




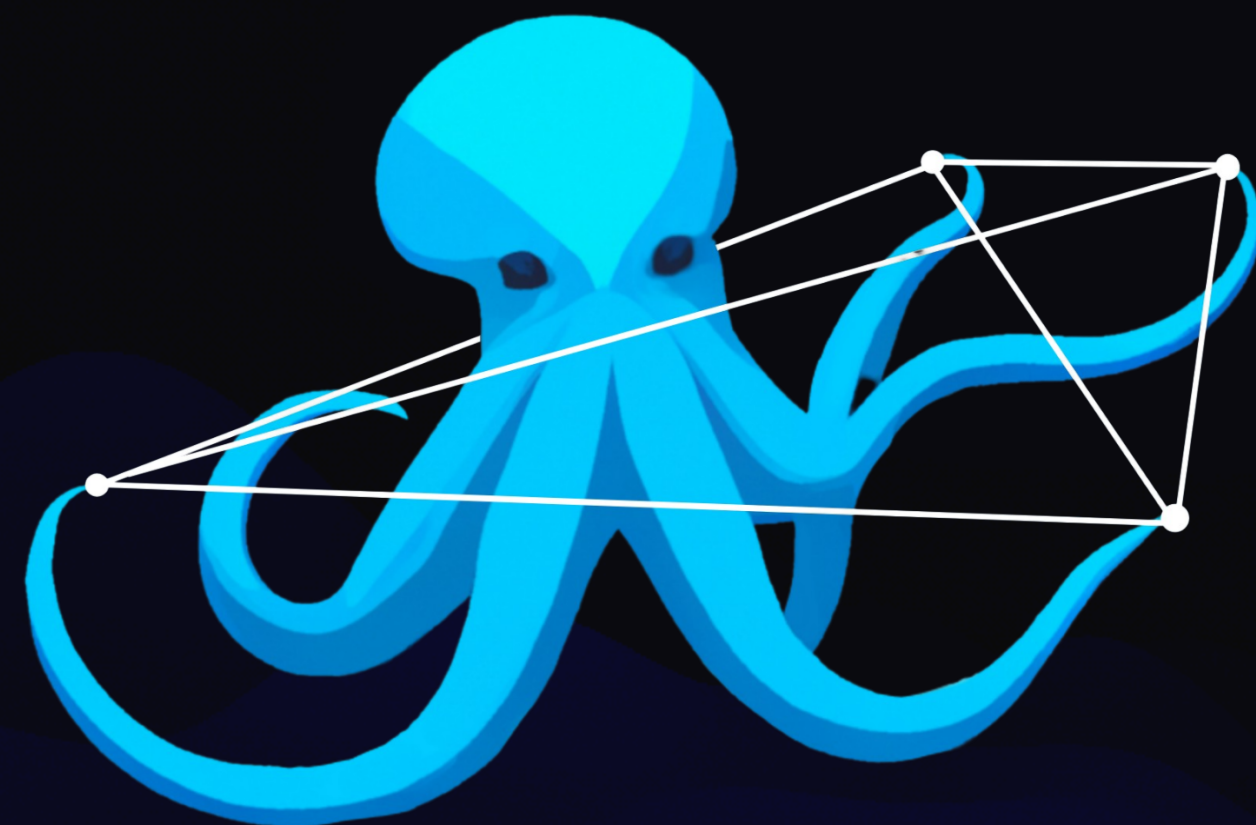
Machine Learning Fortnight 2023

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?

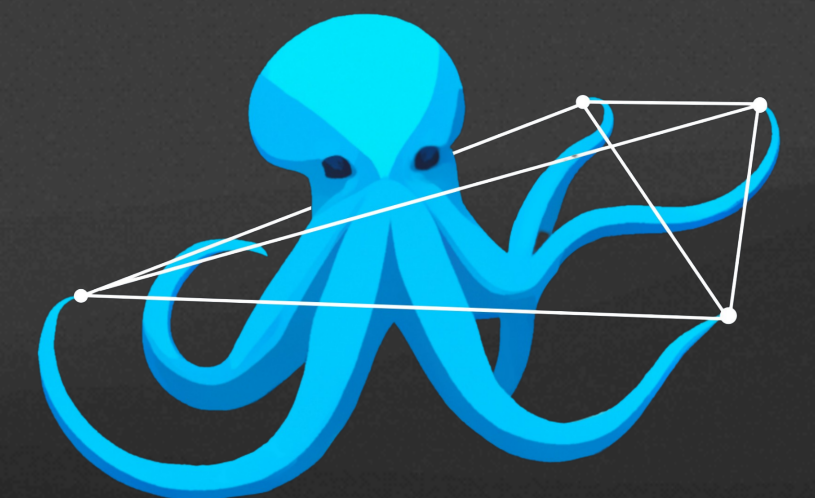
ML Month



GAPC




Our Wonderful Team



Fully
Connected
Graph

Last year...

