Tarea 11: Gauss-Jacobi & Gauss-Seidel

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Tabla de Contenidos

```
%load_ext autoreload
```

1 GITHUB

https://github.com/Vladimirjon/MetodosNumericos_PasquelJohann/tree/main/Tarea11

2 CONJUNTO DE EJERCICIOS

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

a.

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

```python
import numpy as np
from src.iterative_methods import gauss_jacobi

A = np.array([[3, -1, 1],
              [3, 6, 2],
              [3, 3, 7]], dtype=float)

b = np.array([1, 0, 4], dtype=float)

x0 = np.zeros((3, 1))  # Initial guess
tol = 0.000001 # Tolerance
max_iter = 2 # Maximum number of iterations

# Solve using Gauss-Jacobi method
x_jacobi, tray_jacobi = gauss_jacobi(A=A, b=b, x0=x0, tol=tol, max_iter=max_iter)
print("Solution using Gauss-Jacobi method:", x_jacobi)
```

```
[02-04 15:03:49][INFO] i= 0 x: [[0. 0. 0.]]
[02-04 15:03:49][INFO] i= 1 x: [[0.33333333 0.         0.57142857]]
Solution using Gauss-Jacobi method: [[0.33333333]
 [0.        ]
 [0.57142857]]
```

b.

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

```
%autoreload 2
import numpy as np
from src.iterative_methods import gauss_jacobi

A = np.array([[10, -1, 0],
              [-1, 10, -2],
              [0, -2, 10]], dtype=float)

b = np.array([9, 7, 6], dtype=float)

x0 = np.zeros((3, 1))  # Initial guess
tol = 0.000001 # Tolerance
max_iter = 2 # Maximum number of iterations

# Solve using Gauss-Jacobi method
x_jacobi, tray_jacobi = gauss_jacobi(A=A, b=b, x0=x0, tol=tol, max_iter=max_iter)
print("Solution using Gauss-Jacobi method:", x_jacobi)
```

```
[02-04 15:03:59][INFO] i= 0 x: [[0. 0. 0.]]
[02-04 15:03:59][INFO] i= 1 x: [[0.9 0.7 0.6]]
Solution using Gauss-Jacobi method: [[0.9]
 [0.7]
 [0.6]]
```

c.

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

```
%autoreload 2
import numpy as np
from src.iterative_methods import gauss_jacobi

A = np.array([[10, 5, 0, 0],
              [5, 10, -4, 0],
              [0, -4, 8, -1],
              [0, 0, -1, 5]], dtype=float)

b = np.array([6, 25, -11, -11], dtype=float)
```

```python
x0 = np.zeros((4, 1))  # Initial guess
tol = 0.000001  # Tolerance
max_iter = 2  # Maximum number of iterations

# Solve using Gauss-Jacobi method
x_jacobi, tray_jacobi = gauss_jacobi(A=A, b=b, x0=x0, tol=tol, max_iter=max_iter)
print("Solution using Gauss-Jacobi method:", x_jacobi)
```

```
[02-04 15:04:03][INFO] i= 0 x: [[0. 0. 0. 0.]]
[02-04 15:04:03][INFO] i= 1 x: [[ 0.6    2.5   -1.375 -2.2  ]]
Solution using Gauss-Jacobi method: [[ 0.6  ]
 [ 2.5  ]
 [-1.375]
 [-2.2  ]]
```

d.

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

```python
%autoreload 2
import numpy as np
from src.iterative_methods import gauss_jacobi

A = np.array([[4, 1, 1, 0, 1],
              [-1, -3, 1, 1, 0],
              [2, 1, 5, -1, -1],
              [-1, -1, -1, 4, 0],
              [0, 2, -1, 1, 4]], dtype=float)

b = np.array([6, 6, 6, 6, 6], dtype=float)

x0 = np.zeros((5, 1))  # Initial guess
tol = 0.000001  # Tolerance
max_iter = 2  # Maximum number of iterations

# Solve using Gauss-Jacobi method
```

```
x_jacobi, tray_jacobi = gauss_jacobi(A=A, b=b, x0=x0, tol=tol, max_iter=max_iter)
print("Solution using Gauss-Jacobi method:", x_jacobi)
```

```
[02-04 15:04:07][INFO] i= 0 x: [[0. 0. 0. 0. 0.]]
[02-04 15:04:07][INFO] i= 1 x: [[ 1.5 -2.   1.2  1.5  1.5]]
Solution using Gauss-Jacobi method: [[ 1.5]
 [-2. ]
 [ 1.2]
 [ 1.5]
 [ 1.5]]
```

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

a.

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

```
%autoreload 2

from src.iterative_methods import gauss_seidel
import numpy as np

A = np.array([[3, -1, 1],
              [3, 6, 2],
              [3, 3, 7]], dtype=float)

b = np.array([1, 0, 4], dtype=float)

x0 = np.zeros((3, 1))  # Initial guess
tol = 0.000001 # Tolerance
max_iter = 2 # Maximum number of iterations

# Solve using Gauss-Seidel method
x_seidel, tray_seidel = gauss_seidel(A=A, b=b, x0=x0, tol=tol, max_iter=max_iter)
print("Solution using Gauss-Seidel method:", x_seidel)
```

```
[02-04 15:04:12][INFO] i= 0 x: [[0. 0. 0.]]
[02-04 15:04:12][INFO] i= 1 x: [[ 0.33333333 -0.16666667  0.5       ]]
```

```
Solution using Gauss-Seidel method: [[ 0.33333333]
 [-0.16666667]
 [ 0.5       ]]
```

b.

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

```python
%autoreload 2

from src.iterative_methods import gauss_seidel
import numpy as np

A = np.array([[10, -1, 0],
              [-1, 10, -2],
              [0, -2, 10]], dtype=float)

b = np.array([9, 7, 6], dtype=float)

x0 = np.zeros((3, 1))  # Initial guess
tol = 0.000001 # Tolerance
max_iter = 2 # Maximum number of iterations

# Solve using Gauss-Seidel method
x_seidel, tray_seidel = gauss_seidel(A=A, b=b, x0=x0, tol=tol, max_iter=max_iter)
print("Solution using Gauss-Seidel method:", x_seidel)
```

```
[02-04 15:04:15][INFO] i= 0 x: [[0. 0. 0.]]
[02-04 15:04:15][INFO] i= 1 x: [[0.9   0.79  0.758]]
Solution using Gauss-Seidel method: [[0.9  ]
 [0.79 ]
 [0.758]]
```

c.

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

```python
%autoreload 2

from src.iterative_methods import gauss_seidel
import numpy as np

A = np.array([[10, 5, 0, 0],
              [5, 10, -4, 0],
              [0, -4, 8, -1],
              [0, 0, -1, 5]], dtype=float)

b = np.array([6, 25, -11, -11], dtype=float)

x0 = np.zeros((4, 1))  # Initial guess
tol = 0.000001  # Tolerance
max_iter = 2  # Maximum number of iterations

# Solve using Gauss-Seidel method
x_seidel, tray_seidel = gauss_seidel(A=A, b=b, x0=x0, tol=tol, max_iter=max_iter)
print("Solution using Gauss-Seidel method:", x_seidel)
```

```
[02-04 15:04:19][INFO] i= 0 x: [[0. 0. 0. 0.]]
[02-04 15:04:19][INFO] i= 1 x: [[ 0.6    2.2   -0.275 -2.255]]
Solution using Gauss-Seidel method: [[ 0.6  ]
 [ 2.2  ]
 [-0.275]
 [-2.255]]
```

d.

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

```python
%autoreload 2

from src.iterative_methods import gauss_seidel
import numpy as np

A = np.array([[4, 1, 1, 0, 1],
              [-1, -3, 1, 1, 0],
              [2, 1, 5, -1, -1],
              [-1, -1, -1, 4, 0],
              [0, 2, -1, 1, 4]], dtype=float)

b = np.array([6, 6, 6, 6, 6], dtype=float)

x0 = np.zeros((5, 1))  # Initial guess
tol = 0.000001  # Tolerance
max_iter = 2  # Maximum number of iterations

# Solve using Gauss-Seidel method
x_seidel, tray_seidel = gauss_seidel(A=A, b=b, x0=x0, tol=tol, max_iter=max_iter)
print("Solution using Gauss-Seidel method:", x_seidel)
```

```
[02-04 15:04:23][INFO] i= 0 x: [[0. 0. 0. 0. 0.]]
[02-04 15:04:23][INFO] i= 1 x: [[ 1.5     -2.5      1.1      1.525    2.64375]]
Solution using Gauss-Seidel method: [[ 1.5    ]
 [-2.5    ]
 [ 1.1    ]
 [ 1.525  ]
 [ 2.64375]]
```

2.3 3. Utilice el método de Jacobi para resolver los sistemas lineales en el ejercicio 1, con $TOL = 10_{-3}$

a.

