Práctica Nro 4 - Computacion Bioinspirada

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Objetivo de la práctica:

- El objetivo de la práctica es probar las varias alternativas que hay orientadas al modelado de una función, en este caso una función para calcular el promedio de “n” números.
- Para probar estas alternativas se usaron las siguientes fórmulas:
  - Para calcular el promedio real hasta el $numero_n$:

$$promedio_n = \frac{promedio_{n-1} \times (n-1) + numero_n}{n}$$

  - Para calcular el promedio aproximado hacemos uso de una constante α, en la siguiente fórmula :

$$promedio_n = \alpha \times promedio_{n-1} + (1-\alpha) \times numero_n \quad \alpha < 1$$

Actividades

1. Revisa el conteo dado. ¿Cuál aproximación fue la que se acercó más veces al promedio real? ¿Con qué coeficiente α trabajó?

- Al realizar el conteo con un conjunto de 500 números aleatorios se obtuvo lo siguiente:

Alpha	Values
0.25	28
0.50	37
0.75	88
0.05 (custom)	33
0.95 (custom)	314

- En la tabla anterior podemos ver que de los 5 valores α(Alpha) que se aplicaron, el que se acerca más al promedio un mayor número de veces es 0.95 (314 veces).

2. Revisa las diferencias con el promedio más cercano. ¿Cuáles fueron las 10 menores diferencias con el promedio real? ¿Con qué coeficientes α trabajaron?

- Las 10 menores diferencias se pueden obtener al cargar el script “GenerateAverageData.R” en un workspace del lenguaje R, y ordenando de la siguiente forma (se puede revisar de donde vienen las variables y los argumentos en los codigos o scripts al final del archivo).

```
# Guardamos el resultado de la funcion write_formated_data en una variable llamada df(dataframe
df <- write_formated_data(lista, avgs, avg_alphas, alphas = alphas)
# Definimos que queremos ordenar de acuerdo a la columna "closest_difference", donde contiene l
myorder <- order(df$closest_difference)
# finalmente mostramos los 10 primeros elementos del dataframe ordenado por la menor diferencia
head(df[myorder,], 10)
```

- El codigo anterior nos produce los siguientes resultados:

