Next Door Neighbors

Inform: What is Our Carbon Footprint?

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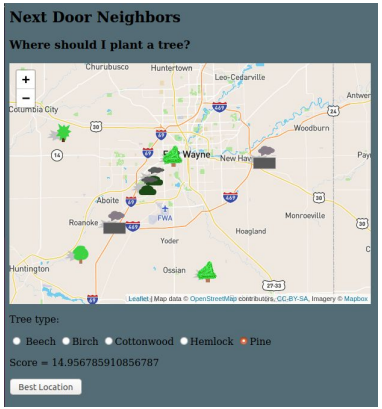
High-Level Summary

Can we place resources more efficiently by using information about neighboring resources? Can we absorb more pollutants by strategically placing trees based on the location of nearby pollution sources?

We built a javascript web app that helps a city planner decide where to place trees. The program shows a numerical score for the choice of location and tree species based on data about nearby sources of carbon dioxide and other pollutants as well as data about the ability of particular tree species to absorb these pollutants. The web app also calculates an optimum tree location.

Where To Find the Project



- **Live Web App:** https://amitofsk.github.io/index.html
- **Video:** https://youtu.be/EOfWkMZgE-M
- **These Slides:** https://docs.google.com/presentation/d/1kYHCL_9Tb9tA0AR1syXXUsVvvxXAhGCOZqmOkp5v6zw/edit?usp=sharing
- **Space Apps Project Page:** https://2020.spaceappschallenge.org/challenges/inform/carbon-footprint/teams/next-door-neighbors/project
- **Code repository: (See the file index.html)** https://github.com/amitofsk/amitofsk.github.io

How the Project Addresses the Challenge

- The analysis starts with data on pollution sources from the EPA and from NASA satellites.
- The average absorption of CO2 is calculated for different tree species from average tree age, height, and diameter.
- The web app is important because it calculates a score for where a user places a tree based on the tree species, the proximity to pollution sources, and the amount of CO2 pollution from each source.
- The web app calculates an optimum location for the tree based on the score.
- The web app is a tool to be used by city planners.
- It can help not only city planners, but anyone trying to optimize resources.

How We Developed the Project

- **Motivation and Inspiration**: A steel mill in Ohio is strategically located next to a power plant and a tomato farm (which uses heat exhaust from it). In our research, we found a NASA spinoff company that optimizes the efficiency of a building by considering the placement of rooms within it. (https://www.ekotrope.com/) We wondered if we could improve the efficiency of strategies used to reduce pollution. Could we improve air quality by strategically placing pollution sinks near pollution sources? Could we improve efficiency in other applications by strategically spatially placing resources?

- **Tools**:
  - The web app was developed with Javascript and HTML.
  - It is hosted on Github.
  - We used the mapping API Leaflet, https://leafletjs.com/
  - A Simulated Annealing algorithm was used to find the optimum tree location.
  - We calculated average CO2 absorbed per year for different for different tree species based on age, height and diameter.

Data Used and References

- **Data on Carbon Sources:**
  - EPA data from companies on methane, CO2, and nitrous oxide sources: … Ft Wayne specific
  - https://ghgdata.epa.gov/ghgp/main.do#
  - NASA satellite data on methane, CO2, nitrous oxide and other pollutants: … For verification
  - https://worldview.earthdata.nasa.gov/
- **Data on how well tree species can absorb pollutants**:
  - https://www.michigan.gov/dnr/0,4570,7-350-79135_79218_79615---,00.html
  - https://www.carbonpirates.com/blog/how-much-carbon-do-trees-absorb/
  - https://ecoss.nau.edu/wp-content/uploads/2016/04/chapter18Menyailo.pdf
  - https://www.unm.edu/~jbrink/365/Documents/Calculating_tree_carbon.pdf
- **Data on age, height, diameter average per tree**:
  - https://en.wikipedia.org/wiki/Fagus_sylvatica
  - http://biorefinery.utk.edu/technical_reviews/Tree%20Size.pdf
  - https://plants.usda.gov/factsheet/pdf/fs_pode3.pdf
  - https://en.wikipedia.org/wiki/Populus_deltoides
  - https://www.srs.fs.usda.gov/pubs/misc/ag_654/volume_1/tsuga/canadensis.htm#:~:text=Mature%20eastern%20hemlock%20trees%20attain,160%20ft)%20(34).
  - https://www.fpl.fs.fed.us/documnts/usda/amwood/239hemlo.pdf
  - https://en.wikipedia.org/wiki/Pine
  - https://en.wikipedia.org/wiki/Jack_pine

Future Work

- **Future work on our web app**:
  - The web app contains information about pollution sources near Ft. Wayne Indiana. This information was entered manually from 2018 EPA data. We found relevant live NASA satellite data for all locations, but didn't integrate it. Next, we would like to integrate this data.
  - The web app calculates an optimality score based on the ability of five tree species to absorb carbon dioxide. Data sources used contain information on methane, nitrous oxide, and other pollutants. Next, we want to use data for other tree species and other pollutants.
  - Trees may absorb pollutants more efficiently at different times in their life. Pollution levels vary with time too. We would like to incorporate time dependent effects.
  - We would like to measure better data on absorption and emission of gases by trees.
- **Future work more generally**: This tool is designed to help city planners place trees in the best locations. However, many situations can benefit from optimizing how resources are spatially laid out.
  - The electrical grid is most efficient if solar panels, wind turbines, and other sources of electricity are spatially next to the loads.
  - A farm has best yield if crops that add nutrients to the soil are placed next to areas of soil that lack those nutrients.
  - Less pollution is produced if a factory is located spatially near its source of raw materials and near its customers because trucks that transport ingredients and finished products pollute.