Portafolio.

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Grupo: 1301

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Contenido

Ejercicio 1: Error de redondeo.

Alexis Palomares Olegario.

19 de agosto del 2021.

Forma normalizada de los números de máquina:

Parte fraccionaria = dígitos significativos

$$\pm\ 0.d_1 d_2 d_3 ... d_k \text{ x } B^e$$

- d_1 : Dígitos con valores 1 a (B-1).
- d_1 : Dígitos con valores 0 a (B-1).
- B : Base numérica (2, 16, 10).
- k : Número de dígitos significativos (precisión).
- e : Exponente entero.

Números de Máquina por tamaño de palabra.

Núm. de dígitos	Signo	Parte característica	Mantisa	Rango del exponente	Exponente (e)
32	1	7	24	- (2^6 - 1) a 2^6	c - (2^6 - 1)
64	1	11	52	- (2^{10} - 1) a 2^{10}	c - (2^{10} - 1)
N = p + q + 1	1	p	q	- (2^{p-1} - 1) a 2^{p-1}	c - (2^{p-1} - 1)

1. **Sea una computadora con: B =2, 3 bits para el exponente (p) y 4 bits para la mantisa (q).**

- Crea el conjunto de números que puede representar.

De acuerdo a la fórmula -(2^{p-1} - 1) a 2^{p-1} tenemos que el rango del exponente es -(2^{3-1} - 1) = -3 a 2^{3-1} = 4.

$\pm 0.1000_2$ **x** 2^e	$\pm 0.1001_2$ **x** 2^e	$\pm 0.1010_2$ **x** 2^e	$\pm 0.1100_2$ **x** 2^e	$\pm 0.1101_2$ **x** 2^e	$\pm 0.1110_2$ **x** 2^e	$\pm 0.1111_2$ **x** 2^e
1.1000 x 2^{-3}	1.1001 x 2^{-3}	0.1010 x 2^{-3}	1.1100 x 2^{-3}	1.1101 x 2^{-3}	0.1110 x 2^{-3}	1.1111 x 2^{-3}
1.1000 x 2^{-2}	1.1001 x 2^{-3}	1.1010 x 2^{-3}	1.1100 x 2^{-3}	1.1101 x 2^{-3}	0.1110 x 2^{-3}	1.1111 x 2^{-3}
1.1000 x 2^{-1}	1.1001 x 2^{-1}	1.1010 x 2^{-1}	1.1100 x 2^{-1}	1.1101 x 2^{-1}	1.1110 x 2^{-1}	1.1111 x 2^{-1}
1.1000 x 2^0	1.1001 x 2^0	1.1010 x 2^0	1.1100 x 2^0	1.1101 x 2^0	0.1110 x 2^0	1.1111 x 2^0
1.1000 x 2^1	1.1001 x 2^1	0.1010 x 2^1	0.1100 x 2^1	1.1101 x 2^1	1.1110 x 2^1	1.1111 x 2^1 =
1.1000 x 2^2	1.1001 x 2^2	1.1010 x 2^2	1.1100 x 2^2	1.1101 x 2^2	1.1110 x 2^2	1.1111 x 2^2
1.1000 x 2^3	1.1001 x 2^3	1.1010 x 2^3	1.1100 x 2^3	0.1101 x 2^3	1.1110 x 2^3	1.1111 x 2^3
1.1000 x 2^4	1.1001 x 2^4	1.1010 x 2^4	1.1100 x 2^4	1.1101 x 2^4	1.1110 x 2^4	1.1111 x 2^4

- Indica los números más pequeño y más grande que se puede representar.

El número más pequeño que se puede representar es: 1.1000 x 2^{-3} = 0.1875 de acuerdo a la tabla.

El número más grande que se puede representar es: 1.1111 x 2^4 = 1.9375 de acuerdo a la tabla.

2. **Sea una computadora con un tamaño de palabra de 12 bits y B = 2; 1 bit del signo, 4 del exponente y 7 bits de la matisa.**

- Determina el rango del exponente.

De acuerdo a la fórmula -(2^{p-1} - 1) a 2^{p-1} tenemos que el rango del exponente es -(2^{4-1} - 1) = -7 a 2^{4-1} = 8.

- Indica los números más grande y más pequeño que se pueden representar.

Como el primer bit de la parte fraccionaria se mantiene en 1, entonces tenemos que que el número más pequeño es:(1 + 0.1000000) x $2^{-7} = (\frac{3}{2})(\frac{1}{128}) = \frac{3}{256}$

Por otra parte el número más grande es : (1 + 0.1111111 x 2^8) $= (1 + \frac{1}{2} + \frac{1}{4} + \frac{1}{8} + \frac{1}{16} + \frac{1}{32} + \frac{1}{64} + \frac{1}{128})$x(256)

$= (\frac{255}{128})(256) = 510$

3. **Determinar el número que representa el siguiente número máquina, además de los números anterior y posterior que pueden representarse.**

$(-1)^s 2^e (1 + f)$

e = c - $(2^{p-1} - 1)$

S	Exponente							Mantisa (24 bits)															
0	1	0	0	0	0	1	0	1	0	1	1	0	0	0	0	0	1	0	0	…	…	0	0

- p = 7 y q = 24, s = 1
- Exponente: c = $(1000010)_2 = (66)_{10}$, entonces e = 66 - 63 = 3
- Mantisa o parte fraccionaria : **1**0**11**00000**1**00000000000000 $= \frac{1}{2} + \frac{1}{8} + \frac{1}{16} + \frac{1}{1024} = (0.6884765625)_{10}$
- El número decimal que representa es : $(-1)^0 2^3(1 + 0.6884765625) = (8)(1 + 0.6884765625) =$ 13.5078125

Restando el último bit tenemos:

S	Exponente							Mantisa (24 bits)															
0	1	0	0	0	0	1	0	1	0	1	1	0	0	0	0	0	0	1	1	…	…	1	1

- p = 7 y q = 24, s = 1

- Exponente: c = $(1000010)_2 = (66)_{10}$, entonces e = 66 - 63 = 3

- Mantisa o parte fraccionaria : **1**0**11**000000**11111111111111** $= \frac{1}{2} + \frac{1}{8} + \frac{1}{16} + \frac{1}{2048} + \frac{1}{4096} + \frac{1}{8192} + \frac{1}{16384} + \frac{1}{32768} + \frac{1}{65536} + \frac{1}{131072} + \frac{1}{262144} + \frac{1}{524288} + \frac{1}{1048576} + \frac{1}{2097152} + \frac{1}{4194304} + \frac{1}{8388608} + \frac{1}{16777216} = (0.6884765029)_{10}$

- El número decimal que representa es : $(-1)^0 2^3(1 + 0.6884765029) = (8)(1 + 0.6884765029) =$ 13.50781202

Sumando el último bit tenemos:

S	Exponente							Mantisa (24 bits)															
0	1	0	0	0	0	1	0	1	0	1	1	0	0	0	0	0	1	0	0	…	…	0	1

- p = 7 y q = 24, s = 1

- Exponente: c = $(1000010)_2 = (66)_{10}$, entonces e = 66 - 63 = 3

- Mantisa o parte fraccionaria : **1**0**11**00000**1**0000000000000**1** $= \frac{1}{2} + \frac{1}{8} + \frac{1}{16} + \frac{1}{1024} + \frac{1}{16777216} = (0.6884766221)_{10}$

- El número decimal que representa es : $(-1)^0 2^3(1 + 0.6884766221) = (8)(1 + 0.6884766221) =$ 13.50781298

El número máquina es : 13.5078125

El número anterior es : 13.50781202

El número posterior es : 13.50781298

Ejercicio 2: Método de bisección.

Alexis Palomares Olegario.

03 de septiembre del 2021.

Ejercicio. Método de bisección.

Próposito: Resolver un problema de aplicación empleando el método de bisección.

Instrucciones:

Determinar el coeficiente de rozamiento c, necesario para que un paracaidista de masa m = 68.1 tenga una velocidad de 40 m/s, después

de una caida libre de t = 10s. La aceleración de la gravedad es 9.8 n/s^2

Este problema se puede resolver determinando la raíz de la ecuación:

f© = gm/c(1- e^(-(c/m)t)) - v

Donde:

t = tiempo

v = velocidad

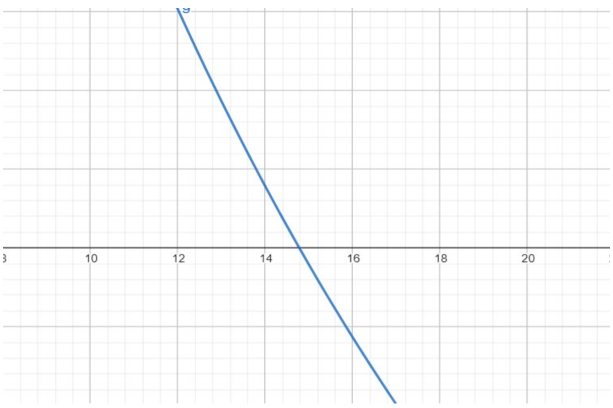
m = masa

g = aceleración de la gravedad

Sustituyendo:

f© = ((9.8*68.1)/c)(1-e(-(c/m)t)) - v

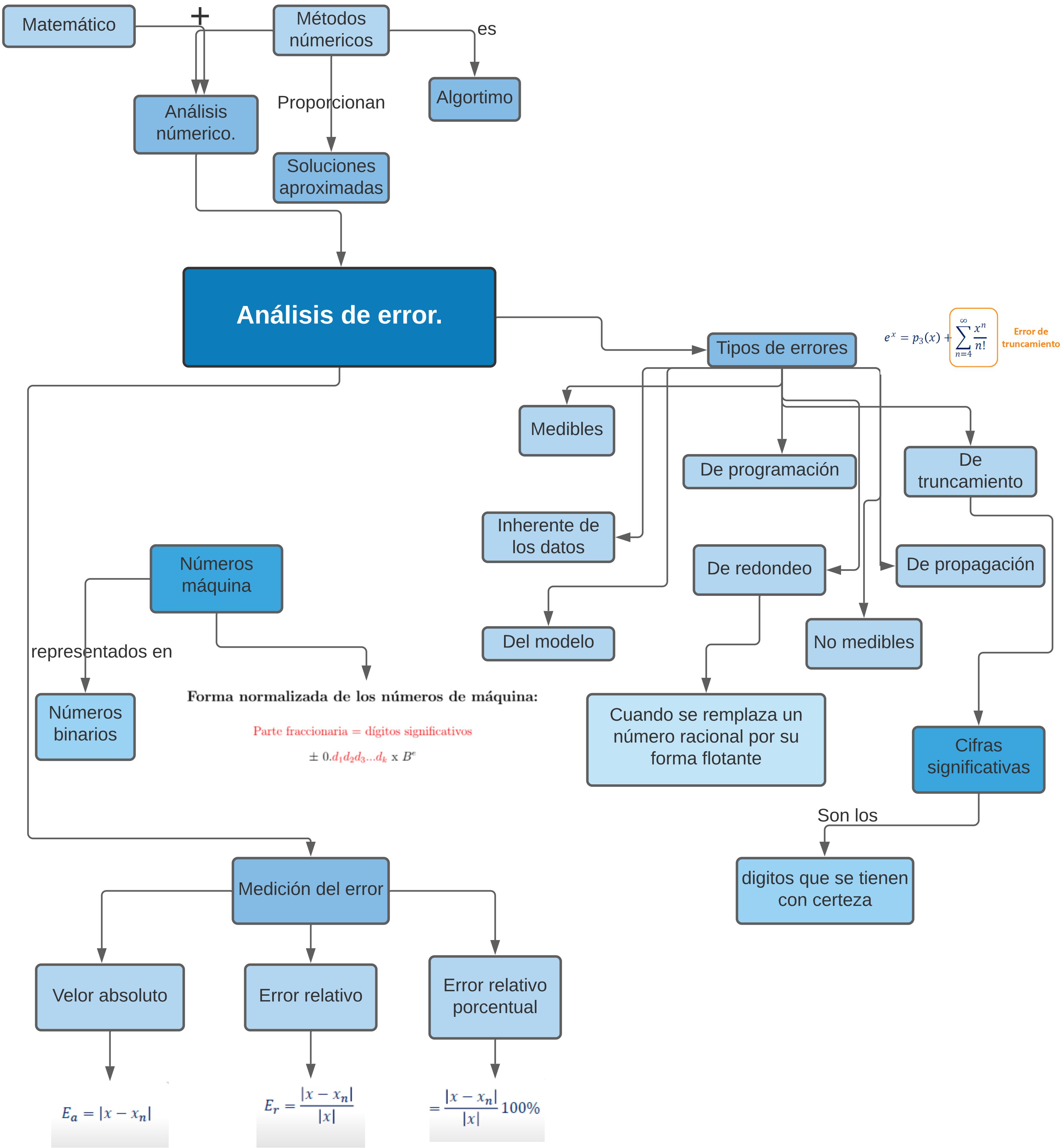
f(c)=((667.38)/(c))-((667.38 ^(-((c)/(6.81))))/(c))-40



