UM Modeling Update 8-27-20

Summary

- We are developing a high-level population model and a more detailed network model of SARS-CoV-2 transmission among students, faculty, staff, and the broader community

- The model parameters are still being calibrated, so these results are very preliminary and may change—but, our initial simulation results suggest:

    - **Impact of students returning**: Case counts in both campus and community populations show substantial increases as the fraction of students who return to Ann Arbor increases
        - These increases are smaller but still substantial if we only consider the return of residential students (assuming that off-campus student populations are unchanged)

    - **Additional classroom mitigation/online coursework**: Eliminating classroom transmission (E.g. by moving to entirely online courses) appears to prevent relatively few cases among student or community populations, but does show moderate decreases in cases among the faculty/staff population.
        - Note that this does not account for any of the other changes that might happen if we went entirely online, like students moving home or reductions in other student-to-student contacts. This simulation also assumes relatively low classroom transmission levels as the base case (due to most classes being online and mitigation measures in place)

    - **Contact reduction and timing of quarantine/isolation**: reducing time from onset to quarantine/isolation for students and ensuring effective quarantine/isolation in students leads to sizable reductions in cases in both the university and community
        - However, in our initial simulations, even very rapid response and highly effective quarantine cannot fully prevent disease spread

- **Uncertainty warning—it is important to note that these results are preliminary and in progress**. The model parameters are still being estimated, and there remains sizable uncertainty in the results at present. These notes give some general initial trends that appear to hold across the simulations we have run so far, but the results still may change as we more fully explore the parameter space.

- Next steps
    - Explore the model behavior across parameter space and calibrate the models using UM and Washtenaw County data
    - Evaluate additional scenarios on testing strategies, contact tracing, and interventions (see additional details below)
    - Develop a regular modeling situation report/dashboard

Additional Details

Overall Goals

- Evaluate and forecast epidemic spread and capacity needs (testing, etc.)
- Run scenarios for different testing and intervention strategies

We are developing two models:

1) A simpler, population-based model that assumes general contact rates but doesn't specifically track types of contacts (classes/housing/friends/etc.), and
2) an individual-level model that tracks contacts via classes, housing, and friendship networks (based on class and housing data at UM).

Both models include:

- Residential students, off-campus students, faculty & staff, community
- Asymptomatic, pre-symptomatic, mild, and severe infections, as well as care-seeking/testing, isolation, and hospitalization
- Parameters based on UM data when available (e.g. population sizes, contact patterns), then regional or Michigan data (hospitalization, death rates), and US and international data otherwise

Scenarios (in progress—**any feedback or suggestions on which scenarios are most useful would be great**)

- Contacts and Population
    - What if only a percentage of students returned to Ann Arbor? (residential & off-campus)
    - What if everyone social distances by a percentage?
    - What if students social distance by a percentage?
    - What if everyone except students social distances by a percentage?
    - Impact of a 2-week shelter in place
        - At campus opening
        - In response to increases in transmission
        - Impact of local shelter in place for specific dorms that see increase in transmission
    - Impact of reductions in classroom contacts (e.g. increase fraction of courses online)
    - Impact of reduction in housing contacts (e.g. reduce dorm occupancy)
- Symptomatic Testing
    - How does time to test/quarantine affect epidemic spread?
    - What if students isolate/quarantine at onset of symptoms?
    - What if students isolate/quarantine as soon as tested?
    - What if students isolate/quarantine once tests are returned?
    - Examine the effects of percent of symptomatics tested, time to test, and percent of contacts reduced during quarantine/isolation
- Asymptomatic testing
    - Examine 3000, 5000, 10000 tests/week among asymptomatic individuals
    - How many tests are needed to reduce weekly incidence to a particular level?
    - Is there an optimal testing allocation for a given level of tests/week?
    - Accounting for estimates of test sensitivity/specificity, what capacity will be needed for the quarantine dorm under different testing levels?
- Compare effect of testing alone vs testing + social distancing + mask use

Forecasting (in progress)

- Generate short term forecasts of cases for the campus and county, using time-varying social distancing data from Unacast

