

# Agent Systems project: Forest fire simulation with use of cellular automata

Base project we found implementing basic simulation:

<https://scipython.com/blog/the-forest-fire-model/?fbclid=IwAR1Zw-Sw90MGI2fn5PV8ziI93T0bqFG4IcAK2HAvjn8vPreIHMh8ZK6jAPM>

Basic rules from that model:

1. A burning cell turns into an empty cell
2. A cell occupied by a tree becomes a burning cell if any of its eight neighboring cells are burning
3. A cell occupied by a tree becomes burning with a probability  $f$  (even if none of its neighboring cells are burning), as though struck by lightning
4. An empty cell becomes occupied by a tree with probability  $p$ .

Forest in that project is randomly generated with a set initial fraction of the forest occupied by trees.

Basic cells:

- tree
- empty
- fire

Additional concepts we implemented:

- more types of cells:
  - rocks
  - water
- inclusion of wind to fire spread
- time of burning: fire has 3 subtypes going from sparkles to coals,
- resistance based on tree state: trees also have few states: sapling, tree old and dead tree, each having altered probability of catching fire
- fire spread based on fire state: all fires also have different chances to spread

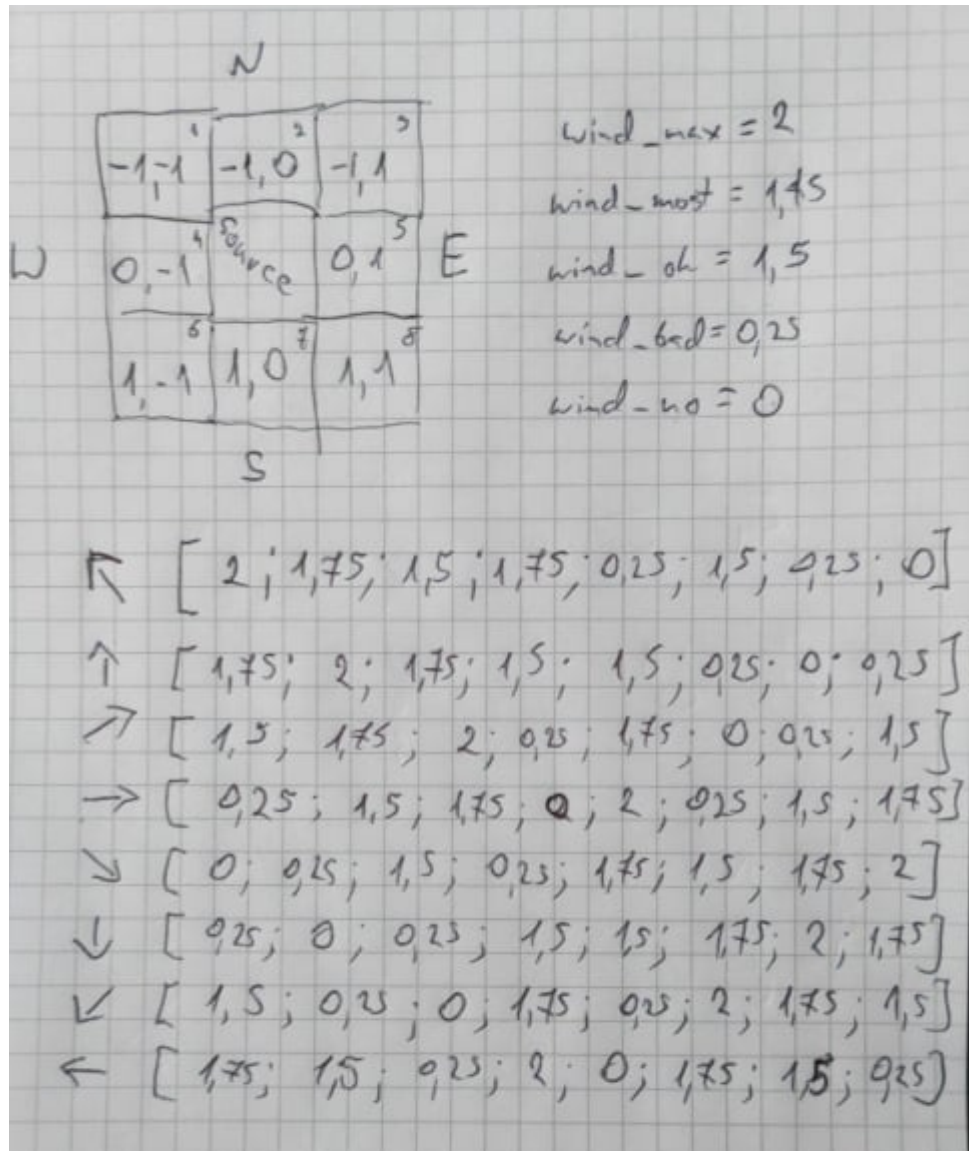
## Implementation Details

- Numpy - calculations
- Matplotlib - visualization + animations
- Streamlit - web app
  - easy to implement user input
    - columns  
(<https://docs.streamlit.io/library/api-reference/layout/st.columns>) + select boxes  
(<https://docs.streamlit.io/library/api-reference/widgets/st.selectbox>) to create editable input grid
    - select box for wind direction input
    - radios/sliders/number inputs for other user inputs (burning time, resistance etc.)  
<https://docs.streamlit.io/library/api-reference/widgets/st.radio>,  
<https://docs.streamlit.io/library/api-reference/widgets/st.slider>,  
[https://docs.streamlit.io/library/api-reference/widgets/st.number\\_input](https://docs.streamlit.io/library/api-reference/widgets/st.number_input)
  - apparently possible to embed matplotlib animations (this is the plan for presenting output)  
(<https://discuss.streamlit.io/t/matplotlib-animation-in-streamlit-through-html-js/5587>, )
  - easy to deploy for free e.g. to heroku

## Wind direction details:

it is based on applying mask concept over grid with added or reduced strength of fire spread like in this example for NW wind:

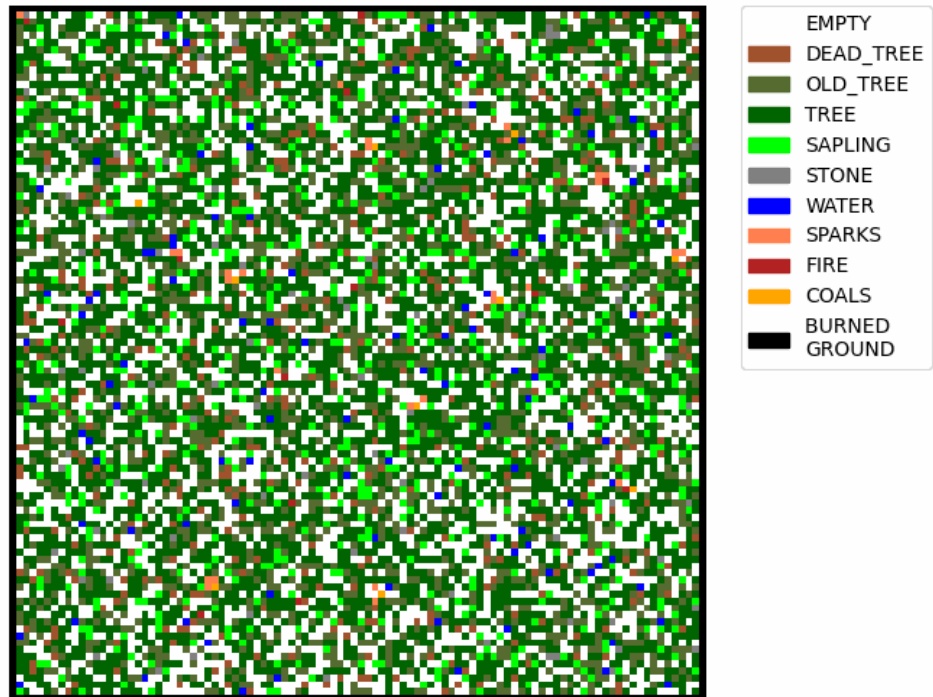
2	1.75	1.5
1.75	source	0.25
1.5	0.25	0



**Water influence details:**

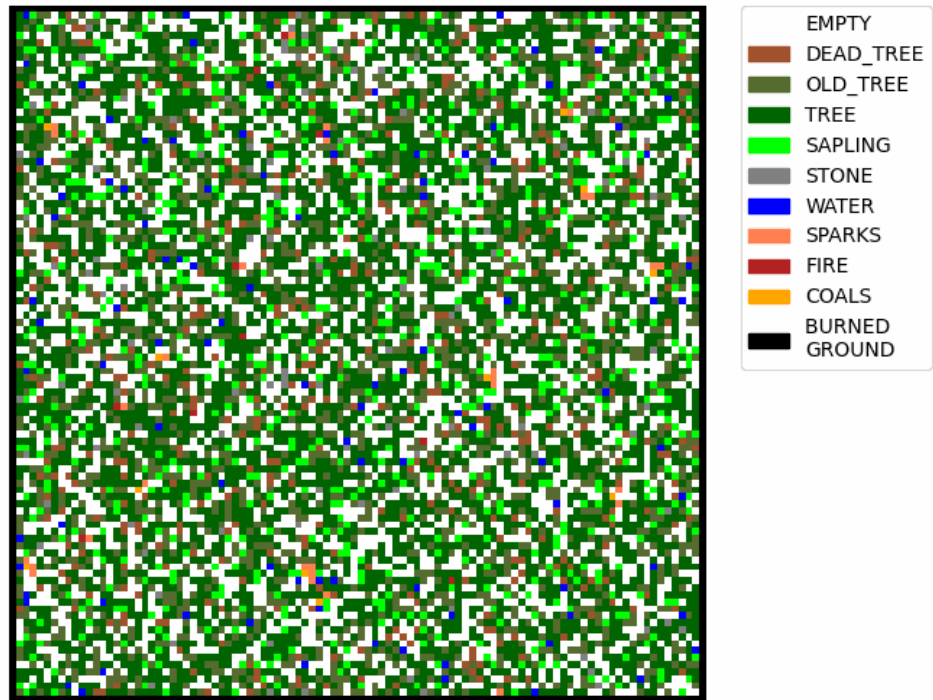
Water is simpler: if a tree is in neighborhood of water it's fire spread factor is multiplied by number from scale 0-1 where 1 is no influence and 0 is full block of spread

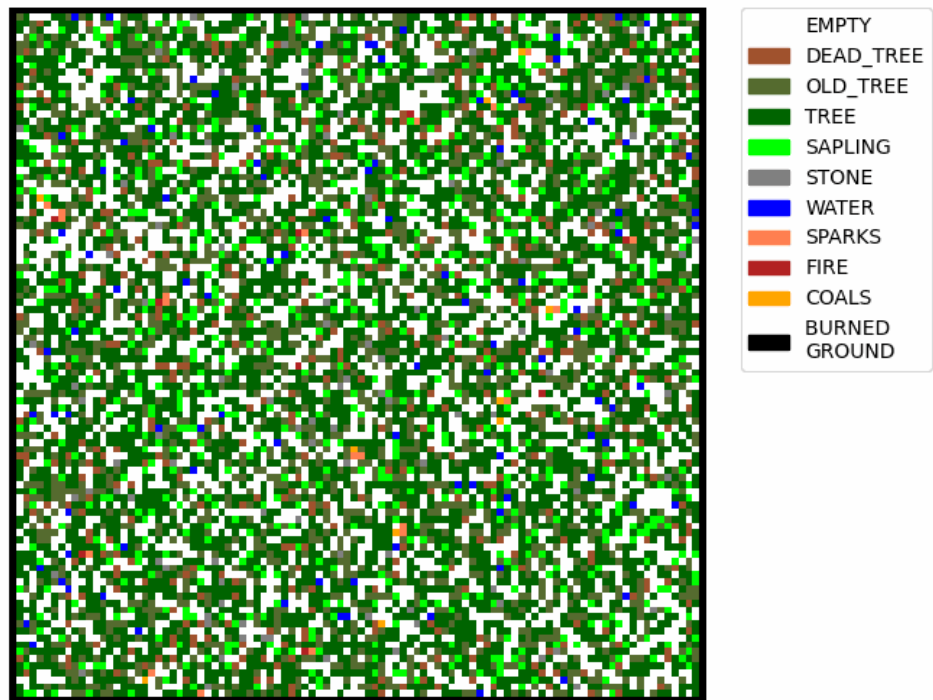
### EXAMPLE OUTPUTS:



speed of animation can be also modified with setting intervals and fps limits:

30 fps





120 fps

All of the implementation is covered under streamlit application giving user easy access to modification of parameters

that can be run with `streamlit run app.py` command from base dir of

Ipit > studia > AS_Fire_Spread				Przeszukaj: AS	
Nazwa	Data modyfikacji	Typ	Rozmiar		
.git	15.01.2022 16:53	Folder plików			
animations	05.01.2022 20:01	Folder plików			
src	05.01.2022 19:50	Folder plików			
app.py	15.01.2022 16:53	Python Source File	1 KB		

project

