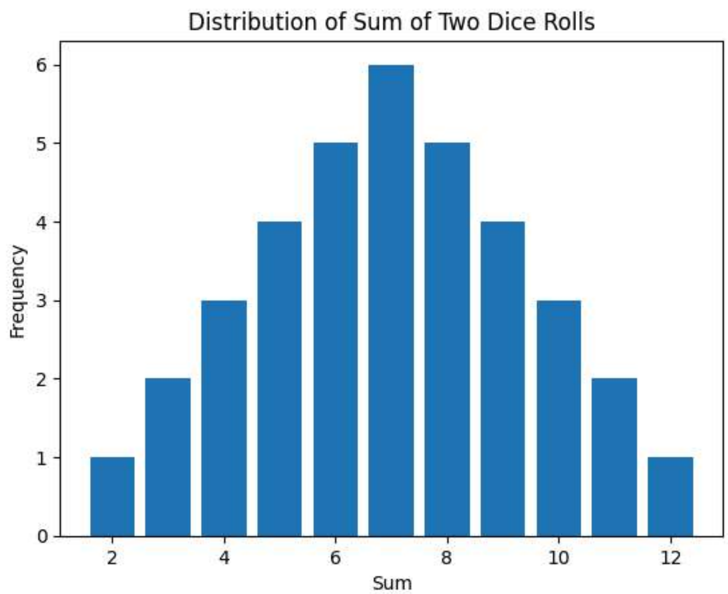
1. A fair six-sided die is rolled twice. Define a random variable representing the sum of the outcomes. What type of distribution does it follow?

```
import numpy as np
import matplotlib.pyplot as plt
from collections import Counter

sums = [i + j for i in range(1, 7) for j in range(1, 7)]
counts = Counter(sums)

plt.bar(counts.keys(), counts.values())
plt.title("Distribution of Sum of Two Dice Rolls")
plt.xlabel("Sum")
plt.ylabel("Frequency")
plt.show()
```

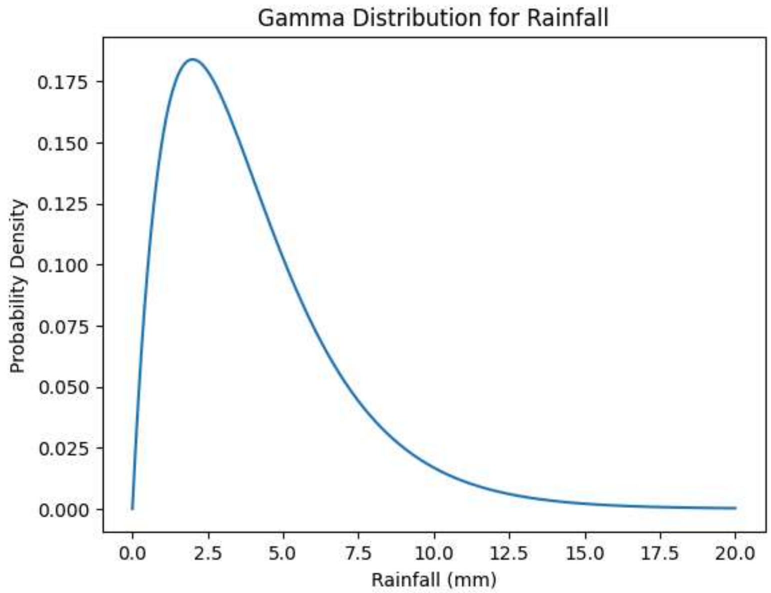


2. A weather station records the amount of rainfall each day. What kind of probability distribution best models this data and why?

```
from scipy.stats import gamma
import matplotlib.pyplot as plt

x = np.linspace(0, 20, 1000)
shape, scale = 2, 2  # example gamma parameters
pdf = gamma.pdf(x, a=shape, scale=scale)

plt.plot(x, pdf)
plt.title("Gamma Distribution for Rainfall")
plt.xlabel("Rainfall (mm)")
plt.ylabel("Probability Density")
plt.show()
```

