

Recommender Systems Workshop

A hands-on workshop on designing and building modern
recommendation engines

Rubi Boim

Why are we here?

Why are we here?

- Hands on experience
- Learn important / practical stuff
- **Have fun ;-)**

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TLDR for today

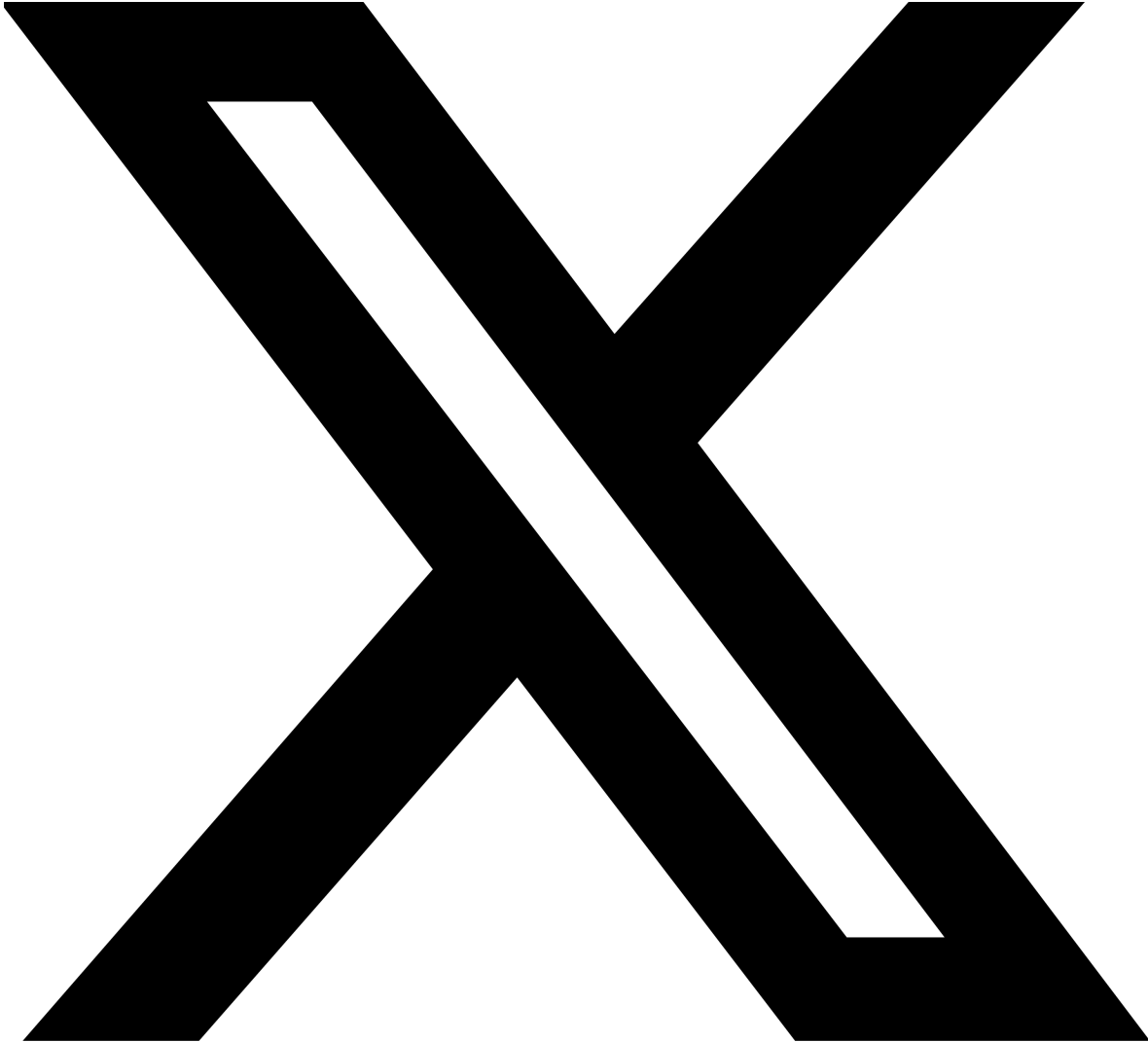
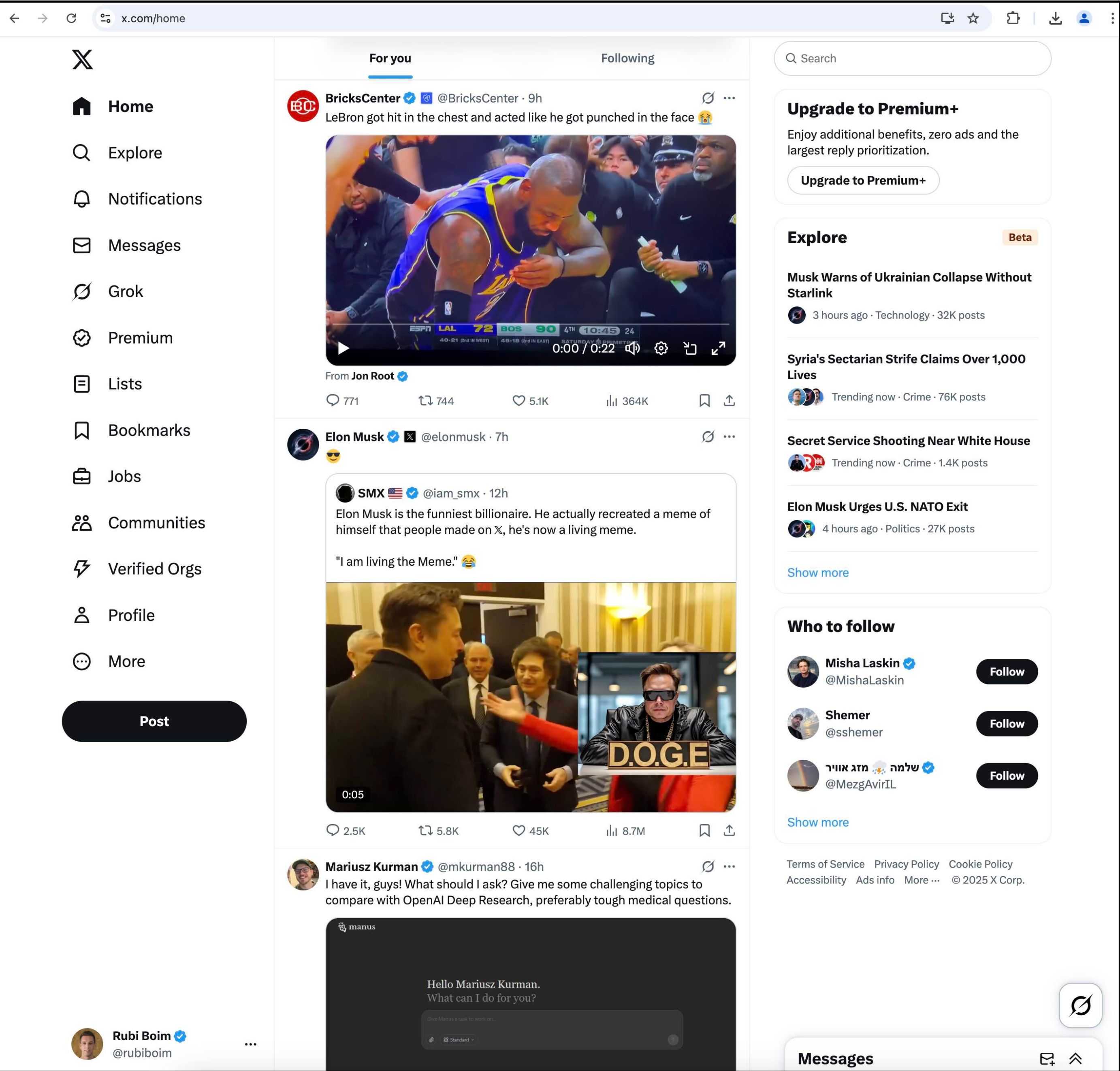
You should be passionate and obsessed with the idea

assume this is your Startup

WHAT ARE RECOMMENDER SYSTEMS?

WHAT ARE RECOMMENDER SYSTEMS?

A type of ML system that predicts and suggests **items**
a **user** might be **interested** in, based on their
preferences, behavior, or characteristics



←

→

↻

x.com/home

X

Home

Explore

Notifications

Messages

Grok

Premium

Lists

Bookmarks

Jobs

Communities

Verified Orgs

Profile

More

Post

For youFollowing

BricksCenter

@BricksCenter · 9h

LeBron got hit in the chest and acted like he got punched in the face 🤕

0:00 / 0:22

🔊⚙️🔗

From Jon Root

7717445.1K364K

Elon Musk

@elonmusk · 7h

SMX

@iam_smx · 12h

Elon Musk is the funniest billionaire. He actually recreated a meme of himself that people made on X, he's now a living meme.

"I am living the Meme." 🤔

0:05

2.5K5.8K45K8.7M

Mariusz Kurman

@mkurman88 · 16h

I have it, guys! What should I ask? Give me some challenging topics to compare with OpenAI Deep Research, preferably tough medical questions.

manus

Hello Mariusz Kurman.
What can I do for you?

Give Manus a task to work on.

Standard

Upgrade to Premium+

Enjoy additional benefits, zero ads and the largest reply prioritization.

Upgrade to Premium+

Explore

Musk Warns of Ukrainian Collapse Without Starlink

3 hours ago · Technology · 32K posts

Syria's Sectarian Strife Claims Over 1,000 Lives

Trending now · Crime · 76K posts

Secret Service Shooting Near White House

Trending now · Crime · 1.4K posts

Elon Musk Urges U.S. NATO Exit

4 hours ago · Politics · 27K posts

Show more

Who to follow

Misha Laskin

@MishaLaskin

Follow

Shemer

@sshemer

Follow

שלמה מזג אוויר

@MezgAvirIL

Follow

Show more

Terms of ServicePrivacy PolicyCookie PolicyAccessibilityAds infoMore ...© 2025 X Corp.

Messages

A large, bold, black 'X' logo on a white background. The 'X' is composed of two thick, slightly irregular diagonal lines that intersect in the center, giving it a hand-drawn or stencil-like appearance.

8

How to **choose / rank** millions of tweets?





There are too many post to choose from.

Instead, Instagram first predicts which accounts will be relevant. Then it predicts the posts

(Also better for applying diversity)



Today's Top Picks for You



My List



Top 10 TV Shows in Israel Today



Blockbuster Movies



Popular Mobile Games for You



Civilization VI GTA: San Andreas - The Definitive... Solitaire Football Manager 2024 Mobile Word Trails Bloons TD 6 Asphalt Xtreme Battleship

WWE: Live & Upcoming



NETFLIX

HomeTV ShowsMoviesNew & PopularMy ListBrowse by Languages

QKids7

Today's Top Picks for You

Recently Added

Recently Added

New Season

Recently Added

Recently Added

Recently Added

My List

Recently Added

Top 10 TV Shows in Israel Today

1

Recently Added

2

Recently Added

3

Recently Added

4

Recently Added

5

Recently Added

6

New Season

Blockbuster Movies

Recently Added

Recently Added

Popular Mobile Games for You

Civilization VI

GTA: San Andreas
- The Definitive..

Solitaire

Football Manager
2024 Mobile

Word Trails

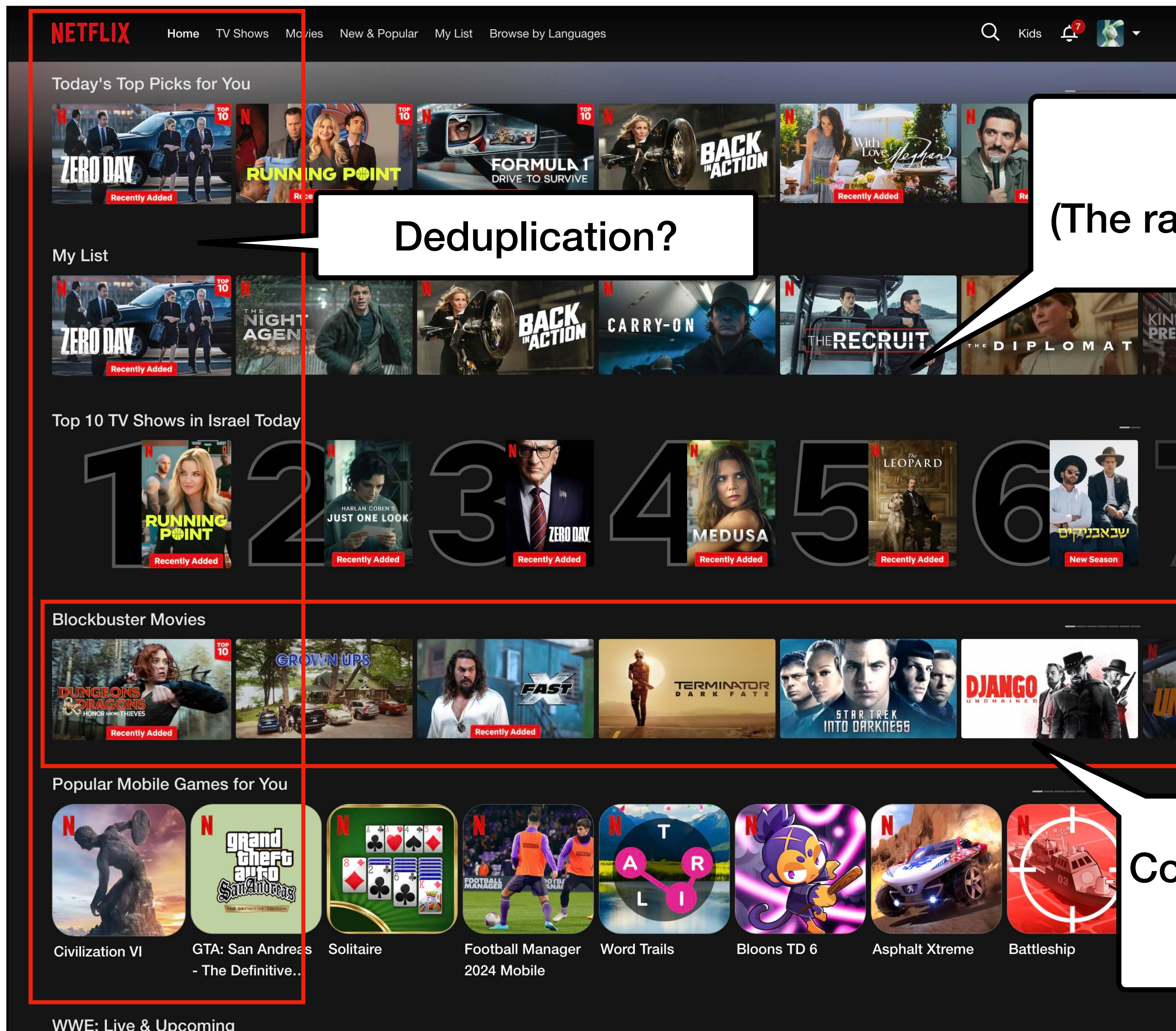
Bloons TD 6

Asphalt Xtreme

Battleship

WWE: Live & Upcoming





Full page personalization
(The rail types are tailored for each user)

Content within each rail is ranked by
relevancy to the user

amazon.com

amazonprime

Deliver to Reuven Herzliya 46

All

Search Amazon

EN

Hello, Rubi

Account & Lists

Returns & Orders

0 Cart

All

Rufus

Free Shipping Zone

Today's Deals

Buy Again

Customer Service

Rubi's Amazon.com

Sell

Browsing History

Gift Cards

Registry

Get ready for Purim



Coleman Chiller Soft...