Intervalo [14.5, 15]:

n	a	b	f(a)	f(b)	p	f(p)	Ea	Er
1	14.5	15	0.55231853	-0.42484088	14.75	0.05895351		
2	14.75	15	0.05895351	-0.42484088	14.875	-0.18412569	0.125	0.008403361
3	14.75	14.875	0.05895351	-0.18412569	14.8125	-0.06288337	0.0625	0.004219409
4	14.75	14.8125	0.05895351	-0.06288337	14.78125	-0.00203947	0.03125	0.002114165
5	14.75	14.78125	0.05895351	-0.00203947	14.765625	0.02843836	0.015625	0.001058201
6	14.765625	14.78125	0.02843836	-0.00203947	14.7734375	0.01319478	0.0078125	0.000528821
7	14.7734375	14.78125	0.01319478	-0.00203947	14.7773438	0.00557649	0.00390625	0.00026434
8	14.7773438	14.78125	0.00557649	-0.00203947	14.7792969	0.00176822	0.00195313	0.000132153
9	14.7792969	14.78125	0.00176822	-0.00203947	14.7802734	-0.0001357	0.00097656	0.0000660720185
10	14.7792969	14.78027344	0.00176822	-0.0001357	14.7797852	0.00081624	0.00048828	0.0000330371007

como 0.000033037101 (abs) es menor que 0.00005, nos detenemos en la iteración 10.


Matemático
+
Métodos numericos
es
Algortimo
Análisis numerico.
Proporcionan
Soluciones aproximadas
Análisis de error.
Tipos de errores
$e^x = p_3(x) + \sum_{n=4}^{\infty} \frac{x^n}{n!}$
Error de truncamiento
Medibles
De programación
De truncamiento
Inherente de los datos
De redondeo
De propagación
Del modelo
No medibles
Números máquina
representados en
Números binarios
Forma normalizada de los números de máquina:
Parte fraccionaria = dígitos significativos
$\pm 0.d_1d_2d_3...d_k \times B^e$
Cuando se remplaza un número racional por su forma flotante
Cifras significativas
Son los
digitos que se tienen con certeza
Medición del error
Velor absoluto
Error relativo
Error relativo porcentual
$E_a = |x - x_n|$
$E_r = \frac{|x - x_n|}{|x|}$
$= \frac{|x - x_n|}{|x|} 100\%$

Ejercicio 3: Método de posición falsa.

Alexis Palomares Olegario.

08 de septiembre del 2021.

Próposito: Resolver un problema de aplicación empleando el método de la posición falsa.

Instrucciones:

La profundidad normal y del flujo en un canal rectangular abierto de ancho w está relacionada con el caudal Q, la pendiente del canal s y el coeficiente de fricción de Manning n mediante las ecuaciones.

y(wy/w+2y)^(2/3) = c = nQ/w*√s

•Determinar y usando el método de la posición falsa para los datos:

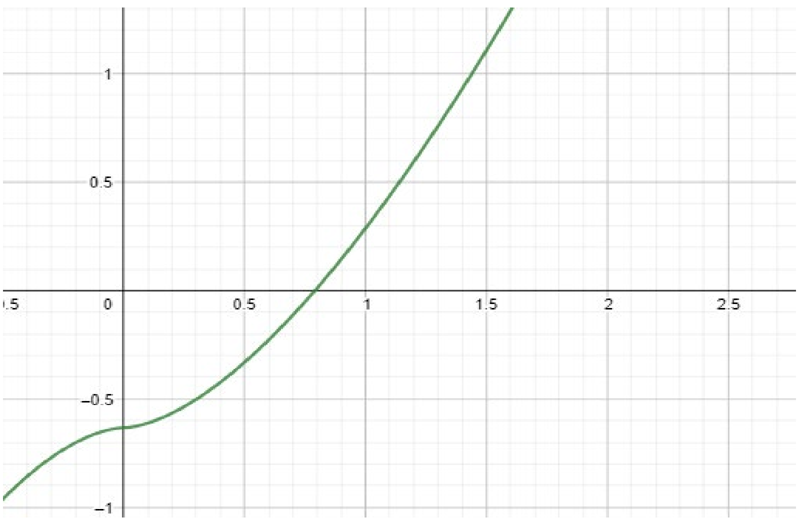
w = 15 m; Q = 20 m^3/s; n = 0.0015; s = 0.001

•Elaborar la gráfica para elegir el intervalo inicial.

•Con un error realtivo porcentual de 0.0002%

Sustituyendo:

y*(((15*y)/(15+2*y))^(2/3))-((0.3)/(15*RAIZ(0.001)))



$$f(x) = x^3 + x^2 - 4x - 1$$

$$x_2 = x_1 - f(x_1)\frac{(x_0 - x_1)}{f(x_0) - f(x_1)}$$

- ***Intervalo [0.5, 1]:***

n	x0	x1	f(x0)	f(x1)	x2	f(x2)	Ea	Er	Erp
1	0.5	1	-0.3307401	0.28748882	0.76748999	-0.0295542			
2	0.76748999	1	-0.0295542	0.28748882	0.78916416	-0.0020124	0.02167416	0.02746471	2.74647097
3	0.78916416	1	-0.0020124	0.28748882	0.79062972	-0.0001344	0.00146556	0.00185366	0.18536591
4	0.79062972	1	-0.0001344	0.28748882	0.79072753	-8.96E-06	9.7811E-05	0.0001237	0.01236975
5	0.79072753	1	-8.96E-06	0.28748882	0.79073405	-5.974E-07	6.5222E-06	8.2482E-06	0.00082482
6	0.79073405	1	-5.974E-07	0.28748882	0.79073448	-3.984E-08	4.3488E-07	5.4997E-07	0.00005500
7	0.79073448	1	-3.984E-08	0.28748882	0.79073451	-2.656E-09	2.8997E-08	3.667E-08	0.00000367

Como el error relativo porcentual es de 0.00000367 % menor a 0.00002%, nos detenemos en la iteración número 7.

El valor de y en la iteración 7 es de 0.79073451

La profundidad normal es de 0.79073451

Ejercicio 4: Método de Newton.

Alexis Palomares Olegario.

18 de septiembre del 2021.

Ejercicio. Método de Newton.

Própósito: Identificar las características del método Newton mediante la solución a un problema de aplicación.

Instrucciones:

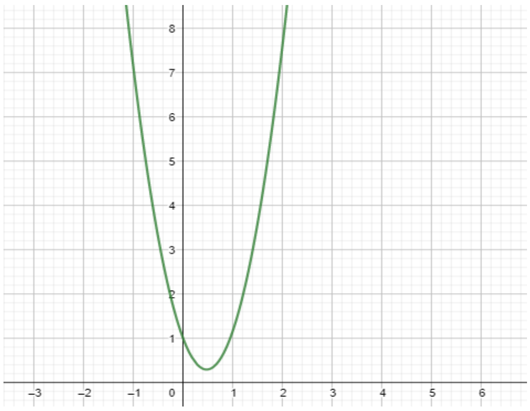
Una placa cuadrada con lados de longitu unitaria tiene su centro en el origen de un sistema de coordenadas cartesianas (x,y). Los lados son paralelos a cualquiera de los ejes x o y. En la placa se perfora un circulo de radio r. El centro del orificio está sobre el eje x a una distancia r del lado izquierdo de la placa. El centroide de la pieza restante tiene una abscisa igual a c, que está definida por:

c = πr^2(0.5 - r)/(1 - πr^2)

El valor de r que maximiza c satisface la ecuación:

πr^2-3r+1=0

Detenemos la iteración hasta que el valor relativo porcentual sea menor a 1%



Debido a que en la gráfica de la ecuación no muestra raíces en los reales, entonces elegí 1 + 2i como valor inicial.

iteración	r_k	función	derivada	Ea	Er	Erp
1	1 + 2ί	-11.4247779608 + 6.566370	3.2831853072 + 12.5663706144ί			
2	0.7332089064 + 1.02114119	-2.7865520887 + 1.6408589	1.606887428 + 6.416019	9.943822778	7.9100681	791.0068064
3	0.5949124959 + 0.55219328	-0.6307885901 + 0.4074885	0.737945453 + 3.469532	2.483650309	3.0598563	305.9856289
4	0.5195436715 + 0.35435492	-0.1051163012 + 0.0936876	0.2643891629 + 2.22647	0.612211053	0.9734906	97.34905629
5	0.4835782872 + 0.30287218	-0.0042630256 + 0.0116339	0.0384119891 + 1.90300	0.130016112	0.2278603	22.78602835
6	0.4775125181 + 0.30050958	0.0000980544 + 0.00009004	0.0002996379 + 1.88815	0.012340185	0.0218719	2.187191573
7	0.477464821 + 0.30056151	-0.0000000013 - 0.00000001	-0.0000000518 + 1.8884	0.000133138	0.000236	0.023598058
8	0.4774648293 + 0.30056151	0 - 0ί	0 + 1.8884836813ί	1.56E-08	2.77E-08	2.7681E-06
9	0.4774648293 + 0.30056151	0 + 0ί	0 + 1.8884836813ί	0	0	0

iteración	r_k	función	derivada	Ea	Er	Erp
1	1 - 2ί	-11.4247779608 - 6.566370	3.2831853072 - 12.5663706144ί			
2	0.7332089064 - 1.021141192	-2.7865520887 - 1.6408589	1.606887428 - 6.416019	9.943822778	7.9100681	791.0068064
3	0.5949124959 - 0.552193282	-0.6307885901 - 0.4074885	0.737945453 - 3.469532	2.483650309	3.0598563	305.9856289
4	0.5195436715 - 0.354354920	-0.1051163012 - 0.0936876	0.2643891629 - 2.22647	0.612211053	0.9734906	97.34905629
5	0.4835782872 - 0.302872185	-0.0042630256 - 0.0116339	0.0384119891 - 1.90300	0.130016112	0.2278603	22.78602835
6	0.4775125181 - 0.300509589	0.0000980544 - 0.00009004	0.0002996379 - 1.88815	0.012340185	0.0218719	2.187191573
7	0.477464821 - 0.3005615135	-0.0000000013 + 0.0000000	-0.0000000518 - 1.8884	0.000133138	0.000236	0.023598058
8	0.4774648293 - 0.300561512	0 + 0ί	0 - 1.8884836813ί	1.56E-08	2.77E-08	2.7681E-06
9	0.4774648293 - 0.300561512	0 - 0ί	0 - 1.8884836813ί	0	0	0

Evaluando las raíces:

0.2275116254 + 0.1681331269ί

0.2274648215 - 0.1681801733ί

Podemos ver que el valor que maximiza la ecuación es r = 0.477464821 - 0.3005615135ί, y c = 0.2275116254 + 0.1681331269ί

Ejercicio 5: Método de la Secante.

Alexis Palomares Olegario.

23 de septiembre del 2021.

Ejercicio. Método de Newton.

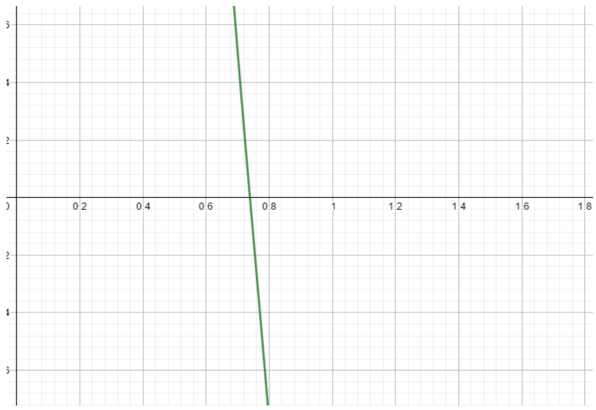
Próposito: Identificar las características del método de la secante mediante la solución de un problema.

