Trabalho6

June 11, 2025

[1]:
```
library(pacman)
p_load(dplyr,glarma,boot)
```

[2]:
```
setwd('C:\\Users\\Marcelo\\OneDrive\\Área de Trabalho\\ts\\glarma')
getwd()
```

'C:/Users/Marcelo/OneDrive/Área de Trabalho/ts/glarma'

1 Simulação

Criando a função que simula o processo:

[3]:
```
simulate_glarma <- function(T = 100, beta = 1, phi = 0, theta = 0.3, x = NULL) {
  if (is.null(x)) x <- rep(1, T)

  z <- numeric(T)
  mu <- numeric(T)
  y <- numeric(T)
  e <- numeric(T)

  for (t in 1:T) {
    z_t <- 0
    if (t > 1) z_t <- z[t - 1] * phi + e[t - 1] * theta

    eta <- beta * x[t] + z_t
    mu[t] <- exp(eta)
    y[t] <- rpois(1, lambda = mu[t])
    e[t] <- (y[t] - mu[t]) / sqrt(mu[t])
    z[t] <- z_t
  }

  return(data.frame(time = 1:T, x = x, y = y, mu = mu, z = z,e=e))
}
```

[4]:
```
Amostra_original<-simulate_glarma(T=100,beta=1,phi=0,theta=0.3,x=NULL)
```

[5]:
```
length(Amostra_original$y)
```

100

[6]:
```
summary(Amostra_original$y)
```

```
   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
   0.00    2.00    3.00    2.77    4.00    8.00
```

[7]:
```
X <- Amostra_original$x
X <- as.matrix(X)
colnames(X) <- "Intercept"
```

[8]:
```
result=glarma(Amostra_original$y, X, phiLags = NULL ,thetaLags = c(1), type =␣
 ↪"Poi")
```

[9]:
```
Theta<-result$delta[2]
Theta
```

theta_1: 0.286750359714207

[10]:
```
Beta<-result$delta[1]
Beta
```

Intercept: 0.9871397206586

2 Bootstrap paramétrico:

[11]:
```
B=100
```

[12]:
```
T=length(Amostra_original$y)
```

gerando as amostras bootstrap:

[13]:
```
mu<-Amostra_original$mu
```

[14]:
```
length(mu)
```

100

[15]:
```
Y_Bootstrap <- matrix(NA, nrow = T, ncol = B)
```

[16]:
```
for (b in 1:B){
    r = simulate_glarma(T=T,beta=1,phi=0,theta=Theta,x=NULL)
    Y_Bootstrap[,b] <- r$y
    }
```

Estimando os parâmetros para cada amostra:

[17]:
```
recupera_par<- function(Y_col){
    fit<-glarma(Y_col, X, phiLags = NULL ,thetaLags = c(1), type = "Poi")
    return(fit$delta[2])}
```

```
[18]: Theta_estimates <- apply(Y_Bootstrap, 2, recupera_par)
```

