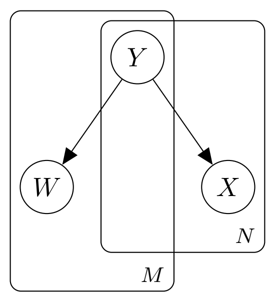
CS267A: Probabilistic Programming and Relational Learning **Spring 2020**

Homework 7: Due Monday June 1, 11:59PM

Instructions: Upload one file to CCLE: a PDF typeset using LaTeX containing your solutions. No late submissions will be accepted. See the syllabus for policies about collaboration and academic honesty.

Problem 1

For the plate model below, draw the full equivalent Bayesian network, with plate M being cloned 3 times and plate N being cloned 2 times.



Problem 2

Suppose in a class we have a series of homeworks, where each homework needs to be done in pairs. Each homework has a difficulty level, and each student has a skill level. There can be different pairs for different homeworks, and everyone in the same group receives the same grade per homework. Assume there are N grad students, N undergrad students, and T homeworks.

In each of the following cases, draw the plate model and the unrolled network for $N = 2, T = 3$, or state and explain why it is not possible.

1. Each pair must consist of one undergraduate and one graduate student.
2. Each pair can be any two students (no longer required to be one undergrad and one grad).

Problem 3

Consider the following Markov logic network:

$$\begin{array}{ll} 1.5 & \forall x. S(x) \Rightarrow C(x). \\ 2.0 & \forall x, y. S(x) \wedge F(x, y) \Rightarrow S(y). \end{array}$$

Suppose there are two constants, labeled A and B.

1. What is the *un-normalized* weight of $\omega_1 = S(a) \wedge C(a) \wedge S(b) \wedge C(b) \wedge F(a,b) \wedge F(b,a) \wedge F(a,a) \wedge F(b,b)$?
2. What is the *un-normalized* weight of $\omega_2 = S(a) \wedge \neg C(a) \wedge S(b) \wedge C(b) \wedge F(a,b) \wedge F(b,a) \wedge F(a,a) \wedge F(b,b)$?
3. What is $\Pr(C(a) \mid S(a))$?

Problem 4

For each of the following, either compute the first-order model count for the following queries using the lifted first-order model counting rules, or state that it is not possible:

1. $\exists x. S(x) \wedge T(x)$, where x is drawn from a domain of size n.
2. $\forall x. S(x) \Rightarrow \left[\exists y. F(x,y)\right]$, where x is drawn from a domain of size n and y is drawn from a domain of size m.
3. $\forall x_1, y_1, x_2, y_2. \left[S(x_1, y_1) \vee R(y_1) \vee S(x_2, y_2) \vee T(y_2) \vee U(y_2)\right]$, where all variables are drawn from a domain of size n.