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ENPM808Y

HW-10

Decision Networks

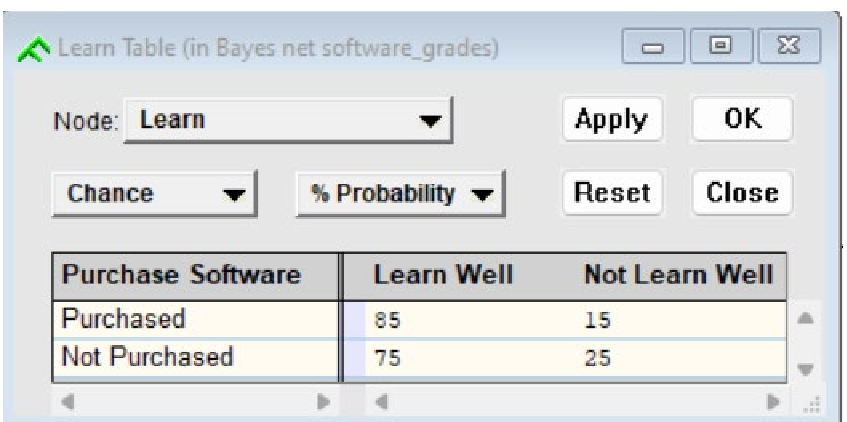
1. **Prompt**: Deciding whether to purchase a software for AI class
   S – Software
   L – Learning well
   P(L|S) – Probability of learning well given software

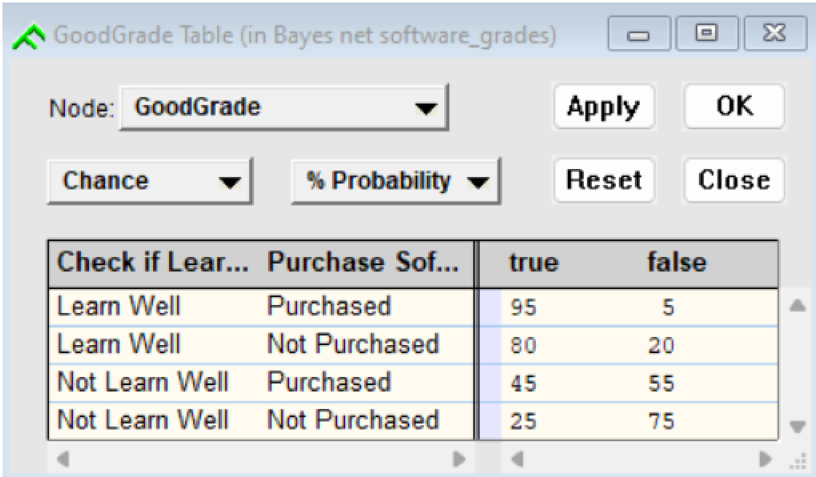
S	P (L=Learning Well| S)
Obtained	0.85
Not Obtained	0.75

G – Good grades

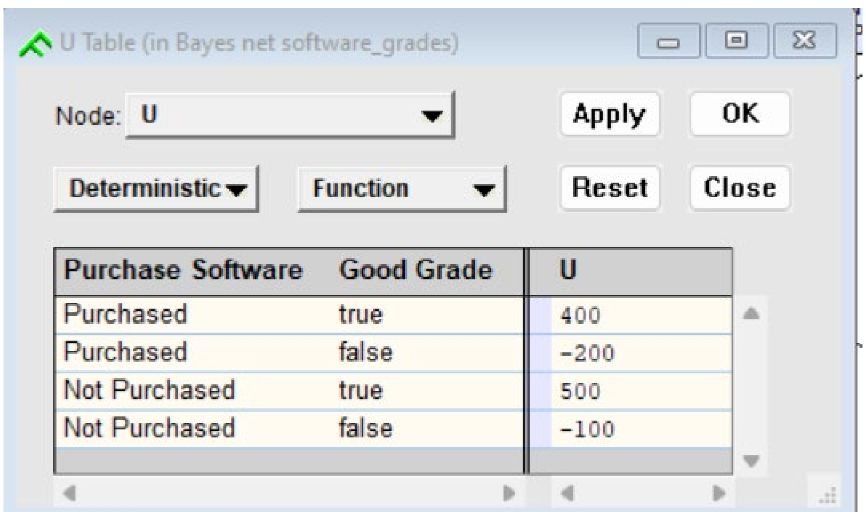
S	L	P (G=Good grades| S,L)
Obtained	Learn Well	0.95
Obtained	Not Learn Well	0.45
Not Obtained	Learn Well	0.80
Not Obtained	Not Learn Well	0.25