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

```
import numpy as np
from src.iterative_methods import gauss_jacobi

A = np.array([[3, -1, 1],
              [3, 6, 2],
              [3, 3, 7]], dtype=float)

b = np.array([1, 0, 4], dtype=float)
```

```
x0 = np.zeros((3, 1))  # Initial guess
tol = 0.001 # Tolerance
max_iter = 2 # Maximum number of iterations

# Solve using Gauss-Jacobi method
x_jacobi, tray_jacobi = gauss_jacobi(A=A, b=b, x0=x0, tol=tol, max_iter=max_iter)
print("Solution using Gauss-Jacobi method:", x_jacobi)
```

```
[02-04 15:02:06][INFO] i= 0 x: [[0. 0. 0.]]
[02-04 15:02:06][INFO] i= 1 x: [[0.33333333 0.         0.57142857]]
Solution using Gauss-Jacobi method: [[0.33333333]
 [0.        ]
 [0.57142857]]
```

b.

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

```
%autoreload 2
import numpy as np
from src.iterative_methods import gauss_jacobi

A = np.array([[10, -1, 0],
              [-1, 10, -2],
              [0, -2, 10]], dtype=float)

b = np.array([9, 7, 6], dtype=float)

x0 = np.zeros((3, 1))  # Initial guess
tol = 0.001 # Tolerance
max_iter = 2 # Maximum number of iterations

# Solve using Gauss-Jacobi method
x_jacobi, tray_jacobi = gauss_jacobi(A=A, b=b, x0=x0, tol=tol, max_iter=max_iter)
print("Solution using Gauss-Jacobi method:", x_jacobi)
```

```
[02-04 15:02:17][INFO] i= 0 x: [[0. 0. 0.]]
[02-04 15:02:17][INFO] i= 1 x: [[0.9 0.7 0.6]]
Solution using Gauss-Jacobi method: [[0.9]
```

```
 [0.7]
 [0.6]]
```

c.

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

```
%autoreload 2
import numpy as np
from src.iterative_methods import gauss_jacobi

A = np.array([[10, 5, 0, 0],
              [5, 10, -4, 0],
              [0, -4, 8, -1],
              [0, 0, -1, 5]], dtype=float)

b = np.array([6, 25, -11, -11], dtype=float)

x0 = np.zeros((4, 1))  # Initial guess
tol = 0.001  # Tolerance
max_iter = 2  # Maximum number of iterations

# Solve using Gauss-Jacobi method
x_jacobi, tray_jacobi = gauss_jacobi(A=A, b=b, x0=x0, tol=tol, max_iter=max_iter)
print("Solution using Gauss-Jacobi method:", x_jacobi)
```

```
[02-04 15:02:30][INFO] i= 0 x: [[0. 0. 0. 0.]]
[02-04 15:02:30][INFO] i= 1 x: [[ 0.6    2.5   -1.375 -2.2  ]]
Solution using Gauss-Jacobi method: [[ 0.6  ]
 [ 2.5  ]
 [-1.375]
 [-2.2  ]]
```

d.

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

```python
%autoreload 2
import numpy as np
from src.iterative_methods import gauss_jacobi

A = np.array([[4, 1, 1, 0, 1],
              [-1, -3, 1, 1, 0],
              [2, 1, 5, -1, -1],
              [-1, -1, -1, 4, 0],
              [0, 2, -1, 1, 4]], dtype=float)

b = np.array([6, 6, 6, 6, 6], dtype=float)

x0 = np.zeros((5, 1))  # Initial guess
tol = 0.001  # Tolerance
max_iter = 2  # Maximum number of iterations

# Solve using Gauss-Jacobi method
x_jacobi, tray_jacobi = gauss_jacobi(A=A, b=b, x0=x0, tol=tol, max_iter=max_iter)
print("Solution using Gauss-Jacobi method:", x_jacobi)
```

```
[02-04 15:02:43][INFO] i= 0 x: [[0. 0. 0. 0. 0.]]
[02-04 15:02:43][INFO] i= 1 x: [[ 1.5 -2.   1.2  1.5  1.5]]
Solution using Gauss-Jacobi method: [[ 1.5]
 [-2. ]
 [ 1.2]
 [ 1.5]
 [ 1.5]]
```

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

a.

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

```python
%autoreload 2

from src.iterative_methods import gauss_seidel
import numpy as np

A = np.array([[3, -1, 1],
              [3, 6, 2],
              [3, 3, 7]], dtype=float)

b = np.array([1, 0, 4], dtype=float)

x0 = np.zeros((3, 1))  # Initial guess
tol = 0.001 # Tolerance
max_iter = 2 # Maximum number of iterations

# Solve using Gauss-Seidel method
x_seidel, tray_seidel = gauss_seidel(A=A, b=b, x0=x0, tol=tol, max_iter=max_iter)
print("Solution using Gauss-Seidel method:", x_seidel)
```

```
[02-04 15:03:35][INFO] i= 0 x: [[0. 0. 0.]]
[02-04 15:03:35][INFO] i= 1 x: [[ 0.33333333 -0.16666667  0.5       ]]
Solution using Gauss-Seidel method: [[ 0.33333333]
 [-0.16666667]
 [ 0.5       ]]
```

b.

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

```
%autoreload 2

from src.iterative_methods import gauss_seidel
import numpy as np

A = np.array([[10, -1, 0],
              [-1, 10, -2],
              [0, -2, 10]], dtype=float)

b = np.array([9, 7, 6], dtype=float)

x0 = np.zeros((3, 1))  # Initial guess
tol = 0.001 # Tolerance
max_iter = 2 # Maximum number of iterations

# Solve using Gauss-Seidel method
x_seidel, tray_seidel = gauss_seidel(A=A, b=b, x0=x0, tol=tol, max_iter=max_iter)
print("Solution using Gauss-Seidel method:", x_seidel)
```

```
[02-04 15:03:20][INFO] i= 0 x: [[0. 0. 0.]]
[02-04 15:03:20][INFO] i= 1 x: [[0.9   0.79  0.758]]
Solution using Gauss-Seidel method: [[0.9  ]
 [0.79 ]
 [0.758]]
```

c.

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

```
%autoreload 2

from src.iterative_methods import gauss_seidel
import numpy as np

A = np.array([[10, 5, 0, 0],
              [5, 10, -4, 0],
              [0, -4, 8, -1],
              [0, 0, -1, 5]], dtype=float)
```

```python
b = np.array([6, 25, -11, -11], dtype=float)

x0 = np.zeros((4, 1))  # Initial guess
tol = 0.001  # Tolerance
max_iter = 2  # Maximum number of iterations

# Solve using Gauss-Seidel method
x_seidel, tray_seidel = gauss_seidel(A=A, b=b, x0=x0, tol=tol, max_iter=max_iter)
print("Solution using Gauss-Seidel method:", x_seidel)
```

```
[02-04 15:03:07][INFO] i= 0 x: [[0. 0. 0. 0.]]
[02-04 15:03:07][INFO] i= 1 x: [[ 0.6    2.2   -0.275 -2.255]]
Solution using Gauss-Seidel method: [[ 0.6  ]
 [ 2.2  ]
 [-0.275]
 [-2.255]]
```

d.

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

```python
%autoreload 2

from src.iterative_methods import gauss_seidel
import numpy as np

A = np.array([[4, 1, 1, 0, 1],
              [-1, -3, 1, 1, 0],
              [2, 1, 5, -1, -1],
              [-1, -1, -1, 4, 0],
              [0, 2, -1, 1, 4]], dtype=float)

b = np.array([6, 6, 6, 6, 6], dtype=float)

x0 = np.zeros((5, 1))  # Initial guess
tol = 0.001  # Tolerance
```

```
max_iter = 2  # Maximum number of iterations

# Solve using Gauss-Seidel method
x_seidel, tray_seidel = gauss_seidel(A=A, b=b, x0=x0, tol=tol, max_iter=max_iter)
print("Solution using Gauss-Seidel method:", x_seidel)
```

```
[02-04 15:02:54][INFO] i= 0 x: [[0. 0. 0. 0. 0.]]
[02-04 15:02:54][INFO] i= 1 x: [[ 1.5     -2.5      1.1      1.525    2.64375]]
Solution using Gauss-Seidel method: [[ 1.5    ]
 [-2.5    ]
 [ 1.1    ]
 [ 1.525  ]
 [ 2.64375]]
```

2.5 5. El sistema lineal

$$\begin{aligned} 2x_1 - x_2 + x_3 &= -1, \\ 2x_1 + 2x_2 + 2x_3 &= 4, \\ -x_1 - x_2 + 2x_3 &= -5. \end{aligned}$$

tiene la solución (1,2,-1)