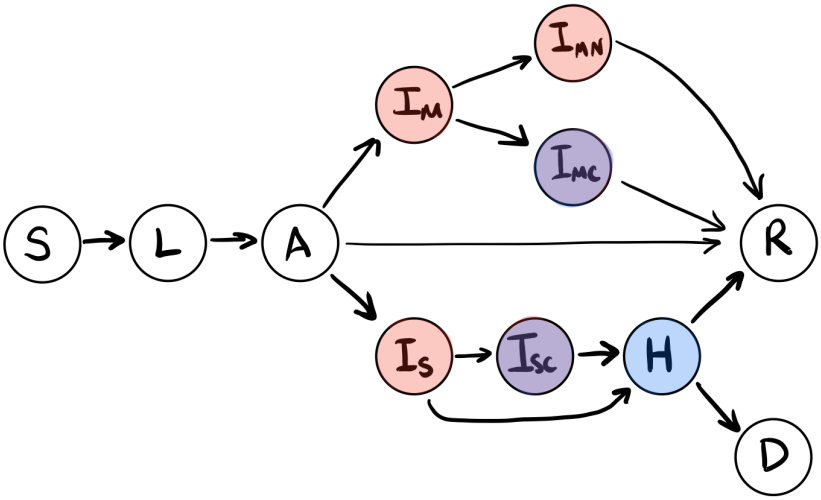

Figure 1. General underlying disease model. Susceptible (S) individuals may become latently infected (L), and then become asymptomatic/presymptomatic (A), after which they may recover (R) or develop mild or severe symptoms (Im and Is). Individuals may seek care (marked with a 'c') or not ('n'), be hospitalized (H), or become deceased (D). Red compartments are infectious and blue compartments have been tested (purple indicates both).

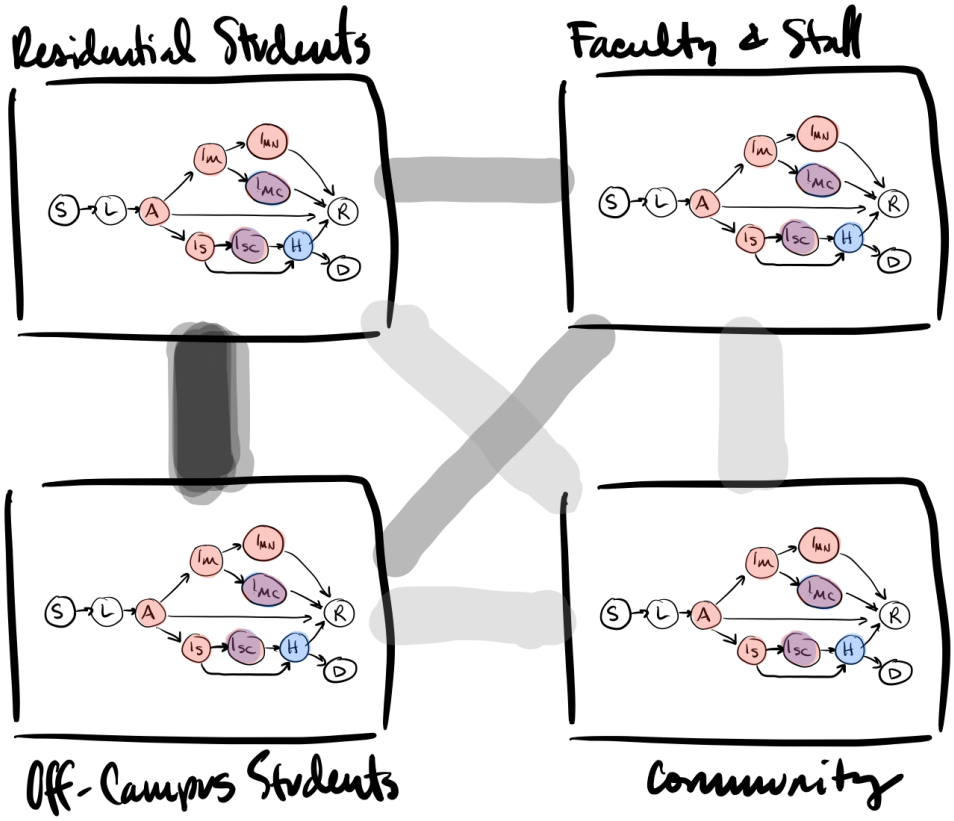

Figure 2. Illustration of contact patterns between populations in the model. Students primarily contact other students (friendships, housing/residences, classrooms), shown in dark grey/black, with some contacts with faculty and staff (e.g. classroom contacts), shown in medium grey, and weaker contacts with the community as a whole, shown in light grey.

