

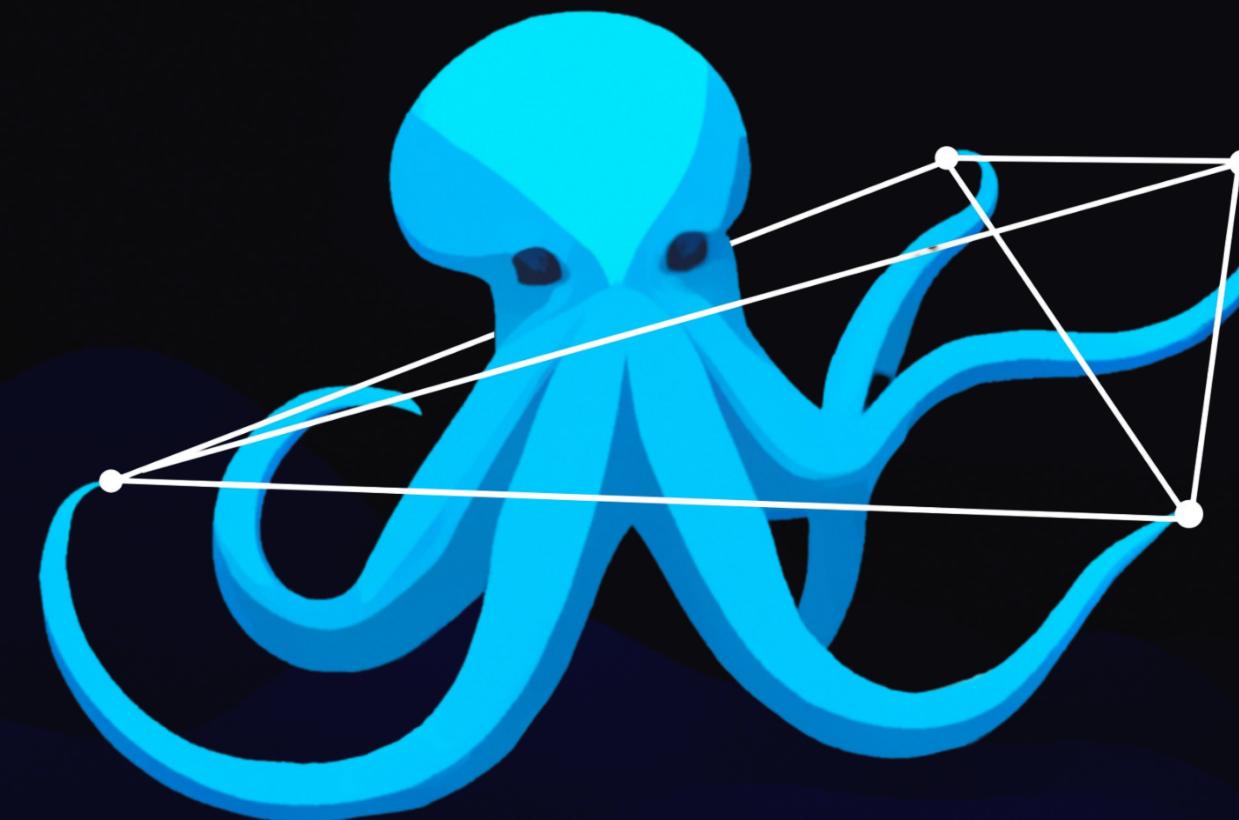
Machine Learning Fortnight 2023

Introduction to Recommender Systems

LB 5173.0055
20 / 11 / 2023
15:00 - 17:00



Fully
Connected
Graph



Fully
Connected
Graph

Machine Learning Fortnight

Introduction to Recommender Systems

Who are we?

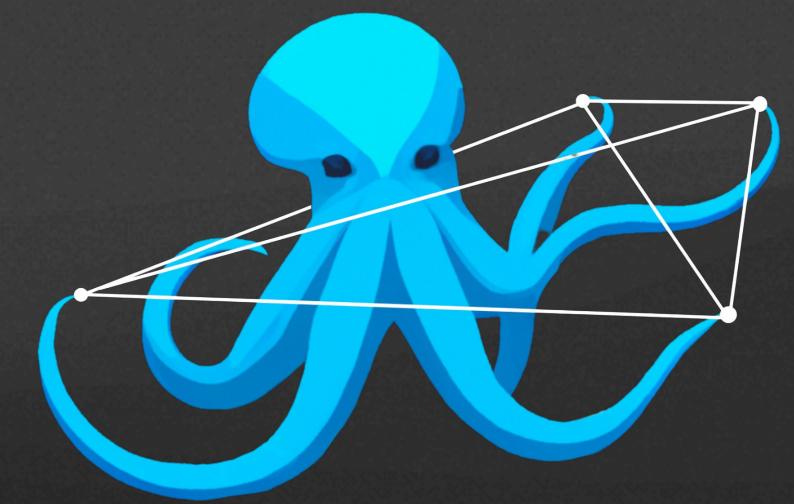
ML Month



GAPC



Our Wonderful Team



Fully
Connected
Graph

Last year...

Predicting housing prices in the Netherlands

The screenshot shows the homepage of a competition titled "Netherlands Accommodation Prices (FCG)". The background features a scenic view of traditional Dutch houses under a sunset sky. The title "Netherlands Accommodation Prices (FCG)" is prominently displayed in the center. Below it, the subtitle "Predict accommodation prices in the Netherlands" is visible. A timestamp "8 teams · a year ago" is shown. The navigation bar at the top includes links for "Overview" (underlined), "Data", "Code", "Models", "Discussion", "Leaderboard", "Rules", "...", "Submissions", "Late Submission" (highlighted in a button), and "...". The "Overview" section contains details about the competition's start date (Nov 14, 2022) and close date (Dec 8, 2022). It also lists "Prizes & Awards" (Kudos, no Points or Medals), "Participation" (13 Competitors, 8 Teams, 133 Entries), and a participation progress bar. The "Late Submission" button is highlighted with a green outline.

