Artificial & Computational Intelligence

AIMLCZG557

Contributors & Designers of document content : Cluster Course Faculty Team

Previous year sample problems

BITS Pilani

Pilani Campus

Artificial and Computational Intelligence

Disclaimer and Acknowledgement

- Few content for these slides may have been obtained from prescribed books and various other source on the Internet
- I hereby acknowledge all the contributors for their material and inputs and gratefully acknowledge people others who made their course materials freely available online.
- .I have provided source information wherever necessary
- This is not a full fledged reading materials. Students are requested to refer to the textbook w.r.t detailed content of the presentation deck that is expected to be shared over e-learning portal - taxilla.
- I have added and modified the content to suit the requirements of the class dynamics & live session's lecture delivery flow for presentation

- **Slide Source / Preparation / Review:**
- From BITS Pilani WILP**:** Prof.Raja vadhana, Prof. Indumathi, Prof.Sangeetha
- From BITS Oncampus & External : Mr.Santosh GSK

Sample Problems

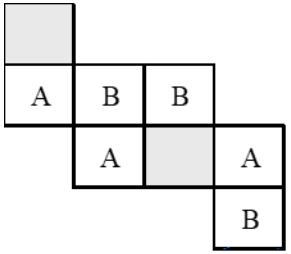
Module 3 : Gaming Problem 1

Consider a 2-player game as in below diagram. The sliding-tile game consists of three "A" tiles, three "B" tiles, and two empty spaces. [Tile shaded in gray – Empty Space/Tile]. In this game a player wins if a pattern of player owned similar three tile are placed adjacent to each other. The term adjacency represents coins are in same row or same column. Assume the player with tile 'A' starts the move from this state. In the game, player "A" and "B" alternate in their turn.

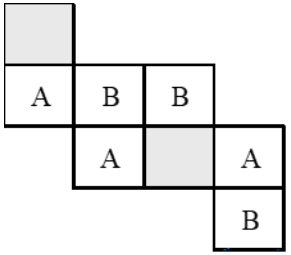
- The puzzle has two legal moves: which results in the swap of position of the tile with the empty location
- Move #1: A tile may move into an adjacent empty location.
- Move #2: A tile can only hop over one tiles in the same row into the empty position.

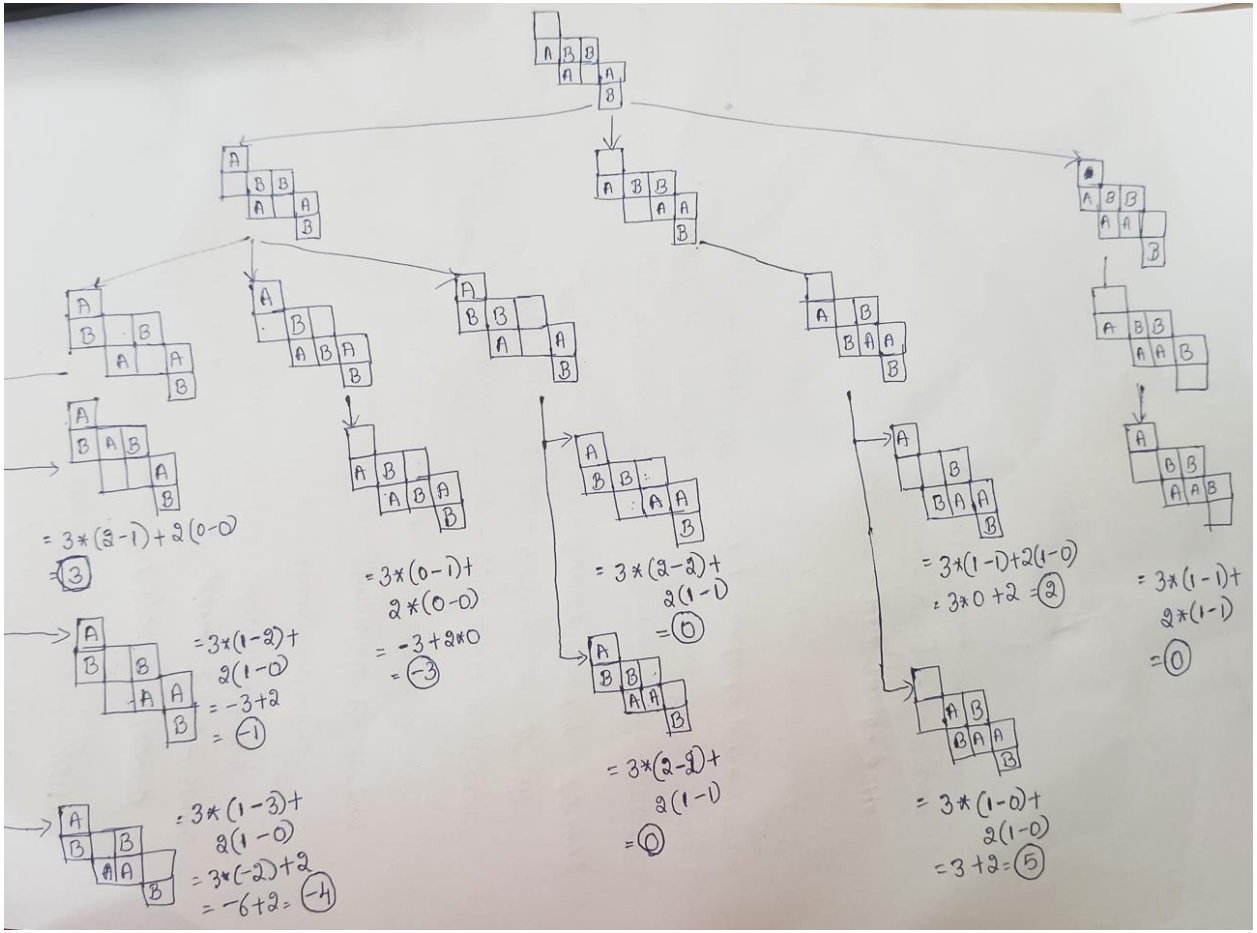
- Expand the complete game tree (with neat diagram) from the given current state up to exactly 3 levels.
- Calculate the utility of the leaves of the tree with below static evaluation function.
- Utility value = [3*(MAX's win chance – MIN's win chance)] + [2*(MAX's No.of.adjacent.pairs – MIN's No.of.adjacents.pairs)]
- Note: eg., For the given Initial configuration, MAX's win chance is calculated as "In the current initial state 3 MAX coins ie., (A) are adjacent to empty cell and hence its win's chance = 3." and the MIN's win chance is calculated as "In the current initial state 1 MIN coins ie., (B) is adjacent to empty cell and hence its win's chance = 1."

