AI Hack 21

Crop Yield Challenge

Challenge Description:

For this challenge, you will be tackling one of the world's most important challenges: modelling crop yields. Climate change is having a big impact in global food security, whilst Earth's population, in particular, in the developing world, continues to grow. Extreme weather events can have significant impacts (http://www.nature.com/articles/nclimate1832) on crops and there is (significant evidence)[https://www.metoffice.gov.uk/weather/climate/climate-and-extreme-weather] (https://www.metoffice.gov.uk/weather/climate/climate-and-extreme-weather%5D) showing that, recently, extreme events have become (1) more extreme and (2) more frequent, making crop yield modelling a useful tool for policy makers and suppliers who are hoping to mitigate these devastating risks.

From a machine learning and statistical perspective, crop yield modelling is a challenging task that can be seen as a **weakly supervised learning** or **multiple instance learning** problem. For every year and census region (e.g. county), we can gather an abundance of features such as daily temperature, vegetation indices and soil moisture, but we only have access to 1 crop yield label. To perform regression, one usually requires the dataset $\{(x_i, y_i)\}_{i=1}^{n}$. In this case, however, we have $\{(\{x_{ij}\}_{j=1}^{N_i}, y_i)\}_{i=1}^{n}$, where N_i is the number of feature vectors available for label y_i. A naive approach would be to reduce to the former by averaging the covariates $\bar{x}_i = \sum_{j=1}^{N_i} x_{ij}$, but this may result in an enormous loss of information.

Could you explore different approaches to modelling crop yields using the provided datasets?

Data:

You are provided with various cleaned datasets that are extracted from the State of Illinois, USA.

- `IL_yield.csv` contains corn yields for various census counties in Illinois
- `illinois-counties.geojson` contains the geometries of counties in Illinois
- `EVI.csv` contains Enhanced Vegetation Indices (https://en.wikipedia.org/wiki/Enhanced_vegetation_index) for pixels extract from The Terra Moderate Resolution Imaging Spectroradiometer (MODIS) Vegetation Indices (MOD13Q1) (https://lpdaac.usgs.gov/products/mod13q1v006/) product, aggregated at the resolution of the pixels in the The Terra and Aqua combined Moderate Resolution Imaging Spectroradiometer (MODIS) Land Cover Climate Modeling Grid (CMG) (MCD12C1) (https://lpdaac.usgs.gov/products/mcd12c1v006/) product that indicate `Majority_Land_Cover_Type_1` is a cropland. The EVI is observed every 16 days.
- `EVI_stacked.csv` is the same as `EVI.csv` except the data is stacked to include the EVI observations for each 16 days in the column.
- `ERA5.csv` contains 2m temperature readings from ERA5 Renalaysis (https://cds.climate.copernicus.eu/cdsapp#!/dataset/reanalysis-era5-land?tab=overview), "the fifth generation ECMWF reanalysis for the global climate and weather for the past 4 to 7 decades". More information about the variable can be found in the link given.

Recommended Reading:

- https://ojs.aaai.org/index.php/AAAI/article/view/11172/11031&hl=en&sa=T&oi=gsb-gga&ct=res&cd=0&d=18807677054144396 08&ei=6kgwYPHHCvGTy9YPmJeAsAk&scisig=AAGvz3M2kSQeDg (https://ojs.aaai.org/index.php/AAAI/article/view/11172/11031&hl=en&sa=T&oi=gsb-gga&ct=res&cd=0&d=18807677054144396 08&ei=6kgwYPHHCvGTy9YPmJeAsAk&scisig=AAGvz3M2kSQeDg)
- https://aiforsocialgood.github.io/icml2019/accepted/track1/pdfs/20_aisg_icml2019.pdf (https://aiforsocialgood.github.io/icml2019/accepted/track1/pdfs/20_aisg_icml2019.pdf)
- http://proceedings.mlr.press/v80/ilse18a/ilse18a.pdf (http://proceedings.mlr.press/v80/ilse18a/ilse18a.pdf)
- https://linkinghub.elsevier.com/retrieve/pii/S0034425711002926 (https://linkinghub.elsevier.com/retrieve/pii/S0034425711002926)
- https://linkinghub.elsevier.com/retrieve/pii/S0034425719304791 (https://linkinghub.elsevier.com/retrieve/pii/S0034425719304791)
- https://ieeexplore.ieee.org/document/9173550/ (https://ieeexplore.ieee.org/document/9173550/)
- https://royalsocietypublishing.org/doi/10.1098/rstb.2019.0510 (https://royalsocietypublishing.org/doi/10.1098/rstb.2019.0510)
- http://www.nature.com/articles/nclimate1832 (http://www.nature.com/articles/nclimate1832)
- http://www.nature.com/articles/nature16467 (http://www.nature.com/articles/nature16467)
- https://royalsocietypublishing.org/doi/10.1098/rstb.2019.0510 (https://royalsocietypublishing.org/doi/10.1098/rstb.2019.0510)

