BM20BTECH11001-Lab4

October 10, 2021

0.1 Experiment:Capturing heights and weights of people

[1]:
```
import pandas as pd
import numpy as np
import seaborn as sb
import matplotlib.pyplot as plt
```

[2]:
```
heights_in_feet = [2, 3.1, 5.2, 4.5, 6.5, 7.1, 5, 2.8, 4.6, 3.44]
```

[3]:
```
weights_in_kg = [7, 20, 48.22, 40.34, 85.43, 65.71, 60.2, 25.8, 27, 20]
```

[4]:
```
bmi_df = pd.DataFrame({'Heights':heights_in_feet, 'Weights':weights_in_kg})
sigma = pd.DataFrame({'Heights':heights_in_feet, 'Weights':weights_in_kg})
```

[5]:
```
bmi_df['BMI'] = (bmi_df['Weights'])/(bmi_df['Heights']*0.3048)
sigma['BMI'] = (bmi_df['Weights'])/(bmi_df['Heights']*0.3048)
```

[6]:
```
bmi_df
```

[6]:

	Heights	Weights	BMI
0	2.00	7.00	11.482940
1	3.10	20.00	21.166709
2	5.20	48.22	30.423481
3	4.50	40.34	29.410907
4	6.50	85.43	43.120331
5	7.10	65.71	30.363942
6	5.00	60.20	39.501312
7	2.80	25.80	30.230596
8	4.60	27.00	19.257104
9	3.44	20.00	19.074651

[7]:
```
health_status = []
pdf = []
for x in range(0,10):
    if bmi_df['BMI'][x] > 30:
        health_status.append('Obese')
        pdf.append(0.5)
    elif ((bmi_df['BMI'][x] >= 15) & (bmi_df['BMI'][x] <=25)):
```

```
        health_status.append('Ideal')
        pdf.append(0.3)
    elif ((bmi_df['BMI'][x] > 25) & (bmi_df['BMI'][x] <=30)):
        health_status.append('Overweight')
        pdf.append(0.1)
    elif bmi_df['BMI'][x] < 15:
        health_status.append('Underweight')
        pdf.append(0.1)
bmi_df['Health'] = pd.Series(health_status)
bmi_df['Probability of a person being underweight/ideal weight/overweight/
 ↪obese'] = pd.Series(pdf)
bmi_df
```

[7]:

```
   Heights  Weights        BMI       Health  \
0     2.00     7.00  11.482940  Underweight
1     3.10    20.00  21.166709        Ideal
2     5.20    48.22  30.423481        Obese
3     4.50    40.34  29.410907   Overweight
4     6.50    85.43  43.120331        Obese
5     7.10    65.71  30.363942        Obese
6     5.00    60.20  39.501312        Obese
7     2.80    25.80  30.230596        Obese
8     4.60    27.00  19.257104        Ideal
9     3.44    20.00  19.074651        Ideal

   Probability of a person being underweight/ideal weight/overweight/obese
0                                                0.1
1                                                0.3
2                                                0.5
3                                                0.1
4                                                0.5
5                                                0.5
6                                                0.5
7                                                0.5
8                                                0.3
9                                                0.3
```

0.2 Few practical events in determining health

0.2.1 Sigma of the experiment of collecting heights and weights is the variable sigma as shown below

[8]:

```
#Defining sigma
sigma
```

[8]:

```
   Heights  Weights        BMI
0     2.00     7.00  11.482940
```

```
1      3.10    20.00  21.166709
2      5.20    48.22  30.423481
3      4.50    40.34  29.410907
4      6.50    85.43  43.120331
5      7.10    65.71  30.363942
6      5.00    60.20  39.501312
7      2.80    25.80  30.230596
8      4.60    27.00  19.257104
9      3.44    20.00  19.074651
```

0.2.2 Calculating F(power set of sigma) such that probability is defined from F to [0,1]

[9]:
```python
subsets = []
for i in range(0,2**10):
    subset = []
    for k in range(10):
        if i and 1<<k:
            subset.append(sigma.loc[k].tolist())
    subsets.append(subset)
F = subsets
```

