**USE OF BIOMASS**

The provided code is meticulously structured to automate the retrieval, preprocessing, and analysis of Sentinel-2 satellite imagery tailored for a specific region of interest (ROI), specified via a GeoJSON file.

* Satellite Imagery Retrieval:
  + The process initiates by configuring user credentials and the Sentinel API endpoint, ensuring secure access to Sentinel data.
  + The GeoJSON file, notably named 'central\_park.geojson', demarcates the ROI. The Sentinel API is then queried for Sentinel-2 products encompassing this ROI between the dates '2023-01-01' and '2023-02-03'.
  + To systematically organize the data, a directory named 'data' is created if it doesn’t pre-exist. Subsequently, all identified satellite products are fetched and stored in this directory.
  + For future reference and traceability, the paths of the downloaded files are meticulously cataloged in 'downloaded\_files.txt', and subsequently echoed for user verification.
* Data Unzipping & Conversion:
  + Integral utility functions facilitate the process:
    - unzip\_sentinel\_product: Assiduously unzips the provided satellite product and purges the original zip file post-extraction.
    - convert\_L1C\_to\_L2A: Transmogrifier the designated L1C product directory into an L2A product leveraging the Sen2Cor tool, a tool endorsed by the European Space Agency (ESA) for atmospheric correction.
  + The algorithm filters the dataset, categorically separating L1C and L2A products. L1C files with corresponding L2A versions are surgically removed to avoid redundancy and optimise storage.
  + Post sanitization of the dataset, all L2A files are seamlessly unzipped. Remaining L1C files (those devoid of L2A counterparts) are unzipped and converted to L2A stature utilising the Sen2Cor utilityq
  + The Sen2cor uses can be seen at the end of the document

Data Preprocessing & Band Extraction:

* At the heart of this phase is the extract\_bands\_from\_safe function, which meticulously extracts crucial bands from a Sentinel-2 SAFE directory, cataloging them as TIFF files.that are required
* The is\_image\_cloudy function provides an evaluative measure on cloud coverage by analyzing the B01 band. This is pivotal for filtering images that might not yield reliable results due to significant cloud obstruction.
* The shadow\_compensation\_advanced function employs the SLIC segmentation algorithm to pinpoint shadowed regions. These identified areas undergo a brightness enhancement, ensuring image clarity and mitigating shadow-induced discrepancies.

Data Extraction & Model Training:

* The code leverages both the power and simplicity of Python's libraries. By importing modules like os, rasterio, shutil, numpy, and machine learning tools from sklearn, it lays the foundation for subsequent operations.
* Through the extract\_vegetation\_indices function, the algorithm derives five pivotal vegetation indices (NDVI, VARI, MNDWI, NDMI, EVI) from the satellite images.
* The extract\_agb\_values function pulls Above Ground Biomass (AGB) values, assuming their presence in the first band of a specific raster.
* The load\_band function provides a mechanism to fetch a particular band from an image.
* Functions like average\_agb\_in\_segment and average\_veg\_index\_in\_segment allow for granular, segment-based analysis of the images, computing the average AGB or vegetation index within specific partitions.
* Data paths are sourced from 'downloaded\_files.txt', followed by a stratified split into training and testing datasets. For each image in the training ensemble, vegetation indices are harnessed as features, with AGB values serving as targets.
* The heart of the analysis is the training of a linear regression model, which learns from these extracted features and targets, paving the way for subsequent predictions.

Predictions & Visualization:

* Employing the trained linear regression model, the AGB values of the test set images are predicted. These predictions are astutely reshaped to resonate with the original image dimensions, offering a lucid visual representation of the anticipated AGB values.

We also provide the user the code / functions to visualize the different vegetation index values and how they may influence the AGB

Places where we could have gotten agb but were restricted

* <https://www.fao.org/forest-resources-assessment/en/>
* <https://data.gov.au/data/dataset/woody-vegetation-biomass> (restricted)
* <https://globbiomass.org/>

In our research and analysis process, we delved into advanced image processing techniques, notably exploring the potential of the image\_segmentation\_method. This approach aimed to partition the satellite imagery into multiple segments or regions, potentially enabling more granular insights into land cover variations and other pertinent features. Alongside this, we ventured into the realm of deep learning by initiating the design and implementation of a Convolutional Neural Network (CNN) model. Our goal with the CNN was to harness its prowess in handling image data, hoping to achieve more accurate and nuanced predictions from our Sentinel-2 datasets.

Things we would take into consideration when we are provided data  
->as the computation of the satellite data is very expensive we will try to use the satellite imagery in dates in which the chances of sky being cloudy is very less

Sen2Cor

Definition: Sen2Cor is a processor for Sentinel-2 Level 2A product generation and formatting. It stands for "Sentinel-2 Correction". The tool is developed by the European Space Agency (ESA) to perform atmospheric corrections on the Level-1C top-of-atmosphere (TOA) products from the Sentinel-2 satellites.

Key Features & Uses:

* Atmospheric Correction:
  + Sen2Cor's primary function is to convert Sentinel-2 Level-1C products, which are provided at TOA reflectances, to Level-2A products, representing bottom-of-atmosphere (BOA) reflectance values. This correction takes into account molecular scattering, aerosol absorption and scattering, and water vapor absorption.
* Cloud & Cloud Shadow Detection:
  + One of the notable features of Sen2Cor is its ability to detect clouds and cloud shadows in Sentinel-2 imagery. By effectively detecting and marking clouds, it aids in the utilization of clear imagery for further analysis.
* Scene Classification:
  + Beyond atmospheric correction, Sen2Cor also provides a scene classification, categorizing pixels into classes such as vegetation, soils/deserts, water, snow, and clouds. This classification can serve as a guide for subsequent analyses