

3rd June, 2023

An Intelligent Modeling Approach to Global Ecological Footprint for Sustainability Analysis

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Introduction

Importance and concept of Ecological
Footprint and Biocapacity



Sustainability



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



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Measures of Sustainability



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



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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.



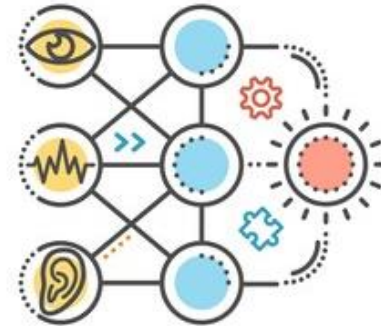
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Proposed Solution

- 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



1 Data Preparation

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



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1 Retrieve the Data



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National Footprint Accounts 2018

The Ecological Footprint of 196 Countries

Data Card

Code (12)

Discussion (1)

About Dataset

National Footprint Accounts 2018

The National Footprint Accounts (NFA) are an annual production from Global Footprint Network (www.footprintnetwork.org). Each year, we combine and synthesize over 30 datasets to calculate the Ecological Footprint and biocapacity of countries across the world in over 50 years.

The goal of this undertaking is to produce accounts of how much area is required to provide the ecological services (resource regeneration and waste assimilation) consumed by humanity ("Ecological Footprint"), and how much biologically productive area exists to provide these ecological services ("biocapacity") in each year. With both values in hand, we can assess the overall sustainability of countries around the world and better understand the collective need for humanity to reduce its impact on nature.

This data underpins both our [Overshoot Day](#) campaign and our [Personal Footprint Calculator](#), both of which you should check out! All of our data is also available on our [Data Platform](#).

Usability




8.53

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Expected update frequency

Not specified

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API How To

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Data

Data access using country, year and type parameters

Endpoints

Path	Description
https://api.footprintnetwork.org/v1/data	Not used
https://api.footprintnetwork.org/v1/data/{countryCode}/{year}	returns data specified by countryCode and year
https://api.footprintnetwork.org/v1/data/{countryCode}/{year}/{record}	returns data specified by countryCode, year and record

Dissertation / 1 Country + 1 Year - get all record type values

GET

https://api.footprintnetwork.org/v1/data/1/2014/all...

Params

Authorization

Headers (7)

Body

Pre-request Script

Tests

Settings

Body

Cookies

Headers (13)

Test Results

Pretty

Raw

Preview

Visualize

JSON

```
1  {
2    {
3      "year": 2014,
4      "shortName": "Armenia",
5      "countryCode": 1,
6      "countryName": "Armenia",
7      "isoa2": "AM",
8      "record": "AreaPerCap",
9      "cropLand": 0.173327249677703,
10     "grazingLand": 0.403754978003192,
11     "forestLand": 0.113214832372682,
12     "fishingGround": 0.0436064990274729,
13     "builtupLand": 0.0293198436261315,
14     "carbon": 0.0,
15     "score": "3A",
16     "value": 0.763223402707182
17   },
18   {
19     "year": 2014,
20     "shortName": "Armenia",
21     "countryCode": 1,
22     "countryName": "Armenia",
23     "isoa2": "AM",
24     "record": "AreaTotHA",
25     "cropLand": 504800.0,
26     "grazingLand": 1175900.0,
```

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







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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	



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3 Forecast Modelling

Tabular Regression

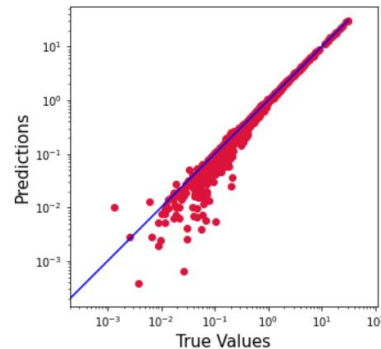
0.0061

- 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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Web Application



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plotly | Dash



Flask



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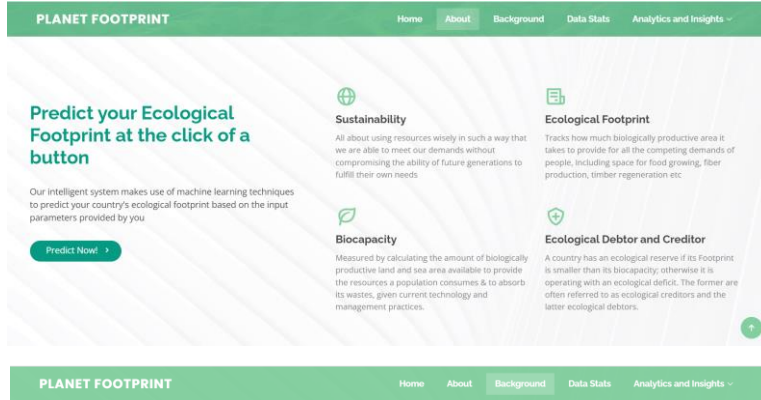


