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CS 480 Fall 2022 Written Assignment #03

Due: Sunday, November 6, 11:00 PM CST

Points: 45

#### **Instructions:**

1. Use this document template to report your answers. Name the complete document as follows:

LastName\_FirstName\_CS480\_Written03.doc or pdf

2. Submit the final document to Blackboard Assignments section before the due date. No late submissions will be accepted.

#### **Objectives:**

- 1. (25 points) Demonstrate your understanding of First-Order Logic syntax.
- 2. (20 points) Demonstrate your understanding of Bayes' Rule.

### **Problem 1 [25 pts]:**

Convert English sentences to FOL. Write each of the following English sentences using First Order Logic. Use the following predicates and constants only.

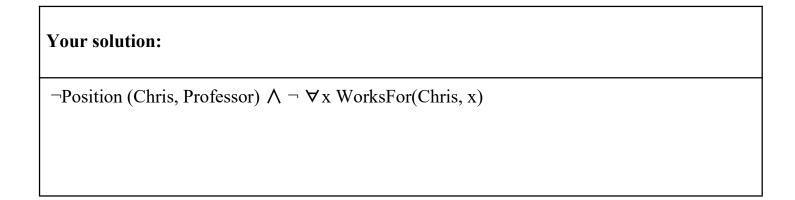
- n Position( $\mathbf{x}$ ,  $\mathbf{y}$ ): Predicate. Person  $\mathbf{x}$  has position  $\mathbf{y}$ . You can also read it as  $\mathbf{x}$  holds  $\mathbf{y}$  or  $\mathbf{x}$  is  $\mathbf{y}$ .
- n Friend(p1, p2): Predicate. Person p1 is a friend of person p2.
- n WorksFor(z1, z2): Predicate. Person z1 works for person z2.
- n Professor, Judge, Footballer, Athlete: Constants denoting some positions. This list is not comprehensive. **There are also other positions not mentioned here**.

a) Penelope is neither a professor nor a footballer [5 pts].				
Your solution:				
¬Position (Penelope, Professor)				

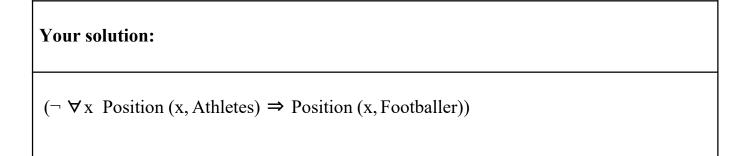
n Chris, Penelope: Constants denoting some people. This list is not comprehensive. There

b) Chris is not a professor and he works for no one [5 pts].

are also other people not mentioned in this list.



c`	Not all athlatas are footballars	[5	ntal	
U,	Not all athletes are footballers	IJ	hral	ŀ



d) Chris does not work for any of Penelope's friends [5 pts].

### Your solution:

 $\forall x \text{ Friend}(x, \text{Penelope}) \Rightarrow \neg \text{ WorksFor}(\text{Chris}, x)$ 

e) Being a judge sometimes means that you have friends [5 pts].

Your	solution:
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Position(x,judge)  $\land \exists y \text{ Friend}(x,y)$ 

### Problem 2 [20 pts]:

We are given the following joint distribution for variables A, B, and C. Please compute the requested probabilities. Show each probability distribution as a table/vector.

A	В	С	P(A, B, C)
Т	Т	Т	0.014
T	T	F	0.126
T	F	T	0.012
T	F	F	0.048
F	Т	T	0.392
F	Т	F	0.168
F	F	T	0.144
F	F	F	0.096

## a) **P**(A, C) [5 pts]

**Solution:** 

P(A,C)

A	C	SOLUTION	P(A,C)
Т	Т	(A = T, B = T, C = T) + (A = T, B = F, C = T) $0.014 + 0.012$	0.026
Т	F	(A = T, B = T, C = F) + (A = T, B = F, C = F) $0.126 + 0.048$	0.174
F	Т	(A = F, B = T, C = T) + (A = F, B = F, C = T) $0.392 + 0.144$	0.536
F	F	(A = F, B = T, C = T) + (A = F, B = F, C = F) $0.168 + 0.096$	0.264

b) P(C) – you can use your answer to part a to compute the answer to this question. [5 pts]

