COS470 Final Study Guide

For each of the following 5 questions, first represent the statement as first-order predicate logic, then convert it to conjunctive normal form. If a statement cannot be represented in FOL, then say so and explain why not.

1. **It always snows in Maine in March.**

∃
∀x (month(x, march) ∧

2. **John and Mary are both professors.**

∃x ∃y (person(x) ∧ named(x, Mary) ∧ (person(y) ∧ named(y, John)) ∧ professor(x) ∧ professor(y)

Professor(John)
Professor(Mary)

3. **There will be a day in March when it snows and is warm.**

∃x ∃y (month(x) ∧ named(x, March) ∧ (day(y) ∧ in(y, x)) ∧ weather(warm) ∧ weather(snowing)

Weather(snowing)
Weather(warm)
DayInMonth(march)

4. **All dogs are canines and all dogs are not canines.**

∀x (dog(x) ∧ canine(x)) ∧ (dog(x) ∧ ¬canine(x))

5. **As a rule, if someone loves dogs, then there's someone who loves them (i.e., the person).**

∀x ∃y lovesdogs(x) -> loves(y, x)

¬(loves(y, x) V lovesdogs(x)

For each of the next two questions, use the axiom set given below. Note that you **must show your answer in the form of a proof tree**, as shown in class.

1. $human(Marcus)$
2. $Pompeian(Marcus)$
3. $born(Marcus, 40)$
4. $\neg human(x_1) \lor mortal(x_1)$
5. $\neg Pompeian(x_2) \lor died(x_2, 79)$
6. $erupted(volcano, 79)$
7. $\neg mortal(x_3) \lor \neg born(x_3, t_1) \lor \neg gt(t_2 - t_1, 150) \lor dead(x_3, t2)$
8. $now = 2019$

6. **Prove: Marcus was dead in AD 250.**

7. **Marcus was Pompeian and Marcus is dead now.**

8. **Someone tells you that they have a new algorithm for theorem proving using resolution that can prove any FOL expression with respect to a set of axioms or let the user know the expression cannot be proven. What can you say about this person's claim, and why?**

9. **What is true of the role of mutations and crossover in genetic algorithms?**

- They are used to eliminate solutions with poor fitness.

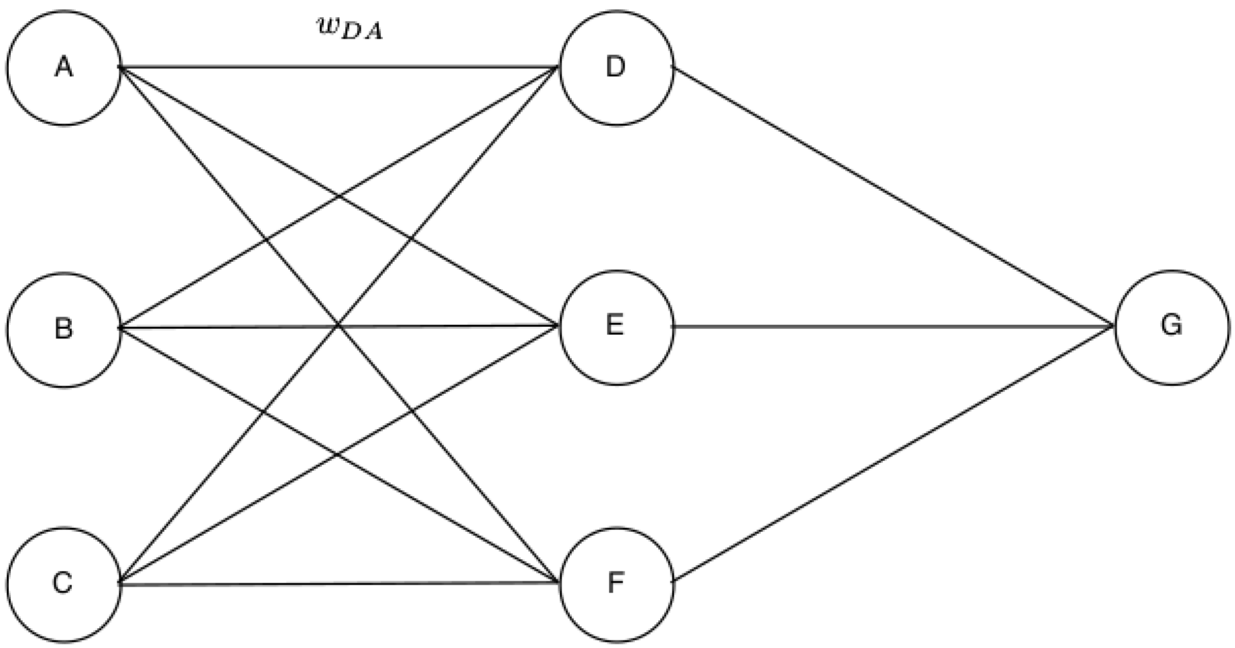
- They are used to keep the algorithm from generating poor choices by accident, and so focus search.

