STelligence

Introduction to AI/ML

Sira Haruethaipree (Gui)
AI Engineer

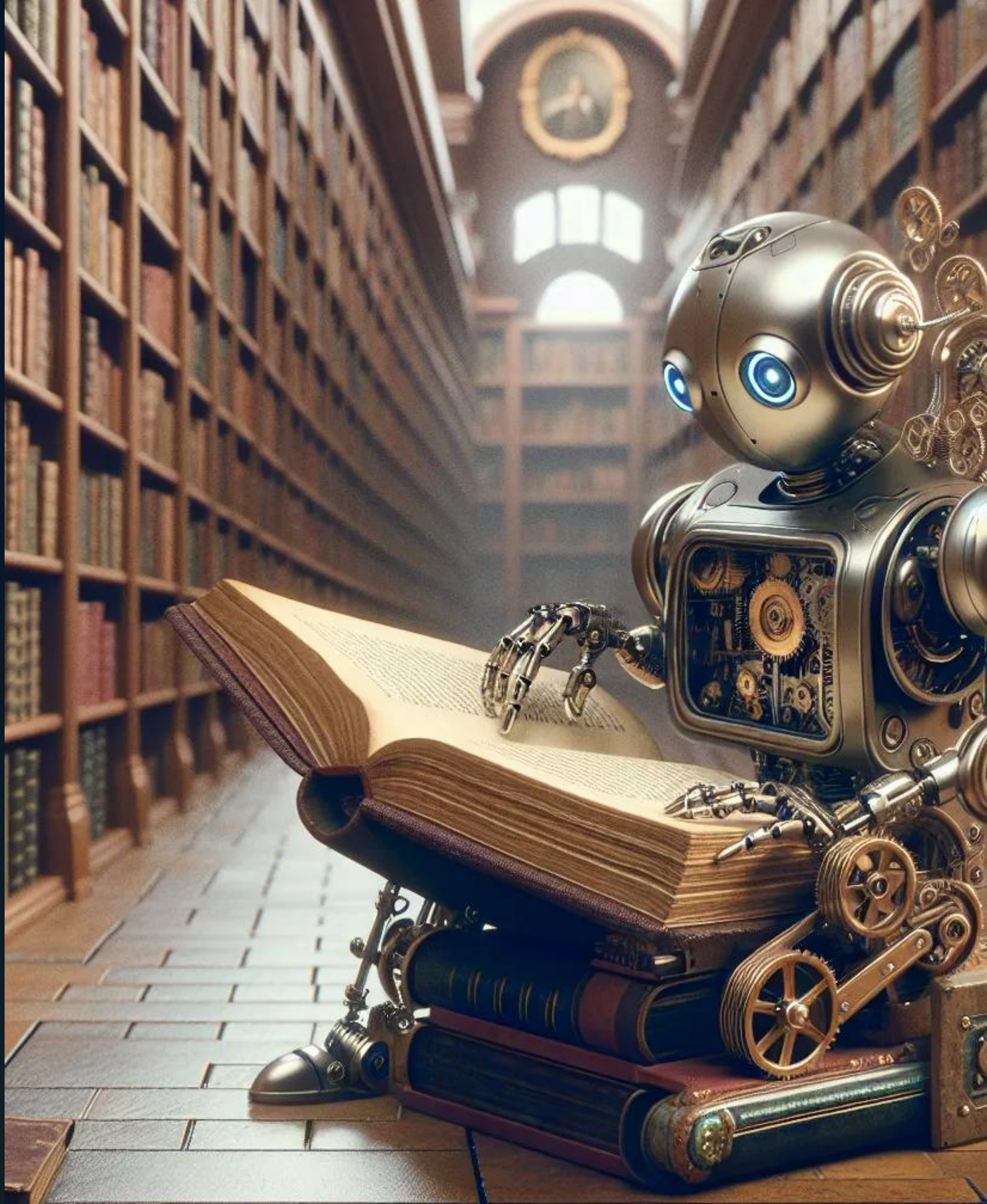
linkedin.com/in/siraharuethaipree

sira.h@stelligence.com

Kornkrit Rattanasamniang (Nay)
AI Engineer

linkedin.com/in/kornkrit-rattanasamniang

kornkrit.r@stelligence.com



Sira Haruethaipree
AI Engineer

sira.h@stelligence.com

linkedin.com/in/siraharuethaipree

Education

- Bachelor of Engineering in Mechatronic Engineering King Mongkut's University of Technology Thonburi (2019)
- Master of Science in Artificial Intelligence for Business Analytics King Mongkut's institute of Technology Ladkrabang (2023)

Work Experience

- AI Engineer

  STELLIGENCE Co., Ltd. (2024 – Present)
- AI&NLP Engineer

  Omniscien Technologies (2023)

Certification

- Coursera IBM Data Science Professional Certificate - IBM
- DeepLearning.AI TensorFlow Developer Specialization - DeepLearning.AI
- Machine Learning Specialization By Deeplearning.AI & Stanford
- Google Data Analytics Professional Certificate - Google

Kornkrit Rattanasamniang
AI Engineer

kornkrit.r@stelligence.com

linkedin.com/in/kornkrit-rattanasamniang

Education

- Bachelor’s Degree, Robotics and Automation Engineer with First Class Honours
  King mongkut's university of technology thonburi (2024)

Work Experience

- AI Engineer
  STELLIGENCE Co., Ltd. (2024 – Present)
- AI Engineer
  The Mather Co., Ltd. (2024)
- AI Engineer (Internship)
  Bangkok Unitrade Co., Ltd. (2023)
- Teaching Assistant
  Institute of field robotics, KMUTT (2022 – 2024)

Types of Machine Learning Algorithms

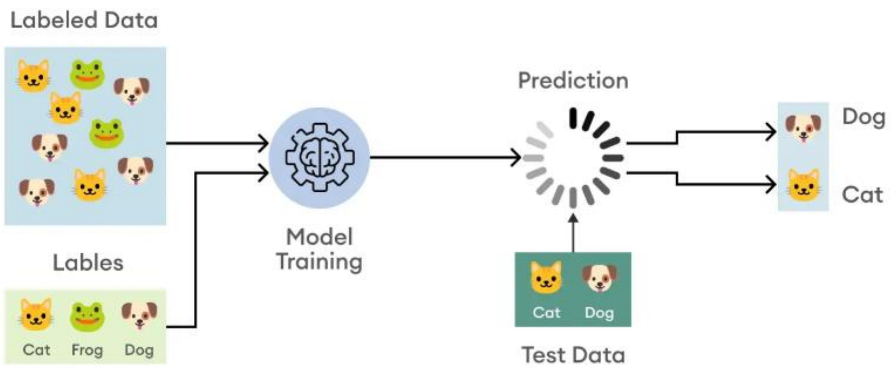
- Supervised Learning: Learning from labeled data (e.g., classification and regression tasks).
- Unsupervised Learning: Learning from unlabeled data (e.g., clustering, anomaly detection).
- Semi-Supervised Learning: A mix of labeled and unlabeled data for training.
- Reinforcement Learning: Learning by interacting with an environment and receiving feedback.
- Self-Supervised Learning: A type of unsupervised learning where the system generates its own labels for training.

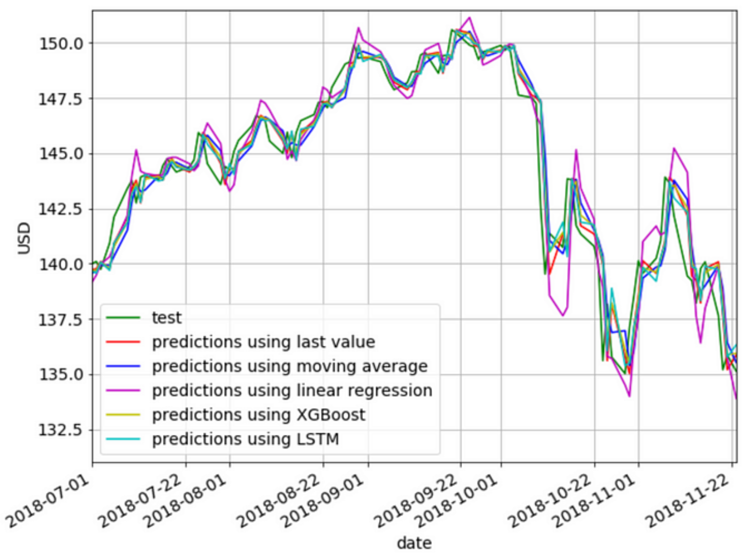
Supervised Learning Algorithms

Definition: Learning from labeled data where the model is trained on input-output pairs.

Examples:

- Classification Algorithms:
  - Logistic Regression
  - Decision Trees
  - Random Forest
  - Support Vector Machines (SVM)
  - k-Nearest Neighbors (k-NN)
- Regression Algorithms:
  - Linear Regression
  - Lasso Regression
  - Ridge Regression
- Time series forecasting
  - ARIMA
  - LSTM





Unsupervised Learning Algorithms

•Definition: Learning from unlabeled data where the algorithm tries to find hidden patterns or structure in the data.

Examples:

- •Clustering Algorithms:
  - •K-means
  - •Hierarchical Clustering
- •Dimensionality Reduction:
  - •Principal Component Analysis (PCA)
  - •t-Distributed Stochastic Neighbor Embedding (t-SNE)

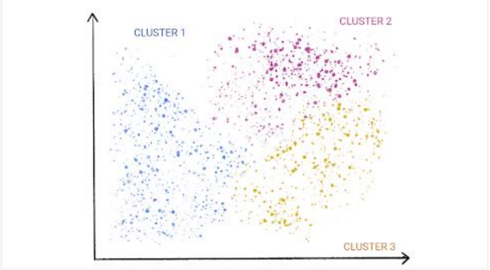


Figure 1. An ML model clustering similar data points.