Suggestions:

- ☐ It will be useful to make use of `pandas`, `geopandas` and `matplotlib` for data processing and visualisation.
- ☐ Be as creative and rigorous as possible with how you make use of the features.
- ☐ Try and take some time to read through the various papers on the recommended reading list.
- ☐ I recommend only using features between April - November 2015, as suggestioned by one of the papers on the list https://www.sciencedirect.com/science/article/pii/S0034425719304791?via%3Dihub (https://www.sciencedirect.com/science/article/pii/S0034425719304791?via%3Dihub).

Good luck - we hope that you enjoy this challenge and look forward to seeing your submissions on Devpost!

In [1]:
```
!ls .
```

```
'AI Hack - Crop Yield Challenge.ipynb'   EVI_stacked.csv
 ERA5.csv                                illinois-counties.geojson
 EVI.csv                                 IL_yield.csv
```

An illustrative plot

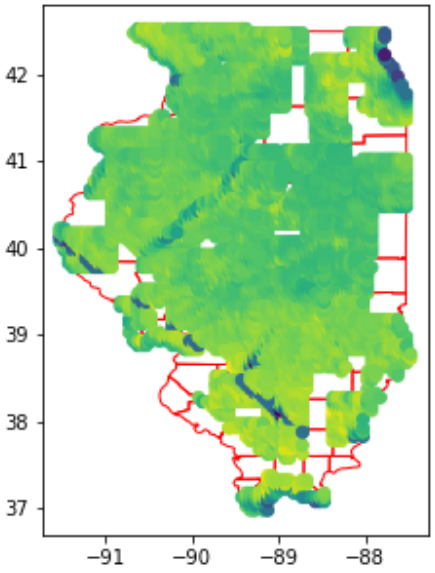
In [8]:
```
import geopandas as gpd
import pandas as pd
import matplotlib.pyplot as plt
```

In [13]:
```
gdf = gpd.read_file("illinois-counties.geojson")
df = pd.read_csv("EVI_stacked.csv")
```

In [15]:
```
df_plot = df[df["year"]==2019]

fig, ax = plt.subplots(figsize=(5, 5))
gdf.plot(ax=ax, facecolor='none', edgecolor='red')
plt.scatter(df_plot["long"], df_plot["lat"], c=df_plot["evi_1"])
```

Out[15]: <matplotlib.collections.PathCollection at 0x7fc53a0d9668>



Contact

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Discord : **https://discord.gg/ymk36q54**

Round 1 Submission

Code Submission

Deadline : Sunday, 21st Feb 2021 at **13:00** UTC/GMT+0
Submission : **https://aihack-2021.devpost.com/**

Report Submission

Deadline : Sunday, 21st Feb 2021 at **13:00** UTC/GMT+0
Submission : **https://aihack-2021.devpost.com/**
Criteria : markdown, pdf, html, or any file formats
that do **not** require special/dedicated tools or software(s)
Tips : Consider these while writing the report.

- What are the goals of your study and why is it important or useful?
- Discuss previous or related work
- Data engineering and processing
- Methodology
- Results: how the results corroborate the assertions in your study.
- Conclusion and discussion, any positive and negative findings.

Presentation Video Submission

Deadline : Sunday, 21st Feb 2021 at **14:00** UTC/GMT+0
Submission : **https://aihack-2021.devpost.com/**
Criteria : Maximum length of 3 minutes

Judging Criteria [Out of 100]

Creativity [15]

Originality of angle of exploration (Interesting questions answered, use of valid alternative dataset(s)

Data Exploration [15]

Quality of techniques used to pre-processed data and to give valuable insights about the dataset(s)

Insight Visualisation [15]

Quality, relevance and effectiveness of visualisations used for exploration and/or analysis

Analytical Techniques [25]

Sophistication and correctness of methods of analysis. Cannot score high if cannot justify method.

Model Validation [5]

Use of metrics in showing performance of analysis.

Interpreting the Result [25]

Ability to interpret the result of the analysis and take a step back to explain the bigger picture. Ability to make a data-driven "business" decision.