(a) Use Netica to implement the decision network for this problem. This network would have two nature nodes (i.e., Learn and GoodGrade), a decision node (Purchase) and a utility node (U).

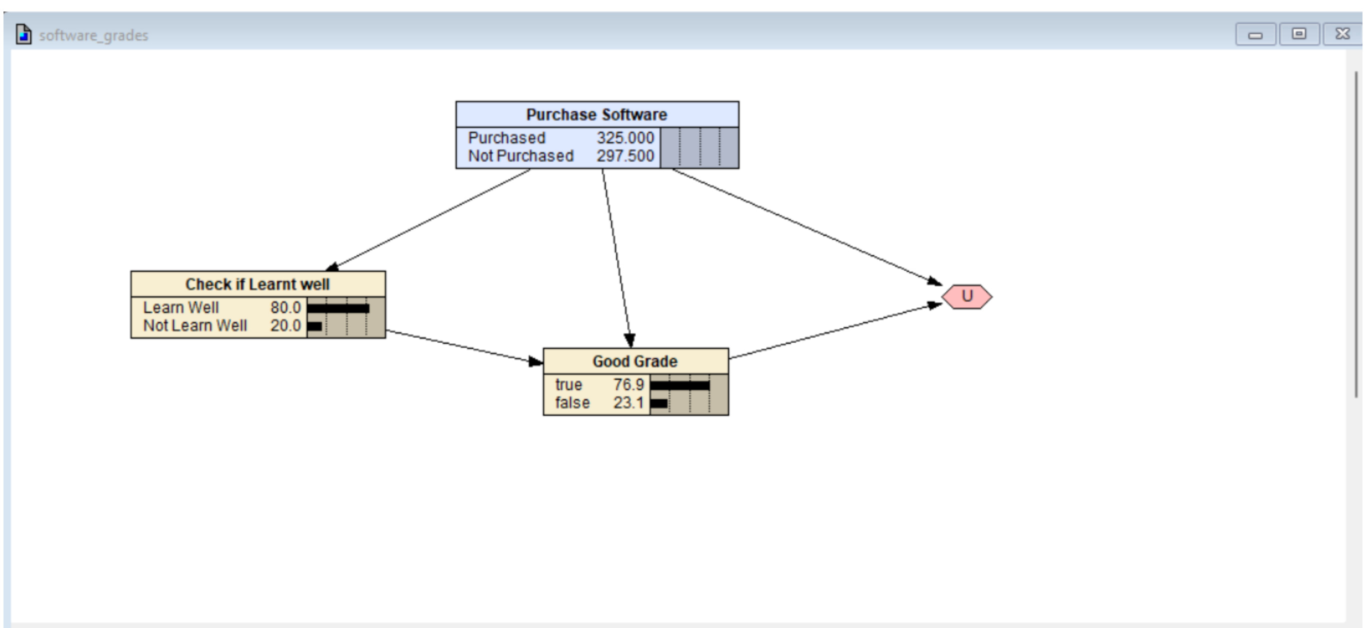




Check if Lear...	Purchase Sof...	true	false
Learn Well	Purchased	95	5
Learn Well	Not Purchased	80	20
Not Learn Well	Purchased	45	55
Not Learn Well	Not Purchased	25	75



Purchase Software	Good Grade	U
Purchased	true	400
Purchased	false	-200
Not Purchased	true	500
Not Purchased	false	-100



(b) Compute the expected utility of purchasing the software as well as the utility of not purchasing it.