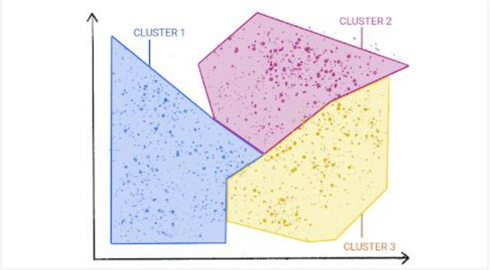
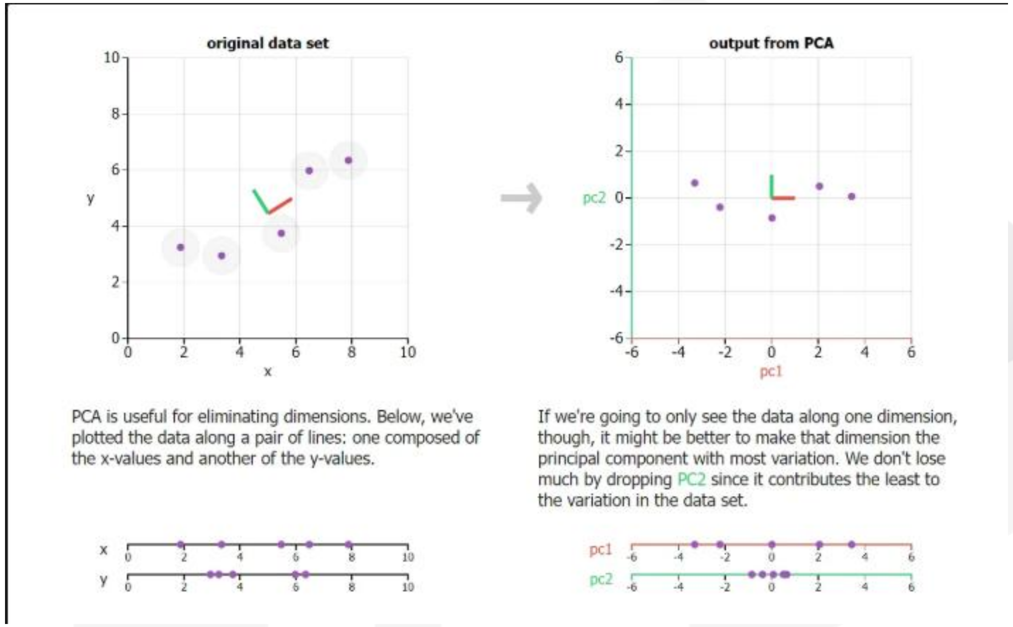


Figure 2. Groups of clusters with natural demarcations.



PCA: https://setosa.io/ev/principal-component-analysis/

Reinforcement Learning Algorithms

Definition: Learning by interacting with the environment and receiving rewards or penalties based on the actions.

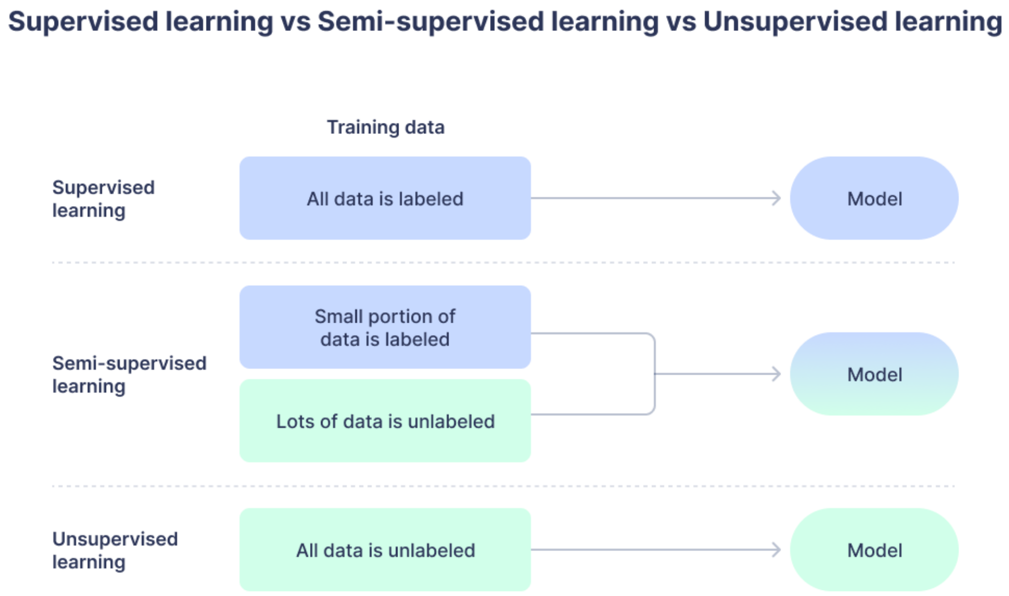
Examples:

- Q-learning
- Deep Q Networks (DQN)
- Policy Gradient Methods
- Proximal Policy Optimization (PPO)

- https://huggingface.co/spaces/ThomasSimonini/Huggy
- https://huggingface.co/learn/deep-rl-course/en/unitbonus1/how-huggy-works

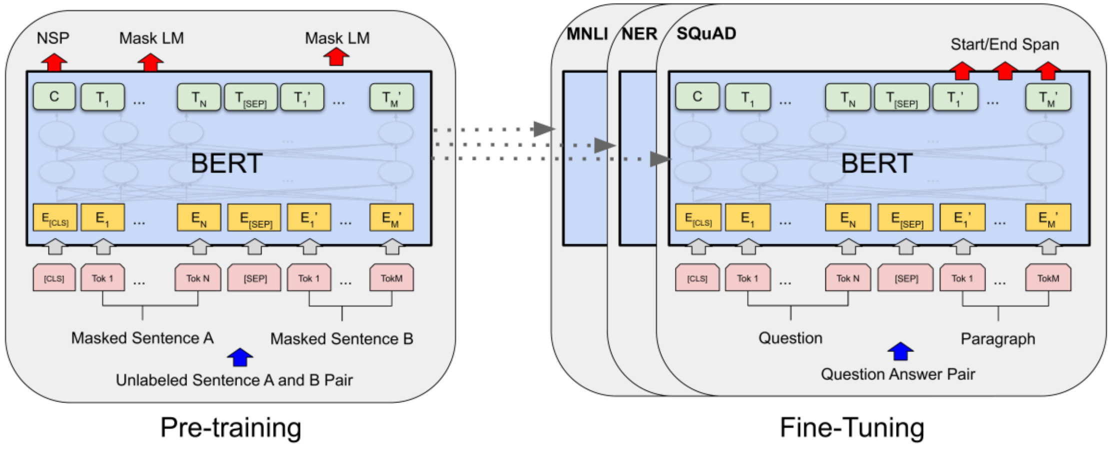
Semi-Supervised Learning Algorithms

Definition: A hybrid of supervised and unsupervised learning where only a small amount of labeled data is used, and a large amount of unlabeled data is available.

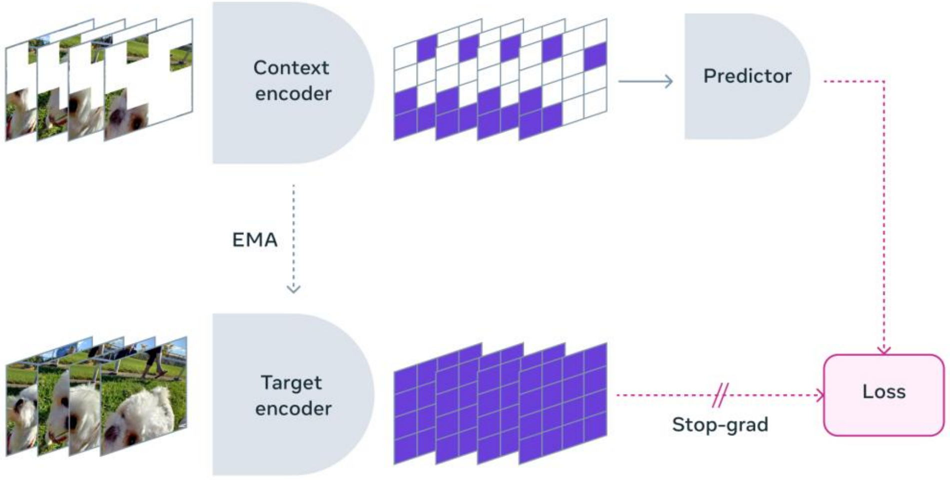


Self-Supervised Learning

Definition: A form of unsupervised learning where the system creates its own labels from the input data (often used for tasks like representation learning).



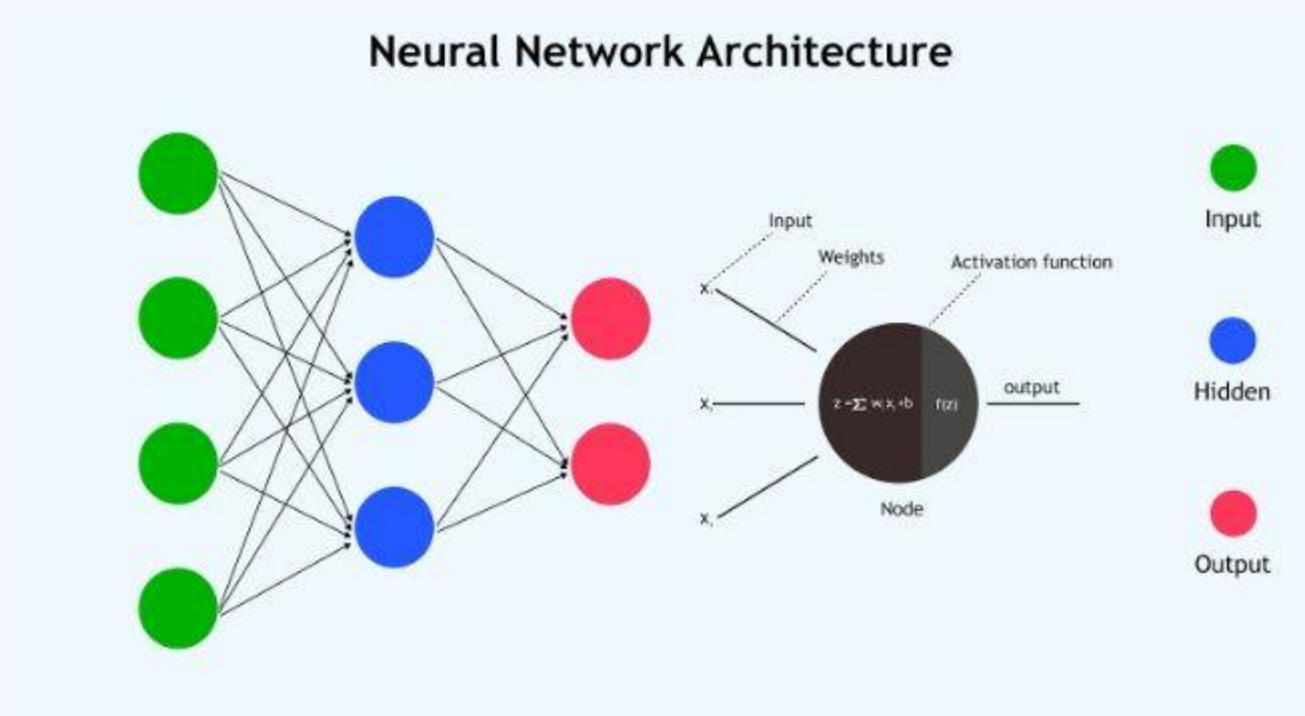
BERT: Pre-training of Deep Bidirectional Transformers for Language Understanding