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

```
%autoreload 2
import numpy as np
from src.iterative_methods import gauss_jacobi

A = np.array([[2, -1, 1],
              [2, 2, 2],
              [-1, -1, 2]], dtype=float)

b = np.array([-1, 4, -5], dtype=float)

x0 = np.zeros((3, 1))  # Initial guess
tol = 0.001 # Tolerance
max_iter = 25 # Maximum number of iterations

# Solve using Gauss-Jacobi method
x_jacobi, tray_jacobi = gauss_jacobi(A=A, b=b, x0=x0, tol=tol, max_iter=max_iter)
print("Gauss-Jacobi después de 25 iteraciones:", x_jacobi)
```

```
[02-04 23:31:23][INFO] i= 0 x: [[0. 0. 0.]]
[02-04 23:31:23][INFO] i= 1 x: [[-0.5  2.  -2.5]]
[02-04 23:31:23][INFO] i= 2 x: [[ 1.75  5.   -1.75]]
[02-04 23:31:23][INFO] i= 3 x: [[2.875 2.    0.875]]
[02-04 23:31:23][INFO] i= 4 x: [[ 0.0625 -1.75   -0.0625]]
[02-04 23:31:23][INFO] i= 5 x: [[-1.34375  2.      -3.34375]]
[02-04 23:31:23][INFO] i= 6 x: [[ 2.171875  6.6875   -2.171875]]
[02-04 23:31:23][INFO] i= 7 x: [[3.9296875 2.        1.9296875]]
[02-04 23:31:23][INFO] i= 8 x: [[-0.46484375 -3.859375    0.46484375]]
[02-04 23:31:23][INFO] i= 9 x: [[-2.66210938  2.         -4.66210938]]
[02-04 23:31:23][INFO] i= 10 x: [[ 2.83105469  9.32421875 -2.83105469]]
[02-04 23:31:23][INFO] i= 11 x: [[5.57763672 2.         3.57763672]]
[02-04 23:31:23][INFO] i= 12 x: [[-1.28881836 -7.15527344  1.28881836]]
[02-04 23:31:23][INFO] i= 13 x: [[-4.7220459  2.        -6.7220459]]
[02-04 23:31:23][INFO] i= 14 x: [[ 3.86102295 13.4440918  -3.86102295]]
[02-04 23:31:23][INFO] i= 15 x: [[8.15255737 2.         6.15255737]]
[02-04 23:31:23][INFO] i= 16 x: [[ -2.57627869 -12.30511475   2.57627869]]
[02-04 23:31:23][INFO] i= 17 x: [[-7.94069672  2.         -9.94069672]]
[02-04 23:31:23][INFO] i= 18 x: [[ 5.47034836 19.88139343 -5.47034836]]
[02-04 23:31:23][INFO] i= 19 x: [[12.1758709  2.        10.1758709]]
[02-04 23:31:23][INFO] i= 20 x: [[ -4.58793545 -20.35174179   4.58793545]]
[02-04 23:31:23][INFO] i= 21 x: [[-12.96983862   2.         -14.96983862]]
[02-04 23:31:23][INFO] i= 22 x: [[ 7.98491931 29.93967724 -7.98491931]]
[02-04 23:31:23][INFO] i= 23 x: [[18.46229827  2.         16.46229827]]
[02-04 23:31:23][INFO] i= 24 x: [[ -7.73114914 -32.92459655   7.73114914]]
Gauss-Jacobi después de 25 iteraciones: [[ -7.73114914]
 [-32.92459655]
 [  7.73114914]]
```

Después de **25 iteraciones**, el método de Gauss-Jacobi no converge a la solución $(1, 2, -1)$ sino que los valores **oscilan y divergen.**

b. Utilice el método de Gauss-Siedel con $x_{(0)} = 0$: para aproximar la solución para el sistema lineal dentro de 10^{-5}

```
%autoreload 2
import numpy as np
from src.iterative_methods import gauss_seidel

A = np.array([[2, -1, 1],
              [2, 2, 2],
              [-1, -1, 2]], dtype=float)
```

```
b = np.array([-1, 4, -5], dtype=float)

x0 = np.zeros((3, 1))  # Initial guess
tol = 1e-5  # Tolerance (10 )
max_iter = 20  # Maximum iterations (Aumentamos por si necesita más iteraciones)

# Solve using Gauss-Seidel method
x_seidel, tray_seidel = gauss_seidel(A=A, b=b, x0=x0, tol=tol, max_iter=max_iter)

print("Solución con Seidel:", x_seidel)
```

```
[02-04 23:36:24][INFO] i= 0 x: [[0. 0. 0.]]
[02-04 23:36:24][INFO] i= 1 x: [[-0.5  2.5 -1.5]]
[02-04 23:36:24][INFO] i= 2 x: [[ 1.5   2.   -0.75]]
[02-04 23:36:24][INFO] i= 3 x: [[ 0.875  1.875 -1.125]]
[02-04 23:36:24][INFO] i= 4 x: [[ 1.      2.125   -0.9375]]
[02-04 23:36:24][INFO] i= 5 x: [[ 1.03125  1.90625 -1.03125]]
[02-04 23:36:24][INFO] i= 6 x: [[ 0.96875   2.0625   -0.984375]]
[02-04 23:36:24][INFO] i= 7 x: [[ 1.0234375  1.9609375 -1.0078125]]
[02-04 23:36:24][INFO] i= 8 x: [[ 0.984375    2.0234375  -0.99609375]]
[02-04 23:36:24][INFO] i= 9 x: [[ 1.00976562  1.98632812 -1.00195312]]
[02-04 23:36:24][INFO] i= 10 x: [[ 0.99414062  2.0078125  -0.99902344]]
[02-04 23:36:24][INFO] i= 11 x: [[ 1.00341797  1.99560547 -1.00048828]]
[02-04 23:36:24][INFO] i= 12 x: [[ 0.99804688  2.00244141 -0.99975586]]
[02-04 23:36:24][INFO] i= 13 x: [[ 1.00109863  1.99865723 -1.00012207]]
[02-04 23:36:24][INFO] i= 14 x: [[ 0.99938965  2.00073242 -0.99993896]]
[02-04 23:36:24][INFO] i= 15 x: [[ 1.00033569  1.99960327 -1.00003052]]
[02-04 23:36:24][INFO] i= 16 x: [[ 0.99981689  2.00021362 -0.99998474]]
[02-04 23:36:24][INFO] i= 17 x: [[ 1.00009918  1.99988556 -1.00000763]]
[02-04 23:36:24][INFO] i= 18 x: [[ 0.99994659  2.00006104 -0.99999619]]
[02-04 23:36:24][INFO] i= 19 x: [[ 1.00002861  1.99996758 -1.00000191]]
Solución con Seidel: [[ 1.00002861]
 [ 1.99996758]
 [-1.00000191]]
```

Gauss-Seidel prueba ser **más eficiente** ***para este sistema***

2.6 6. El sistema lineal

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

tiene la solución (0.9,-0.8,0.7)

a. ¿La matriz de coeficientes

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

tiene diagonal estrictamente dominante?

```python
import numpy as np

A = np.array([
    [1, 0, -1],
    [-1/2, 1, -1/4],
    [1, -1/2, 1]
], dtype=float)

def es_diagonal_dominante(A):
    n = A.shape[0]  # Tamaño de la matriz
    for i in range(n):
        diagonal = abs(A[i, i])  # Elemento diagonal |a_ii|
        suma_no_diagonal = sum(abs(A[i, j]) for j in range(n) if j != i)  # Suma de los otros
        if diagonal <= suma_no_diagonal:
            return False  # No cumple la condición de dominancia estricta
    return True  # La matriz es diagonalmente dominante


if es_diagonal_dominante(A):
    print("Matriz es diagonalmente dominante")
else:
    print("No es diagonalmente dominante")
```

```
No es diagonalmente dominante
```

