Coding Examples

o PDF of Binomial Distribution

```
# Parameters

n <- 10 # Number of trials

p <- 0.5 # Probability of success

# Values of x

x <- 0:n

# PDF

pdf_values <- dbinom(x, size = n, prob = p)

# Print PDF values

print(pdf_values)
```

output:

```
n <- 10
> p <- 0.5
> x <- 0:n
> pdf_values <- dbinom(x, size = n, prob = p)
> print(pdf_values)
 [1] 0.0009765625 0.0097656250 0.0439453125 0.1171875000 0.2050781250 0.2460937500 0.2
050781250 0.1171875000 0.0439453125
[10] 0.0097656250 0.0009765625
```

o CDF of Binomial Distribution

```
# CDF

cdf_values <- pbinom(x, size = n, prob = p)

# Print CDF values

print(cdf_values)
```

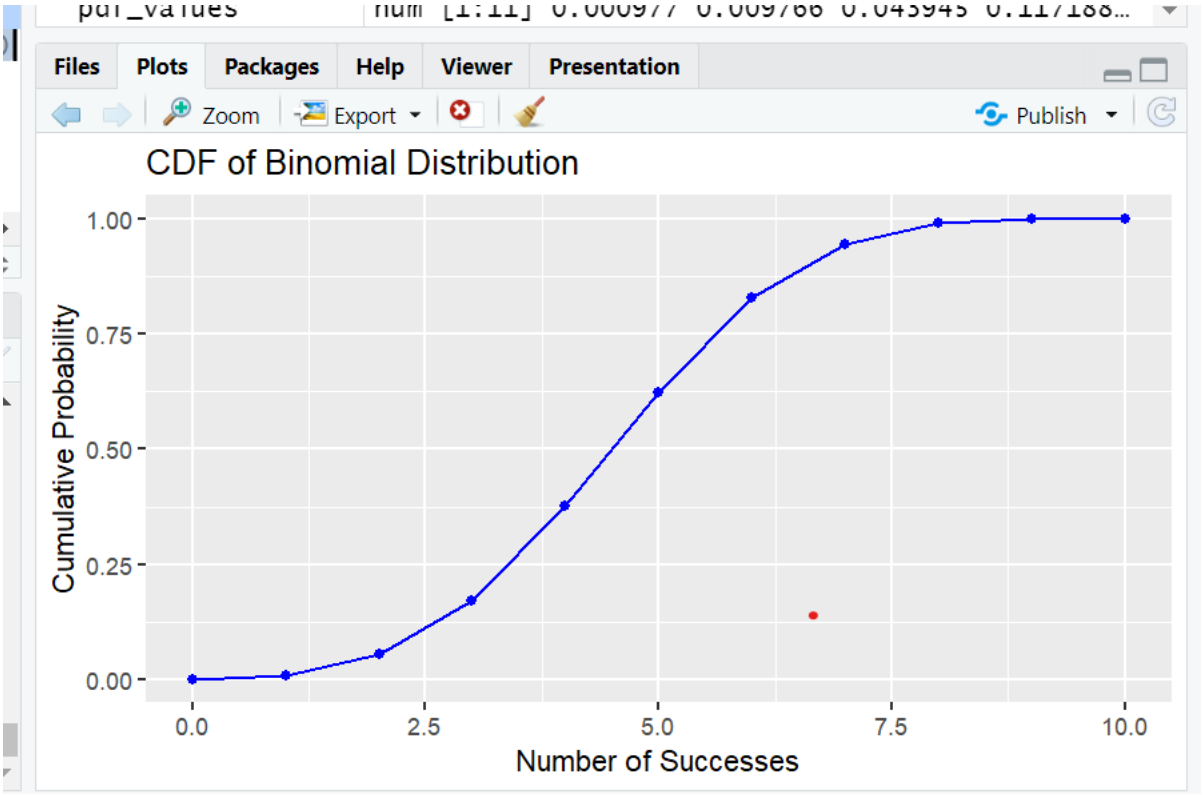
output:

```
cdf_values <- pbinom(x, size = n, prob = p)
> print(cdf_values)
 [1] 0.0009765625 0.0107421875 0.0546875000 0.1718750000 0.3769531250 0.6230468750 0.8
281250000 0.9453125000 0.9892578125
[10] 0.9990234375 1.0000000000
```

o Visualizing PDF and CDF

```
library(ggplot2)

# Data frame for plotting

data <- data.frame(x = x, PDF = pdf_values, CDF = cdf_values)

# Plot PDF

ggplot(data, aes(x = x, y = PDF)) +geom_bar(stat = "identity", fill = "skyblue") +ggtitle("PDF of Binomial Distribution") +

xlab("Number of Successes") + ylab("Probability")

# Plot CDF

ggplot(data, aes(x = x, y = CDF)) +geom_line(color = "blue") +geom_point(color = "blue") +ggtitle("CDF of Binomial Distribution") +

xlab("Number of Successes") + ylab("Cumulative Probability")
```

output:



Exercises

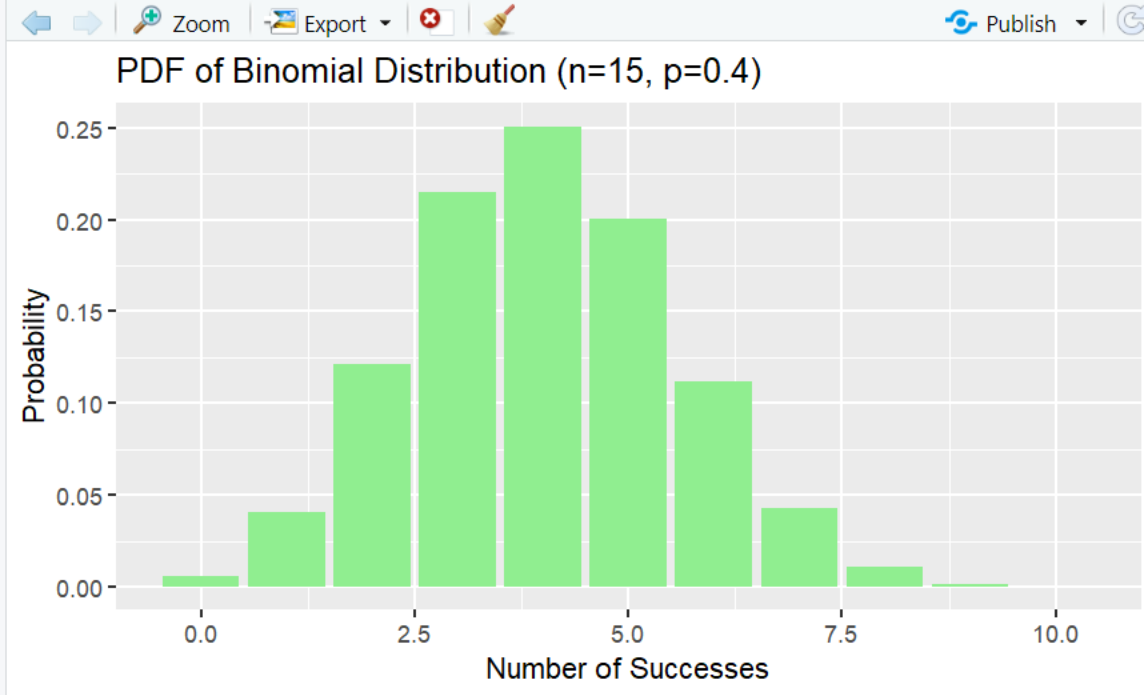
1. Exercise 1: Visualize the PDF for Different Parameters

o Task: Plot the PDF of a binomial distribution with n=15n = 15n=15 and p=0.4p = 0.4p=0.4.

o Expected Output:

```
# Parameters
n <- 15
p <- 0.4
# Values of x
x <- 0:n
# PDF
pdf_values <- dbinom(x, size = n, prob = p)
# Data frame for plotting
data <- data.frame(x = x, PDF = pdf_values)
# Plot PDF
ggplot(data, aes(x = x, y = PDF)) +
geom_bar(stat = "identity", fill = "lightgreen") +
ggtitle("PDF of Binomial Distribution (n=15, p=0.4)") +
xlab("Number of Successes") + ylab("Probability")
```

output:



2. Exercise 2: Visualize the CDF for Different Parameters

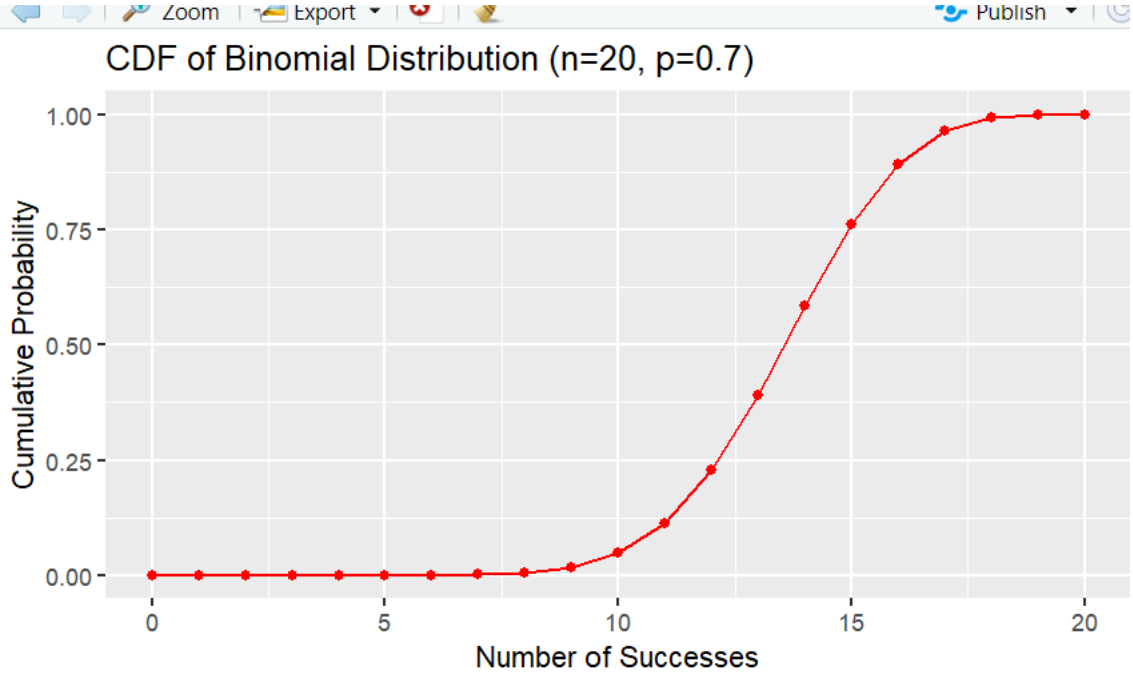
o Task: Plot the CDF of a binomial distribution with n=20n = 20n=20 and p=0.7p = 0.7p=0.7.

