Recommender Systems

Recommender Systems

- Recommender Systems Overview
- Content Based
- Collaborative Filtering
  - Memory Based
    - User Based
    - Item Based
  - Model Based
- Evaluation
  - Metrics based evaluation
  - Human based evaluation

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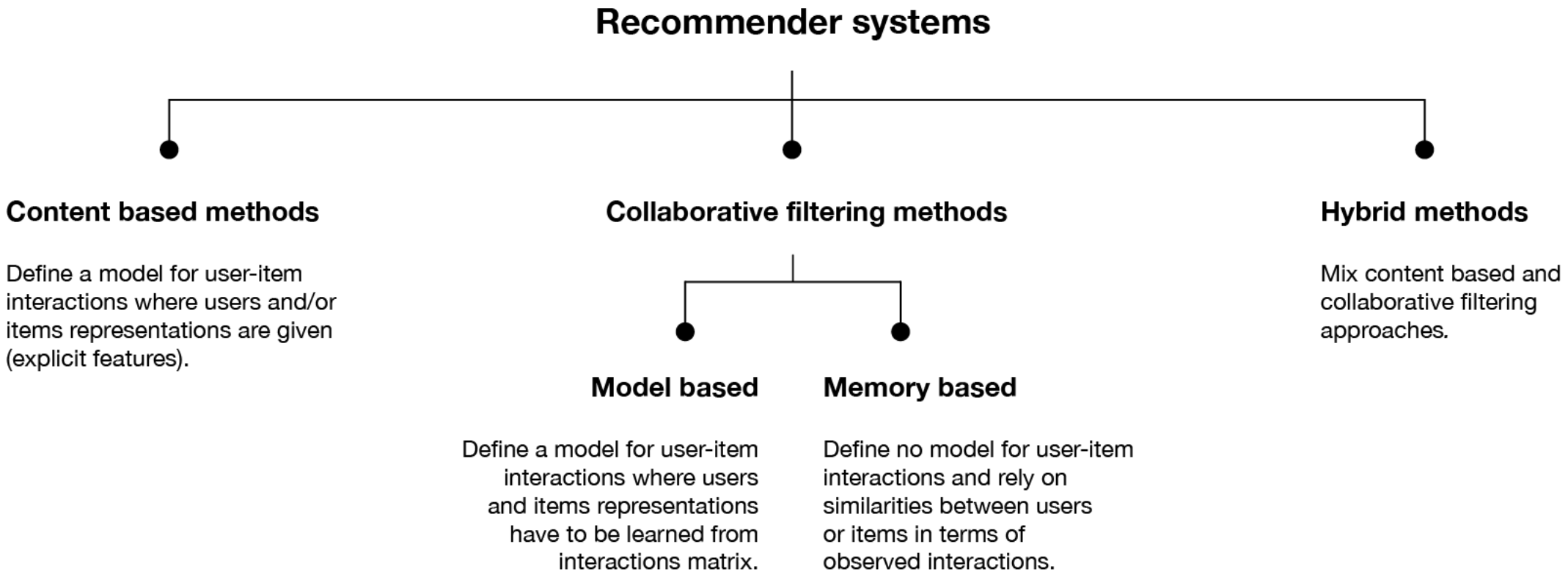
Recommender Systems

- **Collaborative Filtering (CF):**
  - Focus on the knowledge of **users** to items.
    - Memory based
      - User based
      - Item based
    - Model based
- **Content-Based:**
  - Focus on the **attributes** of the items and users.
- **Hybrid:**
  - Both CF and Content-Based are combined.

