ESCUELA POLITÉCNICA NACIONAL
FACULTAD DE INGENIERÍA DE SISTEMAS
MÉTODOS NUMÉRICOS
INGENIERÍA DE CIENCIAS DE LA COMPUTACIÓN

Nombre: Moisés Pineda

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Curso: GR1CC

Docente: Jonathan A. Zea

Repositorio: Metodos_Numericos_GRCC1/Tareas/[Tarea 11] Ejercicios Unidad 04-D Gauss-Jacobi y Gauss-Seidel at main · SantiagoTmg/Metodos_Numericos_GRCC1

CONJUNTO DE EJERCICIOS

1. **Encuentre las primeras dos iteraciones del método de Jacobi para los siguientes sistemas lineales, por medio de $\mathbf{x}^{(0)} = \mathbf{0}$:**

a.
$$\begin{aligned} 3x_1 - x_2 + x_3 &= 1,\\ 3x_1 + 6x_2 + 2x_3 &= 0,\\ 3x_1 + 3x_2 + 7x_3 &= 4. \end{aligned}$$

b.
$$\begin{aligned} 10x_1 - x_2 &= 9,\\ -x_1 + 10x_2 - 2x_3 &= 7,\\ - 2x_2 + 10x_3 &= 6. \end{aligned}$$

c.
$$\begin{aligned} 10x_1 + 5x_2 &= 6,\\ 5x_1 + 10x_2 - 4x_3 &= 25,\\ - 4x_2 + 8x_3 - x_4 &= -11,\\ - x_3 + 5x_4 &= -11. \end{aligned}$$

d.
$$\begin{aligned} 4x_1 + x_2 + x_3 + x_5 &= 6,\\ -x_1 - 3x_2 + x_3 + x_4 &= 6,\\ 2x_1 + x_2 + 5x_3 - x_4 - x_5 &= 6,\\ -x_1 - x_2 - x_3 + 4x_4 &= 6,\\ 2x_2 - x_3 + x_4 + 4x_5 &= 6. \end{aligned}$$

Resultados para el sistema a con Jacobi:
Iteración 0: [0. 0. 0.]
Iteración 1: [0.33333333 0. 0.57142857]
Iteración 2: [0.14285714 -0.35714286 0.42857143]

Resultados para el sistema b con Jacobi:
Iteración 0: [0. 0. 0.]
Iteración 1: [0.9 0.7 0.6]
Iteración 2: [0.97 0.91 0.74]

Resultados para el sistema c con Jacobi:
Iteración 0: [0. 0. 0. 0.]
Iteración 1: [0.6 2.5 -1.375 -2.2]
Iteración 2: [-0.65 1.65 -0.4 -2.475]

Resultados para el sistema d con Jacobi:
Iteración 0: [0. 0. 0. 0. 0.]
Iteración 1: [1.5 -2. 1.2 1.5 1.5]
Iteración 2: [1.325 -1.6 1.6 1.675 2.425]

2. **Repita el ejercicio 1 usando el método de Gauss-Siedel.**

Resultados para el sistema a con Gauss-Seidel:
Iteración 0: [0. 0. 0.]

Iteración 1: [0.33333333 -0.16666667 0.5]
Iteración 2: [0.11111111 -0.22222222 0.61904762]

Resultados para el sistema b con Gauss-Seidel:
Iteración 0: [0. 0. 0.]
Iteración 1: [0.9 0.79 0.758]
Iteración 2: [0.979 0.9495 0.7899]

Resultados para el sistema c con Gauss-Seidel:
Iteración 0: [0. 0. 0. 0.]
Iteración 1: [0.6 2.2 -0.275 -2.255]
Iteración 2: [-0.5 2.64 -0.336875 -2.267375]

Resultados para el sistema d con Gauss-Seidel:
Iteración 0: [0. 0. 0. 0. 0.]
Iteración 1: [1.5 -2.5 1.1 1.525 2.64375]
Iteración 2: [1.1890625 -1.52135417 1.86239583 1.88252604 2.25564453]

3. **Utilice el método de Jacobi para resolver los sistemas lineales en el ejercicio 1, con TOL = 10-3.**

Resultados para el sistema a con Jacobi (TOL = 0.001):
Iteración 0: [0. 0. 0.]
Iteración 1: [0.33333333 0. 0.57142857]
Iteración 2: [0.14285714 -0.35714286 0.42857143]
Iteración 3: [0.07142857 -0.21428571 0.66326531]
Iteración 4: [0.04081633 -0.25680272 0.63265306]
Iteración 5: [0.03684807 -0.23129252 0.66399417]
Iteración 6: [0.03490444 -0.23975543 0.6547619]
Iteración 7: [0.03516089 -0.23570619 0.65922185]
Iteración 8: [0.03502399 -0.23732106 0.65737656]
Iteración 9: [0.03510079 -0.23663751 0.65812732]

