Documentation for Running the Code

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1 Module 1: Wave Simulation (2D)

1.1 Files Included

- 2 .py files

1.2 How to Run:

1. Run the script in `VS Code`.
2. A `Tkinter` window will open, showing the simulation of seismic waves across Mars.
3. The simulation will visualize the propagation of P and S waves.

2 Module 2: Interactive Wave Simulation

2.1 How to Run:

1. Run the Python script.
2. A `Pygame` window will open.
3. Click on the cutaway to generate a circular waveform, and interact with it.

2.2 Reusable Code for the Simulation:

These functions are reused across multiple modules.

- `get_slowness(position)`: This function returns the slowness (analog of refractive index) for a given 2D Cartesian position on Mars. Modify this function to adjust the model for your custom P & S wave velocity model.
- `trace_ray(origin, direction, max_steps=1000)`: This function traces the ray across the 2D cutaway of Mars, starting from the origin and propagating in the direction provided. The Mathematics is implemented exactly, so do not modify this unless you are adding more complexity to the ray tracing.
- `plot_mars_cutaway_with_rays(raypaths, mars_radius=3389.5, core_mantle_boundary` This function plots the ray paths on a matplotlib cutout of Mars. Do not modify this function. The mainline code calls these functions, rendering rays starting at a specific origin and across a range of directions. You can edit the range of directions as needed.

3 Module 6: Seismic Signal Processing Using ML

3.1 Task 1:

1. Open the `.ipynb` file on Kaggle.
2. The dataset is public and contains 11 waves; the code runs on only 2 waves by default.
3. Change the `file_path` with the dataset path provided in the Kaggle input window to process more waves.

3.2 Task 2:

1. This needs to be run in `VSCode`.
2. Download the dataset from the second link in the Datasets file where there are two links into the current directory.
3. To Download click onto the `Access Dataset` button where they give option to download as zip.
4. Extract the zip file.
5. Open the `Models` folder.

6. Bring `LSL_Models` in the current directory.
7. Modify the `input_folder` and `output_folder` variables as necessary.
8. Adjust the `folder_path` to the output folder.
9. Do not modify the `out_subtends` variable (it stores ray termination points).
10. `depthmodels = dataframes` assigns the Martian volume models in pandas DataFrame format.
11. You can adjust the range of angles for initial ray paths or modify the origin.

4 Module 7: Regression Model for Core Radius Prediction

4.1 How to Run:

1. Ensure `LSL_models` is in the current directory.
2. Run the provided code on `VS Code`.
3. The results will be stored in `.csv` files.

5 Module 8: Anomaly Detection in Seismic Data

5.1 How to Run:

1. Open the file on Kaggle and run it directly.
2. The dataset is publicly available.
3. There are four parameters in the `detect_anomalies` function:
    - 1st is file path,
    - 2nd is no. of components for KNN,
    - 3rd is no. of epochs for autoencoders and
    - last one is accuracy up to which anomaly has to be detected.

6 Module 9: Physics-Informed Neural Networks (PINN)

6.1 How to Run:

1. Open the file on Kaggle and run it directly.
2. The dataset is publicly available.