



# Modern RecSys

## Paradigms

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# Large Language & Vision Models as Recommender Systems



# RecSys Issues & Challenges



- **Adaptivity:** changing business needs
- **Robustness:** Attack/ stress
- **Scalability**

## What are LLMs?

LLMs are machine learning models capable of Natural Language Processing (NLP), as they are trained on huge amounts of text data (usually from the internet/books) via deep-learning algorithms.

- **Pre-trained language models:** encode an extensive amount of world knowledge, and they can be applied to a multitude of downstream NLP applications with **zero** or **just a handful of demonstrations.**

# Large Language Models (LLMs) as RecSys



User Preference

Pre-trained  
LLM

Recommendations

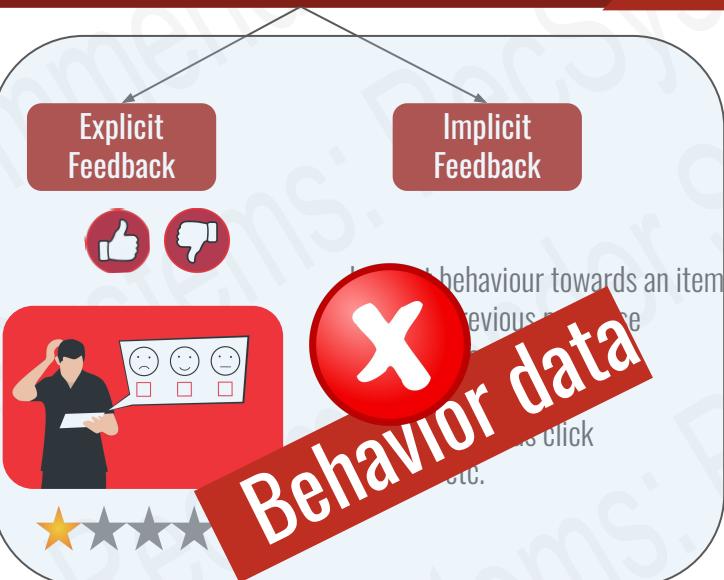
Explicit  
Feedback



Implicit  
Feedback



X  
**Behavior data**



Store knowledge that can complement the behavior data



Predict future behaviours

buying turkey on Thanksgiving day

# Large Language Models (LLMs) as RecSys



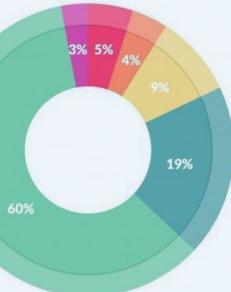
## Data Pre-processing



## Pre-trained LLM

## Post Processing

## Evaluation



What data scientists spend the most time doing

- Building training sets: 3%
- Cleaning and organizing data: 60%
- Collecting data sets: 19%
- Mining data for patterns: 9%
- Refining algorithms: 4%
- Other: 5%

