VII. MARKOV CHAINS ANALYSIS USING MARKOVCHAIN PACKAGE IN R

Aim

The aim of this lab manual is to introduce students to Markov chains and their analysis using the markovchain package in R. Students will learn how to create, analyze, and simulate Markov chains, interpret results, and apply these skills to practical scenarios.

Exercises

1. **Exercise 1: Simple Markov Chain Analysis**
    - **Task:** Create a Markov chain for a system with three states (e.g., "On", "Off", "Idle") and transition probabilities provided.
    - **Expected Output:** Display the Markov chain object, calculate the stationary distribution, simulate the chain, and check for ergodicity.

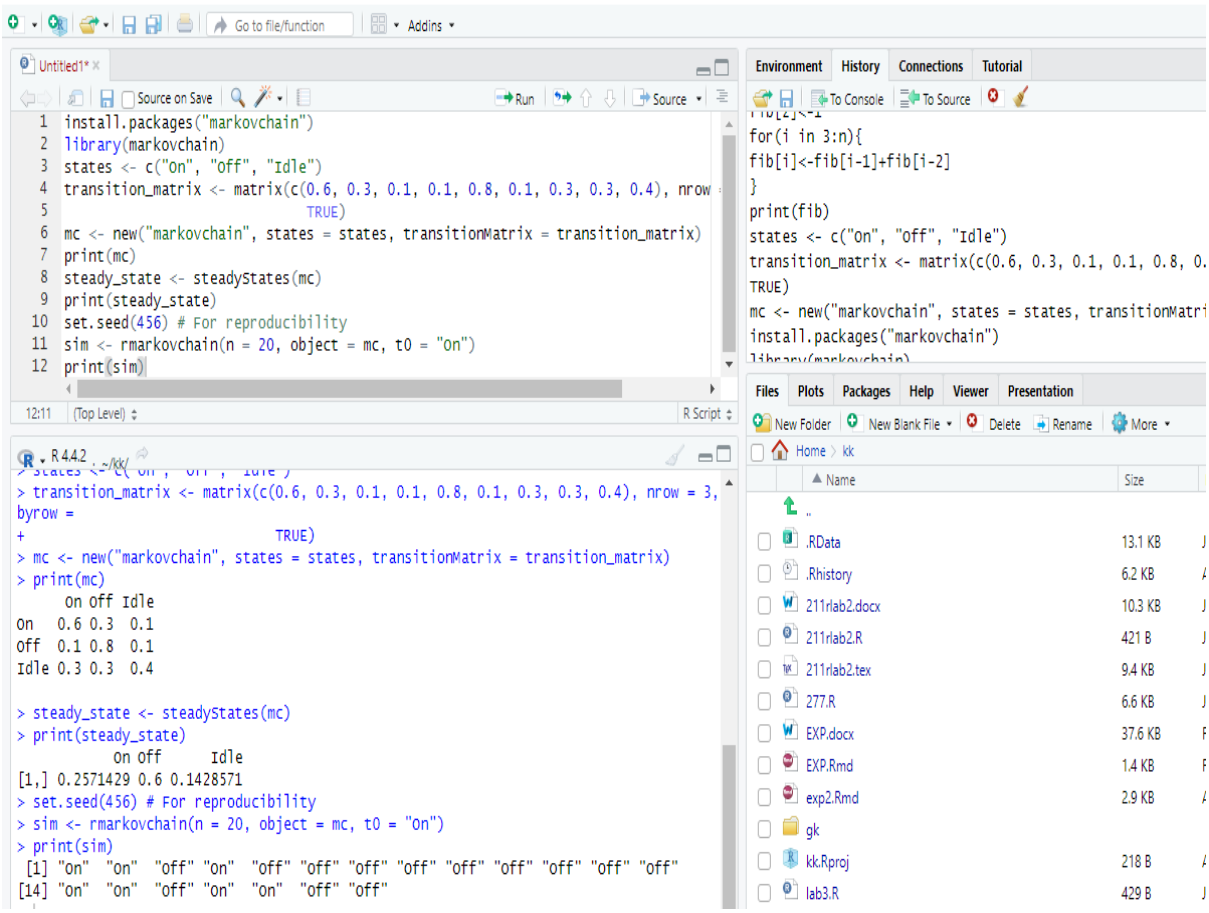
```
# Define states and transition matrix
states <- c("On", "Off", "Idle")
transition_matrix <- matrix(c(0.6, 0.3, 0.1, 0.1, 0.8, 0.1, 0.3, 0.3, 0.4), nrow = 3, byrow = TRUE)

# Create Markov chain
mc <- new("markovchain", states = states, transitionMatrix = transition_matrix)

# Print the Markov chain object
print(mc)

# Calculate stationary distribution
steady_state <- steadyStates(mc)
print(steady_state)

# Simulate the Markov chain
set.seed(456)  # For reproducibility
sim <- rmarkovchain(n = 20, object = mc, t0 = "On")
print(sim)
```



2. Exercise 2: Real-World Application

- **Task:** Apply Markov chains to model a practical scenario (e.g., weather patterns, stock market behavior) using data or assumptions. Formulate a Markov chain, analyze its properties, and interpret the results.

```
# Example: Modeling weather transitions
states <- c("Sunny", "Cloudy", "Rainy")
transition_matrix <- matrix(c(0.7, 0.2, 0.1, 0.3, 0.5, 0.2, 0.2, 0.3, 0.5), nrow = 3, byrow = TRUE)
mc_weather <- new("markovchain", states = states, transitionMatrix = transition_matrix)
```

```
# Print the Markov chain object
print(mc_weather)

# Calculate stationary distribution
steady_state_weather <- steadyStates(mc_weather)
print(steady_state_weather)

# Simulate the Markov chain
set.seed(789)  # For reproducibility
sim_weather <- rmarkovchain(n = 30, object = mc_weather, t0 = "Sunny")
print(sim_weather)

# Check ergodicity
if (is.ergodic(mc_weather)) {
  cat("The weather Markov chain is ergodic.\n")
} else {
  cat("The weather Markov chain is not ergodic.\n")
}
```