Instrucciones:

Sea el problema: Para determinar M se emplea la ecuación:

f(M) = {[(2+0.4M^2)/(2.4)]^3.5-1}/0.7M^2C_{pi} - {√1-M^2 + (M^2C_{pi})/1+√1-M^2}^-1=0

Se supondrá C_{pi}=-0.383 y que se está buscando el valor de M, que se espera está en algún punto entre 0.5 y 0.9. El comportamiento de la función f(M) es importante, para C_{pi} = -0.383, la función decrece desde +∞ hasta -∞ cuando M crece desde 0 hatsa 0.987; entonces es necesario imponer algunas restricciones sobre los valores de acotamiento iniciales, para lo que es importante graficar.



Elegí el intervalo [0.5, 0.9] debido a que es dónde se aproxima la raíz, además de ser el intervalo recomendado.

I	x_k-1	x_k	f(x_k-1)	f(x_k)	x_k+1	f(x_k+1)	Ea	Er	Erp
1	0.5000000000	0.9000000000	4.3802888733	-2.5595659011	0.7524715007	-0.1639485995			
2	0.9000000000	0.7524715007	-2.5595659011	-0.1639485995	0.7423751089	-0.0354524900	0.0100963918	0.0136001216	1.360012164
3	0.7524715007	0.7423751089	-0.1639485995	-0.0354524900	0.7395894819	0.0001124081	0.0027856270	0.0037664502	0.376645023
4	0.7423751089	0.7395894819	-0.0354524900	0.0001124081	0.7395982863	-0.0000001022	0.0000088044	0.0000119043	0.001190428
5	0.7395894819	0.7395982863	0.0001124081	-0.0000001022	0.7395982783	0.0000000000	0.0000000080	0.0000000108	0.00000108102

Como la iteración 5 nos da un error relativo porcentual menor a 0.0003%, nos detenemos ahí, obtenemos que nuestra raíz es 0.739598, es decir, resolviendo el problema, M= 0.739598

Ejercicio 6: Matriz

Alexis Palomares Olegario

07 de octubre del 2021

$$\begin{pmatrix} 1 & 4 & -2 & 0 \\ -3 & -2 & 0 & 1 \\ 3 & 2 & 1 & -1 \\ 2 & -2 & 3 & 4 \end{pmatrix}$$

1.Obtener matriz de menores.

$$\begin{pmatrix} \underline{1} & \underline{4} & \underline{-2} & \underline{0} \\ \underline{-3} & -2 & 0 & 1 \\ \underline{3} & 2 & 1 & -1 \\ \underline{2} & -2 & 3 & 4 \end{pmatrix} = \begin{pmatrix} -2 & 0 & 1 \\ 2 & 1 & -1 \\ -2 & 3 & 4 \end{pmatrix} = \text{-6}$$

$$\begin{pmatrix} \underline{1} & \underline{4} & \underline{-2} & \underline{0} \\ -3 & \underline{-2} & 0 & 1 \\ 3 & \underline{2} & 1 & -1 \\ 2 & \underline{-2} & 3 & 4 \end{pmatrix} = \begin{pmatrix} -3 & 0 & 1 \\ 3 & 1 & -1 \\ 2 & 3 & 4 \end{pmatrix} = \text{-14}$$

$$\begin{pmatrix} \underline{1} & \underline{4} & \underline{-2} & \underline{0} \\ -3 & -2 & \underline{0} & 1 \\ 3 & 2 & \underline{1} & -1 \\ 2 & -2 & \underline{3} & 4 \end{pmatrix} = \begin{pmatrix} -3 & -2 & 1 \\ 3 & 2 & -1 \\ 2 & -2 & 4 \end{pmatrix} = 0$$

$$\begin{pmatrix} \underline{1} & \underline{4} & \underline{-2} & \underline{0} \\ -3 & -2 & 0 & \underline{1} \\ 3 & 2 & 1 & \underline{-1} \\ 2 & -2 & 3 & \underline{4} \end{pmatrix} = \begin{pmatrix} -3 & -2 & 0 \\ 3 & 2 & 1 \\ 2 & -2 & 3 \end{pmatrix} = \text{-10}$$

2. Obtener la matriz de cofactores.

$$\begin{bmatrix} +(-6) & -(-14) & +(0) & -(-10) \\ -(40) & +(35) & -(-50) & +(0) \\ +(-24) & -(-31) & +(50) & -(10) \\ -(-4) & +(-1) & -(0) & +(10) \end{bmatrix}$$

3. Obtener el determinante.

$$\begin{vmatrix} 1 & 4 & -2 & 0 \\ -3 & -2 & 0 & 1 \\ 3 & 2 & 1 & -1 \\ 2 & -2 & 3 & 4 \end{vmatrix} = \text{(-6)*(1) + (14)*(4) + (0)*(-2) + (-10)*(0)} = 50$$

4. Obtener la matriz inversa.

Resolviendo por Gauss - Jordan:

$$\left(\begin{array}{cccc|cccc} 1 & 4 & -2 & 0 & 1 & 0 & 0 & 0 \\ -3 & -2 & 0 & 1 & 0 & 1 & 0 & 0 \\ 3 & 2 & 1 & -1 & 0 & 0 & 1 & 0 \\ 2 & -2 & 3 & 4 & 0 & 0 & 0 & 1 \end{array}\right) \rightarrow \left(\begin{array}{cccc|cccc} 1 & 4 & -2 & 0 & 1 & 0 & 0 & 0 \\ 0 & 10 & -6 & 1 & 3 & 1 & 0 & 0 \\ 0 & -10 & 7 & -1 & -3 & 0 & 1 & 0 \\ 0 & -10 & 7 & 4 & -2 & 0 & 0 & 1 \end{array}\right) \rightarrow$$

$$\left(\begin{array}{cccc|cccc} 1 & 0 & \frac{2}{5} & -\frac{4}{10} & -\frac{1}{5} & -\frac{4}{10} & 0 & 0 \\ 0 & 1 & -\frac{3}{5} & \frac{1}{10} & \frac{3}{10} & \frac{1}{10} & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 & 1 & 1 & 0 \\ 0 & 0 & 1 & 5 & 1 & 1 & 0 & 1 \end{array}\right) \rightarrow \left(\begin{array}{cccc|cccc} 1 & 0 & 0 & -\frac{2}{5} & -\frac{1}{5} & -\frac{4}{5} & -\frac{2}{5} & 0 \\ 0 & 1 & 0 & \frac{1}{10} & \frac{3}{10} & \frac{7}{10} & \frac{3}{5} & 0 \\ 0 & 0 & 1 & 0 & 0 & 1 & 1 & 0 \\ 0 & 0 & 0 & 5 & 1 & 0 & -1 & 1 \end{array}\right) \rightarrow$$

$$\left(\begin{array}{cccc|cccc} 1 & 0 & 0 & 0 & -\frac{3}{25} & -\frac{4}{5} & -\frac{12}{25} & \frac{2}{25} \\ 0 & 1 & 0 & 0 & \frac{7}{25} & \frac{7}{10} & \frac{31}{50} & -\frac{1}{50} \\ 0 & 0 & 1 & 0 & 0 & 1 & 1 & 0 \\ 0 & 0 & 0 & 1 & \frac{1}{5} & 0 & -\frac{1}{5} & \frac{1}{5} \end{array}\right)$$

$$\therefore \begin{pmatrix} -\frac{3}{25} & -\frac{4}{5} & -\frac{12}{25} & \frac{2}{25} \\ \frac{7}{25} & \frac{7}{10} & \frac{31}{50} & -\frac{1}{50} \\ 0 & 1 & 1 & 0 \\ \frac{1}{5} & 0 & -\frac{1}{5} & \frac{1}{5} \end{pmatrix}$$

5. Obtener la matriz adjunta.

$$(50)\begin{pmatrix} -\frac{3}{25} & -\frac{4}{5} & -\frac{12}{25} & \frac{2}{25} \\ \frac{7}{25} & \frac{7}{10} & \frac{31}{50} & -\frac{1}{50} \\ 0 & 1 & 1 & 0 \\ \frac{1}{5} & 0 & -\frac{1}{5} & \frac{1}{5} \end{pmatrix} = \begin{pmatrix} -6 & -40 & -24 & 4 \\ 14 & 35 & 31 & -1 \\ 0 & 50 & 50 & 0 \\ 10 & 0 & -10 & 10 \end{pmatrix}$$

Ejercicio 7 Método de Gauss.

Alexis Palomares Olegario.

11 de Octubre del 2021.

Algoritmo para obtener el determinante de una matriz cuadrada por triángulación (eliminación gaussiana).

```
For(i=0; i<n; i++)
        pivote = A[i][i]
        For(j=i+1; j<n; j++){
                pivote1 = A[j][i]
                aux = pivote1 / pivote
                For(k=0; k<n; k++)
                        A[j][k] = A[j][k]-aux*A[i][k]
                End for
        End for
End for
determinante = 1;
For(i=0; i<n; i++)
        determinante = A[i][i]*det
End for
Write( "El determinante es:  determiante“)
```

Ejercicio 8: Método de intercambio.

Alexis Palomares Olegario.

17 de septiembre del 2021.

Ejercicio. Método de intercambio.

Obtener la inversa de la matriz por el método de intercambio.

	x1	x2	x3	x4
b1	4/1	3/1	-2/1	1/1
b2	1/1	-3/1	0/1	-1/1
b3	2/1	1/1	3/1	-2/1
b4	2/1	-2/1	3/1	-3/1

	b1	x2	x3	x4
x1	1/4	-3/4	1/2	-1/4
b2	1/4	-15/4	1/2	-5/4
b3	1/2	-1/2	4/1	-5/2
b4	1/2	-7/2	4/1	-7/2

	b1	x2	b3	x4
x1	3/16	-11/16	1/8	1/16
b2	3/16	-59/16	1/8	-15/16
x3	-1/8	1/8	1/4	5/8
b4	0/1	-3/1	1/1	-1/1

	b1	b2	b3	x4
x1	9/59	11/59	6/59	14/59
x2	3/59	-16/59	2/59	-15/59
x3	-7/59	-2/59	15/59	35/59
b4	-9/59	48/59	53/59	-14/59

	b1	b2	b3	b4
x1	0/1	1/1	1/1	-1/1
x2	3/14	-8/7	-13/14	15/14
x3	-1/2	2/1	5/2	-5/2
x4	-9/14	24/7	53/14	-59/14

Ejercicio 9: Método de Gauss-Jordan particionado.

Alexis Palomares Olegario.

19 de septiembre del 2021.

Ejercicio. Método de intercambio.

Resolver el siguiente sistema de ecuaciones por el método de Gauss-Jordan particionado.