Recommender Systems



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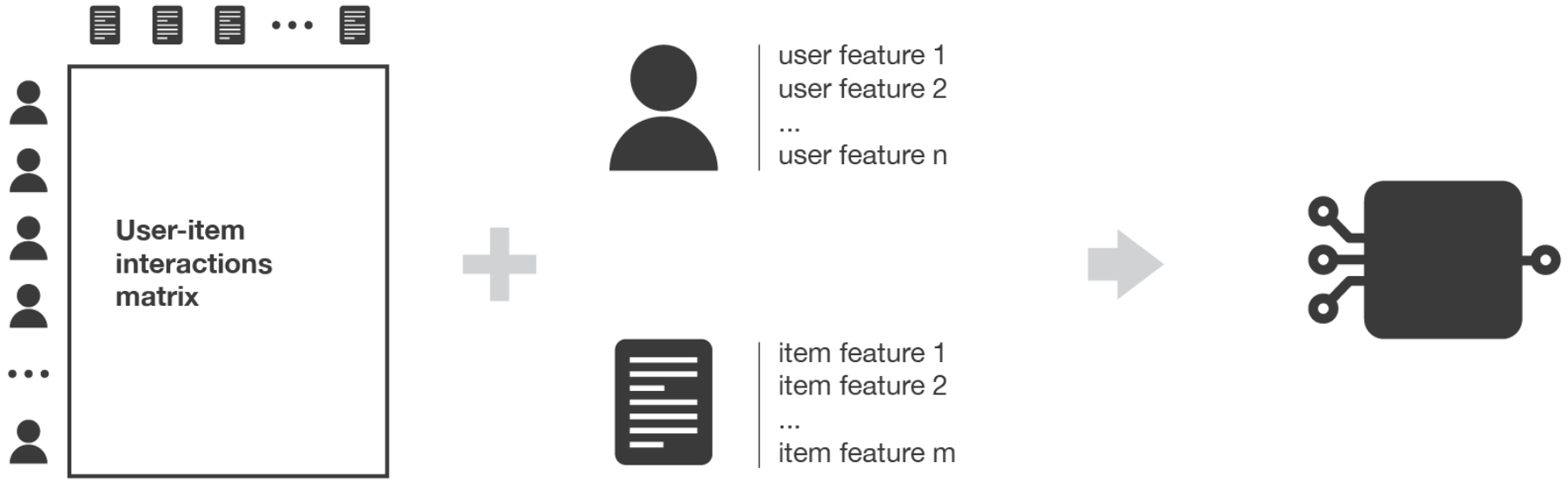
Content Based

- Is a classification (e.g. like/dislike) or regression (e.g. rating) problem

Content Based



Collaborative information

(The user-item interactions matrix)