Resultados para el sistema b con Jacobi (TOL = 0.001):
Iteración 0: [0. 0. 0.]
Iteración 1: [0.9 0.7 0.6]
Iteración 2: [0.97 0.91 0.74]
Iteración 3: [0.991 0.945 0.782]
Iteración 4: [0.9945 0.9555 0.789]
Iteración 5: [0.99555 0.95725 0.7911]
Iteración 6: [0.995725 0.957775 0.79145]

Resultados para el sistema c con Jacobi (TOL = 0.001):
Iteración 0: [0. 0. 0. 0.]
Iteración 1: [0.6 2.5 -1.375 -2.2]
Iteración 2: [-0.65 1.65 -0.4 -2.475]

Iteración 3: [-0.225 2.665 -0.859375 -2.28]
Iteración 4: [-0.7325 2.26875 -0.3275 -2.371875]
Iteración 5: [-0.534375 2.73525 -0.53710938 -2.2655]
Iteración 6: [-0.767625 2.55234375 -0.2905625 -2.30742188]
Iteración 7: [-0.67617187 2.7675875 -0.38725586 -2.2581125]
Iteración 8: [-0.78379375 2.68318359 -0.27347031 -2.27745117]
Iteración 9: [-0.7415918 2.78250875 -0.3180896 -2.25469406]
Iteración 10: [-0.79125438 2.74356006 -0.26558238 -2.26361792]
Iteración 11: [-0.77178003 2.78939423 -0.28617221 -2.25311648]
Iteración 12: [-0.79469712 2.77142113 -0.26194244 -2.25723444]
Iteración 13: [-0.78571057 2.79257158 -0.27144374 -2.25238849]
Iteración 14: [-0.79628579 2.78427779 -0.26026277 -2.25428875]
Iteración 15: [-0.79213889 2.79403779 -0.2646472 -2.25205255]
Iteración 16: [-0.79701889 2.79021057 -0.25948768 -2.25292944]
Iteración 17: [-0.79510528 2.79471438 -0.2615109 -2.25189754]
Iteración 18: [-0.79735719 2.79294828 -0.25913 -2.25230218]
Iteración 19: [-0.79647414 2.79502659 -0.26006363 -2.251826]
Iteración 20: [-0.7975133 2.79421162 -0.25896495 -2.25201273]
Iteración 21: [-0.79710581 2.79517067 -0.25939578 -2.25179299]

Resultados para el sistema d con Jacobi (TOL = 0.001):
Iteración 0: [0. 0. 0. 0. 0.]
Iteración 1: [1.5 -2. 1.2 1.5 1.5]
Iteración 2: [1.325 -1.6 1.6 1.675 2.425]
Iteración 3: [0.89375 -1.35 1.81 1.83125 2.28125]
Iteración 4: [0.8146875 -1.08416667 1.935 1.8384375 2.1696875]
Iteración 5: [0.74486979 -1.01375 1.89258333 1.91638021 2.06622396]
Iteración 6: [0.76373568 -0.97863542 1.90132292 1.90592578 2.00092578]
Iteración 7: [0.76909668 -0.98549566 1.87160313 1.92160579 1.98816699]
Iteración 8: [0.78143139 -0.99196259 1.87141502 1.91380104 1.98024716]
Iteración 9: [0.7850751 -0.99873844 1.8646296 1.91522095 1.98538479]
Iteración 10: [0.78718101 -1.00174151 1.8658388 1.91274157 1.98672138]
Iteración 11: [0.78729533 -1.00286688 1.86536849 1.91281957 1.98914507]
Iteración 12: [0.78708833 -1.00303576 1.86604817 1.91244923 1.98957067]

4. Utilice el método de Gauss-Siedel para resolver los sistemas lineales en el ejercicio 1, con TOL = 10-3.

Resultados para el sistema a con Gauss-Seidel (TOL = 0.001):
Iteración 0: [0. 0. 0.]
Iteración 1: [0.33333333 -0.16666667 0.5]
Iteración 2: [0.11111111 -0.22222222 0.61904762]
Iteración 3: [0.05291005 -0.23280423 0.64852608]
Iteración 4: [0.03955656 -0.23595364 0.65559875]
Iteración 5: [0.0361492 -0.23660752 0.65733928]
Iteración 6: [0.03535107 -0.23678863 0.65775895]

Resultados para el sistema b con Gauss-Seidel (TOL = 0.001):
Iteración 0: [0. 0. 0.]
Iteración 1: [0.9 0.79 0.758]
Iteración 2: [0.979 0.9495 0.7899]
Iteración 3: [0.99495 0.957475 0.791495]
Iteración 4: [0.9957475 0.95787375 0.79157475]