o Expected Output:

```
# Parameters
n <- 20
p <- 0.7
# Values of x
x <- 0:n
# CDF
cdf_values <- pbinom(x, size = n, prob = p)
# Data frame for plotting
data <- data.frame(x = x, CDF = cdf_values)
# Plot CDF
ggplot(data, aes(x = x, y = CDF)) +
```

```
geom_line(color = "red") +
geom_point(color = "red") +
ggtitle("CDF of Binomial Distribution (n=20, p=0.7)") +
xlab("Number of Successes") + ylab("Cumulative Probability")
```

output:



3. Exercise 3: Compare PDFs of Different Binomial Distributions

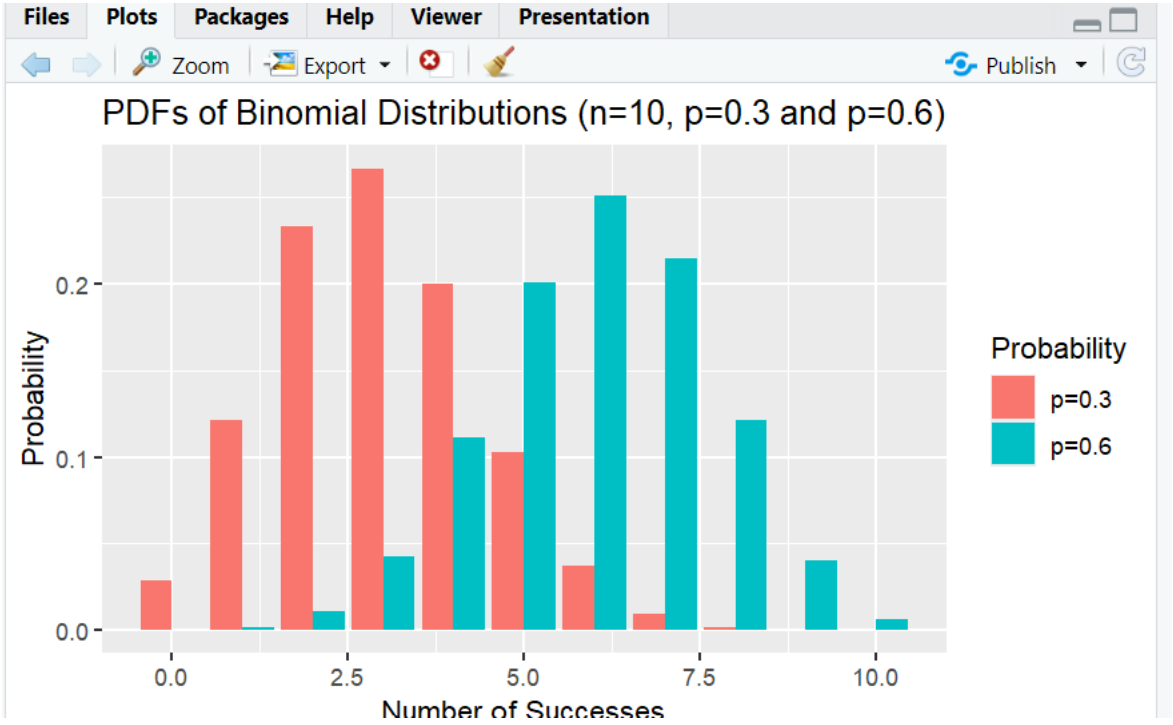
o Task: Plot the PDFs of binomial distributions with parameters n=10,p=0.3n = 10, p = 0.3n=10,p=0.3 and n=10,p=0.6n = 10, p = 0.6n=10,p=0.6 on the same graph for comparison.

o Expected Output:

```
# Parameters
n <- 10
p1 <- 0.3
p2 <- 0.6
# Values of x
x <- 0:n
```

```
# PDF
pdf_values_p1 <- dbinom(x, size = n, prob = p1)
pdf_values_p2 <- dbinom(x, size = n, prob = p2)
# Data frame for plotting
data <- data.frame(x = rep(x, 2),

PDF = c(pdf_values_p1, pdf_values_p2),
Probability = factor(rep(c("p=0.3", "p=0.6"), each = length(x))))

# Plot PDFs
ggplot(data, aes(x = x, y = PDF, fill = Probability)) +
geom_bar(stat = "identity", position = "dodge") +
ggtitle("PDFs of Binomial Distributions (n=10, p=0.3 and p=0.6)") +
xlab("Number of Successes") + ylab("Probability")
```

output:



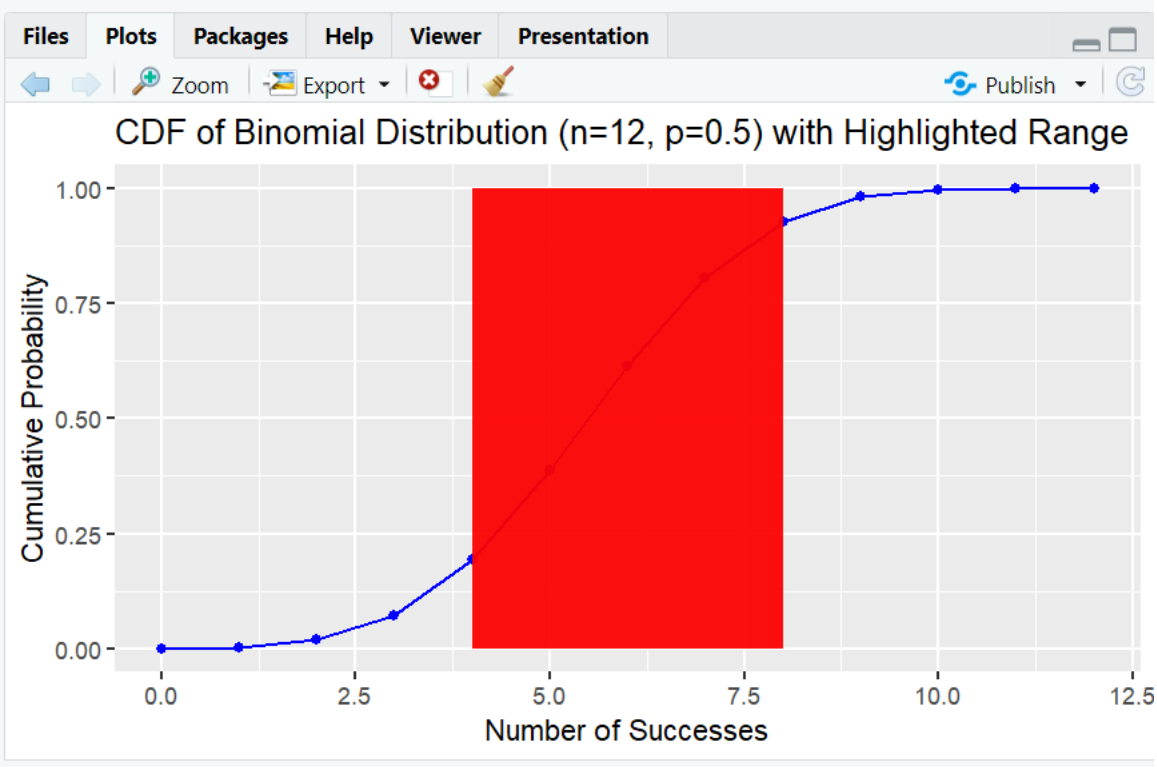
4. Exercise 4: Calculate and Plot the Probability of Success Ranges

o Task: Calculate the probability that the number of successes in a binomial distribution with n=12n = 12n=12 and p=0.5p = 0.5p=0.5 falls between 4 and 8 inclusive. Plot the CDF and highlight the probability range.

o Expected Output:

```
# Parameters
n <- 12
p <- 0.5
# Values of x
x <- 0:n
# CDF
cdf_values <- pbinom(x, size = n, prob = p)
# Probability of successes between 4 and 8
prob_range <- pbinom(8, size = n, prob = p) - pbinom(3, size = n, prob = p)
print(prob_range) # Output should be the cumulative probability
# Data frame for plotting
data <- data.frame(x = x, CDF = cdf_values)
# Plot CDF and highlight the range
ggplot(data, aes(x = x, y = CDF)) +
geom_line(color = "blue") +
geom_point(color = "blue") +
ggtitle("CDF of Binomial Distribution (n=12, p=0.5) with Highlighted Range")
+
xlab("Number of Successes") + ylab("Cumulative Probability") +
geom_rect(aes(xmin = 4, xmax = 8, ymin = 0, ymax = 1), alpha = 0.2, fill =
"red")
```

Output:



Coding Examples

o PDF of Poisson Distribution

```
# Install and load ggplot2 package
install.packages("ggplot2")
library(ggplot2)
# Parameter
lambda <- 4 # Average rate of occurrence
# Values of x
x <- 0:15
# PDF
pdf_values <- dpois(x, lambda)
# Print PDF values
print(pdf_values)
```

output:

```
[1] 1.831564e-02 7.326256e-02 1.465251e-01 1.953668e-01 1.953668e-01
```

[6] 1.562935e-01 1.041956e-01 5.954036e-02 2.977018e-02 1.323119e-02

[11] 5.292477e-03 1.924537e-03 6.415123e-04 1.973884e-04 5.639669e-05

[16] 1.503912e-05

o CDF of Poisson Distribution

```
# Parameter
lambda <- 4 # Average rate of occurrence
# Values of x
x <- 0:15
# CDF
cdf_values <- ppois(x, lambda)
# Print CDF values
print(cdf_values)
```

output:

[1] 0.01831564 0.09157819 0.23810331 0.43347012 0.62883694 0.78513039

[7] 0.88932602 0.94886638 0.97863657 0.99186776 0.99716023 0.99908477

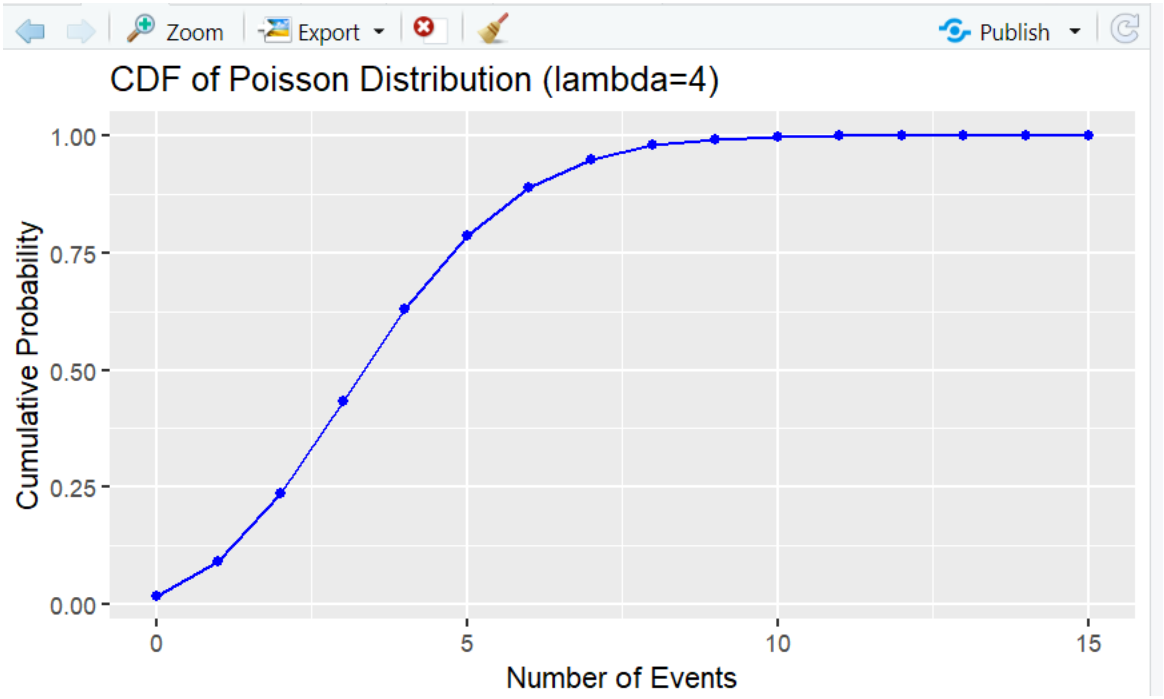
[13] 0.99972628 0.99992367 0.99998007 0.99999511

o Visualizing PDF and CDF

```
# Data frame for plotting
data <- data.frame(x = x, PDF = pdf_values, CDF = cdf_values)
# Plot PDF
ggplot(data, aes(x = x, y = PDF)) +
geom_bar(stat = "identity", fill = "skyblue") +
ggtitle("PDF of Poisson Distribution (lambda=4)") +
xlab("Number of Events") + ylab("Probability")
# Plot CDF
ggplot(data, aes(x = x, y = CDF)) +
```

```
geom_line(color = "blue") +
geom_point(color = "blue") +
ggtitle("CDF of Poisson Distribution (lambda=4)") +
xlab("Number of Events") + ylab("Cumulative Probability")
```

output:



Exercises

1. Exercise 1: Visualize the PDF for Different Parameters

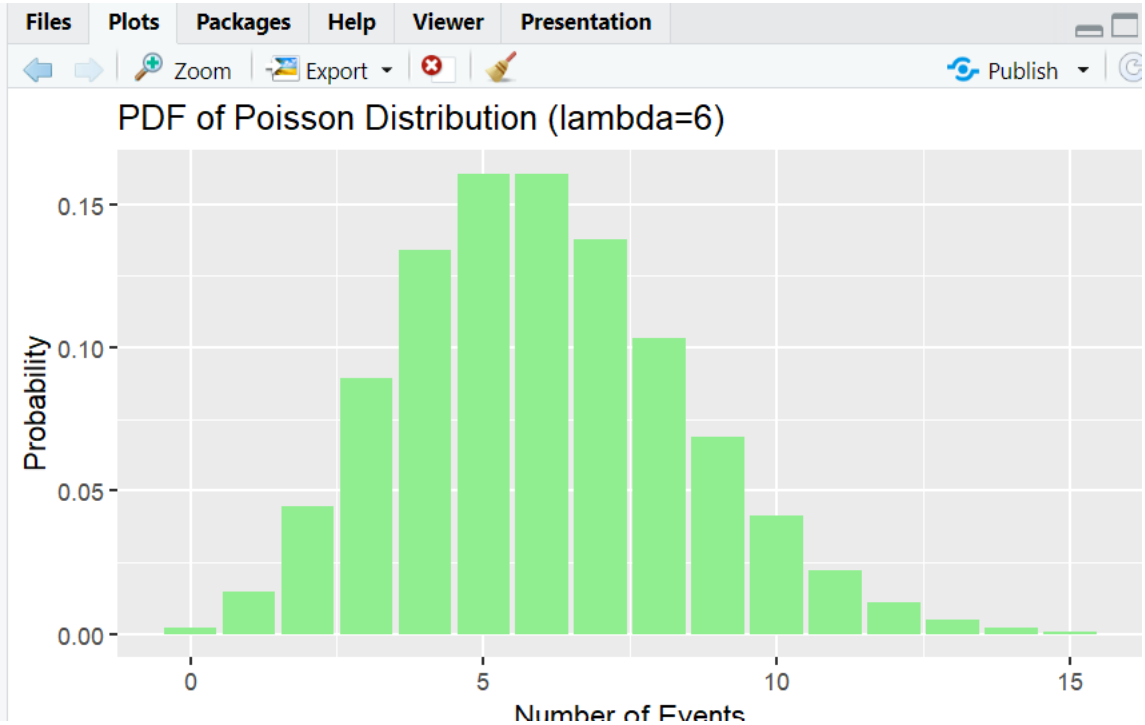
o Task: Plot the PDF of a Poisson distribution with λ = 6.

o Expected Output:

```
# Parameter
lambda <- 6 # Average rate of occurrence
# Values of x
x <- 0:15
# PDF
pdf_values <- dpois(x, lambda)
# Data frame for plotting
```

```
data <- data.frame(x = x, PDF = pdf_values)
# Plot PDF
ggplot(data, aes(x = x, y = PDF)) +
geom_bar(stat = "identity", fill = "lightgreen") +
ggtitle("PDF of Poisson Distribution (lambda=6)") +
xlab("Number of Events") + ylab("Probability")
```

output:



2. Exercise 2: Visualize the CDF for Different Parameters

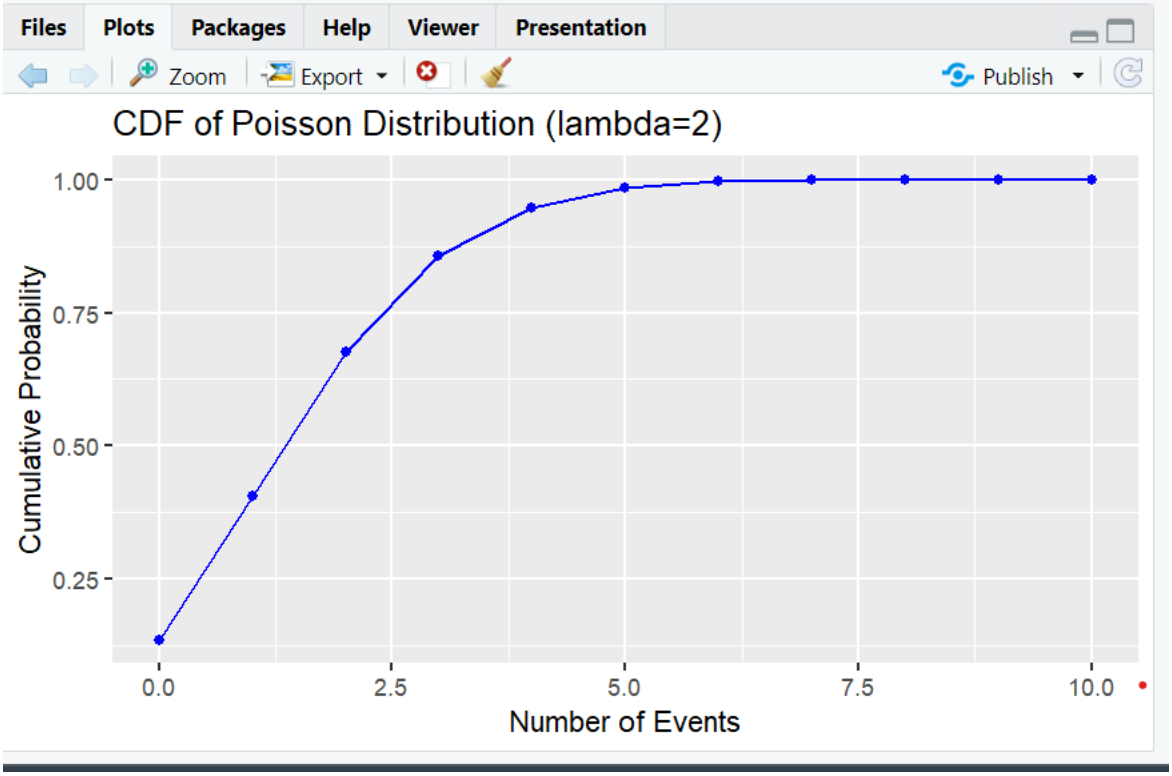
o Task: Plot the CDF of a Poisson distribution with λ = 2.