Content information

Can be users or/and items features

Model

Takes user or/and items features and returns predicted interactions

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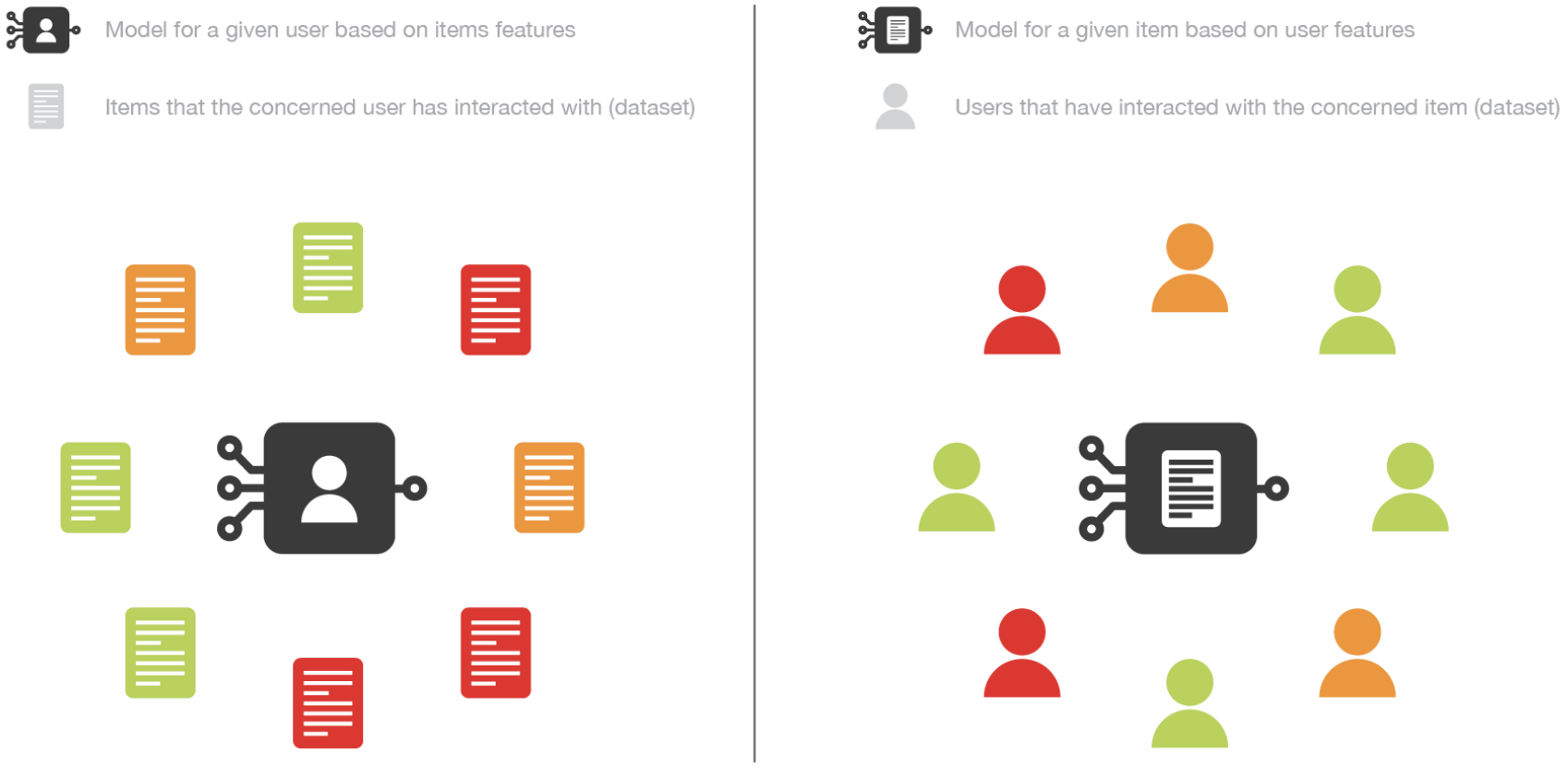
Content Based



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Collaborative Filtering

Users	User-item interactions matrix	Items
suscribers	rating given by a user to a movie (integer)	movies
readers	time spent by a reader on an article (float)	articles
buyers	product clicked or not when suggested (boolean)	products
...		

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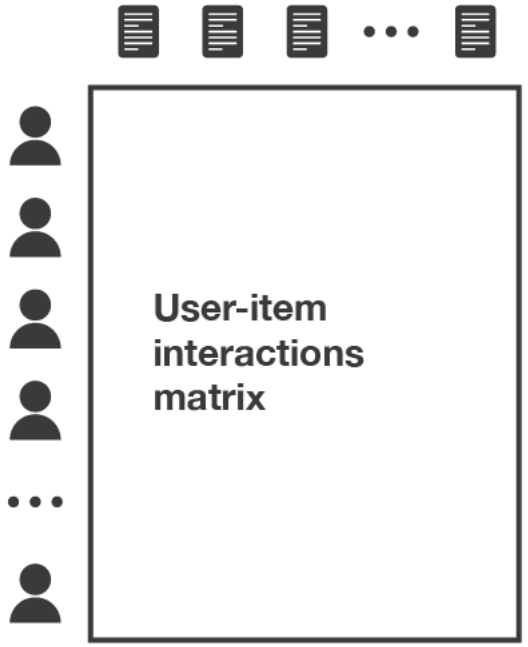
Collaborative Filtering



No Model

- users and items are represented directly by their past interactions (large sparse vectors)
- recommendations are done following nearest neighbours information

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Model

- new representations of users and items are build based on a model (small dense vectors)
- recommendations are done following the model information

