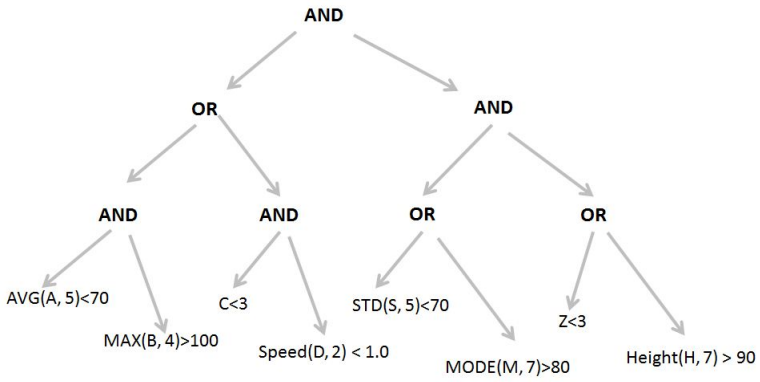
IIT Kharagpur
SMARTPHONE COMPUTING
and
APPLICATION (CS60009)
Mid-semester Examination (Fall 2016-2017)

Duration: 2 Hrs **FM: TBD**

1. Answer all questions **[5x2=10]**

(a) What is Persuasive Technology? Give an example.
Ans: Sensor data gathered from communities (e.g., fitness, healthcare) can be used not only to inform users but to persuade them to make positive behavioral changes. Systems that provide tailored feedback with the goal of changing users behavior are referred to as persuasive technology.
Example: The UbiFit Garden- the display uses the metaphor of a garden with different flowers blooming in response to physical exercise of the user during the day

(b) With respect to sensing draw the query tree for the following:
(($AVG(A,5) < 70$ AND $MAX(B,4) > 100$) OR ($C < 3$ AND $Speed(D,2) < 1.0$)) AND (($STD(S,5) < 70$ OR $MODE(M,7) > 80$) AND ($Z < 3$ OR $Height(H,7) > 90$))
Ans:

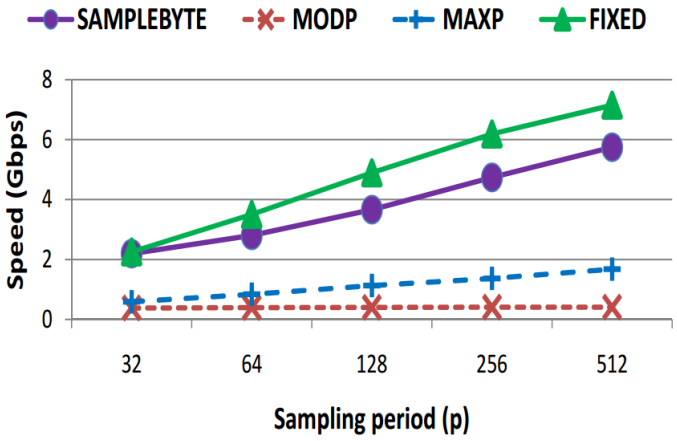


(c) With respect to Android development, briefly mention the difference between **dp** and **sp**.
Ans: The primary difference between sp and dp is that sp preserves a user's font settings. Users who have larger text settings for accessibility will see the font size matched to their text size preferences.

(d) When would you use (i) a Spinner and (ii) a Radio Button during development of an Android app?
-(i) A Spinner is used to create a list of dropdown options.
-(ii) A Radio Button is used when the user can select one out of a group of buttons.

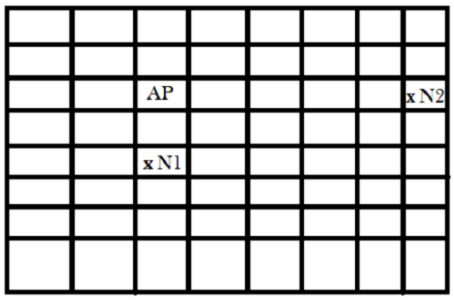
(e) Consider the following graph representing average processing speed variation with sampling period for Max-Match in EndRE:

i. Which algorithm out of the 4 shown above is the least sensitive to variation in sampling period? Which one is the most sensitive?
Ans: MODP is the least sensitive algorithm, FIXED is the most sensitive one.



ii. At what sampling period value does SAMPLEBYTE reach the same efficiency that FIXED achieves at a sampling period of 2^8?
Ans: Sampling period p = 512

2. (a) Use the Seidel & Rappaports formula to estimate the signal strength of WiFi access-point AP at mobile receivers N1 and N2. All black lines are walls.