1. Apply the MIN MAX algorithm on the game tree
2. Apply Alpha – Beta Pruning foo the game tree

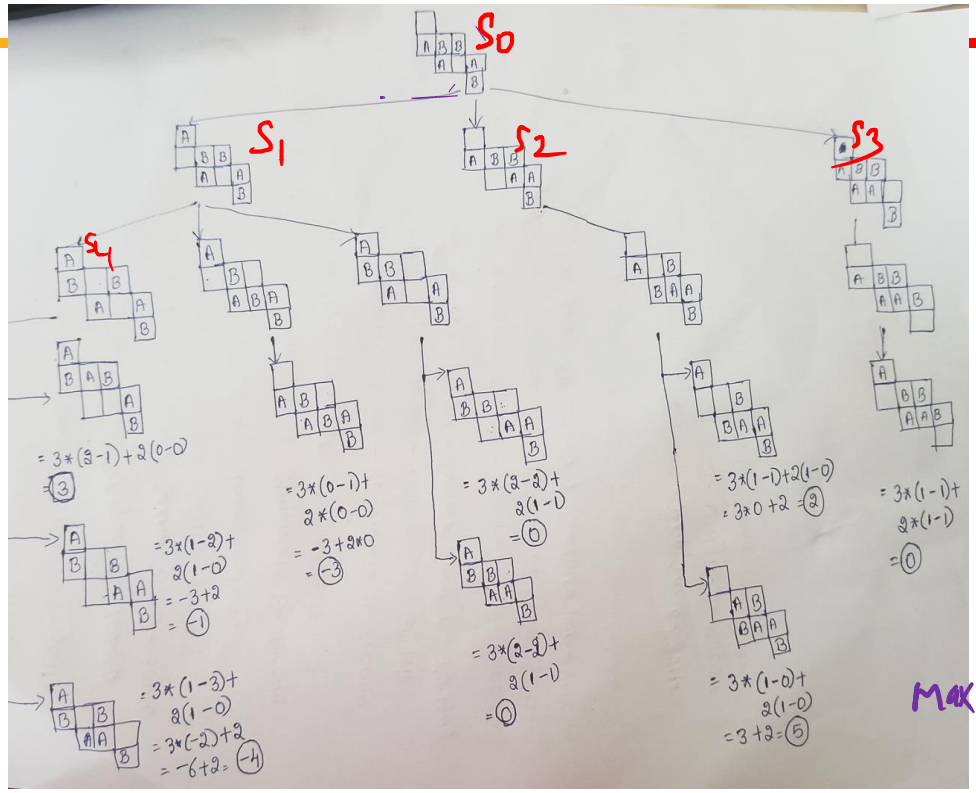


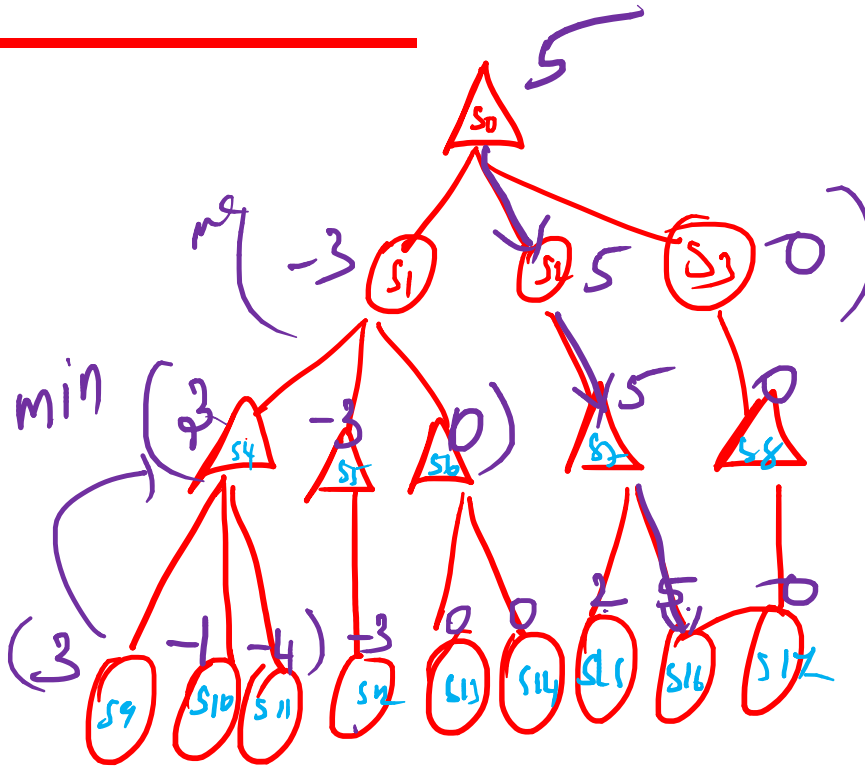
Module 3 : Gaming Problem 1





Module 3 : Gaming Problem 1





A	B	B
	A	
		A
		B

A α β

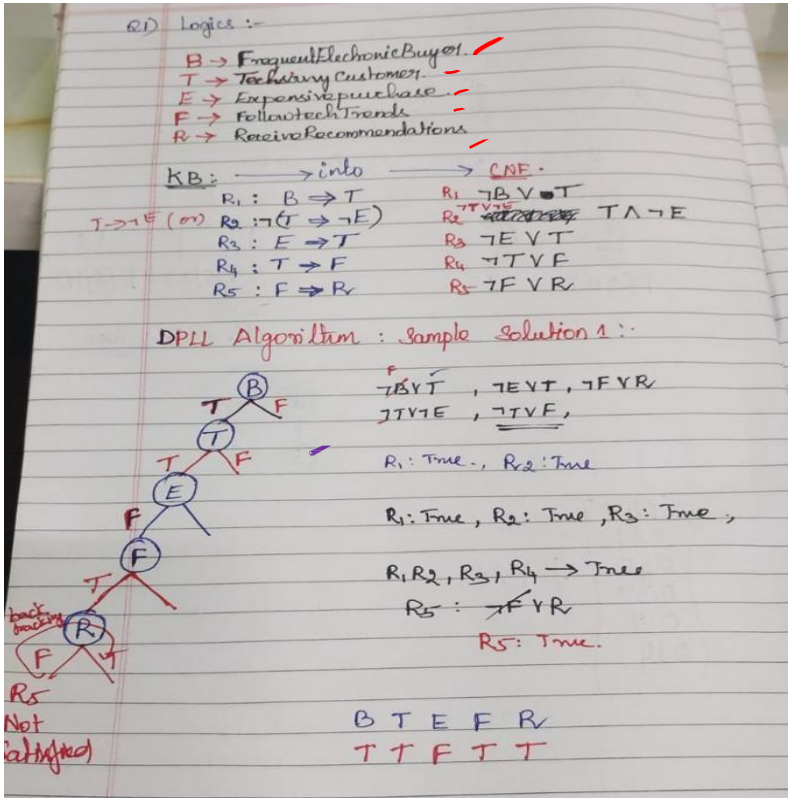
$S_0 \rightarrow S_2 \rightarrow S_7 \rightarrow S_{16}$

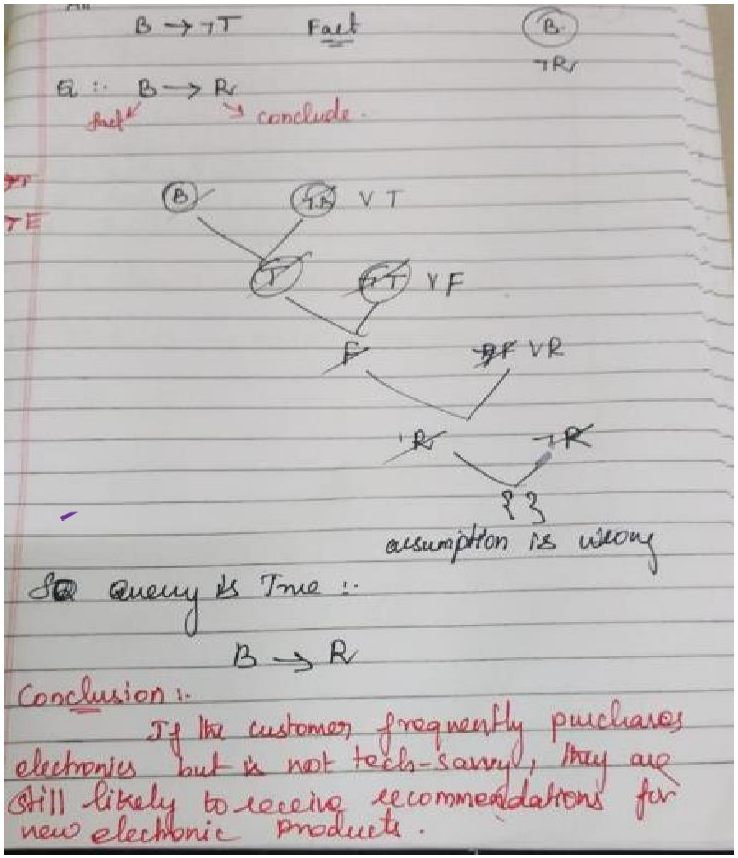
Module 4 : Propositional Logics
Problem 1

"In the marketing industry, all advertised products gain popularity. Not all profitable products have been popular, but all the popular products have been always profitable. Profitable products attract investments from corporates. "

- Represent the knowledge base using propositional logic (without quantifiers) convert KB into CNF and find any three sample complete BSAT (Binary Satisfiability) solutions to the variables using DPLL algorithm. Suppose a customer is known to frequently purchase electronics but has ruled out being tech-savvy (¬T) with 100% certainty. Under this scenario, if the logic agent is asked, "Is the customer likely to receive recommendations for new electronic products?" how does the agent reason to answer the query? Prove by contradiction using the results obtained in part (a) by the resolution method.