Predicting housing prices in the Netherlands



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

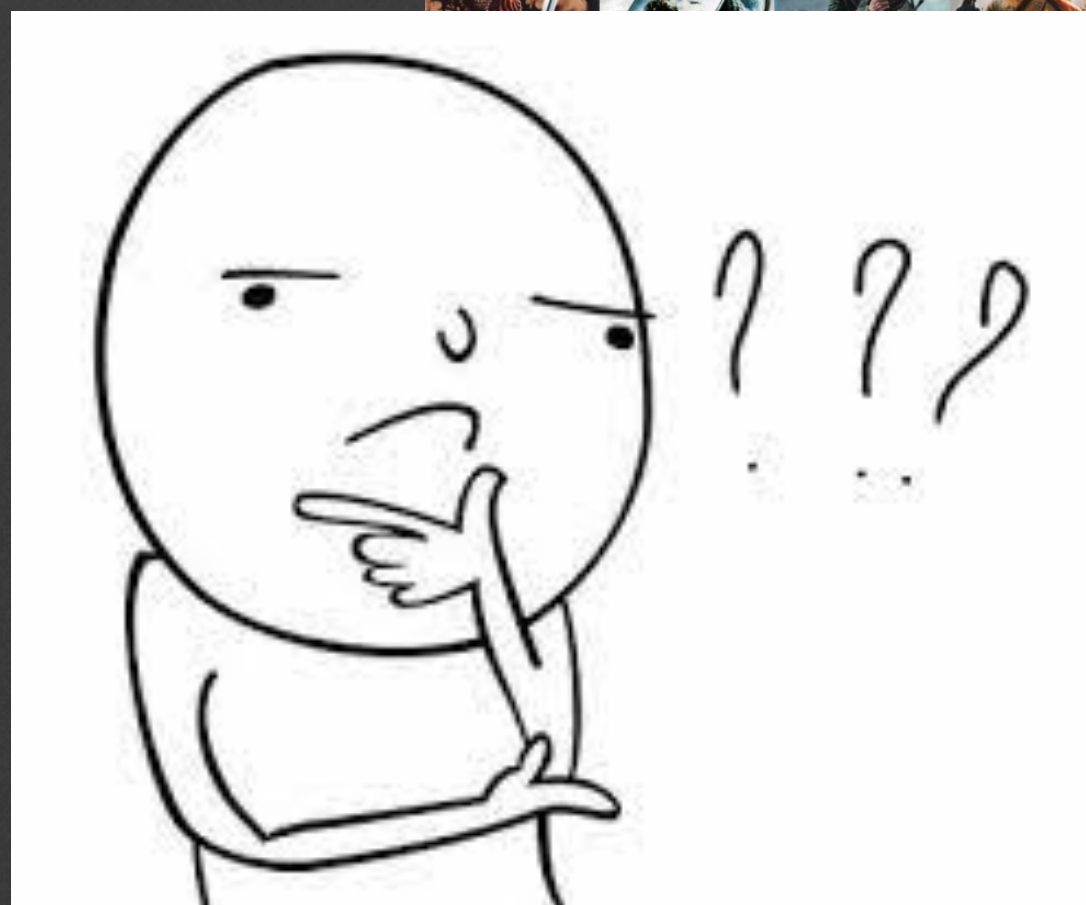
13 Competitors

8 Teams

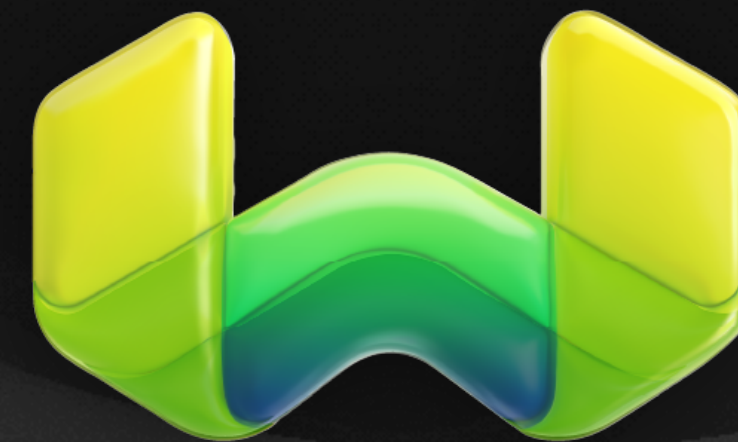
133 Entries

This year... video games are amazing!

But which one should you play?



