Shiny App for Geocoding

May 17, 2024

Introduction

The CTSA/CEGIR geocoding docker container provides means of geocoding a given list of CTSA/CEGIR participant addresses and determining the driving distance (in minutes) to CTSA/CEGIR centers, identifying the center with the shortest driving distance. Users can generate an output CSV via the command line or interact with a Shiny App for a more user-friendly experience.

After installation, the software runs on a local computer without requiring an internet connection, thus maintaining the security and privacy of the participant information. The underlying software is based on Cole Brokamp's deGAUSS package.

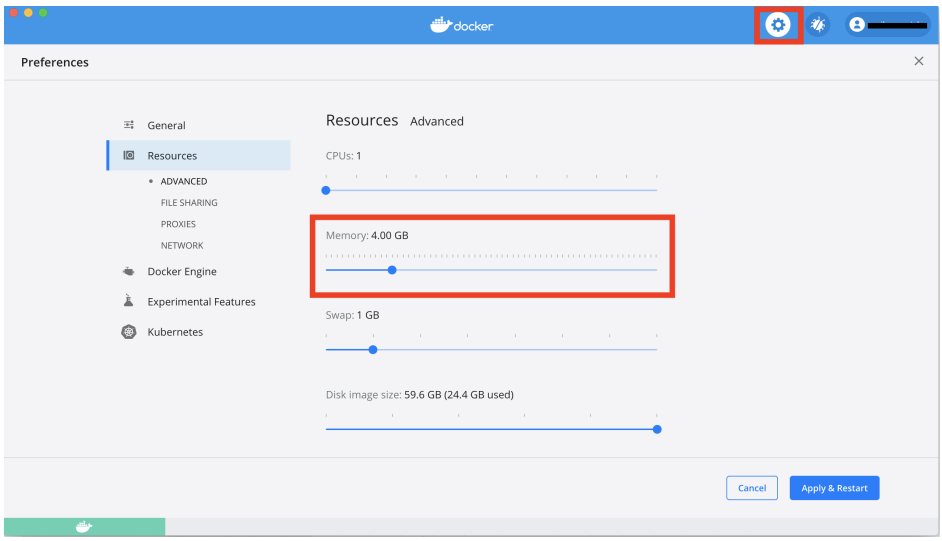
Requirements

- Operating System:
  - MacOS
  - Windows
- RAM: 8GB
- Disk Space: 20GB (docker container is 10GB)
- administrator privileges (initially only, to install the 'docker' software)

Step 0: Install Docker

See the Installing Docker webpage.

Note about Docker Settings:
After installing Docker, but before running containers, go to **Docker Settings > Advanced** and change **memory** to greater than 4000 MB (or 4 GiB)



If you are using a Windows computer, also set **CPUs** to 1.

Step 1: Preparing Your Input

User can perform geocoding in batch by putting the addresses together in a csv file (works with both Shiny App and command line) or seperately geocode a single valid US address in the Shiny App.

The address file must be a CSV file with either a column titled `address` containing all address components or columns titled `lat` and `lon` with the participant's latitude and longitude, respectively. Other columns may be present - in particular a `participant ID` column and an `address_date` column are recommended. If any participants have multiple addresses, `address_date` column with different date is required in order for the program to run properly.

The software will ignore (but preserve) all additional columns besides `address`, `lat` and `lon`.

An example address CSV file might look like the following `address-sample-date-UTAH.csv` file from the docker container:

address-sample-date-UTAH

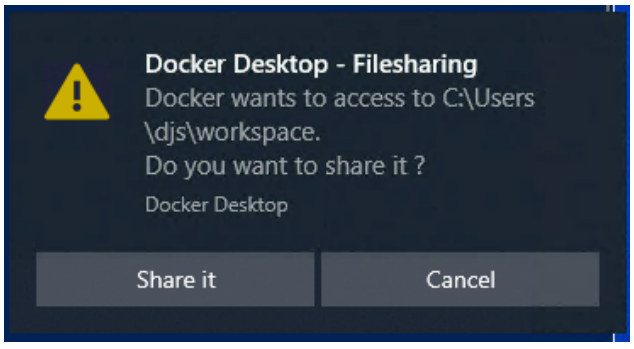
ID	address_date	address	lat	lon
1	1/1/24		39.98248794	-112.2851437
1	1/1/23		39.99908182	-112.1954693
2			40.62336655	-112.0137647
3	5/6/22	5331 Rexford Court, Montgomery AL 36116		
3	3/3/21	6095 Terry Lane, Golden CO 80403		
4	5/4/23	4016 Doane Street, Fremont CA 94538		

Example address CSV files are my_address_file.csv, address-sample.csv or address-sample-date-UTAH.csv, all located in the tests folder of the docker container source.

