Using Multi-Agent Systems to Design an Effective Communication and Plan Recommendation Tool for Smokejumpers

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Abstract

Extinguishing wildfires is a complex problem that requires communication between and coordination of multiple teams as well as people within the teams. In this paper we address the problems of communication and multi-agent coordination for a specific type of wildfire fighting team - smokejumpers. Tying together ideas from related work and experts in the field, in this paper we present a dashboard tool to: (1) bridge communication gaps between multiple coordinating parties (2) provide a visual representation to allow the team leader to make and execute better plans (3) generate recommendations to improve fire-fighting strategies and outcomes. We show effectiveness of approach through simulating various fire outcomes and have set up the dashboard to be tested in the field as the next step.

Keywords

multiagent systems, multiagent coordination, multiagent communication, cellular automata, firefighting, smokejumpers

1 Introduction

The number of wildfires in the world is increasing with the onset of climate change. The ecological, social and economic costs of these fires are as drastic as ever due to the threat to public safety, property, natural resources, and forest ecosystems. Only in the state of California in 2014, the costs of wildfires have approached $1 billion.

Extinguishing a fire requires multiple teams and team members within those teams to coordinate, make a joint plan about how they are going to extinguish a fire, securely transfer information, and make decisions with limited data available. Wildfires could be extinguished more efficiently and their social and economic costs reduced by the use of artificial intelligence, particularly multi-agent systems, reasoning under uncertainty, and plan management.

In this paper we will focus on a particular type of firefighting team: smokejumpers. Smokejumpers are wildland firefighters trained to parachute into fires. Their primary mission is fire suppression and with the speed, range, and capacity of their fixed-wing aircraft, smokejumpers are capable of quickly delivering as few as two or as many as 20 firefighters, with equipment and supplies, directly to the fire in a single trip. Smokejumpers are most often deployed to fires that are extremely remote. There are approximately 500 smokejumpers in the United States responsible for extinguishing about 5% of all wildfires.

From speaking to multiple professionals in the field including Bill Cramer, the base manager of Alaskan smokejumpers, and Daren Belsby, the base manager of North Cascades, it was clear there was both opportunity to improve communication and coordination between the dispatch (role discussed below) and the smokejumping team as well as provide tools to affect planning.

2 Related Work

2.1 Fire Models

Bodrozic et al. produced a piece of related work on the modeling of the spread of fire using cellular automata [1].Quartieri et al. build on this work and introduce an "ignition probability" [2]. However all the rules of the model are very primitive in both papers (the ignition probability, for example is only based on averages of the surrounding burning cells). In our work, we expand on the model to use more sophisticated (and closer the real world) probabilities as well as incorporate real data to achieve empirical results.

2.2 Optimal Firefighting Strategies

Although there is no previous work in the field of smokejumping, literature exists on solving sequential decision-making problems under conditions of uncertainty in forestry [3,4]. We borrowed the MDP framework used in these papers and apply it to the question of finding optimal strategies for fighting fire, given a model of the fire.

2.3 Use of GIS for Emergency Management

There exists much related work on the positive impact of graphical information systems on emergency management outcomes [5,6] including in the area of firefighting. Although no work has been done for smokejumping teams in particular, this literature lead us to hypothesize that in addition to serving as a communication and planning tool, having a visual representation of the fire before the actual encounter can positively impact team-planning outcomes.

3 Background

3.1 Domain description

Before we dive into the problem, we us introduce some relevant terminology from the domain:

Dispatch team
: Team responsible for recording any reported information about the fire, assigning the mission to the smokejumping team, and long-distance commumication with the smokejumping team during the fire as record keeping afterwards.

Smokejumping team
: Team responsible for parachuting out of planes to put out fires.Two important roles on the smokejumping team are:

Spotter Stays in plane, responsible for planning mission

IC Leader on the ground, coordinates team on the group to put out fire

Currently when a fire ignites, the order of actions is the following: the Fire Management Organization (FMO) gets alerted about the fire, the FMO coordinates with the landlord for that land (if there is one) regarding the intention of the fire and what part need to be extinguished, the FMO alerts the dispatch with all the gathered information, the dispatch alerts a smokejumping base, the spotter organizes crew based on information and the crew takes off, the spotter updates dispatch with latest info from the aircraft, the IC is designated based on the difficulty of the fire and the team jumps.

It is important to note that currently all the communications between the smokejumping team and the dispatch are done over either regular and satellite phone.

4 Problem Description

The first problem we identified is that lots of information (especially numerical information like geocoordinates, size of fire, fire descriptors, etc.) needs to get conveyed over the phone very quickly. The cost of miscommunication is high – it has result in wasted time and resources (where resources could include human life), but the probability of miscommunication with the current system is high.

The next problem we have identified is that the team has very little understanding of the fire before actually arriving to the fire sight and any available data about the conditions of the vegetation, etc is not considered before arrival on sight.

Finally the decisions for how to fight a fire are based completely on a single person's experience. While this has served the country well in the past, the fire could be tackled even more efficiently by providing various recommendations on approaches to fighting a particular fire.

4.1 Mathematical Model of Fire

We have considered several models of fire spread (as discussed in our related works section), deciding on the cellular automaton model. Cellular automaton model is a collection of "colored" cells on a grid of specified shape that evolves through a number of discrete time steps according to a set of rules based on the states of neighboring cells. The rules are then applied iteratively for as many time steps as desired.

We have adapted this specific model of fire because it is a simple 2D model could be easily expandable to 3D and allows to account for various factors that impact a fire including: vegetation, flammability, size/shape of fire, and wind direction and intensity data.

From a theoretical point of view, four main ingredients play an important role in cellular automata models:

- The physical environment

  This underlying structure consists of a discrete lattice of cells with a square topology (but could be changed to a different topology). These cells are equal in size and the lattice is finite in our model.