b.Utilice el método iterativo de Gauss-Siedel para aproximar la solución para el sistema lineal con una tolerancia de 10_{22} y un maximo de 300 iteraciones

```
%autoreload 2
import numpy as np
from src.iterative_methods import gauss_seidel

A = np.array([
    [1, 0, -1],
    [-1/2, 1, -1/4],
    [1, -1/2, 1]
], dtype=float)

b = np.array([0.2, -1.425, 2], dtype=float)

x0 = np.zeros((3, 1))

tol = 1e-22  # Tolerancia de 10 ²²
max_iter = 300  # Máximo de iteraciones


x_seidel, tray_seidel = gauss_seidel(A=A, b=b, x0=x0, tol=tol, max_iter=max_iter)
print("Solución con Gauss-Seidel:", x_seidel)
```

```
[02-05 00:07:42][INFO] i= 0 x: [[0. 0. 0.]]
[02-05 00:07:42][INFO] i= 1 x: [[ 0.2    -1.325   1.1375]]
[02-05 00:07:42][INFO] i= 2 x: [[ 1.3375    -0.471875   0.4265625]]
[02-05 00:07:42][INFO] i= 3 x: [[ 0.6265625  -1.00507812  0.87089844]]
[02-05 00:07:42][INFO] i= 4 x: [[ 1.07089844 -0.67182617  0.59318848]]
[02-05 00:07:42][INFO] i= 5 x: [[ 0.79318848 -0.88010864  0.7667572 ]]
[02-05 00:07:42][INFO] i= 6 x: [[ 0.9667572  -0.7499321   0.65827675]]
[02-05 00:07:42][INFO] i= 7 x: [[ 0.85827675 -0.83129244  0.72607703]]
[02-05 00:07:42][INFO] i= 8 x: [[ 0.92607703 -0.78044223  0.68370185]]
[02-05 00:07:42][INFO] i= 9 x: [[ 0.88370185 -0.81222361  0.71018634]]
[02-05 00:07:42][INFO] i= 10 x: [[ 0.91018634 -0.79236024  0.69363354]]
[02-05 00:07:42][INFO] i= 11 x: [[ 0.89363354 -0.80477485  0.70397904]]
[02-05 00:07:42][INFO] i= 12 x: [[ 0.90397904 -0.79701572  0.6975131 ]]
[02-05 00:07:42][INFO] i= 13 x: [[ 0.8975131  -0.80186517  0.70155431]]
[02-05 00:07:42][INFO] i= 14 x: [[ 0.90155431 -0.79883427  0.69902855]]
[02-05 00:07:42][INFO] i= 15 x: [[ 0.89902855 -0.80072858  0.70060715]]
[02-05 00:07:42][INFO] i= 16 x: [[ 0.90060715 -0.79954464  0.69962053]]
[02-05 00:07:42][INFO] i= 17 x: [[ 0.89962053 -0.8002846   0.70023717]]
```

```
[02-05 00:07:42][INFO] i= 18 x: [[ 0.90023717 -0.79982212  0.69985177]]
[02-05 00:07:42][INFO] i= 19 x: [[ 0.89985177 -0.80011117  0.70009264]]
[02-05 00:07:42][INFO] i= 20 x: [[ 0.90009264 -0.79993052  0.6999421 ]]
[02-05 00:07:42][INFO] i= 21 x: [[ 0.8999421  -0.80004343  0.70003619]]
[02-05 00:07:42][INFO] i= 22 x: [[ 0.90003619 -0.79997286  0.69997738]]
[02-05 00:07:42][INFO] i= 23 x: [[ 0.89997738 -0.80001696  0.70001414]]
[02-05 00:07:42][INFO] i= 24 x: [[ 0.90001414 -0.7999894   0.69999116]]
[02-05 00:07:42][INFO] i= 25 x: [[ 0.89999116 -0.80000663  0.70000552]]
[02-05 00:07:42][INFO] i= 26 x: [[ 0.90000552 -0.79999586  0.69999655]]
[02-05 00:07:42][INFO] i= 27 x: [[ 0.89999655 -0.80000259  0.70000216]]
[02-05 00:07:42][INFO] i= 28 x: [[ 0.90000216 -0.79999838  0.69999865]]
[02-05 00:07:42][INFO] i= 29 x: [[ 0.89999865 -0.80000101  0.70000084]]
[02-05 00:07:42][INFO] i= 30 x: [[ 0.90000084 -0.79999937  0.69999947]]
[02-05 00:07:42][INFO] i= 31 x: [[ 0.89999947 -0.80000039  0.70000033]]
[02-05 00:07:42][INFO] i= 32 x: [[ 0.90000033 -0.79999975  0.69999979]]
[02-05 00:07:42][INFO] i= 33 x: [[ 0.89999979 -0.80000015  0.70000013]]
[02-05 00:07:42][INFO] i= 34 x: [[ 0.90000013 -0.7999999   0.69999992]]
[02-05 00:07:42][INFO] i= 35 x: [[ 0.89999992 -0.80000006  0.70000005]]
[02-05 00:07:42][INFO] i= 36 x: [[ 0.90000005 -0.79999996  0.69999997]]
[02-05 00:07:42][INFO] i= 37 x: [[ 0.89999997 -0.80000002  0.70000002]]
[02-05 00:07:42][INFO] i= 38 x: [[ 0.90000002 -0.79999999  0.69999999]]
[02-05 00:07:42][INFO] i= 39 x: [[ 0.89999999 -0.80000001  0.70000001]]
[02-05 00:07:42][INFO] i= 40 x: [[ 0.90000001 -0.79999999  0.7       ]]
[02-05 00:07:42][INFO] i= 41 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 42 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 43 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 44 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 45 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 46 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 47 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 48 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 49 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 50 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 51 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 52 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 53 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 54 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 55 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 56 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 57 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 58 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 59 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 60 x: [[ 0.9 -0.8  0.7]]
```

```
[02-05 00:07:42][INFO] i= 61 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 62 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 63 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 64 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 65 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 66 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 67 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 68 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 69 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 70 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 71 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 72 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 73 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 74 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 75 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 76 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 77 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 78 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 79 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 80 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 81 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 82 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 83 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 84 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 85 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 86 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 87 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 88 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 89 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 90 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 91 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 92 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 93 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 94 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 95 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 96 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 97 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 98 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 99 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 100 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 101 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 102 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 103 x: [[ 0.9 -0.8  0.7]]
```

```
[02-05 00:07:42][INFO] i= 104 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 105 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 106 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 107 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 108 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 109 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 110 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 111 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 112 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 113 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 114 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 115 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 116 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 117 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 118 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 119 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 120 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 121 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 122 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 123 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 124 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 125 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 126 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 127 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 128 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 129 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 130 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 131 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 132 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 133 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 134 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 135 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 136 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 137 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 138 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 139 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 140 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 141 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 142 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 143 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 144 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 145 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 146 x: [[ 0.9 -0.8  0.7]]
```

```
[02-05 00:07:42][INFO] i= 147 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 148 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 149 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 150 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 151 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 152 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 153 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 154 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 155 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 156 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 157 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 158 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 159 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 160 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 161 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 162 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 163 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 164 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 165 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 166 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 167 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 168 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 169 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 170 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 171 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 172 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 173 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 174 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 175 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 176 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 177 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 178 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 179 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 180 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 181 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 182 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 183 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 184 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 185 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 186 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 187 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 188 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 189 x: [[ 0.9 -0.8  0.7]]
```

```
[02-05 00:07:42][INFO] i= 190 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 191 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 192 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 193 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 194 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 195 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 196 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 197 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 198 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 199 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 200 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 201 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 202 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 203 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 204 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 205 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 206 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 207 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 208 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 209 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 210 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 211 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 212 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 213 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 214 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 215 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 216 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 217 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 218 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 219 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 220 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 221 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 222 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 223 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 224 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 225 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 226 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 227 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 228 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 229 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 230 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 231 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 232 x: [[ 0.9 -0.8  0.7]]
```

```
[02-05 00:07:42][INFO] i= 233 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 234 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 235 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 236 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 237 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 238 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 239 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 240 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 241 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 242 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 243 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 244 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 245 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 246 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 247 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 248 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 249 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 250 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 251 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 252 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 253 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 254 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 255 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 256 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 257 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 258 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 259 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 260 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 261 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 262 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 263 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 264 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 265 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 266 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 267 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 268 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 269 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 270 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 271 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 272 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 273 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 274 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 275 x: [[ 0.9 -0.8  0.7]]
```

```
[02-05 00:07:42][INFO] i= 276 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 277 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 278 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 279 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 280 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 281 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 282 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 283 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 284 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 285 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 286 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 287 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 288 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 289 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 290 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 291 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 292 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 293 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 294 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 295 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 296 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 297 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 298 x: [[ 0.9 -0.8  0.7]]
[02-05 00:07:42][INFO] i= 299 x: [[ 0.9 -0.8  0.7]]
Solución con Gauss-Seidel: [[ 0.9]
 [-0.8]
 [ 0.7]]
```

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

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

Primero analizaré si es diagonalmente dominante

```python
import numpy as np

A = np.array([
    [1, 0, -2],
    [-1/2, 1, -1/4],
    [1, -1/2, 1]
], dtype=float)


if es_diagonal_dominante(A):
    print("Matriz es diagonalmente dominante")
else:
    print("No es diagonalmente dominante")
```

```
No es diagonalmente dominante
```