As seen in the figure in part (a), the expected utility for:

Purchasing the software is $325, while for

Not Purchasing the software is $297.5

(c) Would you purchase the software?

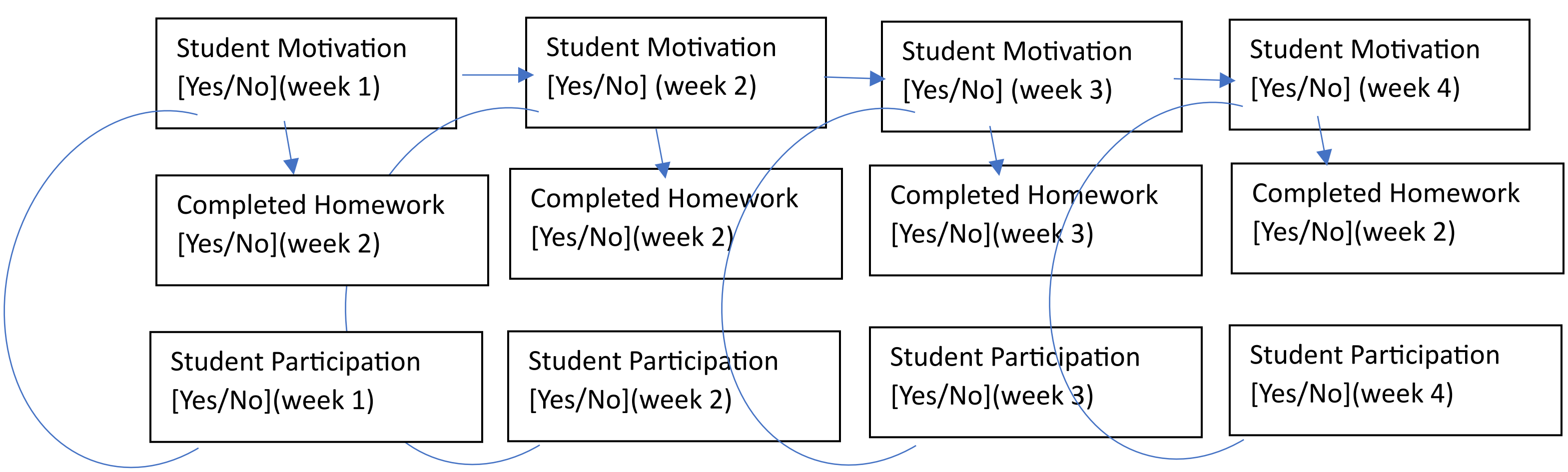
Since higher favorability is correlated with higher dollar value, as provided in the problem getting good grades equating to $500, the decision network shows that purchasing the software yields higher return in utility. So, I would purchase the software