Module 4 : Propositional Logics
Problem 1


Q1) Logics :-
B → FrequentElechonicBuyer.
T → TechSavvyCustomer.
E → Expensivepurchase.
F → FollowtechTrends
R → ReceiveRecommendations
KB: → into → CNF.
R1 : B ⇒ T
R2 : ¬(T ⇒ ¬E)
R3 : E ⇒ T
R4 : T ⇒ F
R5 : F ⇒ R
R1 ¬B V T
R2 T ∧ ¬E
R3 ¬E V T
R4 ¬T V F
R5 ¬F V R
DPLL Algorithm : Sample Solution 1 :
¬B V T , ¬E V T , ¬F V R
T ¬T ¬E , ¬T V F ,
R1 : True , R2 : True
R1 : True , R2 : True , R3 : True ,
R1 R2 , R3 , R4 → True
R5 : ¬F V R
R5 : True.
B T E F R
T T F T T
Not satisfied



Module 4 : Propositional Logics and Predicate logic : Practice Question

"Not everyone who is affected by fever (F) is tested COVID positive (C). Patients exhibiting breathing difficulty (D) and body pain (P) are diagnosed as COVID Positive. There may be other symptoms for COVID infections as well. Fever and body pain are the symptoms of seasonal flu (L) or COVID"

(a) Use propositional logic (without quantifiers) to efficiently represent the knowledge base given as above.

(b) W.r.t below knowledge base from the results of part a), convert it into CNF and find one sample complete BSAT (Binary Satisfiability) solutions to the variables using DPLL algorithm.

(c) Even though it's observed that a patient experienced body pain, the doctor has ruled out flu as the cause with 100% certainty. Under this scenario if the logic agent is asked *"Is the patient COVID negative?"* how does the agent reason to answer the query? Prove by contradiction using the results obtained in part a) by resolution method.

Module 4 : Propositional Logics and Predicate logic : Practice Question

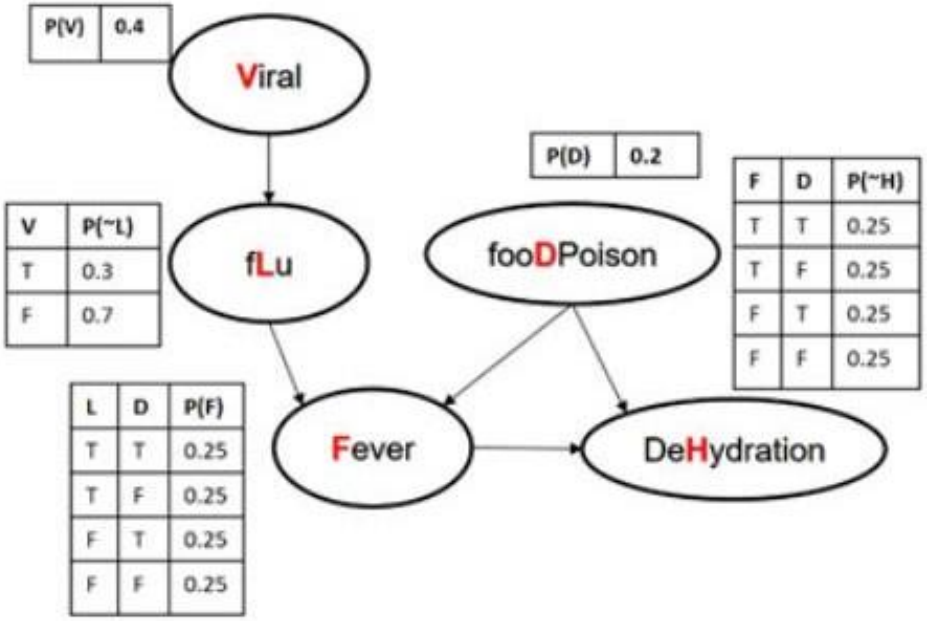
"In the Chandrayan Mission, there are astronauts, scientists, and engineers. Engineers are responsible for the design/maintenance of lunar rovers. Scientists are tasked with conducting experiments on lunar soil samples. Astronauts trained for lunar exploration are also trained in the operation of lunar rovers. Astronauts who operate lunar rovers are responsible for collecting lunar soil samples. Scientists who analyze lunar soil samples can provide valuable insights into lunar geology.

a) Convert the above into predicate logic. Clearly define your own predicate designs and use only predicates with unary arguments.

b) Prove by forward chaining that, "***all astronauts in the Chandrayan Mission can provide valuable insights into lunar geology***" using the result of part a. Show the step by step inferences using neat diagram with direction.

Module : 5
Bayesian Network Problem 1

Consider the below Bayesian Network and answer the following questions:



Exact Inference : What is the chance that a person doesn't get fever given the evidence that his/her blood test results show viral infection and severe dehydration?

Approximate inference – Prior Sampling, Rejection sampling, likelihood weighing,

"0.3, 0.6, 0.2, 0.1, 0.7, 0.5, 0.5, 0.25, 0.45, 0.85, 0.35, 0.9, 0.15, 0.65, 0.51, 0.2, 0.7, 0.10, 0.6, −0.8"

Bayesian Network : Problem 1

innovate achieve lead

Exact Inference : What is the chance that a person doesn't get fever given the evidence that his/her blood test results show viral infection and severe dehydration?