[10]:
```python
#Omega-1
#Event-1: BMI of person >= 25 and <=30
overweight_df = bmi_df[(bmi_df.BMI>=25) & (bmi_df.BMI<=30)]
overweight_df
```

[10]:
```
   Heights  Weights        BMI      Health  \
3      4.5    40.34  29.410907  Overweight

   Probability of a person being underweight/ideal weight/overweight/obese
3                                                0.1
```

[11]:
```python
#Omega-2
#Event-2: BMI of person>30
obese_df = bmi_df[bmi_df['BMI']>30]
obese_df
```

[11]:
```
   Heights  Weights        BMI Health  \
2      5.2    48.22  30.423481  Obese
4      6.5    85.43  43.120331  Obese
5      7.1    65.71  30.363942  Obese
6      5.0    60.20  39.501312  Obese
7      2.8    25.80  30.230596  Obese

   Probability of a person being underweight/ideal weight/overweight/obese
2                                                0.5
```

```
4                                                 0.5
5                                                 0.5
6                                                 0.5
7                                                 0.5
```

[12]:
```
#Omega-3
#Event-3: BMI of person<15
underweight_df = bmi_df[bmi_df['BMI']<=15]
```

[13]:
```
underweight_df
```

[13]:
```
   Heights  Weights       BMI       Health  \
0      2.0      7.0  11.48294  Underweight

   Probability of a person being underweight/ideal weight/overweight/obese
0                                                 0.1
```

[14]:
```
#Omega-4
#Event-4: BMI of person>15 and <25
ideal_df = bmi_df[(bmi_df.BMI>15) & (bmi_df.BMI<25)]
ideal_df
```

[14]:
```
   Heights  Weights        BMI Health  \
1     3.10     20.0  21.166709  Ideal
8     4.60     27.0  19.257104  Ideal
9     3.44     20.0  19.074651  Ideal

   Probability of a person being underweight/ideal weight/overweight/obese
1                                                 0.3
8                                                 0.3
9                                                 0.3
```

0.2.3 Independent events

[15]:
```
#Independent events set 1
ide1_df = bmi_df[(bmi_df['Health']=='Obese')]
ide1_df
ide2_df = bmi_df[(bmi_df['Heights']<3)]
```

[16]:
```
ide2_df
```

[16]:
```
   Heights  Weights        BMI       Health  \
0      2.0      7.0  11.482940  Underweight
7      2.8     25.8  30.230596        Obese

   Probability of a person being underweight/ideal weight/overweight/obese
0                                                 0.1
```

