6.892 Machine learning seminar

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This assignment is due **March 1**. You can either email the assignment to me as plain text (use subject "HOMEWORK 3") or give it to me in class.

1. Analyze the computational cost of using the node elimination algorithm presented in the handout. You can be very brief, simply identifying the key steps and their associated costs.

2. Why does the heuristic method of choosing the elimination ordering work? Can you improve it?

3. Consider a Gaussian process (Brownian motion). This is a collection of Gaussian random variables associated with the points along the time axis such that the covariance between the random variables at times t and t' is

$$Cov(y_t, y_{t'}) = e^{-|t-t'|} \tag{1}$$

   So, any y_t covaries with any other $y_{t'}$. We know, however, that this is a markov process in time. Where is the simple markov dependency structure?

4. **Research level:** We have seen that tree structured models are simple and efficient. To use them in a classification setting, we'd like to maximize the likelihood of the correct label rather than the joint likelihood of the examples $\{x^t\}$ and the labels $\{y^t\}$. Devise an algorithm, approximate if need be, where the structure and/or the parameters of these models are optimized according to

$$\max_{S,\theta_S} \sum_t \log P(y^t|x^t, \theta_S, S) \tag{2}$$

   where θ_S denote the parameters corresponding to the structure S.