Midterm Exam 2

CSCI 561 Spring 2016: Artificial Intelligence

Student ID: | | | | | | | | | | |

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Instructions:

1. Date: **3/29/2015 from 5:00pm – 6:20 pm**
2. Maximum credits/points/percentage for this midterm: 100
3. The percentages for each question are indicated in square brackets [ ] near the question.
4. **No books** (or any other material) are allowed.
5. **Write down your name, student ID and USC email address.**
6. **Your exam will be scanned and uploaded online.**
7. **Answers must be written in the provided boxed only.** Please make sure NOT to write the answer to one question in the box for another one.
8. **Do NOT write on the 2D barcode.**
9. **The back of the pages will NOT be graded.** You should use the back of the pages only for SCRATCH PAPER, not the actual answers.
10. No questions during the exam. **If something is unclear to you, write that in your exam.**
11. **Be brief: a few words are often enough if they are precise and use the correct vocabulary studied in class.**
12. When finished, raise completed exam sheets until approached by proctor.
13. **Adhere to the Academic Integrity code.**

Problems	**100 Percent total**
1- General AI Knowledge	10
2- Propositional Logic	30
3- First-Order Logic	10
4- Inference	20
5- Classical Planning	20
6- AI applications	10

1. [10%] General AI Knowledge

For each of the statements below, fill in the bubble T if the statement is always and unconditionally true, or fill in the bubble F if it is always false, sometimes false, or just does not make sense.

a)	T	F
b)	T	F
c)	T	F
d)	T	F
e)	T	F
f)	T	F
g)	T	F
h)	T	F
i)	T	F
j)	T	F

a) Entailment can be used to derive true conclusions.

b) Sound inference algorithms are always complete.

c) Every sentence of propositional logic is logically equivalent to a conjunction of clauses.

d) ‘$\neg A \vee \neg B \vee \neg C$’ is a Horn clause.

e) Forward chaining is an example of data-driven reasoning.

f) If Married is a predicate and Mother/Father are functions, ‘Married(Father(John),Mother (John))’ is an atomic sentence.

g) In first-order logic, the order in which we use the quantifiers does not change the meaning of a logical sentence.

h) We can unify P(x, y, F(z)) and Q(m, n, F(Frank)).

i) Generalized Modus Ponens is complete for first order logic.

j) Contingent plans allow the agent to use sensor information during execution to decide what branch of the plan to follow.

2. [30%] Propositional Logic

You want to settle an argument between Alice (**A**), Bob (**B**) and Charlie (**C**). They only tell you the following:

1. Alice says: ‘Bob is lying!’
2. Bob says: ‘Charlie is lying’
3. Charlie says: ‘Both Alice and Bob are lying!’

You believe you can use propositional logic to figure out who is telling the truth and who is not. Let **A** represent {Alice is telling the truth} and $\neg$**A** represent {Alice is lying}. Similarly, we will use **B**/$\neg$**B** for Bob and **C**/$\neg$**C** for Charlie.

2A. [6%] Represent the three given sentences using propositional logic using **A**, **B**, **C** as propositional symbols.

1. 2. 3.

2B. [12%] Convert the three derived sentences to CNF form. Show each step used for simplification.

1.   2.   3.

2C. [9%] Use resolution to find out who is telling the truth and who is lying. Show the entire tree and write down for Alice, Bob and Charlie whether they tell the truth or not.

<u>2D. [1%]</u> Daisy (**D**) tells you the following sentence: ‘I am lying’.

Using the previous notations with the symbols **D/¬D**, represent this sentence in propositional logic.

<u>2E. [2%]</u> Use a truth table to prove that Daisy’s sentence is a paradox.

3. [10%] First-Order Logic: logic sentences

Consider a vocabulary of the following symbols:

- Waits(*x, y*)	*x* waits for *y*	(predicate)
- Complains(*x, y*)	*x* complains about *y*	(predicate)
- Happy(*x*)	*x* is happy	(predicate)
- Late(*x*)	*x* is late	(predicate)
- Lover(*x*)	*x*'s lover	(function)

Using the predicates and function defined above, convert the following sentences from English to logic expressions.

3A. [2%] Someone is not happy that his lover is late.

3B. [2%] People do not complain about anyone when they wait for their lover.

3C. [2%] Everyone is happy to be their lover's lover.

3D. [2%] Everyone complains about the person they are waiting for if that person is late.

3E. [2%] Someone complains about everyone that is late or unhappy.