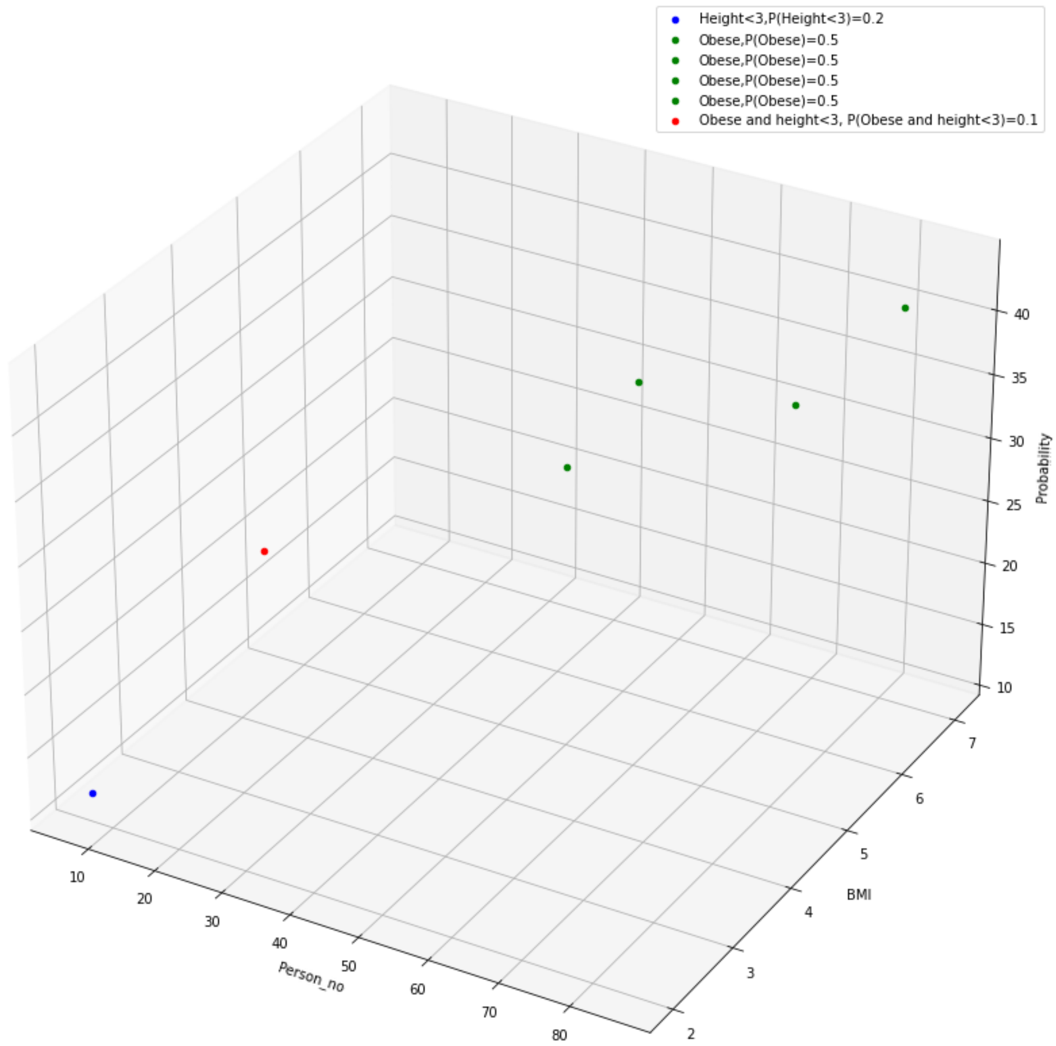
```
7                                                0.5
```

[17]:
```
ide1_df
```

[17]:
```
   Heights  Weights        BMI Health  \
2      5.2    48.22  30.423481  Obese
4      6.5    85.43  43.120331  Obese
5      7.1    65.71  30.363942  Obese
6      5.0    60.20  39.501312  Obese
7      2.8    25.80  30.230596  Obese

   Probability of a person being underweight/ideal weight/overweight/obese
2                                                0.5
4                                                0.5
5                                                0.5
6                                                0.5
7                                                0.5
```

[18]:
```
fig, ax = plt.subplots(figsize=(15,15))
ax = plt.axes(projection="3d")
ax.set_xlabel('Person_no')
ax.set_ylabel('BMI')
ax.set_zlabel('Probability')
colors = ['red','blue','green']
for i in range(0,len(bmi_df)):
    x,y,z = bmi_df['Weights'][i],bmi_df['Heights'][i],bmi_df['BMI'][i]
    if ((bmi_df['Health'][i] == 'Obese') & (bmi_df['Heights'][i]<3)):
        ax.scatter(x,y,z,c=colors[0],label='Obese and height<3, P(Obese and␣
 ↪height<3)=0.1')
    elif (bmi_df['Heights'][i]<3):
        ax.scatter(x,y,z,c=colors[1],label='Height<3,P(Height<3)=0.2')
    elif (bmi_df['Health'][i] =='Obese'):
        ax.scatter(x,y,z,c=colors[2],label='Obese,P(Obese)=0.5')
plt.legend()
plt.show()
```



