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## Homework Problem: Alice Hunts Dragons

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### Homework Problem: Alice Hunts Dragons

10.0 points possible (graded)

When she is not calculating marginal distributions, Alice spends her time hunting dragons. For every dragon she encounters, Alice measures its fire power  $X$  (measured on a scale from **1** to **4**) and its roar volume  $Y$  (measured on a scale from **1** to **3**). She notices that the proportion of dragons with certain fire power and roar volume in the population behaves as the following function:

$$f(x, y) = \begin{cases} x^2 + y^2 & \text{if } x \in \{1, 2, 4\} \text{ and } y \in \{1, 3\} \\ 0 & \text{otherwise.} \end{cases}$$

In other words, the joint probability table  $p_{X,Y}$  is of the form

$$p_{X,Y}(x, y) = cf(x, y) \quad \text{for } x \in \{1, 2, 3, 4\}, y \in \{1, 2, 3\},$$

for some constant  $c > 0$  that you will determine.

- **(a)** Determine the constant  $c$ , which ensures that  $p_{X,Y}$  is a valid probability distribution. (Please be precise with at least 3 decimal places, unless of course the answer doesn't need that many decimal places. You could also put a fraction.)

**Week 3: Inference with Bayes' Theorem for Random Variables**

due Oct 6, 2016 02:30 IST



**Week 3: Independence Structure**

due Oct 6, 2016 02:30 IST



**Week 3: Homework 2**

due Oct 6, 2016 02:30 IST



**Notation Summary Up Through Week 3**

**Weeks 3 and 4: Mini-project on Movie Recommendations**

due Oct 21, 2016 02:30 IST



**Week 4: Decisions and Expectations**

due Oct 13, 2016 02:30 IST



**Week 4: Measuring Randomness**

due Oct 13, 2016 02:30 IST



**Week 4: Towards Infinity in Modeling Uncertainty**

due Oct 13, 2016 02:30 IST



**Week 4: Homework 3**

due Oct 13, 2016 02:30 IST



► **Part 2: Inference in Graphical Models**

Answer: 1/72

- **(b)** Determine  $\mathbb{P}(Y < X)$ . (Note that  $\{Y < X\}$  is an event. Think about what outcomes are in it.)

(Please be precise with at least 3 decimal places, unless of course the answer doesn't need that many decimal places. You could also put a fraction.)

Answer: 47/72

- **(c)** Determine  $\mathbb{P}(X < Y)$ . (Please be precise with at least 3 decimal places, unless of course the answer doesn't need that many decimal places. You could also put a fraction.)

Answer: 23/72

- **(d)** Determine  $\mathbb{P}(Y = X)$ . (Please be precise with at least 3 decimal places, unless of course the answer doesn't need that many decimal places. You could also put a fraction.)

Answer: 2/72

- **(e)** Determine  $\mathbb{P}(Y = 3)$ . (Please be precise with at least 3 decimal places, unless of course the answer doesn't need that many decimal places. You could also put a fraction.)

Answer: 48/72

- ▶ [Part 3: Learning Probabilistic Models](#)
- ▶ [Final Project](#)

- **(f)** Find the probability tables for  $p_X$  and  $p_Y$ . Express your answers as Python dictionaries. (Your answer should be the Python dictionary itself, and *not* the dictionary assigned to a variable, so please do not include, for instance, "prob\_table =" before specifying your answer. You can use fractions. If you use decimals instead, please be accurate and use at least 5 decimal places.)

$p_X$  probability table (the dictionary keys should be the Python integers 1, 2, 3, 4):

Answer: {1: 12/72, 2: 18/72, 3: 0, 4: 42/72}

$p_Y$  probability table (the dictionary keys should be the Python integers 1, 2, 3):

