

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

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).