3rd June, 2023

An Intelligent Modeling Approach to Global Ecological Footprint for Sustainability Analysis

Anagha D Ananth (2021sp93053)

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Introduction

Importance and concept of Ecological Footprint and Biocapacity

Sustainability

Illustration by Alexandre Magnin - Sustainabilityillustrated.com

- Wise use of resources
- It can be in terms of the environment, social responsibility, economic development etc.

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Measures of Sustainability

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Ecological Footprint

- The area of land that is required to regenerate the resources that have been consumed by the population in a country/region.
- Each country will have its own EF and a unique need to cater to, for increased sustainability

Biocapacity

- The ecosystems' capacity to produce biological materials used by people and to absorb waste material generated by humans, under current management schemes & extraction technologies.
- Current biocapacity of the Earth is 1.5 global hectares per person

Problem Statement

The scale of the environmental/social challenge is enormous. We need to fundamentally change the ways things are done to achieve sustainable development. This will need to go beyond resource efficiency to changing the way things are used and made, including cradle-to-cradle processes.

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Proposed Solution

- An end-to-end Machine Learning project
- To enable users learn more about the ecological footprint patterns through the following
    - Interactive Dashboard for Visualization
    - Predictive System for Future

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Work Completed

An update on the work that has been completed so far

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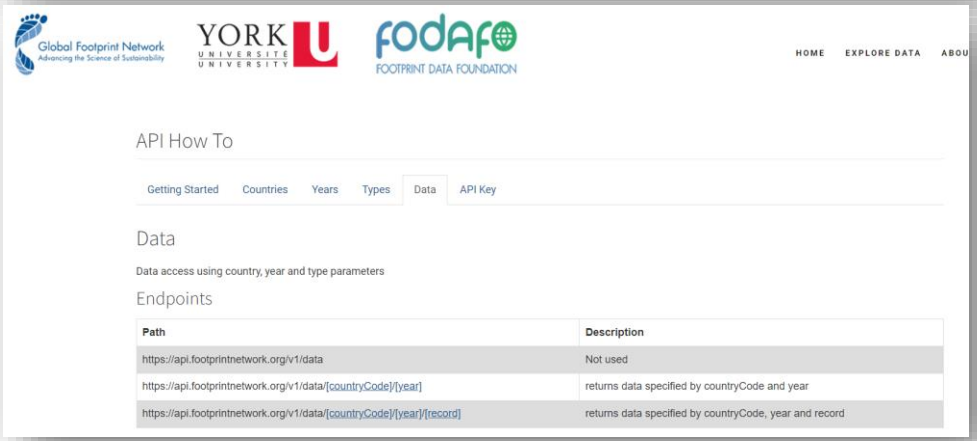
1 Data Preparation

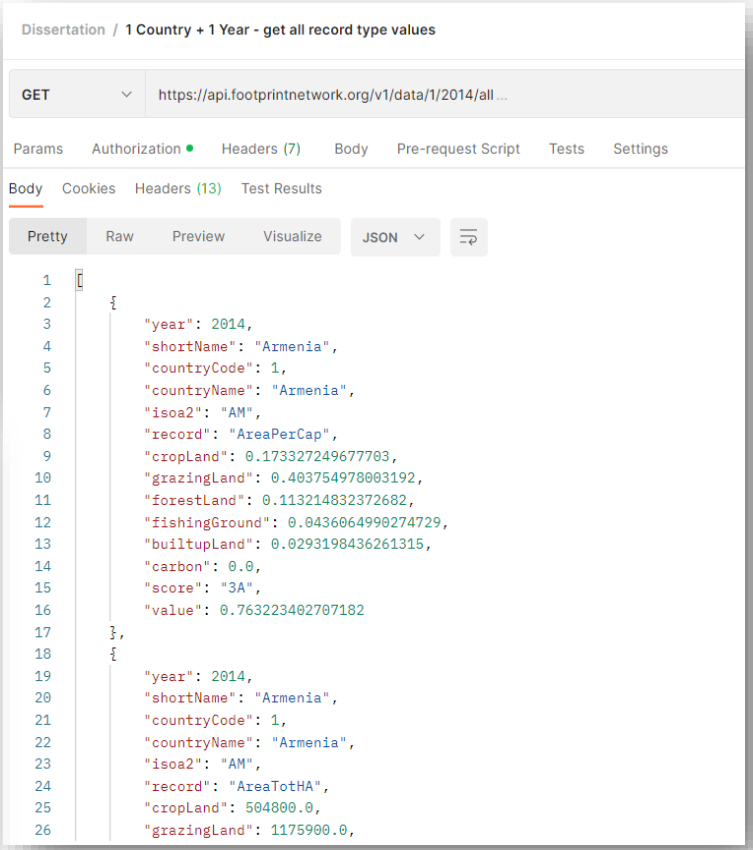
1. Retrieve the Data
2. Pre-process the Data
3. Structure the Data

