

Machine Learning in Finance

Zichao Yang

yang_zichao@outlook.com

www.yzc.me

What is Machine Learning?

“Learning is any process by which a system improves performance from experience.” - Herbert Simon

Definition by Tom Mitchell (1998):

Machine Learning is the study of algorithms that

- improve their performance P
- at some task T
- with experience E .

A well-defined learning task is given by $\langle P, T, E \rangle$.

What is Machine Learning?

Computers can assist us to perform complicated tasks in two different ways:

- **Knowledge-based:** a computer program whose logic encodes a large number of properties of the world, usually developed by a team of experts over many years. (e.g., trading algorithm, regex)
- **Learning-based:** machine learning models extract information directly from historical data and extrapolate to make predictions

1 The accelerating pace of change ...



2 ... and exponential growth in computing power ...

Computer technology, shown here climbing dramatically by powers of 10, is now progressing more each hour than it did in its entire first 90 years

COMPUTER RANKINGS

By calculations per second per \$1,000



Analytical engine
Never fully built, Charles Babbage's invention was designed to solve computational and logical problems



Colossus

The electronic computer, with 1,500 vacuum tubes, helped the British crack German codes during WW II



UNIVAC I

The first commercially marketed computer, used to tabulate the U.S. Census, occupied 943 cu. ft.



Apple II

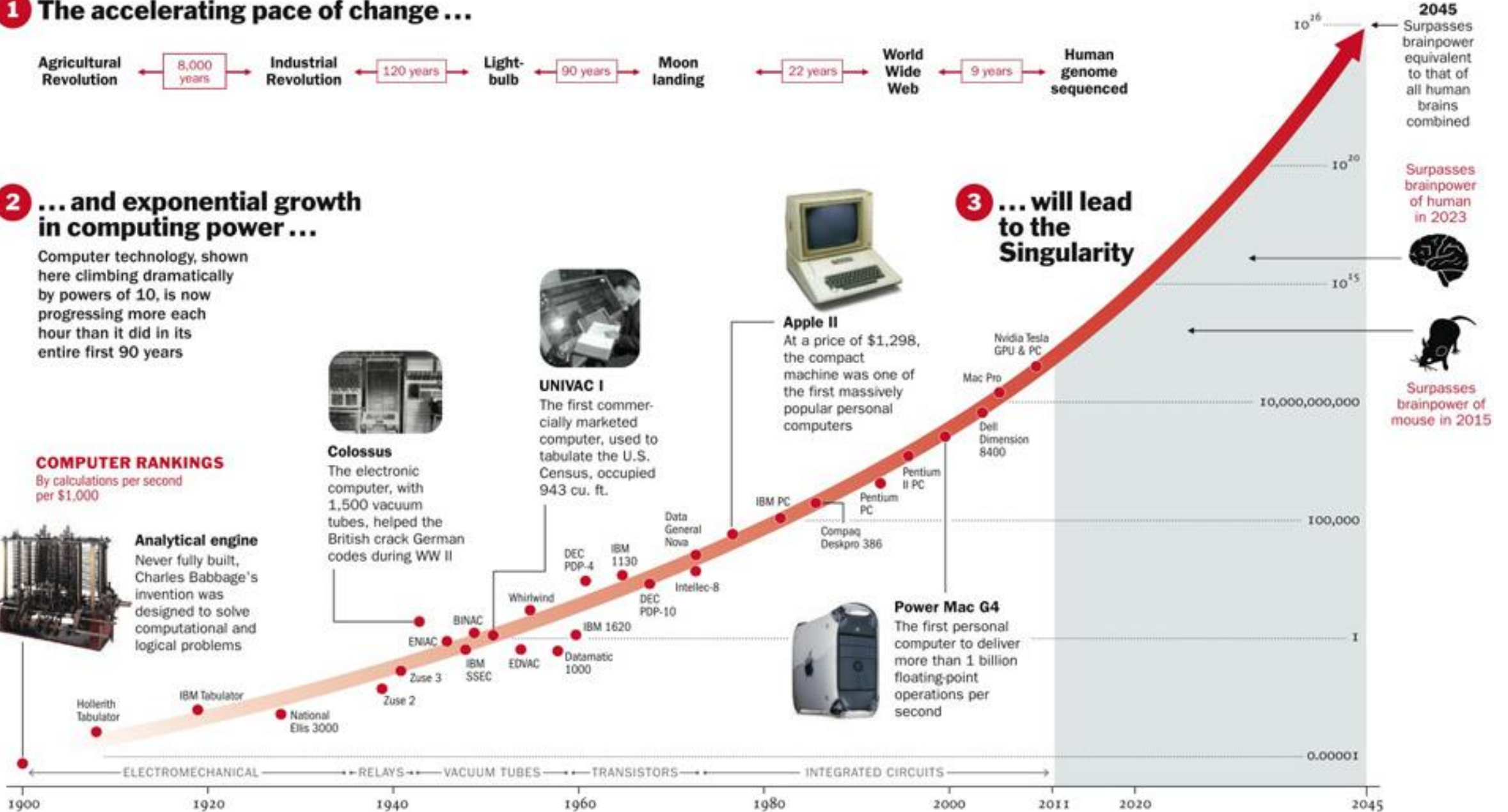
At a price of \$1,298, the compact machine was one of the first massively popular personal computers



