DS251
Assignment 2
Due Date - 24th April EOD

1. Let's consider the Sudoku puzzle as pictured below. There are 81 variables in total, i.e. the tiles to be filled with digits. Each variable is named by its row and its column, and must be assigned a value from 1 to 9, subject to the constraint that no two cells in the same row, column, or box may contain the same value. Write a Python program to solve it as a Constraint Satisfaction problem. Also, find out the total number of steps taken.

			1			7		2
	3		9	5				
		1			2			3
5	9					3		1
	2						7	
7		3					9	8
8			2			1		
				8	5		6	
6		5			9			

2. There is a robot that can move between two rooms and pick up or drop balls with either of his two arms. Initially, all balls and the robot are in the first room. We want the balls to be in the second room.

Objects: The two rooms, eight balls and two robot arms.
Predicates: Is x a room? Is x a ball? Is ball x inside room y? Is robot arm x empty? [...]
Initial state: All balls and the robot are in the first room. All robot arms are empty. [...]
Goal specification: All balls must be in the second room.
Actions/Operators: The robot can move between rooms, pick up a ball or drop a ball.

Create a domain file and problem file for solving this planning problem using PDDL.

3. In logistics, there are trucks and airplanes that can move packages between different airports and cities. We assume that in the initial state there is a truck in Paris airport. An airplane and two packages are in London airport. Paris has two places : south and north. The goal is to have one package in the north location and the other one in the south location.

Create a domain file and problem file for solving this planning problem using PDDL.

Use the following types to create domain and problem files:

- Places, cities and physical objects are considered as objects,
- Packages and vehicles are physical objects,
- Trucks and airplanes are vehicles,
- Airports and locations are places.

4. Represent problem 3 as a SATPlan problem. Write on pen/paper the initial axioms, goal axioms and five sample axioms for each category of other axioms (successor state axioms, precondition axioms etc.) at iteration 1. No need to generate any DIMACS file.

5. Solve the following BlocksWorld problem as a SATPlan problem.

Initial state - on(A, B) ∧ on(B, C) ∧ on(C, T able) ∧ clear(A)

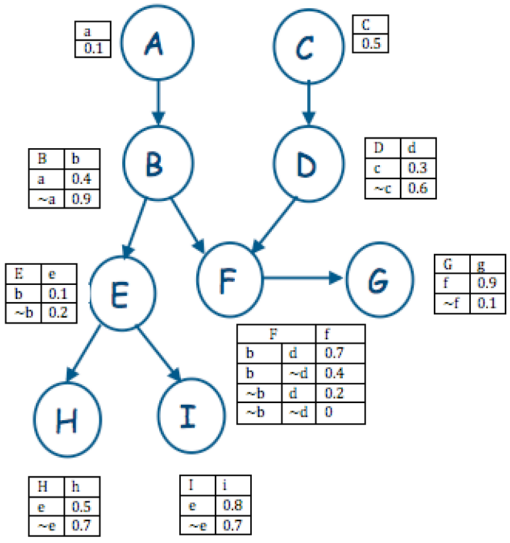
Goal state - on(C, B) ∧ on(B, A) ∧ on(A, T able) ∧ clear(C)

Action(Move(b, f, t)
Precond: on(b, f) ∧ clear(b) ∧ clear(t),
Effect: ¬on(b, f) ∧ on(b, t) ∧ ¬clear(t) ∧ clear(f))

Action(MoveToTable(b, f)
Precond: on(b, f) ∧ clear(b)
Effect: ¬on(b, f) ∧ on(b, Table) ∧ clear(f))

Submit the DIMACS file for every iteration and the corresponding output file from the SAT solver. Also submit the final plan.

6. The following is a Bayesian network with probabilities attached.



Part-1: Calculate the following probabilities - (a) P(I | C) , (b) P(E | ~D) (c) P(G | B,~D) [Show calculations in detail on pen/paper]

Part-2: Use any standard python package (such as https://pypi.org/project/bnlearn/ or https://github.com/pgmpy/pgmpy or https://pomegranate.readthedocs.io/en/latest/BayesianNetwork.html) for building and inferencing from Bayesian Belief Network. Build the same network as given above and validate that the probabilities calculated in part-1 are correct. Submit code and input output.