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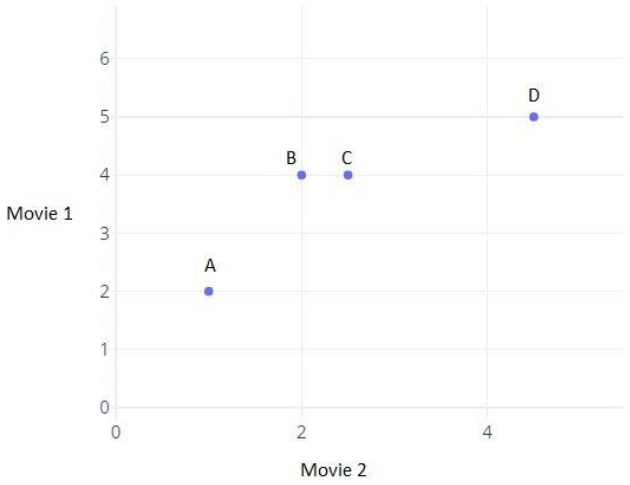
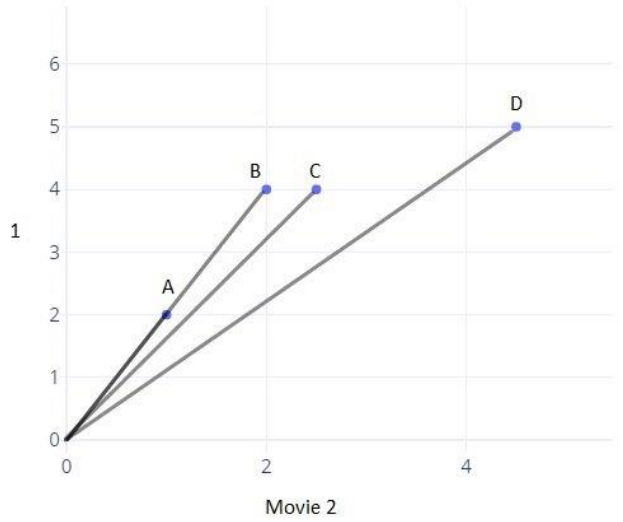
Collaborative Filtering Memory Based

- Tries to find similar users/items
- Steps:
  1. Find similar users/items (using, for example, Cosine similarity)
  2. Compute the missing ratings
- Advantages:
  - Accuracy: Good predictions
  - Flexibility: Easy to update the database
- Disadvantages:
  - Accuracy: May overfit the data
  - Scalability: Stores and uses the entire dataset every time it makes a prediction

Collaborative Filtering Memory Based

- Steps:
  1. Find similar users/items (using, for example, Cosine similarity)
  2. Compute the missing ratings





	Movie 1	Movie 2
User A	1.0	2.0
User B	2.0	4.0
User C	2.5	4.0
User D	4.5	5.0

	Euclidean distance
(c,a)	2.5
(c,b)	0.5
(c,d)	2.2361

	Cosine distance
(c,a)	0.0045
(c,b)	0.0045
(c,d)	0.0153
(a,b)	0.0

https://realpython.com/build-recommendation-engine-collaborative-filtering/#:~:text=Collaborative%20filtering%20is%20a%20technique,similar%20to%20a%20particular%20user.

