birthdayParadoxSurfaces

October 29, 2021

[1]:
```python
from mpl_toolkits import mplot3d
from mpl_toolkits.mplot3d import axes3d
import matplotlib.pyplot as plt
from matplotlib import cm
from matplotlib.ticker import LinearLocator
import numpy as np
import scipy.special
```

[2]:
```python
x = np.arange(1,501,1)
```

[3]:
```python
y = np.arange(1,501,1)
```

[13]:
```python
ys = np.arange(1,138,1)
```

[24]:
```python
X,Y = np.meshgrid(x,y)
```

[14]:
```python
XS,YS = np.meshgrid(x,ys)
```

[25]:
```python
Z2=perf(2,X,Y)
```

[16]:
```python
Z2S=perf(2,XS,YS)
```

[26]:
```python
Z3=perf(3,X,Y)
Z4=perf(4,X,Y)
Z5=perf(5,X,Y)
Z6=perf(6,X,Y)
Z7=perf(7,X,Y)
```

[6]:
```python
def perf(r,s,n):
    return 1-np.exp((-scipy.special.comb(n,r))/s**(r-1))
```

[19]:
```python
# x = np.arange(1,14,1)
y = np.arange(1,500,1)
X,Y = np.meshgrid(xns,yns)
Z2 = perf(2,XNS,YNS)
```

[18]:

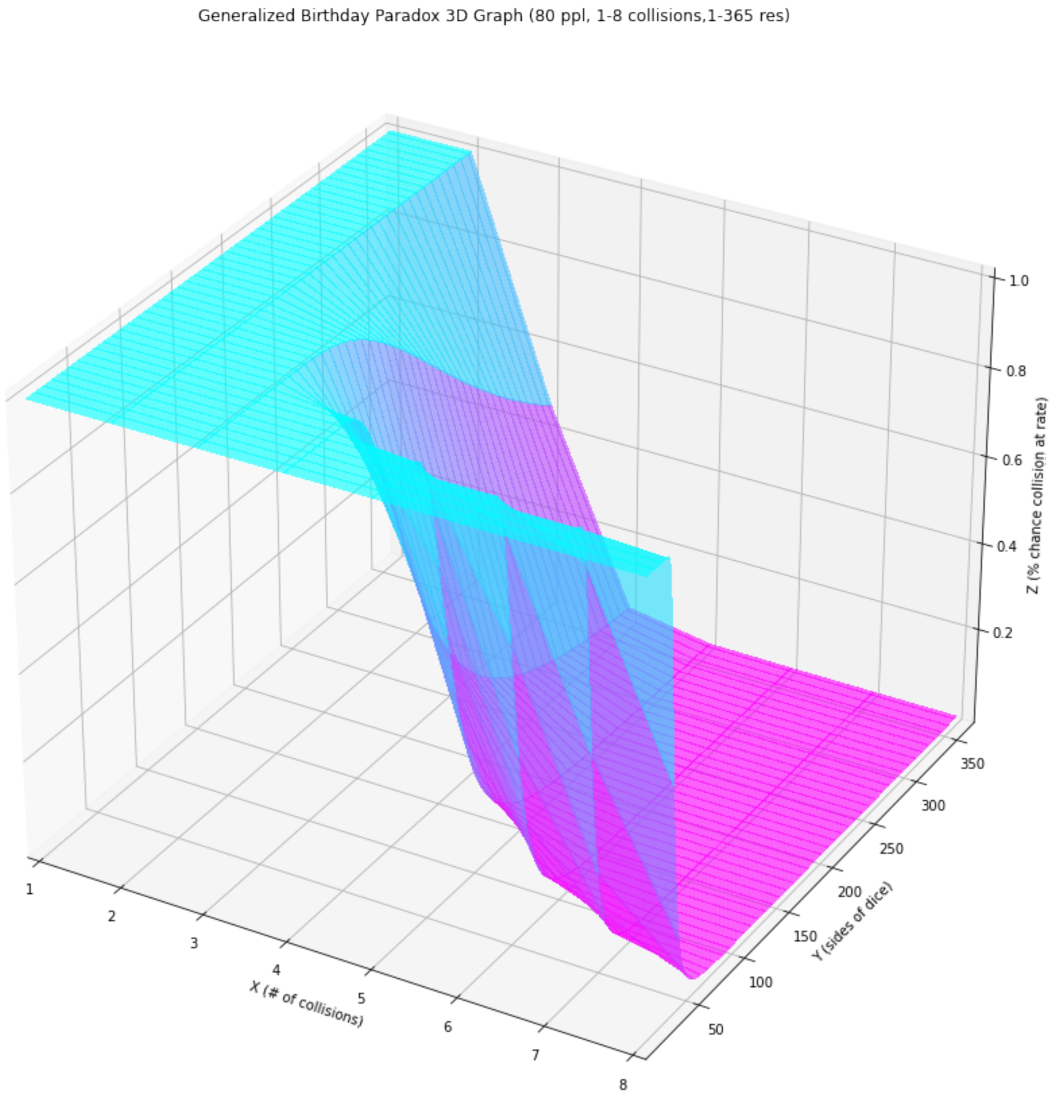
```
xns = np.arange(1,14,1)
yns = np.arange(1,500,1)
XNS,YNS = np.meshgrid(xns,yns)
ZNS = perf(XNS,365,YNS)
```

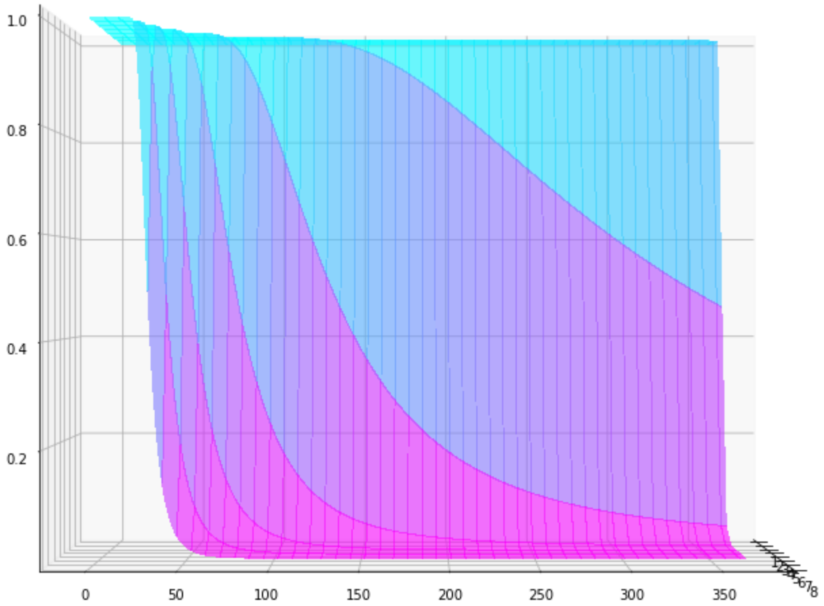
[20]:

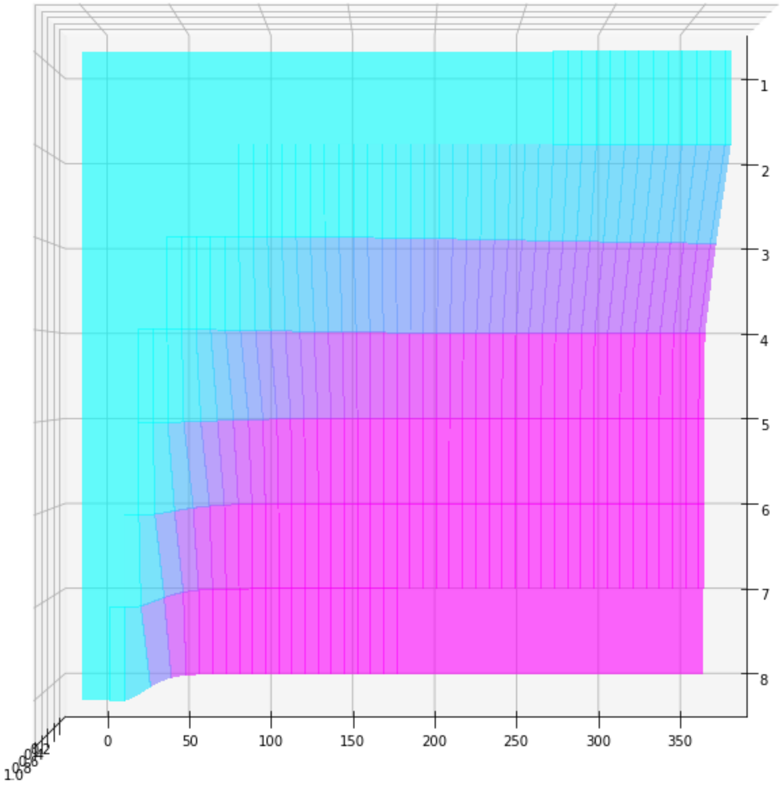
```
xfs = np.arange(1,9,1)
yfs = np.arange(1,365,1)
XFS,YFS = np.meshgrid(xfs,yfs)
ZFS = perf(XFS,YFS,80)
```