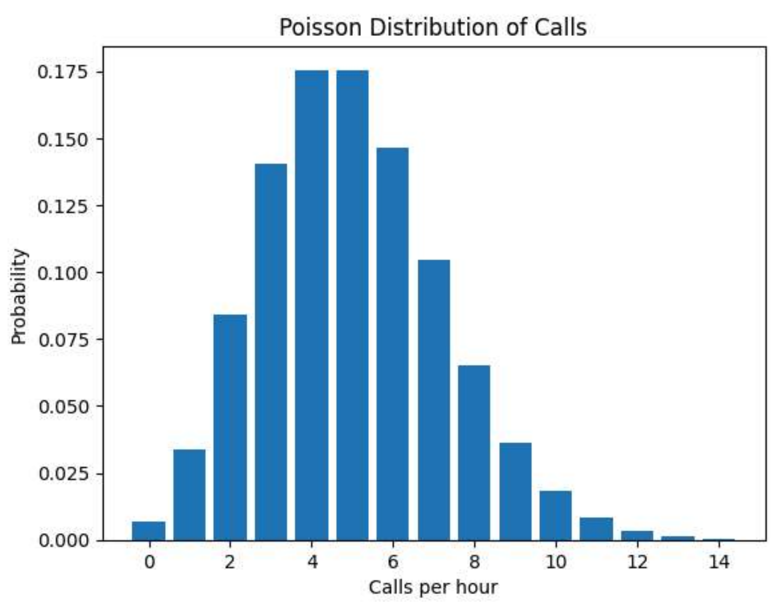


3. A call center receives an average of 5 calls per hour. Model this situation using an appropriate discrete distribution.

```
from scipy.stats import poisson

x = np.arange(0, 15)
pmf = poisson.pmf(x, mu=5)

plt.bar(x, pmf)
plt.title("Poisson Distribution of Calls")
plt.xlabel("Calls per hour")
plt.ylabel("Probability")
plt.show()
```

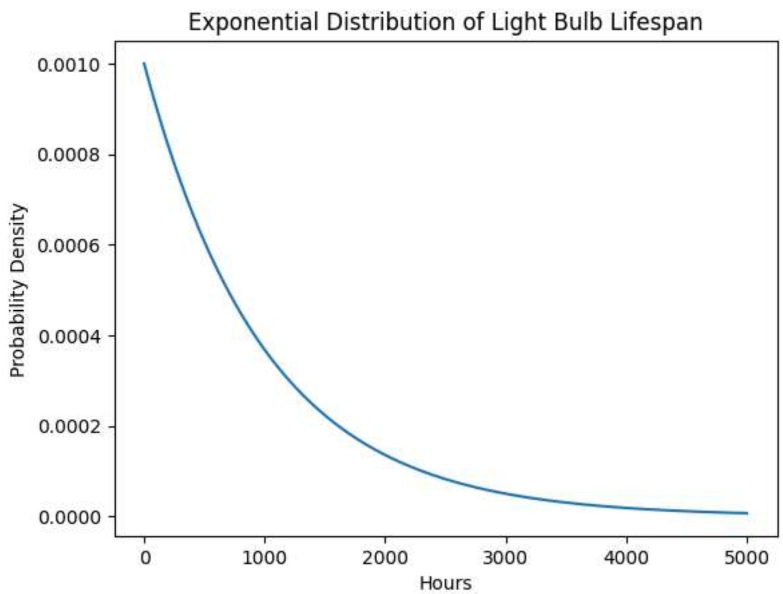


4. The lifespan of a light bulb is measured in hours. Which type of probability distribution can represent this data and how would you estimate its parameters?

```
from scipy.stats import expon

x = np.linspace(0, 5000, 1000)
scale = 1000  # mean lifespan
pdf = expon.pdf(x, scale=scale)
```

```
plt.plot(x, pdf)
plt.title("Exponential Distribution of Light Bulb Lifespan")
plt.xlabel("Hours")
plt.ylabel("Probability Density")
plt.show()
```



5. A student believes they have a 70% chance of passing a test. They update this belief to 90% after some extra study. Which probability concept is being applied?

```
# Prior: 0.7, Posterior after evidence: 0.9
prior = 0.7
likelihood = 0.95
evidence = 0.74  # Hypothetical

posterior = (likelihood * prior) / evidence
print(f"Updated belief (posterior): {posterior:.2f}")
```