- The cells' states

  The state of each cell in our model encodes the following information:

  1. Geocoordinates (latitude, longitude)
  2. Vegetation Intensity (a percentage calculated of the type of vegetation in the area and how flammable it is). A vegetation intensity 1 of means catches on fire very easily, and 0 means impossible to catch fire.
  3. Wind Direction (Assuming the possible directions are n,s,w,e,ne,nw,se,sw)

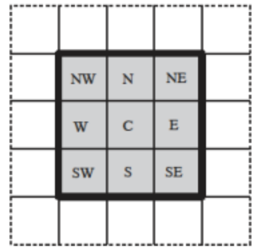


Figure 1: Moore neighborhood

4. Wind Intensity (represented as a percentage and calculated off the speed of wind)
5. Fire Intensity (represented as a percentage and calculated off the amount of factors like vegetation and wind present in the cell as well as the state of surrounding cells). More discussion to follow.
6. Firefighter information if there is a firefighter present in the cell

- The cells' neighborhoods

  For each cell, we define a neighbourhood that locally determines the evolution of the cell. The size of neighbourhood is the same for each cell in the lattice. In a two-dimensional lattice, there are several possibilities, but we chose to use the Moore neighbourhood (Fig 1).

- Local transition rules

  This rule acts upon a cell and its direct neighbourhood, such that the cells state changes from one discrete time step to another. The rule is subsequently applied to all the cells in parallel and a global change is calculated.

Having developed a model of a fire, given inputs like the geocoordinates, the size, and intensity of the fire, we are able to use cellular automata to simulate how the fire will develop over time.

One of the most interesting and early conclusions of the project was the difficulty of effectively modeling a situation such as a wildfire extinguishing operation. The model may be too complex and rely on too much data input, providing an overly specific and ultimately unrealistic view of the fire. On the other hand, too simple of a model loses its credibility and usefulness for the firefighters. One of the great challenges of this project was balancing these variables and delivering a model that was simple enough to be use-able but complex enough to provide valuable insights and recommendations.

4.2 Learning a policy

Having developed a model of the fire and the ability to simulate it over time, we now were interested in the learning the best policy for placement of firefighters to accomplish the mission in the minimal number of time steps.

To learn the optimal policy based on our model, we implemented both value and policy iteration (to see which would deliver the better results quicker).

Both value and policy iteration are methods of computing an optimal Markov Decision Process (MDP) policy and its value.

Value iteration starts at the ”end” and then works backward, refining an estimate of either Q* or V*. Value iteration starts with an arbitrary function V0 and uses the following equations to get the functions for k+1 stages to go from the functions for k stages to go:

$$Q_{k+1}(s,a) \quad = \textstyle\sum_{s'} P(s'|s,a)\ (R(s,a,s') + \gamma V_k(s')) \quad \text{for } k \geq 0$$

$$V_k(s) \quad = \max_a Q_k(s,a) \quad \text{for } k>0.$$

Policy iteration works similarly but starts with a policy and iteratively improves it. It starts with an arbitrary policy 0 (an approximation to the optimal policy works best) and refines it.

In order to use value or policy iteration, we had to convert the state space into an MDP.

An MDP is defined by {S, A, R, T}, where S is the set of possible state, A is the set of possible actions, R is the reward function, and T is the transition matrix.

For our problem definition, the MDP was the following:

- S: all the cells in the area of our simulation
- A: {move 1 cell north, move 1 cell south, move 1 cell east, move 1 cell west, move 1 cell northeast, move 1 cell northwest, move 1 cell southeast, move 1 cell southwest}
- R: rewards are precalculated based on the intensity of a given fire and proximity to this fire [possibly more discussion here on how this was calculated]
- T: we chose for the transitions to be deterministic, so if a firefighter choses to move west, he will move there with probability 1.

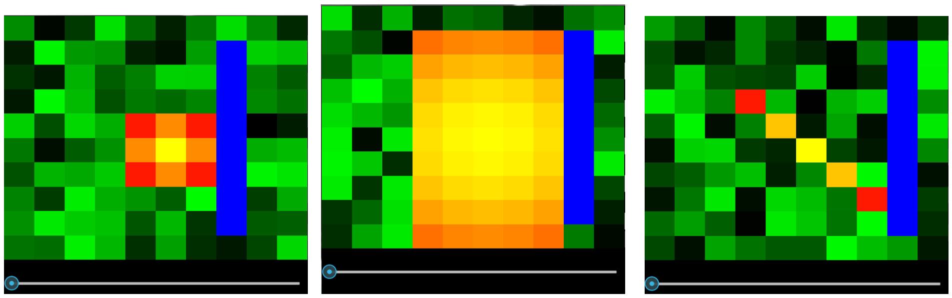
5 Empirical Testing Strategies

We have spoken to several domain experts and referred to literature on wildfire fighting strategies to discover the most popular and effective strategies for fighting fires:

- Control Line: establishing natural or man-made boundaries to control where a fire spreads
- Flanking: starting from the burned areas, firefighters work their way around the edge of the fire spraying the flames in the process
- Hot spotting: identifying the most dangerous portions of the fire and focus on keeping those areas in check
- Knock Down: once hot spots have been assessed in hotspotting, firefighters focus their resources to suppress those spots immediately

We chose components of most of these strategies to derive our own strategies in in this paper:

- Point Configuration: firefighters approach the fire from one side and use hot spotting/knock down strategies



(a) A small round fire (b) A medium elliptical fire (c) A medium odd fire

Figure 2: Types of fires

- Surround Configuration: similar to flanking, where firefighters surround the fire and also use hot spotting/knock down

We have designed 3 different sizes of fire to evaluate on: small, medium, and large, and 3 different shapes: round, elliptical, and non-uniform as can be seen in Figure 2.

Our evaluation here consists of comparing 4 different firefighting approaches:

- Random: firefighters move randomly around the board
- Greedy: firefighters move in the direction of the hottest fire that is closest to them
- Optimal: each of the firefighters uses value/policy iteration to pick the next move ignoring the rest of the firefighters
- Team Optimal: each of the firefighters uses value/policy iteration to pick the next move taking into account the rest of the firefighters on the board

6 Results

The goal of this project was to provide three unique contributions to the problem of teamwork in extinguishing wildfires:

1. Improve method of communication between dispatch the smokejumping team
2. Improve planning by providing a visual representation of the fire
3. Provide a useful and relevant planning assistant to allow teams and their leaders to effectively plan the strategy of attack, minimizing their costs, maximizing their safety, and maximizing overall speed of the fire extinguishing effort.

One difficulty in evaluating this work was that as a tool to be used in the field, the only true way of gathering experimental data to support the claims and efforts put forth in this paper would be real in-field research with test and control groups determining how much better or worse teams equipped with the technology could perform in similar circumstances. An alternative to this could be to follow up with one of the domain experts whose expertize was utilized in the research component of this project and to ask for a professional evaluation of the product and its projected utility in the field. Both of these approaches, however, were beyond the scope of this project and are left as areas for future work and exploration.

