



SUN WATCHER

SAVE THE EARTH FROM ANOTHER CARRINGTON EVENT!

Demo for the 2022 edition of the Space Apps Challenge

****SOLAR*CODERS****

Romain Garrigou
Armand Garrigou
Maha Belrhazi
Jeanne Bourgeois
Olivier Laurent

CHALLENGE

SAVING THE EARTH FROM ANOTHER CARRINGTON EVENT

Mission : process WIND and DSCOVER satellites datas, find correspondances and to create an AI tha would predict WIND datas and to make them easily readable and accessible to everyone !

PROCESSING DATA

TRANSFORMING RAW MEASUREMENTS INTO USABLE DATA

1. Collect data from the NASA website

2. Preprocess magnetic data : track down error values and adjust measurement frequencies through interpolation

3. Use Dynamic Time Warping on magnetic series

```
8 import matplotlib.pyplot as plt
9
10 def preprocess():
11
12     mag_path = "C:\\Users\\garri\\Desktop\\programming\\spaceapp-challenge\\mag\\mag\\"
13     mag_data_files = os.listdir(mag_path)
14     mag_data = []
15     mag_time = []
16     for file_path in mag_data_files:
17         file_path = mag_path + file_path
18         with open(file_path, 'rb') as f:
19             mag = xarray.Dataset(pickle.load(f))
20             time = mag["B1GSE"]["Epoch1"].data
21             BGSE = mag["B1GSE"].data
22             mag_data.append(BGSE)
23             mag_time.append(time)
24     mag_data = np.stack(mag_data).reshape(-1, 3)
25     mag_data = np.where(mag_data > -1e5, mag_data, np.nan)
26     mag_time = np.stack(mag_time).flatten()
27
28     mfi_path = "C:\\Users\\garri\\Desktop\\programming\\spaceapp-challenge\\mfi\\"
29     mfi_data_files = os.listdir(mfi_path)
30     mfi_data = []
31     mfi_time = []
32     for file_path in mfi_data_files:
33         file_path = mfi_path + file_path
34         with open(file_path, 'rb') as f:
35             mfi = xarray.Dataset(pickle.load(f))
36             time = xarray.core.utils.Frozen(mfi["BGSE"].indexes.variables).mapping.mapping["Epoch"].data
37             BGSE = mfi["BGSE"].data
38             mfi_data.append(BGSE)
39             mfi_time.append(time)
40     mfi_data = np.concatenate(mfi_data, axis=0).reshape(-1, 3)
41     mfi_data = np.where(mfi_data > -1e5, mfi_data, np.nan)
42     mfi_time = np.concatenate(mfi_time, axis=0).flatten()
43     mag_datax = mag_data[:, 0]
```

