CSE 571 Fall 2022

Homework 4

Due *October 4, Tuesday* online

Homework Instructions: Read Carefully

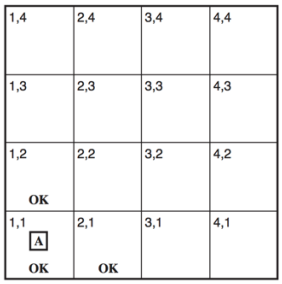
1. Only typed answers will be accepted. Solutions with **ANY** written part (except for hand-drawn illustrative figures) will not be given any credits. If you need to write equations, use "Insert->Equation" with *Word*. *LaTeX (e.g., Overleaf)* also supports equation typesetting.

2. Do **NOT** include questions themselves in your answers. Failing to do some may result in failing the plagiarism check.

3. Answers without explanations will **NOT** be given any credits.

Be precise and concise in your answers. You may add hand-drawn figures when necessary.

Exercise 1.1 (10pt)



Given our Wumpus world shown above, consider the problem in which our agent only concerns with the contents of [1,3], [2,2], and [3,1]. We know that there could be multiple pits and only one Wumpus in the environment. The Wumpus can live in pits.

a. (4pt) Suppose the agent has obtained the following information: having perceived nothing in [1,1], a breeze in [2,1], and a stench in [1,2]. Construct the set of possible worlds for [1,3], [2,2], and [3,1].

b. (3pt) Mark the worlds (in part a.) in which the KB is true and those in which each of the following sentences is true:

α_2 = "There is no pit in [2,2]."

α_3 = "There is a wumpus in [1,3]."

Show that KB $\models \alpha_2$ and KB $\models \alpha_3$.

c. (3pt) Consider a vocabulary with only four propositional symbols, A, B, C, and D. How many models are there for the following sentences? **Explain your answers without directly using truth tables but still basing on the definition of entailment.**

a. $B \vee C$.
b. $\neg A \vee \neg B \vee \neg C \vee \neg D$.
c. $(A \Rightarrow B) \wedge A \wedge \neg B \wedge C \wedge D$.

Exercise 1.2 (12pt)

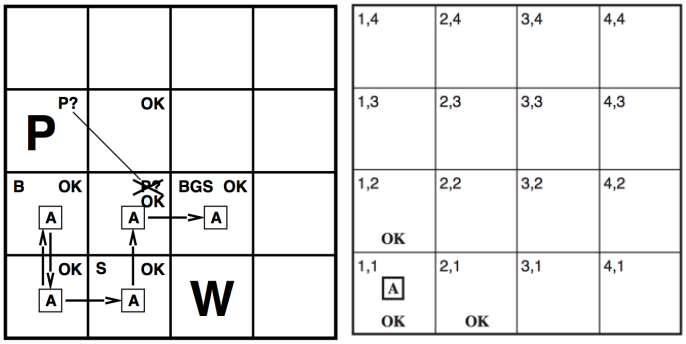
Prove the validity of the following axioms using the definition of entailment. Assume the priority of connectives discussed in class. |- below denotes entailment. Hint: use truth tables to enumerate the possible worlds and model checking to verify entailment. **Explain your answers without directly using truth tables but still basing on the definition of entailment.**

(a) $p \rightarrow q, r \rightarrow s \vdash p \vee r \rightarrow q \vee s$

(b) $(p \vee (q \rightarrow p)) \wedge q \vdash p$

(c) $p \rightarrow (q \vee r), q \rightarrow s, r \rightarrow s \vdash p \rightarrow s$

Exercise 1.3 (9pt)



In the Wumpus world, consider the following actions of the agents [1, 1] →[1, 2](up) →[1, 1] →[2, 1] (the first three actions shown), and the sensor readings as shown in the figure (B for Breeze, S for Stench, and G for Glitter). Use entailment to show that $W_{3,1}$ (Wumpus is at location [3, 1]) is true. Assume that the location (1, 1) is always OK. Clearly write out the KB that is necessary to derive the conclusion and solve it using resolution. Hint: you may not need all the axioms that we discussed in class and we may not have covered all the axioms needed for this question.

Exercise 1.4 (10pt)

a. (4pt) Represent the following sentences in first-order logic, using a vocabulary which you must define:

I. There is an agent who sells policies only to people who are not insured.
II. Politicians can fool some of the people all of the time, and they can fool all of the people some of the time, but they can't fool all of the people all of the time.

b. (6pt) Assume the environment in Exercise 1.3, using first-order logic, express the following sentences:
   I. There is only one Wumpus in the world
   II. Locations that are adjacent to the Wumpus are smelly
   III. If a Breeze is detected, a Pit must be around.

Exercise 1.5 (9pt)

a. (3pt) Use resolution to solve Lewis Carroll's puzzle discuss in class.

b. (6pt) Use resolution to solve the following puzzle:

There are three people (Alex, Ben and Cody), one of whom is a knight, one a knave, and one a spy. The knight always tells the truth, the knave always lies, and the spy can either lie or tell the truth. Alex says: "Cody is a knave." Ben says: "Alex is a knight." Cody says: "I am the spy." Who is the knight, who the knave, and who the spy?