N1 is at a distance of 28 meters from AP. N2 is at 45 meters distance from AP. At 1 meter distance (d_0) from the AP, its strength is −25 dBm. Wall Attenuation Factor (WAF)= 3 dBm. The maximum number of walls up to which attenuation factor makes a difference is 3. The rate at which power attenuates with distance (n) is 2.

i. Write the Wall Attenuation formula in terms of P(d_0), n, WAF and C. Also write what these symbols stand for. **[2]**
Ans: The Wall Attenuation Factor (WAF) model is described by:

$$P(d)[dBm] = P(d_o)[dBm] - 10n\log\left(\frac{d}{d_o}\right) - \begin{cases} nW * WAF & nW < C \\ C * WAF & nW \geq C \end{cases}$$

where n indicates the rate at which the path loss increases with distance, P(do) is the signal power at some reference distance do and d is the transmitter-receiver (T-R) separation distance. C is the maximum number of obstructions (walls) up to which the attenuation factor makes a difference, nW is the number of obstructions (walls) between the transmitter and the receiver, and WAF is the wall attenuation factor.

ii. Calculate signal strengths at N1 and N2. **[4]**
Signal strength at N1 = $p(d0) - 10nlog(d/d0) - nW * WAF$

= -25-10*2*log(28/1)-2*3
= -25-20*1.447-6
= -59.943 dBm
Signal strength at N2 = $p(d0) - 10nlog(d/d0) - C * WAF$
= -25-10*2*log(45/1)-3*3
= -25-20*1.653-9
= -67.06 dBm

(b) *"Using the synchronized timestamps, we merged all of the traces collected during the off-line phase into a single, unified table containing tuples of the form (x,y,d,ssi,snri), where $i \in 1, 2, 3$ corresponding to the three base stations."*
What do the x, y, d, ssi, snri stand for in this statement? **[4]**
Ans: User's location (x,y) the direction (d) (one of north, south, east, or west) that he/she is facing at the time the measurement is made

3. Consider a hypothetical Fitness Tracking Application that seeks to detect a query Q.
Q: *"Take pushups for* 12 *minutes while exposed to an ambient temperature greater than* 25 *Degree C (over a* 15 *minutes window) and exhibit an average pulse rate (over* 5 *minute window) of* $>$ 80 *beats/min".*

Assume that this application uses an external wrist worn device, equipped with accelerometer (sensor S1, sampling rate 120 samples/sec), temperature sensor (sensor S2, sampling at 1 sample/sec) and pulse rate sensor (S3, sampling at 15 samples/sec). The probabilities of each event to be true: P(S1)= 0.60, P(S2)=0.25 and P(S3)=0.20 Furthermore, given the potentially different sample sizes and transmission rates for each sensor, assume that the acquisition energy costs, denoted by E(Si) are as follows: E(S1) = 0.2 nJ/sample, E(S2) = 0.05 nJ/sample and E(S3) = 0.3 nJ/sample.

Find the best acquisition sequence based on normalized acquisition cost (NAC) for the disjunctive query counterpart of Q. **[2+5]**
Ans: Disjunctive query of Q: *"Take pushups for 12 minutes* ***OR*** *exposed to an ambient temperature greater than 25 Degree C (over a 15 minutes window)* ***OR*** *exhibit an average pulse rate (over 5 minute window) of* $>$ 8 *beats/min'.*

For a disjunctive query, the processing can terminate as soon as there is a single TRUE predicate. Accordingly, in this case, the NAC should be computed as a ratio of the acquisition cost **normalized by the predicate being TRUE probability

Therefore: NAC(S_i) = $\frac{SamplingRate\_S_i \times E(S_i)}{P(S_i)}$
NAC(S1) = (120*0.2)/0.6 = 40
NAC(S2) = (1*0.05)/0.25 = 0.2
NAC(S3) = (15*0.3)/0.2 = 22.5
best acquisition sequence= S1,S3,S2

4. (a) Consider the Dejavu system for energy-efficient outdoor localization. Fill in the blanks using concepts from Dejavu: **[2.5]**
   i. As one enters a tunnel, the cellular signals (for the associated and neighboring cells) decreases (increases/decreases).
   ii. The curves in roads are identified by high variance in phone orientation angle (gravity acceleration/phone orientation angle/cellular RSS).

iii. The tunnel is identified by low (high/low) variance in the x-axis (direction of car motion) of the ambient magnetic field and high (high/low) variance in the y-axis (perpendicular to the car direction of motion) of the ambient magnetic field.

iv. Dejavu uses the Vincenty (DBSCAN / Euclidean / Vincenty) formula to compute the new phone position.

