1. Introduction

This project focuses on soil condition mapping using inversion techniques and utilizes the PyGIMLi library for geophysical inversion and PyQt5 for the user interface. Conda manages the environment to ensure cross-platform compatibility and CI automation. Although this project is primarily designed to run on Windows, it also supports macOS and Linux.

2. System Requirement

- Operating System:
  - Windows (primary)
  - macOS (optional) = Linux (optional)
- Python Distribution: Anaconda3
- Libraries(handled via Conda environment):
  - Python 3.10
  - PyGIMLi >= 1.5.0
  - SuiteSparse = 5
  - PyQt5
  - Pandas
  - Matplotlib
  - Numpy
  - pytest

3. How to Get Started

3.1. Download a copy of all of the Application Files from the Github Repository: https://github.com/lshi01/SoilConditionMapping/

3.2. If you use Mac or Linux:

- Step 1: Download and install Anaconda3; Ensure Python 3 is installed with Anaconda.

- Step 2: Create a Virtual Environment
    - Open Anaconda Prompt.
    - Create a new virtual environment named pg with the required libraries by executing the following command:

      ```
      conda create -n pg -c gimli -c conda-forge python=3.10 pygimli=1.5.0 suitesparse=5
      ```

    - Activate virtual environment using code below after successfully installed the virtual environment.

      ```
      conda activate pg
      ```

- Step 3: Install libraries
    - Install additional compulsory dependencies like Pandas, Matplotlib, Numpy, and optionally pytest:

      ```
      conda install pandas matplotlib numpy pytest
      ```

    - Install PyQt5 if not included by default:

      ```
      conda install pyqt
      ```

- Step 4: Run the Python script using Terminal or IDEs (Vscode as an example)
    - Open the project folder in Visual Studio Code.
    - If you are using VS Code, find the Python Interpreter or press **Command + Shift + P** to open the Command Palette.
    - Type or select Python: Select Interpreter.
    - Choose the Anaconda environment pg from the list.
    - Run **main.py** in the project

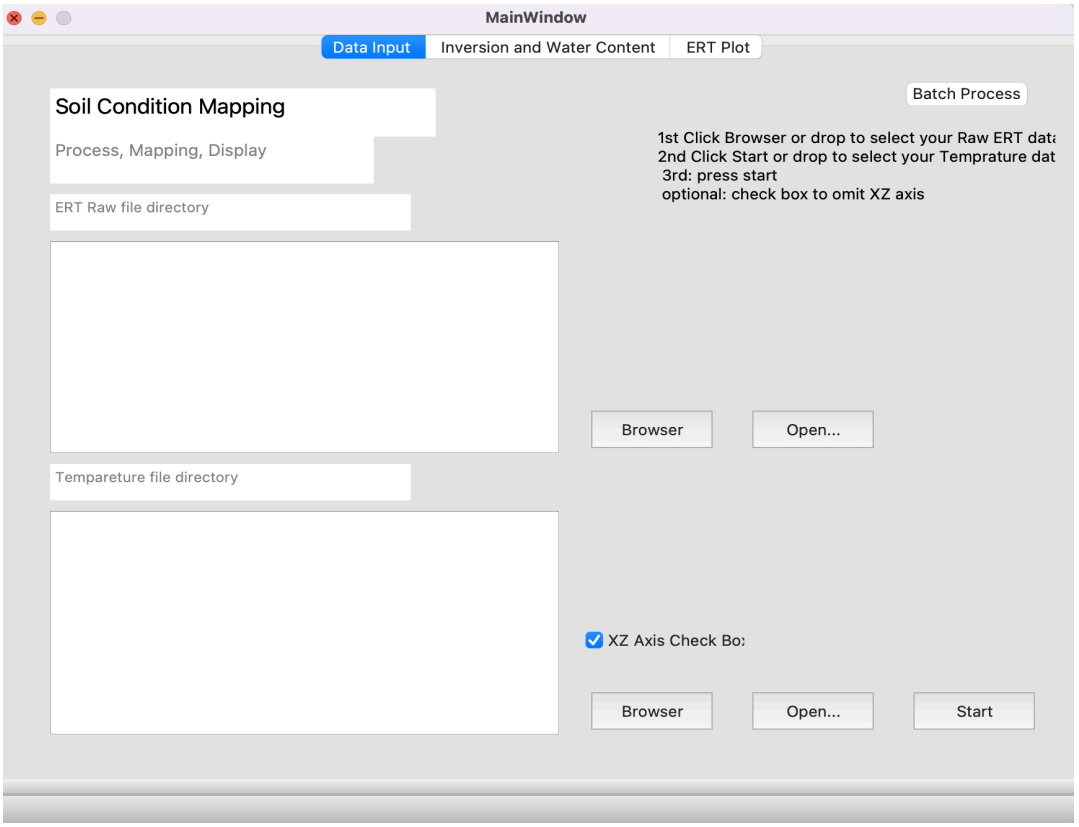
3.3. If you use Windows:

No need for complex steps like on a Mac. Simply click **install.bat** to configure everything, then click **SoilMapping.exe** to run and get started.
(If running SoilMapping.exe doesn't respond, then you'll have to follow the Mac steps **3.1** to start it.)