Resultados para el sistema c con Gauss-Seidel (TOL = 0.001):
Iteración 0: [0. 0. 0. 0.]
Iteración 1: [0.6 2.2 -0.275 -2.255]
Iteración 2: [-0.5 2.64 -0.336875 -2.267375]
Iteración 3: [-0.72 2.72525 -0.29579688 -2.25915938]
Iteración 4: [-0.762625 2.76299375 -0.27589805 -2.25517961]
Iteración 5: [-0.78149687 2.78038922 -0.26670284 -2.25334057]
Iteración 6: [-0.79019461 2.78841617 -0.26245949 -2.2524919]
Iteración 7: [-0.79420808 2.79212025 -0.26050136 -2.25210027]
Iteración 8: [-0.79606012 2.79382952 -0.25959778 -2.25191956]
Iteración 9: [-0.79691476 2.79461827 -0.25918081 -2.25183616]

Resultados para el sistema d con Gauss-Seidel (TOL = 0.001):
Iteración 0: [0. 0. 0. 0. 0.]
Iteración 1: [1.5 -2.5 1.1 1.525 2.64375]
Iteración 2: [1.1890625 -1.52135417 1.86239583 1.88252604 2.25564453]
Iteración 3: [0.85082845 -1.03530219 1.89436317 1.92747236 2.0093738]
Iteración 4: [0.7828913 -0.98701859 1.87161643 1.91687229 1.98219533]
Iteración 5: [0.78330171 -0.998271 1.86614704 1.91279444 1.98747365]
Iteración 6: [0.78616258 -1.00240703 1.86606999 1.91245638 1.98960692]
Iteración 7: [0.78668253 -1.00271872 1.86628339 1.9125618 1.98978976]

5. El sistema lineal

$$2x_1 - x_2 + x_3 = -1,$$
$$2x_1 + 2x_2 + 2x_3 = 4,$$
$$-x_1 - x_2 + 2x_3 = -5,$$

tiene la solución (1, 2, -1)t.

a) Muestre que el método de Jacobi con x(0) = 0 falla al proporcionar una buena aproximación después de 25 iteraciones.

Resultados del método de Jacobi con 25 iteraciones:
Iteración 0: [0. 0. 0.]
Iteración 1: [-0.5 2. -2.5]
Iteración 2: [1.75 5. -1.75]
Iteración 3: [2.875 2. 0.875]
Iteración 4: [0.0625 -1.75 -0.0625]
Iteración 5: [-1.34375 2. -3.34375]
Iteración 6: [2.171875 6.6875 -2.171875]

Iteración 7: [3.9296875 2. 1.9296875]
Iteración 8: [-0.46484375 -3.859375 0.46484375]
Iteración 9: [-2.66210938 2. -4.66210938]
Iteración 10: [2.83105469 9.32421875 -2.83105469]
Iteración 11: [5.57763672 2. 3.57763672]
Iteración 12: [-1.28881836 -7.15527344 1.28881836]
Iteración 13: [-4.7220459 2. -6.7220459]
Iteración 14: [3.86102295 13.4440918 -3.86102295]
Iteración 15: [8.15255737 2. 6.15255737]
Iteración 16: [-2.57627869 -12.30511475 2.57627869]
Iteración 17: [-7.94069672 2. -9.94069672]
Iteración 18: [5.47034836 19.88139343 -5.47034836]
Iteración 19: [12.1758709 2. 10.1758709]
Iteración 20: [-4.58793545 -20.35174179 4.58793545]
Iteración 21: [-12.96983862 2. -14.96983862]
Iteración 22: [7.98491931 29.93967724 -7.98491931]
Iteración 23: [18.46229827 2. 16.46229827]
Iteración 24: [-7.73114914 -32.92459655 7.73114914]
Iteración 25: [-20.82787284 2. -22.82787284]

b) Utilice el método de Gauss-Siedel con x(0) = 0:para aproximar la solución para el sistema lineal dentro de 10−5.

Resultados del método de Gauss-Seidel con tolerancia 10^(-5):
Iteración 0: [0. 0. 0.]
Iteración 1: [-0.5 2.5 -1.5]
Iteración 2: [1.5 2. -0.75]
Iteración 3: [0.875 1.875 -1.125]
Iteración 4: [1. 2.125 -0.9375]
Iteración 5: [1.03125 1.90625 -1.03125]
Iteración 6: [0.96875 2.0625 -0.984375]
Iteración 7: [1.0234375 1.9609375 -1.0078125]
Iteración 8: [0.984375 2.0234375 -0.99609375]
Iteración 9: [1.00976562 1.98632812 -1.00195312]
Iteración 10: [0.99414062 2.0078125 -0.99902344]
Iteración 11: [1.00341797 1.99560547 -1.00048828]
Iteración 12: [0.99804688 2.00244141 -0.99975586]
Iteración 13: [1.00109863 1.99865723 -1.00012207]
Iteración 14: [0.99938965 2.00073242 -0.99993896]
Iteración 15: [1.00033569 1.99960327 -1.00003052]
Iteración 16: [0.99981689 2.00021362 -0.99998474]
Iteración 17: [1.00009918 1.99988556 -1.00000763]
Iteración 18: [0.99994659 2.00006104 -0.99999619]
Iteración 19: [1.00002861 1.99996758 -1.00000191]
Iteración 20: [0.99998474 2.00001717 -0.99999905]
Iteración 21: [1.00000811 1.99999094 -1.00000048]