Instead, for this project, we utilized hypothetical scenarios and common practices derived from initial research of the domain, as outlined in the Empirical testing Strategies section above. Using this, it was possible to gather some initial quantitative results representing the efficacy of the prototype. We now provide both these quantitative as well as some qualitative assessments of the successes of these two goals at the conclusion of the project.

6.1 Communication

The purpose of the communication goal was to reduce the overhead of using human visual information, vocal communication methods, and transcriptions for information gathering, conveying, and storing respectively. In the status quo, firefighters and dispatchers convey incomplete, temporary, visual information to each other over a satellite phone in order to determine the course of action to be taken. This method of gathering data is very time-sensitive - fires spread quickly and it is difficult for a firefighter to constantly update dispatch on the situation. Additionally, the record keeping of the data is highly unreliable as it relies on dispatch transcriptions, which are, much like the observations and reporting strategies used by the firefighters, prone to human error. In the prototype presented here, all three of these elements of poor communication have been effectively eliminated.

The first, reliance on pure visual information, has not been fully solved by this prototype, but can very easily be with integration of visual parsing as a replacement to the current data input by hand. In the current iteration, the prototype calls for a manual configuration of fire size and parameters. This, however, may be offset by integrating a camera into the device on which the software is running, and using an image parsing library to very accurately map the fire seen by the firefighter into the model representation.

The second, time-sensitive problem of the information conveyed, is solved by the temporal nature of the proposed model. Rather than simply providing the firefighters (and subsequently, dispatch) with a stationary model of what the fire looks like - in and of itself a great step towards better communication practices - the prototype also provides a useful prediction of how the fire will spread over time. This is useful to both the firefighters, to help them make assisted decisions on tackling the fire, but also helps dispatch determine whether more resources will be required given the nature of the fire and its spread.

The third and final aspect of communication that needed to be solved was the inaccuracy of the transcriptions and the difficulty of record keeping in the area of firefighting as a result of lost or mistrascribed information. This product solves for this issue by encoding in a storeable and digital fashion the nature of the fire, its spread, and even the precise means by which it ought to and potentially ultimately was attacked. Though this current version of the prototype does not provide explicit storage capabilities, it is easy to see this as an extension that could greatly enhance the record keeping of dispatch which is useful for a variety of reasons including accountability, training, and general reports management.

This was the component that was most difficult to evaluate and impossible to consider quantitatively without testing in the field. However, the improvement in communication is a benefit that comes from the use cases of the dashboard: instead of communicating the information over the phone, the dispatch will simply input the information into our tool. This makes it easy for the smokejumper to take in the information visually as well as easily update the information using the same medium. Since the information is already input into the tool, no extra steps need to be taken to compute the model and provide recommendation: which are our other 2 goals for this tool.

6.2 Plan Recommendation

The previous section outlined qualitatively the problems that were solved in the area of communication by the software presented in this project. In this section, we present the plan recommendation component of the project and evaluate it quantitatively. In order to fully understand the below graphs, it is necessary to first understand the testing framework that was adopted for this component of the project. Below, we outline all of the different components being tested and the comparisons that are being drawn.

6.2.1 Test Framework

The selected test framework was rather simple. On a small, 10x10 board, generate a variety of different common fires in different sizes. Consider several potential starting positions for the firefighters and run each test through 10 iterations. For each iteration, plot how many timesteps were required to eradicate the fire, and then take the average timesteps required for each strategy and plot this in a bar graph. Below are descriptions of the exact variations on each of these tests and the actual graphed out results for many of the tests.

6.2.2 Fire Shape

Three standard fire shapes were considered for this problem - Round, Ellipse, and Non-Uniform. The round fire was simply a fire centered in the middle of the board with a provided radius (determined by the size, which is outlined below). This was a representation of the most common and simple fire that spreads uniformly in all directions. The ellipse fire was simply two round fires placed next to each other. This model provided an elongated version of a fire that often gives firefighters trouble as it is difficult to decide which action to take in the circumstance given that the fire is so difficult to attack. The non-uniform fire is a long, diagonal line of fire that spreads in all directions and is far more unpredicatble than the others. This was the more challenging fire utilzied to evaluate more realistic scenarios.

6.2.3 Fire Size

The three sizes considered for these tests were Small, Medium, and Large, where Large began by taking almost the entirety of the screen while Small was a very simple fire that was usually taken out in 3-5 timesteps by the firefighters.

6.2.4 FireFighter Initial Placement

Three initial placements were considered - point placements, surround placements, and optimal placements. The point placement configuration simply stacked all of the firefighters in one area along one of the sides of the fire. This is the most common strategy used in practice, where firefighters descend to one location and chase the fire to put it out. The second, more comprehensive configuration that is more challenging to organize and thus used less often in the field is the surround strategy (or flanking strategy as it is sometimes called). This strategy calls for the agents to fully surround the flame in the hopes of stopping its spread early on and containing it. The final strategy is the optimal arrangement. This uses the value and policy iteration techniques to maximize the utility of the firefighters by placing them in the best possible locations to gain the most rewards by eradicating the fires fastest. These placements were interesting and obviously of great use to firefighters, but as they were derived to be optimal it was clear that they were going to be the best option in each scenario so it was unnecessary to actually test this configuration against the others.

6.2.5 FireFighter Strategy

Four different strategies were developed in order to get the firefighters to put out the fire faster by working together. The first strategy is random, where a firefighter selects an action at random and takes it in the hope of achieving success. Though this is not practical in reality, we got some interesting results with this strategy and decided to keep it in the testing framework as a sort of baseline approach - if our approaches cannot do better than a simple random approach, then they would not be useful to the problem space. The second approach considered was a local-search inspired greedy approach. This agent strategy simply found the nearest and hottest fire and directed itself towards it. By eradicating the hottest fires, not only would this agent prevent further spread, it would also significantly and quickly decrease the total number of burning cells. The final two strategies were based on solving the MDP - the first being an optimal strategy based on a single agent solving the MDP and taking the best possible actions to maximize its rewards. The second was a multi-agent teamwork based approach, where agents solved the MDP after being signaled to by the other members of the team, allowing for a more comprehensive set of actions

6.2.6 The Graphs

Here we present our results based on execution of the above tests. A discussion of these graphs follows below.