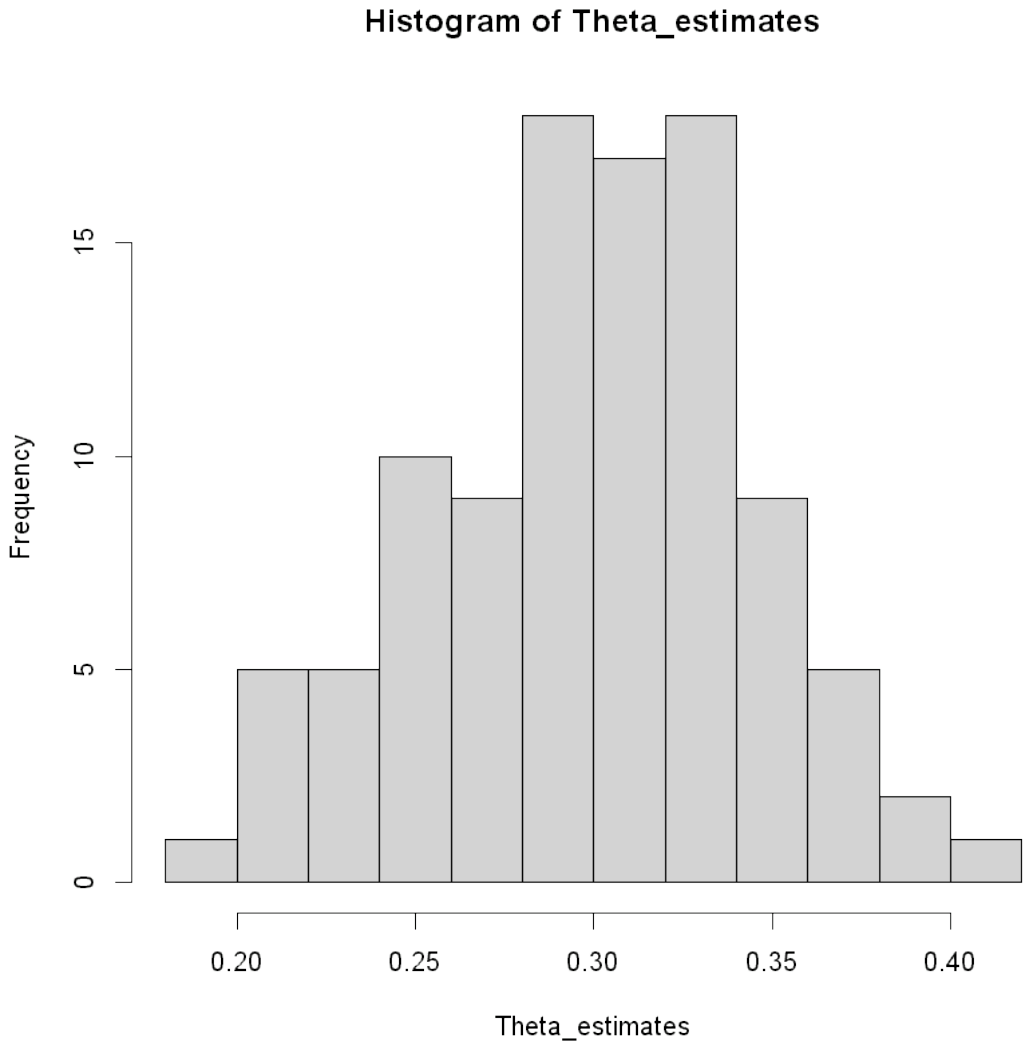
```
[19]: mean(Theta_estimates)
```

0.299230627877932

```
[20]: quantile(Theta_estimates,probs=c(0.025,0.975))
```

2.5\% 0.212654740387911 **97.5\%** 0.380742664849596

```
[21]: hist(Theta_estimates)
```



Nosso bootstrap está funcionando, vamos fazer o experimento monte carlo:

2.0.1 Questão 1

[22]:
```
R = 100
```

[23]:
```
bootstrap_parametrico <- function(B=20,T=100,beta=1,phi=0,theta=0.3)

    {
    Theta_bootstrap<-numeric(B)

    Amostra_original<-simulate_glarma(T=100,beta=1,phi=0,theta=0.3,x=NULL)
    X <- Amostra_original$x
    X <- as.matrix(X)
    colnames(X) <- "Intercept"

    result=glarma(Amostra_original$y, X, phiLags = NULL ,thetaLags = c(1), type␣
↪= "Poi")
    theta_estimado<-result$delta[2]

    T=length(Amostra_original$y)
    mu<-result$mu

    Y_Bootstrap <- matrix(NA, nrow = T, ncol = B)

    for (b in 1:B)
        {
        s = simulate_glarma(T=T,beta=beta,phi=0,theta=theta_estimado,x=NULL)
        Y_Bootstrap[,b] <- s$y
        }

    Theta_bootstrap <- apply(Y_Bootstrap, 2, recupera_par)

    mean_theta <- mean(Theta_bootstrap)

    IC<-quantile(Theta_bootstrap, probs = c(0.025, 0.975))

    return(list('theta_estimado'=theta_estimado,
                'Theta_bootstrap'=Theta_bootstrap,
                'mean_theta'=mean_theta,
                'IC'=IC,
                'Amostra_original'= Amostra_original$y))
    }
```