o Expected Output:

```
# Parameter
lambda <- 2 # Average rate of occurrence
# Values of x
x <- 0:10
# CDF
cdf_values <- ppois(x, lambda)
```

```
# Data frame for plotting
data <- data.frame(x = x, CDF = cdf_values)
# Plot CDF
ggplot(data, aes(x = x, y = CDF)) +
geom_line(color = "blue") +
geom_point(color = "blue") +
ggtitle("CDF of Poisson Distribution (lambda=2)") +
xlab("Number of Events") + ylab("Cumulative Probability")
```

output:



3. Exercise 3: Compare PDFs of Different Poisson Distributions

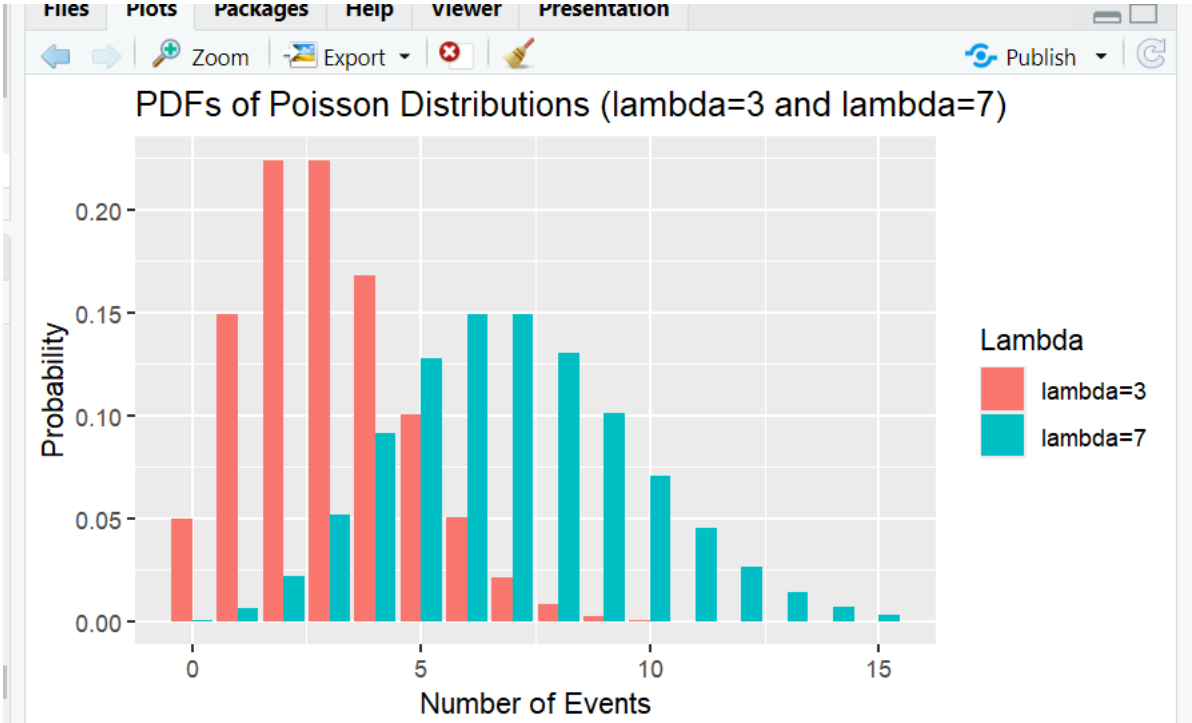
o Task: Plot the PDFs of Poisson distributions with parameters $\lambda = 3$ and $\lambda = 7$ on the same graph for comparison.

o Expected Output:

```
# Parameters
lambda1 <- 3
```

```
lambda2 <- 7
# Values of x
x <- 0:15
# PDF
pdf_values_lambda1 <- dpois(x, lambda1)
pdf_values_lambda2 <- dpois(x, lambda2)
# Data frame for plotting
data <- data.frame(x = rep(x, 2),

PDF = c(pdf_values_lambda1, pdf_values_lambda2),
Lambda = factor(rep(c("lambda=3", "lambda=7"), each = length(x))))

# Plot PDFs
ggplot(data, aes(x = x, y = PDF, fill = Lambda)) +
geom_bar(stat = "identity", position = "dodge") +
ggtitle("PDFs of Poisson Distributions (lambda=3 and lambda=7)") +
xlab("Number of Events") + ylab("Probability")
```

output:



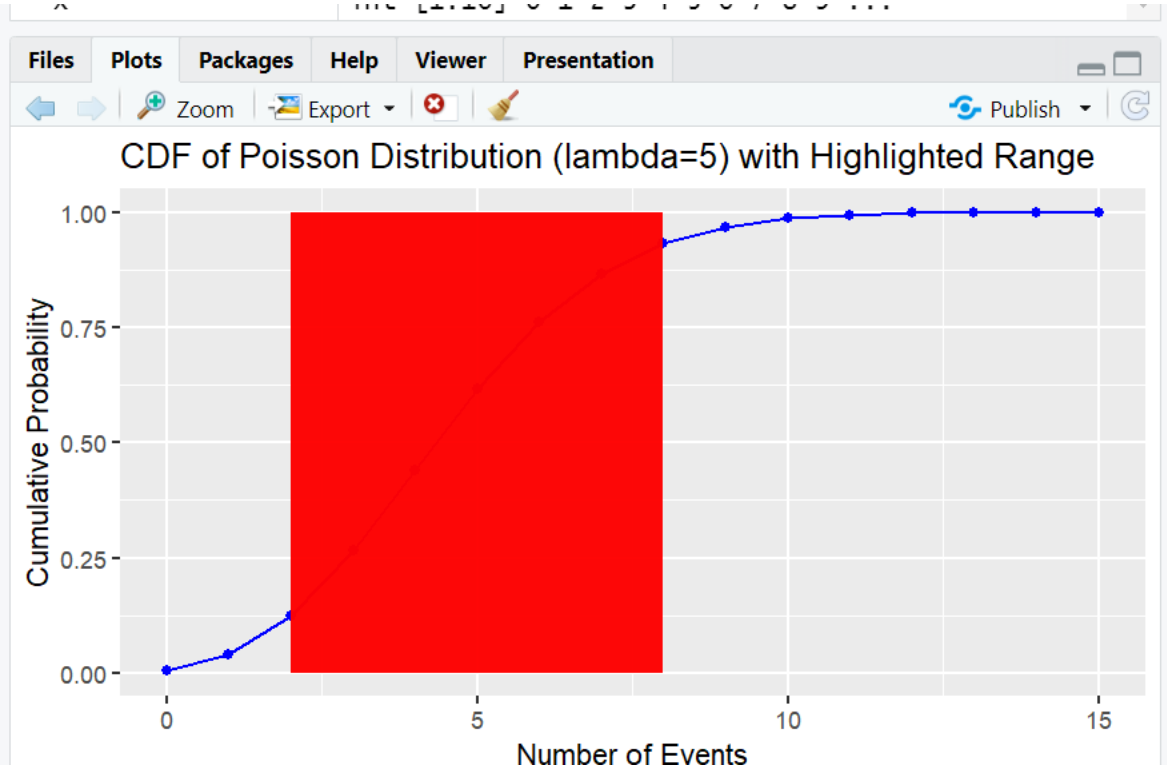
4. Exercise 4: Calculate and Plot the Probability of Event Ranges

o Task: Calculate the probability that the number of events in a Poisson distribution with $\lambda = 5$ falls between 2 and 8 inclusive. Plot the CDF and highlight the probability range.

o Expected Output:

```
# Parameter
lambda <- 5 # Average rate of occurrence
# Values of x
x <- 0:15
# CDF
cdf_values <- ppois(x, lambda)
# Probability of events between 2 and 8
prob_range <- ppois(8, lambda) - ppois(1, lambda)
print(prob_range) # Output should be the cumulative probability
# Data frame for plotting
data <- data.frame(x = x, CDF = cdf_values)
```

```
# Plot CDF and highlight the range
ggplot(data, aes(x = x, y = CDF)) +
geom_line(color = "blue") +
geom_point(color = "blue") +
ggtitle("CDF of Poisson Distribution (lambda=5) with Highlighted Range") +
xlab("Number of Events") + ylab("Cumulative Probability") +
geom_rect(aes(xmin = 2, xmax = 8, ymin = 0, ymax = 1), alpha = 0.2, fill =
"red")
```



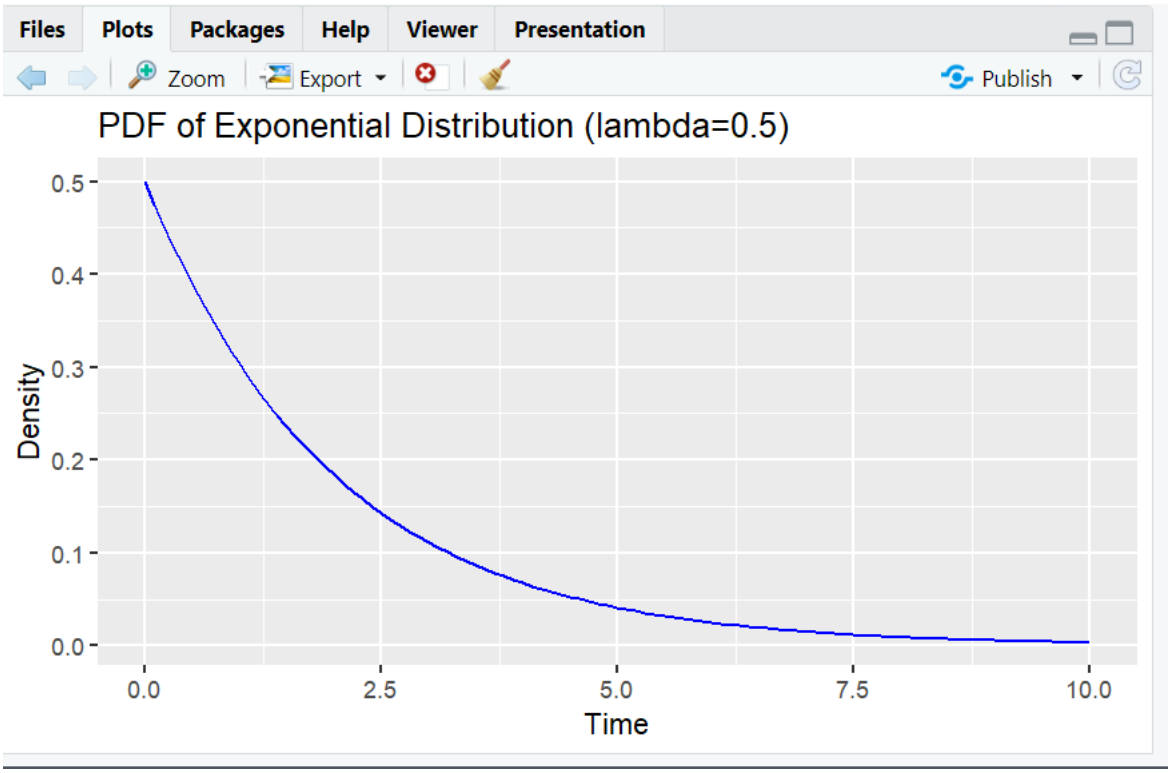
Coding Examples

o PDF of Exponential Distribution

```
# Install and load ggplot2 package
install.packages("ggplot2")
library(ggplot2)
# Parameter
lambda <- 0.5 # Rate parameter
```

```
# Values of x
x <- seq(0, 10, by = 0.1)
# PDF
pdf_values <- dexp(x, rate = lambda)
# Data frame for plotting
data <- data.frame(x = x, PDF = pdf_values)
# Plot PDF
ggplot(data, aes(x = x, y = PDF)) +
geom_line(color = "blue") +
ggtitle("PDF of Exponential Distribution (lambda=0.5)") +
xlab("Time") + ylab("Density")
```

output:

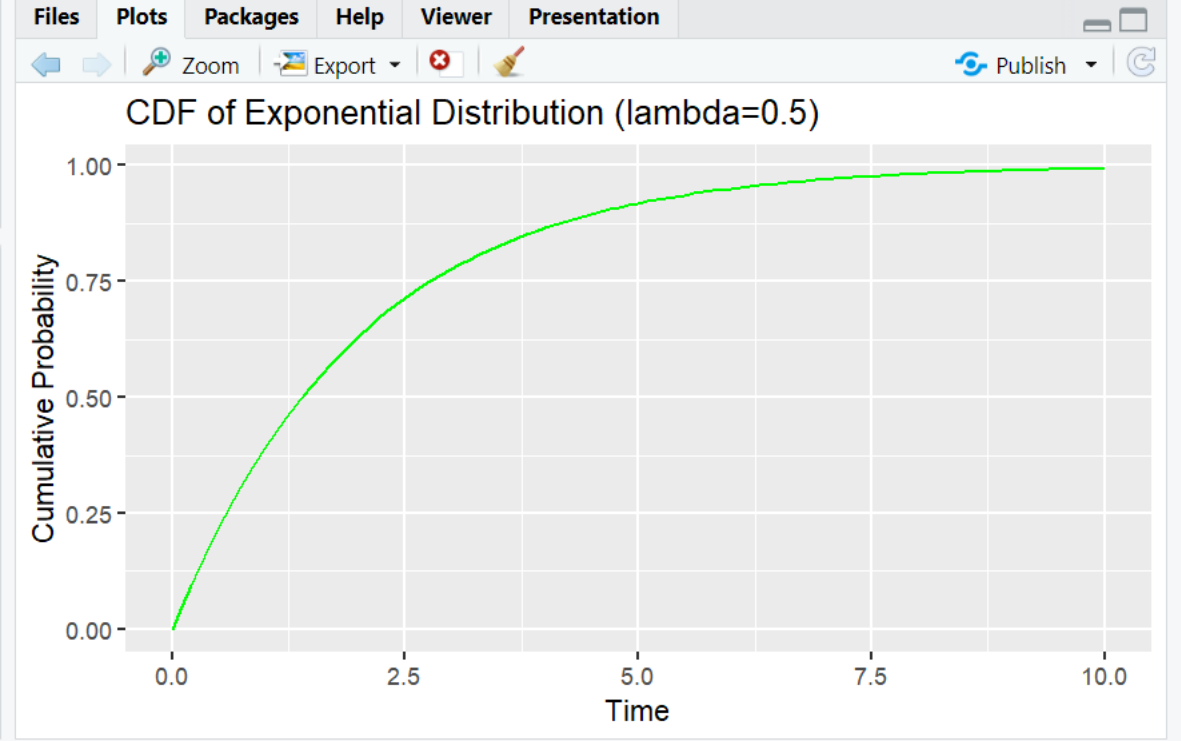


o CDF of Exponential Distribution

```
# Parameter
lambda <- 0.5 # Rate parameter
```

```
# Values of x
x <- seq(0, 10, by = 0.1)
# CDF
cdf_values <- pexp(x, rate = lambda)
# Data frame for plotting
data <- data.frame(x = x, CDF = cdf_values)
# Plot CDF
ggplot(data, aes(x = x, y = CDF)) +
geom_line(color = "green") +
ggtitle("CDF of Exponential Distribution (lambda=0.5)") +
xlab("Time") + ylab("Cumulative Probability")
```

output:



Exercises

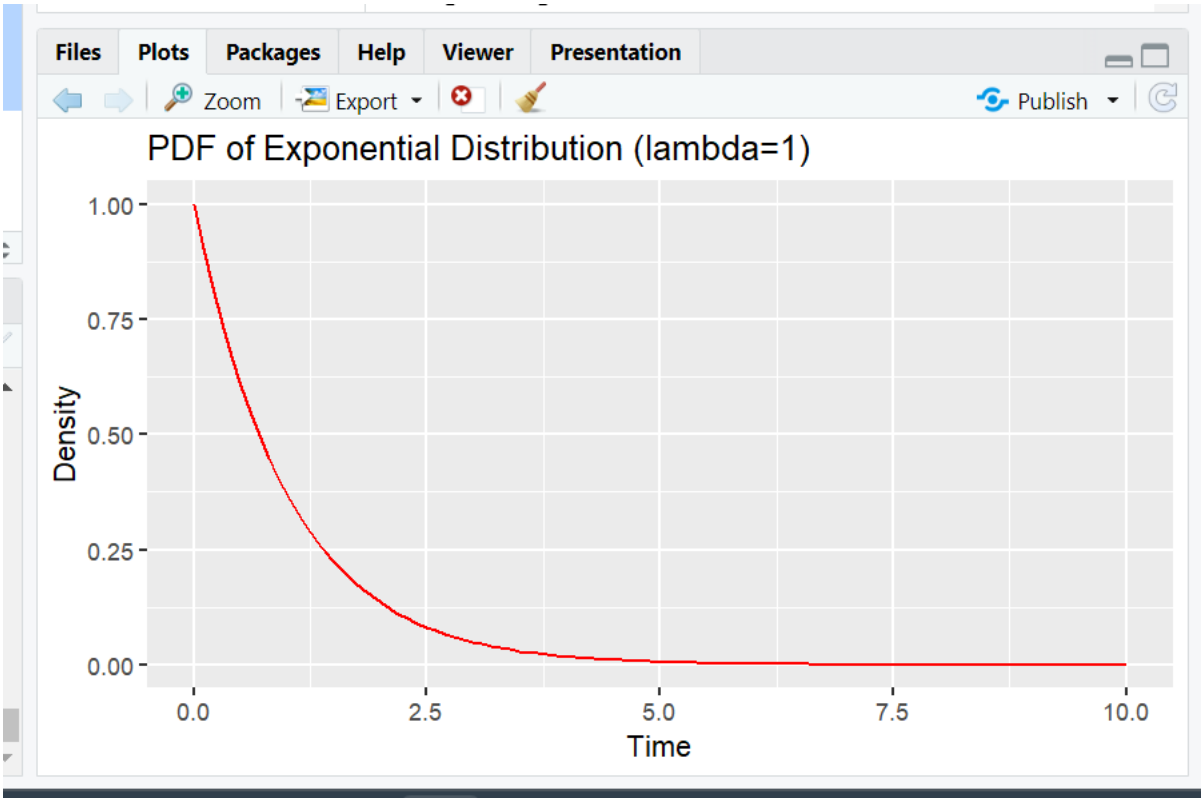
1. Exercise 1: Visualize the PDF for Different Parameters

o Task: Plot the PDF of an exponential distribution with $\lambda = 1$.

o Expected Output:

```
# Parameter
lambda <- 1 # Rate parameter
# Values of x
x <- seq(0, 10, by = 0.1)
# PDF
pdf_values <- dexp(x, rate = lambda)
# Data frame for plotting
data <- data.frame(x = x, PDF = pdf_values)
# Plot PDF
ggplot(data, aes(x = x, y = PDF)) +
geom_line(color = "red") +
ggtitle("PDF of Exponential Distribution (lambda=1)") +
xlab("Time") + ylab("Density")
```

output:



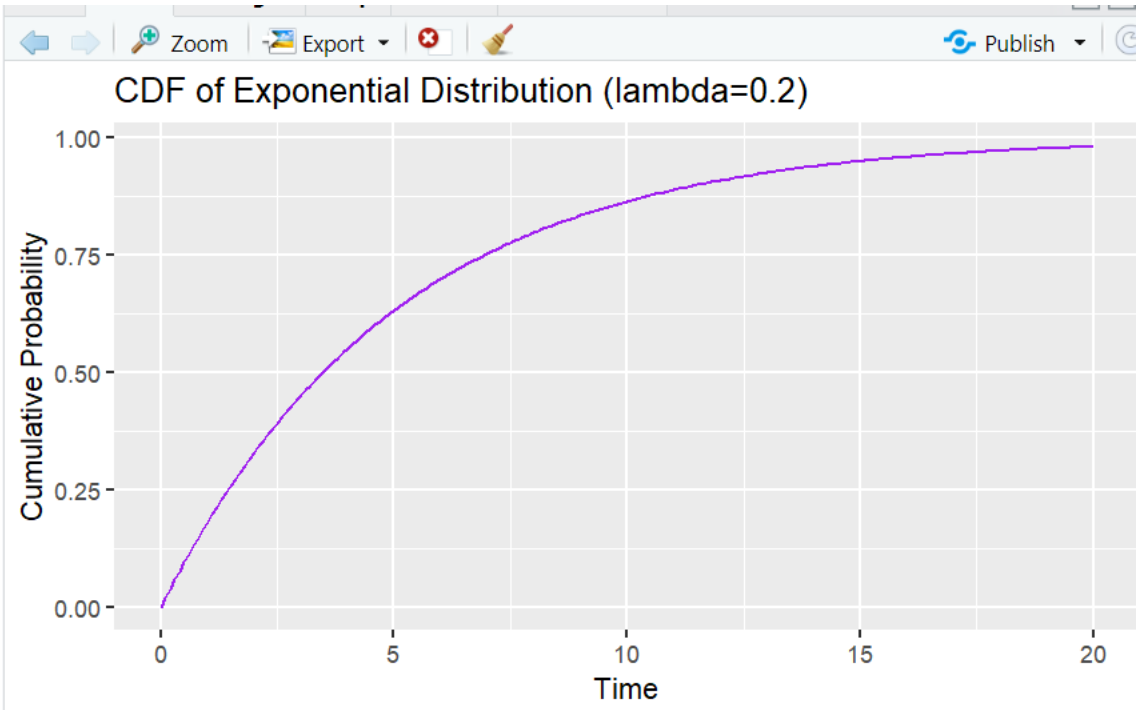
2. Exercise 2: Visualize the CDF for Different Parameters

o Task: Plot the CDF of an exponential distribution with λ = 0.2.