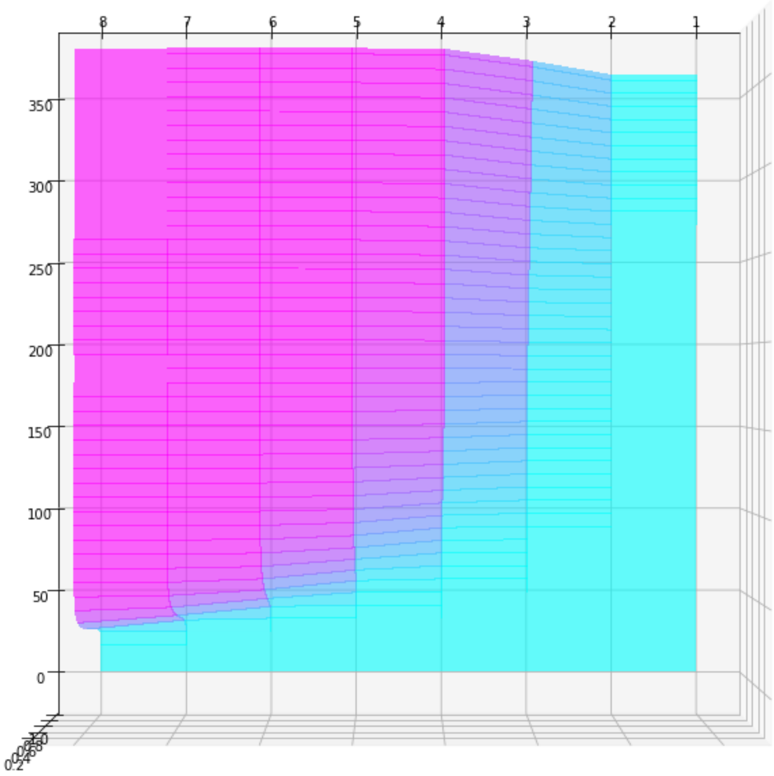
[41]:

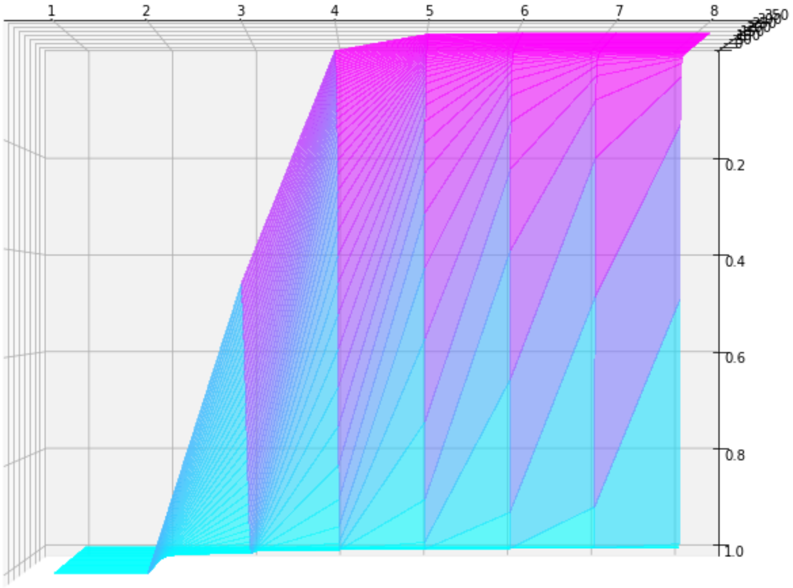
```
%matplotlib inline
fig = plt.figure(figsize=(15,15))
ax = plt.axes(projection = '3d')
ax.plot_surface(XFS, YFS, ZFS, alpha = .6, antialiased=False,cmap = "cool_r")
ax.set_xlabel('X (# of collisions)')
ax.set_xlim(np.min(XFS),np.max(XFS))
ax.set_ylabel('Y (sides of dice)')
ax.set_ylim(np.min(YFS),np.max(YFS))
ax.set_zlabel('Z (% chance collision at rate)')
ax.set_zlim(np.min(ZFS),np.max(ZFS))
ax.set_title('Generalized Birthday Paradox 3D Graph (80 ppl, 1-8 collisions,1-365 res)')
plt.show()
fig = plt.figure(figsize=(15,15))
ax = plt.axes(projection = '3d')
ax.plot_surface(XFS, YFS, ZFS, alpha = .6, antialiased=False,cmap = "cool_r")
ax.view_init(0,0)
plt.show()
fig = plt.figure(figsize=(15,15))
ax = plt.axes(projection = '3d')
ax.plot_surface(XFS, YFS, ZFS,alpha = .6, antialiased=False, cmap = "cool_r")
ax.view_init(90,0)
plt.show()
fig = plt.figure(figsize=(15,15))
ax = plt.axes(projection = '3d')
ax.plot_surface(XFS, YFS, ZFS,alpha = .6, antialiased=False, cmap = "cool_r")
ax.view_init(-90,90)
plt.show()
fig = plt.figure(figsize=(15,15))
ax = plt.axes(projection = '3d')
ax.plot_surface(XFS, YFS, ZFS,alpha = .6, antialiased=False, cmap = "cool_r")
ax.view_init(180,-90)
plt.show()
```


Generalized Birthday Paradox 3D Graph (80 ppl, 1-8 collisions,1-365 res)
X (# of collisions)
1
2
3
4
5
6
7
8
Y (sides of dice)
50
100
150
200
250
300
350
Z (% chance collision at rate)
0.2
0.4
0.6
0.8
1.0