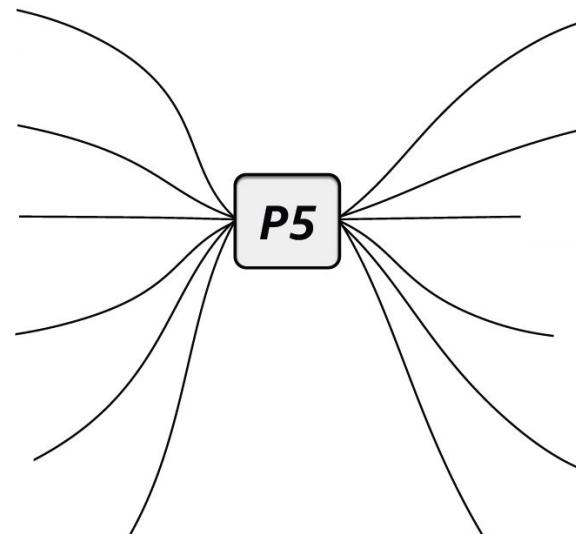


- Sort
- Filter
- Recommend

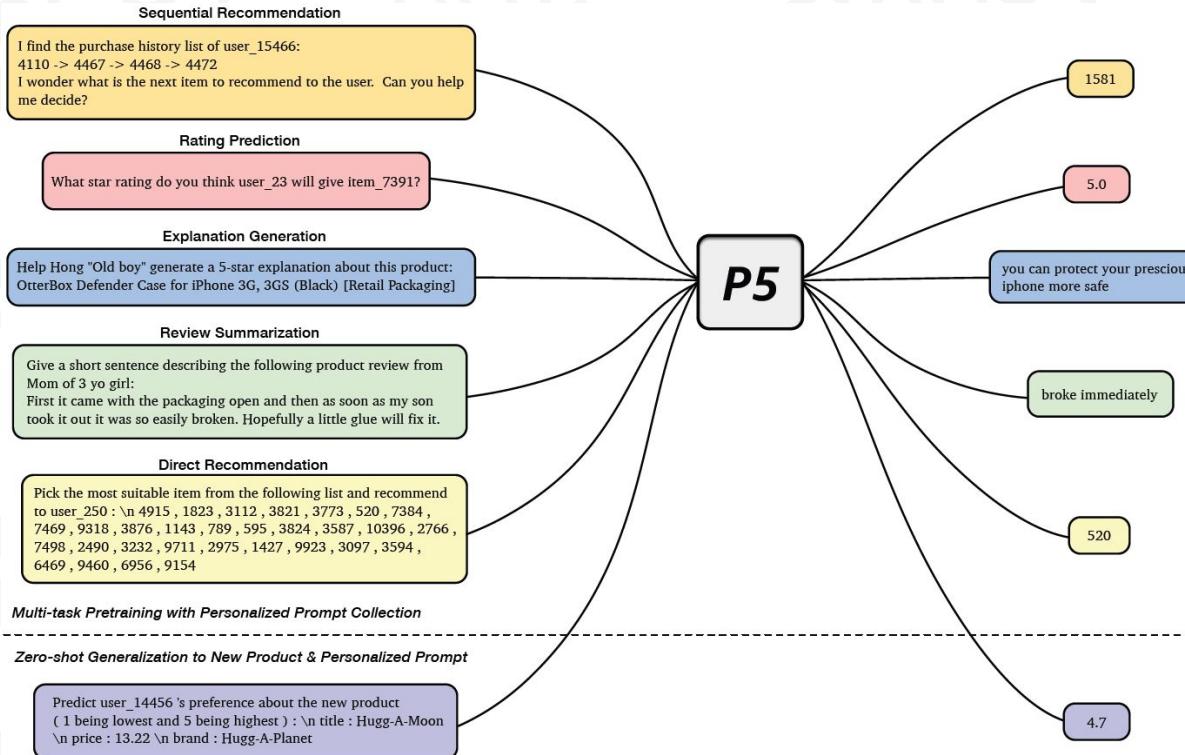


## 1. Pretrain, Personalized Prompt & Predict Paradigm (P5)

Geng et al. 2022



## 1. Pretrain, Personalized Prompt & Predict Paradigm (P5)



## 2. M6-Rec: Generative Pretrained Language Models are Open-Ended

### Recommender Systems.

Cui et al. 2022

- Model pre-trained using Alibaba's LLM (M6)
- Convert recommendation tasks
  - Retrieval,
  - Scoring,
  - Explanation generation
  - Conversational recommendation

#### prompt

For zero-shot scoring tasks



or



- Language understanding or
- Generation

[BOS'] A user clicks hiking shoes [EOS'] [BOS] also clicks trekking poles [EOS]  
[BOS'] A user clicks hiking shoes [EOS'] [BOS] also clicks yoga knee pads [EOS]

user-side features

user + item related features

The plausibility of each is calculated based on token probability from M6.