(b) Give two examples of virtual landmarks. **[2]**
Ans: Examples include points with unique GSM or WiFi RSS signature, areas with anomalous sensor behavior, among others

(c) How do we compute the distance between two samples in the cellular or Wifi feature space? Do mention what the terms stand for **[2]**
Ans: Formula:

$$\frac{1}{|A|}\sum_{\forall a \in A}\frac{min(f_1(a), f_2(a))}{max(f_1(a), f_2(a))}$$

Where A represents the union of the set of APs heard in the two samples; fi(a) represents the RSS heard from AP a in sample i (fi(a) = 0, if a is not heard in sample i

(d) How are bridges and bumps distinct with respect to anchor classification? **[1.5]**
Ans: Bumps cause the same eect as bridges (y or z gravity acceleration going up then down) but bridges are unique in having this eect over a longer distance than bumps.

5. Suppose there are 2 cell-towers T_1 and T_2; each having 4 cells. Cell-names are given in the following manner: C_{ij} is the name of the j^{th} cell belonging to the i^{th} cell-tower. For example, C_{12} is the 2^{nd} cell of cell-tower T_1. Below is a map of the area where war-driving is done. Also note that the car has taken the reading in 1 sec interval.

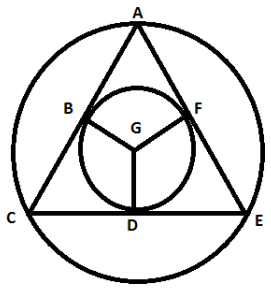


Figure 1: map

The following table contains the X-Y co-ordinates of 7 locations A,B,C,D,E,F,G and cell strengths (in dBm) of all 8 cells at those locations Assume that the strengths of the cells belonging to the same cell-tower at a particular location may differ by any amount.

(a) Find the location of cell C_{13} using strongest RSS and cell C_{24} using weighted centroid methods. **[1+2]**
-Strongest RSS for $C13$ is -15, i.e. location A (7,12)
-Weighted centroid method for C24:
$X = \frac{[7*(-15)+10*(-21)+\cdots+18*(-86)]}{[(-15)+(-21)+...+(-86)]} = \frac{5397}{361} = 14.95$

Location	X	Y	C_{11}	C_{12}	C_{13}	C_{14}	C_{21}	C_{22}	C_{23}	C_{24}
A	7	12	-50	-96	-15	-45	-78	-22	-21	-15
B	10	8	-61	-62	-56	-38	-70	-83	-57	-21
C	9	4	-81	-69	-69	-77	-10	-31	-42	-43
D	13	16	-53	-72	-42	-73	-38	-86	-67	-83
E	16	11	-20	-34	-83	-43	-59	-37	-59	-61
F	21	5	-45	-51	-73	-68	-42	-64	-75	-52
G	18	2	-42	-55	-36	-94	-75	-47	-53	-86

$Y = \frac{[12*(-15)+8*(-21)+...+2*(-86)]}{[(-15)+(-21)+...+(-86)]} = \frac{2951}{361} = 8.174$
Location = (14.95,8.174)

(b) Use RSS Thresholding (assuming threshold −55dBm) to identify which cells can be out of the marked boundary. **[1.5]**
Max(C11) = -20, Max(C12) = -34, Max(C13) = -15, Max(C14) = -38
Max(C21) = -10, Max(C22) = -22, Max(C23) = -21, Max(C24) = -15
Maximum strength of each cell is greater than the threshold. So no cells are out of the boundary

(c) Use Boundary Filtering to identify which cells can be out of the marked Boundary. Explain briefly **[1.5]**
Max(C11) = -20 at E
Max(C12) = -34 at E
Max(C13) = -15 at A
Max(C14) = -38 at B
Max(C21) = -10 at C
Max(C22) = -22 at A
Max(C23) = -21 at A
Max(C24) = -15 at A
As Location A, C and E are on the boundary therefore $C11$,$C12$,$C13$,$C21$,$C22$,$C23$,$C24$ can be out of the marked boundary

(d) Use Tower-based Regrouping (using above two results) to identify whether any of the cell-towers is outside the marked boundary of the area and justify. **[2]**
Using the above two result, both the tower T1 and T2 can be outside the boundary

End