o Expected Output:

```
# Parameter
lambda <- 0.2 # Rate parameter
# Values of x
x <- seq(0, 20, by = 0.1)
# CDF
cdf_values <- pexp(x, rate = lambda)
# Data frame for plotting
data <- data.frame(x = x, CDF = cdf_values)
# Plot CDF
ggplot(data, aes(x = x, y = CDF)) +
geom_line(color = "purple") +
ggtitle("CDF of Exponential Distribution (lambda=0.2)") +
xlab("Time") + ylab("Cumulative Probability")
```

output:



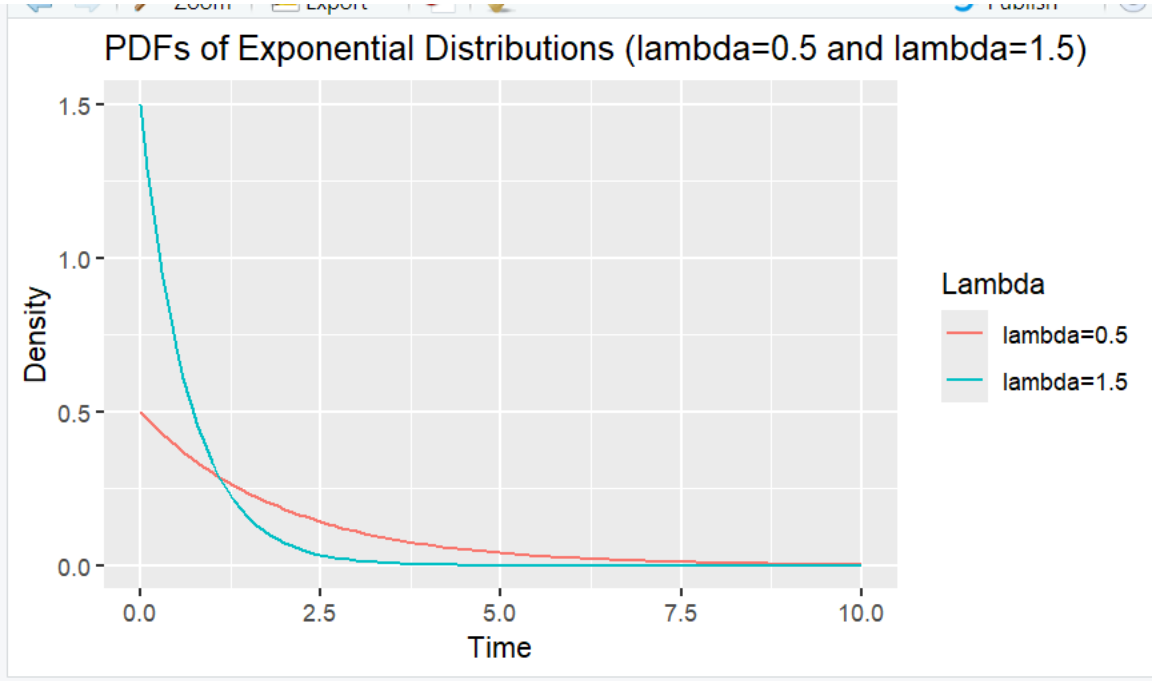
3. Exercise 3: Compare PDFs of Different Exponential Distributions

o Task: Plot the PDFs of exponential distributions with parameters λ = 0.5 and λ = 1.5 on the same graph for comparison.

o Expected Output:

```
# Parameters
lambda1 <- 0.5
lambda2 <- 1.5
# Values of x
x <- seq(0, 10, by = 0.1)
# PDF
pdf_values_lambda1 <- dexp(x, rate = lambda1)
pdf_values_lambda2 <- dexp(x, rate = lambda2)
# Data frame for plotting
data <- data.frame(x = rep(x, 2),

PDF = c(pdf_values_lambda1, pdf_values_lambda2),
Lambda = factor(rep(c("lambda=0.5", "lambda=1.5"), each =

length(x))))
# Plot PDFs
ggplot(data, aes(x = x, y = PDF, color = Lambda)) +
geom_line() +
ggtitle("PDFs of Exponential Distributions (lambda=0.5 and lambda=1.5)") +
xlab("Time") + ylab("Density")
```

output:



4. Exercise 4: Calculate and Plot the Probability of Time Ranges

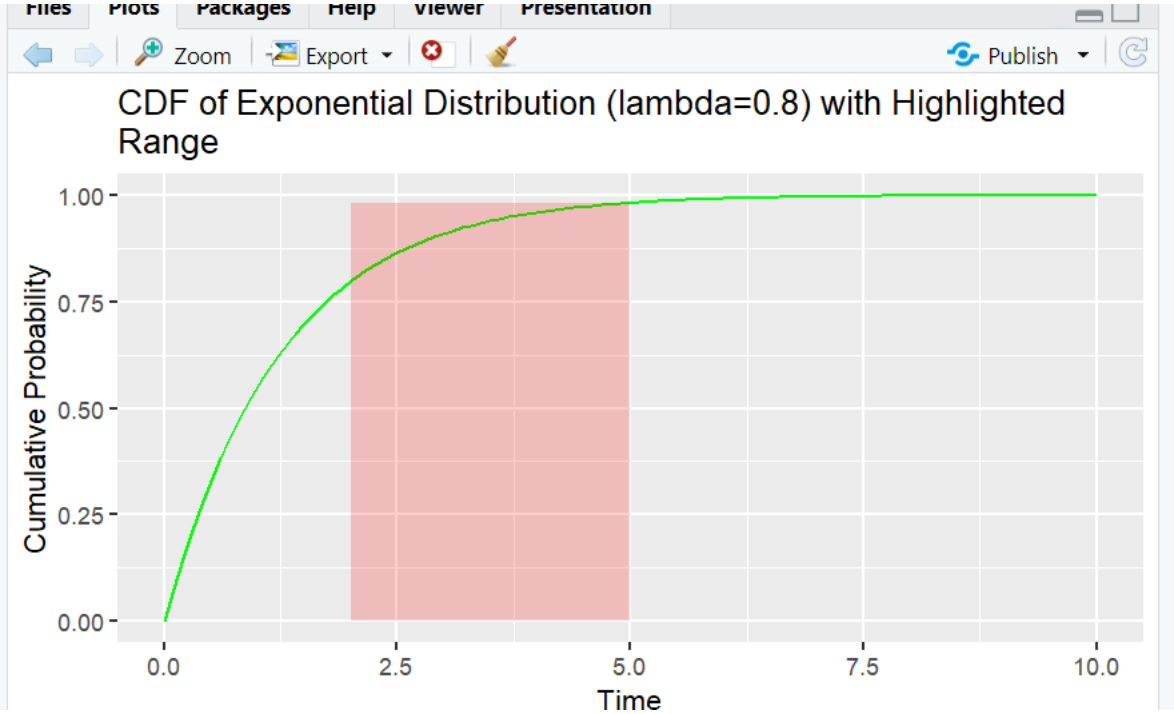
o Task: Calculate the probability that the time between events in an exponential distribution with λ = 0.8 falls between 2 and 5. Plot the CDF and highlight the probability range.

o Expected Output:

```
# Parameter
lambda <- 0.8 # Rate parameter
# Values of x
x <- seq(0, 10, by = 0.1)
# CDF
cdf_values <- pexp(x, rate = lambda)
# Probability of time between 2 and 5
prob_range <- pexp(5, lambda) - pexp(2, lambda)
print(prob_range) # Output should be the cumulative probability
# Data frame for plotting
data <- data.frame(x = x, CDF = cdf_values)
```

```
# Plot CDF and highlight the range
ggplot(data, aes(x = x, y = CDF)) +
geom_line(color = "green") +
ggtitle("CDF of Exponential Distribution (lambda=0.8) with Highlighted
Range") +
xlab("Time") + ylab("Cumulative Probability") +
annotate("rect", xmin = 2, xmax = 5, ymin = 0, ymax = pexp(5, lambda), alpha =
0.2, fill = "red")
```

Output:



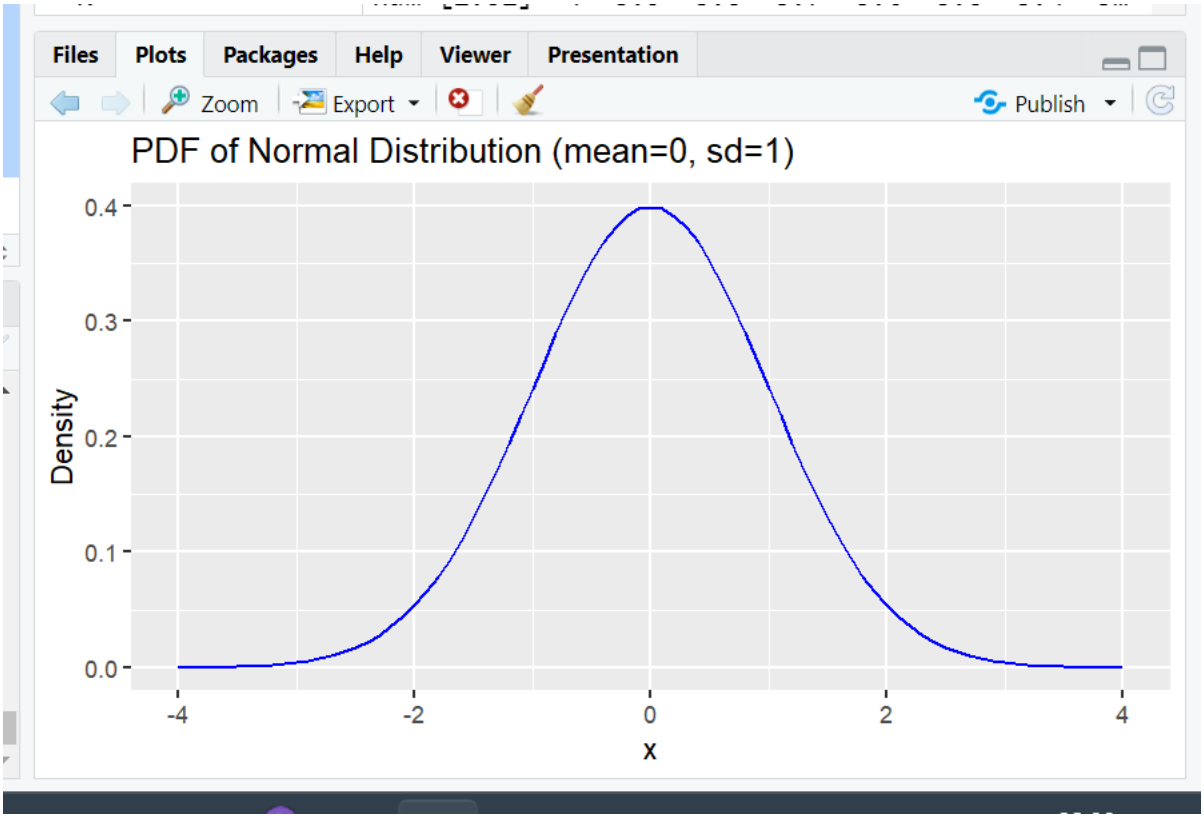
Coding Examples

o PDF of Normal Distribution

```
# Install and load ggplot2 package
install.packages("ggplot2")
library(ggplot2)
# Parameters
mean <- 0 # Mean
```

```
sd <- 1 # Standard deviation
# Values of x
x <- seq(-4, 4, by = 0.1)
# PDF
pdf_values <- dnorm(x, mean = mean, sd = sd)
# Data frame for plotting
data <- data.frame(x = x, PDF = pdf_values)
# Plot PDF
ggplot(data, aes(x = x, y = PDF)) +
geom_line(color = "blue") +
ggtitle("PDF of Normal Distribution (mean=0, sd=1)") +
xlab("x") + ylab("Density")
```

output:

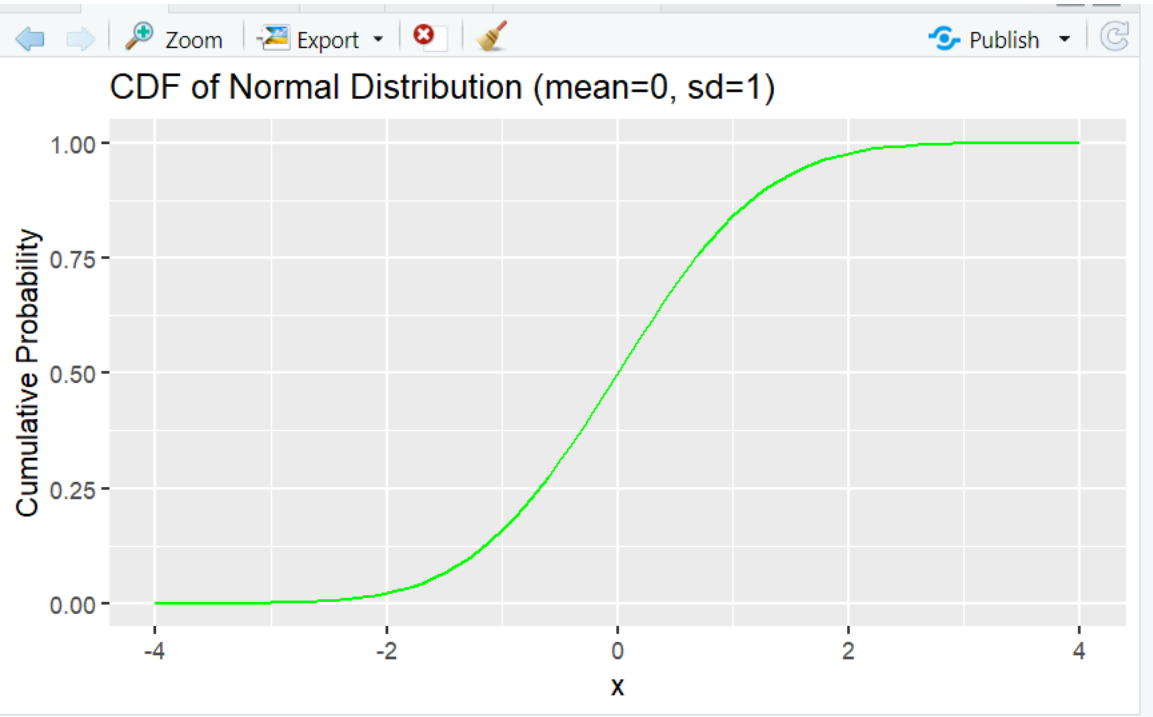


o CDF of Normal Distribution

```
# Parameters
```

```
mean <- 0 # Mean
sd <- 1 # Standard deviation
# Values of x
x <- seq(-4, 4, by = 0.1)
# CDF
cdf_values <- pnorm(x, mean = mean, sd = sd)
# Data frame for plotting
data <- data.frame(x = x, CDF = cdf_values)
# Plot CDF
ggplot(data, aes(x = x, y = CDF)) +
geom_line(color = "green") +
ggtitle("CDF of Normal Distribution (mean=0, sd=1)") +
xlab("x") + ylab("Cumulative Probability")
```

output:



Exercises

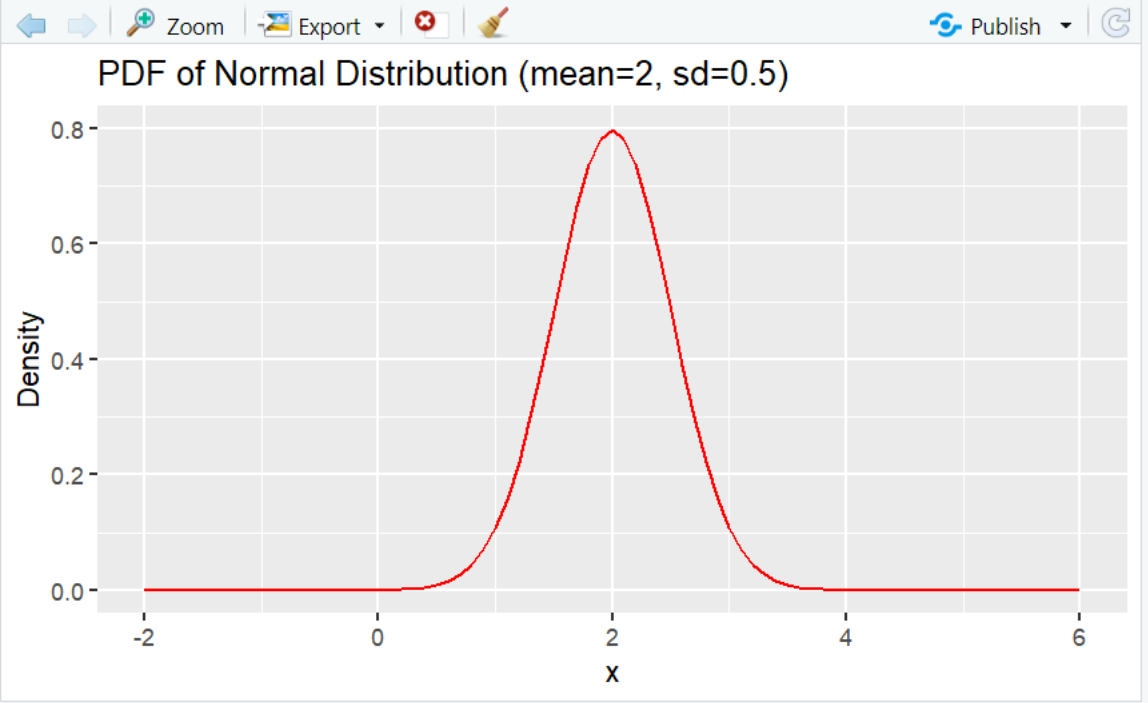
1. Exercise 1: Visualize the PDF for Different Parameters

o Task: Plot the PDF of a normal distribution with $\mu = 2$ and $\sigma = 0.5$.

o Expected Output:

```
# Parameters
mean <- 2 # Mean
sd <- 0.5 # Standard deviation
# Values of x
x <- seq(-2, 6, by = 0.1)
# PDF
pdf_values <- dnorm(x, mean = mean, sd = sd)
# Data frame for plotting
data <- data.frame(x = x, PDF = pdf_values)
# Plot PDF
ggplot(data, aes(x = x, y = PDF)) +
geom_line(color = "red") +
ggtitle("PDF of Normal Distribution (mean=2, sd=0.5)") +
xlab("x") + ylab("Density")
```

output:



2. Exercise 2: Visualize the CDF for Different Parameters

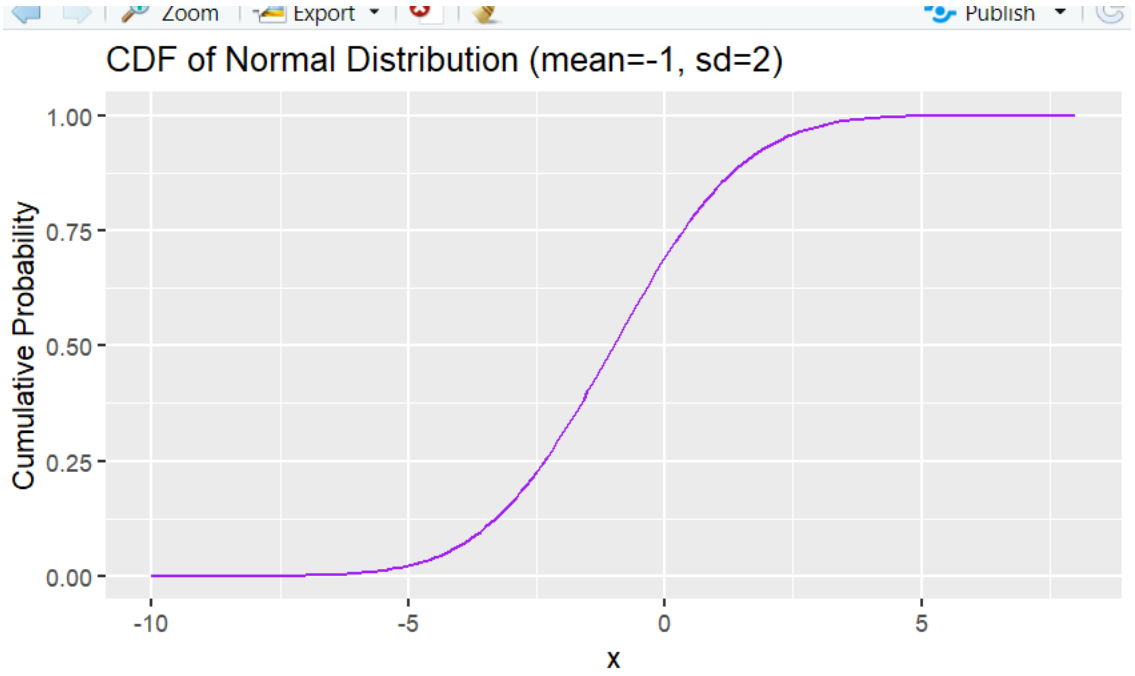
o Task: Plot the CDF of a normal distribution with μ = -1 and σ = 2.

o Expected Output:

```
# Parameters
mean <- -1 # Mean
sd <- 2 # Standard deviation
# Values of x
x <- seq(-10, 8, by = 0.1)
# CDF
cdf_values <- pnorm(x, mean = mean, sd = sd)
# Data frame for plotting
data <- data.frame(x = x, CDF = cdf_values)
# Plot CDF
ggplot(data, aes(x = x, y = CDF)) +
geom_line(color = "purple") +
ggtitle("CDF of Normal Distribution (mean=-1, sd=2)") +
```

xlab("x") + ylab("Cumulative Probability")

output:



3. Exercise 3: Compare PDFs of Different Normal Distributions

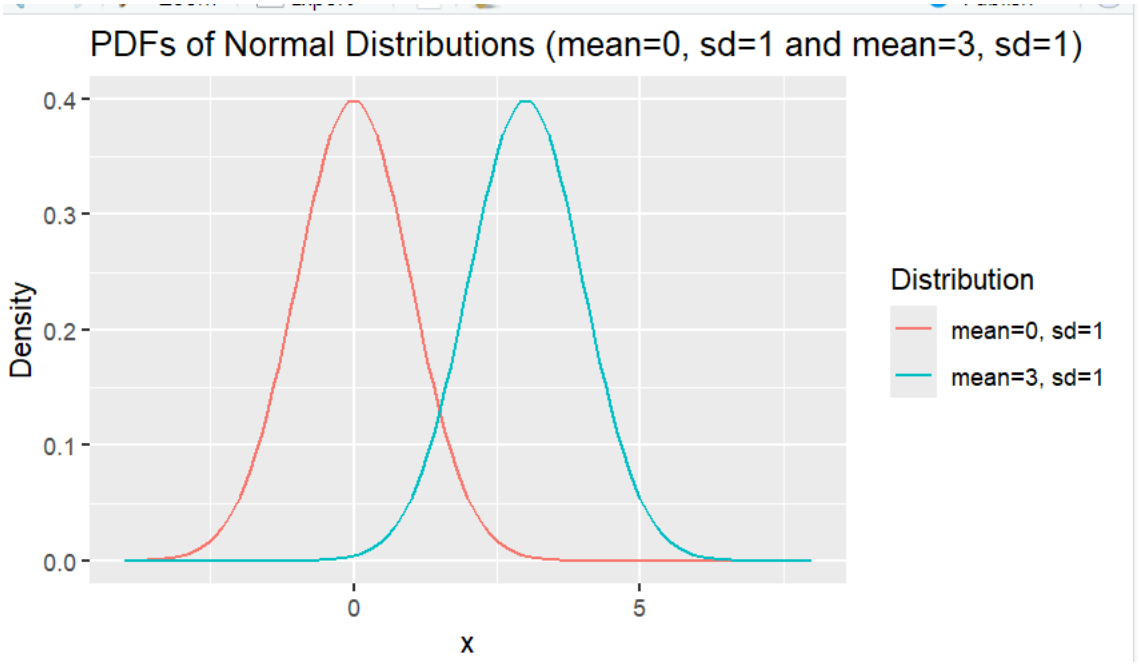
o Task: Plot the PDFs of normal distributions with parameters μ = 0, σ = 1 and μ = 3, σ = 1 on the same graph for comparison.

o Expected Output:

```
# Parameters
mean1 <- 0
sd1 <- 1
mean2 <- 3
sd2 <- 1
# Values of x
x <- seq(-4, 8, by = 0.1)
# PDF
pdf_values_mean1 <- dnorm(x, mean = mean1, sd = sd1)
pdf_values_mean2 <- dnorm(x, mean = mean2, sd = sd2)
```

```
# Data frame for plotting
data <- data.frame(x = rep(x, 2),

PDF = c(pdf_values_mean1, pdf_values_mean2),
Distribution = factor(rep(c("mean=0, sd=1", "mean=3, sd=1"), each =

length(x))))
# Plot PDFs
ggplot(data, aes(x = x, y = PDF, color = Distribution)) +
geom_line() +
ggtitle("PDFs of Normal Distributions (mean=0, sd=1 and mean=3, sd=1)") +
xlab("x") + ylab("Density")
```

output:



4. Exercise 4: Calculate and Plot the Probability of Ranges

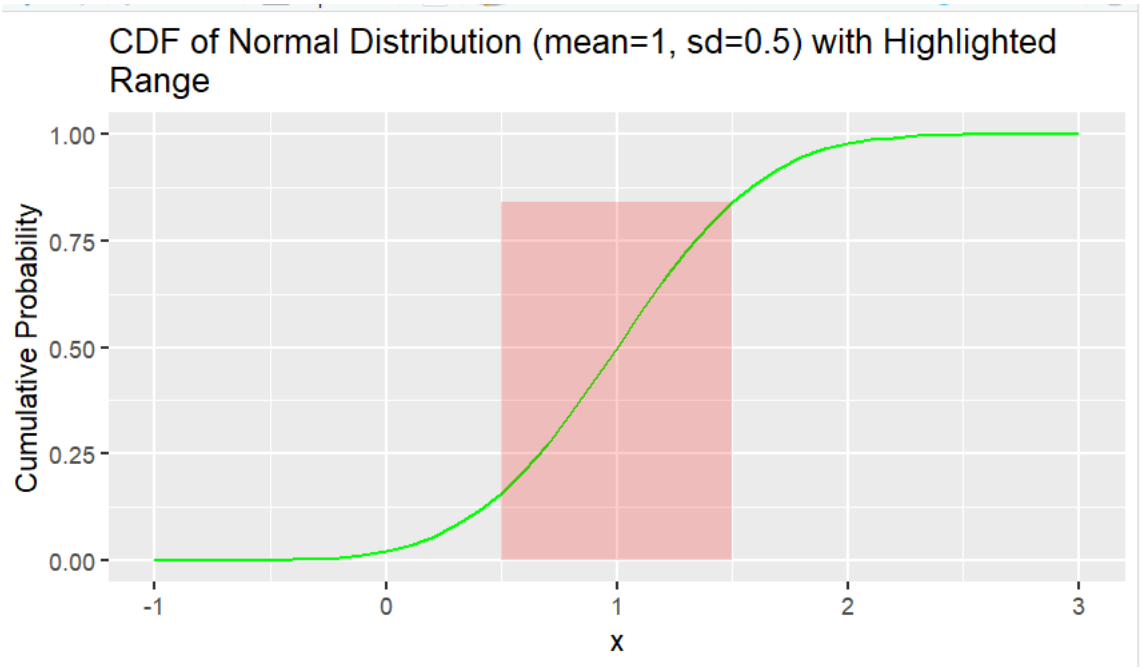
o Task: Calculate the probability that a value from a normal distribution with $\mu = 1$ and $\sigma = 0.5$ falls between 0.5 and 1.5. Plot the CDF and highlight the probability

range.

o Expected Output:

```
# Parameters
mean <- 1 # Mean
sd <- 0.5 # Standard deviation
# Values of x
x <- seq(-1, 3, by = 0.1)
# CDF
cdf_values <- pnorm(x, mean = mean, sd = sd)
# Probability of values between 0.5 and 1.5
prob_range <- pnorm(1.5, mean, sd) - pnorm(0.5, mean, sd)
print(prob_range) # Output should be the cumulative probability
# Data frame for plotting
data <- data.frame(x = x, CDF = cdf_values)
# Plot CDF and highlight the range
ggplot(data, aes(x = x, y = CDF)) +
geom_line(color = "green") +
ggtitle("CDF of Normal Distribution (mean=1, sd=0.5) with Highlighted
Range") +
xlab("x") + ylab("Cumulative Probability") +
annotate("rect", xmin = 0.5, xmax = 1.5, ymin = 0, ymax = pnorm(1.5, mean,
sd), alpha = 0.2, fill = "red")
```

output:


CDF of Normal Distribution (mean=1, sd=0.5) with Highlighted Range
Cumulative Probability
1.00
0.75
0.50
0.25
0.00
-1
0
1
2
3
x