Coleman Pro 24-Can...



Igloo Soft Cooler Gri...



Stanley All Day Julien...

See more



FREE Shipping to Israel

on qualifying orders over USD \$49



Household batteries

3 viewed



Boys' skiing jackets

1 viewed



Computer monitors

1 viewed



Men's sports & recr...

1 viewed

View your browsing history



Buy again



More in Buy Again







Camping chairs



Snowboards



Snowboard bags



Tumblers & water...



Celebrate the women in your life

Shop gifts



Get ready for Purim

Shop for Purim



Get your game on

Shop gaming

Related to items you've viewed

See more

A large, stylized Amazon smile logo on a tan background with a blue corner tab. The logo is a simple black arrow pointing from the letter 'a' to the letter 'z', forming a smile. The background is a light tan color with a blue corner tab in the top-left corner.

amazon.com

amazonprime

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All

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More in Buy Again



Camping chairs



Snowboards



Snowboard bags



Tumblers & water...



Shop gifts



Shop for Purim

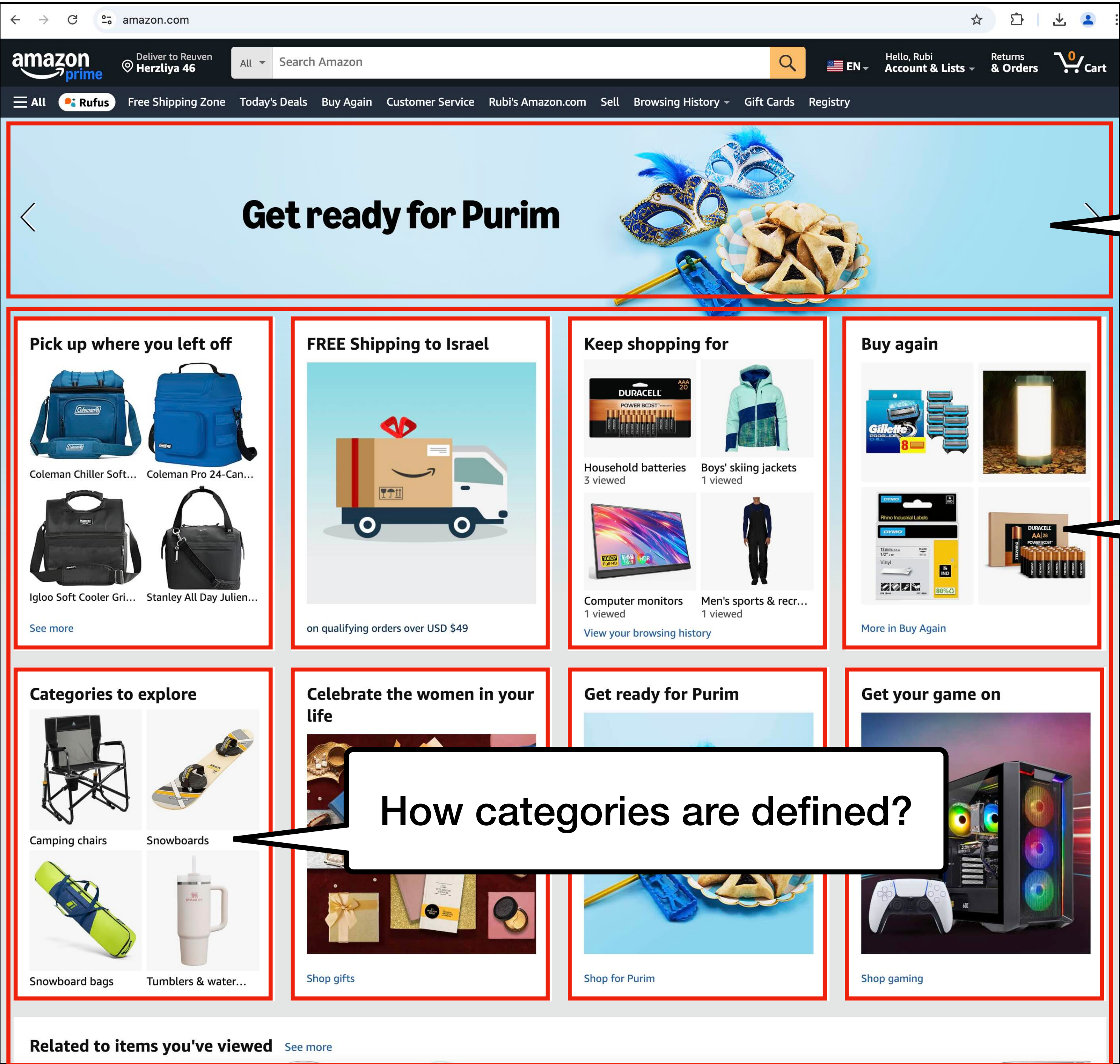


Shop gaming

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Hero banner personalization by location

Static / personalized boxes

How categories are defined?

And more and more...



←→↻ksp.co.il/web/

☆🔖⬇️👤⋮

שפה🌐

עגלה🛒0

חשבון👤

🔍🎤... 75,567 חפשו מוצר או מספר קטלוגי מתוך

מידע ופעולות⋮

עולמות🏠

נגישות🗻

K.S.P.

🔊 שירות לקוחות

📑 מבצעים

🆕 חדש באתר

מציאון ועודפים

מחלקה עסקית

כרטיס מתנה

דרושים

טרייד אין

מדריכי קנייה

סניפים ושעות פעילות

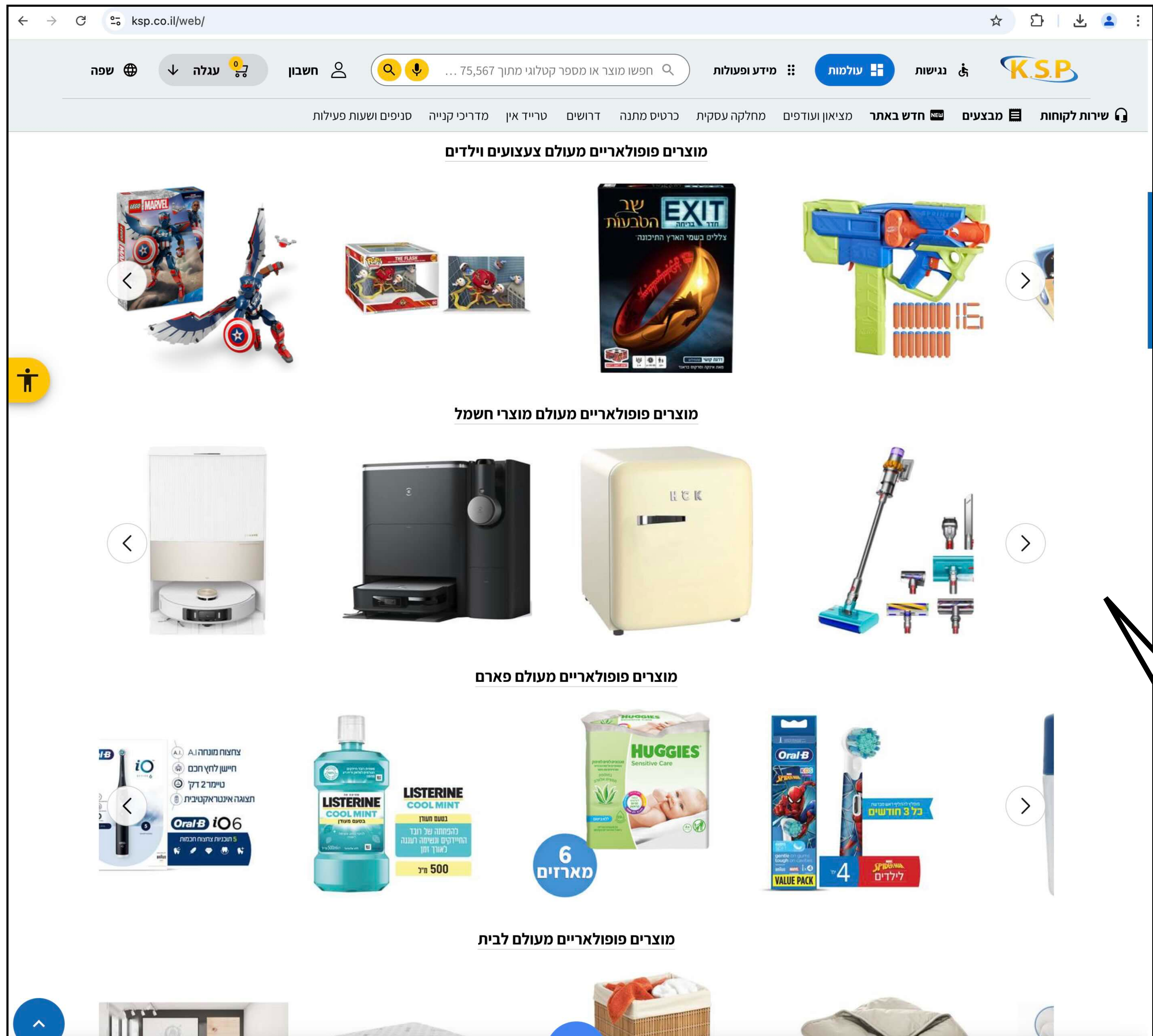
מוצרים פופולאריים מעולם צעצועים וילדים

מוצרים פופולאריים מעולם מוצרי חשמל

מוצרים פופולאריים מעולם פארם

מוצרים פופולאריים מעולם לבית





Static for all users
KSP need to take this workshop :)

ynet.co.il/home/0,7340,L-8,00.html

ynet+ראשי

עודנדל"ןאוכללאשהדיגיטלרכבבריאותרכילותתרבותספורטכלכלהפודקאסטים24/7חדשותynet+

טען ש"ירו לעברו" - ויואשם ברצח בן 14

המשטרה פענחה את רצח הנער בלוד בחודש שעבר, וכתב אישום יוגש נגד סלימאן אבו גאנם מרמלה, שהתגלה כי גרסתו מפוברקת מאיר תורג'מן

AD

ח"כים דורשים לנטוש את ארגון הבריאות העולמי

כמה ח"כים ובהם ניסים ואטורי וגלית דיסטל אטבריאן דרשו לדון בוועדת הבריאות בפרישה. אז מי יחסן את תושבי עזה? אור הדר

הקונספירציות של זהבי: "נחיתה על הירח? איך האמנו?"

קפטן מכבי ת"א חשף צד לא מוכר שלו - וסיפק כמה אמירות מדהימות: "אוטו כזה על הירח, אני לא נוסע איתו לאילת" ynet ספורט

טיפול תרופתי בהשמנה - למי זה מתאים?

הקריטריונים המקובלים להתחלת הטיפול התרופתי, המעקב אחר המטופל - והמעטפת המחייבת מסביב בשיתוף נובו גורדיסק

הכי חם - לא רק חדשות

צעירה יהודייה נרצחה בביתה בבואנוס איירס

איתמר אייכנר

נחשפה סיבת המוות של ג'ין הקמן ואשתו בביתם המבודד

ynet

מרתון ת"א: 15 שנה הרחובות נסגרים, וחברה אחת מרוויחה כלכליסט

אמיתי גזית

"הטיהור הגדול": אילון מאסק מחליף אלפי עובדים בצ'אטבוט AI

רפאל קאהאן

נוסעת חשפה פתק פלירטוט שקיבלה מטייס - ושברה את הרשת

אסף רוזן

חדשות

התלמידים חוזרים לבתי הספר בצפון, השגרה עדיין ארוכה: "פתיחת השנה המרגשת בחיי"

יאיר קראוס, אלכסנדרה לוקש | 14:20

ירי ליד הבית הלבן: השירות החשאי נטרל גבר חמוש

סוכנויות הידיעות | 14:32

זעם ברוסיה: מפלגת השלטון העניקה לאימהות שכולות מטחנות בשר

AFP | 13:52

הקבינט יקבע את מנדט המשלחת: "עשויה לגלות גמישות" | הכיוון החדש שנבחן

איתמר אייכנר, אלכסנדרה לוקש | 12:09

בלי לפרט כמה עזתים בכלל מעוניינים לעזוב מ"רצון": הדיון בכנסת על תוכנית טראמפ

סיון חילאי | 13:54

"קודם תקציב, אחר כך היתר": העברת חוק הפטור מגיוס בספק - וגם שרידות ההואליציה

ניפצו בקבוק על ראשו, כיבו סיגריה על פניו: 6 נאשמו בחטיפת נער, עד שאיבד הכרה

טל חזר ומיד שאל מי חי ומי מת | הקליעים שחדרו את הדלת, החטיפה והחיבוק עם יהל

21

ynet.co.il/home/0,7340,L-8,00.html

ynet+ראשי

עוד נדל"ן אוכל לאשה דיגיטל רכב בריאות רכילות תרבות ספורט כלכלה פודקאסטים 24/7 חדשות

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ynet

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הרשת

אסף רוזן

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AI

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טל חזר ומיד שאל מי חי ומי מת

| הקליעים שחדרו את הדלת,

החטיפה והחיבוק עם יהל

AD

Static for all users
How much "items" ynet has?

Evergreen content?

22

Recsys are ML models that

- **Predicts** user preferences or interests
- **Suggests** items tailored to each user
- **Learns** from user behavior, metadata, and other data
- **Discovers** new items users were not looking for

Recsys are at the core of the business

- **Personalized experience**
each user is unique
- **Utilize long tail**
surface the right items out of millions of options
- **Increases revenue**
and other KPIs (engagement, stickiness, reduce search time, ...)

Do we need a recommender system in the era of llms?
make sure your answer will fit a single slide in length

Thought for a couple of seconds

Yes — but the role changes.

Why it still matters

- LLMs are great at understanding and explaining content.
- Recommenders are great at deciding what to show next under real constraints: scale, freshness, business goals, diversity, safety, and latency.

What LLMs improve

- Better semantic matching for cold-start items/users
- Stronger query understanding and conversational preference capture
- Better ranking features from text, images, and metadata
- Natural-language explanations and interactive discovery

What recommender systems still uniquely do

- Optimize for long-term engagement / conversion / retention
- Learn from implicit feedback at massive scale
- Balance exploration vs. exploitation
- Enforce constraints: inventory, policy, fairness, diversity, budgets
- Operate with low latency and predictable cost

Best view

- Not recommender vs. LLM
- It is recommender + LLM

Practical stack

1. Candidate retrieval
2. LLM/embedding-based understanding
3. Ranking with behavioral signals
4. Re-ranking for diversity/safety/business rules
5. LLM explanation or chat interface

Bottom line

In the LLM era, recommender systems are still needed — LLMs become a powerful component inside them, not a replacement.

