

Advanced Methods and Recent Developments

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Advanced Methods & Applications

Data Structure

A. Table (Raw Data)

User	Item	Time
1	2	1:00 (t1)
1	2	2:00 (t2)
2	2	2:00 (t3)
1	3	3:00 (t4)
2	4	4:00 (t5)
3	4	4:00 (t6)
2	5	5:00 (t7)
3	5	5:00 (t8)
...		

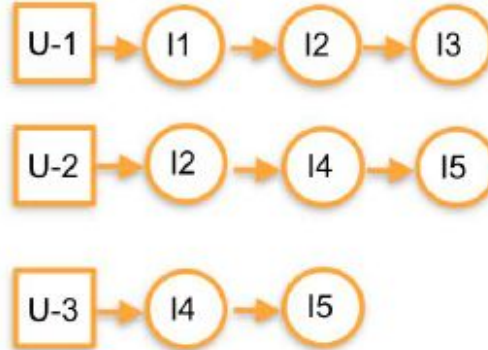
Factorization Machine

B. Matrix

		Item					
		1	2	3	4	5	...
User	1	X	X	X			
	2		X		X	X	
	3				X	X	
	...						

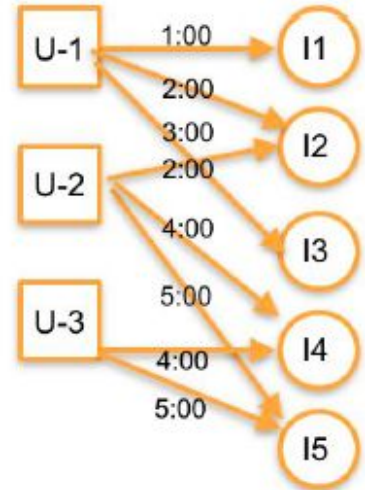
Matrix Factorization

C. Time Series



**Time Series Analysis
Recurrent Neural Net**

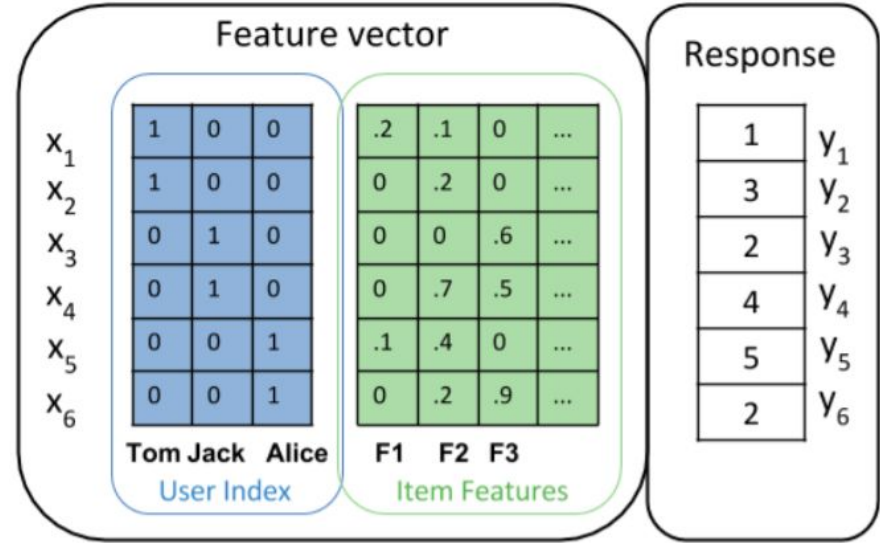
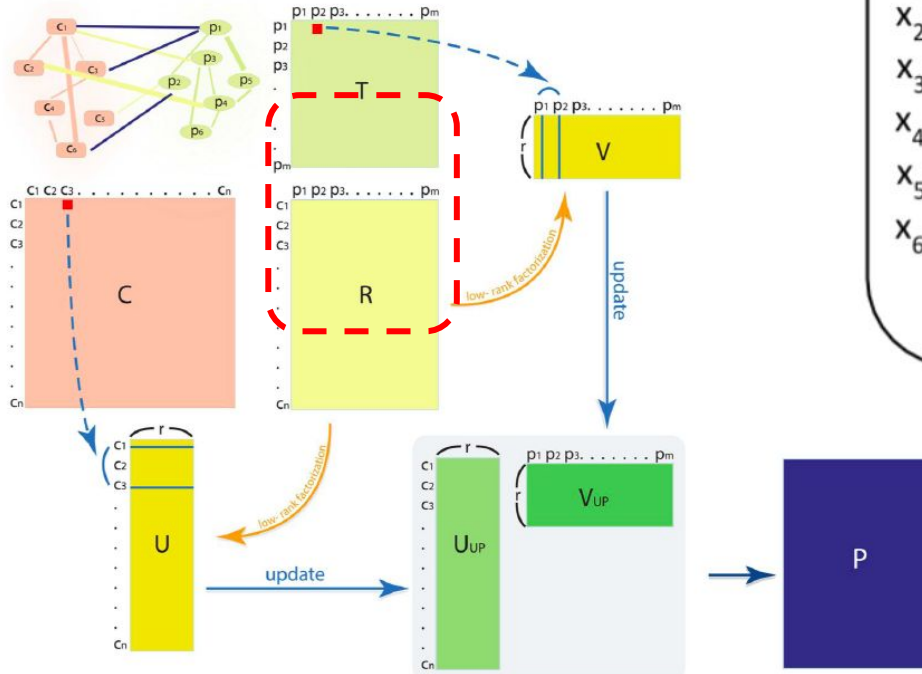
D. Graph/Bipartite

