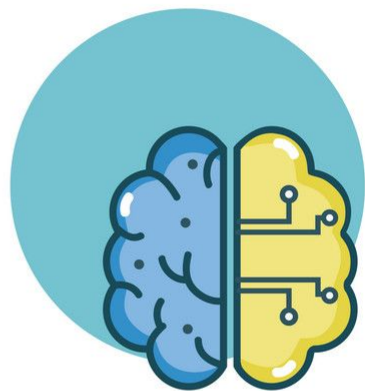


INTRODUCTION TO MACHINE LEARNING

INTRODUCTION



Elisa Ricci



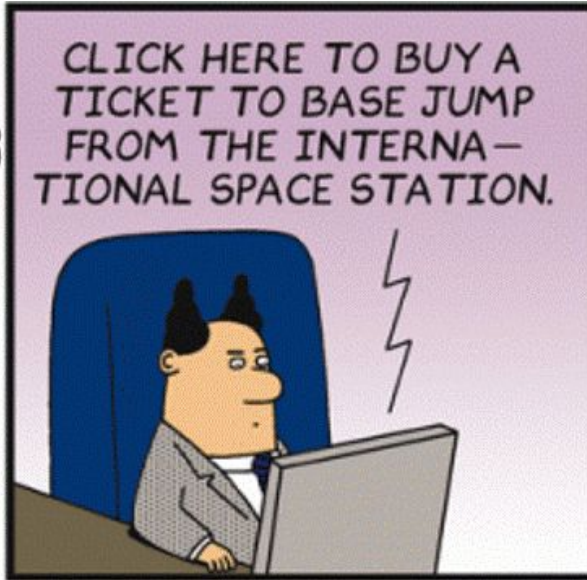
OUTLINE

- What is Machine Learning?
- Why it is worth studying it?

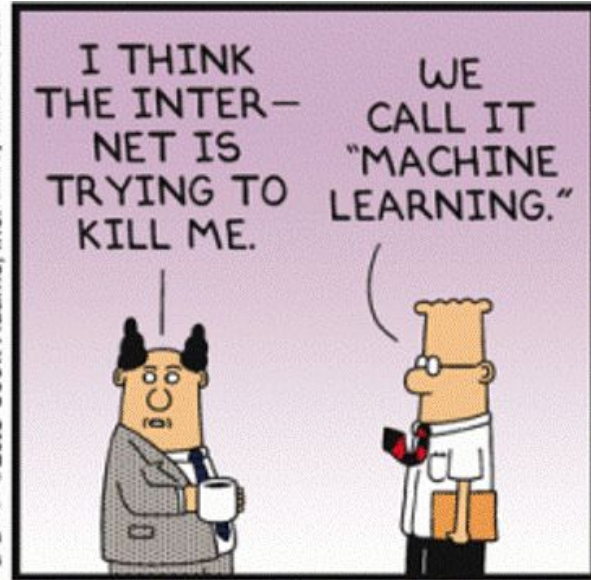
MACHINE LEARNING IS...



Dilbert.com DilbertCartoonist@gmail.com



2-2-13 © 2013 Scott Adams, Inc. /Dist. by Universal Uclick



MACHINE LEARNING IS...

Machine learning is the study of computer algorithms that improve automatically through experience. It is seen as a part of artificial intelligence.



WIKIPEDIA
The Free Encyclopedia

MACHINE LEARNING IS...

ChatGPT 3.5 ▾

In supervised learning, the algorithm learns from labeled data, where the inputs are paired with corresponding outputs. The goal is to learn a mapping from inputs to outputs, which can then be used to make predictions on new, unseen data.


In unsupervised learning, the algorithm learns from unlabeled data, where there are no predefined output labels. Instead, the algorithm seeks to find patterns, structure, or relationships in the data.

Semi-supervised learning combines elements of both supervised and unsupervised learning, using a small amount of labeled data along with a larger amount of unlabeled data.

Reinforcement learning involves training an algorithm to make sequences of decisions by rewarding it for good decisions and penalizing it for bad ones, based on feedback from its environment.

Machine learning has a wide range of applications, including but not limited to image and speech recognition, natural language processing, recommendation systems, medical diagnosis, and autonomous vehicles.

 **You**
what is machine learning (in a sentence)?

 **ChatGPT**
Machine learning is the field of study that gives computers the ability to learn and improve from experience without being explicitly programmed.



Message ChatGPT...



ChatGPT can make mistakes. Consider checking important information.



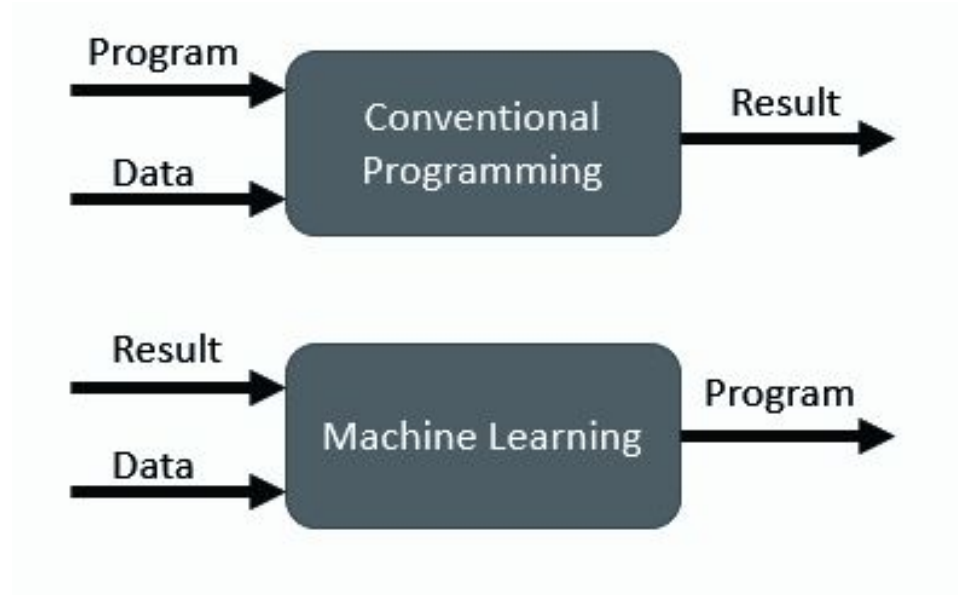
MACHINE LEARNING IS...



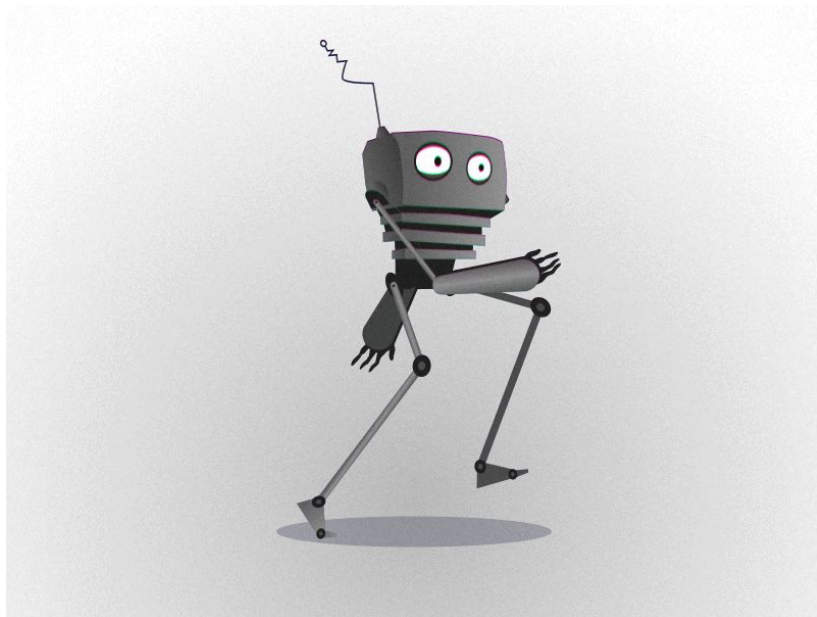
Machine learning is the science of getting computers to act without being explicitly programmed.

A. Samuel (1959)

MACHINE LEARNING IDEA



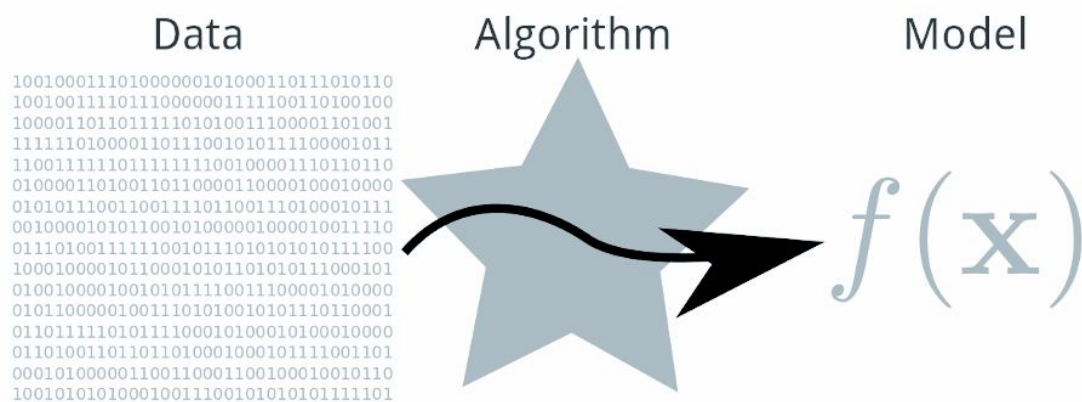
MACHINE LEARNING IDEA



...if we want a robot to be able to walk, we could program the robot to **learn to walk**, or we could attempt to **directly write a program** that specifies how to walk manually.

