

# Machine Learning

## Unsupervised and Self-Supervised Learning

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# Unsupervised Learning

- Unsupervised learning refers to the use of machine learning algorithms to find patterns in data **without** the use of **explicit labels**.
- Key Types
  - **Clustering**: grouping similar data points
    - Apps: Market Segmentation, Anomaly Detection
    - Techniques: **K-Means clustering**, Hierarchical clustering, Agglomerative clustering
  - **Dimensionality Reduction**: reduce the number of features
    - Apps: Data Compression, Embedded Representation
    - Techniques: **Autoencoders**, **PCA**, **t-SNE**, LDA
- Challenges: Sometimes lack of clear metrics as there's no ground truth

# Self-Supervised Learning

- Self-supervised learning is a technique where the learning algorithm generates its own supervisory **signal from the input data**.
  - In text, create a "pretext" task where the model predicts a part of the data given another part of the same data.
    - A **pretext task** is a task that is designed to generate labels from unlabeled data, and that is not directly related to the **downstream** task that we want to solve.
      - Downstream example: English-German Translation
  - In computer vision: there are many use cases
- We typically train self-supervised on huge amounts of data to learn string representations. Then these representations are used for downstream tasks

# Self-Supervised Learning: Computer Vision

- **Jigsaw Puzzle Solving:** An image is divided into multiple patches, shuffled, and then the model is trained to predict the correct arrangement of these patches.
- Observe here the model itself is typically supervised learning
- But we generate the output label from the input label



# Self-Supervised Learning: Computer Vision

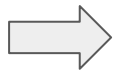
- **Rotation Prediction:** Images are rotated to a certain degree (e.g.,  $0^\circ$ ,  $90^\circ$ ,  $180^\circ$ ,  $270^\circ$ ) and the model is trained to predict the rotation angle applied.



55 degree

# Self-Supervised Learning: Computer Vision

- **Inpainting:** Parts of an image (e.g., the center) are removed, and the model is trained to fill in the missing parts.



# Self-Supervised Learning: Text

- **Next Word Prediction:** Given a sequence of words, predict the next word in the sequence
  - "She went to the XXX", the model might predict "store", "park", "movies", etc.
- **Sentence Order Prediction:** given two consecutive sentences, the model has to predict whether they're in the correct chronological order or not
- **Masked Language:** Words or phrases are removed from a sentence, and the model is trained to fill in the blanks

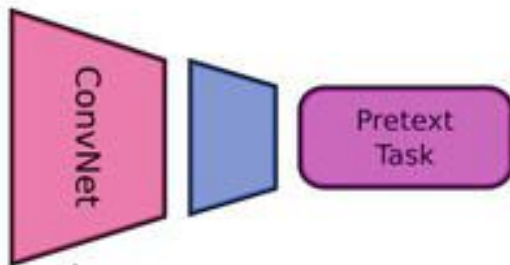
# Downstream Task

- A downstream task refers to a specific problem that benefits from the representations learned during unsupervised or self-supervised learning (pretext task)
  - Think you will learn strong words representation after you learn filling up words
  - Usually we either do fine-tuning or features extraction
- **NLP** Downstream Task: Text Classification, Question Answering, Summarization, Translation
- **CV** Downstream Task: Image Classification, Object Detection, Segmentation, Face Recognition



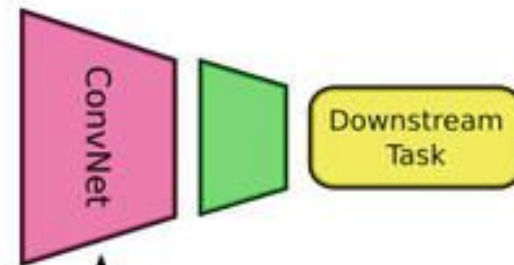
## Self-supervised Pretext Task Training

Unlabeled Dataset



## Supervised Downstream Task Training

Labeled Dataset



Knowledge Transfer

# Recommendation Systems

- **Recommendation systems** are algorithms aimed at suggesting relevant items to users. These items can be anything from movies, books, products, search queries, and even friends in social networks. The suggestions are usually personalized based on a user's past behavior and preferences.
  - They can be implemented in several ways including supervised and unsupervised learning
- **Types**
  - Collaborative Filtering, Content-based Filtering, Matrix Factorization, etc
- One simple and useful approach is to use a **binary classifier**
  - Predicts whether a user would like an item or not
  - Select the highest K items for the user
- Tutorials: [video](#) / [video](#)

*“Acquire knowledge and impart it to the people.”*

*“Seek knowledge from the Cradle to the Grave.”*

