



Recommender System on Big Data

The Netflix Prize

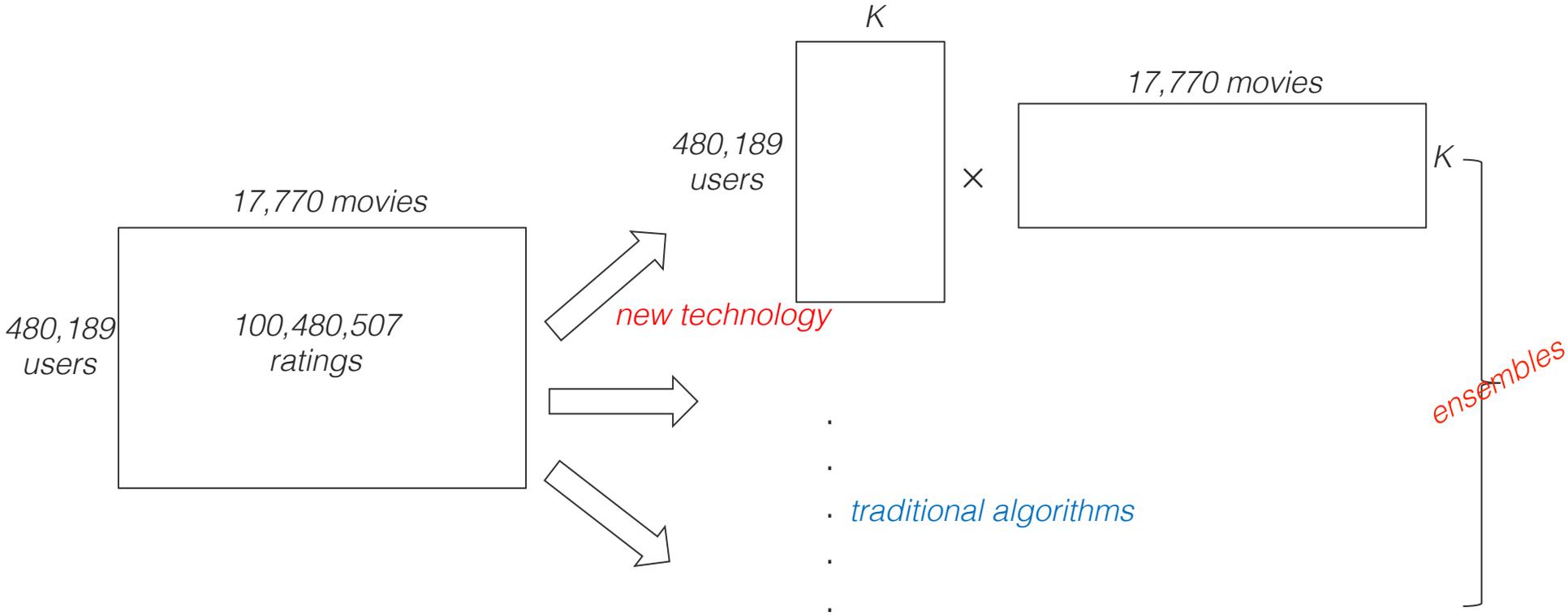


Netflix, Inc. is an American provider of flat rate DVD-by-mail in the United States, where mailed DVDs are sent via Permit Reply Mail.

*The Netflix Prize, begun on October 2, 2006, was an open competition for the best collaborative filtering algorithm to predict user ratings for films. The grand prize is **US\$1,000,000**.*



Emerged by US\$1,000,000 ...



On the other hand ...

amazon.com Recommended for You

Amazon.com has new recommendations for you based on [items](#) you purchased or told us you own.

- [E Minus](#)
- [Just One %\\$#@ Speed Bump After Another ... : More Cartoons \(Speed Bump series\)](#)
- [Collected Stories \(Everyman's Library\)](#)
- [Wish You Were Here: The Official Biography of Douglas Adams](#)
- [Batman Gotham Knight \(Two-Disc Collector's Edition\)](#)

1/3 products are sold via Amazon Recommender System.

Google Search results for 'Work From Home'. A blue speech bubble points to the search results with the text "Your Ads Show Here".