They are the only things that provide a means to explore the problem's search space, and they allow "uphill moves" in the search space.

They are used to ensure that genetic algorithms behave like their biological counterparts.

10. Given the simple neural network below, and assuming that all weights are labeled similarly to the one shown and that all neurons (except the input neurons) have an activation function σ:

1. **What is the value of the output neuron D in terms of A's, B's, and C's activation? (You can just use "A" to represent A's activation, etc.)**
2. **What is the value of the output neuron G in terms of A's, B's, and C's activations?**



11. Suppose you are given these description logic statements in the Tbox (recall, the terminological box, or definitions):

1. Person
2. Female
3. Male
4. $\text{Woman} \equiv \text{Person} \sqcap \text{Female}$
5. $\text{Man} \equiv \text{Person} \sqcap \text{Male}$
6. $\text{Parent} \equiv \text{Person} \sqcap \exists \text{hasChild}.\text{Person}$
7. $\text{Mother} \equiv \text{Woman} \sqcap \text{Parent}$
8. $\text{Father} \equiv \text{Man} \sqcap \text{Parent}$

and these statements in the Abox (recall, the axioms about objects):

$\text{Person}(\text{Roy})$
$\text{hasChild}(\text{Roy},\text{Kathrina})$
$\text{Person}(\text{Kathrina})$
$\text{Female}(\text{Kathrina})$
$\text{Female}(\text{Elise})$
$\text{Person}(\text{Elise})$
$\text{hasChild}(\text{Elise},\text{Kathrina})$

1. **Do you think you have enough information to prove that Roy is a father? Why or why not?**
2. **Do you have enough information to prove that Elise is a mother? Why or why not?**

1.) No, because we can't prove that Roy is a man.

2.) Yes, because we can prove Elise is a Woman and has a child therefore, Elise is a parent

12. In knowledge representation, a *frame*:

☐ is a knowledge structure that encapsulates related data and that has methods that can be called to use the data.

☑ is a knowledge structure contains attributes and values of some thing as well as relationships to other things represented as frames.

☐ is one slice of time represented as FOL statements, meant to be strung together to represent time passing for an object.

- [x] is related to other frames via its *isa* or *instance-of* slot to form an inheritance hierarchy (which might really be a tangled hierarchy).

13. Which is/are true about planning?

- [ ] A causal link records what an operator causes, that is, it links the operator to its effects.
- [ ] Plans can be created in general in polynomial time and space.
- [x] If operators are considered as predicate calculus functions representing situations, then resolution theorem proving using situation calculus can create plans, but it cannot using FOL without considering situations.
- [ ] A nonlinear planner can be created by just running multiple linear planners in parallel.

14. Compare and contrast first-order predicate logic, frames, semantic nets, and description logic. (Don't just give me the definitions or a bunch of facts about them; how are they similar? how do they differ?)

15. Suppose the POP partial-order planner has an operator Go(?a,?d) with preconditions:

- agent(?a)
- at(?a,?s)
- location(?s)
- location(?d)

and effects:

- ¬at(?a,?s)
- at(?a,?d)

1. **If the planner adds Go(Roy, UMaine) to the plan to achieve one of the Finish actions preconditions, at(Roy,UMaine), what would the causal link and the instantiated action look like?**

2. **If the planner adds the action Go(Roy,Hannaford) to the plan, would this threaten the causal link? If not, why not? And, if so, how would the planner know this?**

16. Compare and contrast forward-chaining and backward-chaining rule-based expert systems. Your answer should address issues of what they are used for, the need for uncertain reasoning (and why/why not), and how they operate.