Community Prediction Competition

Netherlands Accommodation Prices (FCG)

Predict accommodation prices in the Netherlands

8 teams · a year ago

Overview Data Code Models Discussion Leaderboard Rules ... Submissions Late Submission ...

Overview

Start
Nov 14, 2022

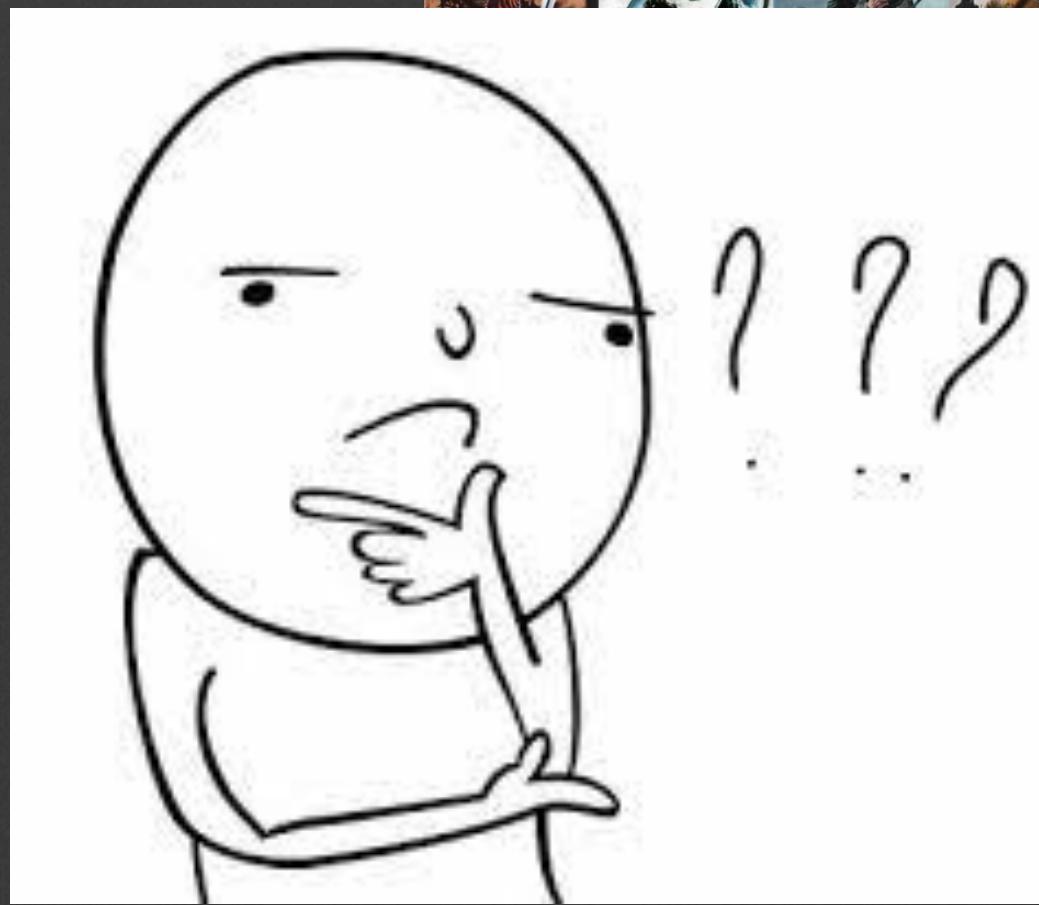
Close
Dec 8, 2022

Prizes & Awards
Kudos
Does not award Points or Medals

Participation
13 Competitors
8 Teams
133 Entries

This year... video games are amazing!

But which one should you play?