Dynamic Modeling

2. **Prompt:** Are students are motivated in the AI course

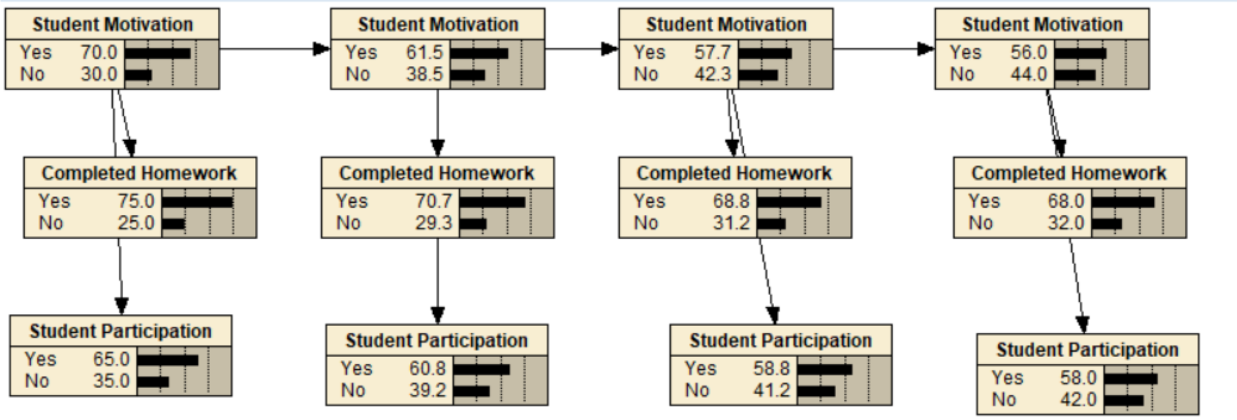
- The prior probability of students being motivated at the start of the semester with no observations is 0.7.
- The probability of student being motivated in week n is 0.75 given that the student was motivated in the previous week, and 0.3 if not.
- The probability of having done the homework is 0.9 if the students were motivated, and 0.4 if not.
- The probability of students' participation if motivated is 0.8, and 0.3 if not.

(a) Formulate this information as a dynamic Bayesian network so that we can predict student motivation from a sequence of observations. Draw the graph (consider 4 weeks) and provide the conditional probability tables (CPTs).

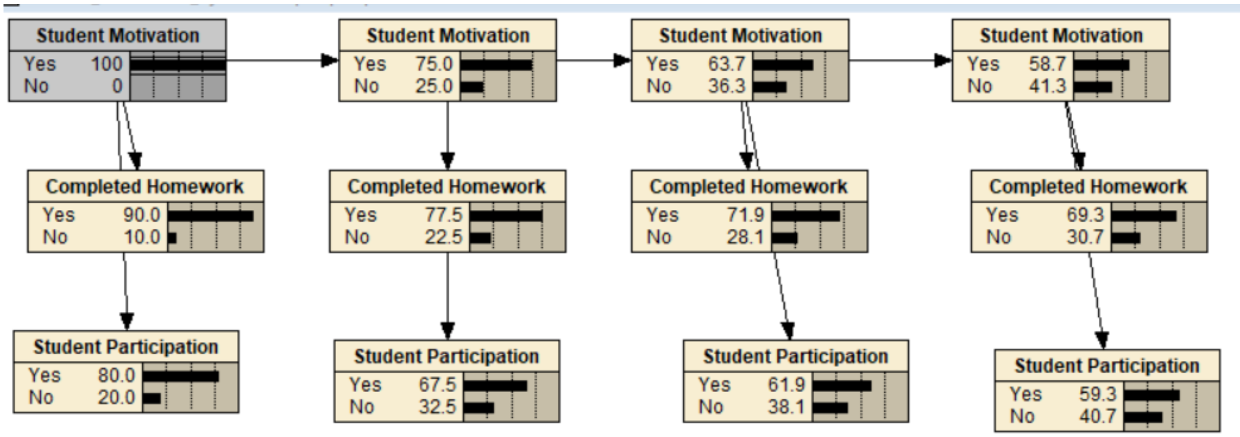


Assumption: There was no homework submission on week 1. Homeworks began getting submitted on week 2. Student participation was measured starting from week 1

(b) Implement in Netica, compile, and compute the following:



