Exponential Distribution Simulation

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Simulation Parameters

```
# Parameters
lambda <- 0.2  # rate parameter of the exponential distribution
n <- 40  # number of exponentials in each sample
simulations <- 1000  # number of simulations

# Theoretical mean and variance of the sample means
theoretical_mean <- 1 / lambda
theoretical_variance <- (1 / lambda)^2 / n  # Variance of the sample mean
```

Simulation Results

```
# Set seed for reproducibility
set.seed(123)

# Simulate the data: 1000 simulations, each with 40 exponential values
sample_means <- replicate(simulations, mean(rexp(n, lambda)))

# Sample mean of the sample means
mean_sample_means <- mean(sample_means)
variance_sample_means <- var(sample_means)

# Print results
cat("Sample Mean of Sample Means:", mean_sample_means, "\n")
```

```
## Sample Mean of Sample Means: 5.011911
```

```
cat("Variance of Sample Means:", variance_sample_means, "\n")
```

```
## Variance of Sample Means: 0.6004928
```

```
cat("Theoretical Mean:", theoretical_mean, "\n")
```

```
## Theoretical Mean: 5
```

```r
cat("Theoretical Variance:", theoretical_variance, "\n")
```

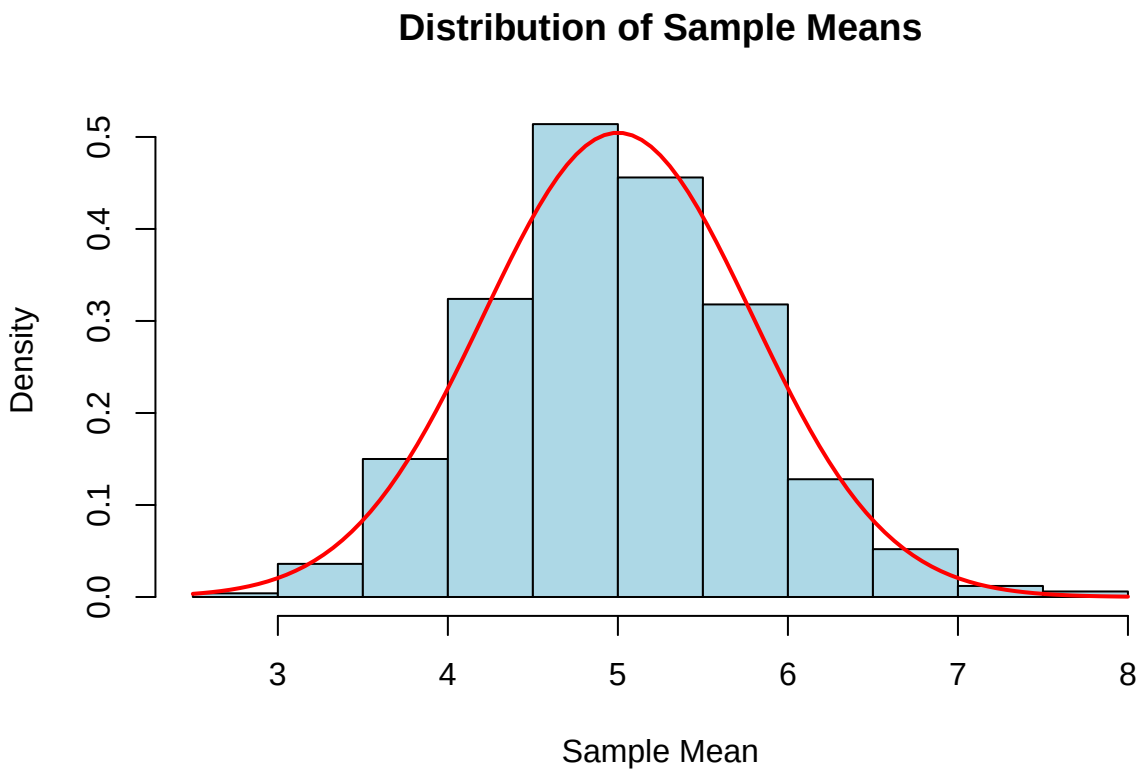
```
## Theoretical Variance: 0.625
```

Visualizations

Distribution of Sample Means

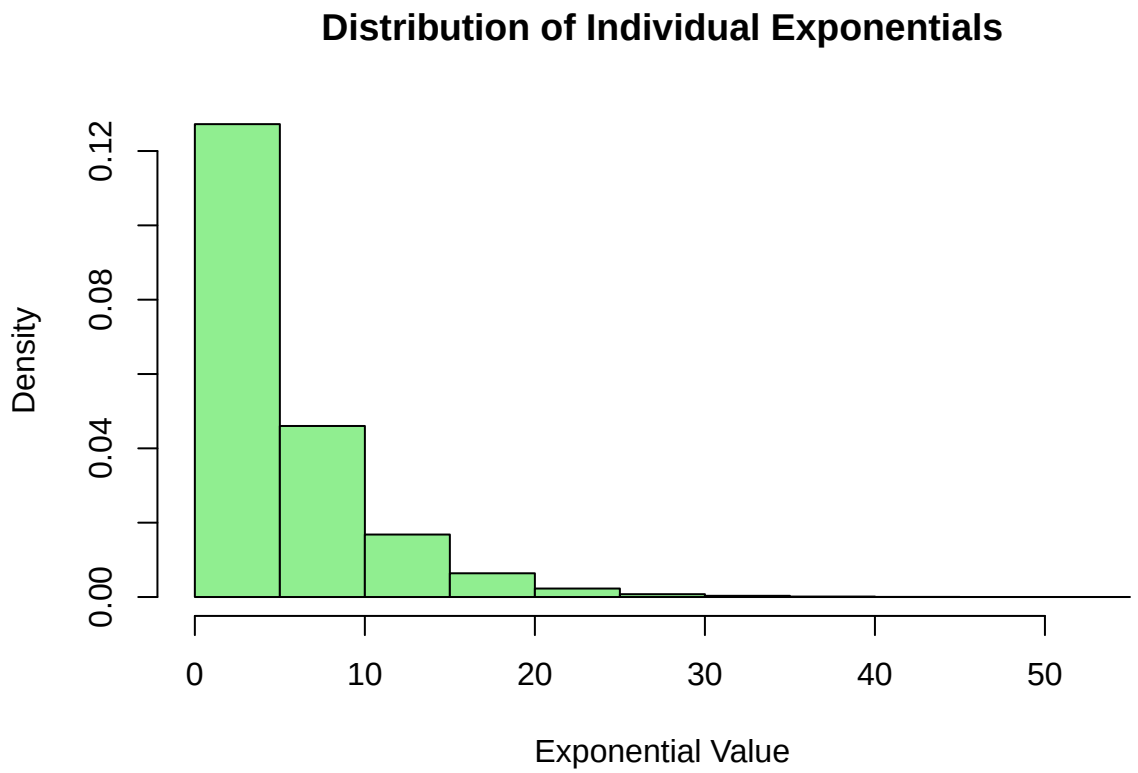
```r
# Plot the distribution of sample means
hist(sample_means, probability = TRUE,
     main = "Distribution of Sample Means",
     xlab = "Sample Mean",
     col = "lightblue",
     border = "black")

# Add the theoretical normal curve to the histogram
curve(dnorm(x, mean = theoretical_mean, sd = sqrt(theoretical_variance)),
      add = TRUE, col = "red", lwd = 2)
```



Distribution of Individual Exponentials

```r
# Plot the distribution of individual exponentials
individual_exponentials <- rexp(simulations * n, lambda)
hist(individual_exponentials, probability = TRUE,
     main = "Distribution of Individual Exponentials",
     xlab = "Exponential Value",
     col = "lightgreen",
     border = "black")
```



Conclusion

This simulation demonstrates the Central Limit Theorem for exponential distributions, showing how sample means converge to a normal distribution with the expected theoretical mean and variance.