1 Conditional Probability Review
(a) 1/5
(b) 26/50 = 13/25
(c) 6/50 = 3/25
(d) P(F*B)/P(B) = 3/25 * 25/13 = 3/13
(e) 3/25 * 1/5 = 15/25 = 3/5
(f) 3/25 = 3/5*3/13 = 3/5*1/5
(g) 11/46
2 Linear Regression

```
"""
PART (a)
I decided to use scikit-learn for this portion
of the homework.
"""

import numpy as np
from sklearn.linear_model import LinearRegression
from math import sqrt
def main():
    """
    PART (b)
    The incercept is 4.360802923546112
    The learned theta vector is [-0.13429383  1.84768377 -0.89658481]
    The RMSE value is 0.18970922173315746
    Below is the code i wroe for this
    """
    x = np.array(
      [[3, 9, 2],
       [6, 9, 1],
       [7, 7, 7],
       [8, 6, 4],
       [1, 0, 8]])
    y = np.array([19,19,10,11,-3])

    theta = np.array([1,0,8]).reshape(1,-1)

    model = LinearRegression().fit(x, y)

    ans = model.predict(theta)

    print(ans)

    inter = model.intercept_
    c = model.coef_
```

```
print(inter)
print(c)

fx = []

for row in x:
    theta = np.array(row).reshape(1,-1)
    fx.append(model.predict(theta))

i = 0
sigma = 0
while i < 5:
    sigma+= (((fx[i] - y[i])*(fx[i] - y[i]))/5)
    i+=1
rms = sqrt(sigma)
print(rms)

"""
PART (c)
The label for the instance [3,3,5] is 5.01804869
Code below
"""

unlabeled = np.array([3,3,5]).reshape(1,-1)

ansC = model.predict(unlabeled)

print(ansC)

"""
PART (D)
The learned theta vector does not change if the rows of
x and y are premuted because the data is not interperpreted
as being order specific so it is the same exact data
Code below
"""

xP = np.array(
   [[6, 9, 1],
    [1, 0, 8],
    [7, 7, 7],
    [3, 9, 2],
    [8, 6, 4]])
```

```
    yP = np.array([19,-3,10,19,11])

    modelP = LinearRegression().fit(xP, yP)

    ansP = modelP.coef_

    print(ansP)



if __name__ == '__main__':
    main()
```

3 More Probability Review

(a) P(k tails on first k tosses| 1st head on (k+1)th tosse)
= (1-λ)*k * λ

(b) P(HT) = # of toesses needed to get the first head
E[P(HT)] = λ + (1-λ)(E[P]+1) "E[p] == E[P(HT)]"
E[P] = λ + E[P] + 1 - λE[P] - λ
E[P] - 1 = E[P] - λE[P]
E[p]-1/-λE[P] = E[p]
E[P] = 1/λ

(c) P(x heads|n tosses) = (n)
(x) * λ^x(1-p)^x-x
= sigma (x=0 to n) of P(x heads|n tosses)
E[P(x|n)] = nλ by the linearity of expectation

4 A Continous Variable plus Baye's Rule

9:50 PM 10/28/2020

(a) $E[P(x \text{ at midday})] = \int_0^1 x(n+1)x^n \, dx$

$= \int_0^1 x(nx^n + x^n) \, dx$

$= \int_0^1 nx^{n+1} + x^{n+1} \, dx$

$= \int_0^1 n\cancel{x}^{n+1} dx + \int_0^1 x^{n+1} dx$

$= n\left(\frac{x^{n+2}}{n+2}\Big|_0^1\right) + \frac{x^{n+2}}{n+2}\Big|_0^1$

$= n\left(\frac{1}{n+2}\right) + \frac{1}{n+2}$

$= \frac{n}{n+2} + \frac{1}{n+2} = \boxed{\frac{n+1}{n+2}}$

(b)

Since we hear no thunder before sunset $x = 1$ since the probability of hearing thunder before sunset is $(1-x)$.

$P(A)$ = expected at midday

$P(B) = 1$ since no thunder before sunset

$P(B|A) = \frac{P(A|B)P(B)}{P(A)}$ $\frac{\cancel{(n+1)x^n} \cdot 1}{\cancel{(n+1)x^n}}$

$= 1$? $\int_0^1 dx = 1 - 0 = 1$