Name: _____ UnityID: _____

CSC 411 Study Guide for Midterm 02

You are allowed one (1) sheet of paper (8"x11") with handwritten notes (front and back) and a calculator. You may be required to wipe the memory of your calculator before the exam. No other review materials are permitted.

Remember, this is a study guide, meant to help you get ready for the exam. The questions here are meant to represent what to expect, but not limited to the only questions that will be on the exam.

You should be ready to answer any of the questions seen here, as well as questions similar to those seen in Lectures, Lecture Exercises, and Problem Sets.

Section	Possible Points
Evaluating Formulas	
CNF	
Knowledge Representation	
FOL Inference	
Planning	
Conditional Probability	
TOTAL	100

Name: _____ UnityID: _____

Evaluating Formulas

1. Given $(a \vee b) \rightarrow (b \rightarrow (a \wedge c))$, answer the questions below:
   a. True or False: This formula satisfiable. True
   b. Build a truth table to show your justification. Draw arrows on the left of the rows to show this justification. (Justification in green)

a	b	c	(a ∨ b)	a ∧ c	b ➔ (a ∧ c)	(a ∨ b) ➔ (b ➔ (a ∧ c))
T	T	T	T	T	T	T
T	T	F	T	F	F	F
T	F	T	T	T	T	T
T	F	F	T	F	T	T
F	T	T	T	F	F	F
F	T	F	T	F	F	F
F	F	T	F	F	T	T
F	F	F	F	F	T	T

Name: _____ UnityID: _____

CNF

2. Convert the following formula into CNF.

$$\neg(p \wedge q) \rightarrow \neg(r \wedge s)$$

$\neg\neg(p \wedge q) \vee \neg(r \wedge s)$ — Eliminate $\rightarrow$

$\neg(\neg p \vee \neg q) \vee \neg(r \wedge s)$ — Drive in 1 negation (De Morgan)

$(\neg\neg p \wedge \neg\neg q) \vee \neg(r \wedge s)$ — " (De Morgan)

$(\neg\neg p \wedge \neg\neg q) \vee (\neg r \vee \neg s)$ — " (De Morgan)

$(p \wedge q) \vee (\neg r \vee \neg s)$ — Remove double negations

$(b \wedge c) \vee d$ — Going to swap to mirror slides

$(\neg r \vee \neg s) \vee (p \wedge q)$ — Swapped

$(\neg r \vee \neg s \vee p) \wedge (\neg r \vee \neg s \vee q)$ — Apply distributive law & Done!

3. Convert the following formula into CNF.

$$\forall x\,((P(x) \vee Q(x) \rightarrow \forall y\,(S(y) \wedge T(y)))$$

$\forall x(\neg(P(x) \vee Q(x)) \vee \forall y(S(y) \wedge T(y)))$ — Eliminate $\rightarrow$

$\forall x((\neg P(x) \wedge \neg Q(x)) \vee \forall y(S(y) \wedge T(y)))$ — De Morgan's

$\forall x y((\neg P(x) \wedge \neg Q(x)) \vee (S(y) \wedge T(y)))$ — Move Quantifiers to Left

$(\neg P(x) \wedge \neg Q(x)) \vee (S(y) \wedge T(y))$ — Drop Quantifiers

$a \vee (b \wedge c)$ — Distributive Template

$((\neg P(x) \wedge \neg Q(x)) \vee S(y)) \wedge ((\neg P(x) \wedge \neg Q(x)) \vee T(y))$ — Apply Distributive $\vee$ over $\wedge$ BUT we are not done!

$((\neg P(x) \vee S(y)) \wedge (Q(x) \vee S(y)) \wedge (\neg P(x) \vee T(y)) \wedge (\neg Q(x) \vee T(y))$ — Because we need to also apply distributive $\wedge$ over $\vee$

Name: _____ UnityID: _____

Knowledge Representation

4. Circle the formula appropriately converts the sentence into FOL: "The night is dark and full of terror."

   a. $\forall x\ Night(x) \rightarrow Dark(x) \wedge FullOf(x, Terror)$

   b. $\forall x\ (Dark(x) \vee Terrible(x)) \rightarrow Night(x)$
   Implies other things can be Dark & Terrible + Terrible ≠ Terror

   c. $\forall x\ Night(x) \rightarrow Dark(x) \vee Terrible(x)$
   Terrible ≠ Terror

   d. $\exists x\ Night(x) \rightarrow Dark(x) \wedge FullOf(Terror)$
   Terror is not attached to x

5. Circle the formula appropriately converts the sentence into FOL: "If you don't succeed, try again."

   a. $\forall x\ \neg Success(x) \rightarrow Repeat(x)$

   b. $\forall x\ Success \rightarrow \neg Repeat(x)$ no (x)
   Don't Try Again

   c. $\forall x\ Failed(x) \rightarrow Repeat(x)$
   Failed ≠ Success

   d. $\forall x\ \neg Failed(x) \rightarrow \neg Repeat(x)$
   Failed ≠ Success

6. Circle the formula appropriately converts the sentence into FOL: "Some students study for all exams"

   a. $\forall xy\ Student(x) \rightarrow Exam(y) \wedge Studied(x, y)$ All x For all y

   b. $\exists x \forall y\ Student(x) \rightarrow Exam(y) \wedge Studied(x, y)$ some x For all y

   c. $\forall x \exists y\ Student(x) \rightarrow Exam(y) \wedge Studied(x, y)$ All x For some y

   d. $\exists xy\ Student(x) \rightarrow Exam(y) \wedge Studied(x, y)$ Some x for all y