Work From Home

Online Personal Loans

Money From Home

Work At Home

Work At Home Jobs

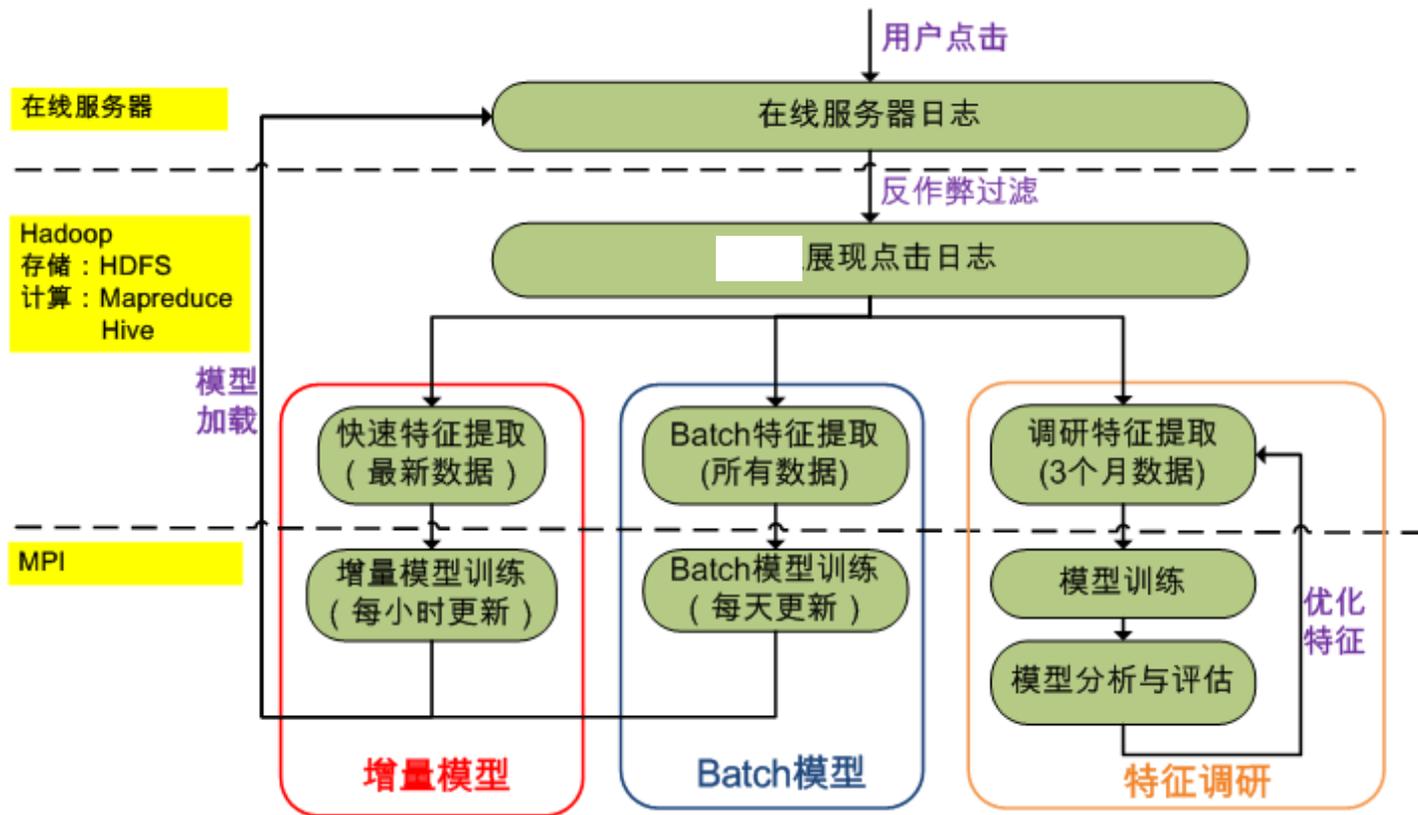
Work At Home

Work At Home

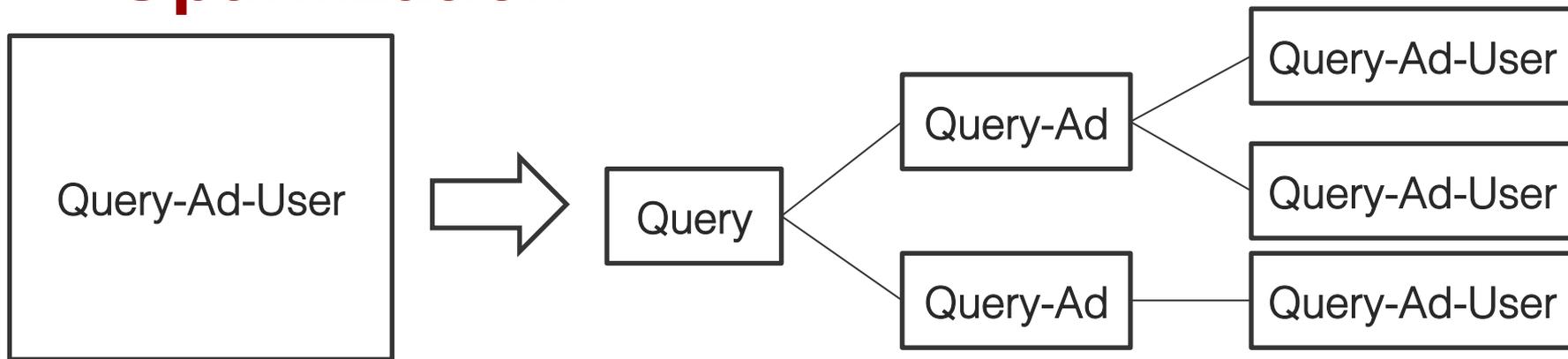
Google earns 42 billion US dollars via Ads Recommender System in 2012.