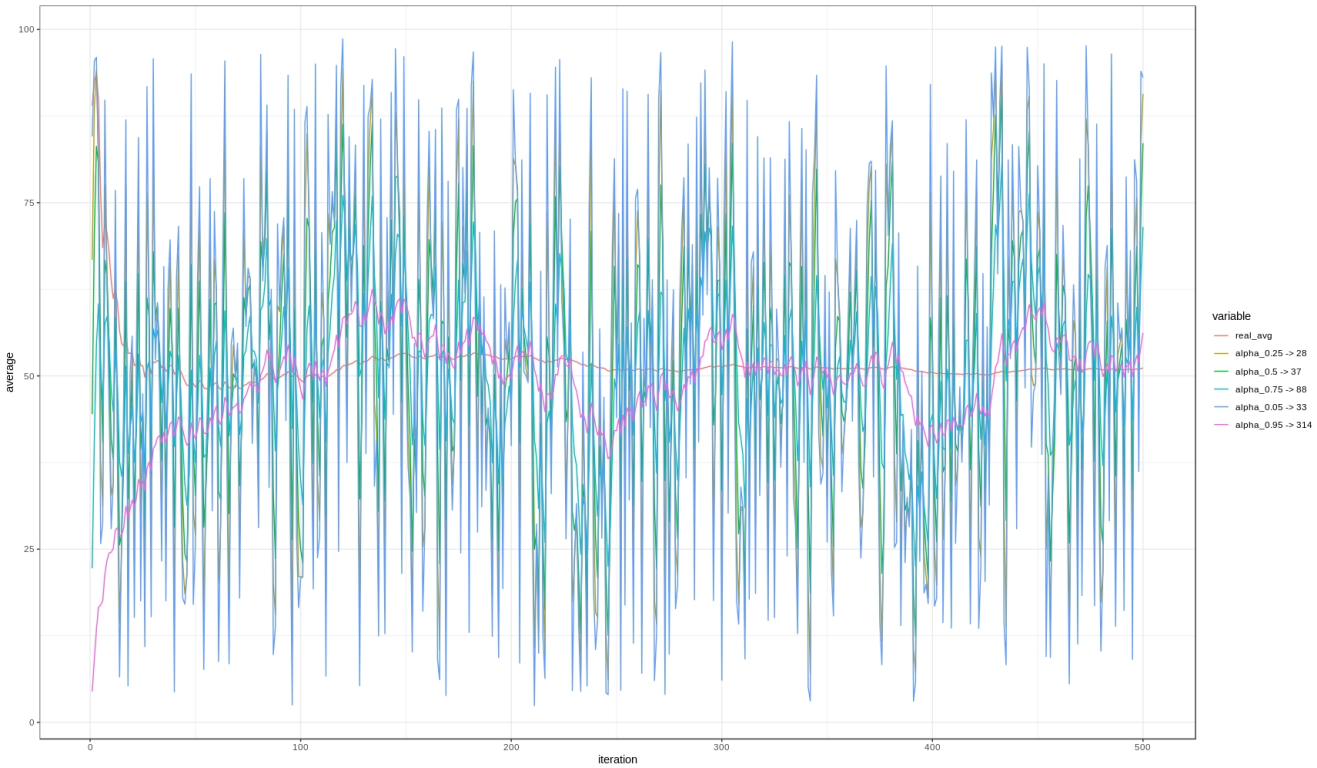
id	values	real_avg	alpha_0.25	alpha_0.5
274	67	50.9416058394161	54.6759237529239	50.9447666948966
192	74	52.8385416666667	60.0787691833696	50.1799069920811
338	87	51.2278106508876	78.2976217600624	65.7716002577851
228	74	52.469298245614	66.5636176327685	59.8504104186312
259	79	50.8610038610039	64.3494862333786	55.1150583731245
410	83	50.3609756097561	67.6135979902778	57.4416021834773
349	66	51.2034383954155	58.6513145679526	53.6771345704384
23	86	53.1739130434783	76.4405569703196	64.7902632951736
35	68	51.6571428571429	58.2688056493137	52.8722632478748
347	34	51.2046109510087	38.4210330872412	46.7085382817535

alpha_0.75	alpha_0.05	alpha_0.95	closest_id	closest_difference
51.5794564534623	63.8520808288098	48.9264329633161	2	0.00316085548057288
46.6057959422735	70.9207966888461	52.8461794224708	5	0.00763775580416137
54.9943215198747	85.722029714073	51.2359470883314	5	0.0081364374437527
57.4325622176024	72.6461677074687	52.4837814866353	5	0.0144832410212246
50.8412592171062	75.6216381004863	45.2386844350643	3	0.0197446438976812
50.3970363681856	79.5301926226148	44.0252112179546	3	0.0360607584294428
52.540521162577	64.495964908675	51.16446271394	5	0.0389756814755415
53.1341542062462	84.3978413429249	35.0592310397158	3	0.0397588372320499
51.5952788618518	65.7641955506151	41.7968982487653	3	0.0618639952910627
52.0720376223591	34.3859634700209	51.1406789074127	5	0.0639320435959831

- He dividido la tabla en dos por motivos de visualizacion; en la tabla anterior se pueden ver las 10 menores diferencias en la columna “closest_difference”, en la tabla se observa la columna “closest_id”, que es el indice, empezando desde 1, del α que produce esa menor diferencia, entonces vemos que las menores diferencias las producen el α_2 que es 0.50, el α_3 que es 0.75 y el α_5 que es 0.95.