[24]:
```
Questao1 <- function(B = 20, T = 100, beta = 1, phi = 0, theta = 0.3, R = 2) {

  theta_estimado <- numeric(R)
  mean_theta_bootstrap <- numeric(R)
  IC_bootstrap <- vector("list", R)
```

```
  for (r in 1:R) {
    result <- tryCatch({
      bootstrap_parametrico(B = B, T = T, beta = beta, phi = phi, theta = theta)
    }, error = function(e) {
      message(sprintf("Erro na repetição %d: %s", r, e$message))
      return(NULL)
    })

    if (!is.null(result)) {
      mean_theta_bootstrap[r] <- result$mean_theta
      IC_bootstrap[[r]] <- result$IC
      theta_estimado[r] <- result$theta_estimado
    } else {
      mean_theta_bootstrap[r] <- NA
      IC_bootstrap[[r]] <- c(NA, NA)
      theta_estimado[r] <- NA
    }
  }

  return(list(
    'theta_estimado' = theta_estimado,
    'mean_theta_bootstrap' = mean_theta_bootstrap,
    'IC_bootstrap' = IC_bootstrap
  ))
}
```

conferindo as funções:

[25]:
```
MM_bootstrap_parametrico<-Questao1()
```

[26]:
```
MM_bootstrap_parametrico
```

$theta_estimado 1. 0.332833908141545 2. 0.246283776816347

$mean_theta_bootstrap 1. 0.347913882289899 2. 0.228574454701011

$IC_bootstrap 1. **2.5\%** 0.239977525471365 **97.5\%** 0.430138281299786

2. **2.5\%** 0.151601398513878 **97.5\%** 0.281869499548131

Respondendo a questão:

[29]:
```
conferindo_cobertura_bootstrap <- function(B = 20, T = 100, beta = 1, phi = 0,␣
↪theta = 0.3, R = 100) {

 resultado <- Questao1(B = B, T = T, beta = beta, phi = phi, theta = theta, R =␣
↪R)

 theta_estimado <- resultado$theta_estimado
```

```
  IC_bootstrap <- resultado$IC_bootstrap

  dentro_do_intervalo <- logical(R)

 for (r in 1:R) {
    intervalo <- IC_bootstrap[[r]]

    if (any(is.na(intervalo))) {
      dentro_do_intervalo[r] <- NA
    } else {
      dentro_do_intervalo[r] <- (theta >= intervalo[1]) && (theta <=␣
 ↪intervalo[2])
    }
  }

  cobertura_percentual <- mean(dentro_do_intervalo, na.rm = TRUE) * 100

  return(list(
    cobertura_percentual = cobertura_percentual,
    total_dentro = sum(dentro_do_intervalo,na.rm=TRUE),
    total_r = sum(!is.na(dentro_do_intervalo))
  ))
}
```

[30]:
```
conferindo_cobertura_bootstrap(R=100,B=40)
```

```
Erro na repetição 8: Fisher Scoring fails to converge from the initial
estimates.

Erro na repetição 63: Fisher Scoring fails to converge from the initial
estimates.

Erro na repetição 81: Fisher Scoring fails to converge from the initial
estimates.

Erro na repetição 91: Fisher Scoring fails to converge from the initial
estimates.

Erro na repetição 95: Fisher Scoring fails to converge from the initial
estimates.
```

$cobertura_percentual 89.4736842105263

$total_dentro 85

$total_r 95

3 Bootstrap Não Paramétrico

[51]:
```
e<-Amostra_original$e
```

[52]:
```
y<-Amostra_original$y
```

[53]:
```
mu<-Amostra_original$mu
```

[54]:
```
X <- Amostra_original$x
X <- as.matrix(X)
colnames(X) <- "Intercept"
```

[55]:
```
e_boot <- replicate(B, sample(e, size = T, replace = TRUE))
```

[56]:
```
gera_y_boot <- function(e,mu)
{

    T <- length(e)
    y <- numeric(T)

    for (t in 1:T)
        {
        y[t] = mu[t] + e[t]*sqrt(mu[t])
        y[t] = round(y[t])
        }
    y[y < 1e-12] <- 0
    return(data.frame(y=y))
}
```

