

BIRLA INSTITUTE OF TECHNOLOGY AND SCIENCE, PILANI GOA CAMPUS

SECOND SEMESTER 2022-2023

Mid-semester Examination

Course Number: BITS F364

Duration: 90 minutes

Course Title: Human Computer Interaction

Full Marks: 50

Instructions:

- Closed book exam.
- Write answers concisely.
- Write different parts of one question in one place.
- Illegible answers (due to poor hand writing etc.) may not be evaluated correctly.

Questions

1. (Part A) Write the correct option(s) for each of the following questions.

[5 * 0.5]

(a) Dwell time in eye tracking is defined as

- (i) Pause in the eye's movement within an AOI
- (ii) Elapsed time between fixations
- (iii) Total amount of time spent looking within an AOI
- (iv) Total number of times the eye fixates within an AOI

(b) Inter-annotator reliability is measured using

- (i) Pearson correlation coefficient
- (ii) Cohen's kappa
- (iii) Cronbach's alpha
- (iv) p-value

(c) What would be the equivalent RSSI for a WiFi signal of strength ($s = 10$ watts), computed as per the following formula ($RSSI = 10 * \log_{10}(s/0.001)$ dBm)?

- (i) 25 dBm
- (ii) 15 dBm
- (iii) 35 dBm
- (iv) 40 dBm

(d) As per the circumplex model of emotion, stressed emotion lie on the

- (i) first quadrant
- (ii) second quadrant
- (iii) third quadrant
- (iv) fourth quadrant

(e) You are designing a location-aware restaurant recommender application. The recommender application first applies a specified distance range to filter out the matching location and then applies a traditional recommendation algorithm. Usage of contextual data in this way is commonly termed as,

- (i) Collaborative filtering
- (ii) Contextual pre-filtering
- (iii) Contextual post-filtering
- (iv) None of the above

(Part B) Write TRUE/FALSE for each of the following statements.

[5 *0.5]

- (a) In an ambient based localization system, the fingerprint derived from accelerometer sensor can give store-level localization (e.g., restaurant / book shop / grocery).
 - (b) The information from short-term memory to long-term memory is transferred via attention.
 - (c) Fixation duration is a better indicator of ASD (autism spectrum disorder) than pupil diameter.
 - (d) Percentage of functions learnt can be used as a usability metric to measure the error tolerance of the system.
 - (e) In the master-apprentice relationship present during contextual inquiry, the user plays the role of the apprentice.
2. (a) What are the emotions present in Ekman's emotion model?
- (b) Show the positions (quadrants) of the following four emotions (*anger, hostility, bored, fear*) on the valence-arousal-dominance model using the diagram. Clearly show the value and label in each axis for full credit.
- (c) Find out the sample size for a survey, which requires a 95% confidence, has a population variance of 0.5, and a margin of error of $\pm 5\%$. The z-score corresponding to 95% CI is 1.96.
- (d) Highlight the problem (if any) with the following survey questions – (i) How satisfied or dissatisfied you are with the course content and evaluation components of the HCI course? (ii) Will this smartphone app help you to be efficient and better at your fitness tracking routine?
- (e) In a survey, there are three questions (Q1, Q2, and Q3). Seven participants (P1 to P7) answered each of these questions and provided their score in a Likert scale (1 to 9). The scores provided by the participants are noted in Table 1. Compute the internal reliability of the survey.

[2 + 4 + 2 + (1+1) + 5]

| Participant | Q1 | Q2 | Q3 |
|-------------|----|----|----|
| P1 | 4 | 6 | 8 |
| P2 | 7 | 5 | 6 |
| P3 | 7 | 8 | 6 |
| P4 | 3 | 2 | 8 |
| P5 | 2 | 6 | 2 |
| P6 | 5 | 4 | 3 |
| P7 | 2 | 4 | 3 |

Table 1: Participant ratings for different questions

3. (a) You are trying to find the distance between two ambient sound-based fingerprints F1 and F2. F1, F2 are computed by finding the frequency distribution of noise amplitude values recorded at two locations (L1, L2 respectively). The noise level at L1 is the following [23, 45,

89, 67, 53, 99, 112, 34, 82, 92] and the noise level at L2 is the following [65, 42, 105, 55, 73, 21, 108, 117, 47, 87]. The frequency distribution of the noise amplitude is based on of 5 equal bin sizes, starting from 20 dBm to 120 dBm. Find (i) Finger prints F1 and F2, (ii) The distance between them (using Euclidean distance).