4. [20%] Inference

Consider the following knowledge base that describes how the Mars rover works:

ReceivedWorkInstruction ⇒ Work	**(1)**
((BatteryIsGood ∧ FlatGround) ∧ (¬Cold)) ⇒ Work	**(2)**
¬Obstacle ⇒ FlatGround	**(3)**
Night ⇒ Cold	**(4)**
Cold ⇒ ¬Hot	**(5)**
ReceivedRestInstruction ⇒ ¬Work	**(6)**
Dark ⇒ Night	**(7)**

Given the following observations:

BatteryIsGood ∧ ¬Night ∧ Hot ∧ ¬Obstacle ∧ ¬ReceivedWorkInstruction	**(8)**

Using the various propositional logic inference rules studied in class, show how each of the following conclusions can be inferred: In each case, mention which <u>inference rule</u> is used [1%], and to which sentence(s) above it was applied [1%]. <u>Every sentence can be proven using only sentences with smaller indices.</u> (Hint: sentence #13 requires two steps, while all others require only one.):

[2%] **¬Obstacle**	(9)	______________________________
[2%] **FlatGround**	(10)	______________________________
[2%] **Hot**	(11)	______________________________
[2%] **¬Cold**	(12)	______________________________
[2%] **BatteryIsGood ∧ FlatGround ∧ ¬Cold**	(13)	______________________________
[2%] **Work**	(14)	______________________________
[2%] **¬Night**	(15)	______________________________
[2%] **¬Dark**	(16)	______________________________
[2%] **¬ReceivedWorkInstruction**	(17)	______________________________
[2%] **¬ReceivedRestInstruction**	(18)	______________________________

5. [20%] Classical Planning

Consider the problem of a planning system for picking up astronaut A from Mars. Due to fuel limitations, there are two spacecraft: Spacecraft B can travel between the Earth's surface (ES) and Earth orbit (EO), Earth orbit and Mars orbit (MO), but not Mars orbit and Mars' surface (MS); Spacecraft C can travel only between Mars' surface and Mars orbit, but not further. Initially, Spacecraft B is on Earth's surface, while Spacecraft C and astronaut A are on Mars' surface.

Please use the following literal definitions to answer questions 5A and 5B:

- **at(O, P)** means object O is at place P (O ∈ {A, B, C}, P ∈ {ES, EO, MS, MO})
- **travelable(S, X, Y)** means Spacecraft S can travel from place X to place Y (S ∈ {B, C}, X,Y ∈ {ES, EO, MS, MO})

5A. [8%] Complete the descriptions of the STRIPS actions for the system.

Action: Spacecraft S travels from X to Y with NO astronaut:

noAstronaut(S, X, Y)

Precondition: ____________________

Effects:

Add literal(s):____________________

Delete literal(s):____________________

Action: Spacecraft S travels from X to Y with astronaut A:

withAstronaut(S, A, X, Y)

Precondition: ____________________

Effects:

Add literal(s):____________________

Delete literal(s):____________________

5B. [7%] NASA plans to launch the spacecraft, pick up the astronaut and return to the Earth surface. Write down the initial condition and the goal of this plan using the given definitions in the previous page. The closed world assumption is used, so whatever is not explicitly stated is assumed to be false.

Initial condition:

Goal:

5C. [5%] Write down the solution plan for 5B using the actions in 5A. (Assume that when spacecraft B and spacecraft C are at the same place, the astronaut could go from one spacecraft to another without any action.)

6. [10%] AI Applications.

1. [2%] In the debate between Neats vs Scruffies :

a. Doug Lenat’s Cyc is an example of a Neat project
b. CMU’s Herb Simon is an example of a Scruffy
c. MIT’s Marvin Minsky is an example of a Scruffy
d. All of the above
e. None of the above

2. [2%] In Planning the problem of representing all things that stay the same from one situation to the next is called the:

a. Ramification problem
b. Frame problem
c. Qualification problem
d. All of the above
e. None of the above

3. [2%] Prolog has traded soundness for efficiency by:

a. Being incomplete due to infinite loops
b. Having to recompute repeated subgoals
c. Having no Occurs-Check
d. All of the above
e. None of the above

4. [2%] An impediment to knowledge sharing is:

a. Lack of communication conventions between KBs
b. Model mismatches at the knowledge level
c. Knowledge encoded in different KR languages
d. All of the above
e. None of the above

5. [2%] When an object inherits from multiple classes a problem can occur:

a. When the object inherits from only one subclass yielding conflicting answers
b. When the object inherits from multiple superclasses yielding conflicting answers
c. When the object inherits from both a superclass and a subclass yielding conflicting answers
d. All of the above
e. None of the above