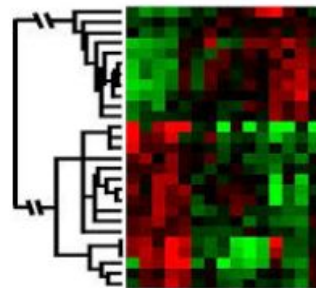
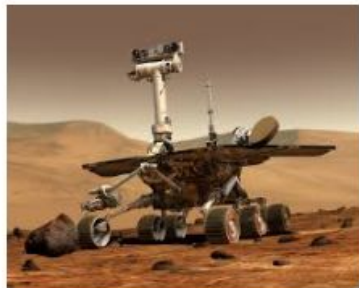
MACHINE LEARNING IDEA

- ML allows computers to acquire knowledge.
- Knowledge is acquired through **algorithms** by learning and inferring from **data**.
- Knowledge is represented by a **model**.
- The model is used on future data.



MACHINE LEARNING: WHEN LEARNING FROM DATA

- ML is used when:
 - Human expertise does not exist (navigating on Mars)
 - Humans cannot explain their expertise (speech recognition)
 - Models must be customized (personalized medicine)
 - Models are based on huge amounts of data (genomics)

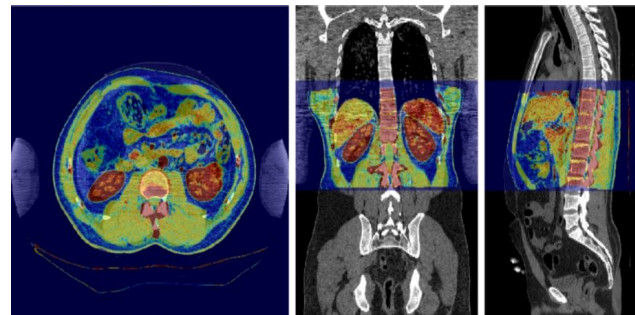
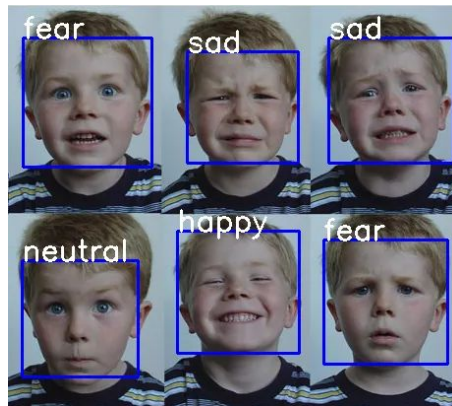
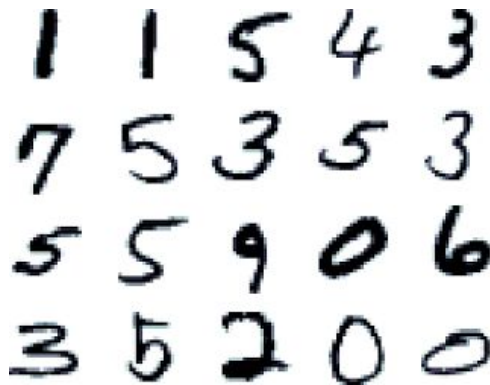


- Learning isn't always useful:
 - There is no need to “learn” to calculate payroll

MACHINE LEARNING: WHEN LEARNING FROM DATA

- **Recognizing patterns:**

- Handwritten digits
- Facial identities or facial expressions
- Medical images



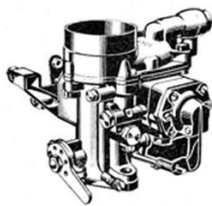
MACHINE LEARNING: WHEN LEARNING FROM DATA

- **Generating** patterns:
 - Generating images or motion sequences

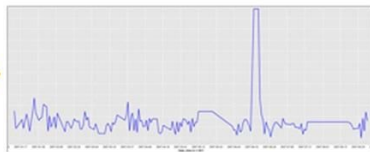


MACHINE LEARNING: WHEN LEARNING FROM DATA

- Recognizing anomalies
 - Unusual credit card transactions
 - Unusual patterns of sensor readings



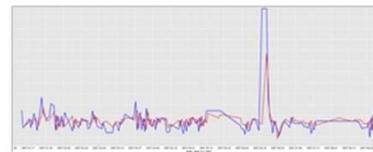
System with
sensors



Time Series from
sensors



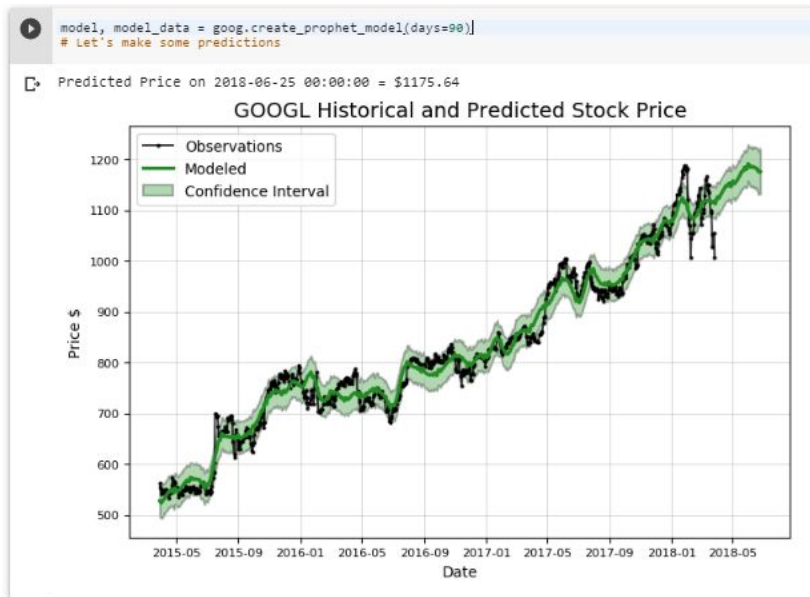
Training of
Machine Learning
model



Predicted
Time Series

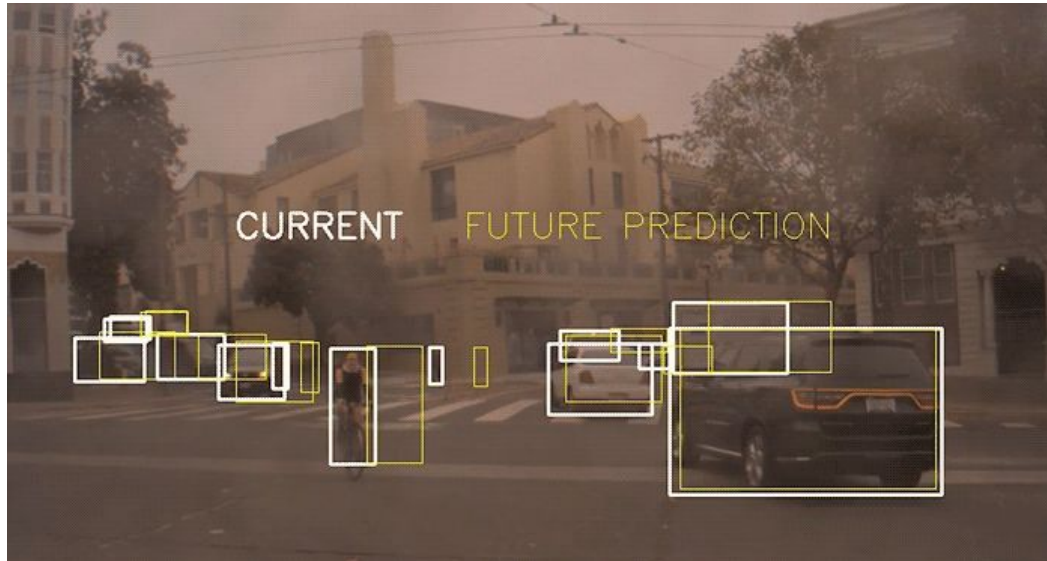
MACHINE LEARNING: WHEN LEARNING FROM DATA

- Prediction:
 - Future stock prices or currency exchange rates



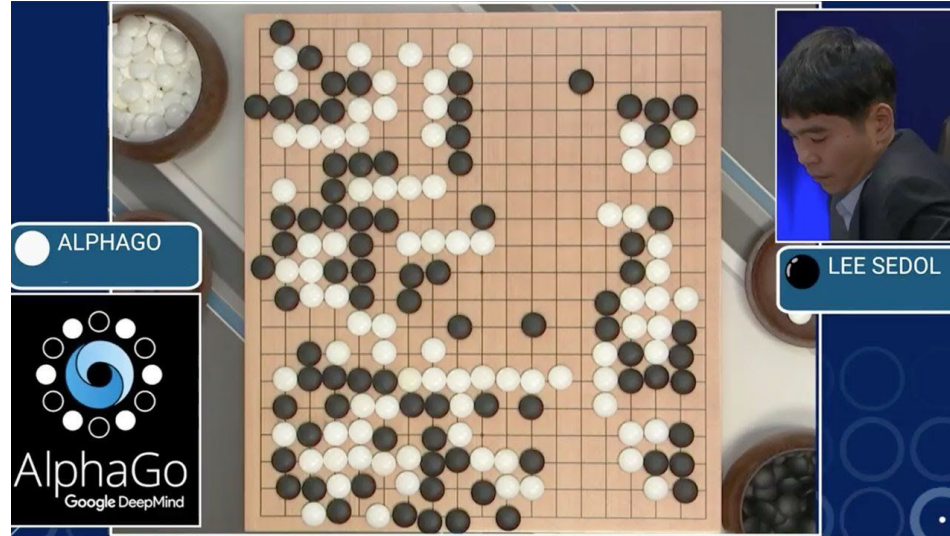
MACHINE LEARNING: WHEN LEARNING FROM DATA