Power Mac G4

The first personal computer to deliver more than 1 billion floating-point operations per second

3 ... will lead to the Singularity



Machine Learning VS. AI

- The term “machine learning” is usually connected with “artificial intelligence (AI)”
- AI does not always imply machine learning, rule based system, tree search, or....even OLS can be called AI.
- Learning based system (machine learning model) extract information directly the data, good at solving pattern recognition problems.

Machine Learning VS. Traditional Programming

Traditional Programming



Machine Learning



History of Machine Learning

- 1957 - Perceptron algorithm (implemented as a circuit!)
- 1959 - Arthur Samuel wrote a learning-based checkers program that could defeat him.
- 1969 - Minsky and Papert's book *Perceptrons* (limitations of linear models)
- 1980s – Some foundational ideas are proposed
 - Connectionist psychologists explored neural models of cognition
 - 1984 - Leslie Valiant formalized the problem of learning as PAC learning
 - 1988 - Backpropagation (re-)discovered by Georey Hinton and colleagues
 - 1988 - Judea Pearl's book *Probabilistic Reasoning in Intelligent Systems* introduced Bayesian networks

History of Machine Learning

- 1990s - the “AI Winter”, a time of pessimism and low funding, but looking back, the 90s were also sort of a golden age for ML research:
 - Markov chain Monte Carlo
 - variational inference
 - kernels and support vector machines
 - boosting
 - convolutional networks
 - reinforcement learning
- 2000s – applied AI fields (vision, NLP, etc.) adopted ML

History of Machine Learning

- 2010s – deep learning
 - 2010-2012: neural nets smashed previous records in speech-to-text and object recognition, ML increasingly adopted by the tech industry
 - 2016: AlphaGo defeated the human Go champion
 - 2018-now: generating photorealistic images and videos
 - 2020: GPT3 language model
- Now - increasing attention to ethical and societal implications

Why deep learning did not work back then?

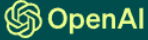
Geoffrey Hinton summarized the findings up to today in these four points:

- Our labeled datasets were thousands of times too small.
- Our computers were millions of times too slow.
- We initialized the weights in a stupid way.
- We used the wrong type of non-linearity.

Current Major Players

- OpenAI
 - Google
 - Tesla
 - Baidu
 - Moonshot AI
 - Universities
-
- NVIDIA (essential)

OpenAI



Research ▾ API ▾ ChatGPT ▾ Safety Company ▾

Search Log in ↗ Try ChatGPT ↗

ChatGPT ●

Overview Team Enterprise Pricing

9:41

ChatGPT >

Me

I am hosting my friends for brunch on Sunday and they are asking what to bring. Could you give me a list of suggestions? I'll be making a frittata and mimosas.