1 Retrieve the Data

kaggle

Global Footprint Network





2 Pre-process the Data

Task	Implementation
Missing values	Either removed or imputed
Duplicate data	Removed
Unnecessary features	Removed
Renaming and rearranging	Uniformly renamed and arranged

- Encoding was done to convert categoric data into numeric
- Scaling was performed on the final dataset for data normalization

Both datasets were then combined resulting in a final shape of (68810, 14)

3 Structure the Data

```
# Defining the EQF for each resource type
crop_eqf = 2.51
graze_eqf = 0.46
forest_eqf = 1.26
fishing_eqf = 0.37
carbon_eqf = 1.26
builtup_eqf = 2.51
```

Country	ISO alpha-3 code	UN Region	UN Sub Region	Year	Record	Crop Land	....	Total	GDP	Population
Cuba	011	Latin America & the Caribbean	Caribbean	2011	BioCap TotGHA	3.341	....	80.821	61822.7	11398201
Cuba	011	Latin America & the Caribbean	Caribbean	2011	EcoCons TotGHA	7.193	....	92.134	61822.7	11398201
Cuba	011	Latin America & the Caribbean	Caribbean	2011	EcoProd TotGHA	12.74	....	72.495	61822.7	11398201
Cuba	011	Latin America & the Caribbean	Caribbean	2011	EcoImport TotGHA	30.741	....	93.10	61822.7	11398201
Cuba	011	Latin America & the Caribbean	Caribbean	2011	EcoExport TotGHA	51.482	....	38.21	61822.7	11398201
Cuba	011	Latin America & the Caribbean	Caribbean	2011	BioCap PerCap	83.10	....	61.39	61822.7	11398201

	country	year	record	bioTotal	ecoTotal	countryCode	bioFootprint	ecoFootprint
0	Afghanistan	1961-01-01	cropLand	4.990785e+06	1.010593e+07	002	1.252687e+07	2.536589e+07
1	Afghanistan	1961-01-01	fishingGround	0.000000e+00	9.706928e+02	002	0.000000e+00	3.591563e+02
2	Afghanistan	1961-01-01	grazingLand	6.212850e+06	1.064433e+07	002	2.857911e+06	4.896393e+06
3	Afghanistan	1961-01-01	builtupLand	2.722616e+05	5.445231e+05	002	6.833765e+05	1.366753e+06
4	Afghanistan	1961-01-01	carbon	0.000000e+00	5.596314e+05	002	0.000000e+00	7.051356e+05

