Workshop 3: Fire Managers and the Fire Response Community

Introduction

As the third workshop of the WIFIRE Commons Project, the WIFIRE team hosted fire managers and firefighters with whom we have developed relationships and who are advocating for the development of technology for the fire service.
We established three goals to help shape the structure and content of the workshop. The goals for this Workshop were:

1. *Educate Attendees*
   Introduce WIFIRE Commons to a representative group of practitioners. Articulate how AI-enabled fire science can transform mitigation, planning, and response
2. *Solicit Challenges*
   Understand shortcomings of data, models, and interfaces in use currently and define practitioner needs for mapping and model services
3. *Identify Opportunities*
   a. Identify opportunities and processes to incorporate existing and future data into the Data Commons
   b. Understand user needs for UX/UI to access, understand, and make decisions on relevant data and models
   c. Solicit input on the practicality of potential AI uses

Workshop format/process

There were two separate sessions held to collect feedback from 2 different audiences:

Day 1: Fire planning and mitigation
Day 2: Fire Response (initial attack, extended attack)

The schedule for each day was the same:

- Present an overview of the WIFIRE Commons and where the project developments can use participant feedback
- Host breakout sessions identifying key themes and challenges within their field
- Reconvene whole group to identify themes
- Focus on key identified challenges to investigate opportunities in a second breakout session

Participants

Participants attended via an on-line meeting which used two sets of breakout rooms to engage the participants and gain the maximum input from attendees. Included in the group were personnel from fire departments, electric utilities, foresters, air and water quality regulators, urban and municipal planners, burn planning and operations experts and environmental consultants. Virtually all participants provided input during the meeting and the meeting generated a wide range of capabilities desired from an AI driven prescriptive burn platform.

In total for both days the following attended the workshops:

- 17 firefighters from several fire departments from California, Colorado and Texas
- 12 government employees with fire-related research, response, and policy
- 15 industry representatives - some of whom fight fire from aircraft
- 5 Fire scientists coming from both government and university institutions

We asked what technology firefighters need for 1) prescribed burning and 2) emerging incidents. How are the tools they use today succeeding and/or failing? They answered by describing their challenges, and it was clear we hit a nerve. They described their struggles with technology to do their job. What exists now is not enough.

Key observations

WIFIRE identifies these 4 themes as cornerstones for what is necessary for the prototype

1. Situational Awareness
    a. Need for automation and validation of data
    b. Ignition is always a surprise, response is always variable
2. Prescribed Fire
    a. Understand real-time planning vs long term planning
    b. Burn windows for prescribed fire must be expanded
    c. Pre-planning of what to focus on "today"
3. Cyberinfrastructure and Interfaces
    a. It must be simple, open, accessible, and in control of the agency that wants to use it
    b. Models are a tool for communication, training and preparation. They can be used to develop solutions and cut through bureaucracy and politics.
4. Communication to public
    a. A way to shift public perception and the science of the tradeoffs

What follows is a summary and outcomes of that conversation.

Workshop Outcomes

Goal 1: Educate Attendees

The first 20 minutes of the workshop sessions included a plenary session with short presentations from WIFIRE Commons members:

(1) **Altintas**: Introduce why WIFIRE was created and why we are moving towards the WIFIRE Commons - WIFIRE has spent the last 5 years deeply embedded in the fire community. We have prioritized what we have heard from you.
(2) **Lin and Hiers**: Show what we are developing and where we are heading including improvements to fuel data, how it informs models, and the benefits of the Commons
(3) **Gil and Pazzani -** AI methods that can be used throughout the fire science process in the AI gateway
(4) **Block and Kleeman:** Introduce the breakout sessions. Describe in broad terms who is in the room and what they contribute. We have brought them together to create a wishlist of what they would like to have so that we can create it. They are the experts these tools will be made for. We request identifying challenges they have in their work and where capabilities and tools can help.

Goal 2: Solicit Challenges

In the initial breakout session, members introduced themselves and we asked: "What is the problem space you are working in? Where are approaches to your problems or the tools that you have falling short? How far from perfect is the information/data you have when making key decisions? What's missing?