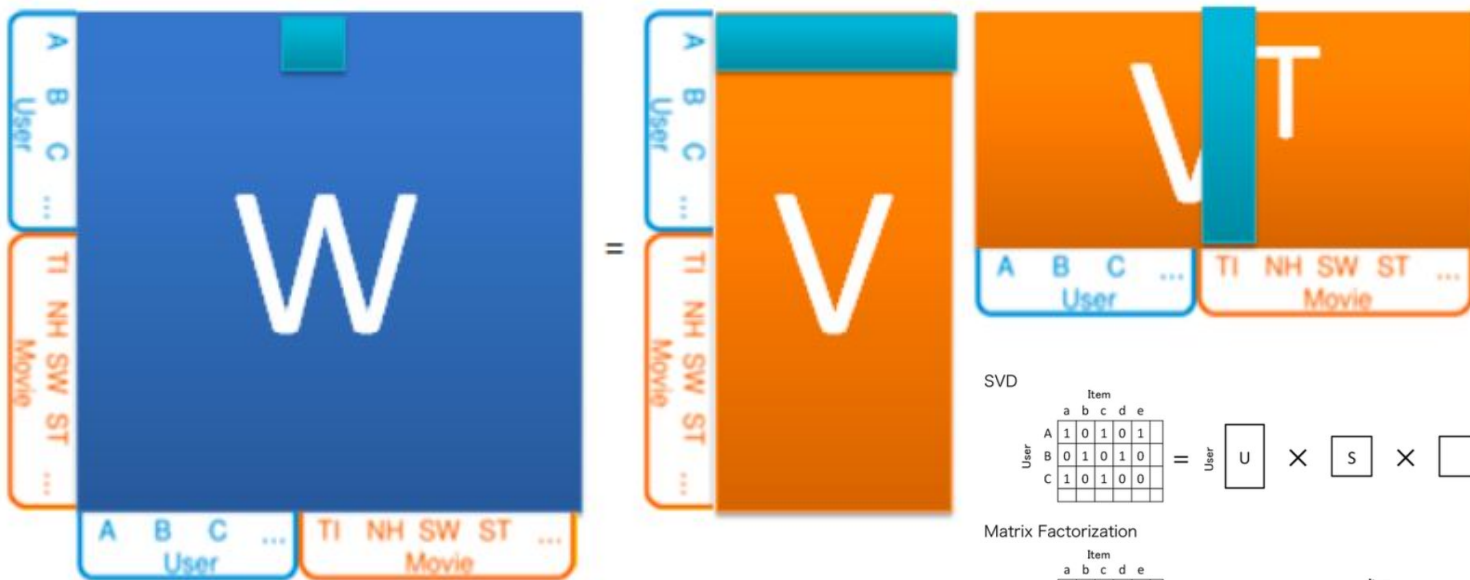


Graphic Modeling

FM (Factorization Machine)

MF (Matrix Factorization)





FM V.S. MF

- FM: $y(x) = \sum w_i x_i + \sum \sum (v_i \cdot v_j) x_i x_j + b$
- MF: $y(x) = w_u + w_i + v_u \cdot v_i + b$

SVD

$$\begin{array}{c} \text{User} \end{array} \begin{array}{c|ccccc} & \text{a} & \text{b} & \text{c} & \text{d} & \text{e} \\ \hline \text{A} & 1 & 0 & 1 & 0 & 1 \\ \text{B} & 0 & 1 & 0 & 1 & 0 \\ \text{C} & 1 & 0 & 1 & 0 & 0 \end{array} = \begin{array}{c} \text{User} \end{array} \begin{array}{|c|} \hline U \\ \hline \end{array} \times \begin{array}{|c|} \hline S \\ \hline \end{array} \times \begin{array}{c} \text{Item} \end{array} \begin{array}{|c|} \hline I \\ \hline \end{array}$$

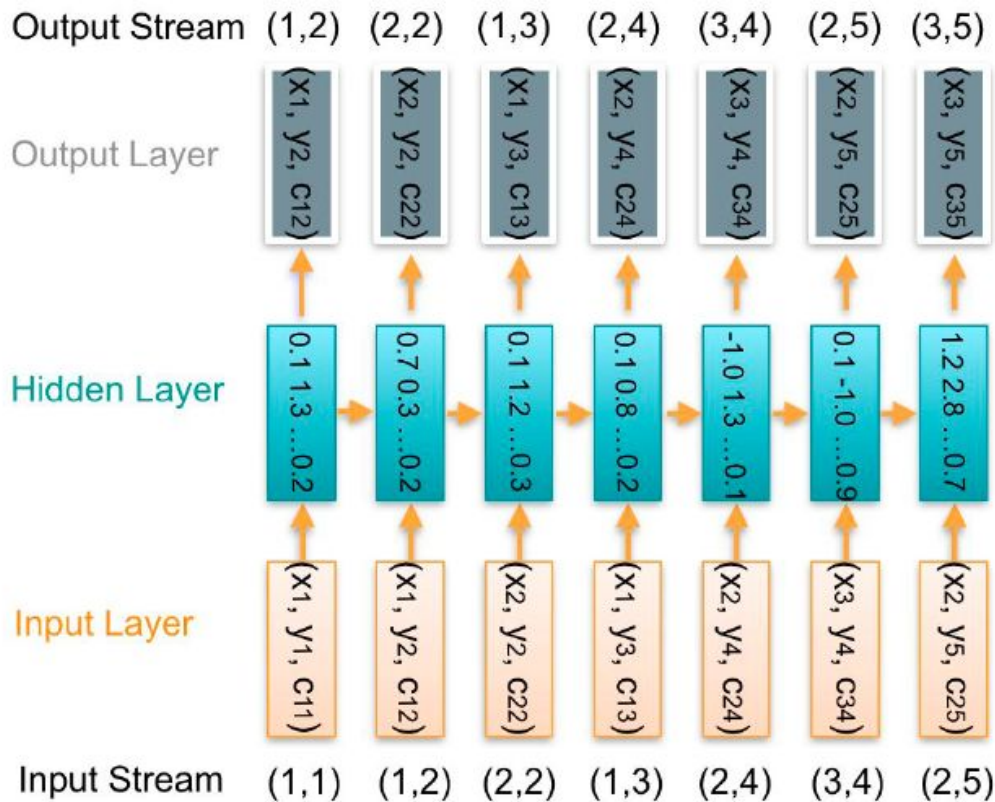
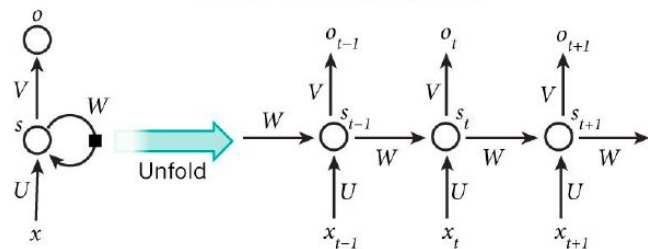
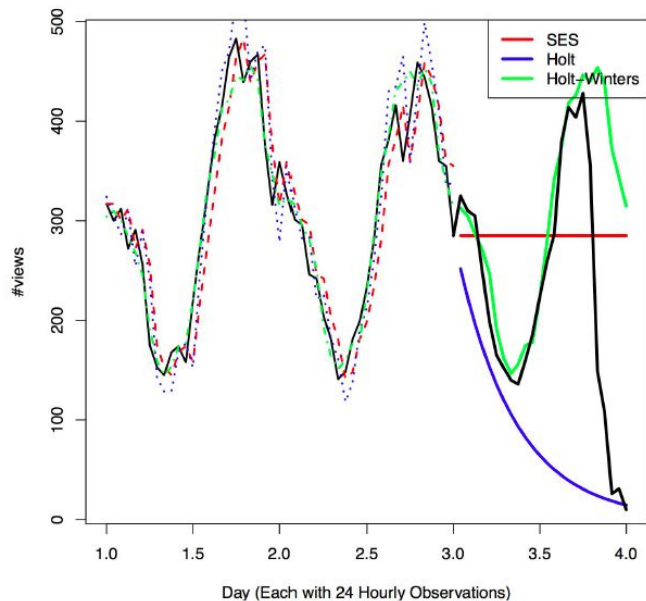
Matrix Factorization