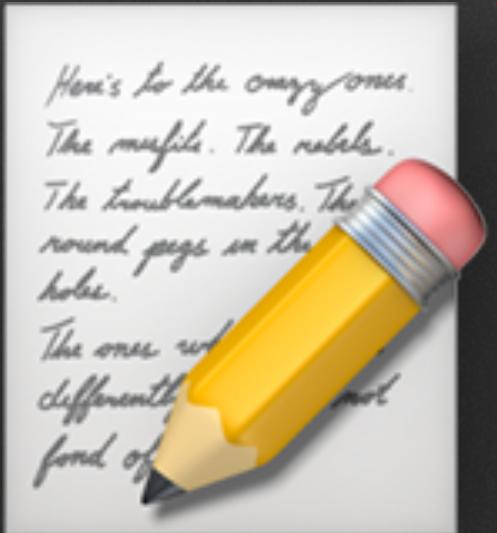
Fortnight overview



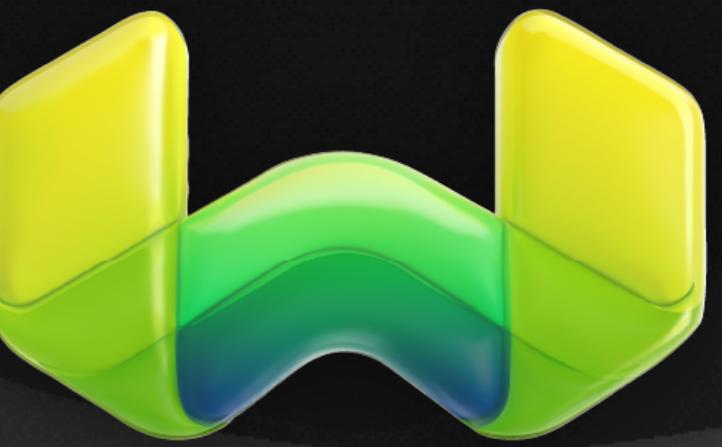
Introduction to
Recommender Systems



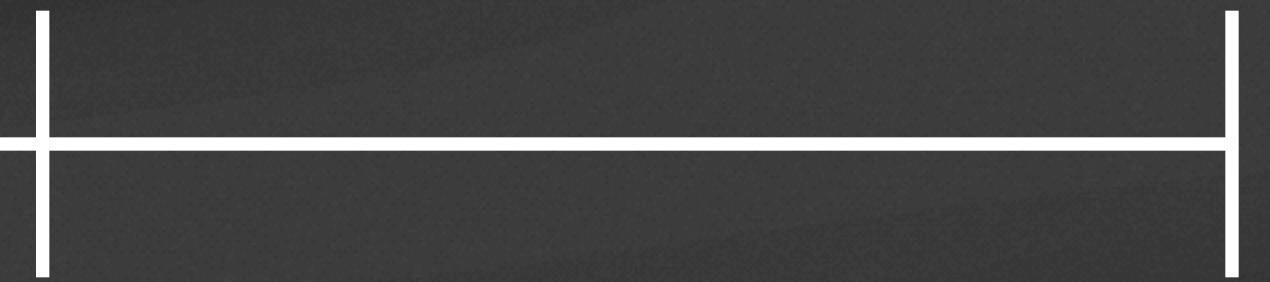
NLP in RecSys



20 Nov



Weaviate
Vector Databases



24 Nov

Finale &
Award Ceremony



27 Nov

1 Dec

Contents

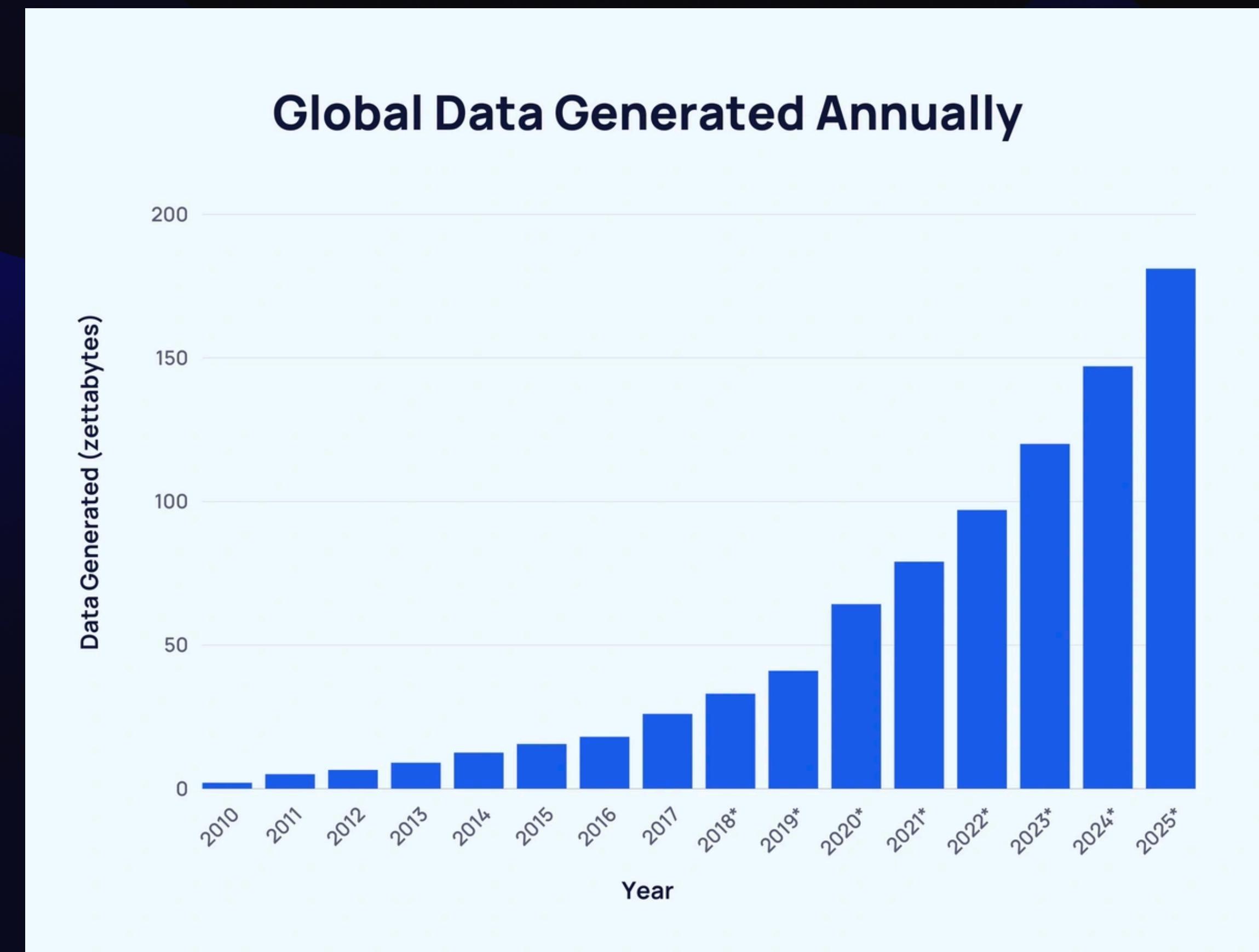
- What Are Recommender Systems?
- Types of Recommender Systems
 - Content filtering
 - Collaborative filtering
 - Hybrid filtering
- Recommendation Algorithms
- Practical Session