Avoids using user IDs or item IDs as input



## Prompt-Tuning Pretrained Language Models

### 3. Language Model Recommender Systems (LMRecSys) Zhang et al. 2022

- Uses the user's past interaction history (watched movies), taken from the MovieLens-1M dataset, to predict the next movie that the user would watch.

prompt

A user watched One Flew Over the Cuckoo's Nest, James and the Giant Peach, and My Fair Lady. Now the user wants to watch [MASK].



Estimate the probability distribution of the next item

## Prompt-Tuning Pretrained Language Models

4. Zero-Shot Next-Item Recommendation (NIR) *Wang et al. 2023*
5. Augmented Recommender System (Chat-REC) *Gao et al. 2023*

# Pros & Cons of using LLMs as RecSys

## Pros

- Zero-shot and few-shot capabilities
  - Sparsity scenarios (**cold start, long tail**)
- Adapting to new information
  - Without changing architecture/ retraining
- Conversational- user engagement
- No need for large amount of data
- Generalization capability: not task specific
- **Explanation Generation**

## Cons

- LLMs are large, complex, and costly to train
- Highly sensitive to input prompts and may not fully follow the instruction prompt.
- Recommendations can be highly **dataset** dependent.
- LLMs may recommend items that are not present in the candidate set.

*Zhang et al. 2023, suggested feeding the candidate item set into prompt.*



# Pros & Cons of using LLMs as RecSys

## Case 1

You are a movie recommender system now.

*\{\{Examples\}\}}*

Input: Here is the watching history of a user: Aliens, E.T. the Extra-Terrestrial, Contact, The Matrix, X-Men. Based on this history, would this user prefer The Fox and the Hound or Steamboat Willie? Answer Choices: (A) The Fox and the Hound (B) Steamboat Willie

Output: The answer index is N/A as neither option is relevant to the user's watching history.





# Pros & Cons of using LLMs as RecSys

## Case 1

You are a movie recommender system now.

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Input: Here is the watching history of a user: Aliens, E.T. the Extra-Terrestrial, Contact, The Matrix, X-Men. Based on this history, would this user prefer The Fox and the Hound or Steamboat Willie? Answer Choices: (A) The Fox and the Hound (B) Steamboat Willie

Output: The answer index is N/A as neither option is relevant to the user's watching history.

## Case 2

You are a book recommender system now.

*\{\{Examples\}\}}*

Input: Here is the reading history of a user: The Cellist of Sarajevo, After I'm Gone: A Novel, The Reason I Jump: The Inner Voice of a Thirteen-Year-Old Boy with Autism, The Serpent of Venice: A Novel, We Are All Completely Beside Ourselves: A Novel. Based on this history, would this user prefer The Secret Life of Bees or The Help? Answer Choices: (A) The Secret Life of Bees (B) The Help

Output: The answer index is N/A. It is difficult to determine the user's preference based on this reading history as neither book is similar in genre or theme to the books they have read.

