

Laboratory 7

Generating different experiments with Markovian structure

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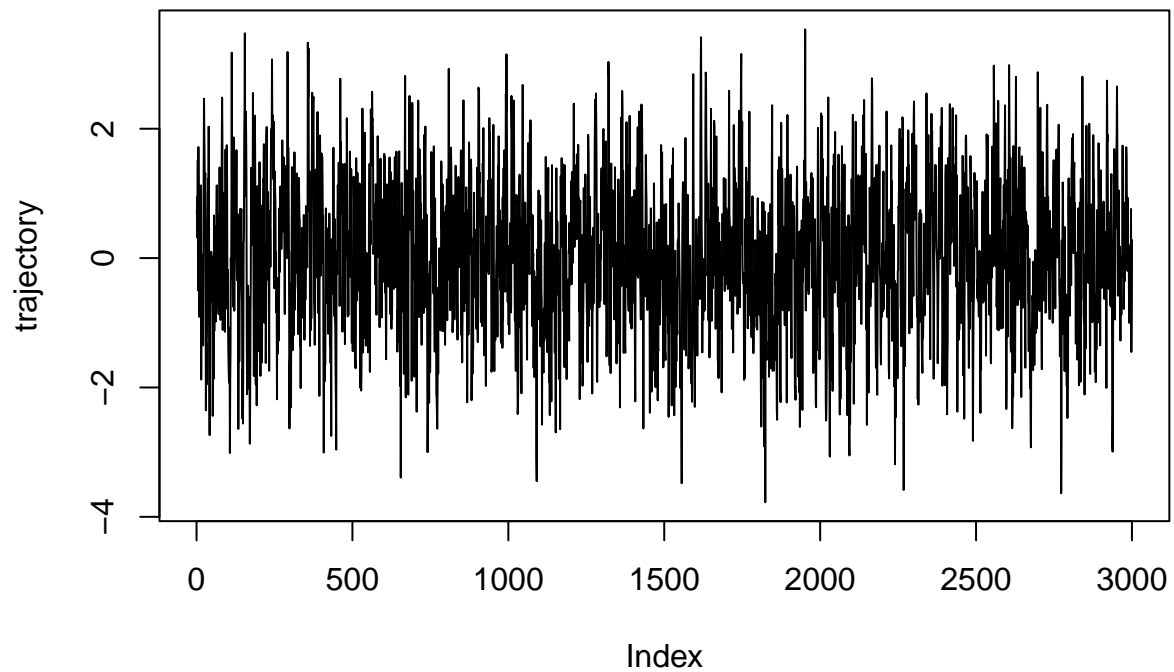
We are doing exercise 2.6 from lecture notes. Firstly, we are creating toy example. Then we define a function which simulates AR(1) process. We are investigating stationarity of our process and answer the question about distribution of X_n .

```
n_times <- 3000
X0 <- rnorm(1)
trajectory <- numeric(n_times)
alpha <- 1/2
trajectory[1] <- X0

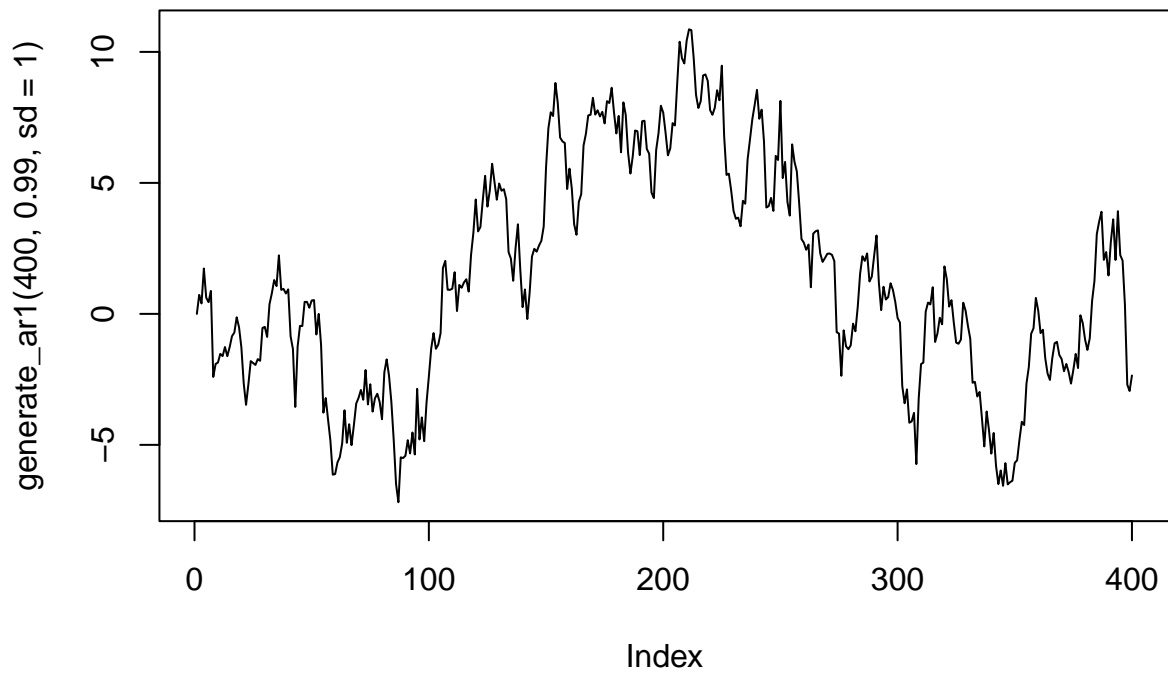
for (i in (2:n_times)){
  trajectory[i] = alpha * trajectory[i-1] + rnorm(1)
}
head(trajectory)
```

```
## [1]  0.6885530  0.9413845  0.3143312  1.5102934 -0.5009041  1.7168632
```