Sum of all records for EcoTotGHA

under each record type

2 Data Visualization

- Grouped by UN Region in the dataset

- Different chart typed for different scenario analysis

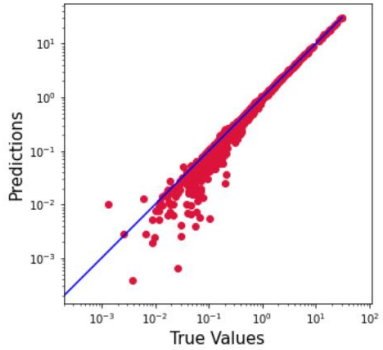
3 Forecast Modelling

ML MODEL	MSE VALUE	EVALUATION PLOT
Decision Tree	0.4423	
Histogram based GBR	0.1436	
Linear Boosting Regressor	0.1399	
Tabular Regression	0.0061	

3 Forecast Modelling

Tabular Regression 0.0061

- EPOCHS = 150
- BATCH_SIZE = 64
- LEARNING_RATE = 0.001
- NUM_FEATURES = len(X.columns)



train_loader = DataLoader(dataset=train_dataset, batch_size=BATCH_SIZE, shuffle=True)

Neural Network Structure

3 layer feedforward neural network with ReLU as the activation at all layers.

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4 Web Application

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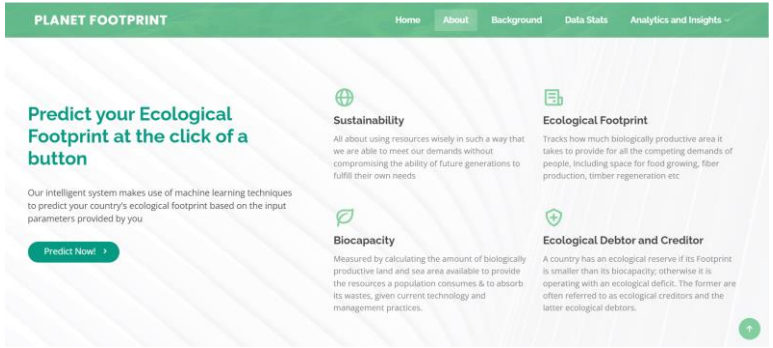
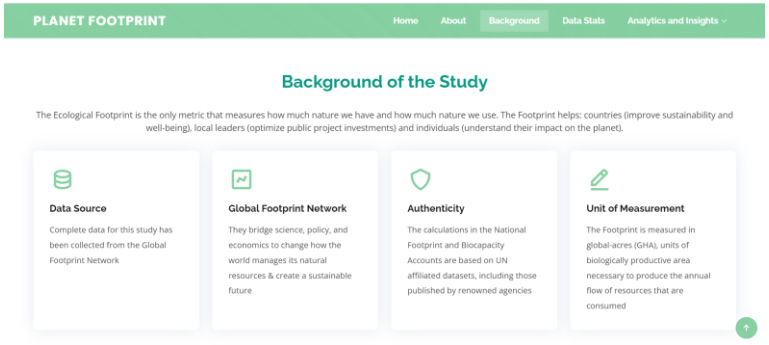
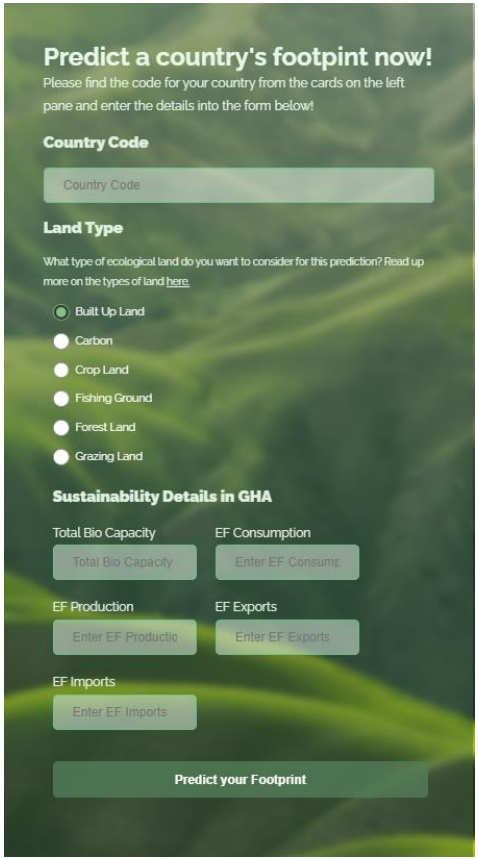
4 Web Application







