Homework_03

September 24, 2019

1 Homework 3

1.0.1 Instructions

Your homeworks have two components: a written portion and a portion that also involves code. Written work should be completed on paper, and coding questions should be done in the notebook. It is your responsibility to ensure that both components of the homework are submitted completely and properly to Gradescope. Refer to the bottom of the notebook for submission instructions.

1.0.2 How to Do Your Homework

The point of homework is for you to try your hand at using what you've learned in class. The steps to follow:

- Go to lecture and sections, and also go over the relevant text sections before starting on the homework. This will remind you what was covered in class, and the text will typically contain examples not covered in lecture. The weekly Preparation Guide will list what you should read.
- Work on some of the practice problems before starting on the homework.
- Attempt the homework problems by yourself with the text, section work, and practice materials all at hand. Sometimes the week's lab will help as well. The two steps above will help this step go faster and be more fruitful.
- At this point, seek help if you need it. Don't ask how to do the problem — ask how to get started, or for a nudge to get you past where you are stuck.
- For a good measure of your understanding, keep track of the fraction of the homework you can do by yourself or with minimal help. It's a better measure than your homework score, and only you can measure it.

In [2]:
```
# Run this cell to set up your notebook

import numpy as np
from scipy import stats
from datascience import *
from prob140 import *

# These lines do some fancy plotting magic
import matplotlib
```

```
%matplotlib inline
import matplotlib.pyplot as plt
plt.style.use('fivethirtyeight')

# These lines make warnings look nicer
import warnings
warnings.simplefilter('ignore', FutureWarning)
```

1.1 1. Binomial and Conditioning

A die is rolled 30 times. Let X be the number of sixes in the first 12 rolls and let Y be the number of sixes in all 30 rolls.

a) [CODE] Find $P(X = 3, Y = 7)$.

In [10]:
```
#Answer to 1a

 # P(X=3, Y=7)

 p_X_3_Y_7 = stats.binom.pmf(3, 12, 1/6) * stats.binom.pmf(4, 18, 1/6)
 p_X_3_Y_7
```

Out[10]:
```
0.03630084173970491
```

b) [CODE] Construct the joint distribution table of X and Y and name it `joint_dist`. It should be a `prob140` joint distribution object so that you can call `prob140` methods on it in subsequent parts. Use as many lines of code as you need.

It will be a large table, so, not surprisingly, the probabilities in the individual cells will be rather small.

In [6]:
```
# Answer to 1b

def joint_prob(x, y):
    if y >= x:
        return stats.binom.pmf(x, 12, 1/6) * stats.binom.pmf(y-x, 18, 1/6)
    else:
        return 0

k_X = np.arange(13)
k_Y = np.arange(31)
joint_dist = Table().values('X', k_X, 'Y', k_Y).probability_function(joint_prob)
joint_dist
```

Out[6]:

	X=0	X=1	X=2	X=3	X=4	\
Y=30	0.000000e+00	0.000000e+00	0.000000e+00	0.000000e+00	0.000000e+00	
Y=29	0.000000e+00	0.000000e+00	0.000000e+00	0.000000e+00	0.000000e+00	
Y=28	0.000000e+00	0.000000e+00	0.000000e+00	0.000000e+00	0.000000e+00	
Y=27	0.000000e+00	0.000000e+00	0.000000e+00	0.000000e+00	0.000000e+00	
Y=26	0.000000e+00	0.000000e+00	0.000000e+00	0.000000e+00	0.000000e+00	
Y=25	0.000000e+00	0.000000e+00	0.000000e+00	0.000000e+00	0.000000e+00	