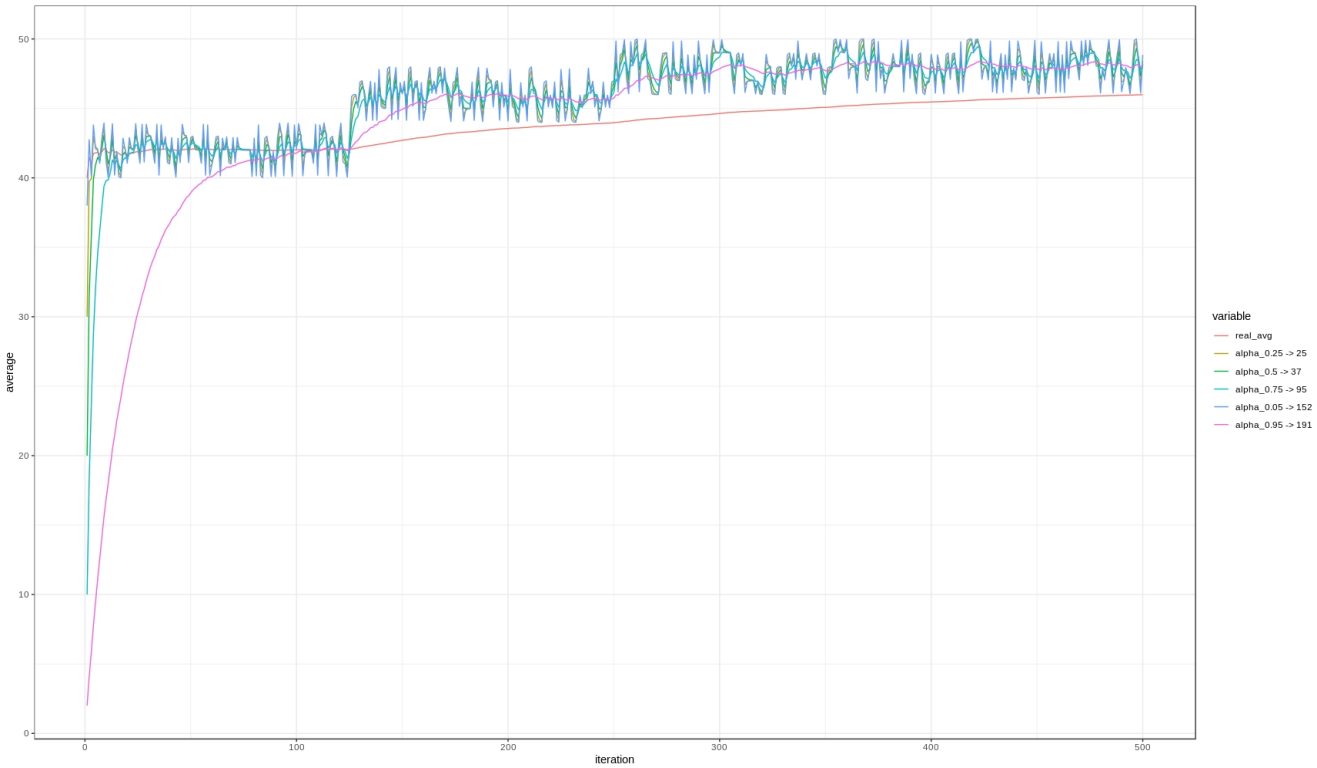
3. En un ambiente de desarrollo real, ¿Cuál aproximación elegirías y por qué? Fundamenta tu respuesta usando el gráfico generado por tu programa.

- NOTA: El gráfico generado por el programa se encuentra disponible en el archivo “result.png” de lo adjuntado, el grafico presenta una representacion donde se señala el punto más próximo, el conteo de cada α, mas en cada punto también su diferencia redondeada a 2 decimas, el archivo es grande, y al importarlo se daria una poca visualizacion, asi que generé otra visualizacion en R mas simplificada para el informe.



- En el grafico se señala que el dato que más se acerca a el average real es el de color rosa ($\alpha = 0.95$), y en la gráfica también se puede ver que es el valor que se mantiene más estable, luego le sigue el de la linea color celeste ($\alpha = 0.75$), en un ambiente real utlizaria el $\alpha = 0.95$, debido a que es mas estable con respecto al resto y su solucion se acerca un mayor numero de veces a la solucion real (linea roja) en al menos casi 3 veces más iteraciones que el resto de soluciones, a pesar de que antes de las 50 iteraciones parece no ser las mejores soluciones, pero se va estabilizando el valor en un rango casi definido al aumentar las iteraciones, si las iteraciones son menores a 50, preferiria un valor como el $\alpha = 0.75$.
- Una consideracion que debemos tomar en cuenta al trabajar con datos reales es que no es completamente aleatoria, los datos tienden a estar en rangos no tan diferenciados, por lo cual generé 500 nuevos datos aleatorios pero en un rango más pequeño [40, 50], y tambien con mayor cantidad de valores repetidos en

rangos menores, en ese contexto se obtiene el siguiente gráfico.