Backend Technology



Optimization



{fea1, fea2, fea3, fea4, fea5, fea6}

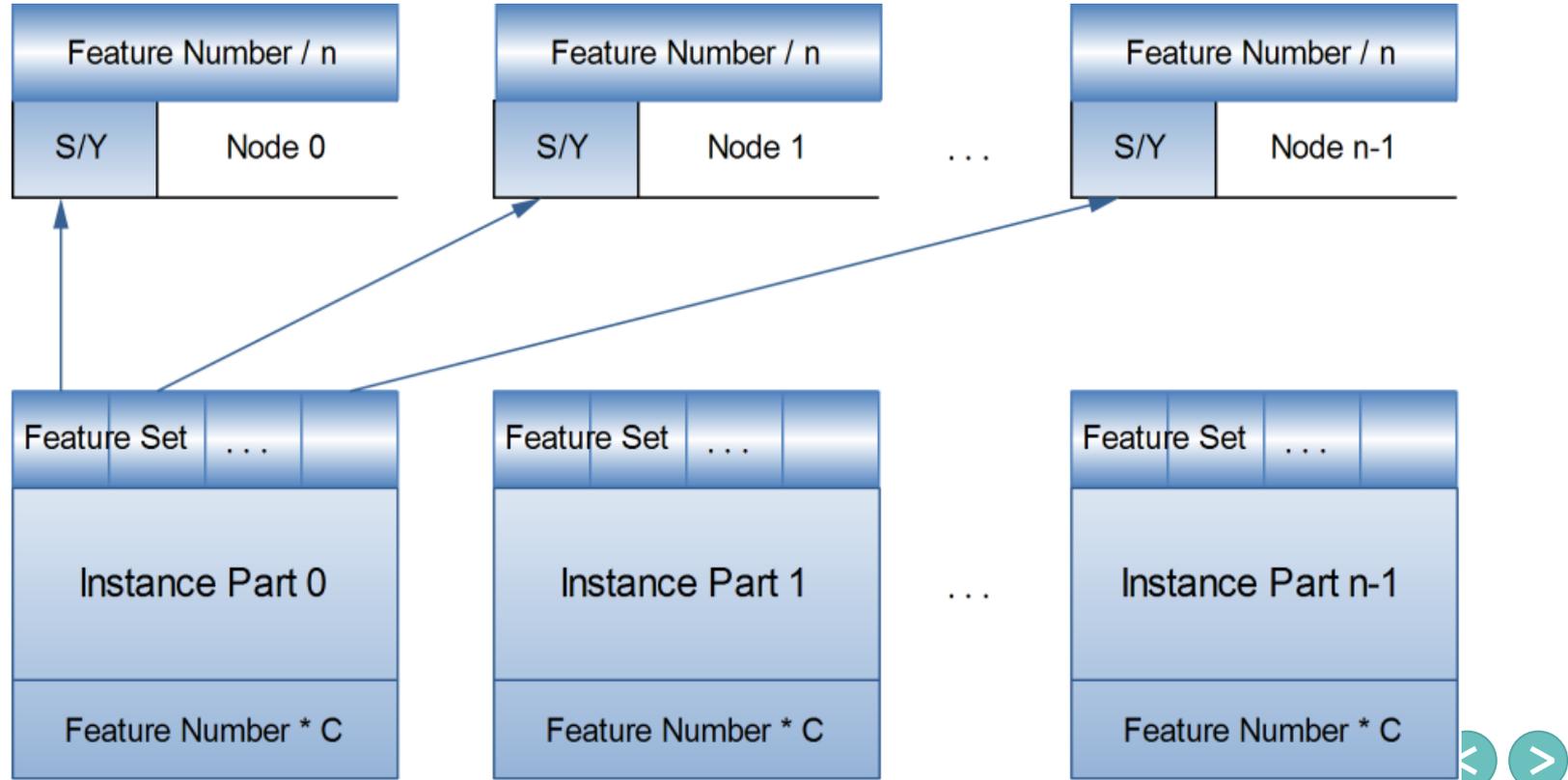
{fea1, fea2, fea3, fea4, fea5, fea7}

{fea1, fea2, fea3, fea4, fea5, fea8}

transformation

{fea1, fea2, fea3, fea4, fea5, {fea6, fea7, fea8}}

Model Training on MPI



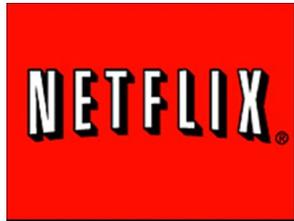
Key Feature for Successful Recommender Systems



