# Project CompSci 2020 (Wildfires)

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January 2020

## 1   Research

Wildfires are an uncontrollable fire in an area of combustible vegetation occurring in rural areas.

### 1.1   Causes

Wildfires are caused by either human ignition or natural causes. Humans are by far the most common cause for wildfires [4], causing 84% of wildfires in the US over the past two decades. The most common human causes include arson, discarded cigarettes, unattended campfires, burning debris and fireworks. Wildfires are also lit by farmers in some areas of the world to ensure the soil stays fertile.

Natural causes only account for about 16% of wildfires. The most common natural cause is lightning strikes.

### 1.2   Spreading

Any fire requires three components to burn: fuel, oxygen and a source of heat. These three components are often referred to as the fire triangle. In the context of wildfires, the fire triangle is scaled up to understand fire spread over a landscape. The three components for wildfires to burn are fuels, weather and topography [3].

Fuel is any flammable material surrounding the fire. In the case of wildfires this includes trees, bushes, grass and sometimes buildings. The more fuel an area has, the larger the fire can grow.

Weather factors such as wind, temperature and humidity also contribute to wildfire intensity. Wind is the most important of the three, because it supplies the fire with oxygen. Wind also pushes the fire in a new direction. The temperature of the environments affects the temperature of the fuel, which influences the chance of the fuel igniting. Humidity affects the moisture level of the fuel, low humidity levels increase the chance of fuel igniting.

The topography of a landscape includes altitude, slope, direction of slopes and features such as canyons and rivers. These topographical factors greatly

affect the spread of fire. For example, fire moves much more quickly uphill than downhill and landscape features such as rivers can act as fire breaks.

### 1.3 Effects

Wildfires can have tremendous effects on nature and human society. They often destroy huge amounts of vegetation and often buildings.

Naturally occurring wildfires can benefit vegetation and can help maintain native biodiversity [1].

## 2 Simulation

### 2.1 Previous work

In Freire and DaCamara [2], the authors discuss a CA model for modeling a forest fire that occurred in the Algarve (southern Portugal). In this model, Moore neighborhood was used. The authors used three rules:

- Rule 1 states a cell that cannot be burned stays the same.

- Rule 2 states a cell that is burning down at present time will be completely burned in the next time step.

- Rule 3 states a burned cell cannot burn again.

- Rule 4 states if a cell is burning down at the present time and there are next-nearest neighbor cells containing vegetation fuel, then the fire can propagate to its neighbors with a probability $P_{burn}$, which is a function of the variables that affect fire spread.

The probability $P_{burn}$ of a given cell depends on a constant reference probability that may be increased or decreased by means of different loadings, the constant reference probability $P_0$ is the probability that a cell int he neighbourhood of a burning cell starts burning at the next time step under no wind and flat terrain. Furthermore, $P_{burn}$ depends on the vegetation type, $P_{veg}$, vegetation density and $P_{den}$; on topography, $P_s$; and on wind fields, $P_w$.

See the paper for the formulas and values for the constants that were used.

## References

[1] Dominick A. DellaSala and Chad T. Hanson. *The Ecological Importance of Mixed-Severity Fires*. Elsevier, 2015, p. 450. ISBN: 978-0-12-802749-3.

[2] J. G. Freire and C. C. DaCamara. "Using cellular automata to simulate wildfire propagation and to assist in fire management". In: *Natural Hazards and Earth System Sciences* 19.1 (2019), pp. 169–179. DOI: 10.5194/nhess-19-169-2019. URL: https://www.nat-hazards-earth-syst-sci.net/19/169/2019/.

[3] National Park Service. *Wildland Fire Behavior*. 2017. URL: `https://www.nps.gov/articles/wildland-fire-behavior.htm`.

[4] Karen C. Short. *Spatial wildfire occurrence data for the United States, 1992-2015 [FPA$_F$OD$_2$0170508](4thEdition)*. 2017. DOI: `https://doi.org/10.2737/RDS-2013-0009.4`.