Project 3 Proposal: Inferno Insights: A Real-Time Comparative Analysis of Fire Weather Indices and Active Wildfire Data

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1. Introduction and Purpose:

This project, "Inferno Insights," aims to provide a comprehensive, real-time analysis of wildfire risk in a specific geographic region (e.g., California) by comparing three distinct fire weather indices: the Canadian Forest Fire Danger Rating System (CFFDRS) Fire Weather Index (FWI), the National Fire Danger Rating System Fire Danger Index (FDI), and the modified Fosberg Fire Weather Index (mFFWI). The project will evaluate the performance of each index in predicting potential fire behavior and benchmark these predictions against active wildfire data. The final deliverable will be an interactive data visualization that overlays the three indices on a map displaying current fire locations, providing a clear and informative picture of real-time fire risk. This tool will enable users to quickly assess the relative severity of fire danger predicted by each method and correlate this with ongoing fire events, offering valuable insights for fire management and public awareness.

2. Data Sources:

- **Weather Data:** Real-time weather data (temperature, relative humidity, wind speed, precipitation) will be acquired through the Open-Meteo API for the target region at hourly intervals. Historical weather data will be used for initial index calculations and model validation. (https://api.open-meteo.com/v1/forecast)

- **Fire Data:** Active fire location and perimeter data will be sourced from the Cal Fire website (https://www.fire.ca.gov/incidents/) or alternative sources like the National Interagency Fire Center (NIFC) API or GeoMAC.

- **Fuel Moisture Data (for CFFDRS):** Default initial values for Duff Moisture Code (DMC) and Drought Code (DC) will be used, with provisions for adjustment based on historical data or expert knowledge, if available.

- **California Natural Resources Agency:** This provides the historic perimeters of all California fire regions. (https://gis.data.cnra.ca.gov/api/download/v1/items/c3c10388e3b24cec8a954ba10458039d/geojson?layers=0)

3. Methodologies:

- **Index Calculation:** Python libraries like pyfwi and custom functions will be used to calculate FWI, FFWI, and mFFWI based on the acquired weather data. The Keetch-Byram Drought Index (KBDI) will be calculated as an input to mFFWI. Equilibrium Moisture Content (m) will be computed as a supplementary indicator of fuel dryness.

- **Data Processing and Integration:** Data from different sources will be cleaned, transformed, and integrated into a PostgreSQL database. Tables will be created to store weather data, index values, and fire incident details. SQLAlchemy will be used for database interaction.

- **Visualization:** An interactive web application will be developed using Flask to display the results. Leaflet or a comparable JavaScript mapping library will be employed to render a base map. Color-coded overlays will represent the spatial distribution of FWI, FDI, and mFFWI values. Active fire locations and perimeters will be overlaid as distinct visual elements. Users will be able to select date/time ranges and geographic areas of interest. Potentially Plotly will be used for interactive charting of index values over time at specific locations.

4. Ethical Considerations:

- **Data Accuracy and Limitations:** The visualization will clearly communicate the limitations of the models and the inherent uncertainty in fire weather predictions. Emphasis will be placed on using the tool for informational purposes rather than critical decision-making without expert consultation.

- **Data Attribution:** Proper attribution will be given to all data sources used in the project.

- **Bias in Data and Models:** Potential biases in the underlying data or models will be acknowledged and discussed. For instance, the limitations of using default fuel moisture values in the CFFDRS calculations will be highlighted.

5. User Interaction:

- **Date Selection:** Users will be able to select a specific date to view historical fire risk and compare it with recorded fire incidents.

- **Geographic Filtering:** Users will be able to zoom in and focus on specific regions of interest.

- **Index Comparison:** The visualization will facilitate easy comparison between the three indices, allowing users to observe differences in their predictions.

- **Information Panels:** Fire areas will be indicated on the map with the intention of expanding the scope to include active fire markers and will provide additional details about the fire (e.g., size, containment status).

6. Timeline:

- **Week 1:** Data acquisition, database setup, index calculation implementation, initial visualization development.

- **Week 2:** Refinement of visualization, user interface enhancements, testing, documentation, presentation preparation.

7. GitHub Repository:

The GitHub repository will include all code, data, documentation, and a comprehensive README file outlining the project, instructions for running the application, data sources, ethical considerations, and team contributions.

8. Planned Technologies/ Methodologies to be Utilized

- Python

- JavaScript

- Flask

- SQL Alchemy

- PostgreSQL

- Leaflet or other suitable mapping library

- Plotly or other suitable charting library

- HTML/CSS

- Open-Meteo API

- pyfwi library

- Cal Fire / NIFC API / GeoMAC

This project seeks to contribute a valuable tool for understanding and visualizing wildfire risk. By comparing multiple indices and integrating real-time fire data, "Inferno Insights" offers a powerful platform for enhancing situational awareness, supporting fire management efforts, and promoting public safety.