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Workshop goal

Build your own recommender system

The exact domain, use case and focus are entirely up to you!

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You should be passionate and obsessed with the idea

assume this is your Startup

Workshop goal

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How to learn?



(01:30 - ...)

<https://x.com/elonmusk/status/1888818629589827943>

privilege to teach and learn

failing in this course is not an option.

understanding the motivation

examples before theories

Buzzwords to be covered (tentative)

- General recommender systems

- Content based
- Collaborative filtering
- Hybrid

- Algorithms

- Similarities (cos / jaccard)
- User based / Item based
- Matrix factorization

- Other

- Embeddings
- Vector DB
- LLMs

Staff

Dr. Rubi Boim

- boim AT **cs**.tau.ac.il
- <https://www.cs.tau.ac.il/~boim/>

Stav Koren (TA)

- stavk AT **mail**.tau.ac.il

Communications

- Course website:
<https://courses.cs.tau.ac.il/recsys/>
- Moodle
<https://moodle.tau.ac.il/course/view.php?id=368356501>

Course plan (tentative)

- Intro
- **Project proposals**
- Recsys algorithms
- Mid checkup
- **Mid semester presentation**
- Final checkup
- **Final presentation**



Course schedule



<https://courses.cs.tau.ac.il/recsys/>

Project proposals

- Present / discuss your project
 - use case
 - data set
 - focus / unique features
- Define modules / sub tasks

Mid semester presentation

15 min presentation in class (in english)

- Live demo (if available)
- Current challenges
- Current road map

Final presentation

15 min presentation in class (in english)

- Live demo
- Lessons learned
- What worked and what didn't work

FAQ

- Group size: 4 students
- Languages / platforms / AI agents: no restrictions
- Deployment: no restrictions (local / web)
- Final submission: single GitHub project

Requirements (1)

- Working demo / MVP
- Interesting features
- Learning algorithm (ML)

Requirements (2)

- Do NOT develop “high accuracy” algorithm - instead combine several “simpler” methods / features

in other words, do not try to win the Netflix prize.
but you can use its data for other stuff

- You should have “several / many” modules
most of them won't be “core recommenders”

How to choose a project topic?

Choosing a topic

- A domain you're **passionate** about
- A **dataset** to work with

Choosing a topic

- A domain you're **passionate** about

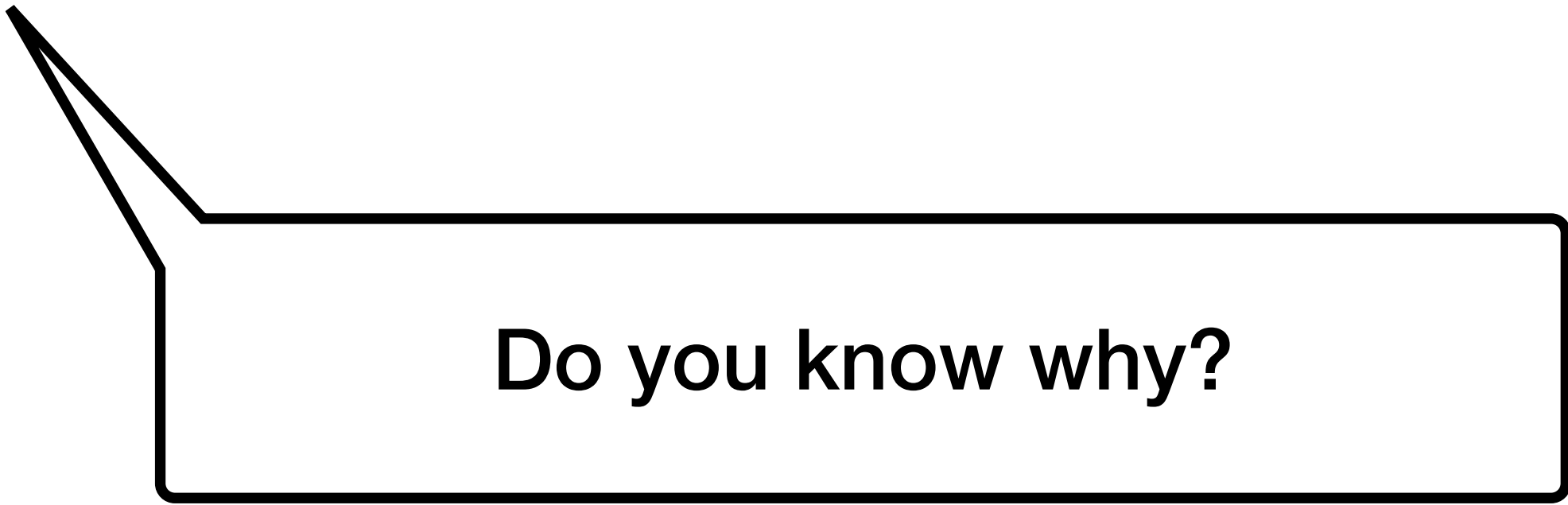
- A **dataset** to work with

(Probably) you need behavioral data

Choosing a topic

- A domain you're **passionate** about
- A **dataset** to work with

(Probably) you need behavioral data



Do you know why?

Choosing a topic

- A domain you're **passionate** about
- A **dataset** to work with

(Probably) you need behavioral data

User watched a movie

User purchased a product

User rated a song

User clicked on an article

...

Choosing a topic

- A domain you're **passionate** about

- A **dataset** to work with

(Probably) you need behavioral data



Recommender System types

- Content based
based on semantic / static properties
- Collaborative filtering
based on user behavior
- Hybrid
A mix of the two

Recommender System types

- **Content based**
based on semantic / static properties

- **Collaborative filtering**
based on user behavior

- **Hybrid**
A mix of the two

Intuition

because you watch comedy movies
with Adam Sandler here are more
comedies you might like

Recommender System types

- Content based
based on semantic / static properties
- Collaborative filtering
based on user behavior
- Hybrid
A mix of the two



view history:



- Comedy
- Adam sandler

Jordan's Profile: Action: 0.34
Drama: 0.23
Comedy: 0.9
SciFi: 0.3

recommendation:



Recommender System types

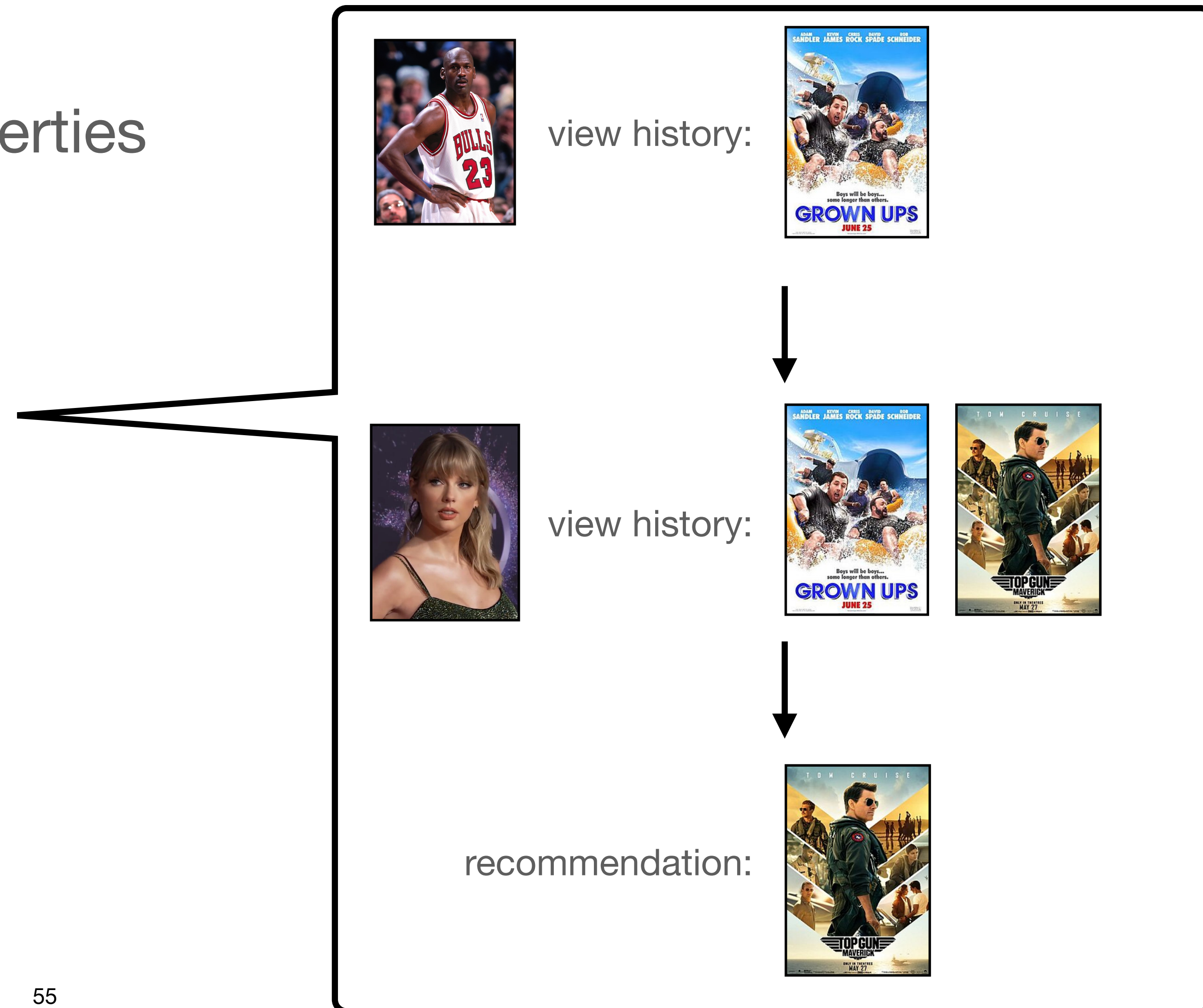
- **Content based**
based on semantic / static properties
- **Collaborative filtering**
based on user behavior
- **Hybrid**
A mix of the two

Intuition

Other users who watch “Grown Ups”
also watched...

Recommender System types

- Content based
based on semantic / static properties
- Collaborative filtering
based on user behavior
- Hybrid
A mix of the two



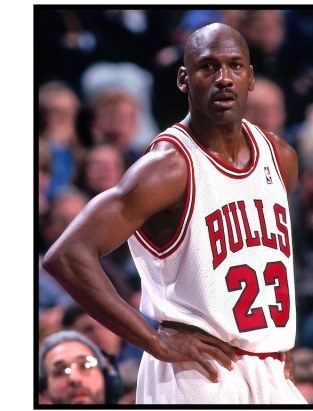
Recommender System types

THIS IS IMPORTANT!

Collaborative Filtering works without
any prior semantic knowledge

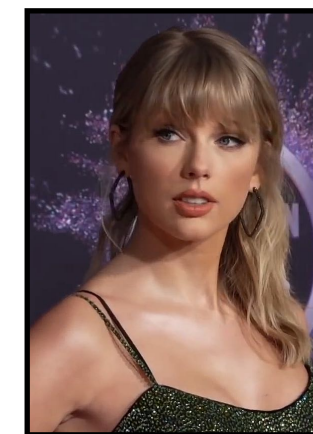
You can blend any type of items
together in the same algorithm
(movies, food, books, hotels..)

properties



view history:

123



view history:

123

456

recommendation:

456

Recommender System types

- **Content based**
based on semantic / static properties
- **Collaborative filtering**
based on user behavior
- **Hybrid**
A mix of the two

Intuition

**Mix the semantics with CF
(there are a lot of ways)**

**for example, predict new genres the
user might like**

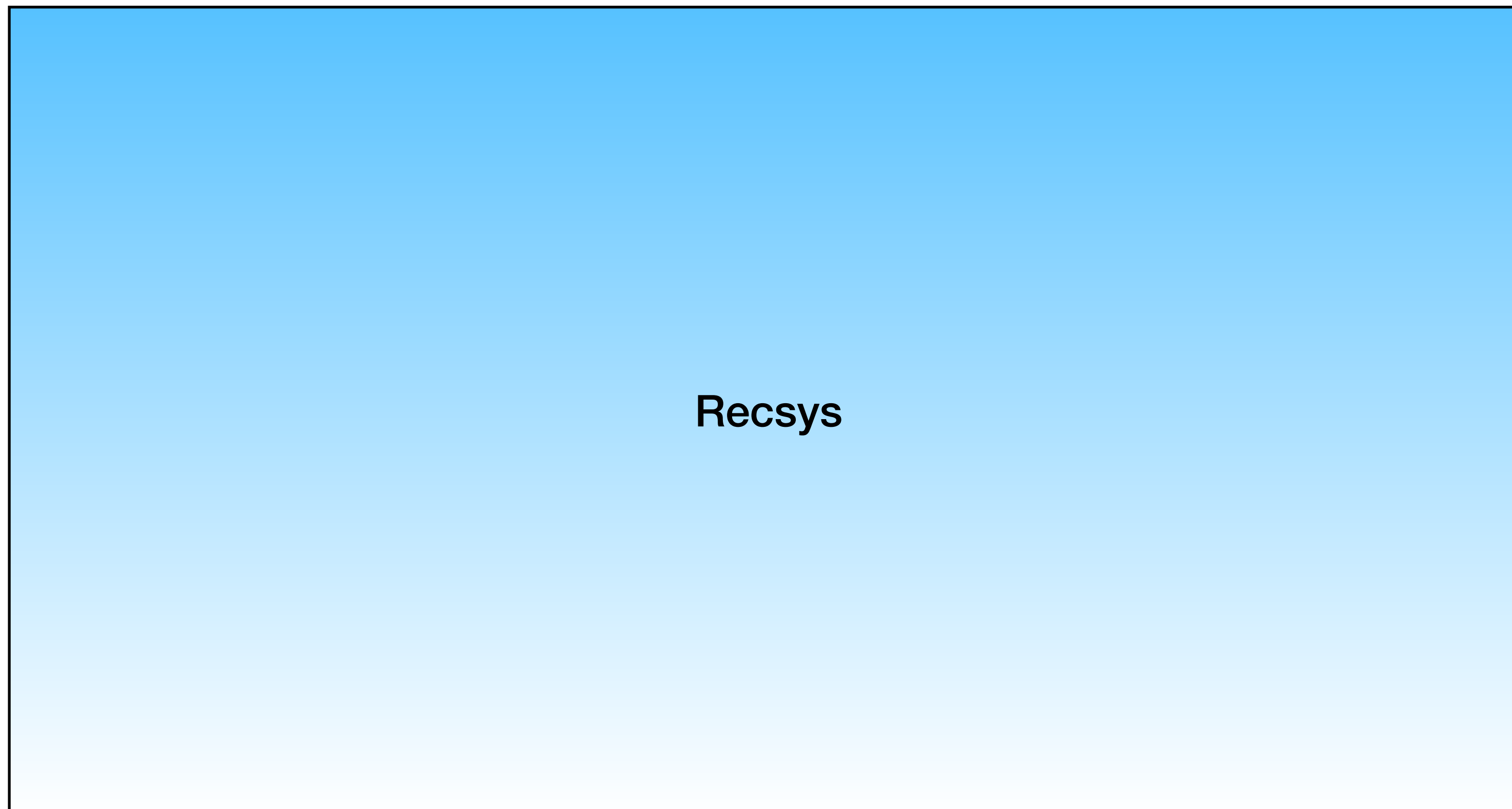
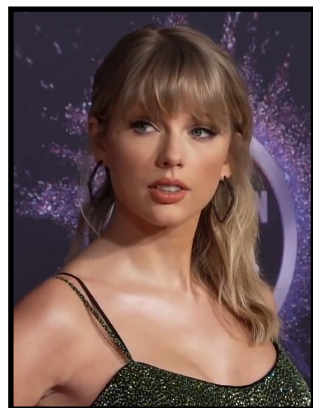
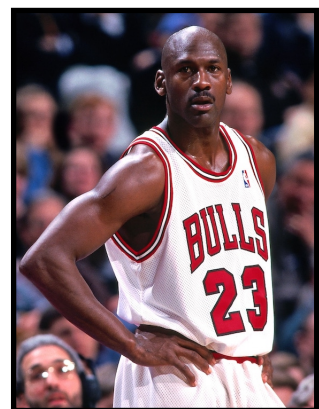
Choosing a topic