(b) In another scenario, you are extracting the similarity between two fingerprints extracted from ambient light. The details corresponding to the fingerprints are mentioned in Table 2. Fingerprint 1 (F1) consists of 3 clusters. The number of points in each cluster and the centroid of each cluster are noted in the table. Similarly, details of the fingerprint 2 (F2) are also noted in the table. Find the similarity between these two fingerprints as per the equation below,

$$S_{12} = \sum_{i,j} \frac{1}{\delta(i,j)} \frac{SizeOf(C_{1i})}{T_1} \frac{SizeOf(C_{2j})}{T_2}$$

where S_{12} is the similarity between F1 and F2, $\delta(i,j)$ is the Euclidean distance between the centroids of cluster C_{1i} and C_{2j} , sizeof (C_{1i}) indicates the number of points in C_{1i} , T_1 and T_2 indicate the total number of points in the clusters corresponding to F1 and F2 respectively.

(c) You are extracting the fingerprint based on movement pattern in a location as a ratio (R) of total time spent in moving (t_{moving}) and total time spent in stationary ($t_{stationary}$). A user spends following amounts of time (30 sec, 80 sec, 20 sec, 50 sec, 75 sec) in moving and following amounts of time (10 sec, 15 sec, 35 sec, 50 sec, 40 sec) as stationary. You may assume every moving period is followed by a stationary period (and vice versa). What is the fingerprint value?

(d) Based on the fingerprint value in the previous step (3c), what is the likely location (or activity) of the user (please provide a very brief reasoning, preferably within 2 sentences).

$$[(4+1) + 7 + 2 + 1]$$

| Fingerprint 1 (F1) | | C ₁₁ | C ₁₂ | C ₁₃ |
|-----------------------|--------------|-----------------|-----------------|-----------------|
| | no of points | 3 | 4 | 5 |
| | centroid | (3,4) | (6,3) | (5,8) |
| Fingerprint 2 (F2) | | C ₂₁ | C ₂₂ | |
| | no of points | 6 | 4 | |
| | centroid | (4,5) | (2,3) | |

Table 2: Details of two fingerprints based on ambient lights

4. (a) You are trying to localize an object inside a room based on the WiFi base station (BS) signal strength. The room has 3 base stations. The signal strengths recorded from these 3 BS (BS1, BS2, and BS3) at different points of the room are as noted in Table 3. (i) Assuming the localization algorithm computes the centroid of 3 nearest neighbours as the target location, find out the location of the object, which records the signal strength from these 3 base stations as follows [BS1 = 55, BS2 = 45, BS3 = 75]. (ii) What would be the location if 4 nearest neighbours are considered for location computation. The distance in the signal space can be computed using Euclidean distance. All signal strength values are expressed in dBm.
- (b) You have developed a smartphone application, which recommends the nearby attractions based on the current location. However, you aim to improve the recommendations further by

applying a contextual post-filtering technique based on the distance of the attractions from the current location. The post-filtering strategy rearranges the ratings of the attractions based on the following rule – $w_i = v_i * DD(u, a_i)$; where w_i is the new rating of attraction i , v_i is the current rating of attraction i , u is current location, and a_i is the location of attraction i . DD is the decay function defined as follows – $DD(u, a_i) = 0$ if distance (u, a_i) is greater than 10 Kms; otherwise, $DD(u, a_i) = 1 - \text{distance}(u, a_i) / 10$. You have the attractions ratings and distance from current location as noted in **Table 4**. What will be the (i) new rating, (ii) decay function, and (iii) ranking of each of the attractions after applying the above-mentioned post-filtering steps? [Please show new rating, decay function, and ranking for each attraction for full credit.]

(c) Highlight the difference between vertical and horizontal prototypes in HCI design.

$$[(5+2) + (3 + 2 + 1) + 2]$$

| Point | Physical location (x,y) | BS1 signal strength (dBm) | BS2 signal strength (dBm) | BS3 signal strength (dBm) |
|---------|-------------------------|---------------------------|---------------------------|---------------------------|
| Point 1 | 7, 8 | 60 | 40 | 80 |
| Point 2 | 2, 3 | 70 | 50 | 65 |
| Point 3 | 4, 5 | 30 | 80 | 40 |
| Point 4 | 6, 4 | 50 | 60 | 70 |
| Point 5 | 5, 7 | 40 | 70 | 50 |

Table 3: Physical location and signal strength measured at different locations inside the room

| Attraction (a_i) | Rating (v_i) | Distance (u, a_i) |
|----------------------|------------------|-----------------------|
| a_1 | 8.9 | 8 |
| a_2 | 7.6 | 7 |
| a_3 | 6.8 | 8 |
| a_4 | 5.9 | 7 |
| a_5 | 5.1 | 9 |

Table 4: Ratings for different attractions and the distance of them from user location