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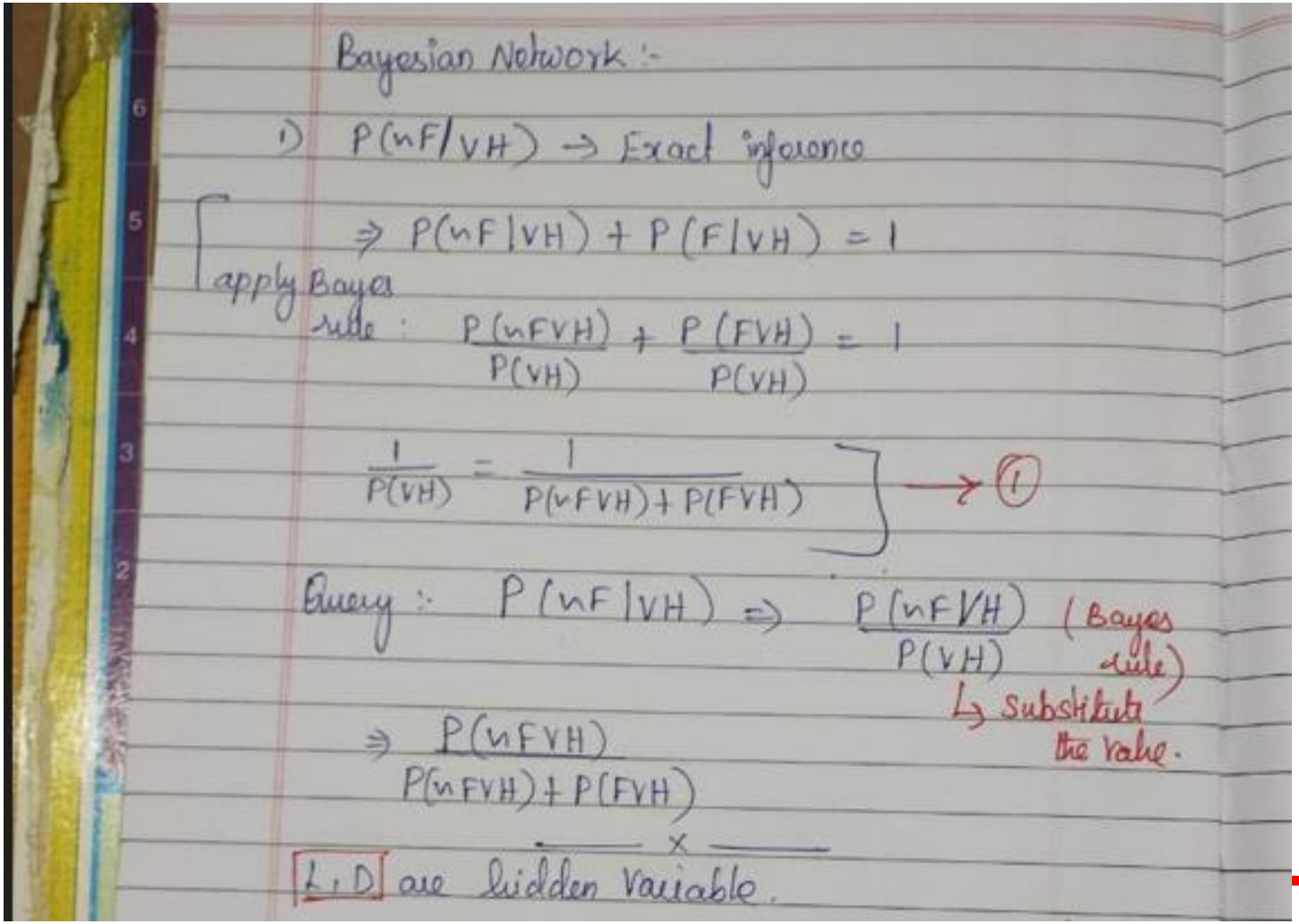