- En el grafico podemos ver que el valor producido por el valor $\alpha = 0.96$ se acerca un mayor numero de veces al valor del promedio real, pero que el valor de $\alpha = 0.05$ nos da menos iteraciones, pero las veces que se acerca al valor real del promedio son valores con una menor diferencia, es decir es mas preciso en ese sentido, por lo cual para elegir el valor depende del si buscamos que el promedio sea mas preciso en un menor numero de veces o si queremos un valor que se acerca mas veces en comparacion al resto, pero con menor precision, en este caso elegiria el valor $\alpha = 0.05$.
- En conclusion la eleccion del valor va a depender mucho de la disposicion de los datos sobre los cuales se trabajan, la probabilidad de datos repetidos, la aleatoriedad y el rango de los mismos.

4. ¿Cómo crees que esta propuesta puede ser mejorada para que el promedio sea más exacto? Explica tu propuesta brevemente.

- Luego de ver los resultados, un patrón que se aprecia es que cuanto mayor es el valor α suele ser mas estable y tiende a una especie de centro, donde se supone esta el promedio, y que cuanto menor es, el valor suele bordear los limites del rango, por lo cual debemos ver que caso nos conviene mas al realizar un analisis sobre los datos, y ver el cambio que presentan en el tiempo, si son cambios que siempre estan dentro de un rango, el valor va a tiende a ser mas estable al centro de ese rango, por lo cual un α mayor suele ser mas efectivo, pero si la disposicion de datos es de que por bloques de tiempo suele el rango cambiar de forma “súbita”, y que estos bloques esten separados de el bloque anterior de forma apreciable, debemos elegir un α más pequeño.
- Como conclusion debemos ajustar el valor de α de acuerdo a como en el tiempo los valores cambien, a que tan separados estan unos de otros respecto a los rangos en los cuales tienden a estabilizarse un bloque de datos, y el cambio de este rango, conforme el cambio sea menor, entonces el valor de α va aumentando, pero si el cambio va haciendose mayor entonces α debe ser de un valor menor.

Archivos

Estructura, los archivos estan detallados en las siguientes secciones.

Codigo Fuente

- GenerateRandomNumbers.R

- GenerateAverageData.R
- GenerateAverageData.R

Archivos Generados

- randomnumbers.txt
- data.txt
- result.png

Otros

- README

Código Fuente (Lenguaje de programación R)

File: GenerateRandomNumbers.R

```r
generaterandom <- function(n, inf, sup){
  l <- sample(inf:sup, n, TRUE)
  return(l)
}

writetofile <- function(numberlist, filename){
  write(numberlist, filename, ncolumns = 1)
}


numbers <- generaterandom(500, 1, 100)
print("RANDOM NUMBERS:")
print(numbers)
print("random numbers saved in randomnumbers.txt")
writetofile(numbers, "randomnumbers.txt")
```