1.0
0.8
0.6
0.4
0.2
0
50
100
150
200
250
300
350
1
2
3
4
5
6
7
8


0
50
100
150
200
250
300
350
1
2
3
4
5
6
7
8
0.2
0.4
0.6
0.8
1.0

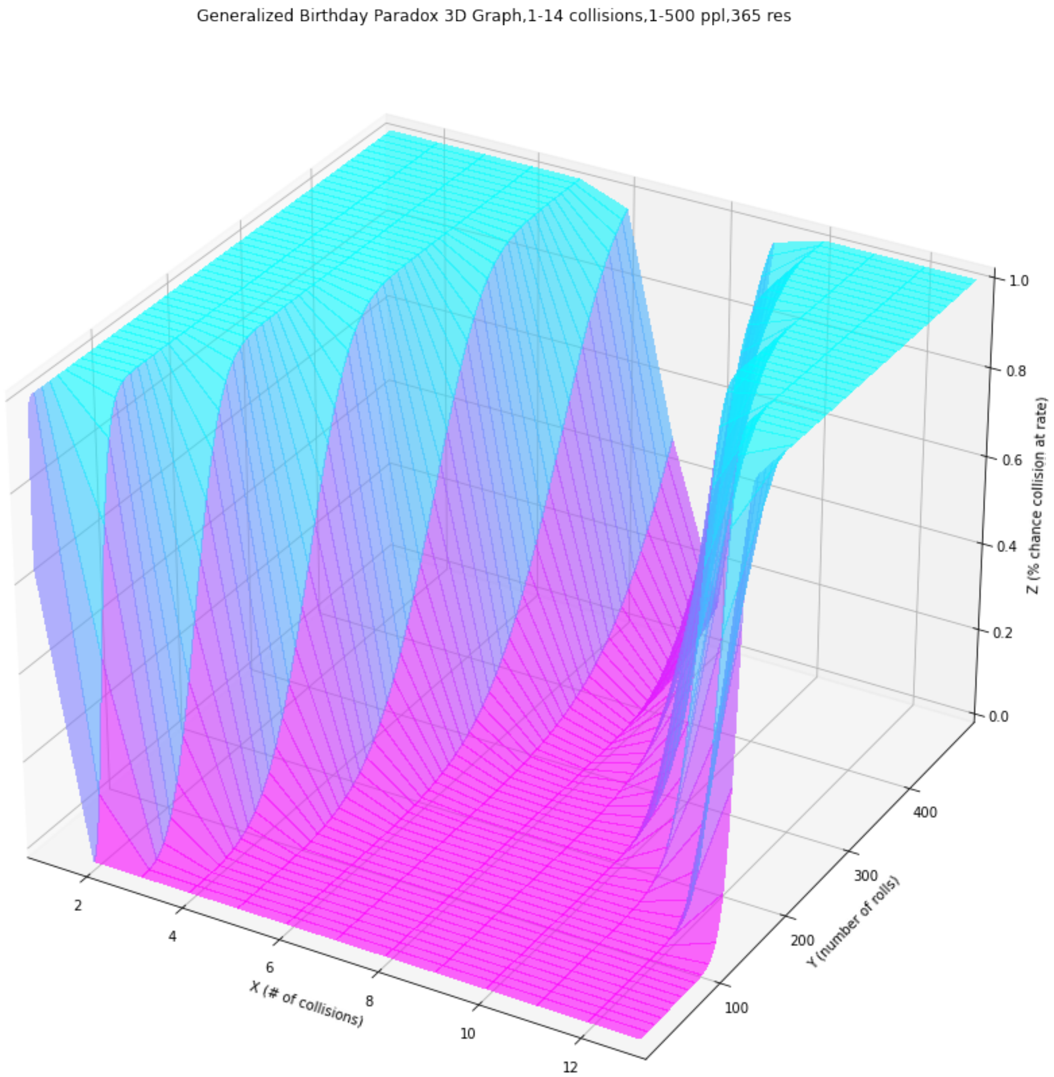

8
7
6
5
4
3
2
1
350
300
250
200
150
100
50
0
1.0
0.8
0.6
0.4
0.2

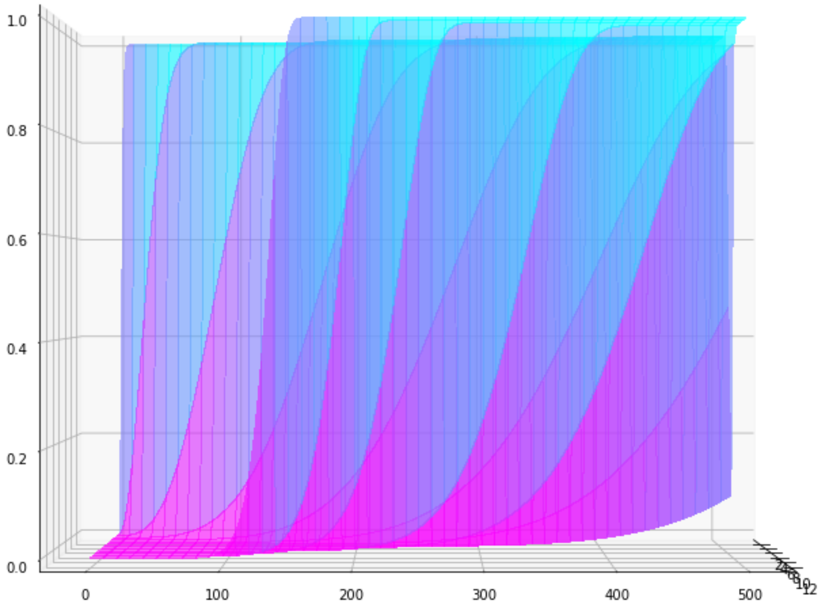


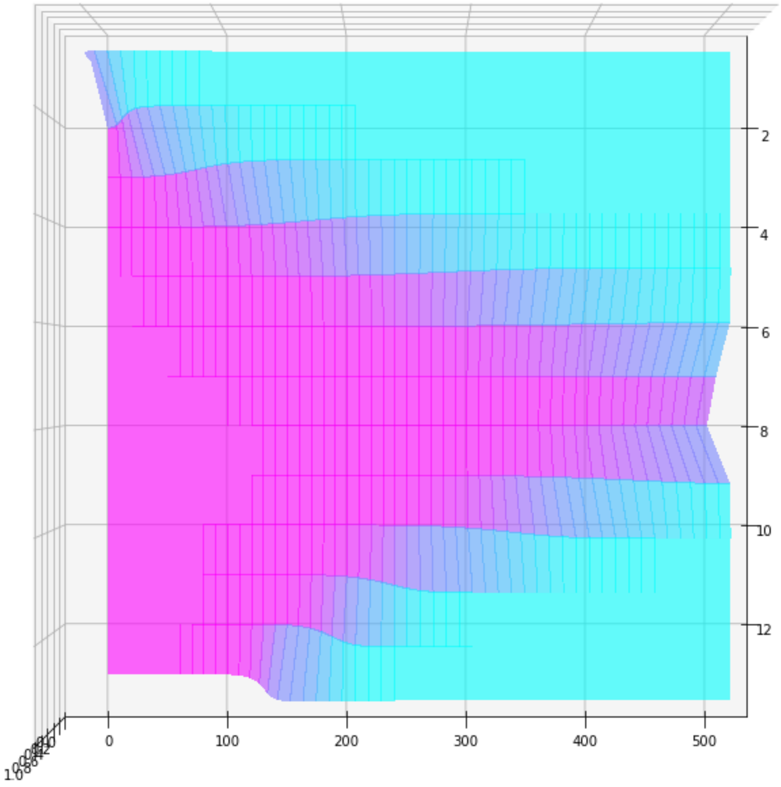
[44]:

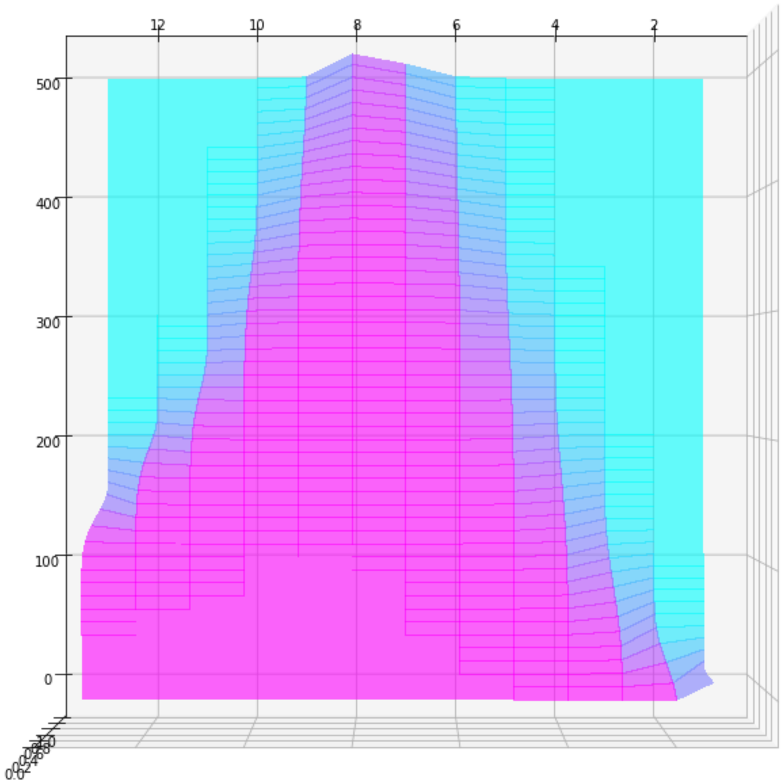
```
%matplotlib inline
fig = plt.figure(figsize=(15,15))
ax = plt.axes(projection = '3d')
ax.plot_surface(XNS, YNS, ZNS, alpha = .6, antialiased=False,cmap = "cool_r")
ax.set_xlabel('X (# of collisions)')
ax.set_xlim(np.min(XNS),np.max(XNS))
ax.set_ylabel('Y (number of rolls)')
ax.set_ylim(np.min(YNS),np.max(YNS))
ax.set_zlabel('Z (% chance collision at rate)')
ax.set_zlim(np.min(ZNS),np.max(ZNS))
ax.set_title('Generalized Birthday Paradox 3D Graph,1-14 collisions,1-500 ppl,365 res')
plt.show()
```

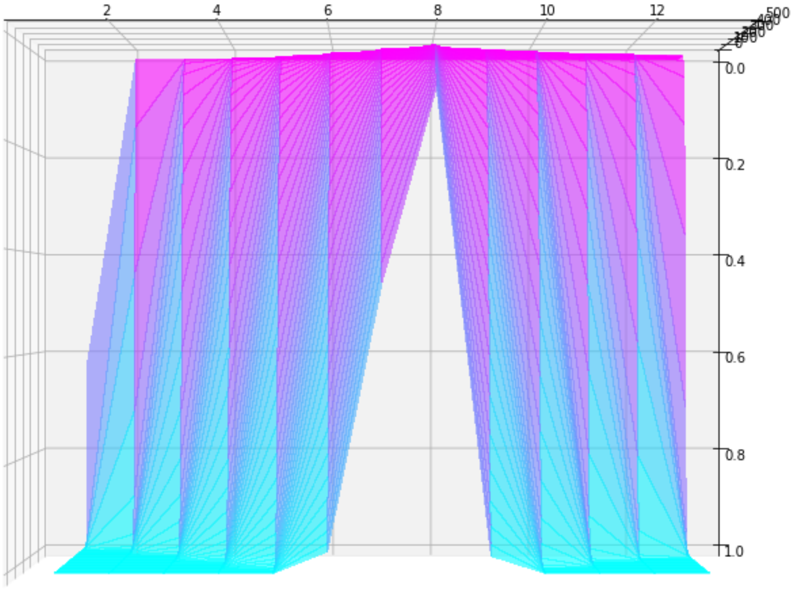
```
fig = plt.figure(figsize=(15,15))
ax = plt.axes(projection = '3d')
ax.plot_surface(XNS, YNS, ZNS, alpha = .6, antialiased=False,cmap = "cool_r")
ax.view_init(0,0)
plt.show()
fig = plt.figure(figsize=(15,15))
ax = plt.axes(projection = '3d')
ax.plot_surface(XNS, YNS, ZNS,alpha = .6, antialiased=False, cmap = "cool_r")
ax.view_init(90,0)
plt.show()
fig = plt.figure(figsize=(15,15))
ax = plt.axes(projection = '3d')
ax.plot_surface(XNS, YNS, ZNS,alpha = .6, antialiased=False, cmap = "cool_r")
ax.view_init(-90,90)
plt.show()
fig = plt.figure(figsize=(15,15))
ax = plt.axes(projection = '3d')
ax.plot_surface(XNS, YNS, ZNS,alpha = .6, antialiased=False, cmap = "cool_r")
ax.view_init(180,-90)
plt.show()
```


Generalized Birthday Paradox 3D Graph,1-14 collisions,1-500 ppl,365 res
X (# of collisions)
2
4
6
8
10
12
Y (number of rolls)
100
200
300
400
Z (% chance collision at rate)
0.0
0.2
0.4
0.6
0.8
1.0