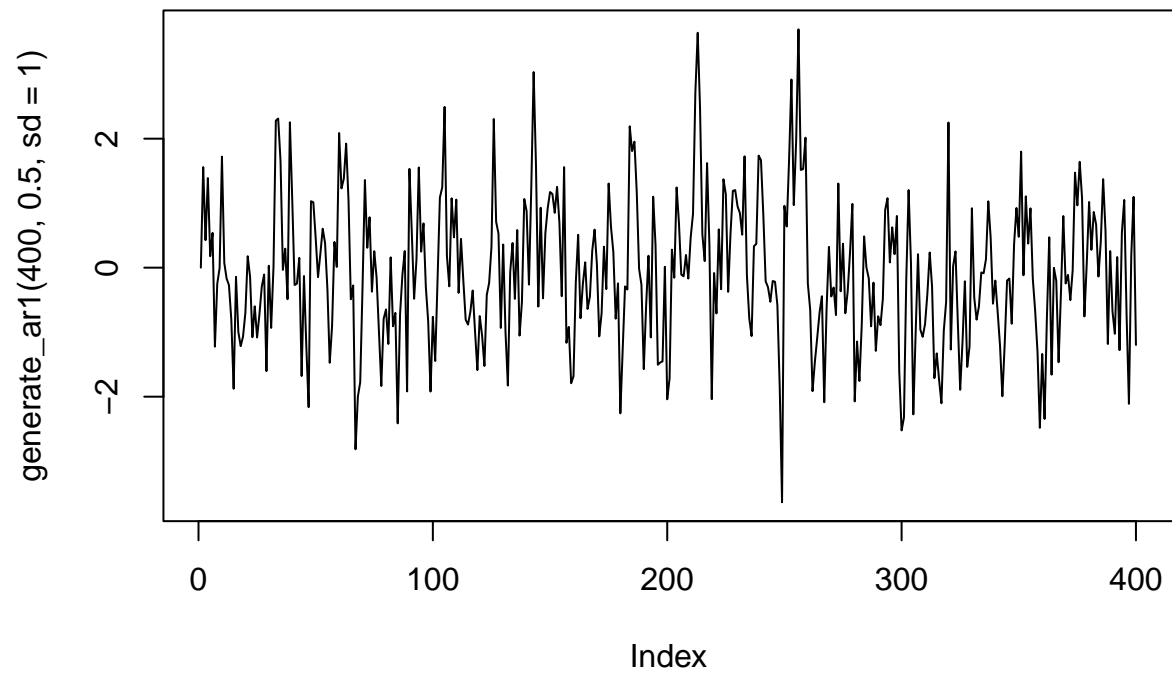
```
plot(trajectory, type = "l")
```



```
generate_ar1 <- function(n_times, alpha, sd){  
  X0 <- 0  
  trajectory <- numeric(n_times)  
  randoms <- rnorm(n_times, mean = 0, sd = sd)  
  
  for (i in (2:n_times)){  
    trajectory[i] = alpha * trajectory[i-1] + randoms[i]  
  }  
  return(trajectory)  
}  
  
plot(generate_ar1(400, 0.99, sd = 1), type = "l")
```



```
plot(generate_ar1(400, 0.5, sd = 1), type = "l")
```



