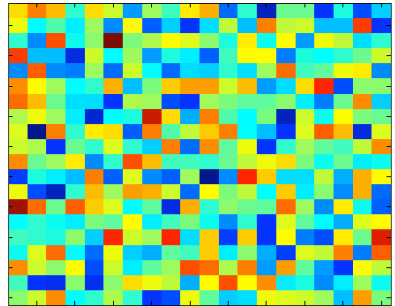
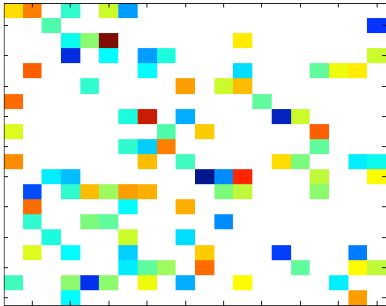


Unsupervised Learning - Matrix Completion

Creating our own truth





amazon.com

Recommended for You

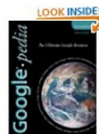
Amazon.com has new recommendations for you based on [items](#) you purchased or told us you own.



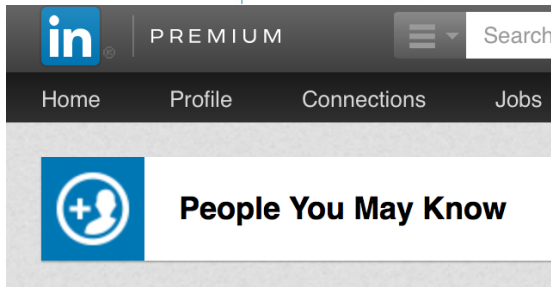
[Google Apps Deciphered: Compute in the Cloud to Streamline Your Desktop](#)



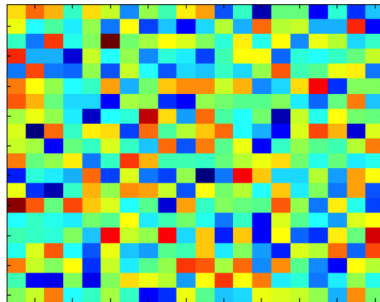
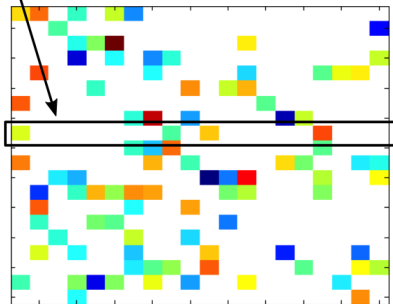
[Google Apps Administrator Guide: A Private-Label Web Workspace](#)



[Googlepedia: The Ultimate Google Resource \(3rd Edition\)](#)

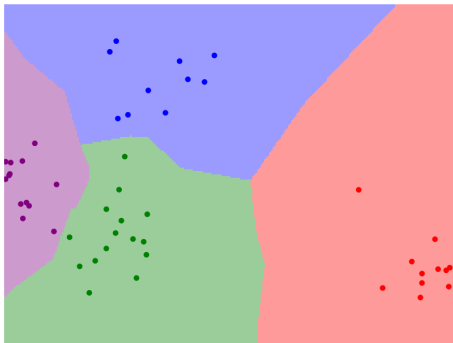


You (a single row)



How Do I Want to Fill in the Missing Entries?

k -Nearest Neighbors



Assumption: My "suggested friends" should be an average of my k closest friends' lists.

k-Nearest Neighbors

$$D_{euclidian} = \left(\sum_{i=1}^n |x_i - y_i|^2 \right)^{1/2}$$

$$D_{manhattan} = \sum_{i=1}^n |x_i - y_i|$$

$$D_{euclidian} = \sqrt{1^2 + 1^2 + 1^2 + 1^2 + 10^2} = \sqrt{104} \approx 10$$

$$D_{manhattan} = 1 + 1 + 1 + 1 + 10 = 14$$

Low Rank Matrix Completion

$$\begin{aligned} \min_M \quad & \text{rank}(M) \\ \text{subject to} \quad & M_{ij} = X_{ij} \end{aligned}$$

The *rank* of a matrix is defined as the number of linearly independent column vectors in a matrix.

Assumption: Our data matrix X can be represented by a small number of characteristics.

Low Rank Matrix Completion

		-1		
			1	
1	1	-1	1	-1
1				-1
		-1		

1	1	-1	1	-1
1	1	-1	1	-1
1	1	-1	1	-1
1	1	-1	1	-1
1	1	-1	1	-1

Matrix Factorization

$$\min_{P,Q} \|X - PQ\|_F^2$$

where $X \in \mathbb{R}^{n \times d}$, $P \in \mathbb{R}^{n \times r}$, $Q \in \mathbb{R}^{r \times d}$,
 $r \ll d$

		Item			
		W	X	Y	Z
User	A		4.5	2.0	
	B	4.0		3.5	
	C		5.0		2.0
	D		3.5	4.0	1.0

Rating Matrix

=

User	A	1.2	0.8
	B	1.4	0.9
	C	1.5	1.0
	D	1.2	0.8

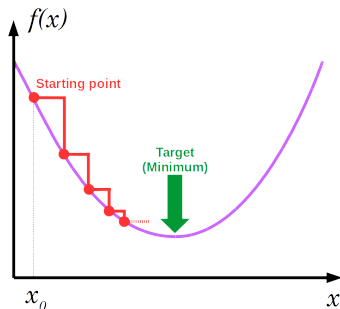
User Matrix

X

		W	X	Y	Z
		1.5	1.2	1.0	0.8
		1.7	0.6	1.1	0.4

Item Matrix

Matrix Factorization - Gradient Descent



Drawback: Since $P \in \mathbb{R}^{n \times r}$ and $Q \in \mathbb{R}^{r \times d}$ there are $(n \times r) + (r \times d)$ variables to optimize.

Matrix Factorization - Alternating Minimization

The Idea:

1. Fix Q and update P .
2. Then, fix P and update Q .
3. Rinse and repeat.

$$\min_{P, Q} \|X - PQ\|_F^2$$

Derived Updates:

$$P^{t+1} = XQ^T(QQ^T)^{-1}$$

$$Q^{t+1} = (P^TP)^{-1}P^TX$$

Questions

These slides are designed for educational purposes, specifically the CSCI-470 Introduction to Machine Learning course at the Colorado School of Mines as part of the Department of Computer Science.

Some content in these slides are obtained from external sources and may be copyright sensitive. Copyright and all rights therein are retained by the respective authors or by other copyright holders. Distributing or reposting the whole or part of these slides not for academic use is HIGHLY prohibited, unless explicit permission from all copyright holders is granted.