Translating Data into Interactive Frameworks

P-I, Shayna Solis (Skolnik), Co-I Adam Silcott, Zoey Armstrong, Interns: Camila Rodriguez, Sofia Grossman, Sarah Au

Navteca LLC

Introduction

Navteca is a technology company that creates practical applications based on new and emerging technology, such as cloud computing, virtual reality (VR) and digital twins, natural language interfaces using conversational AI, geospatial data visualization, and high-performance computing. Collaborating with NASA and other international organizations, the Navteca team has led a multi-year investigation into the applications of virtual and augmented reality for NASA Earth science and disaster applications as a significant new approach to enhancing the way we view and communicate science and data in an engaging, interactive format. In 2020, Navteca launched a stand-alone conversational AI tool that is currently being used by NASA, the Johns Hopkins University Applied Physics Lab, the DC Government, the University of Alaska and others to answer scientific and mission questions using our safe generative AI system, Voice Atlas.

The immersive web-based visualization highlighted here is outfitted with an interactive AI chatbot utilizing Navteca's Voice Atlas software product. This proprietary solution allows users to access information from a custom knowledge base about the Hermit's

Peak wildfire. This is an ideal enhancement to the public outreach component as it allows users to ask multilingual questions and receive answers from only specific, vetted sources of information. This provides both an interactive FAQ and a useful feedback loop for the project stakeholders to see what the public wants to know (the Voice Atlas analytics provide insight into every question asked and answered).

Project Description

The final project, including the interactive chatbot can be viewed here: https://navteca.com/wildfire.html

The objective of the project was to develop a game-engine based data visualization application that ingests scientific datasets from NASA, NOAA, and other sources to focus on the "story" of a significant wildfire event. From interviewing data practitioners and aggregating the results of many proofs of concept, we validated that this type of tool would improve the current visualization approaches which can make it difficult to synthesize multi-scale and multi-source data as well as translate that data into actionable information for non-scientific users, like emergency managers, mayors, and first responders. The visual fidelity of the geospatial virtual environment allows both scientific and non-scientific users to have a common graphical understanding of the data.

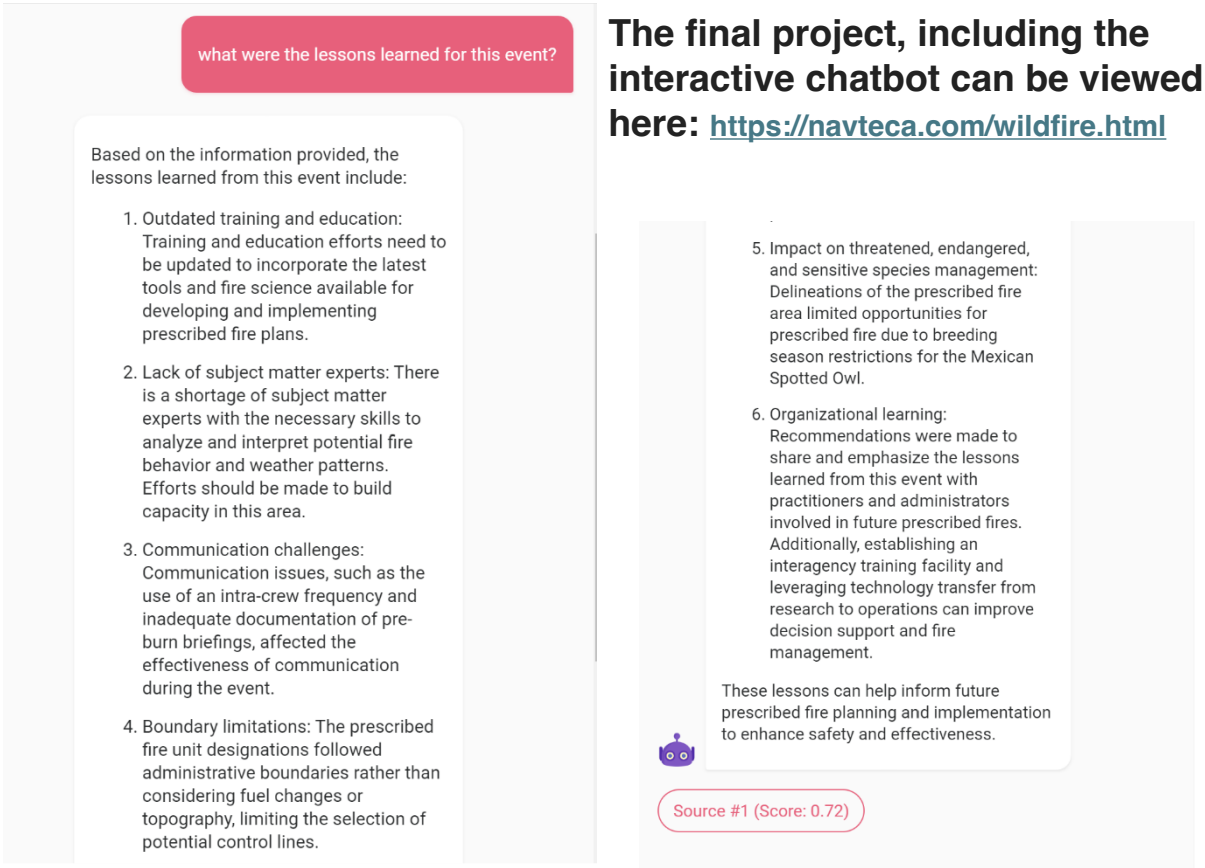
This project was made possible through a grant from the NASA Wildland Fire Program. During the initial grant phase, we chose a case study to focus on: the Hermit's Peak, NM fire that had just been contained around the date of project award. We expected our regional focus to be California for the purpose of the pilot wildfire project, but after interviewing stakeholders from the United States Forest Service (USFS) and the United States Geological Survey (USGS), we determined that the Hermit's Peak fire would be an ideal case study and that the resulting visualization could improve upon understanding of what happened.