ChatGPT

Certainly! Here's a list of brunch items your friends could bring:

1. Fresh fruit salad or a fruit platter
2. Pastries or croissants
3. Bagels with cream cheese and smoked salmon
4. Yogurt with granola and berries
5. Breakfast potatoes or hash browns
6. Sausages or bacon
7. Quiches or savory tarts
8. Pancakes or waffles with syrup
9. Coffee or tea
10. Freshly squeezed orange juice

These options can complement your frittata and mimosas nicely and provide a variety of flavors for your brunch gathering. ●

ChatGPT 3.5 ▾

was quiet for a moment and then he started again.

Can you give me feedback on my short story?

ChatGPT

Your writing is engaging and provides insight into the protagonist's feelings and past experiences. You effectively use descriptive language to paint a picture of the setting and the characters. The dialogue between the protagonist and their father feels natural and adds depth to the story. Additionally, your writing style is clear and easy to follow. However, there are a few areas where you could improve:

1. Punctuation and grammar: There are some minor punctuation and grammar issues throughout the text that could be polished for a smoother reading experience.
2. Clarity: Some parts of the story could benefit from a bit more clarity or elaboration, especially in the transition between scenes and the protagonist's internal thoughts.
3. Show, don't tell: While you do a good job of describing the physical setting, there are moments where you tell the reader about the character's feelings and past experiences. Consider showing these emotions through actions, dialogue, or internal monologue to make the narrative more immersive.

Overall, your writing is well-crafted and engaging, with room for minor improvements in mechanics and clarity. Keep up the good work! ●

Message ChatGPT...

ChatGPT can make mistakes. Consider checking important information.

Download on the App Store

GET IT ON Google Play

Try on web ↗



Attention Is All You Need

Ashish Vaswani* Noam Shazeer* Niki Parmar* Jakob Uszkoreit*
Google Brain Google Brain Google Research Google Research
avaswani@google.com noam@google.com nikip@google.com usz@google.com

Llion Jones* Aidan N. Gomez*[†] Łukasz Kaiser*
Google Research University of Toronto Google Brain
llion@google.com aidan@cs.toronto.edu lukaszkaizer@google.com

Illia Polosukhin*[‡]
illia.polosukhin@gmail.com

Abstract

The dominant sequence transduction models are based on complex recurrent or convolutional neural networks that include an encoder and a decoder. The best performing models also connect the encoder and decoder through an attention mechanism. We propose a new simple network architecture, the Transformer, based solely on attention mechanisms, dispensing with recurrence and convolutions entirely. Experiments on two machine translation tasks show these models to be superior in quality while being more parallelizable and requiring significantly less time to train. Our model achieves 28.4 BLEU on the WMT 2014 English-to-German translation task, improving over the existing best results, including ensembles, by over 2 BLEU. On the WMT 2014 English-to-French translation task, our model establishes a new single-model state-of-the-art BLEU score of 41.8 after training for 3.5 days on eight GPUs, a small fraction of the training costs of the best models from the literature. We show that the Transformer generalizes well to other tasks by applying it successfully to English constituency parsing both with large and limited training data.

BERT: Pre-training of Deep Bidirectional Transformers for Language Understanding

Jacob Devlin Ming-Wei Chang Kenton Lee Kristina Toutanova
Google AI Language
{jacobdevlin, mingweichang, kentonl, kristout}@google.com

