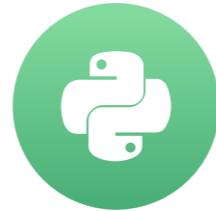


Normal distributions

FOUNDATIONS OF PROBABILITY IN PYTHON

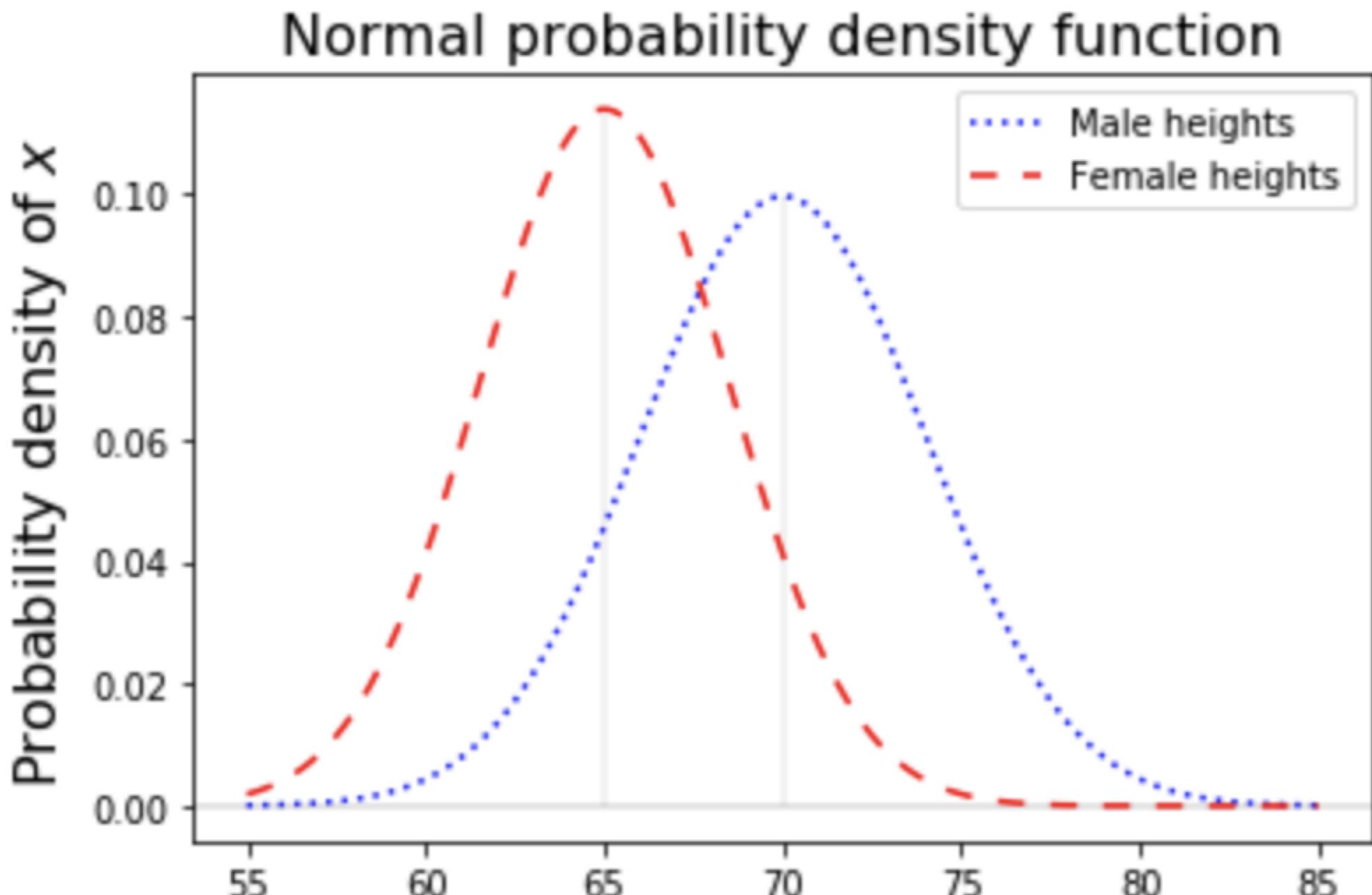


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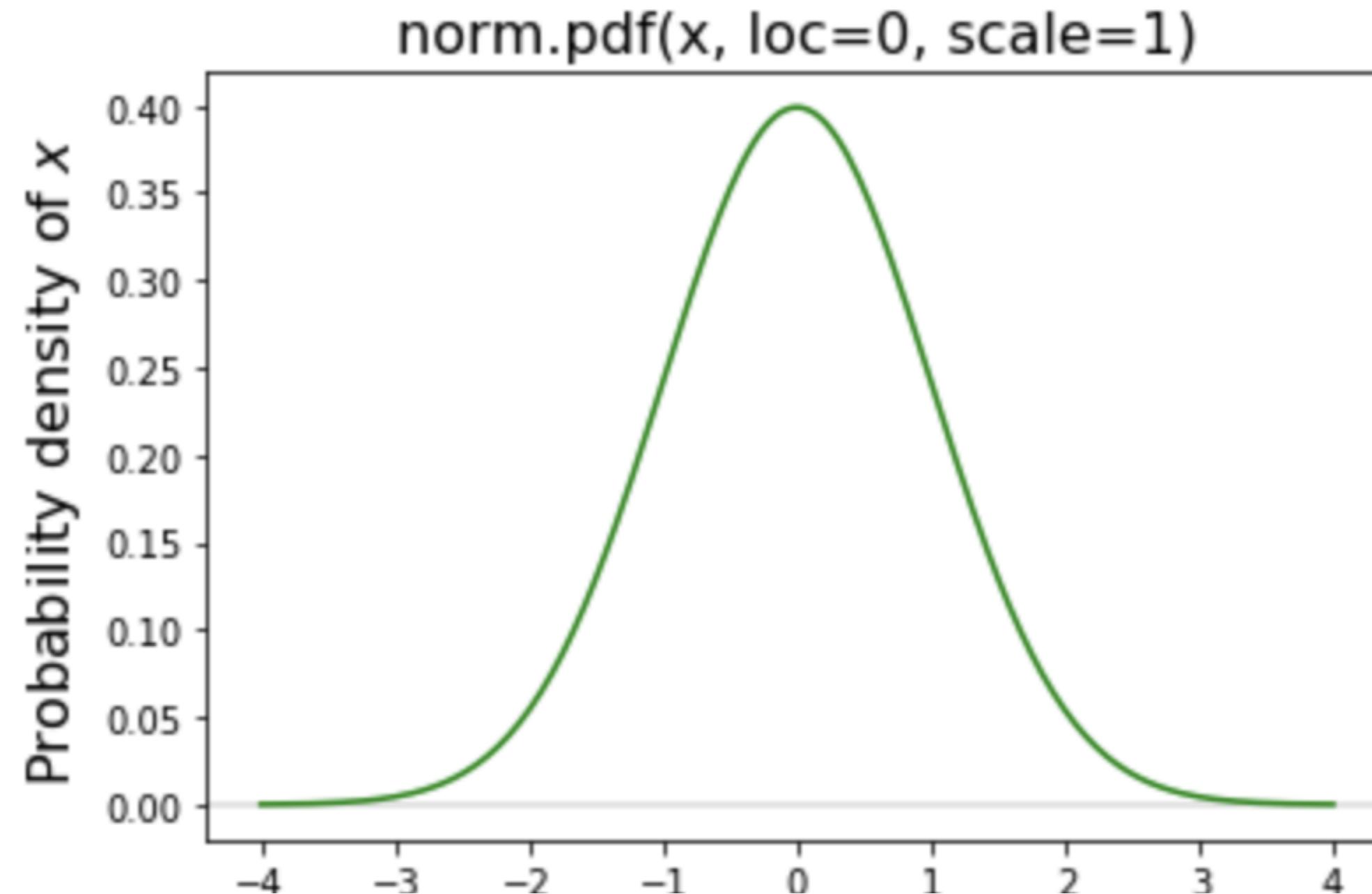
Modeling for measures



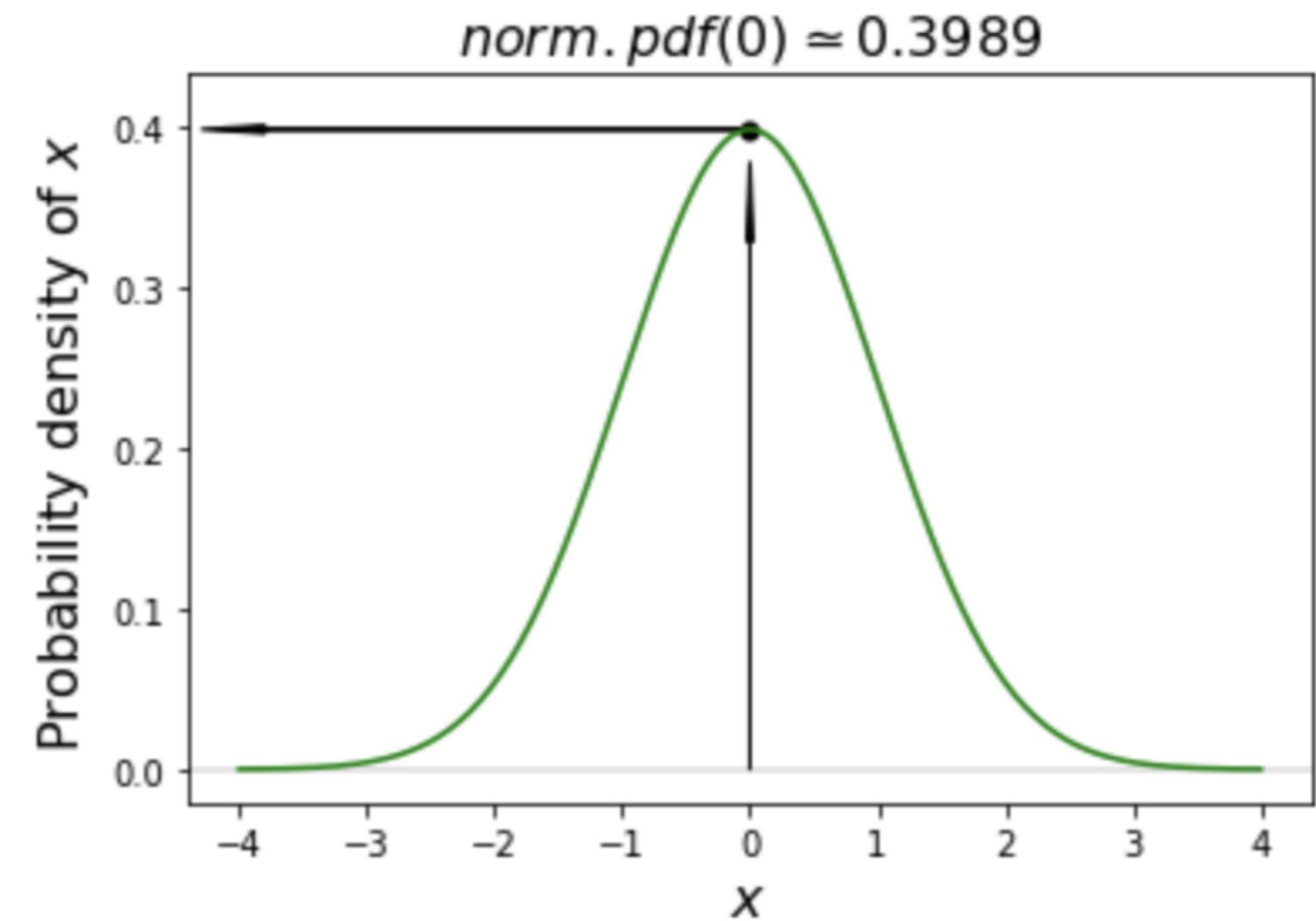
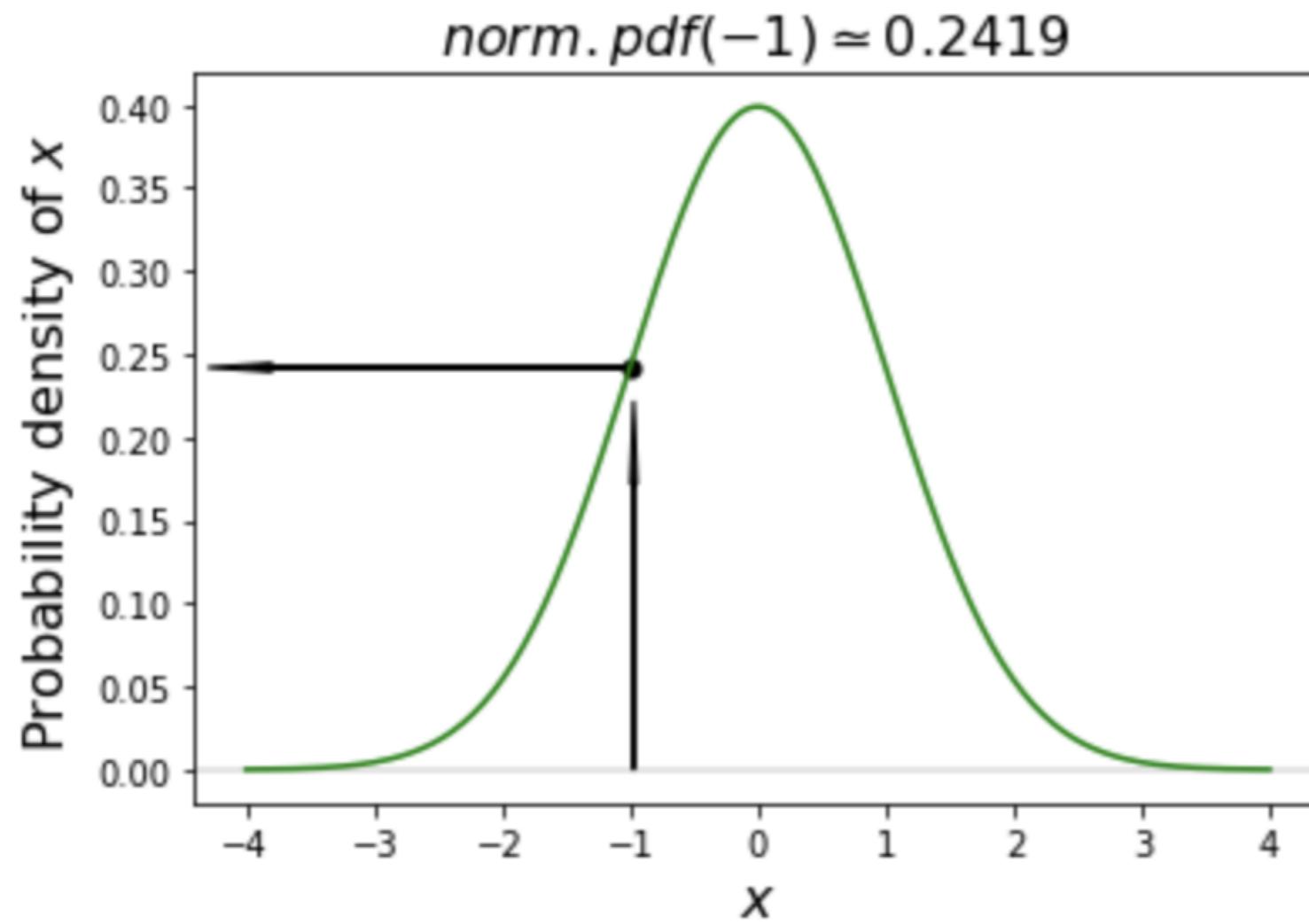
Adults' heights example



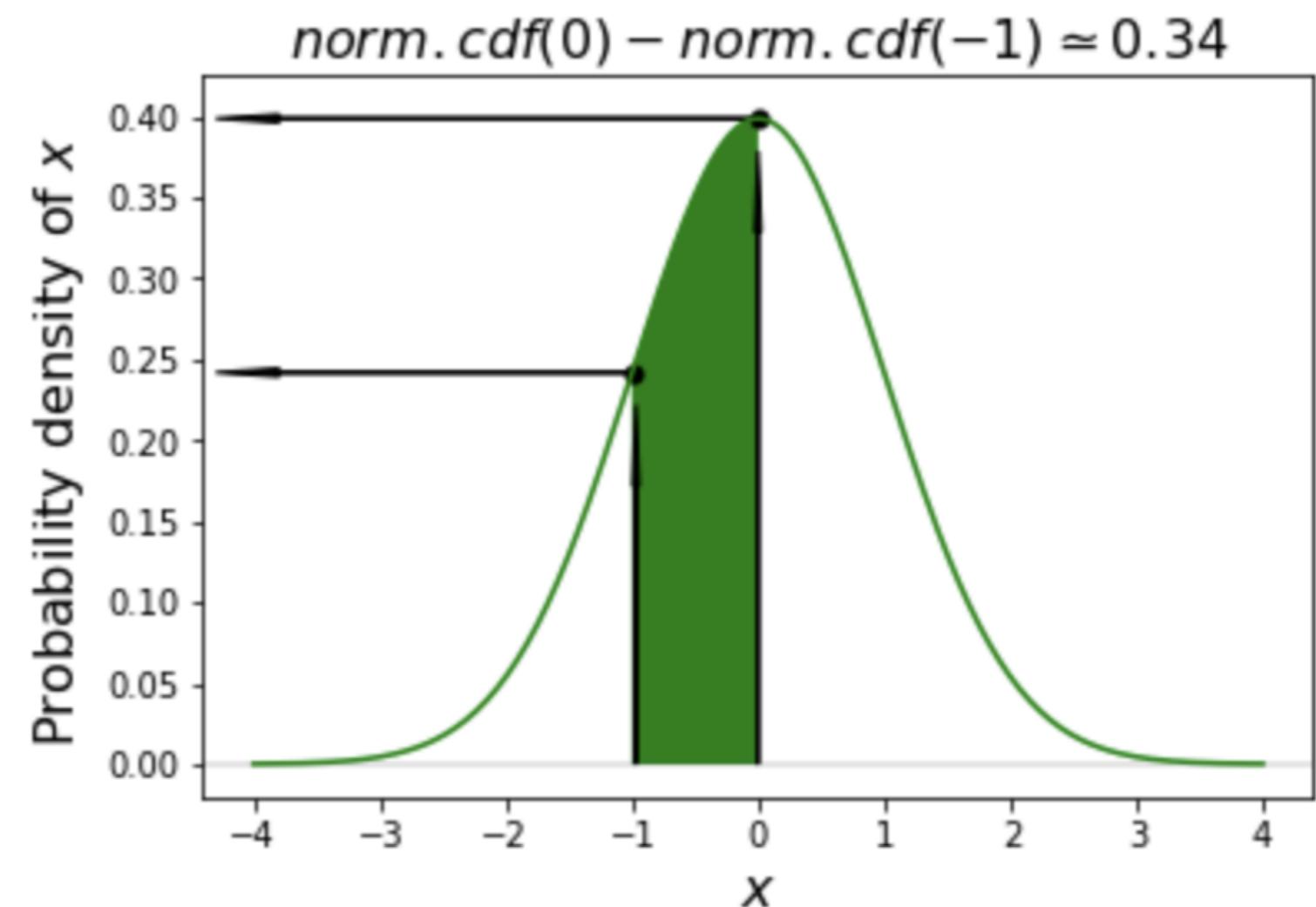
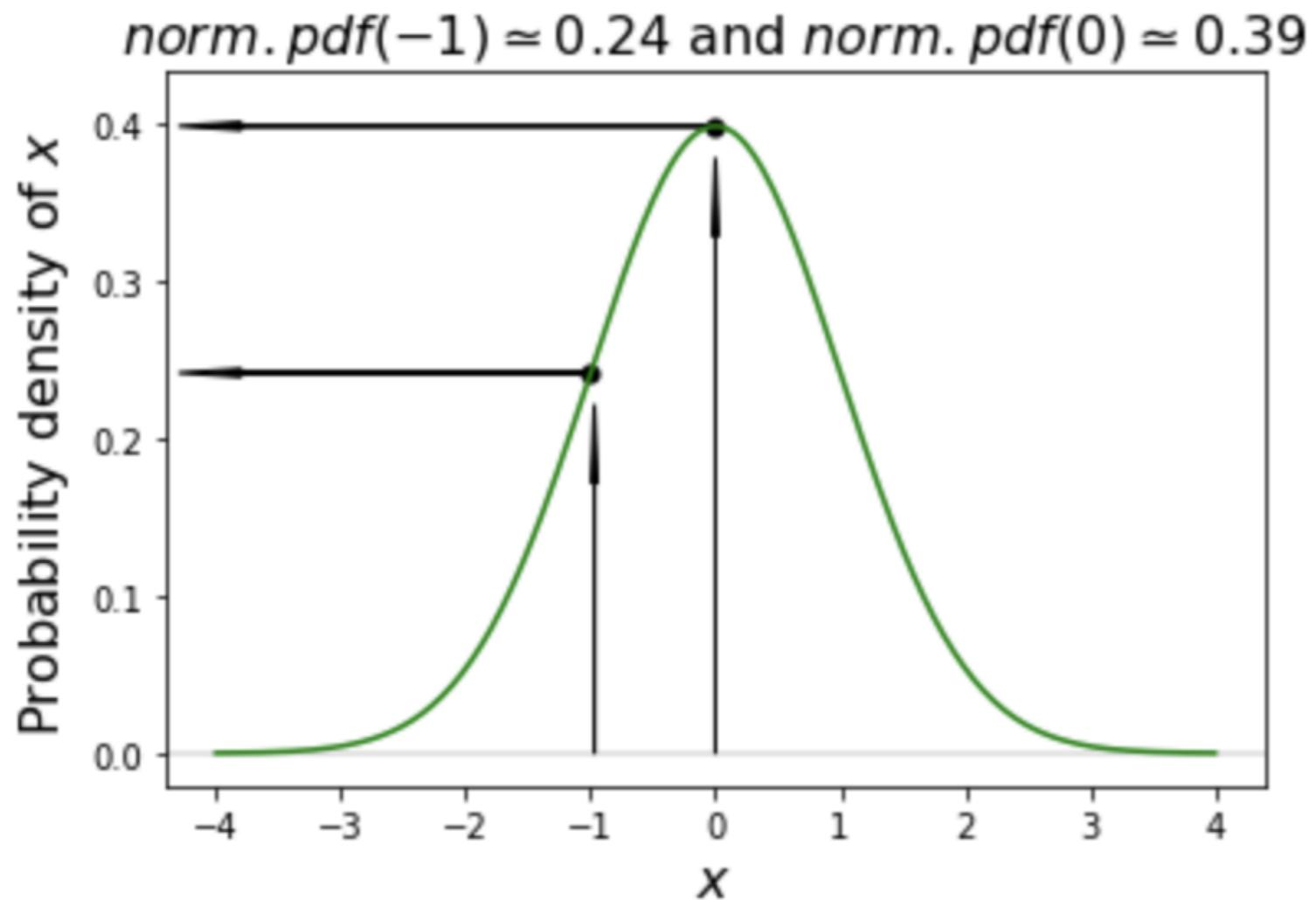
Probability density



