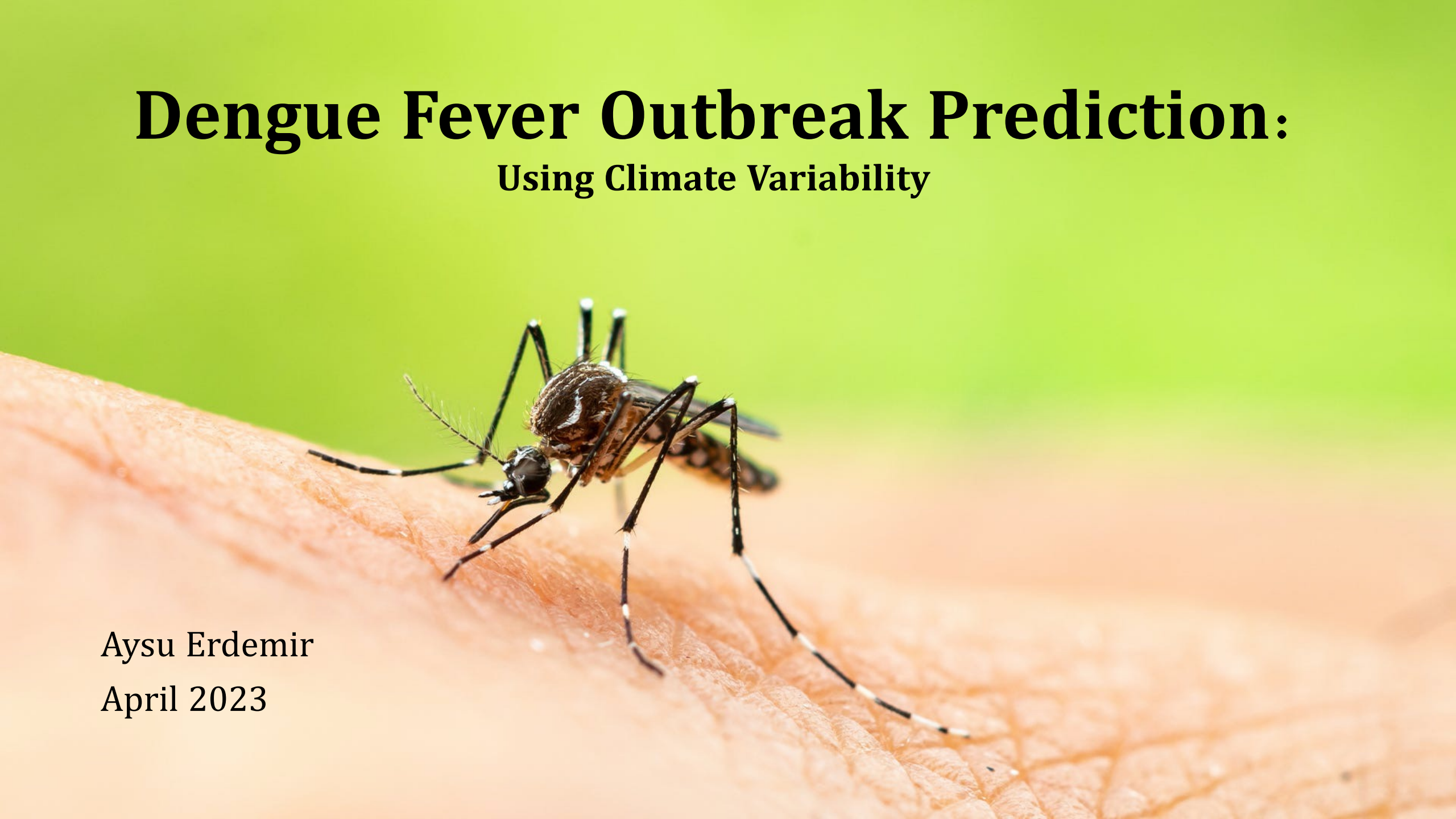
Dengue Fever Outbreak Prediction:

Using Climate Variability



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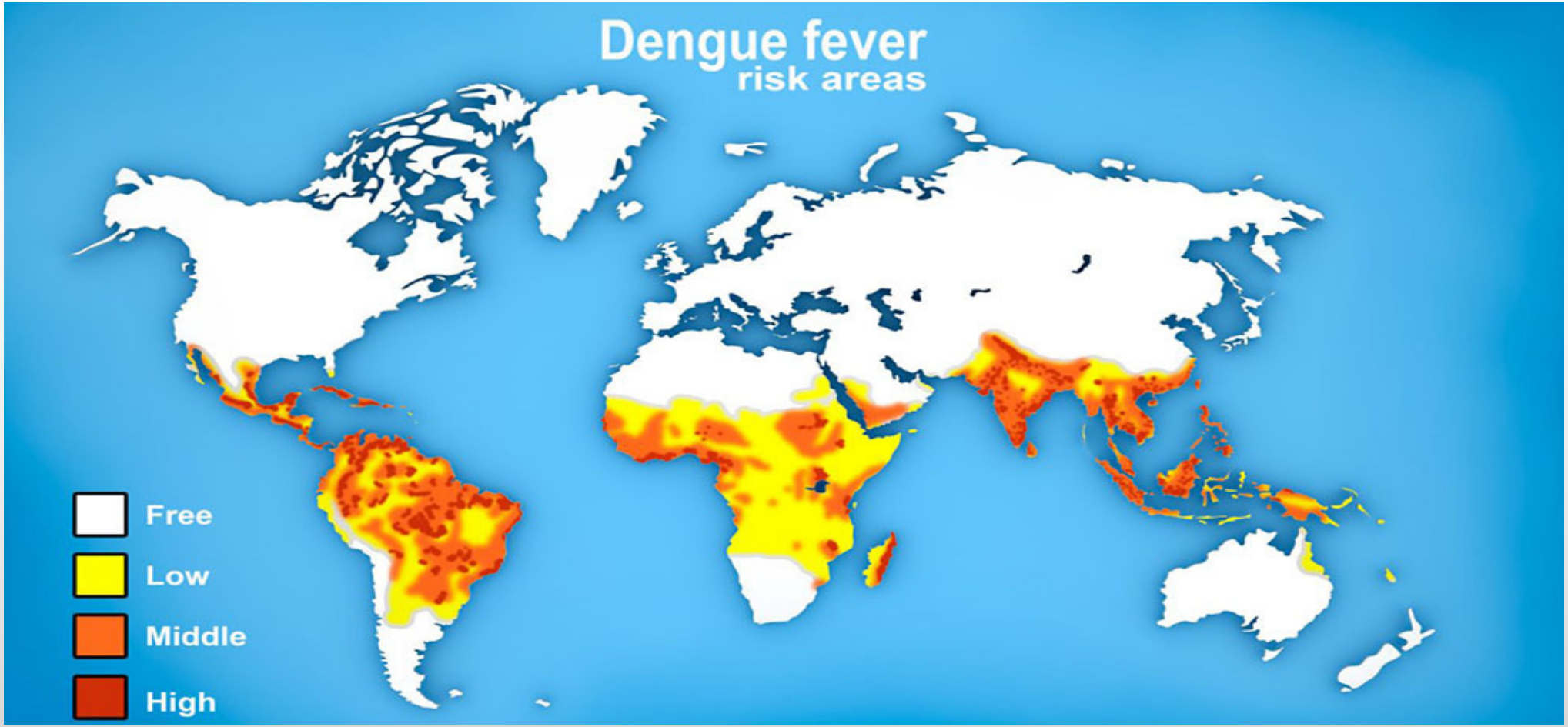
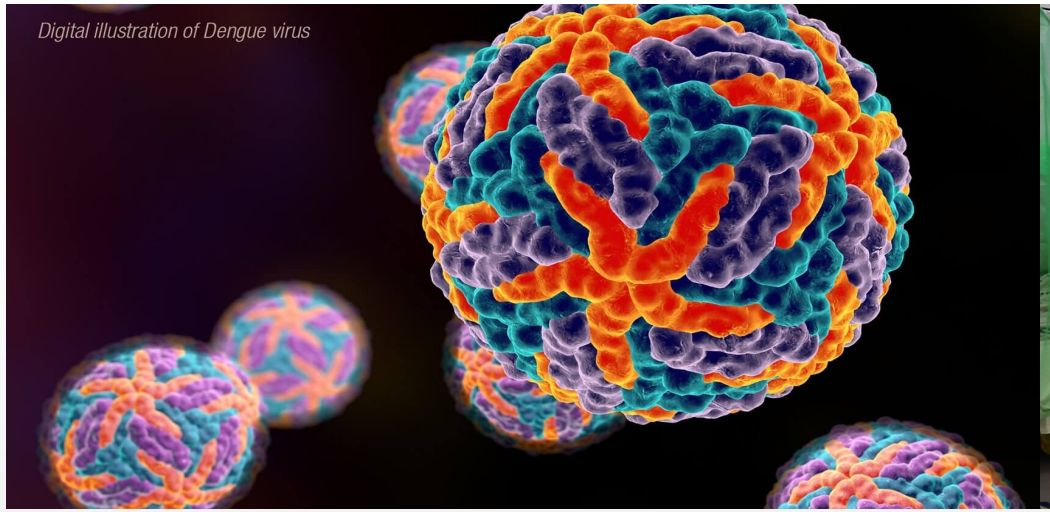


