Luke Zhang

The Effects of First and Secondhand Smoking

Model Description

We all know the harms of smoking. If you smoke, you're at higher risk of cancer, heart disease, stroke, lung diseases, diabetes, tuberculosis, rheumatoid arthritis, and the list goes on. In fact, according to the CDC, smoking is the leading cause of preventable death. Enough said, smoking kills. So, what's the point? When people smoke, not only are they harming themselves, but the people around them who breath the same air. According to the American Lung Association and the U.S. Department of Health and Human Services, secondhand smoke causes over 7 000 deaths from lung cancer and over 33 000 deaths from heart disease each year. In addition, there is no risk-free level of exposure to secondhand smoke. Even short-term exposure can potentially increase the risk of heart attacks.

This automaton models how smoking not only affects the smoker, but impacts those who breathe the surrounding air and are affected by secondhand smoke.

Possible States of a Cell

In this model, there are 2 types of non-living cells, and 2 types of living cells. The non-living cells are buildings, and sidewalk cells. The living cells are non-smoking humans and smoking humans, who move with the buildings and sidewalks. When in a building, secondhand smoke spreads further than it would outdoors.

- Non-smoker.
  - Light green (#00ff00) represents a healthy, non-smoker who has yet to be exposed to secondhand smoke.
  - Darker shades of green (anything in between #00ff00 and #00600) represent a somewhat healthy or unhealthy person. The darker the green, the less healthy the person.

- Dark green (#006000) represents an unhealthy, non-smoker who has repeatedly been exposed to secondhand smoke.

➔ Smoker

- Bright red (#ff0000) represents a “healthy” smoker who has just begun to smoke.
- Darker shades of red (anything between #ff0000 and #600000) represent a somewhat “healthy” or “unhealthy” smoker. The darker the red, the less healthy the person.
- Dark red (#600000) represents an “unhealthy” smoker who has been smoking repeatedly for a long time.

Note: for each human, there are 159 different possible shades of green or red, because there are 159 numbers between #60 and #ff. We will refer to these shades as the health scale or heath level.

Evolution Rules

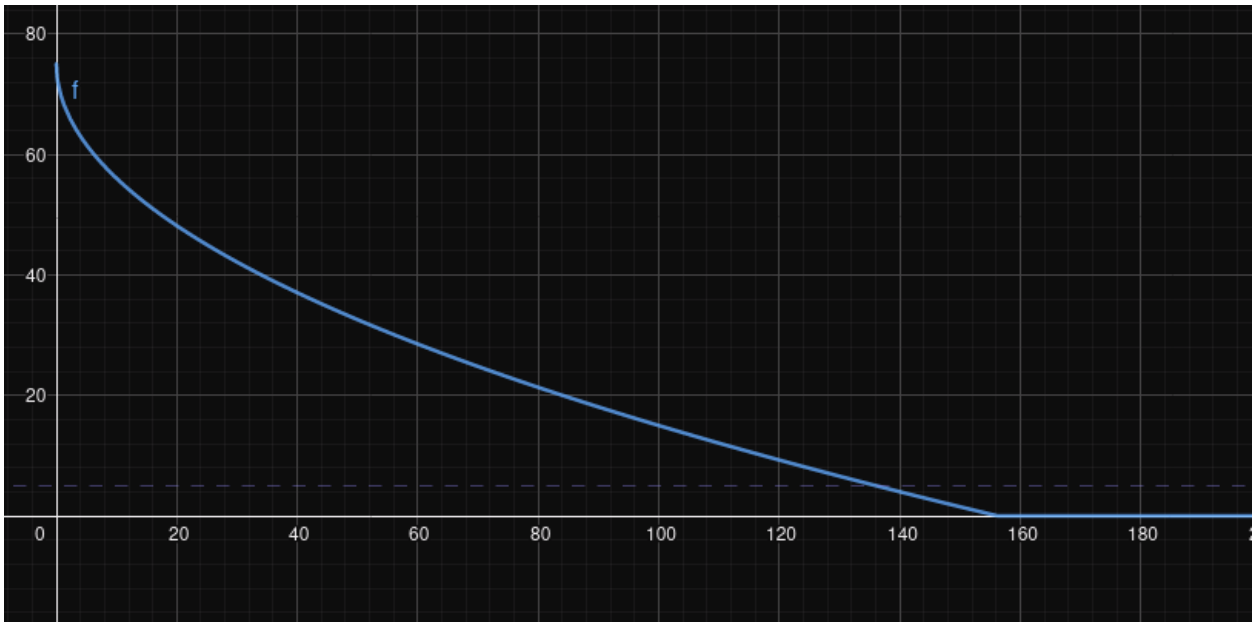
- Humans walk along sidewalks, randomly choose to turn into buildings, and randomly choose to turn at an intersection. If they reach the boundaries, they will turn around and move the opposite direction.
- Humans have a default lifespan of 300 frames
- Secondhand smoke rules:
    - Outdoor:
        - If any human walks exactly within a 1 cell radius of a smoker outdoors, they have a 50% chance of losing either 1/159 or 0.5/159 of their health, since they’re practically breathing in the smoke
        - If any human walks exactly within a 2 cell radius of a smoker outdoors, they have a 50% chance of losing 0.5/159 of their health.
    - Indoor:
        - If any human walks within 1 or 2 cells of a smoker indoors, they have a 50% chance of losing either 1/159 or 0.5/159 of their health
        - If any human walks within 3 or 4 cells of a smoker indoors, they have a 50% chance of losing 0.5/159 of their health
- If a non-smoking human indoors walks within any cell radius of a smoker outdoors or vice versa, there will be no effect, since there’s a brick wall between them
- Every frame a human smokes, they lose 1/159 of their health.