- You can start your search here for a few examples

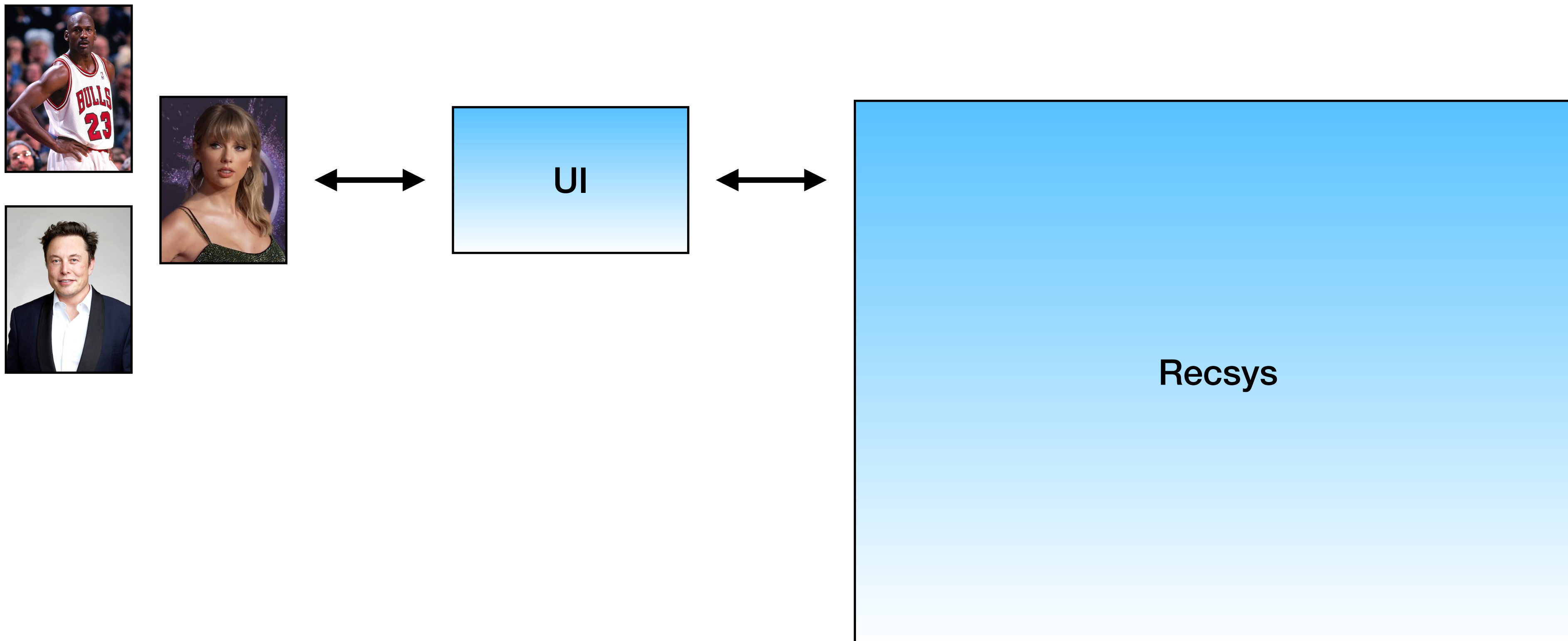
<https://courses.cs.tau.ac.il/recsys/datasets/>

Ok - we got a topic :) What now?

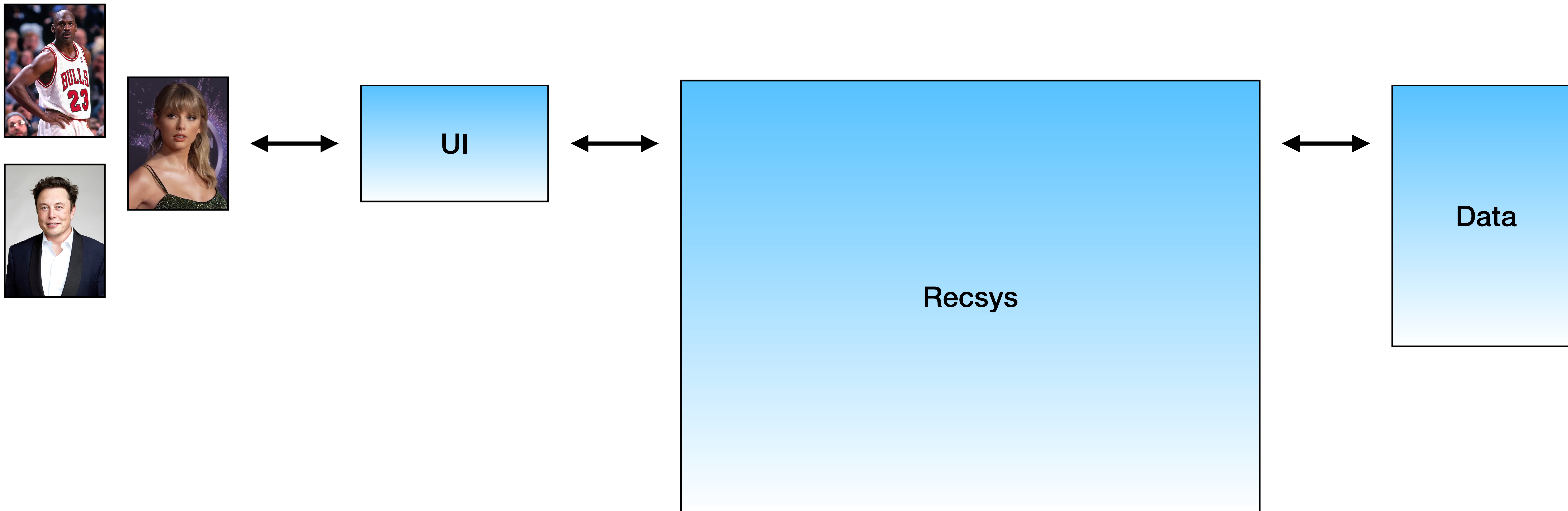
Project modules / services (example)



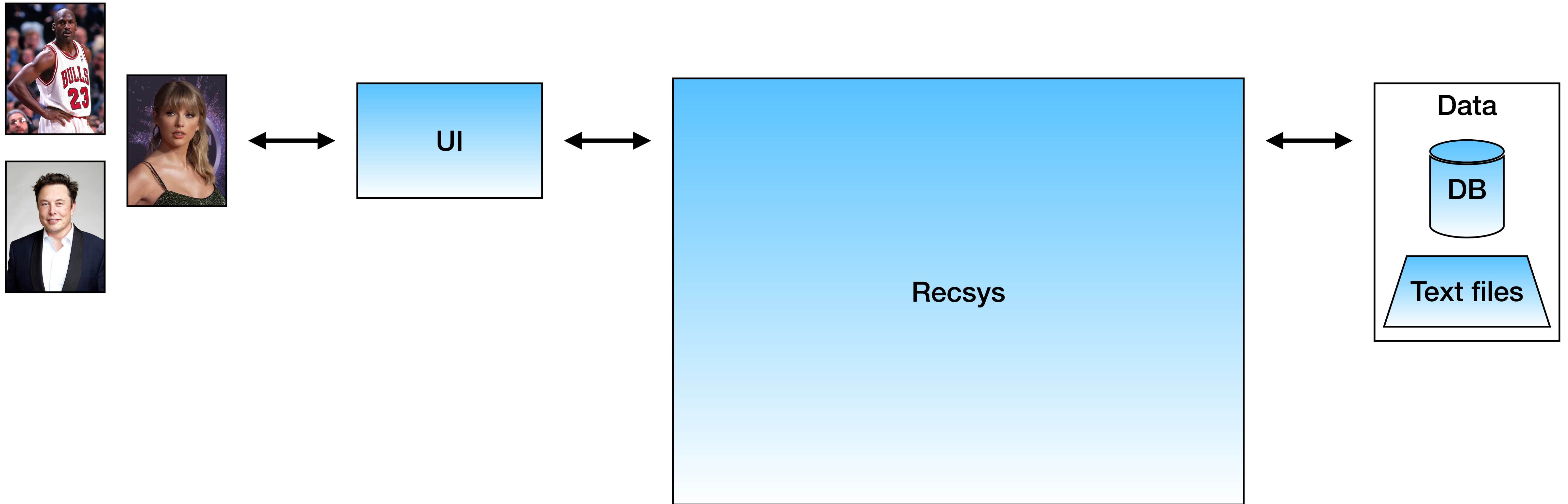
Project modules / services (example)



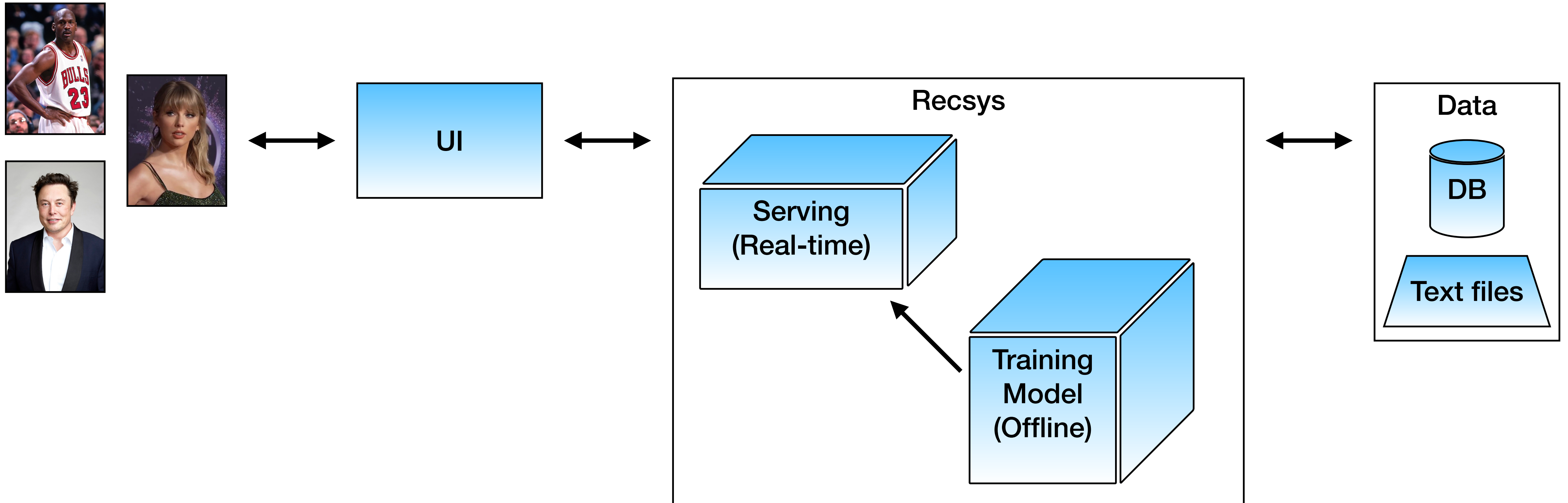
Project modules / services (example)



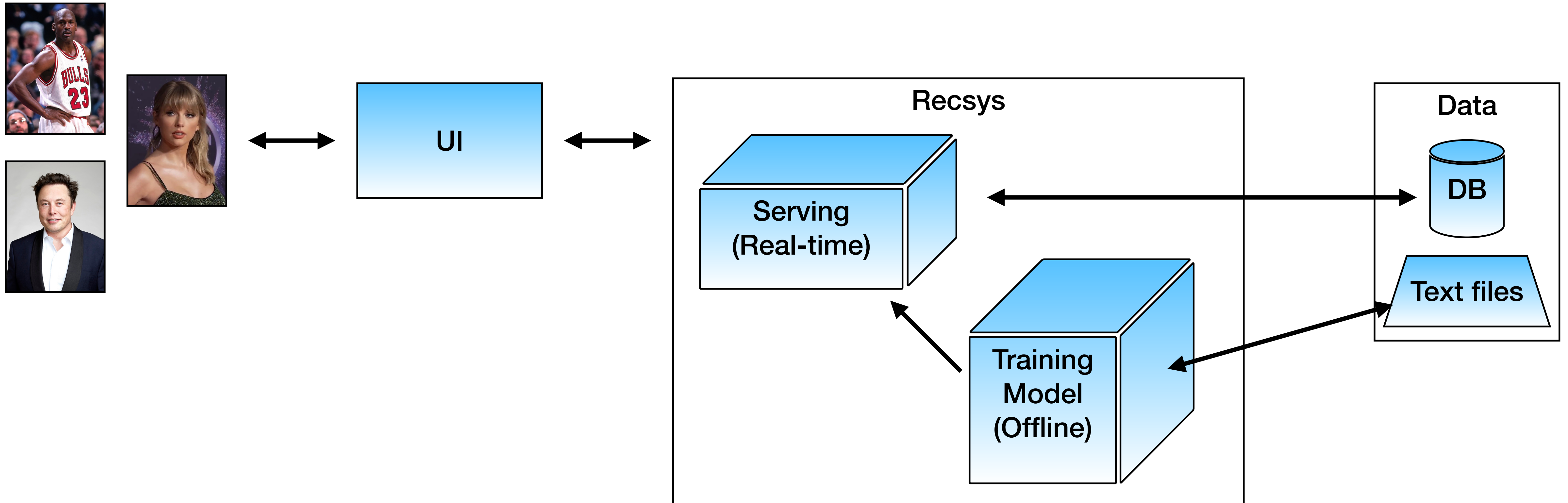
Project modules / services (example)