Fortnight overview



Finale &
Award Ceremony



Introduction to
Recommender Systems

NLP in RecSys

Weaviate
Vector Databases



20 Nov

24 Nov

27 Nov

1 Dec

Contents

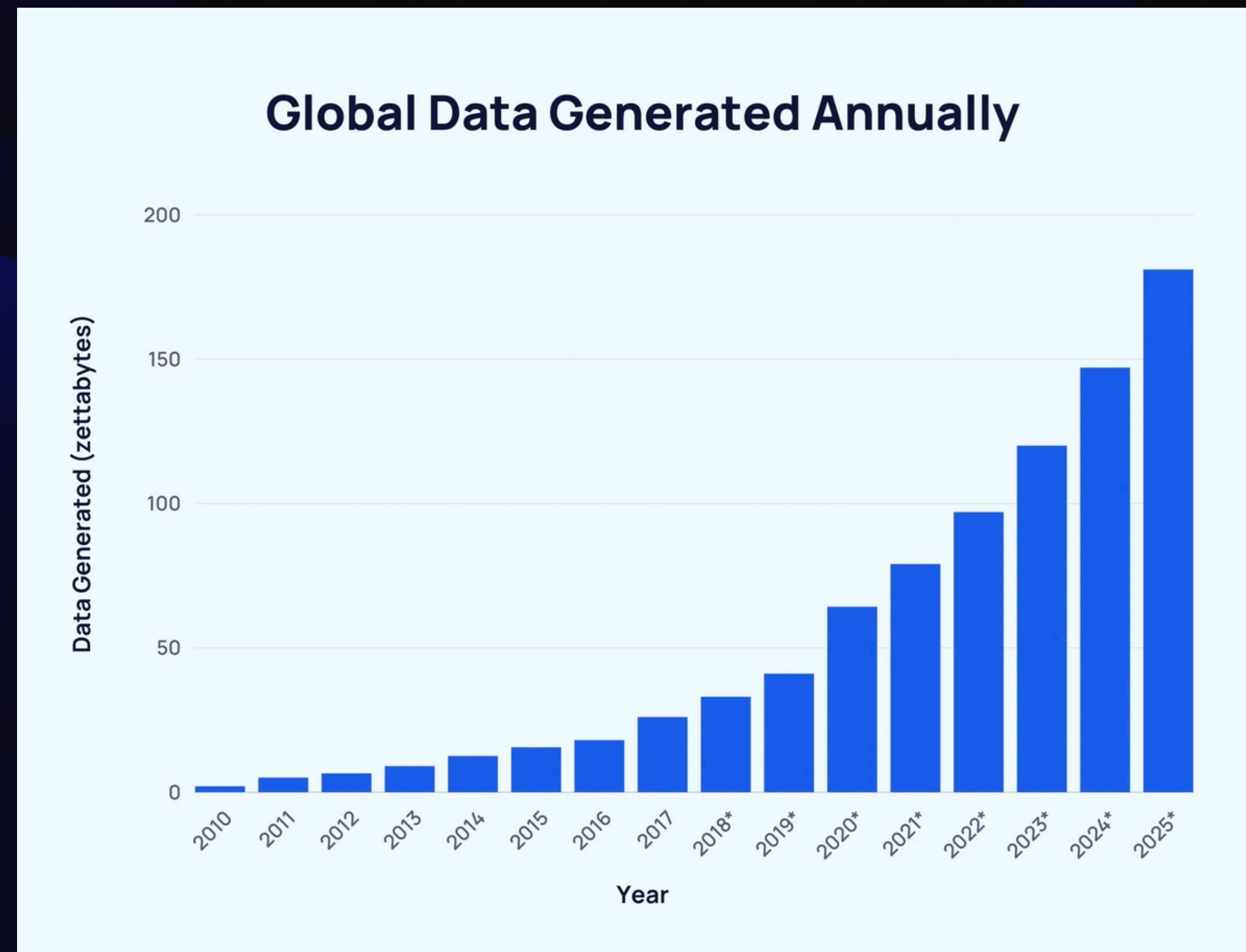
- What Are Recommender Systems?
- Types of Recommender Systems
 - Content filtering
 - Collaborative filtering
 - Hybrid filtering
- Recommendation Algorithms
- **Practical Session**

Prerequisites

Familiar with

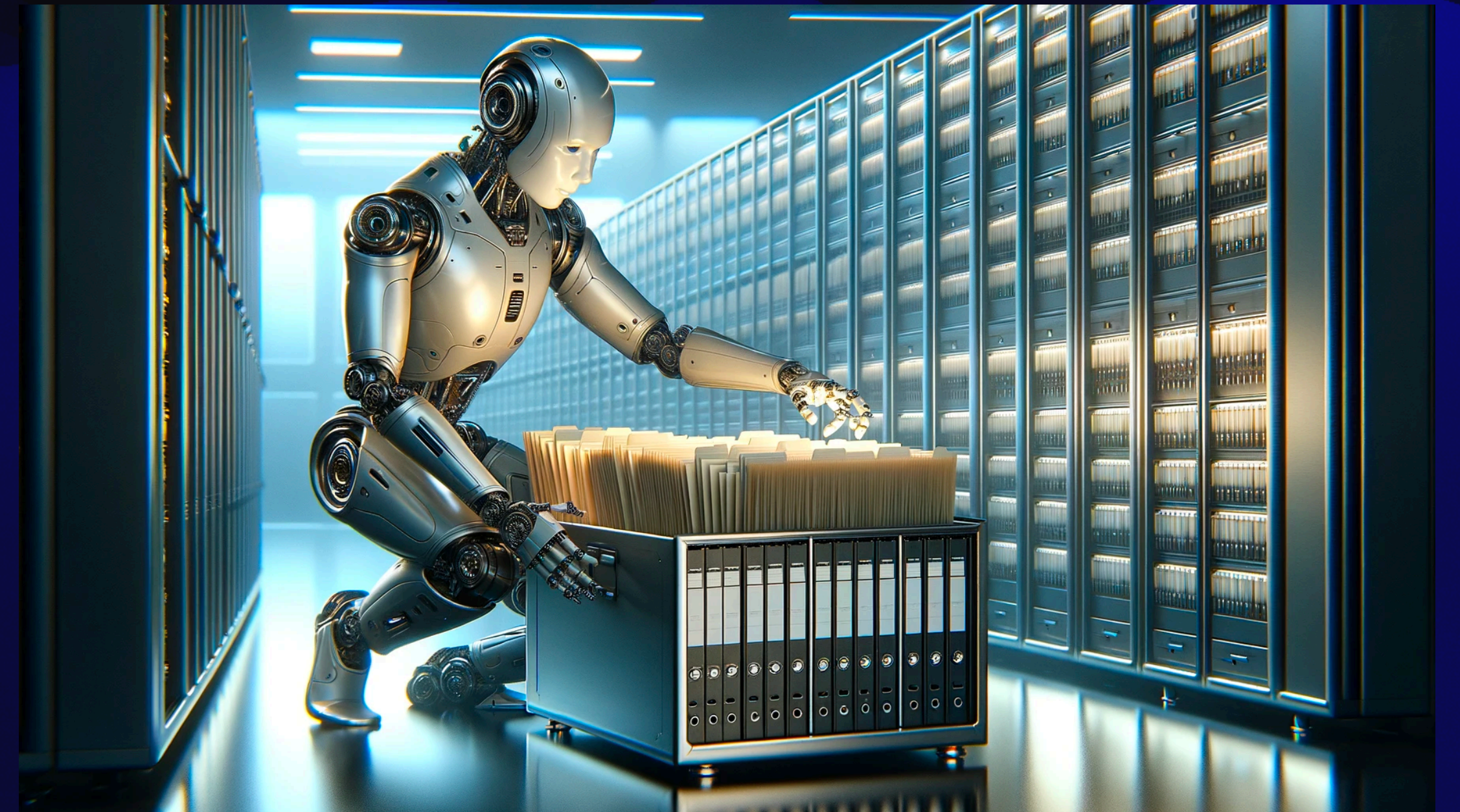
- Machine Learning
- Linear Algebra (inner product, matrix vector product)
- Some experience with Tensorflow and pandas