1.0
0.8
0.6
0.4
0.2
0.0
0
100
200
300
400
500
2
4
6
8
10
12

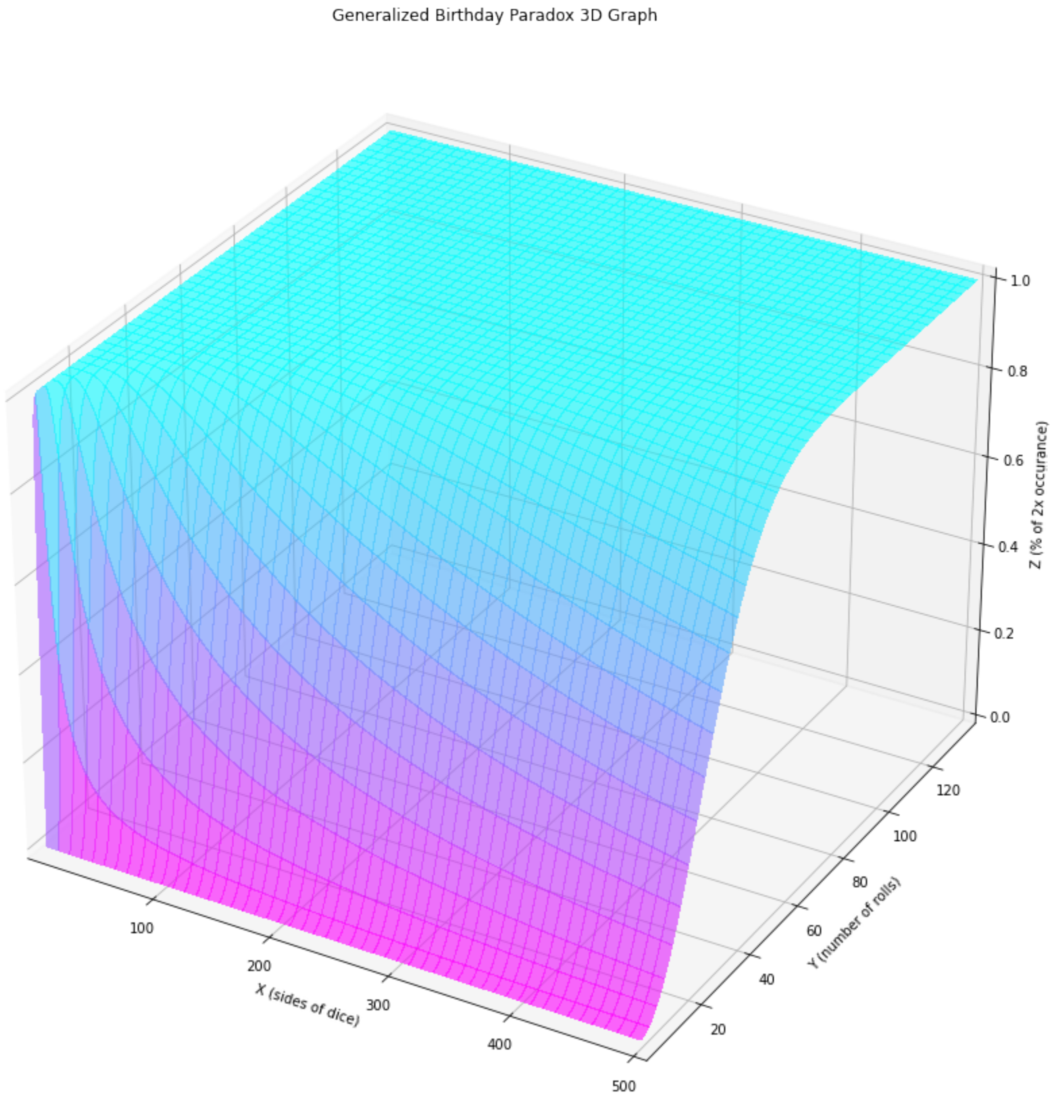

0
100
200
300
400
500
2
4
6
8
10
12
1.0
0.8
0.6
0.4
0.2
0.0

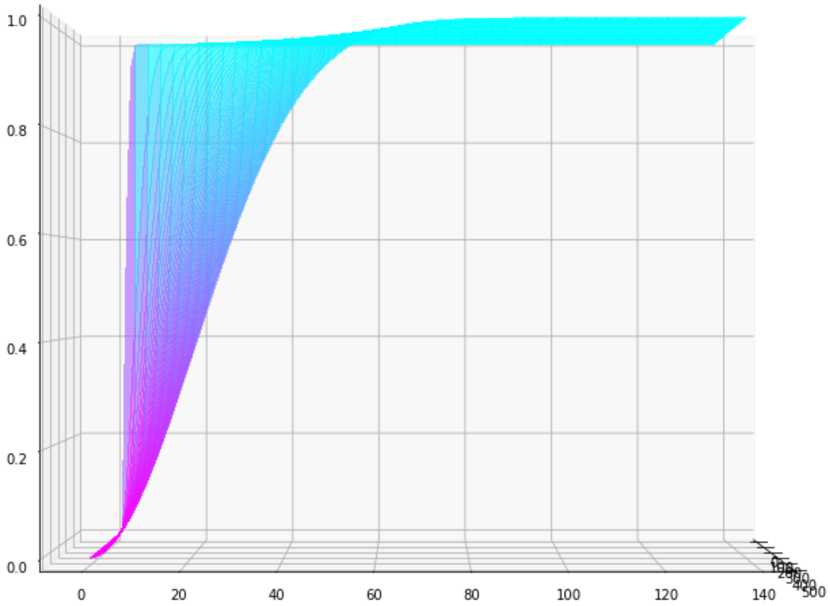

12
10
8
6
4
2
500
400
300
200
100
0
0.0
0.2
0.4
0.6
0.8
1.0

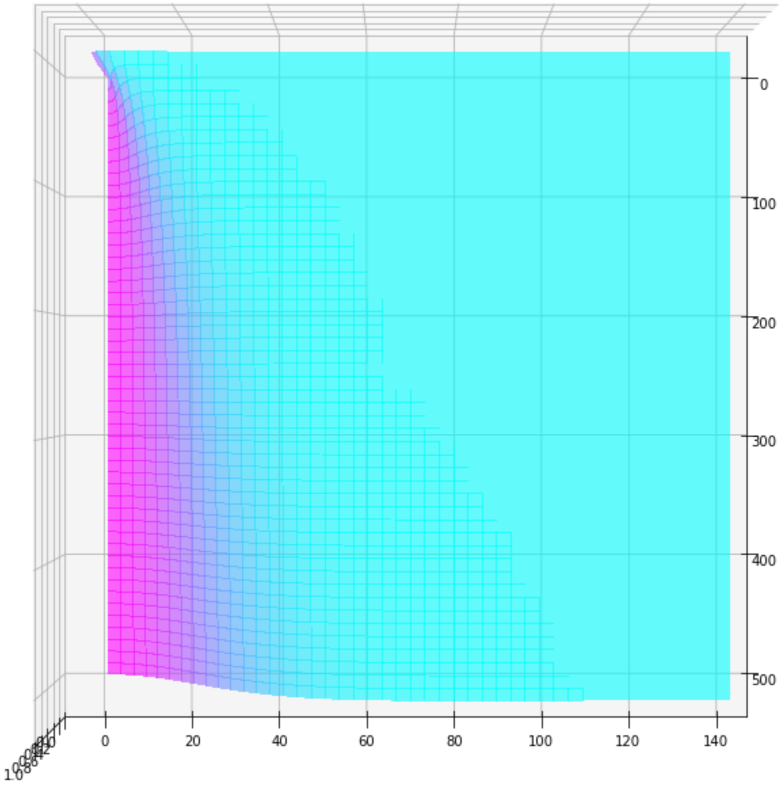


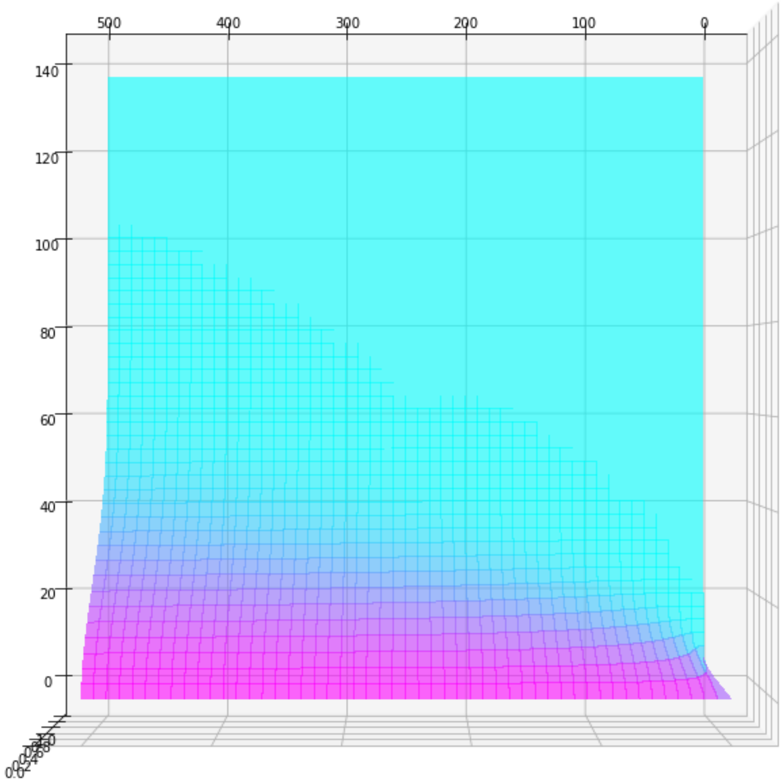
```
[285]: %matplotlib inline
       fig = plt.figure(figsize=(15,15))
       ax = plt.axes(projection = '3d')
       ax.plot_surface(X, Y, Z2S, alpha = .6, antialiased=False,cmap = "cool_r")
       ax.set_xlabel('X (sides of dice)')
       ax.set_xlim(np.min(X),np.max(X))
       ax.set_ylabel('Y (number of rolls)')
       ax.set_ylim(np.min(Y),np.max(Y))
       ax.set_zlabel('Z (% of 2x occurance)')
       ax.set_zlim(np.min(Z2S),np.max(Z2S))
       ax.set_title('Generalized Birthday Paradox 3D Graph')
       plt.show()
       fig = plt.figure(figsize=(15,15))
```