Google



Baidu 百度
百度一下 你就知道

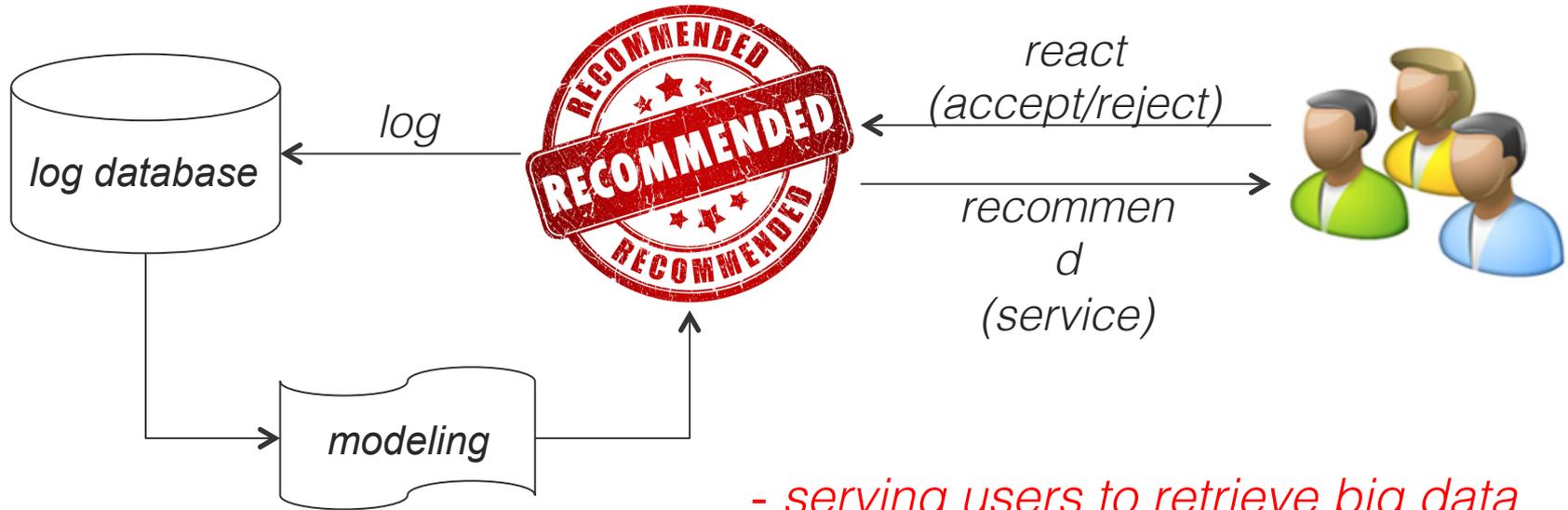


amazon.com

淘宝网
Taobao.com



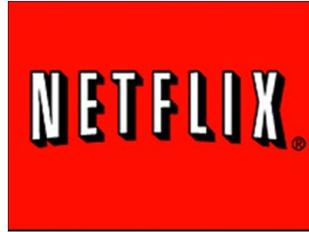
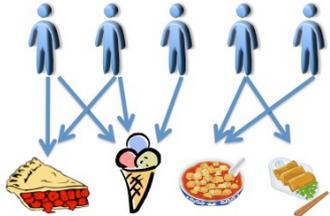
Recommender System on Big Data



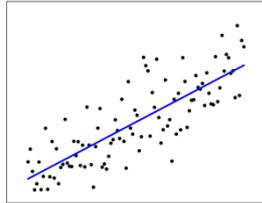
- serving users to retrieve big data
- learning from big data to improve service

Recommendation Technology: 3 Generations

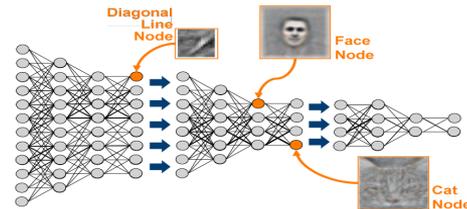
1. Collaborative Filtering



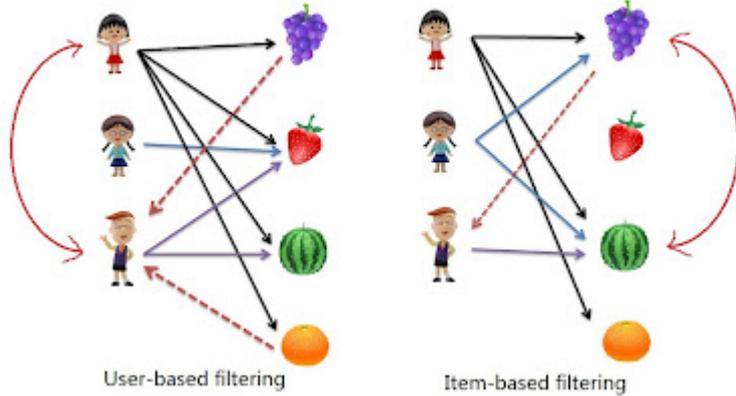
2. Sparse Linear Prediction Model



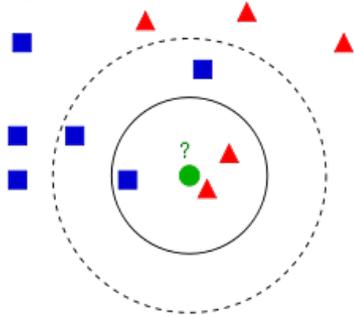
3. Deep Learning (developing)