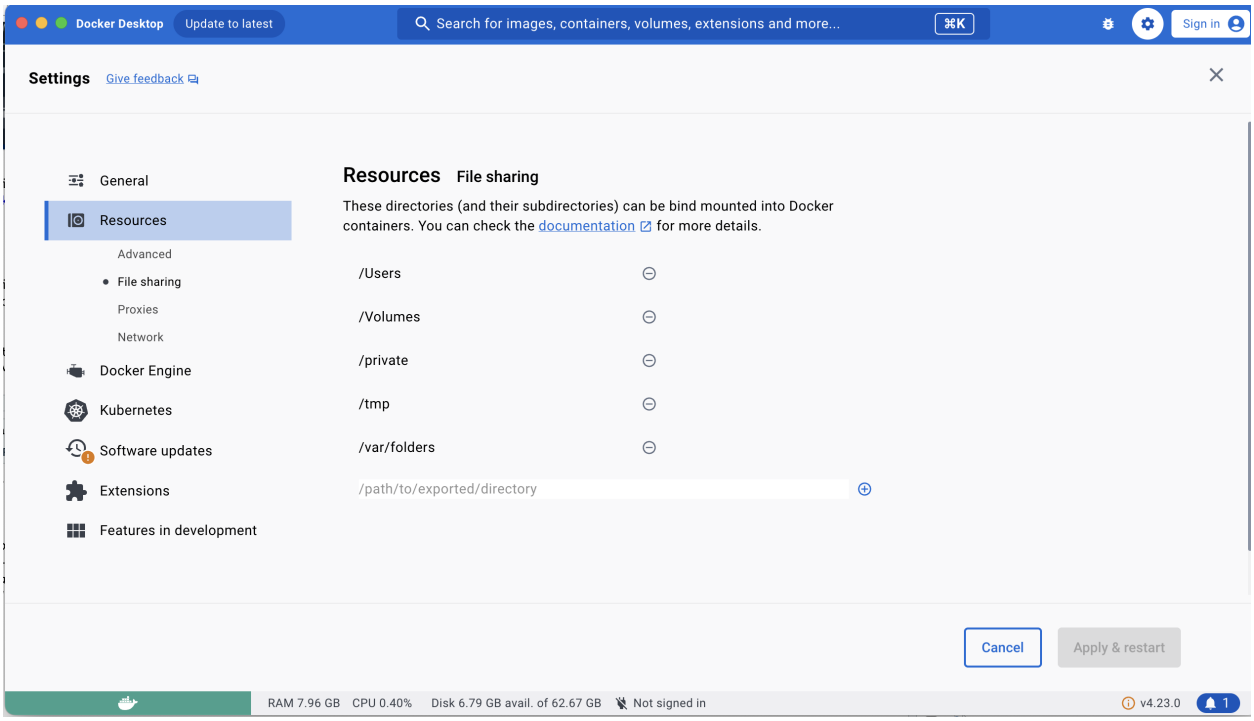
Note: Please make sure to enclose the information in the `address` column in quotation marks (e.g., " ") if it contains commas.

Step 2: Running the CTSA/CEGIR container

Note: On Windows computers you may need to give Docker explicit permissions to access the folder containing the address file (and possibly restart the Docker daemon after you have done so).



However, if notifications are disabled, the confirmation box will not appear and Docker will automatically decline the permission. In that case, go to **Docker Settings > Resources > FileSharing**. Add required folder and hit Apply & Restart



Note: The first time this process is run, docker will download the latest container from the ACC, which takes a few minutes of time. Later runs will not require internet connections (unless the container is to be updated with the latest version).

Note: After processing, **please** inspect the output files and fix obvious formatting problems with the address file should they arise (see also the section below on input address data formatting). The `*-deid.csv` file is safe to be sent to the ACC via secure upload to AWS (similar to the EMR data uploads).

There are 2 options to generate output via Docker command, described below:

2.1 Run Shiny App via docker command

This command launches a Shiny app at http://localhost:3838:

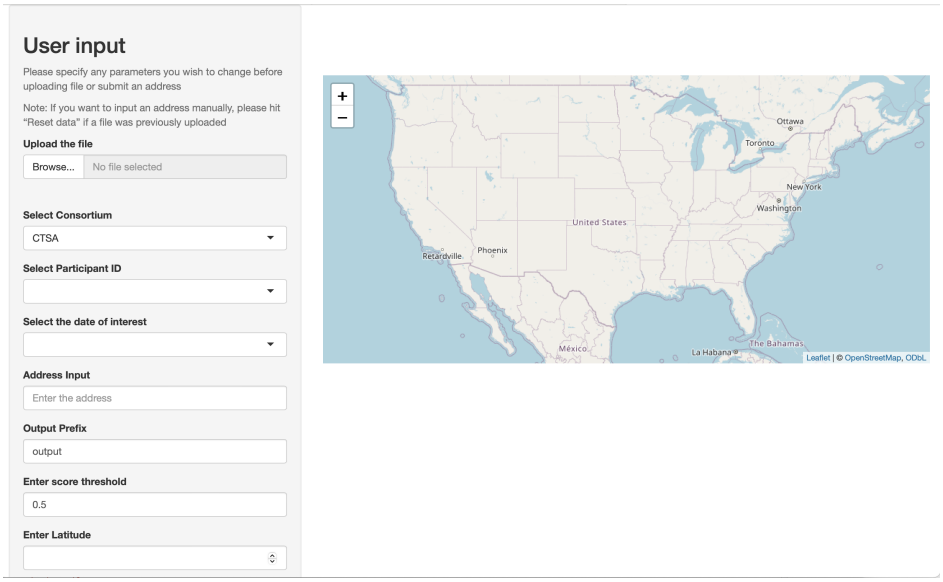
- macOS:

```
docker run --rm -p 3838:3838 -v $PWD:/tmp ghcr.io/dohn5r/geocoder_shiny:0.0.1 --shiny
```

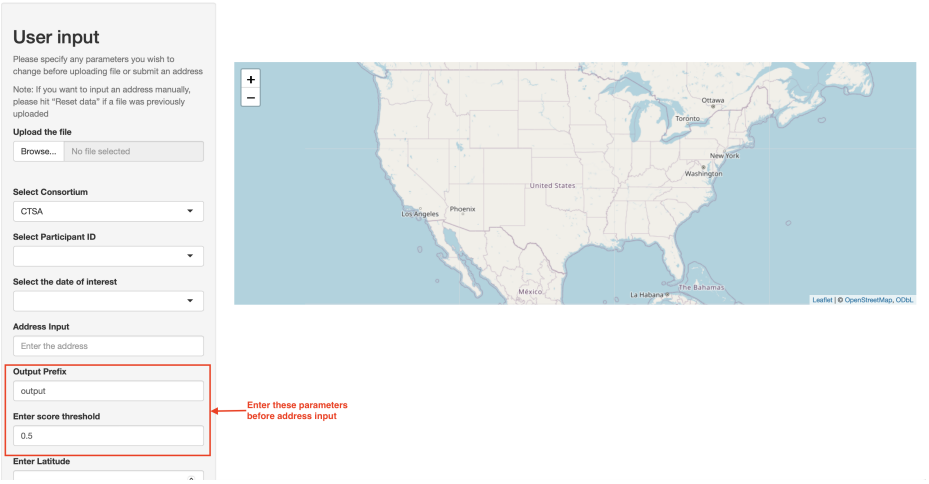
- Windows (CMD):

```
docker run --rm -p 3838:3838 -v "%cd%":/tmp ghcr.io/dohn5r/geocoder_shiny:0.0.1 --shiny
```

Here's a preview of the Shiny app when accessed at http://localhost:3838:

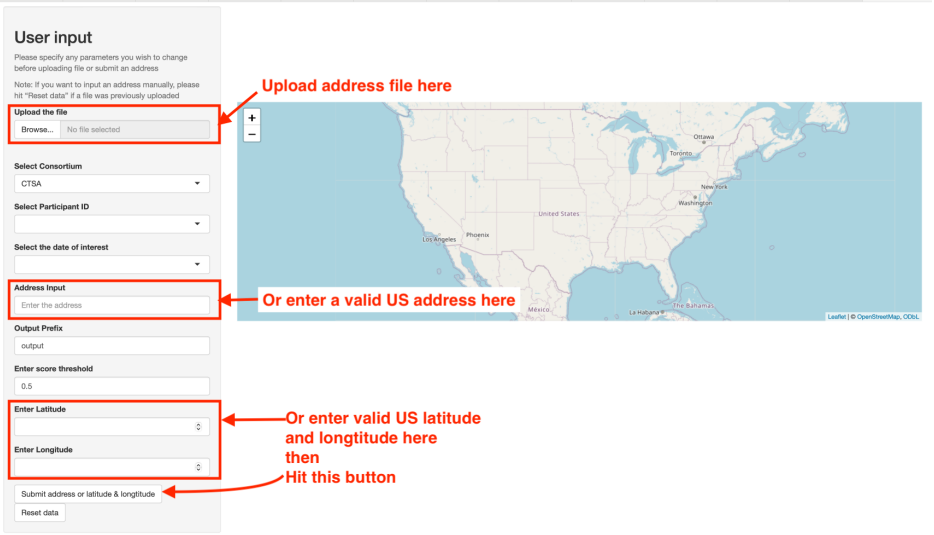


Before inputting address data, if users wish to modify default ***score*** values of 0.5 or ***output prefix*** value of "output", users need to specify those parameters:

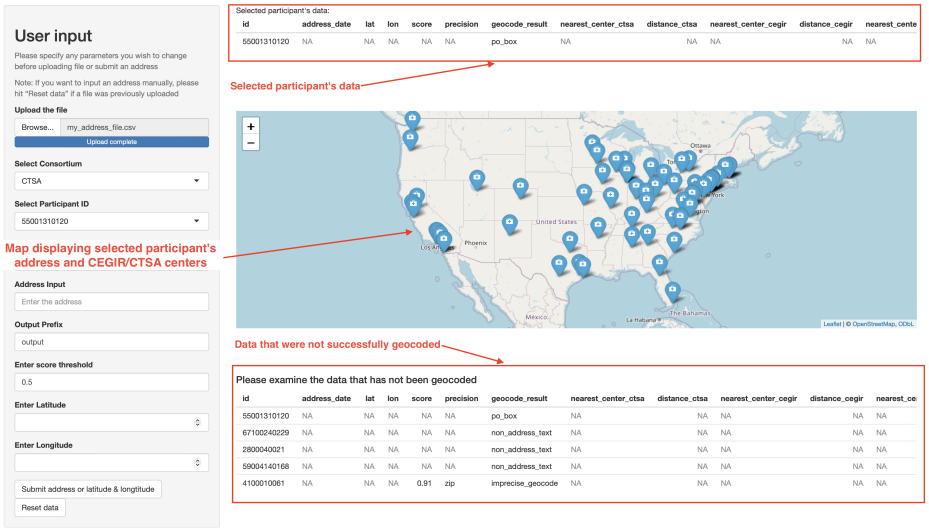


For input data, users can choose any of the following options:

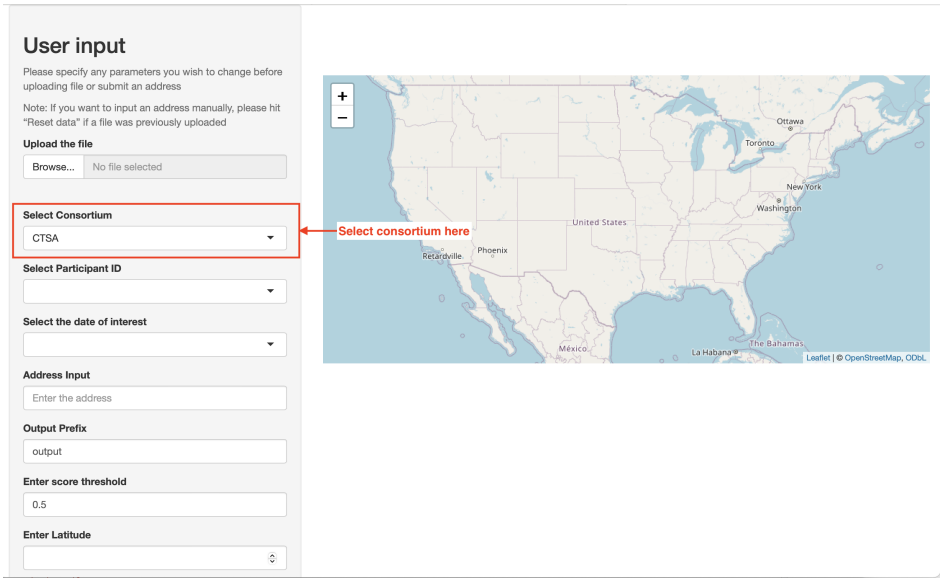
- Upload an Address file prepared in the step 1 by clicking **Browse...** option under **Upload the file**
- Enter a valid US address in **Address Input** field then hit **Submit adddress or latitude & longtitude** button
- Enter valid US latitude and longtitude in **Enter Latitude** and **Enter Longtitude** fields, then hit **Submit adddress or latitude & longtitude** button



Once the Shiny App successfully geocoded your input, selected participant's data are displayed on top of the Shiny App, the map is in the center, and a table containing data that are not successfully geocoded is at the bottom of the app



Users can select consortium of interest in **Select Consortium** dropdown menu anytime before or after geocoding process



Available options are:

- **`CTSA`**
- **`CEGIR`**

Both selected participant table and unsuccessfully geocoded table have the following columns:

- **`id`**: particpant's ID
- **`address_date`**: date when participants resides in the address of interest
- **`lat`** and **`lon`**: geocoded coordinates for matched address
- **`score`**: The percentage of text match between the given address and the geocoded result, expressed as a number between 0 and 1. A higher score indicates a closer match. Note that each score is relative within a precision method (i.e. a **`score`** of `0.8` with a **`precision`** of **`range`**is not the same as a **`score`** of `0.8` with a **`precision`** of **`street`**)
- **`precision`**: The method/precision of the geocode. The value will be one of:
  - **`range`**: interpolated based on address ranges from street segments
  - **`street`**: center of the matched street
  - **`intersection`**: intersection of two streets
  - **`zip`**: centroid of the matched zip code
  - **`city`**: centroid of the matched city
- **`geocode_result`**: A character string summarizing the geocoding result. The value will be one of
  - **`geocoded`**: the address was geocoded with a **`precision`** of either **`range`** or **`street`** and a **`score`** of `0.5` or greater.
  - **`imprecise_geocode`**: the address was geocoded, but results were suppressed because the **`precision`** was **`intersection`**, **`zip`**, or **`city`** and/or the **`score`** was less than `0.5`.
  - **`po_box`**: the address was not geocoded because it is a PO Box
  - **`non_address_text`**: the address was not geocoded because it was blank or listed as "foreign", "verify", or "unknown"
- **`nearest_center_ctsa`** : abbreviation of nearest CTSA center
- **`distance_ctsa`**: drive time to nearest CTSA center
- **`nearest_center_cegir`**: abbreviation of nearest CEGIR center

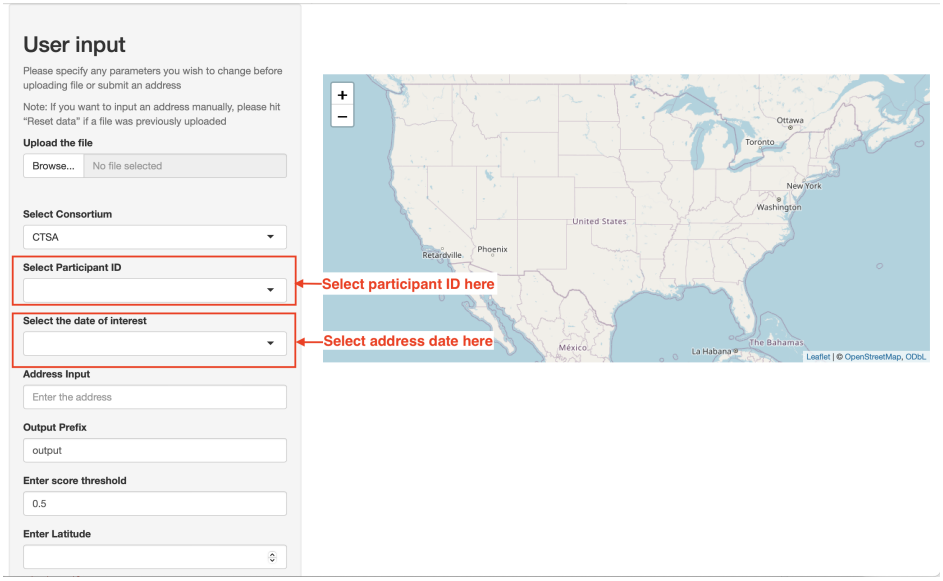
- **`distance_cegir`**: drive time to nearest CEGIR center
- **`nearest_center`**: abbreviation of nearest center in consortium selected
- **`distance`**: drive time to nearest center in consortium selected

In selected participant table, there are 2 additional columns that reflect selected center on map:

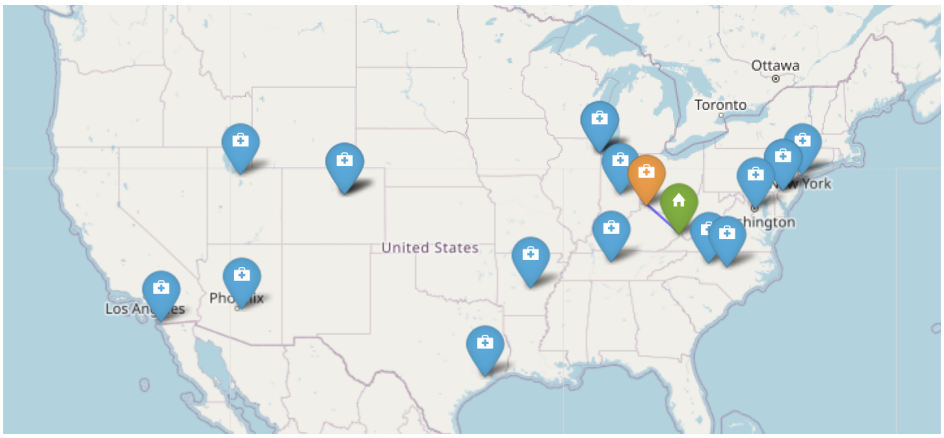
- **`selected_center`**: abbreviation of the clicked center
- **`d_to_selected_center`**: drivetime to selected center