Y=24	0.000000e+00	0.000000e+00	0.000000e+00	0.000000e+00	0.000000e+00
Y=23	0.000000e+00	0.000000e+00	0.000000e+00	0.000000e+00	0.000000e+00
Y=22	0.000000e+00	0.000000e+00	0.000000e+00	0.000000e+00	8.746368e-16
Y=21	0.000000e+00	0.000000e+00	0.000000e+00	1.943637e-15	7.871731e-14
Y=20	0.000000e+00	0.000000e+00	2.915456e-15	1.749274e-13	3.345486e-12
Y=19	0.000000e+00	2.650414e-15	2.623910e-13	7.434412e-12	8.921295e-11
Y=18	1.104339e-15	2.385373e-13	1.115162e-11	1.982510e-10	1.672743e-09
Y=17	9.939054e-14	1.013784e-11	2.973765e-10	3.717206e-09	2.341840e-08
Y=16	4.224098e-12	2.703423e-10	5.575809e-09	5.204089e-08	2.536993e-07
Y=15	1.126426e-10	5.068918e-09	7.806133e-08	5.637763e-07	2.174566e-06
Y=14	2.112049e-09	7.096485e-08	8.456644e-07	4.832368e-06	1.495014e-05
Y=13	2.956869e-08	7.687858e-07	7.248552e-06	3.322253e-05	8.305633e-05
Y=12	3.203274e-07	6.589593e-06	4.983380e-05	1.845696e-04	3.737535e-04
Y=11	2.745664e-06	4.530345e-05	2.768544e-04	8.305633e-04	1.359104e-03
Y=10	1.887644e-05	2.516858e-04	1.245845e-03	3.020230e-03	3.964052e-03
Y=9	1.048691e-04	1.132586e-03	4.530345e-03	8.809004e-03	9.147812e-03
Y=8	4.719109e-04	4.118495e-03	1.321351e-02	2.032847e-02	1.633538e-02
Y=7	1.716040e-03	1.201228e-02	3.049271e-02	3.630084e-02	2.178051e-02
Y=6	5.005116e-03	2.772064e-02	5.445126e-02	4.840112e-02	2.041922e-02
Y=5	1.155027e-02	4.950115e-02	7.260168e-02	4.537605e-02	1.201131e-02
Y=4	2.062548e-02	6.600153e-02	6.806408e-02	2.669180e-02	3.336474e-03
Y=3	2.750064e-02	6.187643e-02	4.003769e-02	7.414388e-03	0.000000e+00
Y=2	2.578185e-02	3.639790e-02	1.112158e-02	0.000000e+00	0.000000e+00
Y=1	1.516579e-02	1.011053e-02	0.000000e+00	0.000000e+00	0.000000e+00
Y=0	4.212720e-03	0.000000e+00	0.000000e+00	0.000000e+00	0.000000e+00

	X=5	X=6	X=7	X=8	X=9 \
Y=30	0.000000e+00	0.000000e+00	0.000000e+00	0.000000e+00	0.000000e+00
Y=29	0.000000e+00	0.000000e+00	0.000000e+00	0.000000e+00	0.000000e+00
Y=28	0.000000e+00	0.000000e+00	0.000000e+00	0.000000e+00	0.000000e+00
Y=27	0.000000e+00	0.000000e+00	0.000000e+00	0.000000e+00	1.243928e-19
Y=26	0.000000e+00	0.000000e+00	0.000000e+00	1.399419e-18	1.119535e-17
Y=25	0.000000e+00	0.000000e+00	1.119535e-17	1.259477e-16	4.758024e-16
Y=24	0.000000e+00	6.530621e-17	1.007582e-15	5.352777e-15	1.268806e-14
Y=23	2.798838e-16	5.877559e-15	4.282222e-14	1.427407e-13	2.379012e-13
Y=22	2.518954e-14	2.497963e-13	1.141926e-12	2.676388e-12	3.330617e-12
Y=21	1.070555e-12	6.661233e-12	2.141111e-11	3.746944e-11	3.608168e-11
Y=20	2.854814e-11	1.248981e-10	2.997555e-10	4.059189e-10	3.092716e-10
Y=19	5.352777e-10	1.748574e-09	3.247351e-09	3.479305e-09	2.126242e-09
Y=18	7.493888e-09	1.894288e-08	2.783444e-08	2.392022e-08	1.181246e-08
Y=17	8.118378e-08	1.623676e-07	1.913618e-07	1.328901e-07	5.315605e-08
Y=16	6.958610e-07	1.116277e-06	1.063121e-06	5.980055e-07	1.932947e-07
Y=15	4.784044e-06	6.201539e-06	4.784044e-06	2.174566e-06	5.637763e-07
Y=14	2.657802e-05	2.790693e-05	1.739652e-05	6.342483e-06	1.301022e-06
Y=13	1.196011e-04	1.014797e-04	5.073986e-05	1.463650e-05	2.323254e-06
Y=12	4.349131e-04	2.959825e-04	1.170920e-04	2.613661e-05	3.097672e-06
Y=11	1.268497e-03	6.830366e-04	2.090928e-04	3.484881e-05	2.904067e-06
Y=10	2.927300e-03	1.219708e-03	2.787905e-04	3.267076e-05	1.708275e-06