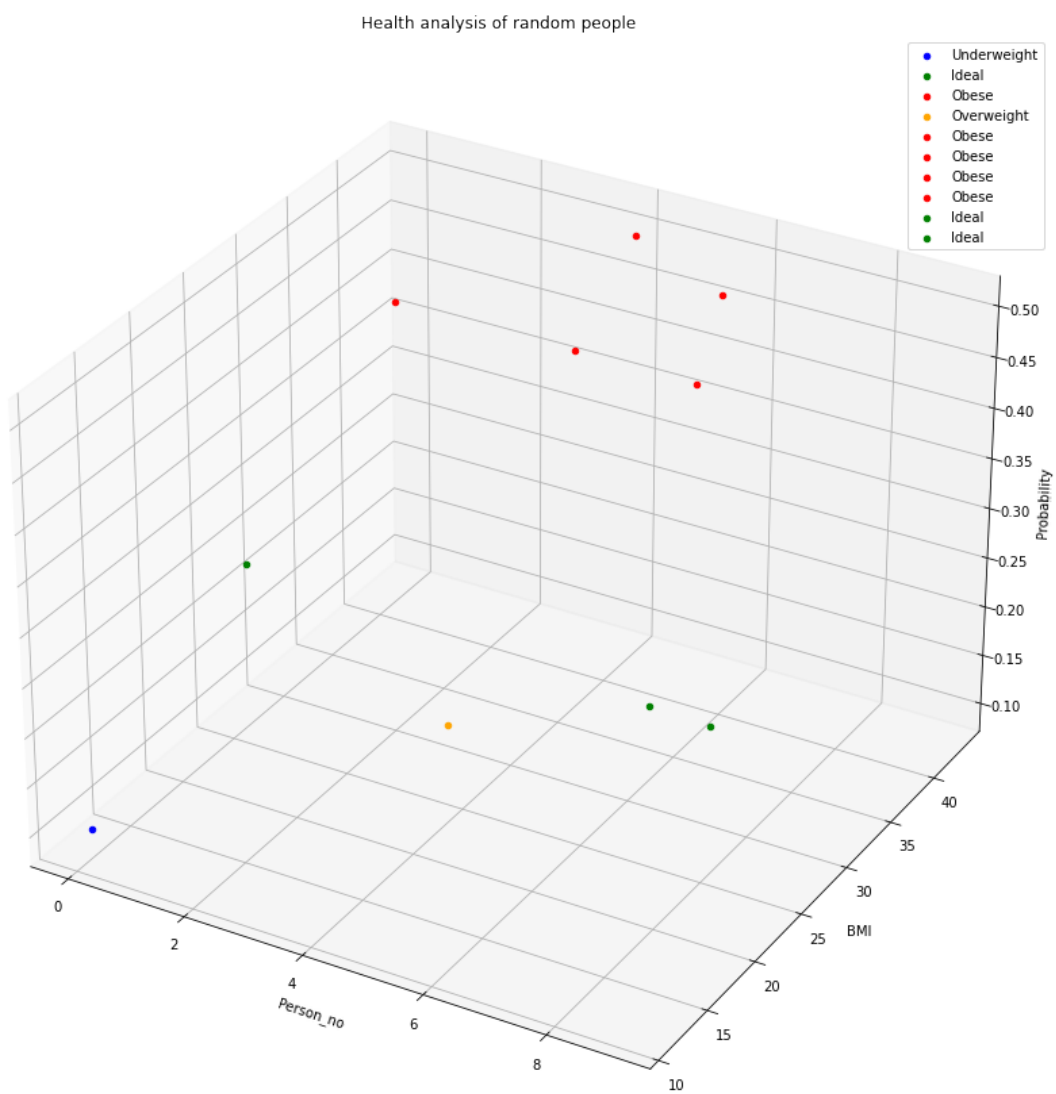
As P(Obese and height<3) = P(Obese)*P(Height<3), P(Obese) and P(Height<3) are independent

0.2.4 Analysis of omega-1,omega-2,omega-3,omega-4

[19]:
```
from mpl_toolkits import mplot3d
colors = ['blue','green','orange','red']
fig = plt.figure(figsize=(15,15))
ax = plt.axes(projection="3d")
ax.set_xlabel('Person_no')
ax.set_ylabel('BMI')
ax.set_zlabel('Probability')
ax.set_title('Health analysis of random people')
```

```
for i in range(0,len(bmi_df)):
    x,y,z = i,bmi_df['BMI'][i],bmi_df['Probability of a person being␣
 ↪underweight/ideal weight/overweight/obese'][i]
    if (bmi_df['Health'][i] == 'Ideal'):
        ax.scatter(x,y,z,c=colors[1],label='Ideal')
    elif (bmi_df['Health'][i]=='Underweight'):
        ax.scatter(x,y,z,c=colors[0],label='Underweight')
    elif (bmi_df['Health'][i] =='Overweight'):
        ax.scatter(x,y,z,c=colors[2],label='Overweight')
    elif (bmi_df['Health'][i] =='Obese'):
        ax.scatter(x,y,z,c=colors[3],label='Obese')

plt.legend()
plt.show()
```



