1) Spreading the flu in a classroom

A handful of hard-working students may make the selfish choice of coming to class when they know they have the flu, thus infecting others and causing problems throughout the community. This model seeks to capture how flu spreads in the classroom. We consider that students are either infectious, or not (e.g., susceptible, infected but not yet infectious, recovered). A student may cough/sneeze/talk, which (to really simplify) produces a cloud of infectious droplets invisible to the human eye. If a person walks through this cloud, the droplets can land in the mouth/nose or be inhaled into the lungs, and this person can get sick. Droplets survive in the air for a few hours.

This problem would be better addressed using an agent-based model (ABM). This is because the agents (i.e. the students) are interacting with both each other and the environment, which cannot be represented as thoroughly with cellular automata (CA). The agents are also not placed in fixed positions, meaning that they can be in any place within the simulated environment (and therefore spread the virus anywhere too).

1. types of agents: students

2. characteristics of agents: susceptible, infected but not yet infectious, infectious, recovered

3. environment: The air can either be infected with virus or not.

4. initial configuration: Model could start with one infected student who may cough/ sneeze/talk creating a cloud of infectious droplets. If any other students walk through this cloud (within the few hours that the droplets remain active), they can transition from the susceptible stage to the infected by not yet infectious. Once students enter the infectious stage, coughing/sneezing/talking could create clouds full of bacteria, which could then lead to infecting more students with the virus.

5. the rules: Students who are in the susceptible stage go to class, students in the infected but not yet infectious stage will still go to class, students who are infectious may decide to cough/sneeze/talk in public areas therefore leading to the further spread of the virus.

6. The model should stop running when students have all recovered.

2) Spreading HIV on campus

The Centers for Disease Control and Prevention (CDC) announced last August that sexually transmissible diseases (STDs) in US reached record high[1]. The Human Immunodeficiency Virus (HIV) is an STD[2]. We are interested in creating a model that simulates how residential Furman students may be getting HIV via unprotected sex over the course of an academic year. Once a person is infected, this person is extremely infectious (via unprotected sex) during the next few weeks. After treatment has occurred, the virus may drop to the point where it becomes undetectable in the body[3], and the consensus is that the risk of transmitting HIV then becomes statistically negligible.

For this problem, cellular automata model would be the most affective. This is because that the problem is related to how agents interact with each other, and not so much about the environment.

1. states: susceptible or infected

2. initial configuration: Model could begin with one infected student having unprotected sex with a susceptible student. If this student becomes infected and decides to have unprotected sex with another student within the next couple weeks (when the virus is at its most infectious rate), the virus could quickly become widely spread.

3. rules: Cells could be changed based on a timer, as the cell would be at it most infectious rate during the first couple weeks of the infection period, after treatment has commenced, the virus may drop to a point where it is virtually undetectable. Cells could also be changed based on neighbors as close proximity might increase chance of engaging in sexual activity. Two time are sufficient of curing the virus, thus changing the state of the cell back to "S" (i.e. susceptible).

4. The program should stop running when the academic year concludes.

t=0 (in graph, susceptible is indicated with "S", and infected would be indicated with "I")

S	S	S	S
S	I	S	S
S	S	S	S
S	I	S	S
S	S	S	S

t=1

S	I	S	S
I	I	I	S
S	I	S	S
I	I	I	S
S	I	S	S

t=2

I	I	I	S
I	S	I	I
I	I	I	S
I	S	I	I
I	I	I	S

3) Landslides

Because of flooding in North Carolina, the stability of some surfaces has been affected and they're now more prone to landslides. For a given land, we're interested in creating a model that can simulate how the land moves when the landslide takes place (i.e., assuming a landslide is triggered we want to know where the land goes). As vegetative structures may affect the dynamics of the landslide, note that the lands in the area of interest all have some shrubs and trees.

This problem would be best addressed using the cellular automata model. This is because the focus in more on the environment and not such much how specific agents are interacting with each other.