[57]:
```
est_bootstrap <- function(y,X)
{
    fit <- glarma(y, X, phiLags = NULL ,thetaLags = c(1), type = "Poi")
    beta <- fit$delta[1]
    theta <- fit$delta[2]

    return(par = c(beta,theta))
}
```

[58]:
```
gera_mu_boot <- function(e,y,x,par)
{
    z <- numeric(T)

    beta <- par[1]
    theta <- par[2]

    for (t in 1:T) {
        z_t <- 0
```

```
        if (t > 1) z_t <-  e[t - 1] * theta

        eta <- beta * x[t] + z_t
        mu[t] <- exp(eta)
        z[t] <- z_t
      }
    return(mu)
}
```

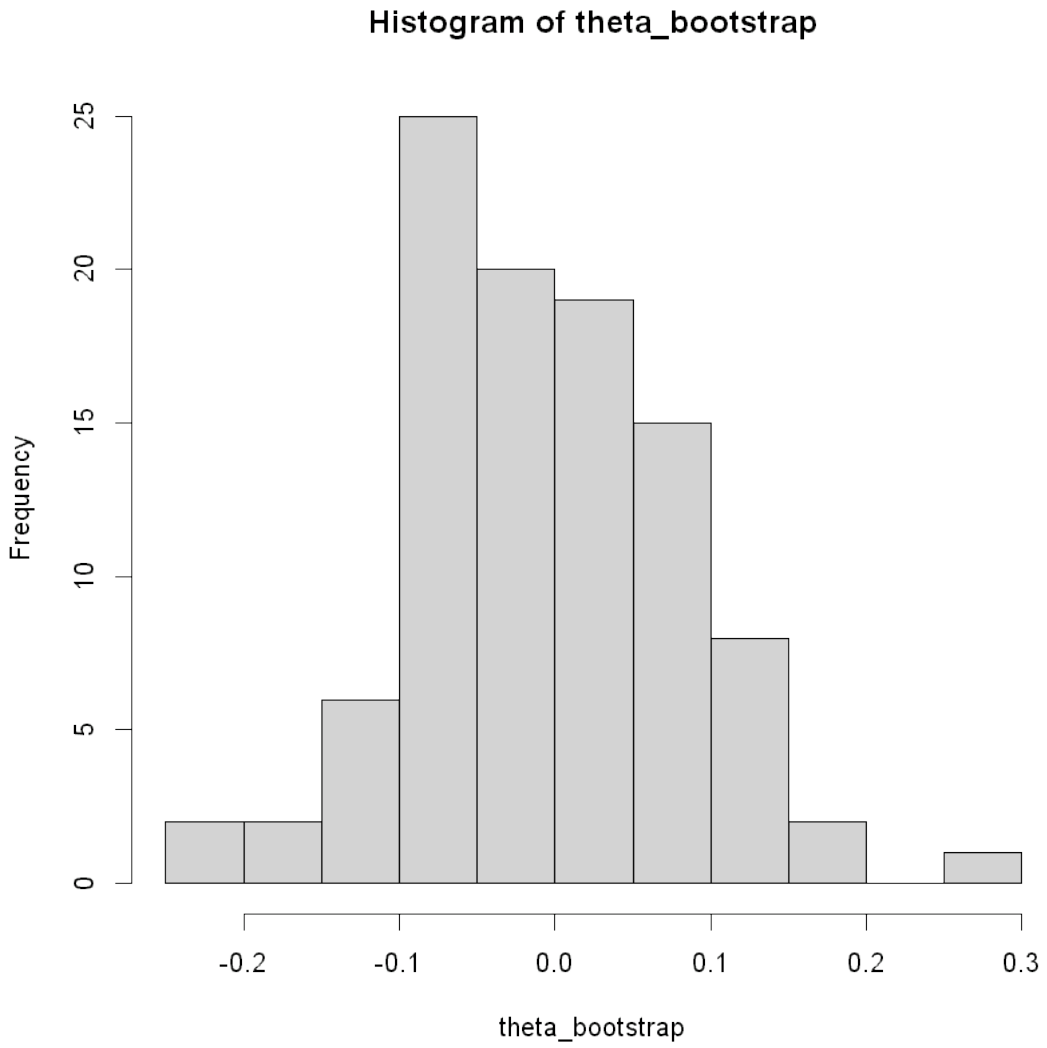
[61]:
```
bootstrap_n_parametrico <- function(e_boot, mu_init, y, X, B)
{

    T <- length(y)
    Y_Bootstrap <- matrix(NA, nrow = T, ncol = B)
    theta <- numeric(B)

    mu_current <- mu_init

  for (b in 1:B) {
    e <- e_boot[, b]

    y_boot <- gera_y_boot(e, mu_current)
    y_boot<-y_boot$y
    Y_Bootstrap[, b] <- y_boot

    par <- est_bootstrap(y_boot, X)
    theta[b] <- par[2]

    mu_current <- gera_mu_boot(e=e, y=y_boot, x=X, par=par)
  }

  return(theta)
}
```