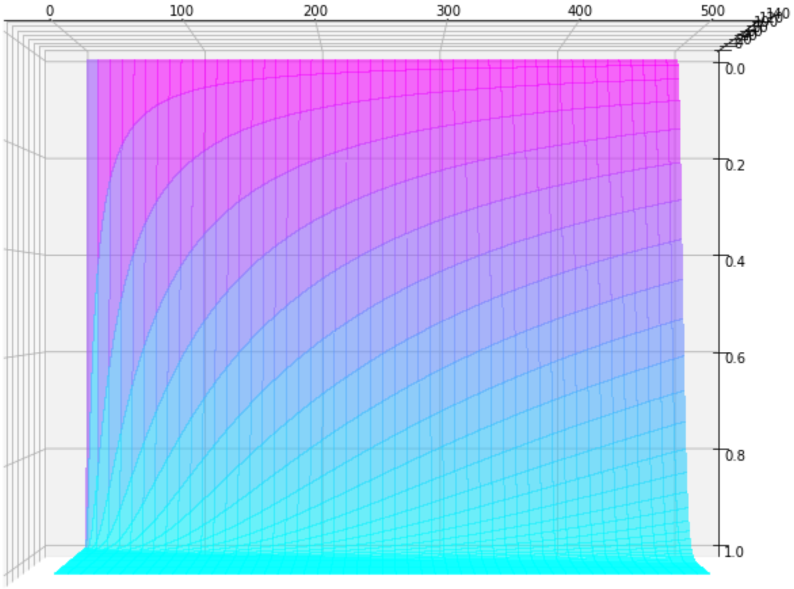
```
ax = plt.axes(projection = '3d')
ax.plot_surface(X, Y, Z2S, alpha = .6, antialiased=False,cmap = "cool_r")
ax.view_init(0,0)
plt.show()
fig = plt.figure(figsize=(15,15))
ax = plt.axes(projection = '3d')
ax.plot_surface(X, Y, Z2S,alpha = .6, antialiased=False, cmap = "cool_r")
ax.view_init(90,0)
plt.show()
fig = plt.figure(figsize=(15,15))
ax = plt.axes(projection = '3d')
ax.plot_surface(X, Y, Z2S,alpha = .6, antialiased=False, cmap = "cool_r")
ax.view_init(-90,90)
plt.show()
fig = plt.figure(figsize=(15,15))
ax = plt.axes(projection = '3d')
ax.plot_surface(X, Y, Z2S,alpha = .6, antialiased=False, cmap = "cool_r")
ax.view_init(180,-90)
plt.show()
```


Generalized Birthday Paradox 3D Graph
X (sides of dice)
100
200
300
400
500
Y (number of rolls)
20
40
60
80
100
120
Z (% of 2x occurance)
0.0
0.2
0.4
0.6
0.8
1.0