2/1	- 3/1	1/1	2/1	0/1	0/1	7/1
1/1	2/1	- 2/1	1/1	0/1	0/1	3/1
2/1	- 3/1	4/1	1/1	1/1	- 1/1	13/1
5/1	1/1	5/1	0/1	- 6/1	0/1	28/1
2/1	4/1	- 2/1	1/1	0/1	- 1/1	10/1
1/1	1/1	2/1	6/1	3/1	0/1	30/1

Se obtiene la inversa de A11

A11^-1=

2/7	3/7
- 1/7	2/7

Se premultiplica la fila por A11^-1

A12'=

- 4/7	1/1
- 5/7	0/1

A13'=

0/1	0/1
0/1	0/1

b1'=

23/7
- 1/7

1/1	0/1	- 4/7	1/1	0/1	0/1	23/7
0/1	1/1	- 5/7	0/1	0/1	0/1	- 1/7
2/1	- 3/1	4/1	1/1	1/1	- 1/1	13/1
5/1	1/1	5/1	0/1	- 6/1	0/1	28/1
2/1	4/1	- 2/1	1/1	0/1	- 1/1	10/1
1/1	1/1	2/1	6/1	3/1	0/1	30/1

A21*A12'=

1/1	2/1
- 25/7	5/1

A21*A13'=

0/1	0/1
0/1	0/1

A21*b1'=

7/1
114/7

A22'=

3/1	- 1/1
60/7	- 5/1

A23'=

1/1	- 1/1
- 6/1	0/1

b2'=

6/1
82/7

A31*A12'=

- 4/1	2/1
- 9/7	1/1

A31*A13'=

0/1	0/1
0/1	0/1

A31*b1'=

6/1
22/7

A32'=

2/1	- 1/1
23/7	5/1

A33'=

0/1	- 1/1
3/1	0/1

b3'=

4/1
188/7

1/1	0/1	- 4/7	1/1	0/1	0/1	23/7
0/1	1/1	- 5/7	0/1	0/1	0/1	- 1/7
0/1	0/1	3/1	- 1/1	1/1	- 1/1	6/1
0/1	0/1	60/7	- 5/1	- 6/1	0/1	82/7
0/1	0/1	2/1	- 1/1	0/1	- 1/1	4/1
0/1	0/1	23/7	5/1	3/1	0/1	188/7

Se obtiene la inversa de A22

A22^-1

7/9	- 7/45
4/3	- 7/15

Se premultiplica la fila por A22^-1

A22^-1*A23=

77/45	- 7/9
62/15	- 4/3

A22^-1*b2=

128/45
38/15

1/1	0/1	- 4/7	1/1	0/1	0/1	23/7
0/1	1/1	- 5/7	0/1	0/1	0/1	- 1/7
0/1	0/1	1/1	0/1	77/45	- 7/9	128/45
0/1	0/1	0/1	1/1	62/15	- 4/3	38/15
0/1	0/1	2/1	- 1/1	0/1	- 1/1	4/1
0/1	0/1	23/7	5/1	3/1	0/1	188/7

A32*A23=

- 32/45	- 2/9
1183/45	- 83/9

A32*b2=

142/45
6934/315

A33'=

32/45	- 7/9
-1048/45	83/9

b3'=

38/45
218/45

1/1	0/1	- 4/7	1/1	0/1	0/1	23/7
0/1	1/1	- 5/7	0/1	0/1	0/1	- 1/7
0/1	0/1	1/1	0/1	77/45	- 7/9	128/45
0/1	0/1	0/1	1/1	62/15	- 4/3	38/15
0/1	0/1	0/1	0/1	32/45	- 7/9	38/45
0/1	0/1	0/1	0/1	-1048/45	83/9	218/45

32/45	- 7/9	38/45
-1048/45	83/9	218/45

A33^-1=

- 83/104	- 7/104
- 131/65	- 4/65

x5=	-1.00
x6=	-2.00

1/1	0/1	3/1
0/1	1/1	4/1

x3=	3.00
x4=	4.00

1/1	0/1	1/1
0/1	1/1	2/1

x1=	1.00

$$x_2 = \begin{vmatrix} 2.00 \end{vmatrix}$$

Vector solución

$$X = \begin{vmatrix} 1.00 \\ 2.00 \\ 3.00 \\ 4.00 \\ -1.00 \\ -2.00 \end{vmatrix}$$

Ejercicio 10: Método de Jacobi.

Alexis Palomares Olegario.

21 de octubre del 2021.

$2x_1$	$-x_2$	$+10x_3$	$-x_4$	= 45
$-x_1$	$+8x_2$	$-x_3$	$+3x_4$	= 15
$2x_1$	$+3x_2$	$-x_3$	$+8x_4$	= -39
$9x_1$	$-x_2$	$+2x_3$	$-2x_4$	= -11

Reacomodando los renglones

$9x_1$	$-x_2$	$+2x_3$	$-2x_4$	= -11
$-x_1$	$+8x_2$	$-x_3$	$+3x_4$	= 15
$2x_1$	$-x_2$	$+10x_3$	$-x_4$	= 45
$2x_1$	$+3x_2$	$-x_3$	$+8x_4$	= -39

Despejando el vector x correspondiente

$x_1^{(k+1)}$	=	- 11/9	$+x_2/9$	$-2x_3/9$	$2x_4/9$
$x_2^{(k+1)}$	=	15/8	$+x_1/8$	$+x_3/8$	$-3x_4/8$
$x_3^{(k+1)}$	=	9/2	$-2x_1/10$	$+x_2/10$	$+x_4/10$
$x_4^{(k+1)}$	=	- 39/8	$-2x_1/8$	$-3x_2/8$	$+x_3/8$

$x_1^{(k+1)}$		0/1	1/9	- 2/9	2/9	$x_1^{(k)}$		- 11/9
$x_2^{(k+1)}$	=	1/8	0/1	1/8	- 3/8	$x_2^{(k)}$		15/8
$x_3^{(k+1)}$		- 1/5	1/10	0/1	1/10	$x_3^{(k)}$	+	9/2
$x_4^{(k+1)}$		- 1/4	- 3/8	1/8	0/1	$x_4^{(k)}$		- 39/8

T			
0/1	1/9	- 2/9	2/9
1/8	0/1	1/8	- 3/8
- 1/5	1/10	0/1	1/10
- 1/4	- 3/8	1/8	0/1

C
- 11/9
15/8
9/2
- 39/8

$x^{(0)}$	$x^{(1)}$	$x^{(2)}$	$x^{(3)}$	$x^{(4)}$	$x^{(5)}$	$x^{(6)}$	$x^{(7)}$	$x^{(8)}$	$x^{(9)}$	$x^{(10)}$
0.0000000000	-1.2222222222	-3.0972222222	-2.7995756173	-3.0538532022	-2.9712778769	-3.0117070202	-2.9950897704	-3.0022039922	-2.9991030274	-3.0004017890
0.0000000000	1.8750000000	4.1128472222	3.8096788194	4.0653145496	3.9740119086	4.0134293304	3.9953422300	4.0024114272	3.9991098595	4.0004266730
0.0000000000	4.5000000000	4.4444444444	5.0597222222	4.9321373457	5.0201750579	4.9897055175	5.0041930256	4.9982125717	5.0007862646	4.9996739199
0.0000000000	-4.8750000000	-4.7100694444	-5.0874565972	-4.9712703752	-5.0195124873	-4.9949131143	-5.0033960542	-4.9989567655	-5.0005767157	-4.9997921574

	$\lvert x^7-x^6\rvert$	$\lvert x^8-x^7\rvert$	$\lvert x^9-x^8\rvert$	$\lvert x^{10}-x^9\rvert$
	0.01661725	-0.007114222	0.003100965	-0.001298762
	-0.0180871	0.007069197	-0.003301568	0.001316814
	0.014487508	-0.005980454	0.002573693	-0.001112345
	-0.00848294	0.004439289	-0.00161995	0.000784558
$\lVert x\rVert_\infty$ =	0.0180871	0.007114222	0.003301568	0.001316814

Ejercicio 11: Gauss - Seidel

Alexis Palomares Olegario.

01 de noviembre del 2021.

Próposito: Realizar el siguiente sistema por el método Gauss-Seidel
1. Resolver el siguiente sistema por descomposición de Cholesky.

$9x_1$	$-x_2$	$+2x_3$	$-2x_4$	= -11
$-x_1$	$+8x_2$	$-x_3$	$+3x_4$	= 15
$2x_1$	$-x_2$	$+10x_3$	$-x_4$	= 45
$2x_1$	$+3x_2$	$-x_3$	$+8x_4$	= -39

Despejando el vector x correspondiente

$x_1^{(k+1)}$	=	- 11/9	$+x_2/9$	$-2x_3/9$	$2x_4/9$
$x_2^{(k+1)}$	=	15/8	$+x_1/8$	$+x_3/8$	$-3x_4/8$
$x_3^{(k+1)}$	=	9/2	$-2x_1/10$	$+x_2/10$	$+x_4/10$
$x_4^{(k+1)}$	=	- 39/8	$-2x_1/8$	$-3x_2/8$	$+x_3/8$

$x_1^{(k+1)}$		0/1	1/9	- 2/9	2/9	$x_1^{(k)}$		- 11/9
$x_2^{(k+1)}$	=	1/8	0/1	1/8	- 3/8	$x_2^{(k)}$		15/8
$x_3^{(k+1)}$		- 1/5	1/10	0/1	1/10	$x_3^{(k)}$	+	9/2
$x_4^{(k+1)}$		- 1/4	- 3/8	1/8	0/1	$x_4^{(k)}$		- 39/8

T			
0/1	1/9	- 2/9	2/9
1/8	0/1	1/8	- 3/8
- 1/5	1/10	0/1	1/10
- 1/4	- 3/8	1/8	0/1

C
- 11/9
15/8
9/2
- 39/8

$x^{(0)}$	$x^{(1)}$	$x^{(2)}$	$x^{(3)}$	$x^{(4)}$	$x^{(5)}$	$x^{(6)}$	$x^{(7)}$	$x^{(8)}$	$x^{(9)}$	$x^{(10)}$
0.0000000000	-1.22222222	-3.14583333	-3.00682026	-3.00231727	-3.00031925	-3.00005529	-3.00000878	-3.00000143	-3.00000023	-3.00000004
0.0000000000	1.72222222	3.82161458	3.96439473	3.99474985	3.99912595	3.99985983	3.99997721	3.99999631	3.99999940	3.99999990
0.0000000000	4.91666667	5.05125868	5.00877955	5.00155389	5.00025068	5.00004093	5.00000663	5.00000107	5.00000017	5.00000003
0.0000000000	-4.60069444	-4.89023980	-4.98384551	-4.99725764	-4.99956108	-4.99992850	-4.99998843	-4.99999812	-4.99999970	-4.99999995

$\lvert x^7-x^6 \rvert$	$\lvert x^8-x^7 \rvert$	$\lvert x^9-x^8 \rvert$	$\lvert x^{10}-x^9 \rvert$
0.00004651	0.00000735	0.00000120	0.00000019
0.00011738	0.00001910	0.00000309	0.00000050
-0.00003431	-0.00000555	-0.00000090	-0.00000015
-0.00005993	-0.00000969	-0.00000157	-0.00000025

$\lVert x \rVert_\infty$ =	0.00011738	0.00001910	0.00000309	0.00000050

La convergencia a comparación del método de Jacobi es más rápida.

Ejercicio 12: Relajación

Alexis Palomares Olegario.

03 de noviembre del 2021.

Própósito: 1. Identificar el procedimiento del método de relajación y la forma en que se construye el vector solución.
2. Comprender los conceptos de residual y factor de ponderación.

Indicaciones: Resolver los siguientes sistemas de ecuaciones empleando el método de relajación.

$9x_1$	$-x_2$	$+2x_3$	$-2x_4$	= -11
$-x_1$	$+8x_2$	$-x_3$	$+3x_4$	= 15
$2x_1$	$-x_2$	$+10x_3$	$-x_4$	= 45
$2x_1$	$+3x_2$	$-x_3$	$+8x_4$	= -39

Despejando

$-x_1$	$+x_2/9$	$-2x_3/9$	$+2x_4/9$	- 11/9	= R1
$+x_1/8$	$-x_2$	$+x_3/8$	$-3x_4/8$	15/8	= R2
$-2x_1/10$	$+x_2/10$	$-x_3$	$+x_4/10$	9/2	= R3
$-2x_1/8$	$-3x_2/8$	$+x_3/8$	$-x_4$	- 39/8	= R4

- 1/1	1/9	- 2/9	2/9	- 11/9
1/8	- 1/1	1/8	3/8	15/8
- 1/5	1/10	- 1/1	1/10	9/2
- 1/4	- 3/8	1/8	- 1/1	- 39/8

x1	x2	x3	x4	R1	R2	R3	R4
0	0	0	0	-1.222222	1.875000	4.500000	-4.875000
			-4.875000	-1.083333	-1.828125	-0.487500	4.875000
				-2.305556	0.046875	4.012500	0.000000
-2.305556				2.305556	-0.288194	0.461111	0.576389
				0.000000	-0.241319	4.473611	0.576389
		4.473611		-0.994136	0.559201	-4.473611	0.559201
				-0.994136	0.317882	0.000000	1.135590
			1.135590	0.252353	0.425846	0.113559	-1.135590
				-0.741782	0.743728	0.113559	0.000000
	0.743728			0.082636	-0.743728	0.074373	-0.278898
				-0.659146	0.000000	0.187932	-0.278898
-0.659146				0.659146	-0.082393	0.131829	0.164786
				0.000000	-0.082393	0.319761	-0.114112
		0.319761		-0.071058	0.039970	-0.319761	0.039970
				-0.071058	-0.042423	0.000000	-0.074141
			-0.074141	-0.016476	-0.027803	-0.007414	0.074141
				-0.087534	-0.070226	-0.007414	0.000000
-0.087534				0.087534	-0.010942	0.017507	0.021883
				0.000000	-0.081168	0.010093	0.021883
	-0.081168			-0.009019	0.081168	-0.008117	0.030438
				-0.009019	0.000000	0.001976	0.052321
			0.052321	0.011627	0.019621	0.005232	-0.052321
				0.002608	0.019621	0.007208	0.000000
	0.019621			0.002180	-0.019621	0.001962	-0.007358
				0.004788	0.000000	0.009170	-0.007358
		0.009170		-0.002038	0.001146	-0.009170	0.001146
				0.002751	0.001146	0.000000	-0.006211
			-0.006211	-0.001380	-0.002329	-0.000621	0.006211
				0.001370	-0.001183	-0.000621	0.000000
0.001370				-0.001370	0.000171	-0.000274	-0.000343
				0.000000	-0.001012	-0.000895	-0.000343
	-0.001012			-0.000112	0.001012	-0.000101	0.000000
				-0.000112	0.000000	-0.000996	-0.000343

