

LING5702: Problem Set 1

Due via Carmen dropbox at 11:59 PM 1/23.

1. Assume a joint probability space, as described in the lecture notes, over a seed you are planting, with factors for species S and color C , each with outcomes:

- species t where the plant turns out to be a tree
- species s where the plant turns out to be a shrub
- color g where the plant turns out to be green
- color b where the plant turns out to be brown

Using the above outcomes ...

- (a) [3 pts.] Write a probability equation expressing that half the time your seed will turn out to be a tree.
- (b) [3 pts.] Write a probability equation expressing that half the time your seed will turn out to be a green tree.
- (c) [3 pts.] Write a probability equation expressing that if your seed turns out to be green, half the time it will be a tree.

2. Suppose you have the following probability model over a seed you are planting using the probability space from the previous problem:

- a third of the time you get a green tree
- a sixth of the time you get a brown tree
- a third of the time you get a green shrub
- a sixth of the time you get a brown shrub

Using the above model ...

- (a) [3 pts.] What is the probability it will turn out to be a green plant (either a tree or a shrub)?
- (b) [3 pts.] If you already know it will turn out to be green, what is the probability it will turn out to be a tree?

3. Using the generalized quantifier functions in the lecture notes on typed lambda calculus and the following predicates:

- **Tree** x , meaning that entity x is a tree
- **Green** x , meaning that entity x is green
- **Round** x , meaning that entity x is round
- **Park** x , meaning that entity x is a park area
- **In** $x y$, meaning that entity x is in area y

(a) [3 pts.] Write a typed lambda calculus expression stating that half the round trees are green.

(b) [3 pts.] Write a typed lambda calculus expression stating that half the trees are green and round.

(c) [3 pts. – difficult!] Write a typed lambda calculus expression stating that all the trees are in some park (possibly a different park for each tree).

4. [difficult!] Using the non-intensional and intensional quantifier functions from the lecture notes on typed lambda calculus:

- **Ratio** $_{\geq n} R S$, meaning that at least n (proportion) of R are in S ,
- **Count** $_{\geq n} R S$, meaning that at least n (instances) of R are in S ,
- **IntensionOfCount** $_{\geq i n} R S$, meaning that i is an intension that at least n of R are in S ,

and the following predicates:

- **Kid** x , meaning that entity x is a kid,
- **Horse** y , meaning that entity y is a horse,
- **Time** t , meaning that entity t is a point in time,
- **Ride** $t x y$, meaning that entity x rides entity y at time t ,
- **Want** $t x i$, meaning that entity x wants intension i to be true at time t ,

write a typed lambda calculus expression stating that:

(a) [2pts.] Every kid wants to ride a horse at some point in time (but they don't care which horse or when);

- (b) [2pts.] For every kid there is a particular real horse that they want to ride at some point in time (but they don't care when, and it may be a different horse for each kid).
- (c) [2pts.] There is a single (presumably famous) horse that every kid wants to ride at some point in time;

Note: only quantifier functions can take lambda functions ($\lambda x \dots$) as arguments; all the predicates can take only entity variables as arguments.