1.0
0.8
0.6
0.4
0.2
0.0
0
20
40
60
80
100
120
140
0
100
200
300
400
500

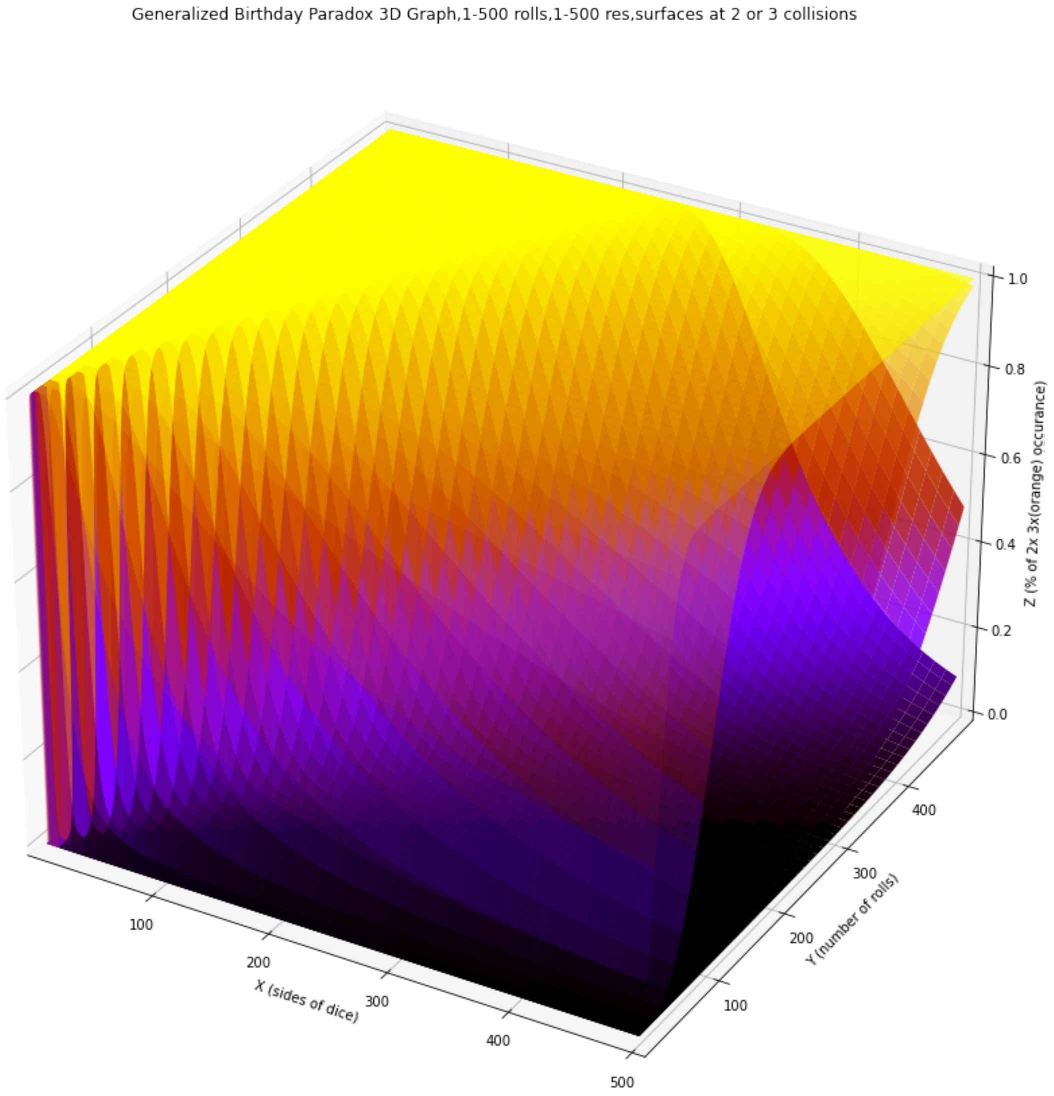

0
100
200
300
400
500
0
20
40
60
80
100
120
140
1.0
0.8
0.6
0.4
0.2
0.0

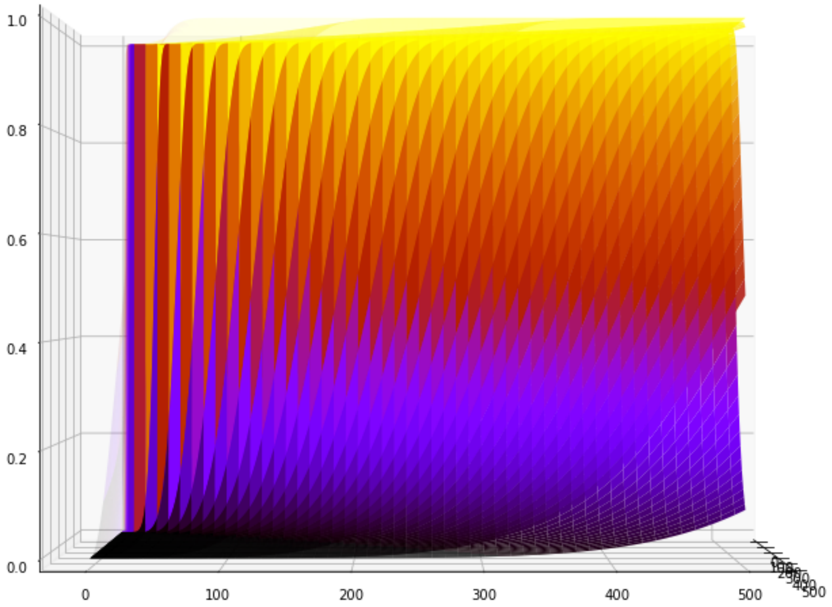

500
400
300
200
100
0
140
120
100
80
60
40
20
0
0.0
0.2
0.4
0.6
0.8
1.0



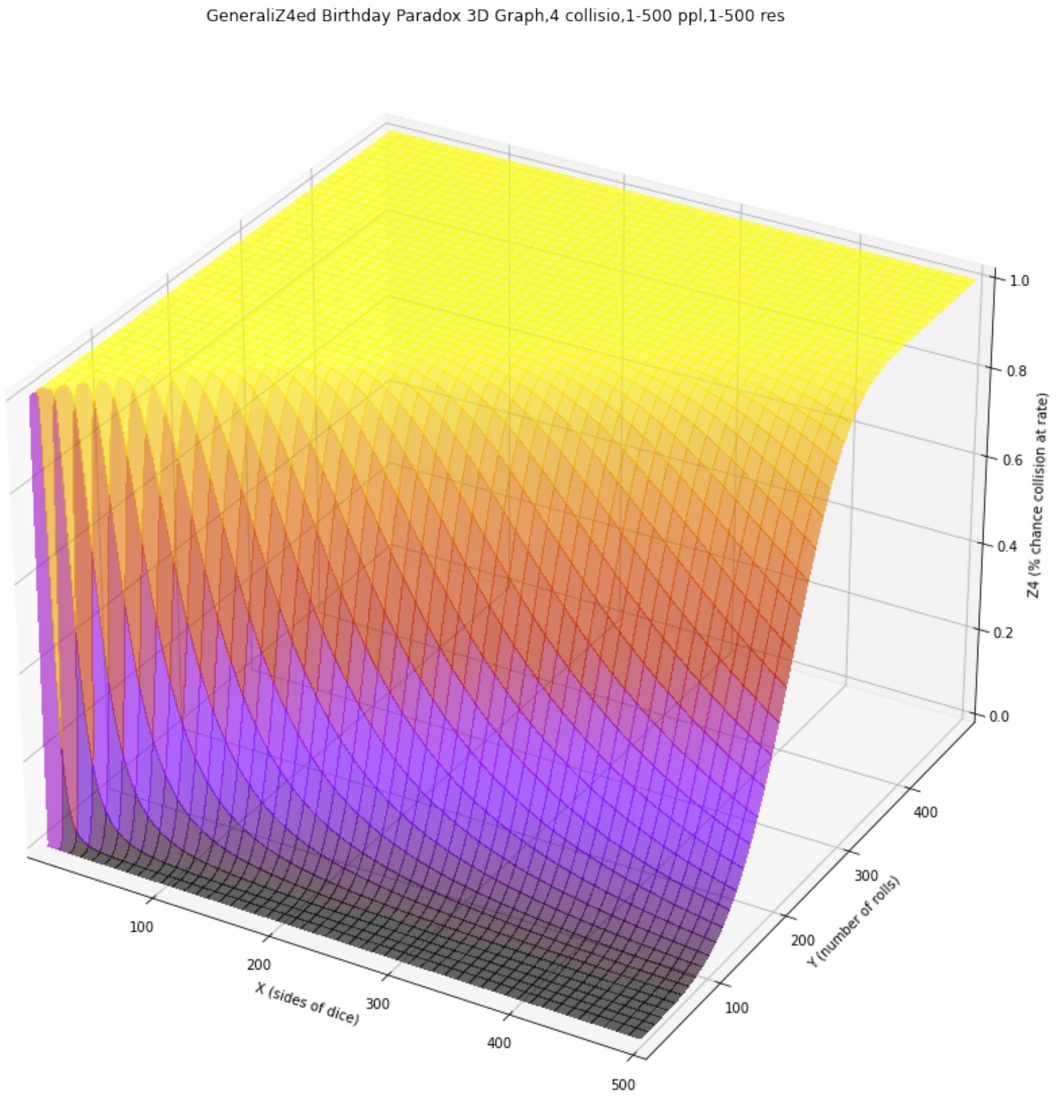
[42]:

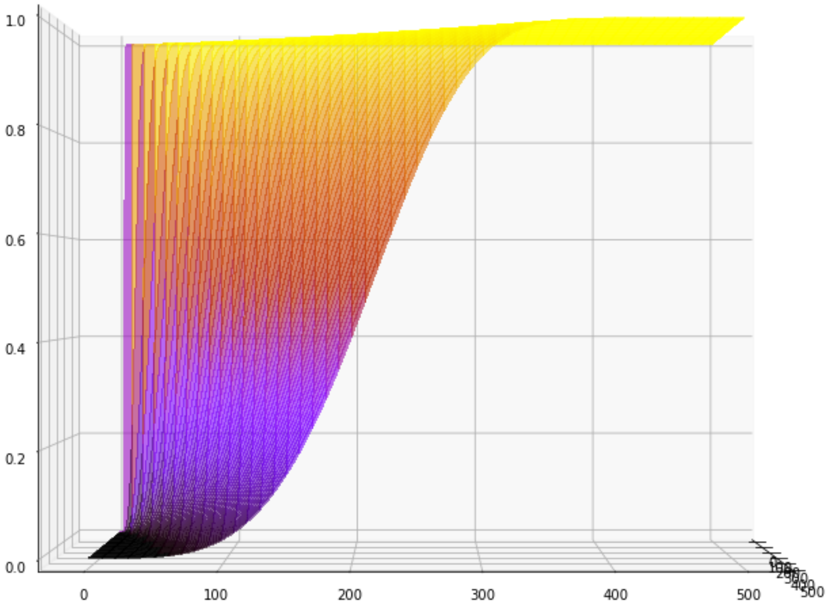
```
%matplotlib inline
fig = plt.figure(figsize=(15,15))
ax = plt.axes(projection = '3d')
ax.plot_surface(X, Y, Z2, alpha = .1, antialiased=True,cmap = "gnuplot")
ax.plot_surface(X, Y, Z3, alpha = .3, antialiased=True,cmap = "gnuplot")
ax.plot_surface(X, Y, Z4, alpha = .5, antialiased=True,cmap = "gnuplot")
ax.plot_surface(X, Y, Z5, alpha = .7, antialiased=True,cmap = "gnuplot")
ax.plot_surface(X, Y, Z6, alpha = .9, antialiased=True,cmap = "gnuplot")
ax.plot_surface(X, Y, Z7, alpha = 1, antialiased=True,cmap = "gnuplot")
ax.set_xlabel('X (sides of dice)')
ax.set_xlim(np.min(X),np.max(X))
ax.set_ylabel('Y (number of rolls)')
ax.set_ylim(np.min(Y),np.max(Y))
ax.set_zlabel('Z (% of 2x 3x(orange) occurance)')
ax.set_zlim(np.min(Z2S),np.max(Z2S))
ax.set_title('Generalized Birthday Paradox 3D Graph,1-500 rolls,1-500␣
 ↪res,surfaces at 2 or 3 collisions')
plt.show()
fig = plt.figure(figsize=(15,15))
ax = plt.axes(projection = '3d')
ax.plot_surface(X, Y, Z2, alpha = .1, antialiased=True,cmap = "gnuplot")
ax.plot_surface(X, Y, Z3, alpha = .3, antialiased=True,cmap = "gnuplot")
ax.plot_surface(X, Y, Z4, alpha = .5, antialiased=True,cmap = "gnuplot")
ax.plot_surface(X, Y, Z5, alpha = .7, antialiased=True,cmap = "gnuplot")
ax.plot_surface(X, Y, Z6, alpha = .9, antialiased=True,cmap = "gnuplot")
ax.plot_surface(X, Y, Z7, alpha = 1, antialiased=True,cmap = "gnuplot")
ax.view_init(0,0)
plt.show()
```

