Ling 5801: Problem Set 5
Due via Carmen dropbox at 11:59 PM 11/14.

1. [10 pts.] Write an equation for a full joint distribution in terms of the following models:
   - $\theta_{SKF}$, for a student knowing the fact that answers a question,
   - $\theta_{SRH}$, for the student raising his or her hand,
   - $\theta_{SCA}$, for the student correctly answering the question,

   with conditional dependencies as shown in the following network:

2. [10 pts.] Draw or describe a graphical representation of an extension of the above probability model, using random variables for:
   - student listening to lesson explaining fact
   - teacher asking question
   - student hearing question

   Justify each additional conditional dependency in a sentence (for example: ‘a student is more likely to raise his or her hand if he or she knows the answer’).

3. [10 pts.] PROGRAMMING: Write a program to read in models of language change over generations of speakers. Use the following format for component models of a grandparent speaker $G$, a parent speaker $P$ (given grandparent), and a child speaker $C$ (given parent) making use of the word ‘who’ as opposed to ‘whom’ in the position of an accusative filler (e.g. ‘who/whom did you invite?’):

   $G : \text{ who } = .1$
   $G : \text{ whom } = .9$
   
   $P \text{ who : who } = 1$
   $P \text{ who : whom } = 0$
   $P \text{ whom : who } = .2$
   $P \text{ whom : whom } = .8$
   
   ;
then use these models to calculate a conditional probability distribution table for $P(P|C)$, and print it in the following format:

- $P_{givC}$ who : who = 0.4375
- $P_{givC}$ who : whom = 0.5625

4. [10 pts.] PROGRAMMING: Write a program to read in models for all variables $R$, $W$, and $O$ in the ‘repeated trials’ model shown at the beginning of the lecture notes on sequence modeling, in the following format:

- $R : ohio = .5$
- $R : phil = .5$
- $W : /nek/ = .6$
- $W : /naek/ = .4$
- $O_{ohio} /nek/ : [nek] = 1$
- $O_{phil} /nek/ : [nek] = .667$
- $O_{phil} /nek/ : [naek] = .333$
- $O_{ohio} /naek/ : [naek] = 1$
- $O_{phil} /naek/ : [naek] = 1$

and an input sequence of any number of observations in the format:

- $I [naek] [nek] [naek] ..$

then print out a probability distribution for $R$ given all of these input observations, in the following format (note: probabilities given observations should not necessarily match initial $R$ model):

- $R_{givenIdata} : ohio = .4$
- $R_{givenIdata} : phil = .6$

Your program should be as short as possible. Hand in all inputs and outputs.