Situational Awareness

1) *Wildfires are dynamic*. Wildfires aren't calibrated; thus, models are run without prior calibration within the context of an active environment (models are only run based on previous conditions). Thus, questioning models is absolutely necessary; we should always examine how accurate projections and predictions are based on current, real-time dynamic behavior. Validating models, however, isn't a simple task. Validating any model for specific scenario(s) is very difficult given climate change (e.g., heavy heterogeneity, variance in wind, etc.). Additionally, other factors, e.g., water supply situations in certain areas, need to be taken into account when modeling for the urban environment.
2) *Saving all lives:* During a fire outbreak, fire mitigation personnel are met with the daunting task of saving all lives (including their own) on the premises concerned. Bureaucracies add another level of complication to the situation and don't seem to make the job easier - they either intentionally, or unintentionally, create delays in the decision-making process. In order to successfully accomplish the task at hand and overcome the aforementioned constraints, these personnel need to be equipped with the appropriate set of tools, including state of the art cyberinfrastructure. Firstly, the real-time information provided to first responders must be presented in a graphical manner, for ease of interpretation. Additionally, the cyberinfrastructure should be able to provide time-based risk predictions (e.g., predictions regarding what the situation at hand will look like after a 10-minute period). The digital infrastructure at hand should also have the capability of assisting personnel in attending to potential victims of a fire outbreak.

Prescribed Fire

3) *Using local data to provide decision-making support for fire managers*: Currently, prescribed fire windows are far too restrictive. If even a single parameter (e.g., relative humidity, wind speed, atmospheric stability, fuel moisture, etc.) is outside the accepted bounds, the burn permit is not issued. However, these parameters interact in complex yet predictable ways, and being able to represent how the mitigating factors interact may help expand the burn window in complex environments to better manage fires in federal systems. Similarly, there are large amounts of unused data and capabilities to help predict air quality and smoke based on local meteorological conditions.
4) *Fires are not created equal*: There are many different fire types, including building fires and wildfires. Another layer of complexity is introduced to the situation when we recognize the following: even if, for example, two separate fires happened to both be categorized as wildfires, these two fires would still be drastically different from one another in terms of fire behavior. Due to this heterogeneity inherent in fire behavior, different fundamental objectives need to be established depending on the fire type and the fire's individual behavioral patterns. State of the art cyberinfrastructure can assist fire mitigation personnel in establishing an apt and solid fundamental objective for the fire or fires at hand.
5) *Limited time, energy, and funds:* In most scenarios, end-users are under some sort of strain to meet particular budgets. For utility companies, these constraints are likely to be a limited amount of money to apply treatments over large landscapes, and a limited amount of manpower to meet those treatments. For fire managers, the constraints are both in manpower and time to both respond to wildfire scenarios and apply treatments, but there is also limited time with which to adopt emerging technologies that still need to be vetted. This is becoming a larger issue as the fire seasons stretch out into longer portions of the year.
6) *Changing environment and the no-analogue scenarios:* As mentioned above, the changing climate has led to an extended fire season which has led to a decrease in down-time for fire managers. Coupled with the effect of the changing environment on the type and intensity of the wildfires that we're seeing every year, fire managers have little time to adopt emerging technologies and models, and previously established models that depend on empiric parameterizations and statistical regression are unable to predict the no-analogue scenarios that are becoming increasingly common.

Cyberinfrastructure and Interfaces

7) *Creating a digital infrastructure to address* ***strict time constraints during fire evacuation****:* During a fire outbreak, firefighters, first responders, and other personnel on the ground are expected to save all lives (or as many as possible) at the respective locations they are based at, within a succinct time window. Unfortunately, the current cyberinfrastructure these personnel are provided with to save lives does not aptly take into consideration these succinct time windows in real-time fashion, and does not effectively facilitate coordination at all scale types. Going forward, future state of the art tools need to be capable of providing the aforementioned

personnel with the following: real-time photos (that can be accessed on phones, tablets, and other pertinent digital devices); resources and intelligence, tailored to each evacuation time window; and instantaneous and dynamic data calibration.