Iteración 22: [0.99999571 2.00000477 -0.99999976]
Iteración 23: [1.00000226 1.9999975 -1.00000012]

6. El sistema lineal

$$\begin{aligned} x_1 \quad\quad\quad - x_3 &= 0.2, \\ -\frac{1}{2}x_1 + x_2 - \frac{1}{4}x_3 &= -1.425, \\ x_1 - \frac{1}{2}x_2 + x_3 &= 2, \end{aligned}$$

tiene la solución (0.9, -0.8, 0.7)t.

a) ¿La matriz de coeficientes

$$A = \begin{bmatrix} 1 & 0 & -1 \\ -\frac{1}{2} & 1 & -\frac{1}{4} \\ 1 & -\frac{1}{2} & 1 \end{bmatrix}$$

tiene diagonal estrictamente dominante?

La matriz NO es diagonal estrictamente dominante.

b) Utilice el método iterativo de Gauss-Siedel para aproximar la solución para el sistema lineal con una tolerancia de 1022 y un máximo de 300 iteraciones.

i= 0 x: [0. 0. 0.]
i= 1 x: [0.2 -1.325 1.1375]
i= 2 x: [1.3375 -0.471875 0.4265625]
i= 3 x: [0.6265625 -1.00507812 0.87089844]
i= 4 x: [1.07089844 -0.67182617 0.59318848]
i= 5 x: [0.79318848 -0.88010864 0.7667572]
i= 6 x: [0.9667572 -0.7499321 0.65827675]
i= 7 x: [0.85827675 -0.83129244 0.72607703]
i= 8 x: [0.92607703 -0.78044223 0.68370185]
i= 9 x: [0.88370185 -0.81222361 0.71018634]
i= 10 x: [0.91018634 -0.79236024 0.69363354]
i= 11 x: [0.89363354 -0.80477485 0.70397904]
i= 12 x: [0.90397904 -0.79701572 0.6975131]
i= 13 x: [0.8975131 -0.80186517 0.70155431]
Convergencia alcanzada en 13 iteraciones.
Solución del sistema lineal método de Gauss-Seidel:
[0.8975131 -0.80186517 0.70155431]

c) ¿Qué pasa en la parte b) cuando el sistema cambia por el siguiente?

$$\begin{aligned} x_1 \quad\quad\quad - 2x_3 &= 0.2, \\ -\frac{1}{2}x_1 + x_2 - \frac{1}{4}x_3 &= -1.425, \\ x_1 - \frac{1}{2}x_2 + x_3 &= 2. \end{aligned}$$

i= 0 x: [0. 0. 0.]

i= 1 x: [0.2   -1.325   1.1375]
i= 2 x: [2.475   0.096875 -0.4265625]
No se alcanzó la convergencia en 2 iteraciones.
Solución del sistema lineal método de Gauss-Seidel:
 [2.475   0.096875 -0.4265625]