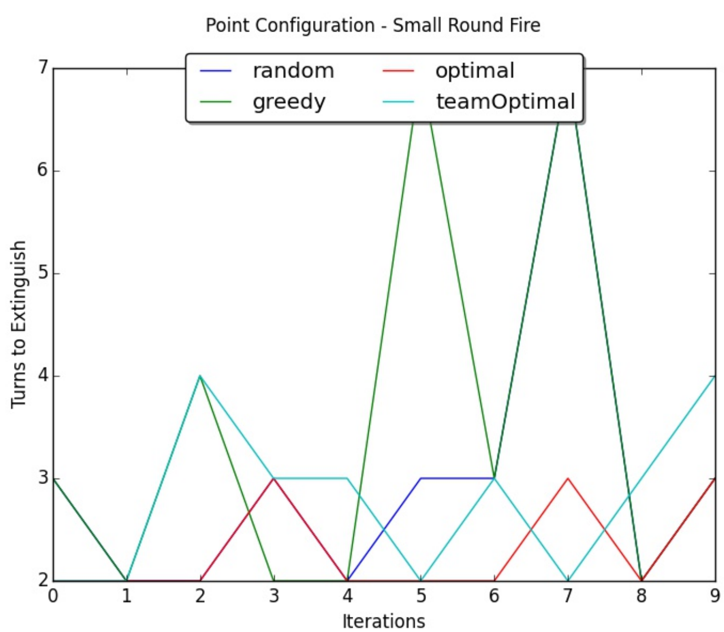


Figure 1 - Point Configuration for a Small Round Fire

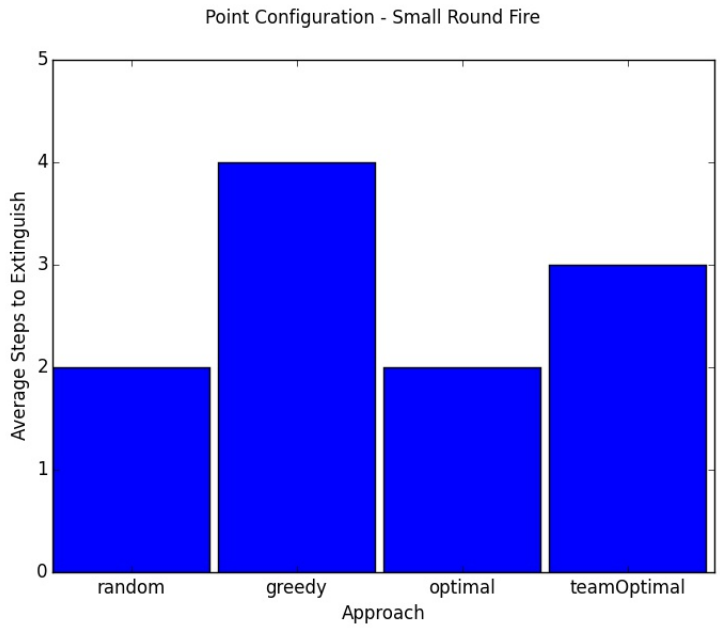


Figure 2 - Point Configuration for a Small Round Fire Bar Graph

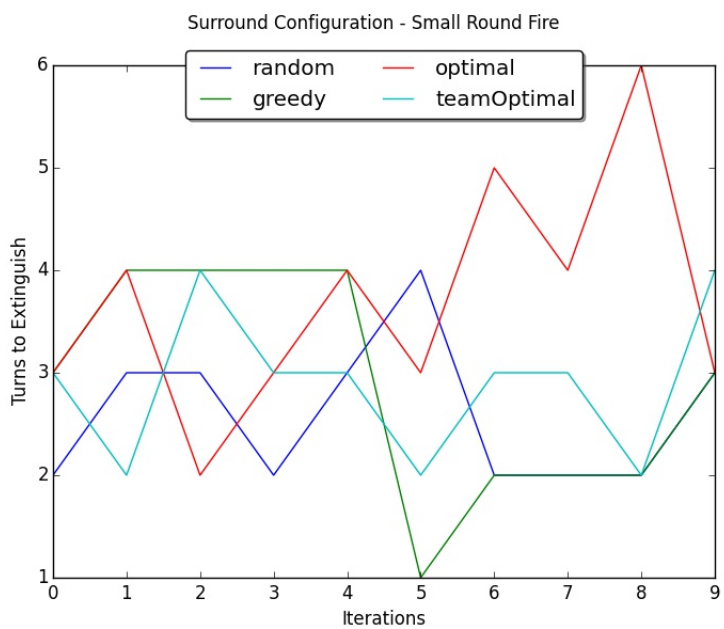


Figure 3 - Surround Configuration for a Small Round Fire

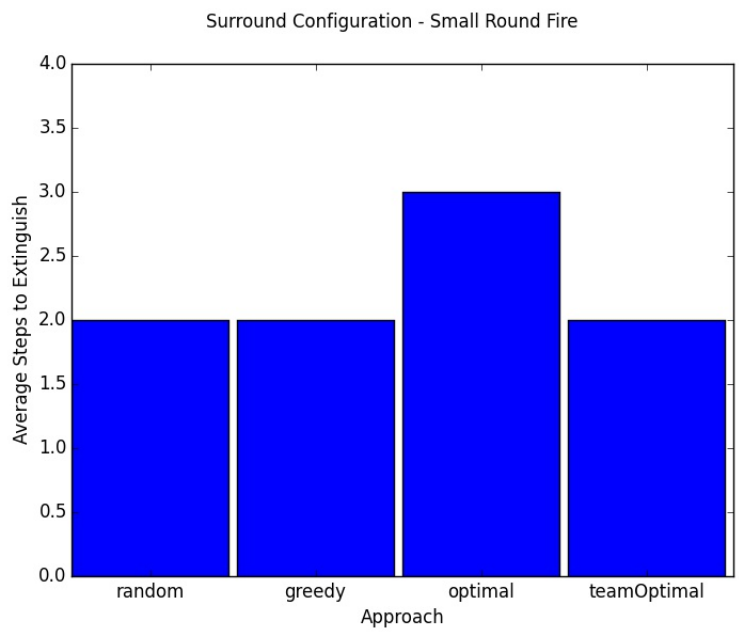


Figure 4 - Surround Configuration for a Small Round Fire Bar Graph

Let us first examine the results for the simplest fire: a small round fire. As we could see in by examining the point configuration in figures 3,4, random and optimal performed the best on average, extinguishing the fire in just 2 time steps. This performance was followed by team optimal and lastly the greedy strategy. Since this is just a small and simple fire, and random performed just as well as optimal, this graph shows us that strategizing for small fires may not have a substantial impact on outcomes.