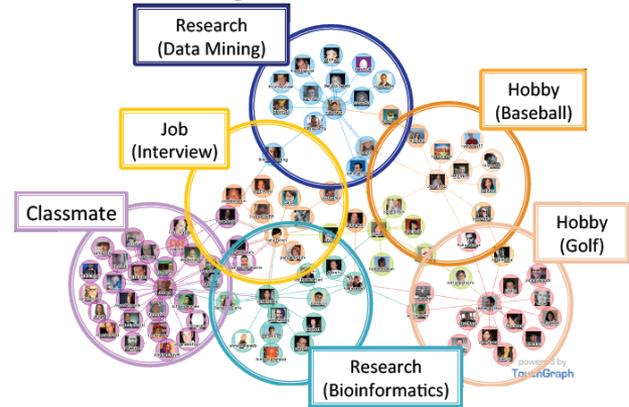
1st Generation – Collaborative Filtering



1. Nearest Neighbor



2. Topic Modeling



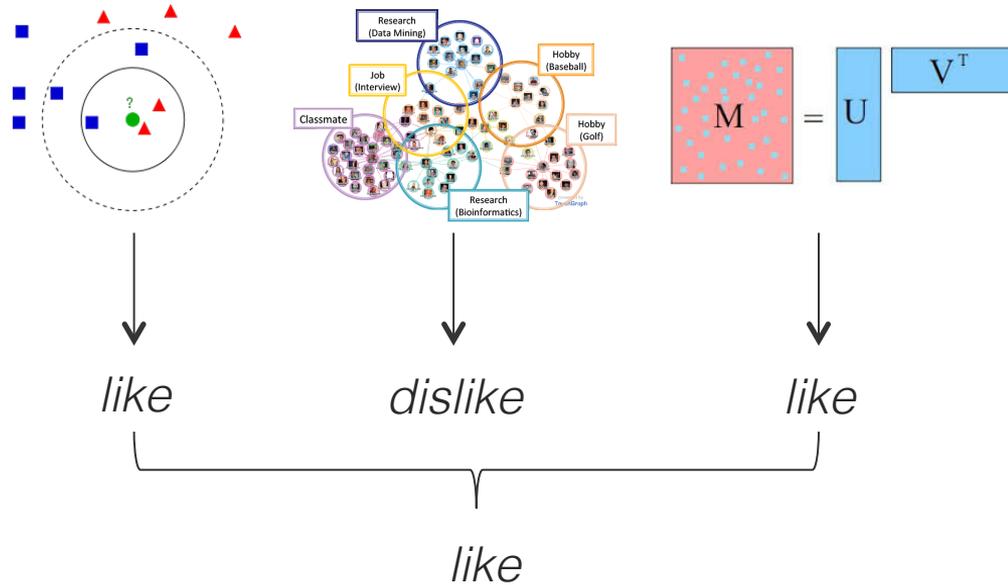
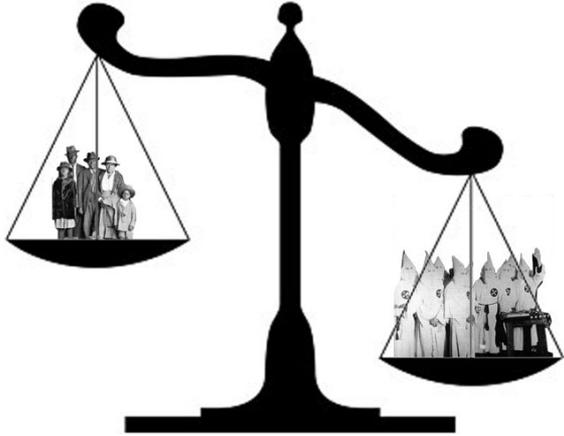
3. Matrix Factorization

$$M = U V^T$$

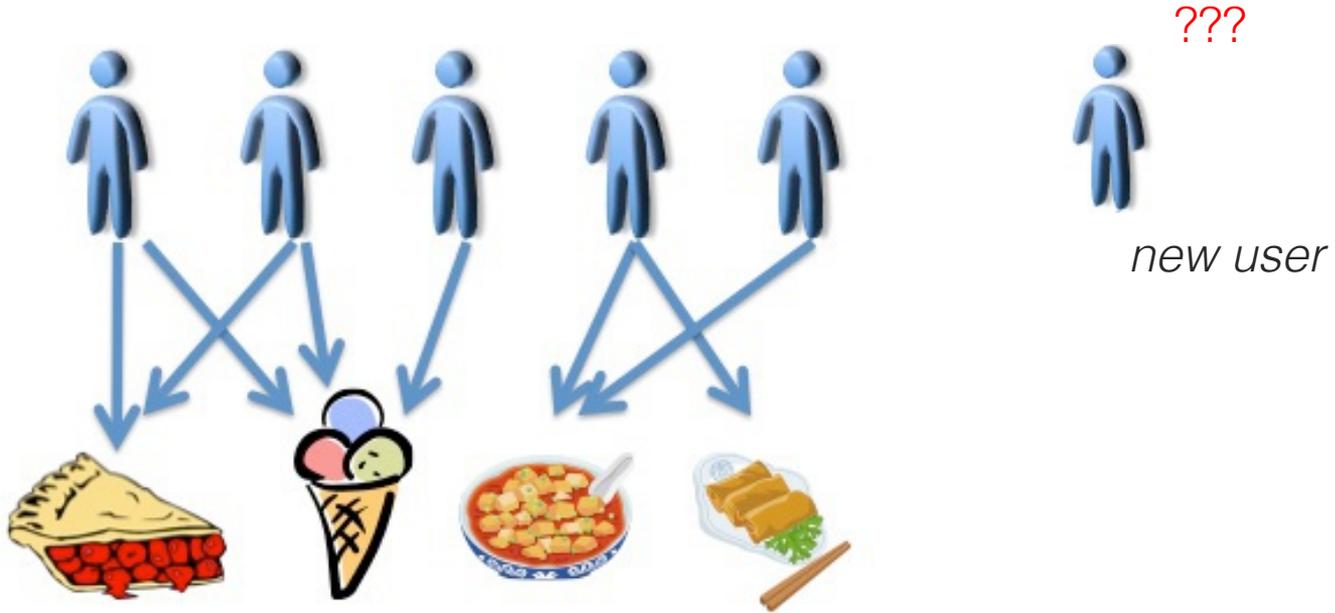
The diagram illustrates Matrix Factorization. A large pink square matrix labeled 'M' is shown on the left. It contains several small blue squares representing non-zero entries. This matrix is equal to the product of two smaller matrices: a vertical blue rectangle labeled 'U' and a horizontal blue rectangle labeled 'V^T'.

