How can you simulate and plot a bivariate normal distribution in R?

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June 29, 2024

To simulate and plot a bivariate normal distribution in R, the user can use the "mvrnorm" function from the "MASS" package. This function generates a specified number of random samples from a bivariate normal distribution with the given mean and covariance matrix. The user can then use the "plot" function to visualize the generated data points on a scatter plot, with the x-axis representing one variable and the y-axis representing the other variable. Additionally, the "ggplot2" package can be used to create a more visually appealing plot with customizable features such as adding a regression line or changing the color scheme. Overall, by utilizing the appropriate R packages and functions, the user can easily simulate and plot a bivariate normal distribution for further analysis and visualization.

Simulate & Plot a Bivariate Normal Distribution in R

In statistics, two variables follow a bivariate normal distribution if they have a normal distribution when added together.

This tutorial explains how to perform the following tasks in R:

Simulate a bivariate normal distributionPlot a bivariate normal distribution using a contour plot (2-D plot)Plot a bivariate normal distribution using a surface plot (3-D plot)

Let's jump in!

Example 1: Simulate a Bivariate Normal Distribution in R

The easiest way to simulate a bivariate normal distribution in R is to use the mvrnorm() function from

the MASS package.

The following code shows how to use this function to simulate a bivariate normal distribution in practice:

```
library(MASS)

#make this example reproducible
set.seed(0)

#simulate bivariate normal distribution
bivariate_data <- as.data.frame(mvrnorm(n=100,
mu=c(0, 0),
Sigma=matrix(c(5, 3, 4, 4), ncol=2)))

#view first six rows of bivariate dataset
head(bivariate_data)

V1 V2
1 -2.03600343 -2.9623059
2 0.07719131 1.2948982
3 -3.26729701 -1.7928069
4 -2.62985132 -2.3015471
5 -1.75126215 0.3056698
6 3.67698436 2.2020238
```

Here's what each argument in the mvrnorm() function does:

n: Defines the sample sizemu: Defines the mean of each variableSigma: Defines the covariance matrix of the two variables

The end result is a data frame with two variables that follow a normal distribution when added together.

Example 2: Plot a Bivariate Normal Distribution

The easiest way to plot a bivariate normal distribution in R is to use functions from the mnormt() package.

For example, we can use the contour() function from this package to create a contour plot, which offers a 2-D visualization of the bivariate normal distribution:

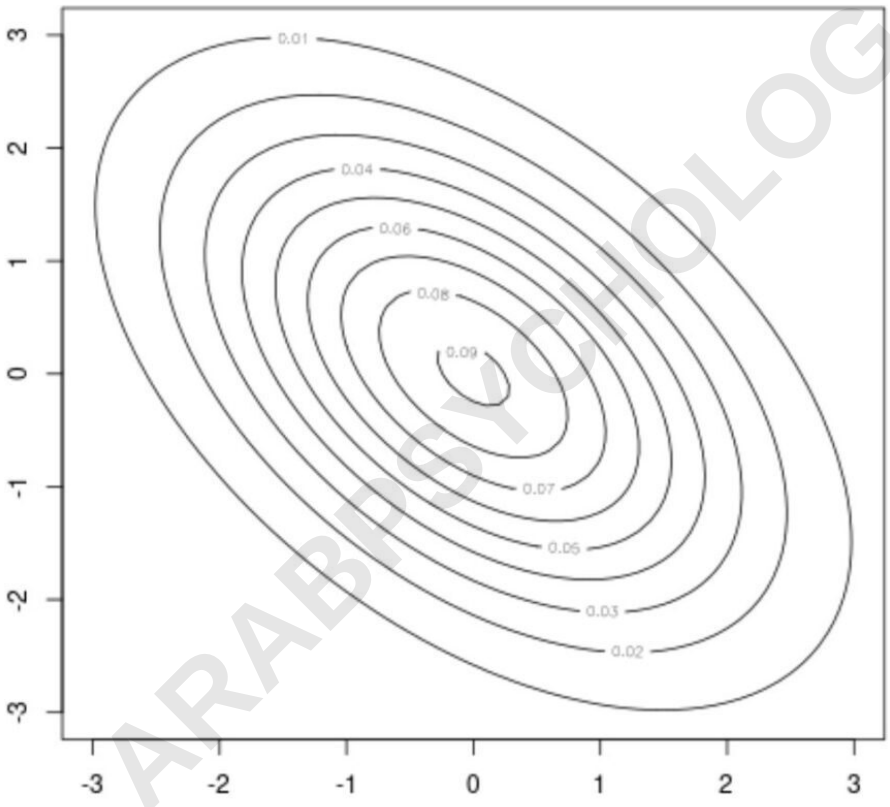
```
library(mnormt)

#make this example reproducible
set.seed(0)

#create bivariate normal distribution
x <- seq(-3, 3, 0.1)
y <- seq(-3, 3, 0.1)
```

```
mu <- c(0, 0)
sigma <- matrix(c(2, -1, -1, 2), nrow=2)
f <- function(x, y) dmnorm(cbind(x, y), mu, sigma)
z <- outer(x, y, f)

#create contour plot
contour(x, y, z)
```