Segundo: Método de Gauss Seidel

```
%autoreload 2
import numpy as np
from src.iterative_methods import gauss_seidel

A = np.array([
    [1, 0, -2],
    [-1/2, 1, -1/4],
    [1, -1/2, 1]
], dtype=float)

b = np.array([0.2, -1.425, 2], dtype=float)

x0 = np.zeros((3, 1))

tol = 1e-22  # Tolerancia de 10 ² ²
max_iter = 300  # Máximo de iteraciones


x_seidel, tray_seidel = gauss_seidel(A=A, b=b, x0=x0, tol=tol, max_iter=max_iter)
print("Solución con Gauss-Seidel:", x_seidel)
```

```
[02-05 00:07:55][INFO] i= 0 x: [[0. 0. 0.]]
[02-05 00:07:55][INFO] i= 1 x: [[ 0.2    -1.325   1.1375]]
[02-05 00:07:55][INFO] i= 2 x: [[ 2.475      0.096875  -0.4265625]]
[02-05 00:07:55][INFO] i= 3 x: [[-0.653125   -1.85820313  1.72402344]]
[02-05 00:07:55][INFO] i= 4 x: [[ 3.64804688  0.8300293  -1.23303223]]
[02-05 00:07:55][INFO] i= 5 x: [[-2.26606445 -2.86629028  2.83291931]]
```

```
[02-05 00:07:55][INFO] i= 6 x: [[ 5.86583862  2.21614914 -2.75776405]]
[02-05 00:07:55][INFO] i= 7 x: [[-5.31552811 -4.77220507  4.92942557]]
[02-05 00:07:55][INFO] i= 8 x: [[10.05885115  4.83678197 -5.64046016]]
[02-05 00:07:55][INFO] i= 9 x: [[-11.08092033  -8.3755752    8.89313272]]
[02-05 00:07:55][INFO] i= 10 x: [[ 17.98626545   9.79141591 -11.0905575 ]]
[02-05 00:07:55][INFO] i= 11 x: [[-21.98111499 -15.18819687  16.38701656]]
[02-05 00:07:55][INFO] i= 12 x: [[ 32.97403311  19.1587707  -21.39464777]]
[02-05 00:07:55][INFO] i= 13 x: [[-42.58929553 -28.06830971  30.55514068]]
[02-05 00:07:55][INFO] i= 14 x: [[ 61.31028136  36.86892585 -40.87581843]]
[02-05 00:07:55][INFO] i= 15 x: [[-81.55163687 -52.41977304  57.34175035]]
[02-05 00:07:55][INFO] i= 16 x: [[114.88350069  70.35218793 -77.70740673]]
[02-05 00:07:55][INFO] i= 17 x: [[-155.21481345  -98.45925841  107.98518425]]
[02-05 00:07:55][INFO] i= 18 x: [[ 216.1703685   133.65648031 -147.34212834]]
[02-05 00:07:55][INFO] i= 19 x: [[-294.48425668 -185.50266043  203.73292647]]
[02-05 00:07:55][INFO] i= 20 x: [[ 407.66585294  253.34115809 -278.9952739 ]]
[02-05 00:07:55][INFO] i= 21 x: [[-557.79054779 -350.06909237  384.75600161]]
[02-05 00:07:55][INFO] i= 22 x: [[ 769.71200321  479.62000201 -527.90200221]]
[02-05 00:07:55][INFO] i= 23 x: [[-1055.60400442  -661.20250276   727.00275304]]
[02-05 00:07:55][INFO] i= 24 x: [[1454.20550607  907.4284413  -998.49128543]]
[02-05 00:07:55][INFO] i= 25 x: [[-1996.78257085 -1249.43910678  1374.06301746]]
[02-05 00:07:55][INFO] i= 26 x: [[ 2748.32603492  1716.25377182 -1888.19914901]]
[02-05 00:07:55][INFO] i= 27 x: [[-3776.19829801 -2361.57393626  2597.41132988]]
[02-05 00:07:55][INFO] i= 28 x: [[ 5195.02265977  3245.43916236 -3570.30307859]]
[02-05 00:07:55][INFO] i= 29 x: [[-7140.40615718 -4464.20384824  4910.30423306]]
[02-05 00:07:55][INFO] i= 30 x: [[ 9820.80846613  6136.55529133 -6750.53082046]]
[02-05 00:07:55][INFO] i= 31 x: [[-13500.86164092  -8439.48852558   9283.11737813]]
[02-05 00:07:55][INFO] i= 32 x: [[ 18566.43475627  11602.57172267 -12763.14889494]]
[02-05 00:07:55][INFO] i= 33 x: [[-25526.09778987 -15955.26111867  17550.46723054]]
[02-05 00:07:55][INFO] i= 34 x: [[ 35101.13446107  21936.75903817 -24130.75494199]]
[02-05 00:07:55][INFO] i= 35 x: [[-48261.30988397 -30164.76867748  33180.92554523]]
[02-05 00:07:55][INFO] i= 36 x: [[ 66362.05109046  41474.83193154 -45622.63512469]]
[02-05 00:07:55][INFO] i= 37 x: [[-91245.07024939 -57029.61890587  62732.26079645]]
[02-05 00:07:55][INFO] i= 38 x: [[125464.72159291  78414.00099557 -86255.72109512]]
[02-05 00:07:55][INFO] i= 39 x: [[-172511.24219025 -107820.97636891  118602.7540058 ]]
[02-05 00:07:55][INFO] i= 40 x: [[ 237205.70801159  148252.11750725 -163077.64925797]]
[02-05 00:07:55][INFO] i= 41 x: [[-326155.09851594 -203848.38657246  224232.90522971]]
[02-05 00:07:55][INFO] i= 42 x: [[ 448466.01045942  280289.80653714 -308319.10719085]]
[02-05 00:07:55][INFO] i= 43 x: [[-616638.0143817  -385400.20898856  423939.90988742]]
[02-05 00:07:55][INFO] i= 44 x: [[ 847880.01977484  529923.56235927 -582916.2385952 ]]
[02-05 00:07:55][INFO] i= 45 x: [[-1165832.2771904   -728646.623244     801510.9655684]]
[02-05 00:07:55][INFO] i= 46 x: [[ 1603022.1311368    1001887.3819605   -1102076.44015655]]
[02-05 00:07:55][INFO] i= 47 x: [[-2204152.6803131   -1377596.87519569  1515356.24271526]]
[02-05 00:07:55][INFO] i= 48 x: [[ 3030712.68543051  1894193.97839407 -2083613.69623348]]
```

```
[02-05 00:07:55][INFO] i= 49 x: [[-4167227.19246695 -2604518.44529185  2864969.96982103]]
[02-05 00:07:55][INFO] i= 50 x: [[ 5729940.13964206  3581211.13727629 -3939332.57100392]]
[02-05 00:07:55][INFO] i= 51 x: [[-7878664.94200784 -4924167.0387549   5416583.42263039]]
[02-05 00:07:55][INFO] i= 52 x: [[10833167.04526077  6770727.95328798 -7447801.06861678]]
[02-05 00:07:55][INFO] i= 53 x: [[-14895601.93723356  -9309752.66077098  10240727.60684807]]
[02-05 00:07:55][INFO] i= 54 x: [[ 20481455.41369615  12800908.18356009 -14080999.3219161 ]]
[02-05 00:07:55][INFO] i= 55 x: [[-28161998.4438322  -17601250.47739513  19361375.20513464]]
[02-05 00:07:55][INFO] i= 56 x: [[ 38722750.61026928  24201717.6814183  -26621889.76956013]]
[02-05 00:07:55][INFO] i= 57 x: [[-53243779.33912025 -33277363.53695016  36605099.57064518]]
[02-05 00:07:55][INFO] i= 58 x: [[ 73210199.34129035  45756373.13830648 -50332010.77213712]]
[02-05 00:07:55][INFO] i= 59 x: [[-1.00664021e+08 -6.29150148e+07  6.92065159e+07]]
[02-05 00:07:55][INFO] i= 60 x: [[ 1.38413032e+08  8.65081436e+07 -9.51589583e+07]]
[02-05 00:07:55][INFO] i= 61 x: [[-1.90317916e+08 -1.18948699e+08  1.30843569e+08]]
[02-05 00:07:55][INFO] i= 62 x: [[ 2.61687138e+08  1.63554460e+08 -1.79909906e+08]]
[02-05 00:07:55][INFO] i= 63 x: [[-3.59819812e+08 -2.24887384e+08  2.47376122e+08]]
[02-05 00:07:55][INFO] i= 64 x: [[ 4.94752244e+08  3.09220151e+08 -3.40142166e+08]]
[02-05 00:07:55][INFO] i= 65 x: [[-6.80284333e+08 -4.25177709e+08  4.67695480e+08]]
[02-05 00:07:55][INFO] i= 66 x: [[ 9.35390960e+08  5.84619349e+08 -6.43081284e+08]]
[02-05 00:07:55][INFO] i= 67 x: [[-1.28616257e+09 -8.03851606e+08  8.84236766e+08]]
[02-05 00:07:55][INFO] i= 68 x: [[ 1.76847353e+09  1.10529596e+09 -1.21582555e+09]]
[02-05 00:07:55][INFO] i= 69 x: [[-2.43165110e+09 -1.51978194e+09  1.67176014e+09]]
[02-05 00:07:55][INFO] i= 70 x: [[ 3.34352027e+09  2.08970017e+09 -2.29867019e+09]]
[02-05 00:07:55][INFO] i= 71 x: [[-4.59734037e+09 -2.87333773e+09  3.16067151e+09]]
[02-05 00:07:55][INFO] i= 72 x: [[ 6.32134301e+09  3.95083938e+09 -4.34592332e+09]]
[02-05 00:07:55][INFO] i= 73 x: [[-8.69184664e+09 -5.43240415e+09  5.97564457e+09]]
[02-05 00:07:55][INFO] i= 74 x: [[ 1.19512891e+10  7.46955571e+09 -8.21651128e+09]]
[02-05 00:07:55][INFO] i= 75 x: [[-1.64330226e+10 -1.02706391e+10  1.12977030e+10]]
[02-05 00:07:55][INFO] i= 76 x: [[ 2.25954060e+10  1.41221288e+10 -1.55343416e+10]]
[02-05 00:07:55][INFO] i= 77 x: [[-3.10686833e+10 -1.94179270e+10  2.13597197e+10]]
[02-05 00:07:55][INFO] i= 78 x: [[ 4.27194395e+10  2.66996497e+10 -2.93696147e+10]]
[02-05 00:07:55][INFO] i= 79 x: [[-5.87392293e+10 -3.67120183e+10  4.03832201e+10]]
[02-05 00:07:55][INFO] i= 80 x: [[ 8.07664403e+10  5.04790252e+10 -5.55269277e+10]]
[02-05 00:07:55][INFO] i= 81 x: [[-1.11053855e+11 -6.94086596e+10  7.63495256e+10]]
[02-05 00:07:55][INFO] i= 82 x: [[ 1.52699051e+11  9.54369070e+10 -1.04980598e+11]]
[02-05 00:07:55][INFO] i= 83 x: [[-2.09961195e+11 -1.31225747e+11  1.44348322e+11]]
[02-05 00:07:55][INFO] i= 84 x: [[ 2.88696644e+11  1.80435402e+11 -1.98478942e+11]]
[02-05 00:07:55][INFO] i= 85 x: [[-3.96957885e+11 -2.48098678e+11  2.72908546e+11]]
[02-05 00:07:55][INFO] i= 86 x: [[ 5.45817092e+11  3.41135682e+11 -3.75249251e+11]]
[02-05 00:07:55][INFO] i= 87 x: [[-7.50498501e+11 -4.69061563e+11  5.15967720e+11]]
[02-05 00:07:55][INFO] i= 88 x: [[ 1.03193544e+12  6.44959650e+11 -7.09455615e+11]]
[02-05 00:07:55][INFO] i= 89 x: [[-1.41891123e+12 -8.86819518e+11  9.75501470e+11]]
[02-05 00:07:55][INFO] i= 90 x: [[ 1.95100294e+12  1.21937684e+12 -1.34131452e+12]]
[02-05 00:07:55][INFO] i= 91 x: [[-2.68262904e+12 -1.67664315e+12  1.84430747e+12]]
```