File: GenerateAverageData.R

```r
getnumbers <- function(filename){
  randomnumbers <- read.delim(filename, header = FALSE)
  randomnumbers <- lapply(randomnumbers, as.double)
  return(randomnumbers$V1)
}

get_real_average <- function(datalist){
  datalen <- length(datalist)
  avglist <- vector("numeric", datalen)
  avgval <- 0
  for (idx in 1:datalen) {
    avgval <- (avgval * (idx - 1) + datalist[idx]) / idx
    avglist[idx] <- avgval
  }
  return(avglist)
}

get_alpha_average <- function(datalist, alpha){
  datalen <- length(datalist)
  avglist <- vector("numeric", datalen)
```

```
  avgval <- 0
  for (idx in 1:datalen) {
    avgval <- alpha * avgval + (1 - alpha) * datalist[idx]
    avglist[idx] <- avgval
  }
  return(avglist)
}

write_formated_data <- function(data, realavg, alpha_avg, alphas){
  col_names <- unlist(lapply(alphas, function(x) return(paste("alpha", as.character(x),sep = "_
  col_names <- c("id", "values", "real_avg" , col_names, "closest_id", "closest_difference")
  datalen <- length(data)
  alphalen <- length(alpha_avg)
  datalist <- vector("list", alphalen + 5)
  datalist[[1]] <- 1:datalen
  datalist[[2]] <- data
  datalist[[3]] <- realavg
  for (idx in 1:alphalen) {
    datalist[[3 + idx]] = alpha_avg[[idx]]
  }
  datalist[[alphalen + 4]] = vector("numeric", datalen)
  datalist[[alphalen + 5]] = vector("numeric", datalen)
  for (idx in 1:datalen){
    difference <- 500.0
    indx <- -1
    for (idy in 1:alphalen) {
      if (abs(alpha_avg[[idy]][idx] - realavg[idx]) < difference) {
        difference <- abs(alpha_avg[[idy]][idx] - realavg[idx])
        indx <- idy
      }
    }
    datalist[[alphalen + 4]][idx] = indx
    datalist[[alphalen + 5]][idx] = difference
  }
  df <- data.frame(matrix(unlist(datalist), ncol=length(datalist), byrow=F))
  colnames(df) <- col_names
  print("CALCULATED AVERAGES: ")
  print(df)
  write.table(df, file = "data.txt", row.names = FALSE)
  print("average data saved in data.txt")
  return(df)
}

lista <- getnumbers("randomnumbers.txt")
avgs <- get_real_average(lista)
alphas <- c(0.25, 0.5, 0.75, 0.05, 0.95)
avg_alphas <- lapply(alphas, get_alpha_average, datalist = lista)
write_formated_data(lista, avgs, avg_alphas, alphas = alphas)
```

File: GenerateGraphic.R

```
library(ggplot2)
library(reshape2)

load_data <- function(filename){
```

```
  df <- read.table(filename, sep=" ", header = TRUE)
  return(df)
}

count_alpha <- function(alphanames){
  return(setNames(as.data.frame(table(alphanames)), c("alpha", "n")))
}

update_name <- function(cname, tabledata){
  for(idx in 1:length(tabledata$alpha)){
    if(tabledata$alpha[idx] == cname){
      new_name <- paste(cname, as.character(tabledata$n[idx]), sep = " -> ")
      return(new_name)
    }
  }
  return(paste(cname, "0", sep = "->"))
}

gen_graphic <- function(df){
  dfhead <- colnames(df)
  names <- c("id","real_avg",dfhead[grepl("alpha",dfhead)])
  dfavg <- subset(df, select = names)
  df_data <- subset(df, select = c("id", "closest_id", "closest_difference"))
  columns <- colnames(dfavg)[(df_data$closest_id) + 2]
  data <- c(df_data$id)
  dfcount <- count_alpha(columns)
  data <- unlist(lapply(data, function(x) return(unlist(dfavg[columns[x]])[[x]])))
  dat <- vector("list",3)
  dat[[1]] <- df_data$id
  dat[[2]] <- data
  dat[[3]] <- round(df_data$closest_difference, 2)
  df_points <- data.frame(matrix(unlist(dat), ncol = length(dat), byrow=F))
  colnames(df_points) <- c("iteration","average","label")
  newheader <- c("iteration", "real_avg", unlist(lapply(colnames(dfavg)[3:length(names)], funct
  colnames(dfavg) <- newheader
  columns <- unlist(lapply(columns, function(x,y) return(update_name(x,y)), dfcount))
  extended_df <- melt(dfavg, id.vars="iteration",value.name = "average")
  ggplot(extended_df, aes(x=iteration, y=average, color=variable)) +
    theme_bw() + geom_line()+
    geom_point(data=df_points, aes(x=iteration, y=average, colour=columns))+
    geom_text(data=df_points, aes(x=iteration, y=average + 0.5, label=label),color="blue",size=
  pdf(NULL)
  ggsave("result.png", scale = 5, limitsize = FALSE)
  print("Plot saved in result.png")
}

df <- load_data("data.txt")
gen_graphic(df)
```