7. Repita el ejercicio 11 usando el método de Jacobi.

```
i= 0 x: [0. 0. 0.]
i= 1 x: [ 0.2   -1.425  2.   ]
i= 2 x: [ 2.2    -0.825   1.0875]
i= 3 x: [ 1.2875   -0.053125 -0.6125  ]
i= 4 x: [-0.4125    -0.934375   0.6859375]
i= 5 x: [ 0.8859375  -1.45976563  1.9453125 ]
i= 6 x: [ 2.1453125  -0.49570312  0.38417969]
i= 7 x: [ 0.58417969 -0.25629883 -0.39316406]
i= 8 x: [-0.19316406 -1.23120117  1.2876709 ]
i= 9 x: [ 1.4876709  -1.19966431  1.57756348]
i= 10 x: [ 1.77756348 -0.28677368 -0.08750305]
i= 11 x: [ 0.11249695 -0.55809402  0.07904968]
i= 12 x: [ 0.27904968 -1.34898911  1.60845604]
i= 13 x: [ 1.80845604 -0.88336115  1.04645576]
i= 14 x: [ 1.24645576 -0.25915804 -0.25013661]
i= 15 x: [-0.05013661 -0.86430627  0.62396522]
i= 16 x: [ 0.82396522 -1.294077    1.61798348]
i= 17 x: [ 1.81798348 -0.60852152  0.52899628]
i= 18 x: [ 0.72899628 -0.38375919 -0.12224424]
i= 19 x: [ 0.07775576 -1.09106292  1.07912412]
i= 20 x: [ 1.27912412 -1.11634109  1.37671278]
i= 21 x: [ 1.57671278 -0.44125974  0.16270533]
i= 22 x: [ 0.36270533 -0.59596728  0.20265735]
i= 23 x: [ 0.40265735 -1.192983    1.33931103]
i= 24 x: [ 1.53931103 -0.88884357  1.00085115]
i= 25 x: [ 1.20085115 -0.4051317   0.01626719]
i= 26 x: [ 0.21626719 -0.82050763  0.596583  ]
i= 27 x: [ 0.796583   -1.16772066  1.373479  ]
i= 28 x: [ 1.573479   -0.68333875  0.61955667]
i= 29 x: [ 0.81955667 -0.48337133  0.08485162]
i= 30 x: [ 0.28485162 -0.99400876  0.93875766]
i= 31 x: [ 1.13875766 -1.04788477  1.218144  ]
i= 32 x: [ 1.418144   -0.55108517  0.33729995]
i= 33 x: [ 0.53729995 -0.63160301  0.30631342]
i= 34 x: [ 0.50631342 -1.07977167  1.14689854]
i= 35 x: [ 1.34689854 -0.88511866  0.95380075]
i= 36 x: [ 1.15380075 -0.51310054  0.21054213]
i= 37 x: [ 0.41054213 -0.79546409  0.58964898]
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i= 38 x: [ 0.78964898 -1.07231669  1.19172582]
i= 39 x: [ 1.39172582 -0.73224405  0.67419268]
i= 40 x: [ 0.87419268 -0.56058892  0.24215215]
i= 41 x: [ 0.44215215 -0.92736562  0.84551286]
i= 42 x: [ 1.04551286 -0.99254571  1.09416504]
i= 43 x: [ 1.29416504 -0.62870231  0.45821428]
i= 44 x: [ 0.65821428 -0.66336391  0.39148381]
i= 45 x: [ 0.59148381 -0.99802191  1.01010376]
i= 46 x: [ 1.21010376 -0.87673215  0.90950524]
i= 47 x: [ 1.10950524 -0.59257181  0.35153016]
i= 48 x: [ 0.55153016 -0.78236484  0.59420886]
i= 49 x: [ 0.79420886 -1.00068271  1.05728742]
i= 50 x: [ 1.25728742 -0.76357372  0.70544979]
i= 51 x: [ 0.90544979 -0.61999384  0.36092572]
i= 52 x: [ 0.56092572 -0.88204367  0.78455329]
i= 53 x: [ 0.98455329 -0.94839882  0.99805244]
i= 54 x: [ 1.19805244 -0.68321025  0.5412473 ]
i= 55 x: [ 0.7412473  -0.69066195  0.46034244]
i= 56 x: [ 0.66034244 -0.93929074  0.91342172]
i= 57 x: [ 1.11342172 -0.86647335  0.87001219]
i= 58 x: [ 1.07001219 -0.65078609  0.4533416 ]
i= 59 x: [ 0.6533416  -0.7766585   0.60459476]
i= 60 x: [ 0.80459476 -0.94718051  0.95832914]
i= 61 x: [ 1.15832914 -0.78312033  0.72181498]
i= 62 x: [ 0.92181498 -0.66538168  0.45011069]
i= 63 x: [ 0.65011069 -0.85156484  0.74549417]
i= 64 x: [ 0.94549417 -0.91357111  0.92410689]
i= 65 x: [ 1.12410689 -0.72122619  0.59772027]
i= 66 x: [ 0.79772027 -0.71351649  0.51528001]
i= 67 x: [ 0.71528001 -0.89731986  0.84552149]
i= 68 x: [ 1.04552149 -0.85597962  0.83606006]
i= 69 x: [ 1.03606006 -0.69322424  0.5264887 ]
i= 70 x: [ 0.7264887  -0.7753478   0.61732782]
i= 71 x: [ 0.81732782 -0.90742369  0.8858374 ]
i= 72 x: [ 1.0858374  -0.79487674  0.72896033]
i= 73 x: [ 0.92896033 -0.69984122  0.51672423]
i= 74 x: [ 0.71672423 -0.83133878  0.72111906]
i= 75 x: [ 0.92111906 -0.88635812  0.86760638]
i= 76 x: [ 1.06760638 -0.74753887  0.63570188]
i= 77 x: [ 0.83570188 -0.73227134  0.55862418]
i= 78 x: [ 0.75862418 -0.86749301  0.79816245]
i= 79 x: [ 0.99816245 -0.8461473   0.80762931]
i= 80 x: [ 1.00762931 -0.72401145  0.5787639 ]
i= 81 x: [ 0.7787639  -0.77649437  0.63036497]
i= 82 x: [ 0.83036497 -0.87802681  0.83298891]
i= 83 x: [ 1.03298891 -0.80157029  0.73062163]
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i= 84 x: [ 0.93062163 -0.72585014  0.56622594]
i= 85 x: [ 0.76622594 -0.8181327   0.7064533 ]
i= 86 x: [ 0.9064533  -0.8652737   0.82470771]
i= 87 x: [ 1.02470771 -0.76559642  0.66090985]
i= 88 x: [ 0.86090985 -0.74741868  0.59249408]
i= 89 x: [ 0.79249408 -0.84642156  0.76538081]
i= 90 x: [ 0.96538081 -0.83740776  0.78429514]
i= 91 x: [ 0.98429514 -0.74623581  0.61591531]
i= 92 x: [ 0.81591531 -0.7788736   0.64258695]
i= 93 x: [ 0.84258695 -0.85639561  0.79464789]
i= 94 x: [ 0.99464789 -0.80504455  0.72921524]
i= 95 x: [ 0.92921524 -0.74537224  0.60282984]
i= 96 x: [ 0.80282984 -0.80968492  0.69809864]
i= 97 x: [ 0.89809864 -0.84906042  0.7923277 ]
i= 98 x: [ 0.9923277  -0.77786876  0.67737115]
i= 99 x: [ 0.87737115 -0.75949336  0.61873792]
i= 100 x: [ 0.81873792 -0.83162994  0.74288217]
i= 101 x: [ 0.94288217 -0.8299105   0.76544711]
i= 102 x: [ 0.96544711 -0.76219714  0.64216258]
i= 103 x: [ 0.84216258 -0.7817358   0.65345432]
i= 104 x: [ 0.85345432 -0.84055513  0.76696952]
i= 105 x: [ 0.96696952 -0.80653046  0.72626812]
i= 106 x: [ 0.92626812 -0.75994821  0.62976525]
i= 107 x: [ 0.82976525 -0.80442463  0.69375778]
i= 108 x: [ 0.89375778 -0.83667793  0.76802243]
i= 109 x: [ 0.96802243 -0.7861155   0.68790326]
i= 110 x: [ 0.88790326 -0.76901297  0.63891982]
i= 111 x: [ 0.83891982 -0.82131842  0.72759026]
i= 112 x: [ 0.92759026 -0.82364253  0.75042098]
i= 113 x: [ 0.95042098 -0.77359963  0.66058848]
i= 114 x: [ 0.86058848 -0.78464239  0.66277921]
i= 115 x: [ 0.86277921 -0.82901096  0.74709033]
i= 116 x: [ 0.94709033 -0.80683781  0.72271531]
i= 117 x: [ 0.92271531 -0.77077601  0.64949077]
i= 118 x: [ 0.84949077 -0.80126965  0.69189669]
i= 119 x: [ 0.89189669 -0.82728045  0.74987441]
i= 120 x: [ 0.94987441 -0.79158306  0.69446309]
i= 121 x: [ 0.89446309 -0.77644702  0.65433407]
i= 122 x: [ 0.85433407 -0.81418494  0.7173134 ]
i= 123 x: [ 0.9173134  -0.81850462  0.73857347]
i= 124 x: [ 0.93857347 -0.78169994  0.6734343 ]
i= 125 x: [ 0.8734343  -0.78735469  0.67057657]
i= 126 x: [ 0.87057657 -0.82063871  0.73288836]
i= 127 x: [ 0.93288836 -0.80648963  0.71910408]
i= 128 x: [ 0.91910408 -0.7787798   0.66386683]
i= 129 x: [ 0.86386683 -0.79948125  0.69150602]
```