0.3 Experiment: Tossing 2 coins and 1 dice

0.3.1 Calculating sigma for the experiment

[20]:
```
#Experiment is tossing 2 coins and one dice
#Outcome of coin toss is given by heads(0) and tails(1)
#F is power set of sigma_2 and probability is mapped from F to [0,1]
sigma_2 = []
for dice in range(1,7):
    for coin_1 in range(0,2):
        for coin_2 in range(0,2):
            sigma_2.append([coin_1,coin_2,dice])
sigma_2
```

[20]:
```
[[0, 0, 1],
 [0, 1, 1],
 [1, 0, 1],
 [1, 1, 1],
 [0, 0, 2],
 [0, 1, 2],
 [1, 0, 2],
 [1, 1, 2],
 [0, 0, 3],
 [0, 1, 3],
 [1, 0, 3],
 [1, 1, 3],
 [0, 0, 4],
 [0, 1, 4],
 [1, 0, 4],
 [1, 1, 4],
 [0, 0, 5],
 [0, 1, 5],
 [1, 0, 5],
 [1, 1, 5],
 [0, 0, 6],
 [0, 1, 6],
 [1, 0, 6],
 [1, 1, 6]]
```

[21]:
```
experiment_df = pd.DataFrame({'Coin_throw_1':pd.Series([sigma_2[x][0] for x in␣
↪range(0,24)]), 'Coin_throw_2':pd.Series([sigma_2[x][1] for x in␣
↪range(0,24)]), 'Dice_throw':pd.Series([sigma_2[x][2] for x in range(0,24)])})
```

[22]:
```
experiment_df
```

[22]:

	Coin_throw_1	Coin_throw_2	Dice_throw
0	0	0	1
1	0	1	1
2	1	0	1
3	1	1	1
4	0	0	2
5	0	1	2
6	1	0	2
7	1	1	2
8	0	0	3
9	0	1	3
10	1	0	3
11	1	1	3
12	0	0	4
13	0	1	4
14	1	0	4
15	1	1	4
16	0	0	5
17	0	1	5
18	1	0	5
19	1	1	5
20	0	0	6
21	0	1	6
22	1	0	6
23	1	1	6

[23]:

```
#One possible event: Getting a heads in first toss
head_first_df = experiment_df[experiment_df['Coin_throw_1']==0]
head_first_df
```