- If a human reaches their lifespan, they will die. When a human dies as a result of this, they will be counted as a death by natural causes.
    - A human's life expectancy is also influenced by their health. If a human dies more than 5 frames in advance of their life expectancy due to smoke exposure, they will be counted as a “smoker” or “secondhand smoker” death. Otherwise, they will be counted as death by natural causes
- If a human's health ever reaches 0, they may die at any time regardless of their life expectancy. This is to model the fact that they will probably have a serious disease caused by smoking at this point
- For every 4 frames a human isn’t exposed to any smoke, they will regain 2/159 of their health

We will calculate the lost life expectancy with the following equation

$$f(x) = max(75 - 6x^{1/2}, 0)$$

Where f(x) is the number of years taken away, and x is the numerator of the “health” level.

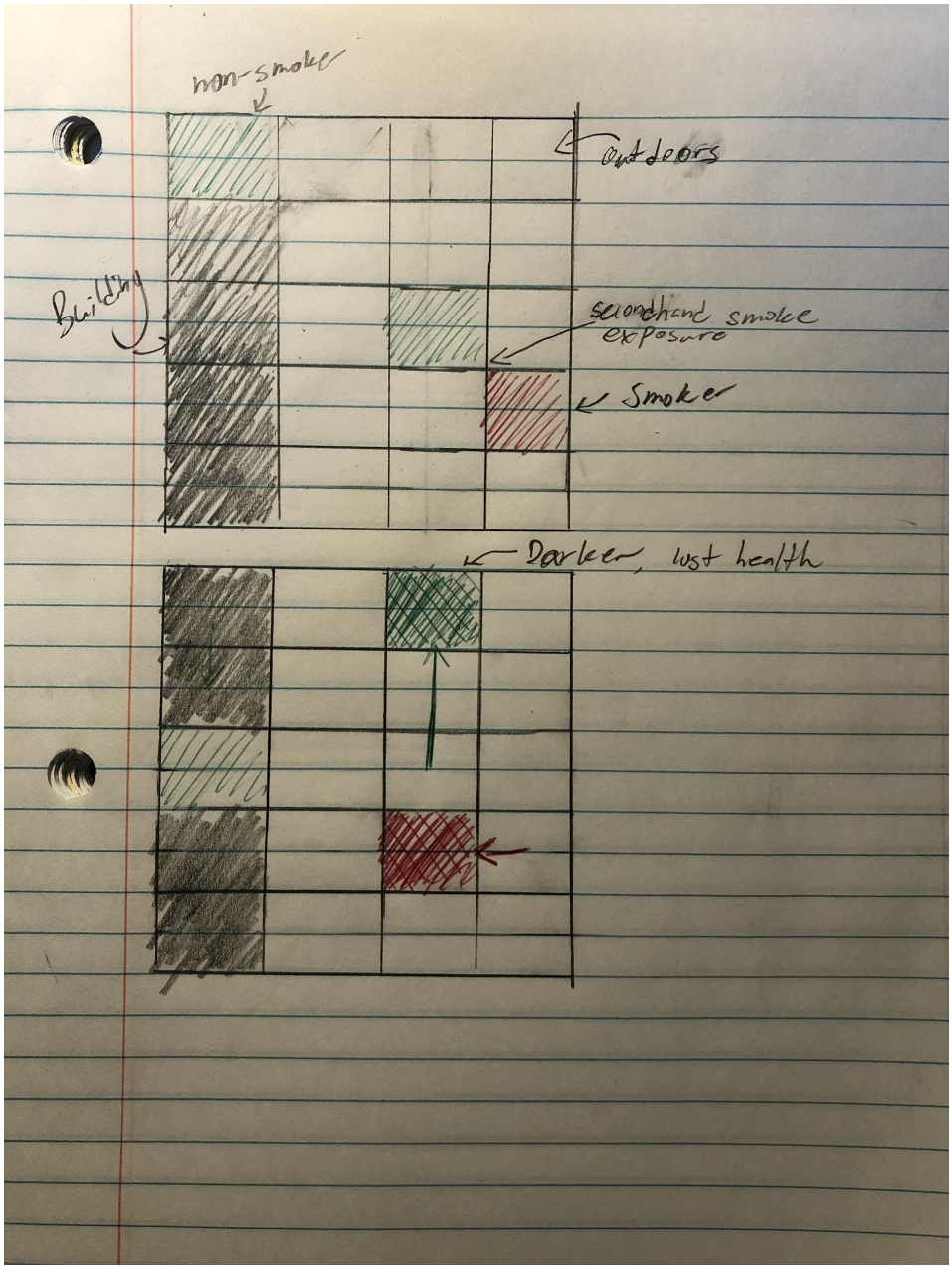


As you can see, at around 144 everything flattens out, rather than the expected 159. This is because smoking won’t affect you right away. The effect compounds over time and requires repeated exposure. Exposure to second hand smoking once or twice probably won’t change your life expectancy. The y = 5 line represents the threshold for when a death is counted as a smoking death.

This means that we calculate the lifespan of a human with the following equation:

$$remainingFrames = lifeExpectancy - framesAlive - f(health)$$

Diagram



Strengths of the model

This model accurately predicts how:

1. Smoking kills. If someone has smoked too much, they will die. It also decreases lifespan. When a human smokes, they lose health which affects their lifespan.

