CSE535: Mobile Computing MidTerm

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Question 1.

We know that the avg speed of traffic = 15 kmph
avg speed in m/s = 15000/3600 = 4.167 m/s

we can compute distance using $D = Speed \times Time$
At time, t = 0 we know distance = 0
At time, t = 5, $D = 4.167 \times 5 = 20.835m$
we compute the distance till it is greater than 50m which is the error in GPS localization

	t = 0	t=5	t=10	t=11	t=12
Distance	0	20.835	41.67	45.837	50.004

Since the location information from GPS would have error after at D = 50m+ which is **Time = 12 seconds** from the above calculations, We should switch from GPS to cellular at **Time = 12 s**

The above calculations are under the assumption that the car moves at constant speed of 4.167 m/s at average traffic.
The time to switch to cellular can also be affected by the traffic, wherein if the car moves very slow or stuck at a traffic and moves 50m in 10 mins and then moves faster later on to give a avg speed of 15kmph then the time to switch to cellular would increase. So it totally depends on how long it takes for the vehicle to cover the first 50m from when the GPS signal was lost.

Question 2.

Given: Brain signal sensing freq = 400Hz
DataPoint size = 32 bit
Hence, $DataRate = 32 = 12.8kbps$
AoA data rate = 5kbps
Other sensor data rate = 300 kbps

We are recording data for 5 seconds,

$$Totaldatatobetransfered = 1589kb$$

	GPU	FOG
Given Upload time	1 Mbps = 1000kbps	5Mbps = 5000 kbps
Time taken to upload 1589kb	1.589 sec	0.3178 sec
Given Computation time	1500 kbps	200 kbps
Time taken to compute 1589kb	1.059 sec	7.945 sec
Total Time	2.648 sec	8.2628 sec

From the above table we see that the total time taken by FOG is greater than GPU.
Hence **GPU is faster than FOG**

For the second part of the question,
Given : GPU Failure rate : 20%
During failure along with the regular computation time, we are told that it takes 500 milliSeconds to communicate the failure and we are told that we follow the same uploading process and computation again.
Hence, **Time taken during failure** $= 2648 + 500 + 2648 = 5796ms$

Hence, we find the

$$AvgTimeTaken = (0.2 \times 5796 + 0.8 \times 2648)/(0.2 + 0.8)$$
$$= \mathbf{3277.6ms}$$

Question 3.

We can create a Finite Markov chain Model to estimate the time after which the AC should be restarted. Considering that the Markov chain would be at the steady state, Lets find the unique states for each person,
Person A (States): Home, Office, Park, Groceries, Restaurant, Movie
Person B (States): Home, Groceries, School, Restaurant, Club, Park, Movie
Now lets create the transition matrices for all the given data(Monday to Sunday):
Person A:

	Home	Office	Park	Groceries	Restaurant	Movie
Home	0.867	0.055	0.055	0.011	0.022	0
Office	0.0425	0.8936	0	0.0213	0.0213	0.0213
Park	0.3571	0	0.6429	0	0	0
Groceries	0.6	0	0	0.4	0	0
Restaurant	0.25	0	0	0.125	0.625	0
Movie	0.333	0	0	0	0	0.667

Person B:

	Home	Groceries	School	Restaurant	Club	Park	Movie
Home	0.8823	0.0168	0.0588	0.0168	0	0.0168	0.0084
Groceries	0	0.5	0	0.5	0	0	0
School	0.3	0	0.667	0	0.033	0	0
Restaurant	0.4	0	0	0.6	0	0	0
Club	0	0	0.333	0	0.667	0	0
Park	0.5	0	0	0	0	0.5	0
Movie	0.333	0	0	0	0	0	0.667

Let H=Home, O=Office, P=Park, G=Groceries, R=Restaurant, M=Movie, C=Club, S=School

Now Our Goal is to find the Expected time to reach Home from Office i.e., $E(H|O)$
To calculate $E(H|O)$, we take one step forward and find out the possibility that the next state could be H,O,G,R,M
So We compute $E(H|O)$ as follows,

$$E(H|O) = 1 + \sum_{j=Allpossiblenextstates} P(j|O)E(H|j)$$

Hence,

$$E(H|O) = 1 + 0.8936E(H|O) + 0.0213E(H|G) + 0.0213E(H|R) + 0.0213E(H|M)$$

$$E(H|P) = 1 + 0.6429E(H|P)$$
$$E(H|R) = 1 + 0.125E(H|G) + 0.625E(H|R)$$
$$E(H|M) = 1 + 0.667E(H|M)$$

Solving all the above equations, we get,

$$E(Home|Office) = 10.977 hours$$

We see that it takes 10.977 hours for person A to come back home from office.