V-JEPA: The next step toward Yann LeCun's vision of advanced machine intelligence (AMI)

- [BERT: https://arxiv.org/pdf/1810.04805](https://arxiv.org/pdf/1810.04805)
- SimCLR: https://ai.meta.com/blog/v-jepa-yann-lecun-ai-model-video-joint-embedding-predictive-architecture/

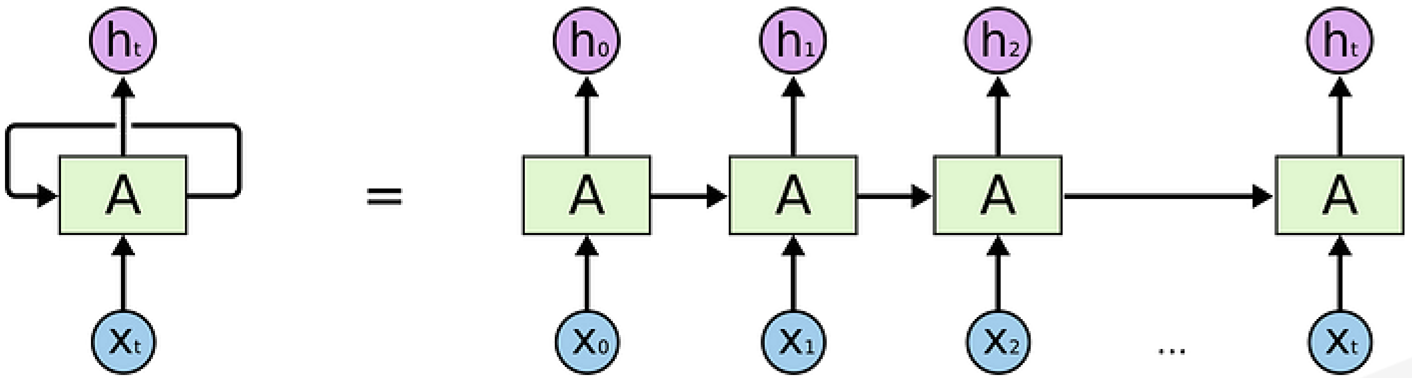
Neural network

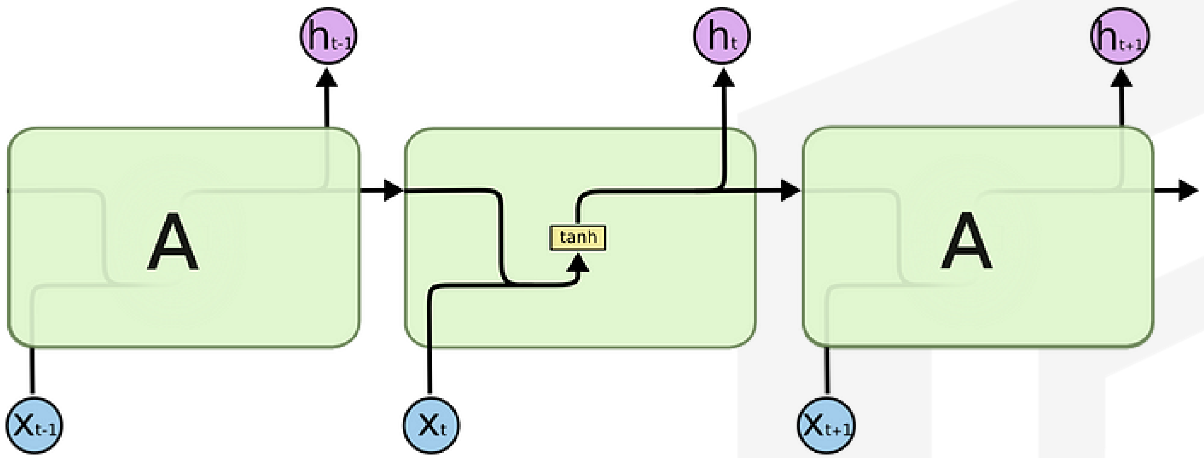



```python
import tensorflow as tf
from tensorflow.keras.models import Sequential
from tensorflow.keras.layers import Dense
import numpy as np

np.random.seed(42)
tf.random.set_seed(42)

model = Sequential()
model.add(Dense(3, input_dim=4, activation='relu'))
model.add(Dense(2, activation='softmax'))

model.compile(optimizer='adam', loss='categorical_crossentropy', metrics=['accuracy'])

model.summary()

X_train = np.random.rand(10, 4)
y_train = np.random.randint(0, 2, size=(10, 2))

model.fit(X_train, y_train, epochs=10)
```

