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SLEI Model Software

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Overview of the SLEI Model Software

The *SLEI Model Software* displays differential outbreak potential of chronic wasting disease (CWD) in white-tailed deer under the influence of a habitat contaminated with infectious prions. Based on a Susceptible-Latent-Exposed-Infective (SLEI) compartment model by Hanley et al. (2022), the software depicts outbreak behavior (R_0), stable equilibria of the disease compartments, and the elasticities of R_0 with respect to input parameters (Hethcote 2000). Information regarding the differential likelihood outbreak by county (or parish, administrative area, or other) can guide state and provincial wildlife managers in the allocation of disease surveillance resources. The *SLEI Model Software* includes (redacted) data containing the cumulative cases of CWD by county in Tennessee, USA, but the software can be adapted using this example for use in other US states or Canadian provinces.

The *SLEI Model Software* contains two R scripts: (1) the `0_Pre_Processing.R` script and (2) the `1_SLEI_App.R` script. The `0_Pre_Processing.R` script creates the spatial shapefiles containing administrative boundaries of the state (or province) of interest. The outputs of this script include latitude and longitude `.txt` files depicting the center of the state (or province) of interest and the `.shp`, `.shx`, `.dbf`, and `.prj` files delineating the spatial boundaries of the state (or province) of interest. [Note: Additional files beginning in "`tl`" and "`cb`" are generated by this script; they are intermediate files in the processing of the state specific geospatial layers and can be disregarded.] The `1_SLEI_App.R` script uptakes the autosaved geospatial files from the `0_Pre_Processing.R` script, then launches the interactive software that displays the results. Thus, the `0_Pre_Processing.R` and `1_SLEI_App.R` scripts must run in sequence.

Data Inputs Needed to Run the SLEI Model Software

Inputs necessary to run the `0_Pre_Processing.R` script include:

0-i. Raw geospatial files containing administrative boundaries for the US and Canada.
*Note: The Cartographic Boundary and TIGER line files (US Census Bureau 2019; 2020) necessary to create the appropriate files for the US states are procured using command lines directly in the script. The files necessary for Canada (Statistics Canada 2019) require additional steps to procure from an outside source. See Steps **5-7** below.*

Inputs necessary to run the `1_SLEI_App.R` script include:

1-i. Text file of contamination data by county (or administrative area, if province), titled "`County_Load.txt`".
Note: Real data have been redacted from the eCommons packet.

1-ii. Geospatial files *autosaved* during the execution of the `0_Pre_Processing.R` script containing the county (or administrative area) boundaries of the state (or province) of interest.

1-iii. Text files *autosaved* during the execution of the `0_Pre_Processing.R` script containing the geographic center of the state (or province) of interest.

1-iv. The folder titled `www` containing the file "`SLEI_Schematic.png`".

SLEI Model Software User Tutorial

Step 1: Open `R` and verify that you are running the appropriate version of the R Software (R Core Team 2020), which is `4.0.2 (2020-06-22) – "Taking Off Again"`
`Copyright (C) 2020 The R Foundation for Statistical Computing Platform: x86_64-w64-mingw32/x64 [64-bit].`
Note that newer versions of R may suffice.

Step 2: Install the appropriate versions of the packages in `R`. Packages include:

(1) “`devtools`” version 2.3.2,
(2) “`shinydashboard`” version 0.7.1,
(3) “`shiny`” version 1.5.0,
(4) “`leaflet`” version 2.0.3,
(5) “`dplyr`” version 1.0.2,
(6) “`leaflet.extras`” version 1.0.0,
(7) “`rgl`” version 0.100.54,
(8) “`shinyBS`” version 0.61,
(9) “`RColorBrewer`” version 1.1-2,
(10) “`sp`” version 1.4-4,
(11) “`sf`” version 0.9-6,
(12) “`rgdal`” version 1.5-18,
(13) “`leafpop`” version 0.0.6,
(14) “`tidyr`” version 1.1.2,
(15) “`shinycssloaders`” version 1.0.0,
(16) “`rmapshaper`” version 0.4.4,
(17) “`tigris`” version 1.0,
(18) “`stringr`” version 1.4.0,
(19) “`maptools`” version 1.0-2,
(20) “`raster`” version 3.4-5,
(21) “`rgeos`” version 0.5-5.

To install a particular version of a package, run the code:

```
library(devtools)
devtools::install_version("package name", version =
"#.#.#").
```

Step 3: Create a folder on your computer that will function as your working directory.

3-a: Create a folder, then name it in accordance with your project. This folder will be your working directory.

3-b: Set the path to the working directory in `R` by clicking the console, clicking “`File`”, “`Change dir…`”, then navigating to your working directory. Click “`OK`”.

3-c: Verify that `R` has the correct path to your working directory by clicking the R console, typing “`dir()`”, and hitting enter. The file names of the contents of your working directory will print in the console.

Step 4: Prepare the *SLEI Model Software* on your machine.

4-a: Download, unzip, and save *SLEI Model Software* contents in your working directory.

4-b: To double check all contents are in your working directory, click the console, type “`dir()`”, and hit enter. The file names of the *SLEI Model Software* contents should appear in the console.

IF PREPPING FOR CANADA complete Steps 5-7; otherwise skip to Step 8.

CANADA - Step 5: Download and prepare the census division unit shapefiles from Statistics Canada.

5-a. Go to *www12.statcan.gc.ca/census-recensement/2011/geo/bound-limit/bound-limit-2016-eng.cfm.*

5-b. Select the following options: Language: "`English`"; Format: "`ArcGIS`"; Boundary files: "`Census division`" under "`Cartographic Boundary File`"; then click "`Continue`" to be directed to the download page.

