

Artificial Intelligence - Assignment 3

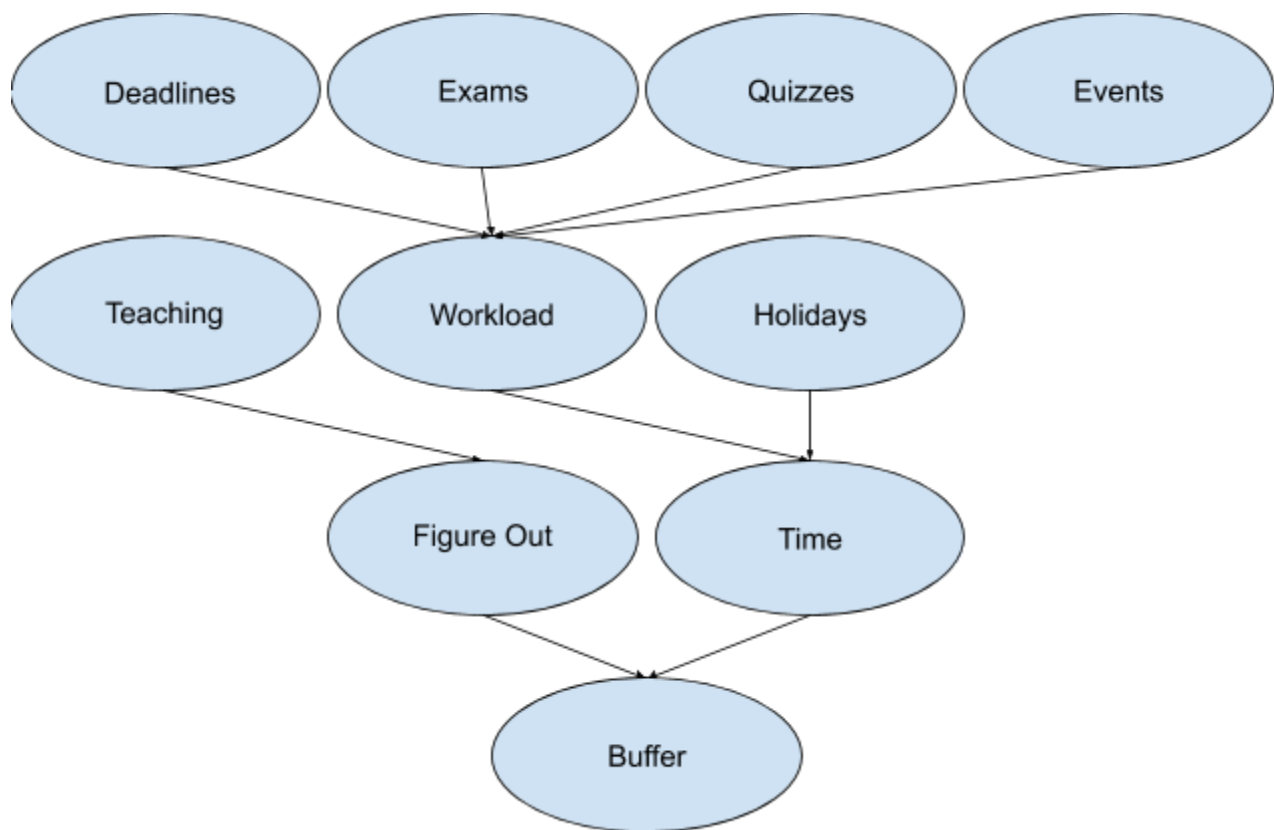
Team 71

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Problem 3

Bayes' Net Diagram



Key

D	Number of Deadlines	0, 1 or 2, 3 or More
Ex	Presence of Exams	True, False
Q	Number of Quizzes	0, 1, 2 or More
Ev	Presence of Events or Festivals	True, False
Te	Whether the portion was Taught in class or not	True, False
W	A student's existing Workload	Low, Average, High
H	Number of Holidays	0, 1, 2
F	Expected Time to Figure out what needs to be done	Negligible, Substantial
T	Effective amount of quality Time to finish the Assignment	< 6 hours, 6 hrs to 12 hrs, > 12 hrs
B	Required number of buffer days	1, 2, 3

The Buffer captures the number of days i.e 'x' in the problem statement.