Probability density examples

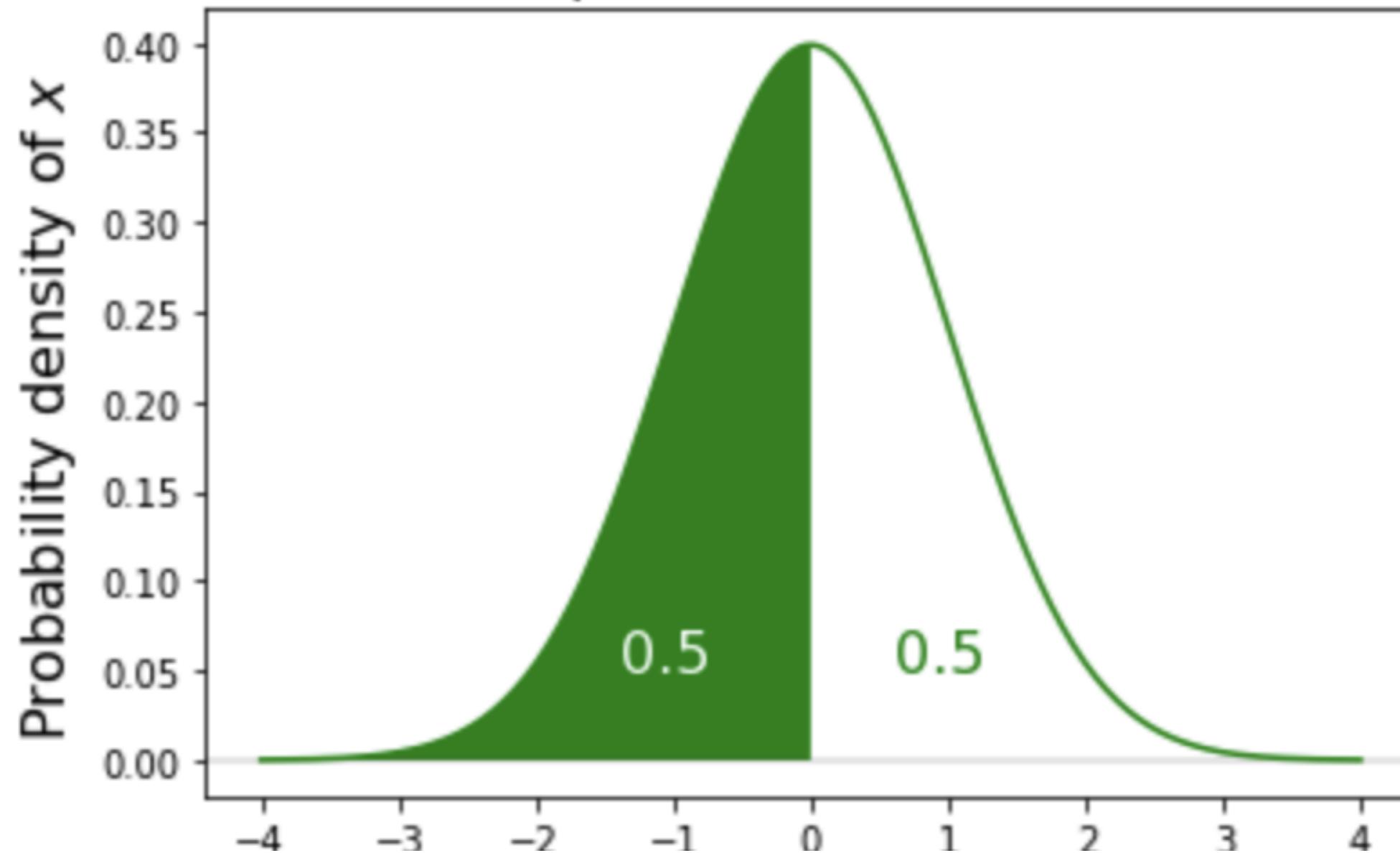


Probability density and probability



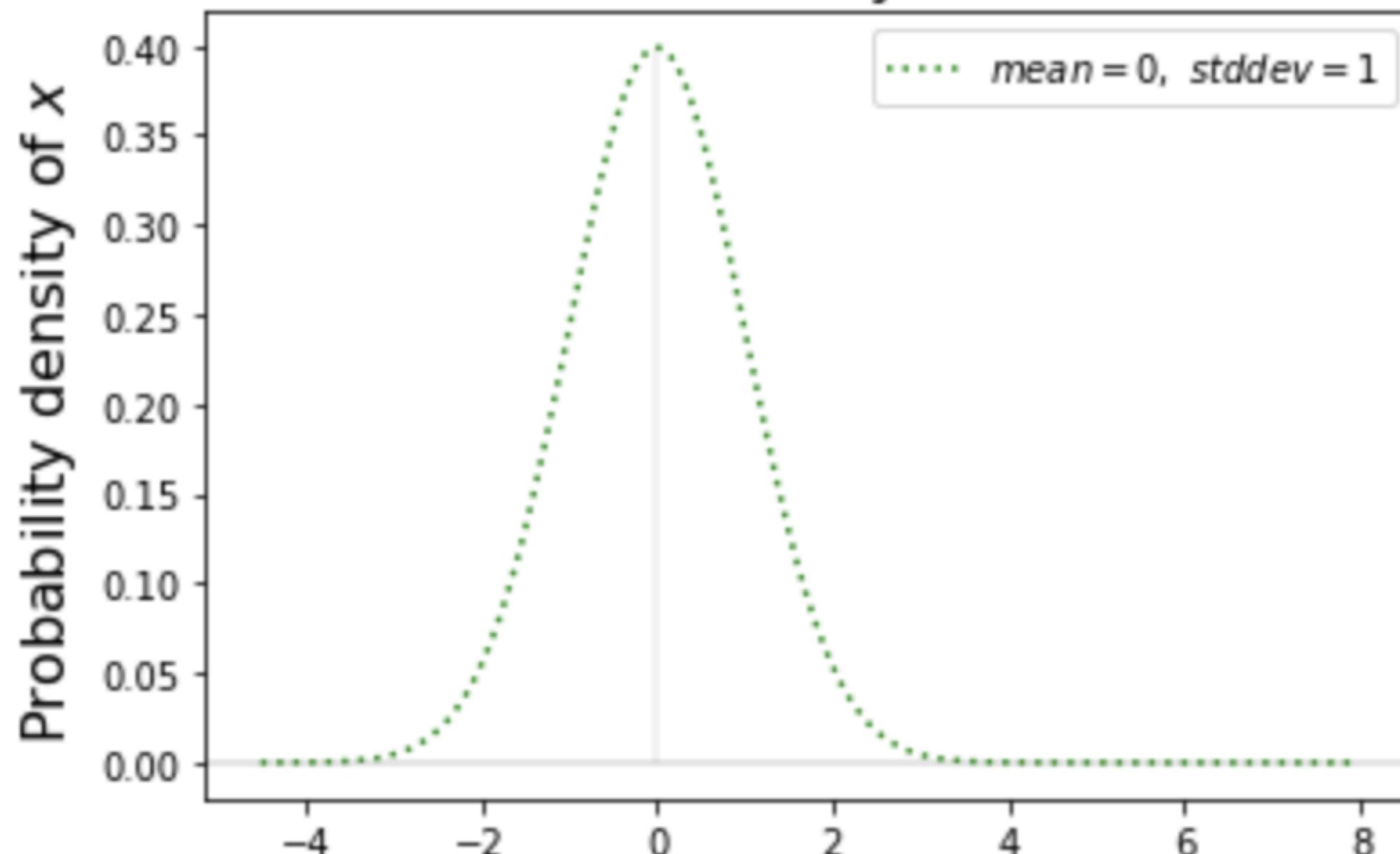
Symmetry

Same shape either side of the mean

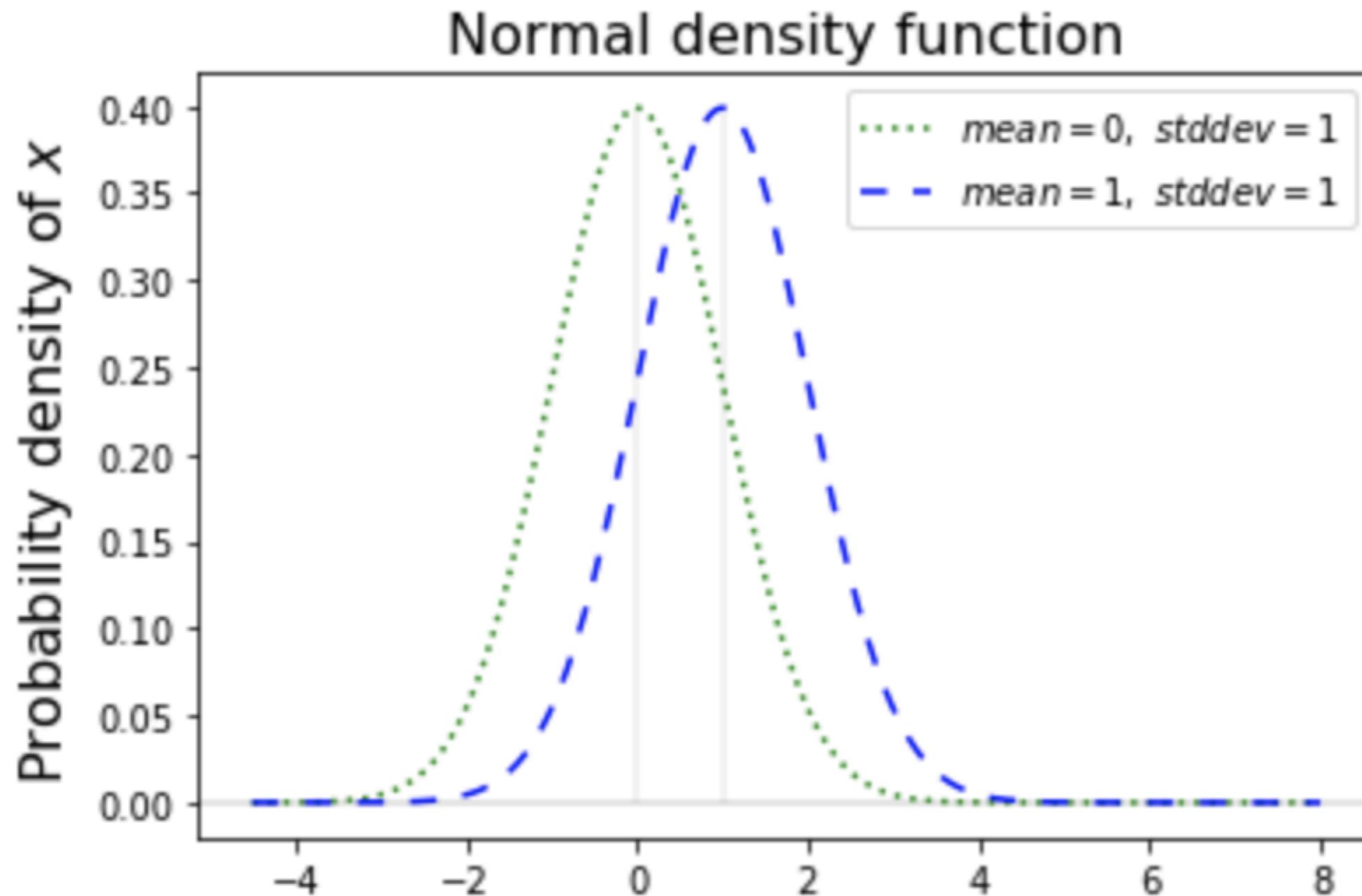


Mean

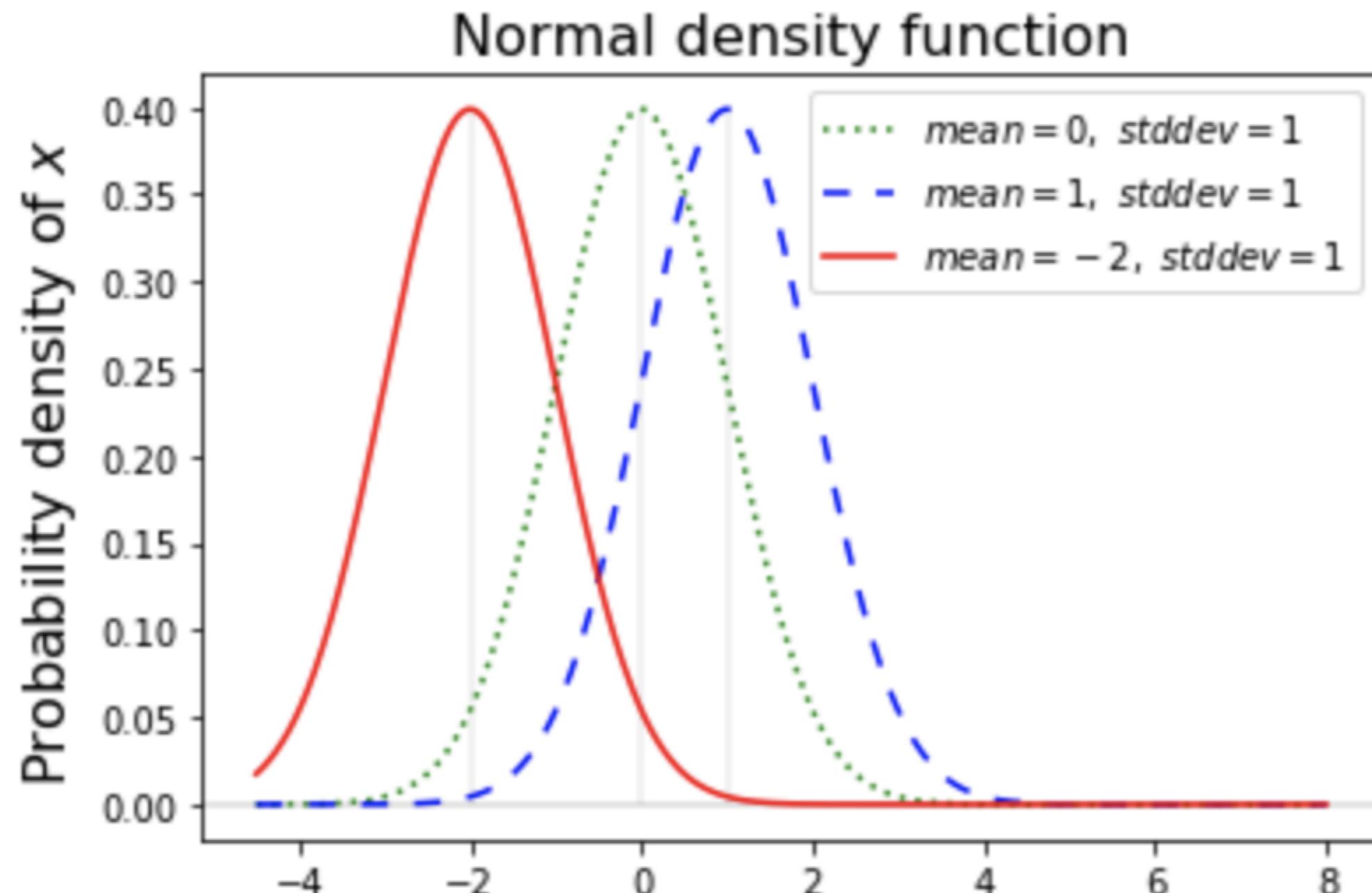
Normal density function



Mean (Cont.)

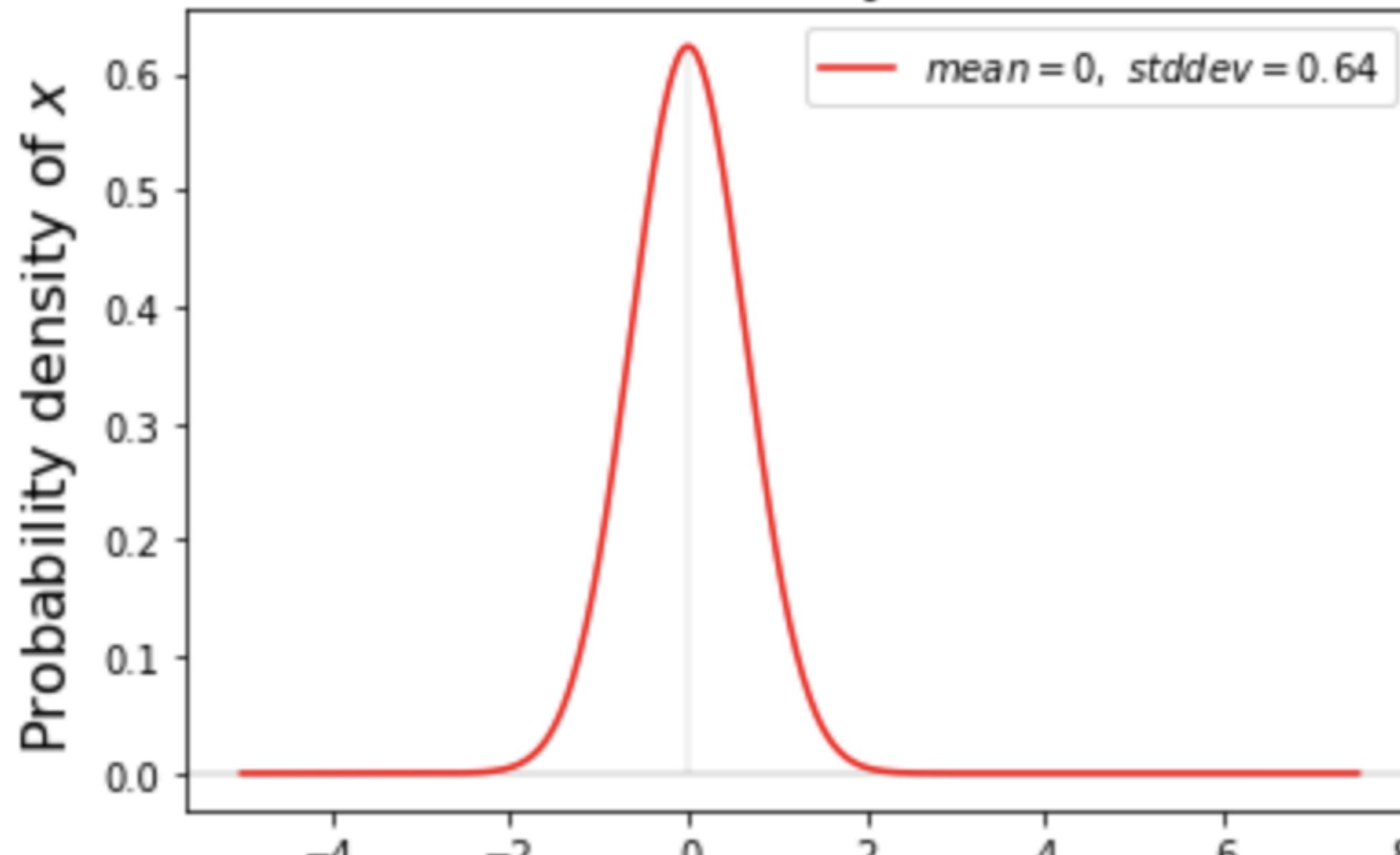


Mean (Cont.)

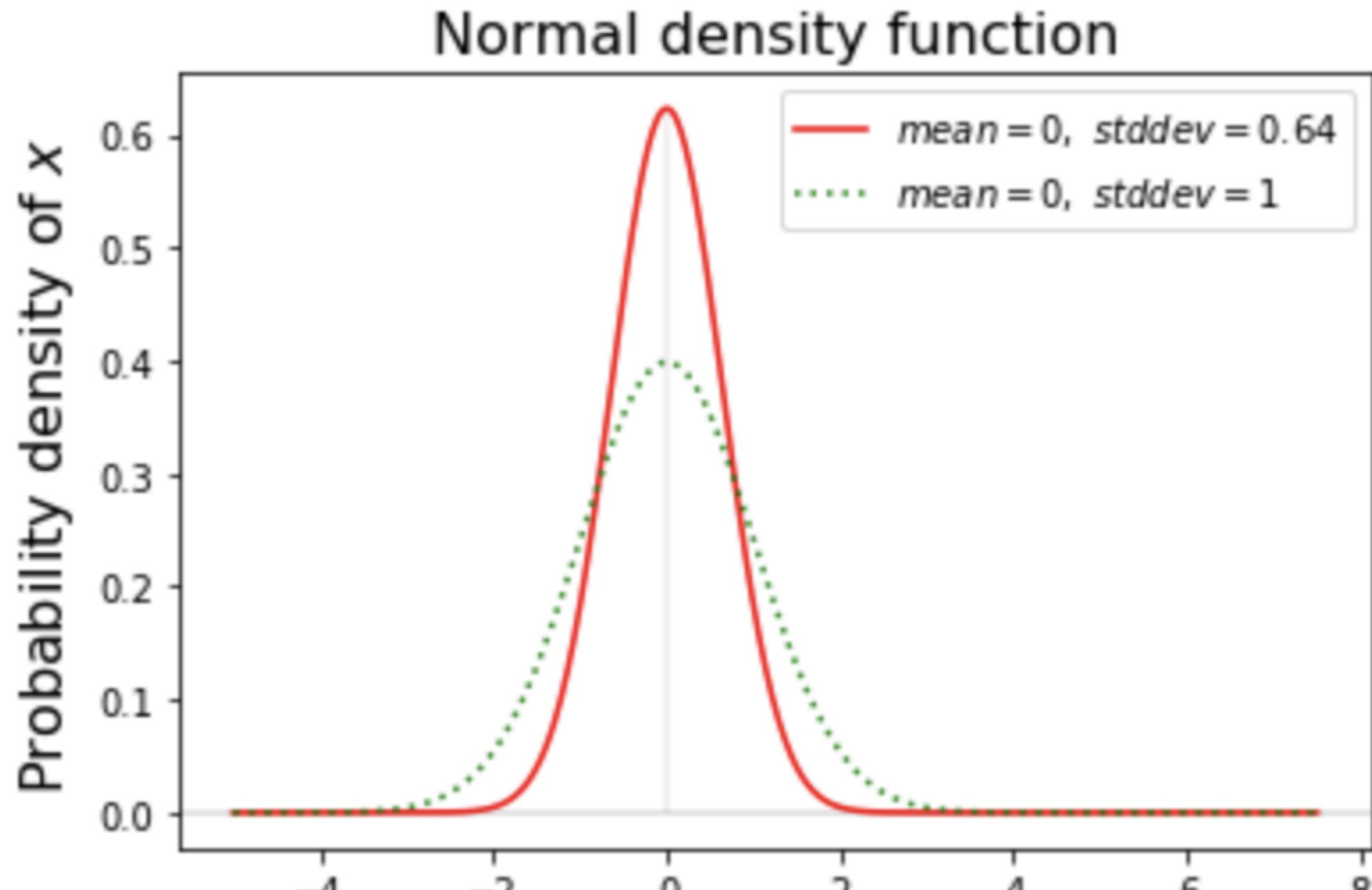


Standard deviation

Normal density function

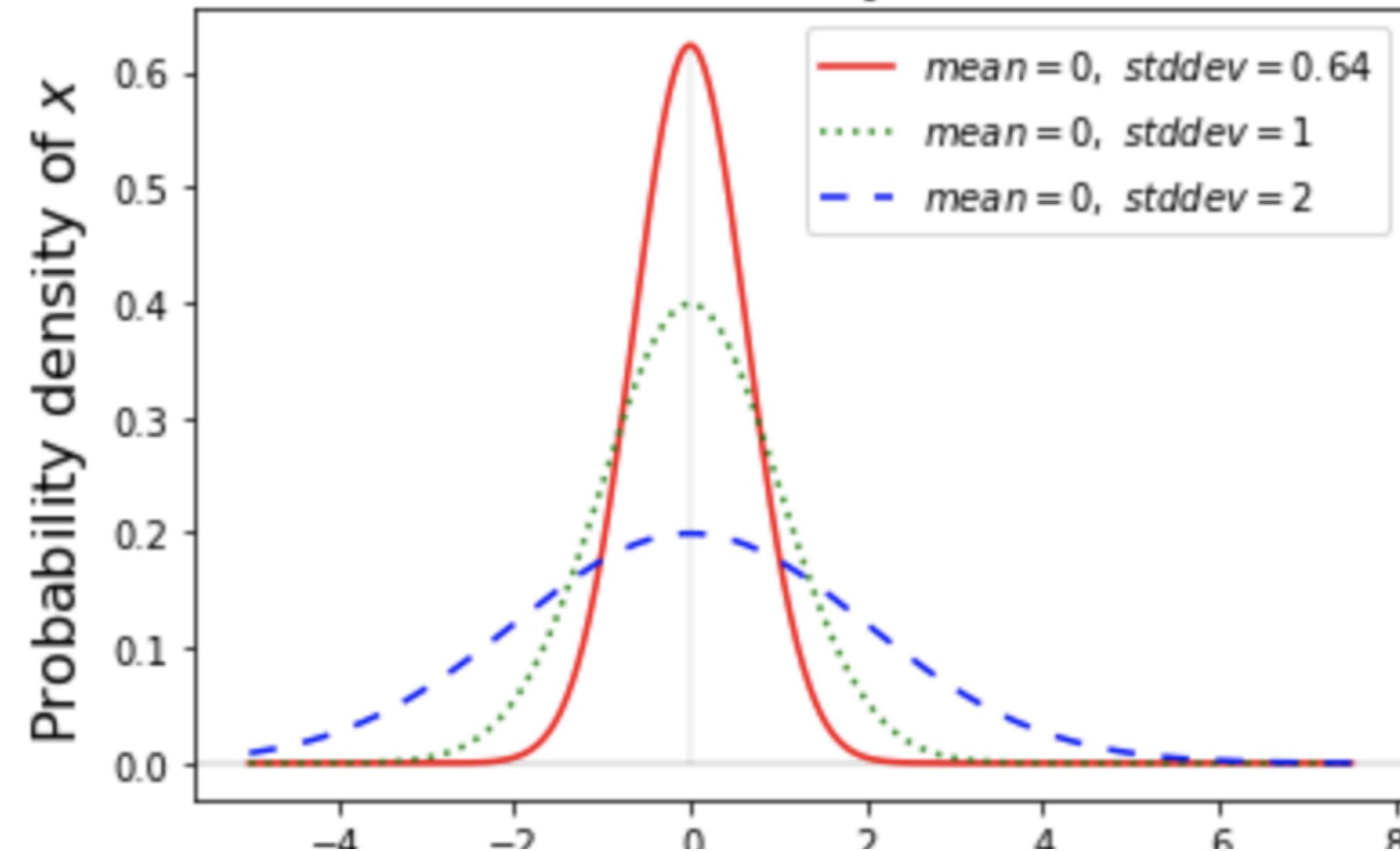


Standard deviation (Cont.)



