Toolkit Tutorial

In this document, we provide a tutorial for the Toolkit, which is located at
https://zmstats.shinyapps.io/CampusPrediction/.

This tutorial has two main components: (1) a step-by-step guide to how to use the Toolkit, and (2) a showcase of output features. In the step-by-step guide, each step is accompanied by one or several pictures, with certain information highlighted using blue rectangles.

1. Step-by-step Guide

Step 0: Layout of the Toolkit. The Toolkit has two main components: all **input parameters** are arranged along the sidebar on the left, and all **output results** are shown on the right. When the Toolkit is first launched, the output results are not shown. Once the user sets the input parameter values for their analysis, the user may click the "Run Analysis" button on the left, and the results are shown on the right. Steps **1-x** provide a brief guide on setting the input parameters. Details of the model parameters and initial states can be found in the Supplementary Materials.

Step 1: Set Input/Output format. In the Toolkit, input of initial data and output of results both have two formats: (1) two-group format of student/employee (default); (2) four-group format of residential/non-residential/faculty/staff. For Input, choosing either format will make certain input boxes available/unavailable.

Step 2: Input population sizes. Once the input format is set, the user can input the total number of students and employees at the university as well as the number of local residents (community population size). If *Input by affiliation* is set to *Student/Employee*, the available input boxes are shown below:

Output by affiliation

Student/Employee ▼

Input by affiliation

Student/Employee ▼

Number of students

22634 ⌃⌄

Number of employees

4882 ⌃⌄

Number of residential students

7118 ⌃⌄

Number of non-residential students

15516 ⌃⌄

Number of faculty

1611 ⌃⌄

Number of staff

3271 ⌃⌄

Community population size

17681 ⌃⌄

On the other hand, if *Residential/Non-residential/Faculty/Staff* is chosen in *Input by affiliation*, the available input boxes are shown below:

Output by affiliation

Residential/Non-residential/Faculty/Staff ▼

Input by affiliation

Residential/Non-residential/Faculty/Staff ▼

Number of students

22634 ⌃⌄

Number of employees

4882 ⌃⌄

Number of residential students

7118 ⌃⌄

Number of non-residential students

15516 ⌃⌄

Number of faculty

1611 ⌃⌄

Number of staff

3271 ⌃⌄

Community population size

17681 ⌃⌄

Step 3: Vaccination data. In the next block, the user inputs the vaccination data for students and employees from one of three formats:

(1) Use CDC estimates. These estimates were provided by the Center for Disease Control and Prevention (CDC) in spring 2022.

(2) Use Clemson estimates. These estimates were based on data collected up to January 10, 2022 at Clemson University.

(3) Input your own. By choosing this option, the user may enter their own vaccination estimates in the box. Note that the numbers should be percentages.

Step 4: Testing strategy and currently infected. The next block of inputs is essential in setting up the initial states for exposed, symptomatic and asymptomatic infectious individuals. These include the testing strategy and currently infected individuals.

The testing strategy (voluntary testing or weekly/bi-weekly/monthly mandatory testing) leads to different methods of calculating the projected infections (Supplementary Appendix 1).

The input *The above numbers are based on* is crucial in computing the initial states for exposed, symptomatic, and asymptomatic individuals (Supplementary Appendix 1).

Step 5: Initial states for recovered and isolation/quarantine. The next group of inputs include percent students/employees recovered within the last 90 days, and the number of students/employees currently under isolation or quarantine. These numbers are used to compute the initial states of the recovered and isolation/quarantine compartments.

Percent students recovered within last 90 days (%)

7.6

Percent employees recovered within last 90 days (%)

6.7

Isolated students

1710

Quarantined students

5

Isolated employees

157

Quarantined employees

4

Step 6: Other input parameters. The input in Steps 1-5 mainly focuses on computing initial states for each compartment. Other input parameters are arranged into four groups controlled by check boxes. The parameters are shown when the associated boxes are checked.