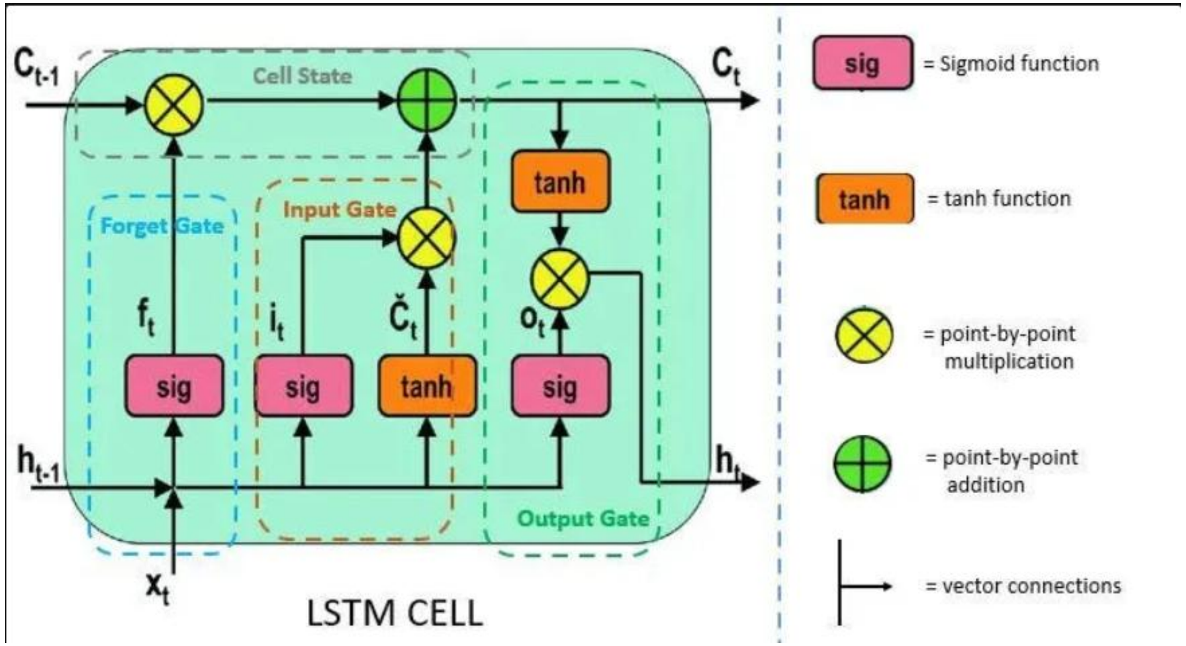
Neural network layer in NLP

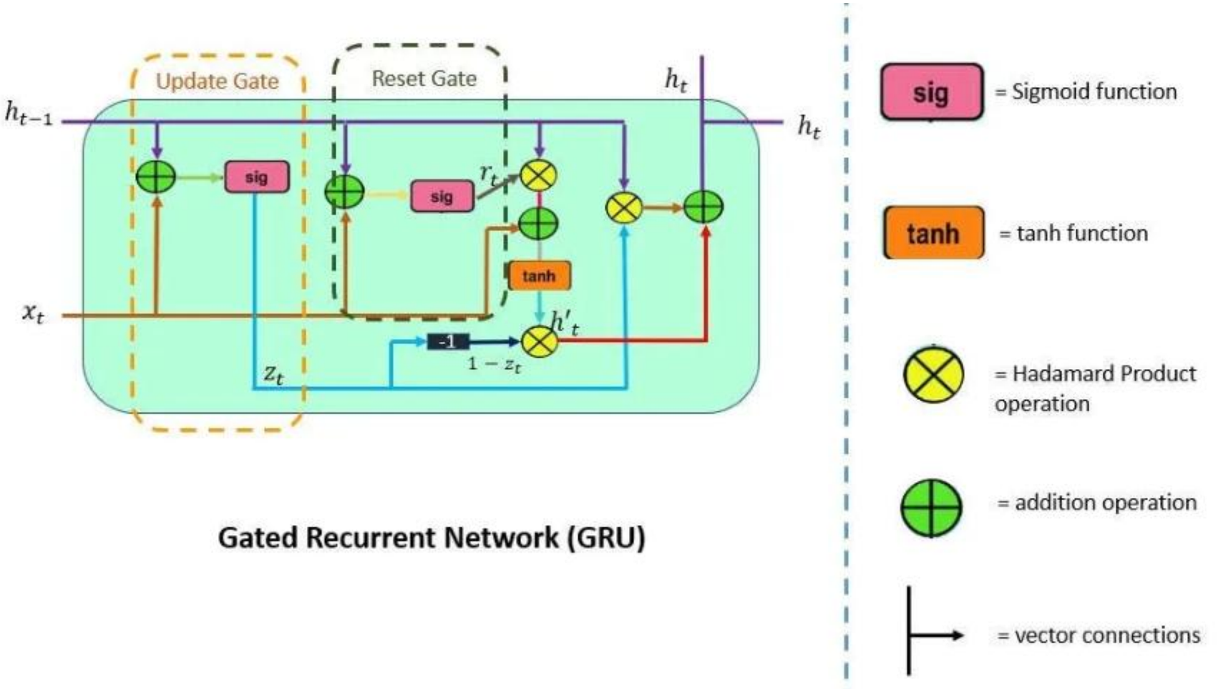
RNN





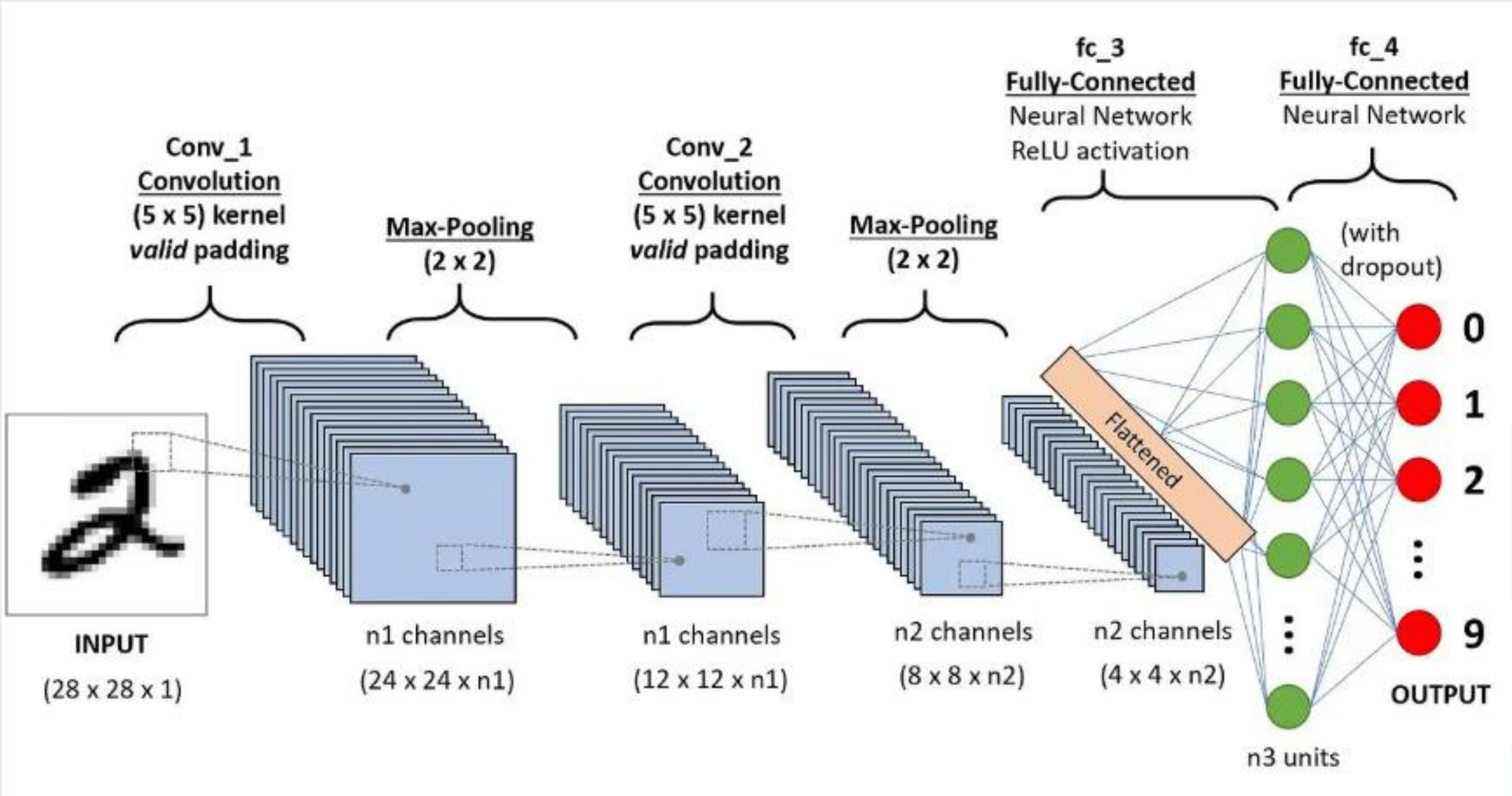
Neural network layer in NLP





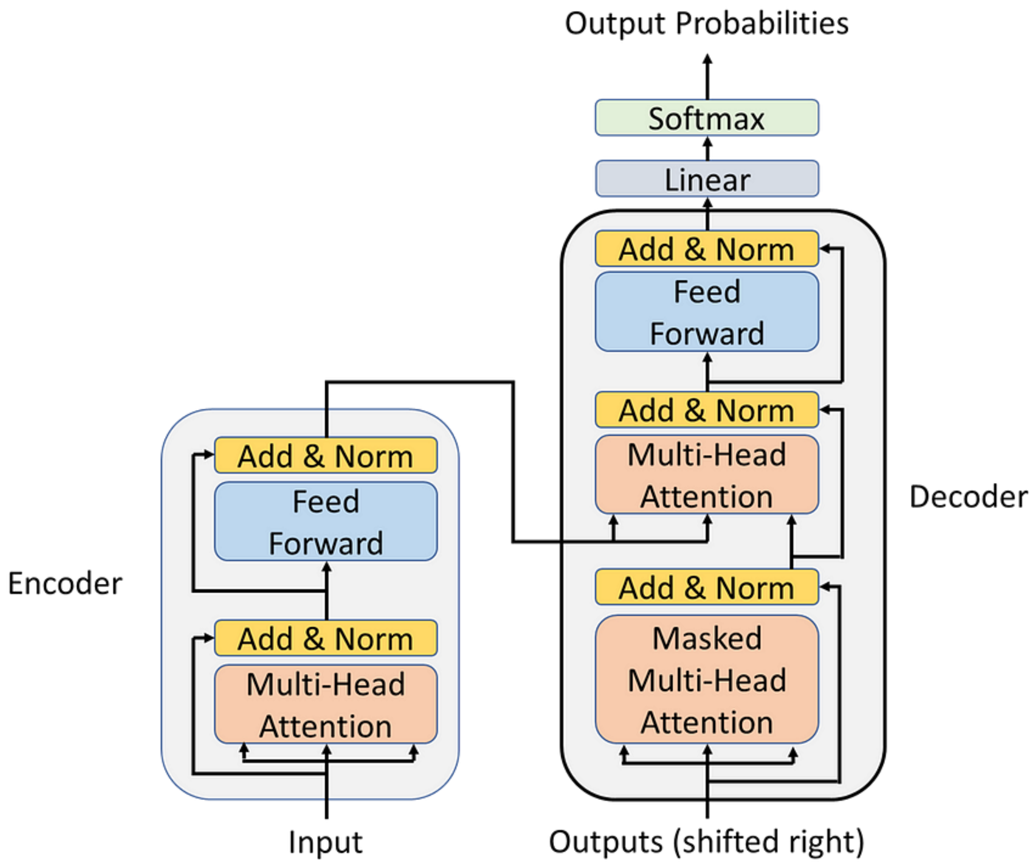
- https://colah.github.io/posts/2015-08-Understanding-LSTMs

