Statistics (MATH 271)

Homework Assignment 2

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KEY

Due data: 16 / 3 / 2018 until 1:00 pm. No late submission will be accepted.

HW2 is prepared to help you doing practice about probability methods that you have learned in lecture 3-5. There are 4 questions.

Please download and print this pdf document. You should only use this document to write your answers/solutions in a provided space in each question. You should also download other files needed to answer questions.

You should write clearly and concisely. Put your final answer to the box given in each question for full credit. You have to show all your work for full credit.

When finished your homework, you can drop your papers to the box outside my office. and submit it before the deadline.

It is not allowed to take another student's solution. You cannot give your solution/results to your classmates.

Good luck.

(Type in capital letters)
First Name:
Last Name:
ID:
Signature:

Question	Score
Q1 (30)	
Q2 (30)	
Q3 (10)	
Q4 (30)	
Total (100)	

1. (30 points) - Biology question.

In this question, you will analyze the cell division numbers that was stimulated by molecule A and B. Number of times cells divide and associated probabilities are given below. Cell stimulated by molecule A has a gene expression of 20 nM for every cell vision while cell stimulated by molecule B has an average gene expression of 45 nM at each cell division.

Cell division numbers = [0, 1, 2, 3]

P(cell divides|Drug A) = [0.5, 0.4, 0.14, 0.06]

Cell division numbers = [0, 1, 2, 3]

P(cell divides|Drug B) = [0.4, 0.2, 0.28, 0.12]

a) What is the mean number of cell division when molecule A and molecule B is used to stimulate cells?

$$\mu_x = x_1 P_1 + x_2 P_2 + \dots + x_n P_n = \sum_{i=1}^{n} x_i P_i$$

$$\mu_A = (0 \times 0.5) + (1 \times 0.4) + (2 \times 0.14) + (3 \times 0.06)$$

$$\mu_A = 0 + 0.4 + 0.28 + 0.18 = 0.86$$

$$\mu_B = (0 \times 0.4) + (1 \times 0.2) + (2 \times 0.28) + (3 \times 0.12)$$

$$\mu_B = 1.12$$

$\boxed{\mu_A = 0.86}$

$\boxed{\mu_B = 1.12}$

b) Compute the total mRNA levels when cells treated with molecule A and B.

$$\text{Total } \mu RNA = \mu_A \times RNA_A + \mu_B \times RNA_B$$

$$= 0.86 \times 20 + 1.12 \times 45$$

$$= 17.2 + 50.4 = 67.6$$

Total mRNA level=

2

2. (30 points) - Biology question.

Different cell types can be identified by measuring gene expression levels. After a long time study of genes provided the following mRNA expression probabilities in kidney and muscle cells. X is an event that randomly chosen cell comes from Kidney and Y is an event that cells express Gene D.

	Kidney Cells	Muscle Cells
Gene A	0.06	0.12
Gene B	0.03	0.25
Gene C	0.3	0.15
Gene D	0.01	0.08

a) What is P(X)

$$P(x) = P(\text{Kidney cells} \cap \text{Gene A}) + P(\text{Kidney cells} \cap \text{Gene B}) + P(\text{Kidney Cells} \cap \text{Gene C})$$
$$+ P(\text{Kidney cells} \cap \text{Gene D})$$

$$= 0.06 + 0.03 + 0.3 + 0.01$$

$$= 0.40$$

$$\boxed{P(X) = 0.40}$$

b) What is the P(Y^C)?

$$P(Y^c) = 1 - P(Y)$$
$$= 1 - [P(\text{Gene D} \cap \text{Kidney cells}) + P(\text{Gene D} \cap \text{Muscle cells})]$$
$$= 1 - [(0.01 + 0.08)]$$
$$= 0.91$$

$$\boxed{P(Y^c) = 0.91}$$

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c) What is the probability of muscle cells expressing Gene D? Write the expression of this event by using X and Y terms?

$$P(X^c \text{ and } Y) = 0.08$$

Expression:	P =
X^c and Y	0.08

d) Given that Z is an event that a selected cell has gene expression of C. what is P(X and Z^c)?

$$P(X \text{ and } Z^c) = P(\text{Kidney cells and Gene A}) + P(\text{Kidney cells and Gene B}) +$$

$$P(\text{Kidney cell and Gene D})$$

$$= 0.06 + 0.03 + 0.01 = 0.1$$

P(X and Z^c) = 0.1

3. (10 points) - Dependent and Independent Events.

