SIMULATIONS

ESTIMATE PI MONTE CARLO

OUR TEAM

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INTRODUCTION

- One popular method for estimating pi is the Monte Carlo method, a computational technique that uses random numbers to simulate complex systems.

- The Monte Carlo method for estimating pi is based on the idea that if you randomly scatter points inside a square and count the number of points that fall inside a circle inscribed in the square, you can estimate the value of pi

STEPS OF ALGORITHM

- Generate a random point (x, y) inside a square of side 2 centred at the origin.
- Determine whether the point falls inside the unit circle inscribed in the square by checking whether $x^2 + y^2 <= 1$.
- Repeat steps 1 and 2 for a large number of points
- Calculate the ratio of the number of points that fell inside the circle to the total number of points generated.
- Multiply the ratio by 4 to estimate the value of pi.

SCREEN OF CODE

```r
# Load the readxl package
library(readxl)
# Read the Excel file containing the x and y sequences
# Replace "input.xlsx" with the path to your Excel file
data <- read_excel("input.xlsx")
# Extract x and y sequences from the data frame
x_sequence <- data[["x_sequence"]]
y_sequence <- data[["y_sequence"]]

# Check if the lengths of x and y sequences match
if (length(x_sequence) != length(y_sequence)) {
  stop("Length of x sequence must match length of y sequence.")
}

```

- this code reads data from an Excel file, extracts two sequences from it, and ensures that the lengths of these sequences match.
- If they don't match, it stops execution and displays an error message.

SCREEN OF CODE

- computes the Euclidean distance from the origin to each point.
- Points with distances greater than the corresponding values in y_sequence are assigned the color "red", otherwise "black".
- Points with distances greater than the corresponding values in **y_sequence** are labeled as "IN", otherwise "OUT".

```
# Calculate distances from the origin for all points
distances <- sqrt(1 - x_sequence^2)
# Initialize an empty vector to store colors
colors <- ifelse(distances > y_sequence, "red", "black")
# Calculate the decision for each point
decisions <- ifelse(distances > y_sequence, "IN", "OUT")
# Create a data frame with the columns
data <- data.frame(
  "First Random Number (X)" = x_sequence,
  "Second Random Number (Y)" = y_sequence,
  "Distances" = distances,
  "Decision" = decisions
)
```

SCREEN OF CODE

```
# Save the data frame to a CSV file
write.csv(data, "output.csv", row.names = TRUE)
# Display the data frame
print(data)
# Save the plot as a PNG image
png("output.png", width = 1600, height = 1400, units = "px", res = 300)
plot(x_sequence, y_sequence, pch = 20, col = colors)
dev.off()
```

- Saving the data data frame to a CSV file named "output.csv".
- It saves a plot of the x_sequence against y_sequence with points colored based on the colors vector to a PNG file named "output.png"