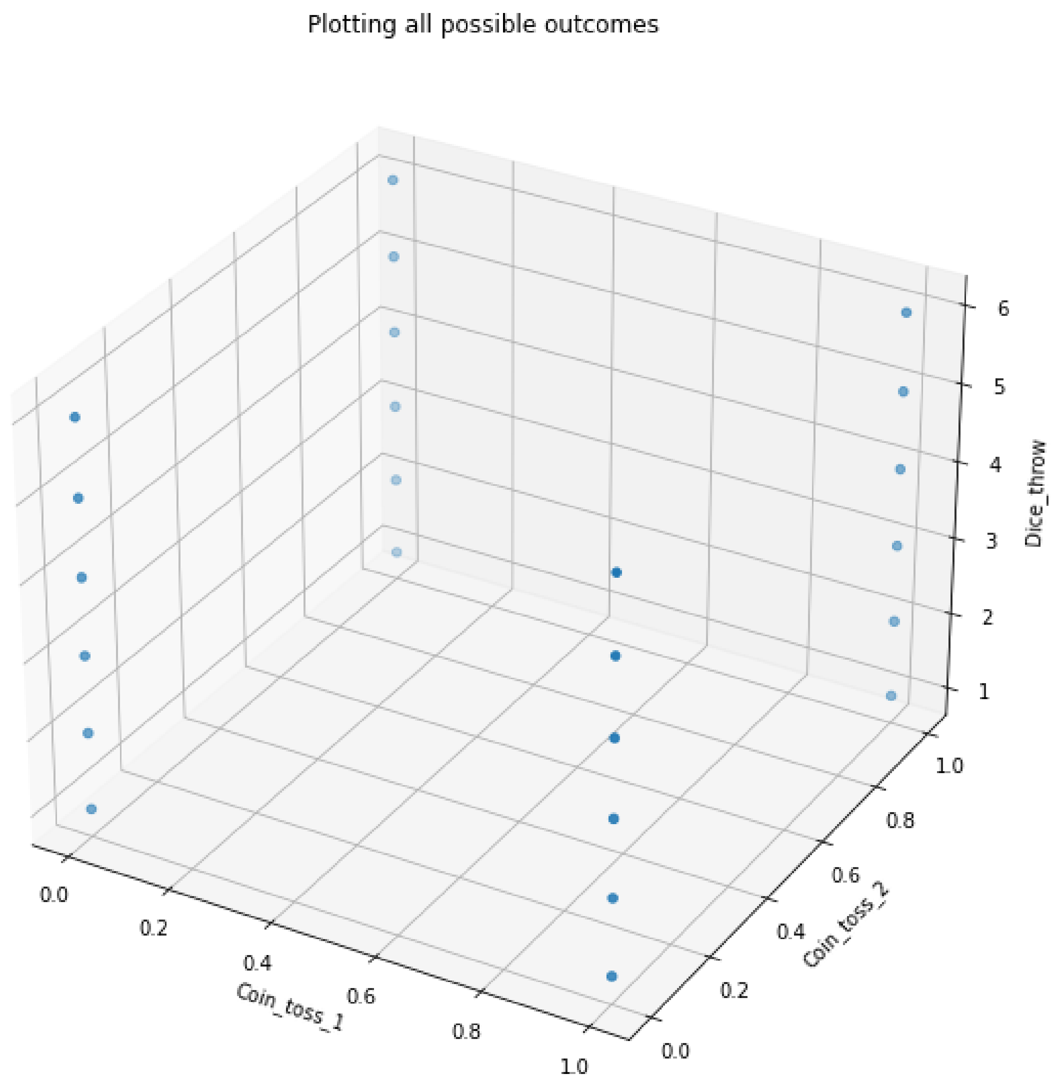
[23]:

	Coin_throw_1	Coin_throw_2	Dice_throw
0	0	0	1
1	0	1	1
4	0	0	2
5	0	1	2
8	0	0	3
9	0	1	3
12	0	0	4
13	0	1	4
16	0	0	5
17	0	1	5
20	0	0	6
21	0	1	6

[24]:

```
#Plotting all possible outcomes
fig = plt.figure(figsize=(10,10))
ax = plt.axes(projection='3d')
```

```
ax.set_title('Plotting all possible outcomes')
ax.set_xlabel('Coin_toss_1')
ax.set_ylabel('Coin_toss_2')
ax.set_zlabel('Dice_throw')
ax.
↪scatter(experiment_df['Coin_throw_1'],experiment_df['Coin_throw_2'],experiment_df['Dice_thr
↪
```