- Prediction:
 - Autonomous driving

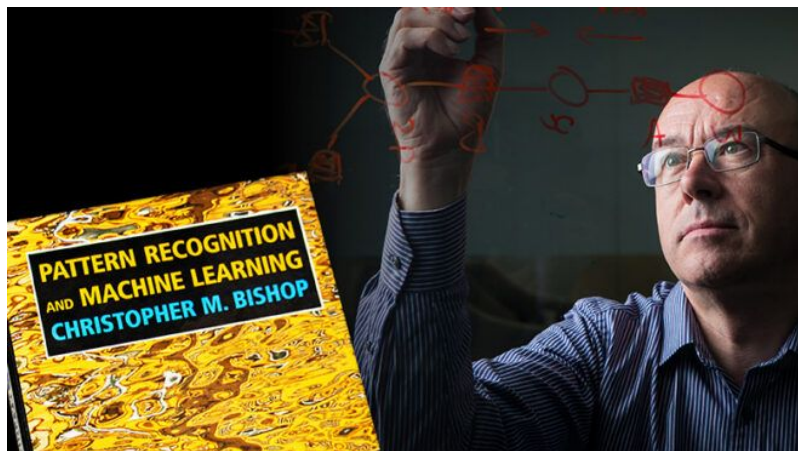


MACHINE LEARNING: WHEN LEARNING FROM DATA

- Predict best moves
 - Play Go against humans



MACHINE LEARNING IS...



It is concerned with the **automatic discovery of regularities in data** through the use of computer algorithms and with the use of these regularities to take actions.

Christopher M. Bishop

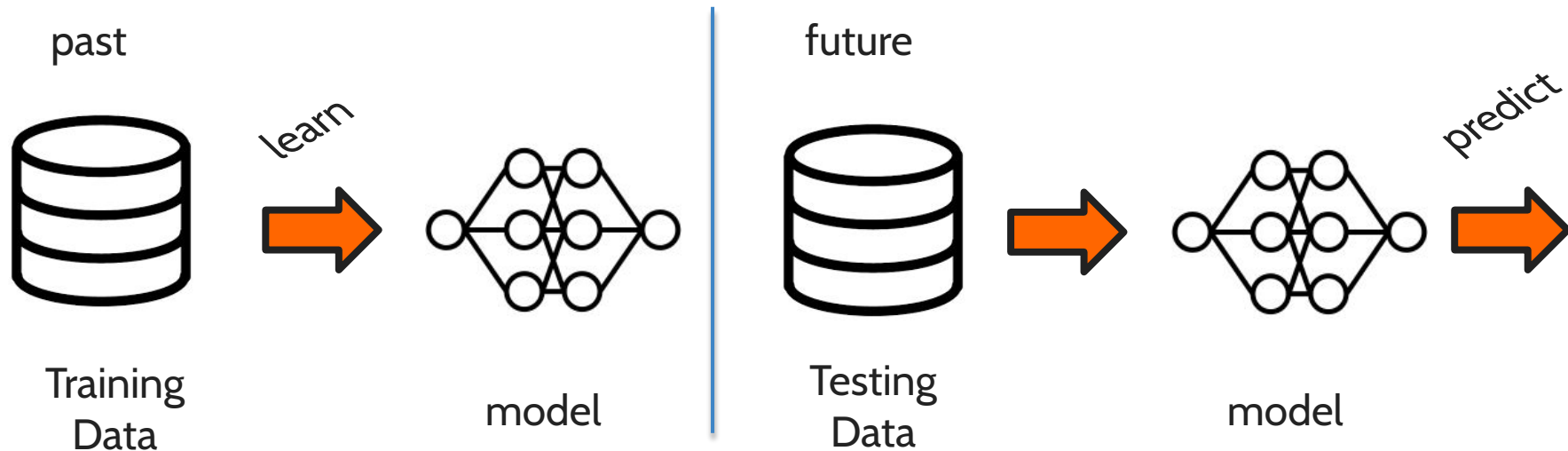
MACHINE LEARNING IS...



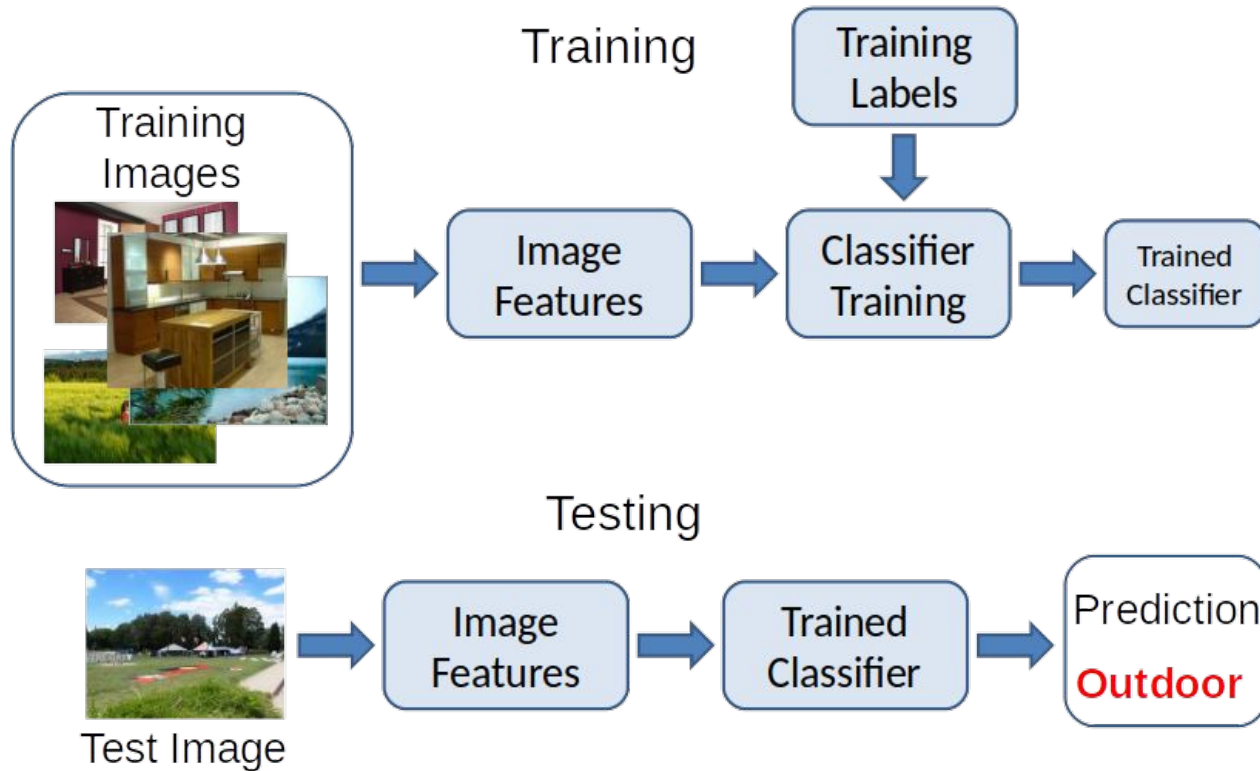
The goal of machine learning is to develop methods that can **automatically detect patterns in data**, and then to use the uncovered patterns to **predict future data** or other outcomes of interest.

Kevin P. Murphy

MACHINE LEARNING IS...



AN EXAMPLE



MACHINE LEARNING IS...



A computer program is said to learn from **experience E** with respect to some class of **tasks T** and performance **measure P**, if its performance at tasks in T, as measured by P, improves with experience E.”.

T. Mitchell (1970)

MACHINE LEARNING IS...

- 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 **a triplet $\langle T, P, E \rangle$** .
- *Can you give some examples?*

MACHINE LEARNING IS...

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

T: Recognizing handwritten words

P: Percentage of words correctly classified

E: Database of human-labeled images of handwritten words

T: Driving on four-lane highways using vision sensors

P: Average distance traveled before a human-judged error

E: A sequence of images and steering commands recorded while observing a human driver.

T: Categorize email messages as spam or legitimate.