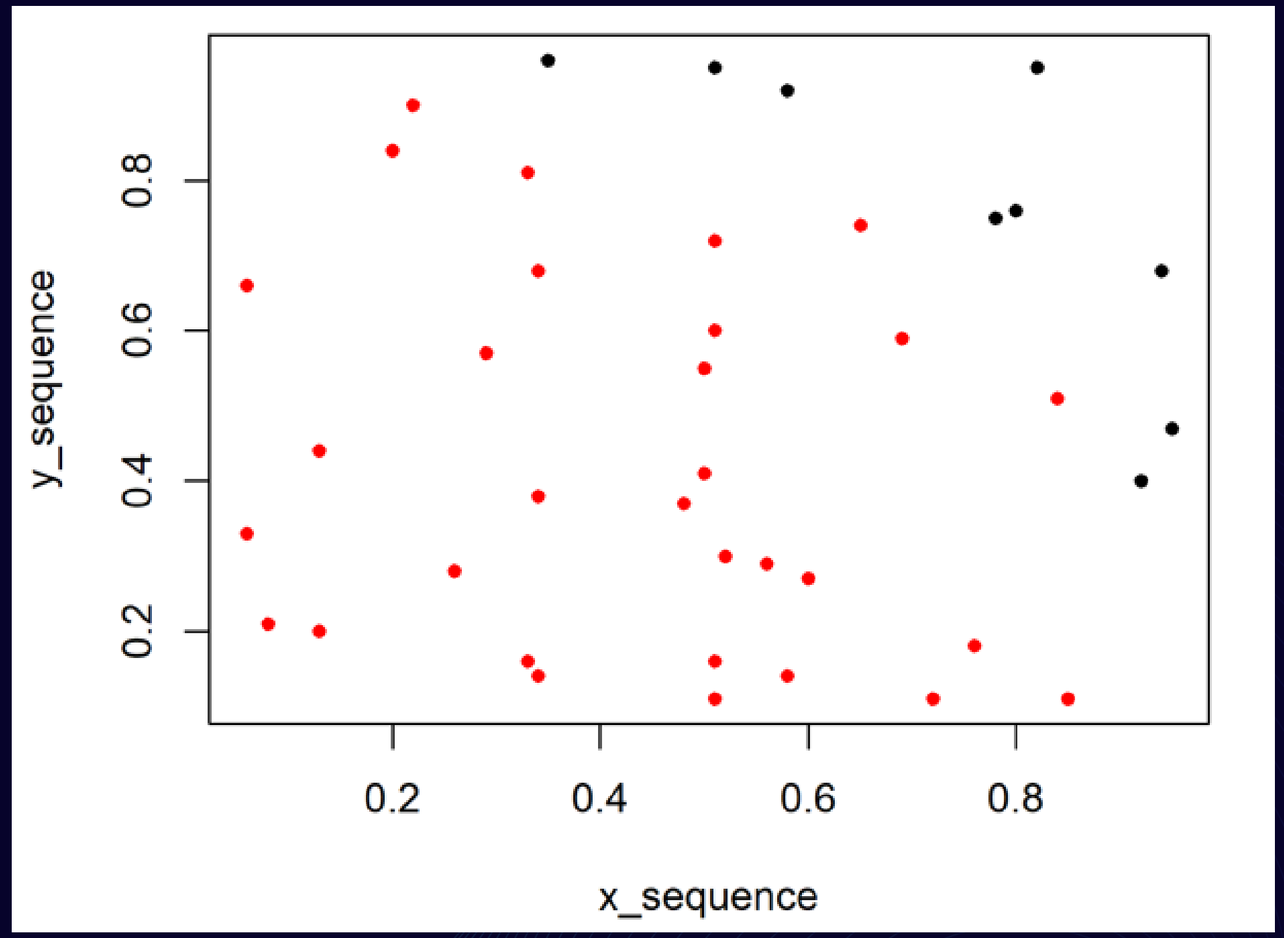
SCREEN OF CODE

- Count the number of "IN" decisions and stored it in M and calculate the numbers of iterations then stores it in N
- It estimates the value of Pi using the formula: estimated_pi=$(M/N)\times4$

```
# Count the number of "OUT" decisions
M <- sum(decisions == "IN")
# Calculate the count of iterations
N <- length(x_sequence)
# Calculate the estimated value of Pi
estimated_pi <- (M/N)*4
# Print the estimated value of Pi
cat("The value of Pi is estimated to be:", estimated_pi, "\n")
```

OUTPUT GRAPH:

- From this graph the points have colour red:
  - when √(1 - x^2) larger than Y
  - the points are inside the circle.
- From this graph the points have colour black:
  - when √(1 - x^2) Small than Y
  - the points are outside the circle.