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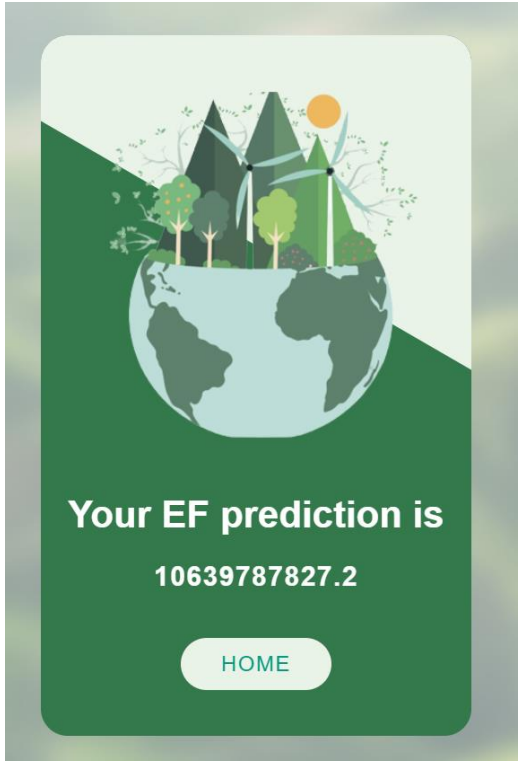
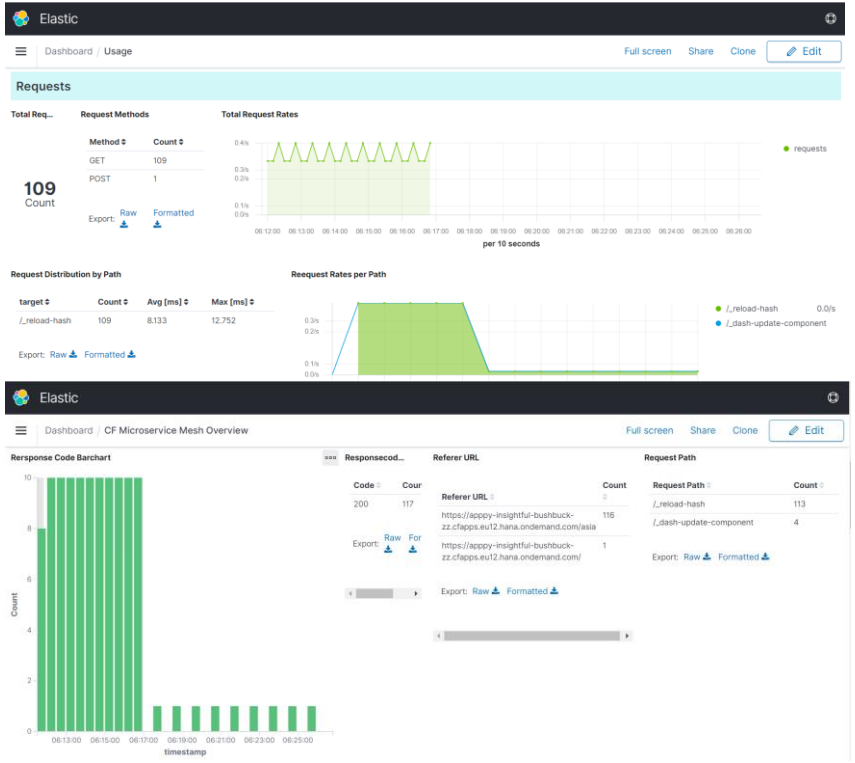
4 Web Application





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Thank You!