

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.

★ **SOLUTION:** The Bayesian network is shown in Fig. 1. It is obtained by setting each variables parents on which it depends.

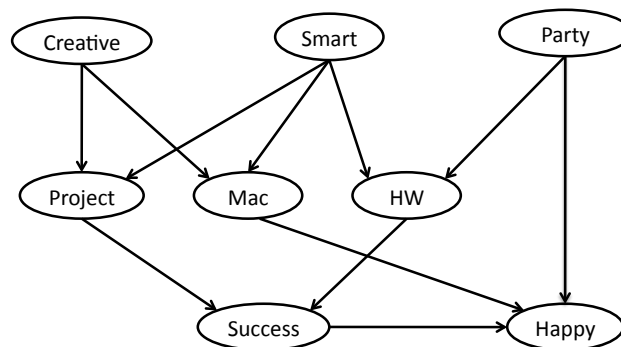


Figure 3: Bayesian Network for Happiness in Life.

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:

★ **SOLUTION:** You can download a complete Bayesian Network for the AISpace Graphical Tool from <http://www.cs.cmu.edu/~ggordon/10601/hws/hw2/bayesnet.xml>.

- What is the probability of being happy?

$$\begin{aligned}
\mathbf{P}(\text{creative} = T) &= 0.69932 \\
\mathbf{P}(\text{smart} = T) &= 0.70472 \\
\mathbf{P}(\text{party} = T) &= 0.60216
\end{aligned}$$

creative	smart	$\mathbf{P}(\text{mac} = T \mid \text{creative}, \text{smart})$
T	T	0.68564
T	F	0.89635
F	T	0.41347
F	F	0.12329

project	hw	$\mathbf{P}(\text{success} = T \mid \text{project}, \text{hw})$
T	T	0.89633
T	F	0.20737
F	T	0.30714
F	F	0.05066

success	mac	party	$\mathbf{P}(\text{happy} = T \mid \text{success}, \text{mac}, \text{party})$
T	T	T	0.95842
T	T	F	0.35837
T	F	T	0.72082
T	F	F	0.30769
F	T	T	0.49234
F	T	F	0.20619
F	F	T	0.42043
F	F	F	0.09646

creative	smart	$\mathbf{P}(\text{project} = T \mid \text{creative}, \text{smart})$
T	T	0.90484
T	F	0.40307
F	T	0.79326
F	F	0.10731

smart	party	$\mathbf{P}(\text{hw} = T \mid \text{smart}, \text{party})$
T	T	0.80252
T	F	0.89790
F	T	0.09447
F	F	0.30556

Table 4: Learned conditional probability tables.

★ SOLUTION:

$$\mathbf{P}(\text{happy} = T) = 0.51575$$

- What is the probability of being happy given that you party often, are wicked smart, but not very creative?

★ SOLUTION:

$$\mathbf{P}(\text{happy} = T \mid \text{party} = T, \text{smart} = T, \text{creative} = F) = 0.6922$$

- What is the probability of being happy given that you are wicked smart and very creative?

★ SOLUTION:

$$\mathbf{P}(\text{happy} = T \mid \text{smart} = T, \text{creative} = T) = 0.58132$$

- What is the probability of being happy given you do not party, and do well on all your homework and class project?

★ SOLUTION:

$$\mathbf{P}(\text{happy} = T \mid \text{party} = F, \text{hw} = T, \text{project} = T) = 0.32108$$

- What is the probability of being happy given you own a mac?

★ SOLUTION:

$$\mathbf{P}(\text{happy} = T \mid \text{mac} = T) = 0.56269$$

- What is the probability that you party often given you are wicked smart?

★ SOLUTION:

$$\mathbf{P}(\text{party} = T \mid \text{smart} = T) = 0.60216$$

- What is the probability that you party often given you are wicked smart and happy?

★ SOLUTION:

$$\mathbf{P}(\text{party} = T \mid \text{smart} = T, \text{happy} = T) = 0.79204$$