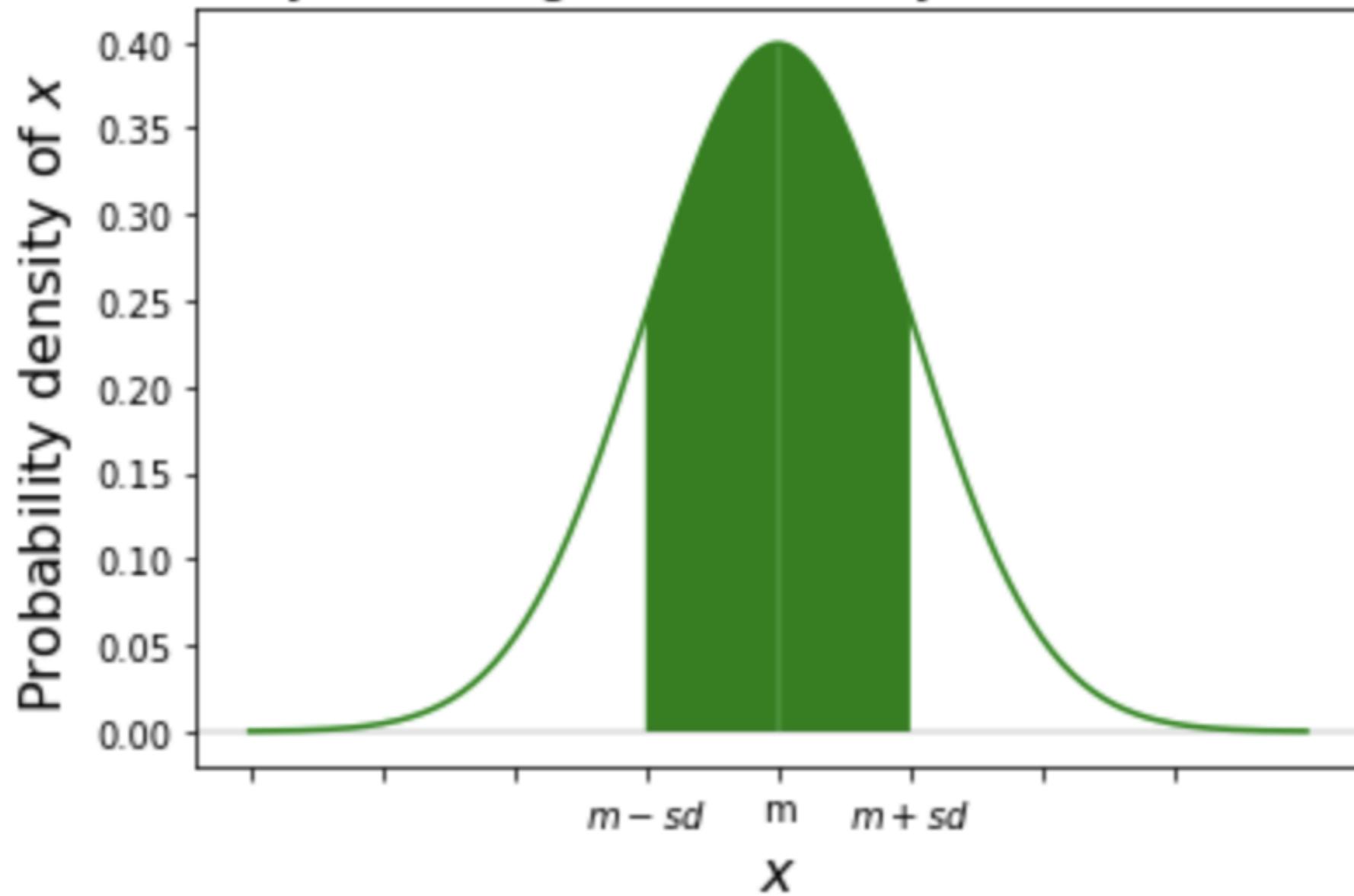
Standard deviation (Cont.)

Normal density function

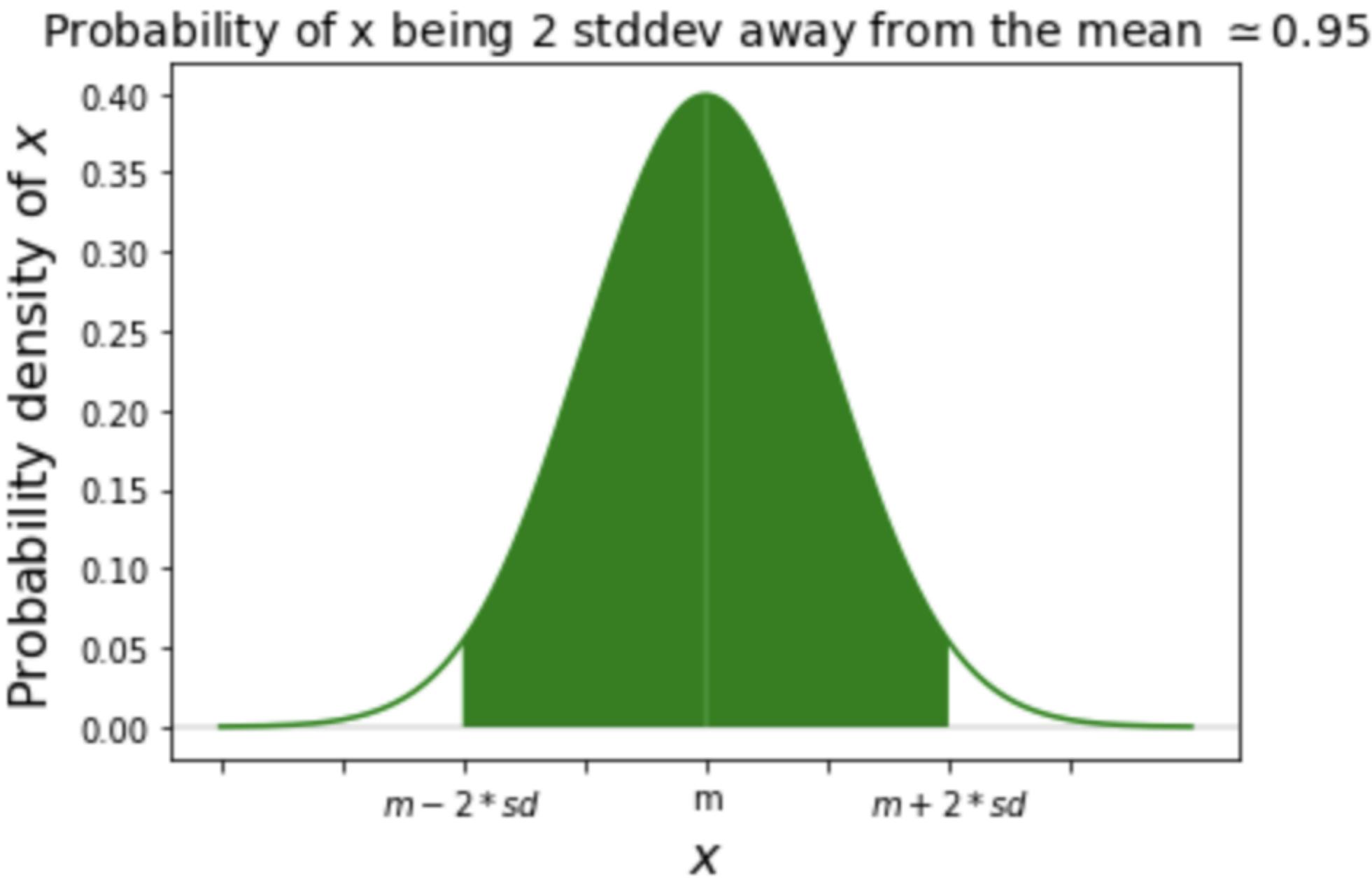


One standard deviation

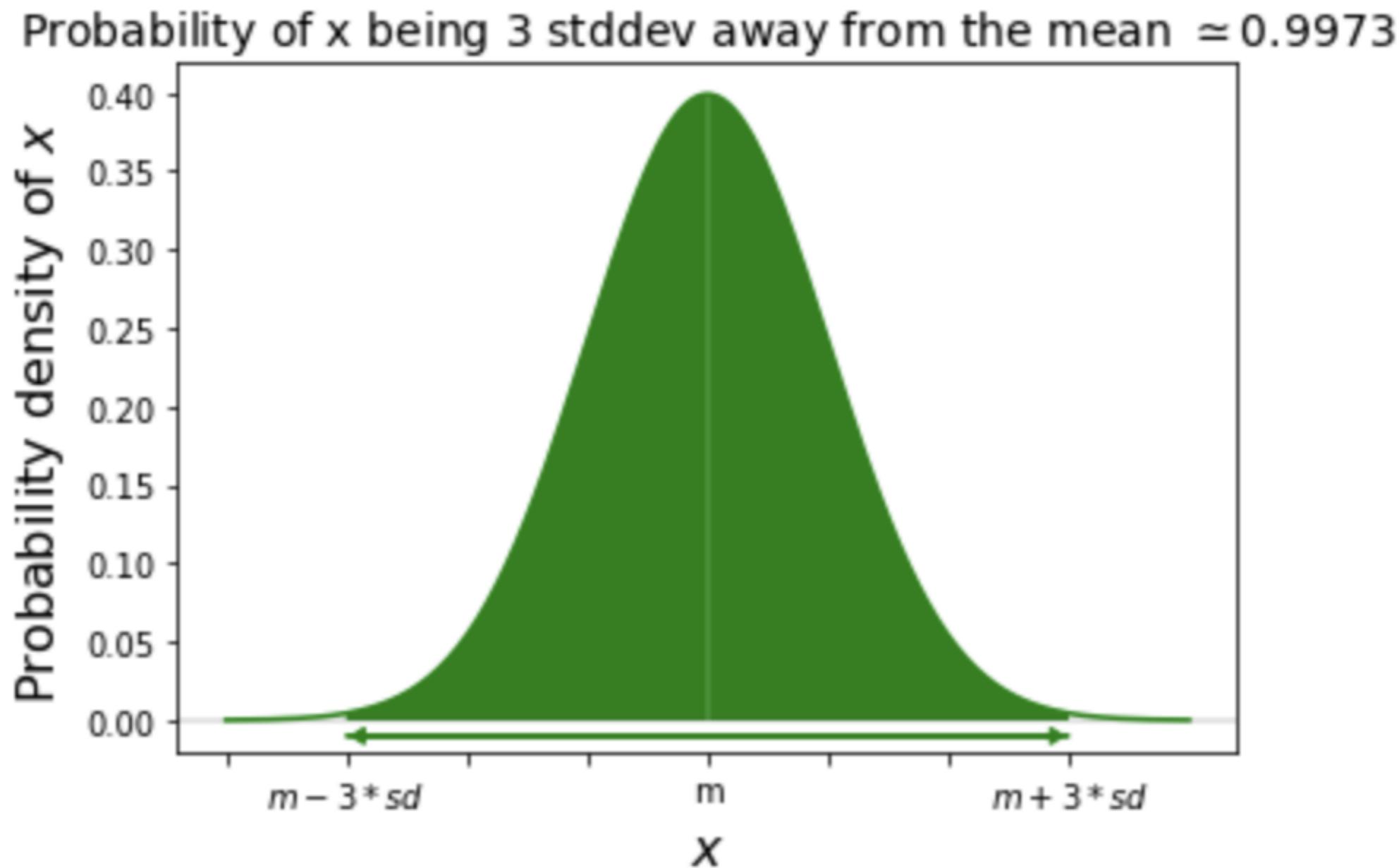
Probability of x being 1 stddev away from the mean ≈ 0.68



Two standard deviations



Three standard deviations



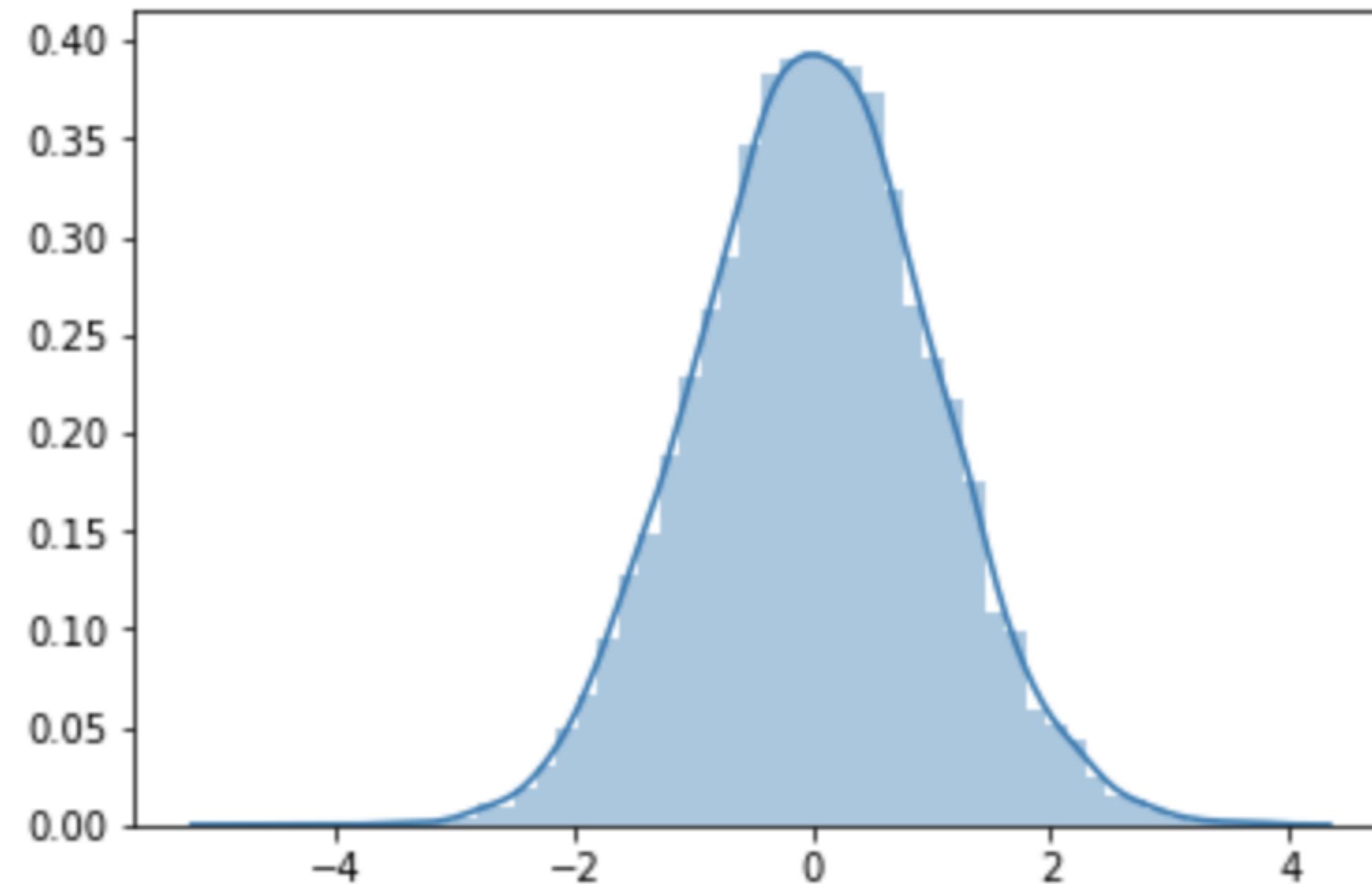
Normal sampling

```
# Import norm, matplotlib.pyplot, and seaborn
from scipy.stats import norm
import matplotlib.pyplot as plt
import seaborn as sns
```

```
# Create the sample using norm.rvs()
sample = norm.rvs(loc=0, scale=1, size=10000, random_state=13)
```

```
# Plot the sample
sns.distplot(sample)
plt.show()
```

Normal sampling (Cont.)

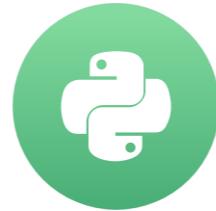


Let's do some exercises with normal distributions

FOUNDATIONS OF PROBABILITY IN PYTHON

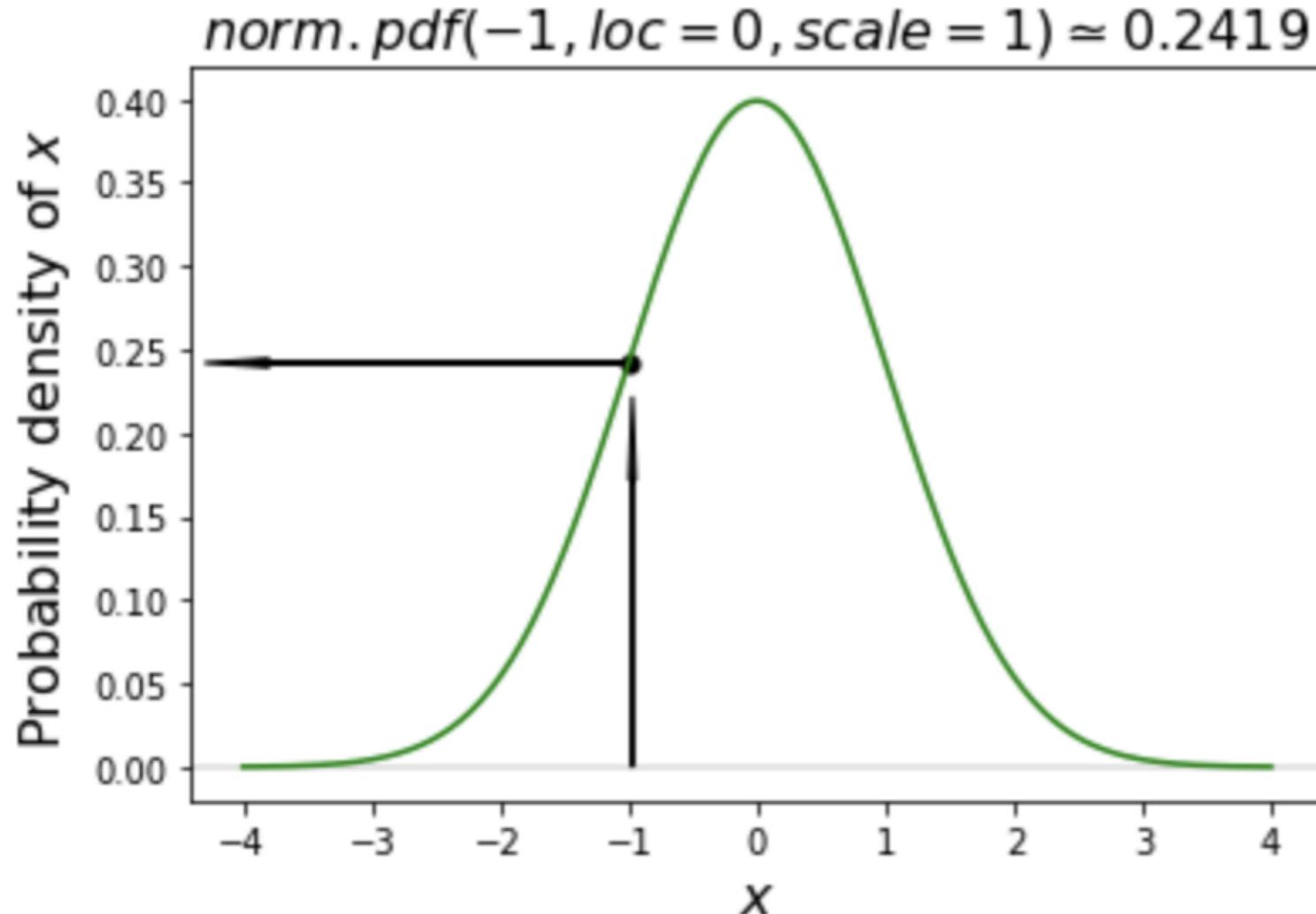
Normal probabilities

FOUNDATIONS OF PROBABILITY IN PYTHON



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Probability density



In Python this can be done in a couple of lines:

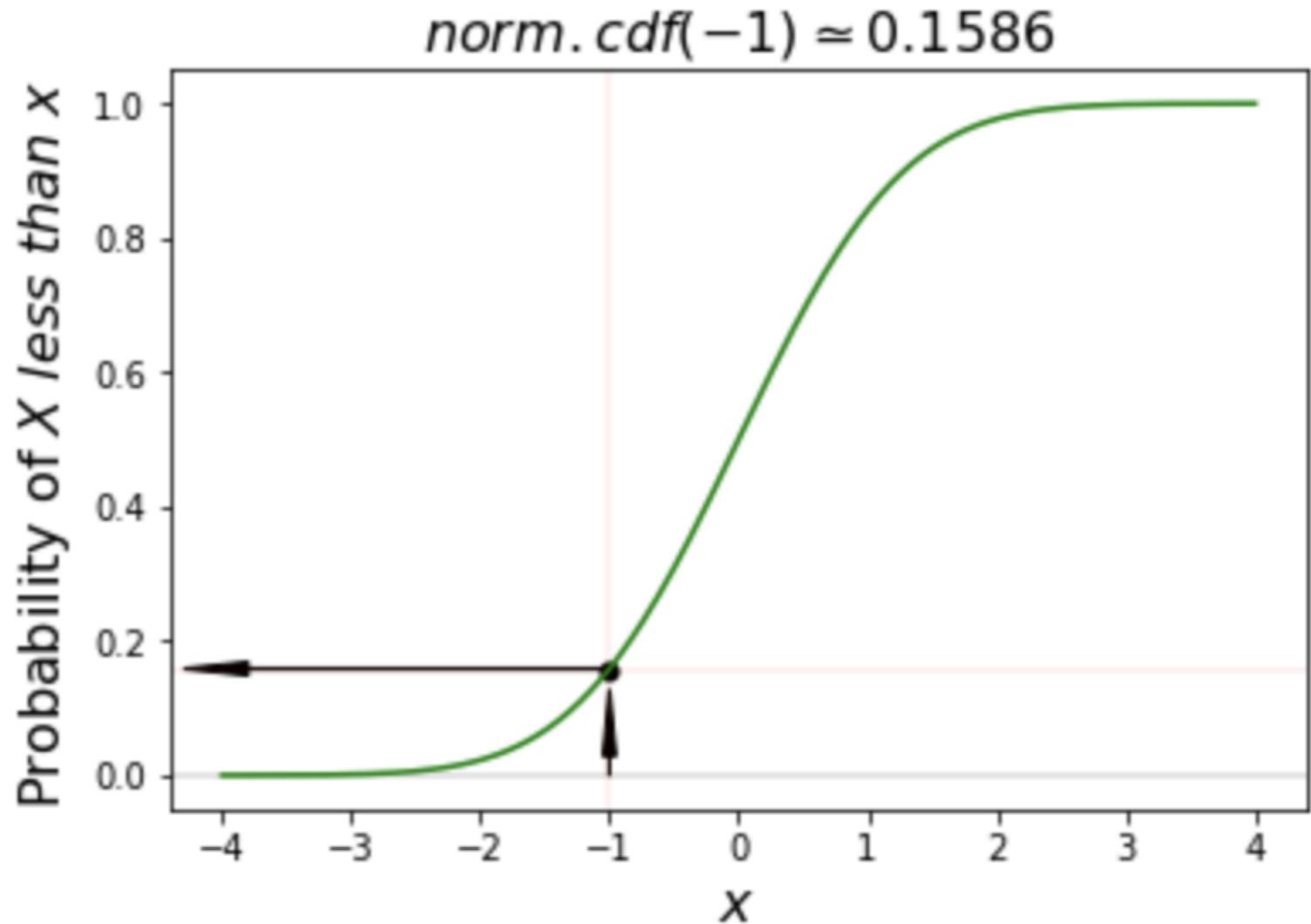
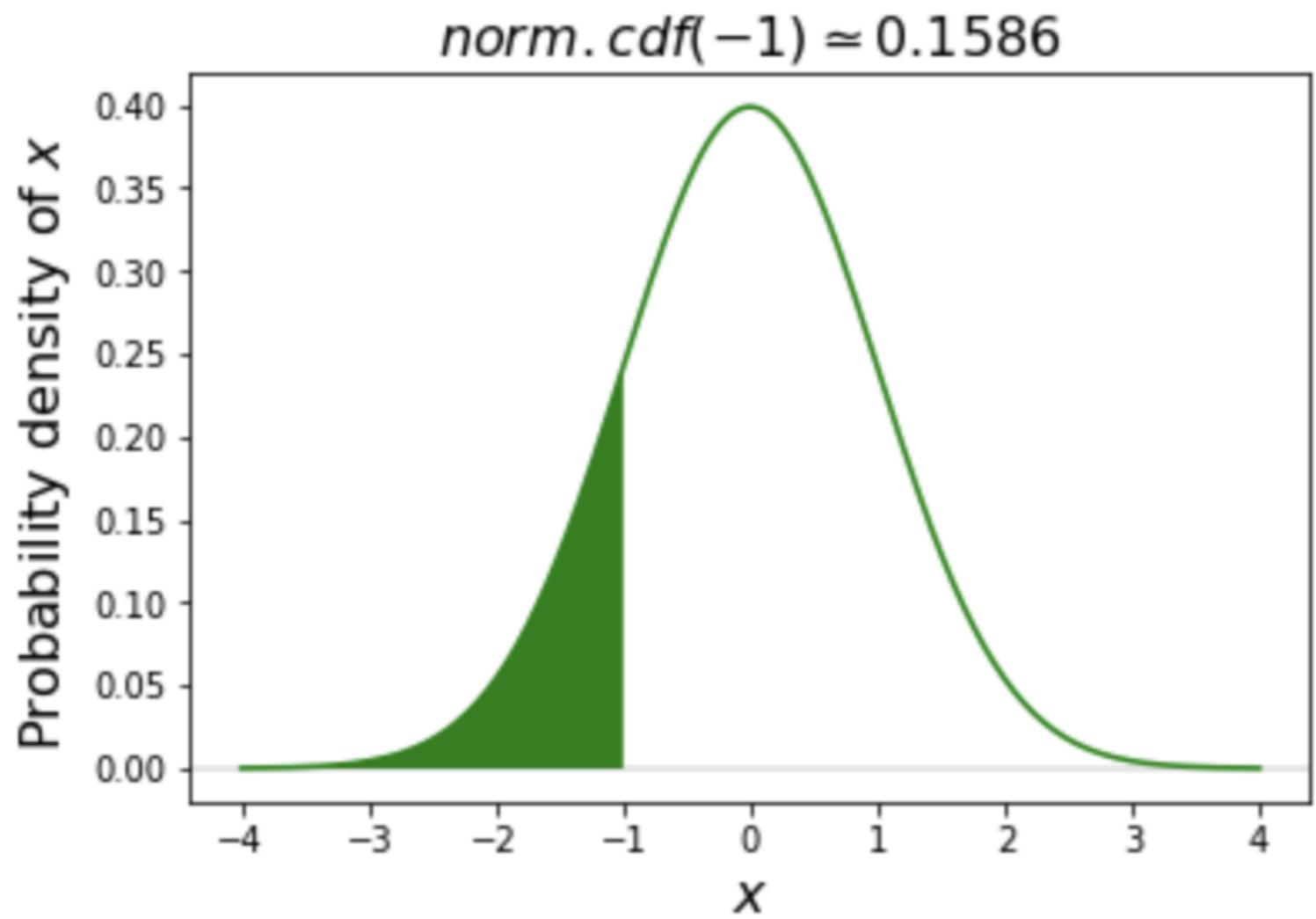
```
# Import norm  
from scipy.stats import norm
```

```
# Calculate the probability density  
# with pdf  
norm.pdf(-1, loc=0, scale=1)
```

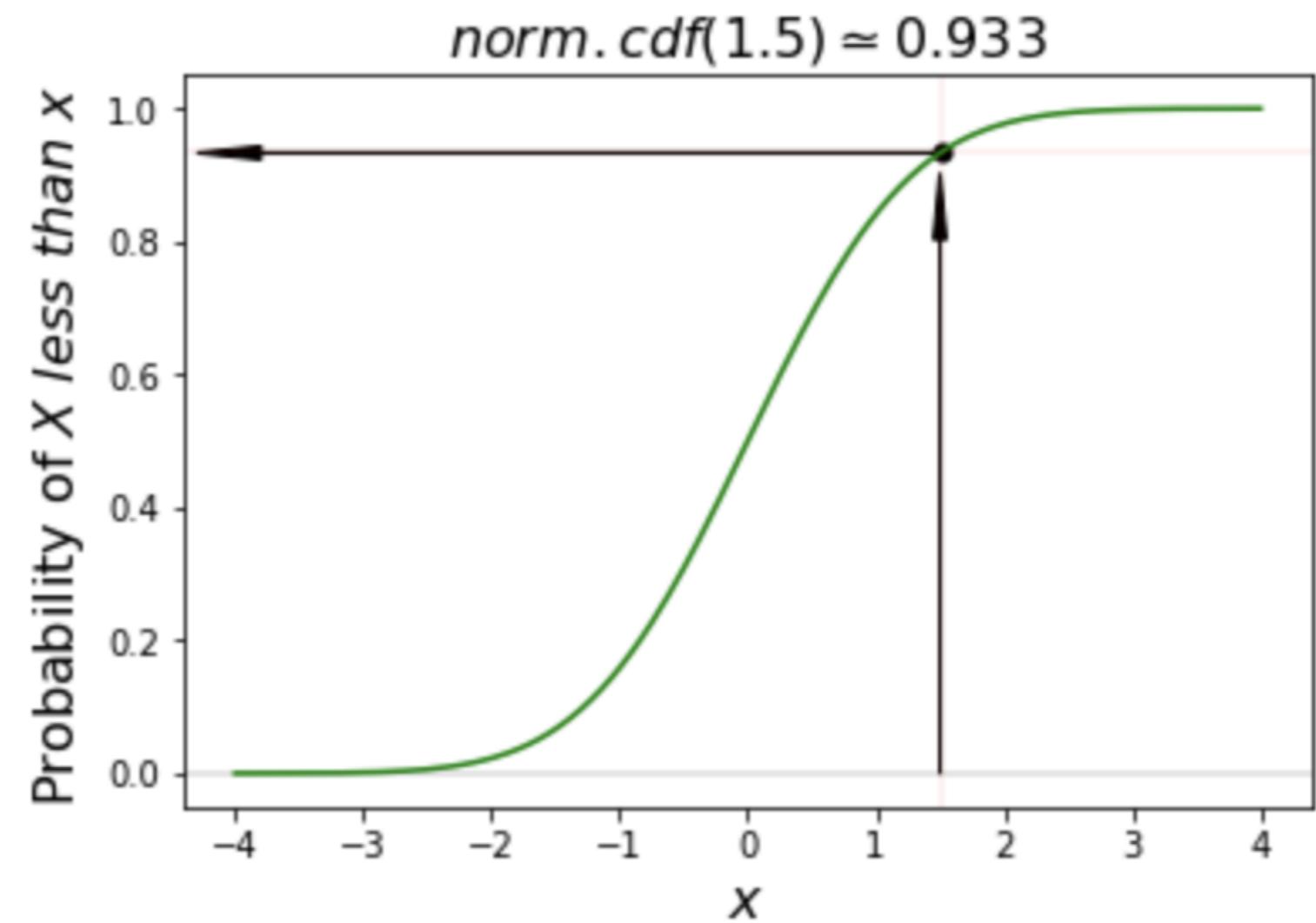
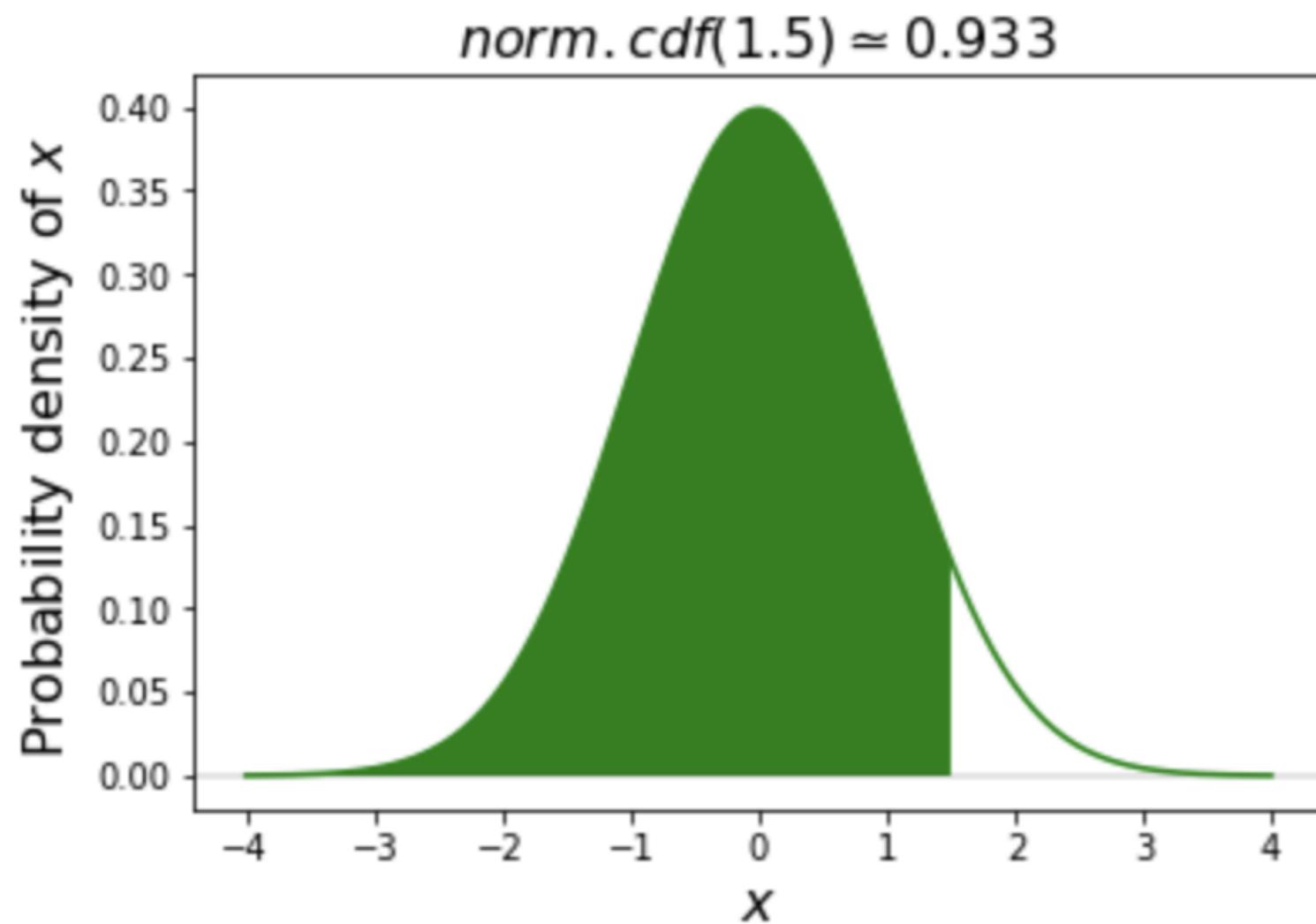
```
0.24197072451914337
```

`loc` parameter specifies the mean and `scale` parameter specifies the standard deviation.

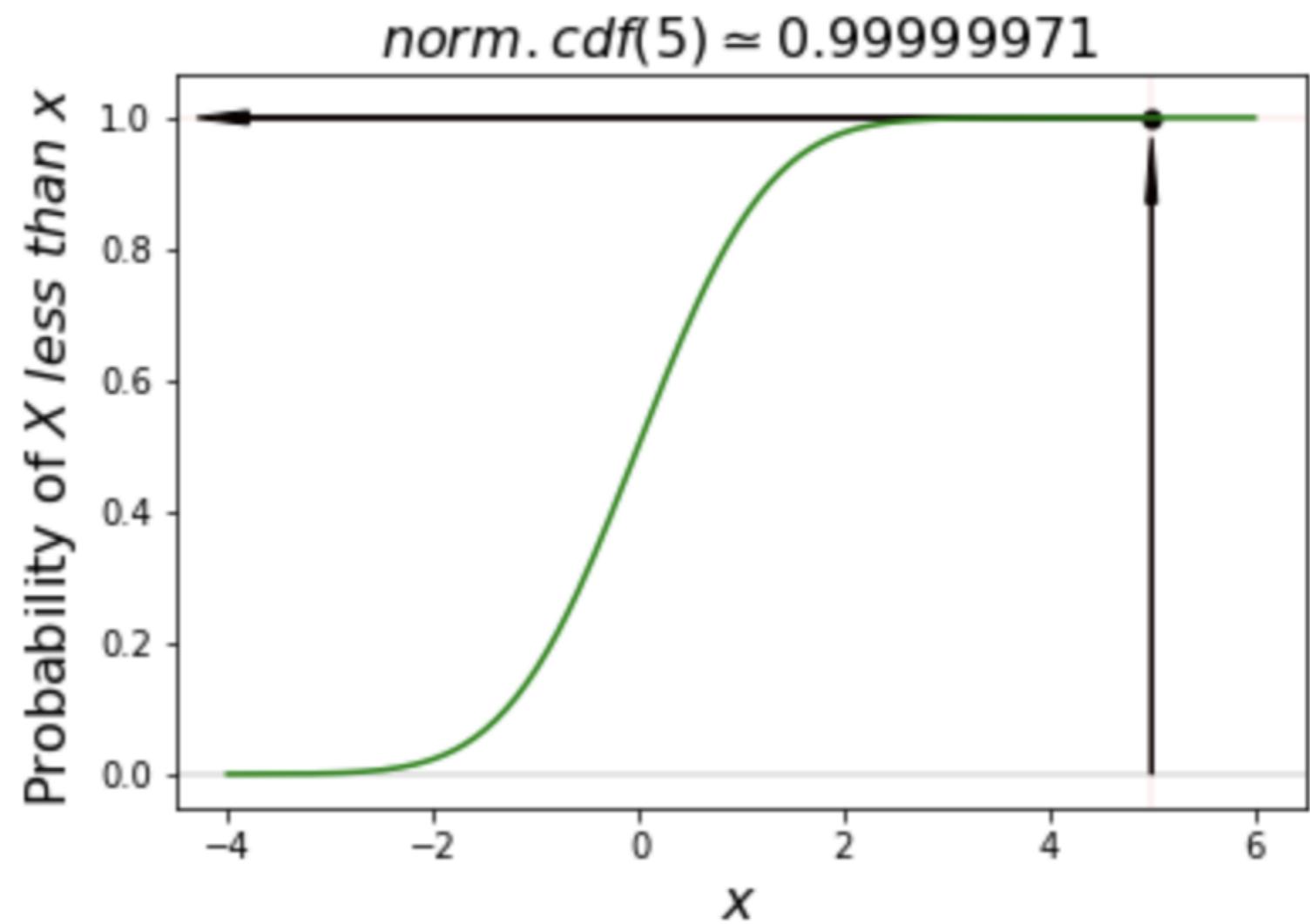
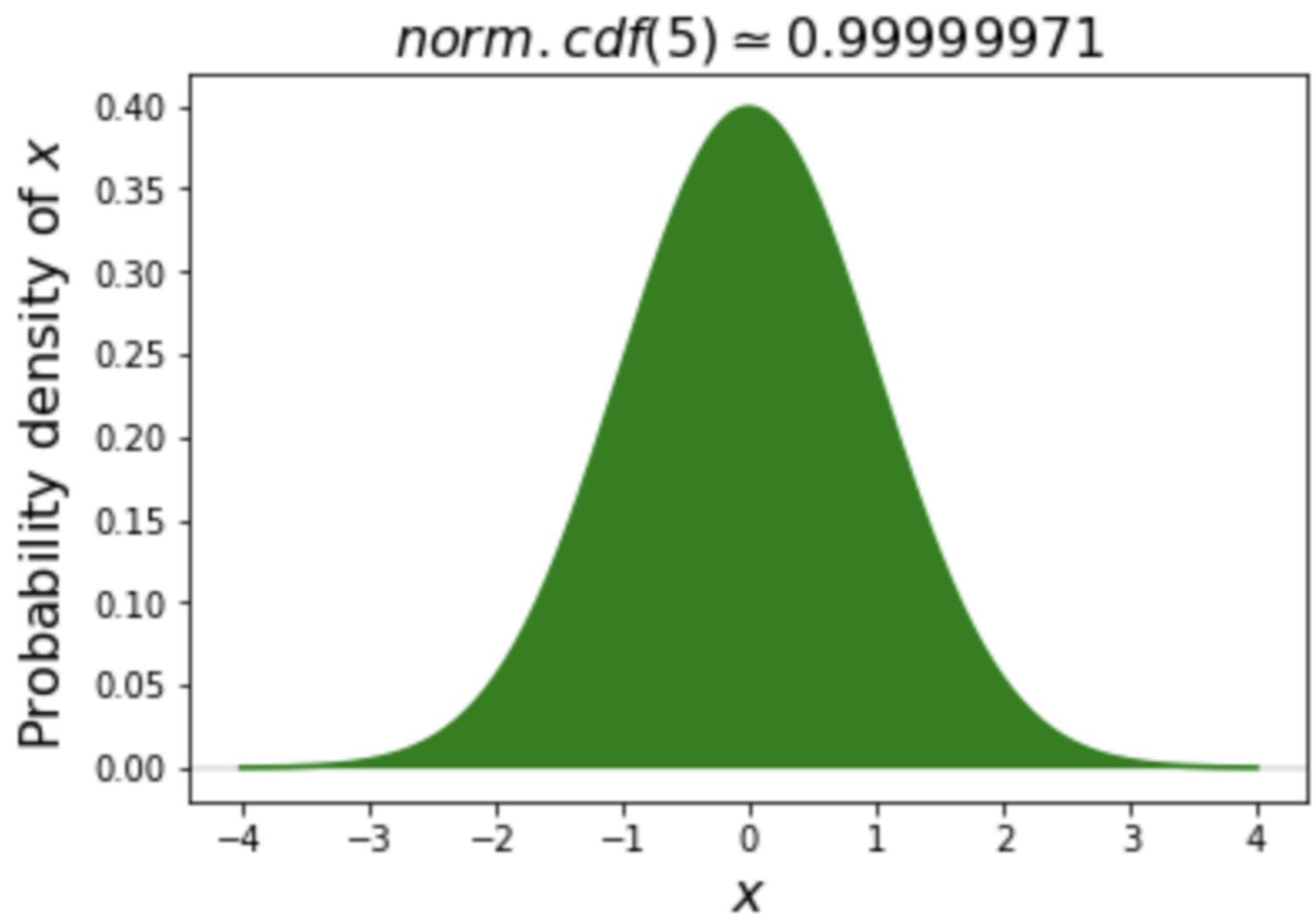
pdf() vs. cdf()



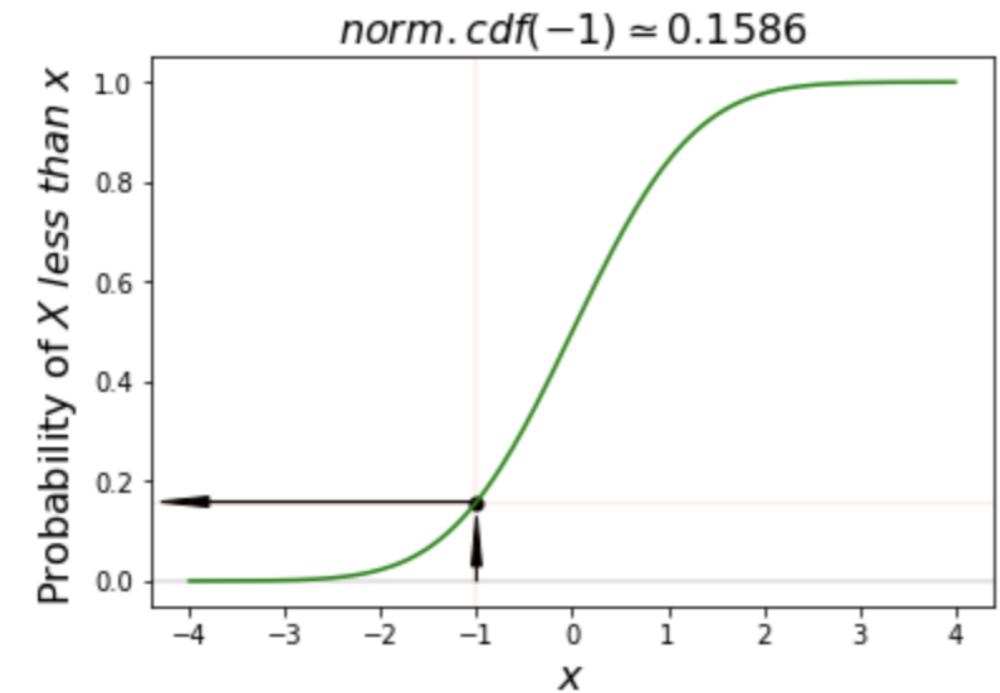
pdf() vs. cdf() (Cont.)



pdf() vs. cdf() (Cont.)