Looking at the surround configuration for small round fires tells the same story: optimal in fact fares the worst here, which means for small fires the simplest does the best.

Another factor to consider is that our reward function in the MDP is not optimized for taking out all fire instances in the shortest period of time but rather putting out the highest intensity fires the fastest. This means that strategies like random can simply "get lucky," especially for small fires and outperform optimal.

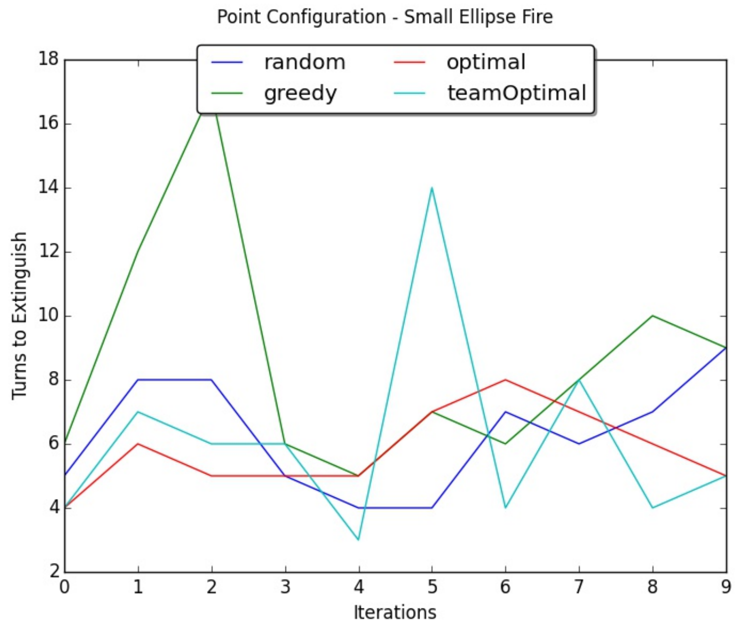


Figure 5 - Point Configuration for a Small Elliptical Fire

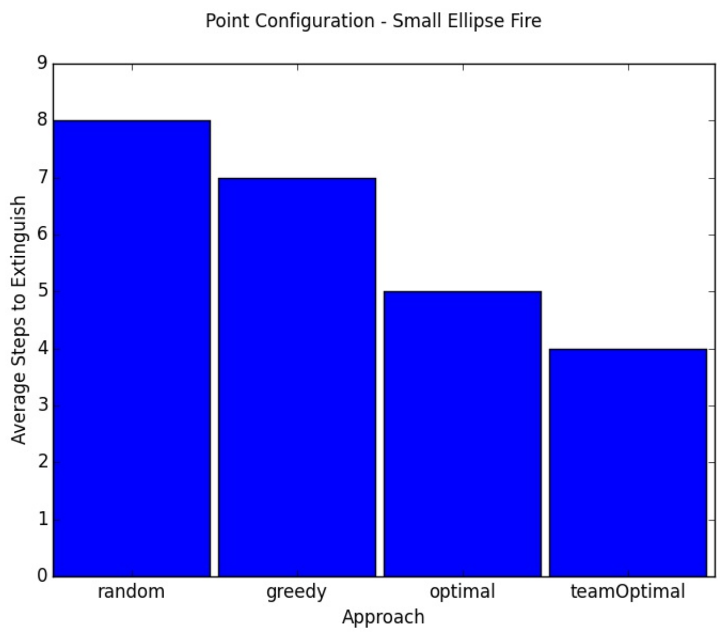


Figure 6 - Point Configuration for a Small Elliptical Fire Bar Graph

Let us now examine a small elliptical fire. Here the results follow our expectations exactly: team optimal performs the best, followed by optimal, greedy, and finally, random.

The elliptical shape is a bit more complicated and requires somewhat more strategizing than for a small round fire. This is because the elliptical shape can let the fire spill out from both sides if not properly surrounded. Thus, it is sensical that the agent that works within a team performs the best while an agent that moves randomly would fare the worst.