		-0.000996		0.000221	-0.000125	0.000996	-0.000125	
				0.000109	-0.000125	0.000000	-0.000467	Se alcanzó la tolerancia
-3.0508651	0.68116918	4.80154581	-3.7674412					

$8x_1$	$+x_2$	$+3x_3$	$-x_4$	= -2
$4x_1$	$+10x_2$	$+2x_3$	$-x_4$	= 17
0	$-x_2$	$+8x_3$	$-2x_4$	= -24
x_1	$-2x_2$	$3x_3$	$+6x_4$	= 9

Despejando

8	1	3	-1	-2.00
4	10	2	-1	17
0	-1	8	-2	-24
1	-2	3	6	9

- 1/1	- 1/8	- 3/8	1/8	- 1/4	=R1
- 2/5	- 1/1	- 1/5	1/10	17/10	=R2
0/1	1/8	- 1/1	1/4	- 3/1	=R3
- 1/6	1/3	- 1/2	- 1/1	3/2	=R4

- 1/1	- 2/5	0/1	- 1/6	=x1
- 1/8	- 1/1	1/8	1/3	=x2
- 3/8	- 1/5	- 1/1	- 1/2	=x3
1/8	1/10	1/4	- 1/1	=x4

x1	x2	x3	x4	R1	R2	R3	R4	
0	0	0	0	-0.250000	1.700000	-3.000000	1.500000	
		-3.000000		9/8	3/5	3/1	3/2	
				0.875000	2.300000	0.000000	3.000000	
			3.000000	3/8	3/10	3/4	- 3/1	
				1.250000	2.600000	0.750000	0.000000	
	2.600000			- 13/40	- 13/5	13/40	13/15	
				0.925000	0.000000	1.075000	0.866667	
		1.075000		- 129/320	- 43/200	- 43/40	- 43/80	
				0.521875	-0.215000	0.000000	0.329167	
0.521875				-0.521875	-0.208750	0.000000	-0.086979	
				0.000000	-0.423750	0.000000	0.242188	
	-0.423750			0.052969	0.423750	-0.052969	-0.141250	
				0.052969	0.000000	-0.052969	0.100938	
			0.100938	0.012617	0.010094	0.025234	-0.100938	
				0.065586	0.010094	-0.027734	0.000000	
0.065586				- 530/8081	- 212/8081	0/1	- 29/2653	
				0.000000	-0.016141	-0.027734	-0.010931	
		-0.027734		0.010400	0.005547	0.027734	0.013867	
				0.010400	-0.010594	0.000000	0.002936	
	-0.010594			6/4531	43/4059	- 6/4531	- 27/7646	
				0.011725	0.000000	-0.001324	-0.000595	
0.011725				-0.011725	-0.004690	0.000000	-0.001954	
				0.000000	-0.004690	-0.001324	-0.002549	
	-0.004690			5/8529	22/4691	- 5/8529	- 3/1919	
				0.000586	0.000000	-0.001910	-0.004112	
			-0.004112	- 3/5836	- 3/7295	- 3/2918	6/1459	
				0.000072	-0.000411	-0.002939	0.000000	
		-0.002939		2/1815	2/3403	10/3403	5/3403	
				0.001174	0.000176	0.000000	0.001469	
			0.001469	0.000184	0.000147	0.000367	-0.001469	
				0.001358	0.000323	0.000367	0.000000	
0.001358				-0.001358	-0.000543	0.000000	-0.000226	
				0.000000	-0.000220	0.000367	-0.000226	
		0.000367		- 1/7260	0/1	- 2/5445	- 1/5445	
				-0.000138	-0.000293	0.000000	-0.000410	
			-0.000410	0/1	0/1	- 1/9757	4/9757	
				-0.000189	-0.000334	-0.000102	0.000000	
	-0.000334			0/1	3/8977	0/1	- 1/8977	
				-0.000147	0.000000	-0.000144	-0.000111	
-0.000147				1/6793	0/1	0/1	0/1	
				0.000000	0.000059	-0.000144	-0.000087	
		-0.000144		0/1	0/1	1/6932	0/1	
				0.000054	0.000088	0.000000	-0.000015	Se alcanzó la tolerancia

0.60039613	2.16063222	-1.9554499	3.09788439

Ejercicio 13: Método de Doolittle.

Alexis Palomares Olegario.

07 de noviembre del 2021.

2. Resolver el siguiente sistema de ecuaciones empleando la factorización Doolittle

10	-2	3	-1	x1	20	-2
2	6	-2	-1	x2	6	7
1	-1	5	-1	x3	18	15
-1	2	-1	8	x4	19	-22

Primer renglón:		Primera columna:	
U11=	10		
U12=	-2	L21=	0.2
U13=	3	L31=	0.1
U14=	-1	L41=	-0.1

Segundo renglón:		Segunda columna:	
U22=	6.4		
U23=	-2.6	L32=	-0.125
U24=	-0.8	L42=	0.28125

Tercer renglón:		Tercer columna:	
U33=	4.375		
U34=	-1	L43=	0.00714286

Cuarto renglón:	
U44=	8.13214286

1	0	0	0	z1	20
0.2	1	0	0	z2	6
0.1	-0.125	1	0	z3	18
-0.1	0.28125	0.00714286	1	z4	19

z1	20
z2	2
z3	16.25
z4	20.3214286

10	-2	3	-1	x1	20
0	6.4	-2.6	-0.8	x2	2
0	0	4.375	-1	x3	16.25
0	0	0	8.13214286	x4	20.3214286

x1=	1.43741765
x2=	2.36583224
x3=	4.28546333
x4=	2.49890206

1	0	0	0	z1	-2
0.2	1	0	0	z2	7
0.1	-0.125	1	0	z3	15
-0.1	0.28125	0.00714286	1	z4	-22

z1	-2
z2	7.4
z3	16.125
z4	-24.3964286

10	-2	3	-1	x1		-2
0	6.4	-2.6	-0.8	x2		7.4
0	0	4.375	-1	x3		16.125
0	0	0	8.13214286	x4		-24.3964286

x1=	-1
x2=	2
x3=	3
x4=	-3

1. Elaborar el algoritmo de factorización de Doolittle para matrices cuadradas

```
For (int i = 0; i < n; i++)
        For (int k = i; k < n; k++)
            For (int j = 0; j < i; j++)
                suma += (U[i][j] * L[j][k])
            End for
            u[i][k] = A[i][k] – suma
        End for
        For (int k = i; k < n; k++)
            IF (i == k)
                L[i][i] = 1
            End if
        End for
            Else
                For (int j = 0; j < i; j++)
                    suma += (L [k][j] * U[j][i])
                End for
                L[k][i] = (A[k][i] - suma) / U[i][i]


            End else
        End for
    End for
```

Ejercicio 14: Cholesky y Crout

Alexis Palomares Olegario.

10 de noviembre del 2021.

Própósito: Ejercitar la capacidad de abstracción para la elaboración de algoritmos y aplicación de procedimientos.
1. Resolver el siguiente sistema por descomposición de Cholesky.

6	2	-1	1	x1		17
2	4	1	0	x2		18
-1	1	4	-1	x3	=	-3
1	0	-1	3	x4		3

l11=	2.44948974
l21=	0.81649658
l31=	-0.40824829
l41=	0.40824829
l22=	1.82574186
l32=	0.73029674
l42=	-0.182574
l33=	1.816590
l43=	-0.38533732
l44=	1.62834737

2.44948974	0	0	0	z1		17
0.81649658	1.82574186	0	0	z2		18
-0.4082483	0.73029674	1.816590	0	z3	=	-3
0.40824829	-0.182574	-0.3853373	1.62834737	z4		3

z1=	6.94022094
z2=	6.75524488
z3=	-2.8074576
z4=	0.19540168

	6.94022094
z=	6.75524488
	-2.8074576
	0.19540168

2.44948974	0.81649658	-0.4082483	0.40824829	x1		6.94022094
0	1.82574186	0.73029674	-0.1825742	x2		6.75524488
0	0	1.81659021	-0.3853373	x3	=	-2.8074576
0	0	0	1.62834737	x4		0.19540168

x4=	0.12
x3=	-1.52
x2=	4.32
x1=	1.12

	1.12
x=	4.32
	-1.52
	0.12

Resolver el siguiente sistema por el método de Crout

5	1	2	-1	2
-1	4	0	2	-9
2	-2	8	1	18
3	-1	1	6	19

1 columna de L		1 renglon de U	
l11=	5		
l21=	-1	u12=	0.2
l31=	2	u13=	0.4
l41=	3	u14=	-0.2
2 columna de L		2 renglon de U	
l22=	4.2		
l32=	-2.4	u23=	0.0952381
l42=	-1.6	u24=	0.42857143
3 columna de L		3 renglon de U	
l33=	7.42857143		
l43=	-0.047619	u34=	0.32692308
4 columna de L			
l44=	7.30128205		

5	0	0	0	z1	2
-1	4.2	0	0	z2	-9
2	-2.4	7.42857143	0	z3	18
3	-1.6	-0.047619	7.30128205	z4	19

z1=	0.4
z2=	-2.047619
z3=	1.65384615
z4=	2

1	0.2	0.4	-0.2	0.4
0	1	0.0952381	0.42857143	-2.047619
0	0	1	0.32692308	1.65384615
0	0	0	1	2

x1=	1
x2=	-3
x3=	1
x4=	2

Ejercicio 13: Método de potencias

Alexis Palomares Olegario.

18 de noviembre del 2021.

Própositо: Aplicar el método de potencias para obtener los valores propios máximo y minímo de unamatriz

4	2	-1	1	4
2	8	4	-3	9
3	6	2	2	11
1	2	1	-1	4

R1=	{z C, |z-4| <= 4}	x [0,8]	
R2=	{z C, |z-9| <= 8}	x [-1,17]	Elegimos como refenrecia este
R3=	{z C, |z-11| <= 2}	x [-9,13]	
R4=	{z C, |z-4| <= -1}	x [-5,3]	

it	0	1	2	3	4	5	6	7	8
	0	2	2.5	2.372093023	2.314225053	2.298519096	2.294206116	2.293062189	2.292755523
	1	8	10.75	10.95348837	10.89596603	10.88308652	10.87871518	10.87763291	10.87733151
	0	6	8.75	8.837209302	8.772823779	8.755650818	8.75048342	8.74914664	8.748782763
	0	2	2.75	2.790697674	2.768577495	2.763445051	2.76179904	2.761384995	2.761270757
lamnda	1	8	10.75	10.95348837	10.89596603	10.88308652	10.87871518	10.87763291	10.87733151
norma	1	8	10.75	10.95348837	10.89596603	10.88308652	10.87871518	10.87763291	10.87733151
	0	0.25	0.23255814	0.21656051	0.212392829	0.211201031	0.210889437	0.210805256	0.210782904
	1	1	1	1	1	1	1	1	1
	0	0.75	0.813953488	0.806794055	0.805144193	0.804519086	0.804367361	0.804324499	0.804313333
	0	0.25	0.255813953	0.25477707	0.254091972	0.253921077	0.253871803	0.253858998	0.25385553
Error:		7	2.75	0.203488372	0.057522342	0.012879514	0.00437134	0.001082267	0.000301396