$$\begin{array}{c} \text{User} \end{array} \begin{array}{c|ccccc} & \text{a} & \text{b} & \text{c} & \text{d} & \text{e} \\ \hline \text{A} & 1 & 0 & 1 & 0 & 1 \\ \text{B} & 0 & 1 & 0 & 1 & 0 \\ \text{C} & 1 & 0 & 1 & 0 & 0 \end{array} \approx \begin{array}{c} \text{User} \end{array} \begin{array}{|c|} \hline U \\ \hline \end{array} \times \begin{array}{c} \text{Item} \end{array} \begin{array}{|c|} \hline I \\ \hline \end{array}$$

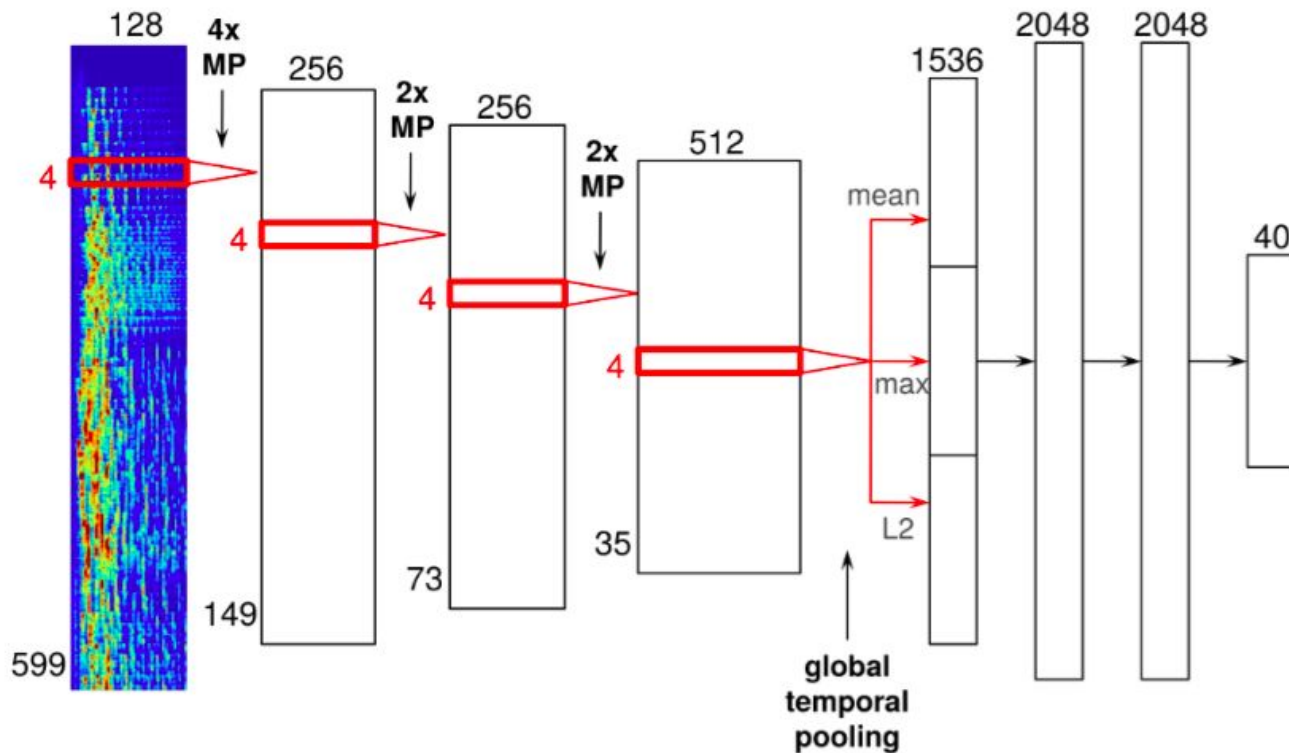
Factorization Machines

$$\begin{array}{c} \text{User} \end{array} \begin{array}{c|ccccc} & \text{A} & \text{B} & \text{C} & & & \\ \hline & 1 & 0 & 0 & & & \\ & 1 & 0 & 0 & & & \\ & 1 & 0 & 0 & & & \\ & 0 & 1 & 0 & & & \\ & 0 & 1 & 0 & & & \\ & 0 & 0 & 1 & & & \\ & 0 & 0 & 1 & & & \end{array} \begin{array}{c|ccccc} & \text{a} & \text{b} & \text{c} & \text{d} & \text{e} \\ \hline & 1 & 0 & 0 & 0 & 0 \\ & 0 & 0 & 1 & 0 & 0 \\ & 0 & 0 & 0 & 0 & 1 \\ & 0 & 1 & 0 & 0 & 0 \\ & 0 & 0 & 0 & 1 & 0 \\ & 0 & 0 & 1 & 0 & 0 \\ & 1 & 0 & 0 & 0 & 0 \end{array} \approx \begin{array}{c} \text{User} \times \text{Item} \end{array} \begin{array}{|c|} \hline V \\ \hline \end{array}$$

