

CSE560 Midterm Exam

Name: _____

Syntax	/8
Intended Interpretations	/4
Interpretations	/11
Semantics	/9
Derivations	/8
Knowledge	/4
Search	/2
	/46

Syntax of Datalog (8 Marks)

Question 1 (2 marks)

Consider the constants *tom* and *sally*, and the 0-ary predicate *raining* and the 2-ary predicate *mother*(-, -). What are all of the legal **atomic** clauses (also called facts) that can be written.

Question 2 (2 marks)

Give two non-atomic clauses (also called rules) that are legal.

Question 3 (2 marks)

If we add the function *motherof*(-), give an *atomic* clause that is now legal.

Question 4 (2 marks)

With the addition of the function *motherof*(-), how many different atomic clauses can we now write?

Intended Interpretation (4 Marks)

Question 5 (2 marks)

Annie is Beth's mother, and Beth is Corine's mother. Imagine that you are a knowledge engineer and have the intended interpretation where a maps to Annie, b maps to Beth, and c maps to Corine, and $mother(X,Y)$ is true if X is Y 's mother.

The following two clauses are clearly true of the intended interpretation.

$mother(a,b)$

$mother(b,c)$

Mark each of the following clauses as to whether it is true or false in the intended interpretation.

$mother(c,a)$

$mother(b,a)$

$mother(a,b) \leftarrow mother(b,c)$

$mother(a,b) \leftarrow mother(c,a)$

$mother(c,a) \leftarrow mother(a,b)$

Question 6 (2 marks)

Now say we add the function $motherof(X)$ that will indicate who the mother of X is.

Write down one fact that the knowledge engineer should add to the knowledge base to capture the full meaning of $motherof$.

Interpretations (11 Marks)

Question 7 (2 marks)

Consider the language with constants a and b , and the 0-ary predicate *raining* and the 1-ary predicate *girl*($_$). For the domain $D = \{x, y, z\}$, how many different ways can an interpretation map the constants (how many different ϕ 's are there)? Explain your answer.

Question 8 (1 marks)

How many ways can an interpretation map the predicate *raining* (how many different ways can π map *raining*)?

Question 9 (2 marks)

How many ways can an interpretation map the predicate *girl*($_$). Give one of the mappings in full.

Question 10 (1 marks)

How many interpretations are there altogether?

Question 11 (1 marks)

If we add the variable i to our syntax, does this change the number of interpretations? Why or why not?

Question 12 (1 marks)

How many of the interpretations from Question 8 are models of $KB = \{\}$.

Question 13 (3 marks)

How many of the interpretations are models of $KB = \{girl(a), girl(b), raining\}$

Semantic Proofs (9 Marks)

Question 14 (2 marks)

What does $KB \models \alpha$ mean? Phrase your answer in terms of interpretations (not models).

Question 15 (1 marks)

What does it mean if α does not logically follow from KB ? Does this mean that α is false in our intended interpretation? Explain your answer.

Question 16 (3 marks)

Consider the following KB

p .

$q \leftarrow p$.

Use a truth table to prove that q logically follows from KB ($KB \models q$). Make sure you explain why your truth table shows $KB \models q$.

Question 17 (3 marks)

Say that a is a constant in our syntax and our KB consists of the following.

$p(X)$.

Give a semantic proof that $p(a)$ logically follows from KB. (Hint: do a proof by contradiction involving interpretations, models, and/or variable assignments.)

Derivations (8 Marks)

Question 18 (2 marks)

What is the most general unifier of the following.

$p(a,b)$ $p(Y,Z)$

$p(a,b,X)$ $p(Y,Z,Z)$

$p(q(X),q(a))$ $p(Z,Z)$

Question 19 (3 marks)

Consider the following KB.

- 1 $parent(X, Y) \leftarrow mother(X, Y)$
- 2 $parent(X, Y) \leftarrow father(X, Y)$
- 3 $ancestor(X, Y) \leftarrow parent(X, Y)$
- 4 $ancestor(X, Z) \leftarrow parent(X, Y) \wedge ancestor(Y, Z)$
- 5 $mother(amy, bob)$

Give a top-down derivation (from query to KB) of $ancestor(amy, bob)$. Show the details of the derivation (which rule used, and the substitution).

Question 20 (2 marks)

Give a bottom-up derivation. Show all steps.

Question 21 (1 marks)

Since the computer only does derivations, why is it necessary to have semantics?

Defining Knowledge (4 Marks)

Question 22 (2 marks)

Using definite clauses (rules and facts), define **pulloutone(Item,List,Remainder)**, which is true if **Item** is in **List**, and **Remainder** is the **List** minus **Item**. You can use either the prolog list notation $[H|T]$ (with $[\]$ as the empty list) or the function notation `cons(H,T)` (with `nil` as the empty list).

Question 23 (1 marks)

What will the answer be for the following query? (You do not have to give a derivation; just give the answer.)

```
?pulloutone(p(X),[p(a),p(b),r,q(c),Z,p(d)],L).
```

Question 24 (1 marks)

What are the other answers (if we did an exhaustive search for all of the possible answers)?

```
?pulloutone(p(X),[p(a),p(b),r,q(c),Z,p(d)],L).
```

Search (2 Marks)

Question 25 (1 marks)

What is the role of search in converting a top-down proof procedure into a reasoning procedure.

Question 26 (1 marks)

Does search play a role in converting a bottom-up proof procedure into a reasoning procedure? Why or why not.