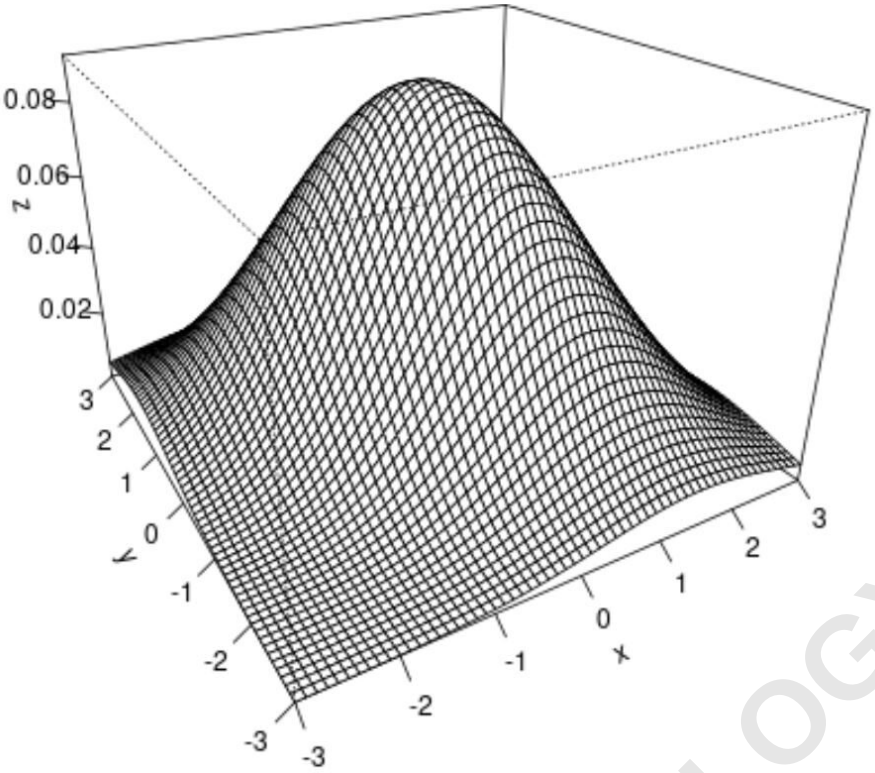
We can also use the persp() function from to create a surface plot, which offers a 3-D visualization of the bivariate normal distribution:

```
library(mnormt)

#make this example reproducible
set.seed(0)

#create bivariate normal distribution
x <- seq(-3, 3, 0.1)
y <- seq(-3, 3, 0.1)
mu <- c(0, 0)
sigma <- matrix(c(2, -1, -1, 2), nrow=2)
f <- function(x, y) dmnorm(cbind(x, y), mu, sigma)
z <- outer(x, y, f)

#create surface plot
persp(x, y, z, theta=-30, phi=25, expand=0.6,
ticktype='detailed')
```



Here's what each argument in the persp() function does:

theta, phi: Defines the angles of the viewing direction.expand: Controls the size of the z-axis.ticktype: Controls the appearance of the ticks on the axes.

The end result is a 3-D surface plot of the bivariate normal distribution.

Additional Resources

The following tutorials explain how to work with other probability distributions in R: