Illustration of our model

Different from what our project spec in which we wanted to minimize fire-fighting time to put off all the fire subject to firemen wages and fire truck transportation expenses that are less than budget constraints and saving animal species, our project now determines at each time t (calculated in days that has a range from 1 to 30) how much resources (including labor, helicopters, and super tankers in our problem) we should use in order to control the fire and deal with the minimal cost to control the fire to certain range (less than initial burning area or less than twice the initial burning area depending on scenarios). Moreover, we do not include wind speed explicitly in our model. Instead, we use a uniform distribution from 0.5 to 1 squared km to model the fire expansion area because we searched data from the website fire speed is about 0.1 of wind speed on average, and because our grid is about 5 km2, we believe 0.5~1 km2 is plausible. Thus, we generate uniform data around this point. Forest type is another thing we do not include in the final model explicitly. We implicitly modeled it by including the fraction of fire expansion in order to emphasize that certain forest type will slow down the fire expansion. Furthermore, in our original plan, we wanted to choose 15 cities to start sending firemen and trucks and tried to encompass the fire to put it off. However, we are now using a different strategy that we turn this stochastic graphic problem into an algebraic equivalence. In other words, we construct a function that outputs the burning area of each grid (i,j to indicate which grid) at a given time t and how it can utilize certain amount of resources such as labor(i,j,t), helicopter(i,j,t), supertanker(i,j,t) to put off fire. For the resources, we do not use trucks as specified in our project spec. Instead we will use helicopters and super tankers, which are more reasonable and more frequently to use when putting off the large range forest fire. Finally, we tried to solve different versions of the problem, from simple to considering more complicated factors. Specifically, we have 6 models or cases. More information about the discussions of different scenarios are included in our Jupyter notebook.

About our data, we tried to use all real data so that our model will be very close to the real-world situation. However, we ran into difficulty to get all authentic data and we use rationale and logic to obtain some reasonable data. Thus, we want to justify some of the data we used that are not totally real. For labor efficiency, we assume that a firefighter can put off 500 square meter fire in one day (working duration is 12 hours per day). For helicopter efficiency, since the helicopter can carry 7200 gallons of water and their drop can cover an area of up to 4 acres by NIFC, we calculated the approximate efficiency of a helicopter. Finally, for the cost of Boeing 747 super tanker per day which is 25000 dollars, we believe that since Brazil got a fund of 22 million dollars from G7 countries, they will use part of this fund for renting super tankers. Our research from the Internet told us the hourly rental price is 25000 dollars, and after calculating the rental price while considering the fund from G7 we got the conclusion that Brazilian government will only need to spend about 10% of the original rental price of super tanker per day, which is 25000 dollars per day.

At the end of our modeling process, we realize that it is better to use stochastic modeling to model this. However, it has more variations and requires more nodes at each time. Also, since our discussion about stochastic modeling is at the very end of the semester and we’ve already had a plan for our model, we finally do not use stochastic modeling. In addition, for the fire expansion area in our model, we are now thinking that we should find a better formula to generate this instead of just using a uniform distribution. Although we justified that this uniform distribution is reasonable, it may not be close enough to the real-world setting. Therefore, we believe that if we have a chance to revise and improve our model, we will think more carefully and try to include the function about the fire expansion area.