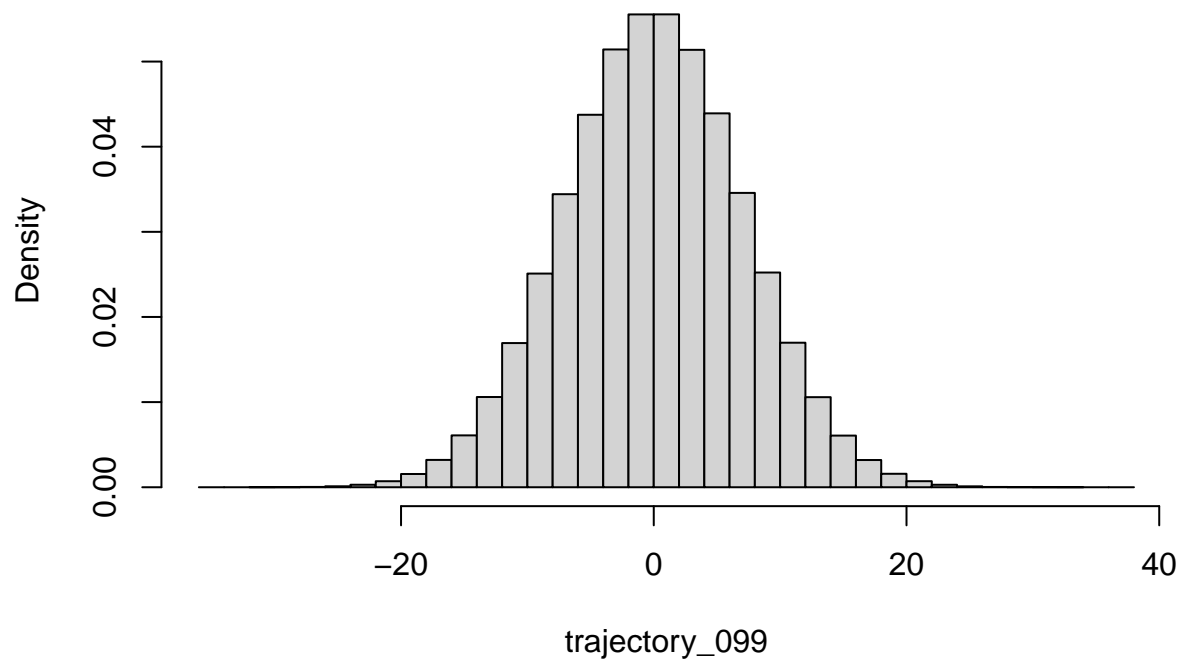
```
plot(generate_ar1(400, 1.01, sd = 1), type = "l")
```



```
trajectory_099 <- generate_ar1(30000000, 0.99, sd = 1)
trajectory_05 <- generate_ar1(30000000, 0.5, sd = 1)

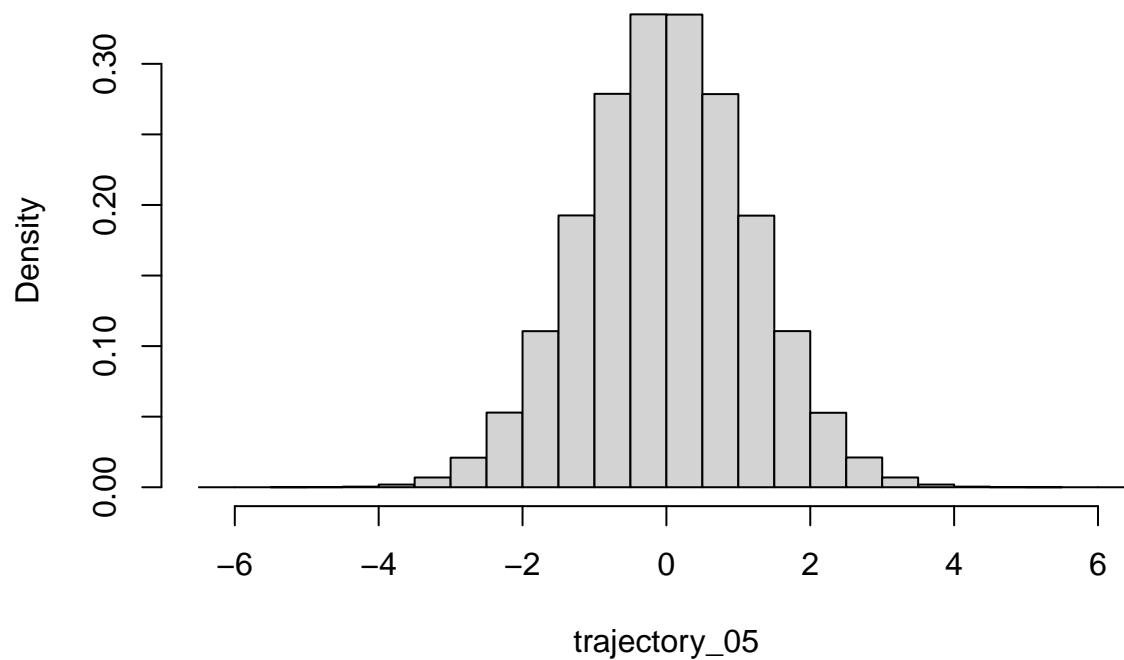
hist(trajectory_099, freq = FALSE)
```

Histogram of trajectory_099



```
hist(trajectory_05, freq = FALSE)
```

Histogram of trajectory_05



```
var(trajectory_099)
```

```
## [1] 50.16248
```

```
var(trajectory_05)
```

```
## [1] 1.332857
```

Let's clear the environment and proceed next task.

```
rm(list = ls())
```

Let's simulate Markov process with continuous time.

```
alpha <- 1
beta <- 3
start <- 1
n_jumps <- 200
time <- 0

step <- function(state, alpha, beta){
  if (state == 1){
    return(c(rexp(alpha)))
  }
}
```

```
else if (state == 2){  
  return(c(rexp(beta)))  
}  
}  
  
trajectory <- vector()  
for (i in 1:n_jumps){  
  trajectory <- c(trajectory, step(i %% 2, alpha, beta))  
}  
  
# to consider
```

Clearing the environment.

```
rm(list = ls())
```