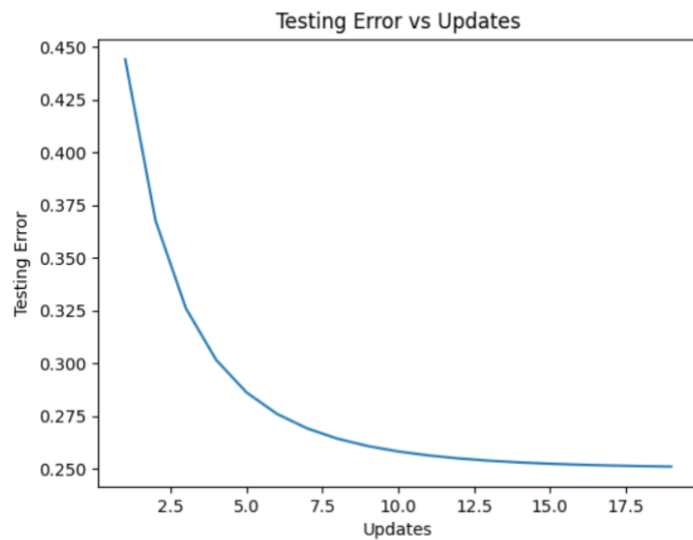


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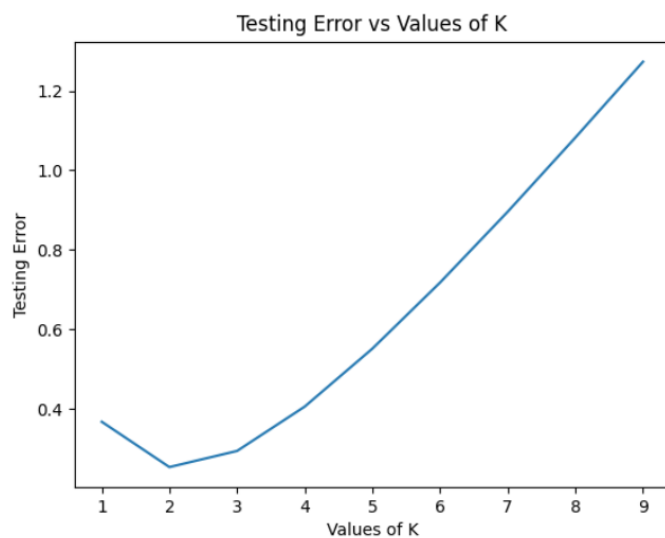
Homework 5

Collaborative Filtering:

Task 2 – Testing Error vs Updates with $k = 2$



Testing Error vs Different k values



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Task 1.

$$\min_{A, B} \sum_{(i,j) \in O} (A_{i:} B_{:j} - M_{ij})^2 + \lambda_1 \|A\|_F^2 + \lambda_2 \|B\|_F^2$$

$$T = \sum_{i,j \neq K} (A_{i:} B_{:j} - M_{ij})^2 + \sum_{i \in O_K, j=K} (A_{i:} B_{:K} - M_{iK})^2 + \lambda_1 \|A\|_F^2 + \lambda_2 \|B\|_F^2$$

$$\frac{\partial T}{\partial B_{:K}} = 0 + \sum_{i \in O_K, j=K} 2(A_{i:} B_{:K} - M_{iK}) \cdot A_{i:}^T + 2\lambda_2 I \cdot B_{:K}$$

$$\Rightarrow \sum_i 2(A_{i:} B_{:K} - M_{iK}) \cdot A_{i:}^T + \lambda_2 I \cdot B_{:K} = 0$$

$$\Rightarrow \sum_{i \in O_K} A_{i:}^T A_{i:} B_{:K} + \lambda_2 I \cdot B_{:K} = \sum_{i \in O_K} M_{iK} \cdot A_{i:}^T$$

$$\Rightarrow B_{:K} \left(\sum_{i \in O_K} A_{i:}^T A_{i:} + \lambda_2 I \right) = \sum_{i \in O_K} M_{iK} \cdot A_{i:}^T$$

$$\Rightarrow B_{:K} = \left(\sum_{i \in O_K} A_{i:}^T A_{i:} + \lambda_2 I \right)^{-1} \cdot \left(\sum_{i \in O_K} M_{iK} A_{i:}^T \right)$$