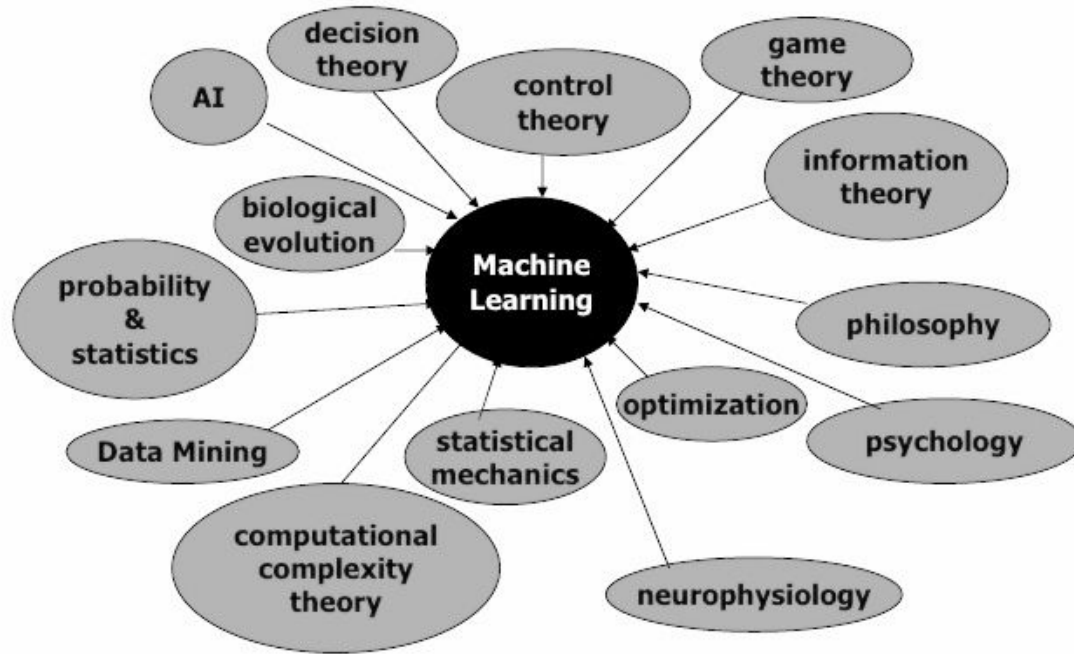
P: Percentage of email messages correctly classified.

E: Database of emails, some with human-given labels

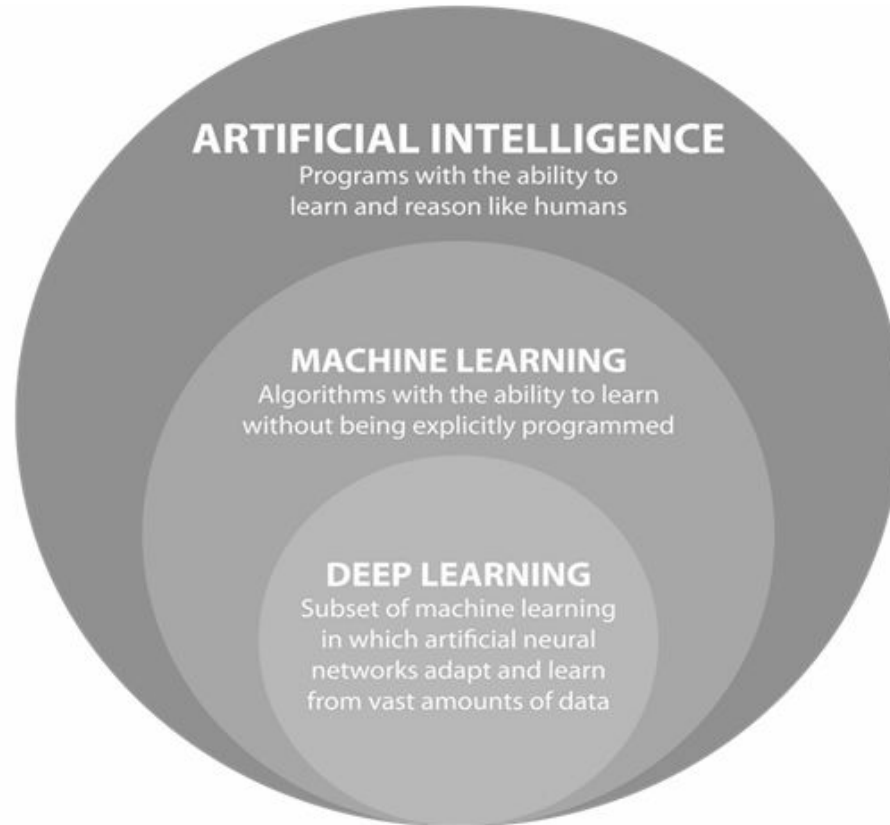
RELATED DISCIPLINES

- ***data mining***: data analysis, not prediction, though often involves some shared techniques
- ***inference*** and/or ***estimation*** in statistics
- ***pattern recognition*** in engineering
- ***signal processing*** in electrical engineering
- ***optimization***

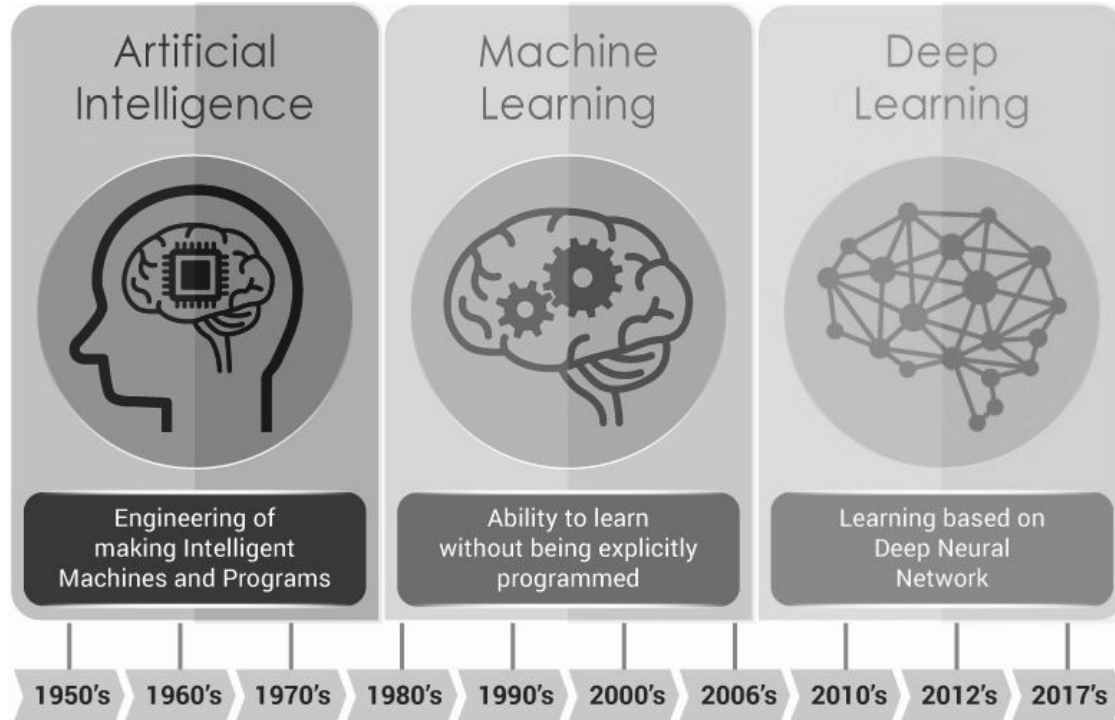
RELATED DISCIPLINES



MACHINE LEARNING, AI & DEEP LEARNING



MACHINE LEARNING, AI & DEEP LEARNING



ARTIFICIAL INTELLIGENCE IS...



Our ultimate objective is to make programs that learn from their experience as effectively as humans do.

J. McCarthy, 1958

MACHINE LEARNING IS...



Machine learning is the science of getting computers to act without being explicitly programmed.

A. Samuel (1959)

MACHINE LEARNING SUCCESS STORIES

Face detection (2002)



MACHINE LEARNING SUCCESS STORIES

Pedestrian Detection (2005)



MACHINE LEARNING SUCCESS STORIES

Body Tracking (RGB-D)



DEEP LEARNING IS...

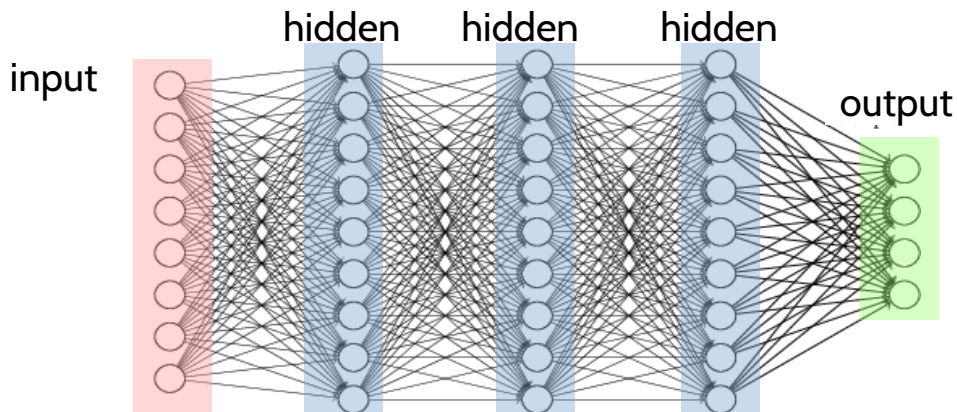


“Deep learning allows computational models that are composed of multiple processing layers to learn representations of data with multiple levels of abstraction”

Nature

DEEP LEARNING IS...

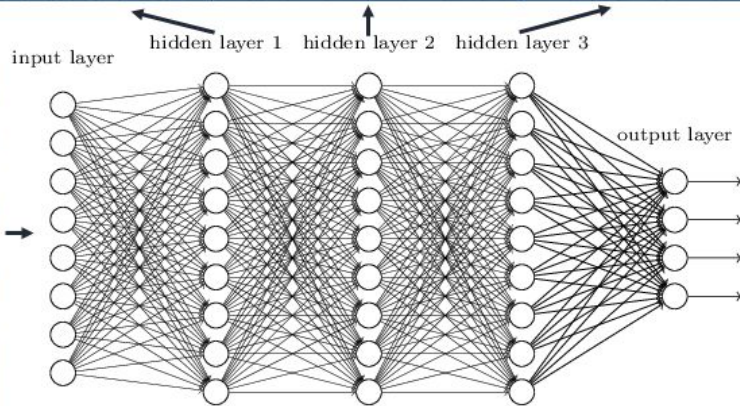
Deep Learning means using a neural network with several layers of nodes between input and output



DEEP LEARNING IS...

