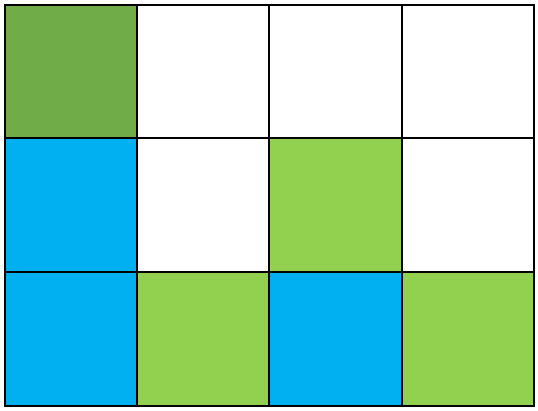
QUESTION 1

Consider the Connect Three game on a 3x4 board. Player 1 has 12 Blue checkers, and Player 2 has 12 Green checkers. In Connect Three, the objective is to align three of your checkers either horizontally, vertically, or diagonally before your opponent does. On your turn, place one of your checkers into an open slot at the top of the board. The checkers falls to the lowest unoccupied space in that column, occupying it. Assume that player with Blue colored checkers moves first and answer the following questions.



a) Construct the game tree (with neat diagram) from the given current state (0th level) as Start Node up to exactly 2 levels only (1st & 2nd Level – i.e., one round for each of the player).

b) Calculate the utility of the leaves of the tree with below static evaluation function.

BOARD VALUE = 5*(MAX player chance of WIN) – 2*(MIN player chance of WIN)

Player Chance of WIN = No. of Matches possible is this player is allowed to fill all the empty cells with its checkers.

c) Apply the Min-Max algorithm on the game tree constructed in part a) using static evaluation values calculated in the part b) and highlight the best path chosen by players in the game given.

[3+3+3 = 9 Marks]

QUESTION 2

Not all instances of a low-voltage alert (V) in a smart city's power grid are caused by an absent power station (P). Some alerts may occur due to faulty connections (F) or energy leakage (E). When both a high-load condition (H) and a missing load balancer (L) are detected, the system identifies it as an overloaded segment (O).

Power fluctuations (W) may also be triggered by faulty lines (F), energy surges (S), or timing mismatches (T). Additionally, if a low-voltage alert (V) occurs without a power fluctuation (¬W), it must indicate a critical failure (C).

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

b. W.r.t below knowledge base from the results of part a), convert it into CNF.

c. Find a sample complete BSAT (Binary Satisfiability) solution for the variables using the DPLL algorithm, as explained in class. Provide a step-by-step approach.

[2+2.5+2.5 = 7 Marks]

Question 3

Ensuring a successful Crop Yield (CY) in a smart agriculture setup depends on multiple interrelated environmental and technological factors. The probability of a good crop yield (CY) is influenced by Soil Health (S), Irrigation Efficiency (I), and Pest Control Measures (P).

Soil Health (S) plays a critical role in nutrient availability and plant growth. Poor soil quality increases the risk of low yield. Irrigation Efficiency (I) ensures that crops receive optimal water levels and is positively influenced by Sensor Accuracy (SA) and Weather Forecast Integration (W). Effective Pest Control Measures (P) help in preventing crop damage and are positively influenced by Monitoring Drones (D) and Soil Health (S). Additionally, Weather Forecast Integration (W) directly impacts both Irrigation Efficiency (I) and Pest Control Measures (P) by enabling proactive decisions. The combined status of Crop Yield (CY) and Pest Control (P) contributes to the Economic Profitability (EP) of the agricultural cycle. However, Farmer Support Programs (FSP) can help mitigate losses and positively affect Economic Profitability, even when crop yield is sub-optimal. When a system has Healthy Soil and Efficient Irrigation, the crop yield is highly likely (70%) to be successful. If the soil is healthy but irrigation is inefficient, crop yield is still likely (60%) to be successful, indicating water can partially compensate. When both soil and irrigation are poor, the success of crop yield drops significantly to 10%.

NOTE:

[Soil Health (S): Good (True) / Poor (False)]

[Irrigation Efficiency (I): High (True) / Low (False)]

a. Draw the complete Bayes net with fully filled conditional probability tables. Consider the random variables embedded in the events (conditional or unconditional) as significant events, takes only binary values "TRUE" or "FALSE" and assume all are equally likely to occur except those which are explicitly specified in the problem statement.

b. Use D-Separation approach to prove if the below statement is True or False.

"Crop Yield (CY) is independent of Weather Forecast Integration (W), given we already know the Irrigation Efficiency."

c. What is the probability that a farm with Good Soil Health, Efficient Irrigation, and Effective Pest Control, but without Farmer Support Programs, will still result in Economic Profitability (EP)?

[4+3+2 = 9 Marks]

Question 4

In a hospital, patients can be in one of three health states: **Stable, Under Observation, or Critical.** Patients in the **Stable** state have a **50%** chance of remaining Stable, a **40%** chance of moving to **Under Observation**, and a **10%** chance of worsening to **Critical**. Patients in the **Under Observation** state have a **20%** chance of recovering to **Stable**, a **60%** chance of remaining **Under Observation**, and a **20%** chance of deteriorating to **Critical**. Patients in the **Critical** state have an **80%** chance of remaining **Critical** and a **20%** chance of improving to **Under Observation**.

The observed condition (symptom intensity) of patients is categorized into either **"Mild"** or **"Severe"**:

- Patients in the **Stable** state exhibit **Mild** symptoms **70%** of the time; those in **Under Observation** show **Severe** symptoms **60%** of the time.
- Patients in the **Critical** state exhibit **Severe** symptoms **90%** of the time.

Tasks:

a. Construct the **Markov Model** by extracting the **transition** and **emission probability matrices** from the problem statement. Depict them with neat diagrams in addition to tabular representation. Assume **equal likelihood** for the initial state.

b. Using the sequence of patient outcomes (**"Severe", "Mild"**), apply the **Viterbi algorithm** to determine the most likely sequence of health states followed by the patient. Strictly follow the approach as discussed in class only.

[3+5 = 8 Marks]

Question 5

a. Is it possible that the heuristic designed for informed search technique turns out to be admissible but not consistent? Explain with a numerical example with a relatable real-world case study.

b. Explain the evaluation process of the **Breadth First Search (BFS) algorithm** using an example.

c. Calculate the missing probability values and determine the likelihood that a **Tata Sky customer's behaviour** in their monthly channel subscription renewal process follows this specific sequence:

(**purchase new channel subscription, continue existing subscription, purchase new channel subscription**). Calculate the **initial probability** using the given sequence.

Transition Probability Matrix:

Continue Existing Subscription	**Purchase New Channel Subscription**	**←Previous State** **Current State ↓**
0.6	??	**Continue Existing Subscription**
??	0.2	**Purchase New Channel Subscription**

Emission Probability Matrix:

Continue Existing Subscription	**Purchase New Channel Subscription**	**Evidence V**
0.1	0.4	**Opt-for the Deal of the Day**
??	0.3	**Rent a movie**
0.4	**??**	**Watch three channels**

[2 + 2 + 3 = 7 Marks]