# INTRODUCTION TO DATA SCIENCE

This lecture is
based on course by E. Fox and C. Guestrin, Univ of Washington

22/12/2020

WFAiS UJ, Informatyka Stosowana
I stopień studiów

# Recommending system: films



Machine learning: recommending system

- Personalizacja

100 Hours a Minute

*What do I care about?*

Information overload

↓

Browsing is "history"

– Need new ways to discover content

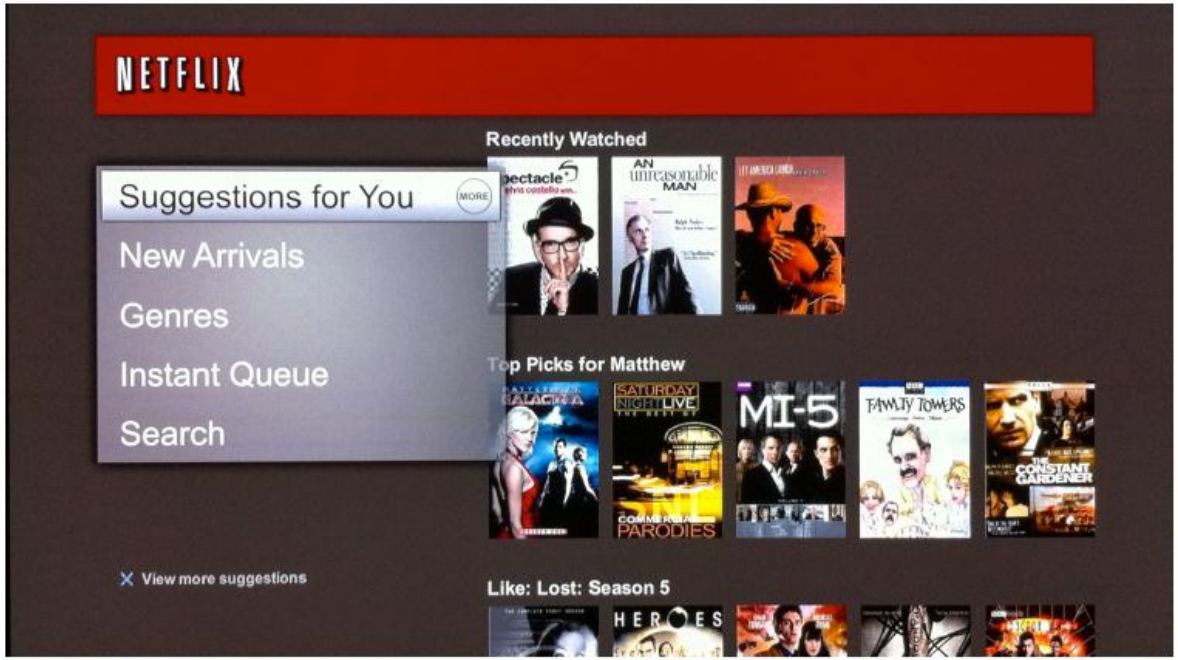
Personalization: Connects *users & items*