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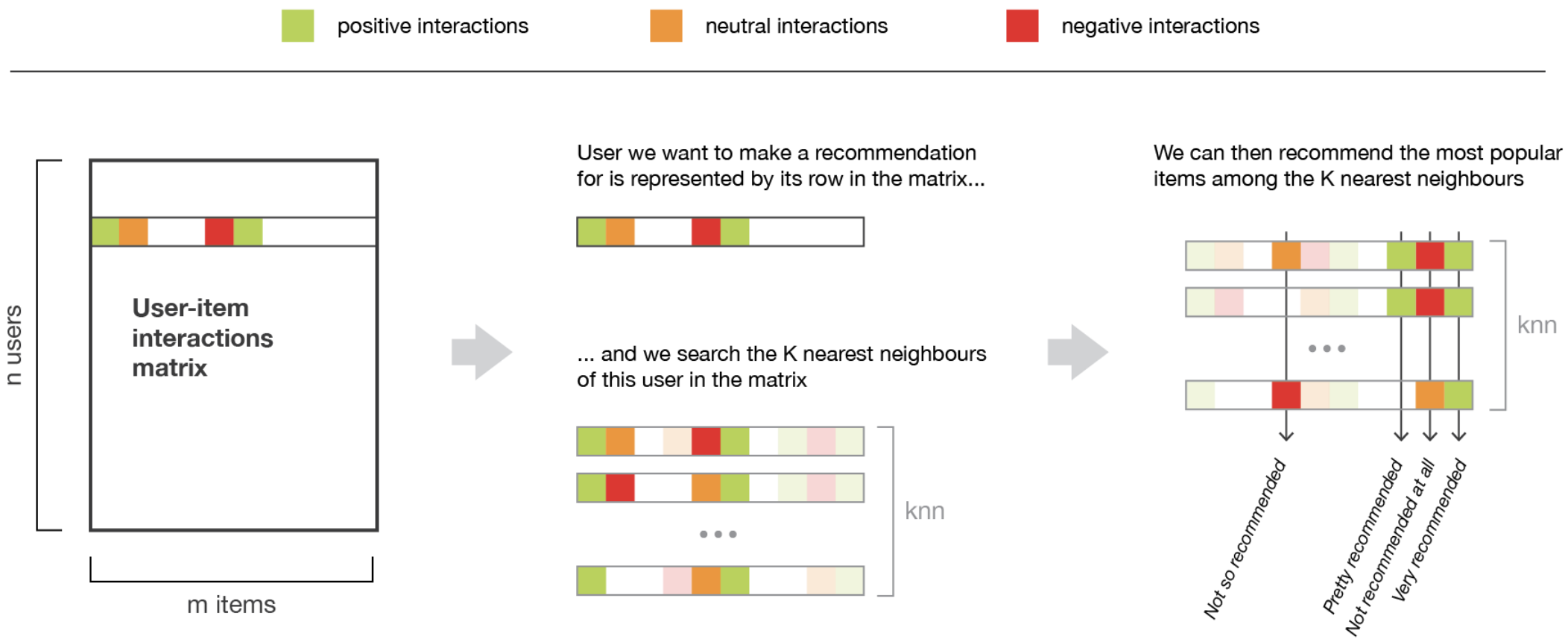
Collaborative Filtering Memory Based

- **User based**: Given a user *X*, find the *k* most similar **users** to user *X* based on their interactions on the same item, make the recommendation

- **Item based**: Given an user *X*, get its *n* most preferred items, find the *k* most similar **items** to them, make the recommendation