1.5G – Ensemble Learning

Basic Idea: training *multiple* models, and *voting*



Problem – weak for new users



2nd Generation – Sparse Linear Prediction Model

$$P(\text{click}|\text{show}) = w \cdot x$$

← *model* *ads*

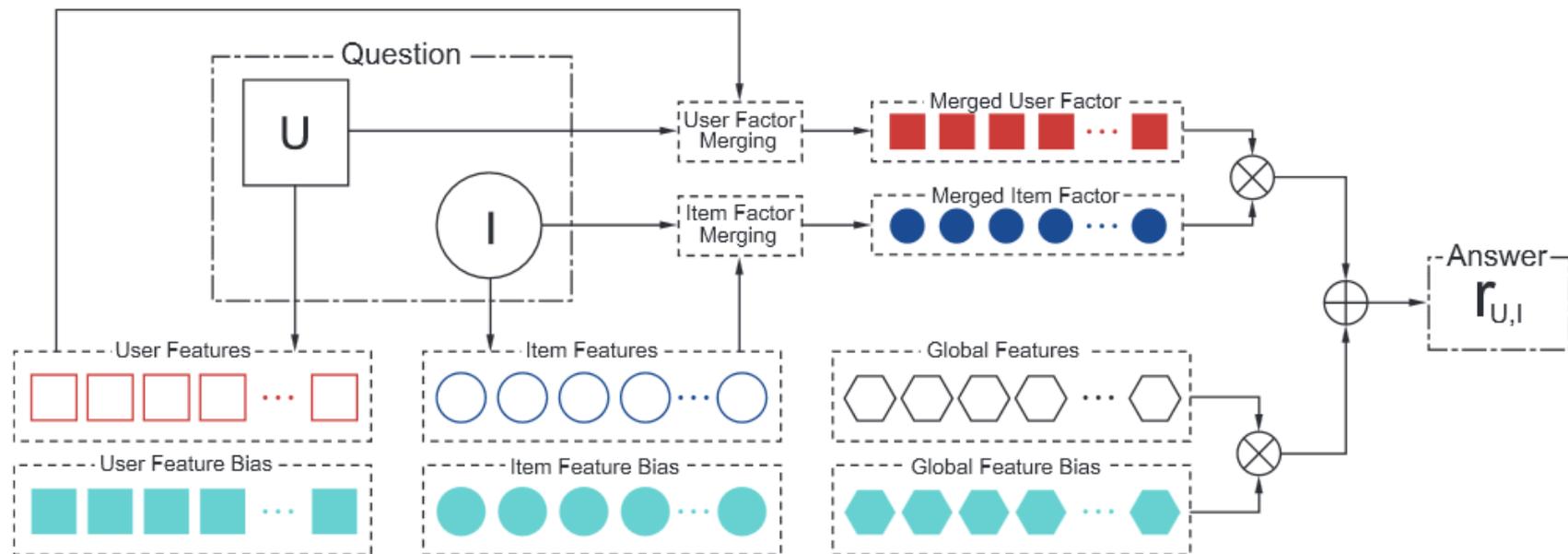
> 100 billion features

$$x = (1, 0, 0, 0, 1, \dots, 1, 0, \dots, 0, 1, 0, 0)$$