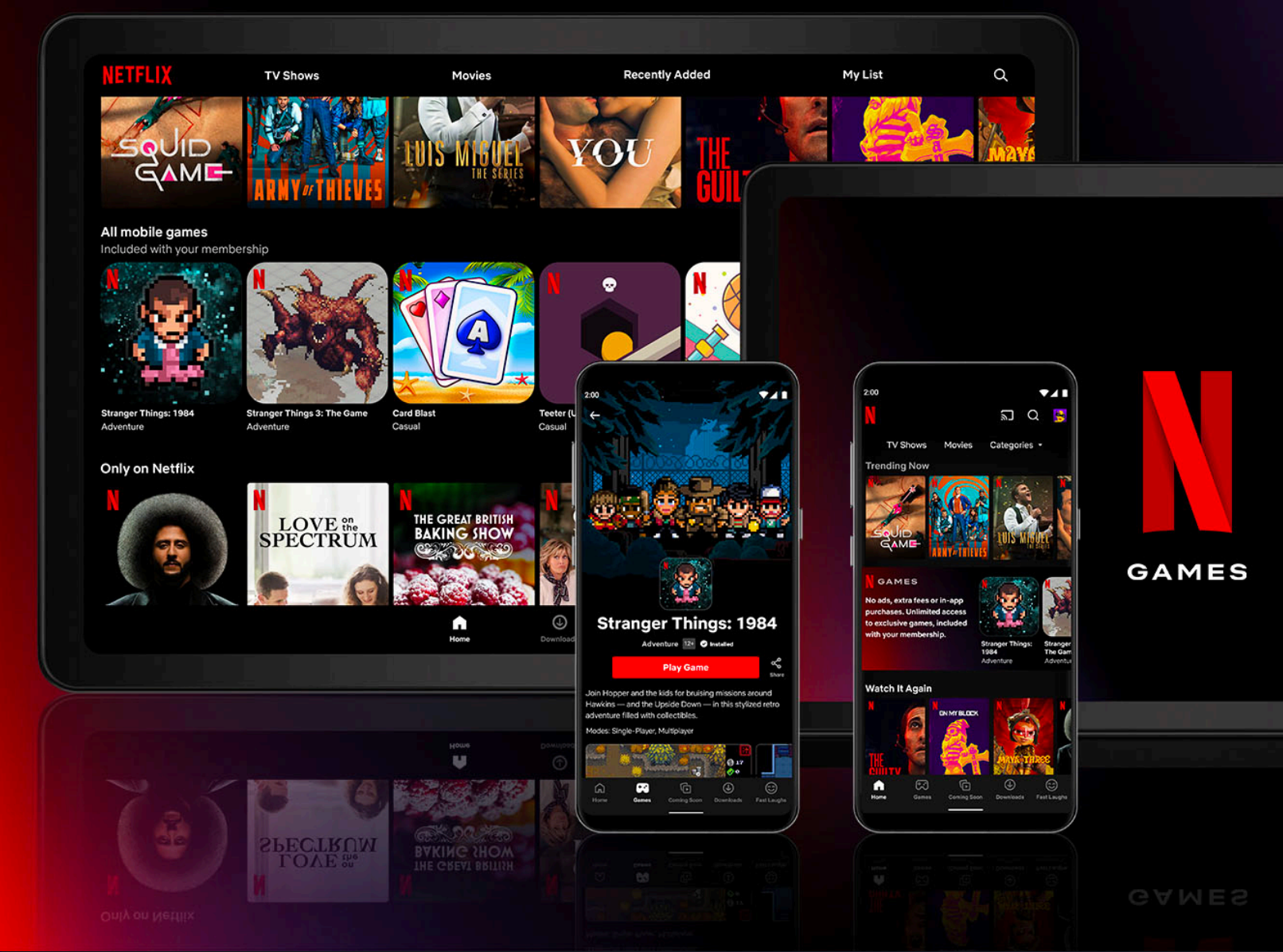
The world generates **2.5 quintillion bytes** per day. That's 1,000 petabytes!



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

They *filter* the information





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/recommen...