1. states: land is either stable or unstable

2. initial configuration: Model could begin with landslide being triggered, therefore leading to unstable land. As the land moves, stable land could become unstable.

3. rules: Cells could be changed based on geographic variations (such as elevation, level of flooding, amount of vegetation, etc.) as well as be effected by neighboring cells (if a landslide is triggered in a neighboring cell, would that make a neighboring cell more likely to also experience a landslide?).

4. This program could stop running after sufficient data is collected, or, since it is related to the recent high levels of flooding in N.C., until flood waters dry up.

t=0 (In this graph, land can be either stable (“S”) or unstable (“U”).

S	S	S	S
S	U	S	S
S	S	S	S
S	S	U	S
S	S	S	S

t=1

S	U	S	S
U	U	U	S
S	U	U	S
S	U	U	U
S	S	U	S

t=2

U	U	U	S
U	U	U	U
U	U	U	U
U	U	U	U
S	U	U	U

4) Landslides... revisited
Assume the setting and goals are identical to problem (3) above. In addition, assume that landowners with peculiar hobbies also have bongos, oryxes, kudus, and lechwe[4] grazing on the land. As they graze, they damage shrubs (but not trees) and thus remove some of the vegetative structures that hold the land together.

For this problem, agent-based modeling would be more accurate. This is because there are additional agents (the bongos, oryxes, kudus, and lechwe) that are interacting with the environment and causing effects that could make the land further susceptible to landslides. The agents positions are also not fixed.

1. agents: bongos, oryxes, kudus, and lechwe (broadly, the animals)

2. characteristics of the agents: consumption rates of vegetation

3. environment: Record how much damage the agents have inflicted on the land (essentially how much vegetation have the agents consumed), could also take into account general vegetation structure, amount of floodwater present (or just generally water levels in soil)

4. initial configuration: Initially, there would be the maximum amount of bongos, oryxes, kudus, and lechwe and their consumption rates would all be at the maximum amount as none of them have consumed any vegetation yet. Once they begin consumption, the land becomes increasingly damaged, therefore furthering the likelihood of a landslide occurrence. The agents will also likely reproduce at fairly rapid rates, as the environment is full of food for them and lacks predatory species.

The increase in the amount of agents will further the amount of environmental damage therefore increasing the likelihood of a landslide occurring.

5. rules: It can be assumed that all the agents will continue to eat until full and not consume more vegetation until hungry again.

6. The model should stop running when sufficient data of how land moves in relation to land damage (caused by both high levels of flooding and a surplus of agents who eat vegetation thus weakening the land structure).

5) Up to you
Describe a real-world problem that you personally care about (you don't need to say why you care about it). Include this description in your PDF, and solve the problem just like the other four above.

Problem: Residential burglaries in large cities, such as New York City, are increasing. Certain geographic factors as well as qualities of both the victims and the guilty could be indicators of the likelihood of a burglary occurring. Using ABM, I would simulate the relations between the agents and the environment. Agents are also not is fixed positions within the simulation, and that is another factor that makes it a problem that is better suited for ABM. The goal of building a model for this problem would be to display how environmental factors or behavioral changes have on burglary activity in a real area.

1. agents: victims and burglars

2. characteristics of the agents: a homeowner could either be more intelligent or not when it comes to creating a safe environment for their home (i.e. installing a security system or not), and a criminal could either feel "safe" or not (in terms of feeling that that home was a good home to target and not get caught), whether or not the burglar is aware of opportunities presented, whether the burglar could be classified more as an opportunist or planner

3. environment: The environment could be discussed on multiple layers. Firstly, looking at the community as a whole. Crime rates for that particular community could be gathered. Secondly, look at the individual properties. Security, accessibility, visibility, occupancy, and traffic volume near the property are all important factors in determining whether or not the property would be an attractive target.

4. rules: Certain neighborhoods are more susceptible to being burglarized than others.

5. Data can stop being collected once there is sufficient evidence to support specific trends that lead to increased burglary occurrences.