DS 410 - Mini Project

Big Data Dinosaurs

Natalie Chow, Dylan Crothers, Ryan Dang, Totton Hollenbeak,
Travis Navarro, Yeji Park

Predicting pH After Extreme Weather Events

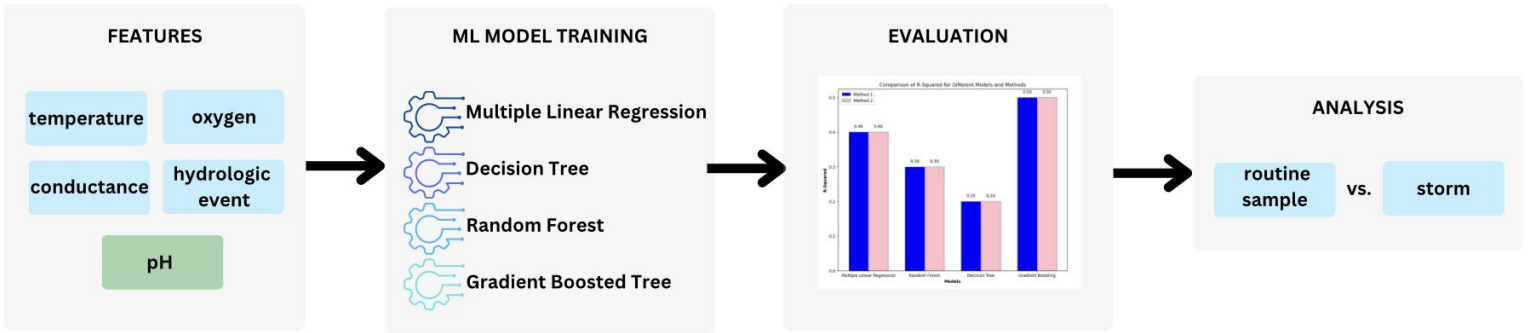
PennState

Data Science Question

- How is pH affected by extreme weather events?

- **Motivation**
  - Extreme weather events have become increasingly more common due to climate change
  - These have significant and lasting effects on water quality from surface water, groundwater, and other sources
  - Consumption of low-quality water post-event poses significant public health and safety risks to to those living in the affected areas
  - pH is an important indicator for contamination

- **Modeling and Analysis**



Dataset Acquisition

- **Origin of Dataset**: Water Quality Portal
  - Local: 81 x 86824
  - Cluster: 81 x 2651847

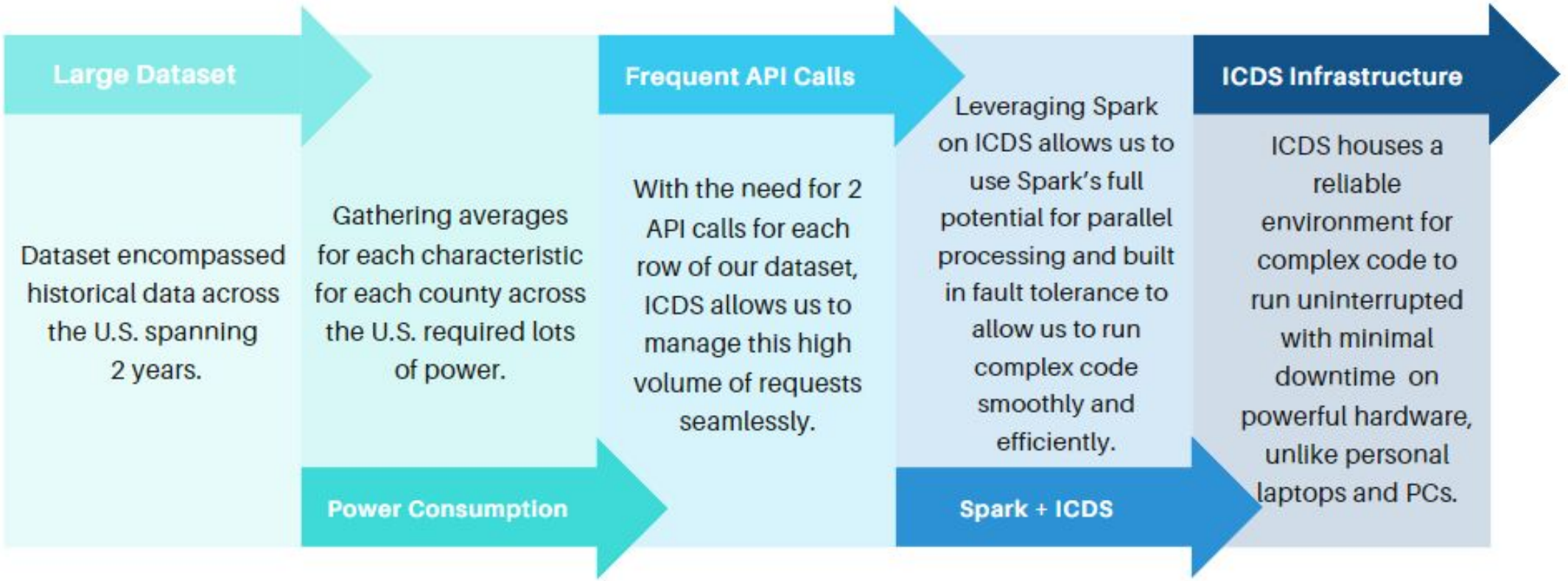
```
|-- Temperature, water: float (nullable = true)
|-- Specific conductance: float (nullable = true)
|-- Oxygen: float (nullable = true)
|-- HydrologicEvent: float (nullable = false)
|-- pH: float (nullable = true)
```