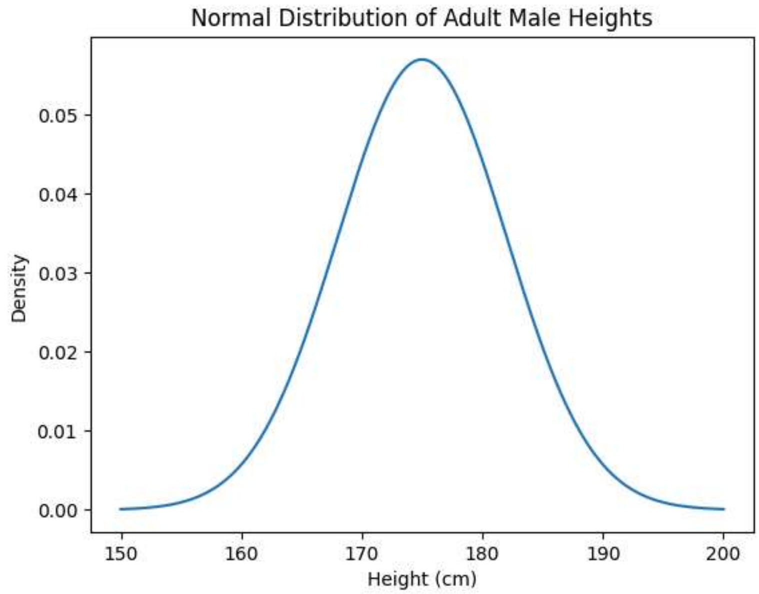
```
Updated belief (posterior): 0.90
```

6. A survey measures the height of adult males in a city. What kind of distribution is suitable and what assumptions are typically made?

```
from scipy.stats import norm

mean, std = 175, 7  # cm
x = np.linspace(150, 200, 1000)
pdf = norm.pdf(x, mean, std)

plt.plot(x, pdf)
plt.title("Normal Distribution of Adult Male Heights")
plt.xlabel("Height (cm)")
plt.ylabel("Density")
plt.show()
```

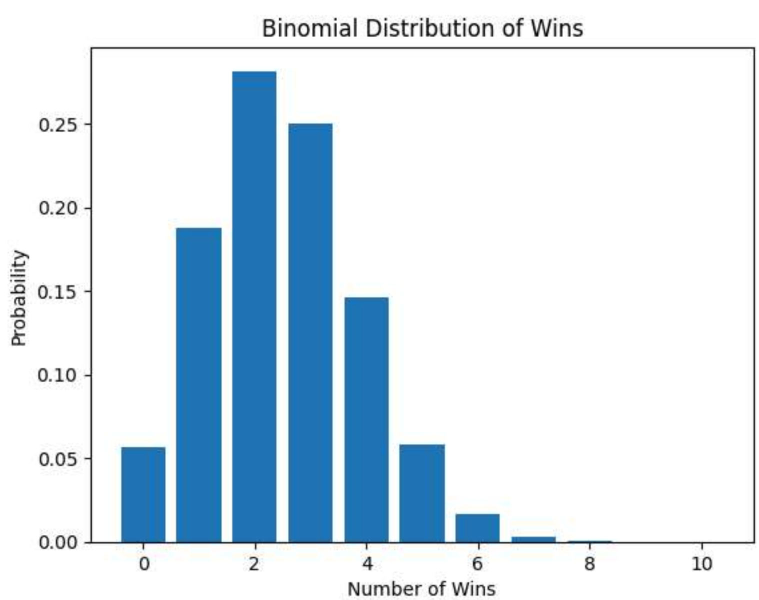


7. In a game, a player has a 1 in 4 chance of winning. If they play 10 times, model the number of wins with an appropriate distribution.

```
from scipy.stats import binom

n, p = 10, 0.25
x = np.arange(0, n+1)
pmf = binom.pmf(x, n, p)

plt.bar(x, pmf)
plt.title("Binomial Distribution of Wins")
plt.xlabel("Number of Wins")
plt.ylabel("Probability")
plt.show()
```



8. A machine produces items with a certain probability of being defective. Explain how to model the number of defectives using a suitable probability distribution.

```
# For binomial
n, p = 100, 0.02
pmf = binom.pmf(np.arange(0, 10), n, p)

plt.bar(np.arange(0, 10), pmf)
```