Y=9	5.227321e-03	1.626278e-03	2.613661e-04	1.921809e-05	4.745208e-07
Y=8	6.969762e-03	1.524635e-03	1.537447e-04	5.338359e-06	0.000000e+00
Y=7	6.534152e-03	8.968443e-04	4.270687e-05	0.000000e+00	0.000000e+00
Y=6	3.843619e-03	2.491234e-04	0.000000e+00	0.000000e+00	0.000000e+00
Y=5	1.067672e-03	0.000000e+00	0.000000e+00	0.000000e+00	0.000000e+00
Y=4	0.000000e+00	0.000000e+00	0.000000e+00	0.000000e+00	0.000000e+00
Y=3	0.000000e+00	0.000000e+00	0.000000e+00	0.000000e+00	0.000000e+00
Y=2	0.000000e+00	0.000000e+00	0.000000e+00	0.000000e+00	0.000000e+00
Y=1	0.000000e+00	0.000000e+00	0.000000e+00	0.000000e+00	0.000000e+00
Y=0	0.000000e+00	0.000000e+00	0.000000e+00	0.000000e+00	0.000000e+00

	X=10	X=11	X=12
Y=30	0.000000e+00	0.000000e+00	4.523374e-24
Y=29	0.000000e+00	2.714024e-22	4.071037e-22
Y=28	7.463567e-21	2.442622e-20	1.730191e-20
Y=27	6.717210e-19	1.038114e-18	4.613841e-19
Y=26	2.854814e-17	2.768305e-17	8.650953e-18
Y=25	7.612838e-16	5.190572e-16	1.211133e-16
Y=24	1.427407e-14	7.266800e-15	1.312061e-15
Y=23	1.998370e-13	7.872367e-14	1.124624e-14
Y=22	2.164901e-12	6.747743e-13	7.731789e-14
Y=21	1.855629e-11	4.639073e-12	4.295438e-13
Y=20	1.275745e-10	2.577263e-11	1.932947e-12
Y=19	7.087473e-10	1.159768e-10	7.028899e-12
Y=18	3.189363e-09	4.217339e-10	2.050096e-11
Y=17	1.159768e-08	1.230057e-09	4.730990e-11
Y=16	3.382658e-08	2.838594e-09	8.448196e-11
Y=15	7.806133e-08	5.068918e-09	1.126426e-10
Y=14	1.393952e-07	6.758557e-09	1.056024e-10
Y=13	1.858603e-07	6.336147e-09	6.211909e-11
Y=12	1.742440e-07	3.727145e-09	1.725530e-11
Y=11	1.024965e-07	1.035318e-09	0.000000e+00
Y=10	2.847125e-08	0.000000e+00	0.000000e+00
Y=9	0.000000e+00	0.000000e+00	0.000000e+00
Y=8	0.000000e+00	0.000000e+00	0.000000e+00
Y=7	0.000000e+00	0.000000e+00	0.000000e+00
Y=6	0.000000e+00	0.000000e+00	0.000000e+00
Y=5	0.000000e+00	0.000000e+00	0.000000e+00
Y=4	0.000000e+00	0.000000e+00	0.000000e+00
Y=3	0.000000e+00	0.000000e+00	0.000000e+00
Y=2	0.000000e+00	0.000000e+00	0.000000e+00
Y=1	0.000000e+00	0.000000e+00	0.000000e+00
Y=0	0.000000e+00	0.000000e+00	0.000000e+00

c) [CODE] Display the conditional distribution of X given $Y = y$, for all the possible values y of Y.

```
In [7]: # Answer to 1c
```