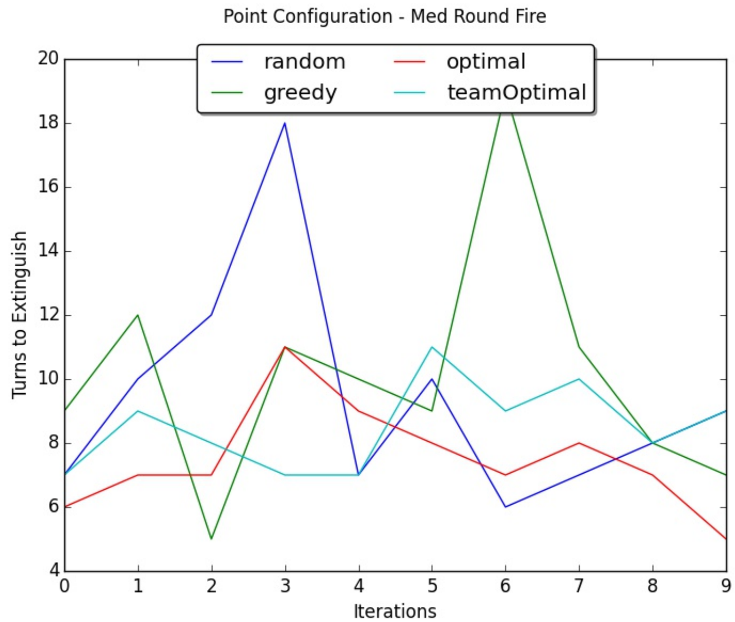


Figure 9 - Point Configuration for a Medium Round Fire

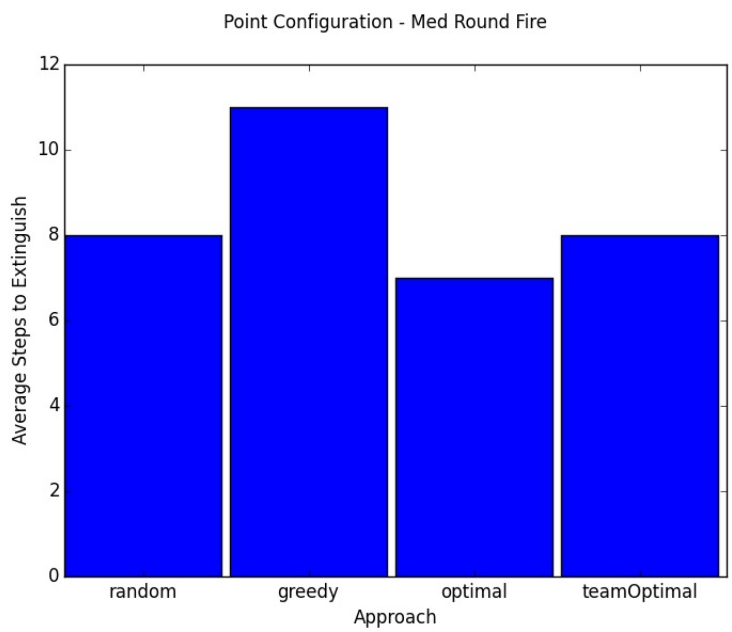


Figure 10 - Point Configuration for a Medium Round Fire Bar Graph

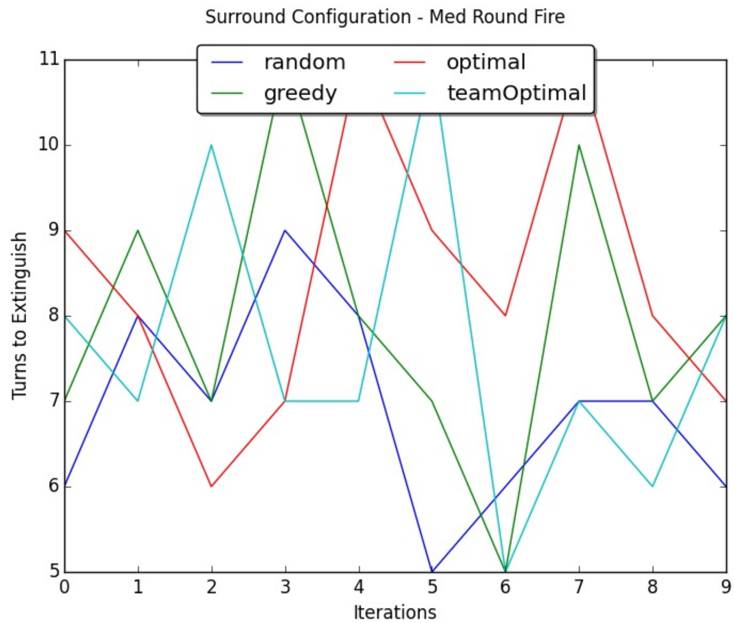


Figure 11 - Surround Configuration for a Medium Round Fire

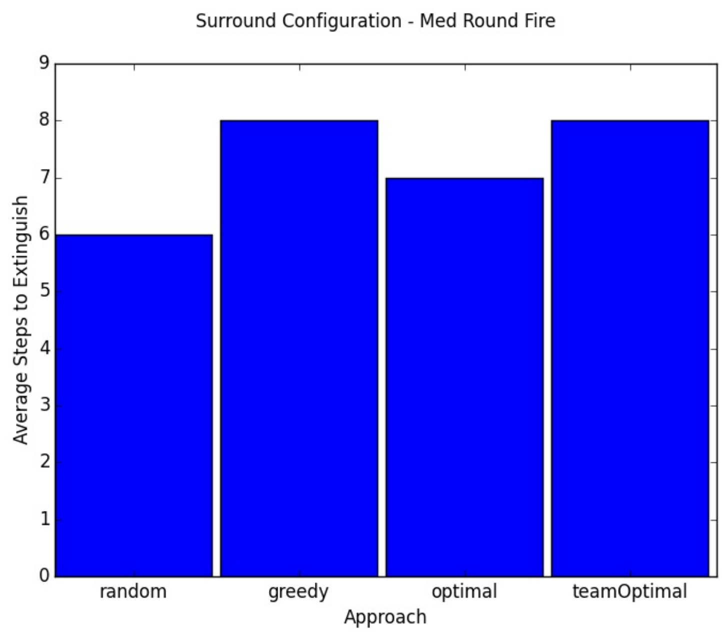


Figure 12 - Surround Configuration for a Medium Round Fire Bar Graph

These graphs reveal much both about the optimal strategies we employed in this test framework and about the differences between the point and surround initial configurations. The two sets of graphs differ drastically - the first, driven by point configuration, has decent performance for both its optimal and team optimal strategies, while experiencing several difficult trials with the random and greedy policies, pushing their average timesteps to extinguish the fire.

It is clear from the bar graph here that the optimal strategy performs exceptionally well for this initialization, which is to be expected. What is unexpected, however, is its poor performance on the surround policy. In fact, the random policy, on average, extinguishes the fire 1 timestep quicker than the optimal strategy and 2 timesteps quicker than the team strategy. Generally, there does not seem to be one strategy that clearly predominates in this case, despite the random policy having a slightly better average performance.

In the line graph, there is much variability in all of the approaches, which seems to indicate that the strategy for surrounding the fire is in and of itself extremely effective in deterring its spread and in putting it out. This makes sense intuitively - when a uniform fire is surrounded by firefighters, the fire simply cannot spread, and even randomly moving agents will quickly manage to extinguish all the flames. This is supported by our optimal lineup generated for this fire, which also suggests a roundabout layout of the firefighters as the optimal strategy of attack against this and all other round fires.