Abstract

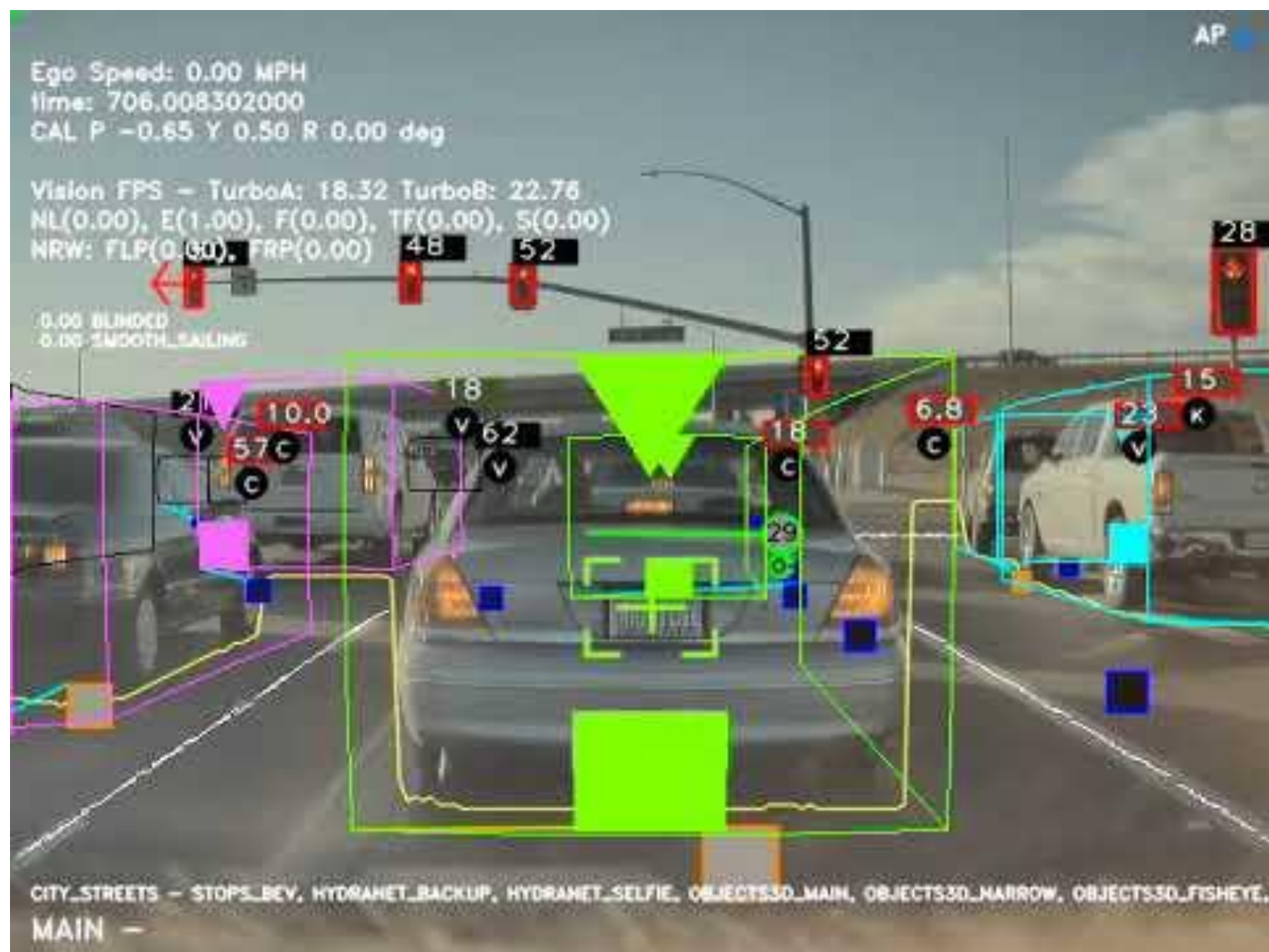
We introduce a new language representation model called **BERT**, which stands for **B**idirectional **E**ncoder **R**epresentations from **T**ransformers. Unlike recent language representation models (Peters et al., 2018a; Radford et al., 2018), BERT is designed to pre-train deep bidirectional representations from unlabeled text by jointly conditioning on both left and right context in all layers. As a result, the pre-trained BERT model can be fine-tuned with just one additional output layer to create state-of-the-art models for a wide range of tasks, such as question answering and language inference, without substantial task-specific architecture modifications.

BERT is conceptually simple and empirically powerful. It obtains new state-of-the-art results on eleven natural language processing tasks, including pushing the GLUE score to 80.5% (7.7% point absolute improvement), MultiNLI accuracy to 86.7% (4.6% absolute improvement), SQuAD v1.1 question answering Test F1 to 93.2 (1.5 point absolute improvement) and SQuAD v2.0 Test F1 to 83.1 (5.1 point absolute improvement).