8) *Data accessibility and communication*: There is a need for improved access to more commercial satellite image data (e.g., optical, Synthetic-Aperture Radar, etc.) and a need to increase accuracy. Additionally, there is a need for better integration between teams working on next generation fire modeling tools that can capture the extreme fire dynamics of today. There's a desire for a better interface from Emergency Operations Center (EOC) to the field so data can be presented effectively to people in the field. The current fire/weather alert systems are not working for fire danger. They are not providing meaningful fire warnings. There is a need for more automation and something easy to use (i.e., how can we incorporate a red flag rating system?).
9) *Data discovery and decision-support*: There is limited ability to discover the most important data to focus on. It's hard to find the appropriate data. There is a need for tools/frameworks to identify the appropriate data to solve particular problems. It's not reasonable to depend on 1 or 2 experts to choose appropriate data. Also, there's a need for validation schemes for models as well as guides for who should use which models and in which scenarios one would need to think about specific use cases (e.g., wind-driven fire scenarios, plume-dominated fire scenarios, etc.). Risk and hazard analyses are not well developed for the wildland-urban interface (WUI). Data for fuels are lacking and there's a need for fine scale and accurate fuels data.
10) *Lack of standardization*: One of the reasons why there is a lack of common operating tools in the fire response and evacuation space, is that fire departments across the nation take a variety of paths in the domains of fire response and evacuation. Due to the fact that various fire agencies and departments across the nation operate under separate jurisdictions and have drastically different use cases from one another, delineating one standardization on a federal level (or even a statewide level) is a Herculean task. These nationwide jurisdictional and use case differences also result in there being issues in terms of aggregating datasets, as datasets, oftentimes, end up being incompatible with one another.
11) *Need for centralized source of data and models*: Both data and models are spread out across multiple communities and agents, making it difficult for an exterior collaborator to get a full understanding of the state, advantages, disadvantages and best use practices for data and models. Furthermore, these should be framed in a way that is easy to understand and apply by people who are not experts on the subject or have large amounts of time to get used to the nuances of each model. In terms of data, there is a need for standards to be set in various scenarios, as well as a need to establish routines through which new data can be processed, analyzed, and compared to previous data.

Communication with the Public

12) There is a need to improve tools for communication with the public. Current communication tools are not predictive or pro-active. The message to the public needs to be simplified in its format, analogous to, for example, the format of a 10-day weather forecast.

Goal 3: Identify Opportunities

When heading back into breakouts we asked, "In the themes that are emerging here,, what should the future look like? For example, imagine you are deployed to a fire in a new place at night, and you have to fight the fire. What does the perfect scenario of data and tools look like to you?"

Situational Awareness

1. Having an accessible hub for data and models that can be accessed remotely would be of great use for firefighters on the scene. Folks on the line need to have an intermediary to validate what they're getting in a structure that they trust. A real time feed is not reliable or trusted, the next is the workflow to publish and deliver the information out quickly, and if it were to change, they would get an alert. The packaging and delivery is done for them and they're just doing quality control, and the data is distributed correctly for different levels of command.
2. In order to accurately and effectively bring speed and automation to the decision-making processes employed during fire evacuation, the following practices can be employed: repurposing battlefield assessment tools used in the military space, for the fire space; installing more satellites to increase data fidelity and ensure that other components in the data pipeline continue to work; integrating accurately downscaled fuels, winds, etc.
3. In order to improve evacuation planning, the following practices can be employed: harnessing planning and predictive tools, such as Zonehaven; applying situational awareness tools as best as possible during the initial attack phases; and modeling structures, ahead of time, in order to prioritize areas accordingly for fire evacuation and preempt effects of existing structures on fire behavior, and vice-versa.
4. More open-source tools and cyberinfrastructure can be created, distributed, and publicized online, in order to meaningfully move forward towards achieving the eventual goal of the standardization of situational awareness tools.

