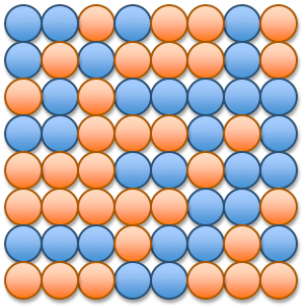


# UNIT 10C

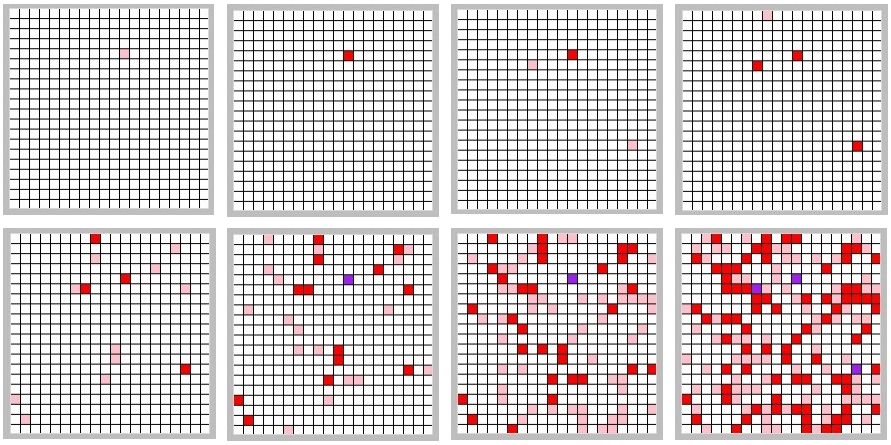
## Visualizing Data: Simulation Example



## Example: Flu Virus Simulation

- Goal: Develop a simple graphical simulation that shows how disease spreads through a population.
  - Agent-based
  - Abstract
  - Dynamic
  - Stochastic
  - Discrete

# Example: Flu Virus Simulation



# Model Assumptions

- A person starts off as healthy.
- Each day, a healthy person comes in contact with 4 random people. If any of those random people is contagious, then the healthy person becomes infected.
- It takes one day for the infected person to become contagious.
- After a person has been contagious for 4 days, then the person is non-contagious and cannot spread the virus nor can the person get the virus again due to immunity.

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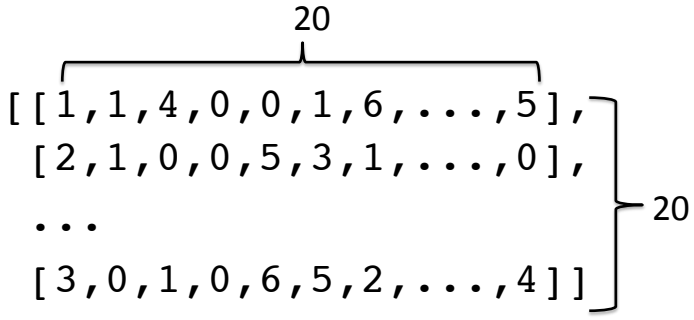
# Health States

| | | | |
|---|---|---|---|
| 0 | white | healthy | `HEALTHY = 0` |
| 1 | pink | infected | `INFECTED = 1` |
| 2 | red | contagious (day 1) | `DAY1 = 2` |
| 3 | red | contagious (day 2) | `DAY2 = 3` |
| 4 | red | contagious (day 3) | `DAY3 = 4` |
| 5 | red | contagious (day 4) | `DAY4 = 5` |
| 6 | purple | immune (non-contagious) | `IMMUNE = 6` |

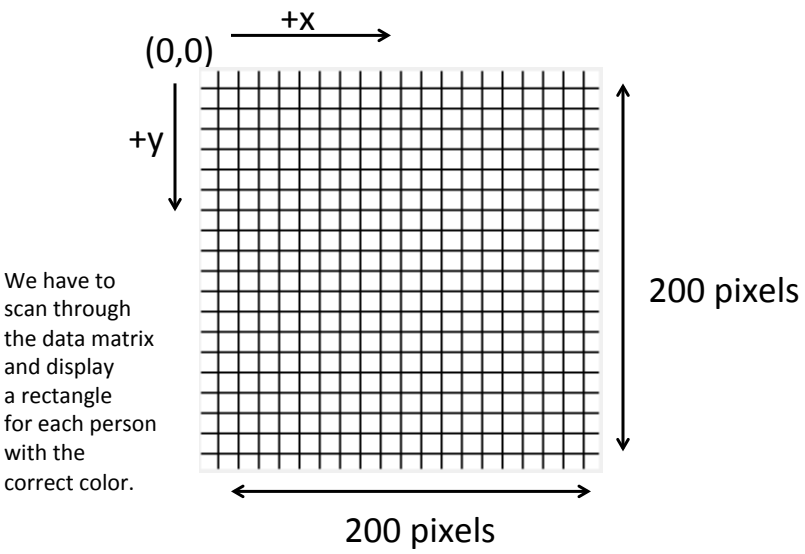


# Storing the Population

- We can use a matrix (list of lists) of size 20 X 20
- Each entry is an integer representing a person's health state.



# Displaying the Population




We have to scan through the data matrix and display a rectangle for each person with the correct color.