(1) **Proportion of infections detected through voluntary testing.** These parameters specify the proportion of symptomatic infections out of all infections. This is due to the assumption that symptomatic individuals automatically get tested (*Methods*).
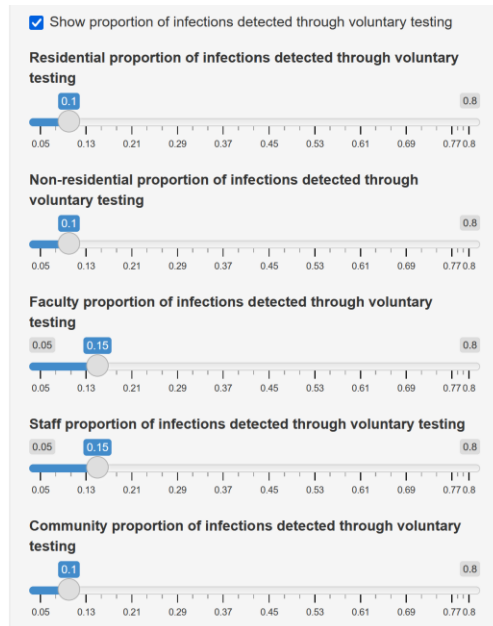

(2) **Additional recovered.** To account for potential underreporting of infections, the user can adjust the observed recovered individuals using the proportion of additional recovered. The user must select *Yes* under the *Add additional recovered* tab to add the additional recovered to the initial states.
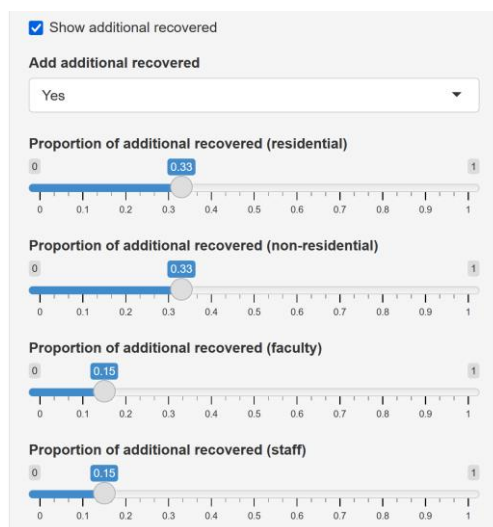
(3) **Basic reproduction number (R$_0$).** The basic reproduction numbers by affiliation are computed and validated using data from Fall, 2021 at Clemson University.
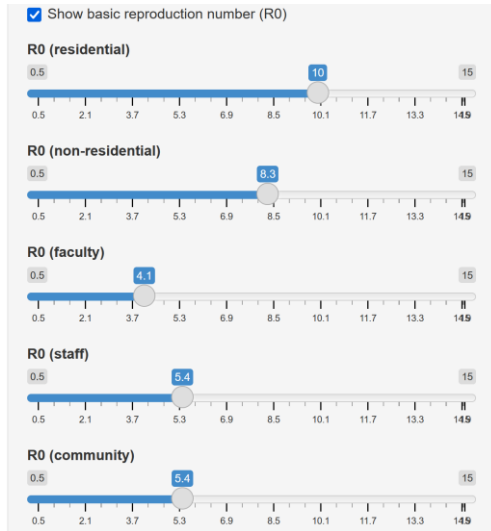