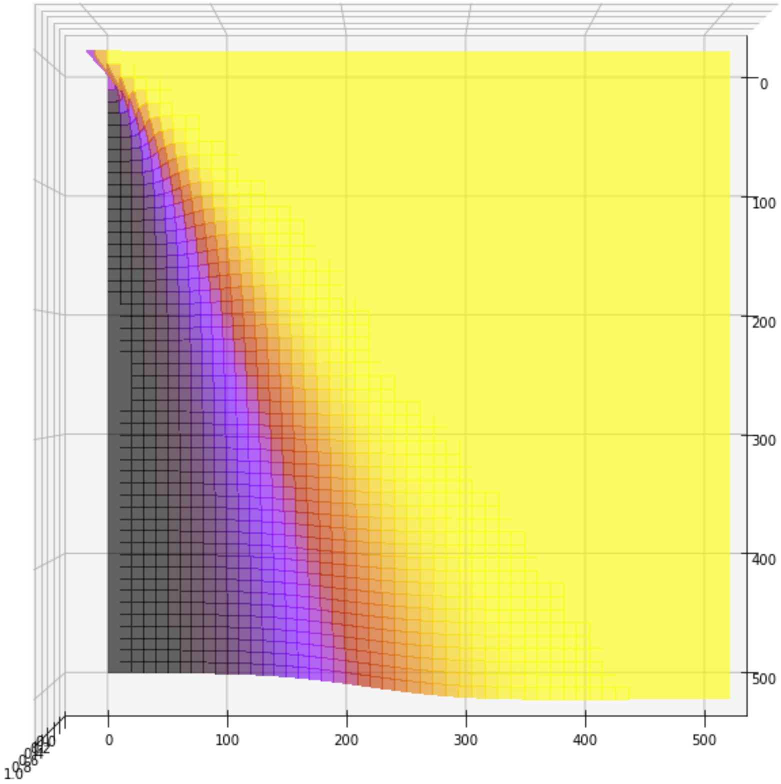


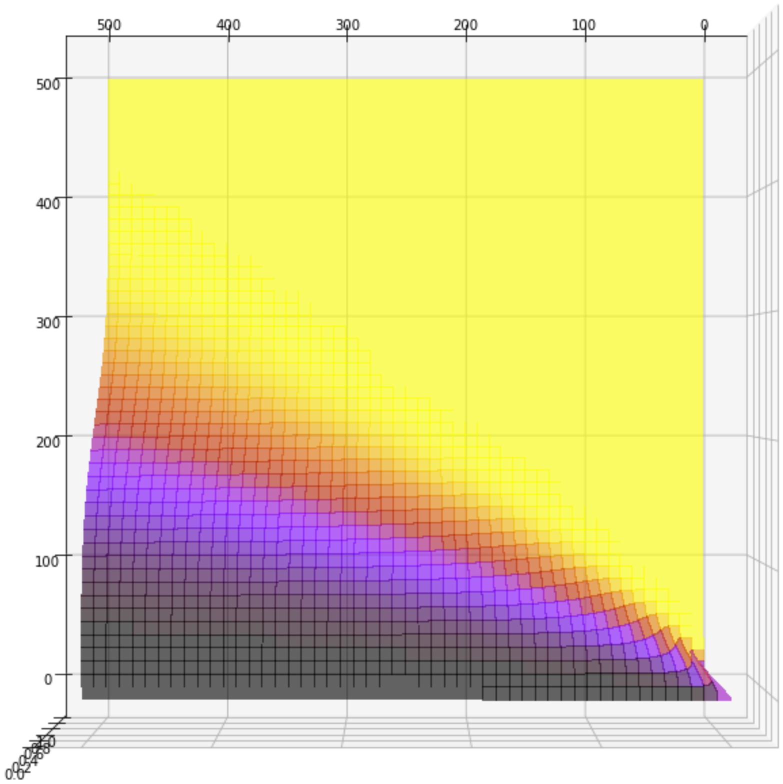


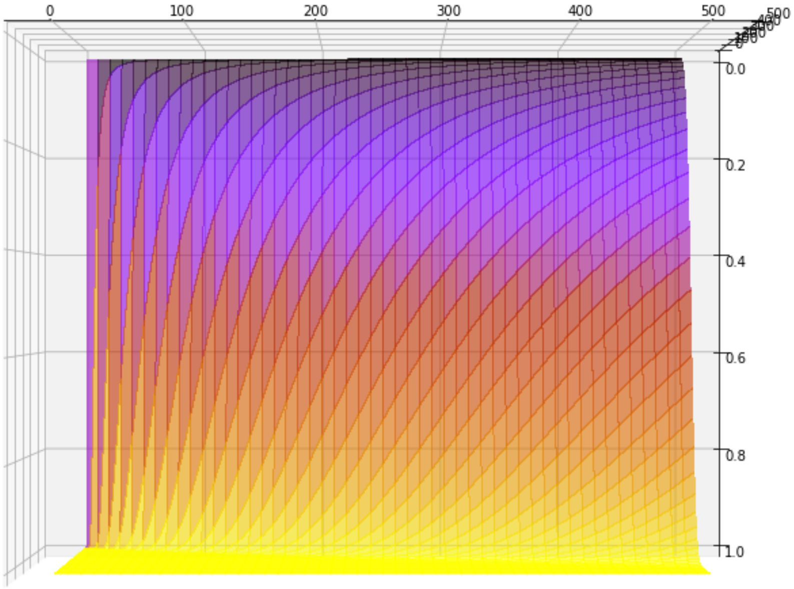
```
[38]: %matplotlib inline
      fig = plt.figure(figsize=(15,15))
      ax = plt.axes(projection = '3d')
      ax.plot_surface(X, Y, Z4, alpha = .6, antialiased=False,cmap = "gnuplot")
      ax.set_xlabel('X (sides of dice)')
      ax.set_xlim(np.min(X),np.max(X))
      ax.set_ylabel('Y (number of rolls)')
      ax.set_ylim(np.min(Y),np.max(Y))
      ax.set_zlabel('Z4 (% chance collision at rate)')
      ax.set_zlim(np.min(Z4),np.max(Z4))
ax.set_title('GeneraliZ4ed Birthday Paradox 3D Graph,4 collisio,1-500 ppl,1-500 res')
plt.show()
fig = plt.figure(figsize=(15,15))
ax = plt.axes(projection = '3d')
ax.plot_surface(X, Y, Z4, alpha = .6, antialiased=False,cmap = "gnuplot")
ax.view_init(0,0)
plt.show()
fig = plt.figure(figsize=(15,15))
ax = plt.axes(projection = '3d')
ax.plot_surface(X, Y, Z4,alpha = .6, antialiased=False, cmap = "gnuplot")
ax.view_init(90,0)
plt.show()
fig = plt.figure(figsize=(15,15))
ax = plt.axes(projection = '3d')
ax.plot_surface(X, Y, Z4,alpha = .6, antialiased=False, cmap = "gnuplot")
ax.view_init(-90,90)
plt.show()
fig = plt.figure(figsize=(15,15))
ax = plt.axes(projection = '3d')
ax.plot_surface(X, Y, Z4,alpha = .6, antialiased=False, cmap = "gnuplot")
ax.view_init(180,-90)
```


GeneraliZ4ed Birthday Paradox 3D Graph,4 collisio,1-500 ppl,1-500 res
X (sides of dice)
100
200
300
400
500
Y (number of rolls)
100
200
300
400
Z4 (% chance collision at rate)
0.0
0.2
0.4
0.6
0.8
1.0