Let's do the same and find out how long it takes for person B to come back. Since person B is coming from School, we need $E(Home|School) or E(H|S)$

$$E(H|S) = 1 + 0.667E(H|S) + 0.033E(H|C)$$

$$E(H|C) = 1 + 0.333E(H|S) + 0.667E(H|C)$$

Solving above equations, we get,

$$E(Home|School) = 3.66 Hours$$

Since time taken by Person B is lesser than A, the AC should be restarted before B arrives home. Now since it takes 15 mins to get the AC to work on desired temperature, the estimated time to restart the AC would be $3.66 - 0.25 =$ **3.41 Hours** from 9 AM

This gives us a rough idea of when the thermostat should restart the AC.
Now diving down to the specific questions
(i) We need to find the time after which the Nest thermostat should restart the AC given that the location of **Person A = 'Office'** and **Person B = 'School'** at 9 Am.
Days when the above condition satisfies: **Monday, Tuesday, Wednesday, Thursday**
The Transition matrix for Person A and B for these 4 days is as follows:
Person A:

	Home	Office	Park	Groceries	Restaurant	Movie
Home	40/46	3/46	2/46	1/46	0	0
Office	2/40	36/40	0	1/40	1/40	0
Park	2/4	0	2/4	0	0	0
Groceries	2/3	0	0	1/3	0	0
Restaurant	1/3	0	0	0	2/3	0
Movie	0	0	0	0	0	0

Person B:

	Home	Groceries	School	Restaurant	Club	Park	Movie
Home	58/65	2/65	5/65	0	0	0	0
Groceries	0	2/4	2/4	0	0	0	0
School	7/24	0	16/24	0	1/24	0	0
Restaurant	0	0	0	0	0	0	0
Club	0	0	1/3	0	2/3	0	0
Park	0	0	0	0	0	0	0
Movie	0	0	0	0	0	0	0

Now Our Goal is to find the Expected time to reach Home from Office i.e., $E(H|O)$
To calculate $E(H|O)$, we take one step forward and find out the possibility that the next state could be H,O,G,R,M
So We compute $E(H|O)$ as follows,

$$E(H|O) = 1 + \sum_{j=Allpossiblenextstates} P(j|O)E(H|j)$$

Hence,

$$E(H|O) = 1 + 36/40E(H|O) + 1/40E(H|G) + 1/40E(H|R)$$

$$E(H|G) = 1 + 1/3E(H|G)$$
$$E(H|R) = 1 + 2/3E(H|R)$$

Solving all the above equations, we get,

$$E(Home|Office) = 11.125hours$$

We see that it takes 11.125 hours for person A to come back home from office.

Let's do the same and find out how long it takes for person B to come back. Since person B is coming from School, we need $E(Home|School) or E(H|S)$

$$E(H|S) = 1 + 16/24E(H|S) + 1/24E(H|C)$$

$$E(H|C) = 1 + 1/3E(H|S) + 2/3E(H|C)$$

Solving above equations, we get,

$$E(Home|School) = 3.85Hours$$

From the above values we see that B reaches home sooner than A, hence we choose time taken by B to come home to calculate when to restart the AC.

$$9Am + 3.85hours - 15minutes = 12:36AM$$

But since on Thursday, No body is home by 12:36 Am, see who arrives first and we find out that B reaches home 6 PM, hence on thursday the AC should restart at 5:45 PM
Monday to wednesday: 12:36 AM, Thursday: 5:45 PM

(ii) We need to find the time after which the Nest thermostat should restart the AC given that the location of Person A = 'Not Home' and Person B = 'Not Home' at 9 Am.
Days when the above condition satisfies: Monday, Tuesday, Wednesday, Thursday and Saturday
The Transition matrix for Person A and B for these 5 days is as follows:
Person A:

	Home	Office	Park	Groceries	Restaurant	Movie
Home	52/61	3/61	3/61	1/61	2/61	0
Office	2/40	36/40	0	1/40	1/40	0
Park	3/6	0	3/6	0	0	0
Groceries	3/5	0	0	2/5	0	0
Restaurant	2/8	0	0	1/8	5/8	0
Movie	0	0	0	0	0	0

