6. Alternating Minimization

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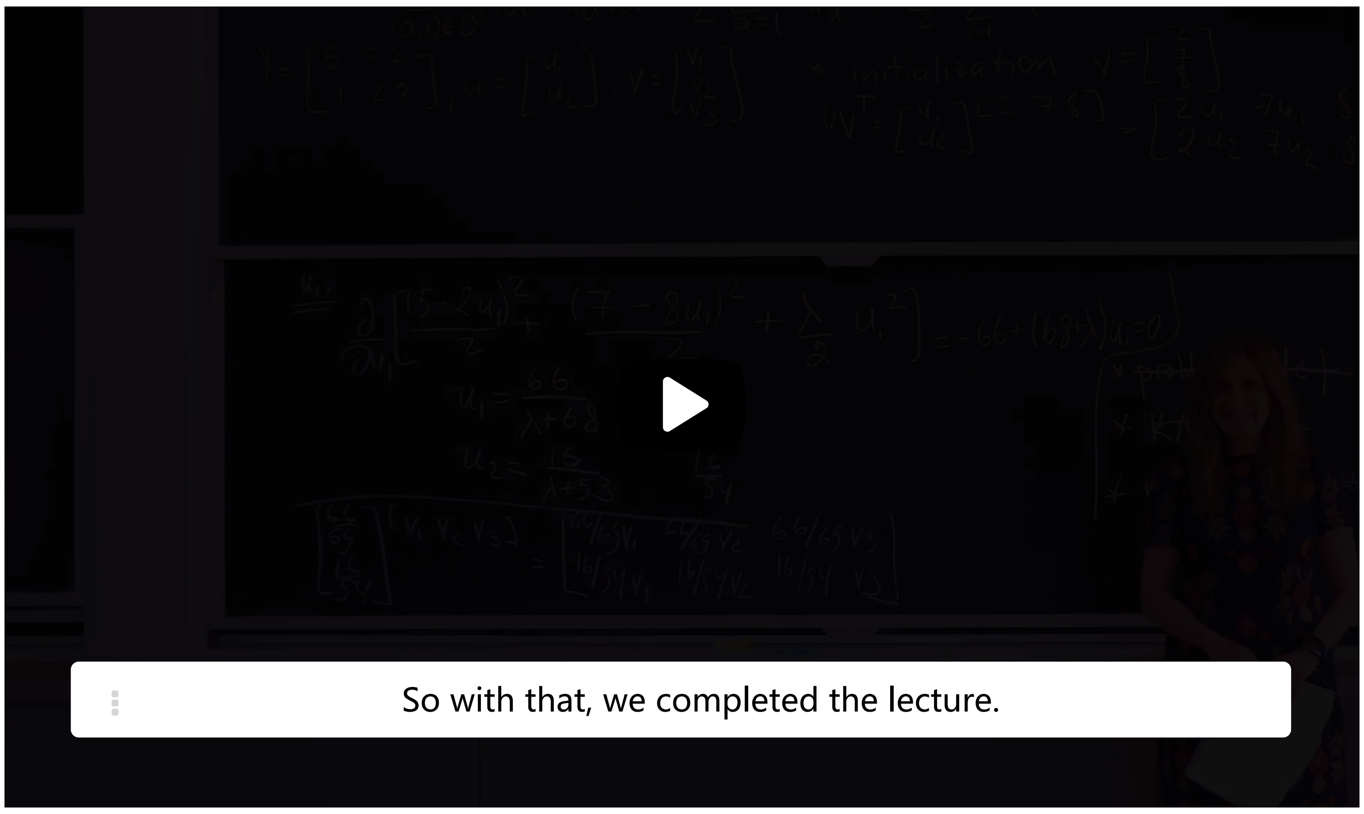

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But what I would like to tell you,
that this very simple algorithm actually
enables you, in a very interesting way,
to find connection between different users and products.
And given this very relatively simple machinery,
you can actually solve a very non-trivial problem
of product recommendation.
So with that, we completed the lecture.

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Alternating Minimization Concept Question

1/1 point (graded)
As in the video above, we now want to find U and V that minimize our new objective

$$J = \sum_{(a,i)\in D} \frac{\left(Y_{ai} - \left[UV^T\right]_{ai}\right)^2}{2} + \frac{\lambda}{2}\left(\sum_{a,k} U_{ak}^2 + \sum_{i,k} V_{ik}^2\right).$$

To simplify the problem, we fix U and solve for V, then fix V to be the result from the previous step and solve for U, and repeat this alternate process until we find the solution.

Consider the case $k = 1$. The matrices U and V reduce to vectors u and v, such that $u_a = U_{a1}$ and $v_i = V_{i1}$.

When v is fixed, minimizing J becomes equivalent to minimizing ...

- $\frac{(Y_{ai} - u_a v_i)^2}{2} + \frac{\lambda}{2}\sum_a (u_a)^2$
- $\sum_{(a,i)\in D} \frac{(Y_{ai} - u_a v_i)^2}{2} + \frac{\lambda}{2}\sum_a (u_a)^2$ ✔

$$\sum_{(a,i)\in D} \frac{(Y_{ai} - u_a v_i)^2}{2}$$

$$\sum_{(a,i)\in D} \frac{(Y_{ai} - u_a v_i)^2}{2} + \frac{\lambda}{2} \sum_i (v_i)^2$$

Solution:

Regarding terms containing only V as constants, minimizing J is equivalent to minimizing

$$\sum_{(a,i)\in D} \frac{(Y_{ai} - u_a v_i)^2}{2} + \frac{\lambda}{2} \sum_a (u_a)^2.$$

Submit You have used 1 of 3 attempts

Answers are displayed within the problem

Fixing V and Finding U

2/2 points (graded)

Now, assume we have 2 users, 3 movies, and a 2 by 3 matrix Y given by

$$Y = \begin{bmatrix} 1 & 8 & ? \\ 2 & ? & 5 \end{bmatrix}$$

Our goal is to find U and V such that $X = UV^T$ closely approximates the observed ratings in Y.

Assume we start by fixing V to initial values of $[4, 2, 1]^T$. Find the optimal 2×1 vector U in this case. (Express your answer in terms of λ).

First element of U is:

20/(20+lambda) **Answer:** 20/(20+lambda)

The second element of U is:

13/(17+lambda) **Answer:** 13/(17+lambda)

STANDARD NOTATION

Solution:

To compute the first element (u_1), compute the objective (ignore missing elements from Y), derive and compare to zero to find the minimum:

$$\frac{\partial}{\partial u_1}[\frac{(1-4u_1)^2}{2} + \frac{(8-2u_1)^2}{2} + \frac{\lambda}{2}u_1^2] = (\lambda + 20)\, u_1 - 20 = 0.$$

Submit You have used 2 of 3 attempts

Answers are displayed within the problem