Bayesian Network

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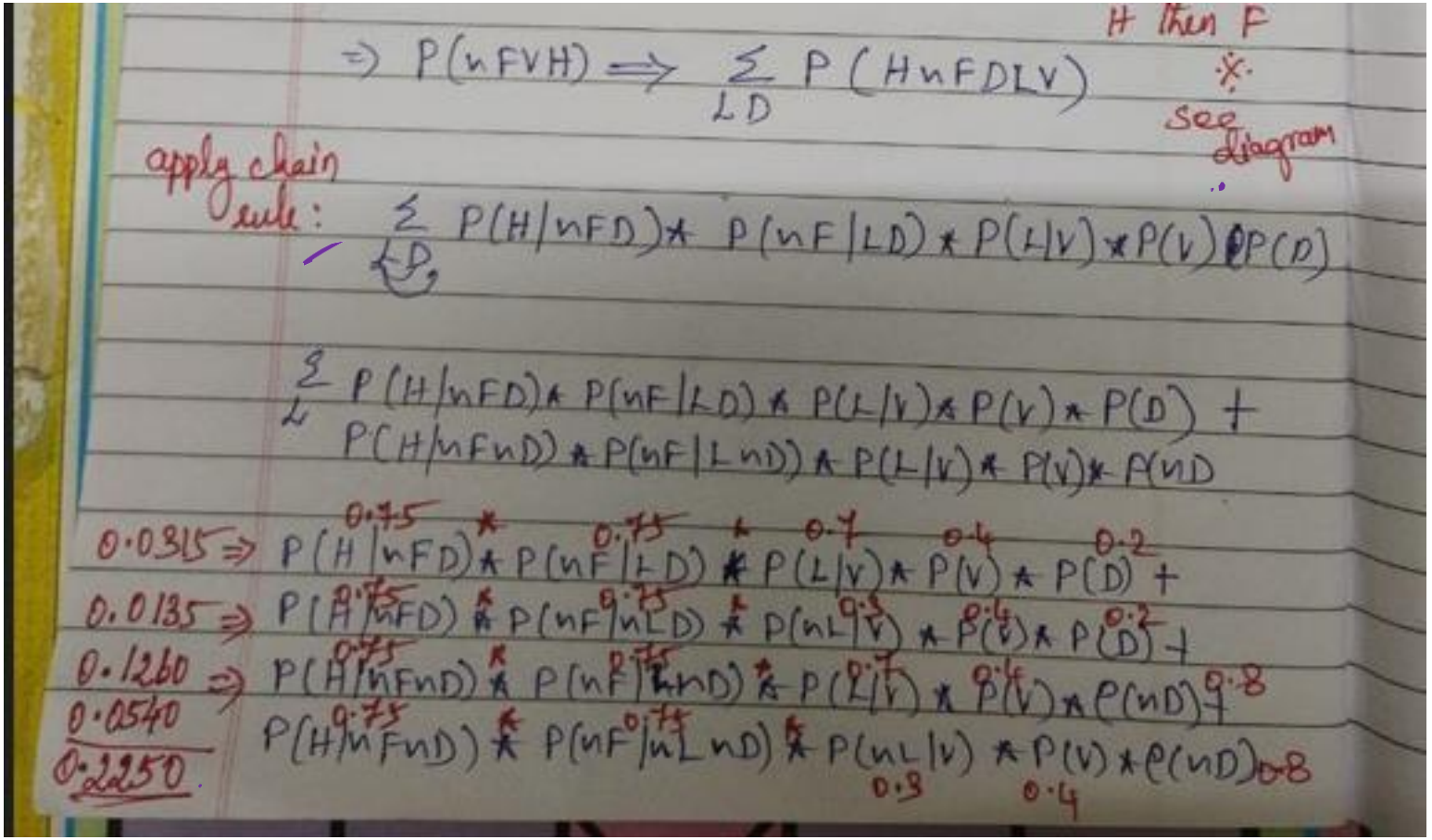
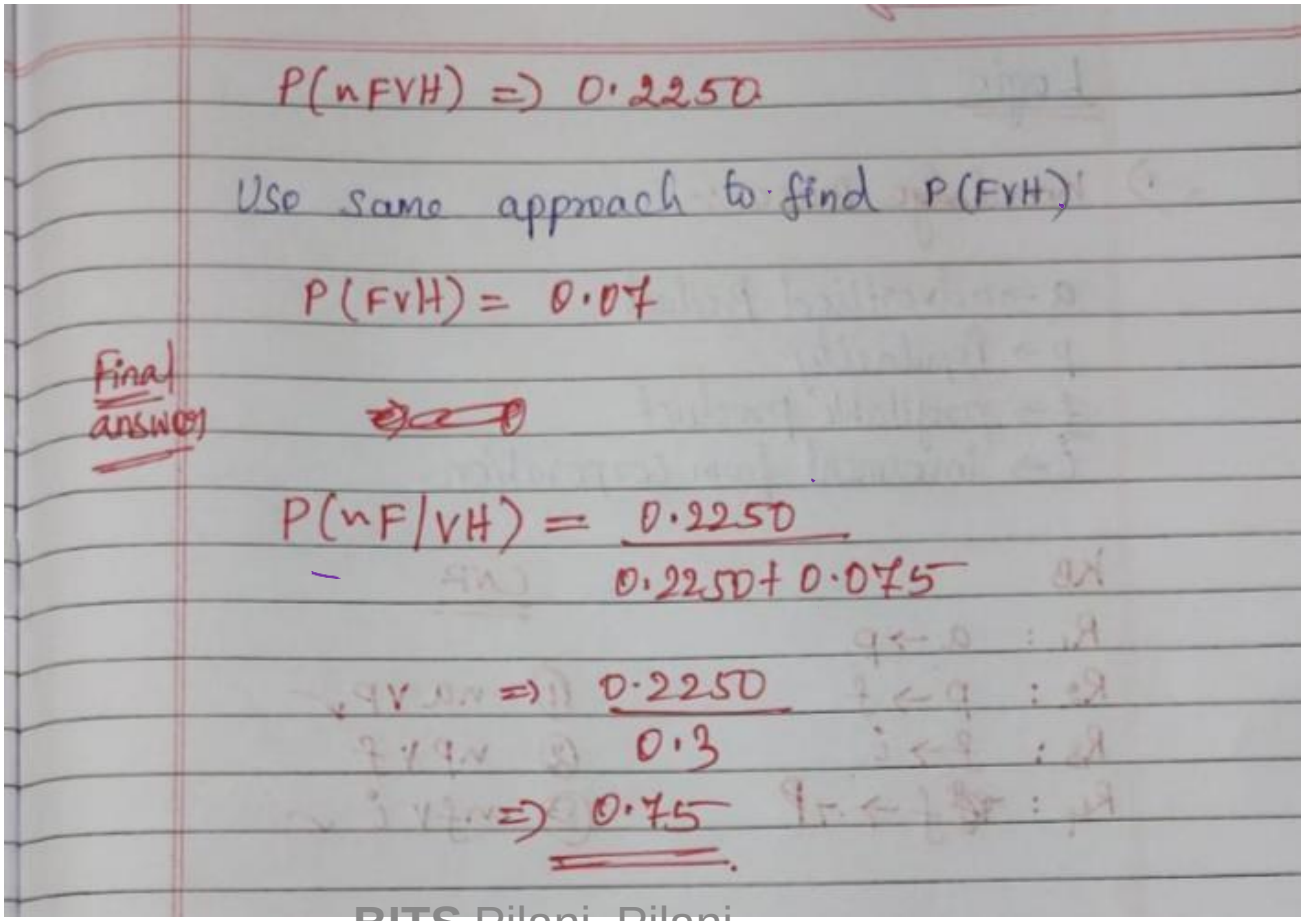


Bayesian Network : Problem 2

Exact Inference : What is the chance that a person doesn't get fever given the evidence that his/her blood test results show viral infection and severe dehydration?