Person B:

	Home	Groceries	School	Restaurant	Club	Park	Movie
Home	72/82	2/82	5/82	2/82	0	1/82	0
Groceries	0	2/4	2/4	0	0	0	0
School	7/24	0	16/24	0	1/24	0	0
Restaurant	2/5	0	0	3/5	0	0	0
Club	0	0	1/3	0	2/3	0	0
Park	1/2	0	0	0	0	1/2	0
Movie	0	0	0	0	0	0	0

Now Our Goal is to find the Expected time to reach Home from Not Home i.e., $E(H|O)\&E(H|R)$ Let's use the E(H|O) calculated above
To find E(H|R) for Saturday, we do

$$E(H|R) = 1 + 3/5E(H|R)$$

$$E(H|R) = 2.5Hours$$

Let's do the same and find out how long it takes for person B to come back.

$$E(H|R) = 1 + 1/8E(H|R) + 1/8E(H|G)$$

$$E(H|G) = 1 + 2/5E(H|G)$$

Solving above equations, we get,

$$E(H|R) = 1.88Hours$$

From the above values we see that on Saturday B reaches home sooner than A, hence we choose time taken by B to come home to calculate when to restart the AC.

$$9Am + 1.88hours - 15minutes = 10:38AM$$

On Saturday the AC should be started at 10:38 AM
Monday to Wednesday: 12:36 AM, Thursday: 5:45 PM, Saturday: 10:38 AM

Approximating the above result we get:
(i)**Monday to Wednesday: 12:45 AM, Thursday: 5:45 PM**
Monday to Wednesday: 12:45 AM, Thursday: 5:45 PM, Saturday: 10:45 AM

Question 4.

(i) The key here is that the "world class" is publicly available. This means that, even when the adversary doesn't know the exact model used by the application, it can still make use of its the black box access.i.e., The adversary can input each data point from the publicly available world class and find out the soft label(the computed class) which is nothing but the evaluations of the equation wx + b for all input x. This way the adversary now has the complete data set with input and it's appropriate class computed by the biometric authentication system. Now this dataset can be used to train the new model created by the adversary, and this model is trained in such a way as to compute all the classes exactly as in the dataset, with minimal error. This way the adversary would be able to build a model exactly as that of the model used by the biometric authentication system. By finding the model of this kind, means that we have computed the values of w and b as close as possible to the ones used in the original model.

(ii) Since we are mimicking a new model, the above mentioned strategy is not going to be affected when the SVM is replaced by Kernel SVM model in the biometric authentication system. There may be minor misclassification, but it won't turn out to be a huge factor. It is a two class problem and SVM is usually used on linearly separable data. Hence we can assume that the biometric authentication system works on a linearly separable data. But even if it is not linearly separable, by replacing it with the kernel SVM is just going to transform the non linearly separable data in 2D space to higher dimension by plotting the 2D along the next dimension. This way we can draw a plane in 3D to come up with a linearly separable classification model.

Question 5.

I would like to mention Tesla's auto pilot and self driving capabilities as an example for this mismatch in mental models of designer, engineer and the end user.

Example: Tesla auto pilot and self driving capabilities
Designer/Engineer's mental Model: User would stay awake and apply a small turning force to the wheel every 10 secs to 30 secs
User's mental model: Auto pilot works on its own from the start of the trip from driveway to destination without user interaction
Safety risk: Car crash, fatal injuries, Traffic issues

Explanation: Tesla auto pilot and self driving feature, performs its self driving abilities in a restricted way wherein the turns at signals are expected to be done by the user. But if the user is not awake at the time of signal turns, the car might get stuck at the signal which causes inconvenience to other drivers. But more fatal injuries are possible when the user is asleep while driving in a highway. Here the auto pilot system expects the user to apply a small turning force to the wheel every 10 to 30 secs in order to know that the car is assisted by a driver. But as a user if we sleep during the journey, there are higher risks of getting into a fatal car crash due to lack of assistance. There have been many reported Tesla car crashes due to the above reason in the early releases of the Tesla cars.

From the above example we see that the designer/Engineer's mental model seems to not align with the user's mental model and hence we see that this is one of the biggest problem faced in developing a context aware applications.