

CS255: Artificial Intelligence

Exercise Sheet 7 - Bayesian AI

Bayesian AI

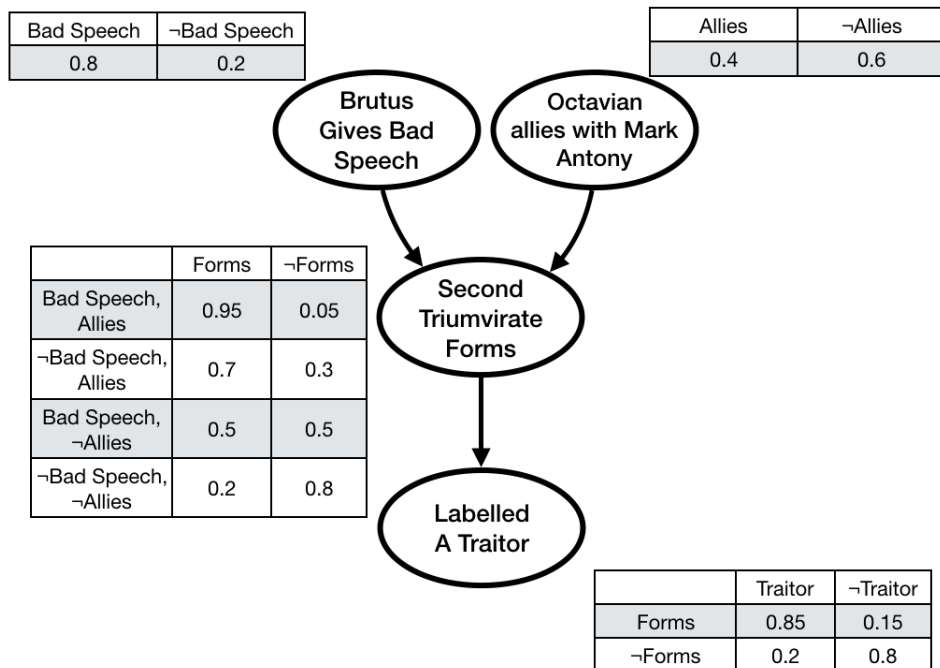
1. Suppose the probability of contracting a rare tropical disease Chickungunya on a holiday to India is 0.0001. Fred, on his return to the United Kingdom from a Jungle Safari in India, feels unwell and decides to see his doctor. Fred complains to his doctor of *joint pain*. The doctor had heard that there had been some cases of Chickungunya reported in India and also knew that 64% of people with Chickungunya complained of joint pain. There are other causes of Joint Pain however and the doctor estimates that the probability of *joint pain* in the absence of Chickungunya is 0.6. The doctor ordered a very reliable test used to diagnose Chickungunya that returned a *positive* result 99% of the time when the patient had Chickungunya and only returned a *positive* result 4% of the time when the patient tested was not suffering from the disease. The test result returned for Fred was *positive*.
 - (a) Based on the evidence to date can the doctor conclude that Fred has Chickungunya?
 - (b) Realising that there are no other symptoms of the disease or any other more accurate tests available, the doctor decides to ask for the test to be repeated. Once again a positive test result is obtained. How, if at all, will this affect his belief in the diagnosis of Chickungunya?
 - (c) Can the strategy of repeating the same test over and over again improve his belief in a positive diagnosis of Chickengunya? If so, what is the minimum number of times that the test must be carried out, assuming a positive result each time, for the belief in Chickungunya to be greater than the belief in *not Chickungunya*?
2. Consider the following table, which models the joint probability distribution for events that someone is a smoker, someone drinks coffee and someone has insomnia.

	Smoker		¬Smoker	
	Coffee	¬Coffee	Coffee	¬Coffee
Insomnia	0.132	0.011	0.098	0.001
¬Insomnia	0.21	0.11	0.184	0.254

- (a) Using marginalisation, what is the probability of someone smoking and having insomnia?
- (b) What is the probability of someone being a coffee drinker?
- (c) What is more likely, someone who smokes also having insomnia, or someone who has insomnia being a smoker?

3. Cicero is worried about the current state of the Roman Republic. Below, is the belief network he has constructed for the events following the assassination of Julius Caesar. Cicero believes the upcoming speech by Brutus and the possible partnership of Octavian with Mark Anthony will influence the probability of a Second Triumvirate being formed. Cicero is also worried about his position with the republic, and believes there is a probability he may be labelled a traitor, which is affected by the formation of the Second Triumvirate.

- (a) List all of the factors represented in this network.
- (b) Using variable elimination, create the probability table for the query $p(\text{Allies} | \text{BadSpeech} = \text{True}, \text{Traitor} = \text{True})$



4. *Clever Disarray (CD)* and *Unprepared Yet United (UYU)* are to play a football match. You believe that the result of the match is dependent on whether or not Payne Wooney would be fit to play for UYU. Reports suggest that the prior probability that Payne will be fit is 0.3. You believe that the probability of UYU winning if Payne is fit is 0.8, while the probability of UYU winning if Payne is unfit to play is 0.2. You are offered a bet on the game where you could double your money if you bet on UYU and they won. Alternatively you could decide not to bet.
- (a) Draw a decision tree for the problem.
 - (b) Based on the probabilities and Utility function defined, would you bet on UYU winning or not. Justify your answer.
 - (c) Draw an influence diagram for the problem.