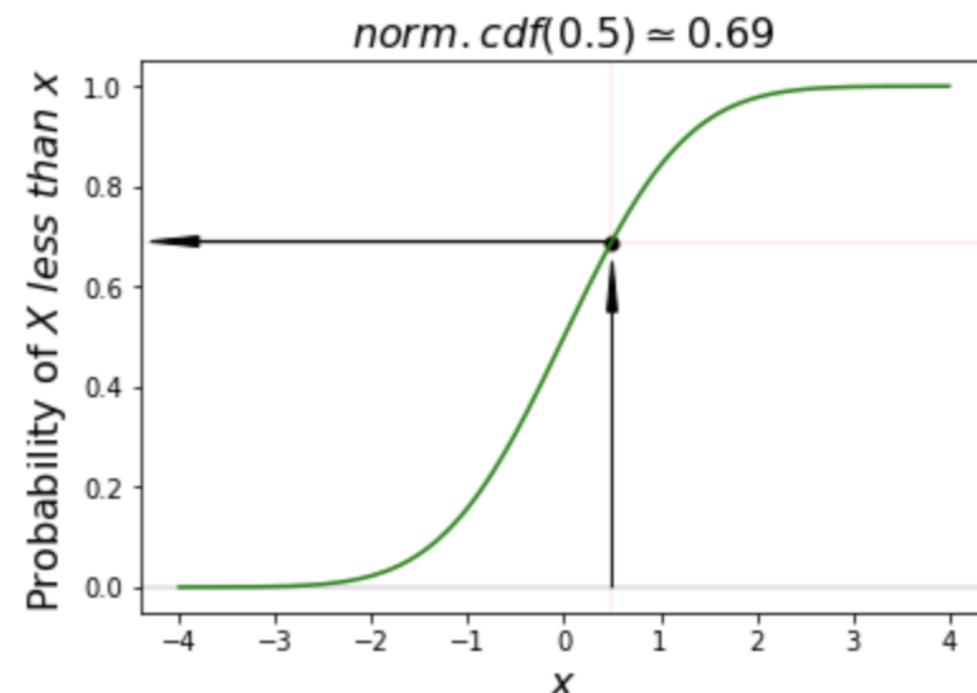


Cumulative distribution function examples



```
# Calculate cdf of -1  
norm.cdf(-1)
```

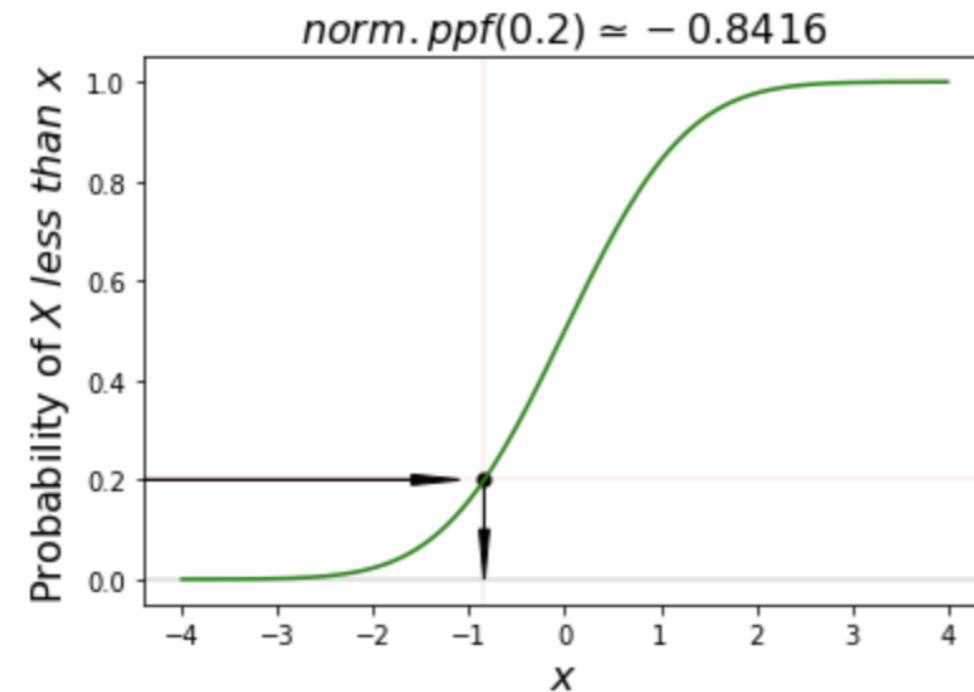
```
0.15865525393145707
```



```
# Calculate cdf of 0.5  
norm.cdf(0.5)
```

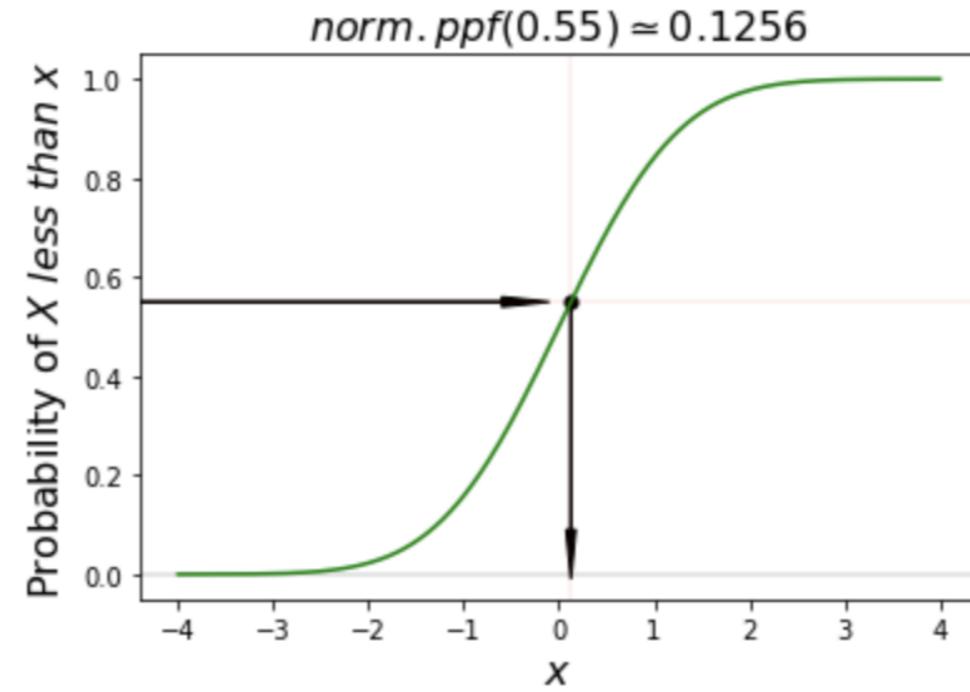
```
0.6914624612740131
```

The percent point function (ppf)



```
# Calculate ppf of 0.2  
norm.ppf(0.2)
```

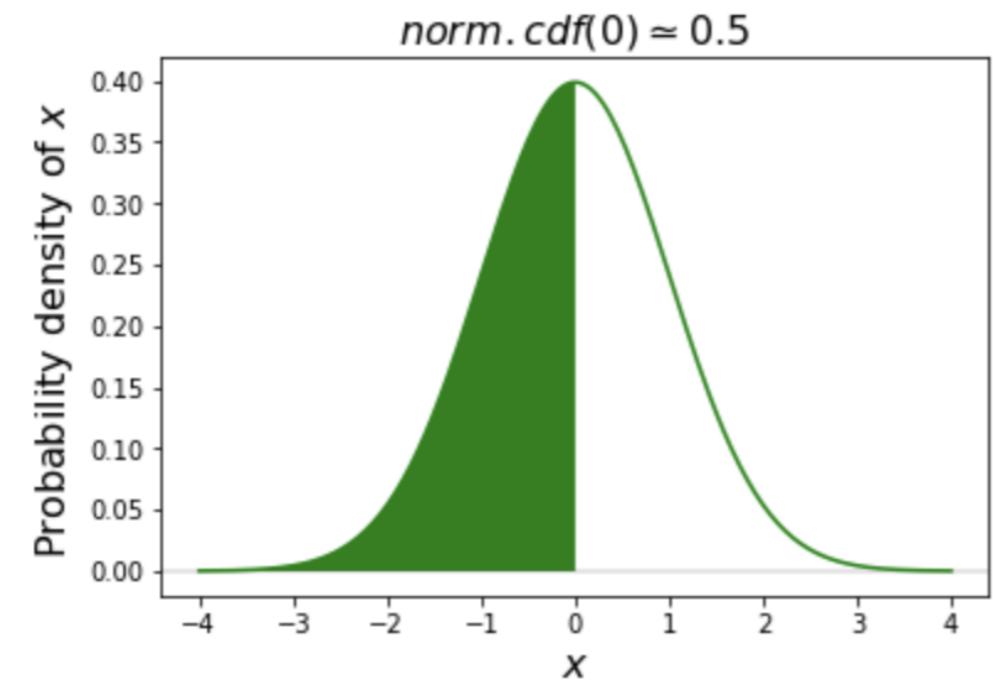
```
-0.8416212335729142
```



```
# Calculate ppf of 55%  
norm.ppf(0.55)
```

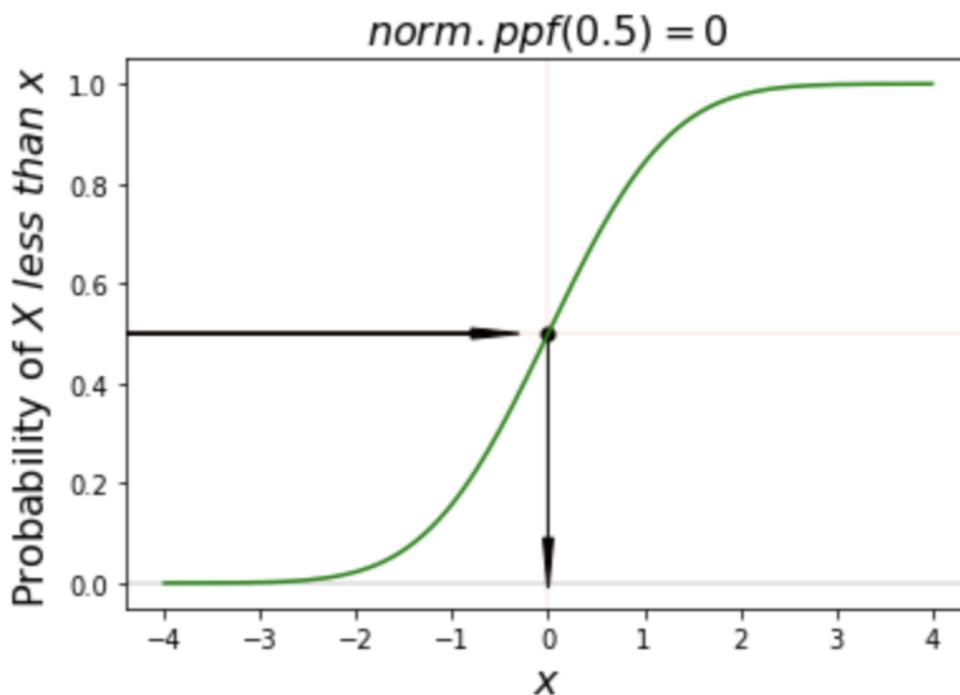
```
0.12566134685507416
```

ppf() is the inverse of cdf()



```
# Calculate cdf of value 0  
norm.cdf(0)
```

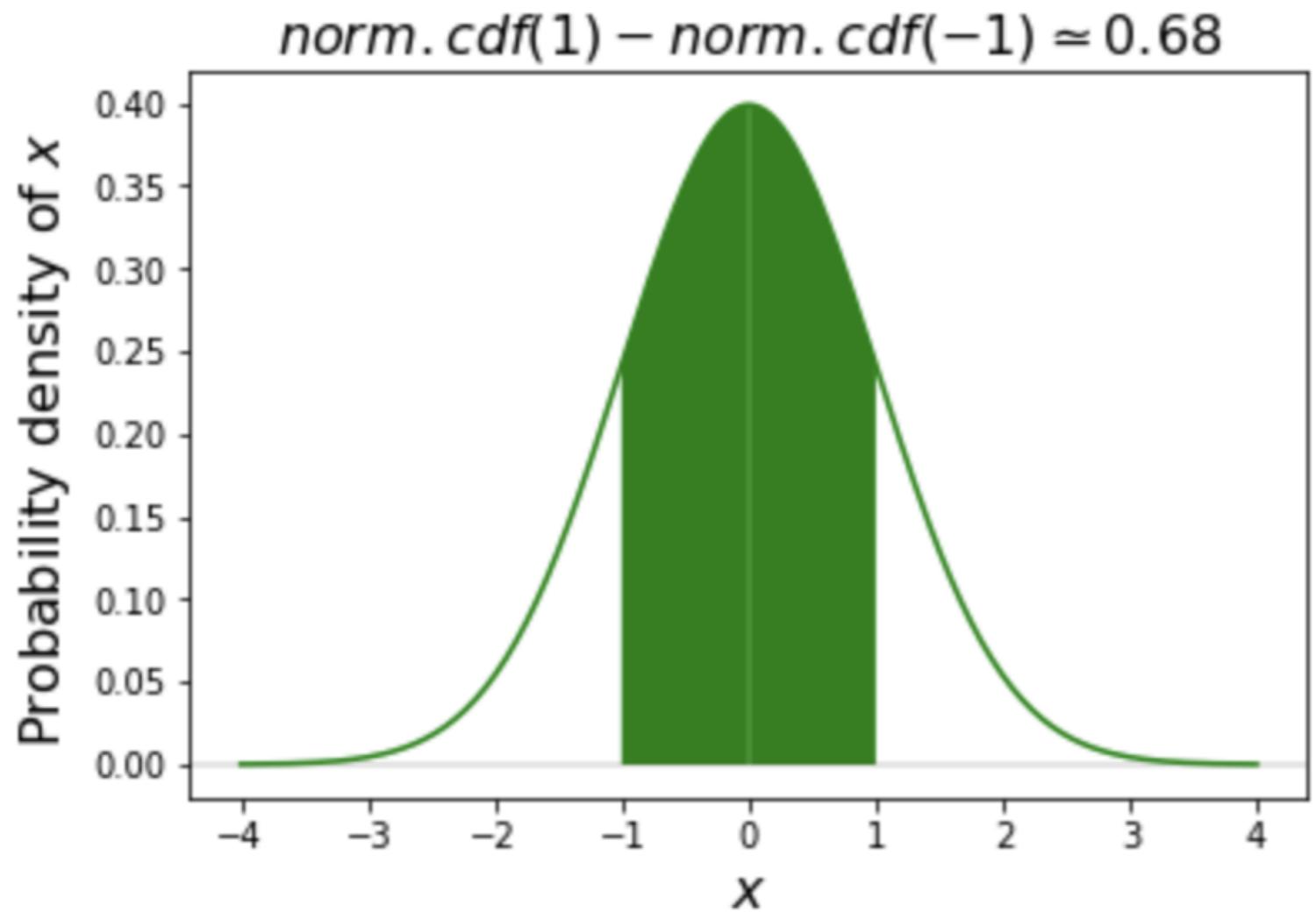
0.5



```
# Calculate ppf of probability 50%  
norm.ppf(0.5)
```

0

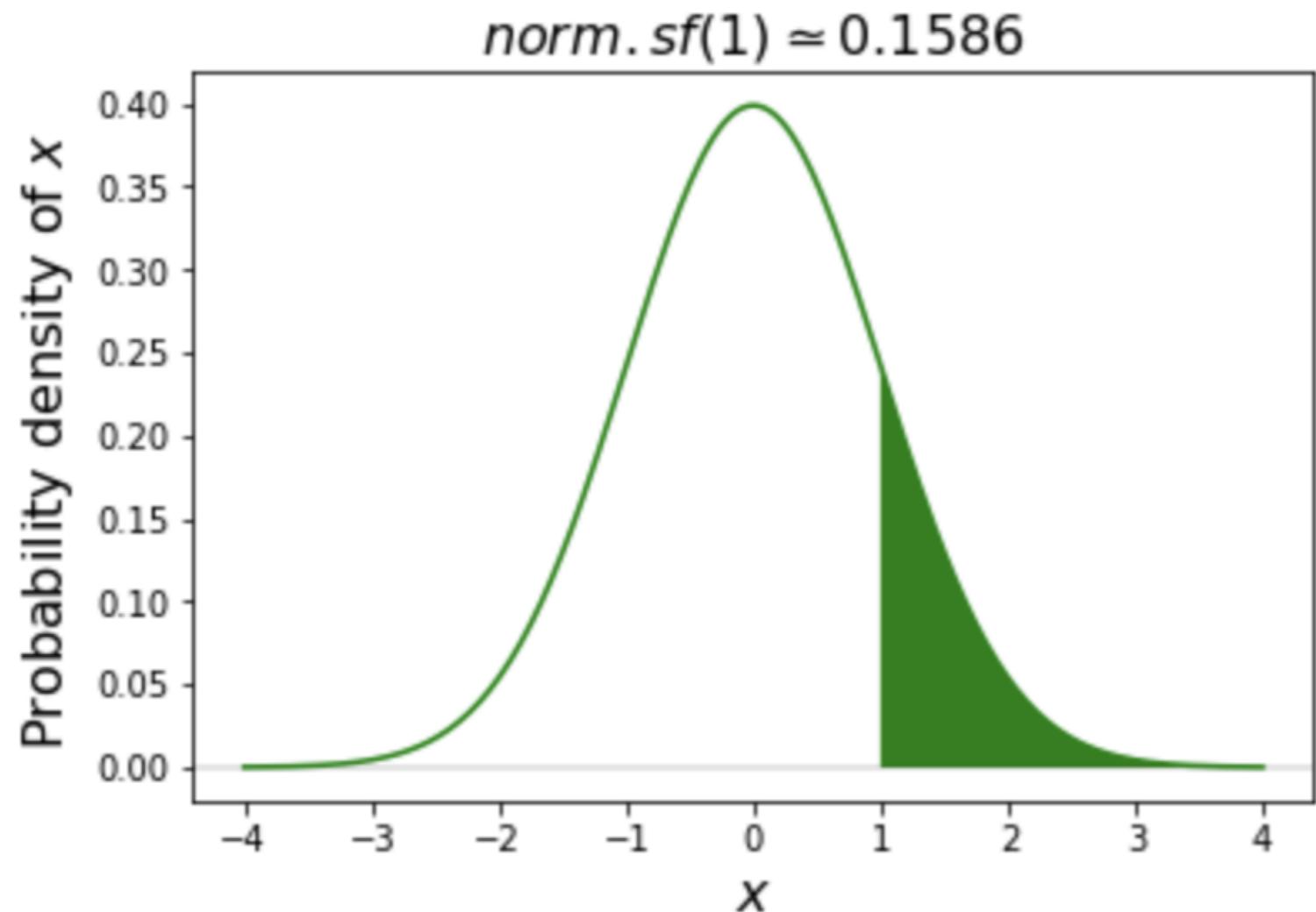
Probability between two values



```
# Create our variables  
a = -1  
b = 1  
  
# Calculate the probability between  
# two values, subtracting  
norm.cdf(b) - norm.cdf(a)
```

0.6826894921370859

Tail probability



```
# Create our variable
```

```
a = 1
```

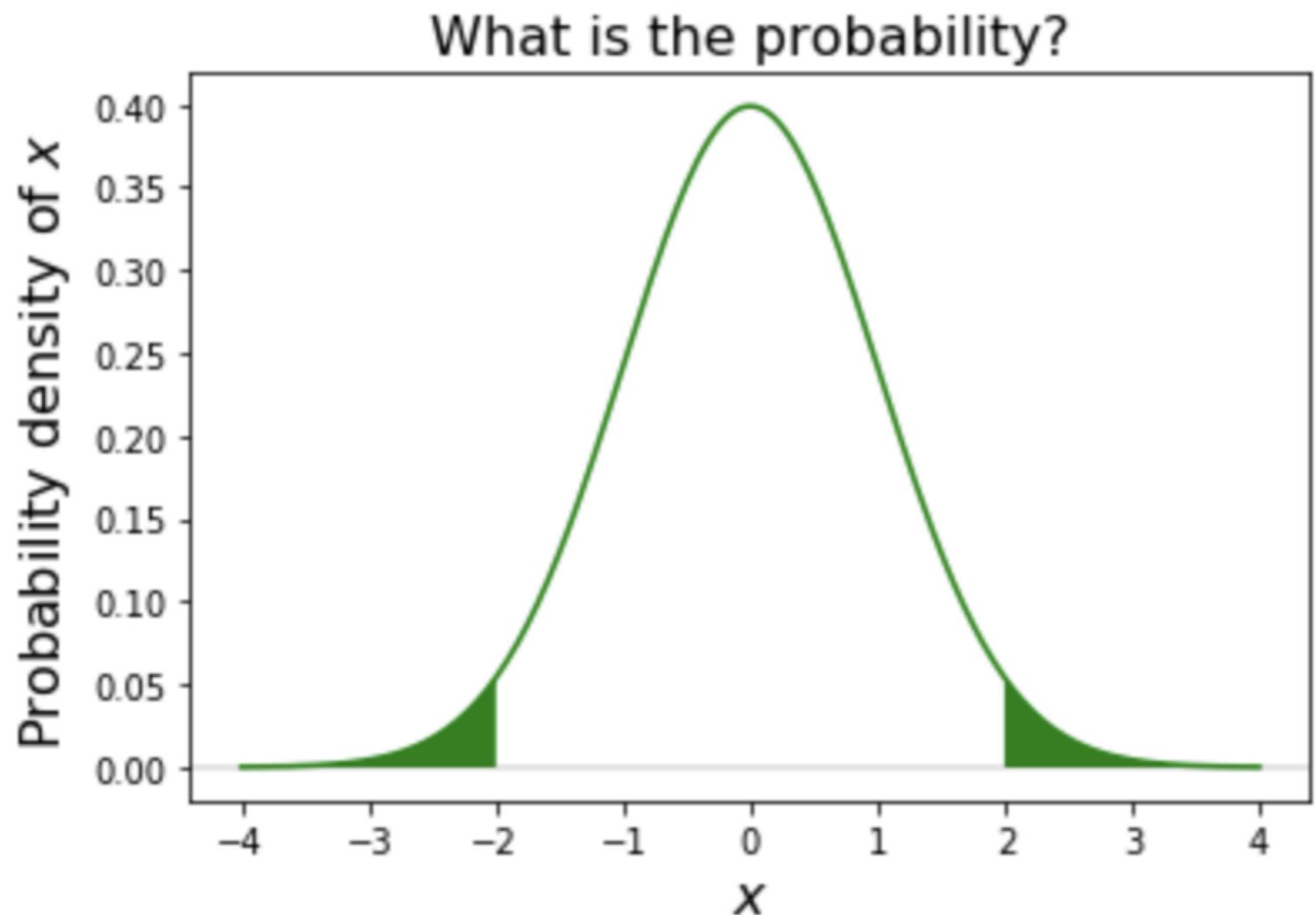
```
# Calculate the complement
```

```
# of cdf() using sf()
```

```
norm.sf(a)
```

```
0.15865525393145707
```