BY MINITAB:

- after we run simulations by R then we write output into file (excel).
  then take this file as input in MINITAB to visualize it by scatterplots

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- From this graph the points have colour black:
  - when √(1 - x^2) Small than Y
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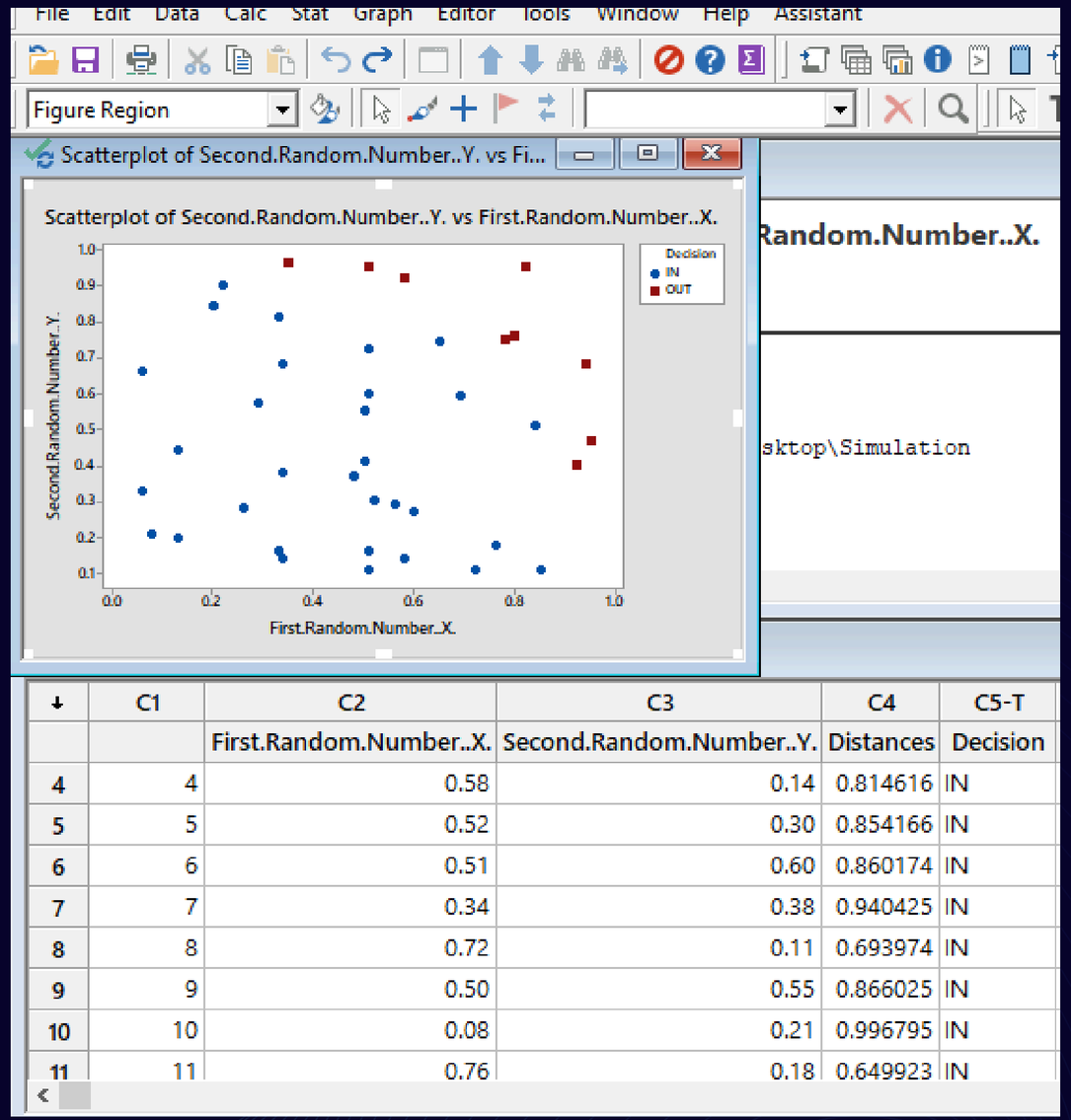

	C1	C2	C3	C4	C5-T
		First.Random.Number..X.	Second.Random.Number..Y.	Distances	Decision
4	4	0.58	0.14	0.814616	IN
5	5	0.52	0.30	0.854166	IN
6	6	0.51	0.60	0.860174	IN
7	7	0.34	0.38	0.940425	IN
8	8	0.72	0.11	0.693974	IN
9	9	0.50	0.55	0.866025	IN
10	10	0.08	0.21	0.996795	IN
11	11	0.76	0.18	0.649923	IN