Time Series Model and RNN (recurrent neural network)

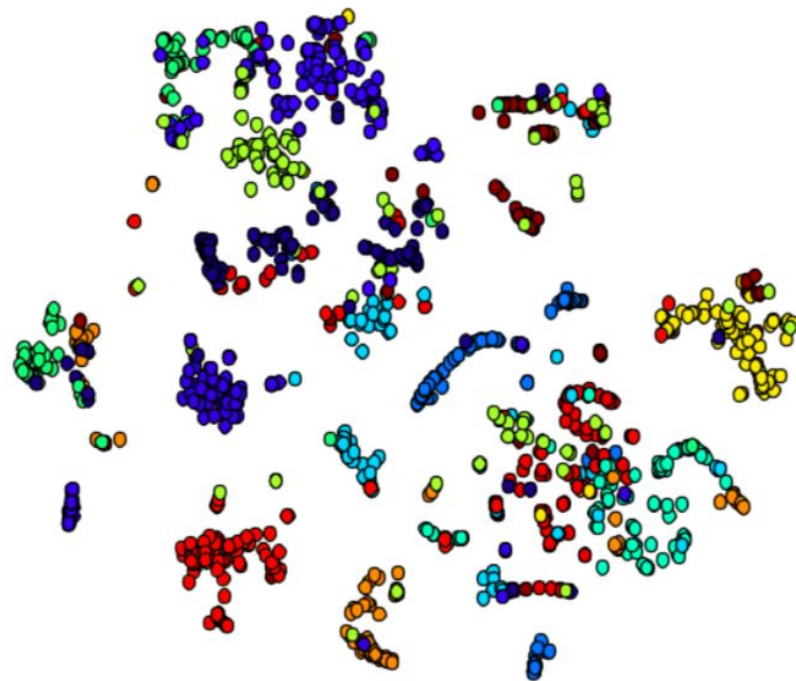
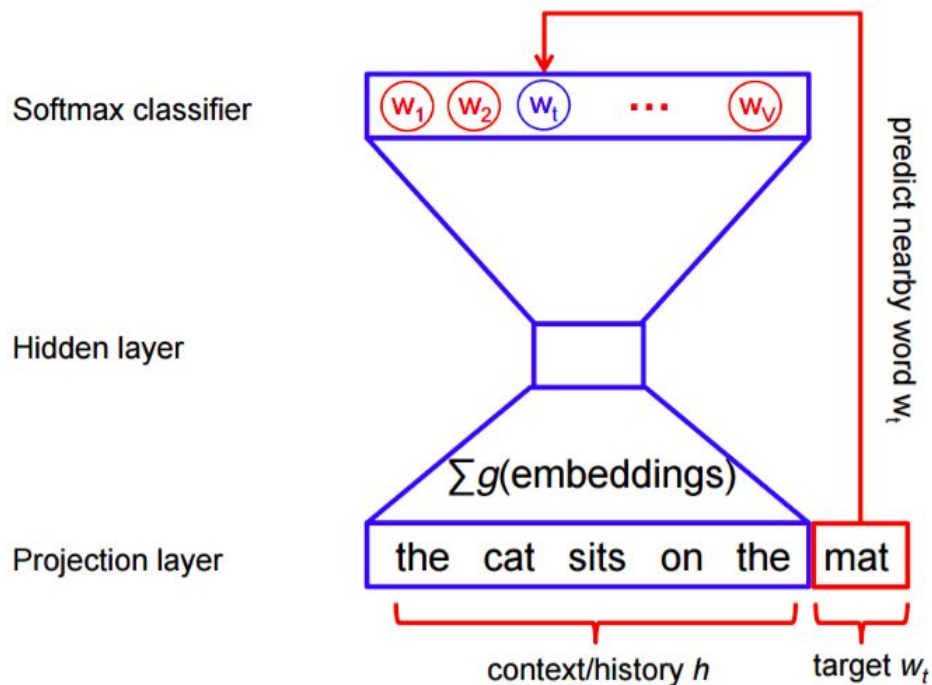