(4) **Additional parameters.** The *Show additional parameters* box includes a list of other parameters, including community baseline parameters, time in isolation and quarantine, disease dynamics parameters, and the length of the projection period (in number of weeks). Shown below are some of these parameters and their default values. See Table S6-S8 in the Supplementary Materials for the complete list of parameters and default values.
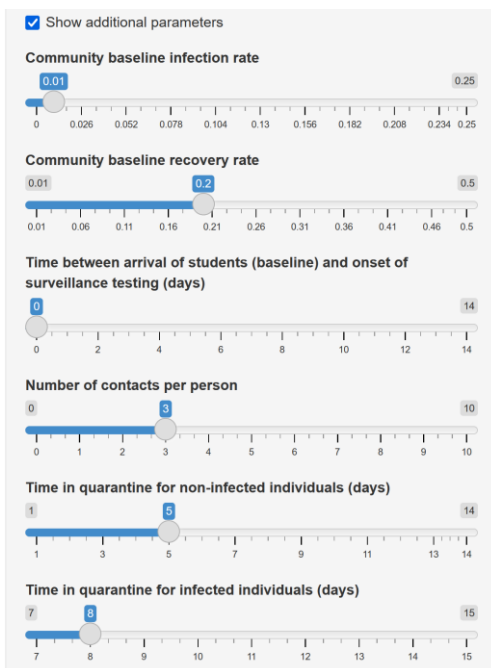
