Assignment #2 – Logic Exercises

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**CSC 480- Artificial Intelligence I**

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A) Represent these facts as sentences in first-order predicate calculus statements.

* Animals can outrun any animals they eat.  
  **x y animal(x)  animal(y)  eats(x,y)  outruns(x,y)**
* Carnivores eat some other animals.  
  **x y carnivore(x)  animal(y)  eats(x,y)**
* Outrunning is transitive, i.e., if x outruns y, and y outruns z, then x outruns z.  
  **x y z outruns(x,y)  outruns(y,z)  outruns(x,z)**
* Lions eat zebras.  
  **eats(lions,zebras)**
* Zebras can outrun dogs.  
  **outruns(zebras,dogs)**
* Dogs are carnivores.  
  **carnivore(dogs)**

B) Translate them into clausal form.

* x y animal(x)  animal(y)  eats(x,y)  outruns(x,y)  
  x y  [animal(x)  animal(y)  eats(x,y)]  outruns(x,y)  
  [animal(x)  animal(y)  eats(x,y)]  outruns(x,y)  
  **animal(x)  animal(y)  eats(x,y)  outruns(x,y)**
* x y carnivore(x)  animal(y)  eats(x,y)  
  x carnivore(x)  animal(sk(x))  eats(x, sk(x))  
  **carnivore(x)  animal(sk(x))  eats(x, sk(x))**
* x y z outruns(x,y)  outruns(y,z)  outruns(x,z)  
  x y z  [outruns(x,y)  outruns(y,z)]  outruns(x,z)  
  [outruns(x,y)  outruns(y,z)]  outruns(x,z)  
  **outruns(x,y)  outruns(y,z)  outruns(x,z)**
* **eats(lions,zebras)**
* **outruns(zebras,dogs)**
* **carnivore(dogs)**

C) Use resolution-refutation to prove that a lion can outrun a dog. In addition to the facts explicitly stated above, you may need to write other predicate calculus statements to do the proof.  
Add FOPL statement:  
carnivore(x)  animal(x)  
in clausal form:  
carnivore(x)  animal(x)

Assume: outruns(lions,dogs)

carnivore(x)  animal(sk(x))  eats(x, sk(x)) eats(lions,zebras)

carnivore(lions)  animal(zebras)  eats(lions,zebras) carnivore(x)  animal(x)

animal(lions) carnivore(lions)

animal(x)  animal(y)  eats(x,y)  outruns(x,y)

outruns(lions,zebras)

outruns(x,y)  outruns(y,z)  outruns(x,z) outruns(zebras,dogs)

outruns(lions,dogs)

Contradiction with assumption, conclude:

**outruns(lions,dogs)**

D) What other animals can a lion outrun? Show your work. Answers in **BOLD**.

carnivore(x)  animal(sk(x))  eats(x, sk(x)) carnivore(lions)

carnivore(lions)  animal(eaten\_by(lions))  eats(lions,eaten\_by(lions)) //sk(lions)=eaten\_by(lions)

animal(x)  animal(y)  eats(x,y)  outruns(x,y)

animal(lions)

**outruns(lions, eaten\_by(lions))** // lions outrun anything eaten\_by(lions)

outruns(lions,eaten\_by(lions)) eats(lions,zebras)

outruns(lions,zebras) outruns(x,y)  outruns(y,z)  outruns(x,z)

outruns(zebras,dogs)

**outruns(lions,dogs)**

carnivore(x)  animal(x) carnivore(dogs)

animal(dogs)

carnivore(x)  animal(sk(x))  eats(x, sk(x)) carnivore(dogs)

carnivore(dogs)  animal(eaten\_by(dogs))  eats(dogs,eaten\_by(dogs)) //sk(dogs)=eaten\_by(dogs)

animal(x)  animal(y)  eats(x,y)  outruns(x,y)

animal(dogs)

outruns(dogs, eaten\_by(dogs)) // dogs outruns anything eaten\_by(dogs)

outruns(x,y)  outruns(y,z)  outruns(x,z)

outruns(lions,dogs)

**outruns(lions, eaten\_by(dogs))** // lions outrun anything eaten\_by(dogs)