Machine Learning

Recommender Systems

Learning Objectives

By the end of this lesson, you will be able to:

- Examine different use cases and delve into different recommender systems and their designs

- Build a recommender engine using PyTorch

- Inspect different filtering techniques
  Discuss dimensional reductions and matrix factorization

Business Scenario

An e-commerce company is experiencing a decline in customer engagement and sales due to outdated product recommendations. To address this issue, the company has decided to implement a new recommendation engine that uses machine learning algorithms like collaborative and content-based filtering, as well as hybrid techniques.

The new engine will gather, analyze and filter data in real-time, serving a global user base with advanced search and upsell capabilities. Personalized recommendations will be provided to customers, enhancing the overall user experience and increasing engagement.

The recommendation engine aims to automate the process of finding new products that users are likely to enjoy, resulting in higher sales for the company. By adopting a modern and effective approach to recommendation, the e-commerce company aims to remain competitive and retain customers.

How Do Recommendation Engines Work?

Discussion: Recommender Systems

- What are recommender systems?

- What are the different types of recommender systems?

- Give examples of recommender systems.

Working of Recommendation Engines

A recommendation engine is a data filtering tool that uses machine learning algorithms to recommend the most relevant items for a particular requirement.

There are generally three main types of recommender systems:

Collaborative filtering

Content-based filtering

Hybrid filtering

Working of Recommendation Engines

Collaborative filtering: considers similarities between users and items to provide recommendations

Example: Recommendation based on interests of similar users

Content-based filtering: analyzes data to create a list of recommended products

Example: Product recommendation based on a user's browsing history

Hybrids filtering: benefits from the advantages of the other two types

Example: Netflix recommendations based on users' watch history as well as search habits of similar viewers

Recommendation Engines

Recommendation engines process data via the following phases:

1. Collecting: data such as page views, view history, or cart events may be procured

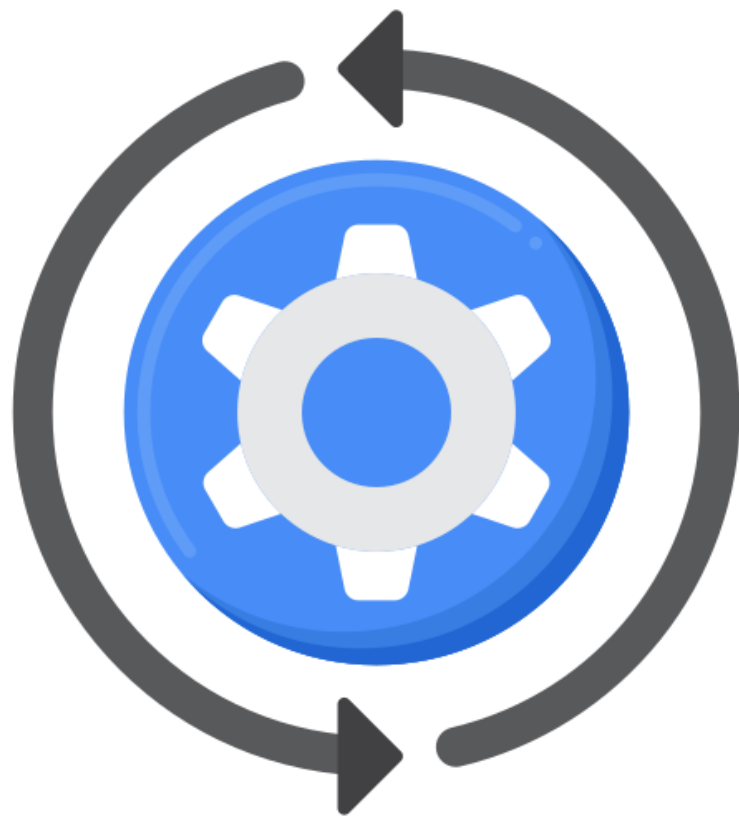**2. Storing:** data is stored in databases or object storage
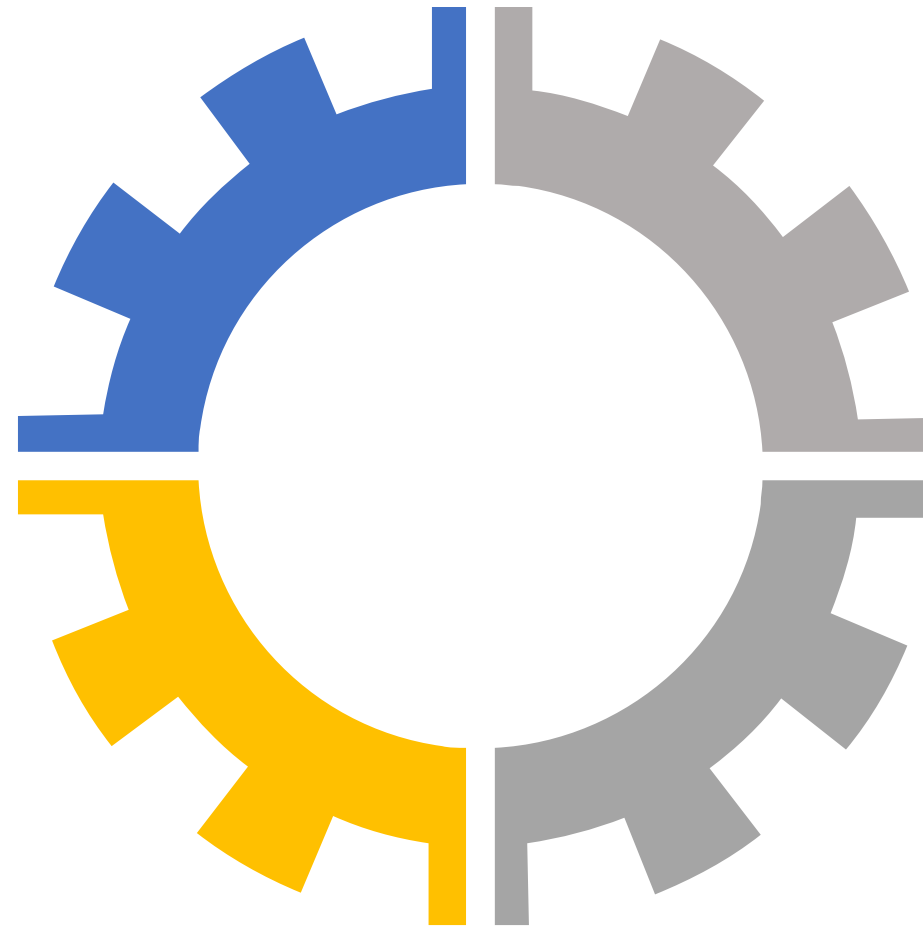
4. Filtering: data is filtered to narrow down on relevant information and make recommendations

