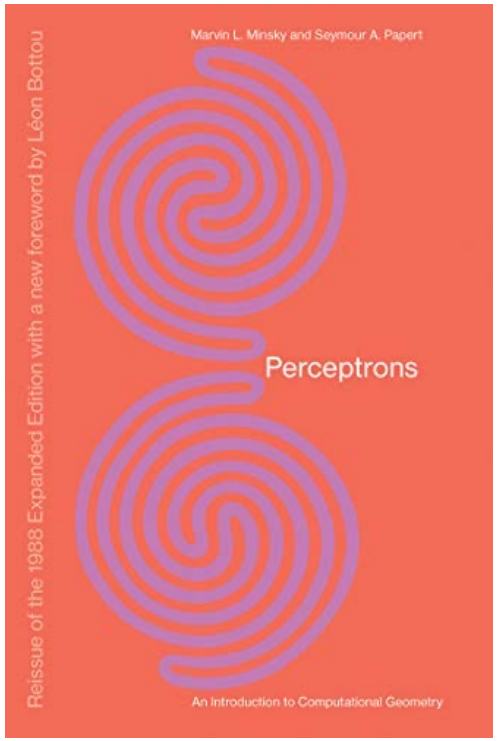
McMaster University

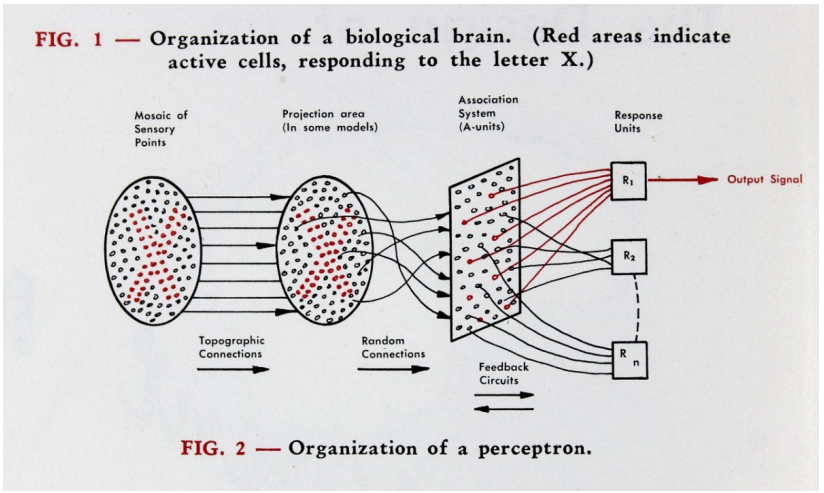


> Copy and paste is a design error.
> -David Parnas

Jan Mycielski



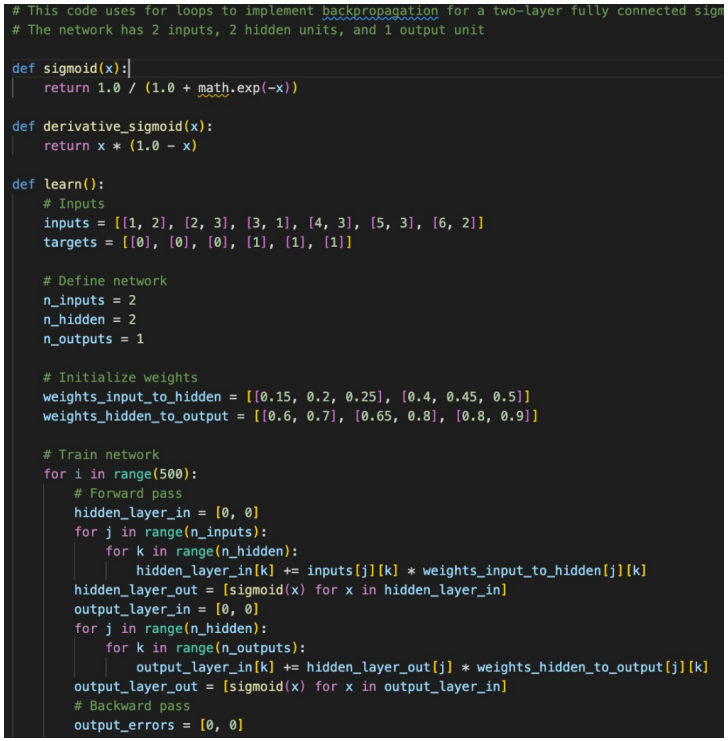




Perceptrons: an intro to computational geometry
by Marvin Minsky and Seymour Papert, 1969.
An edition with handwritten corrections
released in the early 1970s.

How was ML done

- Code was *bespoke*
  - Written *de novo* each time
- But by the early 2000s:
  - Shared theoretical core of knowledge:
    - Backpropagation
    - Statistical Learning Theory
- What was taught:
  - Theory of neural networks and limitation of learning algorithms
  - How to code them by hand



```
# This code uses for loops to implement backpropagation for a two-layer fully connected sigm
# The network has 2 inputs, 2 hidden units, and 1 output unit

def sigmoid(x):
    return 1.0 / (1.0 + math.exp(-x))

def derivative_sigmoid(x):
    return x * (1.0 - x)

def learn():
    # Inputs
    inputs = [[1, 2], [2, 3], [3, 1], [4, 3], [5, 3], [6, 2]]
    targets = [[0], [0], [0], [1], [1], [1]]

    # Define network
    n_inputs = 2
    n_hidden = 2
    n_outputs = 1

    # Initialize weights
    weights_input_to_hidden = [[0.15, 0.2, 0.25], [0.4, 0.45, 0.5]]
    weights_hidden_to_output = [[0.6, 0.7], [0.65, 0.8], [0.8, 0.9]]

    # Train network
    for i in range(500):
        # Forward pass
        hidden_layer_in = [0, 0]
        for j in range(n_inputs):
            for k in range(n_hidden):
                hidden_layer_in[k] += inputs[j][k] * weights_input_to_hidden[j][k]
        hidden_layer_out = [sigmoid(x) for x in hidden_layer_in]
        output_layer_in = [0, 0]
        for j in range(n_hidden):
            for k in range(n_outputs):
                output_layer_in[k] += hidden_layer_out[j] * weights_hidden_to_output[j][k]
        output_layer_out = [sigmoid(x) for x in output_layer_in]
        # Backward pass
        output_errors = [0, 0]
```

Present

Powerful tools

The Cloud as enabler

- Specs of an AWS SageMaker instance:
  - `ml.g5.48xlarge:`
    - `8 NVIDIA A10G Tensor Core GPUs`
    - `192 vCPUs!`
    - `768GiB storage`

MAR 27, 2022 · S10 E5 · 29 MIN LEFT
Nvidia: The GPU Company
Acquired

▶ Resume

https://podcasts.apple.com/us/podcast/acquired/id1050462261?i=1000558142063

- But Cloud is *not* the solution for everything:
  read this post on the Stack Overflow architecture

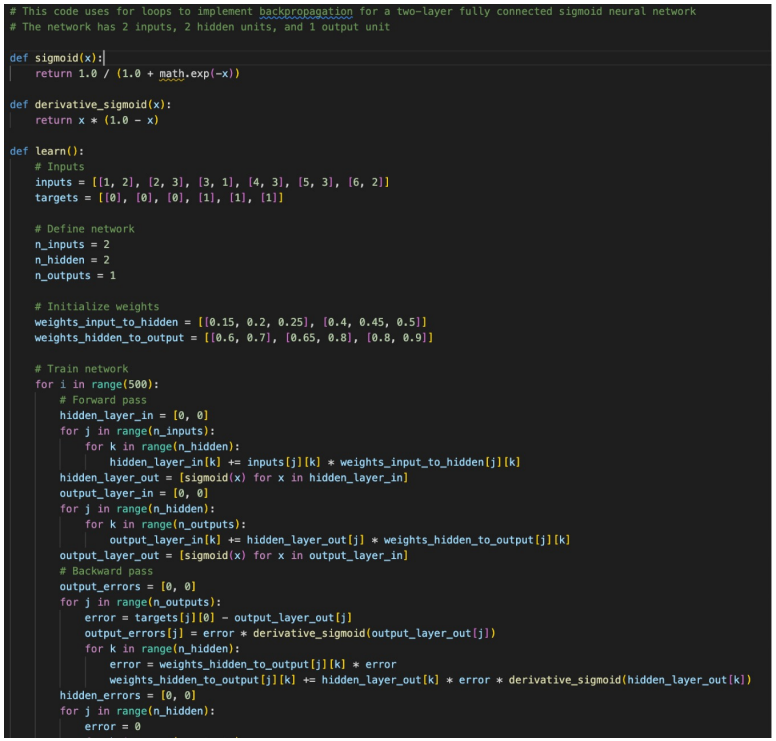
Proliferation of Packages

- 2007 – Theano
- 2010 – Scikit Learn
- 2014 – Jupyter Notebooks
- 2014 – XGBoost
- 2015 – Tensorflow, Keras
- 2016 – PyTorch, MXNet

PyTorch implementation

```python
class Net(nn.Module):
    def __init__(self):
        super(Net, self).__init__()
        self.fc1 = nn.Linear(2, 2)
        self.fc2 = nn.Linear(2, 1)

    def forward(self, x):
        x = F.sigmoid(self.fc1(x))
        x = self.fc2(x)
        return x
```



```python
# This code uses for loops to implement backpropagation for a two-layer fully connected sigmoid neural network
# The network has 2 inputs, 2 hidden units, and 1 output unit

def sigmoid(x):
    return 1.0 / (1.0 + math.exp(-x))

def derivative_sigmoid(x):
    return x * (1.0 - x)

def learn():
    # Inputs
    inputs = [[1, 2], [2, 3], [3, 1], [4, 3], [5, 3], [6, 2]]
    targets = [[0], [0], [0], [1], [1], [1]]

    # Define network
    n_inputs = 2
    n_hidden = 2
    n_outputs = 1

    # Initialize weights
    weights_input_to_hidden = [[0.15, 0.2, 0.25], [0.4, 0.45, 0.5]]
    weights_hidden_to_output = [[0.6, 0.7], [0.65, 0.8], [0.8, 0.9]]

    # Train network
    for i in range(500):
        # Forward pass
        hidden_layer_in = [0, 0]
        for j in range(n_inputs):
            for k in range(n_hidden):
                hidden_layer_in[k] += inputs[j][k] * weights_input_to_hidden[j][k]
        hidden_layer_out = [sigmoid(x) for x in hidden_layer_in]
        output_layer_in = [0, 0]
        for j in range(n_hidden):
            for k in range(n_outputs):
                output_layer_in[k] += hidden_layer_out[j] * weights_hidden_to_output[j][k]
        output_layer_out = [sigmoid(x) for x in output_layer_in]
        # Backward pass
        output_errors = [0, 0]
        for j in range(n_outputs):
            error = targets[j][0] - output_layer_out[j]
            output_errors[j] = error * derivative_sigmoid(output_layer_out[j])
            for k in range(n_hidden):
                error = weights_hidden_to_output[j][k] * error
                weights_hidden_to_output[j][k] += hidden_layer_out[k] * error * derivative_sigmoid(hidden_layer_out[k])
        hidden_errors = [0, 0]
        for j in range(n_hidden):
            error = 0
```

Impact

- New tools allowed practitioner to go up one level of abstraction:
  - Before: “How do I take all this math and write it in code?”
  - Now: “How can I structure this network to solve my problem?
  - Or Even: “How do I organize my data/problem so a model can train on it?”

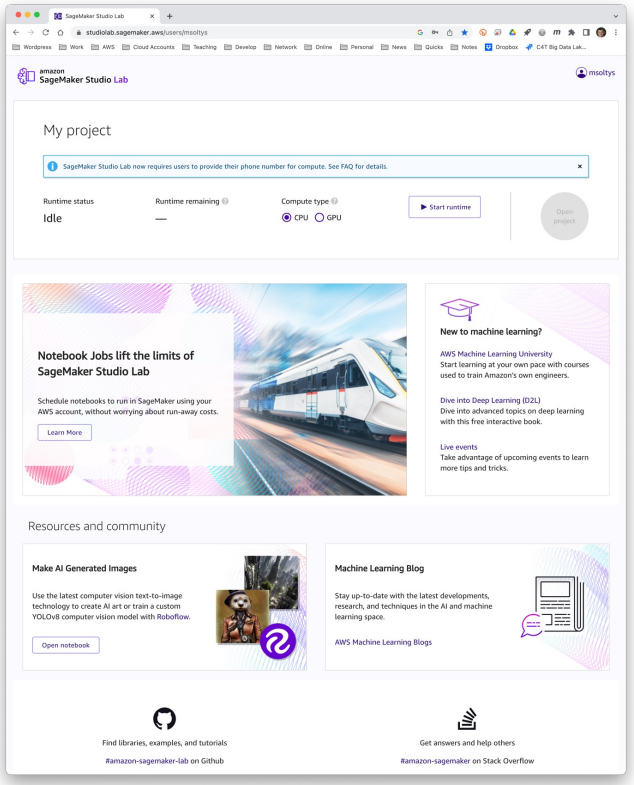
- Entry bar was high (PhD!), but now:
  - Moving ML from research to production with emphasis on tooling
  - Open Source tools like AutoGluon: https://auto.gluon.ai

```
from autogluon.tabular import TabularPredictor

predictor = TabularPredictor(label="label").fit(train_data="train.csv")
predictions = predictor.predict("test.csv")
```

