

CS444 Predicate Logic Exercises

1. Using the predicate symbols shown and appropriate quantifiers, write each English language statement as a predicate well formed formula. (The domain is the whole world.)¹

$B(x)$ is “x is a ball.”

$R(x)$ is “x is round.”

$S(x)$ is “x is a soccer ball.”

- (a) All balls are round.
- (b) Not all balls are soccer balls.
- (c) All soccer balls are round.
- (d) Some balls are not round.
- (e) Some balls are round, but soccer balls are not.

2. Imagine that you work for an auto-maker, and that your company is introducing a new safety feature: SUPERBRAKES. Deploying the Superbrakes cuts the stopping distance of the car in half, potentially avoiding an accident. Unfortunately, the Superbrake canister only supports a single use, and must be professionally reset after deployment.

Your job is to design an AI system to determine whether or not the current driving situation warrants the deployment of the Superbrake system.

¹From *Mathematical Structures for Computer Science*, Judith Gersting, W.H. Freeman and Company, 2007.

Inputs to the decision system include:

- The speed of the car.
- Several sensor values for each of the four wheels
 - wet
 - slipping
 - damaged

A particular wheel is considered “dangerous” if it is slipping, damaged or wet. Superbrakes should deploy if the speed is above 50 miles/hour, at least one wheel is slipping, and at least three of the four wheels are “dangerous”.

- (a) Express the Superbrake decision procedure as a predicate logic knowledge base. (What is an appropriate domain?)
- (b) Express the Superbrake decision procedure as a Datalog knowledge base. (<- for \leftarrow , & for \wedge , capital letters for variables).

3. Exercise 12.1²

Consider a domain with two individuals (\clubsuit and \spadesuit), two predicate symbols (p and q), and three constants (a , b , c). The knowledge base KB is defined by

$p(X) \leftarrow q(X).$
 $q(a).$

- (a) Give one interpretation that is a model of KB .
- (b) Give one interpretation that is not a model of KB .
- (c) How many interpretations are there? Give a brief justification of your answer.

²*Artificial Intelligence: Foundations of Computational Agents*, David Poole and Alan Mackworth, Cambridge University Press, 2010.