Step 7: Run analysis. After setting all input parameters from Steps 1 to 6, the user can now go back to the top of the sidebar and choose an output format from *Student/Employee* or *Residential/Non-residential/Faculty/Staff*. Then, after clicking the *Run Analysis* button, the results will be shown on the right. Shown below is the projected symptomatic cases for the two-group output based on the default values.
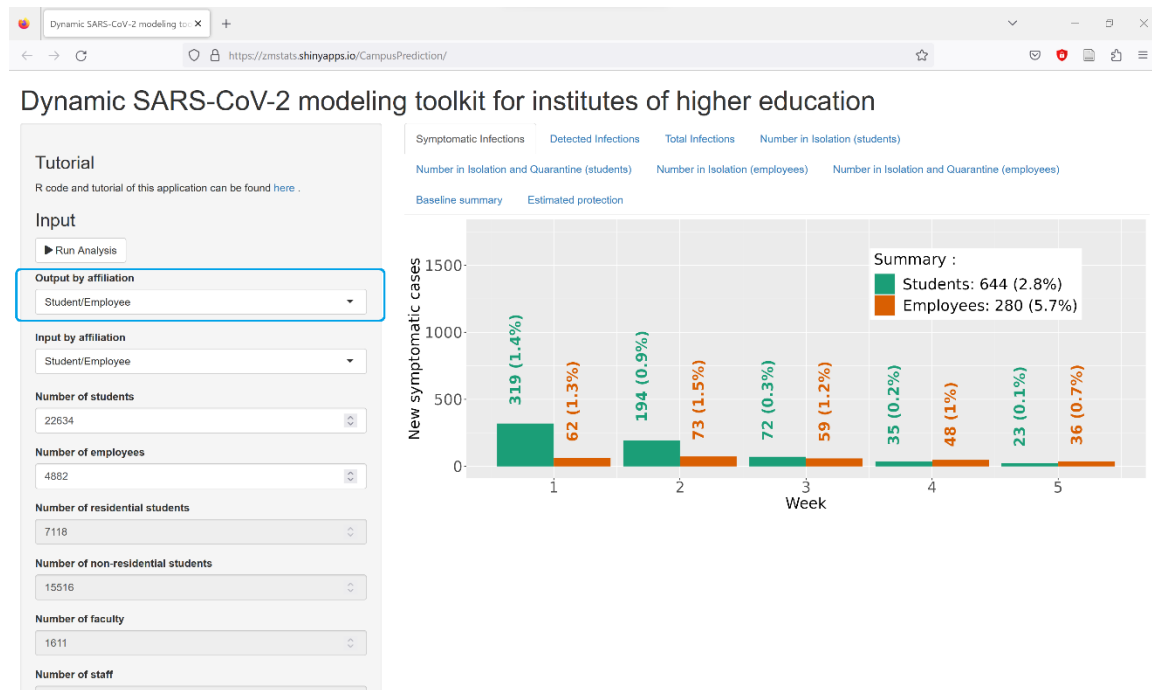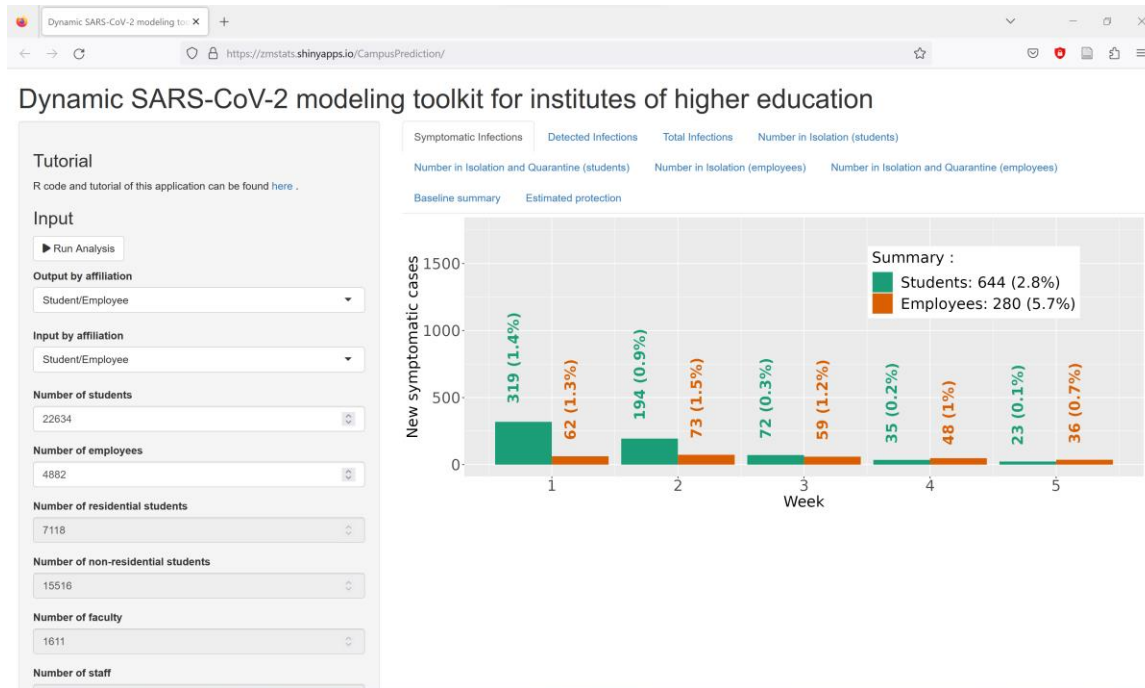