Recommender via Deep Learning

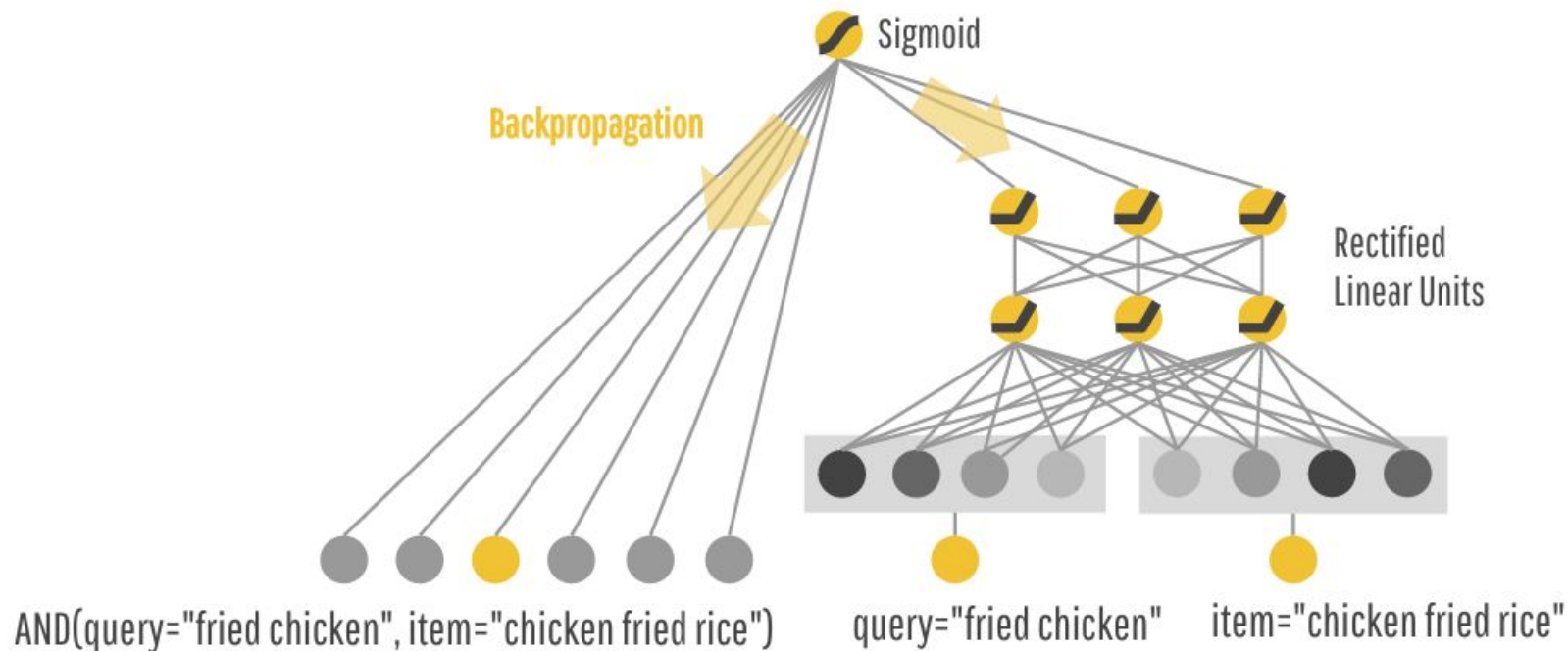


Spotify Music Recommender via CNN by Sander Dieleman (2014)

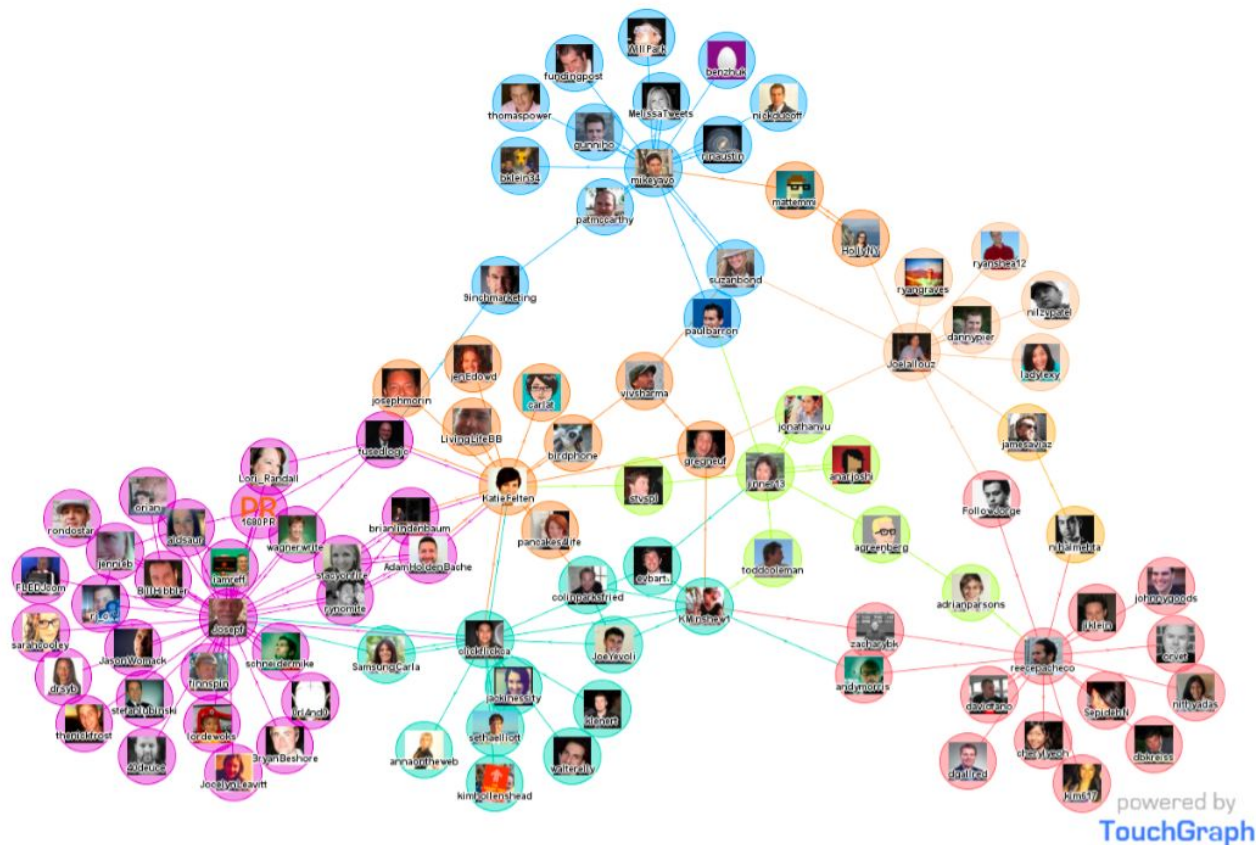
Item2Vec: Word Embedding and Distributional Semantics