↓ ↓ ↓
user demographic *relevance* *short-term behaviors*



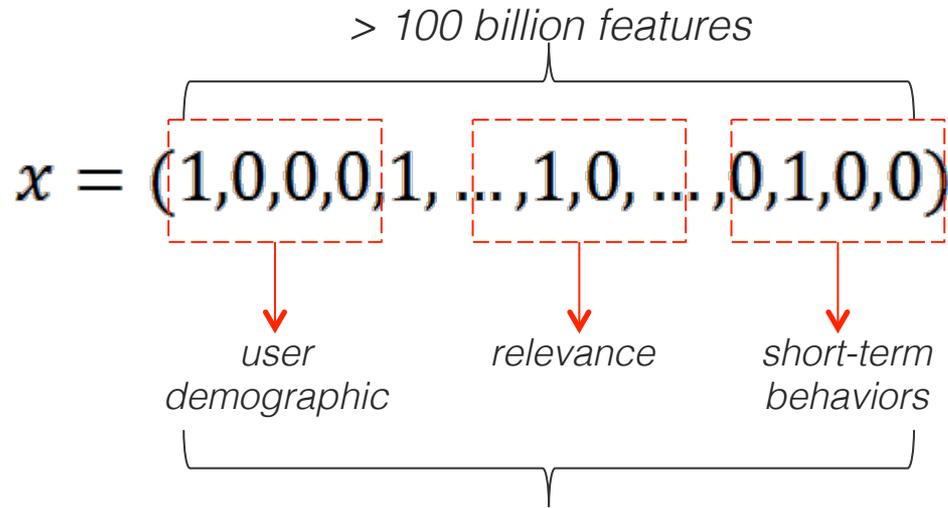
2.5G – Feature based Collaborative Filtering



(Tianqi Chen, et al. ICML 2012)



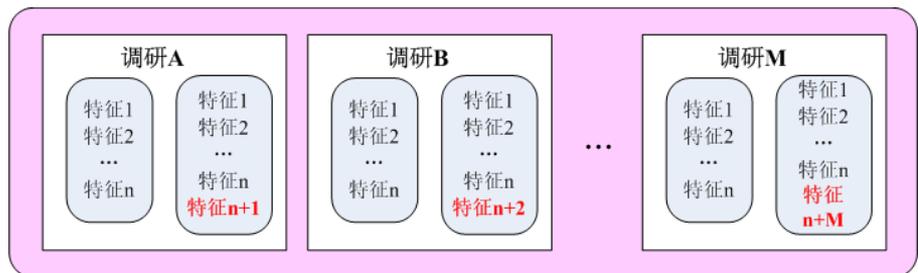
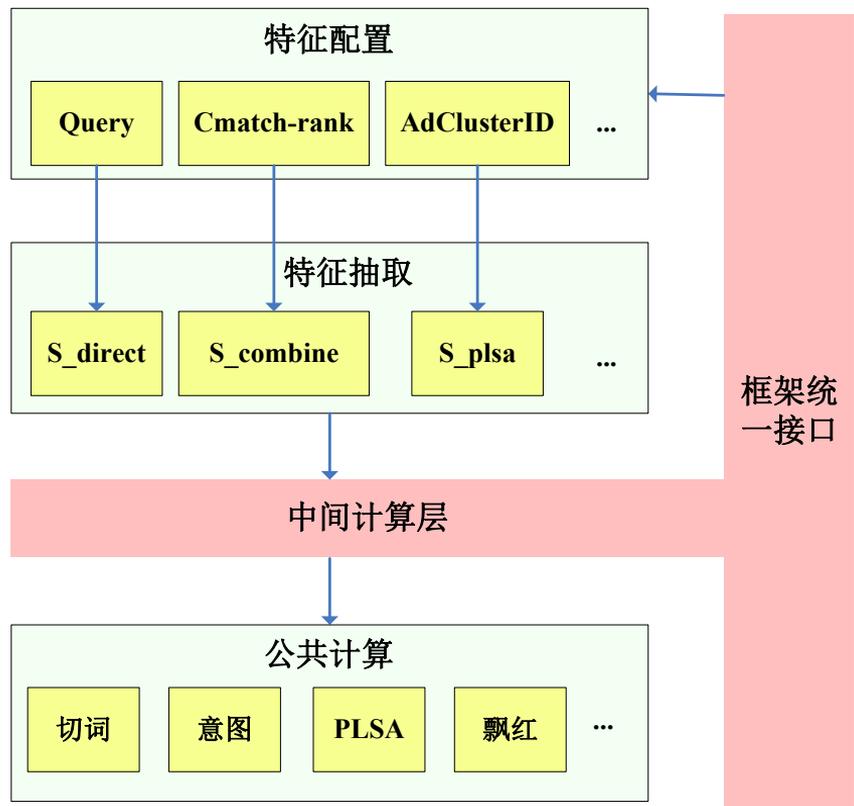
Problem – cost on feature engineering