MACHINE LEARNING

TRAINING AN AI TO PREDICT WIND'S DATA FROM DSCOVER'S

A pytorch neural network

- Inputs from DSCOVER, targets from WIND
- Determine measures quality and uncertainty using expected quantiles
- If necessary, use deep ensembles

```
import torch.nn as nn
import torch.nn.functional as F

class STD(nn.Module):
    def __init__(self, n_features: int, hidden_units: int, distributional: bool):
        super(STD, self).__init__()
        self.n_features = n_features
        self.hidden_units = hidden_units

        self.input_layer = nn.Linear(n_features, hidden_units)

        # predict value and variance
        self.hidden_layer = nn.Linear(hidden_units, 2 if distributional else 0)

    def forward(self, x):
        out = F.relu(self.input_layer(x))
        return self.hidden_layer(out)

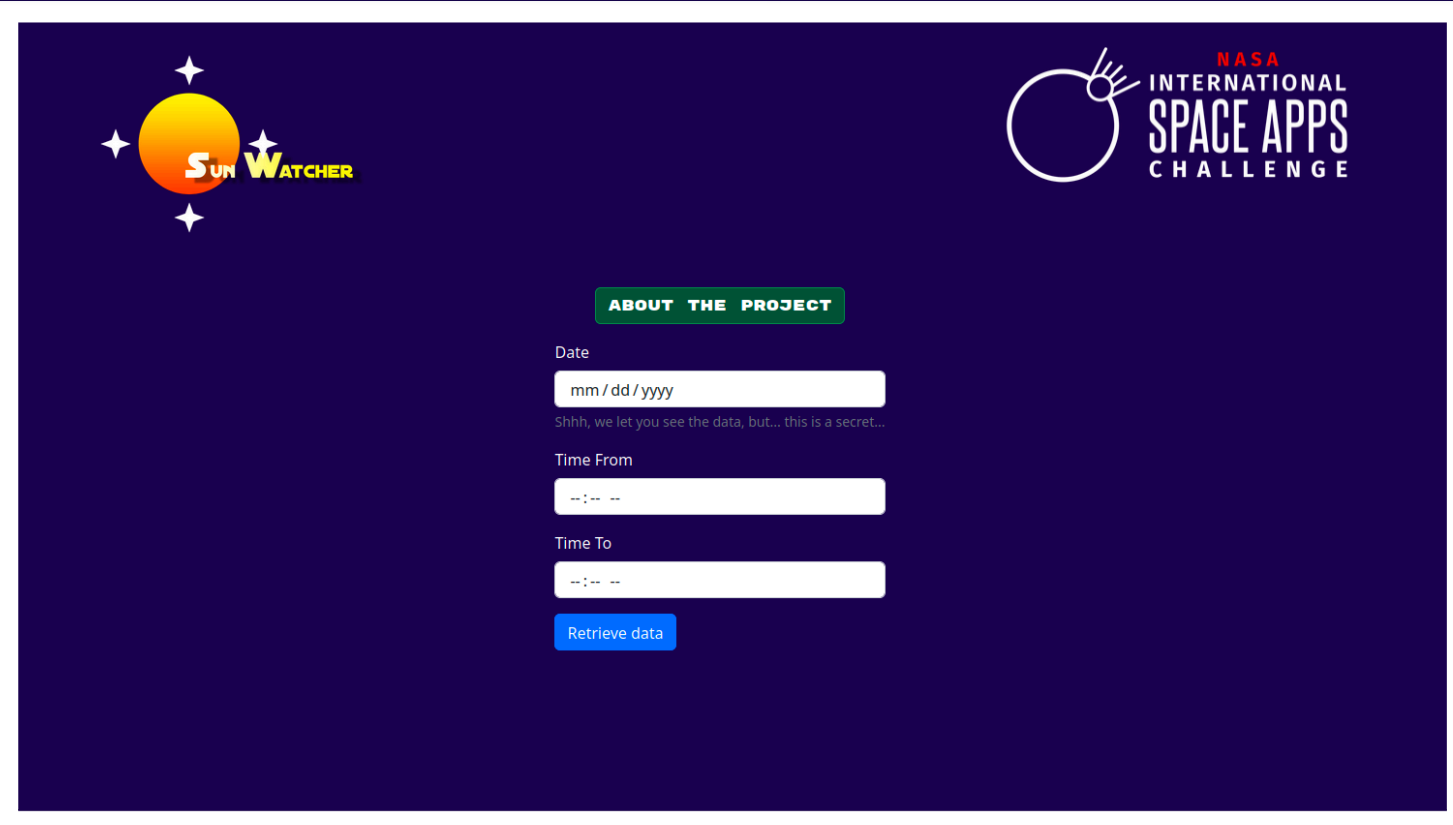
def MLP_STD(n_features: int, hidden_units: int):
    return STD(n_features=n_features, hidden_units=hidden_units)
```