On the other hand, the projected symptomatic cases for the four-group output are shown below.
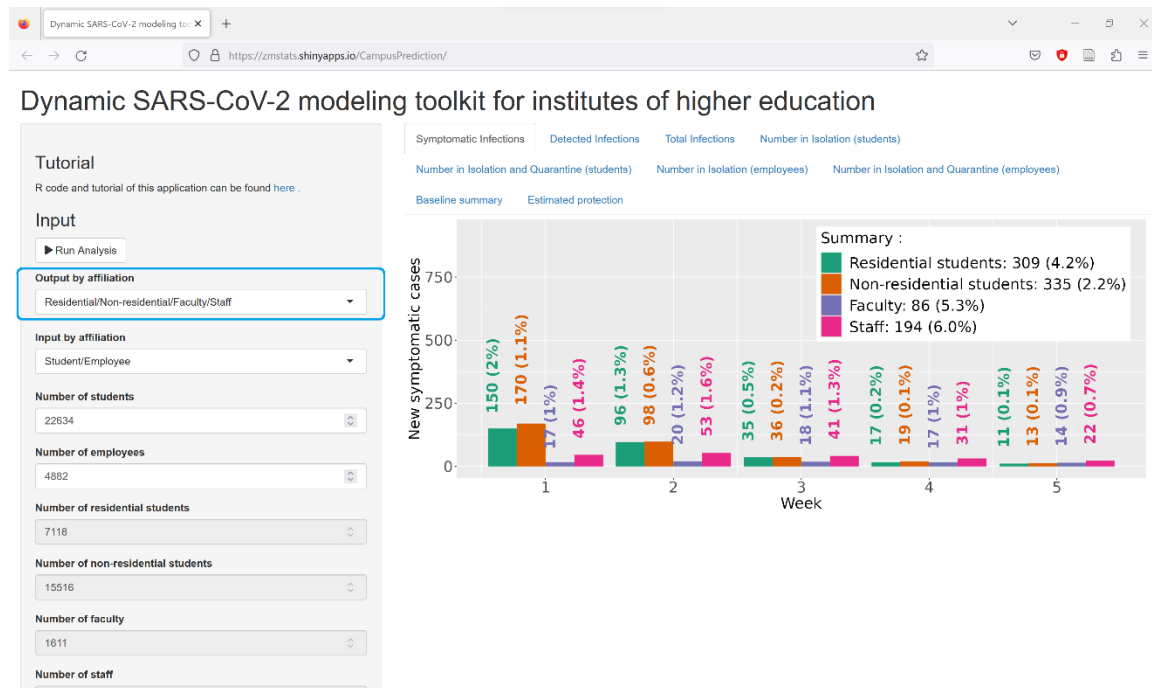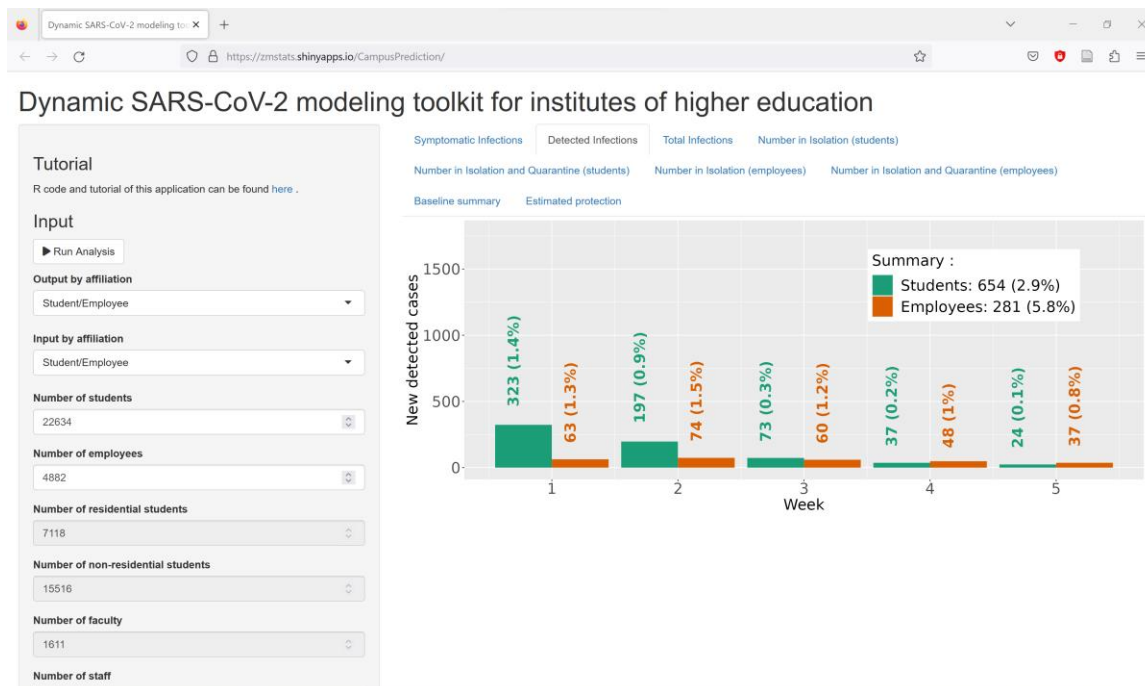
2. Output features