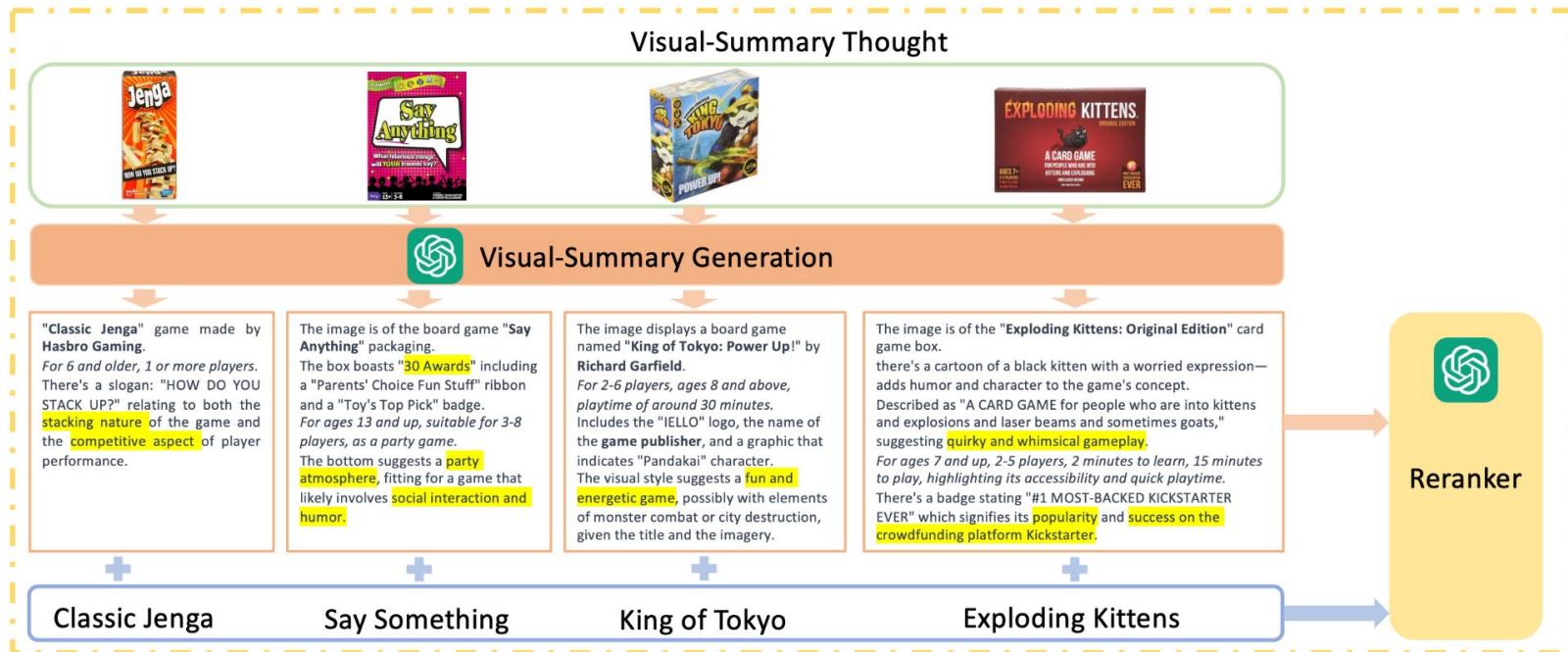




# Large Vision-Language Models as Recommender Systems

# SOTA: Large Vision-Language Models (LVLMs) as RecSys

## Rec-GPT4V: Multimodal Recommendation with Large Vision-Language Models





# Common Issues and Challenges in RecSys

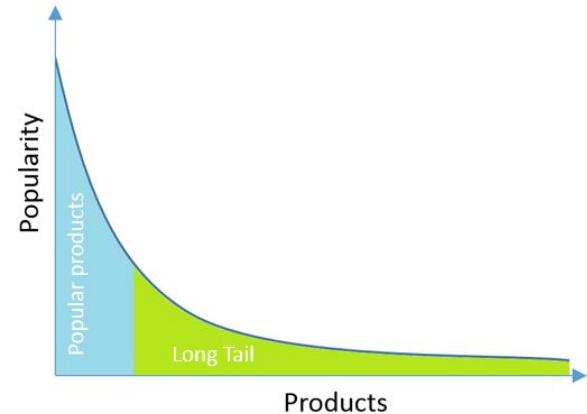
# RecSys Issues & Challenges

- **Cold start**

→ Sparsity

$$\text{Sparsity} = \frac{\# \text{ ratings}}{\text{total } \# \text{ cells}}$$

- Ratings
- Time spent
- Product clicked



- **Diversity**



# RecSys Issues & Challenges

- **Privacy**: Third party, sensitive private information

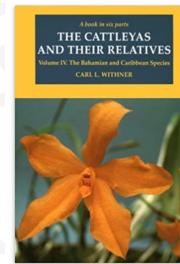
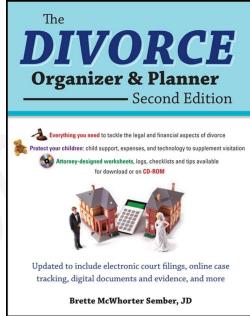
→ **Collaborative Filtering**: users willingly disclose their preferences to the system in the hope of getting useful recommendations.