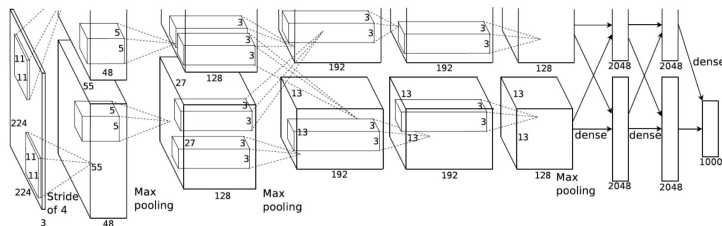
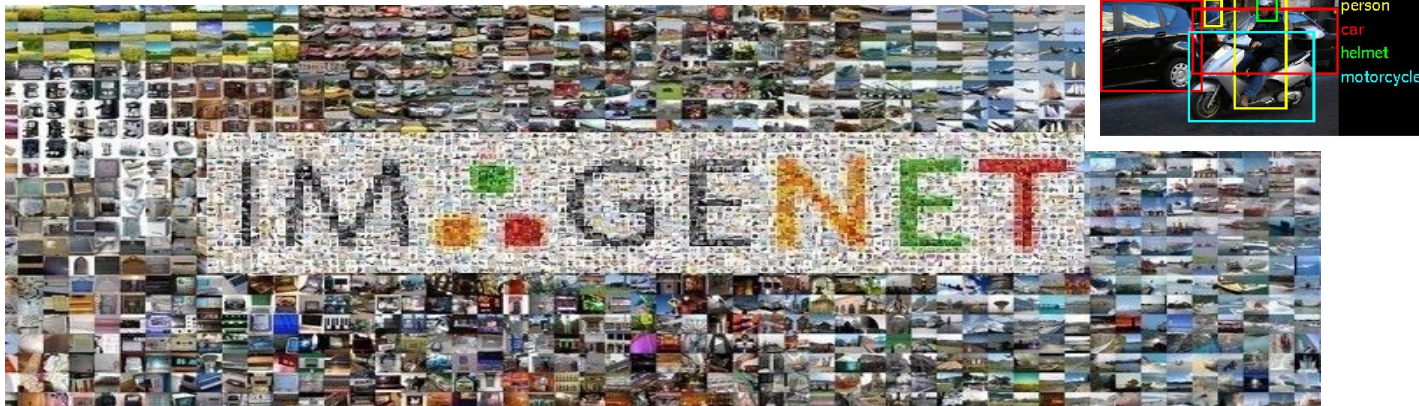
The series of layers between input and output compute relevant features automatically in a series of stages, just as our brains seem to.

Deep neural networks learn hierarchical feature representations

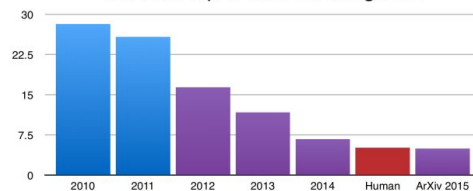


DEEP LEARNING SUCCESS STORIES

Object recognition (2012)

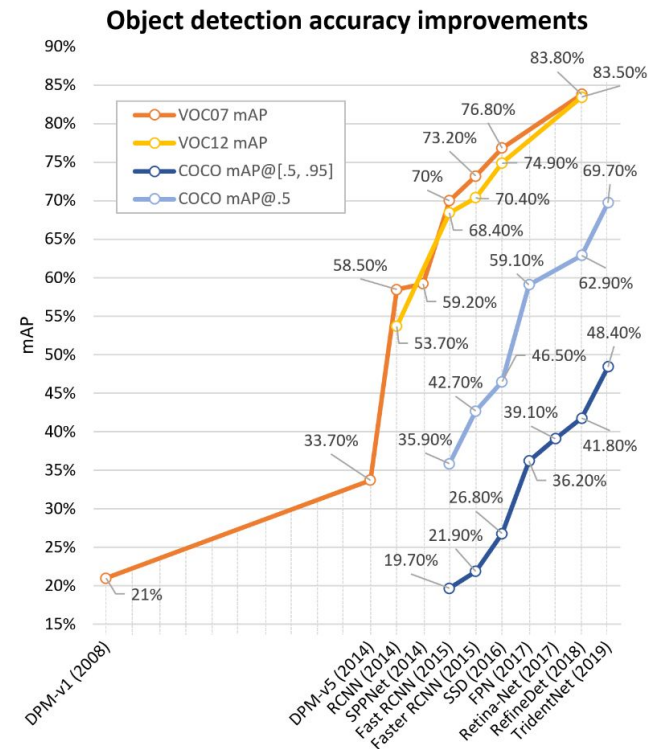
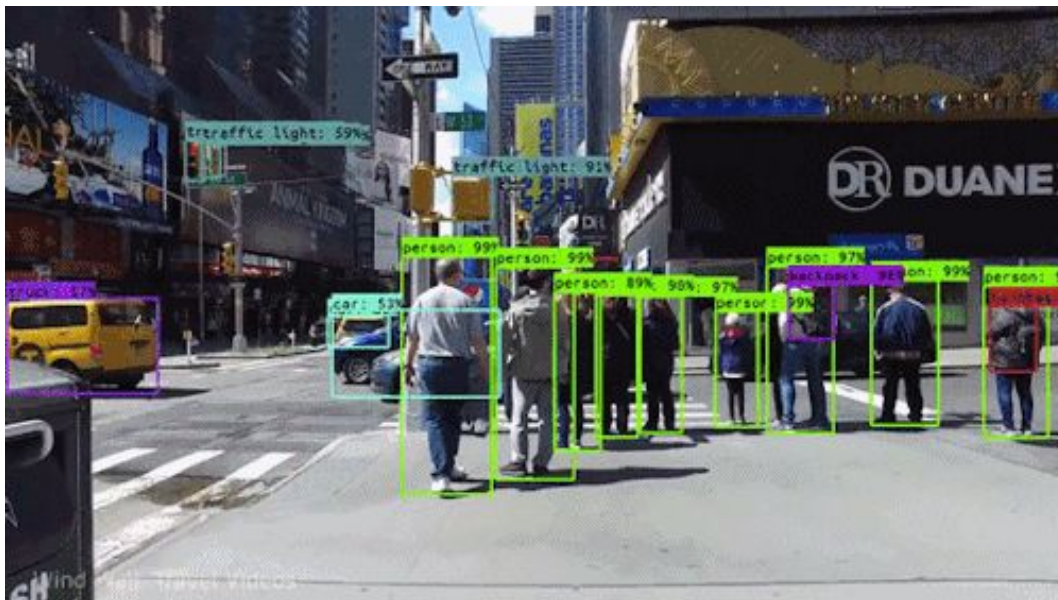


ILSVRC top-5 error on ImageNet



DEEP LEARNING SUCCESS STORIES

Object detection

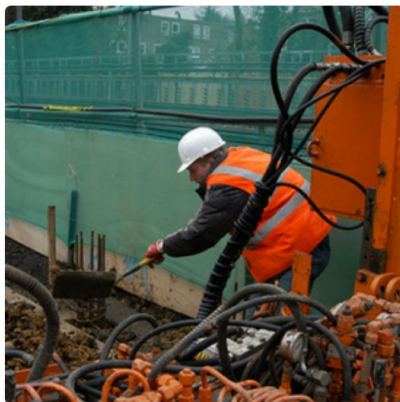


DEEP LEARNING SUCCESS STORIES

Image captioning (2015)



"man in black shirt is playing guitar."



"construction worker in orange safety vest is working on road."



"two young girls are playing with lego toy."

DEEP LEARNING SUCCESS STORIES

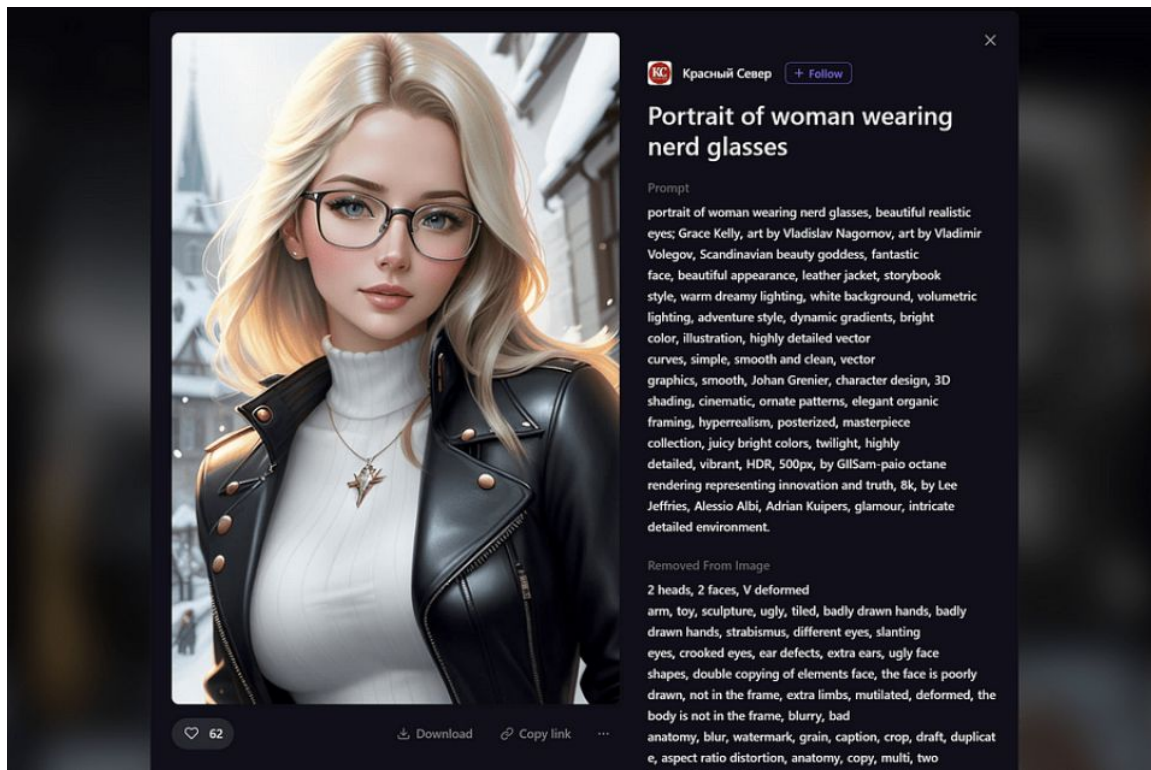
Image synthesis (2016)