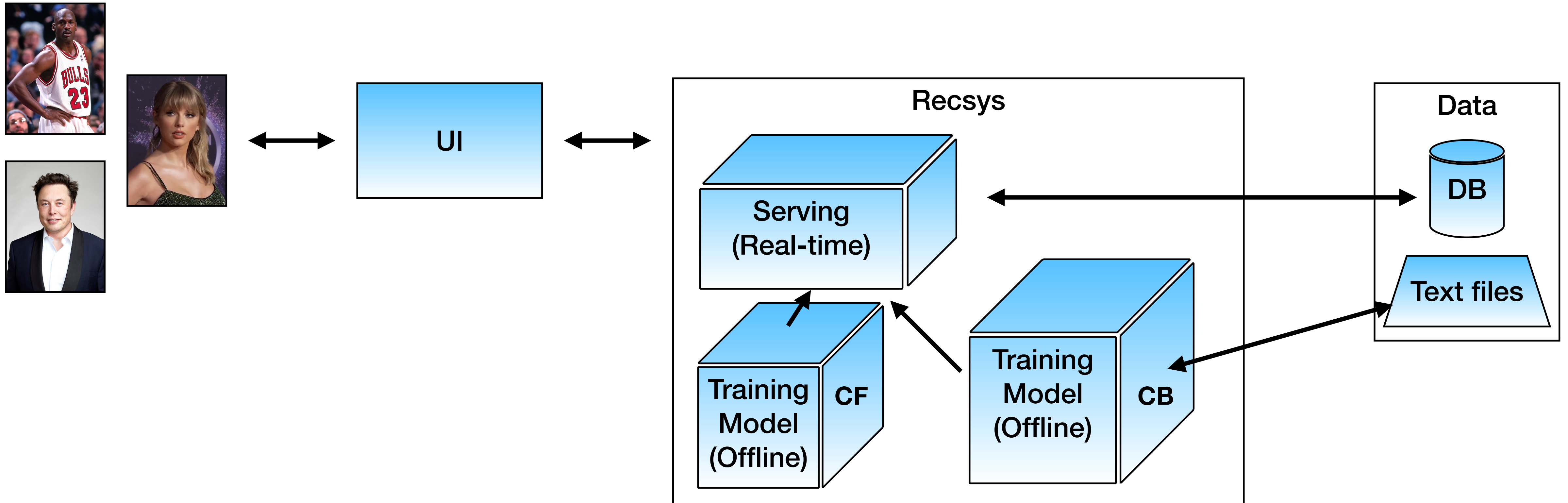
Project modules / services (example)



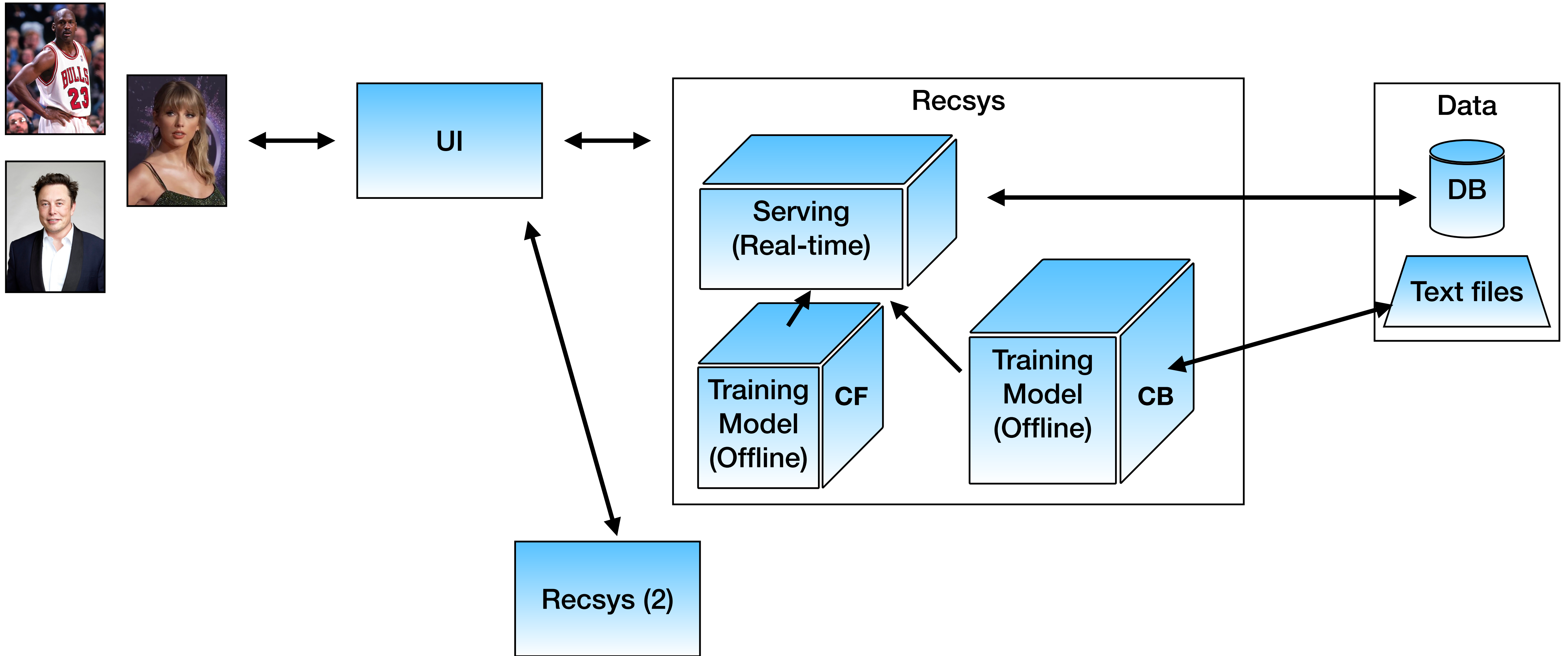
Project modules / services (example)



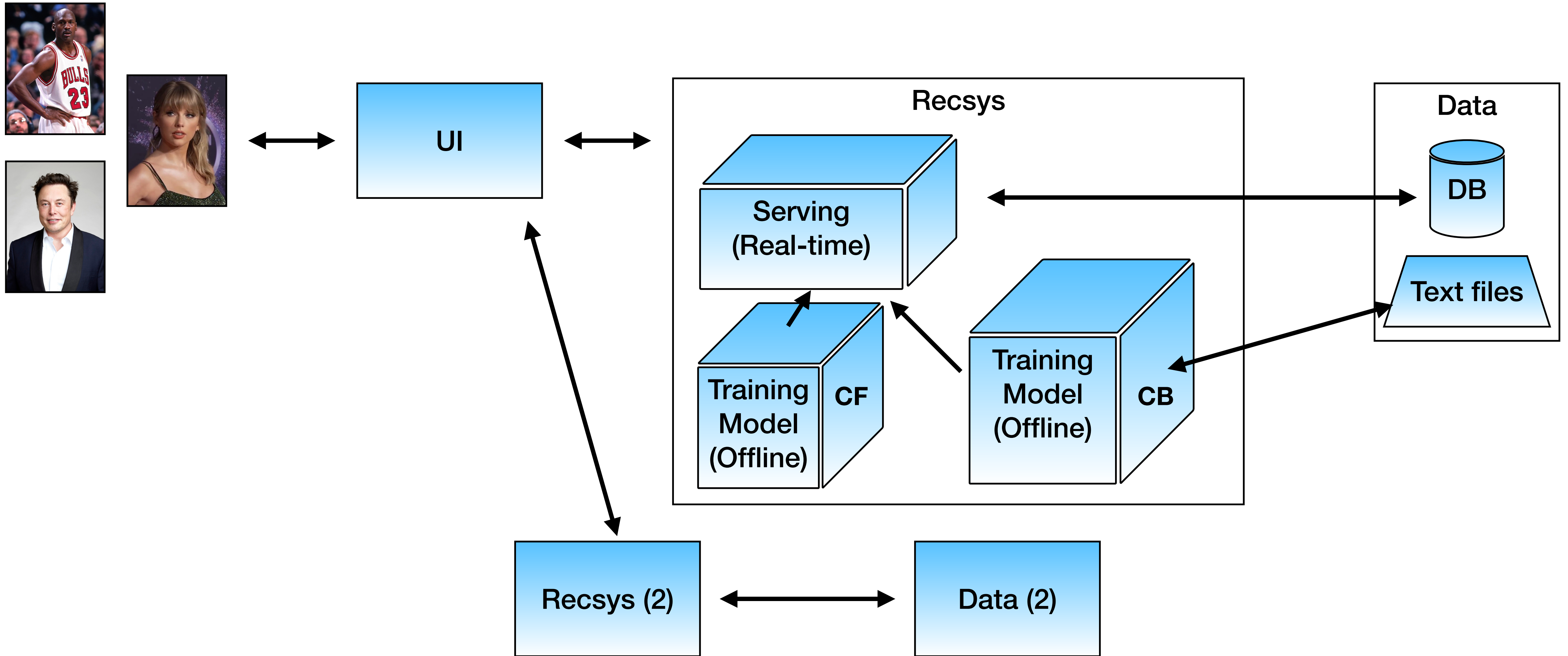
Project modules / services (example)



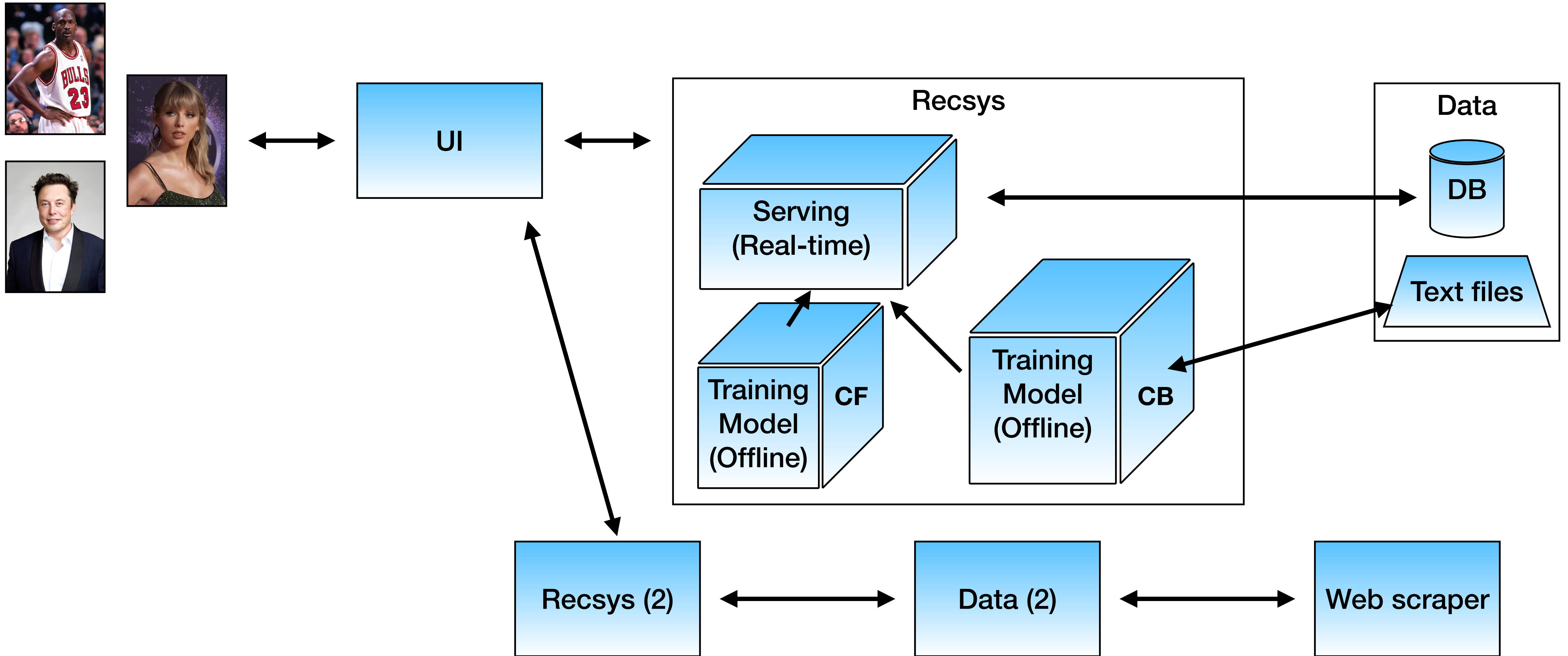
Project modules / services (example)



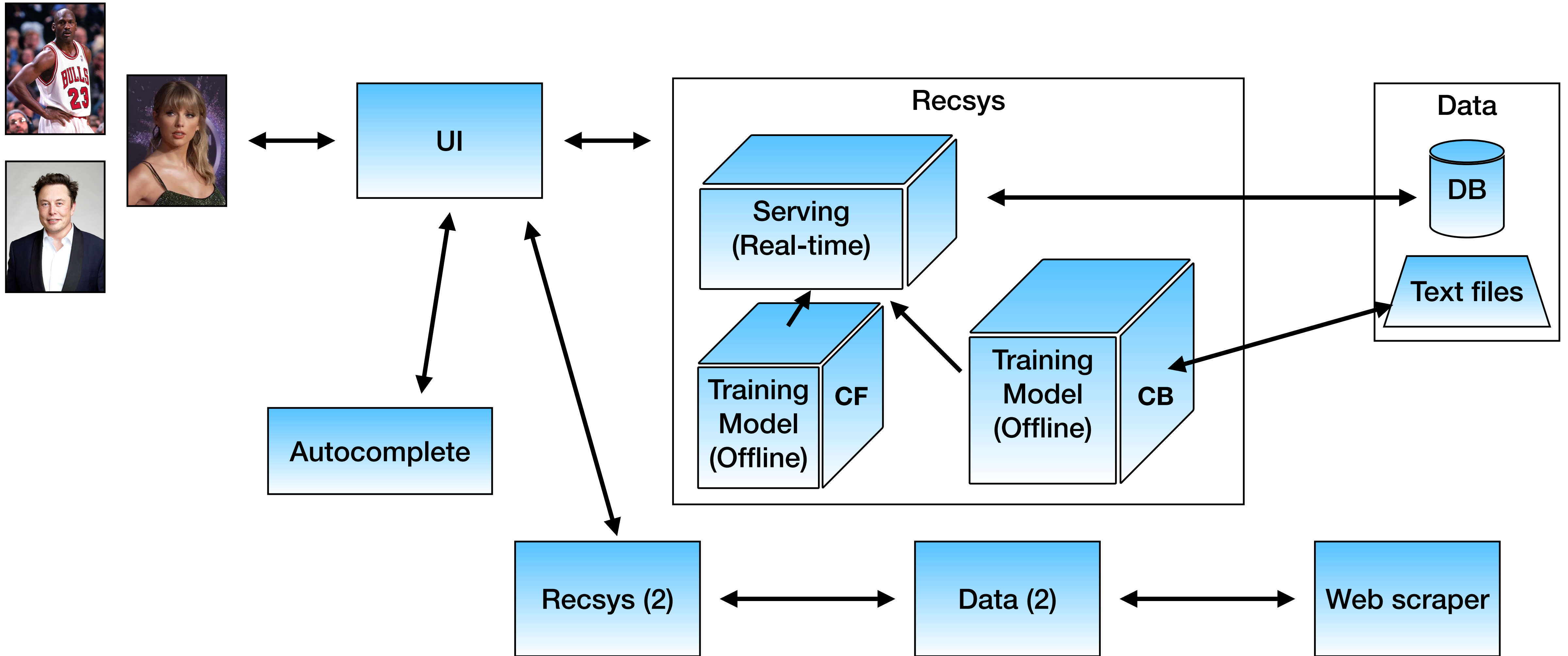
Project modules / services (example)