Note: By default, **`selected_center`** is the abbreviation of the nearest center and **`d_to_selected_center`** is based on selected center

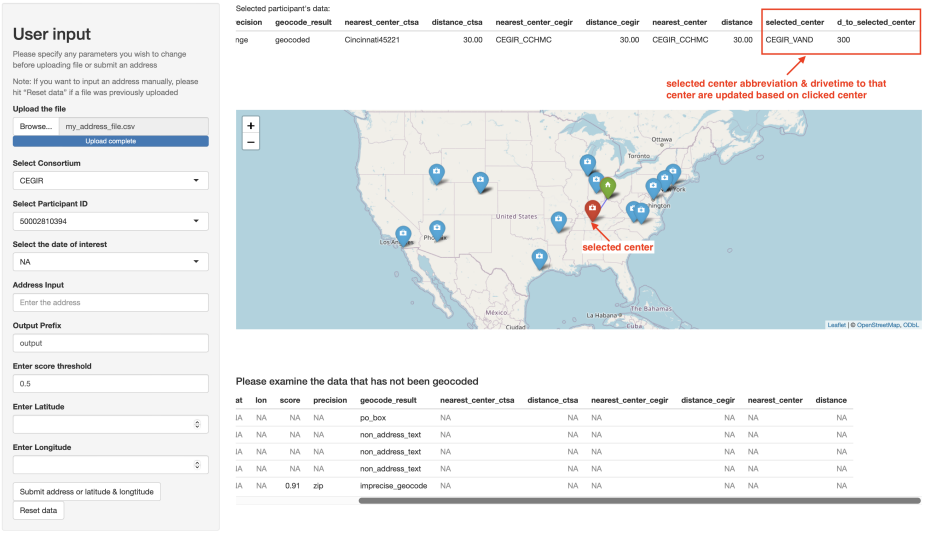
Participant IDs will appear in **Select Participant ID** drop-down menu. Users can then select participant ID of interest in **Select Participant ID** drop-down menu. If the selected participant have multiple addresses, users can select the date of interest:



By default, the participant's home address (indicated by a green home symbol) and the nearest center (indicated by an orange medkit symbol) are displayed on the map, together with the centers in the selected consortium (indicated by a blue medkit symbol)



When users click on a different center, the selected center turns red. Also, **`selected_center`** and **`d_to_selected_center`** are updated according to the clicked center on map.



Note: If the participant's address(es) could not be geocoded successfully, the green home symbol would not be displayed on the map. However, the data will still appear in the selected participant's data table.

If `my_address_file.csv` is the input address uploaded to Shiny App with an address column named **`address`**, with default **`output`** output prefix, will produce 3 output files:

- `output-with-phi.csv`: This file has full output data, **including PII data**. Do NOT sent this to the ACC.
- `output-deid.csv`: This file contains de-identified fields specified by the user as well as location-derived information. By default, the list of de-identified fields contain "id", "address_date", "matched_state", "precision", "geocode_result", "nearest_center_ctsa", "distance_ctsa", "nearest_center_ctsa", "distance_ctsa", "version".
  - "id" and "address_date" are copied verbatim from the input address file; it is the user's responsibility to ensure they don't contain PHI
- `output-log.txt`: This file is an output log of the processing.

2.2 Generate csv output via docker command

If `my_address_file.csv` is an address file in the current working directory with an address column named **`address`**, then the command to process it through the CTSA/CEGIR geocoding container is:

- macOS:

```
docker run --rm -v $PWD:/tmp ghcr.io/dohn5r/geocoder_shiny:0.0.1 \
-i my_address_file.csv -o output_file
```

- Windows (CMD):

```
docker run --rm -v "%cd%":/tmp ghcr.io/dohn5r/geocoder_shiny:0.0.1 ^
-i my_address_file.csv -o output_file
```

will produce 3 output files:

- `output_file-with-phi.csv`: This file has full output data, **including PII data**. Do NOT sent this to the ACC.
- `output_file-deid.csv`: This file contains de-identified fields specified by the user as well as location-derived information. By default, the list of de-identified fields contain "id", "address_date",

"matched_state", "precision", "geocode_result", "nearest_center_ctsa", "distance_ctsa", "nearest_center_ctsa", "distance_ctsa", "version".