Se alcanzó la tolerancia, por lo tanto el valor propio máximo es de 10.87733151

Inversa de la matriz

-1/13	-8/13	2/13	27/13	37/13
9/26	10/13	-5/26	-61/26	75/26
-10/13	-15/13	7/13	49/13	74/13
-2/13	-3/13	4/13	2/13	9/13

it	0	1	2	3	4	5	6	7	8	9	10
	0	2/13	20/13	1797/2275	1945/1844	28867/30964	39620/40281	66409/69100	25142/25899	65738/68013	37882/39119
	0	-5/26	-311/182	-796/975	-61970/56063	-10949/11320	-13308/12995	-75623/75705	-63018/62411	-65850/65521	-70779/70283
	1	7/13	75/26	3137/2275	74822/40781	26598/16505	113472/66659	159869/96198	152147/90608	74993/44862	19871/11864
	0	4/13	79/182	877/2275	16280/40781	38/97	8414/21323	37907/96384	16259/41283	28625/72726	20401/51818
lamnda	1	7/13	75/26	3137/2275	74822/40781	26598/16505	113472/66659	159869/96198	152147/90608	74993/44862	1.674899
norma	1	7/13	75/26	3137/2275	74822/40781	26598/16505	113472/66659	159869/96198	152147/90608	74993/44862	1.674899
	0	2/7	8/15	1797/3137	50513/87865	37554/64915	32886/56915	46166/79831	15311/26484	33200/57419	19489/33708
	0	-5/14	-311/525	-5572/9411	-23780/39471	-4849/8079	-11819/19646	-13823/22997	-39683/65993	-16070/26729	-53732/89365
	1	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1
	0	4/7	79/525	877/3137	740/3401	14798/60873	13693/59071	1667/7044	6131/26140	19507/82847	13635/58006
Error:		6/13	61/26	527/350	356/781	9890/44307	8707/95930	3121/77250	796/46001	0.00754	0.00326

Se alcanzó la tolerancia, por lo tanto el valor propio minímo es de 0.597050979

Ejercicio 16: Transformación de Householder

Alexis Palomares Olegario.

19 de noviembre del 2021.

Próposito: A plicar la transformación de semenjanza de Householder a una matriz simétrica para simplificarla en superior Hessemberg.
Indicaciones: Aplicar la transformación de Householder a la siguiente matriz.

-2	3	1	-1
3	4	2	5
1	2	1	3
-1	5	3	-4

G= 3.31662479

r= 3.236500762

w1= 0

w2= 0.975841697

w3= 0.154487836

w4= -0.154487836

$$w=\begin{vmatrix} 0 \\ 0.975841697 \\ 0.154487836 \\ -0.154487836 \end{vmatrix}$$

$$ww^t=\begin{vmatrix} 0 \\ 0.975841697 \\ 0.154487836 \\ -0.154487836 \end{vmatrix} \begin{vmatrix} 0 & 0.9758417 & 0.154487836 & -0.1544878 \end{vmatrix}$$

$$=\begin{vmatrix} 0 & 0 & 0 & 0 \\ 0 & 0.952267017 & 0.15075567 & -0.150755672 \\ 0 & 0.150755672 & 0.02386649 & -0.023866492 \\ 0 & -0.150755672 & -0.0238665 & 0.023866492 \end{vmatrix}$$

$$p(1)= \quad I - 2ww^t= \begin{vmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{vmatrix} -2 \begin{vmatrix} 0 & 0 & 0 & 0 \\ 0 & 0.95226702 & 0.15075567 & -0.1507557 \\ 0 & 0.15075567 & 0.02386649 & -0.0238665 \\ 0 & -0.1507557 & -0.0238665 & 0.02386649 \end{vmatrix}$$

$$= \begin{matrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{matrix} + \begin{matrix} 0 & 0 & 0 & 0 \\ 0 & -1.904534 & -0.3015113 & 0.30151134 \\ 0 & -0.3015113 & -0.047733 & 0.04773298 \\ 0 & 0.30151134 & 0.04773298 & -0.047733 \end{matrix}$$

$$= \begin{vmatrix} 1 & 0 & 0 & 0 \\ 0 & -0.904534034 & -0.301511345 & 0.301511345 \\ 0 & -0.301511345 & 0.952267017 & 0.047732983 \\ 0 & 0.301511345 & 0.047732983 & 0.952267017 \end{vmatrix}$$

$$A(2)= \begin{vmatrix} 1 & 0 & 0 & 0 \\ 0 & -0.904534034 & -0.301511345 & 0.301511345 \\ 0 & -0.301511345 & 0.952267017 & 0.047732983 \\ 0 & 0.301511345 & 0.047732983 & 0.952267017 \end{vmatrix} \begin{vmatrix} -2 & 3 & 1 & -1 \\ 3 & 4 & 2 & 5 \\ 1 & 2 & 1 & 3 \\ -1 & 5 & 3 & -4 \end{vmatrix} \begin{vmatrix} 1 & 0 & 0 & 0 \\ 0 & -0.904534 & -0.3015113 & 0.30151134 \\ 0 & -0.3015113 & 0.95226702 & 0.04773298 \\ 0 & 0.30151134 & 0.04773298 & 0.95226702 \end{vmatrix}$$

$$= \begin{matrix} -2 & -3.31662479 & 5.55112E-17 & 0 \\ -3.31662479 & 0.818181818 & -0.646920207 & -7.192374752 \\ 5.55112E-17 & -0.646920207 & 0.241664763 & 1.409090909 \\ 0 & -7.192374752 & 1.409090909 & -0.059846581 \end{matrix}$$

Tr(A(2))= -1

G= 7.221409858

r= 4.872221484

w3= 0.674691172
w4= -0.738100143

$$w=\begin{vmatrix} 0 \\ 0 \\ 0.674691172 \\ -0.738100143 \end{vmatrix}$$

$$ww^t=\begin{vmatrix} 0 \\ 0 \\ 0.674691172 \\ -0.738100143 \end{vmatrix} \begin{vmatrix} 0 & 0 & 0.674691172 & -0.7381001 \end{vmatrix}$$

$$=\begin{vmatrix} 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 0.45520818 & -0.497989651 \\ 0 & 0 & -0.4979897 & 0.544791822 \end{vmatrix}$$

$$p(2)= \quad I - 2ww^t= \begin{vmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{vmatrix} -2 \begin{vmatrix} 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 0.45520818 & -0.4979897 \\ 0 & 0 & -0.4979897 & 0.54479182 \end{vmatrix}$$

$$= \begin{matrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \end{matrix} + \begin{matrix} 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \end{matrix}$$

$$\begin{matrix} 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{matrix} \qquad \begin{matrix} 0 & 0 & -0.9104164 & 0.9959793 \\ 0 & 0 & 0.9959793 & -1.0895836 \end{matrix}$$

$$= \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 0.089583644 & 0.995979302 \\ 0 & 0 & 0.995979302 & -0.089583644 \end{bmatrix}$$

$$A(3)= \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 0.089583644 & 0.995979302 \\ 0 & 0 & 0.995979302 & -0.089583644 \end{bmatrix} \begin{bmatrix} -2 & -3.3166248 & 5.55112E-17 & 0 \\ -3.31662479 & 0.81818182 & -0.646920207 & -7.1923748 \\ 5.55112E-17 & -0.6469202 & 0.241664763 & 1.40909091 \\ 0 & -7.1923748 & 1.409090909 & -0.0598466 \end{bmatrix} \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 0.08958364 & 0.9959793 \\ 0 & 0 & 0.9959793 & -0.0895836 \end{bmatrix}$$

$$= \begin{matrix} -2 & -3.31662479 & 4.97289E-18 & 5.5288E-17 \\ -3.31662479 & 0.818181818 & -7.221409858 & 2.66454E-15 \\ 4.97289E-18 & -7.221409858 & 0.194021034 & 1.413376238 \\ 5.5288E-17 & 2.77556E-15 & 1.413376238 & -0.012202853 \end{matrix}$$

$$Tr(A(3))= -1$$

Ejercicio 17: Método de iteración QR

Alexis Palomares Olegario.

26 de noviembre del 2021.

Própósito: Aplicar el método de iteración QR para obtener los valores propios de una matriz.
Indicaciones: Aplicar la transformación de Householder a la siguiente matriz.

-2	-3.3166248	0	0
-3.3166248	0.81818182	-7.2214099	0
0	-7.2214099	0.19402103	1.41337624
0	0	1.41337624	-0.0122029