[Image credit: NVIDIA - GauGAN]

DEEP LEARNING SUCCESS STORIES

Text to Image synthesis (2022)



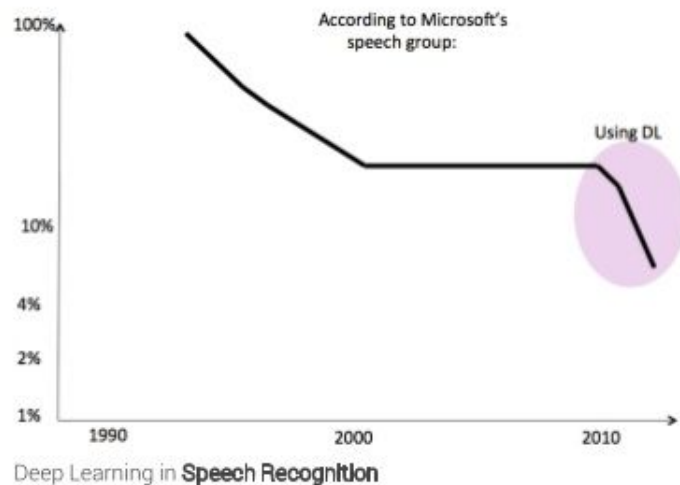
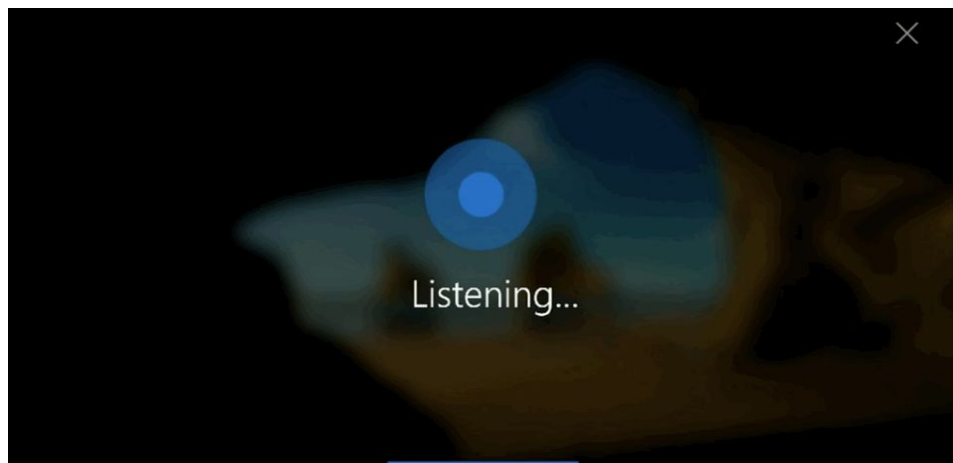
DEEP LEARNING SUCCESS STORIES

Video synthesis
(2024)



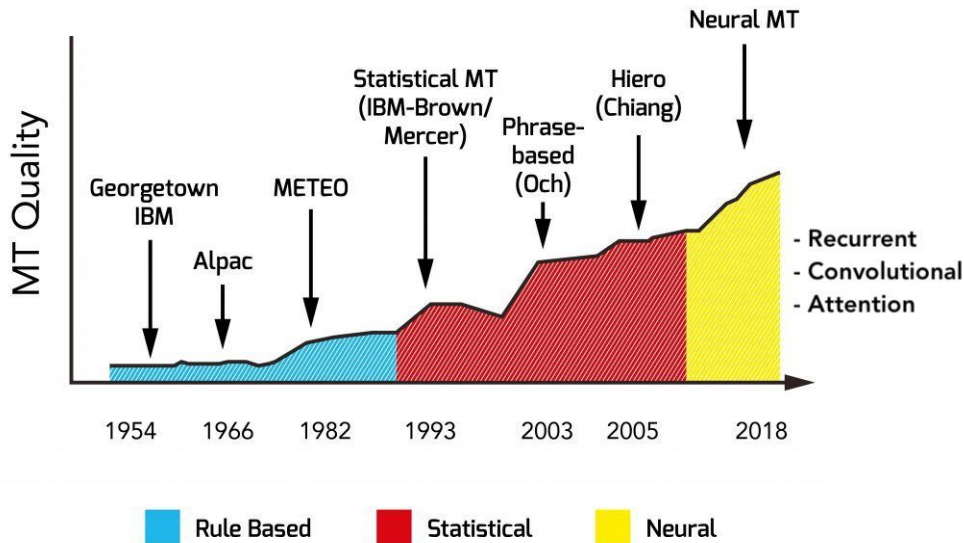
DEEP LEARNING SUCCESS STORIES

Speech Recognition (2009)



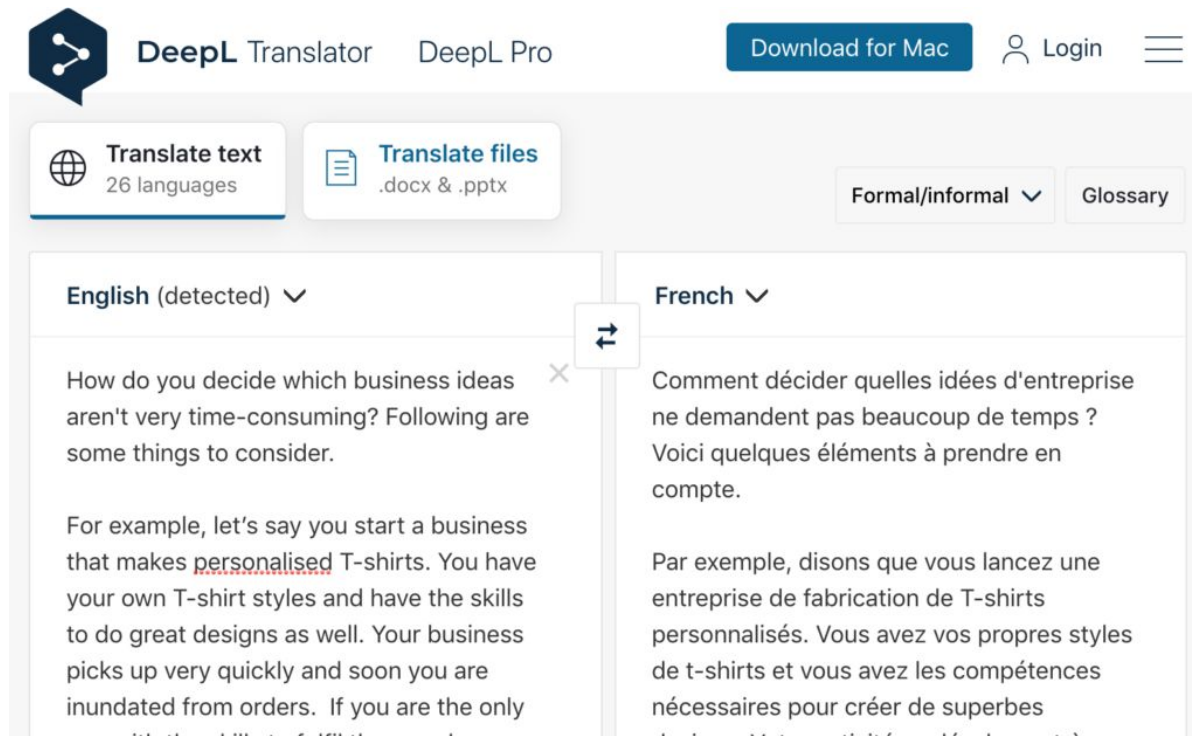
DEEP LEARNING SUCCESS STORIES

Neural Machine Translation (2014)



DEEP LEARNING SUCCESS STORIES

Neural Machine Translation



The screenshot displays the DeepL Translator web application. At the top, the logo is a blue hexagon with a white network icon. To its right are the labels "DeepL Translator" and "DeepL Pro". Further right is a blue button labeled "Download for Mac", followed by a "Login" link with a user icon and a hamburger menu icon. Below the header, there are two main buttons: "Translate text" (with a globe icon and "26 languages") and "Translate files" (with a document icon and ".docx & .pptx"). To the right of these are buttons for "Formal/informal" (with a dropdown arrow) and "Glossary". The main content area is split into two columns. The left column is labeled "English (detected)" with a dropdown arrow. It contains two paragraphs of English text. The right column is labeled "French" with a dropdown arrow. It contains the corresponding French translation of the text. A small square button with a double-headed arrow is positioned between the two columns, allowing for switching the translation direction. A small 'x' icon is visible next to the first paragraph in the English column.