Prescribed Fire

5. Next-gen models are able to represent crucial mechanisms of fire spread and fire-atmosphere interactions and are able to identify critical thresholds and interactions. Making these models readily available and easy to implement in new scenarios (even if it requires simplifications and assumptions), implementing them on edge cases of the prescription window would help make the prescription window more dynamic and sensitive to such interactions. Another way to use local data to improve decision making is by designing and implementing a workflow through which citizen science, a grassroots approach to data collection, can be ingested into models and forecasts. Another opportunity is using measurements and forecasts gathered during an incident instead of readily-available but geographically static measurements (i.e. RAWS Stations) for better fire behavior model predictions.
6. Collaborating with end-users to ingest their datasets to be able to better understand and work towards their needs. Leverage the computational resources available to the WIFIRE Commons to

run a spatially explicit constrained optimization for the particular budgets and constraints required. Using real time modelling to identify areas on the landscape that are within the thresholds of control, integrating roads and fire behavior to see where there are opportunities for engagement.

Cyberinfrastructure

7. There are data accessibility and communication opportunities that can be availed of to create a comprehensive suite of models with an interface that looks very intuitive to end-users (e.g., including a flowpath graphic makes for an improved user interface). There are opportunities to build models that are complex under-the-hood, but have a simple interface for the end-user. In this way, you wouldn't need an experienced subject matter expert for articulating assumptions and nuances of models.
8. There are data discovery and decision-support opportunities that can be availed of to build technology to help find the appropriate data for mitigation action. There are opportunities for using modeling during an event in order to help with decision-support. Data could be used to help understand decisions from a monetary perspective by leveraging multiple types of data, such as those focused on resource allocation. Examples such as using Zillow for getting home values and Waze routing app to route people out of burn areas, traffic feeds, and analyzing neighborhoods with limited ingress/egress were proposed as possible sources to consider. Other opportunities include using AI to detect small scale changes in conditions and inform better models. Data can be made more accessible in easy to access location (i.e unmanned aerial vehicle (UAV) data). There are opportunities to develop forecasting tools that are trustworthy by assigning probabilities/trust values to predictions.
9. Data hosting is a more urgent and pressing issue rather than Common Operating Picture (COP) management. The cost to end-user should be minimal. Continued development should be collaborative and versioned (to address Tim's point that change is necessary)
10. In order to create models that can be effectively applied in the wildfire space, the following methods should be employed: maintaining and curating well-characterized datasets that models can be test against; running data ensembles so that variability in fuels data and weather data can be noted, and this variability can inform what is being fed into models; curating data that indicate a wide range of possible fire behaviors.
11. The WIFIRE Lab should clearly communicate its presence as a hub that is dedicated to collaboration and transparency; currently, there is no single system that brings different components of data (e.g., fuels data, vegetation data, etc.) together and curates these components, and the WIFIRE Lab is a hub that aims to change that and resolve this issue.

Communication with Public

12. The utilization of next-gen models will help but an aspect that is not often considered is the public and political side to fire management. Making sure that the tools being used can effectively communicate what is occurring and what the risks and consequences of burning now against burning later.

13. Efforts can be geared toward making model outputs self-describing, and effectively explaining AI and the validity of models to the public.

Synthesis and Conclusions

Participants pointed out many key considerations for moving forward with AI in fire mitigation and prevention, identifying many challenges the field faces around common data structures, model and data sharing, and institutional challenges towards making the progress necessary. The opportunities identified created a roadmap for clear implementation of the WIFIRE Commons prototype.

Broader Impacts / Long term benefits

- The value of this type of system for initial attack firefighters is that Burn Pro 3D will have long term effects by allowing for much more extensive controlled burning, thus reducing the intensity and severity of wildfires across the State, creating a much safer and more predictable fire environment for firefighters in the future
- Decision-making in the moment
    - Coping with complexity
    - Sharing decisions in better vis
- Reinforce messages - Public confidence
    - Moving the State of CA residents towards and understanding and acceptance towards large scale healthy fire practices