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Gauss-Seidel Method
Language: Java

Matrix:

$$A = \begin{bmatrix} 16 & 3 \\ 7 & -11 \end{bmatrix} \text{ and } b = \begin{bmatrix} 11 \\ 13 \end{bmatrix}$$

The code's output (result):

```
0.8121827411167513
-0.6649746192893401
```

Java Code:
Java Gauss-Seidel Class:

```
################################################################################
package com.project.gauss_seidel;

/*
 * Let's define some private fields for the incomplete matrix and for the coefficient vector...
 */
public class GaussSeidel {
	private double[][] A;
	private double[] b;

	/*
	 * Now I create a new constructor that takes as argument an incomplete matrix and a coefficient vector. Let it throw
an exception,
	 * if one of the arguments is NULL or if they don't have the same order...
	 */
	public GaussSeidel(double[][] A, double[] b) {
		if (A == null || b == null) {
			throw new NullPointerException();
		}

		if (A.length != b.length) {
			throw new IllegalArgumentException();
		}

		this.A = A;
		this.b = b;
	}
```

```
	/*
	 * Creating a method to check whether the linear system can be solved applying the Gauss-Seidel method
	 */

	public boolean converges() {
		/*
		 * The Gauss-Seidel method can't converge if the incomplete matrix A is not a diagonally dominant matrix.
		 * So, each element of the diagonal of the matrix must be less than the sum of the values of its own row.
		 */
		for (int i = 0; i < A.length; i++) {
			double diagonal = Math.abs(A[i][i]);
			double tmpSum = 0;

			for (int j = 0; j < A.length; j++) {
				if (i != j)
					tmpSum += Math.abs(A[i][j]);
				if (tmpSum >= diagonal)
					return false;
			}
		}
		return true;
	}

	public double[] solveSystem(int precision) {
		if (!converges()) //if the converges() method returns false, just notify the user since it could still
converge.
			System.err.println("The solution couldn't converge ! Please try again later xD");

		double[] x = initialize(new double[A.length]);
		for (int k = 0; k < precision; k++) // precision of the solution.
			for (int i = 0; i < A.length; i++) {
				double x0 = 0;
				for (int j = 0; j < A.length; j++)
					if (i != j) {
						x0 += A[i][j]*x[j];
						System.out.println("The element x0 is:" + x[0]);
					}
				x[i] = (b[i] - x0)/A[i][i]; // bi-x0/aii
				System.out.println("The element is x" + i);
				System.out.println(" which is " + x[i]);
			}
		return x;
	}
```

```
	private double[] initialize(double[] ds) {
		for (int i = 0; i < ds.length; i++) {
			ds[i] = 0;
		}
		return ds;
	}
}
```

```
################################################################################
```

Java Main Class:

```
################################################################################
package com.project.gauss_seidel;

public class MainClass_Gauss_Seidel {

	public static void main(String[] args) {
		double[][] A = { {16, 3}, {7, -11} }; // A matrix
		double[] b = {11, 13}; // b matrix

		//double[][] A = { {10, 3, -2}, {2, 8, -1}, {1, 1, 5} }; // A matrix
	    //double[] b = {57, 20, -4}; // b matrix


		GaussSeidel solver = new GaussSeidel(A, b);
		double[] x = solver.solveSystem(100); // 100 = precision

		//Matrix A


		for (int i = 0; i < x.length; i++) {
			System.out.println(x[i]);
		}

	}

}
################################################################################
```

I've changed the code to show step-by-step to obtain the result, which output is:

```
The element x0 is:0.0
The element is x0
 which is 0.6875
```

```
The element x0 is:0.6875
The element is x1
 which is -0.7443181818181818
The element x0 is:0.6875
The element is x0
 which is 0.8270596590909091
The element x0 is:0.8270596590909091
The element is x1
 which is -0.6555074896694215
The element x0 is:0.8270596590909091
The element is x0
 which is 0.8104076543130165
The element x0 is:0.8104076543130165
The element is x1
 which is -0.6661042199826258
The element x0 is:0.8104076543130165
The element is x0
 which is 0.8123945412467424
The element x0 is:0.8123945412467424
The element is x1
 which is -0.6648398373884367
The element x0 is:0.8123945412467424
The element is x0
 which is 0.8121574695103319
The element x0 is:0.8121574695103319
The element is x1
 which is -0.6649907012206979
The element x0 is:0.8121574695103319
The element is x0
 which is 0.8121857564788808
The element x0 is:0.8121857564788808
The element is x1
 which is -0.6649727004225304
The element x0 is:0.8121857564788808
The element is x0
 which is 0.8121823813292245
The element x0 is:0.8121823813292245
The element is x1
 which is -0.6649748482450389
The element x0 is:0.8121823813292245
The element is x0
 which is 0.8121827840459448
The element x0 is:0.8121827840459448
The element is x1
 which is -0.6649745919707624
```

```
The element x0 is:0.8121827840459448
The element is x0
 which is 0.812182735994518
The element x0 is:0.812182735994518
The element is x1
 which is -0.6649746225489431
The element x0 is:0.812182735994518
The element is x0
 which is 0.8121827417279268
The element x0 is:0.8121827417279268
The element is x1
 which is -0.6649746189004102
The element x0 is:0.8121827417279268
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The element x0 is:0.8121827410438269
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The element x0 is:0.8121827411254525
The element is x1
 which is -0.664974619283803
The element x0 is:0.8121827411254525
The element is x0
 which is 0.8121827411157131
The element x0 is:0.8121827411157131
The element is x1
 which is -0.6649746192900007
The element x0 is:0.8121827411157131
The element is x0
 which is 0.8121827411168752
The element x0 is:0.8121827411168752
The element is x1
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The element x0 is:0.8121827411167365
The element is x1
 which is -0.6649746192893495
The element x0 is:0.8121827411167365
The element is x0
 which is 0.812182741116753
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The element x0 is:0.812182741116753
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