There are two existing strategies for applying pre-trained language representations to downstream tasks: *feature-based* and *fine-tuning*. The feature-based approach, such as ELMo (Peters et al., 2018a), uses task-specific architectures that include the pre-trained representations as additional features. The fine-tuning approach, such as the Generative Pre-trained Transformer (OpenAI GPT) (Radford et al., 2018), introduces minimal task-specific parameters, and is trained on the downstream tasks by simply fine-tuning *all* pre-trained parameters. The two approaches share the same objective function during pre-training, where they use unidirectional language models to learn general language representations.

We argue that current techniques restrict the power of the pre-trained representations, especially for the fine-tuning approaches. The major limitation is that standard language models are unidirectional, and this limits the choice of architectures that can be used during pre-training. For example, in OpenAI GPT, the authors use a left-to-right architecture, where every token can only attend to previous tokens in the self-attention layers

Tesla



Baidu



Moonshot AI

 Moonshot AI



你好， 欢迎探索月之暗面

寻求将能源转化为智能的最优解

 **Kimi.ai**

Kimi 是一个有着超大“内存”的智能助手，可以一口气读完二十万字的小说，还会上网冲浪，快来跟他聊聊吧

立即体验 →


Moonshot 开放平台

开放平台支持灵活的 API 调用，轻松完成对接，让您的程序拥有领先体验

立即体验 →

NVIDIA



昇思
MindSpore


安装 学习 文档 资源 社区 动态 昇思大模型平台 HOT


Q 全站搜索... 代码 中文


AI开发平台 ModelArts


面向开发者的一站式AI开发平台，为机器学习与深度学习提供海量数据预处理及半自动化标注、大规模分布式 Training、自动化模型生成，及端-边-云模型按需部署能力，帮助用户快速创建和部署模型，管理全周期AI workflow。


[查看详情 →](#)



应用案例
各行业领域使用昇思MindSpore案例

昇思2.2版本正式发布
持续提升大模型能力

知识地图
从入门到精通，玩转MindSpore

昇思社区活动
开源社区交流分享

昇思MindSpore，全场景AI框架

NVIDIA

NVIDIA Corp

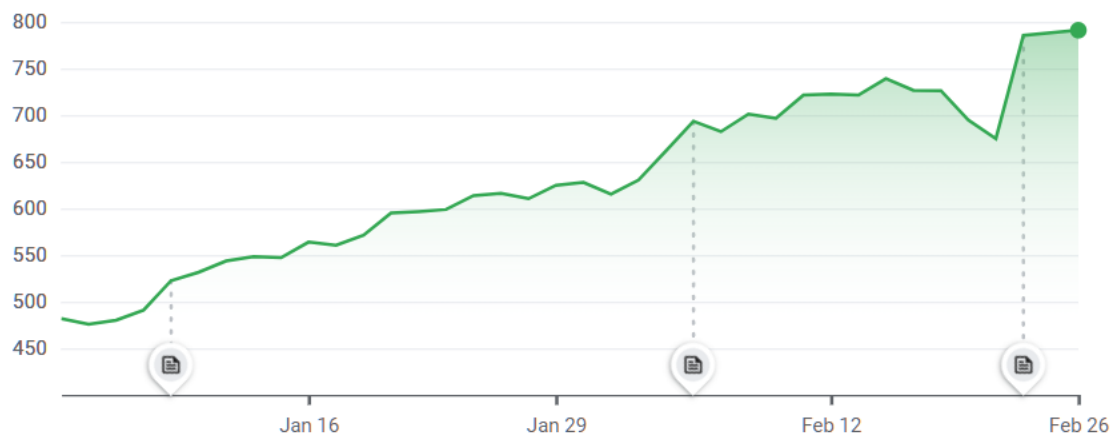
\$790.92 ↑ 64.20% +309.24 YTD

After Hours: **\$789.50** (↓ 0.18%) -1.42

Closed: Feb 26, 7:59:45 PM UTC-5 · USD · NASDAQ · Disclaimer

1D 5D 1M 6M YTD 1Y 5Y MAX

Key events



The Wall Street ... • Jan 8, 2024

Chip Stocks Climb as Nvidia Shares Rise

↑ 6.43% on that day

Investor's Busin... • Feb 5, 2024

Nvidia Stock Unstoppable; Deckers Soars On Earnings Beat

↑ 4.79% on that day

The Wall Street ... • Feb 22, 2024

Nvidia Stock Leaps After Chipmaker's Blockbuster Earnings

↑ 16.40% on that day

THE WALL STREET JOURNAL.