- Dengue is a **viral infection** that spreads from mosquitoes to people.
- It is more common in **tropical and subtropical climates**.
- It causes flu–like symptoms such as fever, headache, body aches, nausea and rash; but sometimes it worsens to **severe dengue**, a life–threatening complication.



Stakeholder:

CDC, Center for Disease Control and Prevention

Business Problem:

Can we **predict** when the **next dengue outbreak** will happen, using the relationship between climate and dengue dynamics?

Project Value:

- Improve research initiatives to better understand the complex relationship between climate and dengue.
- Resource allocation to help fight life–threatening dengue epidemics.

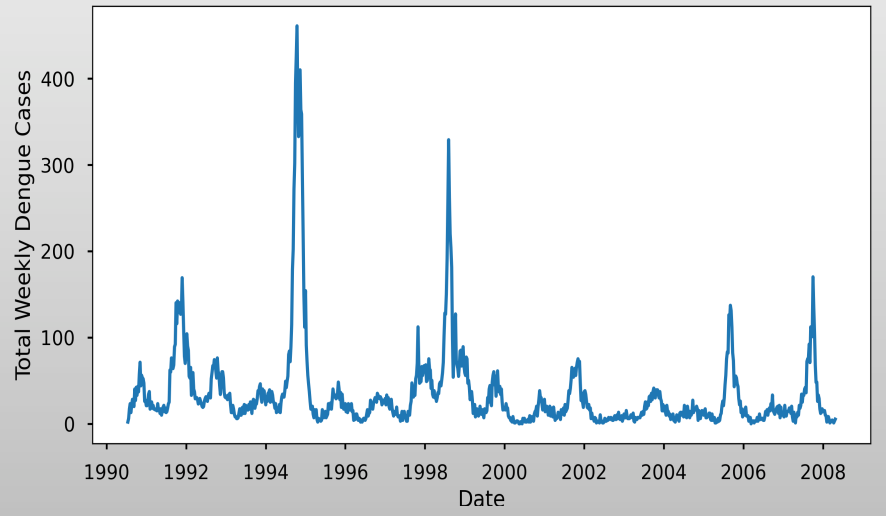
Data:

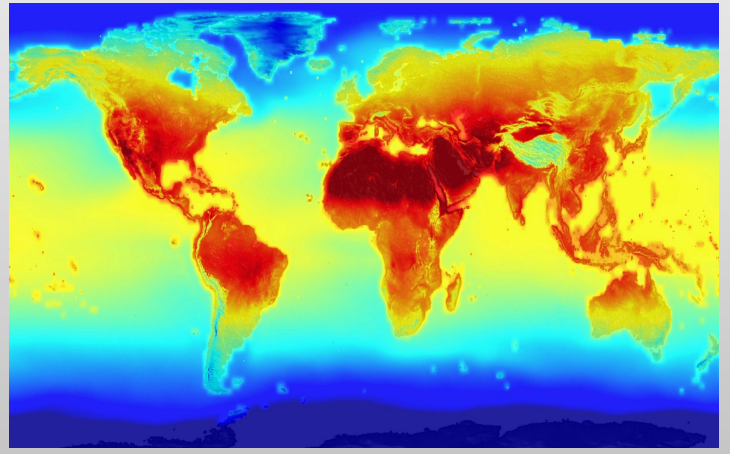
Time series data obtained from DrivenData including weekly dengue case counts in **Puerto Rico** from year 1990 to 2008 along with accompanying climate features such as:

- Humidity,
- Max, min, average temperature
- Precipitation
- Vegetation index

Additional data from 2008–2013 included climate features without case counts.

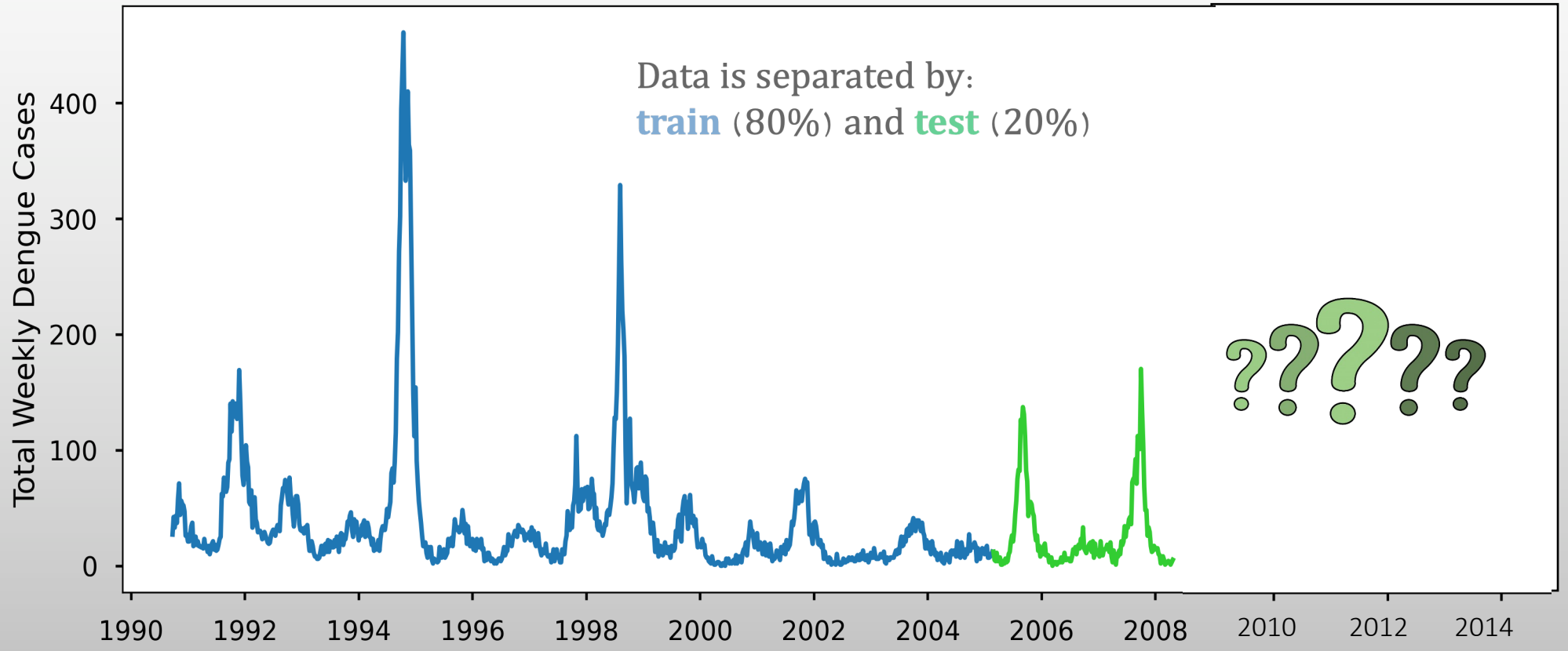
Weekly case counts + **Climate variables**