  - "id" and "address_date" are copied verbatim from the input address file; it is the user's responsibility to ensure they don't contain PHI

- `output_file-log.txt`: This file is an output log of the processing.

Running the CTSA/CEGIR deGAUSS container (the longer version)

Command line parameters to show help, version and site list are as follows:

- `-h` or `--help`: Show available parameters. For example, users can use this command:

```
docker run ghcr.io/dohn5r/geocoder_shiny:0.0.1 -h
```

or

```
docker run ghcr.io/dohn5r/geocoder_shiny:0.0.1 --help
```

- `-v` or `--version`: Show the current version of Docker container with this command:

```
docker run ghcr.io/dohn5r/geocoder_shiny:0.0.1 -v
```

or

```
docker run ghcr.io/dohn5r/geocoder_shiny:0.0.1 --version
```

This container **requires** both of the following arguments:

- `-i` to specify the path to the input address CSV file

This container takes the following optional arguments:

- `-o` or `--output-file-prefix` to specify prefix of output files. By default, the prefix is `output`, which will generate output.log, output-phi.csv, output-deid.csv
- `--f` or `--include-deid-fields` to specify list of fields to include in output. Default fields:
  - id, address_date, matched_state, precision, geocode_result, nearest_center_ctsa, distance_ctsa, nearest_center_ctsa, distance_ctsa, version
- `--force` to force the container to overwrite output files if one of the output files already exists. By default, the program would exit if one of the output files already exists

Running the CTSA/CEGIR container (additional details)

This Docker image does the following:

1. perform geocoding on addresses (if not geocoded already, i.e., if `lat` and `lon` are not specified in the input), adding the following columns:

- **`matched_street`**, **`matched_city`**, **`matched_state`**, **`matched_zip`**: matched address componets (e.g., `matched_street` is the street the geocoder matched with the input address); can be used to investigate input address misspellings, typos, etc.
- **`precision`**: The method/precision of the geocode. The value will be one of:
  - `range`: interpolated based on address ranges from street segments
  - `street`: center of the matched street
  - `intersection`: intersection of two streets
  - `zip`: centroid of the matched zip code
  - `city`: centroid of the matched city
- **`score`**: The percentage of text match between the given address and the geocoded result, expressed as a number between 0 and 1. A higher score indicates a closer match. Note that each score is relative within a precision method (i.e. a `score` of `0.8` with a `precision` of `range`is not the same as a `score` of `0.8` with a `precision` of `street`).

- `lat` and `lon`: geocoded coordinates for matched address
- `geocode_result`: A character string summarizing the geocoding result. The value will be one of
  - `geocoded`: the address was geocoded with a `precision` of either `range` or `street` and a `score` of `0.5` or greater.
  - `imprecise_geocode`: the address was geocoded, but results were suppressed because the `precision` was `intersection`, `zip`, or `city` and/or the `score` was less than `0.5`.
  - `po_box`: the address was not geocoded because it is a PO Box
  - `non_address_text`: the address was not geocoded because it was blank or listed as "foreign", "verify", or "unknown"
- then compute drive time to a CTSA/CEGIR specified by user, adding the following columns:
  - **`nearest_center_ctsa`** and **`nearest_center_cegir`**: Nearest CTSA/CEGIR center as computed by the Docker image
  - **`distance_ctsa`** and **`distance_cegir`**: Distance to the nearest CTSA/CEGIR center as computed by the Docker image