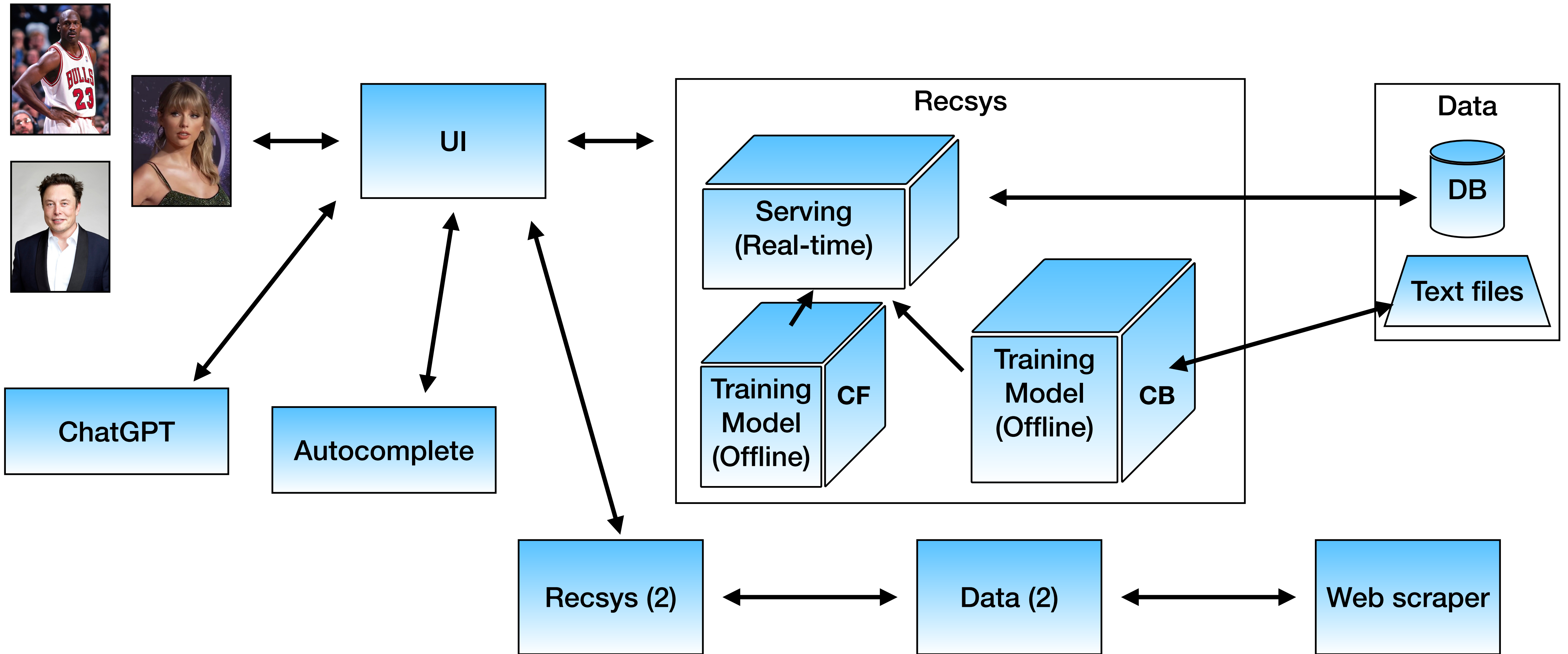
Project modules / services (example)



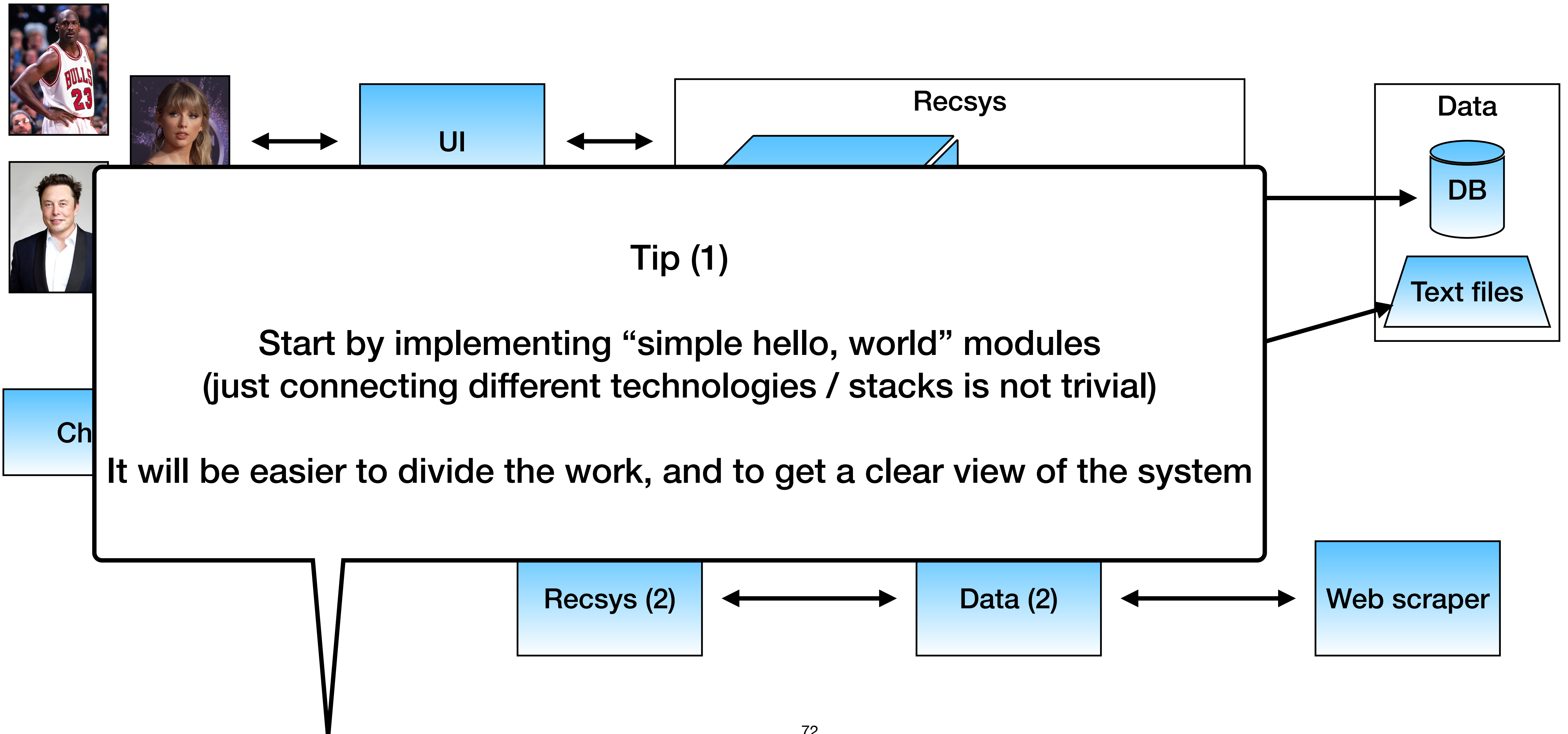
Project modules / services (example)



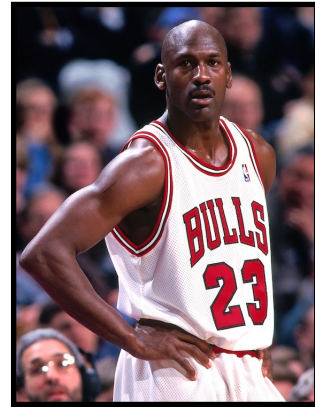
Project modules / services (example)



Project modules / services (example)



Project modules / services (example)



Tip (2.1)

You are NOT expected to develop a PRODUCTION system.

You do NOT need to support:

Highly available / Highly scalable

Chat

Recsys (2)

Data (2)

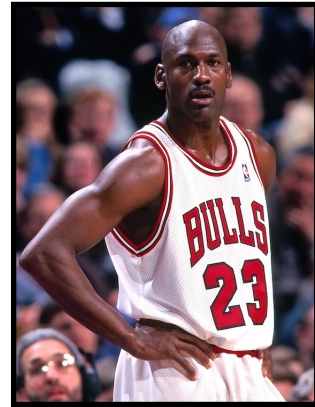
Web scraper

Data

DB

Text files

Project modules / services (example)

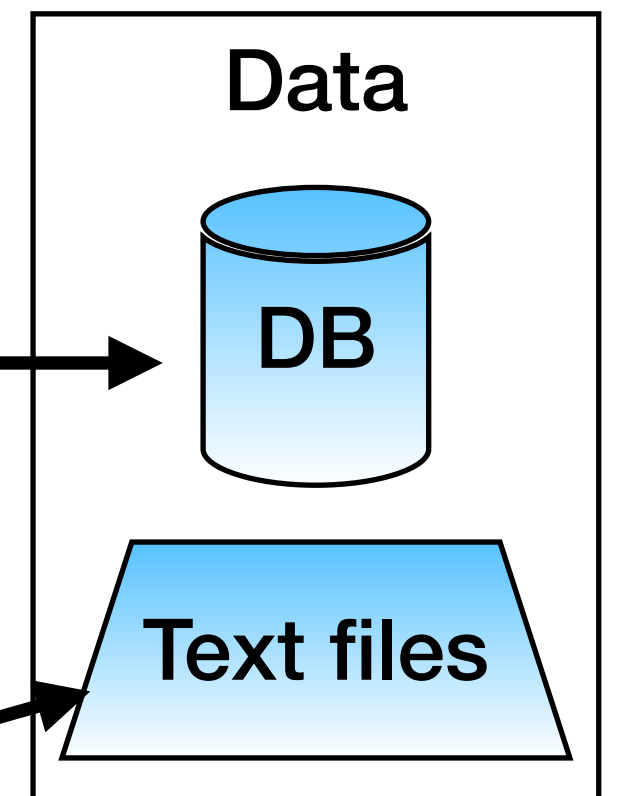


Tip (2.2)

You are NOT expected to develop a PRODUCTION system.

You do NOT need to support:

Synchronization between models and data



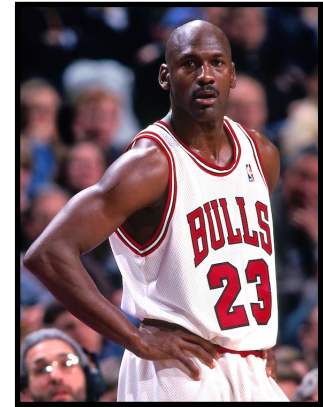
Chat

Recsys (2)

Data (2)

Web scraper

Project modules / services (example)



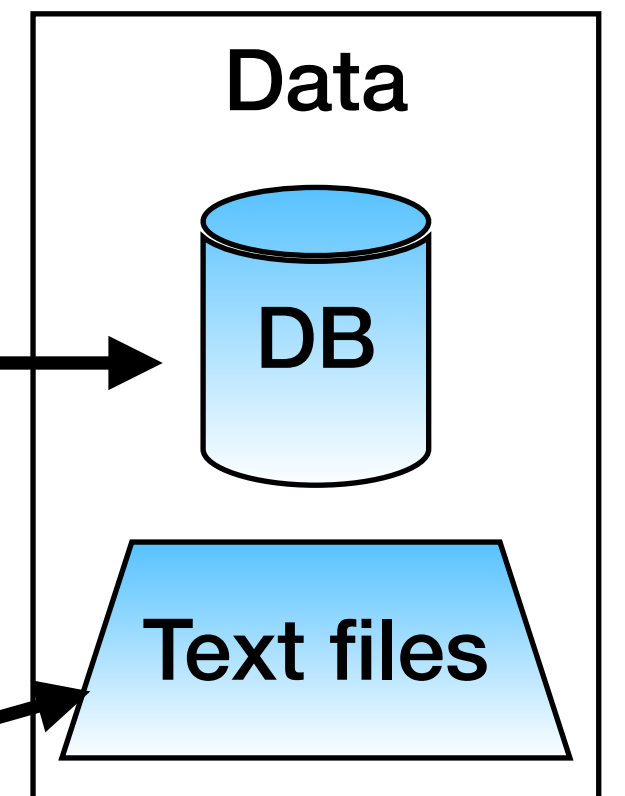
Tip (2.3)

You are NOT expected to develop a PRODUCTION system.

You do NOT need to support:

Automatic model training
(But do address “bootstrapped” user / item)

Chat

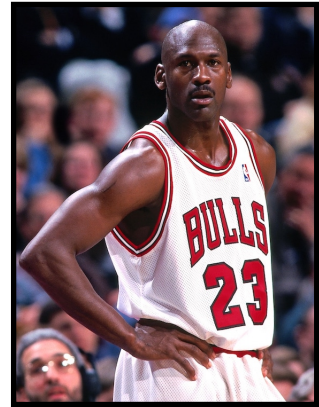


Recsys (2)

Data (2)

Web scraper

Project modules / services (example)

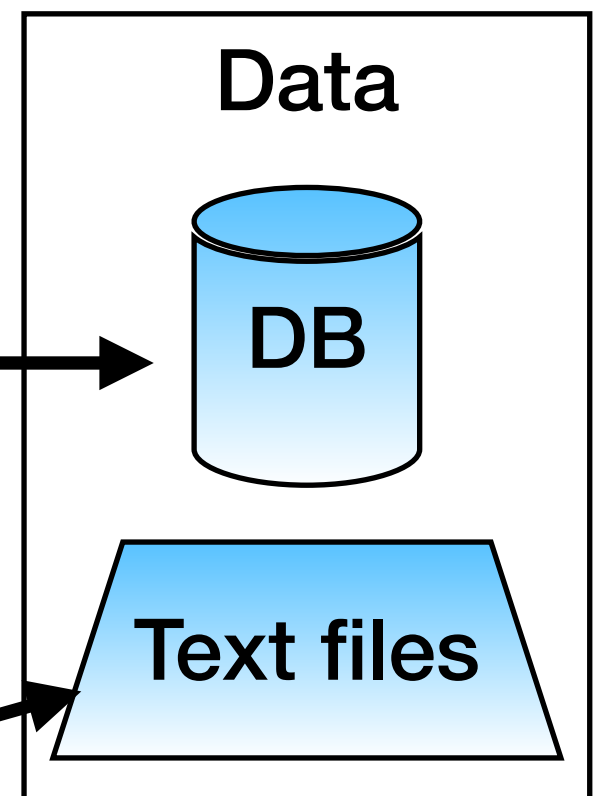


Tip (3)

You can use local open source and/or can use online (free) APIs
(Do not add a credit card!!!)