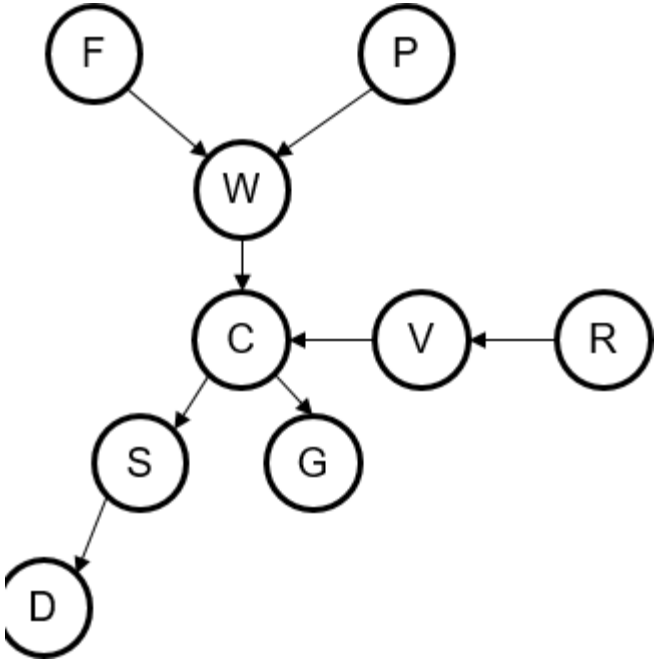
Approximate inference – Prior Sampling, Rejection sampling, likelihood weighing, "0.3, 0.6, 0.2, 0.1, 0.7, 0.5, 0.5, 0.25, 0.45, 0.85, 0.35, 0.9, 0.15, 0.65, 0.51, 0.2, 0.7, 0.10, 0.6, 0.8"



Bayesian Network : Problem 2

Most of the WILP students are fans (F) of cricket irrespective of their gender. With the new season of IPL (Indian Premier League) having started on the exam month almost every cricket fans spend time to watch(W) the live play. Sometimes being a parent (P) reduces the probability of watching the IPL live season. A likely consequence of watching matches is reduced concentration(C) on the following day/s. A consequence of the reduced concentration is increased stress(S) with work environment leading to reduced productivity (D) in project. Lack of concentration might also be caused by viral (V) infection, which is common in this rainy season(R). WILP students have the comprehensive exams and reduced concentration would reduce the probability of good grades (G) in the exam which reflects the performance of students in examination. Assume an AI agent is fed this information and it answers to certain queries that can be inferred. Assume all the events(conditional or unconditional) are equally likely to occur:

Construct Bayesian Network from the given scenario



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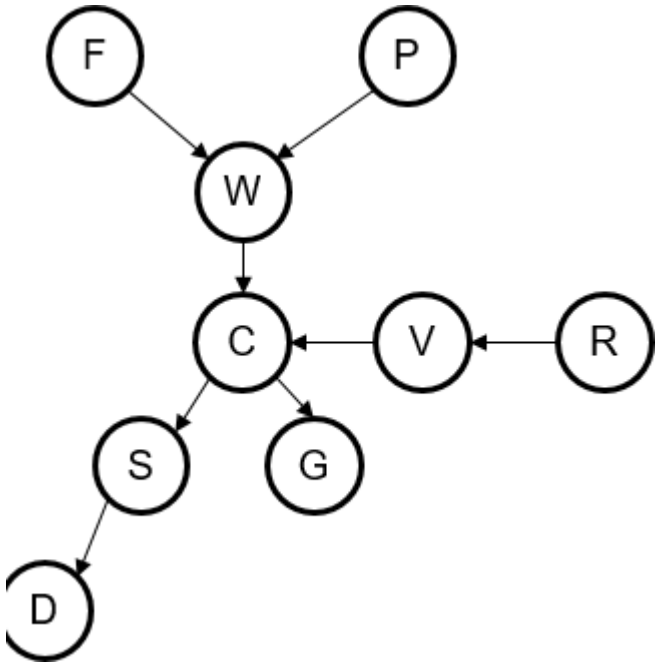

Example Joint Prob.Distribution Query :

What is the chance that “an ardent fan of cricket who is a parent of two kids, never misses an IPL match, doesn’t get stressed in work environment, is affected by viral infection and performs well in the comprehensive examination”?

Ans: P(FPW~SVG) → Apply chain rule

D-Seperation: Performance of in the examination is independent of stress in work environment given its known that the student is affected by viral infection

Ans: G ⊥ S | V → Solve using D-Seperation

Module 6 : Explain HMM & Viterbi Algorithm

In general it's observed that low concentration/focus among students leads to low grades in 80% of time and high concentration/focus produces good grades in 95% of time. 60% of time students realize that low concentration had led to challenges in completed exams and they decide to concentrate more in the upcoming next exams. 30% of time students are always prudent and proactively prepare with concentration for every exams. At the start of the course enrolment, usually 98% of students are willing to concentrate more for evaluations.

AI agent is designed to perform learner behavioral analysis based on given model. With inputs of grade scored by students for few semesters, how the AI system answers the query, where B=Scoring Low Grade, G= Scoring High Grade.