We now showcase the main outputs in the Toolkit. For simplicity, we use the two-affiliation output type.
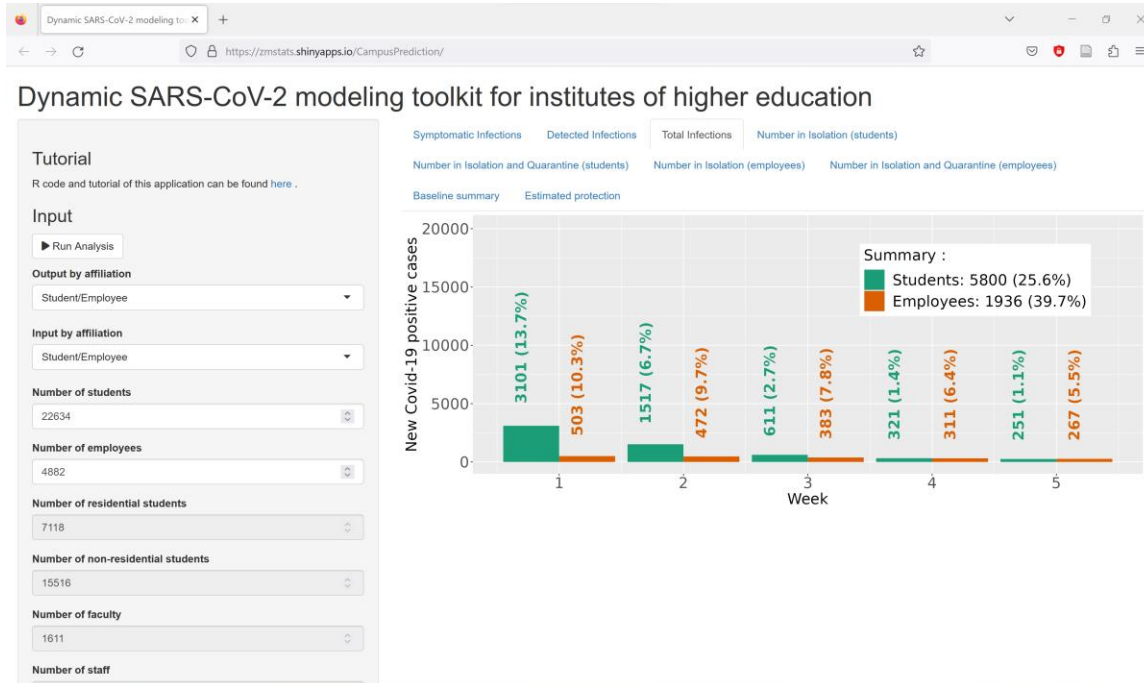
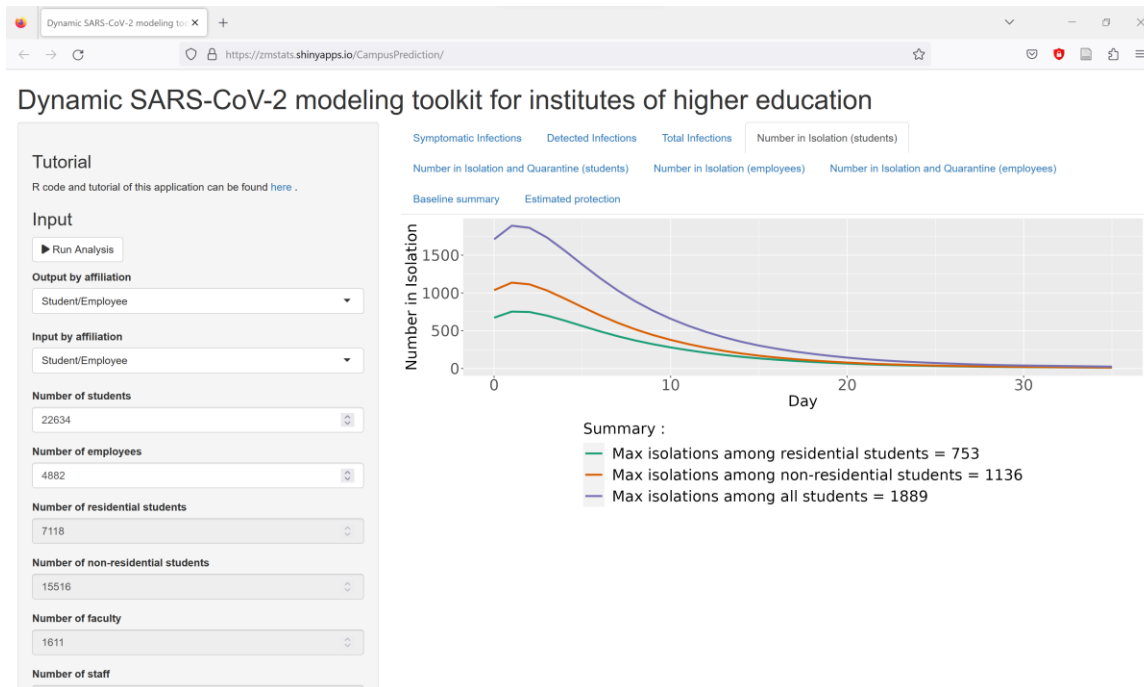(1) Projected weekly symptomatic infections.