Prerequisites

Familiar with

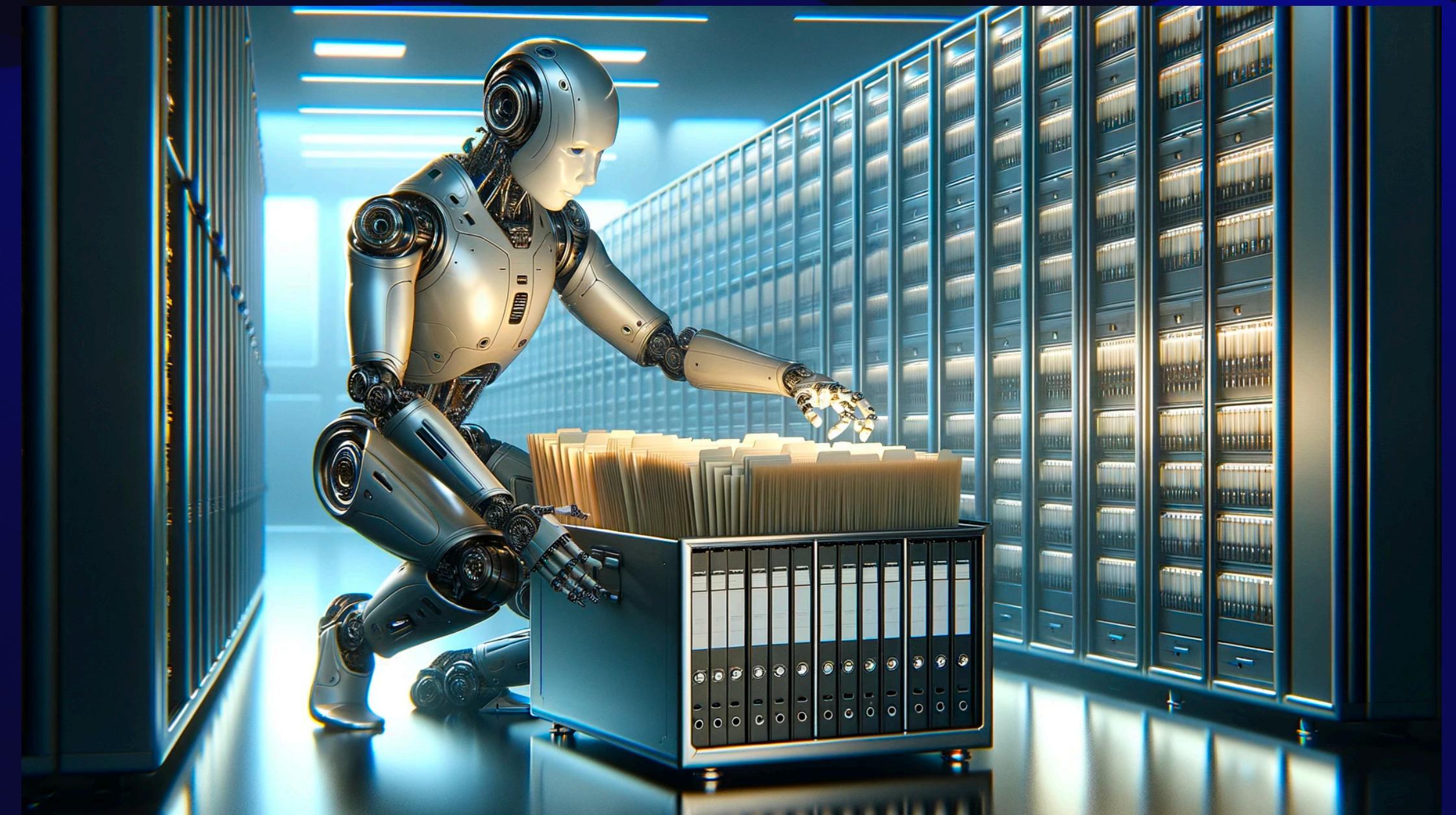
- Machine Learning
- Linear Algebra (inner product, matrix vector product)
- Some experience with Tensorflow and pandas

The world generates **2.5 quintillion bytes** per day. That's 1,000 petabytes!



Recommender Systems are methods to suggest relevant content to users based on their preferences and behavior.

They *filter* the information



NETFLIX

TV Shows Movies Recently Added My List

All mobile games included with your membership

Stranger Things: 1984 Adventure

Stranger Things 3: The Game Adventure

Card Blast Casual

Tetris Blitz Casual

Only on Netflix

N LOVE on SPECTRUM

THE GREAT BRITISH BAKING SHOW

Stranger Things: 1984 Adventure

Play Game

The Dumb TV

Stranger Things: 1984 Adventure

Join Hopper and the kids for bruising missions around Hawkins and the Upside Down—in this stylized retro adventure filled with exclusive content.

Mode: Single Player, Multiplayer

Home Games Coming Soon Downloads Free Games

Customer Service Gift Cards Sell

Best graphics card"

Results

ZOTAC Gaming GeForce RTX 3060 Twin Edge OC 12GB GDDR6 192-BIT 75 Gbps PCIe 4.0 Graphics Card

IceStorm 2.0 Cooling, Active Fan Control, Freeze Fan Stop ZT-A30600H-10M

★★★★★ 3,608

\$289.99 List: \$339.99

Delivery Fri, Nov 17

Ships to Netherlands

More Buying Choices

\$266.79 (34 used & new offers)

Overall Pick

PNY GeForce RTX™ 4060 8GB XLR8 Gaming Verto RGB Triple Fan Graphics Card DLSS 3

★★★★★ 68

\$329.99

Delivery Fri, Nov 17

Ships to Netherlands

Google

Pls tell what are recommender systems

Images Examples Videos News Books Flights Finance

About 25.300.000 results (0,36 seconds)

Wikipedia

https://en.wikipedia.org/wiki/Recommender_system

Recommender system

The system generates recommendations using only information about rating profiles for different users or items. By locating peer users/items with a rating ...

People also ask :

- What is a recommender system in simple terms?
- What is an example of a recommender system?
- What are recommender systems and why are they important?
- How do you assess a recommender system?

Feedback

Nvidia

https://www.nvidia.com/en-us/glossary/recommender-system/

What is a Recon

A recommendation system uses data to help predict

STORE LIBRARY COMMUNITY

WHAT'S NEW

Introducing Steam Remote Play Together

Blues Song Pack III - Rocksmith 2014 Edition Remastered DLC

The Blueprint Update Rolls Out on December 4

The Item Shop: A Closer Look

Ver. 1.14 update information

FIGHTING GAMES (22)

Street Fighter V

Dragon Ball FighterZ

TEKKEN 7

Ultra Street Fighter IV

Tekken Tag Tournament 2

Soulcalibur VI

Downloads

boodschappen in huis

3 PRODUCTEN PAKKET 7.97 per pakket

Chiquita proteïne ontbijt pakket

4 PRODUCTEN PAKKET 7.16 per pakket

Chiquita school-tussendoortjes pakket

Picks

Featured profiles of the day, picked just for you.