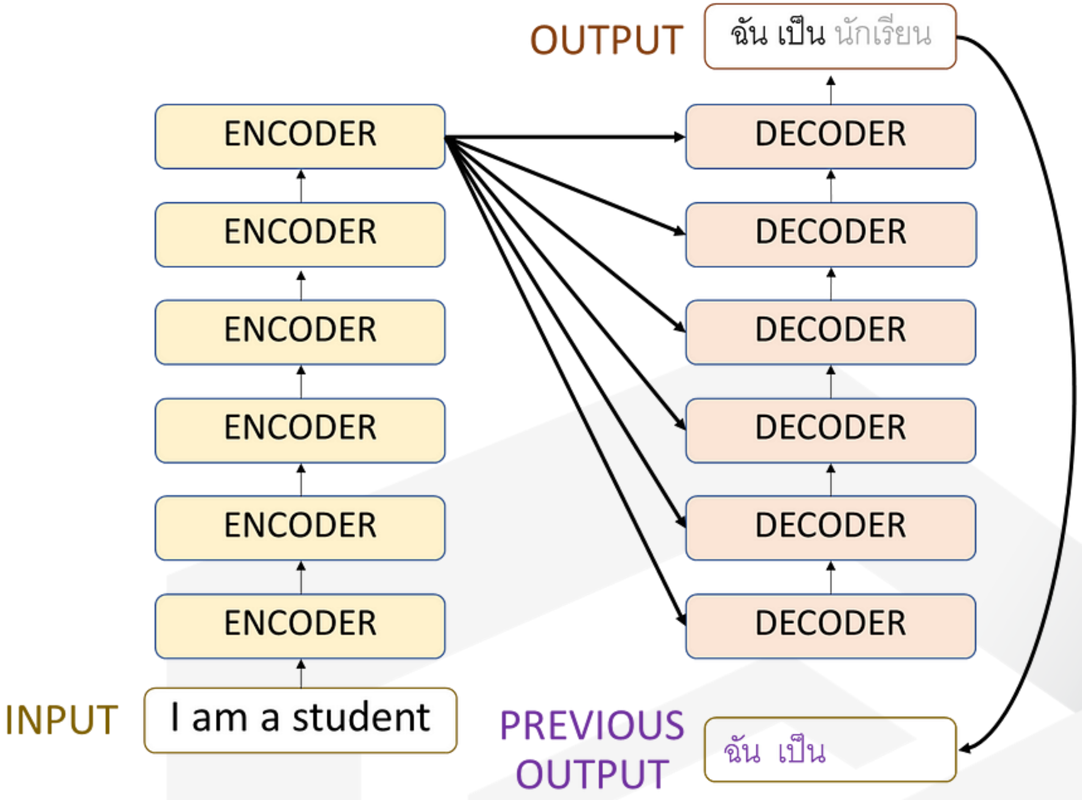
Convolutional neural network



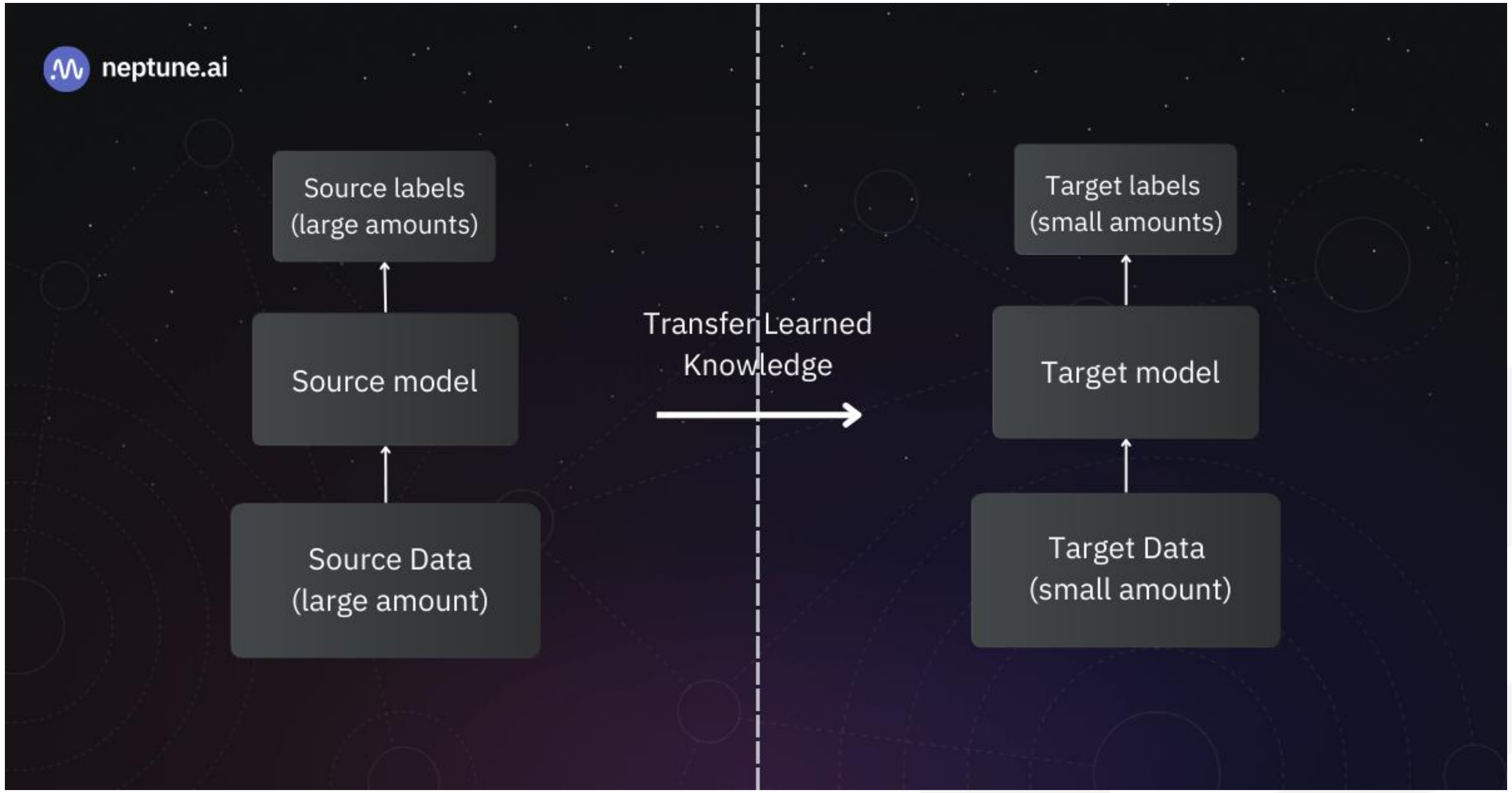
- https://adamharley.com/nn_vis/cnn/3d.html
- https://medium.com/@muhammadshoaibali/flattening-cnn-layers-for-neural-network-694a232eda6a

Attention Is All You Need

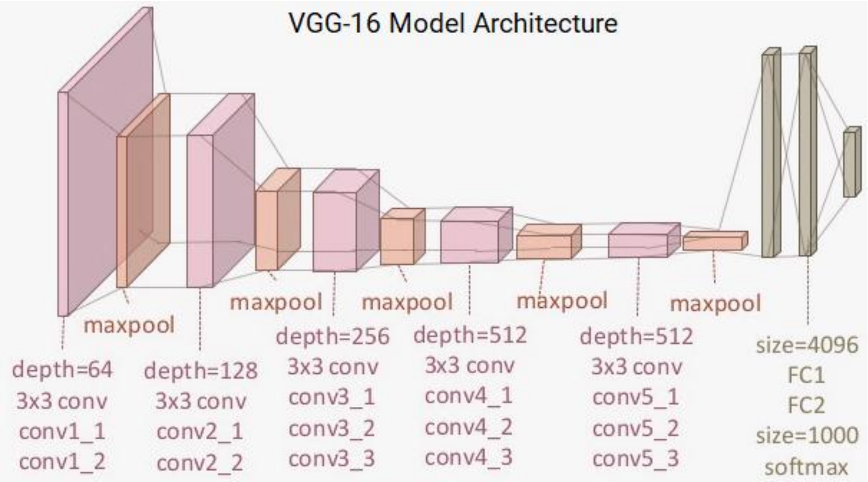


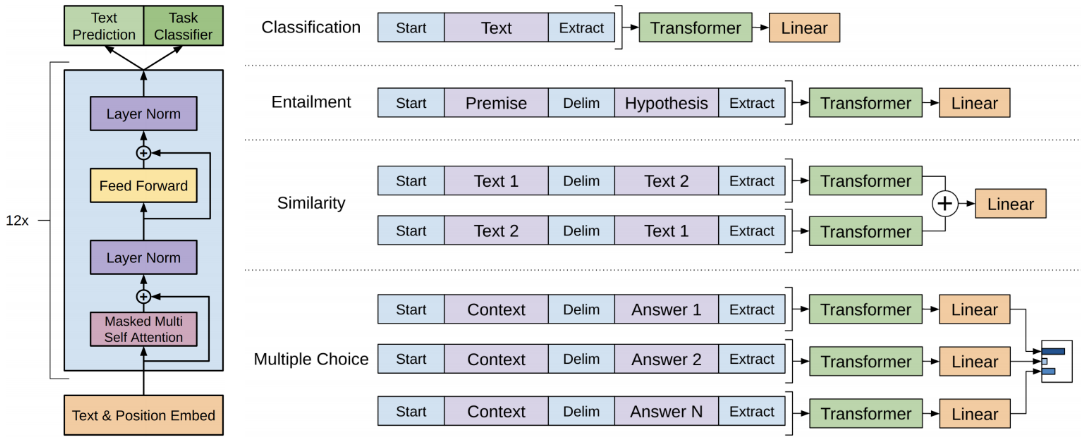


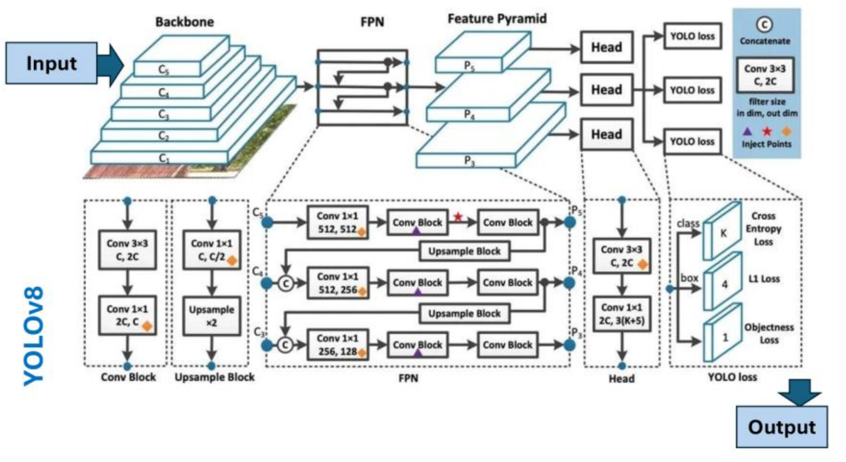
Transfer learning

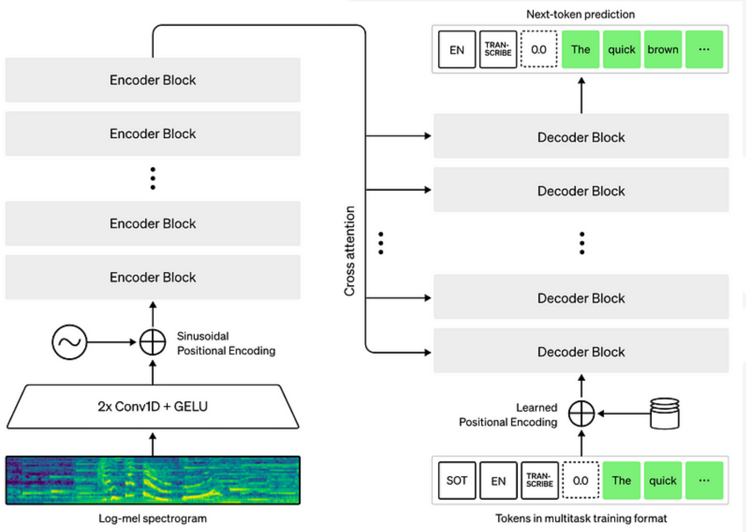


Transfer learning





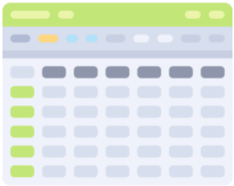




AI Applications Across Data Types

STelligence

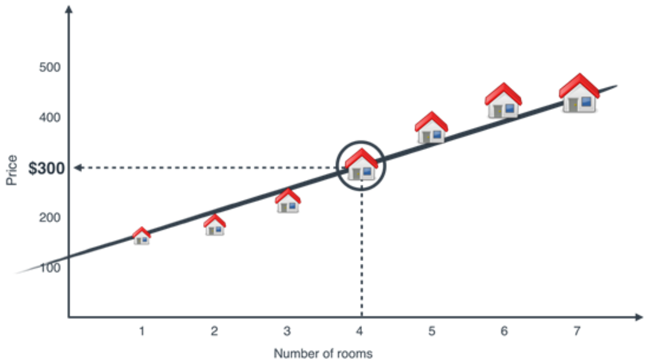
Type of Data

- Structure data
  - 
    Tabular data
- Unstructure data
  - 
    Image
  - 
    Audio
  - 

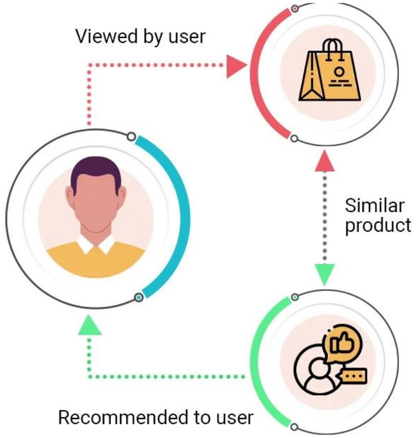
    Text

AI Applications Across Data Types

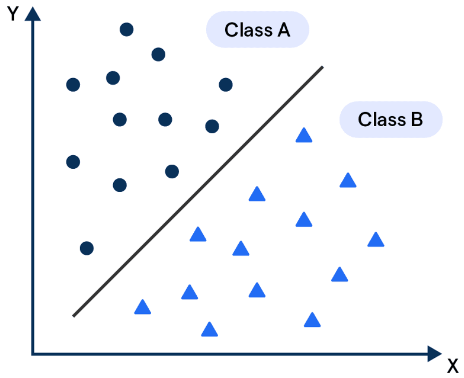
Structured Data (Tabular Data)