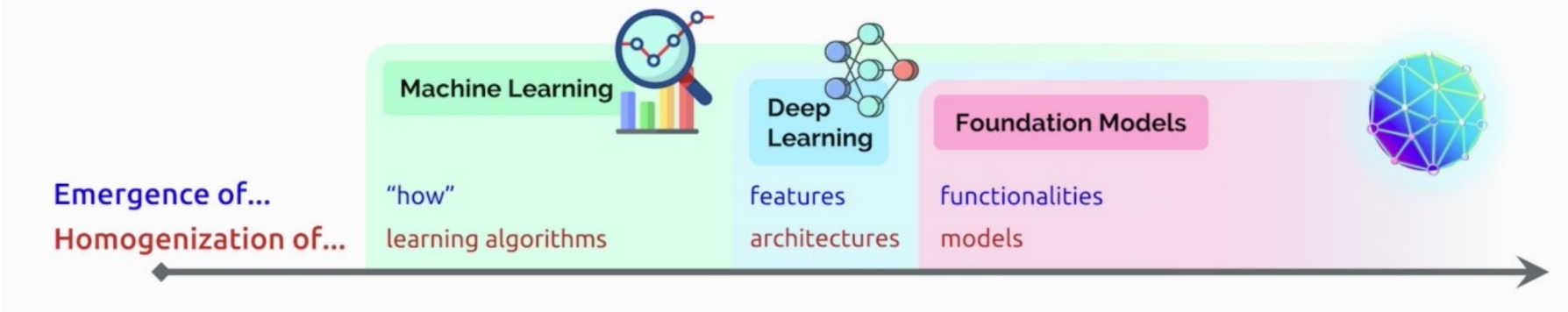
SageMaker Studio Lab

- https://studiolab.sagemaker.aws
- **Free**
- Takes about a week to be approved for account
- Linked to GitHub with lots of examples
- Community on Stack Overflow



Future
Foundation Models

Foundation models

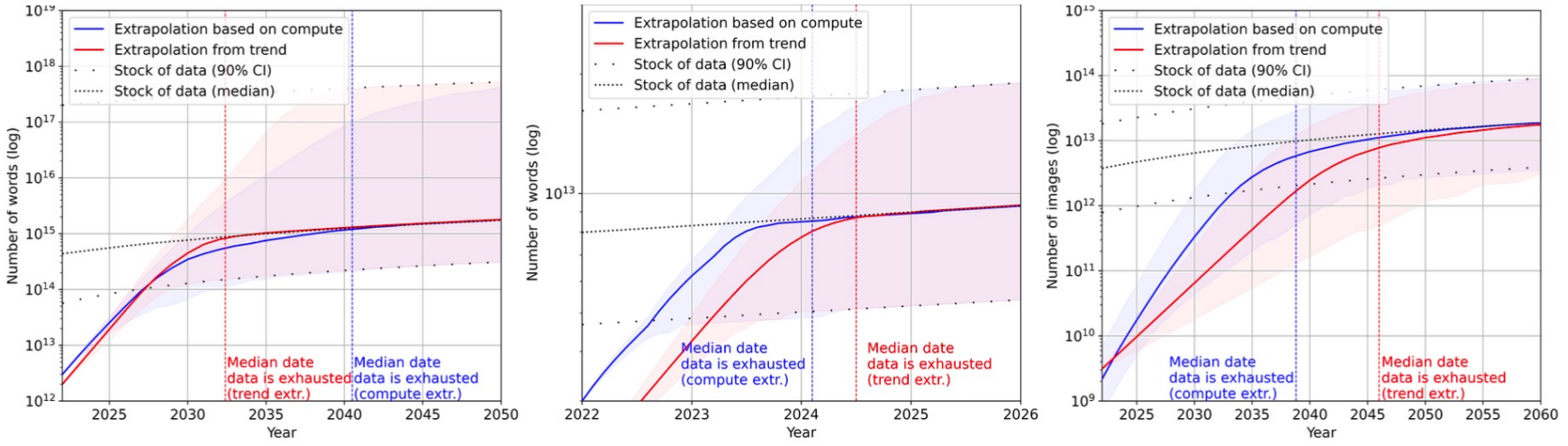


- Increased standardization of models:
  - Code Whisperer
  - GPT-3
  - Stable Diffusion
  - Chat GPT