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[02-05 00:07:55][INFO] i= 92 x: [[ 3.68861493e+12  2.30538433e+12 -2.53592277e+12]]
[02-05 00:07:55][INFO] i= 93 x: [[-5.07184553e+12 -3.16990346e+12  3.48689380e+12]]
[02-05 00:07:55][INFO] i= 94 x: [[ 6.97378761e+12  4.35861726e+12 -4.79447898e+12]]
[02-05 00:07:55][INFO] i= 95 x: [[-9.58895796e+12 -5.99309873e+12  6.59240860e+12]]
[02-05 00:07:55][INFO] i= 96 x: [[ 1.31848172e+13  8.24051075e+12 -9.06456182e+12]]
[02-05 00:07:55][INFO] i= 97 x: [[-1.81291236e+13 -1.13307023e+13  1.24637725e+13]]
[02-05 00:07:55][INFO] i= 98 x: [[ 2.49275450e+13  1.55797156e+13 -1.71376872e+13]]
[02-05 00:07:55][INFO] i= 99 x: [[-3.42753744e+13 -2.14221090e+13  2.35643199e+13]]
[02-05 00:07:55][INFO] i= 100 x: [[ 4.71286398e+13  2.94553999e+13 -3.24009399e+13]]
[02-05 00:07:55][INFO] i= 101 x: [[-6.48018797e+13 -4.05011748e+13  4.45512923e+13]]
[02-05 00:07:55][INFO] i= 102 x: [[ 8.91025846e+13  5.56891154e+13 -6.12580269e+13]]
[02-05 00:07:55][INFO] i= 103 x: [[-1.22516054e+14 -7.65725336e+13  8.42297870e+13]]
[02-05 00:07:55][INFO] i= 104 x: [[ 1.68459574e+14  1.05287234e+14 -1.15815957e+14]]
[02-05 00:07:55][INFO] i= 105 x: [[-2.31631914e+14 -1.44769946e+14  1.59246941e+14]]
[02-05 00:07:55][INFO] i= 106 x: [[ 3.18493882e+14  1.99058676e+14 -2.18964544e+14]]
[02-05 00:07:55][INFO] i= 107 x: [[-4.37929088e+14 -2.73705680e+14  3.01076248e+14]]
[02-05 00:07:55][INFO] i= 108 x: [[ 6.02152496e+14  3.76345310e+14 -4.13979841e+14]]
[02-05 00:07:55][INFO] i= 109 x: [[-8.27959682e+14 -5.17474801e+14  5.69222281e+14]]
[02-05 00:07:55][INFO] i= 110 x: [[ 1.13844456e+15  7.11527852e+14 -7.82680637e+14]]
[02-05 00:07:55][INFO] i= 111 x: [[-1.56536127e+15 -9.78350796e+14  1.07618588e+15]]
[02-05 00:07:55][INFO] i= 112 x: [[ 2.15237175e+15  1.34523234e+15 -1.47975558e+15]]
[02-05 00:07:55][INFO] i= 113 x: [[-2.95951116e+15 -1.84969447e+15  2.03466392e+15]]
[02-05 00:07:55][INFO] i= 114 x: [[ 4.06932784e+15  2.54332990e+15 -2.79766289e+15]]
[02-05 00:07:55][INFO] i= 115 x: [[-5.59532578e+15 -3.49707861e+15  3.84678648e+15]]
[02-05 00:07:55][INFO] i= 116 x: [[ 7.69357295e+15  4.80848309e+15 -5.28933140e+15]]
[02-05 00:07:55][INFO] i= 117 x: [[-1.05786628e+16 -6.61166425e+15  7.27283068e+15]]
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[02-05 00:07:55][INFO] i= 122 x: [[ 5.19929268e+16  3.24955792e+16 -3.57451371e+16]]
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[02-05 00:07:55][INFO] i= 124 x: [[ 9.82991271e+16  6.14369545e+16 -6.75806499e+16]]
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[02-05 00:07:55][INFO] i= 127 x: [[-2.55539332e+17 -1.59712083e+17  1.75683291e+17]]
[02-05 00:07:55][INFO] i= 128 x: [[ 3.51366582e+17  2.19604114e+17 -2.41564525e+17]]
[02-05 00:07:55][INFO] i= 129 x: [[-4.83129050e+17 -3.01955657e+17  3.32151222e+17]]
[02-05 00:07:55][INFO] i= 130 x: [[ 6.64302444e+17  4.15189028e+17 -4.56707931e+17]]
[02-05 00:07:55][INFO] i= 131 x: [[-9.13415861e+17 -5.70884913e+17  6.27973404e+17]]
[02-05 00:07:55][INFO] i= 132 x: [[ 1.25594681e+18  7.84966756e+17 -8.63463431e+17]]
[02-05 00:07:55][INFO] i= 133 x: [[-1.72692686e+18 -1.07932929e+18  1.18726222e+18]]
[02-05 00:07:55][INFO] i= 134 x: [[ 2.37452444e+18  1.48407777e+18 -1.63248555e+18]]
```

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[02-05 00:07:55][INFO] i= 135 x: [[-3.26497110e+18 -2.04060694e+18  2.24466763e+18]]
[02-05 00:07:55][INFO] i= 136 x: [[ 4.48933526e+18  2.80583454e+18 -3.08641799e+18]]
[02-05 00:07:55][INFO] i= 137 x: [[-6.17283598e+18 -3.85802249e+18  4.24382474e+18]]
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[02-05 00:07:55][INFO] i= 139 x: [[-1.16705180e+19 -7.29407377e+18  8.02348115e+18]]
[02-05 00:07:55][INFO] i= 140 x: [[ 1.60469623e+19  1.00293514e+19 -1.10322866e+19]]
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[02-05 00:07:55][INFO] i= 142 x: [[ 3.03387881e+19  1.89617426e+19 -2.08579168e+19]]
[02-05 00:07:55][INFO] i= 143 x: [[-4.17158336e+19 -2.60723960e+19  2.86796356e+19]]
[02-05 00:07:55][INFO] i= 144 x: [[ 5.73592712e+19  3.58495445e+19 -3.94344990e+19]]
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[02-05 00:07:55][INFO] i= 148 x: [[ 2.05028586e+20  1.28142867e+20 -1.40957153e+20]]
[02-05 00:07:55][INFO] i= 149 x: [[-2.81914306e+20 -1.76196441e+20  1.93816086e+20]]
[02-05 00:07:55][INFO] i= 150 x: [[ 3.87632171e+20  2.42270107e+20 -2.66497118e+20]]
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[02-05 00:07:55][INFO] i= 152 x: [[ 7.32867074e+20  4.58041921e+20 -5.03846113e+20]]
[02-05 00:07:55][INFO] i= 153 x: [[-1.00769223e+21 -6.29807641e+20  6.92788406e+20]]
[02-05 00:07:55][INFO] i= 154 x: [[ 1.38557681e+21  8.65985507e+20 -9.52584058e+20]]
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[02-05 00:07:55][INFO] i= 160 x: [[ 9.36368500e+21  5.85230313e+21 -6.43753344e+21]]
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[02-05 00:07:55][INFO] i= 174 x: [[ 8.08508462e+23  5.05317789e+23 -5.55849568e+23]]
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[02-05 00:07:55][INFO] i= 176 x: [[ 1.52858631e+24  9.55366445e+23 -1.05090309e+24]]
[02-05 00:07:55][INFO] i= 177 x: [[-2.10180618e+24 -1.31362886e+24  1.44499175e+24]]
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[02-05 00:07:55][INFO] i= 178 x: [[ 2.88998350e+24  1.80623968e+24 -1.98686365e+24]]
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[02-05 00:07:55][INFO] i= 184 x: [[ 1.95304186e+25  1.22065116e+25 -1.34271628e+25]]
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[02-05 00:07:55][INFO] i= 188 x: [[ 6.98107565e+25  4.36317228e+25 -4.79948951e+25]]
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[02-05 00:07:55][INFO] i= 203 x: [[-8.28824951e+27 -5.18015594e+27  5.69817154e+27]]