Determine whether the following events A and B are independent or dependent? Circle your answer.

a) A is an event that a cat (named Tesla) living in Turkey has half-folded ear and B is an event that a cat (named Edison) living in Scotland has fully-folded ear.

<div align="center">Dependent   (Independent)</div>

b) A is an event that a person has a high sugar consumption and B is an event that he weights over 100 kg.

<div align="center">(Dependent)   Independent</div>

c) A is an event that you will be submit this homework on time and B is an event that you will submit your next homework on time.

<div align="center">(Dependent)   Independent</div>

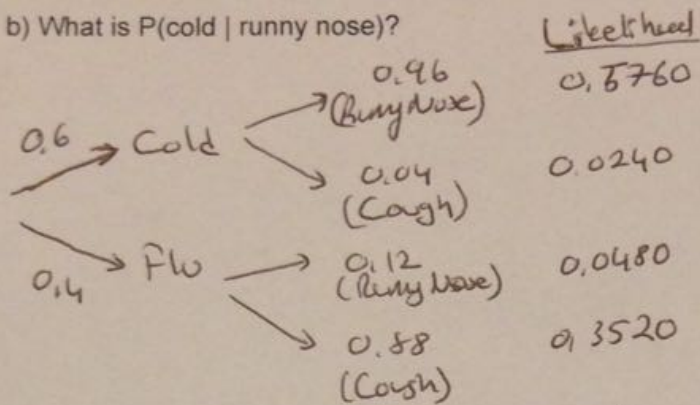d) A is an event that a student studies at ITU and B is an event that a student currently lives in Istanbul.

<div align="center">(Dependent)   Independent</div>

4. (30 points) -

Flu or cold are the most common diseases in winter season and have various symptoms such as fever, cough, runny nose, sore throat etc. Patients were studied if any given symptom is associated with flu or cold. 96 people who had cold, were observed to have runny nose. 4 people who had cold were observed to have a cough. 88 people who have flu, were observed to have cough and 12 people who had flu were observed to have runny nose. Suppose a person has some symptoms and estimates that P(Cold)=0.6. Answer the following questions.

a) Fill the following table by using frequency values.

	Runny Nose	Cough
Cold	0,96	0,04
flu	0,12	0,88

b) What is P(cold | runny nose)?   Likelihood

0.96
→(Runy Nose)   0,5760

0.6 → Cold
→ 0.04   0.0240
(Cough)

→ flu → 0.12   0,0480
0.4   (Runy Nose)

→ 0.88   0,3520
(Cough)

$$P(C \mid \text{Runny Nose}) = \frac{P(C \text{ and Runny Nose})}{P(\text{Runny Nose})} =$$

$$= \frac{0.5760}{0.5760 + 0.048} = 0.92$$

P = 0.92

c) After a few days, a person who was thinking to have a cold, observed that he has a cough symptom. What is P(cold | cough)?

0.96 ────→ 0.8832

0.92 → Cold
0.04 ────→ 0,0368

→ flu → 0.12 ────→ 0,0096
1−P=

0.08
→ 0.88 ────→ 0,0704
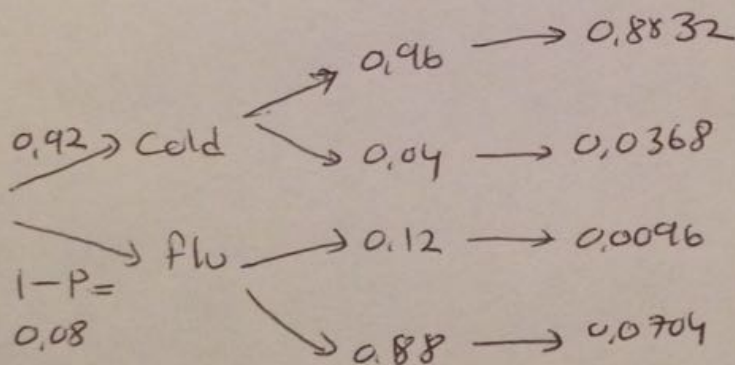
$$P(C \mid \text{Cough}) = \frac{P(\text{Cold and Cough})}{P(\text{Cough})} = \frac{0.0368}{0.0368 + 0.0704} = 0.34$$

P = 0.34

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