3. Analyzing: similar items are collated and matched

Recommendation Engines

Analytical techniques may be implemented in real time (in seconds) or near real time (in minutes) and may also be performed in batches.

Real-time systems are preferred when instant recommendations are necessary.

Batch analysis may be performed for periodic analysis requirements, such as daily sales.

Application of Recommendation Engines

E-commerce sites and streaming services

Use product recommendation engines to customize what to display to visitors based on their preferences and browsing history

Social networking platforms

Use recommendation systems to connect users with similar interests based on their online activity

Internet service providers

Modulate offerings based on clients' internet consumption patterns

Banks

Analyze credit card usage and account activity to recommend relevant wealth management products to customers

Use Cases of Recommendation Engines

Use Cases of Recommendation Engines

From the news feed on our phones to e-commerce products, the work of recommender systems is visible everywhere.

Let us investigate a few use cases.

E-Commerce Sites

Recommendation engines are responsible for the personalization of products ranging from clothing to offers on gadgets, jewelry designs and food.

This is done by collecting and analyzing data on:

Past purchases

Social media interactions

Content interactions

Social Media Platforms

They leverage recommendation engines to:

Support common social behavior

Target better customers

Target increased interactions

Target better matches

It enables personalized product discovery by users and helps businesses showcase the right stock keeping units (SKUs) to customers and customize discounts, plans and other offerings.

Media Platforms

They use recommendation engines to show the most relevant content to users based on their history and interactions.

Some of the platforms that use recommendation engines are:

Search Engines

Each user receives unique search results that are tailored to them based on their past clicks and activities.

Recommender systems leverage image, text and even voice data to be prepared with more relevant search results.
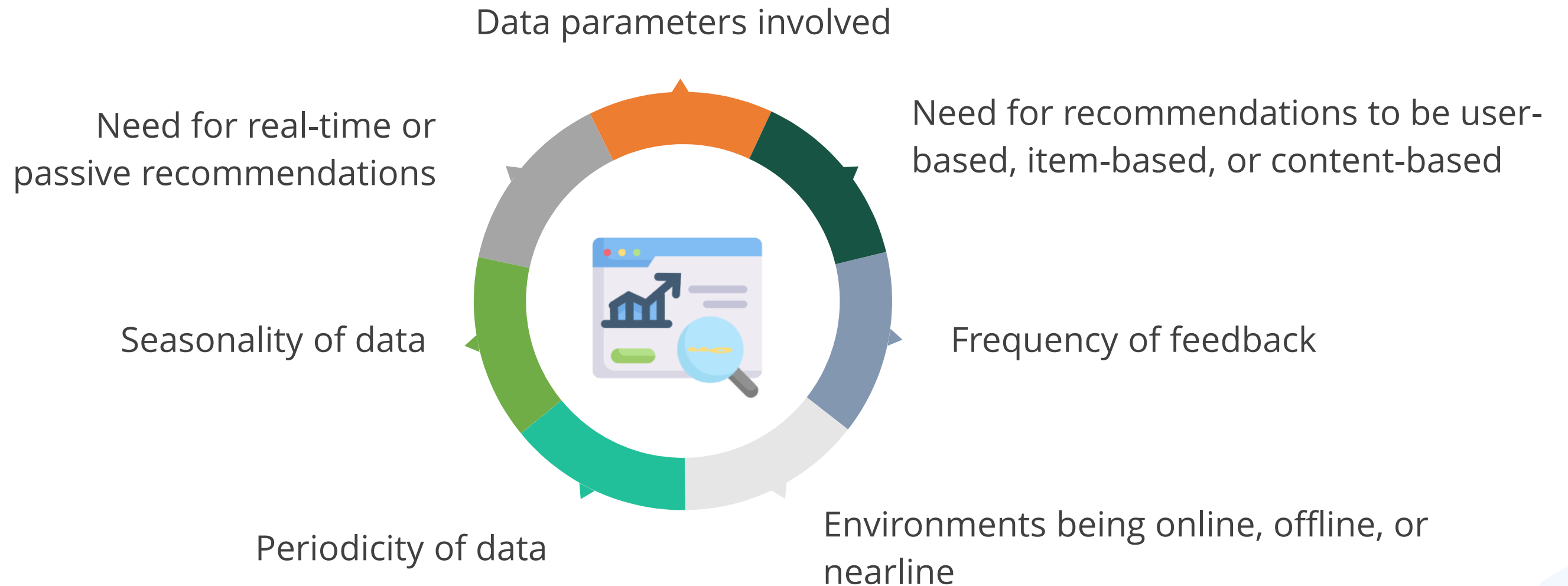
Examples of Recommender Systems and Their Designs

Examples of Recommender Systems

Recommendation engines are used across various industries such as:

Finance companies

Social networks

6

1

Internet service providers

5

Advertising engines

2

Retail outlets

4

Search engines

3
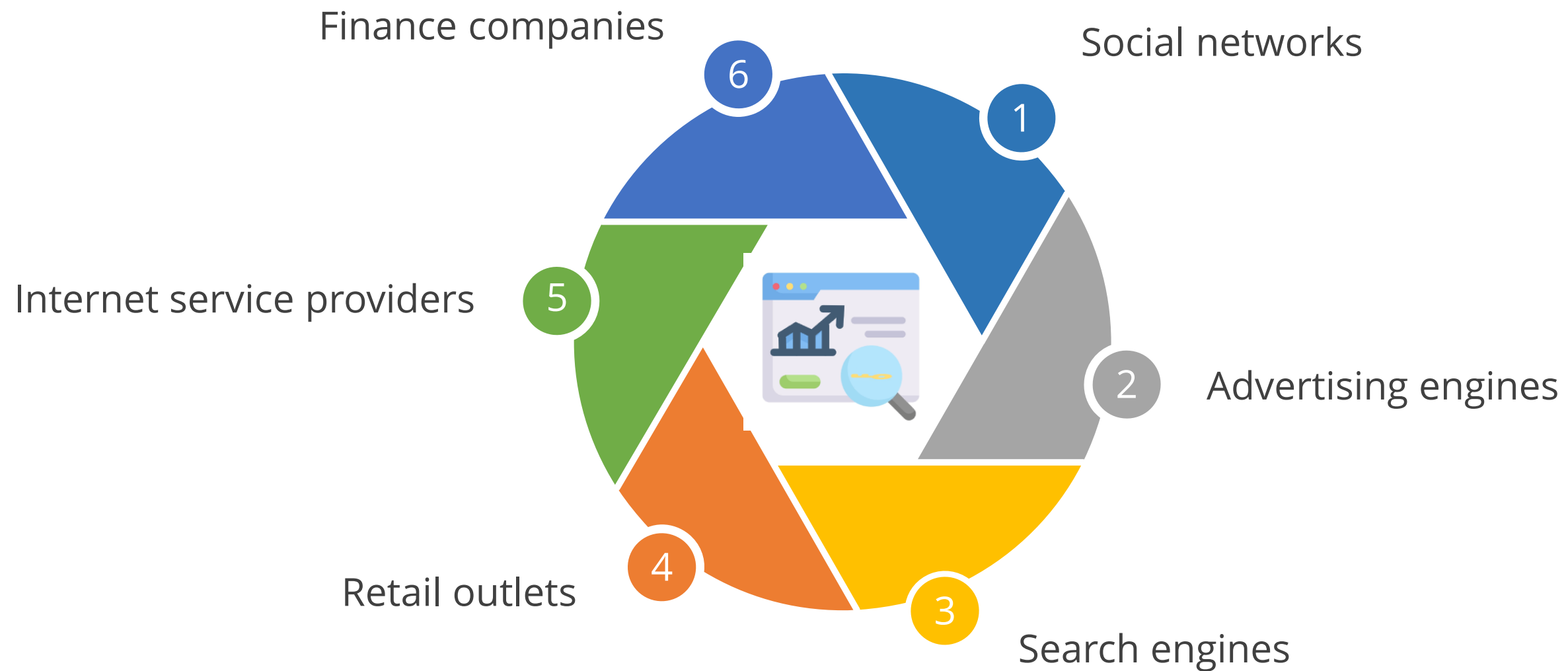
Design Factors

The design of the recommender systems depends on:

Data parameters involved

Need for recommendations to be user-based, item-based, or content-based

Frequency of feedback

Environments being online, offline, or nearline

Periodicity of data

Seasonality of data

Need for real-time or passive recommendations

Design Factors

While designing recommendation engines, one must consider the main purpose of the application.

Example

News portals may have some sections with the same content for all based on the overall popularity, and some sections customized for the local user.

The application can be for a global user base, hyperlocal, or highly customized.