Creative Entrepreneur Scholar Kyle, 24 6 left

GET MORE

Recommender systems are everywhere...

Content Based Filtering

Content-based filtering recommends items similar to those the user has shown interest in based on item features.

Content-based Filtering

watched by user



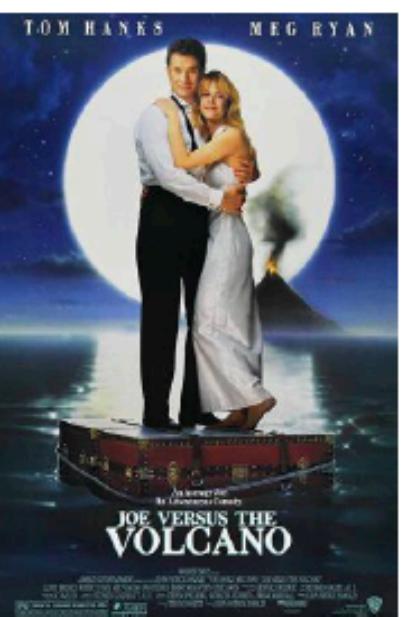
Genres:

- Comedy
- Romance

Cast:

- Tom Hanks
- Meg Ryan

similar
movies



Genres:

- Comedy
- Romance

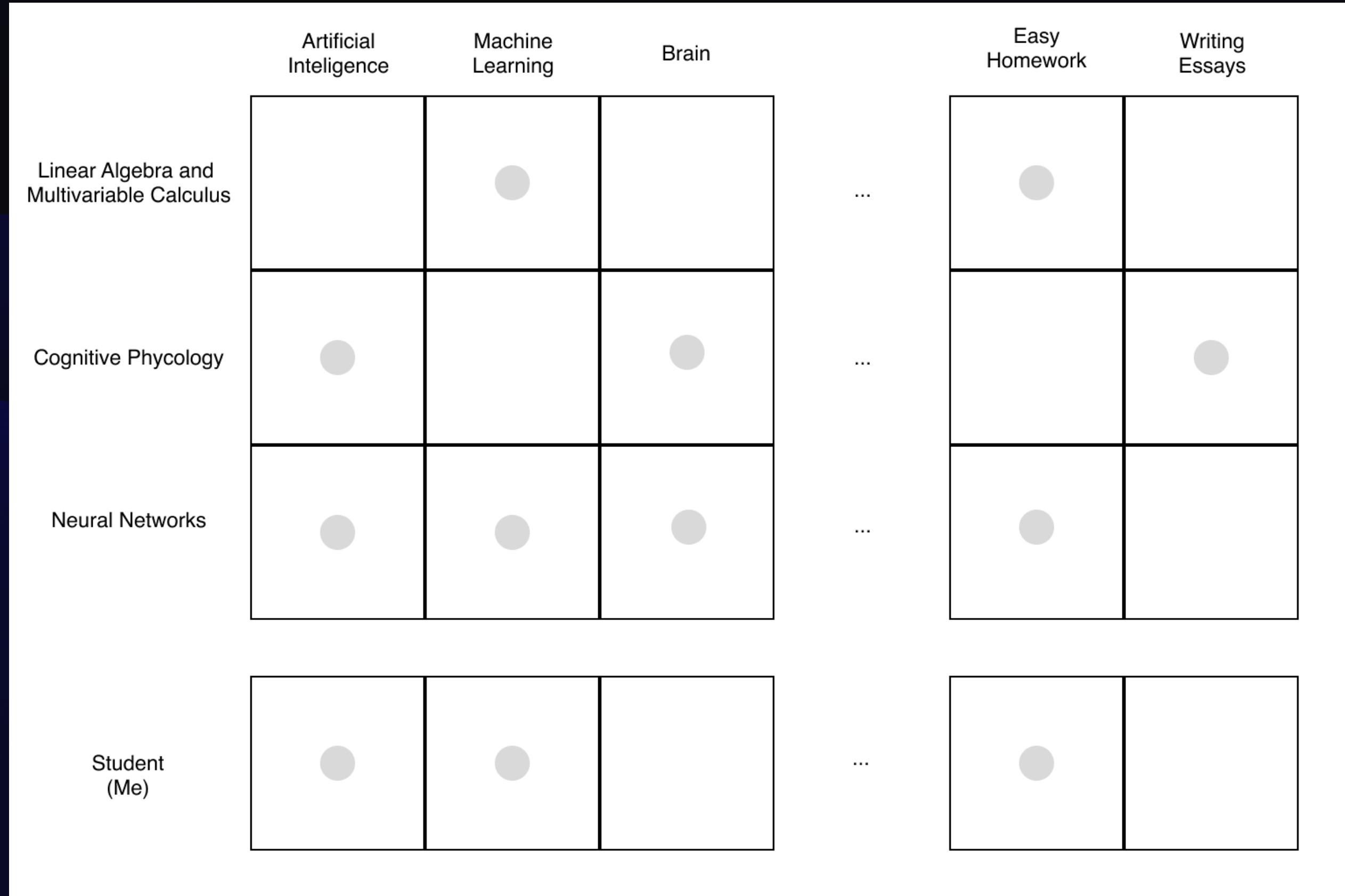
Cast:

- Tom Hanks
- Meg Ryan

recommended
to him



Content Based Filtering



$$\langle x, y \rangle = \sum_{i=1}^d x_i y_i$$

```
import numpy as np

courses = np.array([
    [0, 1, 0, 1, 0],
    [1, 0, 1, 0, 1],
    [1, 1, 1, 1, 0]
])

student = np.array([
    [1, 1, 0, 1, 0]
])

print(np.dot(student, courses.T))

# Output: [[2 1 3]]
```