[62]:
```
theta_bootstrap <- bootstrap_n_parametrico(e_boot=e_boot,mu=mu,y=y,X=X,B=B)
```

[63]:
```
mean(theta_bootstrap)
```

-0.00848453725125449

[64]:
```
hist(theta_bootstrap)
```



O bootstrap não paramétrico deu errado, como o esperado.

3.0.1 Questão 2

[65]:
```
Questao2 <- function(B=20,T=100,beta=1,phi=0,theta=0.3,R=2)
    {

    theta_estimado<-numeric(R)
    mean_theta_bootstrap<-numeric(R)
    IC_bootstrap <- vector("list", R)

    for (r in 1:R)
        {
```

```
        Theta_bootstrap<-numeric(B)

        Amostra_original<-simulate_glarma(T=100,beta=1,phi=0,theta=0.3,x=NULL)
        X <- Amostra_original$x
        X <- as.matrix(X)
        colnames(X) <- "Intercept"

        result=glarma(Amostra_original$y, X, phiLags = NULL ,thetaLags = c(1),␣
↪type = "Poi")
        theta_estimado[r]<-result$delta[2]

        e<-Amostra_original$e
        e_boot <- replicate(B, sample(e, size = T, replace = TRUE))


      ␣
↪Theta_bootstrap<-bootstrap_n_parametrico(e_boot=e_boot,B=20,mu_init=Amostra_original$mu,y=Amo

        mean_theta_bootstrap[r] <- mean(Theta_bootstrap)

        IC_bootstrap[[r]]<-quantile(Theta_bootstrap, probs = c(0.025, 0.975))
        }
  ␣
↪return(list('theta_estimado'=theta_estimado,'mean_theta_bootstrap'=mean_theta_bootstrap,'IC_b
    }
```

Testando as funções:

[66]:
```
MM_bootstrap_n_parametrico<-Questao2()
```

[67]:
```
MM_bootstrap_n_parametrico
```

$theta_estimado 1. 0.278925297660273 2. 0.316321698253395

$mean_theta_bootstrap 1. 0.000663816010143372 2. 0.030683902690339

$IC_bootstrap 1. **2.5\%** -0.0857034660864085 **97.5\%** 0.0832748860233778

2. **2.5\%** -0.081325667723224 **97.5\%** 0.307746798782541

[68]:
```
conferindo_cobertura_bootstrap2 <- function(B = 20, T = 100, beta = 1, phi = 0,␣
↪theta = 0.3, R = 100) {

 resultado <- Questao2(B = B, T = T, beta = beta, phi = phi, theta = theta, R =␣
↪R)

 theta_estimado <- resultado$theta_estimado
 IC_bootstrap <- resultado$IC_bootstrap

 dentro_do_intervalo <- logical(R)
```

```
  for (r in 1:R) {
    intervalo <- IC_bootstrap[[r]]
    dentro_do_intervalo[r] <- (theta >= intervalo[1]) && (theta <= intervalo[2])
  }

  cobertura_percentual <- mean(dentro_do_intervalo) * 100

  return(list(
    cobertura_percentual = cobertura_percentual,
    total_dentro = sum(dentro_do_intervalo),
    total_r = R
  ))
}
```

[69]:
```
conferindo_cobertura_bootstrap2(R=2)
```

$cobertura_percentual 0

$total_dentro 0

$total_r 2

Já sabemos que o algorítmo está errado, logo fiz poucas iterações.