Answer: {1: 24/72, 2: 0, 3: 48/72}

### Solution:

**(a)** Determine the constant  $c$ , which ensures that  $p_{X,Y}$  is a valid probability distribution.

**Solution:** From the definition of  $f$  it follows that there are six coordinate pairs  $(x, y)$  with nonzero probabilities of occurring. These are  $(1, 1)$ ,  $(1, 3)$ ,  $(2, 1)$ ,  $(2, 3)$ ,  $(4, 1)$  and  $(4, 3)$ . The probability of a pair is proportional to the sum of the squares of the coordinates of the pair,  $x^2 + y^2$ . Therefore there is a constant  $c$  such that the PMF  $p_{X,Y}(x, y)$ :

$$p_{X,Y}(x, y) = \begin{cases} c(x^2 + y^2) & \text{if } x \in \{1, 2, 4\} \text{ and } y \in \{1, 3\} \\ 0 & \text{otherwise.} \end{cases}$$

Because the probability of the entire sample space must equal 1, we have

$(1 + 1)c + (1 + 9)c + (4 + 1)c + (4 + 9)c + (16 + 1)c + (16 + 9)c = 1$  which implies that  $c = \frac{1}{72}$  and therefore:

$$p_{X,Y}(x, y) = \begin{cases} \frac{1}{72}(x^2 + y^2) & \text{if } x \in \{1, 2, 4\} \text{ and } y \in \{1, 3\} \\ 0 & \text{otherwise.} \end{cases}$$

(b) Determine  $\mathbb{P}(Y < X)$ .

**Solution:** There are three sample points for which  $y < x$ :

$$P(Y < X) = P((2, 1)) + P((4, 1)) + P((4, 3)) = \frac{5}{72} + \frac{17}{72} + \frac{25}{72} = \frac{47}{72}$$

(c) Determine  $\mathbb{P}(X < Y)$ .

**Solution:** There are two sample points for which  $y > x$ :

$$P(X > Y) = P((1, 3)) + P((2, 3)) = \frac{10}{72} + \frac{13}{72} = \frac{23}{72}$$

(d) Determine  $\mathbb{P}(Y = X)$ .

**Solution:** There is only one sample point for which  $y = x$ :  $P(Y = X) = P((1, 1)) = \frac{2}{72}$

(e) Determine  $\mathbb{P}(Y = 3)$ .

**Solution:** There are three sample points for which  $y = 3$ .

$$P(Y = 3) = P((1, 3)) + P((2, 3)) + P((4, 3)) = \frac{10}{72} + \frac{13}{72} + \frac{25}{72} = \frac{48}{72}$$

(f) Find the marginal PMF  $p_X(x)$  and  $p_Y(y)$ .

**Solution:** In general for two discrete random variables  $X$  and  $Y$  for which a joint PMF is defined, we have:

$$p_X(x) = \sum_y p_{X,Y}(x, y) \quad p_Y(y) = \sum_x p_{X,Y}(x, y)$$

In this problem, the ranges of  $\mathbf{X}$  and  $\mathbf{Y}$  are quite restricted so we can determine the marginal PMF by enumeration:  $p_X(2) = P((2, 1)) + P((2, 3)) = \frac{18}{72}$

Performing the required computations:

$$p_X(x) = \begin{cases} 12/72 & \text{if } x = 1 \\ 18/72 & \text{if } x = 2 \\ 42/72 & \text{if } x = 4 \\ 0 & \text{otherwise.} \end{cases}$$

And

$$p_Y(y) = \begin{cases} 24/72 & \text{if } y = 1 \\ 48/72 & \text{if } y = 3 \\ 0 & \text{otherwise.} \end{cases}$$

Submit

You have used 0 of 5 attempts

### Discussion

**Topic:** Homework 1 / Homework Problem: Alice Hunts Dragons

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## One event dependent on multiple non interdependent events

discussion posted 2 months ago by **bhaskarv2758282**

Hi , Another thing that came to my mind is what is the conditional probability when one event is dependent on multiple non interdependent events...

This post is visible to everyone.

**+ Expand discussion**

## Multiple dependent events

discussion posted 2 months ago by **bhaskarv2758282**

Hi, What happens when there are multiple dependencies . For ex :- event A is dependent on event B, event B is dependent on event C and so on....

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**+ Expand discussion**

## A word of caution

discussion posted 2 months ago by **wamreyaz**

### Take the following precautions:

1. The sets are exactly as printed  $x = \{1, 2, 4\}$  and  $y = \{1, 3\}$ .
2. We have to find the *probability distribution*...