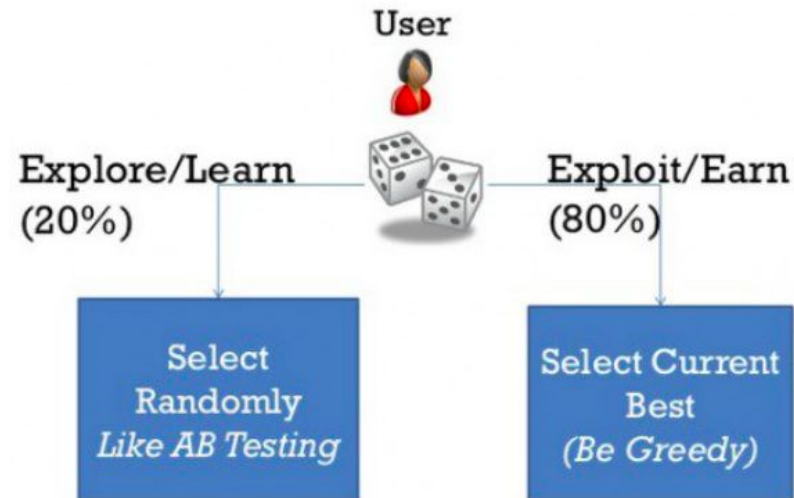
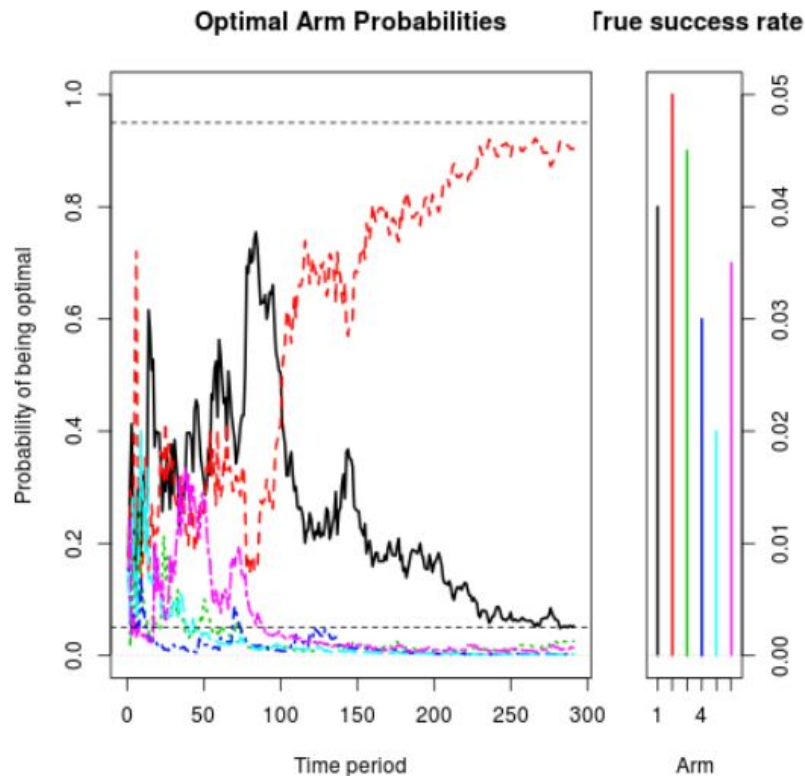
Deep & Wide Neural Network



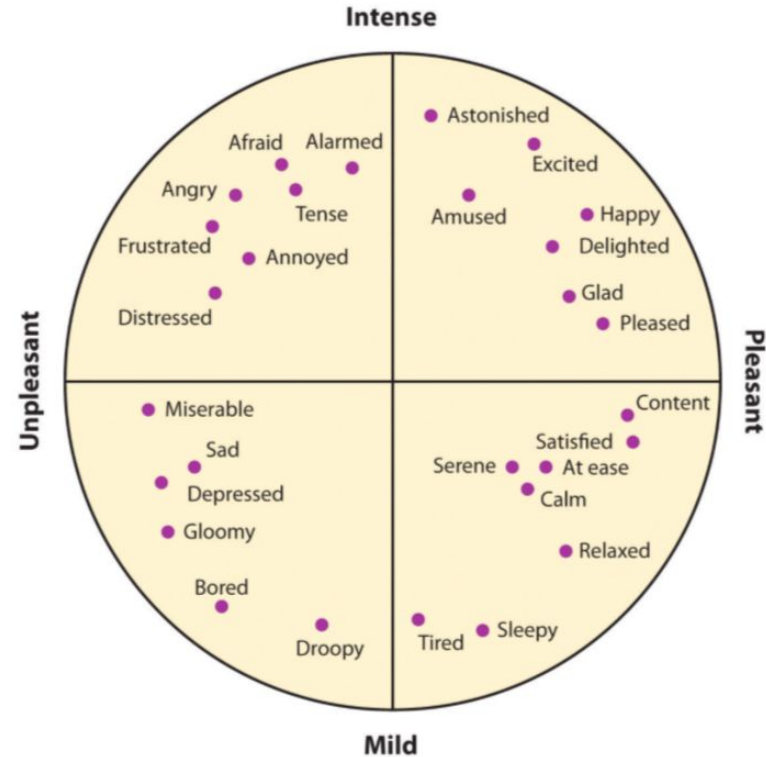
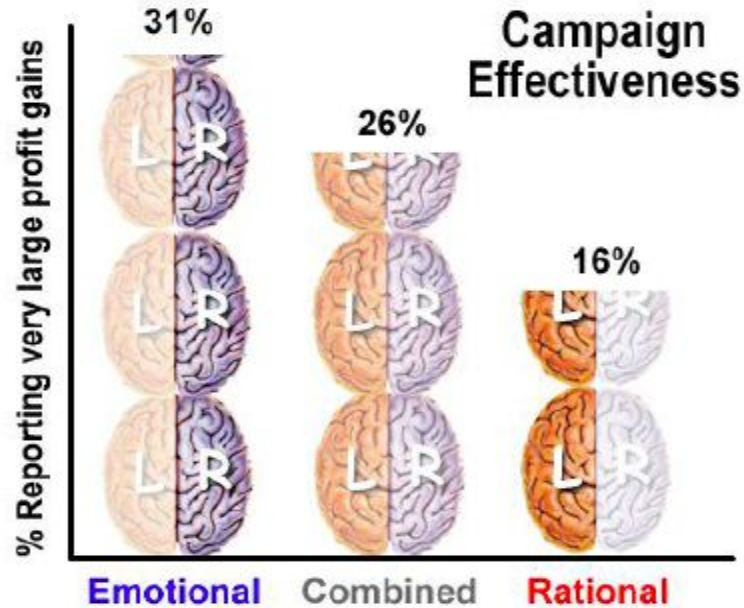
Graph based Recommenders and Social Network