Archivos Generados

File: randomnumbers.txt

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```

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```

File: data.txt

```
"id" "values" "real_avg" "alpha_0.25" "alpha_0.5" "alpha_0.75" "alpha_0.05" "alpha_0.95" "close
```

```
1 59 59 44.25 29.5 14.75 56.05 2.95 4 2.95
2 64 61.5 59.0625 46.75 27.0625 63.6025 6.0025 4 2.1025
3 22 48.3333333333333 31.265625 34.375 25.796875 24.080125 6.802375 2 13.9583333333333
4 52 49.25 46.81640625 43.1875 32.34765625 50.60400625 9.06225625000001 4 1.35400625
5 21 43.6 27.4541015625 32.09375 29.5107421875 22.4802003125 9.65914343750001 2 11.50625
6 24 40.3333333333333 24.863525390625 28.046875 28.133056640625 23.924010015625 10.376186265625
7 30 38.8571428571429 28.7158813476562 29.0234375 28.5997924804688 29.6962005007812 11.35737695
8 100 46.5 82.1789703369141 64.51171875 46.4498443603516 96.4848100250391 15.7895081047266 3 0.
9 92 51.5555555555556 89.5447425842285 78.255859375 57.8373832702637 92.2242405012519 19.600032
10 26 49 41.8861856460571 52.1279296875 49.8780374526978 29.3112120250626 19.9200310645157 3 0.
11 11 45.5454545454545 18.7215464115143 31.56396484375 40.1585280895233 11.9155606012531 19.474
12 43 45.3333333333333 36.9303866028786 37.281982421875 40.8688960671425 41.4457780300627 20.65
13 98 49.3846153846154 82.7325966507196 67.6409912109375 55.1516720503569 95.1722889015031 24.5
14 5 46.2142857142857 24.4331491626799 36.3204956054688 42.6137540377676 9.50861444507516 23.54
15 95 49.4666666666667 77.35828729067 65.6602478027344 55.7103155283257 90.7254307222538 27.114
16 31 48.3125 42.5895718226675 48.3301239013672 49.5327366462443 33.9862715361127 27.3090837496
17 39 47.7647058823529 39.8973929556669 43.6650619506836 46.8995524846832 38.7493135768056 27.8
18 10 45.6666666666667 17.4743482389167 26.8325309753418 37.6746643635124 11.4374656788403 26.9
19 90 48 71.8685870597292 58.4162654876709 50.7559982726343 86.071873283942 30.149000679855 3 2
20 88 50 83.9671467649323 73.2081327438354 60.0669987044757 87.9035936641971 33.0415506458622 3
21 69 50.9047619047619 72.7417866912331 71.1040663719177 62.3002490283568 69.9451796832099 34.8
22 80 52.2272727272727 78.1854466728083 75.5520331859589 66.7251867712676 79.4972589841605 37.0
23 93 54 89.2963616682021 84.2760165929794 73.2938900784507 92.324862949208 39.8926244849961 5
24 91 55.5416666666667 90.5740904170505 87.6380082964897 77.720417558838 91.0662431474604 42.44
25 15 53.92 33.8935226042626 51.3190041482449 62.0403131691285 18.803312157373 41.075593597709
26 41 53.4230769230769 39.2233806510657 46.1595020741224 56.7802348768464 39.8901656078686 41.0
27 22 52.2592592592593 26.3058451627664 34.0797510370612 48.0851761576348 22.8945082803934 40.1
28 84 53.3928571428571 69.5764612906916 59.0398755185306 57.0638821182261 80.9447254140197 42.3
