CS 228T QUIZ 4

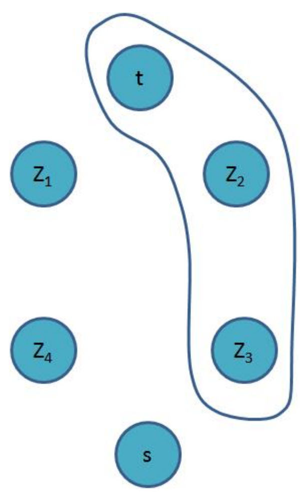
1. Suppose the max-marginals have been computed. What do you think of the idea of using the max-marginal for each variable X_i to compute its optimal assignment, and then using these to compose a full joint assignment to all variables?

2. In sum-product message passing, the final belief is $\beta_i(c_i) = \sum_w \tilde{P}(c_i, w)$, where $w = \mathcal{X} - c_i$. What do you think the final $\beta_i(c_i)$ is for the case of max-product message passing?

3. In sum-product message passing, the clique tree was calibrated when neighboring clusters agreed on their marginals. State the analogous condition for a clique tree to be max-calibrated.

4. Is the integer LP formulation of MAP inference a convex problem?

5. Suppose we are performing MAP inference over 4 binary variables that have edges $X_1 - X_2$, $X_2 - X_3$, $X_3 - X_4$, and $X_4 - X_1$. The following are all nonzero energies that compose our energy function: $\epsilon_1[0] = 1, \lambda_{1,2} = 2, \epsilon_2[0] = 8, \lambda_{2,3} = 7, \epsilon_3[1] = 1, \lambda_{3,4} = 1, \epsilon_4[1] = 5, \lambda_{1,4} = 4$. The following is a cut of the corresponding graph construction for this problem, where we omit the graph edges:



(a) What is the value of the cut?
(b) The above network is now modified so that each variable can take on 3 possible values instead of 2. The above energies remain the same, and we have the following additional energy terms over the variables X_3 and X_4: $\epsilon_{3,4}[0,2] = 2, \epsilon_{3,4}[2,0] = 6, \epsilon_{3,4}[1,2] = 3, \epsilon_{3,4}[2,1] = 4, \epsilon_{3,4}[2,2] = 1$. We will now perform alpha-expansion to try to solve the MAP problem. We begin with the assignment $(0,0,0,0)$ to (X_1, X_2, X_3, X_4), and the target label is 2. What is the value of the new energy potential $\epsilon'_{3,4}[t_3^0, t_4^1]$?
(c) Will we be able to compute the exact MAP assignment of the new energy (after the alpha-expansion) in the previous question using a graph cut?

(For these questions, you can just provide the number for the first two, and a yes/no answer for the last one.)

Date: September 29, 2020.

6. Consider the convex optimization problem

$$\begin{array}{ll} \text{minimize} & f(x) \\ \text{subject to} & x \in \mathcal{C}, \end{array}$$

with variable $x \in \mathbb{R}^n$. Suppose f is *additive*, *i.e.*,

$$f(x) = \sum_{i=1}^{N} f_i(x).$$

Note here that each term f_i shares the same variable x. Explain briefly how to transform the original problem so the objective becomes *separable*, *i.e.*,

$$f(x) = \sum_{i=1}^{N} f_i(x_i).$$