- **Data Processing**
  - remove unnecessary columns
  - filter for specific units
  - replace NAs with AVG
  - feature extraction: making each feature into individual columns
  - remove extremities
    - i.e. pH values not in range 0-14 for normal pH scale

- **Challenges**
  - difference in unit measurements and data types
  - replacing missing values with a ***reasonable mean***
  - rows represent only a single quality measure for one sample

Temperature: deg C, deg F
Oxygen: mg/l, %, % saturatn

Requirement for ICDS



Methods

1. **Multiple Linear Regression**
   - a method used to evaluate how strong the relationship is between 2 or more independent variables and one dependent variable

$$pH = \beta 0 + \beta 1(\text{Temperature}) + \beta 2(\text{Conductance}) + \beta 3(\text{Oxygen}) + \beta 4(\text{Hydrologic event})$$

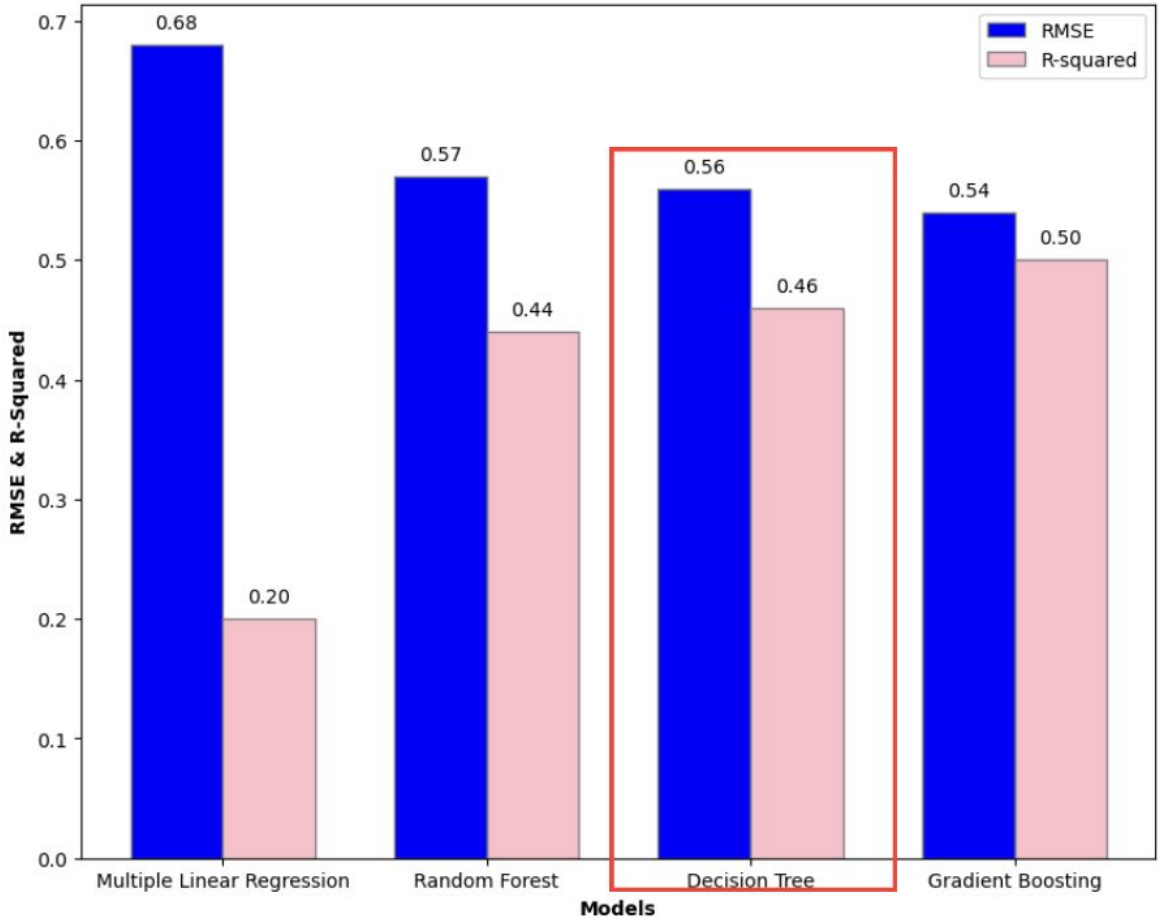
2. **Decision Tree Regression**
   - a ML technique used for predicting continuous variables which accommodates non-linear relationships and interactions among variables

3. **Random Forest**
   - a ML algorithm that operates by constructing multiple decision trees during training and outputting the average prediction of the individual trees for regression purposes
   - combines predictions from multiple trees and mitigates the risk of overfitting and generally yields more robust and accurate predictions compared to individual decision tree

4. **Gradient Boosting Regression**
   - a ML technique that constructs trees sequentially, with each tree learning from the mistakes of the previous ones
   - is a capable of achieving high accuracy and generalization performance across a wide range of datasets

Results

Comparing RMSE & R-squared among the Models



Inferential Analysis

$$\hat{pH} = 0.0268Temp + .105Oxygen + 2.67Conductance - .290Hydrologic + 6.28$$

ICDS Utilization

- Changed the number of nodes for each experiment
- Kept memory per node constant
  - 16GB
- No correlation found between execution time and the amount of resources