Content Based Filtering

Advantages:

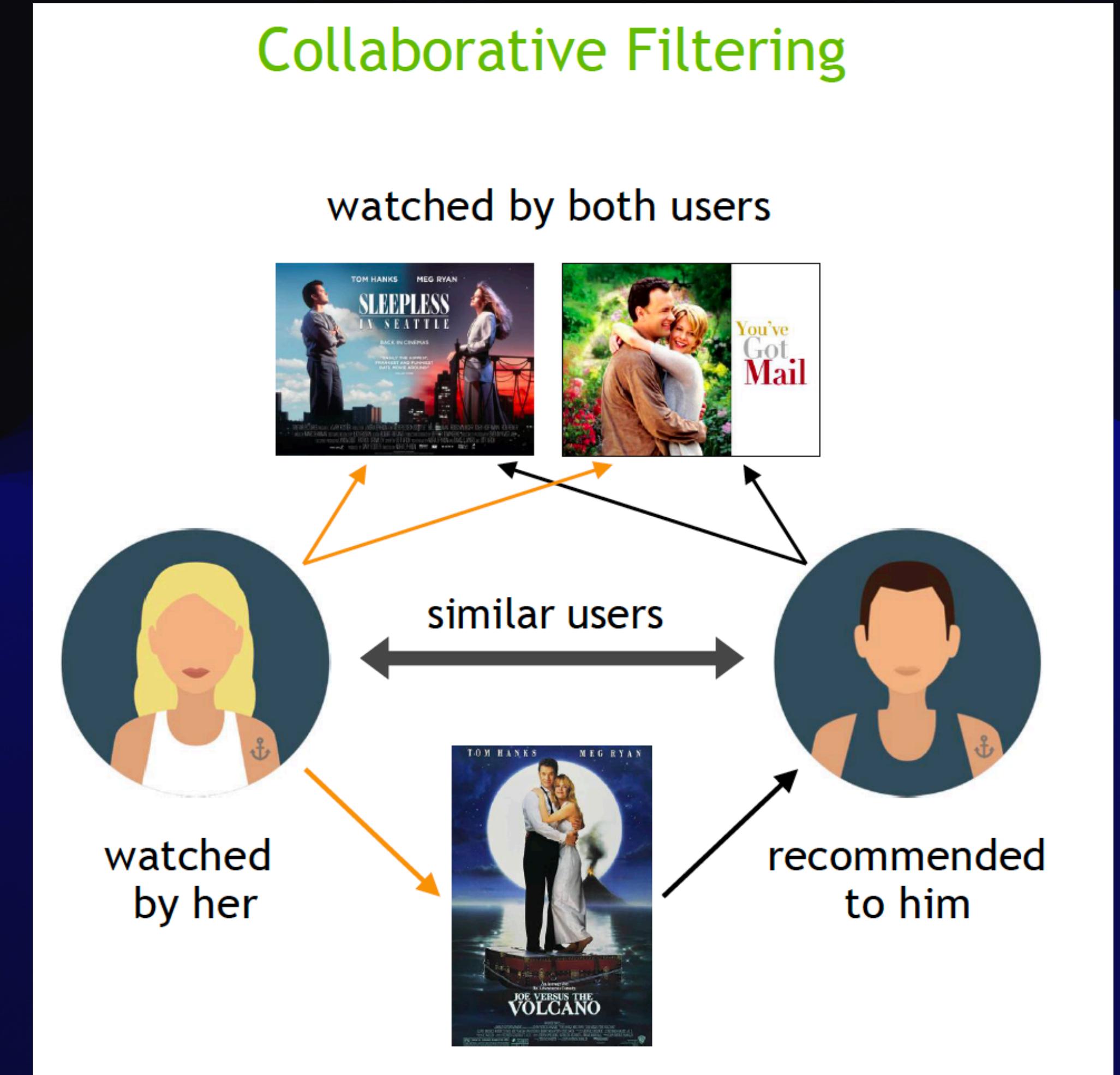
- No need for data about other users; recommendations are user-specific.
- Scalable to a large number of users.
- Can recommend niche items tailored to individual preferences.

Disadvantages:

- Requires domain knowledge for hand-engineering item features.
- Limited ability to expand on users' existing interests; recommendations are based on current preferences.

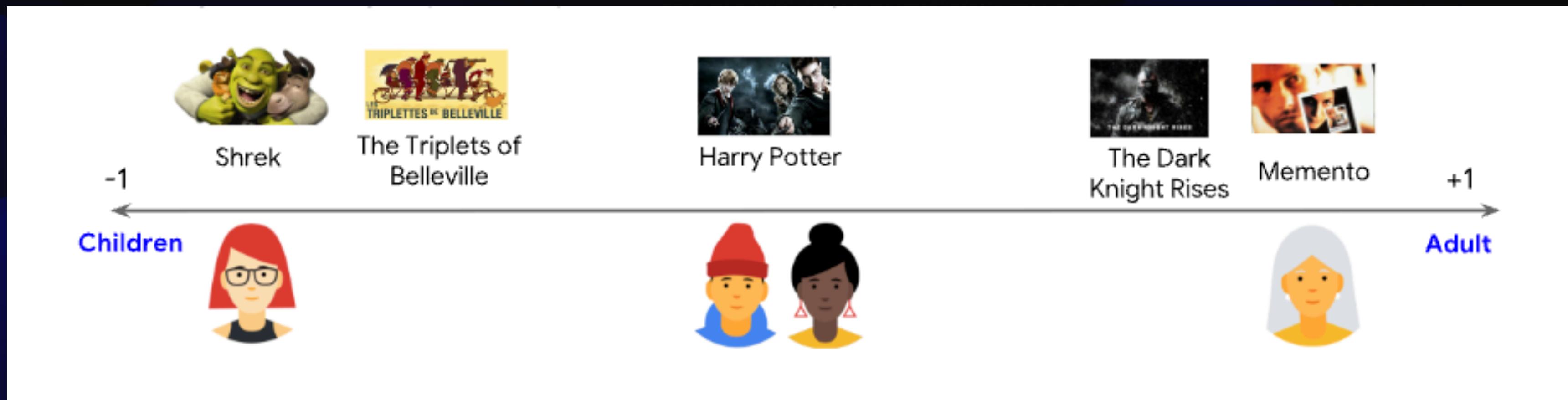
Collaborative Filtering

Collaborative filtering uses past similar decisions to predict future selections based on shared preferences.