What is a Recon

A recommendation s...
uses data to help predi...

boodschappen in huis

3 PRODUCTEN PAKKET 7.97 per pakket

Chiquita proteïne ontbijt pakket

4 PRODUCTEN PAKKET 7.66 per pakket

Chiquita school-tussendoortjes pakket

Nutri-score ABCDE

Picks

Featured profiles of the day, picked just for you.

- Creative
- Entrepreneur
- Scholar
- Surfer
- Doctor

5 Picks Left GET MORE

Customer Service Gift Cards Sell

Best graphics card"

Results

ZOTAC Gaming GeForce RTX 3060 Twin Edge OC 12GB GDDR6 192-bit 15 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

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

Vict 1.14 update information

FIGHTING GAMES (20)

Sort by Hours Played

- 108 hours
- 25 hours
- 19 hours
- 17 hours
- 14 hours
- 13 hours

DOWNLOADS

FRIENDS & CHAT

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

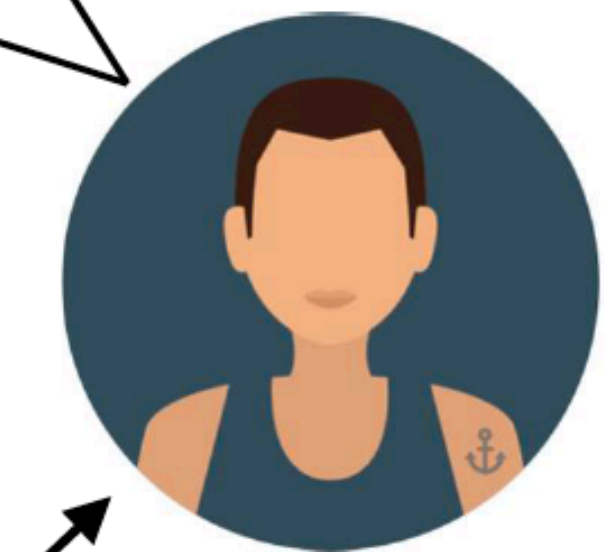


Genres:

- Comedy
- Romance

Cast:

- Tom Hanks
- Meg Ryan



recommended to him

Content Based Filtering

	Artificial Intelligence	Machine Learning	Brain	...	Easy Homework	Writing Essays
Linear Algebra and Multivariable Calculus		●		...	●	
Cognitive Phycology	●		●	...		●
Neural Networks	●	●	●	...	●	
Student (Me)	●	●		...	●	