viewers

videos

# Recomending system:

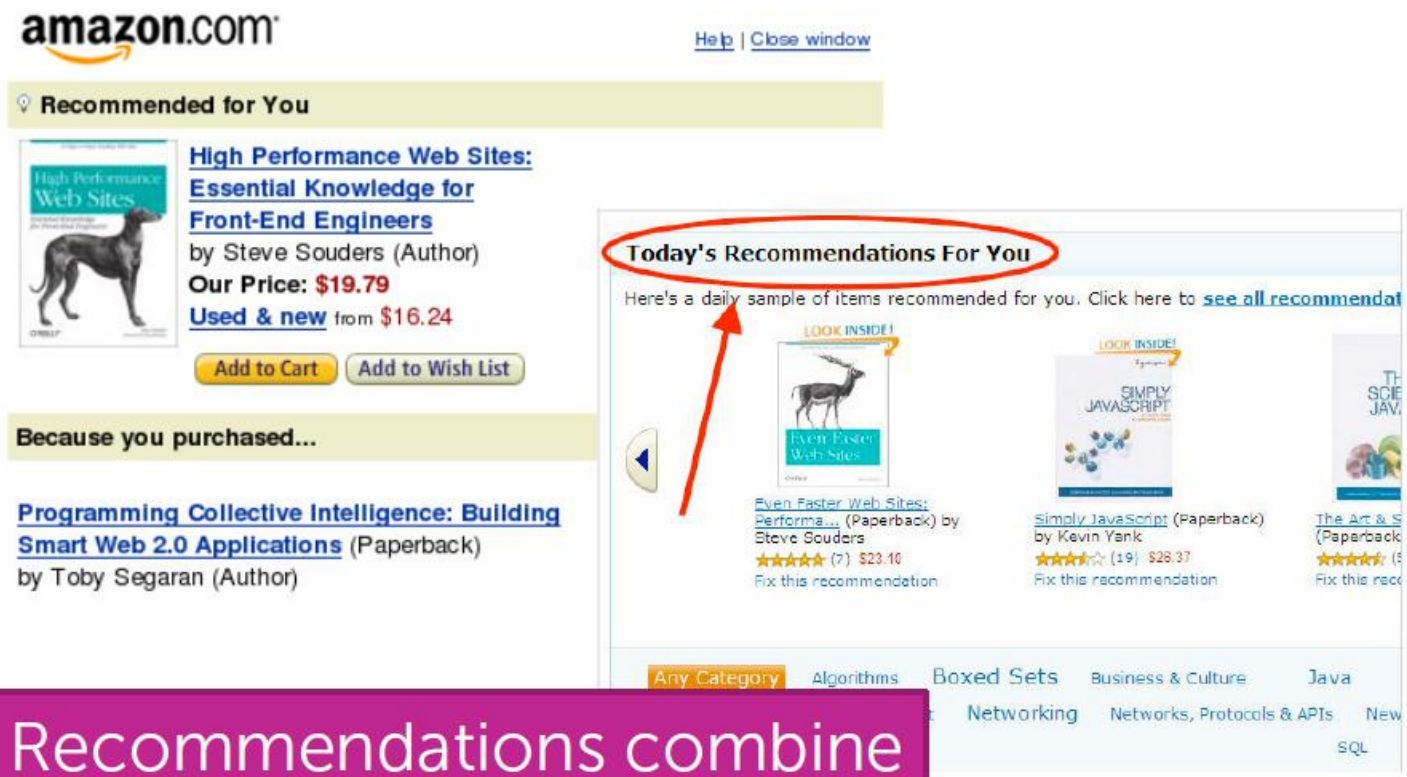





Connect users with movies they may want to watch

# Recomending system:






Recommendations combine global & session interests

# Recommending system: popularity?

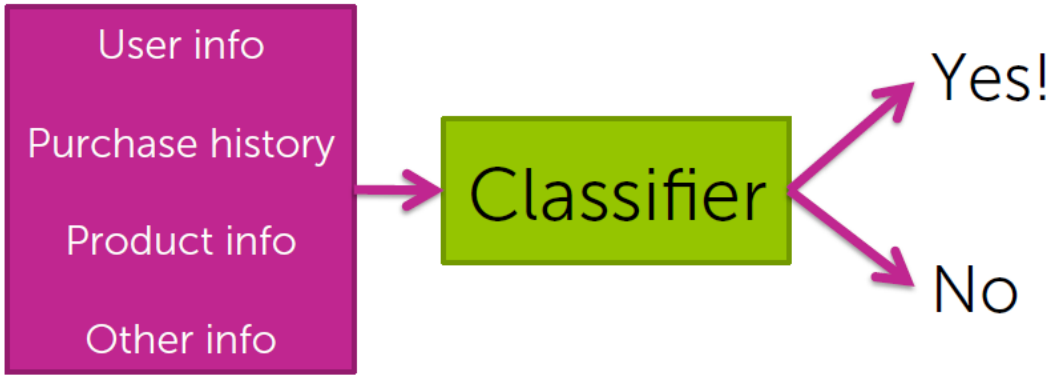


- **Popularity?**
  - **Ranking vs number of downloading?**
  - **No personalisation in this case**

# Recommending system: classification



- **Classification?**
  - **What is probability that I will buy this product?**
  - **Personalisation: purhase history, monthly and yearly trends, etc.**



# Recommending system: correlations



- **Analyse correlations. Customers who bought product A also bought product B**
  - **Correlation matrix**