Examples of Recommender Systems

Let us examine the design of recommendation systems with some sector-specific use cases.
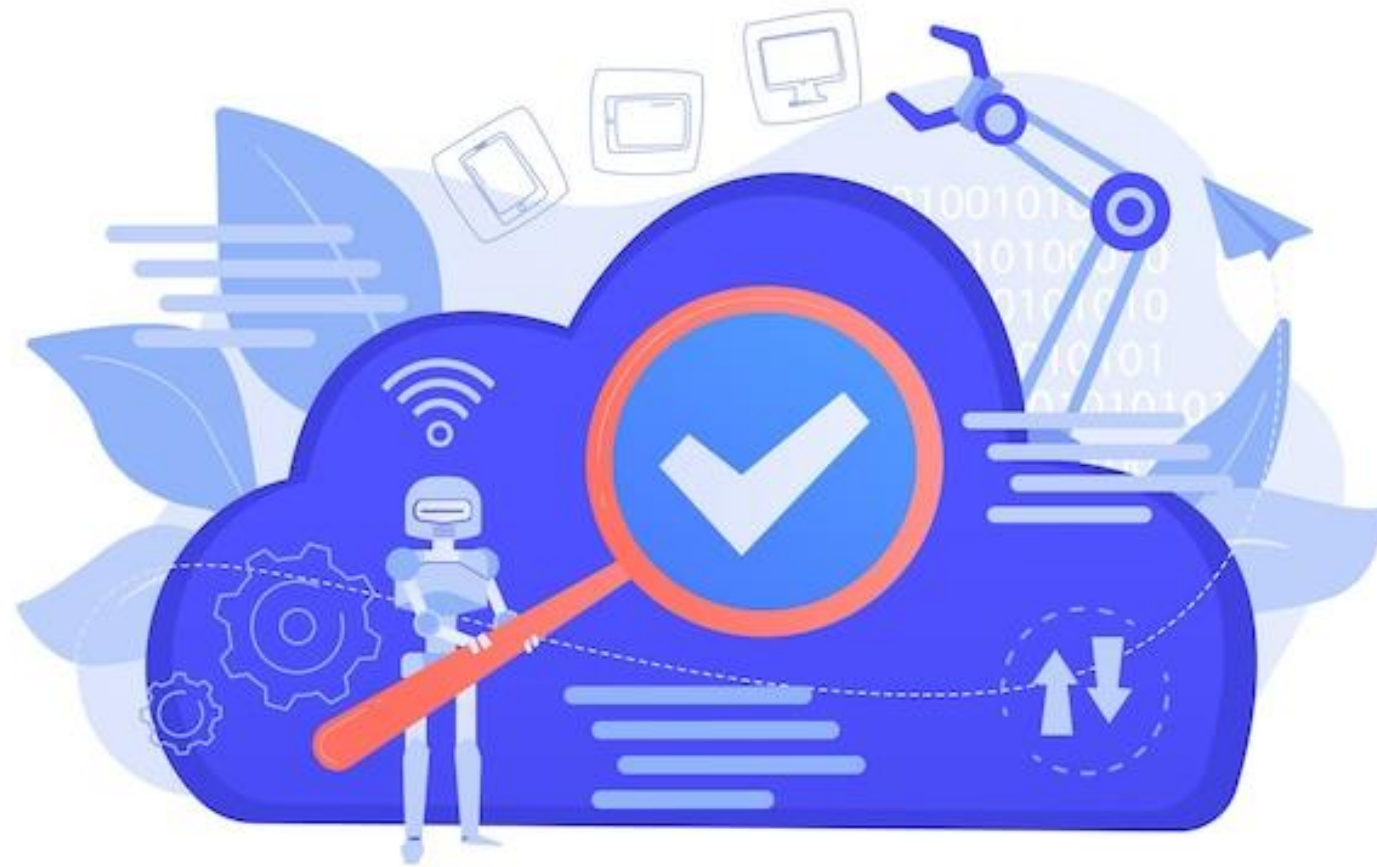
In retail, recommendation engines come with advanced search and upsell capabilities.

Examples of Recommender Systems

Retailers like H&M recommend **Others also bought** products for users searching for fitted tops.
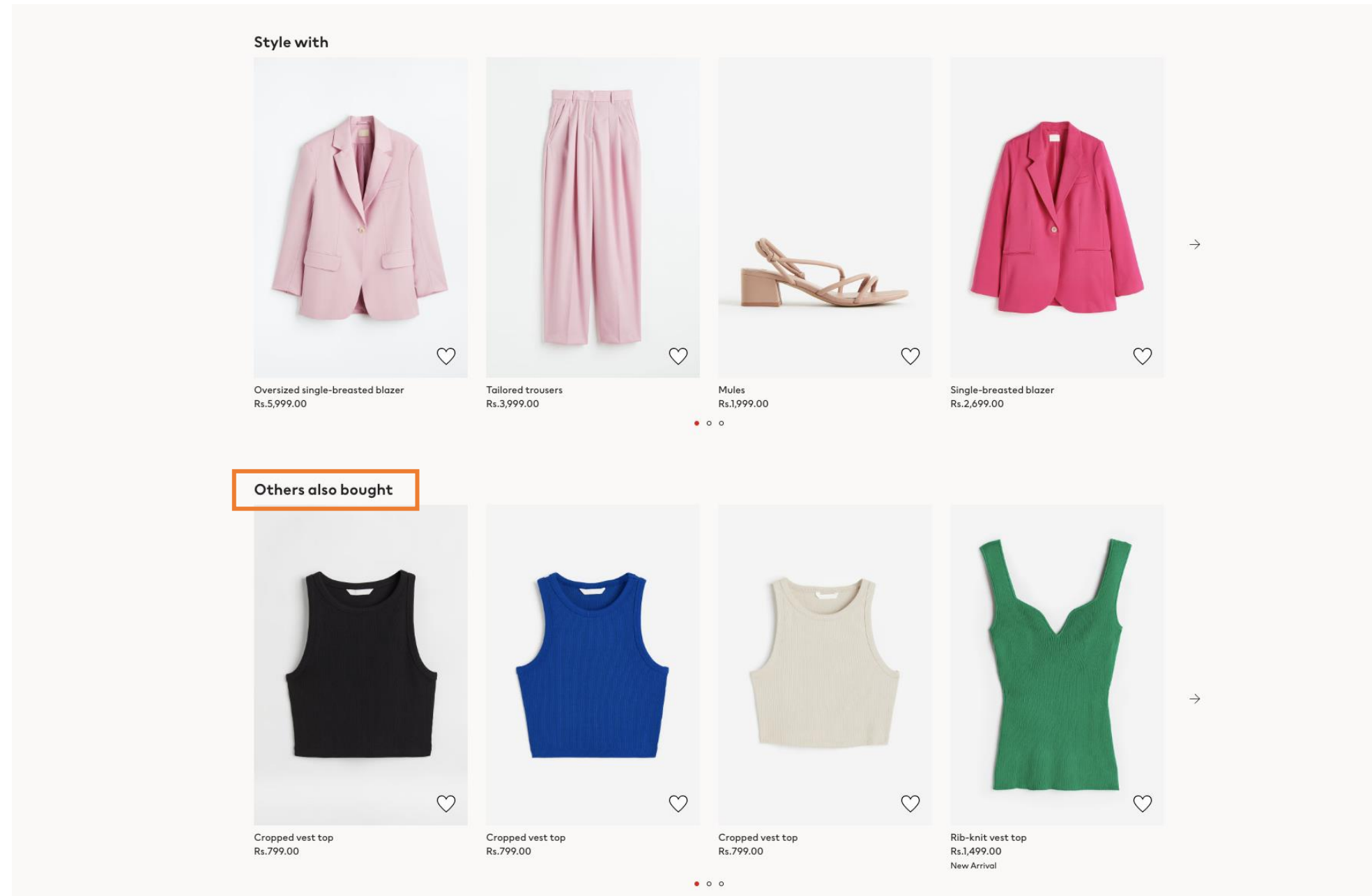
Examples of Recommender Systems
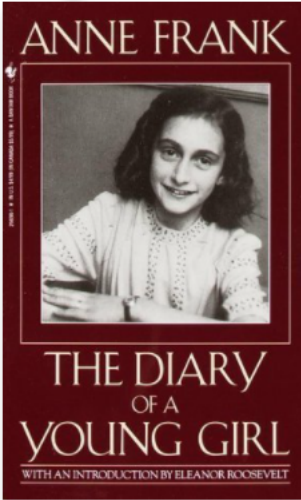
After selecting a particular top, recommender systems also recommend the tops that others have bought under **Others also bought**.