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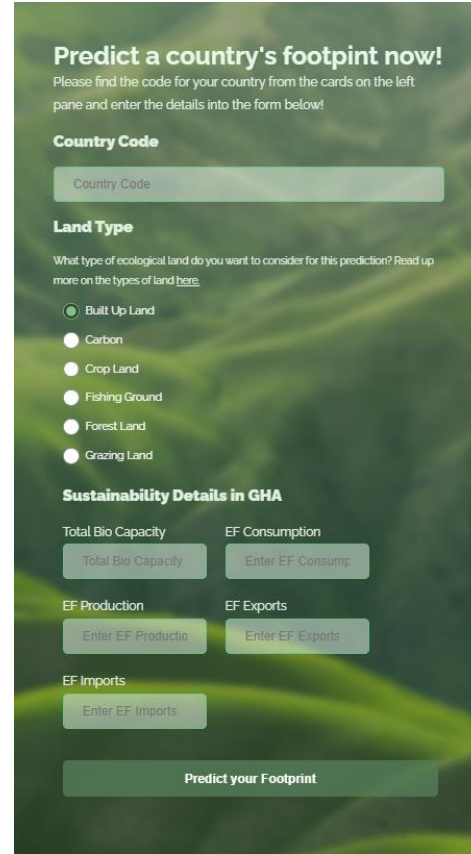
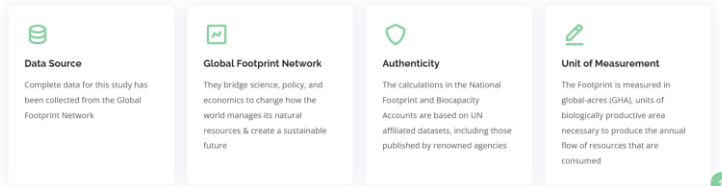
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Web Application



Background of the Study

The Ecological Footprint is the only metric that measures how much nature we have and how much nature we use. The Footprint helps countries (improve sustainability and well-being), local leaders (optimize public project investments) and individuals (understand their impact on the planet).



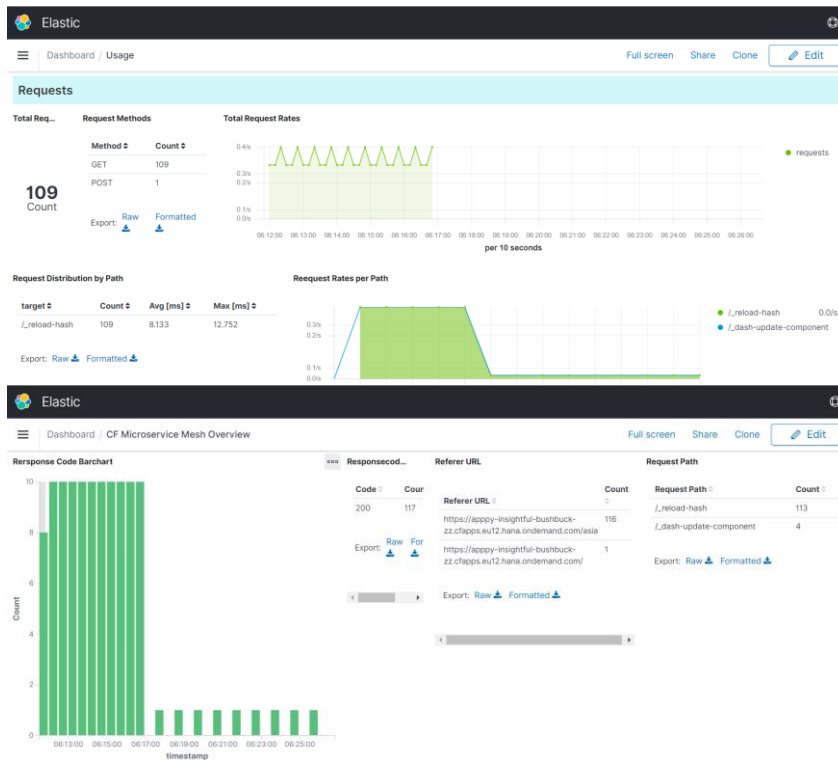
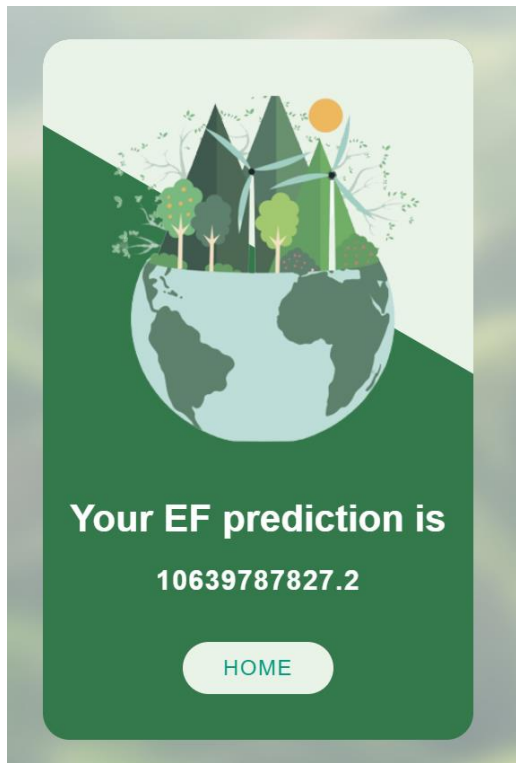
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Web Application



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Thank You!