		Q				Q^T				QAQ^t					
	1	1	0	0	0	1	0	0	0	-2	-0.3733829	3.2955402	0	Tr	Tolerancia
(3,2)		0	0.11257919	0.99364276	0	0	0.11257919	-0.9936428	0	-0.3733829	-1.4136926	6.9685397	1.40439106	-1	
		0	-0.9936428	0.11257919	0	0	0.99364276	0.11257919	0	3.2955402	6.9685397	2.4258954	0.15911675		
		0	0	0	1	0	0	0	1	0	1.40439106	0.15911675	-0.0122029		
	2	1	0	0	0	1	0	0	0	-2	-3.1555143	-1.0211412	0		
(3,2)		0	-0.1988179	-0.9800365	0	0	-0.1988179	0.98003646	0	-3.1555143	4.98974475	-5.6694883	-0.4351583	-1	1.29905145
		0	0.98003646	-0.1988179	0	0	-0.9800365	-0.1988179	0	-1.0211412	-5.6694883	-3.9775419	1.34471918		
		0	0	0	1	0	0	0	1	0	-0.4351583	1.34471918	-0.0122029		
	3	1	0	0	0	1	0	0	0	-2	-2.8513055	1.69412428	0		
(3,2)		0	0.6606723	0.75067444	0	0	0.6606723	-0.7506744	0	-2.8513055	-5.6869931	-3.7271617	0.72194931	-1	1.94232652
		0	-0.7506744	0.6606723	0	0	0.75067444	0.6606723	0	1.69412428	-3.7271617	6.69919596	1.21508089		
		0	0	0	1	0	0	0	1	0	0.72194931	1.21508089	-0.0122029		
	4	1	0	0	0	1	0	0	0	-2	3.31340926	0.14601059	0		
(3,2)		0	-0.8363802	0.54814981	0	0	-0.8363802	-0.5481498	0	3.31340926	1.45218422	-7.1659669	0.06222226	-1	0.41375248
		0	-0.5481498	-0.8363802	0	0	0.54814981	-0.8363802	0	0.14601059	-7.1659669	-0.4399814	-1.4120059		
		0	0	0	1	0	0	0	1	0	0.06222226	-1.4120059	-0.0122029		
	5	-0.5167651	-0.8561272	0	0	-0.5167651	0.8561272	0	0	3.46210665	-0.0164385	6.05952603	-0.0532702		
(2,1)		0.8561272	-0.5167651	0	0	-0.8561272	-0.5167651	0	0	-0.0164385	-4.0099224	3.82812555	-0.0321543	-1	2.74611677
		0	0	1	0	0	0	1	0	6.05952603	3.82812555	-0.4399814	-1.4120059		
		0	0	0	1	0	0	0	1	-0.0532702	-0.0321543	-1.4120059	-0.0122029		
	6	1	0	0	0	1	0	0	0	3.46210665	-4.1723357	-4.394285	-0.0532702		
(3,2)		0	-0.723313	-0.6905203	0	0	-0.723313	0.69052032	0	-4.1723357	1.51629981	1.96053582	0.99827642	-1	1.665241
		0	0.69052032	-0.723313	0	0	-0.6905203	-0.723313	0	-4.394285	1.96053582	-5.9662036	0.99911904		
		0	0	0	1	0	0	0	1	-0.0532702	0.99827642	0.99911904	-0.0122029		
	7	0.61886591	0	0.78549665	0	0.61886591	0	-0.7854967	0	-6.627482	-1.042122	-3.5549562	0.75183757		
(3,1)		0	1	0	0	0	1	0	0	-1.042122	1.51629981	4.49066448	0.99827642	-1	0.09637945
		-0.7854967	0	0.61886591	0	0.78549665	0	0.61886591	0	-3.5549562	4.49066448	4.12338505	0.66016425		
		0	0	0	1	0	0	0	1	0.75183757	0.99827642	0.66016425	-0.0122029		
	8	1	0	0	0	1	0	0	0	-6.627482	3.03474774	-2.1246266	0.75183757		
(3,2)		0	0.31991133	-0.9474475	0	0	0.31991133	0.94744749	0	3.03474774	1.13433396	-4.3616914	-0.306111	-1	0.12897306
		0	0.94744749	0.31991133	0	0	-0.9474475	0.31991133	0	-2.1246266	-4.3616914	4.5053509	1.15700851		
		0	0	0	1	0	0	0	1	0.75183757	-0.306111	1.15700851	-0.0122029		
	9	1	0	0	0	1	0	0	0	-6.627482	-1.2923969	-3.4718068	0.75183757		
(3,2)		0	0.25169499	0.96780661	0	0	0.25169499	-0.9678066	0	-1.2923969	2.16684877	4.63021491	1.04271387	-1	0.26852349
		0	-0.9678066	0.25169499	0	0	0.96780661	0.25169499	0	-3.4718068	4.63021491	3.47283609	0.58746952		
		0	0	0	1	0	0	0	1	0.75183757	1.04271387	0.58746952	-0.0122029		
	10	1	0	0	0	1	0	0	0	-6.627482	2.59671006	-2.6421258	0.75183757		
(3,2)		0	0.42386214	-0.9057267	0	0	0.42386214	0.90572672	0	2.59671006	-0.3169057	-3.4678671	-0.0901199	-1	1.16234785
		0	0.90572672	0.42386214	0	0	-0.9057267	0.42386214	0	-2.6421258	-3.4678671	5.95659057	1.1934199		
		0	0	0	1	0	0	0	1	0.75183757	-0.0901199	1.1934199	-0.0122029		
	11	1	0	0	0	1	0	0	0	-6.627482	-2.8674741	-2.3454903	0.75183757		
(3,2)		0	-0.0910043	0.9958505	0	0	-0.0910043	-0.9958505	0	-2.8674741	6.53319721	2.84188091	1.1966691	-1	0.600393
		0	-0.9958505	-0.0910043	0	0	0.9958505	-0.0910043	0	-2.3454903	2.84188091	-0.8935124	-0.0188604		
		0	0	0	1	0	0	0	1	0.75183757	1.1966691	-0.0188604	-0.0122029		
	12	-0.9177795	0.39709033	0	0	-0.9177795	-0.3970903	0	0	-2.4622441	-6.7594793	3.2811264	-0.2148354		
(2,1)		-0.3970903	-0.9177795	0	0	0.39709033	-0.9177795	0	0	-6.7594793	2.36795935	-1.6768486	-1.3968258	-1	3.89200524
		0	0	1	0	0	0	1	0	3.2811264	-1.6768486	-0.8935124	-0.0188604		
		0	0	0	1	0	0	0	1	-0.2148354	-1.3968258	-0.0188604	-0.0122029		
	13	-0.342265	0.93960347	0	0	-0.342265	-0.9396035	0	0	6.14973109	3.62243506	-2.6985875	-1.2389318		
(2,1)		-0.9396035	-0.342265	0	0	0.93960347	-0.342265	0	0	3.62243506	-6.2440159	-2.5090312	0.67994468	-1	3.13704424
		0	0	1	0	0	0	1	0	-2.6985875	-2.5090312	-0.8935124	-0.0188604		
		0	0	0	1	0	0	0	1	-1.2389318	0.67994468	-0.0188604	-0.0122029		
	14	0.86163121	-0.5075349	0	0	0.86163121	0.50753489	0	0	-0.2110337	7.17610037	-1.0517663	-1.4125979		
(2,1)		0.50753489	0.86163121	0	0	-0.5075349	0.86163121	0	0	7.17610037	0.11674895	-3.5314868	-0.0429395	-1	3.55366531
		0	0	1	0	0	0	1	0	-1.0517663	-3.5314868	-0.8935124	-0.0188604		
		0	0	0	1	0	0	0	1	-1.4125979	-0.0429395	-0.0188604	-0.0122029		
	15	-0.0293952	-0.9995679	0	0	-0.0293952	0.99956787	0	0	0.53816852	-7.1540679	3.56087761	0.08444451		
(2,1)		0.99956787	-0.0293952	0	0	-0.9995679	-0.0293952	0	0	-7.1540679	-0.6324533	-0.9475033	-1.4107253	-1	0.02203243
		0	0	1	0	0	0	1	0	3.56087761	-0.9475033	-0.8935124	-0.0188604		
		0	0	0	1	0	0	0	1	0.08444451	-1.4107253	-0.0188604	-0.0122029		
	16	0.07501358	0.99718251	0	0	0.07501358	-0.9971825	0	0	-1.6961466	6.9859904	-0.6777195	-1.4004161		
(2,1)		-0.9971825	0.07501358	0	0	0.99718251	0.07501358	0	0	6.9859904	1.60186184	-3.6219205	-0.1900301	-1	0.16807753
		0	0	1	0	0	0	1	0	-0.6777195	-3.6219205	-0.8935124	-0.0188604		
		0	0	0	1	0	0	0	1	-1.4004161	-0.1900301	-0.0188604	-0.0122029		
	16	-0.2359381	-0.9717681	0	0	-0.2359381	0.97176809	0	0	4.62172756	-5.4520574	3.6795666	0.51507671		
(2,1)		0.97176809	-0.2359381	0	0	-0.9717681	-0.2359381	0	0	-5.4520574	-4.7160124	0.19596279	-1.3160443	-1	1.53393297
		0	0	1	0	0	0	1	0	3.6795666	0.19596279	-0.8935124	-0.0188604		
		0	0	0	1	0	0	0	1	0.51507671	-1.3160443	-0.0188604	-0.0122029		
	17	0.6466308	0.76280313	0	0	0.6466308	-0.7628031	0	0	-6.1900866	-3.7131541	2.52880211	-0.6708183		
(2,1)		-0.7628031	0.6466308	0	0	0.76280313	0.6466308	0	0	-3.7131541	6.09580181	-2.6800693	-1.2438969	-1	1.73890333
		0	0	1	0	0	0	1	0	2.52880211	-2.6800693	-0.8935124	-0.0188604		
		0	0	0	1	0	0	0	1	-0.6708183	-1.2438969	-0.0188604	-0.0122029		
	18	-0.8575478	0.51440429	0	0	-0.8575478	-0.5144043	0	0	0.33684374	-7.1676936	-3.5472078	-0.0646072		