Examples of Recommender Systems

Sites like Goodreads provide **READERS ALSO ENJOYED** and **See similar books** options.

There is a recommendation engine at work here.

Examples of Recommender Systems

AI-based recommendation systems account for the hyper-personalized recommendations on media sites.
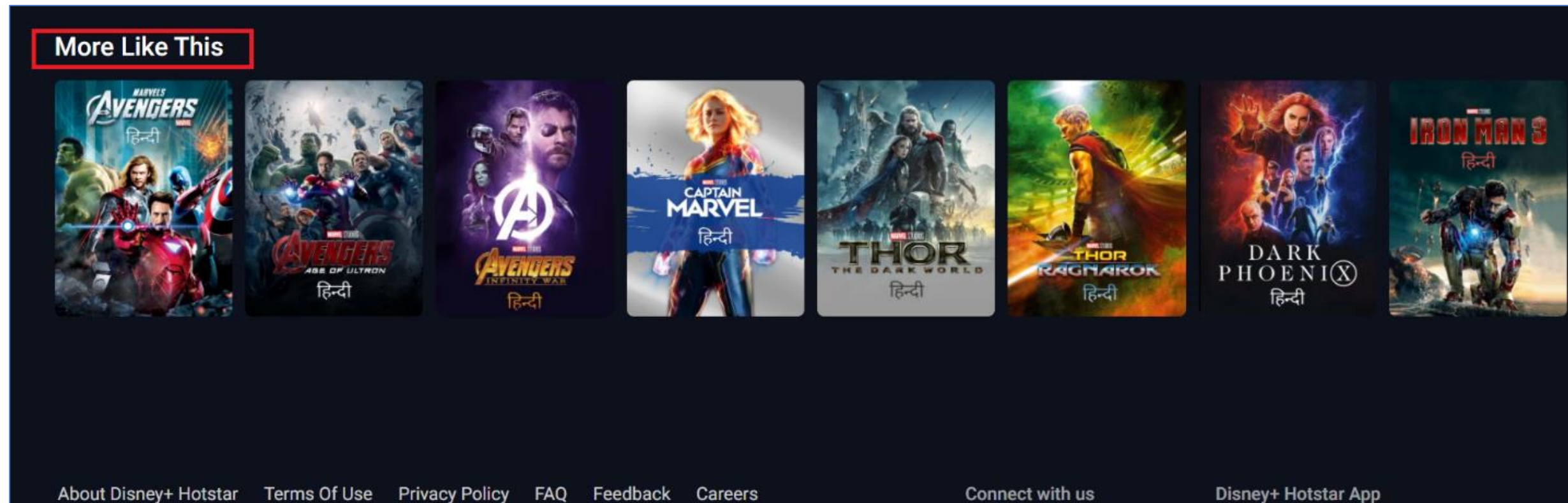
Upsell features such as **More Like This** keep viewers hooked to such portals.

Examples of Recommender Systems

Recommendations like **Related to items you've viewed** can be seen on e-commerce sites.

Constant feedback from users is essential for the engines to make relevant recommendations.

Discussion: Recommender Systems

- What are recommender systems?

Answer: A recommendation system is a subclass of Information filtering Systems that seeks to predict the preference a user might give for an item.

- What are the different types of recommender systems?

Answer: The different types of recommender systems are collaborative filtering, content-based filtering, and hybrid filtering.

- Give examples of recommender systems.

Answer: Recommendation engines are used across various domains such as Youtube, E-commerce, OTT, and Book selling.

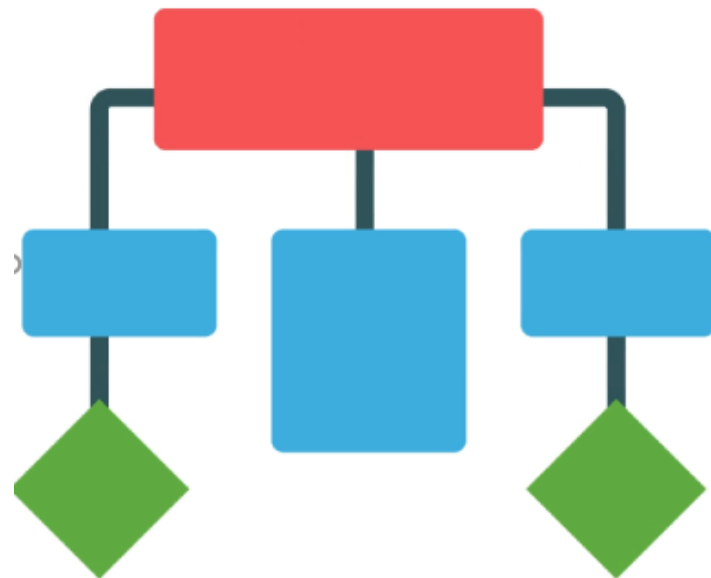# Leveraging PyTorch to Build a Recommendation Engine

Discussion: Pytorch

- What is PyTorch?

