EAFIT University

SCHOOL OF APPLIED SCIENCES AND ENGINEERING

NUMERICAL ANALYSIS USER MANUAL PROJECT

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Introduction

SACA_JUDAS (Calculator Animation) is an interactive web application designed to support numerical analysis learning. It implements nonlinear equation methods, linear system solvers, and polynomial interpolation techniques, providing both numerical and visual outputs such as tables, graphs and intermediate iteration data.

This manual explains how to install, use, and interact with the system.

How to Initialize

To run the application locally:

1. Install dependencies:

   ```
   pip install -r requirements.txt
   ```

2. Launch the application:

   ```
   uvicorn main:app --reload
   ```

You may also check the GitHub repository here: `https://github.com/jero98772/Saca-judas`

Input Parameters

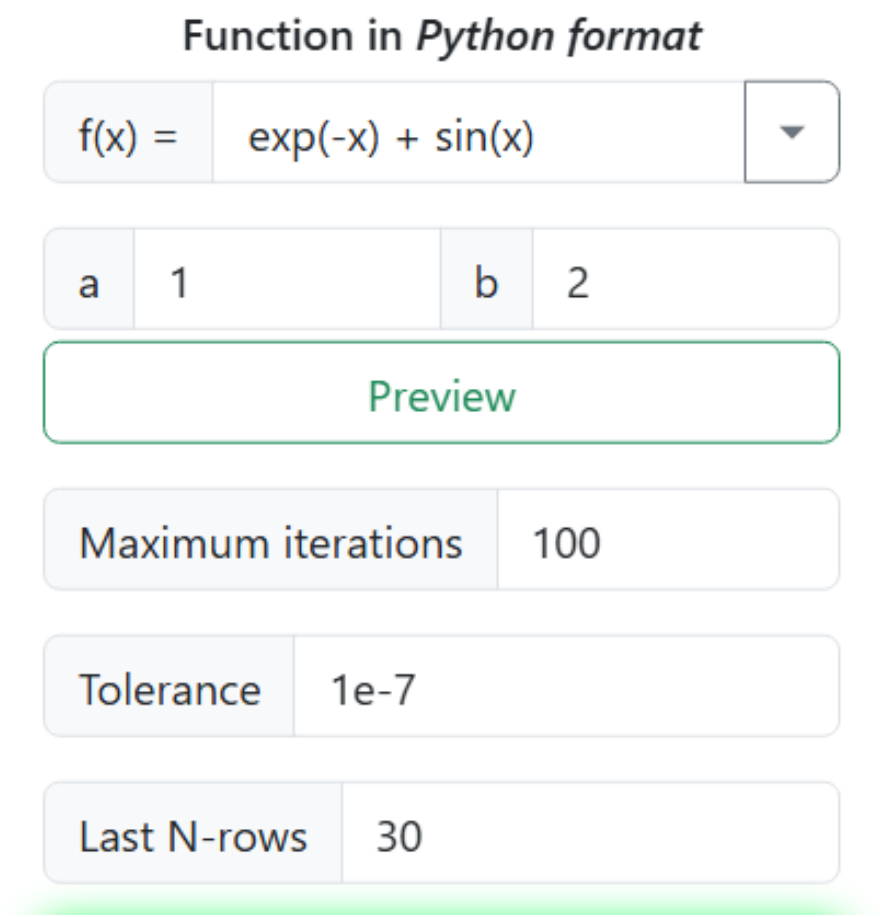

Figure 1: Parts of the calculator interface.

The application requires the user to enter mathematical expressions using Python-like syntax. If the expression is written in any other format, the calculator will not work.

Below is a list of valid expression formats:

1. **Polynomial functions**

```
x**2 + 3*x - 5
4*x**3 - 2*x + 1
x**5 - 7*x + 10
```

2. **Exponential functions**

```
exp(x)
2*exp(3*x)
exp(x) + x**2
```

3. **Logarithmic functions**

```
log(x)
log(x + 1)
log(x)/x
```

4. **Trigonometric functions**

```
sin(x)
cos(x)
tan(x)
sin(x) + cos(x)
```

5. **Inverse trigonometric functions**

```
asin(x)
acos(x)
atan(x)
```

6. **Rational functions**

```
(x**2 + 1)/(x - 3)
1/(x**2 + 4)
(x + 2)/(x**3 - 1)
```

7. **Composite functions**

```
sin(exp(x))
exp(sin(x))
log(sin(x) + 1)
```

8. **Mixed expressions**

```
sin(x) + exp(x) - x**3
cos(x)/log(x)
exp(x)*sin(x) + x**2
```

Matrix Grid System

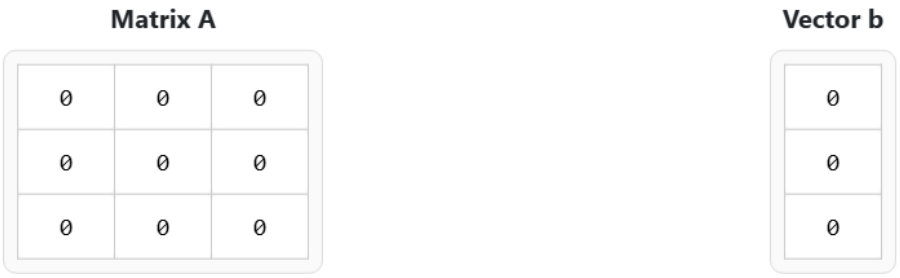

Figure 2: Interactive matrix grid.