The ability to translate and synthesize scientific data and information into actionable and usable contexts is paramount to effective decision-making. This project combines two emerging technology areas: **immersive visualization using game engines and artificial intelligence (AI) natural language processing (NLP)** to create an interactive visual framework for displaying 3D geospatial wildfire data as it relates to disaster risk and resilience.

One challenge was representing large amounts of data in real-time. The quantity of real-world data that applies to an event like the Hermit's Peak fire is enormous. In pre-rendered environments this is less of an issue, but in a real-time environment it becomes a unique challenge. We needed to be able to show thousands of fire points, smoke vectors, trees, and other visual effects without affecting the frame rate.

Final Outcomes

The outcome of the project is an interactive visualization that incorporates geospatial and 3D data, natural language AI interfaces and scientific data. Visual and interactive components allow users to query relevant data sets and obtain information visually and conversationally.



The final project, including the interactive chatbot can be viewed here: https://navteca.com/wildfire.html

Fig. 1 Questions asked in the AI chat interface only pull from a vetted, trusted knowledge base

Significant Results

1. Accomplishments include the ability to generate trees, foliage, and fuel according to region and type as well as the successful connection via API of the Voice Atlas NLP system and the visual Unity framework.
2. The API connection to Voice Atlas was successful, and an initial Atlas (knowledge base) for Hermit's Peak was created. The knowledge base parses information from the USFS incident report and provides answers to questions within the context of the visualization. This is especially important for asking things like" what were the lessons learned from Hermit's Peak?" The knowledge base also

contains information about the data in the visualization, which is a key component to making data products that follow FAIR data guidelines and Open Science best practices.

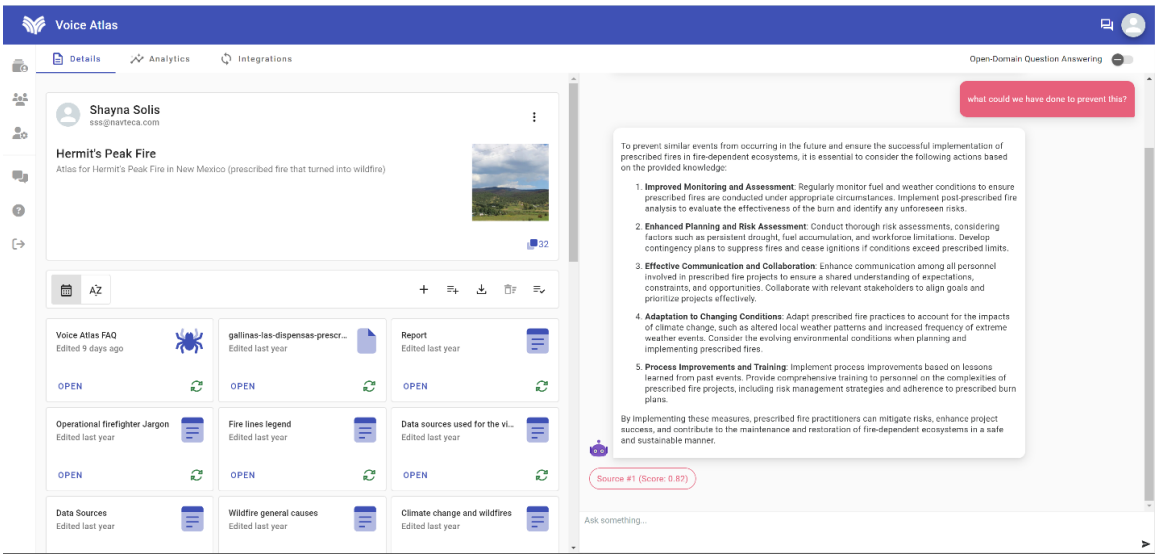


Fig.2 The backend of the AI tool shows the hybrid knowledge sources

3. The project team has successfully visualized complex phenomena such as the erratic winds that cause the prescribed burn to become a wildlife and the mottled appearance of the landscape based on burn severity data.

4. The project team held many stakeholder meetings with the Forest Service and received valuable feedback and encouragement from the attendees who felt like this new visualization approach improves communicating complex data stories.

5. The project team received positive, impactful feedback at the many conferences and events, including from NM stakeholders who viewed the visualizations at the NASA booth at the IWAF conference in Boise, ID in April 2024.

6. The ability to translate and synthesize scientific data and information into actionable and usable contexts is paramount to effective decision-making. This project shows the potential for a geospatial framework for displaying 3D geospatial data as it relates to disaster risk and resilience.

7. Additional work continues and the team has visualized other fires using similar techniques, including for the Eaton and Palisades fires that occurred in Los Angles in January 2025. These visualizations were included in a PBS documentary.

Fig.3 The Hermit's peak fire as visualized using the Unity game engine

More examples: Unity has a built-in conversion for point cache files into texture files with associated attributes, so we used that for fire points. We successfully experimented with representing fire spread with a gradient map, which allowed for all effects to be generated from one effect instance driven by the same data sources.

Fig. 4 Complex data layers including smoke, fire perimeter, containments efforts, and wind vectors are included in the visualization