For example,
Autocomplete: algolia
Chat: ChatGPT
Embeddings: cohere
AI: Hugging Face

Chat

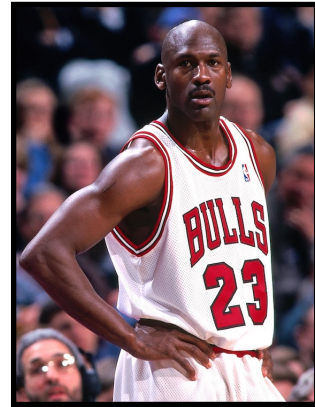


Recsys (2)

Data (2)

Web scraper

Project modules / services (example)



Tip (4)

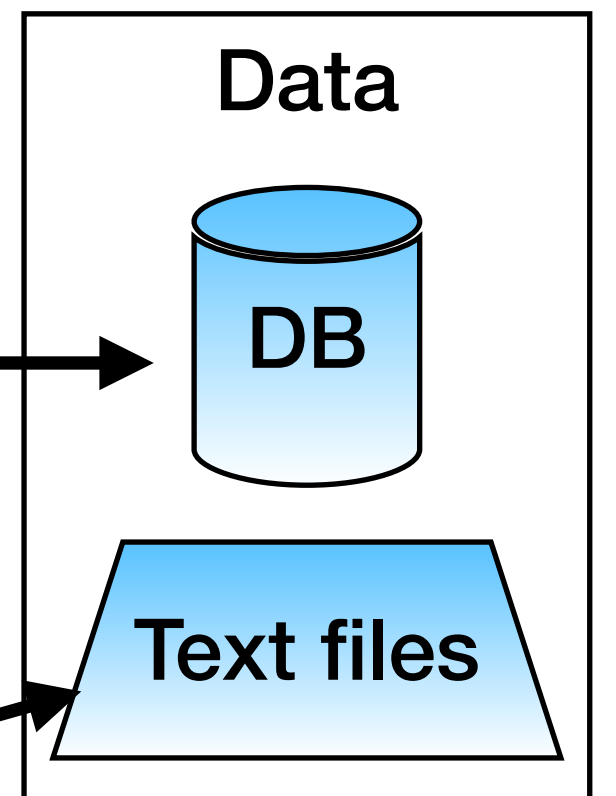
Optimize (mostly your time) for experience, not for “optimal”

For example,

If you never used a DB - you do not need to take the BigData course
and learn about schema design / normalization / partitions...

But your solution should work

Chat

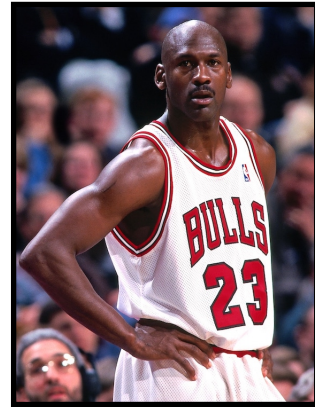


Recsys (2)

Data (2)

Web scraper

Project modules / services (example)

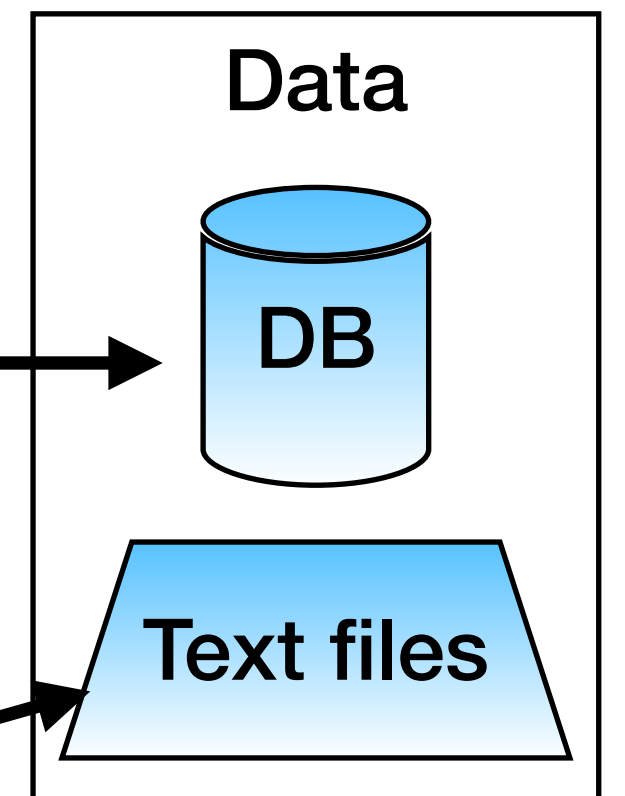


Tip (5)

You can store the data on files, on DBs or both

(Probably it will be easier for you to train the models from txt files you transformed)

Chat

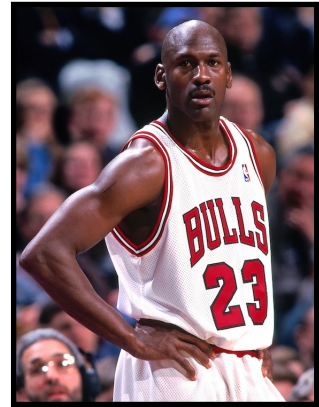


Recsys (2)

Data (2)

Web scraper

Project modules / services (example)



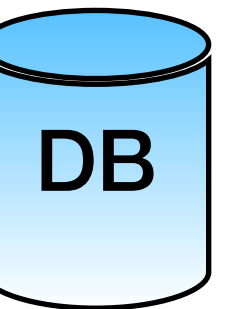
Tip (6)

Recent trends are cool (!)

Don't be afraid to use Vector DBs, LLMs, MCP...

Chat

Data



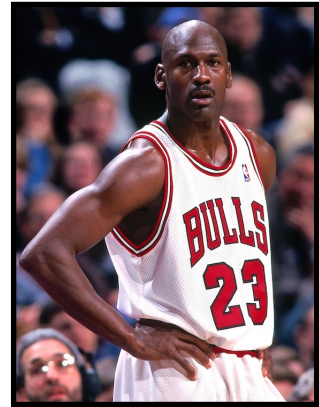
Text files

Recsys (2)

Data (2)

Web scraper

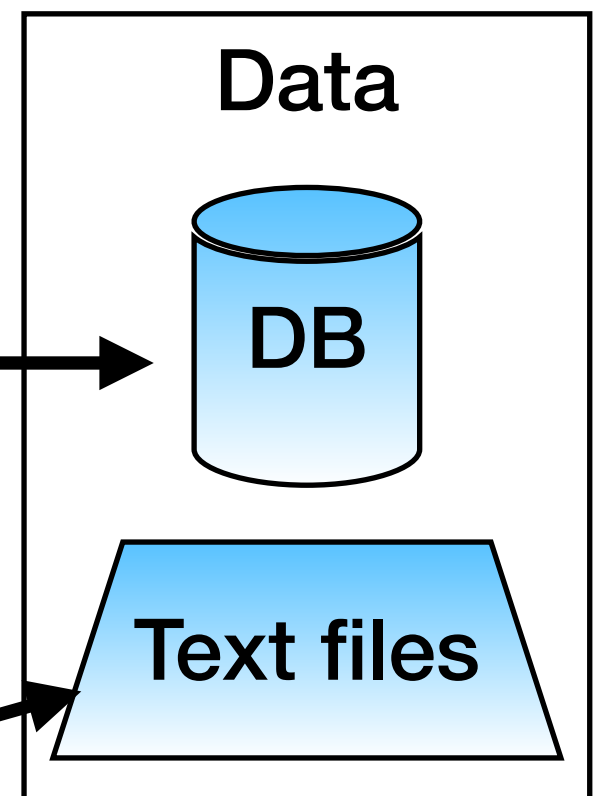
Project modules / services (example)



Tip (7)

To build recommendation model, you can (and probably should) use an existing framework
(For Matrix factorization, Item based CF, Clustering or whatever you choose)

Chat

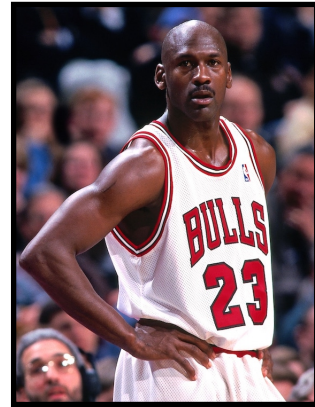


Recsys (2)

Data (2)

Web scraper

Project modules / services (example)

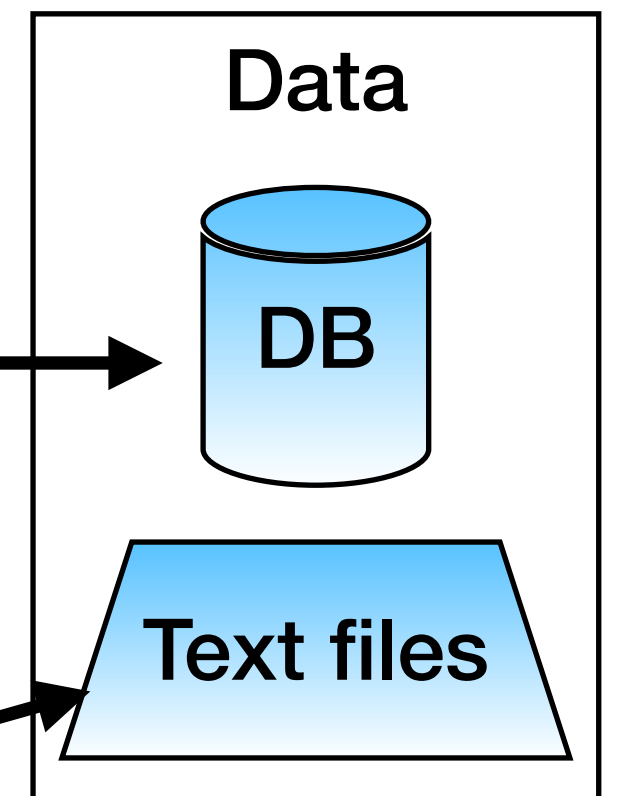


Tip (8)

How to choose the best framework?
There is no such thing...

Start by your preferred programming language, and search for (video) tutorials

Chat

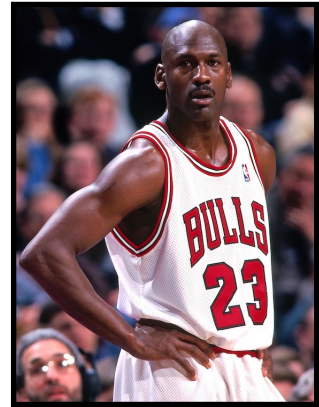


Recsys (2)

Data (2)

Web scraper

Project modules / services (example)



Tip (9)

How to know how to start?

Start with your idea, and then validate you can get a data set

Chat

Recsys (2)

Data (2)

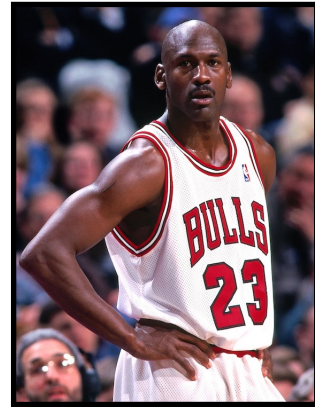
Web scraper

Data

DB

Text files

Project modules / services (example)



You should be passionate and obsessed with the idea
assume this is your Startup

Chat

Recsys (2)



Data (2)

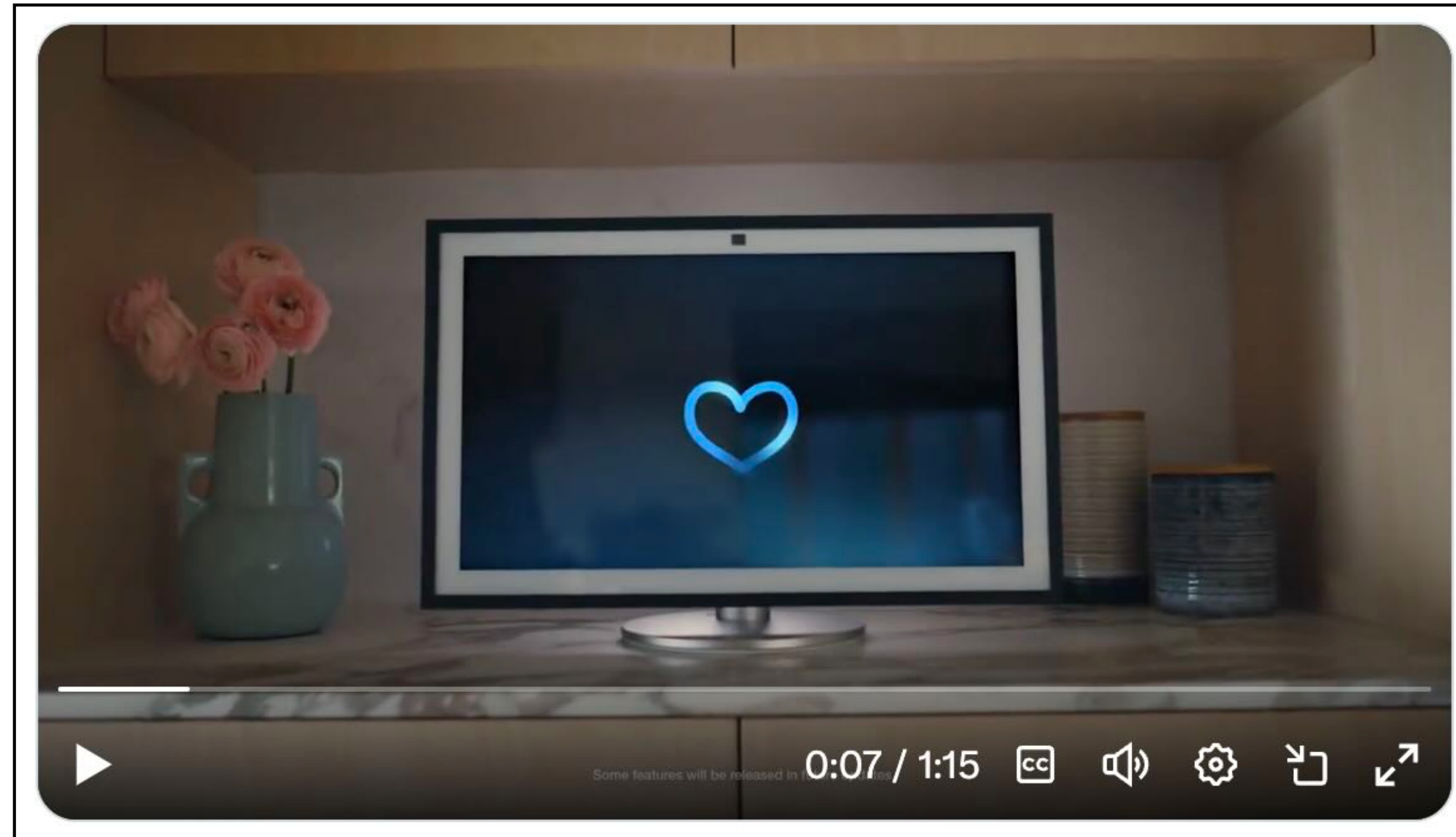


Web scraper

Move fast and break things

If you want to get inspired

Alexa+



<https://x.com/ajassy/status/1894787418647339374>

Personalization at Netflix

YouTube Premium IL Search

Trends in Recommendation & Personalization at Netflix Justin Basilico

No, personalization is **hard**!