Characteristics of Foundation Models

- Often trained “self-supervised”
- Predict portions of data from other portions with no explicit labels
  - Eg., fill in blanked out word in text, or fill in missing portion of image
  - Use rich data source (say most text written in history of humanity)
- Expensive, requiring millions $ to train
- Made once, then reused by many without modification of any kind
- Interact by making a sentence where the only way to fill the blank is with answer you want:
  - Eg., “George Washington was barn in the year ___”

Running out of data



(a) Projections for low-quality language data

(b) Projections for high-quality language data

(c) Projections for vision data

Will we run out of data? An analysis of the limits of scaling datasets in Machine Learning

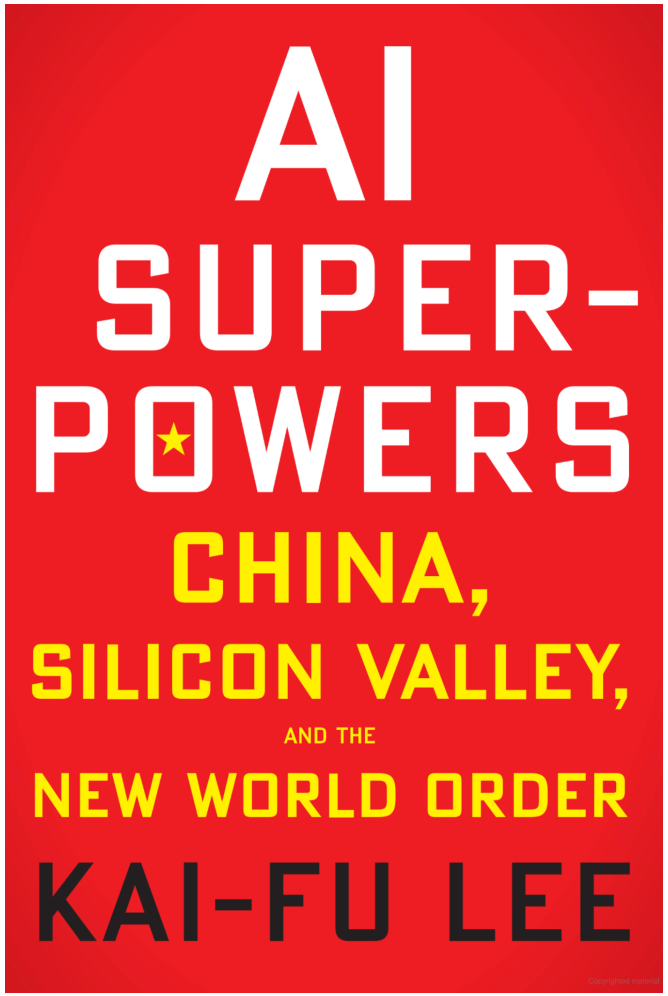
Pablo Villalobos*, Jaime Sevilla*†, Lennart Heim*§, Tamay Besiroglu*‡, Marius Hobbhahn *¶, Anson Ho*

Explain-ability and Ethics

- How to demonstrate (prove) that a model is correct?
  - Why is model training so successful?
- How to demonstrate that a model is not biased?
- How to protect human beings?

Important but not intellectually “elegant”

- CI/CD aspect of ML
  - In industry Git is one of the most important tools
  - Understanding the mathematical foundations is probably the least important
- Documentation has to be superb, and it seldom is
- It doesn’t work for a long time … , until it finally works a little bit
- Interpretation of data – what does 0.3 likelihood of coming to CI mean?
- Communications of methodology and findings – super important! Listen to customer, do not push your fav technology; what is business need?
- Politics of data:
  - No one wants to share their data, even within the same organization; negotiating for data and terms of usage (e.g., access) takes 50% of time of entire effort
  - Hard to reach agreement on ”goodness” of data
  - Even harder to reach agreement on “conclusion” and how to craft policy based on the data


AI
SUPER-
POWERS
CHINA,
SILICON VALLEY,
AND THE
NEW WORLD ORDER
KAI-FU LEE

Man has made his match … now it’s his problem

Skynet is a fictional neural network-based AI system that animates the Terminator