29 33 52.6896551724138 42.1441153226729 46.0199377592653 51.0479115886696 35.397236270701 41.84
30 42 52.3333333333333 42.0360288306682 44.0099688796327 48.7859336915022 41.6698618135351 41.8
31 35 51.7741935483871 36.7590072076671 39.5049844398163 45.3394502686266 35.3334930906768 41.5
32 9 50.4375 15.9397518019168 24.2524922199082 36.25458770147 10.3166746545338 39.8860613755011
33 66 50.9090909090909 53.4849379504792 45.1262461099541 43.6909407761025 63.2158337327267 41.1
34 83 51.8529411764706 75.6212344876198 64.063123054977 53.5182055820769 82.0107916866363 43.28
35 83 52.7428571428571 81.155308621905 73.5315615274885 60.8886541865576 82.9505395843318 45.26
36 44 52.5 53.2888271554762 58.7657807637443 56.6664906399182 45.9475269792166 45.2046587782293
37 55 52.5675675675676 54.5722067888691 56.8828903818721 56.2498679799387 54.5473763489608 45.6
38 57 52.6842105263158 56.3930516972173 56.9414451909361 56.437400984954 56.877368817448 46.259
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405 404 94 49.6039603960396 87.1351394765127 79.8539960355783 67.738890925516 92.425821106246 55.94
406 405 97 49.720987654321 94.5337848691282 88.4269980177892 75.054168194137 96.7712910553123 57.99
407 406 99 49.8423645320197 97.883446217282 93.7134990088946 81.0406261456028 98.8885645527656 60.0
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419 418 84 50.2464114832536 79.57994603416 70.927176147219 62.0343449949887 83.3943561903052 61.028
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432 431 11 50.5962877030163 25.1751470056168 42.1137606416195 57.4146867694772 13.492549551304 61.5
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439 438 1 50.6666666666667 10.5650741666874 26.4305762550127 45.0288647439482 2.2731544738223 58.98
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441 440 50 50.7 50.535317135418 48.1076440637532 50.2037364184708 50.6406828861846 58.8688732887162
442 441 53 50.7052154195012 52.3838292838545 50.5538220318766 50.9028023138531 52.8820341443092 58.
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491 86 50.2219959266803 68.5057007014162 55.4705104051138 46.7765848774037 82.0715318567631 48.
492 46 50.2134146341464 51.626425175354 50.7352552025569 46.5824386580528 47.8035765928382 48.4
493 8 50.1277890466532 18.9066062938385 29.3676276012784 36.9368289935396 9.99017882964191 46.4
494 72 50.1720647773279 58.7266515734596 50.6838138006392 45.7026217451547 68.8995089414821 47.
495 49 50.169696969697 51.4316628933649 49.8419069003196 46.526966308866 49.9949754470741 47.77
496 67 50.2036290322581 63.1079157233412 58.4209534501598 51.6452247316495 66.1497487723537 48.
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499 58 50.060120240481 45.7516861831772 39.17761918127 39.3347041836646 55.2483937185965 45.640
500 56 50.072 53.4379215457943 47.588809590635 43.5010281377485 55.9624196859298 46.15873300551
```
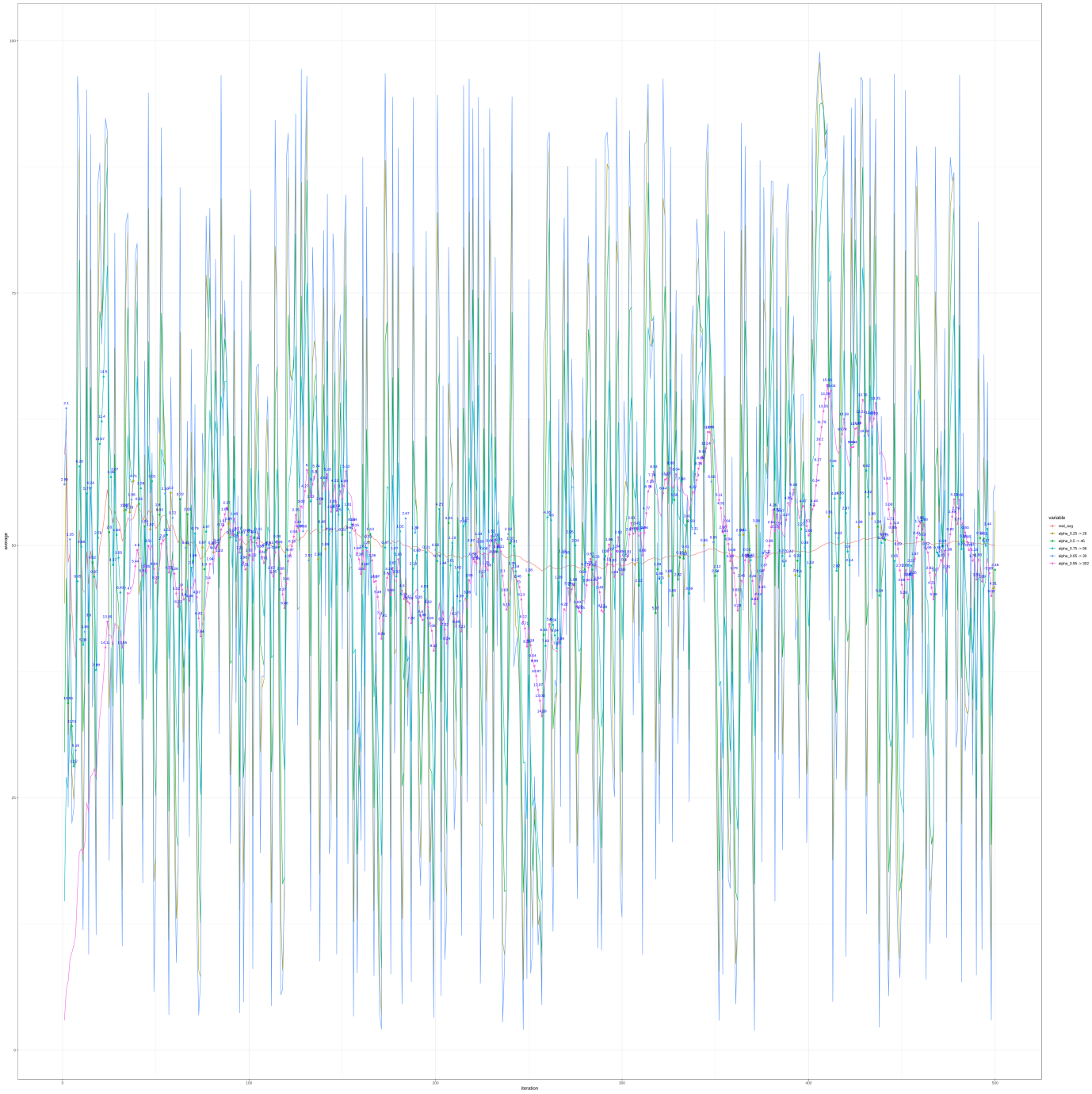