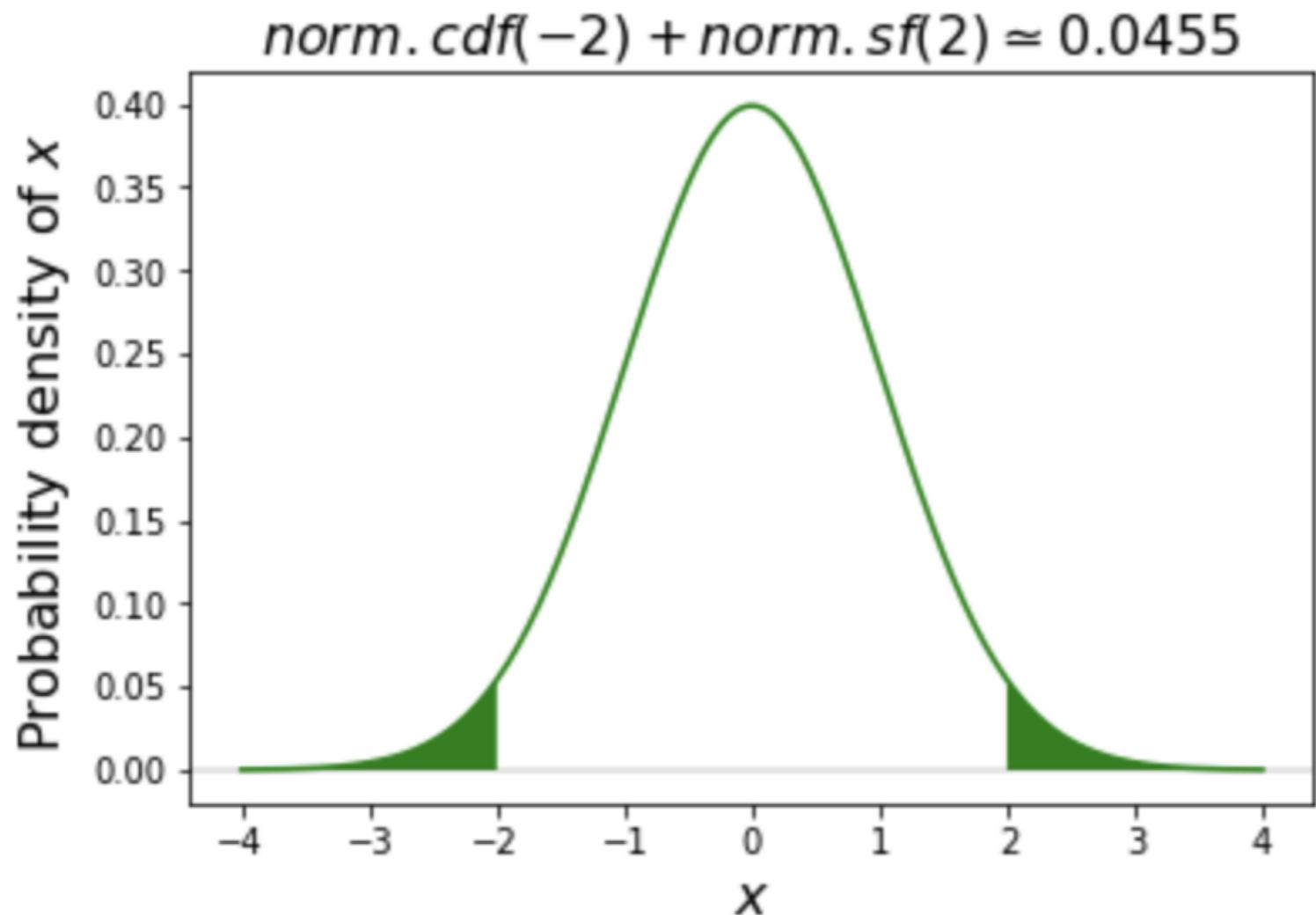
Tails



```
# Create our variables  
a = -2  
b = 2  
# Calculate tail probability  
# by adding each tail  
norm.cdf(a) + norm.sf(b)
```

```
0.04550026389635839
```

Tails (Cont.)



```
# Create our variables
```

```
a = -2
```

```
b = 2
```

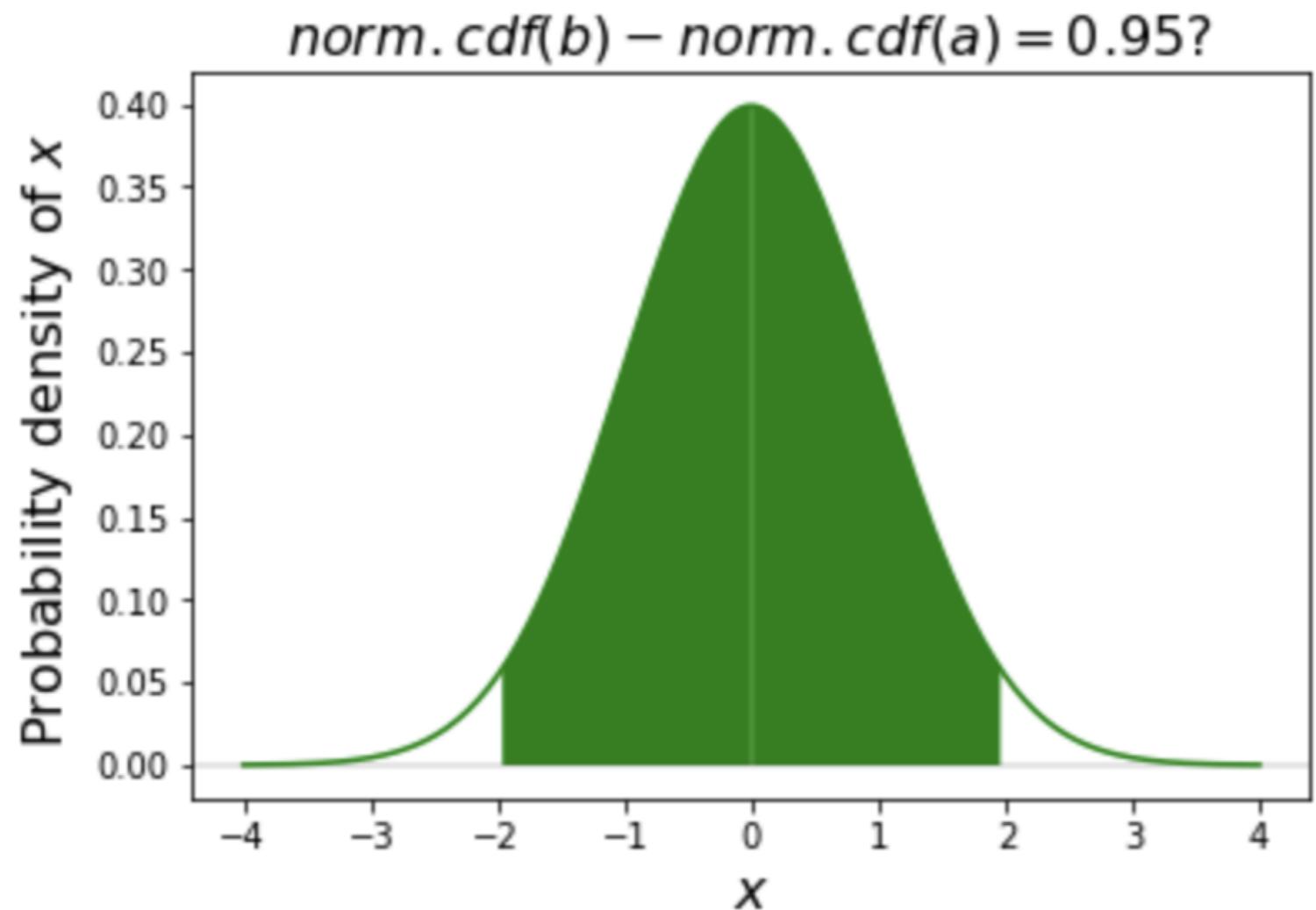
```
# Calculate tail probability
```

```
# by adding each tail
```

```
norm.cdf(a) + norm.sf(b)
```

```
0.04550026389635839
```

Intervals



```
# Create our variable
```

```
alpha = 0.95
```

```
# Calculate the interval
```

```
norm.interval(alpha)
```

```
(-1.959963984540054, 1.959963984540054)
```

On to some practice!

FOUNDATIONS OF PROBABILITY IN PYTHON

Poisson distributions

FOUNDATIONS OF PROBABILITY IN PYTHON

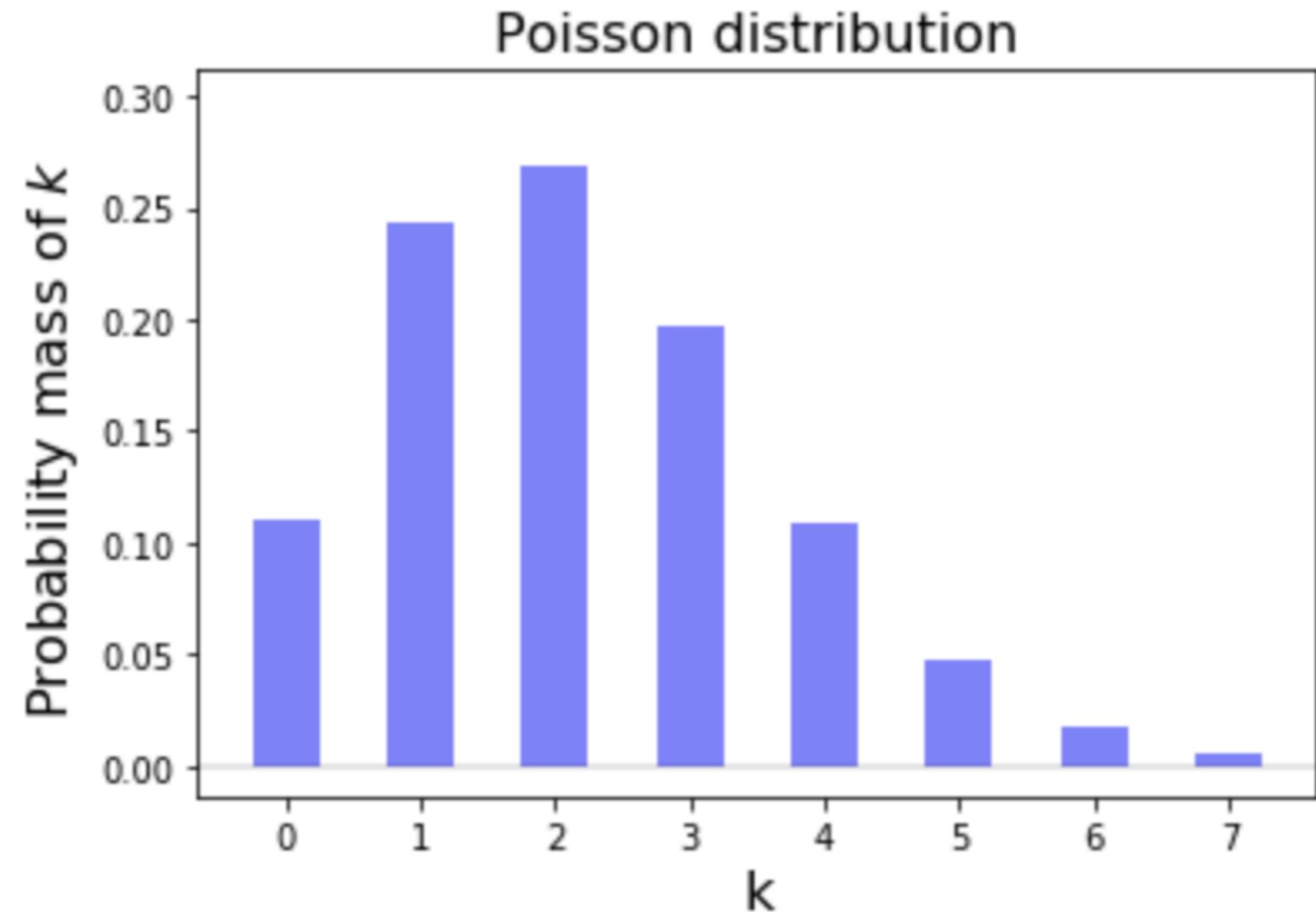


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Poisson modeling



Poisson distribution properties



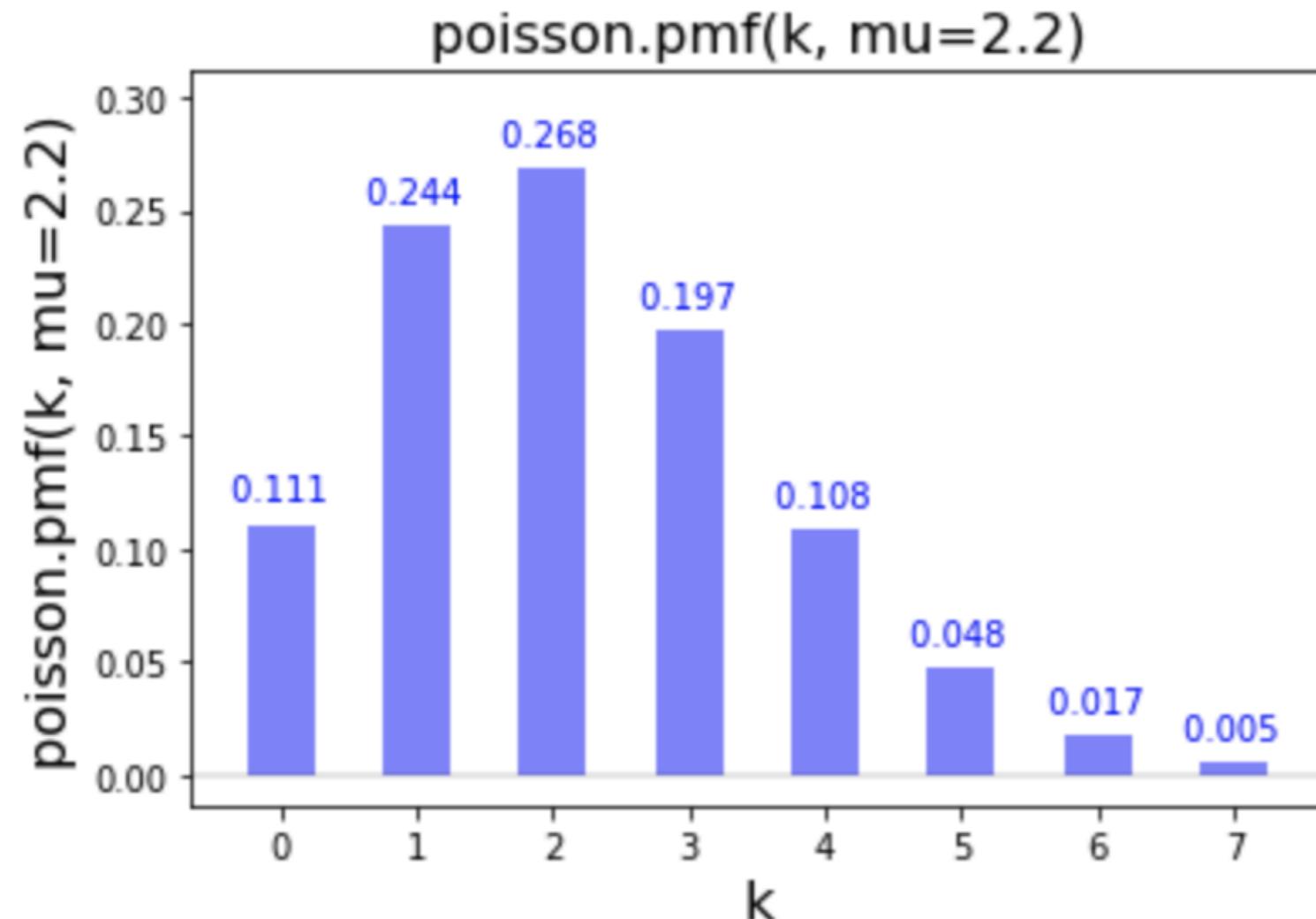
Probability mass function (pmf)



Imagine you have 2.2 calls per minute.

Probability mass function (pmf) (Cont.)

In Python we do the following:



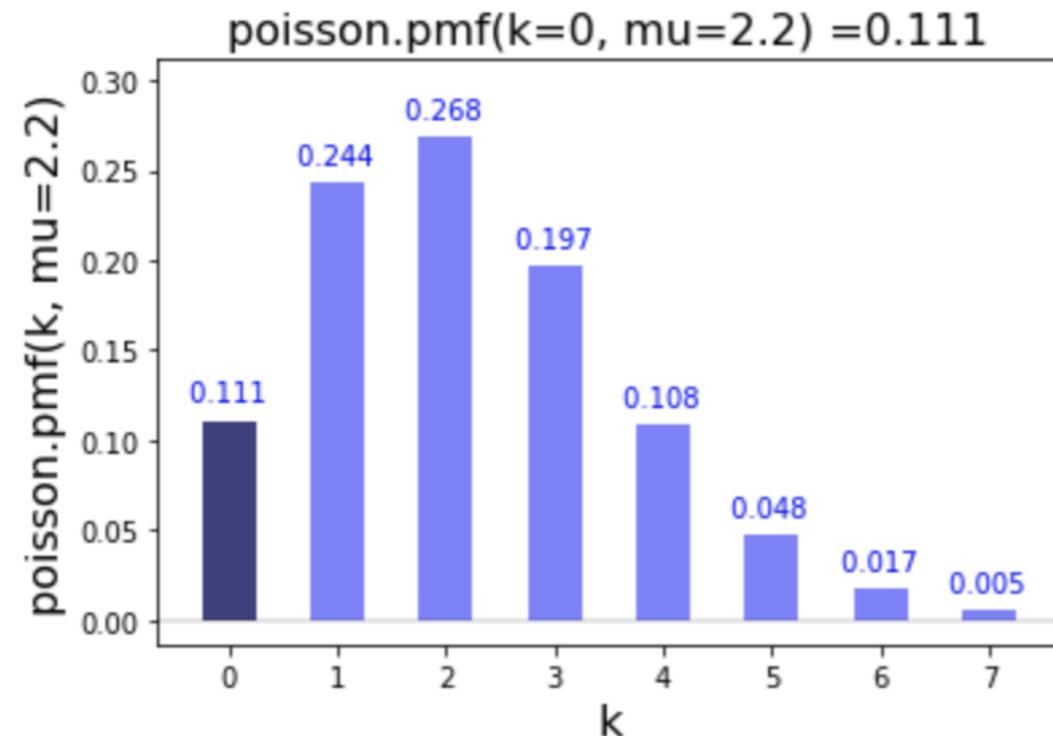
```
# Import poisson  
from scipy.stats import poisson
```

```
# Calculate the probability mass  
# with pmf  
poisson.pmf(k=3, mu=2.2)
```

```
0.19663867170702193
```

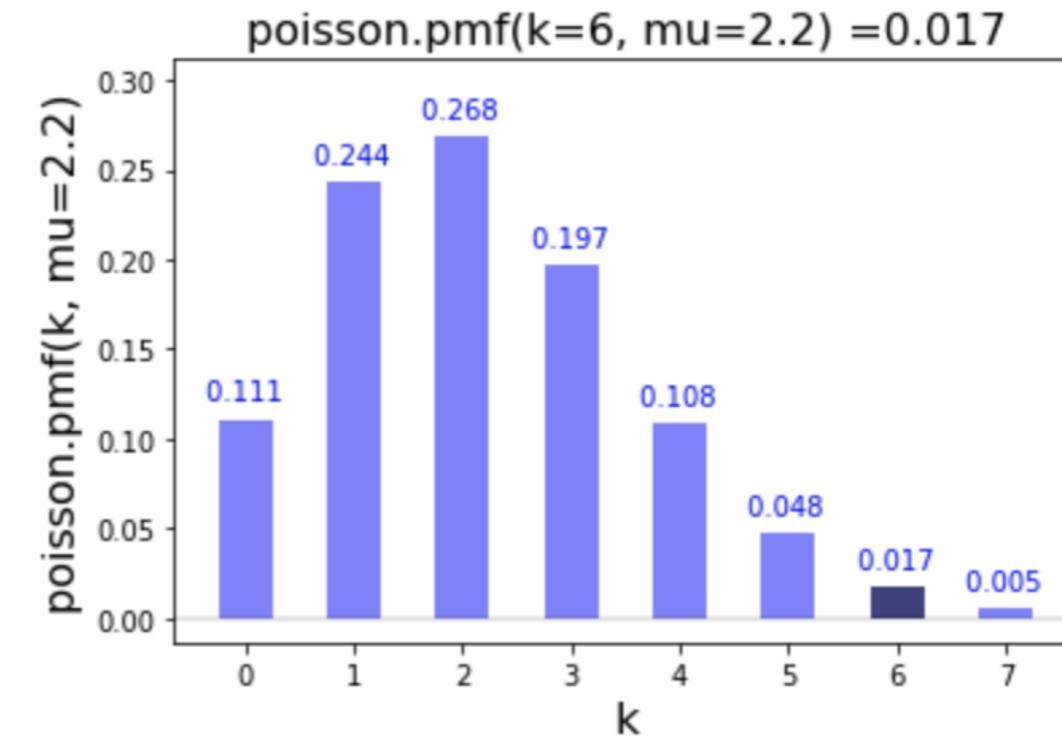
mu parameter specifies the mean of successful

