Factorization machines

Feature vector **x** | Target y

	User				Movie					Other Movies rated					Time	Last Movie rated					Target y	
	A	B	C	...	TI	NH	SW	ST	...	TI	NH	SW	ST	...	Time	TI	NH	SW	ST	...		
$\mathbf{x}_1$	1	0	0	...	1	0	0	0	...	0.3	0.3	0.3	0	...	13	0	0	0	0	...	5	y_1
$\mathbf{x}_2$	1	0	0	...	0	1	0	0	...	0.3	0.3	0.3	0	...	14	1	0	0	0	...	3	y_2
$\mathbf{x}_3$	1	0	0	...	0	0	1	0	...	0.3	0.3	0.3	0	...	16	0	1	0	0	...	1	y_3
$\mathbf{x}_4$	0	1	0	...	0	0	1	0	...	0	0	0.5	0.5	...	5	0	0	0	0	...	4	y_4
$\mathbf{x}_5$	0	1	0	...	0	0	0	1	...	0	0	0.5	0.5	...	8	0	0	1	0	...	5	y_5
$\mathbf{x}_6$	0	0	1	...	1	0	0	0	...	0.5	0	0.5	0	...	9	0	0	0	0	...	1	y_6
$\mathbf{x}_7$	0	0	1	...	0	0	1	0	...	0.5	0	0.5	0	...	12	1	0	0	0	...	5	y_7

Factorization machines

Let's consider the weight of a pair of features

$$\check{y}(x) = w_0 + \sum_{j=1}^{p} w_j x_j + \sum_{j=1}^{p} \sum_{\acute{j}=j+1}^{p} x_j x_{\acute{j}} w_{j,\acute{j}}$$

independent interactions

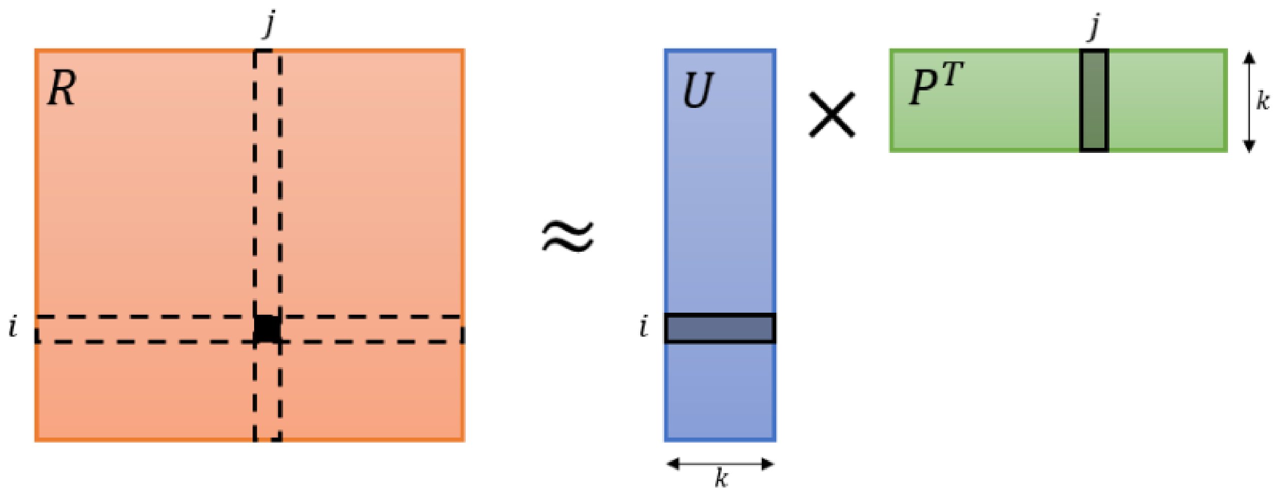
The model has too many parameters, far more than data points

Factorization machines

Let $w\ i,j$ be the weight assigned to feature pair i,j

Key idea: Set $w_{i,j} = \langle v_i, v_j \rangle$ same as matrix factorization

v_i are vectors in k-dimensional space
Weights of different pairs of features are not independent



Factorization machines

$$\check{y}(x) = w_0 + \sum_{j=1}^{p} w_j x_j + \sum_{j=1}^{p} \sum_{j'=j+1}^{p} x_j x_{j'} \langle v_j v_{j'} \rangle$$

$$\check{y}(x) = w_0 + \sum_{j=1}^{p} w_j x_j + \sum_{j=1}^{p} \sum_{j'=j+1}^{p} x_j x_{j'} \sum_{f=1}^{k} v_{f,j} v_{f,j'}$$

breaking the independence of
interaction parameters