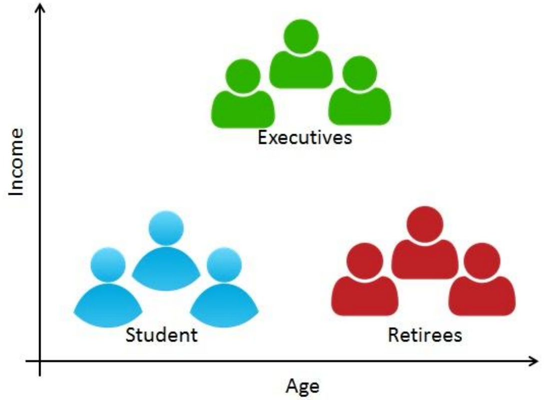
Predictive Modeling / Regression



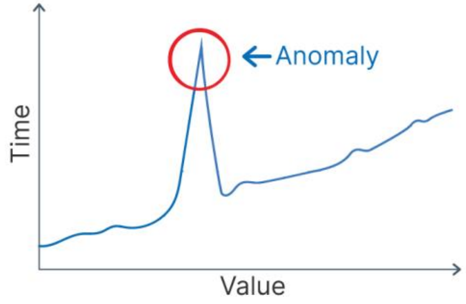
Recommendation **Systems**



Classification



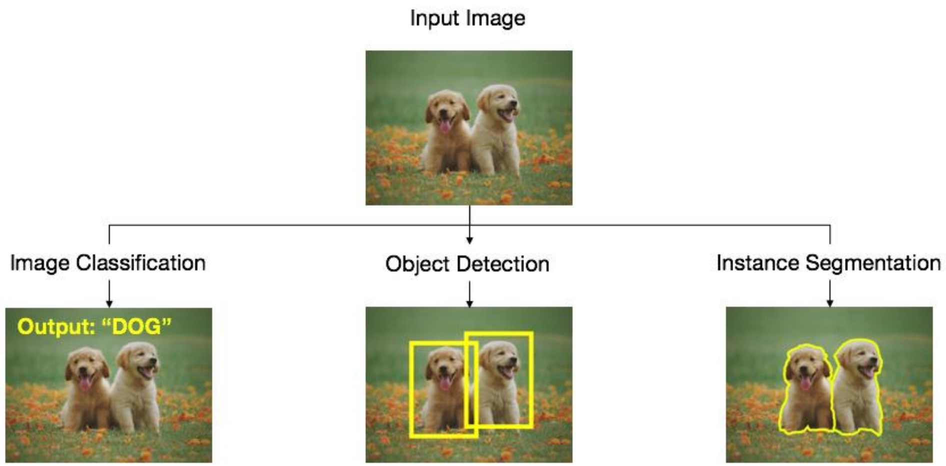
Clustering

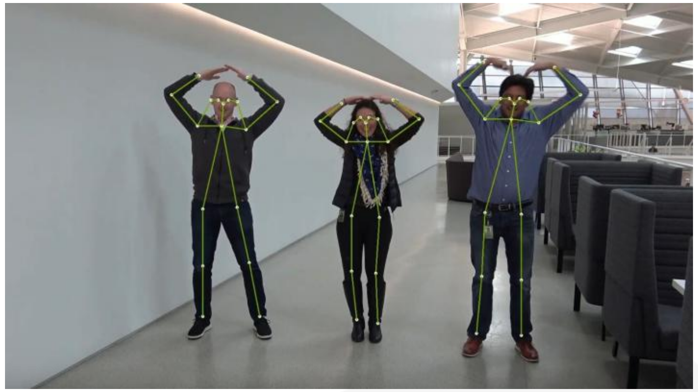


Anomaly Detection

AI Applications Across Data Types

Unstructured Data - Image Data





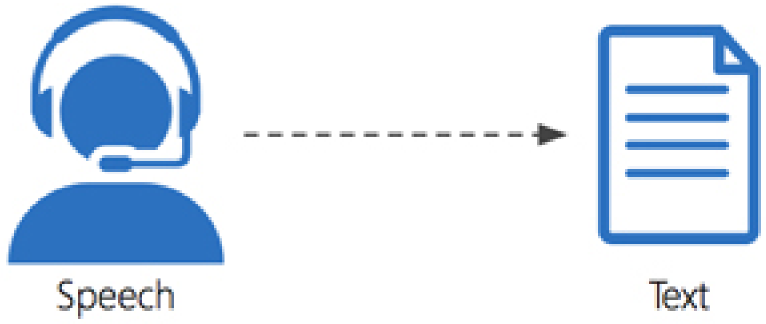
Pose landmark detection

OCR

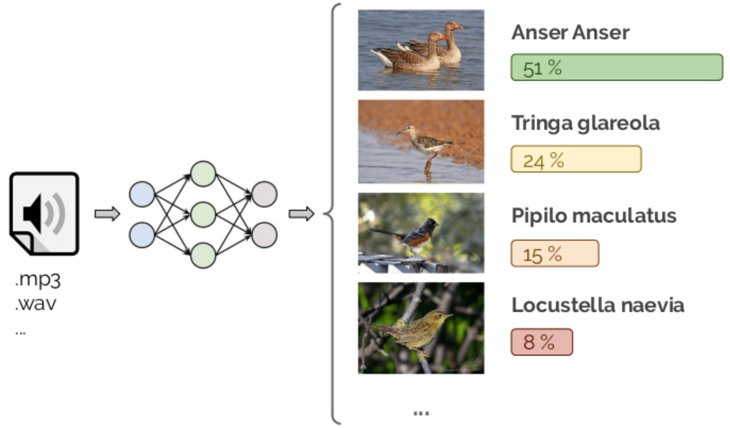
Facial recognition

AI Applications Across Data Types

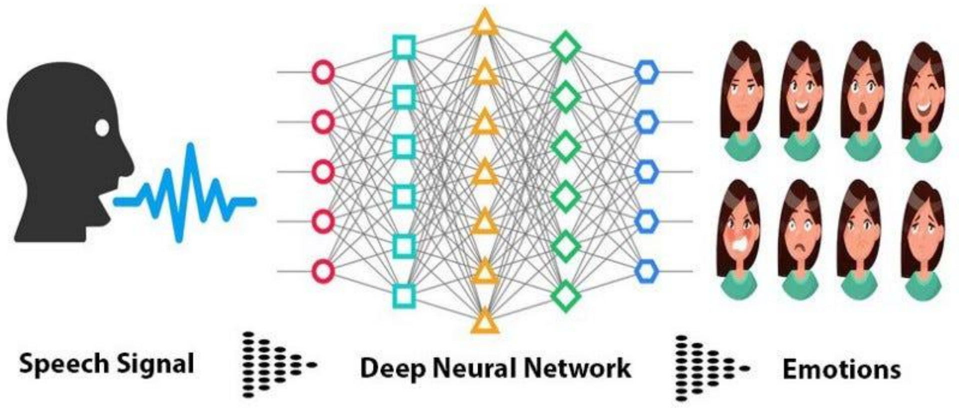
Unstructured Data - Audio Data



Speech to text



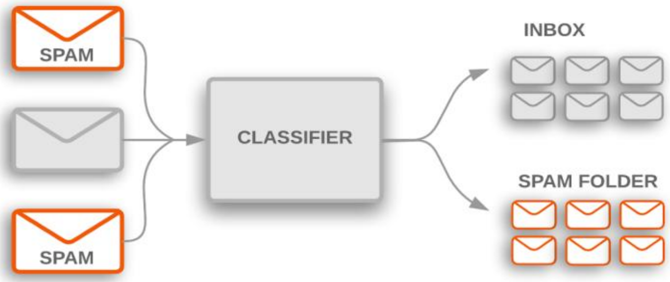
Audio classification



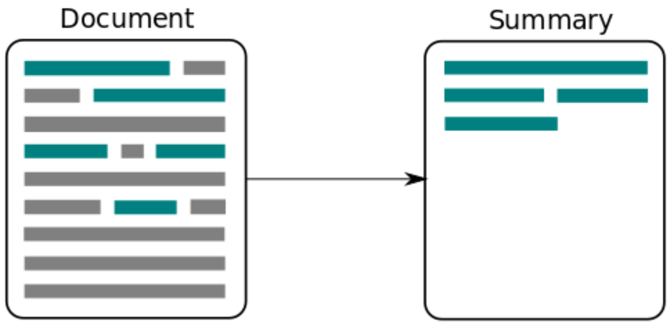
Emotion Detection

AI Applications Across Data Types

Unstructured Data - Text Data

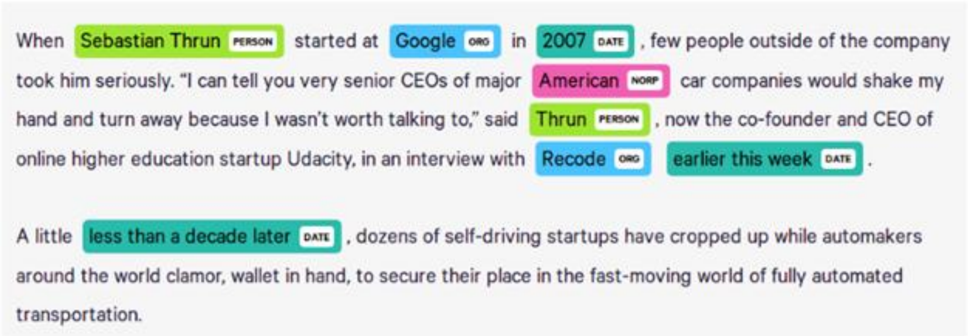


Spam detection

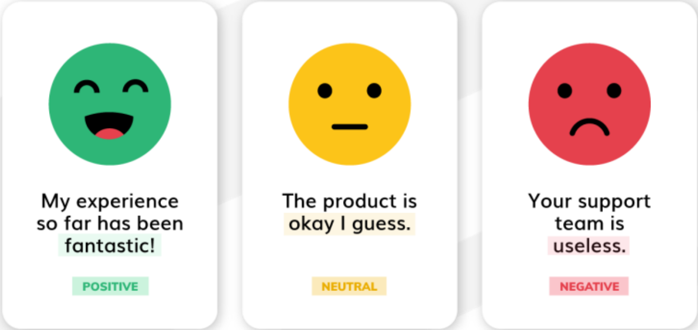


Text summarization

Chatbot



Entity recognition



Sentiment classification

Evaluate regression model

Mean squared error (MSE) is one of the most popular evaluation metrics. As shown in the following formula, MSE is closely related to the residual sum of squares. The difference is that you are now interested in the average error instead of the total error.