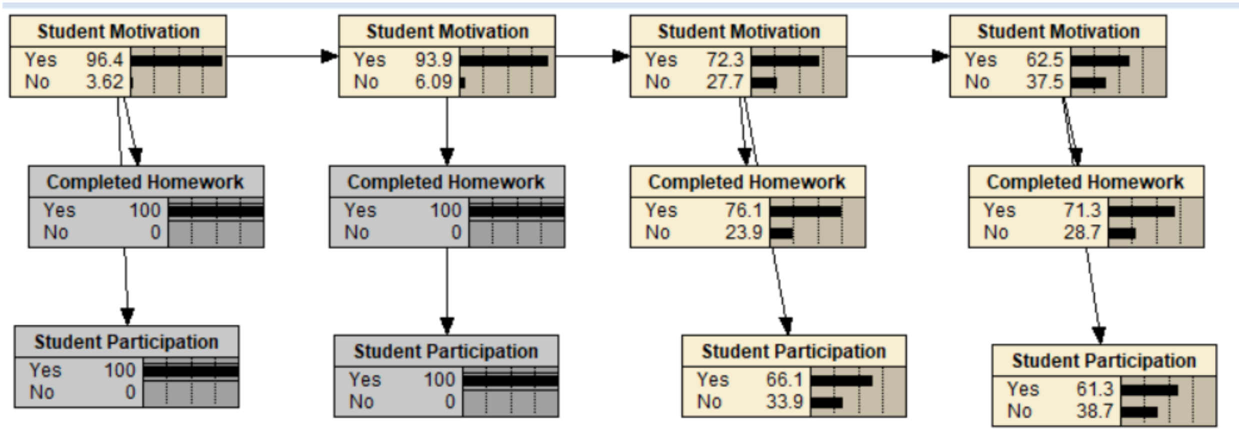
b1) what is the chance that a student who is motivated in week 1 is motivated in week 2? in week 4?



Week 2: 75%

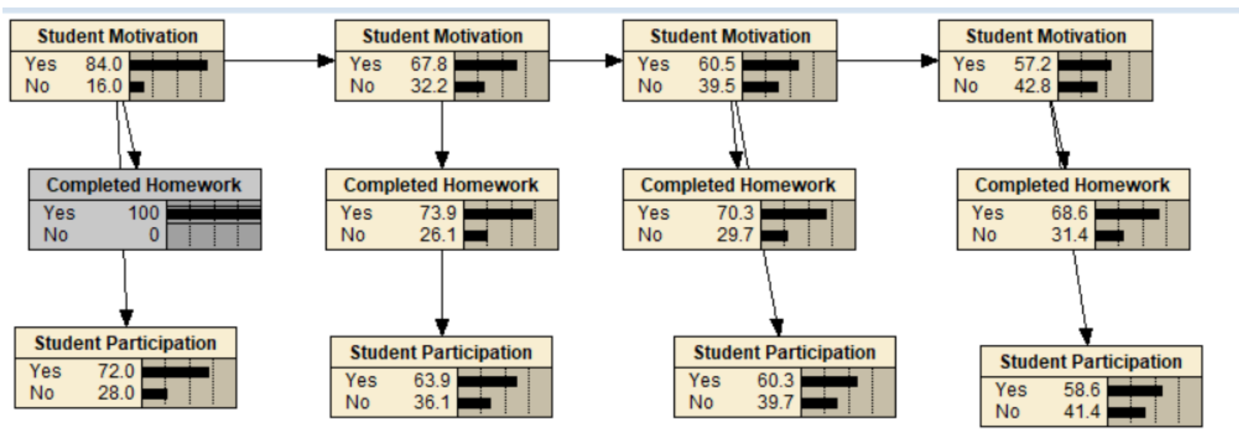
Week 4: 58.7%

b2) what is the chance that a student who has done homework and participated in both week 1 and week 2 is motivated in week 3?