- Specify the benefits of PyTorch.

PyTorch

PyTorch is an open-source library that connects research-oriented inventions and discoveries in machine learning to commercial applications.

Example

It allows customization of algorithms on mathematical findings to leverage these for commercial applications.

One such application is recommendation engines.

Leveraging PyTorch

Collaborative filtering is one of the methods used to build recommendation engines.

It performs automatic prediction based on the following principle:

If users A and B like item T1 and user B likes item T2, then user A might have a higher chance of liking T2 based on preference similarity.
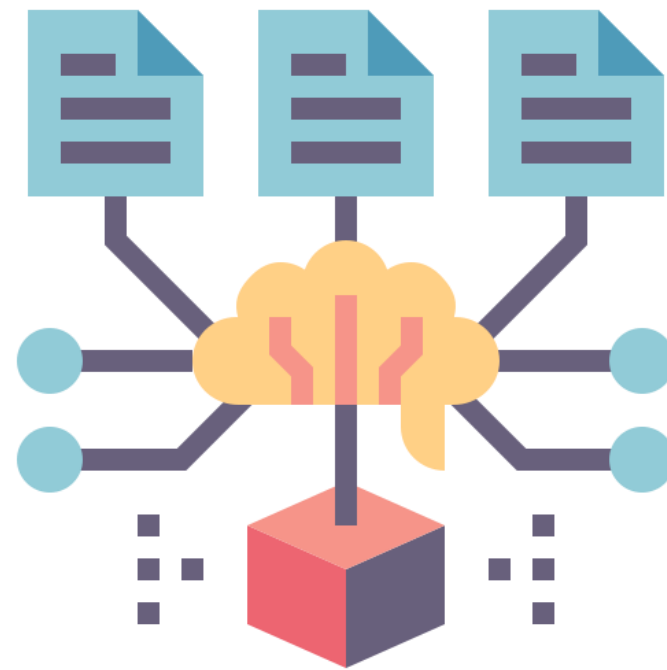
Leveraging PyTorch

Collaborative filtering is used in movies, arts and location recommendations.

Predictions of user likability for different items can be made, enabling users to view items they haven't seen before.

Leveraging PyTorch

Since the goal is to produce predictions for every combination, the data complexity becomes high.

Therefore, PyTorch coding offers algorithm optimization.

Leveraging PyTorch

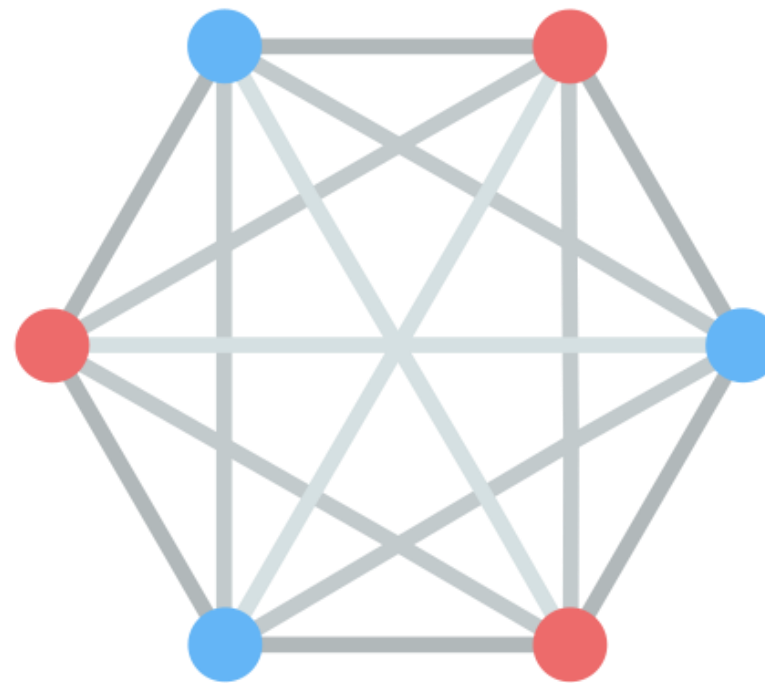Since the goal is to produce predictions for every combination, the data complexity becomes high.

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Types of Collaborative Filtering: Memory Based

It is a recommendation engine where user predictions are based on the item or user similarity.
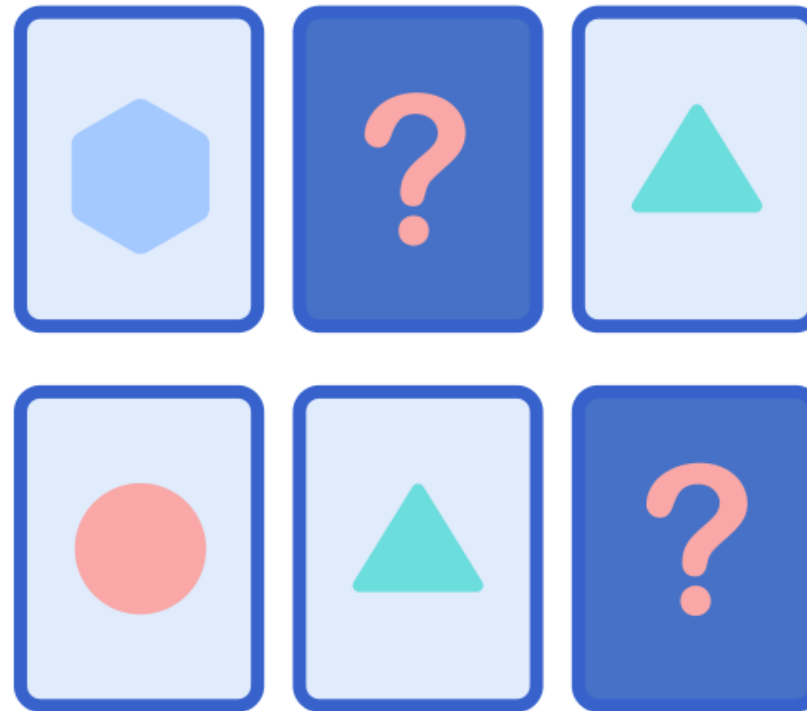
The time-space complexity for all combinations in memory-based recommendation engines may be very high if all combinations of item preferences are considered.