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

```
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:

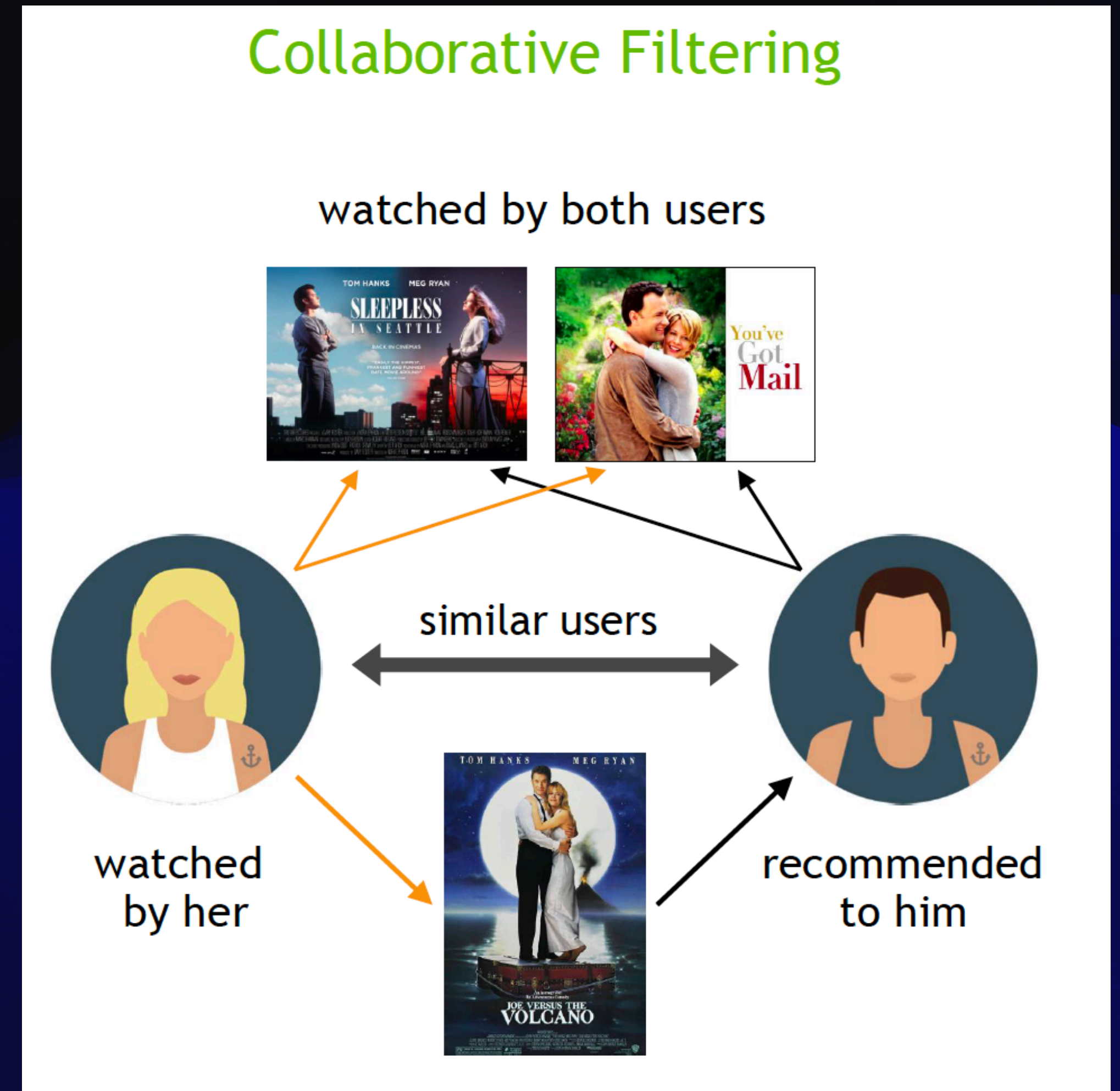
- No need for data about other users; recommendations are user-specific.
- Scalable to a large number of users.
- Can recommend niche items tailored to individual preferences.

Disadvantages:

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

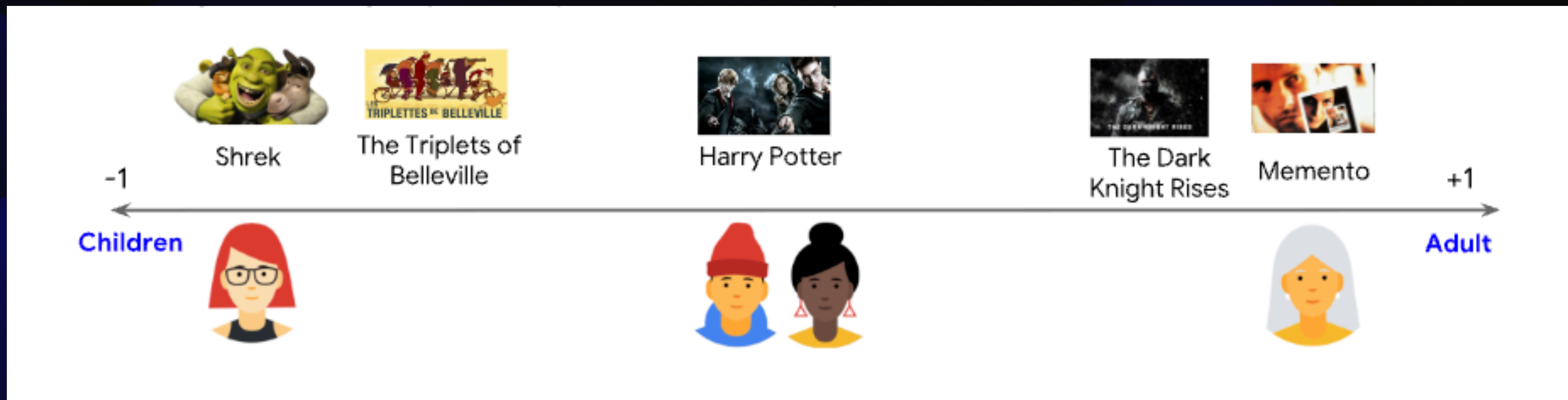
Collaborative Filtering

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



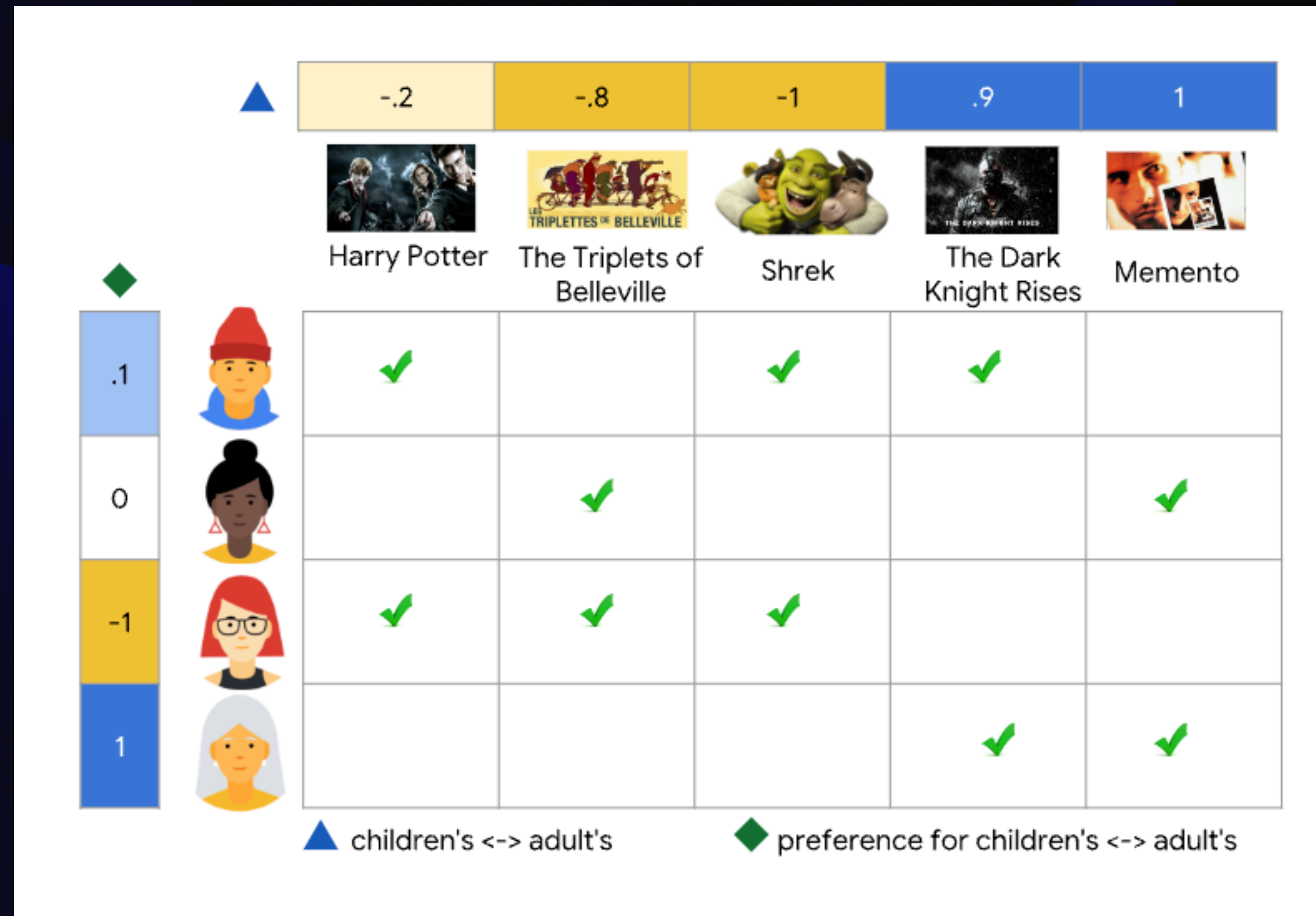
Collaborative Filtering

1D embedding



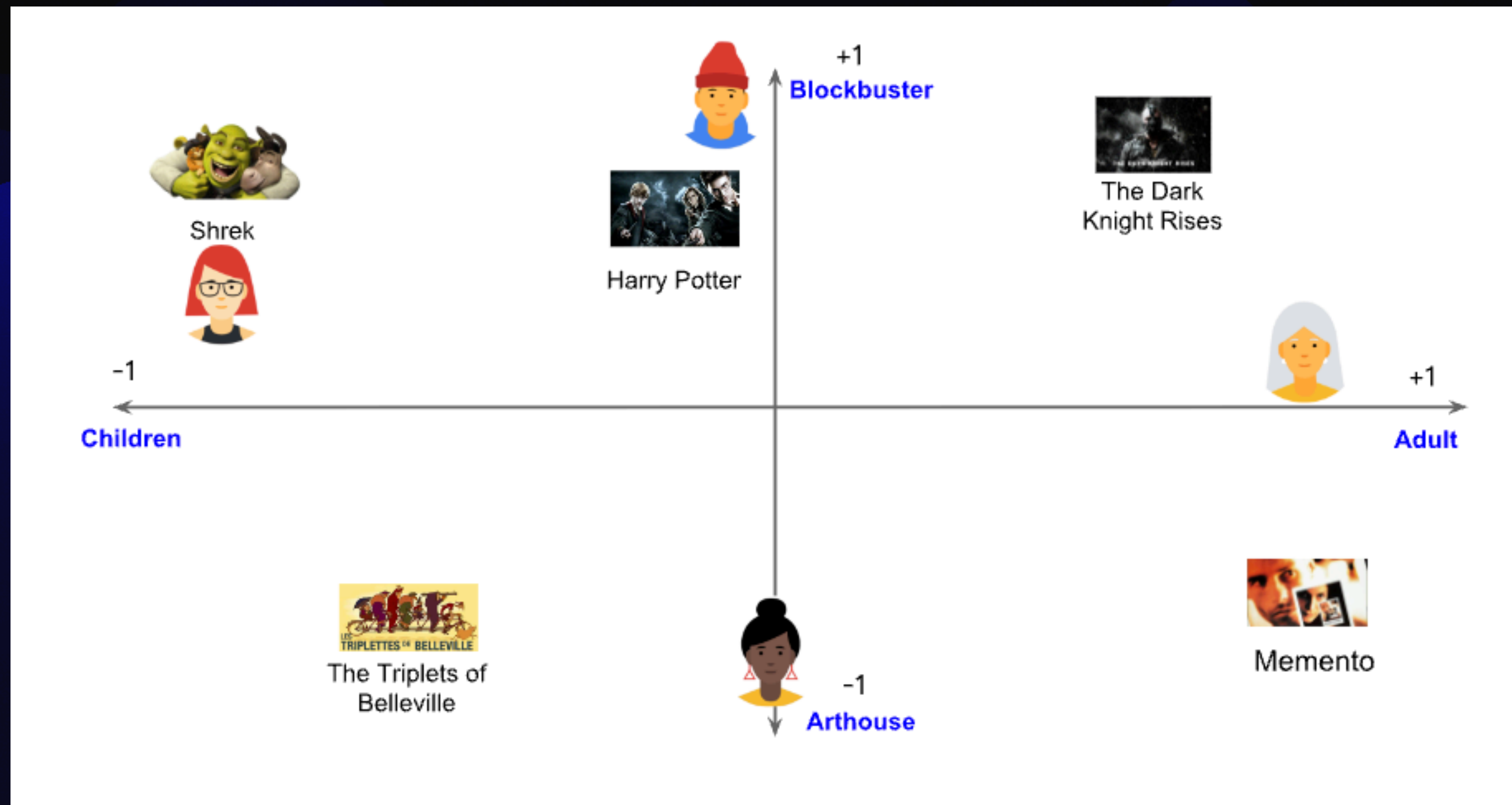
Collaborative Filtering

1D embedding



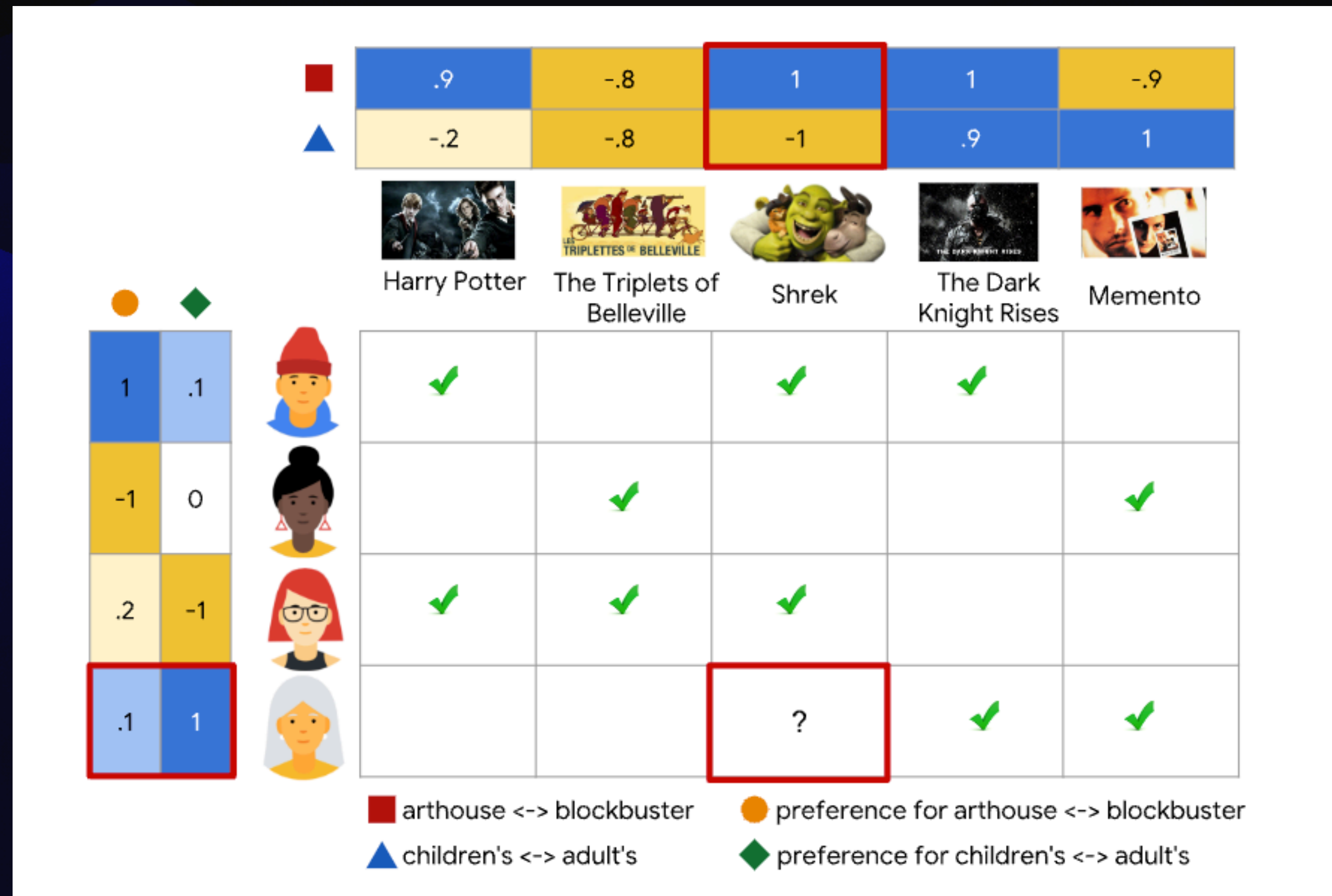
Collaborative Filtering

2D embeddings



Collaborative Filtering

2D embeddings



Collaborative Filtering

Matrix Factorization

Matrix Factorization

Matrix factorization is a simple embedding model. Given the feedback matrix $A \in \mathbb{R}^{m \times n}$, 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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$$\min_{U \in \mathbb{R}^{m \times d}, V \in \mathbb{R}^{n \times d}} \sum_{(i,j) \in \text{obs}} (A_{ij} - \langle U_i, V_j \rangle)^2.$$

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

Matrix Factorization

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

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.

Machine Learning Advanced courses Guides More ▾ 🔍 Search 🌐 English ▾ ⋮ 🖼️

Advanced courses

Home Recommendation Systems

Filter

Introduction

Background

- Large-Scale Recommendation Systems
- Terminology
- Recommendation Systems Overview
- ✓ Check Your Understanding

Candidate Generation

- Candidate Generation Overview
- ▶ Content-Based Filtering
- ▶ Collaborative Filtering and Matrix Factorization
- ▶ Recommendation Using Deep Neural Networks

Home > Products > Machine Learning > Advanced courses > Recommendation Systems

Was this helpful? 👍 🗨️

Introduction

Send feedback

🕒 **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.

<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
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Graph

