### *Note: All equations generated using website:* <http://www.hostmath.com/>

### **Task 2 (20 points)**

You are a meteorologist that places temperature sensors all of the world, and you set them up so that they automatically e-mail you, each day, the high temperature for that day. Unfortunately, you have forgotten whether you placed a certain sensor S in Maine or in the Sahara desert (but you are sure you placed it in one of those two places) . The probability that you placed sensor S in Maine is 5%. The probability of getting a daily high temperature of 80 degrees or more is 20% in Maine and 90% in Sahara. Assume that probability of a daily high for any day is conditionally independent of the daily high for the previous day, given the location of the sensor.

**Part a:** If the first e-mail you got from sensor S indicates a daily high under 80 degrees, what is the probability that the sensor is placed in Maine?

**Part b:** If the first e-mail you got from sensor S indicates a daily high under 80 degrees, what is the probability that the second e-mail also indicates a daily high under 80 degrees?

**Part c:** What is the probability that the first three e-mails all indicate daily highs under 80 degrees?

Answer:

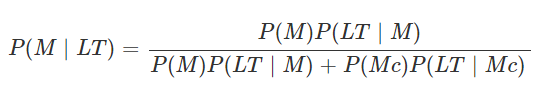
**a:**

Prior Probability of sensor placement: Maine, 5%, Sahara 95%

Let LT = event temperature recorded < 80 degrees, M = sensor placed at Maine

P(LT|M)=0.8, P(LT|Mc)=0.1 [ P(Mc) = Complement of P(M) ]

Then,



=0.05×0.8 / (0.05×0.8) + (0.95×0.1)≈ **0.2963**

**b**:

Posterior probability of sensor placement (from part a) : Maine, 29.63%, Sahara 70.37%

By the law of total probability,

P(LT) = (0.2962×0.8) + (0.7038×0.1) ≈ **0.3073**

**c:**

Given that days are independent,

 P (All 3emails indicating LT on first, second, third days)=0.135 x 0.135 x 0.135 ≈ **0.00246**

### **Task 3 (20 points)**

In a certain probability problem, we have 11 variables: A, B1, B2, ..., B10.

* Variable A has 5 values.
* Each of variables B1, ..., B10 have 7 possible values. Each Bi is conditionally independent of all other 9 Bj variables (with j != i) given A.

Based on these facts:

**Part a:** How many numbers do you need to store in the joint distribution table of these 11 variables?

**Part b:** What is the most space-efficient way (in terms of how many numbers you need to store) representation for the joint probability distribution of these 11 variables? How many numbers do you need to store in your solution? Your answer should work with any variables satisfying the assumptions stated above.

Answer:

a: 710  x 5 = 1412376245

b: The most space efficient way to store the variables for a solution would be to store them in a vector and rewrite over them when they have been used up. The maximum values to be used will be( 7^2 )\* 5