Collaborative Filtering Memory Based User Based



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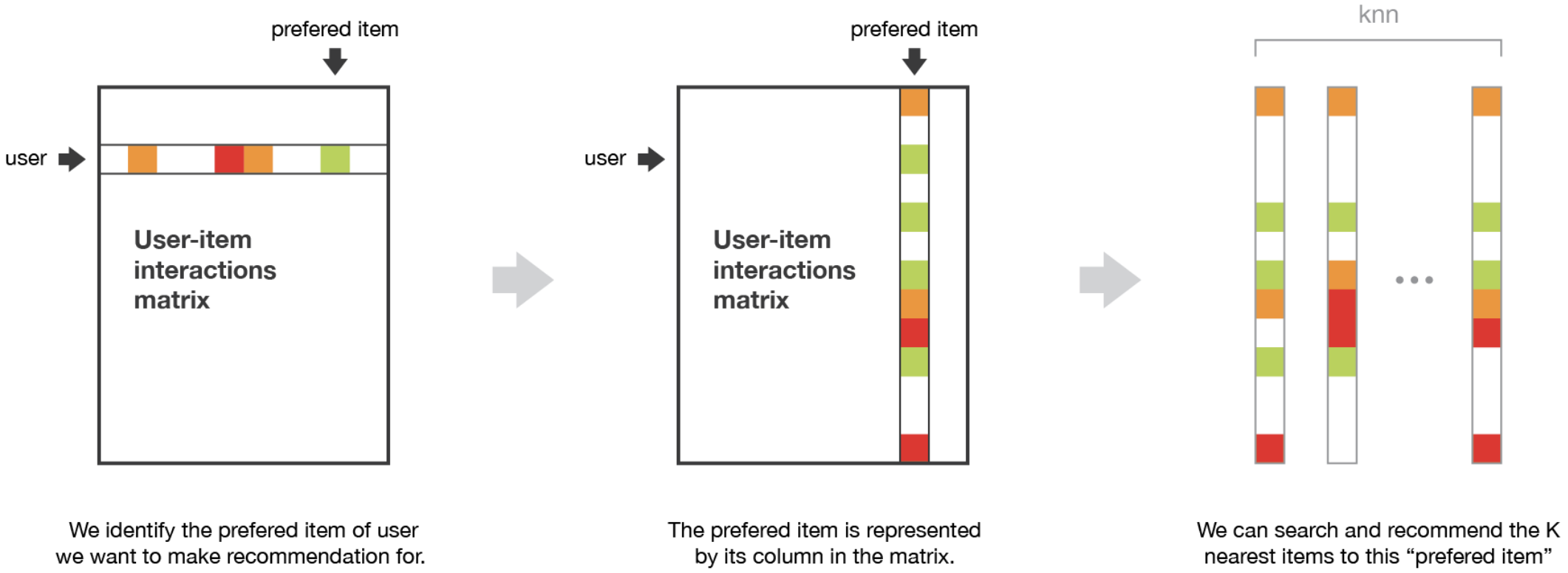
Collaborative Filtering Memory Based Item Based



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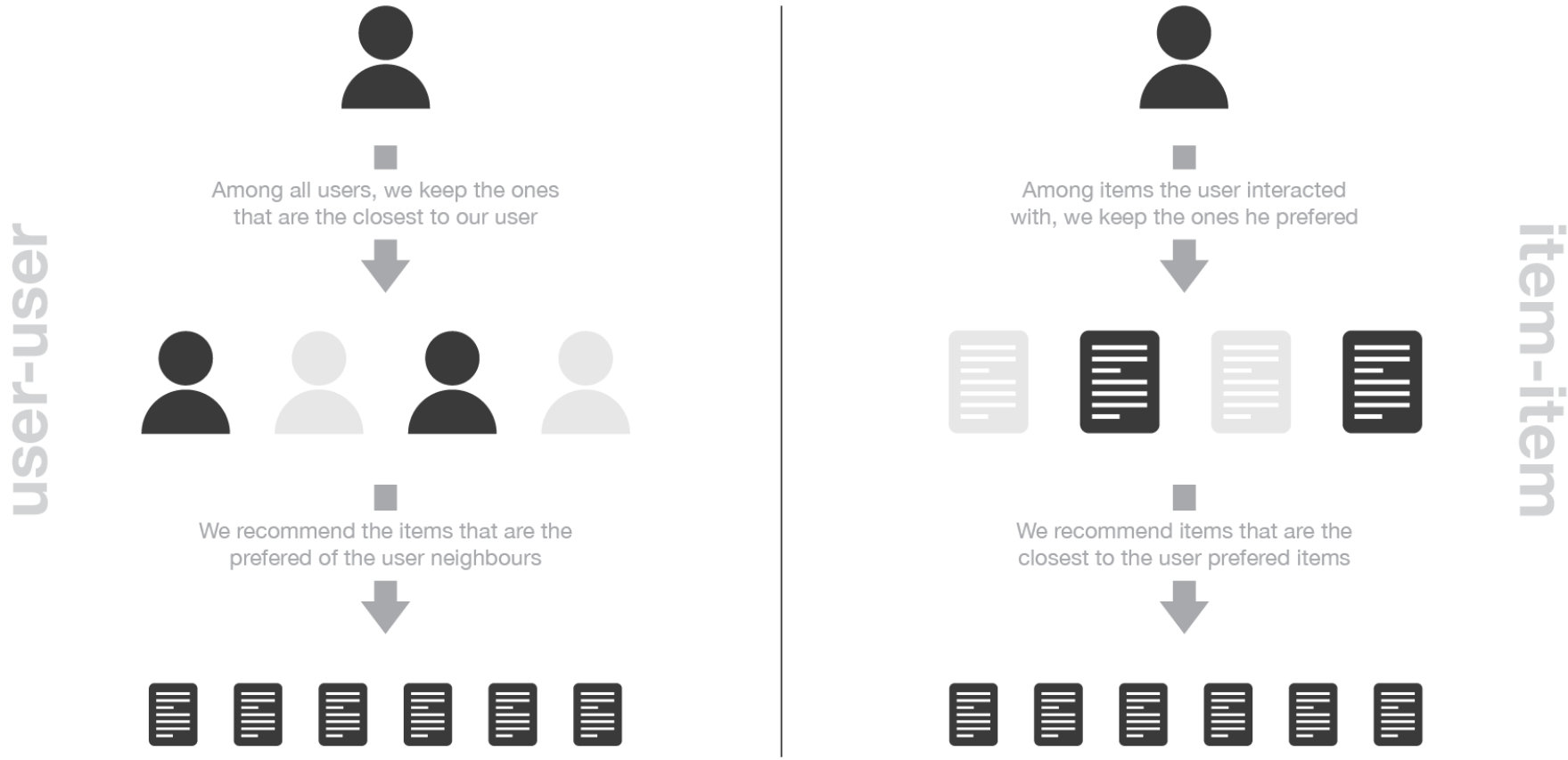
Collaborative Filtering Memory Based