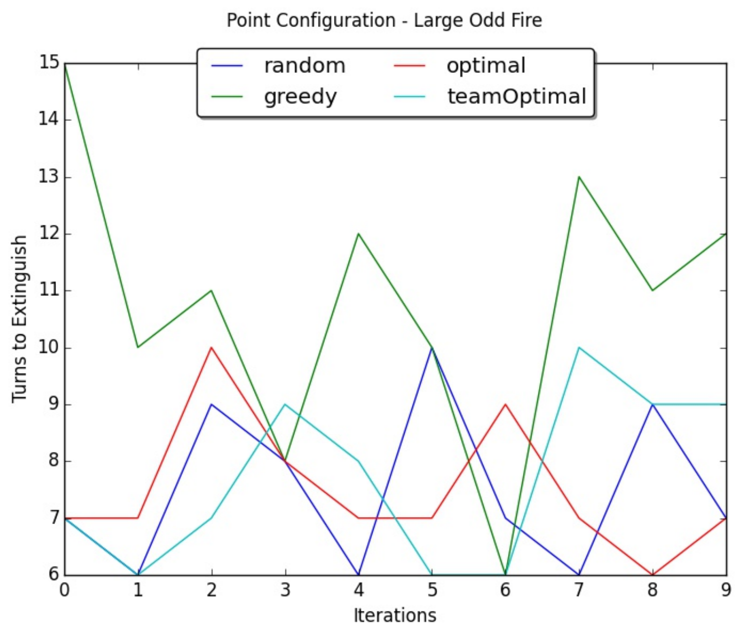


Figure 12 - Point Configuration for a Large Odd-Shaped Fire

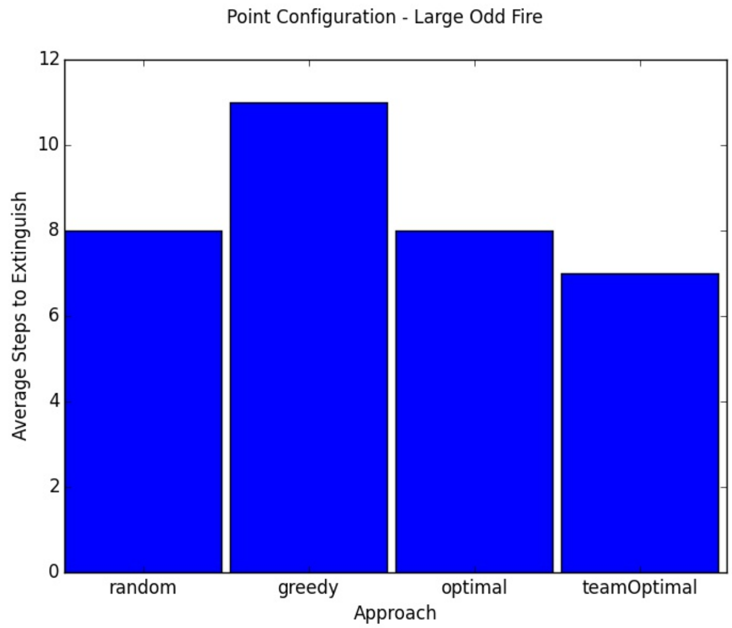


Figure 13 - Point Configuration for a Large Odd-Shaped Fire Bar Graph

For the large odd-shaped fire, team optimal strategy performed the best, followed by optimal and random, and then greedy. Since the odd-shaped fire (as seen in Fig 2) is more spread out, the reasoning for why team optimal would perform the best is similar to the elliptical fires: since the shape is more complicated, there are multiple ways for this fire to escape and so strategizing from the beginning about how to contain it can certainly help improve outcomes.

7 Conclusion

The purpose of this project was to utilize multi-agent modeling to create a more reliable approach to extinguishing wildfires by improving communication, coordination, and planning for smokejumpers.

The results for the communication portion of the product are hypothetical and based on qualitative comparisons to the status quo. However, as mentioned the communication results are not the focus of the project since the improvement in communication comes as a by-product of inputting data into our platform (which can also easily track information eliminating the need for transcription) and using this as a substitution for communication by phone (the state quo).

Results for the planning and modeling component were evaluated on their effectiveness by quantitatively comparing recommendations to commonly used approaches for tackling wildfires. Of the two components of firefighting strategy planning, the focus of this evaluation was on the actual policy taken upon landing rather than the initial distribution of the firefighters. This was done for two reasons - the first was that the derivation for the optimal initialization was rather slow and not conducive to repeated, rigorous testing. The second was that by the nature of the optimal distribution, it would always perform better than any other initialization. It was more valuable to determine the optimal strategy on the ground therefore, and then utilize this to derive the optimal initialization parameters. For this reason, the evaluation approach considered only the post-landing strategies, including a random approach, a greedy approach, an optimal, value iteration based approach, and a team-oriented multi-agent value iteration based approach.

Based on our research and talking to domain experts, out of our implemented firefighting strategies, the greedy approach is most similar for firefighters act on the ground. As can be seen in our simulations, optimal and team optimal strategies outperform greedy for all fire-sizes except small (as discussed above). Although our tool could use more testing, these preliminary results lead us to believe that firefighters could benefit significantly from taking into account policy recommendations.

Ultimately, this project reveals that even in its preliminary stages, a tool such as the one presented in this paper has promising results in improving the capabilities of firefighters and their teams in extinguishing wildfires. Though the domain explored in this project was very narrow and specific, and though the final prototype would not be ready to go into production as a companion application for smokejumpers around the country, the success of the prototype reveals the immense potential this work may have if developed further. As will be discussed in the Future Work section below, with only a few small improvements to the user interface, data syncing, and computational optimizations, this product could certainly be utilized to its full potential. At its current stage, this prototype still needs the be rigorously tested and refined in the field, but the results drawn in this paper, from both a communications and a plan recommendation perspective are highly promising.

8 Future Work

These are several steps we envision for this work to take in the future in several areas:

- Data: An immediate step which we have already gathered the majority of the data for would be incorporating actual wind and vegetation data based on the input gps coordinates of the fire.
- Fire model: There are two important parts that were beyond the scope of this project, but could be incorporated in the future: indicating sensitive burning areas and the corresponding priorities (whether there are people in the fire, endangered species, etc.), as well as incorporating the notion of safety (determining which parts of the fire are safe for firefighters to enter).
- UI: In order for this tool to be effective with smokejumpers, the UI would have to be carefully designed and evaluated to best suit their needs and use cases.
- Testing: Beyond the simulations we conduced, we see the next step for evaluation (before taking the tool out to be tested in the field), to be evaluating various strategies and use cases by domain experts.
- Alternative applications: although we designed this tool to be used during an actual fire outbreak, another good use case would be to train of smokejumpers to learn how to tackle various types of fire.