The matrix input interface supports **dynamic expansion and automatic minimization**. Its behavior is described as follows:

Dynamic Minimization

The system automatically removes unnecessary rows and columns according to these rules:

- If the last row (bottom-most) and the last column (right-most) contain only zeros or empty cells, and the user presses the `Up Arrow` key while located in the last row, then the system removes that row along with the corresponding last column.
- Similarly, if the last row and last column are empty and the user presses the `Left Arrow` key while located in the last column, the system removes that column along with the last row.

Dynamic Expansion

- When the user types a non-zero or non-empty value in the last available row or column, the matrix automatically expands by adding a new empty row and/or column.

Consistency with the Vector b

- Whenever the matrix expands, the coefficient vector b expands as well by adding an additional entry.
- When the matrix is minimized (a row and column are removed), the vector b is reduced to remain dimensionally consistent.

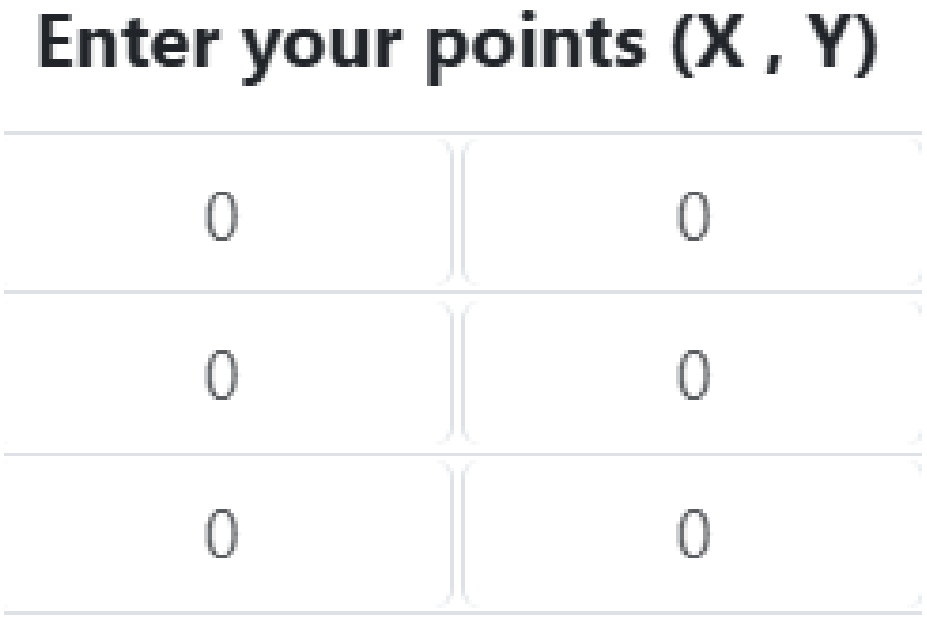

Figure 3: Coefficient vector *b*.

Complete User Manual

General Description

SACA_JUDAS is a numerical methods tool that allows solving nonlinear equations, systems of linear equations, and interpolation problems. The platform provides visual and numerical feedback such as iteration tables, intermediate values, method diagnostics, and plots.

Method Categories

- **Nonlinear Equations:** Bisection, False Position, Fixed Point, Newton, Modified Newton, Secant, Incremental Search.
- **Linear Systems:** Gaussian Elimination (simple, partial and total pivoting), LU factorizations (Crout, Doolittle), Cholesky, Jacobi, Gauss-Seidel, SOR.
- **Interpolation:** Lagrange, Newton, Vandermonde, Linear/Quadratic/Cubic tracers.

Example: Bisection Method

Inputs:

- Function $f(x)$
- Interval $[a,b]$
- Maximum iterations
- Tolerance
- Number of rows to visualize

Validations:

- $a < b$
- Tolerance > 0
- Maximum iterations > 0
- Function must evaluate correctly on input

Linear System Methods

All linear system methods depend on matrix input. The dynamic matrix grid ensures users can enter matrices of any size without manually adding or removing rows.

Interpolation Methods

Interpolation pages allow entering points and generating polynomials and graphs in real time. Cubic tracers generate piecewise cubic functions and graphs.

Error Messages

Common messages include:

- Invalid interval.
- Incorrect function syntax.
- Matrix dimension mismatch.
- Division by zero.
- Empty or incomplete fields.

Credits

- Application: SACA_JUDAS – Calculator Animation.
- Course: Numerical Analysis.
- Lecturer: Edwar Samir Posada Murillo.
- Authors: Samuel Madrid Ossa, Victor Daniel Arango Sohm, Carlos David Sanchez Soto, Edy Julius López Rojas.
- Institution: Universidad EAFIT.
- Year: 2025.