DeepL Translator DeepL Pro [Download for Mac](#) [Login](#)

Translate text 26 languages **Translate files** .docx & .pptx **Formal/informal** **Glossary**

English (detected) **French**

How do you decide which business ideas aren't very time-consuming? Following are some things to consider.

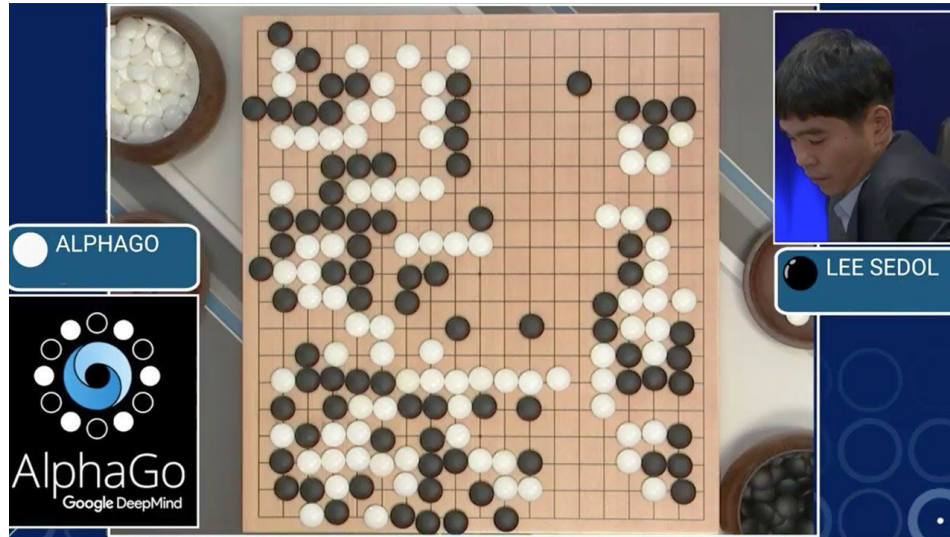
For example, let's say you start a business that makes personalised T-shirts. You have your own T-shirt styles and have the skills to do great designs as well. Your business picks up very quickly and soon you are inundated from orders. If you are the only

Comment décider quelles idées d'entreprise ne demandent pas beaucoup de temps ? Voici quelques éléments à prendre en compte.

Par exemple, disons que vous lancez une entreprise de fabrication de T-shirts personnalisés. Vous avez vos propres styles de t-shirts et vous avez les compétences nécessaires pour créer de superbes

DEEP LEARNING SUCCESS STORIES

AlphaGO (2015)



DEEP LEARNING SUCCESS STORIES

ChatGPT (2022)



What is ChatGPT?



ChatGPT is a chatbot designed to assist with customer support, conversation, and information gathering tasks. It uses natural language processing and GPT-3 technology to generate responses that are tailored to the user's input. ChatGPT can handle a wide range of queries and provide answers in real-time, making it a valuable tool for businesses looking to improve their customer support experience.

< 2 / 2 >



DEEP LEARNING REVOLUTION: WHY NOW?

- Flood of available data
- Increased computational power
- Growing number of ML algorithms and theory developed by researchers
- Increased support from industry

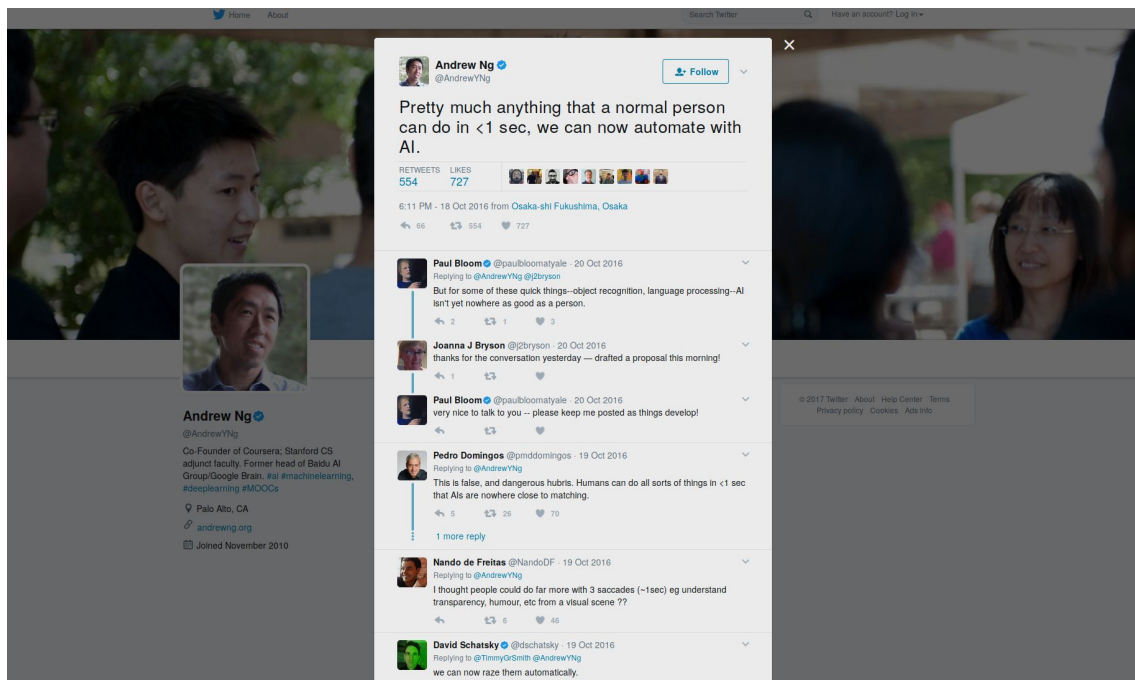
WHY STUDYING MACHINE LEARNING?

Machine Learning is everywhere.



WHY STUDYING MACHINE LEARNING?

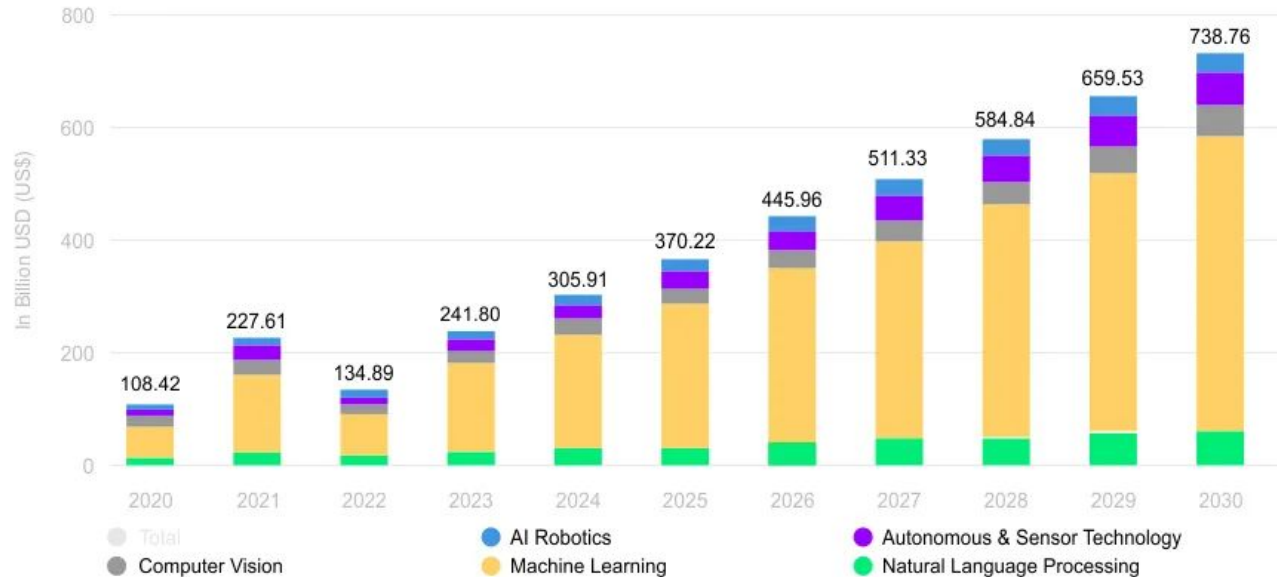
Machine Learning is everywhere.



MACHINE LEARNING JOBS

MARKET SIZE

MARKET SIZE CHANGE



Notes: Data shown is using current exchange rates and reflects market impacts of the Russia-Ukraine war.