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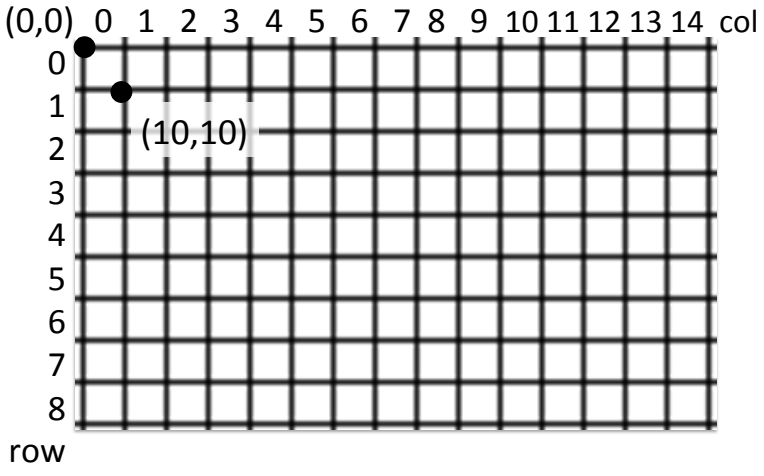
# Displaying The First Person

A rectangle with top left (0,0) and bottom right (10,10)

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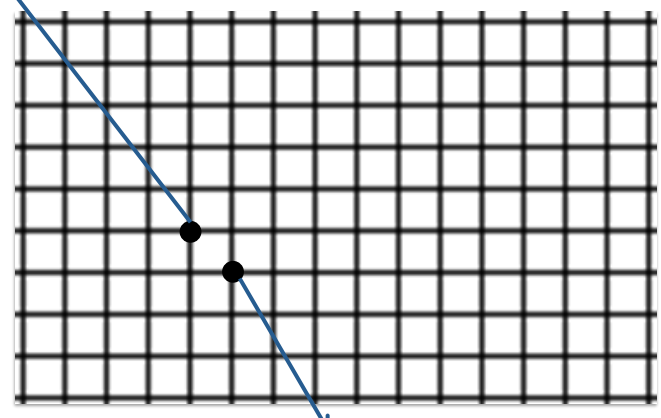
# Generalizing

| row | col | top left x | top left y | bottom right x | bottom right y |
|---|---|---|---|---|---|
| 1 | 1 | 10 | 10 | 20 | 20 |
| 1 | 2 | 20 | 10 | 30 | 20 |
| 1 | 3 | 30 | 10 | 40 | 20 |
| 2 | 1 | 10 | 20 | 20 | 30 |
| 3 | 1 | 10 | 30 | 20 | 40 |
| row | col | col*10 | row*10 | col*10+10 | row*10+10 |

# Displaying Any Person

(col*10, row * 10)



(col *10 + 10, row * 10 + 10)

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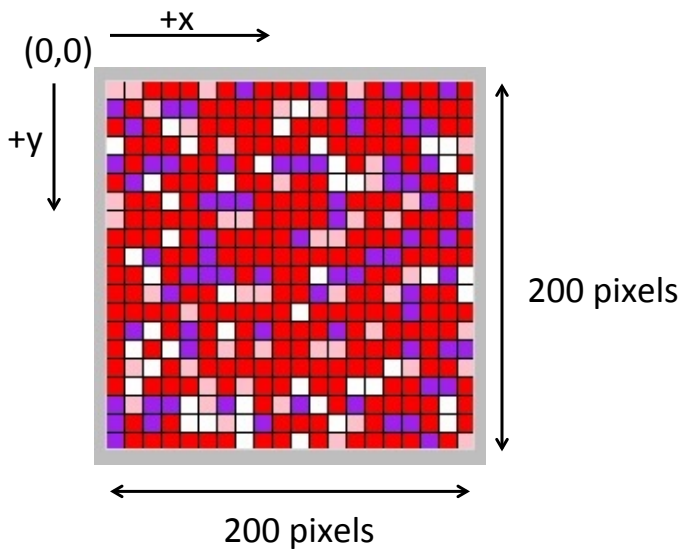
## Display of 400 people




## Coding the simulation

IN CLASS DEMONSTRATION

Exercise on your own:

How can you change the simulation so you can use parameters to adjust the:

- delay time
- population size (assuming its a perfect square)

## New feature: Events by chance

If a healthy person contacts a contagious person, she gets sick 40% of the time.

```
random_x = randint(0,19)
random_y = randint(0,19)
if contagious(matrix, random_x, random_y) \
        and randint(0,99) < 40:
   newmatrix[i][j] = 1
```

## New feature: Finding neighbors

Instead of picking 4 random people, you pick the 4 neighbors of the person.

```
cell = matrix[i][j]
# NO!
if matrix[i-1][j] == INFECTED:
   ...
# YES!
if i > 0 and matrix[i-1][j]==INFECTED:
   ...
```

# Why Do Simulations?

- To predict the behavior of a system.
  - Will this building survive an earthquake?
- To test a theory against data.
  - Do the predictions generated by these equations match what we observe in the real world?
- To explore consequences of assumptions.
  - How quickly does the flu virus spread?

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