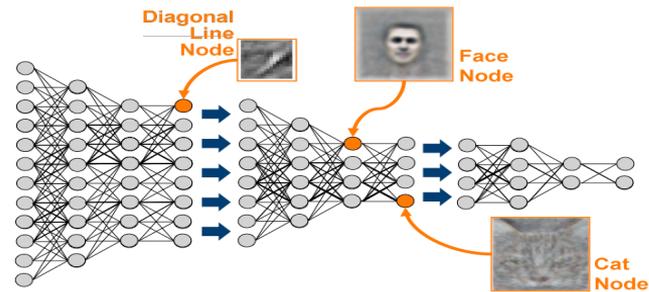
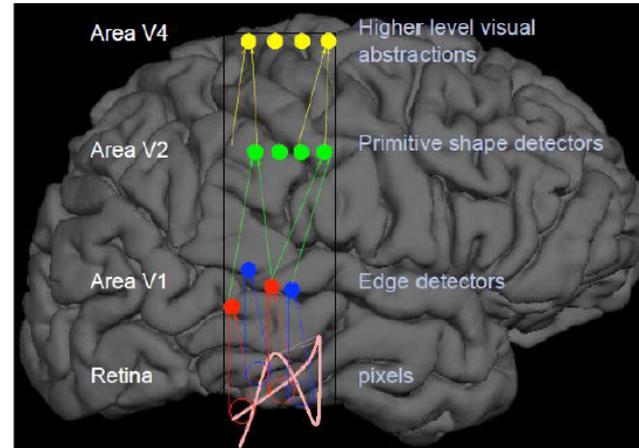
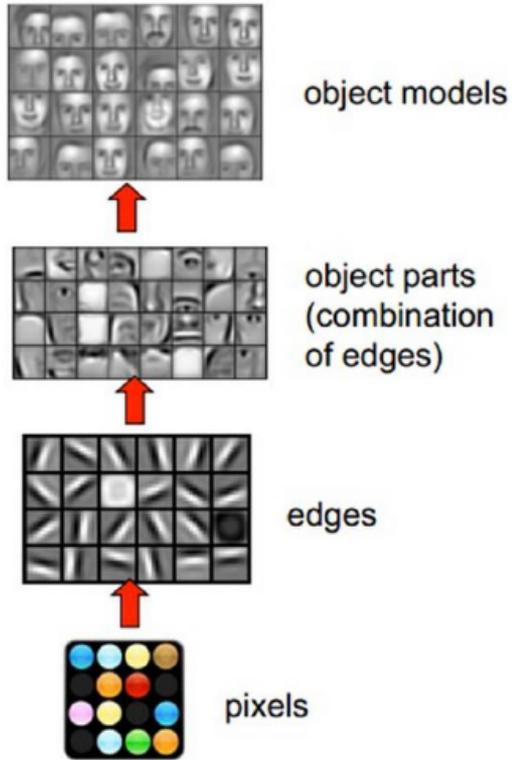
*too many people to
manage these features*

- 1. Need a lot of domain experts to design features.*
- 2. Managing the expert team is not easy.*
- 3. Hard to repeat the successful experience to other application.*

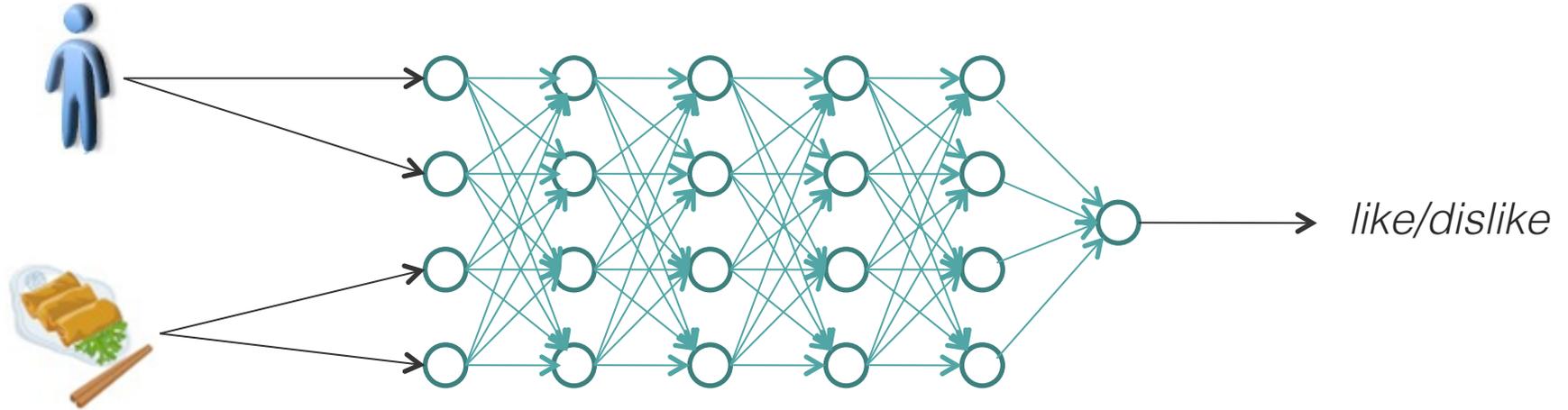
Managing Feature Engineering Team



3rd Generation – Deep Learning



Deep Learning for Recommendation



Deep Recommender Systems

- Advantage:
 - Less domain experts for feature engineering
 - Deep (3G) Systems: 5~10 Top Scientists/Engineers + Supporting
 - Flat (2G) Systems: 5~10 Top Scientists/Engineers + 50 Domain Experts + Supporting
 - Easy to duplicate to other applications
- Challenge
 - System & Algorithm design
 - Need top scientists/engineers



Summary

- Recommender systems have already achieved great success in several companies.
- As deep learning technology develops, recommender systems will easily come into more applications.
- In the future, there will be several flat (2G) recommender systems with high cost, and a lot of deep (3G) recommender systems with low cost.



24

Thanks!