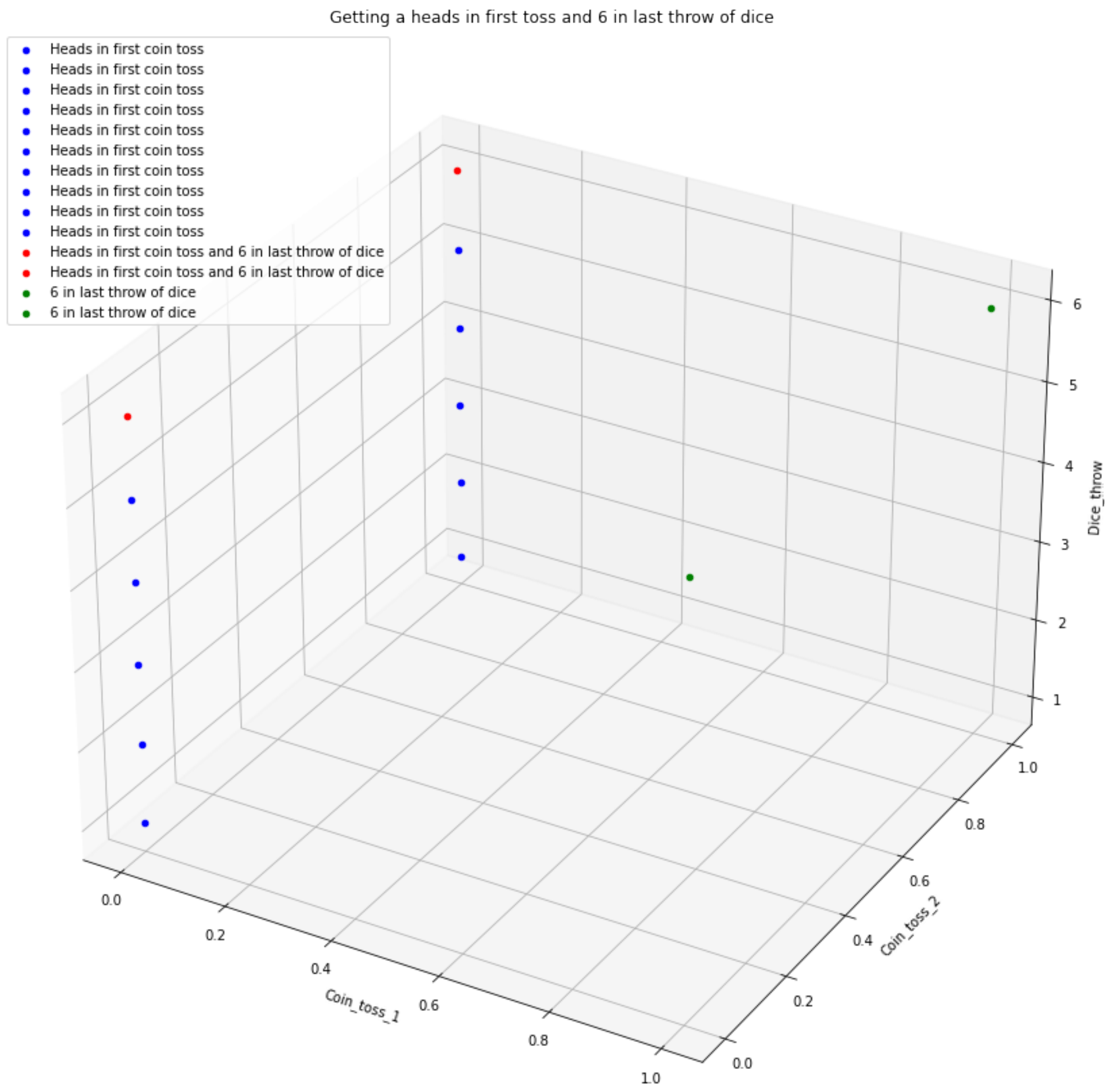


0.3.2 Independent events

Getting a heads in first coin toss and 6 in last throw of dice

[25]:

```
fig, ax = plt.subplots(figsize=(15,15))
ax = plt.axes(projection="3d")
colors = ['red','blue','green']
ax.set_title('Getting a heads in first toss and 6 in last throw of dice')
ax.set_xlabel('Coin_toss_1')
ax.set_ylabel('Coin_toss_2')
ax.set_zlabel('Dice_throw')
for i in range(0,len(experiment_df)):
    x,y,z =␣
 ↪experiment_df['Coin_throw_1'][i],experiment_df['Coin_throw_2'][i],experiment_df['Dice_throw
    if ((experiment_df['Coin_throw_1'][i] == 0) &␣
 ↪(experiment_df['Dice_throw'][i]==6)):
        ax.scatter(x,y,z,c=colors[0],label='Heads in first coin toss and 6 in␣
 ↪last throw of dice')
    elif(experiment_df['Coin_throw_1'][i]==0):
        ax.scatter(x,y,z,c=colors[1],label='Heads in first coin toss')
    elif(experiment_df['Dice_throw'][i]==6):
        ax.scatter(x,y,z,c=colors[2],label='6 in last throw of dice')
plt.legend()
plt.show()
```



As P(heads in toss-1)*P(6 in throw of dice) = (1/12) = P(heads in toss-1 and 6 in last throw of dice), both are independent events