Collaborative Filtering

1D embedding



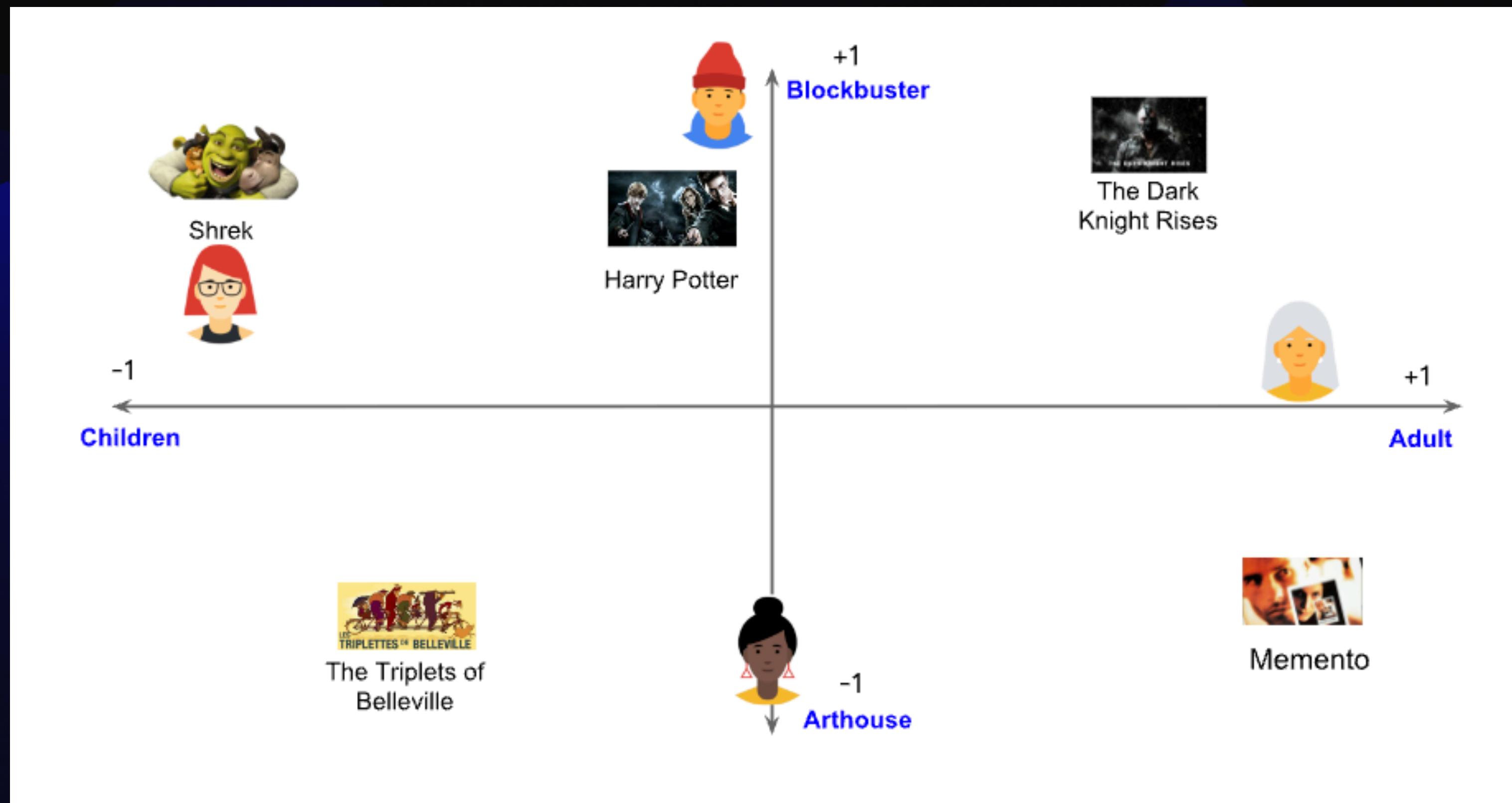
Collaborative Filtering

1D embedding



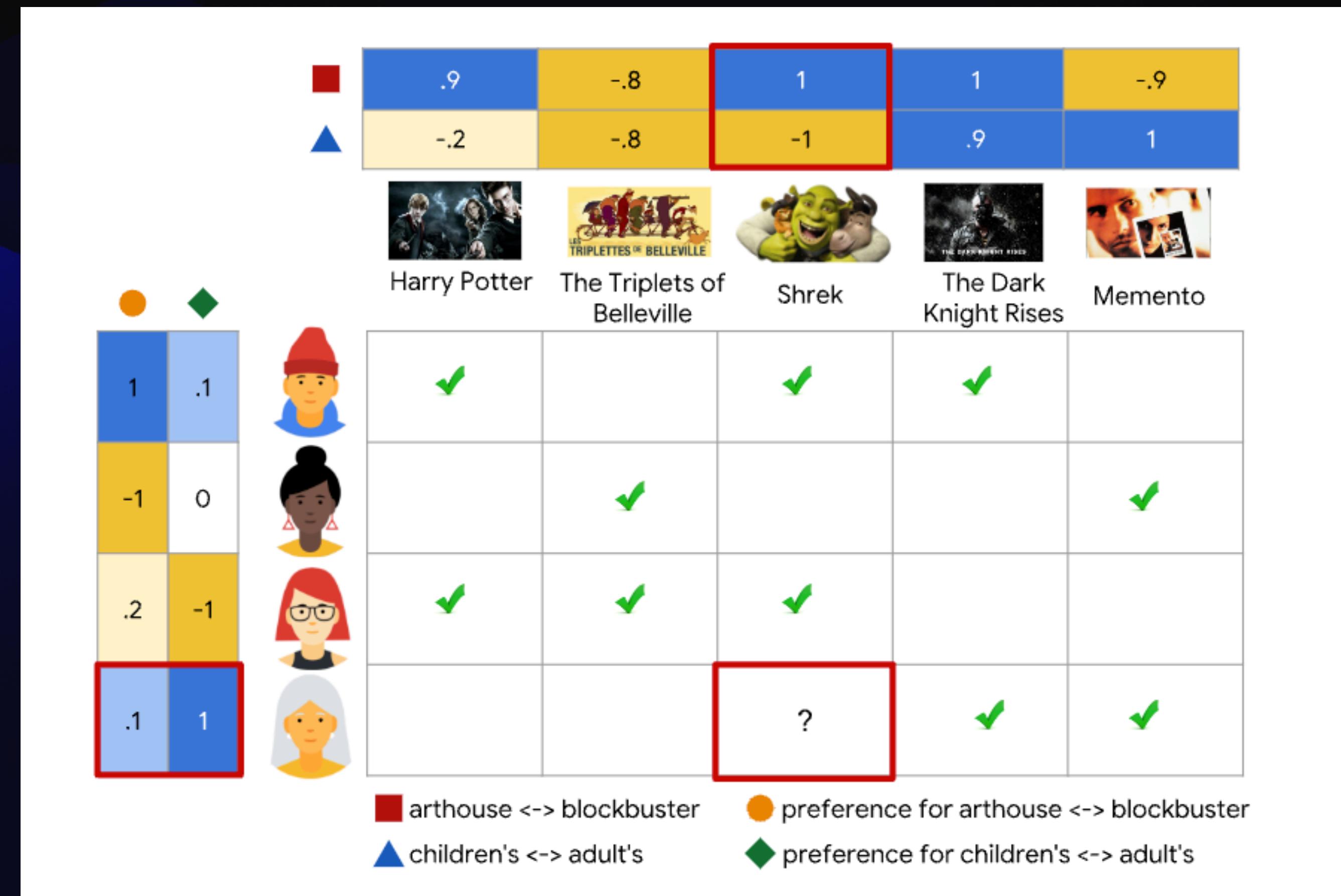
Collaborative Filtering

2D embeddings



Collaborative Filtering

2D embeddings



Collaborative Filtering

Matrix Factorization

Matrix Factorization

Matrix factorization is a simple embedding model. Given the feedback matrix $A \in R^{m \times n}$, where m is the number of users (or queries) and n is the number of items, the model learns:

- A user embedding matrix $U \in \mathbb{R}^{m \times d}$, where row i is the embedding for user i.
 - An item embedding matrix $V \in \mathbb{R}^{n \times d}$, where row j is the embedding for item j



Collaborative Filtering

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$$\min_{U \in R^{m \times d}, V \in R^{n \times d}} \sum_{(i,j) \in \text{obs}} (A_{ij} - \langle U_i, V_j \rangle)^2.$$

The task is similar to ...

However, it is not efficient enough :(

SVD				
1	0	1	1	0
0	1	0	0	1
1	1	1	0	0
0	0	0	1	1

$$\begin{aligned} & \|A - UV^T\|_F^2 \\ &= \sum_{(i,j)} (A_{ij} - U_i \cdot V_j)^2 \end{aligned}$$

Collaborative Filtering

Matrix Factorization

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Weighted Matrix Factorization:

$$\min_{U \in \mathbb{R}^{m \times d}, V \in \mathbb{R}^{n \times d}} \sum_{(i,j) \in \text{obs}} (A_{ij} - \langle U_i, V_j \rangle)^2 + w_0 \sum_{(i,j) \notin \text{obs}} (\langle U_i, V_j \rangle)^2.$$

Collaborative Filtering

Matrix Factorization (Optimization)

Stochastic Gradient Descent (SGD)

generic algorithm to minimize loss functions.

Optimize U and V matrices together

Alternating Least Squares (ALS)

specialized to this particular objective.

- Fix U , optimize V
- Fix V , optimize U

Collaborative Filtering