(2) Projected weekly detected infections. Under voluntary testing, the detected cases should be close to the symptomatic cases.
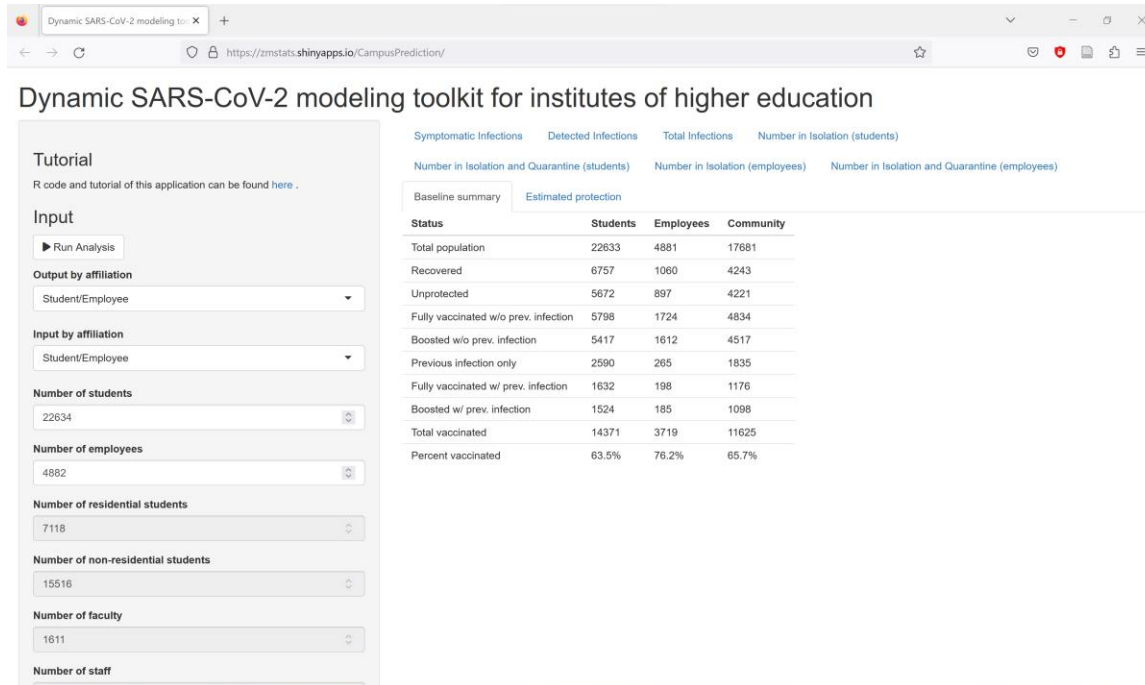
(3) Projected total infections. The total infections include detected as well as undetected infections.

(4) Number of students in isolation.

(5) Baseline summary. The summary includes the number of individuals in each subpopulation, recovered individuals, and individuals in each protection level.

(6) Estimated protection from vaccination and previous infection. These estimates are calculated based on the Cox proportional hazards model using data from Spring 2022 at Clemson University (*Methods*).