4 Bayesian about Happiness [60 points]

As part of a comprehensive study of the role of 10-601 on people's happiness we have been collecting important data from graduating students. In an entirely optional survey that all students are required to complete, we ask the following highly objective questions:

- Do you party frequently [`Party`: Yes/No]?
- Are you wicked smart [`Smart`: Yes/No]?
- Are you creative [`Creative`: Yes/No]? (Please only answer Yes or No)
- Did you do well on all your homework assignments? [`HW`: Yes/No]
- Do you use a Mac? [`Mac`: Yes/No]
- Did your 10-601 project succeed? [`Project`: Yes/No]
- Did you succeed in your most important class (which is 10-601)? [`Success`: Yes/No]
- Are you currently Happy? [`Happy`: Yes/No]

You can obtain the comma-separated survey results from http://www.cs.cmu.edu/~ggordon/10601/hws/hw2/students.csv.zip. Each row in `students.csv` corresponds to the responses of a separate student. The columns in `students.csv` correspond to each question (random variable) in the order `Party`, `Smart`, `Creative`, `HW`, `Mac`, `Project`, `Success`, and `Happy`. The entries are either zero, corresponding to `No` response, or one, corresponding to a `Yes` response. After consulting a behavioral psychologist we obtained the following complete set of conditional relationships:

- `HW` depends only on `Party` and `Smart`
- `Mac` depends only on `Smart` and `Creative`
- `Project` depends only on `Smart` and `Creative`
- `Success` depends only on `HW` and `Project`
- `Happy` depends only on `Party`, `Mac`, and `Success`

4.1 Understanding The Model [12 Points]

1. Draw the Bayesian network.
2. Write joint distribution as a product of conditional probabilities.
3. What is the number of independent parameters needed for each conditional probability table?
4. What is the total number of independent parameters?

4.5 Inference [15 Points]

Using any of the following software,

- **Recommended:** AISpace Graphical Tool http://www.aispace.org/bayes/version5.1.6/bayes.jnlp other formats (jar, exe, applet) are available http://www.aispace.org/downloads.shtml
- The Matlab Bayes Net Toolbox: http://people.cs.ubc.ca/~murphyk/Software/BNT/bnt.html
- WinBUGS (Bayesian Inference Using Gibbs Sampling) http://www.mrc-bsu.cam.ac.uk/bugs/

along with your conditional probability table estimates, calculate the following probabilities:

- What is the probability of being happy?

- What is the probability of being happy given that you party often, are wicked smart, but not very creative?
- What is the probability of being happy given that you are wicked smart and very creative?
- What is the probability of being happy given you do not party, and do well on all your homework and class project?
- What is the probability of being happy given you own a mac?
- What is the probability that you party often given you are wicked smart?
- What is the probability that you party often given you are wicked smart and happy?