English Edition | Print Edition | Video | Audio | Latest Headlines | More

World Business U.S. Politics Economy **Tech** Finance Opinion Arts & Culture Lifestyle Real Estate Personal Fin.

TECHNOLOGY | ARTIFICIAL INTELLIGENCE

Sam Altman Seeks Trillions of Dollars to Reshape Business of Chips and AI

OpenAI chief pursues investors including the U.A.E. for a project possibly requiring up to \$7 trillion

By [Keach Hagey](#) [Follow](#) and [Asa Fitch](#) [Follow](#)

Feb. 8, 2024 9:00 pm ET

[Share](#) [Bookmark](#) [Resize](#) [Gift unlocked article](#) [Listen \(8 min\)](#)

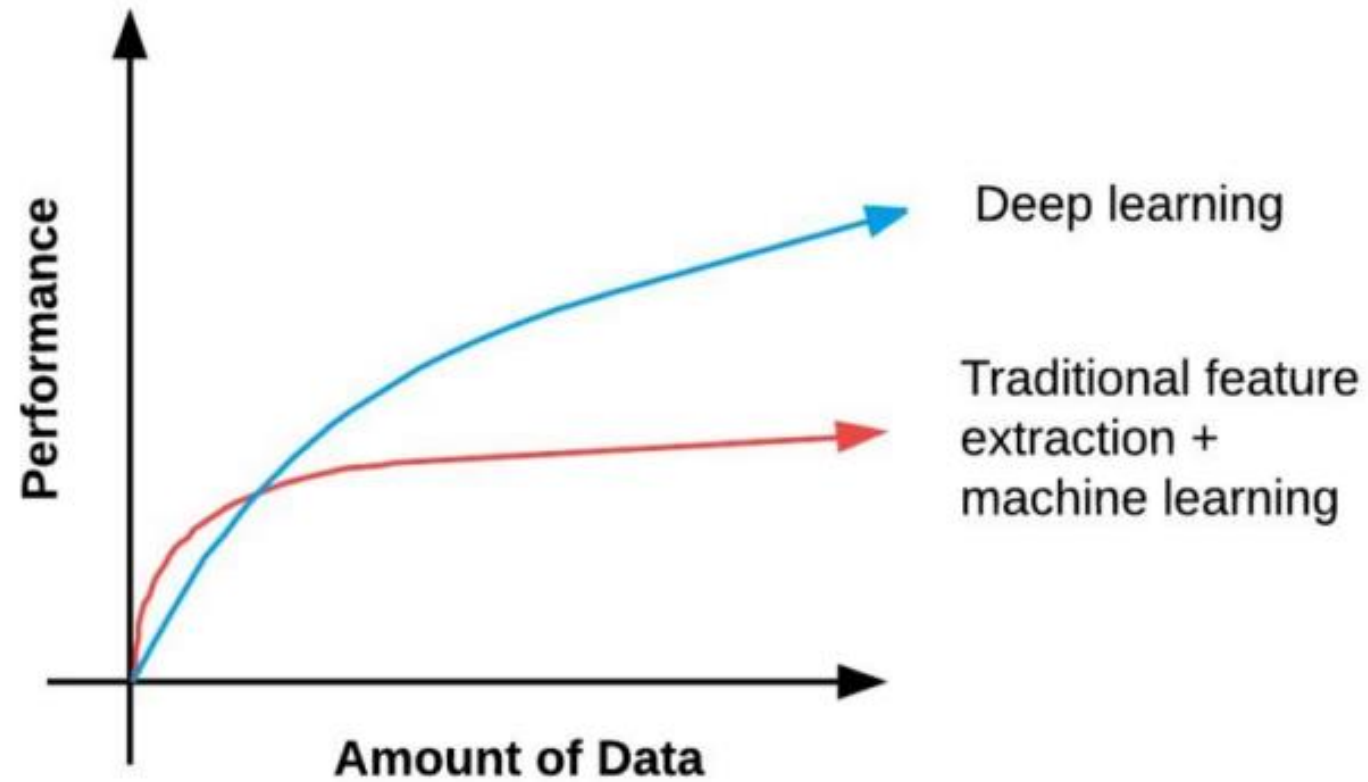


OpenAI CEO Sam Altman wants to boost the world's chip-building capacity and expand the ability to power AI. PHOTO: GIAN EHRENZELLER/EPA/SHUTTERSTOCK

Types of Machine Learning

- Statistic Machine Learning Models
 - LASSO
 - SVM
 - Random Forest
 - ...
- Deep Learning Models
 - MLP
 - CNN
 - RNN, LSTM (outdated)
 - Transformer
 - ...

ML VS. DL



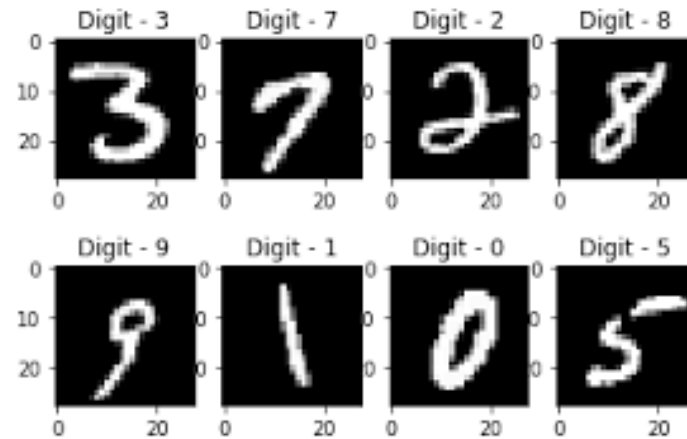
Credit: Adrian Rosebrock. 2017. Deep Learning for Computer Vision With Python. (2017)

Types of Machine Learning

- Supervised Learning
 - training data + desired outputs (labels)
- Semi-supervised Learning
 - A subset of supervised learning, training data + a few labels
- Unsupervised Learning
 - training data (without desired outputs)
- Self-supervised Learning