# **Solution:**

C	SOLUTION	P(C)
Т	(A = T, B = T, C = T) + (A = T, B = F, C = T) + (A = F, B = T, C = T) + (A = F, B = F, C = T) 0.014 + 0.012 + 0.392 + 0.144	0.562
F	(A = T, B = T, C = F) + (A = T, B = F, C = F) + (A = F, B = T, C = T) + (A = F, B = F, C = F) $0.126 + 0.048 + 0.168 + 0.096$	0.438

c) P(A|C) – you can use your answers to parts a and b to compute the answer to this question. [5 pts]

**Solution:** 

A	C	SOLUTION	P(A/C)
T	Т	(A = T, B = T, C = T) + (A = T, B = F, C = T) / (A = T, B = T, C = T) + (A = T, B = F, C = T) + (A = F, B = T, C = T) + (A = F, B = F, C = T) $(0.014 + 0.012) / (0.014 + 0.012 + 0.392 + 0.144)$ $0.026 / 0.562$	0.0462
T	F	(A = T, B = T, C = F) + (A = T, B = F, C = F) / (A = T, B = T, C = F) + (A = T, B = F, C = F) + (A = F, B = T, C = T) + (A = F, B = F, C = F) (0.126 + 0.048) / (0.126 + 0.048 + 0.168 + 0.096) 0.174 / 0.438	0.397
F	Т	(A = F, B = T, C = T) + (A = F, B = F, C = T) / (A = T, B = T, C = T) + (A = T, B = F, C = T) + (A = F, B = T, C = T) + (A = F, B = F, C = T)  (0.392 + 0.144)/(0.014 + 0.012 + 0.392 + 0.144)  0.536 / 0.562	0.9537

F	F	(A = F, B = T, C = T) + (A = F, B = F, C = F) /	0.6027
		(0.168 + 0.096) / (0.126 + 0.048 + 0.168 + 0.096)	
		0.264 / 0.438	

Soluti	Solution:						
A	В	C	SOLUTION	<b>P</b> ( <b>A</b> , <b>B</b>   <b>C</b> )			
T	Т	Т	(A = T, B = T, C = T) / (A = T, B = T, C = T) + (A = T, B = F, C = T) + (A = F, B = T, C = T) + (A = F, B = F, C = T) 0.014 / 0.562	0.0249			
Т	Т	F	(A = T, B = T, C = F) / (A = T, B = T, C = F) + (A = T, B = F, C = F) + (A = F, B = T, C = T) + (A = F, B = F, C = F) 0.126 / 0.438	0.287			
Т	F	Т	(A = T, B = F, C = T) / (A = T, B = T, C = T) + (A = T, B = F, C = T) + (A = F, B = T, C = T) + (A = F, B = F, C = T) 0.012 / 0.562	0.0213			
Т	F	F	(A = T, B = F, C = F) / A = T, B = T, C = F) + (A = T, B = F, C = F) + (A = F, B = T, C = T) + (A = F, B = F, C = F) 0.048 / 0.438	0.109			

F	T	T	(A = F, B = T, C = T) / (A = T, B = T, C = T) + (A = T, B = F, C = T) + (A = F, B = T, C = T) + (A = F, B = F, C = T) 0.392 / 0.562	0.697
F	Т	F	(A = F, B = T, C = T) / (A = T, B = T, C = F) + (A = T, B = F, C = F) + (A = F, B = T, C = T) + (A = F, B = F, C = F) 0.168 / 0.438	0.3835
F	F	Т	(A = F, B = F, C = T) / (A = T, B = T, C = T) + (A = T, B = F, C = T) + (A = F, B = T, C = T) + (A = F, B = F, C = T) 0.144 / 0.562	0.256
F	F	F	(A = F, B = F, C = F) / (A = T, B = T, C = F) + (A = T, B = F, C = F) + (A = F, B = T, C = T) + (A = F, B = F, C = F) 0.096 / 0.438	0.219