Name: _____ UnityID: _____

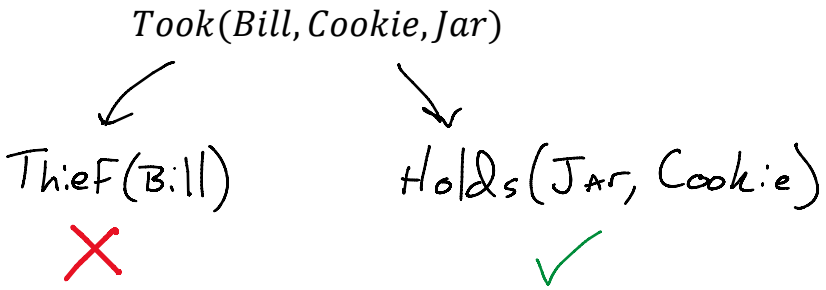
FOL Inference

7. Given the KB below, use backwards chaining to determine whether the query is true.

$$\alpha = Took(Bill, Cookie, Jar)$$

Draw out the clauses that need to be resolved in order to resolve α. Place a ✓ by clauses that can be inferred through the KB and an ✘ by clauses that cannot.

1	$Holds(Jar, Cookie)$	The Jar contains Cookies
2	$Thief(Tom)$	Tom is a Thief
3	$(Thief(x) \wedge Holds(y, z)) \rightarrow Took(x, z, y)$	If X is a Thief and Y contains Z, then X took Z from Y (converted to CNF)
?	$Took(Bill, Cookie, Jar)$	



8. Based on the chaining above, α is:

a. True

b. False

Name: _____ UnityID: _____

9. Given the KB below, use resolution through contradiction to determine whether the query is true.

$$\alpha = Flies(Tweety)$$

Make sure to indicate the premise's line number you are referencing and substitutions necessary at each step in the right column. More rows than necessary were included.

1	$\neg Bird(x) \vee Flies(x)$	All Birds Fly
2	$Bird(Tweety)$	Tweety is a Bird
3	$\neg Flies(Tweety)$	Negation of α (Goal)
4	$\neg Bird(Tweety)$	1+3 $\{x/Tweety\}$
5	$\{\}$	2+4
6	↑ contradiction found	
7		
8		
9		
10		

10. Based on the resolution above, α is:

a. True

b. False

Name: _____ UnityID: _____

Planning

Given the following initial and goal states,

Initial State: $AtTile(T1) \wedge Clean(T1) \wedge Dirty(T2)$

Goal State: $Clean(T1) \wedge Clean(T2)$

11. Design an **`Action(Move(from, to))`**, such that you can only move if you are **`at`** a tile and it is **`clean`**. The result is that you are no longer at the **`from`** location, and are now at the **`to`** location.

`Action(Move(from, to))`

Preconditions: **`AtTile(from) ∧ Clean(from)`**

Effect: **`¬AtTile (from) ∧ AtTile (to)`**

12. Design an **`Action(Sweep(location))`**, such that you can only sweep if you are at a **`location`** and it is **`dirty`**. The result is that **`location`** is no longer **`dirty`** and is **`clean`**.

`Action(Sweep(location))`

Preconditions: **`AtTile (location) ∧ Dirty(location)`**

Effect: **`¬Dirty(location) ∧ Clean(location)`**

Name: _____ UnityID: _____

13. What is the plan for reaching the goal state from the initial state? Note more rows were provided than need to be filled.

Action	**Move(T1, T2)**
Action	**Sweep(T2)**
Action	/
Action	/
Action	/
Action	/
Action	/
Action	/
Action	/
Action	/
Action	/

Name: _____ UnityID: _____

Conditional Probability

Consider the following truth table:

$\boldsymbol{A}$	$\boldsymbol{B}$	$\boldsymbol{C}$	$\boldsymbol{P(A,B,C)}$
T	T	T	0.20
T	T	F	0.10
T	F	T	0.15
T	F	F	0.05
F	T	T	0.15
F	T	F	0.15
F	F	T	0.10
F	F	F	0.10

14. Answer the following conditional probability formulas. Please round your answers to the nearest thousandths.

$\boldsymbol{P(A = false \mid B = true, C = true)}$	$\frac{P(\neg A, B, C)}{P(B, C)} = \frac{0.15}{0.35} = 0.429$
$\boldsymbol{P(A = false, B = false \mid C = true)}$	$\frac{P(\neg A, \neg B, C)}{P(C)} = \frac{0.1}{0.6} = 0.167$
$\boldsymbol{P(A = true, B = true \mid C = false)}$	$\frac{P(A, B, \neg C)}{P(\neg C)} = \frac{0.1}{0.4} = 0.25$
$\boldsymbol{P(A = false \mid B = false, C = true)}$	$\frac{P(\neg A, \neg B, C)}{P(\neg B, C)} = \frac{0.1}{0.25} = 0.4$
$\boldsymbol{P(A = true, B = false \mid C = true)}$	$\frac{P(A, \neg B, C)}{P(C)} = \frac{0.15}{0.6} = 0.25$

Name: _____ UnityID: _____

This page has been left blank for notes.

THIS SHEET WILL NOT BE CONSIDERED FOR GRADING