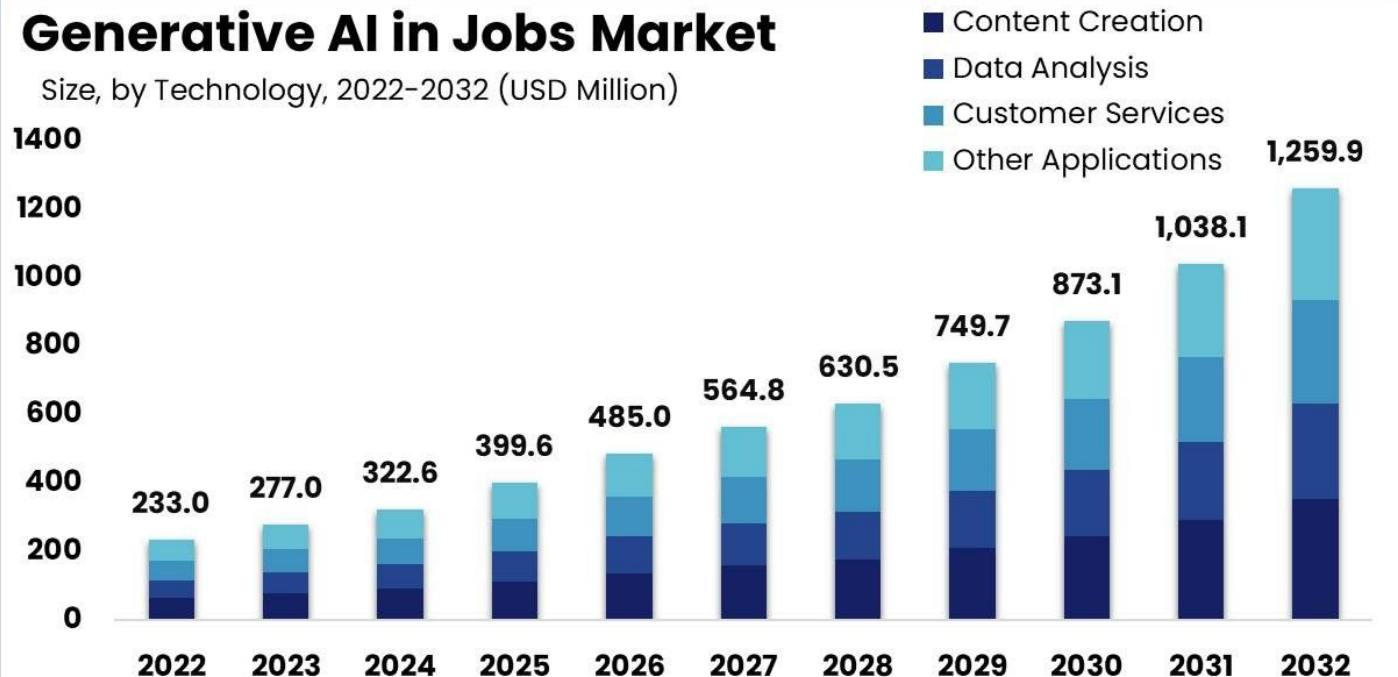
Most recent update: Aug 2023

Source: Statista Market Insights

MACHINE LEARNING JOBS

Generative AI in Jobs Market

Size, by Technology, 2022-2032 (USD Million)



The Market will Grow
At the CAGR of:

18.9%

The forecasted market
size for 2032 in USD:

\$1,259.9M



MarketResearch**.biz**
WIDE RANGE OF GLOBAL MARKET REPORTS

MACHINE LEARNING JOBS

The screenshot shows a web browser displaying the 'Agenda Digitale' website. The URL in the address bar is <https://www.agendadigitale.eu/cultura-digitale/intelligenza-artificiale-la-via-italiana-ecco-i-settori-a-maggiore-potenziale/>. The page features a dark blue header with the 'Agenda Digitale' logo and a navigation menu. The main content area has a white background with a large article title. On the left, there is a sidebar with an IBM logo and event information. On the right, there are two promotional boxes: one for a webinar and another for 'ESG360'. The article text discusses the potential of artificial intelligence in Italy across various sectors.

NETWORK **DIGITAL 360** I NOSTRI SERVIZI

MENU Agenda **Digitale** Cittadinanza digitale Sicurezza Informatica Sanità digitale Industry 4.0 Infrastrutture digitali Procurement dell'innovazione Fatturazione elettronica Documenti digitali Scuola digitale ACCEDI

IBM

"All In" Hybrid Cloud con IBM
11 marzo 2021
Live da IBM Garage
Registrati →

Automazione, modernizzazione, sicurezza, accelerazione con l'AI
Registrati →

SCENARI

Intelligenza artificiale, la via italiana: ecco i settori a maggiore potenziale

Home > Cultura Digitale

f in t e s

L'intelligenza artificiale, seppure a piccoli passi, continua a farsi strada nel nostro Paese. Dall'agricoltura alla manifattura, dalla cultura e turismo alla salute e benessere, all'ambiente, le infrastrutture e la PA, vediamo quali sono i settori in cui la tecnologia potrà esprimere al meglio il suo potenziale

14 Ott 2020

Maria Rosaria Della Porta
research fellow Istituto per la Competitività, I-Com

WEBINAR
Intelligenza artificiale: Impatto sulle nostre vite, diritti e libertà

Il webcast è disponibile **GUARDA**

ESG360
Il portale sull'innovazione per la sostenibilità

IBM

BENEFITS



Efficiency

Automate repetitive tasks, increasing efficiency and productivity.



Decision Support

Analyze vast amounts of data to provide valuable insights for decision-making.



Accuracy

ML systems can perform complex tasks with precision and accuracy.



Innovation

Development of innovative solutions and technologies.

RISKS



Algorithmic Bias

AI can perpetuate biases in decision-making, impacting fairness.



Privacy Concerns

AI technologies raise privacy issues through the collection and analysis of massive amounts of personal data.

RISKS



Bias in Facial Recognition

Facial recognition systems have shown biases against certain demographics, leading to discriminatory outcomes in law enforcement and surveillance.



Misinformation by Chatbots

AI-powered chatbots have spread misinformation and fake news, leading to widespread confusion and mistrust in online information sources.

RISKS

Job Displacement

Automation thanks to ML may lead to widespread job loss, particularly in industries relying on routine tasks.

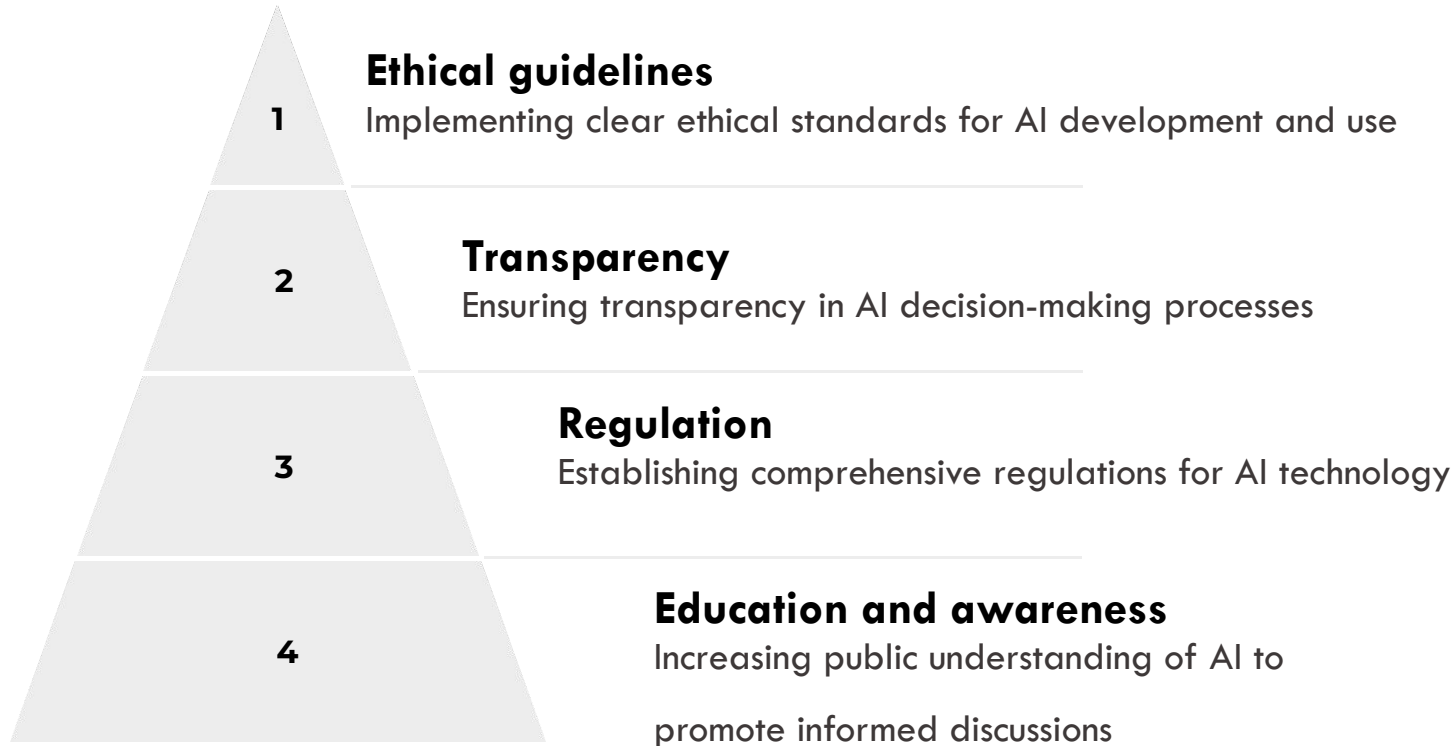
Growing and declining occupations, globally

These are the jobs that have grown or declined the most over the past 5 years.



Declining jobs, and their associated occupational change indices, were identified by tracking how each occupation's share of total hiring on LinkedIn's platform. Hiring information is gleaned based on when a member states they are hiring, while a negative index means that the occupation's share of total hiring is declining.

MITIGATING THE RISKS



QUESTIONS?