pmf examples



```
# Calculate pmf of 0  
poisson.pmf(k=0, mu=2.2)
```

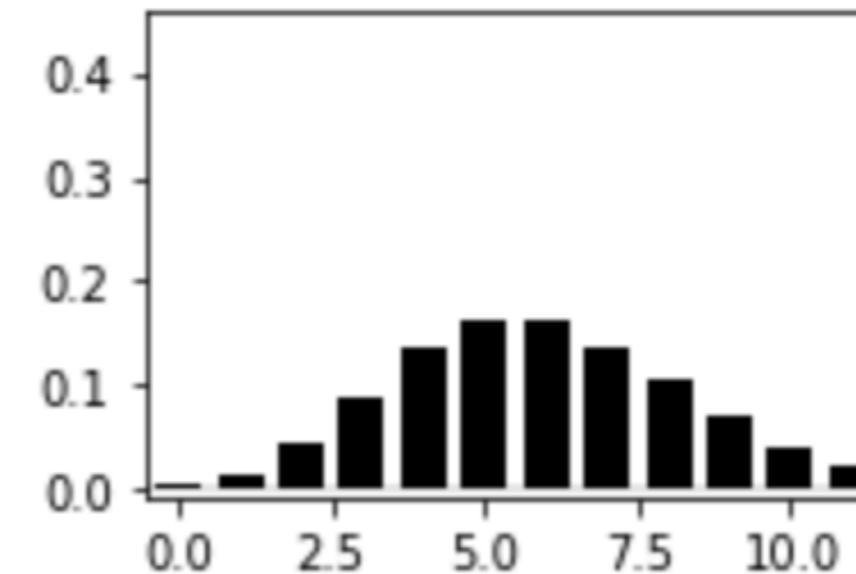
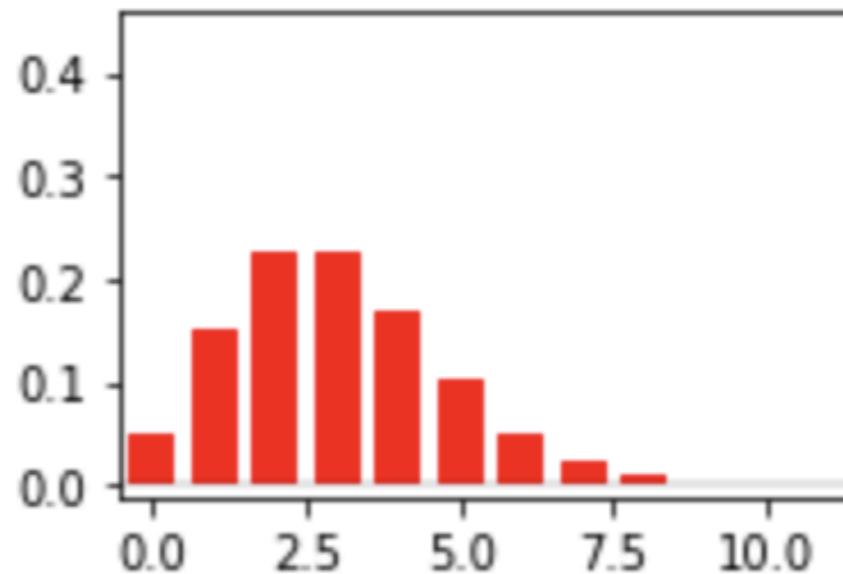
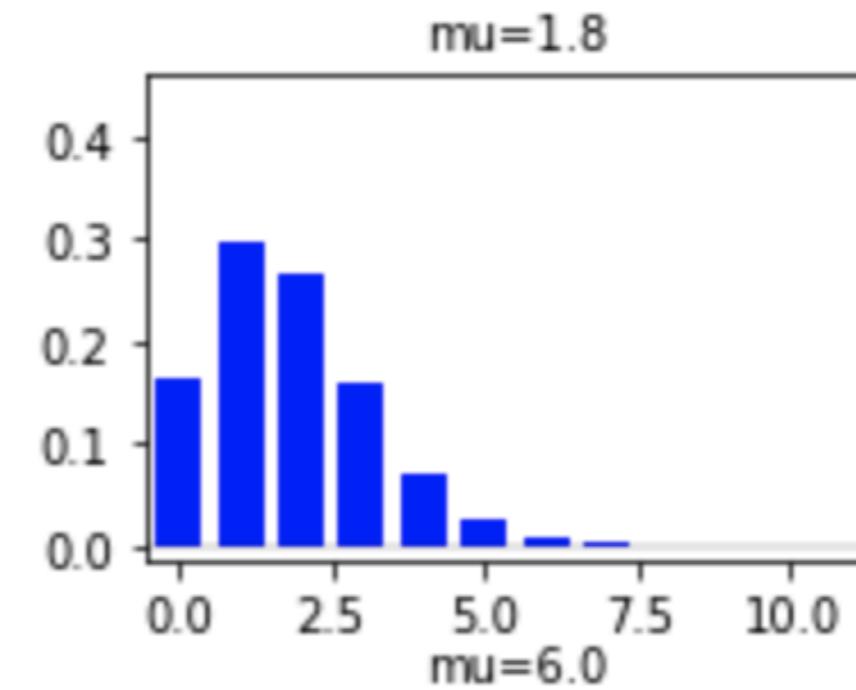
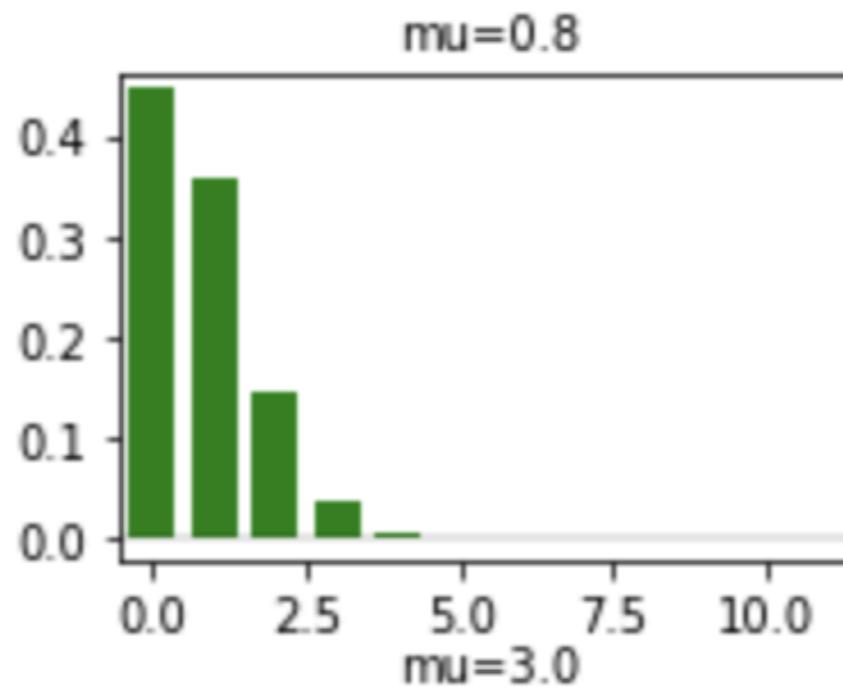
```
0.11080315836233387
```



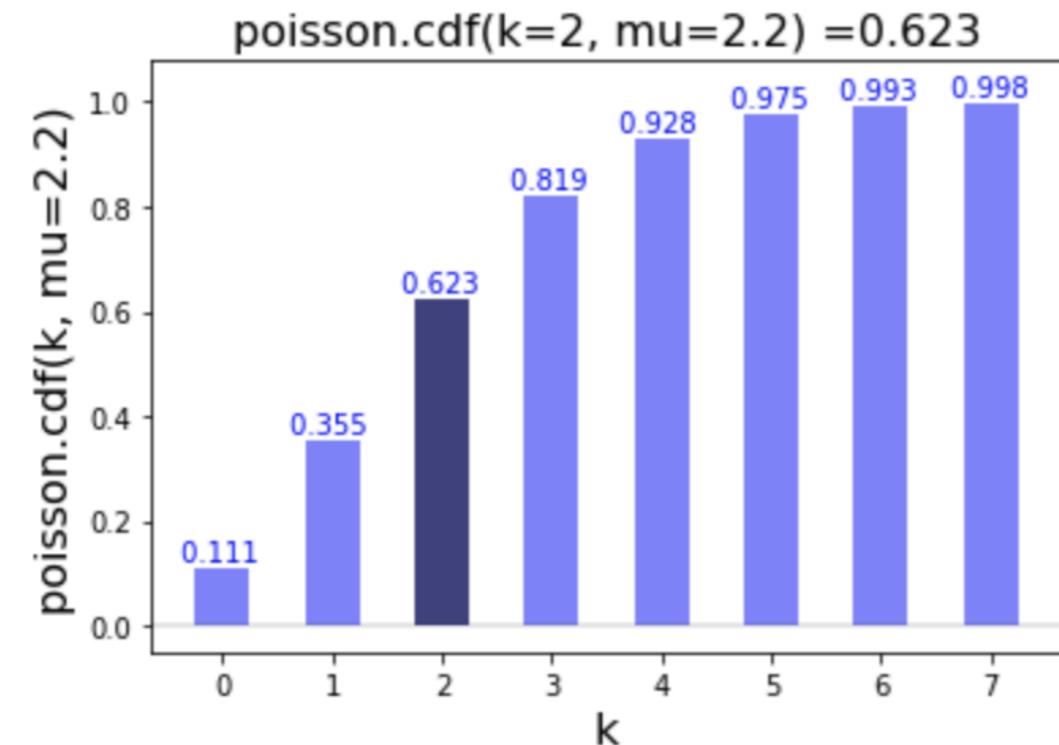
```
# Calculate pmf of 6  
poisson.pmf(k=6, mu=2.2)
```

```
0.01744840480280308
```

Different means

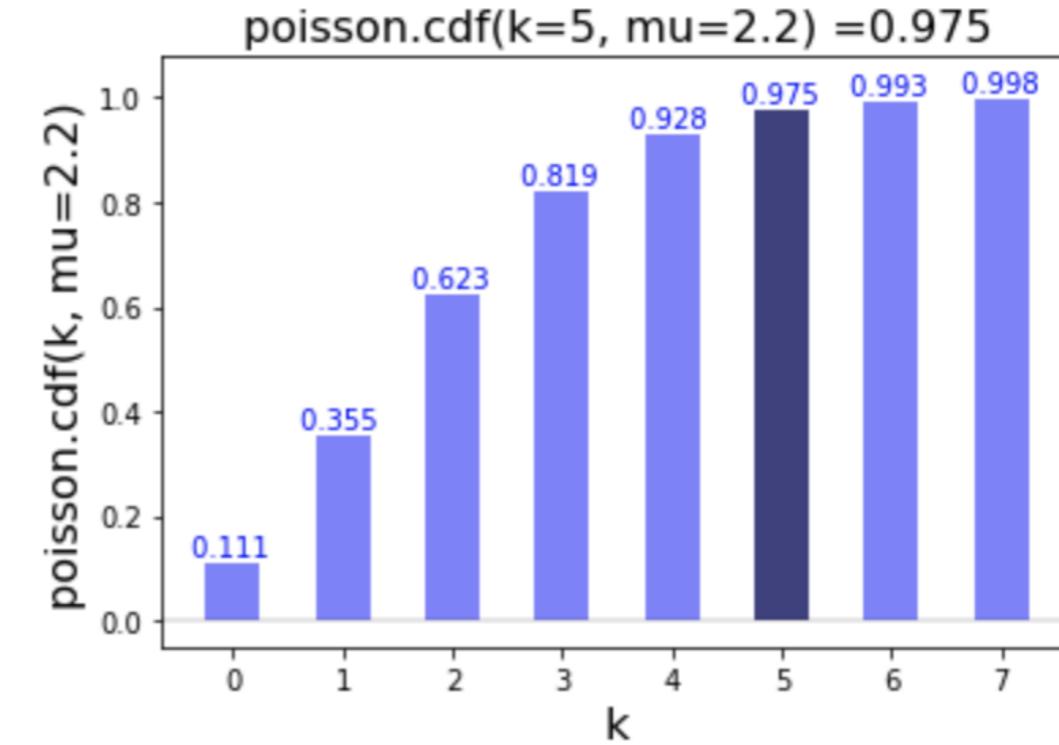


Cumulative distribution function (cdf)



```
# Calculate cdf of 2  
poisson.cdf(k=2, mu=2.2)
```

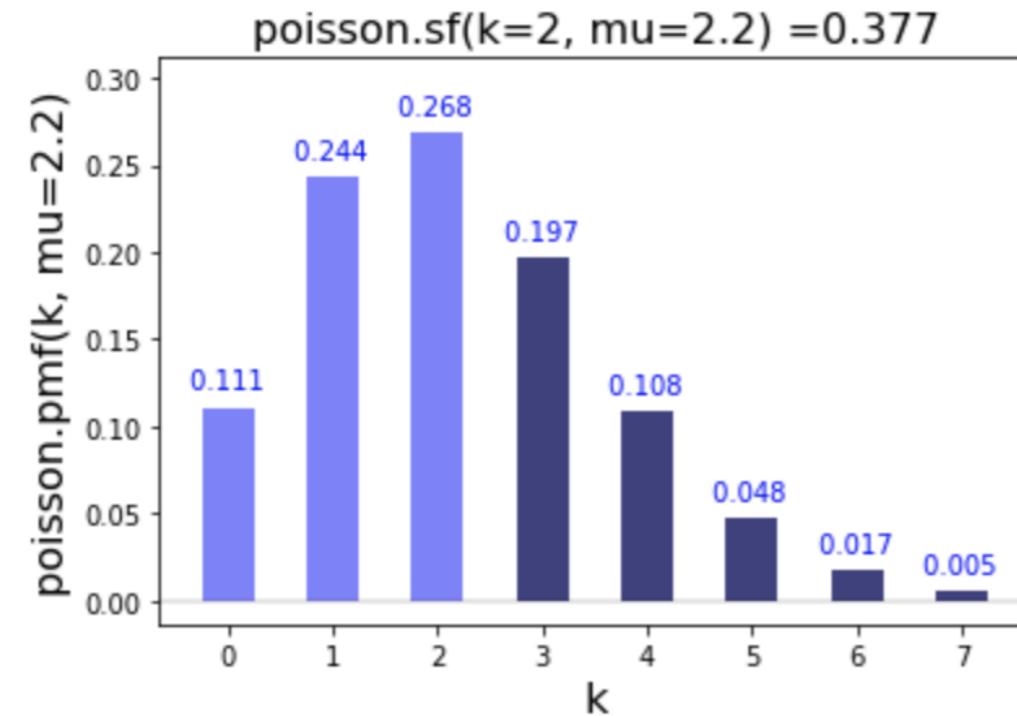
```
0.6227137499963162
```



```
# Calculate cdf of 5  
poisson.cdf(k=5, mu=2.2)
```

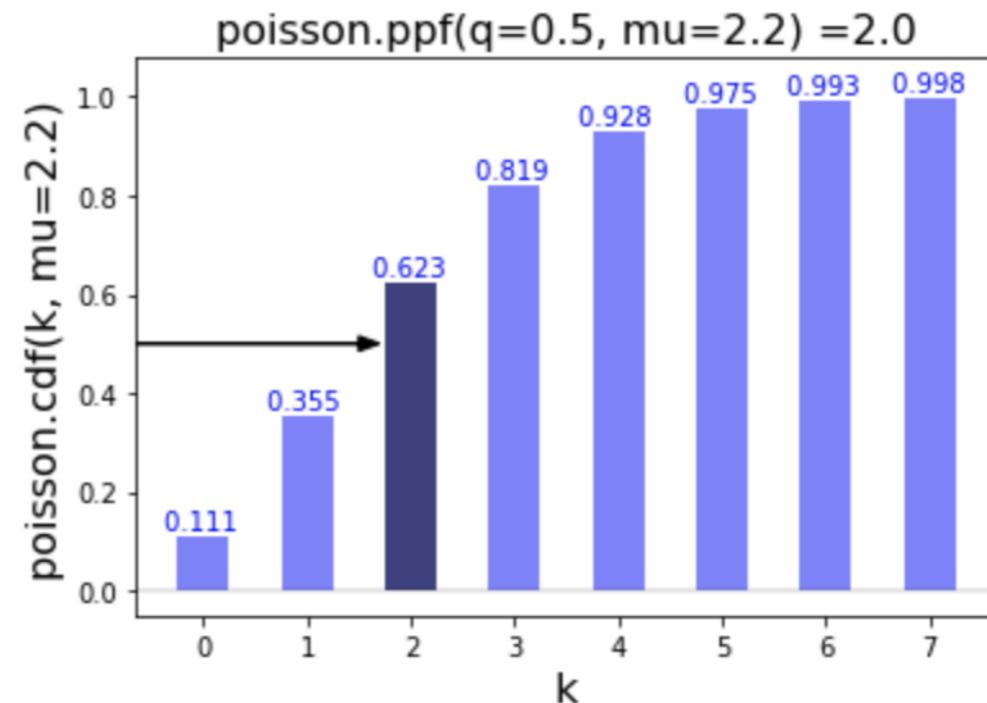
```
0.9750902496952996
```

Survival function and percent point function (ppf)



```
# Calculate sf of 2  
poisson.sf(k=2, mu=2.2)
```

```
0.3772862500036838
```



```
# Calculate ppf of 0.5  
poisson.ppf(q=0.5, mu=2.2)
```

```
2.0
```

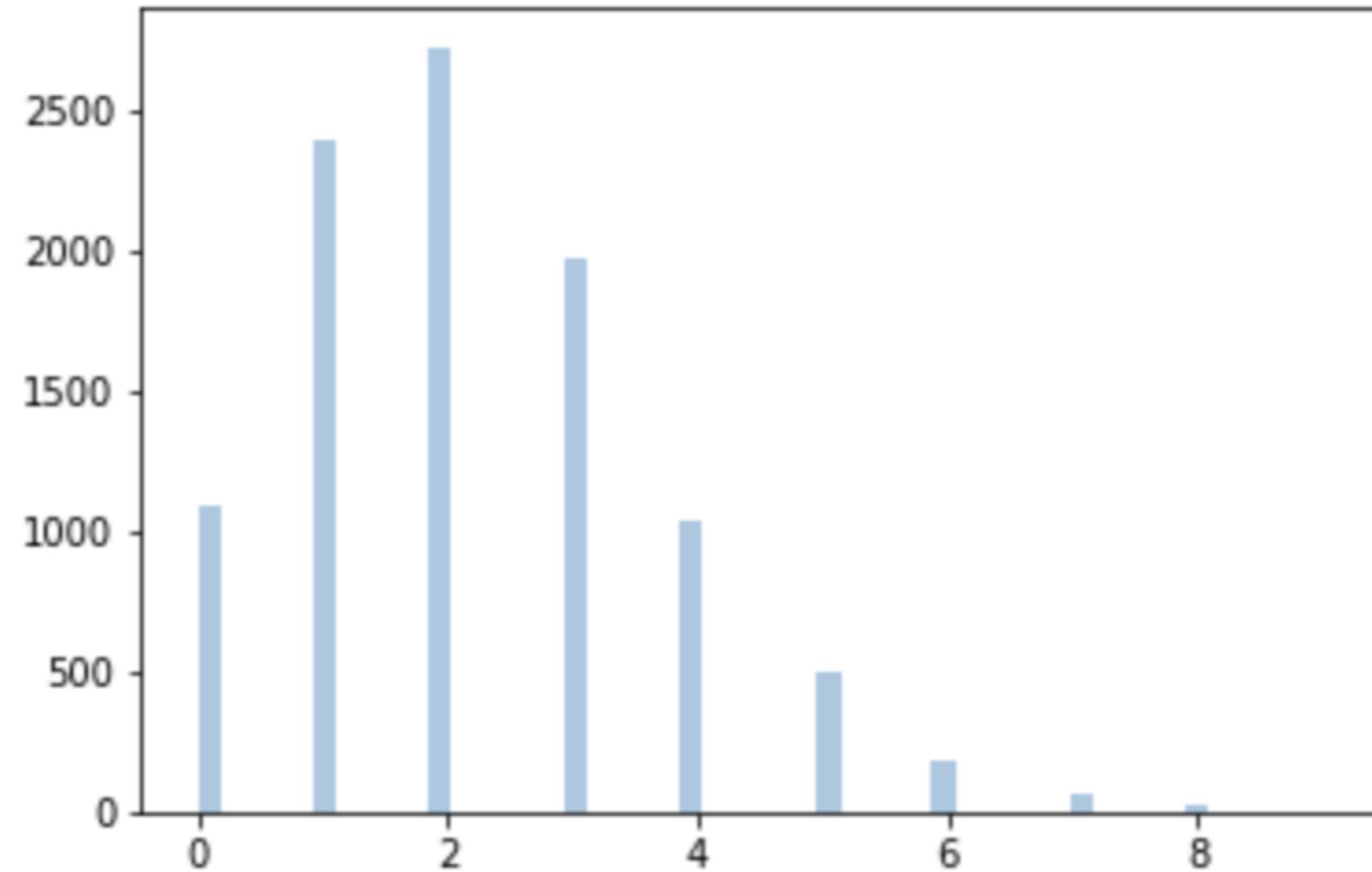
Sample generation (rvs)

```
# Import poisson, matplotlib.pyplot, and seaborn
from scipy.stats import poisson
import matplotlib.pyplot as plt
import seaborn as sns
```

```
# Create the sample using poisson.rvs()
sample = poisson.rvs(mu=2.2, size=10000, random_state=13)
```

```
# Plot the sample
sns.distplot(sample, kde=False)
plt.show()
```

Sample generation (Cont.)



Let's practice with Poisson

FOUNDATIONS OF PROBABILITY IN PYTHON

Geometric distributions

FOUNDATIONS OF PROBABILITY IN PYTHON

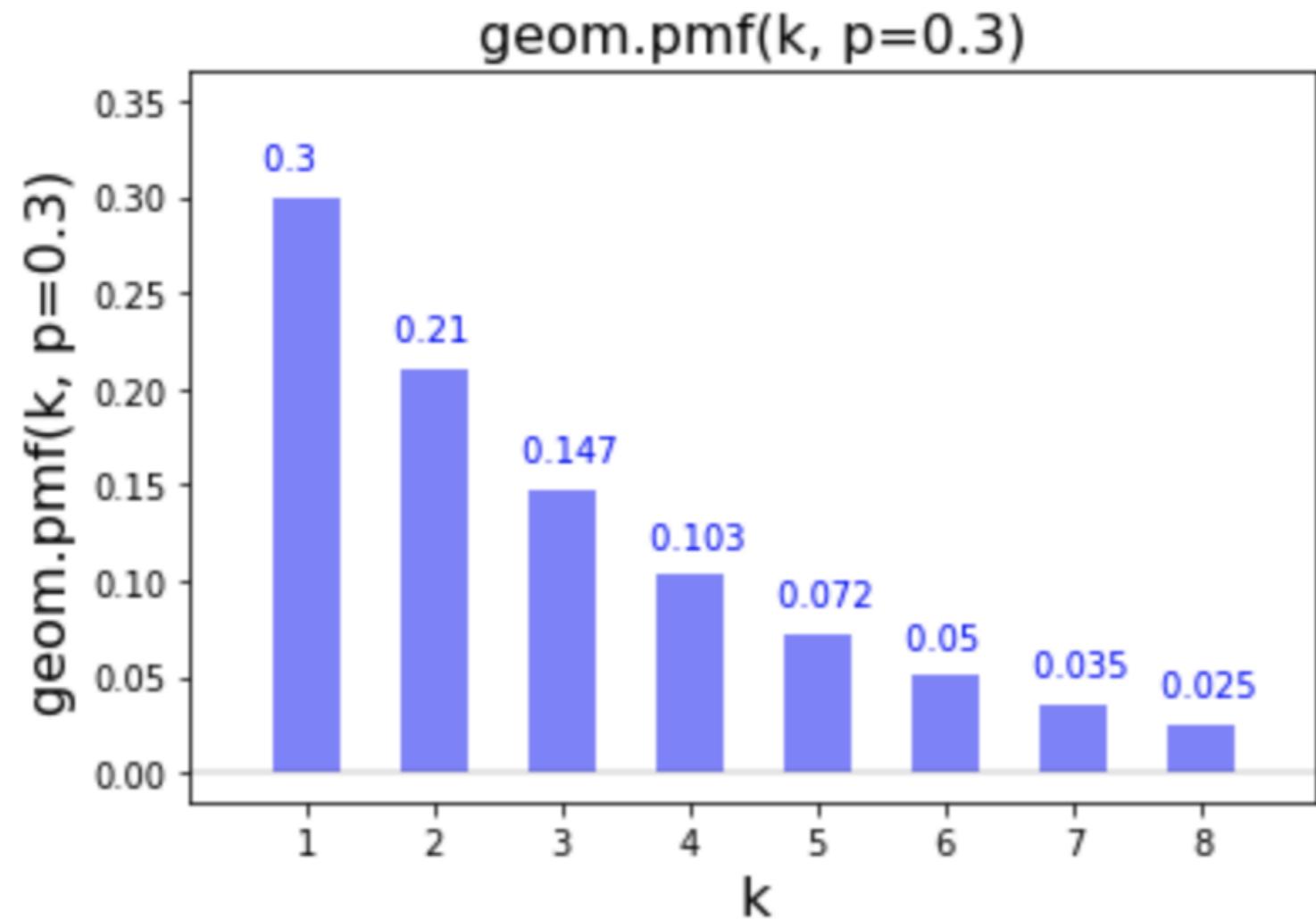


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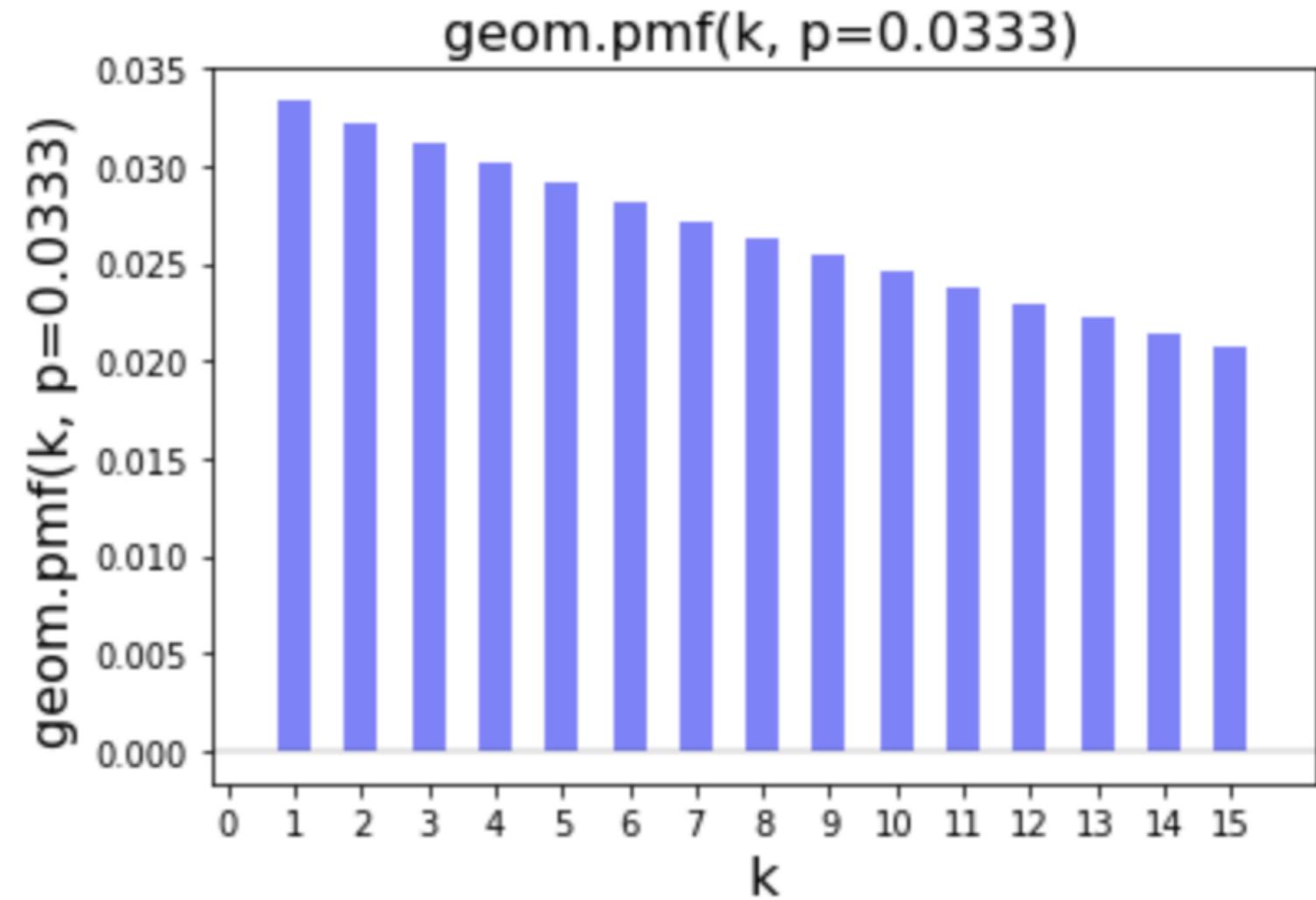
Geometric modeling