Example Markov Model Query :

"What is the most likely explanation of the student behavior if pattern observed is B-G-B"? – Apply Veterbi Algorithm

Explain HMM & Viterbi Algorithm

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Transition Model Concentration level		←Previous Exam
Low	High	V current exam
0.4	0.7	Low
0.6	0.3	High

Emission Model		
Low	High	
0.8	0.05	B Less Grades
0.2	0.95	G Good Grades

Initial Probability:
P(High Concentration) = 0.98
P(Low Concentration) = 0.02

Example Markov Model Query :
"What is the most likely explanation of the student behavior if the grade score sequence pattern observed is B-G-B"? – Apply Veterbi Algorithm

Explain HMM & Viterbi Algorithm

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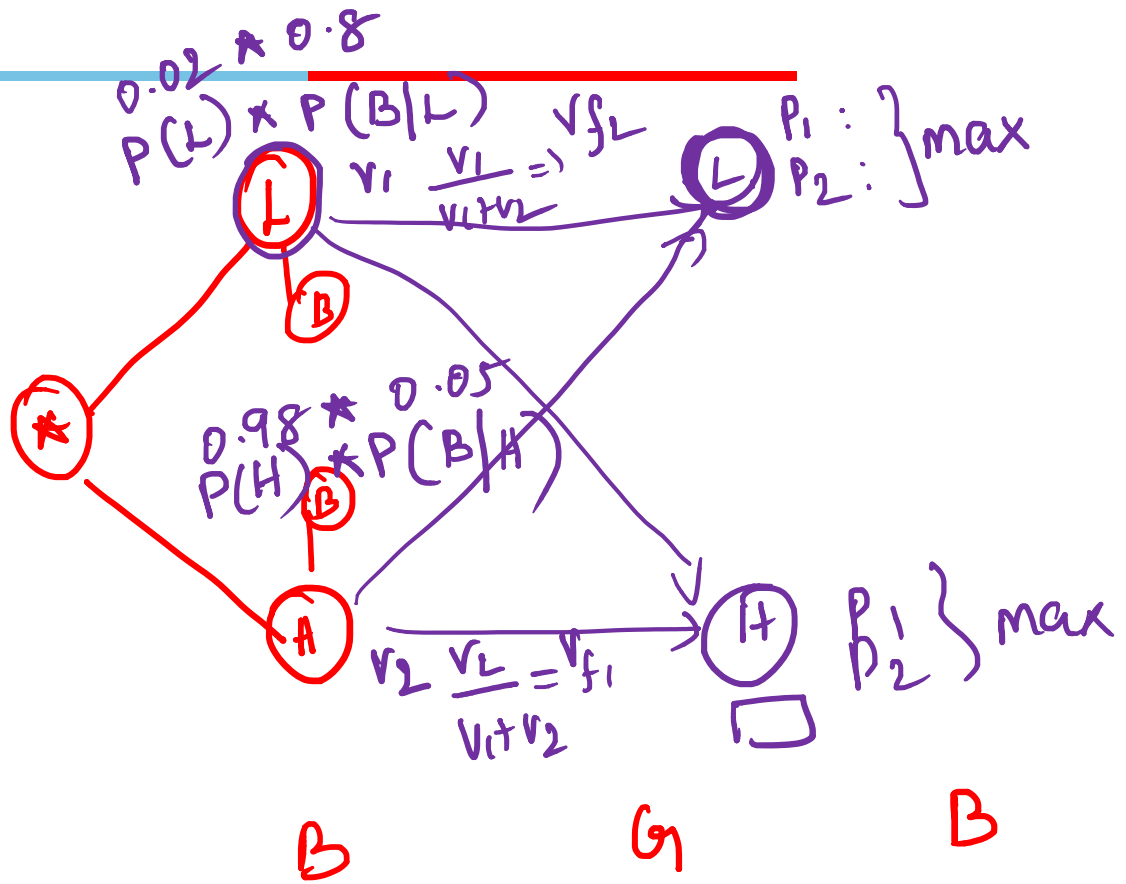

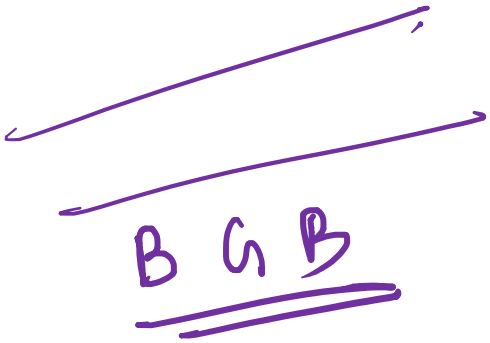

Explain HMM & Viterbi Algorithm

"In a ride-sharing app, users can choose between Economy, Premium, or Luxury rides. People mostly pick Economy for short trips 80% of the time, while Premium is preferred for longer trip, more comfortable rides like going to the airport 70% of the time. Luxury rides, known for their extravagance, are also preferred 30% of the time by few customers for longer trips. After using the app, 60% of users who initially chose an Economy ride decide to upgrade to a Premium ride for their next trip, while 40% continue with the Economy option. Similarly, 75% of users who initially choose a Premium ride opt to continue with Premium for their subsequent rides. However, 20% of them decide to switch to the Luxury category for special occasions, while 5% switch to Economy for shorter trips. For users who select the Luxury category initially, 90% stay with Luxury for their future rides, while 10% occasionally choose Premium for more cost-effective luxury.

For the below observations in the two sequence of customer's requirement, what is the most likely sequence of ride category preferred by the customer. Strictly follow the approach as discussed in class only.

(short-trip, long-trip)

Required Reading: AIMA - Chapter #15.1, #15.2, #15.3, #20.3.3

Thank You for all your Attention

Note : Some of the slides are adopted from AIMA TB materials