Course Code: CS4053 / AI4006	**Course Name:** Recommender Systems
Course Instructor: Syed Zain Ul Hassan	
Student ID:	**Section:**

Instructions:

- Return the question paper after exam.
- There are **3 questions** on **1 page** with **2 sides**.
- In case of any ambiguity, you may make assumption. But your assumption should not contradict any statement in the question paper.

Time: 60 minutes   **Max Marks**: 30 Points

Answer 1

a) **Answer:** No. The factor for User 3 does not truly represent the original interaction matrix e.g., for Item 1, the dot product U3 . I1 gives us (0x3 + 1 x1) = 1 instead of the original rating 4.

b) **Answer:** (0x1 + 1x4) = 4.

c) **Answer:** The original interaction matrix would take 3x5 = 15 units of storage, while the two factors would take (3x2) + (2x5) = 16 units of storage. Although, for this particular example the original interaction matrix is taking up less storage than its factors, when the size of the matrix is large, there will be a significant decrease in the storage requirements for the factored matrices compared to the original matrix.

d) Initialized matrix:

	Item 1	Item 2	Item 3	Item 4	Item 5
User 1	0.9	0.7	0.4	0.8	0.3
User 2	0.5	0.6	0.2	0.1	0.7
User 3	0.5	0.6	0.2	0.1	0.7

Sum of Squared Error:
$(3-0.9)^2+(1.0.7)^2+(1-0.4)^2+(3-0.8)^2+(1-0.3)^2+(1-0.5)^2+(2-0.6)^2+(1-0.1)^2+(3-0.7)^2+(4-0.5)^2+(3-0.6)^2+(5-0.2)^2+(4-0.1)^2+(4-0.7)^2 = 85.56$

Answer 2

a) Normalized features and preference vectors:

	HD Display	RAM	Storage	Price
L1	1	0.25	0.502	0.542
L2	0	0.5	1	0.833
L3	1	1	1	1

HD Display	RAM	Storage	Price
0	1	0.502	0.625

For L1:
HD Display = 1 − | 1 − 0 | = 0
RAM = 1 - | 0.25 − 1 | = 0.25
Storage = 1 - | 0.502 - 0.502 | = 1
Price = 1 - | 0.542 − 0.625 | = 0.917
Sim(L1) = (0.25x1 + 1x1 + 0.917x1 + 0) / 4 = 0.542

For L2:
HD Display = 1 − | 0 − 0 | = 1
RAM = 1 - | 0. 5 − 1 | = 0.5
Storage = 1 - | 0.502 − 1| = 0.502
Price = 1 - | 0.833 − 0.625 | = 0.792
Sim(L1) = (1x1 + 0.5x1 + 0.502x1 + 0.792x1) / 4 = 0.698

For L3:
HD Display = 1 − | 0 − 1 | = 0
RAM = 1 - | 1 − 1 | = 1
Storage = 1 - | 0.502 - 1 | = 0.502
Price = 1 - | 0.625 - 1 | = 0.625
Sim(L1) = (0x1 + 1x1 + 0.502x1 + 0.625x1) / 4 = 0.531

Laptop 2 (L2) will be recommended as it has the highest score.

b) Limitations of Constraint-based Recommender Systems:
- It may generate zero recommendations in some cases.
- Users are not always sure of what their full requirements are.
- If business rules often change, updates to the knowledge-base and constraints need to be made.
- Domain expertise is required.

Answer 3

If the data points in a given training set are already linearly separable, there isn't any need to induce non-linearity, hence there should be no role of activations in that case and a large regressor would suffice.

Good luck!