Types of Collaborative Filtering: Model Based

Model-based collaborative filtering refines the principle of similarity-based recommendation depending on the model used, such as PCA and clustering.
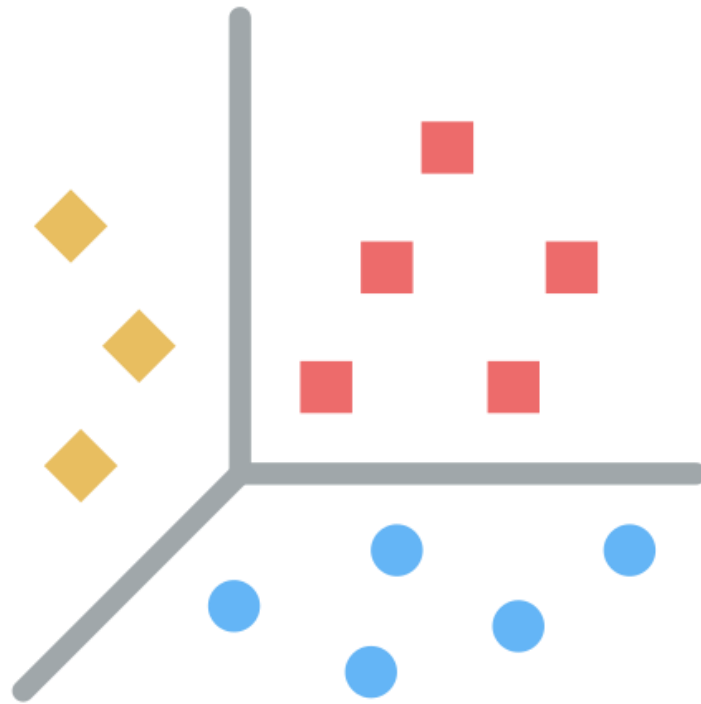
It is a combination of the other two methods.

Discussion: PyTorch

- What is PyTorch?

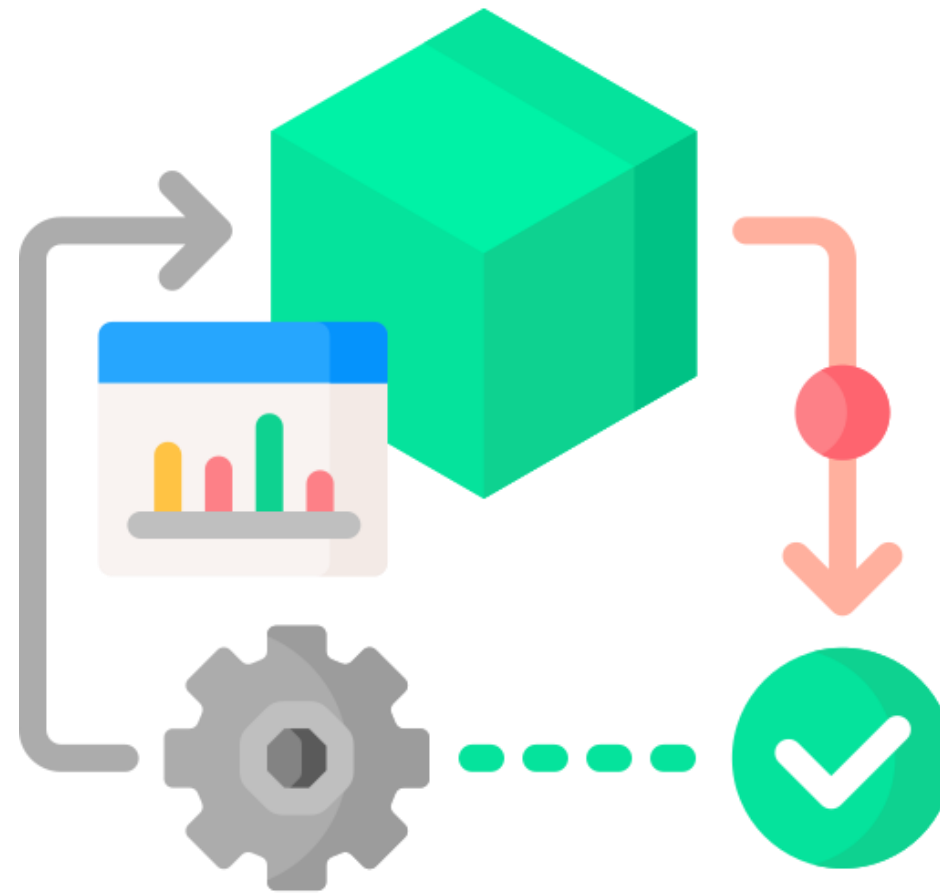**Answer:** PyTorch is an open-source machine learning (ML) framework based on the Python programming language and the Torch library. It is used for developing and training neural network-based deep learning models.

- Specify the benefits of PyTorch.

   Answer: The benefits of PyTorch are:
   - It offers developers an easy-to-learn, simple-to-code structure that's based on Python.
   - It enables easy debugging with popular Python tools.
   - It offers scalability and is well-supported on major cloud platforms.
   - It provides a small community focused on open source.

Assisted Practices

Let's understand the topics below using Jupyter Notebook.