2. Repeated secondhand smoke decreases lifespan. When a human is exposed to secondhand smoke, they lose health which affects their lifespan.
3. Not being exposed to smoke for a while means your lungs may heal. For every 4 frames a human isn't exposed to any smoke, they will regain 2/159 of their health. Obviously, the healing processing takes longer than the damage process. This is also something the model accurately predicts.
4. Smoking indoors exacerbates the effects of secondhand smoke exposure. When someone is exposed to secondhand indoors, the radius of the smoke effect and the potency of the smoke increases.

Simplifying Assumptions

1. Not everyone is affected by smoke the same. Some people can smoke and still live a long life. This model treats everyone the same
2. The effects of smoking usually aren't actually as bad as the model makes it out to be. According to CBS**,** only ¼ smokers die before their 65th birthday. That's still bad, but nowhere near as bad as the model predicts.
3. There are smokers who end up quitting. Smokers also don't have to smoke all the time. Just cause you walked by a smoker doesn't mean they're smoking. It also doesn't mean they can't quit, or try alternatives such as chewing tobacco.
4. Some people smoke more than others. If you smoke a cigarette a week, that's nowhere near as bad as a pack a day. To just clump in smokers as all the same is inaccurate, but necessary for a model as simple as this one. I
5. People tend to avoid smokers. For example, people hold their breath, cross the street, or keep a distance from smokers. In addition, some smokers tend to avoid smoking around others to be polite.