References

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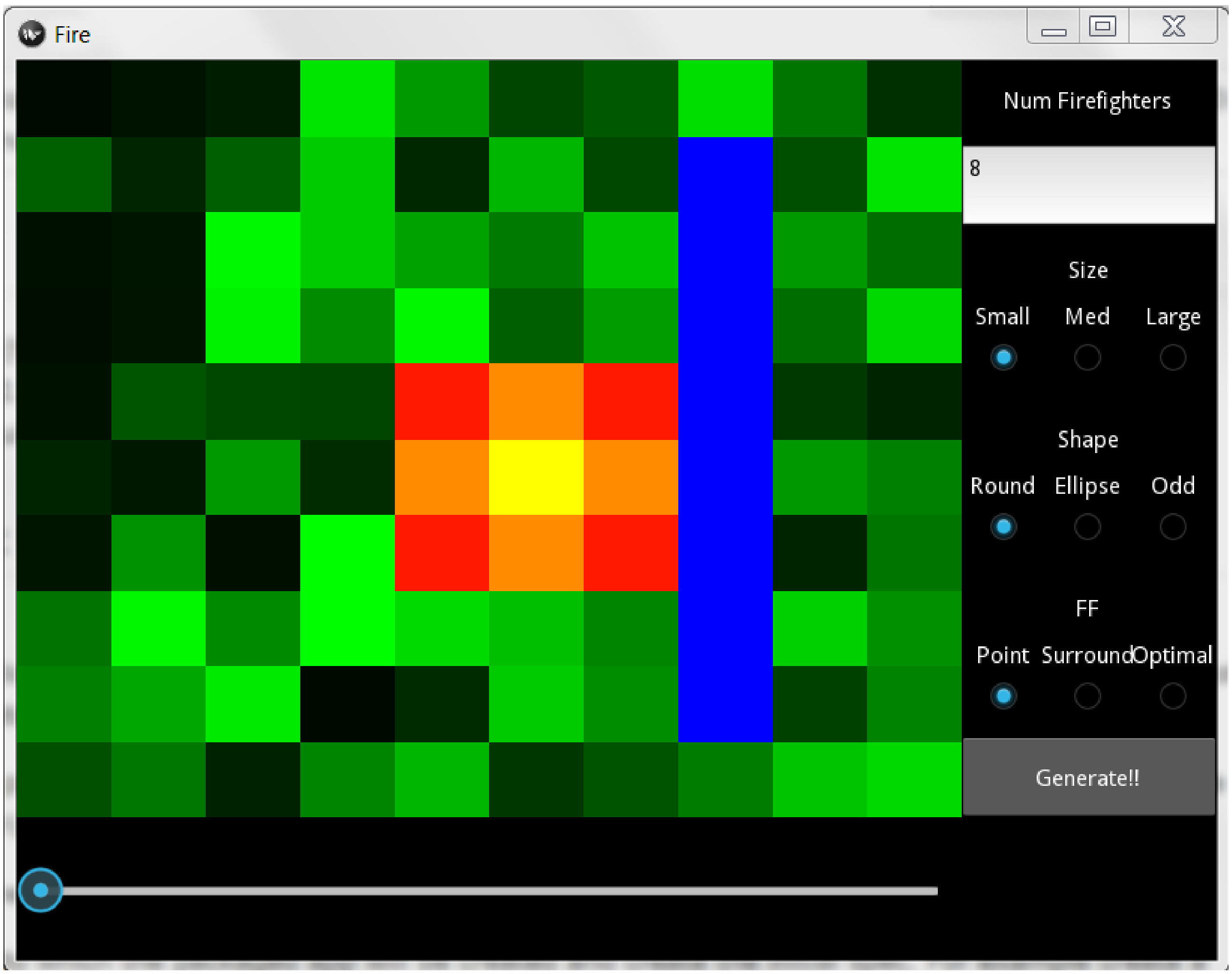
9 Appendix

9.1 Figure A. The User Interface of the Dashboard



9.2 Figure B. Incident Dispatch Log for Dalton River Crossing Fire Department

Entry Time	Station	Channel	Incident Log Entry	Entered By
5/20/2014				
19:30:29	Smoke Report	From Smoke Report TTY Message	No TTYMessage Message Sent	jmedl
19:30:30	Smoke Report	From Smoke Report Comments		jmedl
19:31:35	butteri	phone	notified of report and coming in	jmedl
19:31:49	aicc tac	tty	roll 1 load of smj	jmedl
19:44:49	j-12	blue	+23 ete. +aff	jmedl
19:47:35	437cc	sat phone	@ 1935 reporting fire upstream yukon river crossing, 2 acre burning in spotty fuels, 100 % active, 15ft flame lengths with variable E and N winds. East winds carry fire parallel and north winds away from structure threatened with 2 people on the ground at structure.	jmedl
19:48:16	437cc	sat phone	@ 1935. advised J-12 will be responding and given 128.45 for commo. sat phone [redacted]	jmedl
19:49:22	437cc	sat phone	BLM Ranger McMillan in a super cub, FDO, will stay over the fire to keep an eye on people on ground.	jmedl
19:50:15	437cc	sat phone	access 1/4 mi north bank of the yukon river by boat. by ground north side upstream of yukon river bridge, access 2 mi hike	jmedl
19:50:46	437cc	sat phone	declaring an emergency due to lack of egress possibility for the people on the ground	jmedl
19:52:05	7CC	Sat Phone	Fire update: 3 ac, running to the west, 20 ft flame lenghts. Relayed to J-12, helo ordered.	bamartin
19:52:12	helibase	phone	please launch H-6LE. gave fire info toasty	jmedl
19:56:01	Civilian	Phone	David sees large column, can`t see actual fire, looks like it`s widening. Contact [redacted]	bamartin
19:59:58	7CC	Sat Phone	Dropped note to the occupants to notify them firefighters were en route	bamartin
20:00:05	437cc	sat phone	@ 1935 fire burning within 100 ft of structure	jmedl
20:04:19	6LE	person	Will launch to fire. Will send a fuel truck up.	hshook
20:14:03	j-12	blue	over the fire coords are correct. east side of the haul road. other structure in direction of the river, south of main structure several hundred yards out from fire but threatened.	jmedl
20:14:49	j-12	blue	3 acres, 50% active, old burn area. pockets of fire.	jmedl
20:17:28	J-12	blue	not a suitable jump spot around the fire. put jumpers out near 5 mi bridge. counting on H-6LE for support.	jmedl