- 8.06_Collaborative Filtering and Memory-Based Modeling
- 8.07_Item-Based Collaborative Filtering
- 8.08_User-Based Collaborative Filtering
- 8.09_Model-Based Collaborative Filtering
- 8.10_Dimensionality Reduction and Matrix Factorization
- 8.11_Accuracy Matrices in ML

Note: Please download the pdf files for each topics mentioned above from the Reference Material section.

Key Takeaways

◉ Recommendation engines use machine learning algorithms to filter and recommend relevant items.

◉ There are three types of recommendation engines: collaborative filtering, content-based filtering and hybrids.

◉ Recommendation engines process data through the collecting, storing, analyzing and filtering phases.

◉ They have various applications including e-commerce, social media, internet service providers and finance companies.

◉ PyTorch is an open-source library used to build recommendation engines based on user preferences and is commonly used in e-commerce, retail and social media.
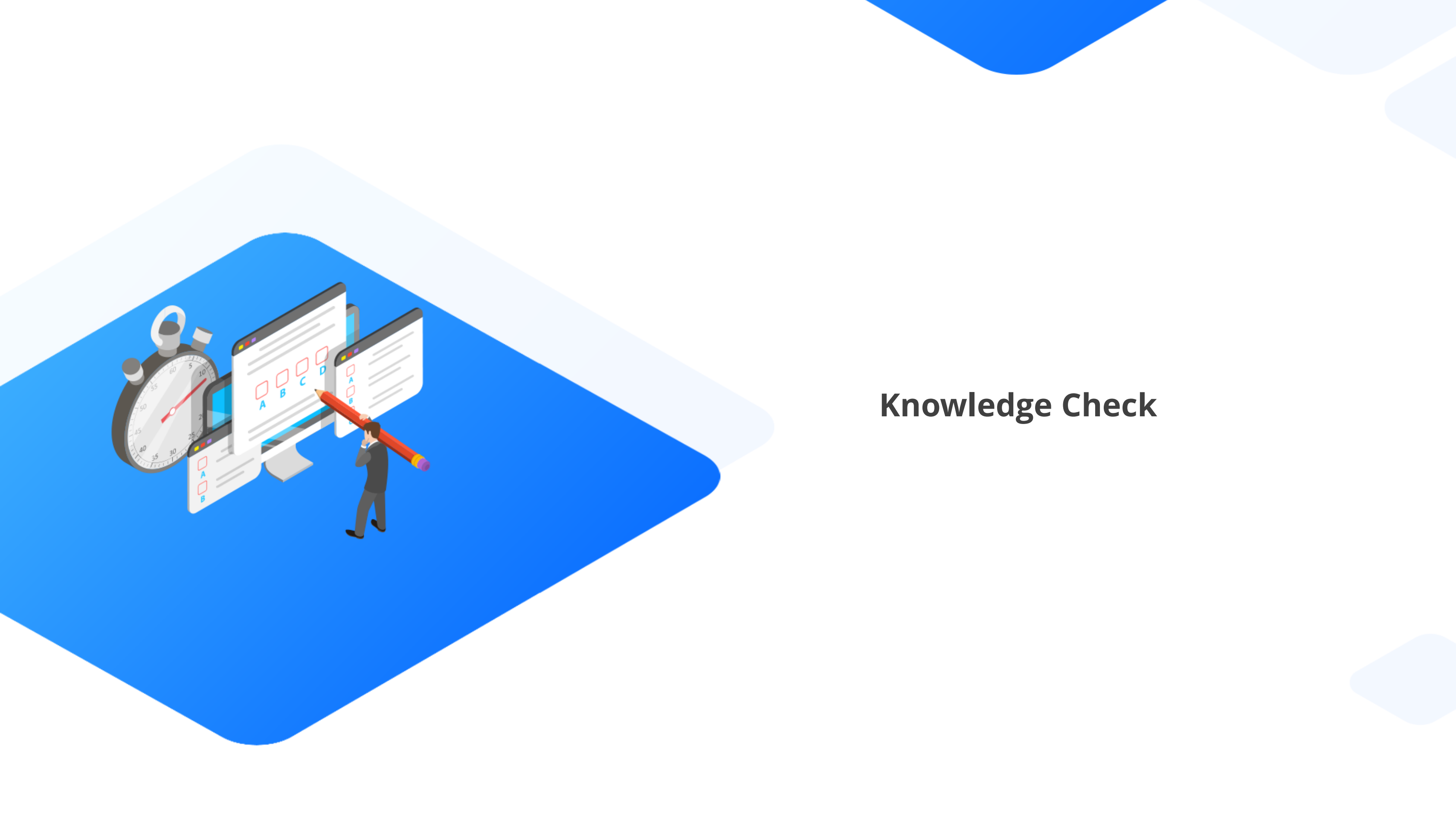
Knowledge Check

What are the three types of recommendation engines?

A.   Hybrid, analytical and batch

B.   Collaborative filtering, content-based filtering and hybrid

C.   Online, offline and nearline

D.   Real time, passive and hybrid

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A.   Hybrid, analytical and batch

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D.   Real time, passive and hybrid

The correct answer is **B**

There are three types of recommendation engines: collaborative filtering, content-based filtering and hybrid.

What is the purpose of data collection in recommendation engines?

A.   To perform real-time analysis

B.   To create a list of recommended products

C.   To narrow down relevant information

D.   To procure data such as page views, view history, or cart events

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D.   To procure data such as page views, view history, or cart events

The correct answer is   **D**

Data collection is the first step in the recommendation engine process, and it involves procuring data such as page views, view history, or cart events.

What is collaborative filtering?

A.   Analyzing data to create a list of recommended products

B.   Modulating offerings based on clients' internet consumption patterns

C.   Providing recommendations based on the interests of similar users

D.   Filtering data to narrow down on relevant information

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The correct answer is **C**

Collaborative filtering is a type of recommendation engine that provides recommendations based on the interests of similar users.

Thank You!