- Every person is unique with a variety of interests
 - ... and sometimes multiple people use the same profile
- Help people find what they want when they're not sure what they want
- Non-stationary, context-dependent, mood-dependent, ...
- Large datasets but small data per member
 - ... and potentially biased by the output of your system
- Cold-start problems on all sides
- More than just accuracy: diversity, novelty, freshness, fairness, ...
- ...

NETFLIX

scale TransformX 3:58 / 31:59 • Is this solved yet >

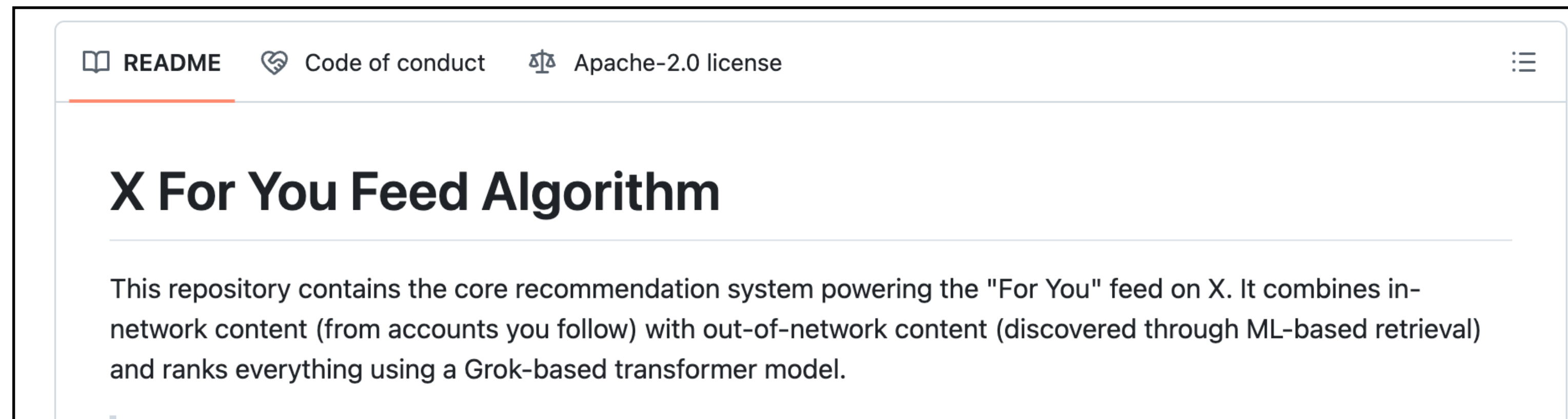
Trends in Recommendation & Personalization at Netflix

Scale AI 26.1K subscribers Subscribe

845 Share Download Clip

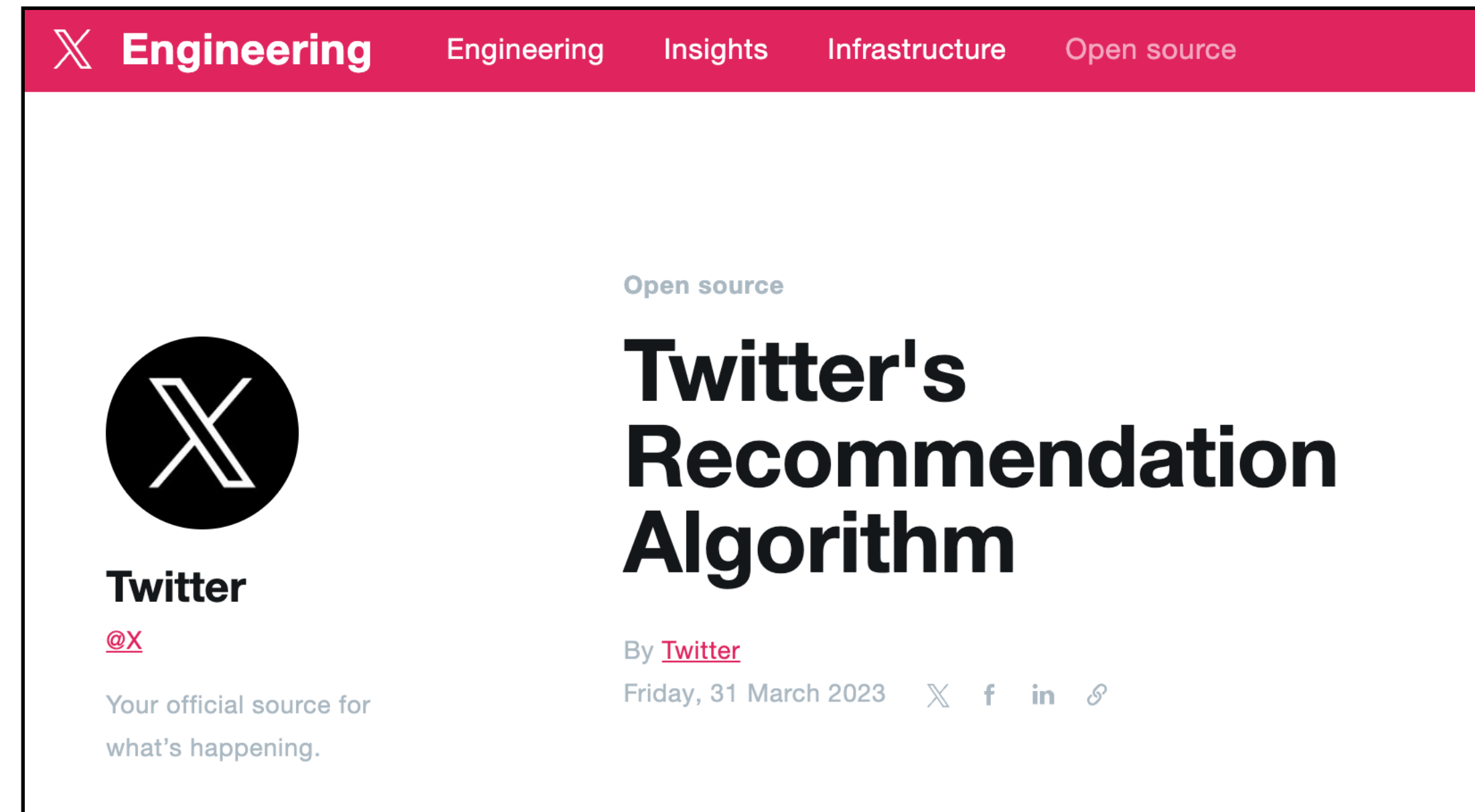
<https://www.youtube.com/watch?v=IByC2keY3vo>

Personalization at X



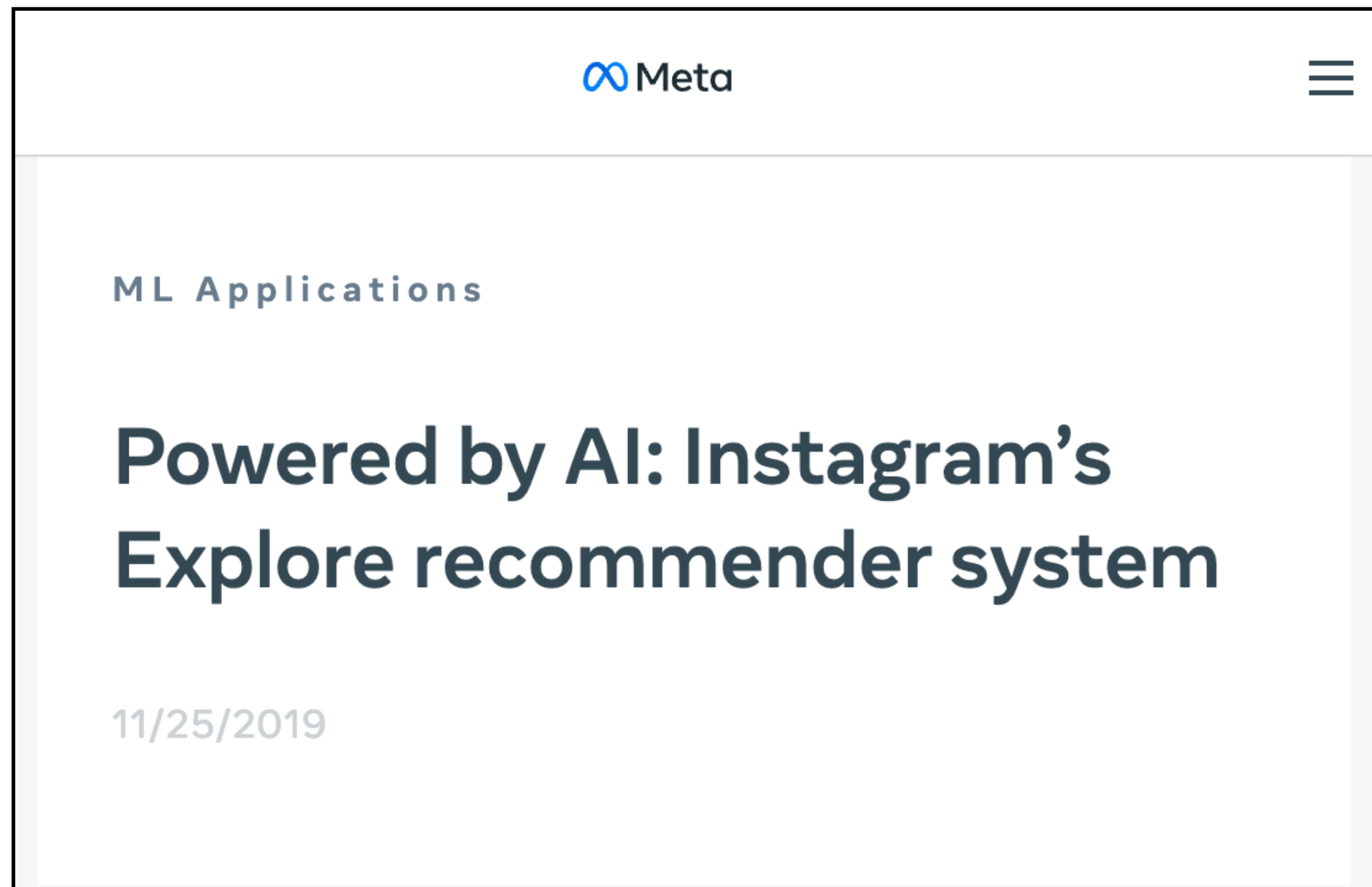
<https://github.com/xai-org/x-algorithm>

Personalization at Twitter / X

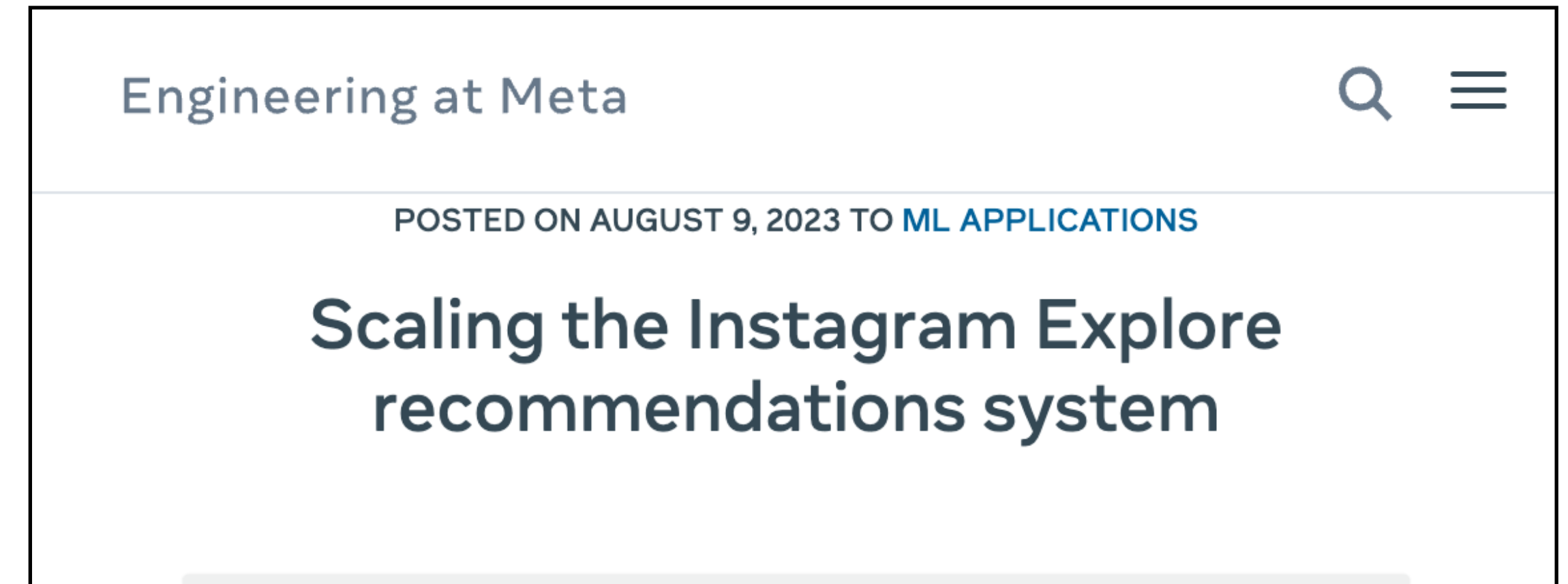


https://blog.x.com/engineering/en_us/topics/open-source/2023/twitter-recommendation-algorithm

Personalization at Instagram



<https://ai.meta.com/blog/powered-by-ai-instagram-expl-recommender-system/>



<https://engineering.fb.com/2023/08/09/ml-applications/scaling-instagram-explore-recommendations-system/>