Explore & Exploit: Reinforcement Learning

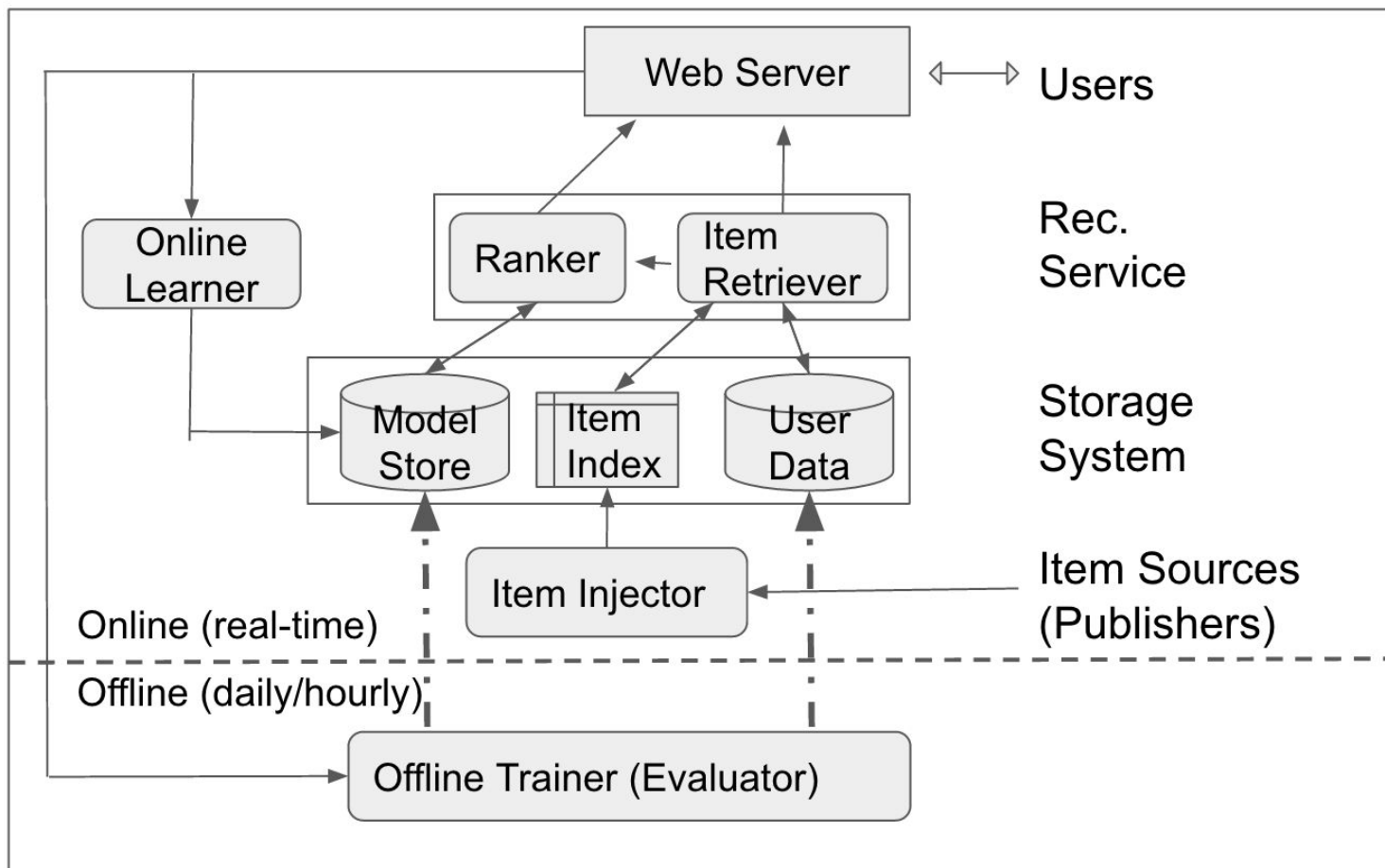


Represent Emotion and Trust

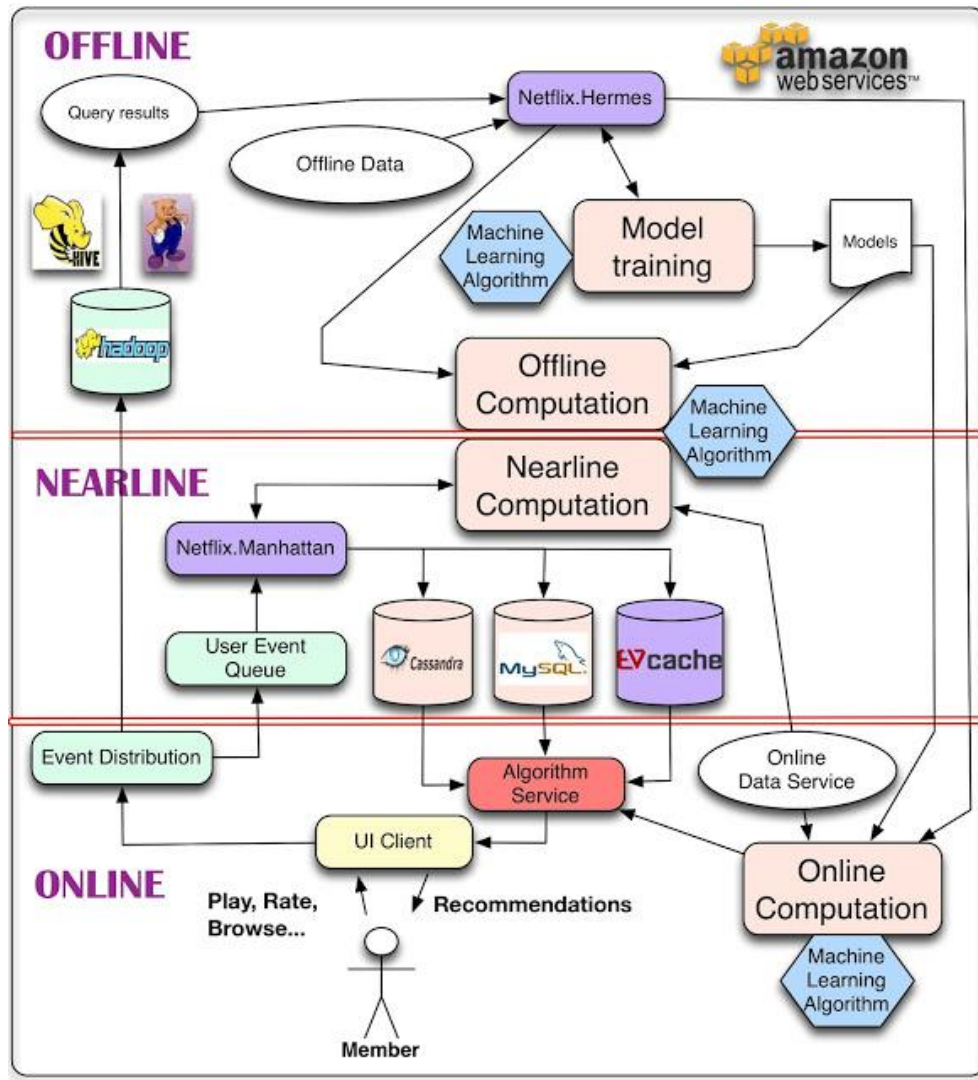


System Design