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[02-05 00:07:55][INFO] i= 214 x: [[ 2.75291306e+29  1.72057066e+29 -1.89262773e+29]]
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[02-05 00:07:55][INFO] i= 216 x: [[ 5.20472626e+29  3.25295391e+29 -3.57824930e+29]]
[02-05 00:07:55][INFO] i= 217 x: [[-7.15649860e+29 -4.47281163e+29  4.92009279e+29]]
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```

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[02-05 00:07:55][INFO] i= 221 x: [[-2.55806387e+30 -1.59878992e+30  1.75866891e+30]]
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[02-05 00:07:55][INFO] i= 224 x: [[ 6.64996682e+30  4.15622926e+30 -4.57185219e+30]]
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[02-05 00:07:55][INFO] i= 226 x: [[ 1.25725935e+31  7.85787094e+30 -8.64365804e+30]]
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[02-05 00:07:55][INFO] i= 245 x: [[-5.33551247e+33 -3.33469530e+33  3.66816483e+33]]
[02-05 00:07:55][INFO] i= 246 x: [[ 7.33632965e+33  4.58520603e+33 -5.04372664e+33]]
[02-05 00:07:55][INFO] i= 247 x: [[-1.00874533e+34 -6.30465829e+33  6.93512412e+33]]
[02-05 00:07:55][INFO] i= 248 x: [[ 1.38702482e+34  8.66890516e+33 -9.53579567e+33]]
[02-05 00:07:55][INFO] i= 249 x: [[-1.90715913e+34 -1.19197446e+34  1.31117190e+34]]
[02-05 00:07:55][INFO] i= 250 x: [[ 2.62234381e+34  1.63896488e+34 -1.80286137e+34]]
[02-05 00:07:55][INFO] i= 251 x: [[-3.60572274e+34 -2.25357671e+34  2.47893438e+34]]
[02-05 00:07:55][INFO] i= 252 x: [[ 4.95786876e+34  3.09866798e+34 -3.40853478e+34]]
[02-05 00:07:55][INFO] i= 253 x: [[-6.81706955e+34 -4.26066847e+34  4.68673532e+34]]
[02-05 00:07:55][INFO] i= 254 x: [[ 9.37347063e+34  5.85841915e+34 -6.44426106e+34]]
[02-05 00:07:55][INFO] i= 255 x: [[-1.28885221e+35 -8.05532633e+34  8.86085896e+34]]
[02-05 00:07:55][INFO] i= 256 x: [[ 1.77217179e+35  1.10760737e+35 -1.21836811e+35]]
[02-05 00:07:55][INFO] i= 257 x: [[-2.43673621e+35 -1.52296013e+35  1.67525615e+35]]
[02-05 00:07:55][INFO] i= 258 x: [[ 3.35051229e+35  2.09407018e+35 -2.30347720e+35]]
[02-05 00:07:55][INFO] i= 259 x: [[-4.60695440e+35 -2.87934650e+35  3.16728115e+35]]
[02-05 00:07:55][INFO] i= 260 x: [[ 6.33456230e+35  3.95910144e+35 -4.35501158e+35]]
[02-05 00:07:55][INFO] i= 261 x: [[-8.71002317e+35 -5.44376448e+35  5.98814093e+35]]
[02-05 00:07:55][INFO] i= 262 x: [[ 1.19762819e+36  7.48517616e+35 -8.23369378e+35]]
[02-05 00:07:55][INFO] i= 263 x: [[-1.64673876e+36 -1.02921172e+36  1.13213289e+36]]
```

```
[02-05 00:07:55][INFO] i= 264 x: [[ 2.26426579e+36  1.41516612e+36 -1.55668273e+36]]
[02-05 00:07:55][INFO] i= 265 x: [[-3.11336546e+36 -1.94585341e+36  2.14043875e+36]]
[02-05 00:07:55][INFO] i= 266 x: [[ 4.28087751e+36  2.67554844e+36 -2.94310329e+36]]
[02-05 00:07:55][INFO] i= 267 x: [[-5.88620657e+36 -3.67887911e+36  4.04676702e+36]]
[02-05 00:07:55][INFO] i= 268 x: [[ 8.09353404e+36  5.05845877e+36 -5.56430465e+36]]
[02-05 00:07:55][INFO] i= 269 x: [[-1.11286093e+37 -6.95538081e+36  7.65091889e+36]]
[02-05 00:07:55][INFO] i= 270 x: [[ 1.53018378e+37  9.56364862e+36 -1.05200135e+37]]
[02-05 00:07:55][INFO] i= 271 x: [[-2.10400270e+37 -1.31500168e+37  1.44650185e+37]]
[02-05 00:07:55][INFO] i= 272 x: [[ 2.89300371e+37  1.80812732e+37 -1.98894005e+37]]
[02-05 00:07:55][INFO] i= 273 x: [[-3.97788010e+37 -2.48617506e+37  2.73479257e+37]]
[02-05 00:07:55][INFO] i= 274 x: [[ 5.46958513e+37  3.41849071e+37 -3.76033978e+37]]
[02-05 00:07:55][INFO] i= 275 x: [[-7.52067956e+37 -4.70042472e+37  5.17046720e+37]]
[02-05 00:07:55][INFO] i= 276 x: [[ 1.03409344e+38  6.46308400e+37 -7.10939239e+37]]
[02-05 00:07:55][INFO] i= 277 x: [[-1.42187848e+38 -8.88674049e+37  9.77541454e+37]]
[02-05 00:07:55][INFO] i= 278 x: [[ 1.95508291e+38  1.22192682e+38 -1.34411950e+38]]
[02-05 00:07:55][INFO] i= 279 x: [[-2.68823900e+38 -1.68014937e+38  1.84816431e+38]]
[02-05 00:07:55][INFO] i= 280 x: [[ 3.69632862e+38  2.31020539e+38 -2.54122593e+38]]
[02-05 00:07:55][INFO] i= 281 x: [[-5.08245186e+38 -3.17653241e+38  3.49418565e+38]]
[02-05 00:07:55][INFO] i= 282 x: [[ 6.98837130e+38  4.36773207e+38 -4.80450527e+38]]
[02-05 00:07:55][INFO] i= 283 x: [[-9.60901054e+38 -6.00563159e+38  6.60619475e+38]]
[02-05 00:07:55][INFO] i= 284 x: [[ 1.32123895e+39  8.25774344e+38 -9.08351778e+38]]
[02-05 00:07:55][INFO] i= 285 x: [[-1.81670356e+39 -1.13543972e+39  1.24898369e+39]]
[02-05 00:07:55][INFO] i= 286 x: [[ 2.49796739e+39  1.56122962e+39 -1.71735258e+39]]
[02-05 00:07:55][INFO] i= 287 x: [[-3.43470516e+39 -2.14669073e+39  2.36135980e+39]]
[02-05 00:07:55][INFO] i= 288 x: [[ 4.72271960e+39  2.95169975e+39 -3.24686972e+39]]
[02-05 00:07:55][INFO] i= 289 x: [[-6.49373944e+39 -4.05858715e+39  4.46444587e+39]]
[02-05 00:07:55][INFO] i= 290 x: [[ 8.92889174e+39  5.58055733e+39 -6.13861307e+39]]
[02-05 00:07:55][INFO] i= 291 x: [[-1.22772261e+40 -7.67326634e+39  8.44059297e+39]]
[02-05 00:07:55][INFO] i= 292 x: [[ 1.68811859e+40  1.05507412e+40 -1.16058153e+40]]
[02-05 00:07:55][INFO] i= 293 x: [[-2.32116307e+40 -1.45072692e+40  1.59579961e+40]]
[02-05 00:07:55][INFO] i= 294 x: [[ 3.19159922e+40  1.99474951e+40 -2.19422446e+40]]
[02-05 00:07:55][INFO] i= 295 x: [[-4.38844892e+40 -2.74278058e+40  3.01705863e+40]]
[02-05 00:07:55][INFO] i= 296 x: [[ 6.03411727e+40  3.77132329e+40 -4.14845562e+40]]
[02-05 00:07:55][INFO] i= 297 x: [[-8.29691124e+40 -5.18556953e+40  5.70412648e+40]]
[02-05 00:07:55][INFO] i= 298 x: [[ 1.14082530e+41  7.13015810e+40 -7.84317391e+40]]
[02-05 00:07:55][INFO] i= 299 x: [[-1.56863478e+41 -9.80396739e+40  1.07843641e+41]]
Solución con Gauss-Seidel: [[-1.56863478e+41]
 [-9.80396739e+40]
 [ 1.07843641e+41]]
```