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i= 130 x: [ 0.89150602 -0.82019008  0.73639254]
i= 131 x: [ 0.93639254 -0.79514885  0.69839894]
i= 132 x: [ 0.89839894 -0.78220399  0.66603303]
i= 133 x: [ 0.86603303 -0.80929227  0.71049906]
i= 134 x: [ 0.91049906 -0.81435872  0.72932083]
i= 135 x: [ 0.92932083 -0.78742026  0.68232158]
i= 136 x: [ 0.88232158 -0.78975919  0.67696904]
i= 137 x: [ 0.87696904 -0.81459695  0.72279883]
i= 138 x: [ 0.92279883 -0.80581577  0.71573249]
i= 139 x: [ 0.91573249 -0.78466746  0.67429328]
i= 140 x: [ 0.87429328 -0.79856044  0.69193378]
i= 141 x: [ 0.89193378 -0.81486991  0.7264265 ]
i= 142 x: [ 0.9264265  -0.79742648  0.70063126]
i= 143 x: [ 0.90063126 -0.78662893  0.67486026]
i= 144 x: [ 0.87486026 -0.8059693   0.70605427]
i= 145 x: [ 0.90605427 -0.8110563   0.72215509]
i= 146 x: [ 0.92215509 -0.79143409  0.68841758]
i= 147 x: [ 0.88841758 -0.79181806  0.68212786]
i= 148 x: [ 0.88212786 -0.81025925  0.71567339]
i= 149 x: [ 0.91567339 -0.80501772  0.71274251]
i= 150 x: [ 0.91274251 -0.78897768  0.68181775]
i= 151 x: [ 0.88181775 -0.79817431  0.69276865]
i= 152 x: [ 0.89276865 -0.81089896  0.7190951 ]
i= 153 x: [ 0.9190951  -0.7988419   0.70178187]
i= 154 x: [ 0.90178187 -0.79000698  0.68148395]
i= 155 x: [ 0.88148395 -0.80373808  0.70321464]
i= 156 x: [ 0.90321464 -0.80845436  0.71664701]
i= 157 x: [ 0.91664701 -0.79423093  0.69255818]
i= 158 x: [ 0.89255818 -0.79353695  0.68623753]
i= 159 x: [ 0.88623753 -0.80716153  0.71067335]
i= 160 x: [ 0.91067335 -0.8042129   0.71018171]
i= 161 x: [ 0.91018171 -0.7921179   0.6872202 ]
i= 162 x: [ 0.8872202  -0.79810409  0.69375934]
i= 163 x: [ 0.89375934 -0.80795006  0.71372775]
i= 164 x: [ 0.91372775 -0.79968839  0.70226563]
i= 165 x: [ 0.90226563 -0.79256972  0.68642805]
i= 166 x: [ 0.88642805 -0.80226017  0.70144951]
i= 167 x: [ 0.90144951 -0.80642359  0.71244186]
i= 168 x: [ 0.91244186 -0.79616478  0.69533869]
i= 169 x: [ 0.89533869 -0.7949444   0.68947575]
i= 170 x: [ 0.88947575 -0.80496172  0.70718911]
i= 171 x: [ 0.90718911 -0.80346485  0.70804339]
i= 172 x: [ 0.90804339 -0.7943946   0.69107847]
i= 173 x: [ 0.89107847 -0.79820869  0.69475931]
i= 174 x: [ 0.89475931 -0.80577094  0.70981719]
i= 175 x: [ 0.90981719 -0.80016605  0.70235522]
```