 - A subset of unsupervised learning, recover patterns from the data
- Reinforcement Learning
 - Rewards from sequence of actions

Tasks

- Computer vision: object detection, OCR, semantic segmentation...



Tasks

- NLP: Machine translation, sentiment analysis, topic modeling, spam filtering.

Chinese (Simplified) ▼

↔

English ▼

Enter text

Enter text

Translation

Translation

🎤

Open in Google Translate

•

Feedback



Back to Our Course

We follow this paper to explore the applications of various machine learning models within the finance research field:

Kelly, B., & Xiu, D. (2023). Financial machine learning. *Foundations and Trends® in Finance*, 13(3-4), 205-363.

Download link: https://bfi.uchicago.edu/wp-content/uploads/2023/07/BFI_WP_2023-100.pdf

Reference Books

Nielsen, Michael. [*Neural Networks and Deep Learning*](#), 2019.

周志华 . 《机器学习》 , 清华大学出版社, 2016.

Zhou, Zhi-Hua. *Machine learning*. Springer Nature, 2021.

Géron, Aurélien. *Hands-on machine learning with Scikit-Learn, Keras, and TensorFlow*. " O'Reilly Media, Inc.", 2022.

Stevens, Eli, Luca Antiga, and Thomas Viehmann. *Deep learning with PyTorch*. Manning Publications, 2020.

Goodfellow, Ian, Yoshua Bengio, and Aaron Courville. *Deep learning*. MIT press, 2016.

Course Requirement

- A functional laptop that can run python
- Attend the class
- A group project, 2-3 people pre group, and presentation
- Final report