El método de Gauss-Seidel **diverge completamente**. El hecho de que la matriz no sea diagonalmente dominante hace que sea **inestable y no converja**

2.7 7. 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.

$$\left[\begin{array}{cccccccccccc|c}
4 & -1 & 0 & 0 & -1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 220 \\
-1 & 4 & -1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 110 \\
0 & -1 & 4 & -1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 110 \\
0 & 0 & -1 & 4 & 0 & -1 & 0 & 0 & 0 & 0 & 0 & 0 & 220 \\
-1 & 0 & 0 & 0 & 4 & 0 & -1 & 0 & 0 & 0 & 0 & 0 & 110 \\
0 & 0 & 0 & -1 & 0 & 4 & 0 & -1 & 0 & 0 & 0 & 0 & 110 \\
0 & 0 & 0 & 0 & -1 & 0 & 4 & 0 & -1 & 0 & 0 & 0 & 110 \\
0 & 0 & 0 & 0 & 0 & -1 & 0 & 4 & 0 & 0 & 0 & -1 & 110 \\
0 & 0 & 0 & 0 & 0 & 0 & -1 & 0 & 4 & -1 & 0 & 0 & 220 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & -1 & 4 & -1 & 0 & 110 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & -1 & 4 & -1 & 110 \\
0 & 0 & 0 & 0 & 0 & -1 & 0 & 0 & 0 & 0 & -1 & 4 & 220
\end{array}\right]
\begin{bmatrix} w_1 \\ w_2 \\ w_3 \\ w_4 \\ w_5 \\ w_6 \\ w_7 \\ w_8 \\ w_9 \\ w_{10} \\ w_{11} \\ w_{12} \end{bmatrix}
=
\begin{bmatrix} 220 \\ 110 \\ 110 \\ 220 \\ 110 \\ 110 \\ 110 \\ 110 \\ 220 \\ 110 \\ 110 \\ 220 \end{bmatrix}$$

a. ¿La matriz es estrictamente diagonal dominante?

```python
import numpy as np

A = np.array([
    [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]
], dtype=float)
```

```
if es_diagonal_dominante(A):
    print("Matriz es diagonalmente dominante")
else:
    print("No es diagonalmente dominante")
```

```
Matriz es diagonalmente dominante
```

b. Resuelva el sistema lineal usando el método de Jacobi con $x_{(0)} = 0$ y $TOL = 10_{-2}$

```
%autoreload 2
import numpy as np
from src.iterative_methods import gauss_jacobi

A = np.array([
    [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]
], dtype=float)


b = np.array([220, 110, 110, 220, 110, 110, 110, 110, 220, 110, 110, 220], dtype=float)
x0 = np.zeros((12, 1))

# Parámetros de iteración
tol = 0.01  # 10^-2
max_iter = 300  # Número máximo de iteraciones


x_jacobi, tray_jacobi = gauss_jacobi(A=A, b=b, x0=x0, tol=tol, max_iter=max_iter)
print("Solución con Jacobi:")
print(x_jacobi)
```

```
[02-05 00:30:55][INFO] i= 0 x: [[0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0.]]
[02-05 00:30:55][INFO] i= 1 x: [[55.  27.5 27.5 55.  27.5 27.5 27.5 27.5 55.  27.5 27.5 55. ]
[02-05 00:30:55][INFO] i= 2 x: [[68.75  48.125 48.125 68.75  48.125 48.125 48.125 48.125 68.7
  48.125 68.75 ]]
[02-05 00:30:55][INFO] i= 3 x: [[79.0625  56.71875 56.71875 79.0625  56.71875 56.71875 56.718
  79.0625  56.71875 56.71875 79.0625 ]]
[02-05 00:30:55][INFO] i= 4 x: [[83.359375  61.4453125 61.4453125 83.359375  61.4453125 61.44
  61.4453125 61.4453125 83.359375  61.4453125 61.4453125 83.359375 ]]
[02-05 00:30:55][INFO] i= 5 x: [[85.72265625 63.70117188 63.70117188 85.72265625 63.70117188
  63.70117188 63.70117188 85.72265625 63.70117188 63.70117188 85.72265625]]
[02-05 00:30:55][INFO] i= 6 x: [[86.85058594 64.85595703 64.85595703 86.85058594 64.85595703
  64.85595703 64.85595703 86.85058594 64.85595703 64.85595703 86.85058594]]
[02-05 00:30:55][INFO] i= 7 x: [[87.42797852 65.42663574 65.42663574 87.42797852 65.42663574
  65.42663574 65.42663574 87.42797852 65.42663574 65.42663574 87.42797852]]
[02-05 00:30:55][INFO] i= 8 x: [[87.71331787 65.71365356 65.71365356 87.71331787 65.71365356
  65.71365356 65.71365356 87.71331787 65.71365356 65.71365356 87.71331787]]
[02-05 00:30:55][INFO] i= 9 x: [[87.85682678 65.85674286 65.85674286 87.85682678 65.85674286
  65.85674286 65.85674286 87.85682678 65.85674286 65.85674286 87.85682678]]
[02-05 00:30:55][INFO] i= 10 x: [[87.92837143 65.92839241 65.92839241 87.92837143 65.92839241
  65.92839241 65.92839241 87.92837143 65.92839241 65.92839241 87.92837143]]
[02-05 00:30:55][INFO] i= 11 x: [[87.96419621 65.96419096 65.96419096 87.96419621 65.96419096
  65.96419096 65.96419096 87.96419621 65.96419096 65.96419096 87.96419621]]
[02-05 00:30:55][INFO] i= 12 x: [[87.98209548 65.98209679 65.98209679 87.98209548 65.98209679
  65.98209679 65.98209679 87.98209548 65.98209679 65.98209679 87.98209548]]
[02-05 00:30:55][INFO] i= 13 x: [[87.9910484  65.99104807 65.99104807 87.9910484  65.99104807
  65.99104807 65.99104807 87.9910484  65.99104807 65.99104807 87.9910484 ]]
[02-05 00:30:55][INFO] i= 14 x: [[87.99552403 65.99552412 65.99552412 87.99552403 65.99552412
  65.99552412 65.99552412 87.99552403 65.99552412 65.99552412 87.99552403]]
Solución con Jacobi:
[[87.99776206]
 [65.99776204]
 [65.99776204]
 [87.99776206]
 [65.99776204]
 [65.99776204]
 [65.99776204]
 [65.99776204]
 [87.99776206]
 [65.99776204]
 [65.99776204]
 [87.99776206]]
```

c. Repita (b) mediante el método de Gauss-Seidel

```
%autoreload 2
import numpy as np
from src.iterative_methods import gauss_seidel

A = np.array([
    [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]
], dtype=float)


b = np.array([220, 110, 110, 220, 110, 110, 110, 110, 220, 110, 110, 220], dtype=float)
x0 = np.zeros((12, 1))

# Parámetros de iteración
tol = 0.01  # 10^-2
max_iter = 300  # Número máximo de iteraciones


x_seidel, tray_seidel = gauss_seidel(A=A, b=b, x0=x0, tol=tol, max_iter=max_iter)
print("Solución con Seidel:")
print(x_seidel)
```

```
[02-05 00:32:25][INFO] i= 0 x: [[0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0.]]
[02-05 00:32:25][INFO] i= 1 x: [[55.         41.25       37.8125     64.453125   41.25
  37.8125     38.40332031 64.453125   43.61328125 38.40332031 75.50415039]]
[02-05 00:32:25][INFO] i= 2 x: [[75.625      55.859375   57.578125   80.29785156 55.859375
  57.578125   60.66986084 80.29785156 57.17529297 60.66986084 84.46128845]]
[02-05 00:32:25][INFO] i= 3 x: [[82.9296875  62.62695312 63.23120117 85.10162354 62.62695312
  63.23120117 64.60103989 85.10162354 63.94287109 64.60103989 87.13597775]]
[02-05 00:32:25][INFO] i= 4 x: [[86.31347656 64.88616943 64.99694824 87.23495483 64.88616943
  64.99694824 65.64874411 87.23495483 65.45899868 65.64874411 87.7769357 ]]
[02-05 00:32:25][INFO] i= 5 x: [[87.44308472 65.61000824 65.71124077 87.79255986 65.61000824
```

```
  65.71124077 65.90931542 87.79255986 65.86032599 65.90931542 87.94241035]]
[02-05 00:32:25][INFO] i= 6 x: [[87.80500412 65.87906122 65.91790527 87.94455782 65.87906122
  65.91790527 65.97646967 87.94455782 65.96346831 65.97646967 87.98498449]]
[02-05 00:32:25][INFO] i= 7 x: [[87.93953061 65.96435897 65.9772292  87.98517438 65.96435897
  65.9772292  65.99384888 87.98517438 65.99041101 65.99384888 87.99606497]]
[02-05 00:32:25][INFO] i= 8 x: [[87.98217949 65.98985217 65.99375664 87.99604191 65.98985217
  65.99375664 65.99838442 87.99604191 65.9974727  65.99838442 87.99896428]]
[02-05 00:32:25][INFO] i= 9 x: [[87.99492609 65.99717068 65.99830315 87.99894396 65.99717068
  65.99830315 65.99957409 87.99894396 65.99933209 65.99957409 87.99972655]]
Solución con 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]]
```