```
i= 176 x: [ 0.90235522 -0.7945026   0.69009979]
i= 177 x: [ 0.89009979 -0.80129744  0.70039348]
i= 178 x: [ 0.90039348 -0.80485174  0.70925149]
i= 179 x: [ 0.90925149 -0.79749039  0.69718065]
i= 180 x: [ 0.89718065 -0.79607909  0.69200332]
i= 181 x: [ 0.89200332 -0.80340885  0.7047798 ]
i= 182 x: [ 0.9047798  -0.80280339  0.70629226]
i= 183 x: [ 0.90629226 -0.79603703  0.6938185 ]
i= 184 x: [ 0.8938185  -0.79839924  0.69568922]
i= 185 x: [ 0.89568922 -0.80416844  0.70698188]
i= 186 x: [ 0.90698188 -0.80040992  0.70222656]
i= 187 x: [ 0.90222656 -0.79595242  0.69281316]
i= 188 x: [ 0.89281316 -0.80068343  0.69979723]
i= 189 x: [ 0.89979723 -0.80364411  0.70684512]
i= 190 x: [ 0.90684512 -0.7983901   0.69838071]
i= 191 x: [ 0.89838071 -0.79698226  0.69395983]
Convergencia alcanzada en 191 iteraciones.
Solución del sistema lineal método de Jacobi:
 [ 0.89838071 -0.79698226  0.69395983]