4 Questão 3

criando as funções:

[31]:
```
prev_glarma <- function(y, x, beta, theta, h = 2, seed = NULL) {

 futuro_x <- rep(mean(x[, 1], na.rm = TRUE), h)

  if (!is.null(seed)) set.seed(seed)

  T <- length(y)
  mu <- numeric(T)
  e <- numeric(T)
  z <- numeric(T)

  #passo 1, recontruir z,e,mu

  for (t in 1:T) {

    z_t <- if (t > 1) e[t - 1] * theta else 0

    eta <- beta * x[t] + z_t
    mu[t] <- exp(eta)
    e[t] <- (y[t] - mu[t]) / sqrt(mu[t])
```

```
    z[t] <- z_t
  }

  # passo 2, previsão
  y_pred <- numeric(h)
  mu_pred <- numeric(h)

  z_t <- z[T]
  e_t <- e[T]

  for (i in 1:h) {

    z_t <- e_t * theta

    eta <- beta * futuro_x[i] + z_t
    mu_pred[i] <- exp(eta)

    y_pred[i] <- rpois(1, lambda = mu_pred[i])
    e_t <- (y_pred[i] - mu_pred[i]) / sqrt(mu_pred[i])

  }

  return(data.frame(
    step = 1:h,
    x = futuro_x,
    mu = mu_pred,
    y_pred = y_pred
  ))
}
```

[32]:
```
intervalo_preditivo_bootstrap <- function(H=2,T=100,B=20, beta = 1, phi = 0,␣
↪theta = 0.3){

    theta_boot <- numeric(B)
    Y_pred <- matrix(NA, nrow = H, ncol = B)
    IC_pred <- vector("list", H)


    x_train <- rep(1,(T-H))
    x_train <- as.matrix(x_train)
    colnames(x_train) <- "Intercept"

    boot <- bootstrap_parametrico(T=100,B=20, beta = 1, phi = 0, theta = 0.3)

    Y <- boot$Amostra_original
    Y_train = Y[1:(T-H)]
    Y_test = Y[(T-H+1):T]
```

```
    theta_boot<-boot$Theta_bootstrap

    for (b in 1:B)
        {
        prev<-prev_glarma(y=Y_train,x=x_train,beta=beta,theta=theta_boot[b],h=H)
        Y_pred[,b]<-prev$y_pred
        }
    for (h in 1:H)
        {
        IC_pred[[h]]<-quantile(Y_pred[h,], probs = c(0.025, 0.975))
        }
    return(list('Y_test'=Y_test,'IC_pred'=IC_pred))
}
```

[33]:
```
conferindo_IP <- function(B = 20, T = 100, beta = 1, phi = 0, theta = 0.3, H  =␣
↪3) {

  resultado <- intervalo_preditivo_bootstrap(H=H,T=T,B=20, beta = beta, phi =␣
↪phi, theta = theta)

  Y_test <- resultado$Y_test
  IC_pred <- resultado$IC_pred

  dentro_do_intervalo <- logical(H)

  for (h in 1:H) {
    intervalo <- IC_pred[[h]]
    dentro_do_intervalo[h] <- (Y_test[h] >= intervalo[1]) && (Y_test[h] <=␣
↪intervalo[2])
  }

  cobertura_percentual <- mean(dentro_do_intervalo) * 100

  return(list(
    Intervalos=resultado,
    total_dentro = sum(dentro_do_intervalo),
    total_H = H
  ))
}
```

[34]:
```
conferindo_IP(H=5)
```

$Intervalos **$Y_test** 1. 1 2. 5 3. 6 4. 3 5. 4

$IC_pred 1. **2.5\%** 0 **97.5\%** 3

2. **2.5\%** 0 **97.5\%** 4

3. **2.5\%** 0 **97.5\%** 6
4. **2.5\%** 0 **97.5\%** 8.19999999999999
5. **2.5\%** 0 **97.5\%** 6

$total_dentro 4

$total_H 5

Para H passos, Y_teste está dentro dos intervalos de confiança feito com o bootstrap paramétrico.