4. Interface Overview

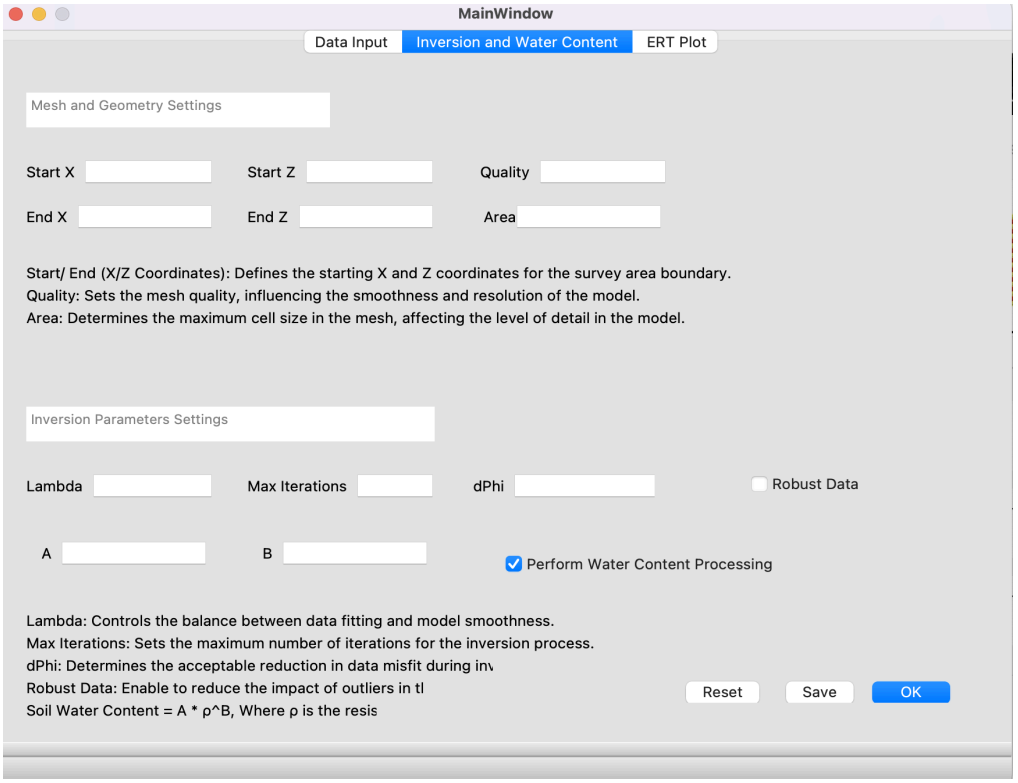
After running the program, the project's main interface will appear. The window is divided into three tabs: Data Input, Inversion and Water Content, and ERT Plot. Below is a brief description of each section:

4.1. Data Input: Allows you to select ERT and temperature files for initial data processing.



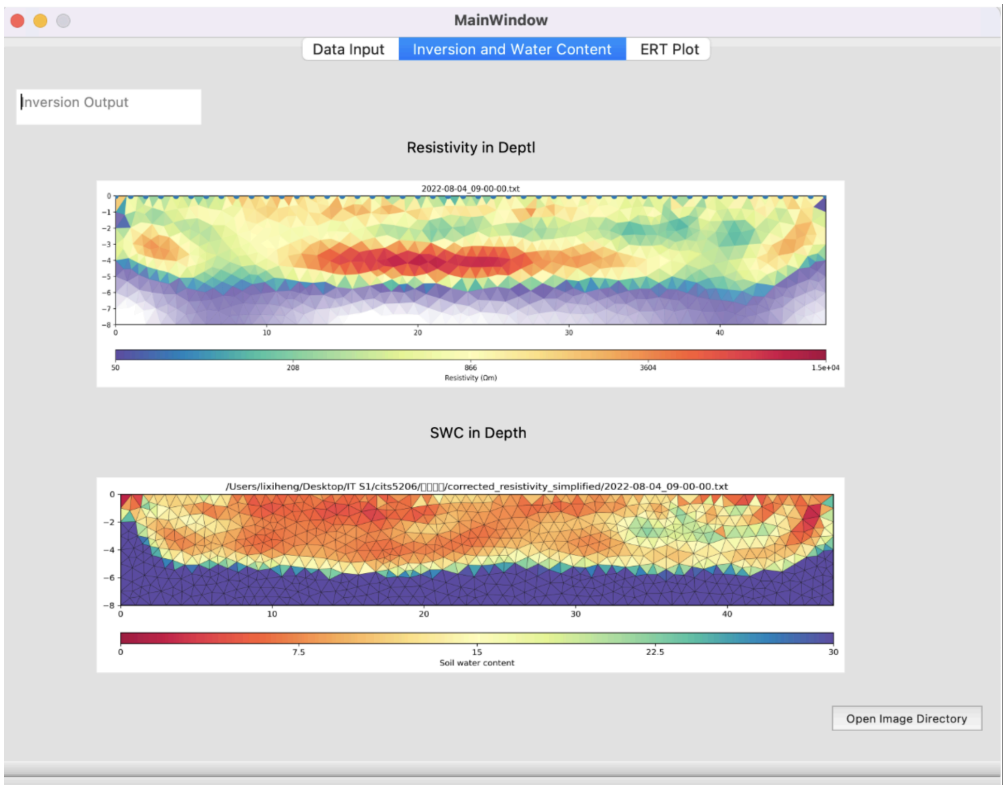
- **ERT Raw file** and **Temperature file**: These options allow you to browse and select the raw ERT and temperature files.
- **XZ Axis Check Box**: When checked, this option will ignore the XZ axis data during processing.
- **Batch Process**: This option is used for batch processing multiple ERT files.

4.2. Inversion and Water Content: Let you input parameters and perform soil water content analysis.



- **Robust Data**: When checked, this option will reduce the impact of outliers in the data, making the processing more robust to noise.
- **Perform Water Content Processing**: When checked, this option will trigger the calculation and visualization of soil water content based on the inversion results.

4.3. ERT Plot: Displays the final generated ERT plot.

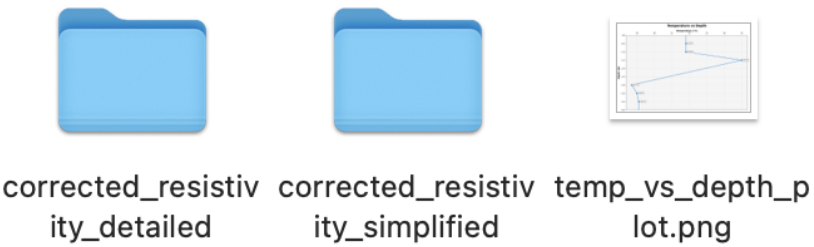


5. How to Use

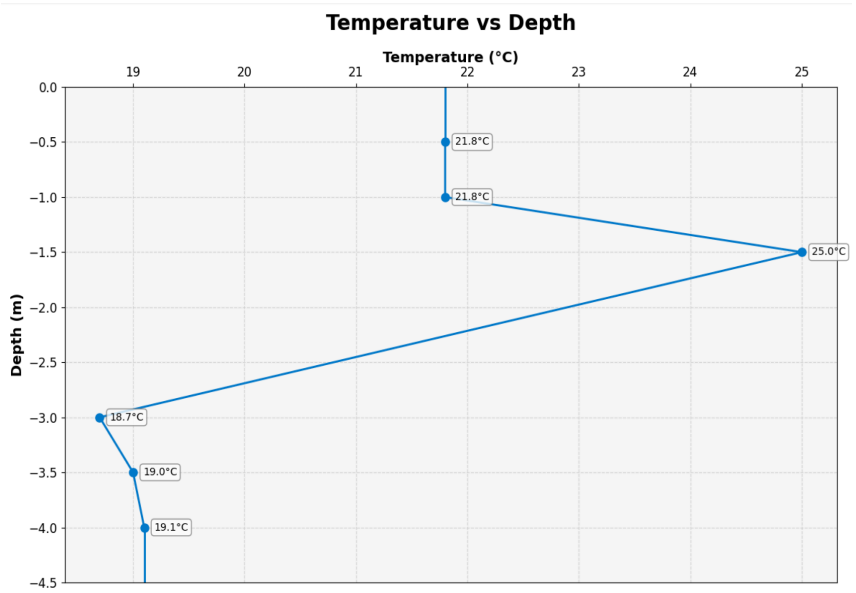
5.1 Data Input

In the **Data Input** tab, you can select and process your files as follows:

1. **Selecting ERT and Temperature Files:**
    - Click the first **Browser** button to select a **.tx0 ERT file**.
    - Click the second **Browser** button to select the corresponding **temperature .txt file**.
    - Once the files are selected, click **Start** to process them. This will generate two output folders (and a png file):
        - **corrected_resistivity_detailed**: This folder contains detailed data, offering more in-depth information for analysis.
        - **corrected_resistivity_simplified**: This folder contains simplified data, which will be used as input for the **Inversion and Water Content** tab.