User  purchased *diapers*

1. Look at *diapers* row of matrix

2. Recommend other items with largest counts
   - *baby wipes*, *milk*, *baby food*,...

# Recommending system: correlations

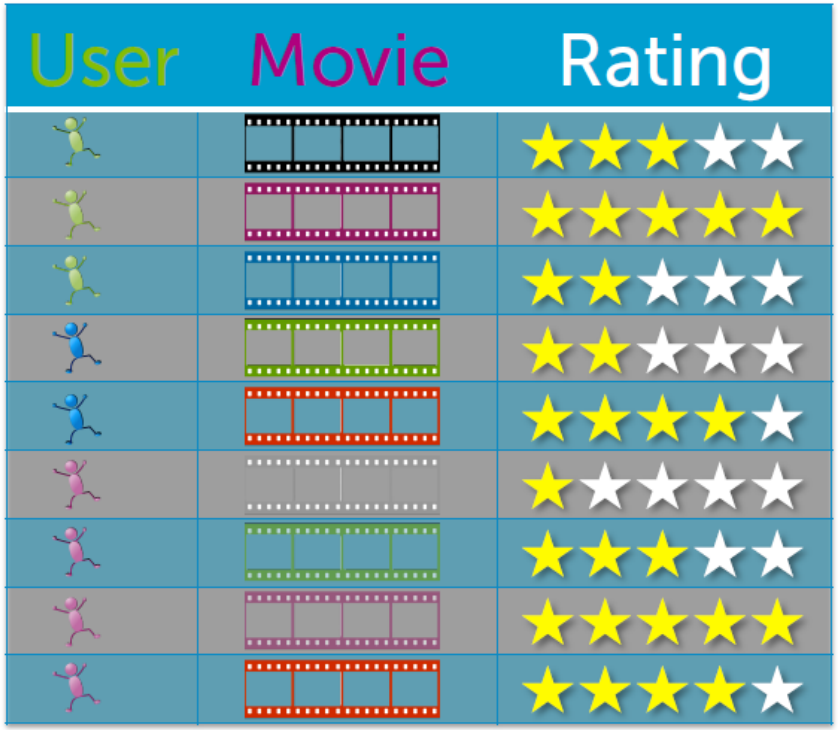


- **Analyse correlations. Customers who bought product A also bought product B**
  - **Should we normalise correlation matrix?**
  - **How to quantify that products are „products"?**
- **Limitation of correlationss:**
  - **It is not looking at the purhasing history (trends in time)**
  - **How to add a new customer (no info on correlations)?**

# Recommmending system: films



- Users watch movies and rate them

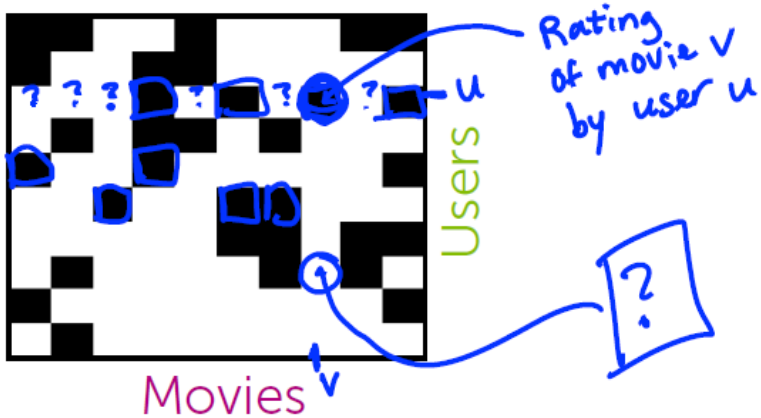



Each user only watches a few of the available movies

# Recommending system: films



Rating =




- **Data:** Users score some movies

  $\boxed{Rating(u,v)}$ known for black cells

  *Rating(u,v)* unknown for white cells

- **Goal:** Filling missing data?

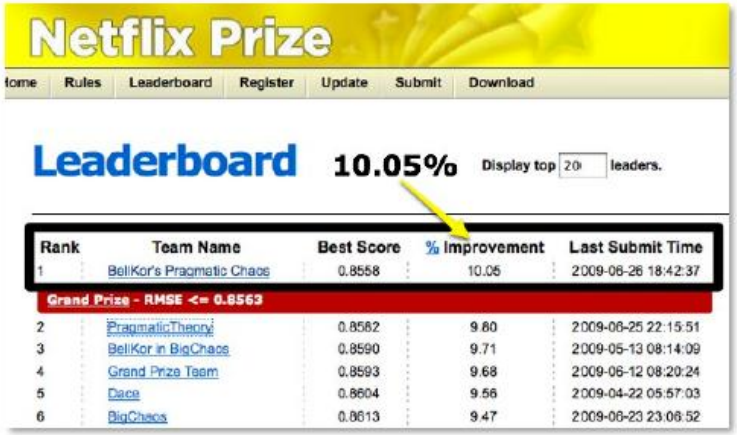


filling in a ?