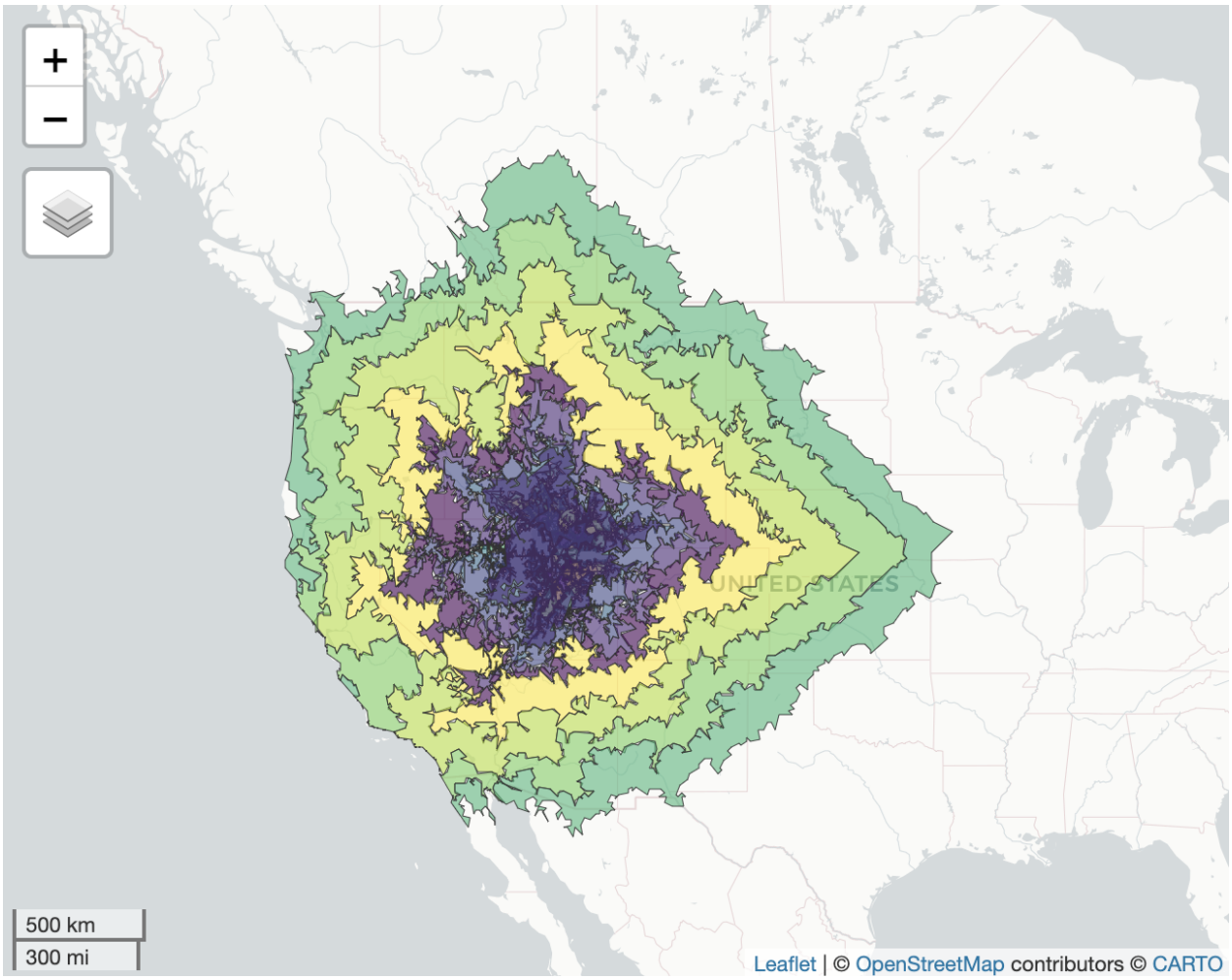
Details on the processing steps contained in the software

1. Geocoding

Input address data formatting

- Other columns may be present, but it is recommended to only include `address`, an optional identifier column (e.g., `id`) and an optional `address_date` column.
- Address data must be in one column called `address`.
- Separate the different address components with a space
- Do not include apartment numbers or "second address line" (but its okay if you can't remove them)
- ZIP codes must be five digits (i.e. `32709`) and not "plus four" (i.e. `32709-0000`)
- Do not try to geocode addresses without a valid 5 digit zip code; this is used by the geocoder to complete its initial searches and, if missing, will likely return incorrect matches
- Spelling should be as accurate as possible, but the program does complete "fuzzy matching" so an exact match is not striclty necessary
- Capitalization does not affect results
- Abbreviations may be used (i.e. `St.` instead of `Street` or `OH` instead of `Ohio`)
- Use Arabic numerals instead of written numbers (i.e. `13` instead of `thirteen`)
- Address strings with out of order items could return NA (i.e. `3333 Burnet Ave Cincinnati 45229 OH`)
- Geomarker data used was prepared following the instructions here using the 2021 TIGER/Line Street Range Address files from the Census

2. Drive time This container uses isochrones to assign drive time to care center for each input address. Drive time isochrones are concentric polygons, in which each point inside a polygon has (roughly) the same drive time to the care center. Below is an example of drive time isochrones around the CTSA/CEGIR center in Utah



Drive time isochrones were obtained using a self-hosted openroute service in order to overcome the time limitations of the publicly available API.

We defined 24 levels of isochrones with driving distances up to 960 minutes (16 hours): 15 30 45 60 75 90 105 120 135 150 165 180 195 210 225 240 300 360 420 480 600 720 840 960 minutes

3. Nearest center The centers with the shortest drive times are identified from the computed drivetime data above.

DeGAUSS Details

For detailed documentation on DeGAUSS, including general usage and installation, please see the DeGAUSS homepage.