$$MSE = \frac{1}{N}\Sigma_{i=1}^{N}(y_i - \hat{y_i})^2$$

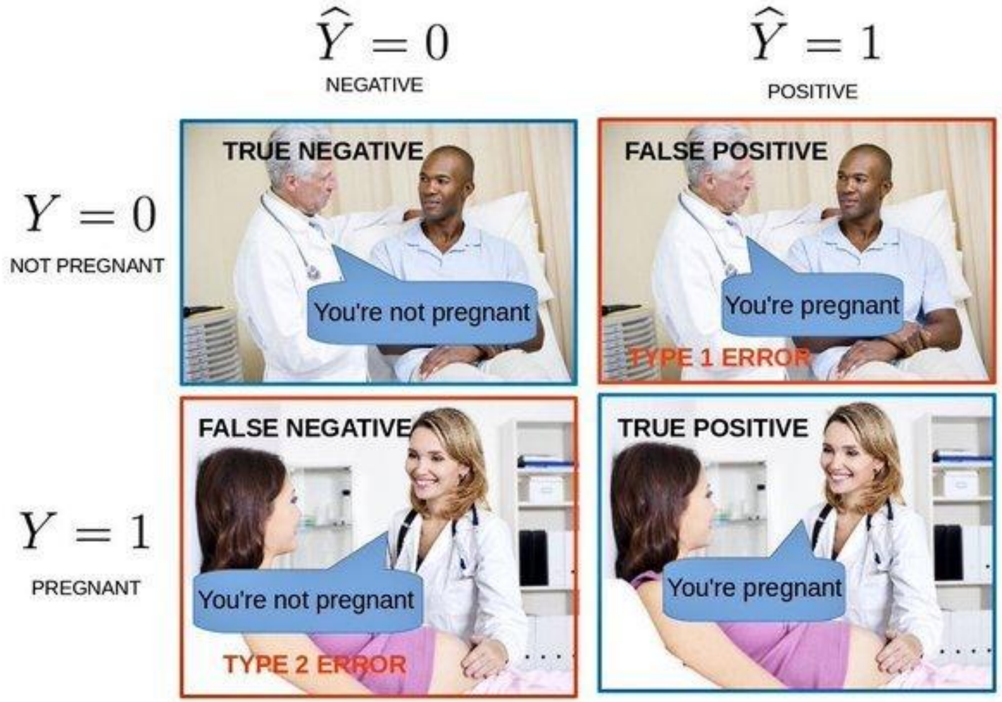
The formula to calculate mean absolute error (MAE) is similar to the MSE formula. Replace the square with the absolute value.

$$MAE = \frac{1}{N}\Sigma_{i=1}^{N}|y_i - \hat{y_i}|$$

R-squared (R^2), also known as the coefficient of determination, represents the proportion of variance explained by a model. To be more precise, R^2 corresponds to the degree to which the variance in the dependent variable (the target) can be explained by the independent variables (features).

$$R^2 = 1 - \frac{RSS}{TSS} = 1 - \frac{\Sigma_{i=1}^{N}(y_i - \hat{y_i})^2}{\Sigma_{i=1}^{N}(y_i - \bar{y_i})^2}$$

Evaluate classification model



$$\text{Accuracy} = \frac{\text{correct classifications}}{\text{total classifications}} = \frac{TP + TN}{TP + TN + FP + FN}$$

Accuracy is a metric that measures how often a machine learning model correctly predicts the outcome.

$$\text{Precision} = \frac{\text{True Positives (TP)}}{\text{True Positives (TP)} + \text{False Positives (FP)}}$$

Precision is a metric that measures how often a machine learning model correctly predicts the positive class.

$$\text{Recall} = \frac{\text{True Positives (TP)}}{\text{True Positives (TP)} + \text{False Negatives (FN)}}$$

Recall is a metric that measures how often a machine learning model correctly identifies positive instances (true positives) from all the actual positive samples in the dataset.

Evaluate classification model

STelligence

The F-Beta Score is a measure that assesses the accuracy of an output of a model from two aspects of precision and recall. Unlike in F1 Score that directed average percentage of recall and percent of precision, it allows to prioritize one of two using the β parameter.

$$F_\beta = (1+\beta^2) \cdot \frac{\text{Precision} \cdot \text{Recall}}{(\beta^2 \cdot \text{Precision} + \text{Recall})}$$

Scenario: A binary classification model is applied to a dataset, resulting in the following confusion matrix:

	Predicted Positive	**Predicted Negative**
Actual Positive	TP = 40	FN = 10
Actual Negative	FP = 5	TN = 45

Step1: Calculate Precision

$$\text{Precision} = \frac{40}{40+5} = \frac{40}{45} \approx 0.8889$$

Step2: Calculate Recall

$$\text{Recall} = \frac{40}{40+10} = \frac{40}{50} = 0.8$$

Step3: Calculate F-Beta Score

For **β = 1** (F1 Score):

$$F_1 = (1+1^2) \cdot \frac{0.8889 \cdot 0.8}{(1^2 \cdot 0.8889) + 0.8} = 2 \cdot \frac{0.7111}{1.6889} \approx 0.842$$

For **β = 2** (F2 Score, recall-focused):

$$F_2 = (1+2^2) \cdot \frac{0.8889 \cdot 0.8}{(2^2 \cdot 0.8889) + 0.8} = 5 \cdot \frac{0.7111}{4.3556} \approx 0.817$$

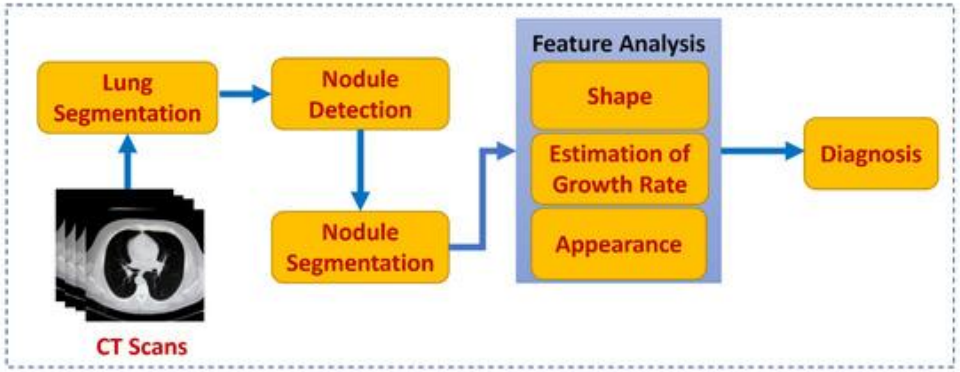
For **β = 0.5** (F0.5 Score, precision-focused):

$$F_{0.5} = (1+0.5^2) \cdot \frac{0.8889 \cdot 0.8}{(0.5^2 \cdot 0.8889) + 0.8} = 1.25 \cdot \frac{0.7111}{0.4222 + 0.8} \approx 0.934$$

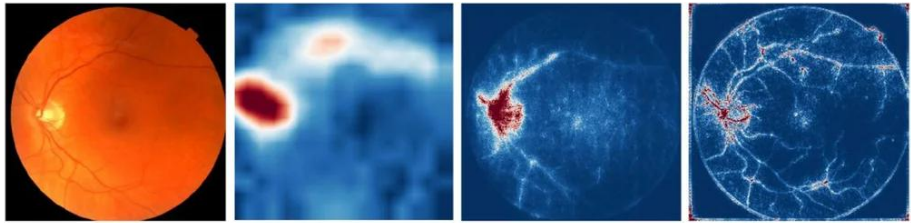
AI Solution in Health Care

AI for Imaging and Diagnostics

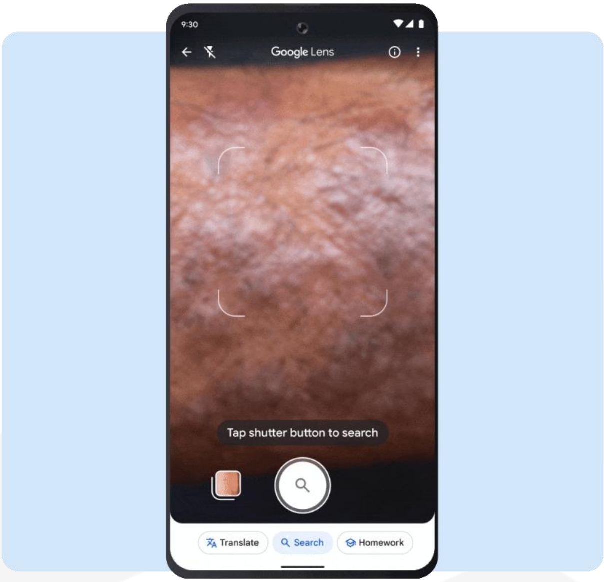
AI is utilized to analyze medical images, such as X-rays, MRIs, CT scans, and other to assist in diagnosing conditions



Diagnostic Dilemma of Pulmonary Nodules
https://www.mdpi.com/2072-6694/14/7/1840



Detecting hidden signs of anemia from the eye
https://blog.google/technology/health/anemia-detection-retina/



Deep learning system for diagnosis of skin diseases
https://jamanetwork.com/journals/jamanetworkopen/fullarticle/2779250

AI Solution in Health Care

Diagnosis chat bot

Diagnosis chatbots use AI to interact with users, collect symptom information, and suggest possible diagnoses. By analyzing user input through natural language processing, they provide guidance on potential conditions and recommend next steps.