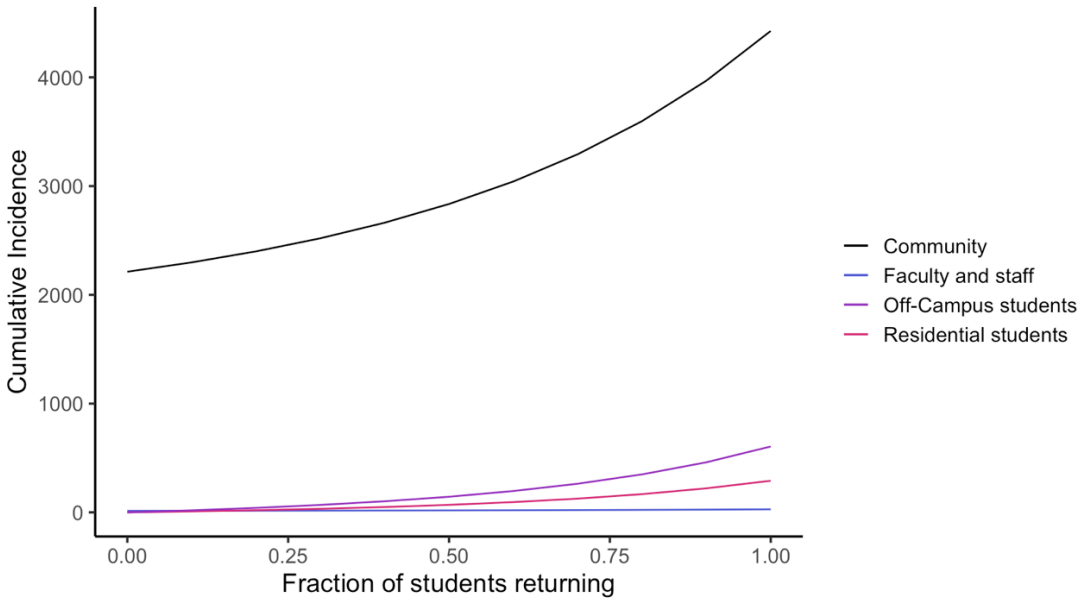

Figure 3. One example simulation run using the compartmental population model, comparing cumulative cases over Fall semester depending on the fraction of students that return to Ann Arbor. There are substantial increases in cases in the community as the fraction of students returning increases. Note that this is only a single simulation for example purposes, and a full range of model simulations sampled across parameter values is currently in progress.

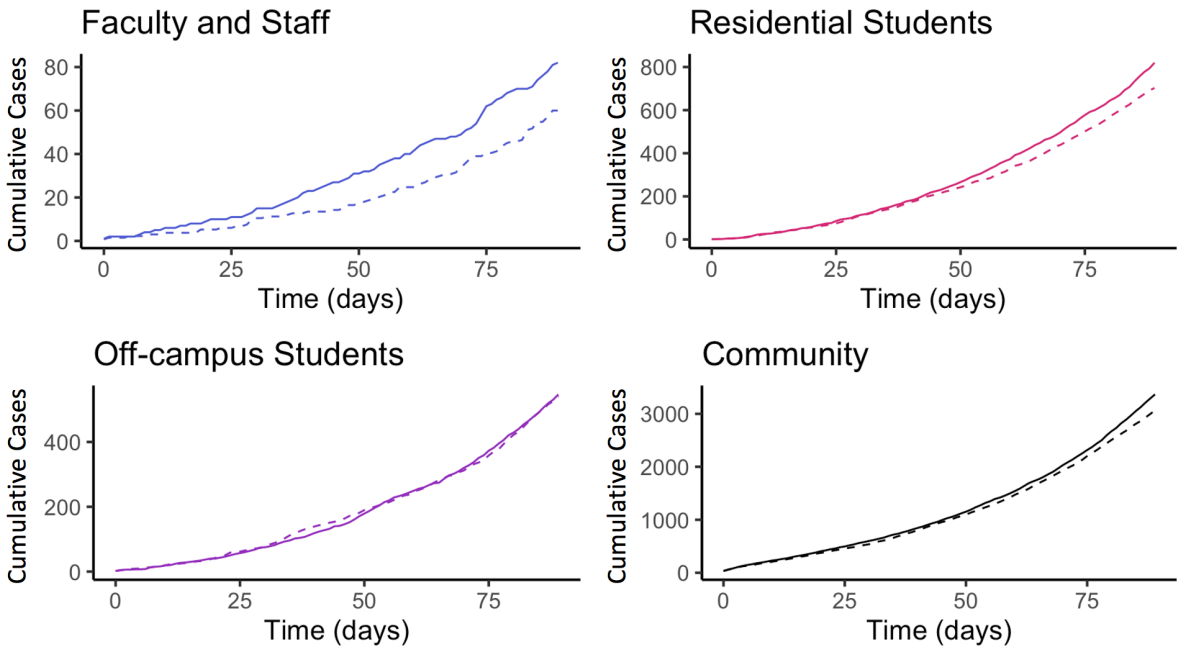

Figure 4. One example simulation run using the network model, comparing cumulative cases with the current planned distribution of online/hybrid courses (solid line) vs. online-only courses (dashed line). Note that this is only a single simulation for example purposes, and a full range of model simulations sampled across parameter values is currently in progress.