1.0
0.8
0.6
0.4
0.2
0.0
0
100
200
300
400
500
0
100
200
300
400
500

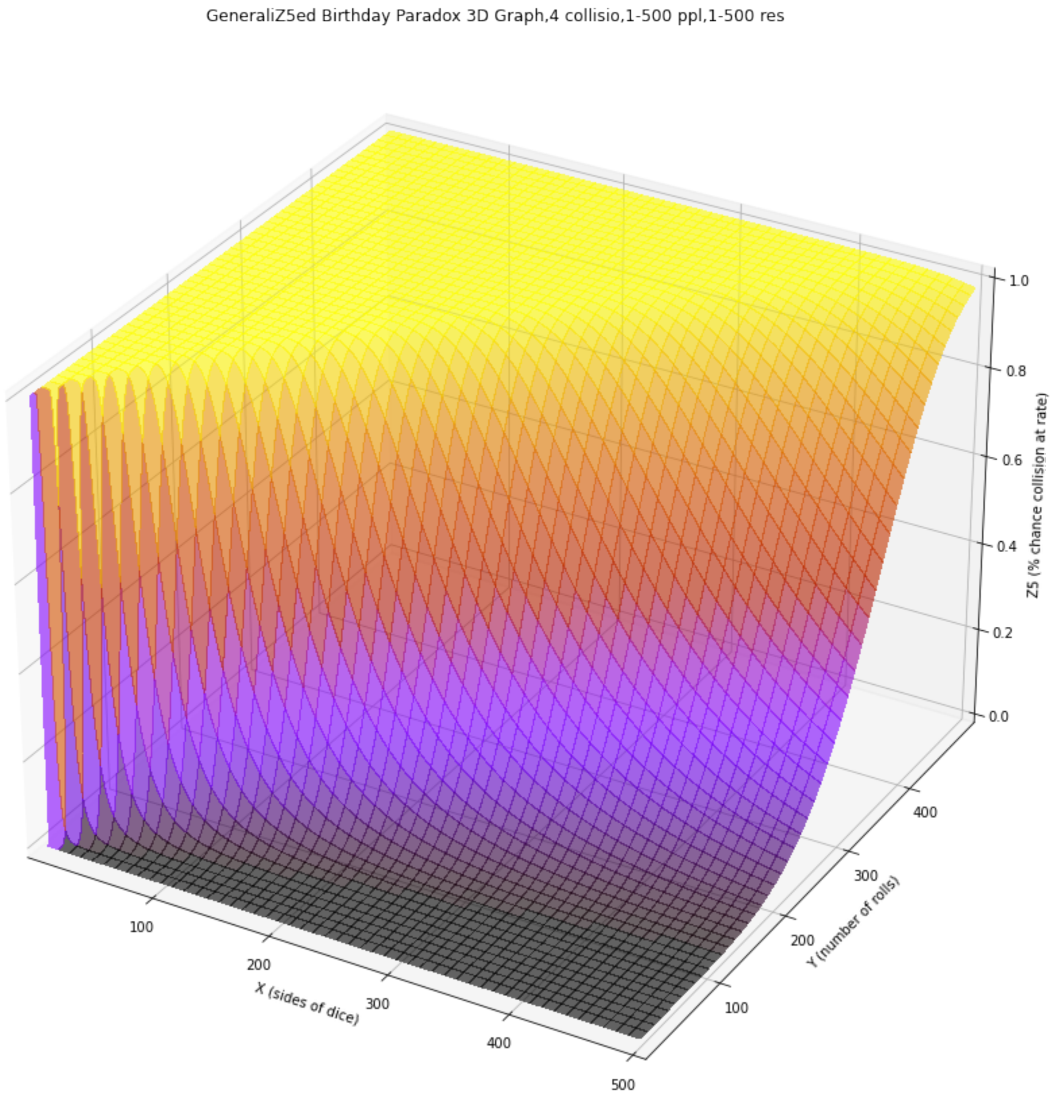

0
100
200
300
400
500
0
100
200
300
400
500
1.0

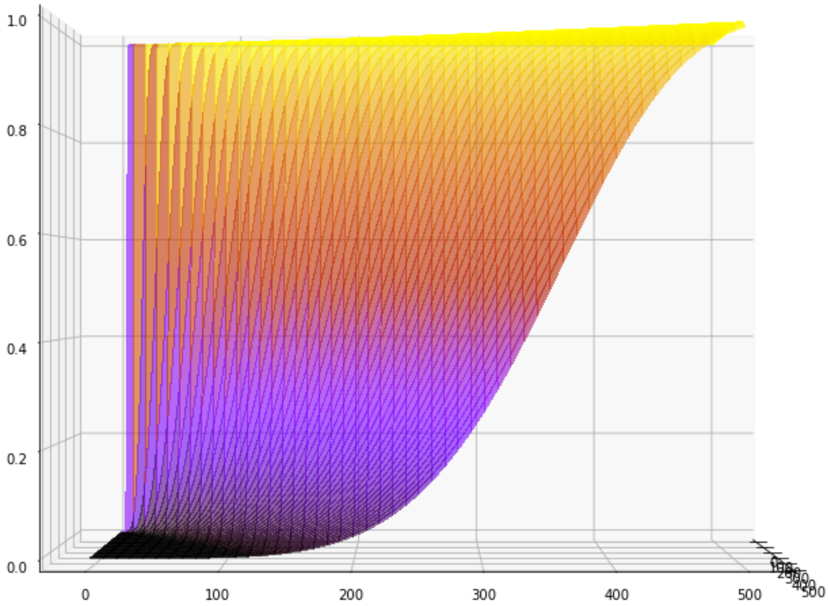

500
400
300
200
100
0
500
400
300
200
100
0
0.0
0.2
0.4
0.6
0.8
1.0

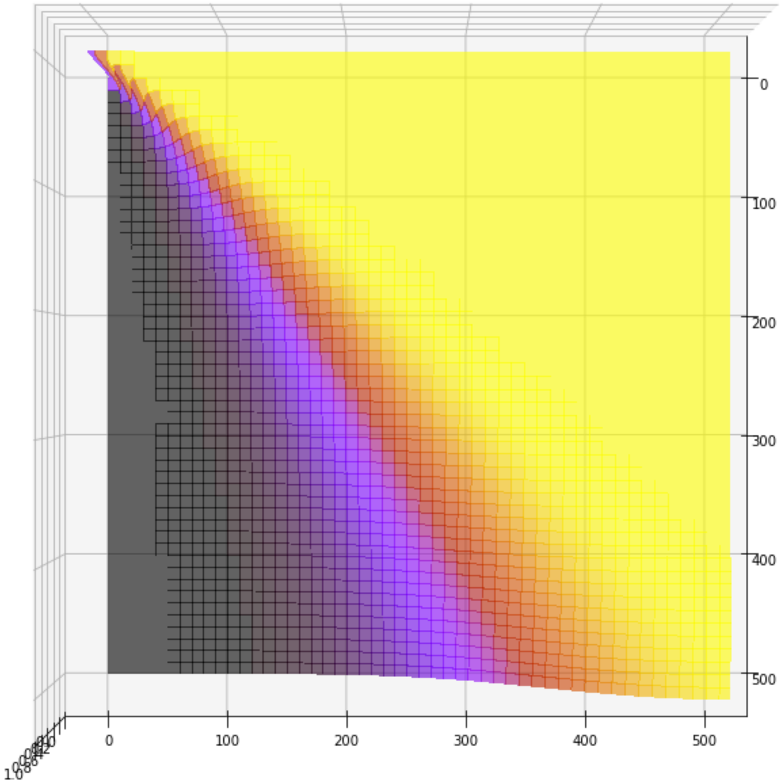


[43]:
```
%matplotlib inline
fig = plt.figure(figsize=(15,15))
ax = plt.axes(projection = '3d')
ax.plot_surface(X, Y, Z5, alpha = .6, antialiased=False,cmap = "gnuplot")
ax.set_xlabel('X (sides of dice)')
ax.set_xlim(np.min(X),np.max(X))
ax.set_ylabel('Y (number of rolls)')
ax.set_ylim(np.min(Y),np.max(Y))
ax.set_zlabel('Z5 (% chance collision at rate)')
ax.set_zlim(np.min(Z5),np.max(Z5))
ax.set_title('GeneraliZ5ed Birthday Paradox 3D Graph,4 collisio,1-500 ppl,1-500␣
 ↪res')
plt.show()
```

```
fig = plt.figure(figsize=(15,15))
ax = plt.axes(projection = '3d')
ax.plot_surface(X, Y, Z5, alpha = .6, antialiased=False,cmap = "gnuplot")
ax.view_init(0,0)
plt.show()
fig = plt.figure(figsize=(15,15))
ax = plt.axes(projection = '3d')
ax.plot_surface(X, Y, Z5,alpha = .6, antialiased=False, cmap = "gnuplot")
ax.view_init(90,0)
plt.show()
fig = plt.figure(figsize=(15,15))
ax = plt.axes(projection = '3d')
ax.plot_surface(X, Y, Z5,alpha = .6, antialiased=False, cmap = "gnuplot")
ax.view_init(-90,90)
plt.show()
fig = plt.figure(figsize=(15,15))
ax = plt.axes(projection = '3d')
ax.plot_surface(X, Y, Z5,alpha = .6, antialiased=False, cmap = "gnuplot")
ax.view_init(180,-90)
```


GeneraliZ5ed Birthday Paradox 3D Graph,4 collisio,1-500 ppl,1-500 res
Z5 (% chance collision at rate)
1.0
0.8
0.6
0.4
0.2
0.0
X (sides of dice)
100
200
300
400
500
Y (number of rolls)
100
200
300
400


1.0
0.8
0.6
0.4
0.2
0.0
0
100
200
300
400
500
0
100
200
300
400
500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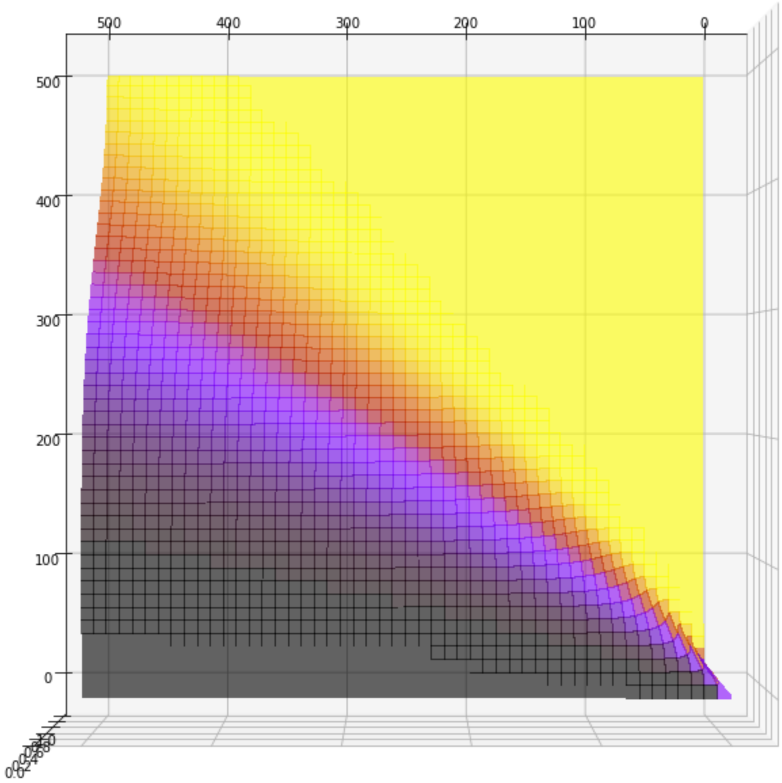
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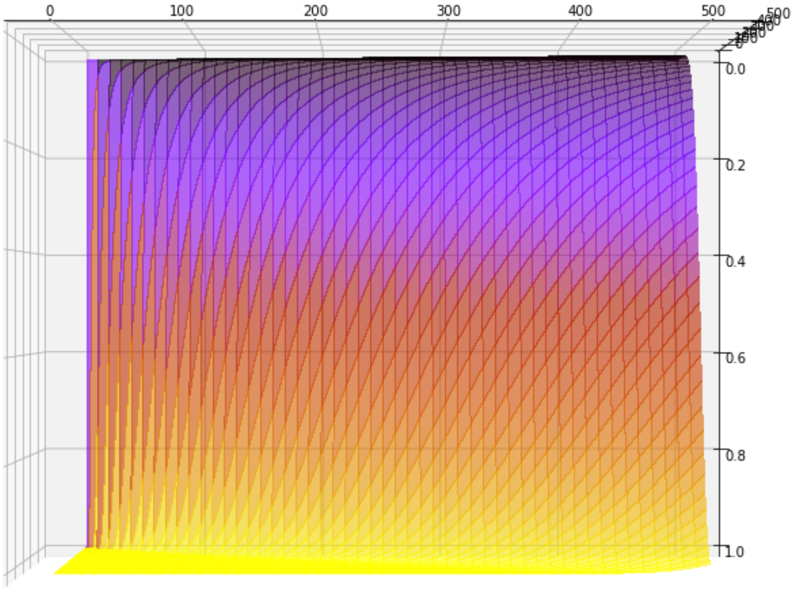
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