WEBSITE

MAKING DATA AVAILABLE TO THE PUBLIC

Front page

- A description of our tool
- An interface to get computed data easily



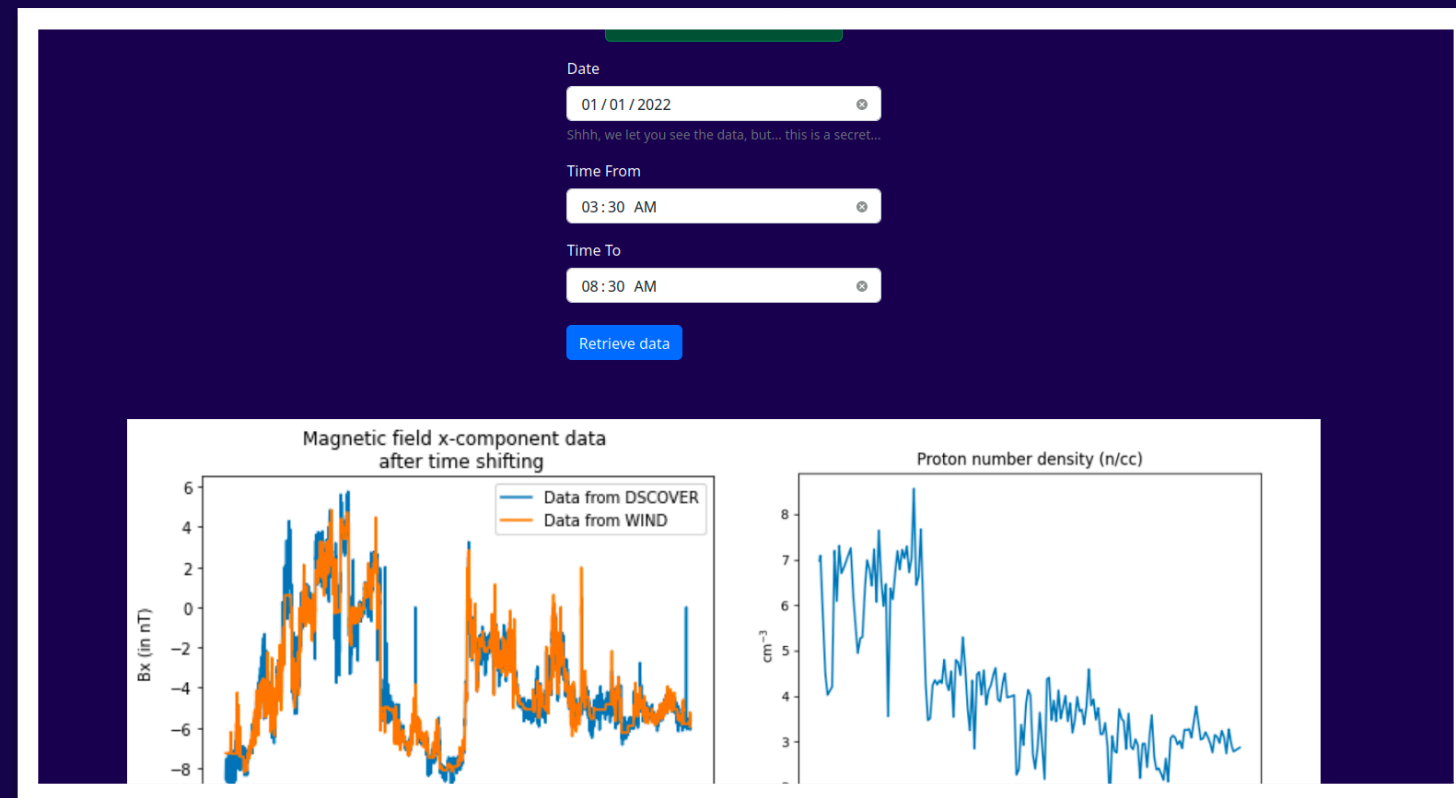
The screenshot shows the front page of the Sun Watcher website. The page has a dark blue background. In the top left corner, there is a logo for 'SUN WATCHER' featuring a stylized sun with rays and the text 'SUN WATCHER'. In the top right corner, there is a logo for 'NASA INTERNATIONAL SPACE APPS CHALLENGE' featuring a stylized hand holding a globe and the text 'NASA INTERNATIONAL SPACE APPS CHALLENGE'. Below the logos, there is a green button labeled 'ABOUT THE PROJECT'. Underneath this button, there is a form with the following fields: 'Date' with a placeholder 'mm / dd / yyyy', a text input field with the placeholder 'Shhh, we let you see the data, but... this is a secret...', 'Time From' with a placeholder '-- : -- --', and 'Time To' with a placeholder '-- : -- --'. At the bottom of the form, there is a blue button labeled 'Retrieve data'.

WEBSITE

MAKING DATA AVAILABLE TO THE PUBLIC

A request example:

- See easily what's computed
- An attractive way to show our results to the public



THANK YOU

FOR LETTING US HAVING THAT AMAZING EXPERIENCE AS NASA SCIENTISTS!!

****SOLAR*CODERS****