5-c. Download the zipped folder (`lcd_000b16a_e.zip`).

5-d. Unzip the downloaded folder into the working directory.

CANADA - Step 6: Download and prepare the geographic attribute file for the 2016 census year for Canada.

6-a. Go to *www12.statcan.gc.ca/census-recensement/2011/geo/ref/att-eng.cfm*.

6-b. Select the following options: Census year: `2016`; Format: "`Comma-separated values (.csv)`"; then click "`Continue`" to be directed to the download page.

6-c. Download the zipped folder (`2016_92-151_XBB_csv.zip`).

6-d. Unzip the downloaded folder into the working directory.

CANADA - Step 7: Open the 0_Pre_Processing.R script.

7-a. Remove the commented-out code "#-----#" from all the pertinent lines of code.

7-b. Update the `FullStateName` object on line 100 with the name of the province of interest.

Step 8: Open the `0_Pre_Processing.R` script. Hit "`Run all`".

Step 9: Open the `1_SLEI_App.R` script. Hit "`Run all`".

Step 10: Once done interacting with the software, close `R`.

Instructions to Modify the SLEI Model Software for Use in a New State (or Province)

The *SLEI Model Software* was developed to accommodate the needs of a consortium of state and provincial wildlife agencies that opted to participate in the Surveillance Optimization Project for Chronic Wasting Disease (SOP4CWD). This software is easily modified to run for a different state or province.

Step i: Open the "`County_Load.txt`" script and modify it for the new state (or province).

i-a. In the left (number) column, number additional (or remove) rows equaling the exact number of counties (or parishes, administrative areas, or other) in the state (or province) of interest. Do not change the header from `County`; leave it as is.

i-b. In the `County` column, list county names in alphabetical order starting with A. The county names should include the associated legal/statistical area description names (i.e., "County", "Parish", etc.) and should match the `NAMELSAD` attribute of the geospatial file for the state (or province) of interest. Do not change the header from `County`; leave it as is.

i-c. In the `Load` column, list the cumulative number of confirmed CWD infections known to exist in that county.

ii-c. Save the modified "`County_Load.txt`" script.

Step ii: Open the `0_Pre_Processing_App.R` script.

ii-a. Find/replace "Tennessee" with the new state (or province) name, written (if applicable) without a space. (i.e., "South Carolina" should be "SouthCarolina").

Step iii: Open the `1_SLEI_App.R` script.

iii-a. Find/replace "Tennessee" with the new state (or province) name, written (if applicable) without a space. (i.e., "South Carolina" should be "SouthCarolina").

Step iv: Run *Steps 1-10* (above).

Note: If you previously completed Steps 2-7 for another state (or province) (i.e., installed the appropriate packages, setup your working directory, prepared the Software, and if prepping for Canada, downloaded and added the Canadian census division unit shapefiles and geographic attribute file to your working directory), you may skip Steps 2-7.

Technical Details

`0_Pre_Processing.R` was written under `R` version `4.0.2 (2020-06-22) -- "Taking Off Again" Copyright (C) 2020 The R Foundation for Statistical Computing Platform: x86_64-w64-mingw32/x64 [64-bit]`. The script requires: (1) "`devtools`" version 2.3.2 (Wickman et al. 2020), (2) "`dplyr`" version 1.0.2 (Wickman et al. 2021), (3) "`rgdal`" version 1.5-18 (Bivand et al. 2020), (4) "`tigris`" version 1.0 (Walker 2020), (5) "`stringr`" version 1.4.0 (Wickman 2019), (6) "`maptools`" version 1.0-2 (Bivand and Lewin-Koh 2021), (7) "`raster`" version 3.4-5 (Hijmans 2020), (8) "`rgeos`" version 0.5-5 (Bivand and Rundel 2020), and (9) "`rmapshaper`" version 0.4.4 (Teucher and Russell 2020).

`1_SLEI_App.R` was written under `R` version `4.0.2 (2020-06-22) -- "Taking Off Again" Copyright (C) 2020 The R Foundation for Statistical Computing Platform: x86_64-w64-mingw32/x64 [64-bit]`. The script requires: (1) "`devtools`" version 2.3.2 (Wickman et al. 2020), (2) "`shinydashboard`" version 0.7.1 (Chang and Borges Ribeiro 2018), (3) "`shiny`" version 1.5.0 (Chang et al. 2020),

(4) “`leaflet`” version 2.0.3 (Cheng et al. 2019), (5) “`dplyr`” version 1.0.2 (Wickman et al. 2021), (6) “`leaflet.extras`” version 1.0.0 (Karambelkar and Schloerke 2018), (7) “`rgl`” version 0.100.54 (Adler et al. 2020), (8) “`shinyBS`” version 0.61 (Bailey 2015), (9) “`RColorBrewer`” version 1.1-2 (Neuwirth 2014), (10) “`sp`” version 1.4-4 (Pebesma and Bivand 2005; Bivand et al. 2013), (11) “`sf`” version 0.9-6 (Pebesma 2018), (12) “`rgdal`” version 1.5-18 (Bivand et al. 2020), (13) “`leafpop`” version 0.0.6 (Appelhans and Detsch 2020), (14) “`tidyr`” version 1.1.2 (Wickman 2020), (15) “`shinycssloaders`” version 1.0.0 (Sali and Attali 2020), and (16) “`rmapshaper`” version 0.4.4 (Teucher and Russell 2020).

Note: Newer versions of R may be used to run the software, but newer version of packages may not run as intended. However, the commands in lines 45-53 of the pre-processing script and in lines 44-59 of the app script allow you to upload and run as intended any outdated and/or retired packages.

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