i= 0 x: [0. 0. 0.]
i= 1 x: [ 0.2    -1.425  2.    ]
i= 2 x: [ 4.2    -1.025   1.0875]
No se alcanzó la convergencia en 2 iteraciones.
Solución del sistema lineal método de Jacobi:
 [ 4.2    -1.025   1.0875]
```

8. **Un cable coaxial está formado por un conductor interno de 0.1 pulgadas cuadradas y un conductor externo de 0.5 pulgadas cuadradas. El potencial en un punto en la sección transversal del cable se describe mediante la ecuación de Laplace.**
   Suponga que el conductor interno se mantiene en 0 volts y el conductor externo se mantiene en 110 volts. Aproximar el potencial entre los dos conductores requiere resolver el siguiente sistema lineal.

$$\begin{bmatrix} 4 & -1 & 0 & 0 & -1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ -1 & 4 & -1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & -1 & 4 & -1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & -1 & 4 & 0 & -1 & 0 & 0 & 0 & 0 & 0 & 0 \\ -1 & 0 & 0 & 0 & 4 & 0 & -1 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & -1 & 0 & 4 & 0 & -1 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & -1 & 0 & 4 & 0 & -1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & -1 & 0 & 4 & 0 & 0 & 0 & -1 \\ 0 & 0 & 0 & 0 & 0 & 0 & -1 & 0 & 4 & -1 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & -1 & 4 & -1 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & -1 & 4 & -1 \\ 0 & 0 & 0 & 0 & 0 & -1 & 0 & 0 & 0 & 0 & -1 & 4 \end{bmatrix} \begin{bmatrix} w_1 \\ w_2 \\ w_3 \\ w_4 \\ w_5 \\ w_6 \\ w_7 \\ w_8 \\ w_9 \\ w_{10} \\ w_{11} \\ w_{12} \end{bmatrix} = \begin{bmatrix} 220 \\ 110 \\ 110 \\ 220 \\ 110 \\ 110 \\ 110 \\ 110 \\ 220 \\ 110 \\ 110 \\ 220 \end{bmatrix}.$$

a. ¿La matriz es estrictamente diagonalmente dominante?

La matriz es diagonalmente dominante: True

b. Resuelva el sistema lineal usando el método de Jacobi con x(0) = 0 y TOL = 10-2.

i= 0 x: [0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0.]
i= 1 x: [55. 27.5 27.5 55. 27.5 27.5 27.5 27.5 55. 27.5 27.5 55.]
i= 2 x: [68.75 48.125 48.125 68.75 48.125 48.125 48.125 48.125 68.75 48.125 48.125 68.75]
i= 3 x: [79.0625 56.71875 56.71875 79.0625 56.71875 56.71875 56.71875 56.71875 79.0625 56.71875 56.71875 79.0625]
i= 4 x: [83.359375 61.4453125 61.4453125 83.359375 61.4453125 61.4453125 61.4453125 61.4453125 83.359375 61.4453125 61.4453125 83.359375]
i= 5 x: [85.72265625 63.70117188 63.70117188 85.72265625 63.70117188 63.70117188 63.70117188 63.70117188 85.72265625 63.70117188 63.70117188 85.72265625]
i= 6 x: [86.85058594 64.85595703 64.85595703 86.85058594 64.85595703 64.85595703 64.85595703 64.85595703 86.85058594 64.85595703 64.85595703 86.85058594]
i= 7 x: [87.42797852 65.42663574 65.42663574 87.42797852 65.42663574 65.42663574 65.42663574 65.42663574 87.42797852 65.42663574 65.42663574 87.42797852]
i= 8 x: [87.71331787 65.71365356 65.71365356 87.71331787 65.71365356 65.71365356 65.71365356 65.71365356 87.71331787 65.71365356 65.71365356 87.71331787]
No se alcanzó la convergencia en 8 iteraciones.
Solución del sistema lineal método de Jacobi:
[87.71331787 65.71365356 65.71365356 87.71331787 65.71365356 65.71365356 65.71365356 65.71365356 87.71331787 65.71365356 65.71365356 87.71331787]

c. Repita la parte b) mediante el método de Gauss-Siedel.

```
i= 0 x: [0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0.]
i= 1 x: [55.         41.25       37.8125     64.453125   41.25       43.61328125
 37.8125     38.40332031 64.453125   43.61328125 38.40332031 75.50415039]
i= 2 x: [75.625      55.859375   57.578125   80.29785156 55.859375   57.17529297
 57.578125   60.66986084 80.29785156 57.17529297 60.66986084 84.46128845]
i= 3 x: [82.9296875  62.62695312 63.23120117 85.10162354 62.62695312 63.94287109
 63.23120117 64.60103989 85.10162354 63.94287109 64.60103989 87.13597775]
i= 4 x: [86.31347656 64.88616943 64.99694824 87.23495483 64.88616943 65.45899868
 64.99694824 65.64874411 87.23495483 65.45899868 65.64874411 87.7769357 ]
i= 5 x: [87.44308472 65.61000824 65.71124077 87.79255986 65.61000824 65.86032599
 65.71124077 65.90931542 87.79255986 65.86032599 65.90931542 87.94241035]
i= 6 x: [87.80500412 65.87906122 65.91790527 87.94455782 65.87906122 65.96346831
 65.91790527 65.97646967 87.94455782 65.96346831 65.97646967 87.98498449]
i= 7 x: [87.93953061 65.96435897 65.9772292  87.98517438 65.96435897 65.99041101
 65.9772292  65.99384888 87.98517438 65.99041101 65.99384888 87.99606497]
i= 8 x: [87.98217949 65.98985217 65.99375664 87.99604191 65.98985217 65.9974727
 65.99375664 65.99838442 87.99604191 65.9974727  65.99838442 87.99896428]
i= 9 x: [87.99492609 65.99717068 65.99830315 87.99894396 65.99717068 65.99933209
 65.99830315 65.99957409 87.99894396 65.99933209 65.99957409 87.99972655]
i= 10 x: [87.99858534 65.99922212 65.99954152 87.9997184  65.99922212 65.99982312
 65.99954152 65.99988742 87.9997184  65.99982312 65.99988742 87.99992764]
Convergencia alcanzada en 10 iteraciones.
Solución del sistema lineal método de Gauss-Seidel:
 [87.99858534 65.99922212 65.99954152 87.9997184  65.99922212 65.99982312
 65.99954152 65.99988742 87.9997184  65.99982312 65.99988742 87.99992764]
```