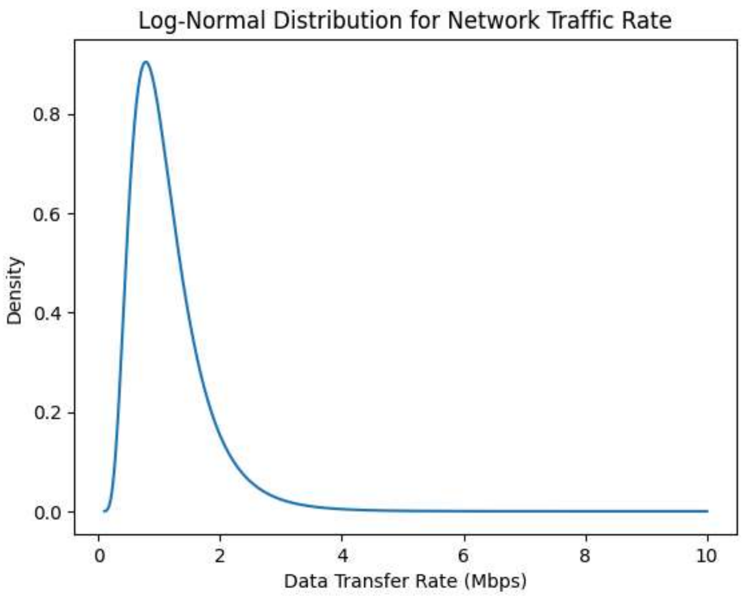
```
plt.title("Binomial Model for Defective Items")
plt.xlabel("Defective Count")
plt.ylabel("Probability")
plt.show()
```

9. You are monitoring network traffic which follows a continuous flow of data. Which probability distribution might help in modeling data transfer rates?

```
from scipy.stats import lognorm

s = 0.5  # shape parameter
x = np.linspace(0.1, 10, 1000)
pdf = lognorm.pdf(x, s)

plt.plot(x, pdf)
plt.title("Log-Normal Distribution for Network Traffic Rate")
plt.xlabel("Data Transfer Rate (Mbps)")
plt.ylabel("Density")
plt.show()
```



10. A person estimates their chance of rain tomorrow is 30%, but after watching a weather report, they update it to 60%. What kind of probability update is this?

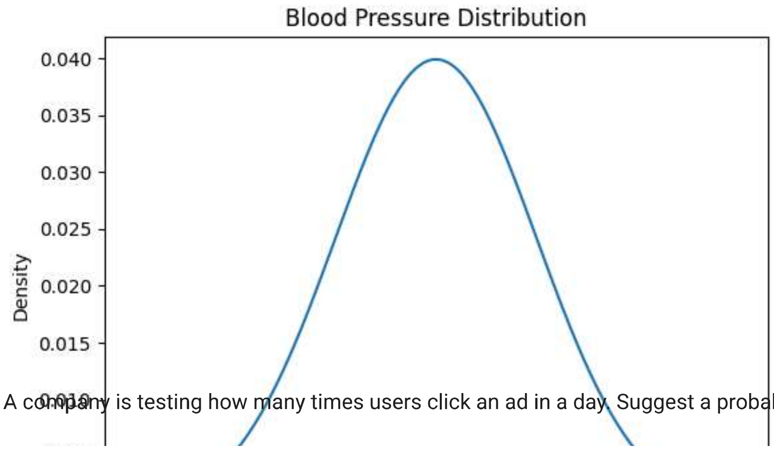
```
# Prior = 0.3, Posterior = 0.6 after seeing forecast
prior = 0.3
new_evidence = 0.8  # Forecast strongly suggests rain
updated_belief = (prior * new_evidence) / ((prior * new_evidence) + ((1 - prior) * (1 - new_evidence)))
print(f"Updated probability of rain: {updated_belief:.2f}")
```

```
Updated probability of rain: 0.63
```

11. Consider a hospital measuring patient blood pressure throughout the day. What distribution might be useful for modeling this continuous data?

```
mean, std = 120, 10
x = np.linspace(90, 150, 1000)
pdf = norm.pdf(x, mean, std)

plt.plot(x, pdf)
plt.title("Blood Pressure Distribution")
plt.xlabel("Blood Pressure (mmHg)")
plt.ylabel("Density")
plt.show()
```



12. A company is testing how many times users click an ad in a day. Suggest a probability distribution model and explain your choice

```
lambda_clicks =3  # average clicks per day
x = np.arange(0, 15)
pmf = poisson.pmf(x, lambda_clicks)

plt.bar(x, pmf)
plt.title("Poisson Distribution of Ad Clicks")
plt.xlabel("Clicks per Day")
plt.ylabel("Probability")
plt.show()
```