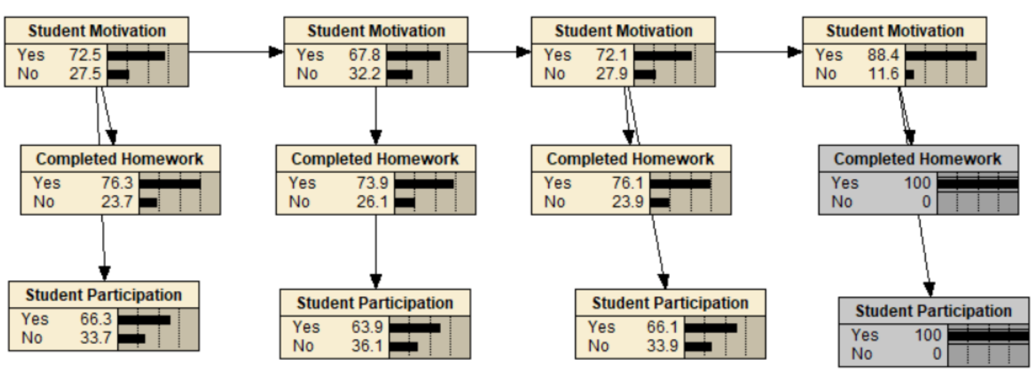
Week 3: 72.3%

B3) what is the chance that the student who in week 1 does homework but does not participate is motivated in week 4?



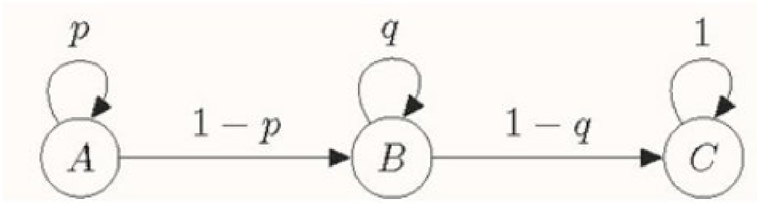
Week 4: 57.2%

B4) what is the chance that the student who does homework and participates in class in week 4 was motivated in week1?



Week 1: 72.5%

3. Suppose that an object is moving according to the following transition model:



Here, 0 < p < 1 and 0 < q < 1 are arbitrary probabilities. At time 0, the object is known to be in state A.

a. What is the probability that the object is in A at time n >= 0?

a) the probability that the object is in A at time n>=0?

A B C

Initial Probability: $P_\emptyset = [1, 0, 0]$

$n >= 0$ $\quad P_A = \underset{n=1}{p} \times \underset{n=2}{p} \times \underset{n=3}{p} \times \underset{n=4}{p} \ldots = p^n \Rightarrow \boxed{P(A) = p^n}$

b. What is the probability that the object first reaches B at time n >=1?

b) the probability the object 1st reaches B at time n>=1?

$P_B = (1-p) \times P_{(n-1)}$ → at $n=0$ $P_B = \emptyset$

$\Rightarrow \boxed{n=1 \quad P_B = (1-p) \times P(A)_\emptyset = (1-p) \times 1 = \boxed{1-p}}$

$n=2$ $\quad P_B = P_{(n-1)} \times q = (1-p) \times q$

$n=3$ $\quad P_B = P_{(n-1)} \times q = (1-p) \times q \ldots$ $\quad \boxed{P_B = (1-p) \times q^n}$

c. What is the probability that the object is in B at time n >= 1?

c) The probability that the object is in B at time $n \geq 1$?

$n=1 \quad P_B = 1-p$

$n=2 \quad P_B = P_{(n-1)} \times q = (1-p) \times q$

$n=3 \quad P_B = P_{(n-1)} \times q = (1-p) \times q^2$

$\vdots$

$\boxed{n=k \quad P_B = (1-p) \times q^{k-1}}$

d. (Bonus) What is the probability that the object first reaches C at time n >=2?

d.) The probability that the object first reaches C at time $n \geq 2$?

$n=0 \quad P_0 = [1, 0, 0] \quad \Rightarrow n=1 \quad P_B = (1-p) \times 1$

$n=2 \quad P_C = (1-p) \times (1-q)$

$n=3 \quad P_C = P(C) \times P_{(n-1)} = (1-p)(1-q) \times 1$

$\vdots$

$\boxed{n=k \quad P_C = (1-p)(1-q)}$