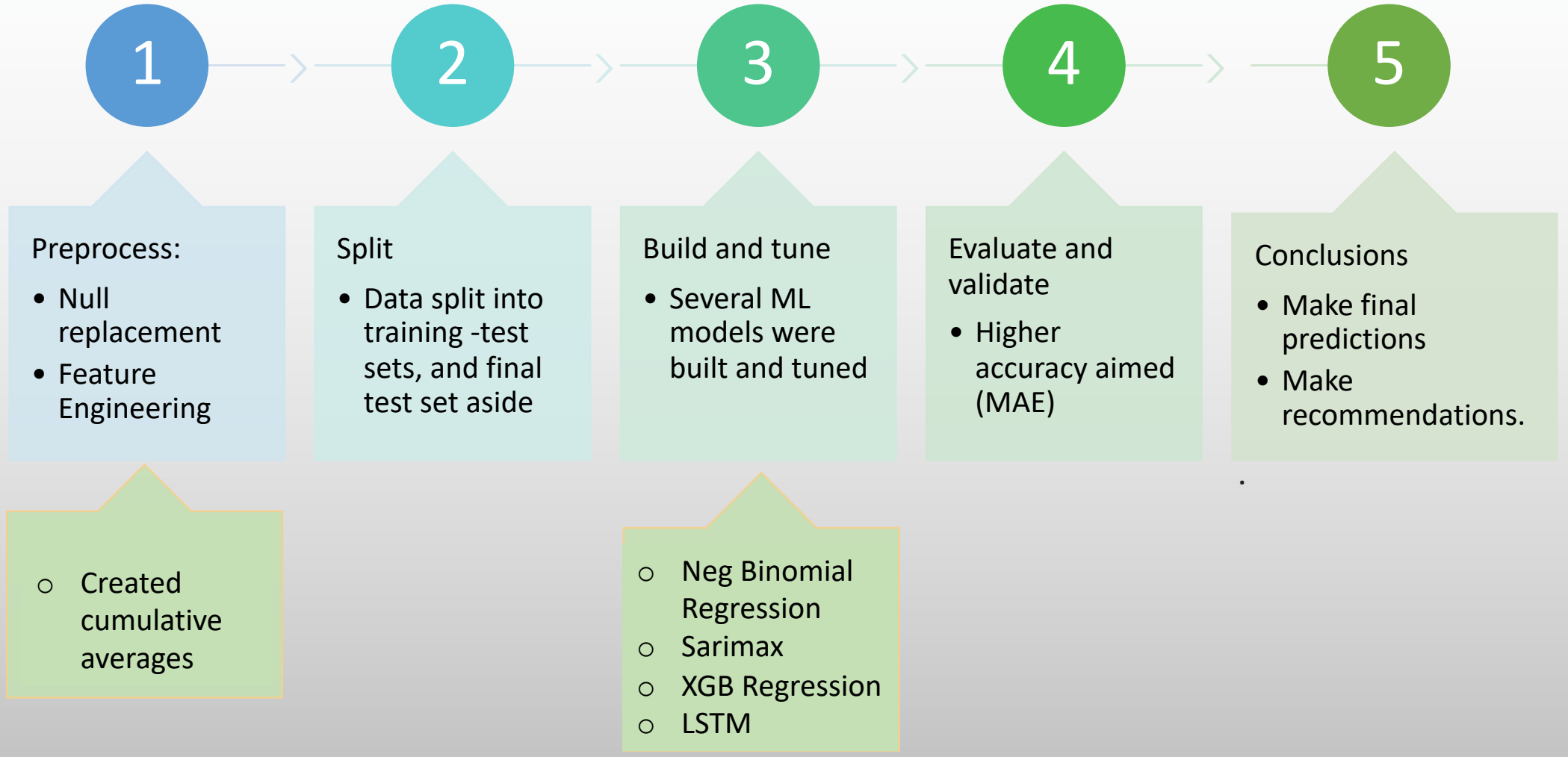


Goal:

- Build **several machine learning models** to **forecast** upcoming weekly dengue cases as accurately as possible.
- Performance is evaluated according to the **Mean Absolute Error** (absolute difference between actual and predicted case counts).