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## Not graded?

discussion posted 2 months ago by **RostTB**

I have submitted correctly the answers but the homework wasn't graded. Any reason for that ?

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## no solution? / solve with code or not?

question posted 2 months ago by **WiHHi\_Z3\_PuX**

I got full points but I'm not quite sure if got there "the right way".

I wrote code for every step and my results are not fractions (not  $1/3$ ,...

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**+ Expand discussion**

## Extension of deadline

discussion posted 2 months ago by **bhaskarv2758282**

A request !! can you please give me an extension of the deadline . I am extremely busy with my work commitments !!! please consider !!

Currently...

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## Probability of me scoring any points on this problem = $|\emptyset|$

discussion posted 2 months ago by **dnlm**

May be denser than I ever knew or imagined, could not get a single one of these questions correct in 5 attempts.

Looking forward to the answers....

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**+ Expand discussion**

## Part (b) and (c)

discussion posted 2 months ago by **naqqash**

Just to understand it right, I want to ask.

When I say  $(X > Y)$  I will take the values where  $Y = 1, 2$  and  $3$  I will add all those values and then...

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## Understood probability in my dreams :|

discussion posted 2 months ago by **sayantanTalukder**

Wasted 4 out of 5 submissions, 0 out of 10 points in all, went to take a nap convinced that I am way thicker than I think I am and probability...

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**+ Expand discussion**

## Determine $P(X < Y)$ and $P(Y < X)$ ?!

question posted 2 months ago by **NabilBg**

Hi,

On the HW dragun i got all corrects except 'b' and 'c' which couldn't know why is wrong, i need more detail?! it can be solve by using integration,...

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**+ Expand discussion**

did you really intend  $X = \{1, 2, 4\}$  AND  $Y = \{1, 3\}$

question posted 2 months ago by **aryehweiss**

did you really mean  $x = \{1, 2, 4\}$  and  $y = \{1, 3\}$ , so that when  $x = 3$  or  $y = 2$  the prob is zero?

that would explain why I am getting everything...

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**+ Expand discussion**

did we have to do normalization

question posted 2 months ago by **dipeshpaliwal**

i have made joint prob. table of  $x$  and  $y$  according to  $f(x, y)$  like for  $(1, 1)$  its  $1^2 + 1^2$  than did i have normalize the values? **strong text...**

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**+ Expand discussion**

## Grade error

discussion posted 2 months ago by **paulvanlorenzo**

Be careful, In my first attempt I had the normalization constant wrong and the grader say it was fine! ;) If you have the normalization constant...

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## Wrong line of thinking in B?

discussion posted 2 months ago by **Traumfabrik**

Hello, please tell me where i am going wrong.

X can go from 1-4 and y from 1-3. that makes a total of 12 combinations. 6 of them have a y smaller...

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**+ Expand discussion**

## Grader error?

discussion posted 2 months ago by **rajatthomas**

There is something wrong. I got the normalization constant correct. So, I assume I made the probability table correctly. Numbers in (b) (c) and...

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**+ Expand discussion**

## Parts b, c, d

question posted 2 months ago by **samirbajaj**

For the probabilities  $P(X < Y)$ ,  $P(X = Y)$ , and  $P(Y < X)$ , I tried computing them as ratios of events, but the answers were rejected.

I tried including...

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## Just one piece of advice

discussion posted 2 months ago by **khurram5**

Translate 'x in {1,2,4} and y in {1, 3}' literally. Don't interpret it any different.

Once you do this it's a just matter of coding in python...

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## Can someone explain part a to me?

discussion posted 2 months ago by **DG84**

so as I understand it, the question comes from the definition of the pmf. That the sum has to add to 1 but how do you add them together? ( $1^2$ ...

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## A correct formulation

discussion posted 2 months ago by **Vytautas\_Dumbliauskas**

The formulation of the task is tricky but definitely correct. The only misunderstanding is that (a) part accepts a wrong answer which can create...

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## "Error" upon submitting answers to problem

question posted 2 months ago by **dtb25**

When I attempt to submit my answers to this problem, I get the following error notification: <http://puu.sh/rgCb3/618c47925d.png>

My submission...

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