2. Additionally, this Python tool processes temperature data from .tx0 files based on a specific date and time extracted from the filename. It then visualizes the temperature at various depths using a customized plot. (an example plot is shown below)



This chart shows the temperature at different depths. The X-axis represents the temperature, and the Y-axis represents the depth. The points on the graph indicate the temperature values at various depth levels, and the line traces how the temperature changes with depth.

3. **Batch Processing (Optional):**
    - Click the **Batch Process** button to select a folder containing **multiple .tx0 files**, and choose a corresponding temperature file.
    - The system will process all the files in the folder, generating both the **detailed** and **simplified** folders, but **no temperature chart will be generated** in batch mode.

5.2. Inversion and Water Content

In the **Inversion and Water Content** tab, you can perform soil water content inversion analysis:

1. **Input Inversion Parameters:**
    - You can manually input grid geometry and inversion parameters (Lambda, dPhi, etc.), or you can simply click **OK** to use the default values.
    - The **.txt file** from the **simplified** folder generated in the **Data Input** tab will be used as input for the inversion.
2. **Viewing the Output:**
    - After clicking **OK**, the system will take about a minute to generate two visual output charts on this tab (Example output shown below) :
        - **Resistivity in Depth**: A visualization of the resistivity distribution across different depths.

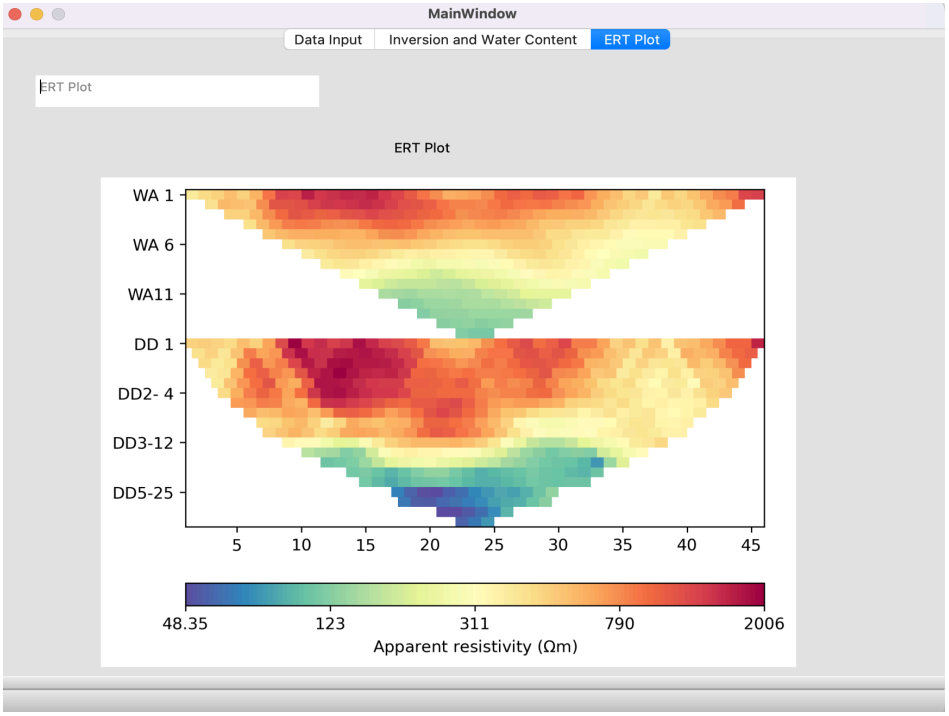
- **SWC in Depth**: A visualization of the soil water content distribution across different depths.

These images use color gradients to represent the resistivity and soil water content. The colors give you a clear visual understanding of how soil properties vary with depth.

3. **Saving the Output:** Click the **Open Image Directory** button at the bottom right to access the folder where the output images are saved.

5.3. ERT Plot

In the **ERT Plot** tab, the system will display the ERT plot, an example plot as shown below:



This plot visualizes the resistivity distribution with depth. Different color regions represent different resistivity values, which allows users to assess variations in the subsurface soil structure.

6. Error Handling

- **Date Mismatch:** If the dates of the selected ERT and temperature files don’t match, the **detailed** and **simplified** folders will be empty.
- **Invalid File Format:** The system only supports .**tx0** and **.txt** file formats. If you choose files in a different format, the system will display an error.