Geometric parameter

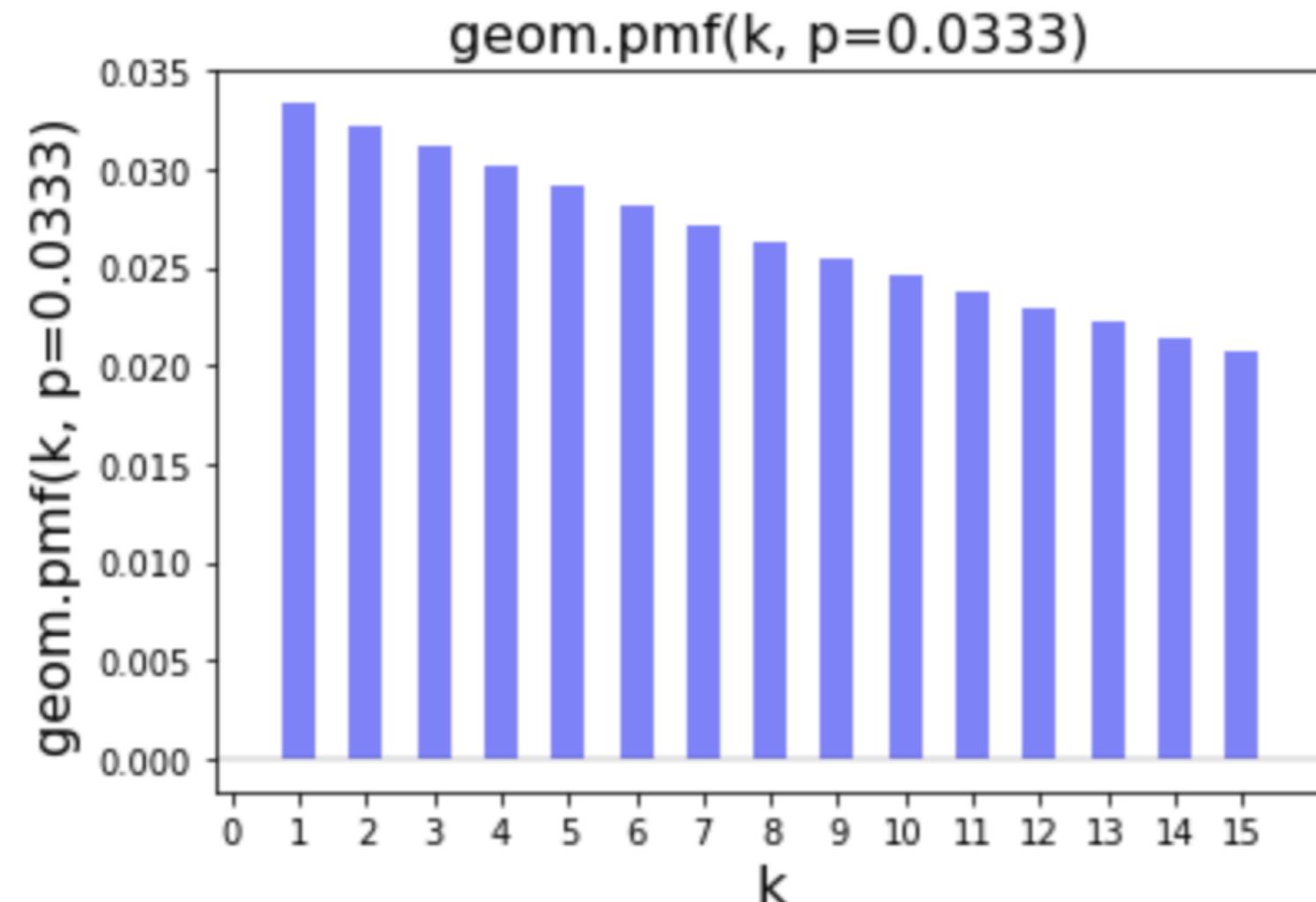


Model for a basketball player with probability 0.3 of scoring.



We can model a grizzly bear that has a 0.033 probability of catching a salmon.

Probability mass function (pmf)



In Python we code this as follows:

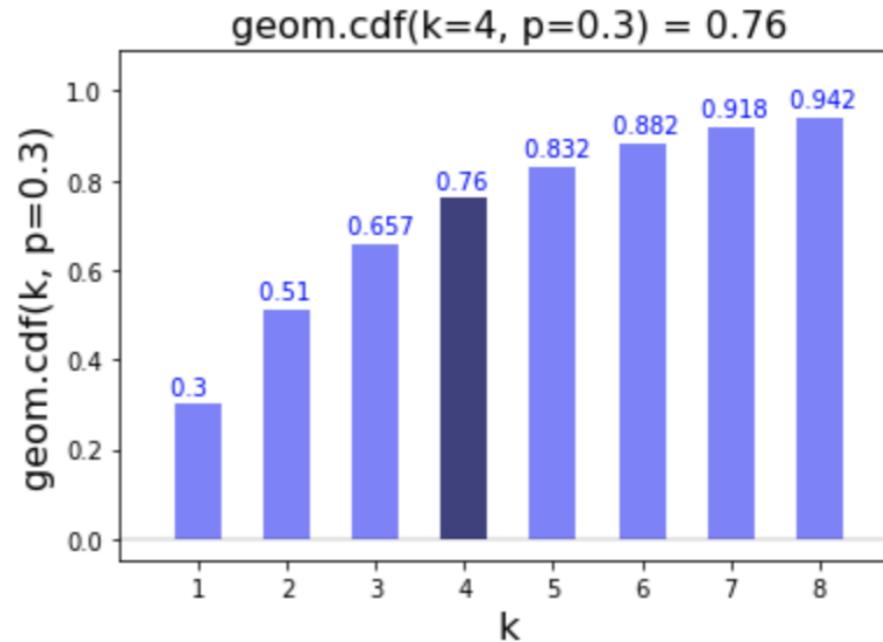
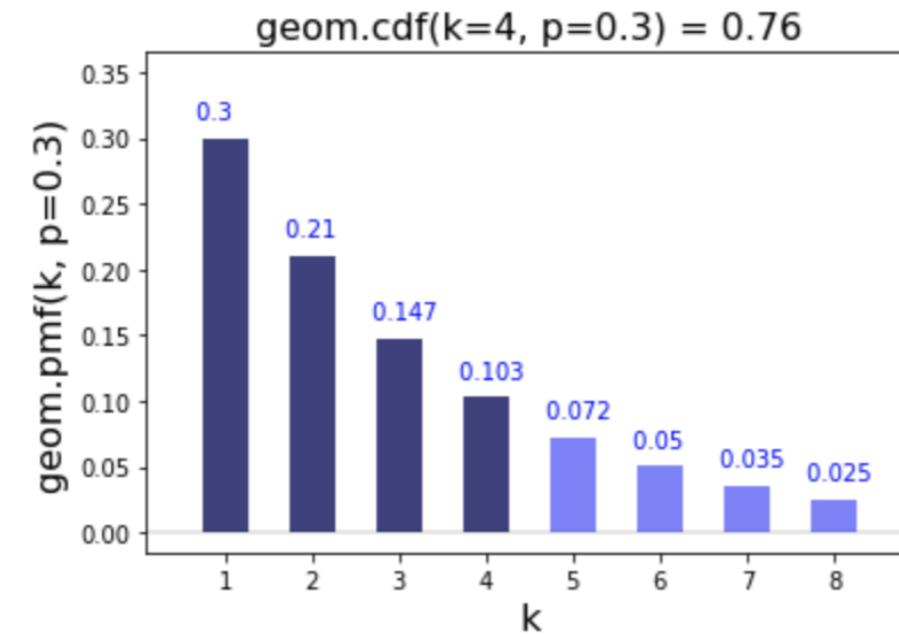
```
# Import geom  
from scipy.stats import geom
```

```
# Calculate the probability mass  
# with pmf  
geom.pmf(k=30, p=0.0333)
```

```
0.02455102908739612
```

p parameter specifies probability of success.

Cumulative distribution function (cdf)

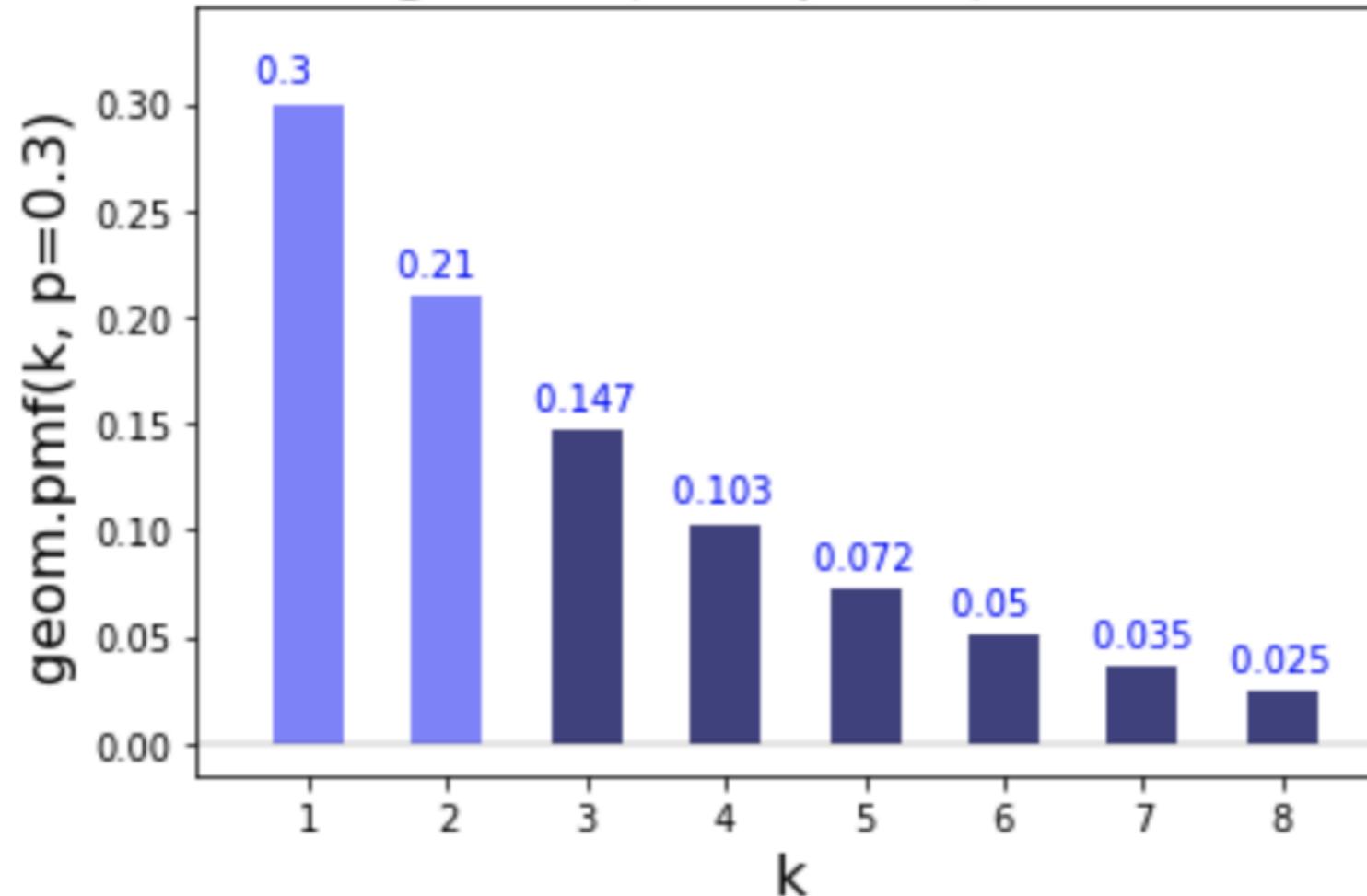


```
# Calculate cdf of 4  
geom.cdf(k=4, p=0.3)
```

```
0.7598999999999999
```

Survival function (sf)

geom.sf(k=2, p=0.3) = 0.49

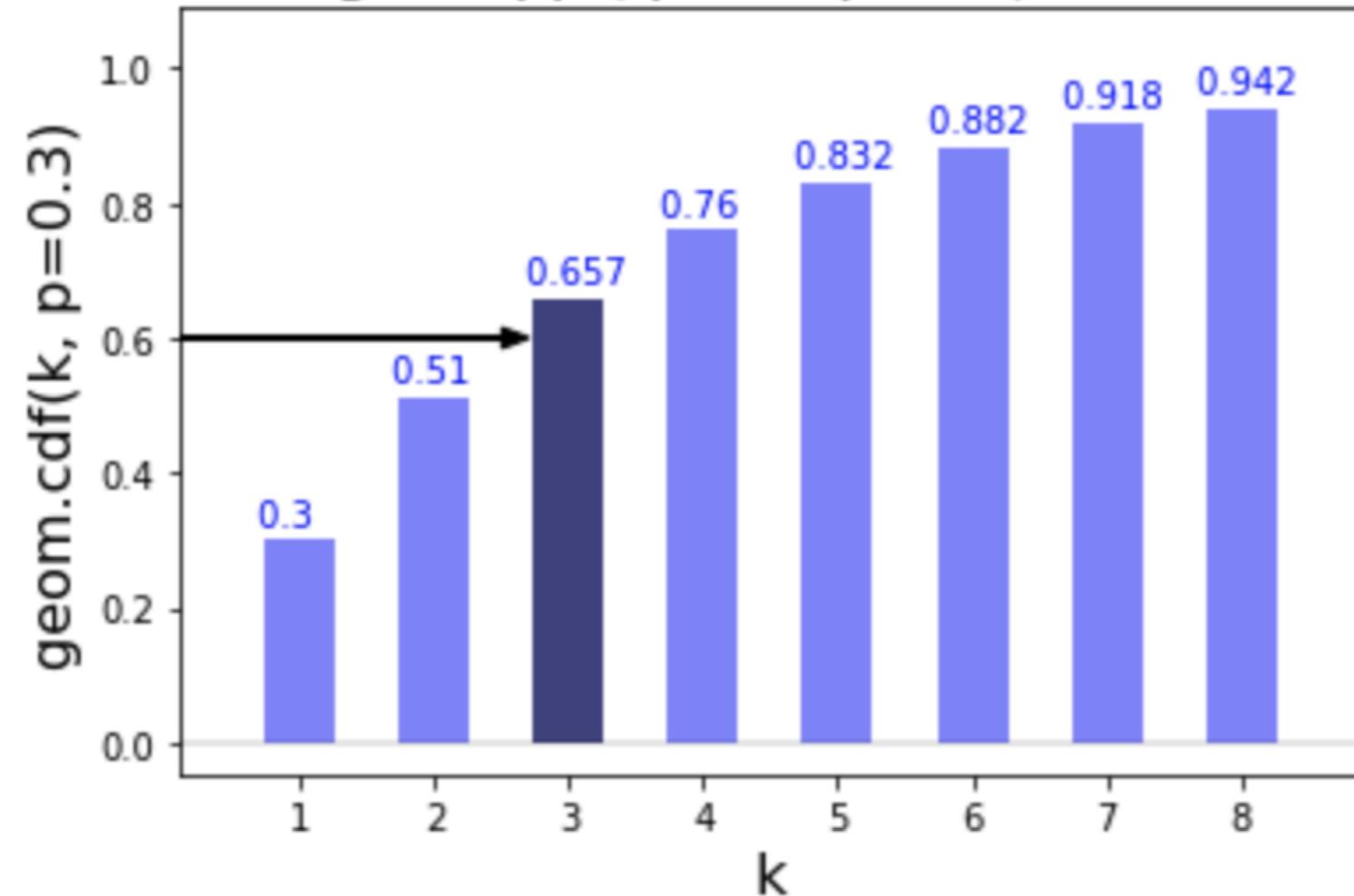


```
# Calculate sf of 2  
geom.sf(k=2, p=0.3)
```

```
0.4900000000000005
```

Percent point function (ppf)

geom.ppf($q=0.6$, $p=0.3$) = 3.0



```
# Calculate ppf of 0.6  
geom.ppf(q=0.6, p=0.3)
```

3.0

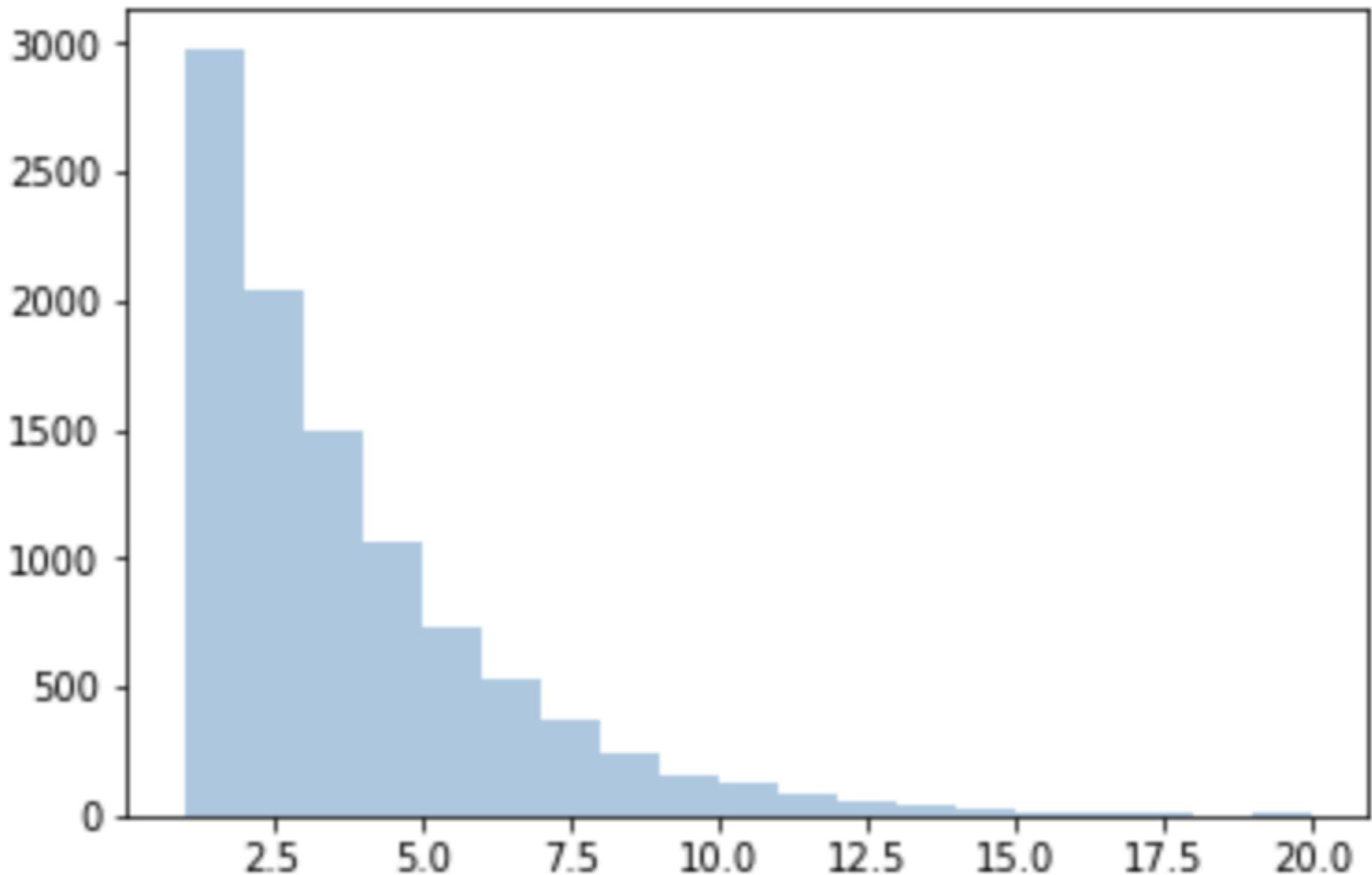
Sample generation (rvs)

```
# Import poisson, matplotlib.pyplot, and seaborn
from scipy.stats import geom
import matplotlib.pyplot as plt
import seaborn as sns
```

```
# Create the sample using geom.rvs()
sample = geom.rvs(p=0.3, size=10000, random_state=13)
```

```
# Plot the sample
sns.distplot(sample, bins = np.linspace(0,20,21), kde=False)
plt.show()
```

Sample generation (rvs) (Cont.)



**Let's go try until we
succeed!**

FOUNDATIONS OF PROBABILITY IN PYTHON