(2,1)		-0.5144043	-0.8575478	0	0	0.51440429	-0.8575478	0	0	-7.1676936	-0.4311285	0.9974609	1.41177285	-1	3.45453951
		0	0	1	0	0	0	1	0	-3.5472078	0.9974609	-0.8935124	-0.0188604		
		0	0	0	1	0	0	0	1	-0.0646072	1.41177285	-0.0188604	-0.0122029		
	19	0.04694291	0.99889757	0	0	0.04694291	-0.9988976	0	0	-1.1016391	7.1000925	0.82984502	1.40718363		
(2,1)		-0.9988976	0.04694291	0	0	0.99889757	0.04694291	0	0	7.1000925	1.00735432	3.59012103	0.13080869	-1	0.0676011
		0	0	1	0	0	0	1	0	0.82984502	3.59012103	-0.8935124	-0.0188604		
		0	0	0	1	0	0	0	1	1.40718363	0.13080869	-0.0188604	-0.0122029		
	20	-0.1533238	-0.988176	0	0	-0.1533238	0.988176	0	0	3.10925883	-6.4467362	-3.6749064	-0.3450168		
(2,1)		0.988176	-0.1533238	0	0	-0.988176	-0.1533238	0	0	-6.4467362	-3.2035436	0.26958184	1.370489	-1	0.65335626
		0	0	1	0	0	0	1	0	-3.6749064	0.26958184	-0.8935124	-0.0188604		
		0	0	0	1	0	0	0	1	-0.3450168	1.370489	-0.0188604	-0.0122029		
	21	0.43441379	0.90071342	0	0	0.43441379	-0.9007134	0	0	-7.0572089	1.54345208	-1.3536141	1.08453777		
(2,1)		-0.9007134	0.43441379	0	0	0.90071342	0.43441379	0	0	1.54345208	6.96292411	3.42714761	0.90612057	-1	3.01958863
		0	0	1	0	0	0	1	0	-1.3536141	3.42714761	-0.8935124	-0.0188604		
		0	0	0	1	0	0	0	1	1.08453777	0.90612057	-0.0188604	-0.0122029		
	22	1	0	0	0	1	0	0	0	-7.0572089	1.98256325	-0.5328774	1.08453777		
(3,2)		0	0.89720915	-0.4416059	0	0	0.89720915	0.44160587	0	1.98256325	2.7150356	5.20327302	0.82130851	-1	1.77612541
		0	0.44160587	0.89720915	0	0	-0.4416059	0.89720915	0	-0.5328774	5.20327302	3.35437616	0.38322648		
		0	0	0	1	0	0	0	1	1.08453777	0.82130851	0.38322648	-0.0122029		
	23	1	0	0	0	1	0	0	0	-7.0572089	1.38957235	1.51115984	1.08453777		
(3,2)		0	0.4626041	-0.886565	0	0	0.4626041	0.88656497	0	1.38957235	-1.0504664	-3.2384574	0.04018551	-1	1.96481561
		0	0.88656497	0.4626041	0	0	-0.886565	0.4626041	0	1.51115984	-3.2384574	7.11987819	0.9054255		
		0	0	0	1	0	0	0	1	1.08453777	0.04018551	0.9054255	-0.0122029		
	24	1	0	0	0	1	0	0	0	-7.0572089	1.00868224	-1.7880368	1.08453777		
(3,2)		0	-0.3085461	0.95120938	0	0	-0.3085461	-0.9512094	0	1.00868224	8.24297806	0.22391987	0.84885014	-1	1.45042063
		0	-0.9512094	-0.3085461	0	0	0.95120938	-0.3085461	0	-1.7880368	0.22391987	-2.1735663	-0.3175904		
		0	0	0	1	0	0	0	1	1.08453777	0.84885014	-0.3175904	-0.0122029		
	25	-0.9693706	0	0.24560279	0	-0.9693706	0	-0.2456028	0	-5.911232	-0.9227915	-2.7350236	-1.1293201		
(3,1)		0	1	0	0	0	1	0	0	-0.9227915	8.24297806	-0.4647965	0.84885014	-1	0.94698681
		-0.2456028	0	-0.9693706	0	0.24560279	0	-0.9693706	0	-2.7350236	-0.4647965	-3.3195432	0.04149725		
		0	0	0	1	0	0	0	1	-1.1293201	0.84885014	0.04149725	-0.0122029		
	26	-0.9075639	0	0.41991394	0	-0.9075639	0	-0.4199139	0	-3.3696173	0.64231776	-2.758192	1.04235543		
(3,1)		0	1	0	0	0	1	0	0	0.64231776	8.24297806	0.80932556	0.84885014	-1	0.02316842
		-0.4199139	0	-0.9075639	0	0.41991394	0	-0.9075639	0	-2.758192	0.80932556	-5.8611579	0.43655583		
		0	0	0	1	0	0	0	1	1.04235543	0.84885014	0.43655583	-0.0122029		
	27	-0.7738186	0	0.6334073	0	-0.7738186	0	-0.6334073	0	-1.665422	0.01559531	0.67621733	-0.5300763		
(3,1)		0	1	0	0	0	1	0	0	0.01559531	8.24297806	-1.0331199	0.84885014	-1	1.7250721
		-0.6334073	0	-0.7738186	0	0.6334073	0	-0.7738186	0	0.67621733	-1.0331199	-7.5653532	-0.9980506		
		0	0	0	1	0	0	0	1	-0.5300763	0.84885014	-0.9980506	-0.0122029		
	28	1	0	0	0	1	0	0	0	-1.665422	0.09956889	0.66902849	-0.5300763		
(3,2)		0	0.99223712	0.12436038	0	0	0.99223712	-0.1243604	0	0.09956889	7.74353059	-2.9518333	0.71814266	-1	1.91871343
		0	-0.1243604	0.99223712	0	0	0.12436038	0.99223712	0	0.66902849	-2.9518333	-7.0659057	-1.0958661		
		0	0	0	1	0	0	0	1	-0.5300763	0.71814266	-1.0958661	-0.0122029		
	29	1	0	0	0	1	0	0	0	-1.665422	0.3313444	0.58968125	-0.5300763		
(3,2)		0	0.93441076	0.35619732	0	0	0.93441076	-0.3561973	0	0.3313444	3.89961611	-7.1318895	0.28069565	-1	4.18005618
		0	-0.3561973	0.93441076	0	0	0.35619732	0.93441076	0	0.58968125	-7.1318895	-3.2219912	-1.2797896		
		0	0	0	1	0	0	0	1	-0.5300763	0.28069565	-1.2797896	-0.0122029		
	30	1	0	0	0	1	0	0	0	-1.665422	0.67635191	-0.0078221	-0.5300763		
(3,2)		0	0.47975211	0.87740407	0	0	0.47975211	-0.8774041	0	0.67635191	-7.5870118	0.85116416	-0.9882283	-1	6.28072536
		0	-0.8774041	0.47975211	0	0	0.87740407	0.47975211	0	-0.0078221	0.85116416	8.26463672	-0.8602653		
		0	0	0	1	0	0	0	1	-0.5300763	-0.9882283	-0.8602653	-0.0122029		
	31	1	0	0	0	1	0	0	0	-1.665422	-0.739152	-0.0078221	0.4382775		
(4,2)		0	-0.9916236	0	0.12916158	0	-0.9916236	0	-0.1291616	-0.739152	-7.2074996	-0.9551477	-1.9254346	-1	0.1039835
		0	0	1	0	0	0	1	0	-0.0078221	-0.9551477	8.26463672	0.74312161		
		0	-0.1291616	0	-0.9916236	0	0.12916158	0	-0.9916236	0.4382775	-1.9254346	0.74312161	-0.3917151		
	32	1	0	0	0	1	0	0	0	-1.665422	0.8272258	-0.0078221	-0.2326592		
(4,2)		0	-0.9661202	0	0.25809246	0	-0.9661202	0	-0.2580925	0.8272258	-5.7932806	1.11458156	-3.3684262	-1	0.15943389
		0	0	1	0	0	0	1	0	-0.0078221	1.11458156	8.26463672	-0.4714284		
		0	-0.2580925	0	-0.9661202	0	0.25809246	0	-0.9661202	-0.2326592	-3.3684262	-0.4714284	-1.8059341		
	33	1	0	0	0	1	0	0	0	-1.665422	-0.8320753	-0.0078221	-0.2146708		
(4,2)		0	-0.8644916	0	0.5026472	0	-0.8644916	0	-0.5026472	-0.8320753	-1.8584672	-1.2005086	-3.3989709	-1	0.08592704
		0	0	1	0	0	0	1	0	-0.0078221	-1.2005086	8.26463672	-0.1526954		
		0	-0.5026472	0	-0.8644916	0	0.5026472	0	-0.8644916	-0.2146708	-3.3989709	-0.1526954	-5.7407475		
	34	1	0	0	0	1	0	0	0	-1.665422	0.21082894	-0.0078221	0.83305701		
(4,2)		0	-0.4797438	0	0.87740862	0	-0.4797438	0	-0.8774086	0.21082894	-1.985758	0.44196029	3.46857008	-1	0.75854831
		0	0	1	0	0	0	1	0	-0.0078221	0.44196029	8.26463672	1.12659126		
		0	-0.8774086	0	-0.4797438	0	0.87740862	0	-0.4797438	0.83305701	3.46857008	1.12659126	-5.6134567		
	35	1	0	0	0	1	0	0	0	-1.665422	-0.8277102	-0.0078221	-0.2309298		
(4,2)		0	-0.49684	0	-0.8678421	0	-0.49684	0	0.86784214	-0.8277102	-1.726812	-1.1972869	-3.3203234	-1	0.75532665
		0	0	1	0	0	0	1	0	-0.0078221	-1.1972869	8.26463672	-0.1761839		
		0	0.86784214	0	-0.49684	0	-0.8678421	0	-0.49684	-0.2309298	-3.3203234	-0.1761839	-5.8724026		
	36	1	0	0	0	1	0	0	0	-1.665422	0.17703017	-0.0078221	0.84088831		
(4,2)		0	-0.461404	0	0.88719013	0	-0.461404	0	-0.8871901	0.17703017	-2.2714633	0.39612443	3.60358205	-1	0.80116251
		0	0	1	0	0	0	1	0	-0.0078221	0.39612443	8.26463672	1.1435131		
		0	-0.8871901	0	-0.461404	0	0.88719013	0	-0.461404	0.84088831	3.60358205	1.1435131	-5.3277514		
	37	1	0	0	0	1	0	0	0	-1.665422	-0.8057607	-0.0078221	-0.2986345		
(4,2)		0	-0.5332404	0	-0.8459637	0	-0.5332404	0	0.84596375	-0.8057607	-1.2075436	-1.1786002	-2.9329564	-1	0.78247576
		0	0	1	0	0	0	1	0	-0.0078221	-1.1786002	8.26463672	-0.2746605		
		0	0.84596375	0	-0.5332404	0	-0.8459637	0	-0.5332404	-0.2986345	-2.9329564	-0.2746605	-6.3916711		
	38	1	0	0	0	1	0	0	0	-1.665422	0.03061628	-0.0078221	0.85877557		
(4,2)		0	-0.3807109	0	0.92469412	0	-0.3807109	0	-0.9246941	0.03061628	-3.5752371	0.19472898	3.9077725	-1	0.9838712
		0	0	1	0	0	0	1	0	-0.0078221	0.19472898	8.26463672	1.1944109		
		0	-0.9246941	0	-0.3807109	0	0.92469412	0	-0.3807109	0.85877557	3.9077725	1.1944109	-4.0239776		
	39	1	0	0	0	1	0	0	0	-1.665422	-0.6542725	-0.0078221	-0.5570999		
(4,2)		0	-0.6750177	0	-0.7378016	0	-0.6750177	0	0.73780156	-0.6542725	0.07285927	-1.0126837	-0.5701142	-1	3.24519538
		0	0	1	0	0	0	1	0	-0.0078221	-1.0126837	8.26463672	-0.6625771		
		0	0.73780156	0	-0.6750177	0	-0.7378016	0	-0.6750177	-0.5570999	-0.5701142	-0.6625771	-7.672074		
	40	1	0	0	0	1	0	0	0	-1.665422	-0.6542725	-0.052317	-0.5546931		
(4,3)		0	1	0	0	0	1	0	0	-0.6542725	0.07285927	-1.0550049	-0.4873635	-1	1.26102635
		0	0	0.99680178	0.07991374	0	0	0.99680178	-0.0799137	-0.052317	-1.0550049	8.05730225	-1.9236035		
		0	0	-0.0799137	0.99680178	0	0	0.07991374	0.99680178	-0.5546931	-0.4873635	-1.9236035	-7.4647395		

	41	1	0	0	0	1	0	0	0	-1.665422	-0.6542725	-0.1796946	-0.5273816		
(4,3)		0	1	0	0	0	1	0	0	-0.6542725	0.07285927	-1.1393388	-0.229054	-1	3.29845705
		0	0	0.97266464	0.23221433	0	0	0.97266464	-0.2322143	-0.1796946	-1.1393388	6.35134366	-5.2220605		
		0	0	-0.2322143	0.97266464	0	0	0.23221433	0.97266464	-0.5273816	-0.229054	-5.2220605	-5.7587809		
	42	1	0	0	0	1	0	0	0	-1.665422	-0.6542725	-0.4737393	-0.2932449		
(4,3)		0	1	0	0	0	1	0	0	-0.6542725	0.07285927	-1.0255357	0.54665807	-1	1.7282697
		0	0	0.77243476	0.63509412	0	0	0.77243476	-0.6350941	-0.4737393	-1.0255357	-3.6567687	-6.9503302		
		0	0	-0.6350941	0.77243476	0	0	0.63509412	0.77243476	-0.2932449	0.54665807	-6.9503302	4.24933148		
	43	1	0	0	0	1	0	0	0	-1.665422	-0.6542725	-0.0389368	0.55579264		
(4,3)		0	1	0	0	0	1	0	0	-0.6542725	0.07285927	0.96129167	0.65305201	-1	5.98903855
		0	0	-0.4656168	0.88498643	0	0	-0.4656168	-0.8849864	-0.0389368	0.96129167	8.2632663	0.6788568		
		0	0	-0.8849864	-0.4656168	0	0	0.88498643	-0.4656168	0.55579264	0.65305201	0.6788568	-7.6707035		
	44	1	0	0	0	1	0	0	0	-1.665422	-0.0106221	-0.655344	0.55579264		
(3,2)		0	0.07557633	-0.99714	0	0	0.07557633	0.99714002	0	-0.0106221	8.07159826	-1.5675408	-0.62756	-1	0.60624916
		0	0.99714002	0.07557633	0	0	-0.99714	0.07557633	0	-0.655344	-1.5675408	0.2645273	0.70248979		
		0	0	0	1	0	0	0	1	0.55579264	-0.62756	0.70248979	-7.6707035		
	45	1	0	0	0	1	0	0	0	-1.665422	-0.1353638	-0.6412996	0.55579264		
(3,2)		0	0.98165949	0.19064271	0	0	0.98165949	-0.1906427	0	-0.1353638	7.20113439	-2.9146612	-0.4821257	-1	1.34712041
		0	-0.1906427	0.98165949	0	0	0.19064271	0.98165949	0	-0.6412996	-2.9146612	1.13499118	0.80924551		
		0	0	0	1	0	0	0	1	0.55579264	-0.4821257	0.80924551	-7.6707035		
	46	1	0	0	0	1	0	0	0	-1.665422	-0.3660806	-0.5436667	0.55579264		
(3,2)		0	0.92695056	0.37518351	0	0	0.92695056	-0.3751835	0	-0.3660806	4.31994618	-4.2037727	-0.1432911	-1	1.28911146
		0	-0.3751835	0.92695056	0	0	0.37518351	0.92695056	0	-0.5436667	-4.2037727	4.01617939	0.93101619		
		0	0	0	1	0	0	0	1	0.55579264	-0.1432911	0.93101619	-7.6707035		
	47	1	0	0	0	1	0	0	0	-1.665422	-0.6415175	-0.1343275	0.55579264		
(3,2)		0	0.71667768	0.69740454	0	0	0.71667768	-0.6974045	0	-0.6415175	-0.030009	-0.2663958	0.54660138	-1	3.43660231
		0	-0.6974045	0.71667768	0	0	0.69740454	0.71667768	0	-0.1343275	-0.2663958	8.36613457	0.76717039		
		0	0	0	1	0	0	0	1	0.55579264	0.54660138	0.76717039	-7.6707035		
	48	1	0	0	0	1	0	0	0	-1.665422	-0.6415175	-0.1845193	0.5412042		
(4,3)		0	1	0	0	0	1	0	0	-0.6415175	-0.030009	-0.3151964	0.51999134	-1	1.44551312
		0	0	0.99582193	-0.0913164	0	0	0.99582193	0.09131638	-0.1845193	-0.3151964	8.09288345	2.21268351		
		0	0	0.09131638	0.99582193	0	0	-0.0913164	0.99582193	0.5412042	0.51999134	2.21268351	-7.3974524		
	49	1	0	0	0	1	0	0	0	-1.665422	-0.6415175	-0.320719	0.47338002		
(4,3)		0	1	0	0	0	1	0	0	-0.6415175	-0.030009	-0.4411752	0.41845453	-1	3.63284805
		0	0	0.9645962	-0.2637312	0	0	0.9645962	0.26373123	-0.320719	-0.4411752	5.88967865	5.84553156		
		0	0	0.26373123	0.9645962	0	0	-0.2637312	0.9645962	0.47338002	0.41845453	5.84553156	-5.1942476		
	50	1	0	0	0	1	0	0	0	-1.665422	-0.6415175	-0.5611028	0.11005921		
(4,3)		0	1	0	0	0	1	0	0	-0.6415175	-0.030009	-0.6079062	-0.0137792	-1	0.25974488
		0	0	0.70976185	-0.7044417	0	0	0.70976185	0.70444171	-0.5611028	-0.6079062	-5.4559542	5.58578667		
		0	0	0.70444171	0.70976185	0	0	-0.7044417	0.70976185	0.11005921	-0.0137792	5.58578667	6.1513852		

CONCLUSIÓN:

El curso de métodos numéricos impartido por la profesora, me ayudó a reforzar tres habilidades formativas a largo plazo.

1. La relación entre los distintos sistemas para la obtención de los resultados, y su relación con la generalización matemática, su deducción formal desde los procesos matemáticos a la aplicación.
2. El uso de herramientas para implementar y acelerar la iteración de estos sistemas.
3. El ambiente de la implementación de estos métodos en Excel.