Conditional Probability Tables:

Deadlines

D	0	1 or 2	3 or More
P(D)	0.1	0.7	0.2

Exams

Ex	True	False
P(Ex)	0.3	0.7

Quizzes

Q	0	1	2 or More
P(Q)	0.6	0.3	0.1

Events

E	True	False
P(E)	0.7	0.3

Teaching

Te	True	False
P(Te)	0.75	0.25

Workload

D	Ex	Q	Ev	W.Low	W.Average	W.High
0	True	0	True	0.166	0.308	0.526
0	True	0	False	0.227	0.422	0.351
0	True	1	True	0.141	0.262	0.596
0	True	1	False	0.203	0.376	0.421
0	True	> 2	True	0.110	0.217	0.667
0	True	> 2	False	0.178	0.331	0.491
0	False	0	True	0.289	0.536	0.175
0	False	0	False	0.350	0.650	0.000
0	False	1	True	0.264	0.490	0.246
0	False	1	False	0.325	0.604	0.070
0	False	> 2	True	0.239	0.445	0.316
0	False	> 2	False	0.301	0.559	0.140
1 or 2	True	0	True	0.129	0.239	0.632
1 or 2	True	0	False	0.190	0.354	0.456
1 or 2	True	1	True	0.104	0.194	0.702
1 or 2	True	1	False	0.166	0.308	0.526
1 or 2	True	> 2	True	0.080	0.148	0.772

1 or 2	True	> 2	False	0.141	0.262	0.596
1 or 2	False	0	True	0.250	0.468	0.281
1 or 2	False	0	False	0.313	0.582	0.105
1 or 2	False	1	True	0.227	0.422	0.351
1 or 2	False	1	False	0.289	0.536	0.175
1 or 2	False	> 2	True	0.203	0.376	0.421
1 or 2	False	> 2	False	0.264	0.490	0.246
> 3	True	0	True	0.055	0.103	0.842
> 3	True	0	False	0.113	0.217	0.667
> 3	True	1	True	0.031	0.057	0.912
> 3	True	1	False	0.092	0.171	0.737
> 3	True	> 2	True	0.006	0.011	0.982
> 3	True	> 2	False	0.068	0.125	0.807
> 3	False	0	True	0.178	0.331	0.491
> 3	False	0	False	0.239	0.445	0.316
> 3	False	1	True	0.154	0.285	0.561
> 3	False	1	False	0.215	0.399	0.386
> 3	False	> 2	True	0.129	0.239	0.632
> 3	False	> 2	False	0.190	0.354	0.456

Holidays

H	0	1	2
P(H)	0.7	0.28	0.02

Figure Out

Te	F.Negligible	F.Substantial
True	0.95	0.05
False	0.25	0.75

Time

W	H	< 6 hours	6 to 12 hrs	> 12 hrs
Low	0	0.6	0.3	0.1
Low	1	0.55	0.33	0.12
Low	2	0.5	0.35	0.15
Average	0	0.85	0.1	0.05
Average	1	0.8	0.12	0.08
Average	2	0.75	0.15	0.1
High	0	0.99	0.009	0.001
High	1	0.95	0.04	0.01
High	2	0.9	0.08	0.02

Buffer

F	T	B.1	B.2	B.3
Negligible	< 6 hrs	0.1	0.2	0.7
Negligible	6 to 12 hrs	0.3	0.3	0.4
Negligible	> 12 hrs	0.7	0.2	0.1
Substantial	< 6 hrs	0.01	0.04	0.95
Substantial	6 to 12 hrs	0.05	0.15	0.8
Substantial	> 12 hrs	0.1	0.3	0.6

Justifications:

1. The probabilities of number of deadlines and quizzes and the presence of assignments and events/fests have been arrived upon by intuitively gauging the situation or rather the current predicament of the students of our batch.
2. In most courses, the assignment is posted after covering the required background knowledge and hence $P(Te)$ has been given a high probability of 0.75.
3. To arrive at a scale for the workload, the following formula has been used:

$$\begin{aligned} &P(\text{Workload being high}) \\ &= (U * 100 + V * 20 + W * 50 + X * 30) / 290 \end{aligned}$$

Where

U : 0 if Ex is False, 1 otherwise

V : 0 if Q is 0, 1 if Q is 1, 2 if Q > 2

W : 0 if Ev is False, 1 if Ev is True

X : 0 if D is 0, 1 if D is 1 or 2, 3 if D is > 3

And the residual has been divided in a 65 : 35 ratio between the average and low Workload probabilities respectively

5. The probabilities of the week having a holiday have been arrived at by judging the number of holidays in a typical week in the academic calendar.

6. If the content has been covered, the probability that very little figuring out on part of the students is required, is really high. The table turns in case the portion has not been covered adequately.

7. Whether the Time available is in the range < 6 hrs, 6 to 12 hrs or > 12 hrs can be identified based on the workload and the number of holidays. As #Holidays increase, Time available goes up and as Workload increases, time available goes down.

8. The buffer value 'x' is based on the effective time available and the whether the time spent in figuring out is negligible or substantial. The buffer should be increased as lesser and lesser time is available and should be decreased if lesser time is spent in figuring out what is to be done. This has been probabilistically captured.

Query

Form: $P(X \mid p(X), p(p(X)))$

$P(B = 1 \mid F = \text{Negligible}, Te = \text{True})$

$$= \frac{P(B = 1, F = \text{Negligible}, Te = \text{True})}{P(F = \text{Negligible}, Te = \text{True})}$$

Now, $P(B = 1, F = \text{Negligible}, Te = \text{True})$

=

$$\sum_D \sum_{Ex} \sum_Q \sum_{Ev} \sum_W \sum_H \sum_T P(B=1, F=\text{Negligible}, Te=\text{True}, D, Ex, Q, Ev, W, H, T)$$

=

$$\begin{aligned} & \sum_D \sum_{Ex} \sum_Q \sum_{Ev} \sum_W \sum_H \sum_T P(B = 1 \mid F, T). P(F = \text{Negligible} \mid Te = \text{True}) \\ & \quad . P(Te = \text{True}). P(D). P(Ex). P(Q). P(Ev) \\ & \quad . P(W \mid D, Ex, Q, Ev). P(H). P(T \mid W, H) \end{aligned}$$

And

$P(F = \text{Negligible}, Te = \text{True})$

=

$$\sum_{B} \sum_{D} \sum_{Ex} \sum_{Q} \sum_{Ev} \sum_{W} \sum_{H} \sum_{T} P(F=\text{Negligible}, Te=\text{True}, B, D, Ex, Q, Ev, W, H, T)$$

=

$$\begin{aligned} & \sum_{B} \sum_{D} \sum_{Ex} \sum_{Q} \sum_{Ev} \sum_{W} \sum_{H} \sum_{T} P(F = \text{Negligible} \mid Te = \text{True}). P(Te = \text{True}) \\ & \quad .P(D). P(Ex). P(Q). P(Ev). P(B \mid F, T) \\ & \quad .P(W \mid D, Ex, Q, Ev). P(H). P(T \mid W, H) \end{aligned}$$

- With summations being over respective Domains

Therefore,

Required Probability = 0.15107130955968837

(Kindly Refer to the python code for the calculation)

Similarly,

$P(B = 2 \mid F = \text{Negligible}, Te = \text{True}) = 0.211409844524415$

And,

$P(B = 3 \mid F = \text{Negligible}, Te = \text{True}) = 0.6375188459158962$

- Simply modify b = '1', '2' or '3' in line 417.