Symptom **Collection**

↓

Analyzing Input

↓

Diagnosis Algorithm

↓

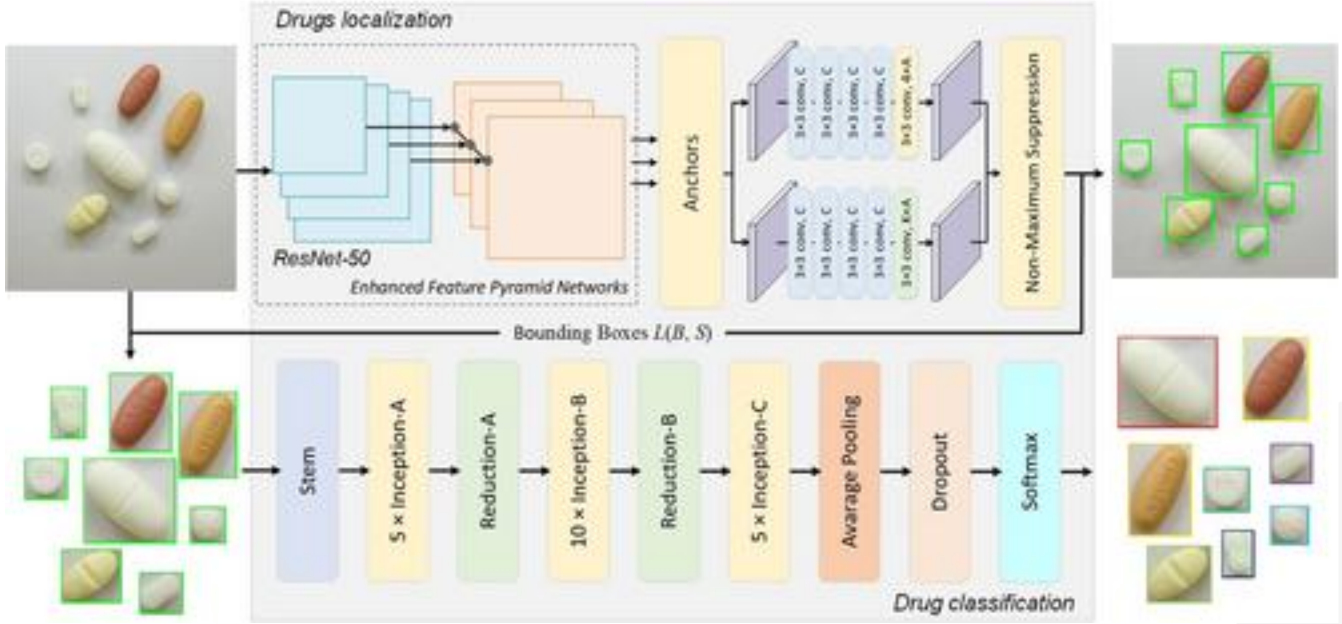
Diagnosis Suggestion

AI Solution in Health Care

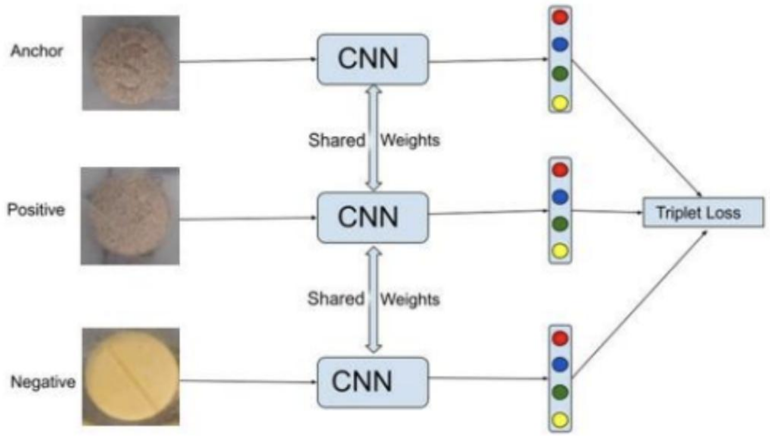
STelligence

AI for Pill Classification and Identification

AI is increasingly used for pill classification by analyzing images of tablets and capsules to identify their shape, color, and imprints. Using machine learning algorithms, AI can compare these visual features to large databases of known medications, helping to accurately classify pills and detect counterfeit drugs



https://ietresearch.onlinelibrary.wiley.com/doi/10.1049/iet-cvi.2019.0171

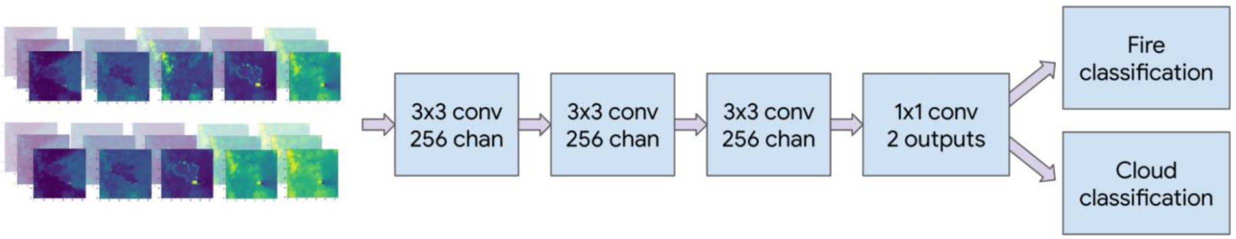


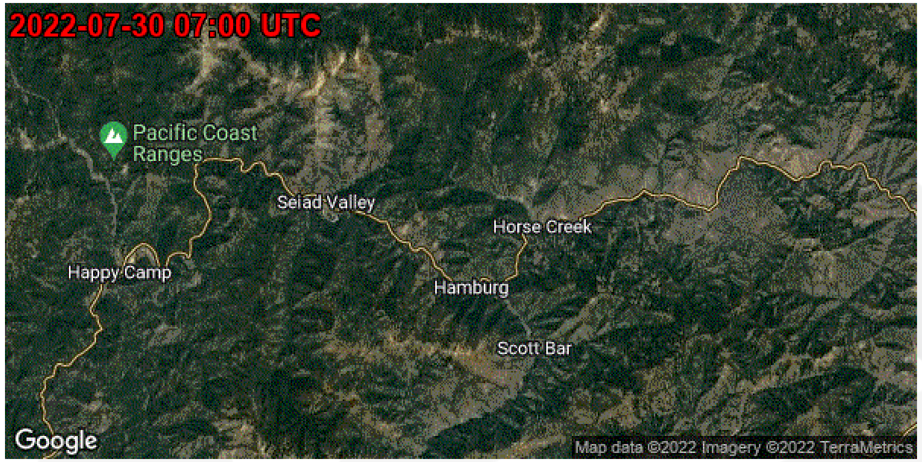
Siamese Network

AI Solution in Climate

Real-time tracking of wildfire boundaries using satellite imagery

Google applies machine learning to track and map wildfires in real time using satellite imagery from geostationary satellites like GOES-16, GOES-18, Himawari-9, and GK2A. Their model, a convolutional neural network (CNN), detects fire boundaries accurately every 10–15 minutes and integrates cloud detection to improve precision. This technology helps inform communities and authorities through Google Search and Google Maps, providing life-saving information in critical moments.



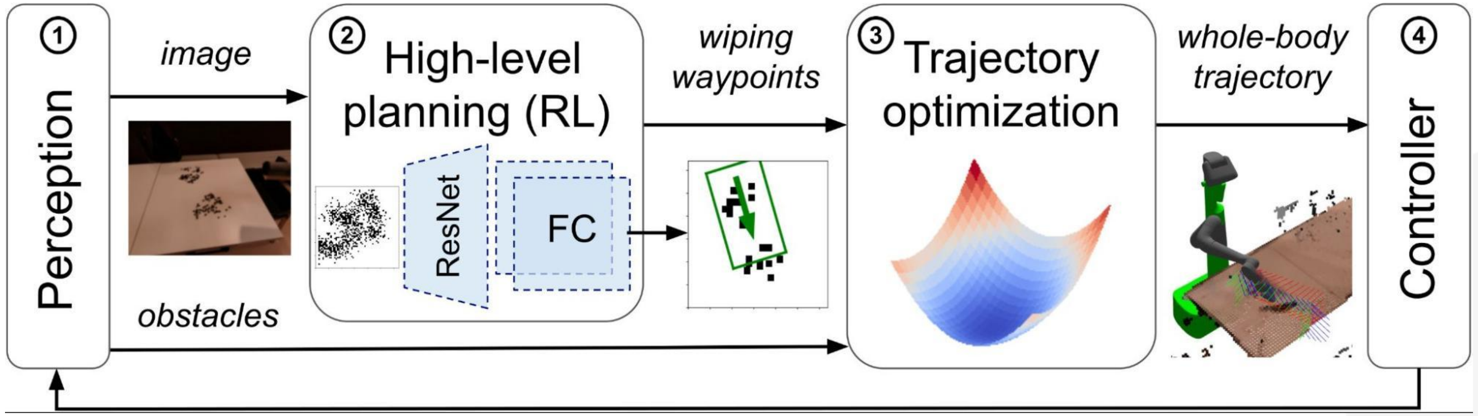


- https://research.google/blog/real-time-tracking-of-wildfire-boundaries-using-satellite-imagery/

AI Solution in Robotic

Towards ML-enabled cleaning robots

Google's table-wiping framework uses a vision-based RL policy to plan wipe actions, and a trajectory optimizer to convert those plans into whole-body robot motions, with perception and low-level control completing the loop.



Assignment (Score 30 points)

Text Classification

Task Requirement (15 points):

- Use the sentiment dataset to classify the text into Positive or Negative sentiment. Follow the instructions below:
  - You can build your models using statistical methods (e.g., TF-IDF, Bag of Words, Naive Bayes, Logistic Regression) or neural networks (e.g., RNN, LSTM, GRU) to classify the test set.
  - The provided dataset contains only the test set, so you are not allowed to use it for training. You must explore or create your own training dataset to perform the classification task.
  - (5 points) – Preprocess the data and generate a training dataset.
  - (5 points) – Model development: Build at least 3 models. You can earn extra points if you apply advanced techniques or demonstrate good performance.
  - (5 points) – Analyze and compare the results from each model. Present your findings clearly.

Provided Test Dataset:
- Contains 2 sentiment classes: Positive and Negative

Image Classification

Task Requirement (15 points):

- Using the provided test set dataset to build an image classification system to classify a multiclass dataset, Develop and evaluate 3 different approach
  - (3 points) Build and train a CNN without using any pre-trained weights. (you are not allowed to use test set for training.)
  - (3 points) Use pre-trained model (e.g., VGG, ResNet) without training
  - (3 points) Use a pre-trained model as a base and train the model using your training dataset (you are not allowed to use test set for training.)
  - You can use other additional approach to solve this problem
- (2 points) You are required to conduct at least three distinct experiments to evaluate how different techniques impact the performance of your model. These experiments can be: Difference pretrained model, Image preprocessing, Data augmentation, Model Parameter tuning or other technique.
- (2 points) Each experiment must include a detailed performance.
  - Training and validation accuracy/loss
  - Classification performance across each class
  - Visual examples of misclassified images
  - Other
- (2 points) Provide an analysis of all experiments, highlighting the impact of each technique on model performance and identify which combinations were most effective.

Provided Test Dataset:
- Contains 5 animal classes: dog, cat, elephant, lion , tiger.
- 20 images per class