Likes growing Orchid



Bought



Customers who viewed this item also bought

The DIVORCE Organizer & Planner – Second Edition

Updated to include electronic court filings, online case tracking, digital documents and evidence, and more

Brette McWhorter Sember, JD

4.5 stars based on 10 reviews

Paperback \$7.99 \$16.63 shipping

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Child Custody Journal: Child Custody Battle & Co-parenting Log Book. Detailed Record Journ...

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CHILD CUSTODY LOG BOOK

Child Custody Log Book: Child Support and Custody Journal That Wins Custody Battle. With... Eric Reeves Publication

Eddie M Sanchez Publishing

4.5 stars based on 22 reviews

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child custody log book

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4.5 stars based on 23 reviews

Paperback \$6.99 \$16.81 shipping

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Samir Schoen

4.5 stars based on 29 reviews

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Lara Carter

4.5 stars based on 23 reviews

Paperback \$6.99 \$18.87 \$16.81 shipping

Child Custody Journal: Child Custody Visitation Planner Calendar and Co-Parenting Log Book to Plan and Record...

Charlie L. Press

4.5 stars based on 29 reviews

Paperback \$6.99 \$16.81 shipping

The Cattleyas and Their Relatives: Volume IV: The Bahamian and Caribbean Species Hardcover – April 15, 1996

by Carl L. Witthner (Author)

4.6 stars based on 3 ratings

Book 4 of 5: Cattleyas and Their Relatives

Hardcover from \$34.66

8 Used from \$34.66

See all formats and editions

Cattleyas are frequently called "the Queen of the Orchids," and Carl Witthner's passion for them started before World War II. About 12 years ago he published the first in this series of six books, which now comes to a conclusion with this final volume. The South American *Erycilla* species have not previously been the subject of a book, and the genus presents many problems and difficulties. A few of the species are known from a single herbarium specimen and may well now be extinct because of the continuing loss of habitat.



# RecSys Issues & Challenges



## Privacy

- Complete privacy may not be realistic → compromise on minimizing the privacy breaches
- Comes at the expense of the accuracy of the recommendations.
- Important to analyze this trade-off carefully.

# RecSys Issues & Challenges

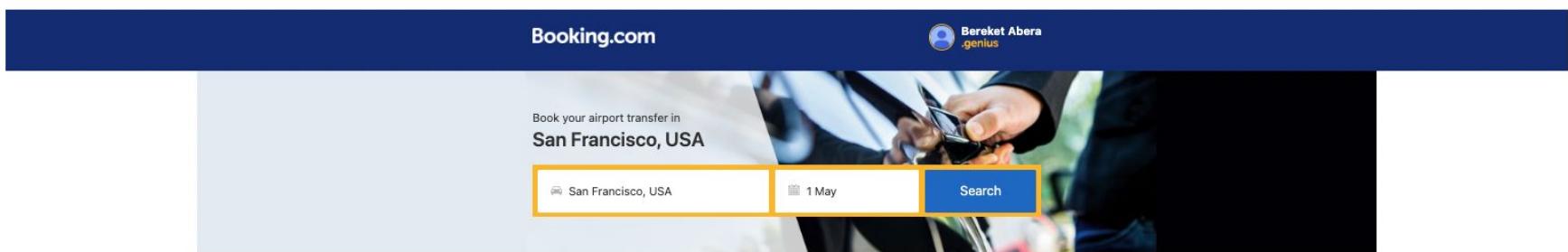
- **Proactiveness:** Predict when and how to push Recommendations ← implicit request

Bereket, book a taxi direct to Holiday Inn Express Hotel & Suites Fisherman's Wharf ➔ [Inbox](#)



Booking.com <[email.campaign@sg.booking.com](mailto:email.campaign@sg.booking.com)> [Unsubscribe](#)  
to me ➔

Apr 27, 2019, 11:55 PM [Star](#) [Forward](#) [Print](#)



The screenshot shows an email from Booking.com. At the top, there's a dark blue header bar with the Booking.com logo on the left and a user profile picture of 'Bereket Abera .genius' on the right. Below the header, the main content area has a dark blue background with a blurred image of two people in a car. On the left side of the image, white text reads 'Book your airport transfer in San Francisco, USA'. Below this, there's a search bar with three input fields: 'San Francisco, USA' (with a car icon), '1 May' (with a calendar icon), and a blue 'Search' button. The rest of the email body contains promotional text and a call-to-action button at the bottom.