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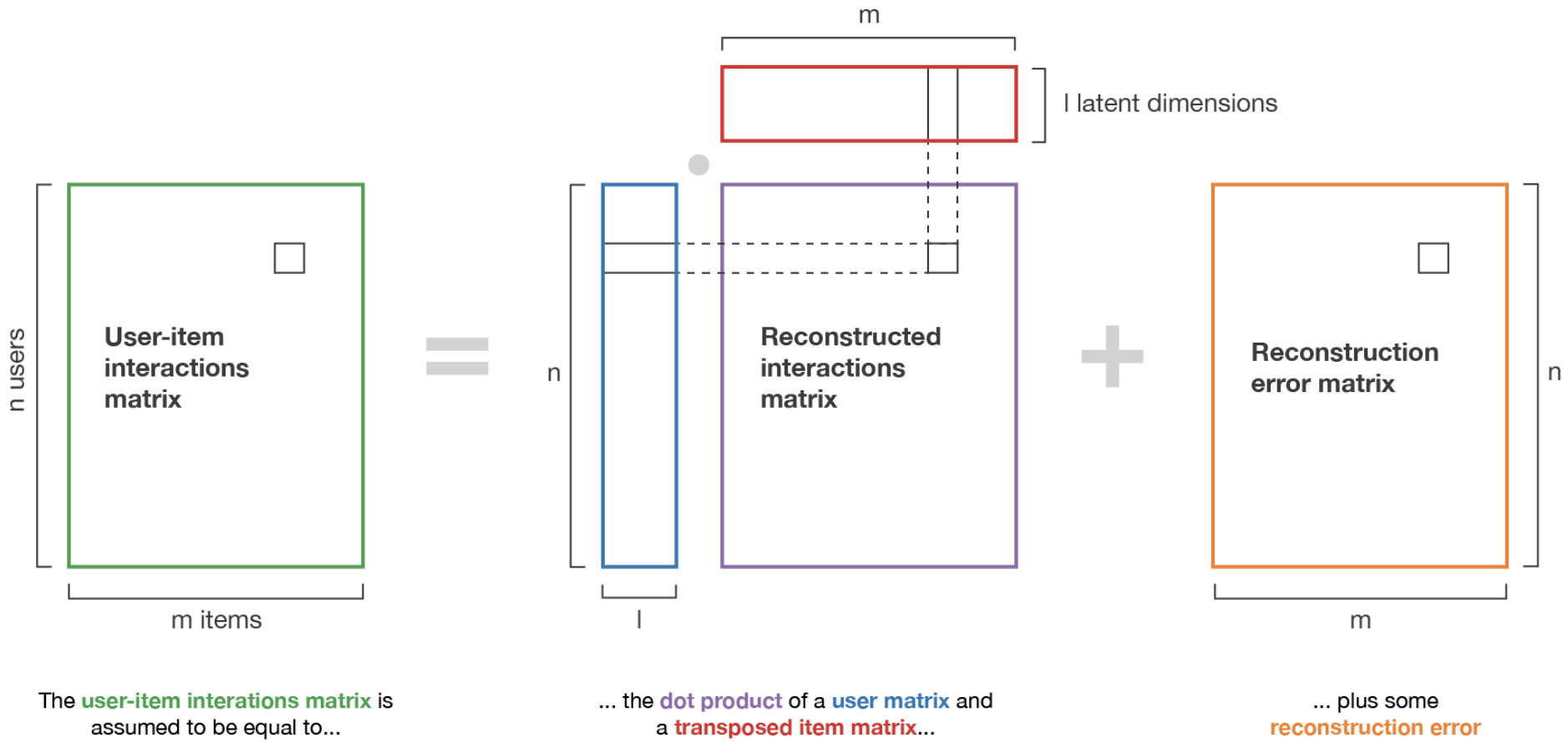
Collaborative Filtering Model Based