# Recommending system: optimisation



- Squeezing last bit of accuracy by blending models
- Netflix Prize 2006-2009
  - 100M ratings
  - 17,770 movies
  - 480,189 users
  - Predict 3 million ratings to highest accuracy
  - Winning team blended over 100 models



# Recommending system: how effective?



## The world of all baby products

# Recommending system: how effective?



User likes subset of items

# Recommending system: how effective?



How many liked items were recommended?


**Recall**

$$\frac{\text{\# liked \& shown}}{\text{\# liked}} = \frac{3}{5}$$

# Recommending system: how effective?



How many recommended items were liked?


**Precision**

$$\frac{\text{\# liked \& shown}}{\text{\# shown}} = \frac{3}{11}$$

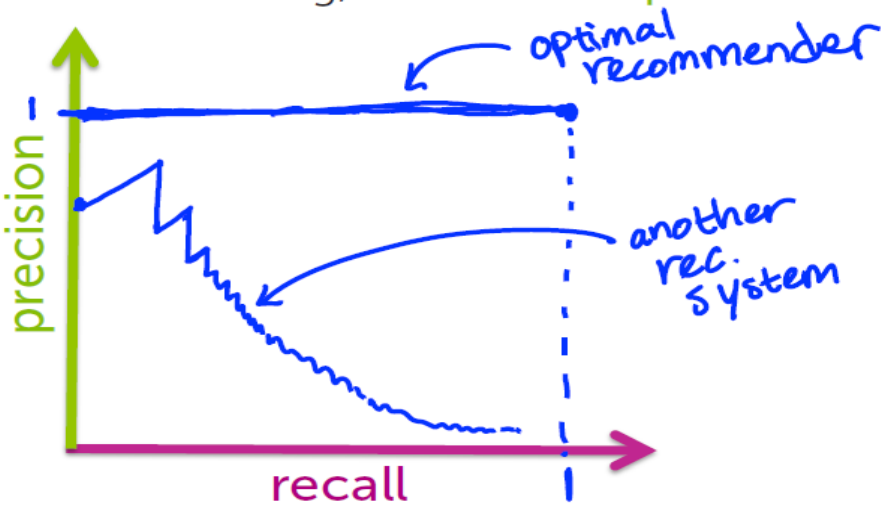
# Recommending system: how effective?



## Precision-recall curve

- **Input:** A specific recommender system
- **Output:** Algorithm-specific precision-recall curve

- To draw curve, vary threshold on # items recommended
  - For each setting, calculate the precision and recall

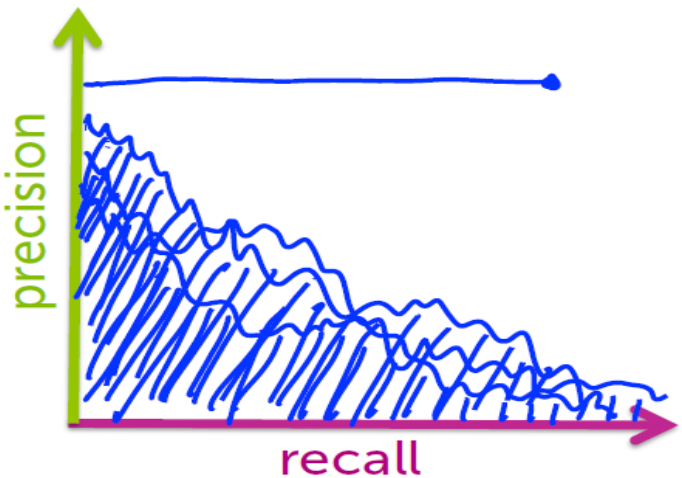


# Recommending system: how effective?



## Which Algorithm is Best?

- For a given precision, want recall as large as possible (or vice versa)
- One metric: largest area under the curve (AUC)
- Another: set desired recall and maximize precision (precision at k)



# Recommending system



**Models**

- Collaborative filtering
- Matrix factorization
- PCA

**Algorithms**

- Coordinate descent
- Eigen decomposition
- SVD

**Concepts**

- Matrix completion, eigenvalues, random projections, cold-start problem, diversity, scaling up