Hi Bereket,

Looking for a convenient, reliable way to get to your accommodation? Your driver and car will be waiting at the airport – no unfamiliar public transport to navigate, no worries on finding the way to your stay.

✓ **Guaranteed price**   ✓ **Guaranteed pick-up**   ✓ **Tried and trusted drivers**

Want to get back to the airport just as easily? Book your return journey at the same time and enjoy your holiday with one less thing to worry about.

[Find your ride](#)



RECOMMENDER  
SYSTEMS

# RecSys Issues & Challenges

- Explainability

Because you watched shows about Anti-Heroes and Moral Ambiguity >

DAREDEVIL

HOUSE of CARDS

NARCOS

BLO

Because you watched shows with Sharp Humor and Strong Female Leads >

JESSICA JONES

ORANGE is the BLACK

Master of None

FRIEND

Because you watched shows about Dangerous Worlds and Complex Consequences >

LUKE CAGE

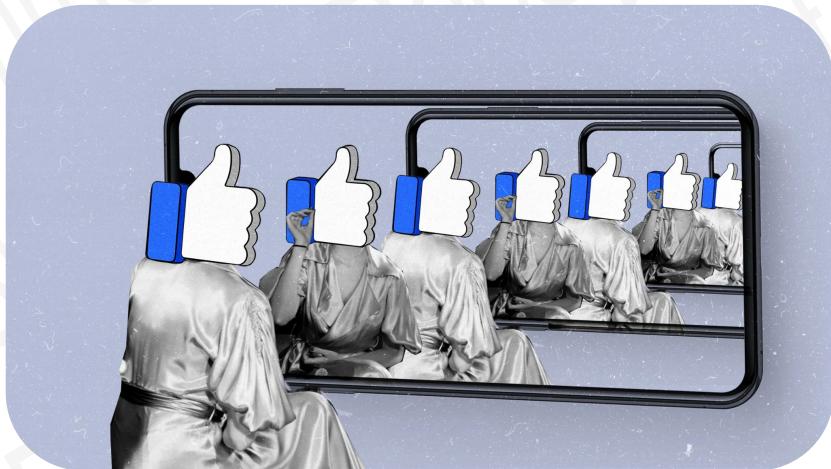
BLACK MIRROR

STRANGER THINGS

FOXY Amanda KNOX

# RecSys Issues & Challenges

- Echo Chamber

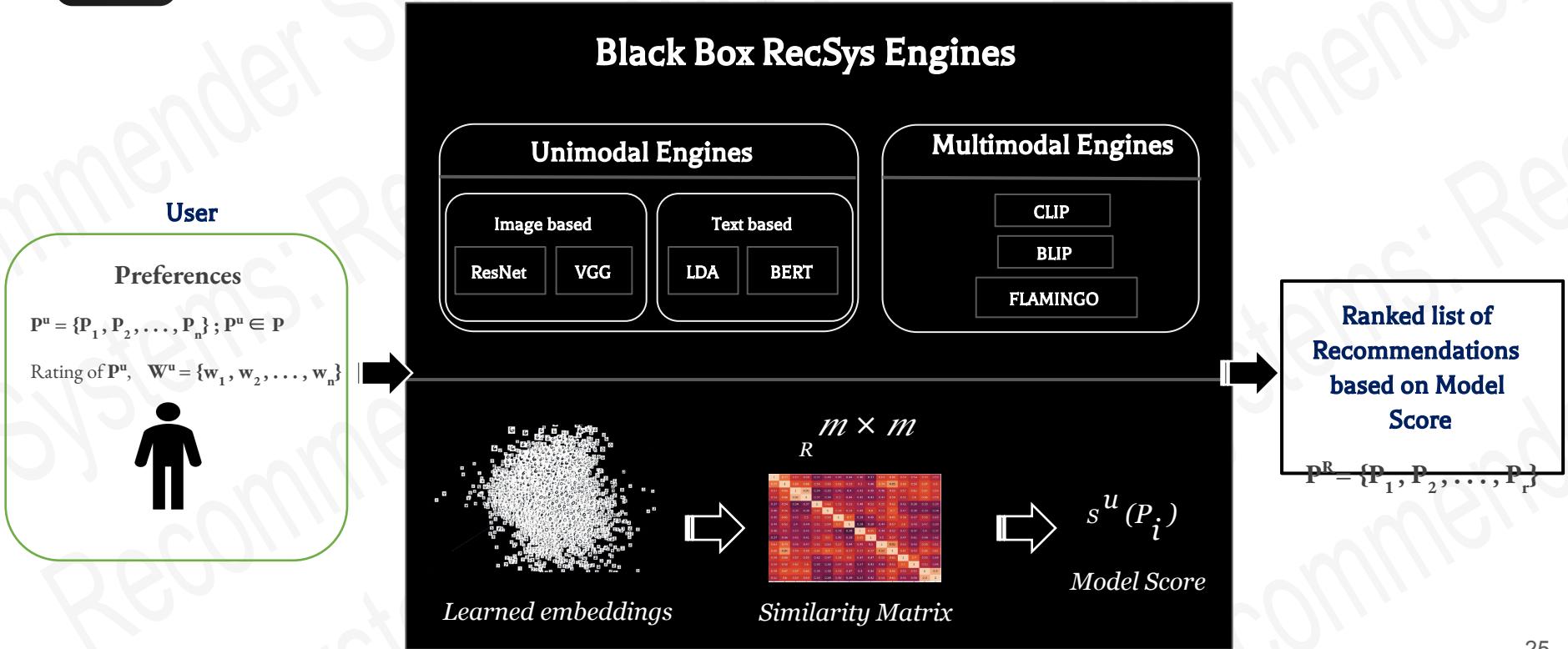


- **Filter bubbles**



- Limiting exposure to diverse perspectives.
- Reinforcing existing biases and stereotypes.

# RecSys Issues & Challenges





# Exploration and Controllability

User

Preferences

$$P^u = \{P_1, P_2, \dots, P_n\}; P^u \in P$$

Rating of  $P^u$ ,  $W^u = \{w_1, w_2, \dots, w_n\}$



Black Box  
RecSys  
Engines

$s^u(P_i)$   
*Model Score*

Controlling Popularity Bias

$$S_{AG}^u(p_i) = S^u(p_i) + \beta S^{\text{pop}}(p_i)$$

Giving users the Control

Generate Recommendations

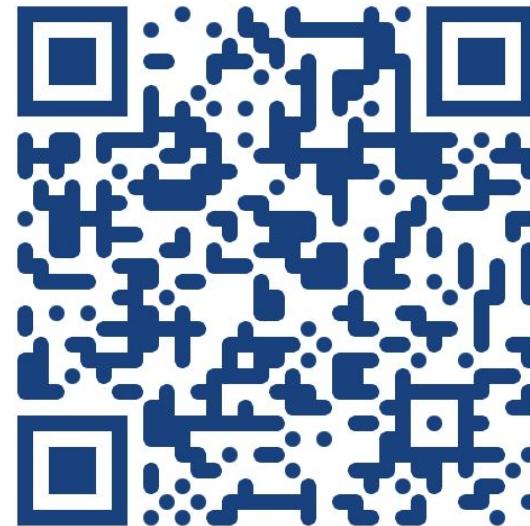


# Reflection



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@bek\_yilma



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[Moodle](#)