- Builds a machine learning model (uses a latent model)
- Steps:
  1. Build a machine learning algorithm (for example, Singular Value Decomposition)
  2. Compute the missing ratings
- Advantage:
  - Scalability: Does not use the entire dataset
  - Speed: Queries the model and not the whole dataset
  - Avoidance of overfit: As it does not use the entire dataset, it’s harder to overfit
- Disadvantages:
  - Inflexibility: Harder to add data
  - Accuracy: Depending on the model used, it may not have high accuracy

Collaborative Filtering Model Based



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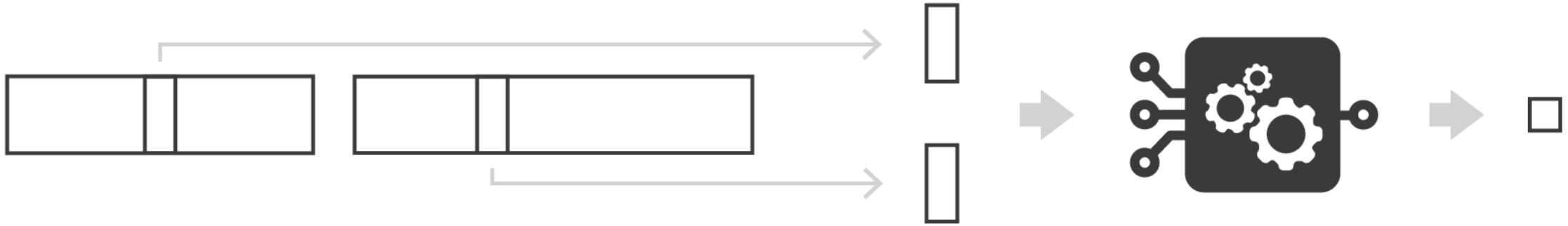
Collaborative Filtering Model Based



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Metrics based evaluation

- Using train/test split
  - Regression: MAE, MSE, RMSE
  - “Binarize”
  - Classification: Accuracy, precision, recall

Human based evaluation

- Serendipity:
  - Avoid:
    - Star Wars 1,
    - Star Wars 2,
    - Star Wars 3
  - Aim for:
    - Star Wars 1,
    - Star trek into darkness,
    - Indiana Jones and the raiders of the lost ark
- Exaplainability:
  - “People who liked this item also liked this one”
  - “You liked this item, you may be intereseted in this one”