Methodology:



Preprocess:

❑ Null values were imputed using **interpolation** and **predictive modeling** (KNN).

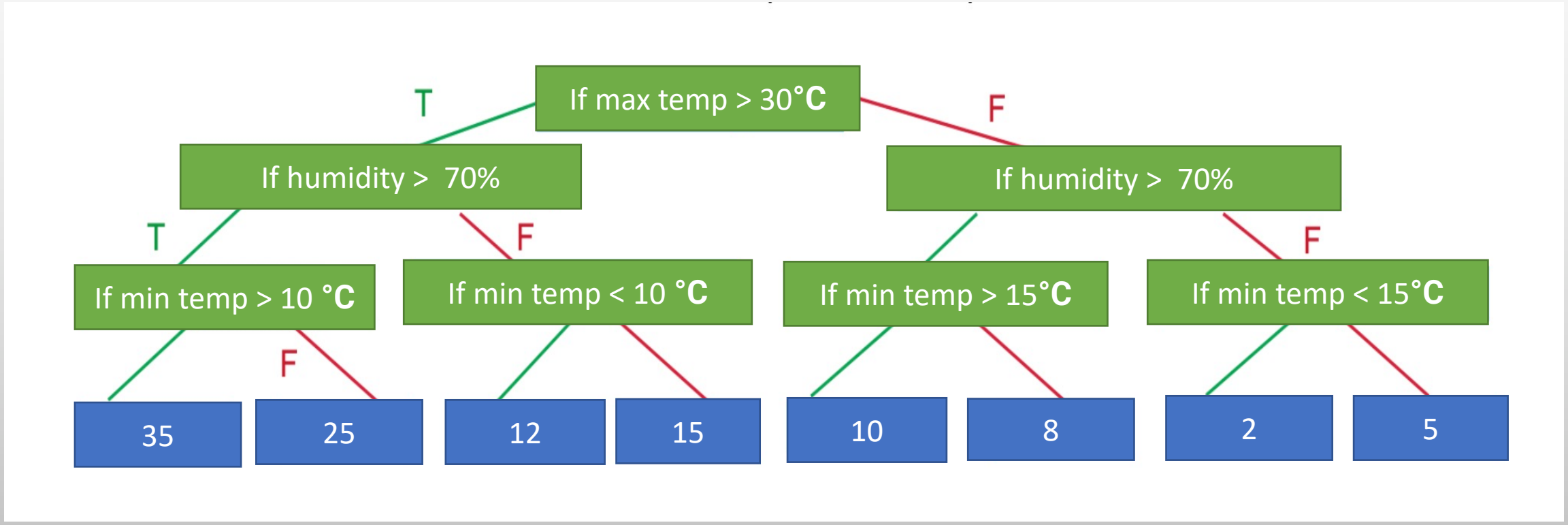
❑ Main climate variables were:

- **Shifted** by 2 weeks (to account for mosquito lifecycle and incubation period of the virus).
- **Feature-engineered** by taking the mostly correlated cumulative averages at various lags ranging from 2–4 months.

Best performing model:

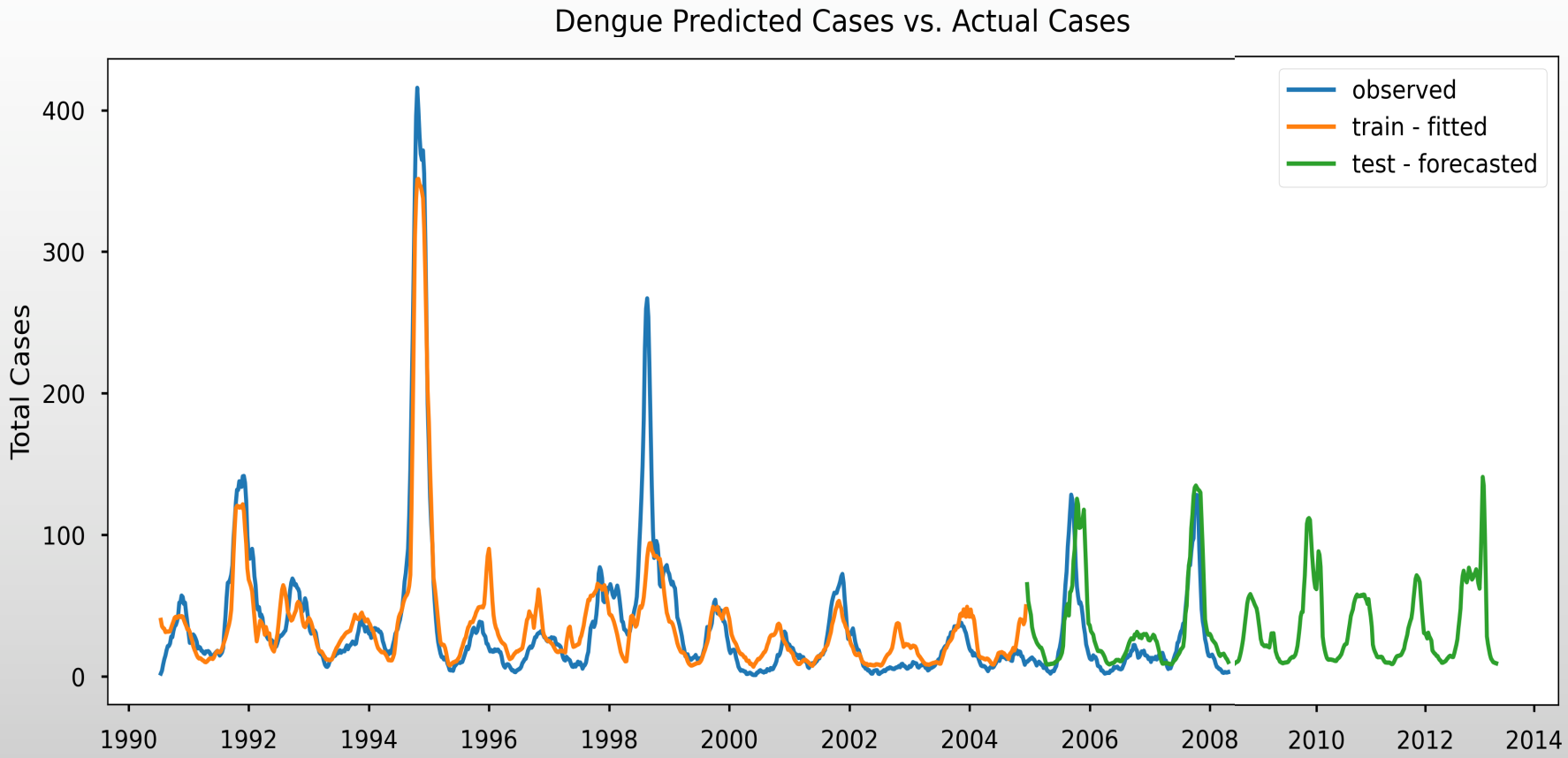
XGBoost Regression (decision tree + gradient boosting)

In the simple example below, a decision tree is used to estimate dengue case numbers (the label) based on max temperature, min temperature and humidity (the features).



Validate and Evaluate:

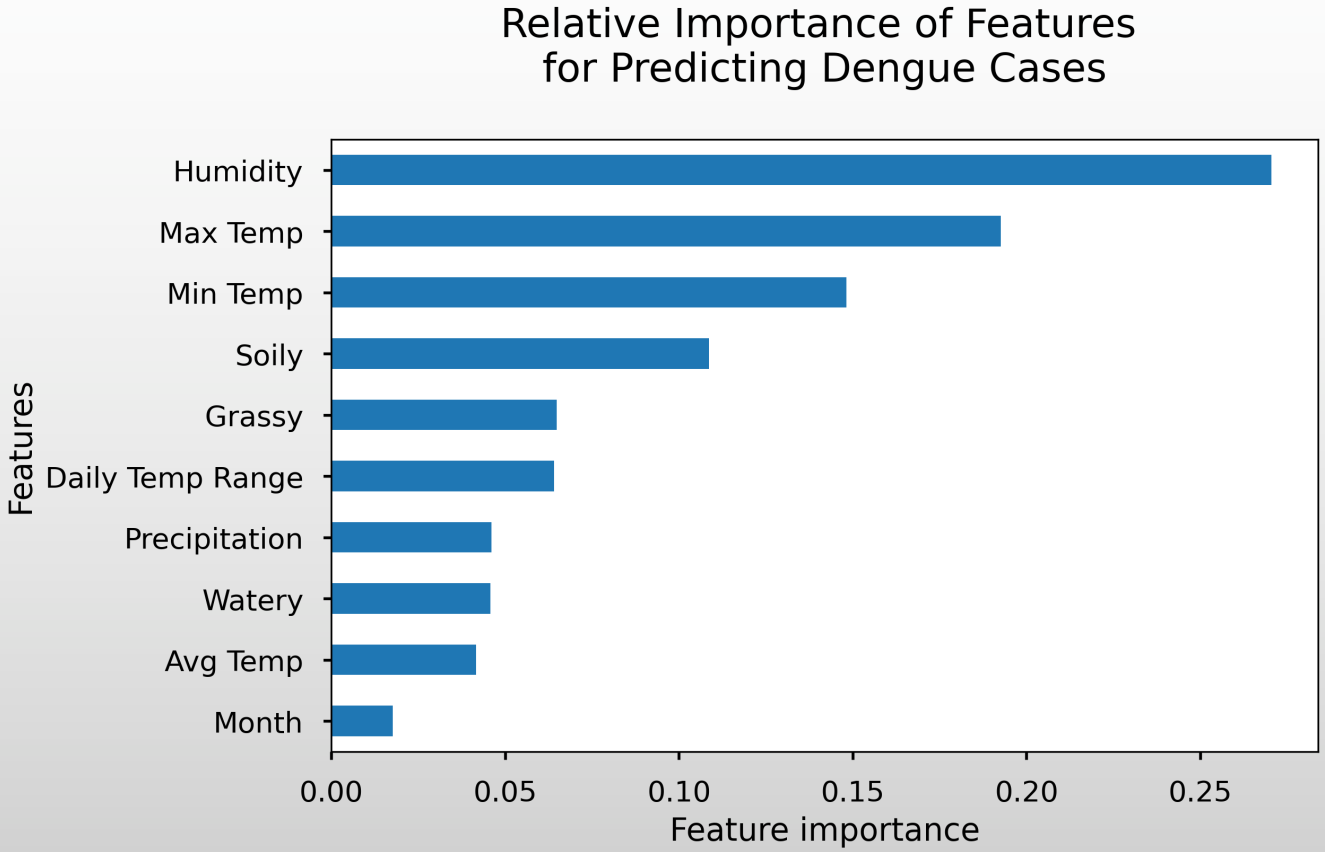
Model Performance and forecasting



	Train	Test
Mean Absolute Error in **weekly case counts**	**14.6**	**17.7**

- Final model detects majority of the individual peaks / outbreaks.
- 2 more moderate size outbreaks are expected to happen at the end of 2009 and 2012

Feature Importance



Sustained humidity and sustained maximum temperature are the two most important features in predicting dengue cases.

Conclusions / Recommendations:

- Dengue cases rely on climate variables, but the relationship is complex.
  - Further models should take into consideration cumulative computations of climate features over a period rather than isolated numbers.
- Climate change and global warming may make dengue outbreaks and similar mosquito born illnesses more deadly in the future.
  - Knowing the next outbreak would help countries to allocate more resources to the health care system for timely intervention.

Limitations and Improvements

- More recent data needs to be collected to achieve more accurate predictions for future.

- Since the relationship between dengue and climate is complex:

  - **Nonlinear relationships** need to be taken into account with more complex models.
  - More meaningful climate related features need to be engineered.

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