File: result.png

Para una mejor observacion, ver la imagen adjunta en los archivos que se enviaron junto a este informe.



Otros Archivos

File: README

```
Computacion Bioinspirada - Practica 4
-------------------------------------

Esta carpeta contiene 4 scripts en el lenguaje de programacion "R".
Para poder correrlos puede cargar los scripts en cualquier workspace de "R" y
llamar a las funciones, pero al ser esto poco interactivo se recomienda
usar el comando Rscript(linux) o Rscript.exe(windows)

NOTA: Tener instalado los paquetes de R: ggplot2 y reshape2

La ejecucion es la siguiente(en este orden):
$ Rscript GenerateRandomNumbers.R
```

```
-- Esto creara un archivo randomnumbers.txt con 500 numeros aleatorios
-- que tienen valores desde 1 a 100, cada numero en cada linea del file.

$ Rscript GenerateAverageData.R
-- Esto leera el archivo con los numeros random creado previamente con
-- anterior comando, y hara los calculos para determinar los promedios,
-- luego guardara los resultados en un archivo data.txt en el formato
-- definido en los requerimentos, mas un header.

$ Rscript GenerateGraphic.R
-- Esto leera el archivo con los datos de los promedios obtenido al
-- ejecutar el comando anterior, luego generara el respectivo grafico y
-- lo guardara en result.png, al abrir la imagen se recomienda hacer zoom
-- ya que al contener muchos datos, se creo con un gran tamanho.
```