

## Homework set 5: Prolog — due Monday 19 February

Total number of points available on this homework is 100. Full credit is equivalent to 100 points.

1. (20 pts.) Define numerals as follows, rendering Peano's axioms in Prolog:

```
%% num(X) means: X is a numeral.
num(0).
num(s(X)) :- num(X).
```

```
%% sum(X, Y, Z) means: X, Y, Z are numerals
%%           such that Z is the sum of X and Y.
sum(X, 0, X) :- num(X).
sum(X, s(Y), s(Z)) :- sum(X, Y, Z).
```

Why can't we write simply `sum(X, 0, X)` for the first rule?

What are the answers to the following queries:

- (a) `?- sum(s(s(0)), s(s(s(0))), Z)`.  
 (b) `?- sum(X, Y, s(s(s(0))))`.

2. (20 pts.) Continuing the preceding exercise, write the rules for multiplication `mult(X, Y, Z)`, meaning that Z is the product of X and Y. Multiplication is defined by the following axioms:

- $x \cdot 0 = 0$
- $x \cdot s(y) = (x \cdot y) + x$

3. (60 pts.) The following are the rules for `list(L)`, which means that L is a list.

```
list([]).
list(_|T) :- list(T).
```

- (a) (10 pts.) Write the rules for `len(L, X)`, which means that X, a numeral as defined in the preceding exercises, is the length of the list L.  
 (b) (20 pts.) Write the rules for `append(L1, L2, L3)`, which means that the concatenation of lists L1 and L2 is the same as list L3.  
 (c) (20 pts.) Write the rules for `reverse(L1, L2)`, which means that list L2 is the reverse of list L1.  
 (d) (10 pts.) Write the rules for `palindrome(L)`, which means that list L is a palindrome.