Recommender System Design

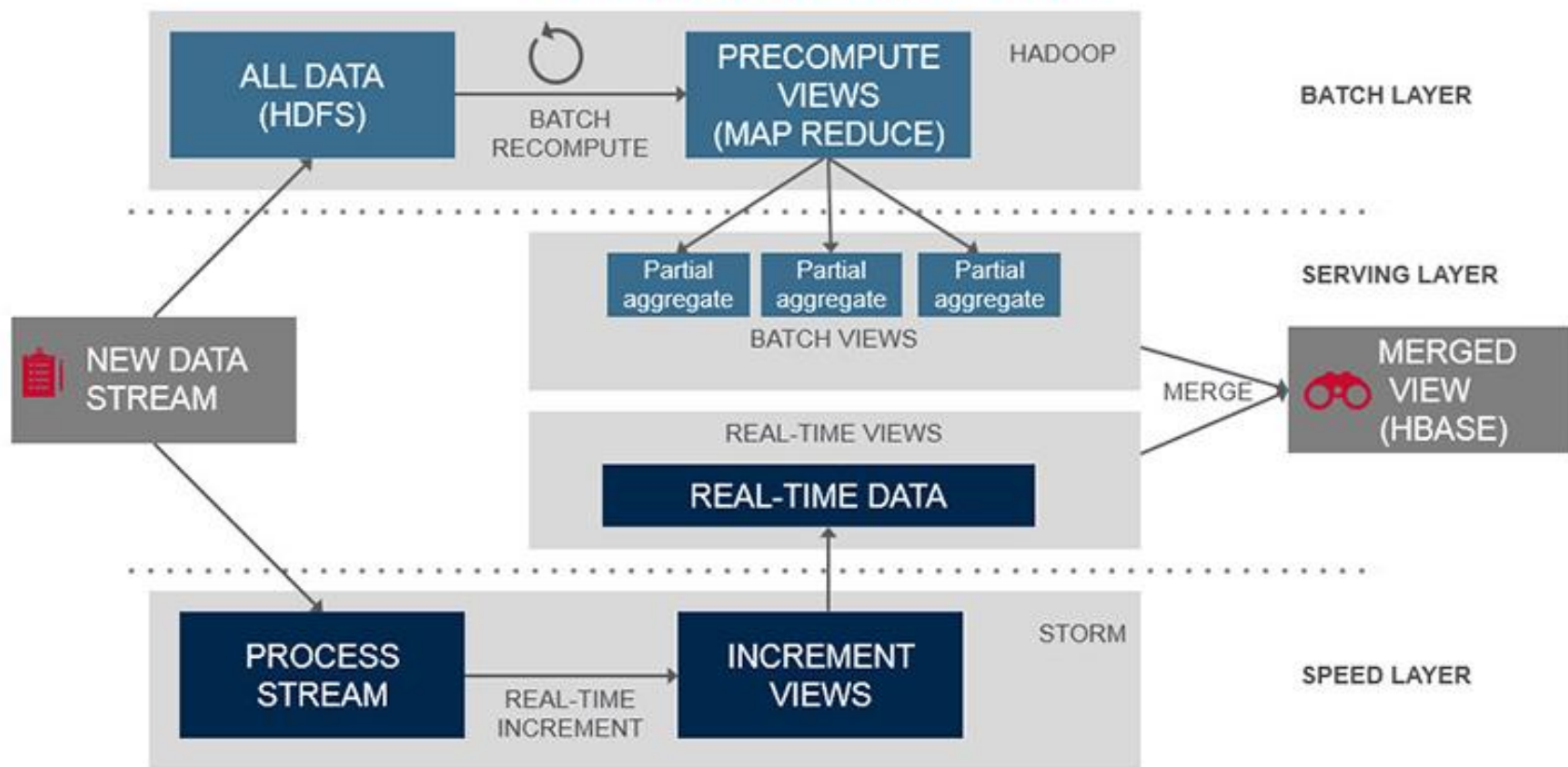


Case 1. Netflix



Big Data Architecture

Lambda Architecture



Kafka + Spark + Cassandra

