

Mid Term Exam (Fall 2024)

DA 626: Recommendation System Design Using Deep Learning

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Total Marks: 100 marks

1. Calculate the “?” in the user-item matrix through the following schemes. Use **Cosine Distance** metrics for similarity. Consider **two neighbors**, when estimating the “?” spots. [5x10 = 50 marks]

- (a) Using user based collaborative filtering. Use **Average** (μ_j is used for estimated ratings for user j) or **overall neighborhood-based prediction function** ($\mu_{w,j}$ is used for estimated ratings where z_i is the ratings of the neighbor i). These are denoted through Equation 1 and Equation 2 respectively.

$$\mu_j = \frac{1}{N} \sum z_i \quad (1)$$

$$\mu_{w,j} = \frac{\sum z_i \cdot \text{Sim}(i, j)}{\sum \text{Sim}(i, j)} \quad (2)$$

	Item 1	Item 2	Item 3	Item 4	Item 5
User 1	3	1	2	5	5
User 2	5	3	4	1	?
User 3	3	3	1	5	4
User 4	4	3	3	3	2
User 5	1	5	5	2	1

	Item 1	Item 2	Item 3	Item 4	Item 5
Item 1	1	0.6	0.6	0.1	0.1
Item 2	0.6	1	0.3	0.2	0.1
Item 3	0.6	0.3	1	0.2	0.1
Item 4	0.1	0.2	0.2	1	0.3
Item 5	0.1	0.1	0.1	0.3	1

- (b) Using item based collaborative filtering. Use **Average** or **overall neighborhood-based prediction function**. These are denoted through Equation 1 and Equation 2 respectively.
- (c) Using context based recommendation system. Use **Average** or **overall neighborhood-based prediction function**. These are denoted through Equation 1 and Equation 2 respectively.
- (d) Using a hybrid recommendation system as a function of the weighted average of collaborative filtering method(s) and content-based systems, where the weights assigned can be justified. What is your justification for the weights that are assigned to your hybrid recommendation system?

	Item 1	Item 2	Item 3	Item 4	Item 5
User 1	3	1	2	5	5
User 2	5	3	4	1	?
User 3	3	3	1	5	4
User 4	4	3	3	3	2
User 5	1	5	5	2	1
Attacker 6	1	5	5	2	1
Attacker 7	5	2	5	3	2

	Item 1	Item 2	Item 3	Item 4	Item 5
Item 1	1	0.6	0.6	0.1	0.1
Item 2	0.6	1	0.3	0.2	0.1
Item 3	0.6	0.3	1	0.2	0.1
Item 4	0.1	0.2	0.2	1	0.3
Item 5	0.1	0.1	0.1	0.3	1

- (e) A hacker has incubated some attackers to the table. Have they succeeded in their mission? Write in one line what they achieved or couldn't achieve.
2. You are provided the output of a model and the suggested sequence. Relevance is defined as anything > 25 for a metric defined for a scenario. [20 marks]

Item	Score	Relevance
a1	50	1
a2	40	1
a3	30	1
a4	20	0
a5	10	0

$$\begin{aligned}
 (6, 12) &= \frac{5 + 15 + 20 + 2}{\sqrt{5} \cdot \sqrt{65}} \\
 &= 0.243 \\
 (7, 12) &= \frac{25 + 6 + 20 + 3}{\sqrt{5} \cdot \sqrt{63}} \quad 20.95
 \end{aligned}$$

Ideal (Ground Truth)	Estimated by Model X
a1	a3
a2	a2
a3	a1
a4	a4
a5	a5

- (a) Calculate DCG and nDCG where they are denoted through the Equation 3 and Equation 4. Use **Score in Table 2** for rel_i for DCG and nDCG. [8 marks]

$$DCG_p = \sum_{i=1}^p \frac{rel_i}{\log_2(i+1)} \quad (3)$$

$$nDCG_p = \frac{DCG_p}{IDCG_p} \quad (4)$$

- (b) Calculate precision@N and recall@N, where consider $N = \{1, 2, 3, 4, 5\}$. [8 marks]

$$\text{Precision} = \frac{TP}{TP + FP} \quad (5)$$

$$\text{Recall} = \frac{TP}{TP + FN} \quad (6)$$

- (c) What can you conclude from this analysis? [4 marks]

3. Answer in one-two lines. [3x10 = 30 marks]

- (a) What is the disadvantage of sigmoid and tanh activation function?
- (b) What is the difference between Gradient Descent and Stochastic Gradient Descent?
- (c) What is skipgram in word2vec?
- (d) What is the use of the word embedding?
- (e) What is tokenization?
- (f) What is softmax layer? Write equation (if possible).
- (g) In GAN, which one is better, differentiator or generator?
- (h) How is BERT model evaluated?
- (i) What are the advantages and disadvantages of biLSTM?
- (j) What is Adam Optimizer? Write Equations (if possible).

$$2.21 + 19.38 + 20.08 = 30.17$$

$$\log_2(3) = \frac{\log_{10} 3}{\log_{10} 2}$$

$$\frac{0.477}{0.301} = 1.52$$