Matrix Factorization (SGD vs ALS)

SGD

- 👍 Very flexible—can use other loss functions.
- 👍 Can be parallelized.
- 👎 Slower—does not converge as quickly.
- 👎 Harder to handle the unobserved entries (need to use negative sampling or gravity).

ALS

- 👎 Reliant on Loss Squares only.
- 👍 Can be parallelized.
- 👍 Converges faster than SGD.
- 👍 Easier to handle unobserved entries.

The screenshot shows a web browser window with the following details:

- Header:** Machine Learning, Advanced courses (highlighted), Guides, More, Search, English, and a user profile icon.
- Breadcrumbs:** Home > Products > Machine Learning > Advanced courses > Recommendation Systems.
- Section Title:** Introduction
- Content Summary:** Estimated Course Time: 4 hours. Welcome to **Recommendation Systems**! We've designed this course to expand your knowledge of recommendation systems and explain different models used in recommendation, including matrix factorization and deep neural networks.
- Objectives:**
 - Describe the purpose of recommendation systems.
 - Understand the components of a recommendation system including candidate generation, scoring, and re-ranking.
- Navigation:** Filter, Send feedback, and a three-dot menu icon.

<https://developers.google.com/machine-learning/recommendation>

Practical Session :D

Break till ...

ML Fortnight 2023

- **Register yourself**
- Read the Kaggle page
- Build a recommender system
- Evaluate your model
- Submit your results
- Iterate and improve!

Machine Learning Fortnight

Nov 20 – Dec 1

Learn, code, win!

- 3 lectures
- 1 competition
- cool prizes
- lots of fun!

Develop a game recommendation system and gain valuable experience in process!



Scan here for more info

Or just look up:
mlfortnight.svcover.nl



Cover



Fully
Connected
Graph