Entering and cleaning data #3

Odds and ends

Groups for homework #5

Group projects

Pulling online data

APIs

API: "Application Program Interface"

An API provides the rules for software applications to interact. In the case of open data APIs, they provide the rules you need to know to write R code to request and pull data from the organization's web server into your R session.

Often, an API can help you avoid downloading all available data, and instead only download the subset you need.

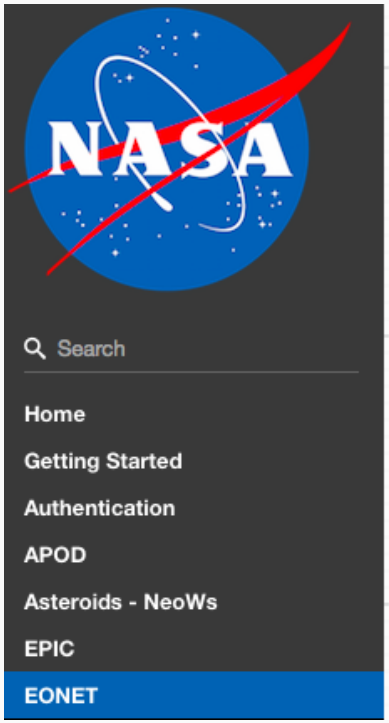
APIs

Strategy for using APIs from R:

- Figure out the API rules for HTTP requests
- Write R code to create a request in the proper format
- Send the request using GET or POST HTTP methods
- Once you get back data from the request, parse it into an easier-to-use format if necessary

API documentation

Start by reading any documentation available for the API. This will often give information on what data is available and how to put together requests.



QUERYING BY DATE(S)

Parameter	Type	Default	Description
date	YYYY-MM-DD	Most Recent Available	Retrieve matadata for all imagery available for a given date.
available_dates	string	All Available Dates	Retrieve a listing of all dates with available imagery.
api_key	string	DEMO_KEY	api.nasa.gov key for expanded usage

EXAMPLE QUERIES

`https://api.nasa.gov/EPIC/api/v1.0/images.php?api_key=DEMO_KEY`

`https://api.nasa.gov/EPIC/api/v1.0/images.php?date=2015-10-31&api_key=DEMO_KEY`

`https://api.nasa.gov/EPIC/api/v1.0/images.php?available_dates&api_key=DEMO_KEY`

More examples and usage tips can be found on the EPIC About Page.

Source: https://api.nasa.gov/api.html#EONET

API key

Many organizations will require you to get an API key and use this key in each of your API requests. This key allows the organization to control API access, including enforcing rate limits per user. API rate limits restrict how often you can request data (e.g., an hourly limit of 1,000 requests per user for NASA APIs).

You should keep this key private. In particular, make sure you do not include it in code that is posted to GitHub.

Example– `riem` package

The `riem` package, developed by Maelle Salmon and an ROpenSci package, is an excellent and straightforward example of how you can use R to pull open data through a web API.

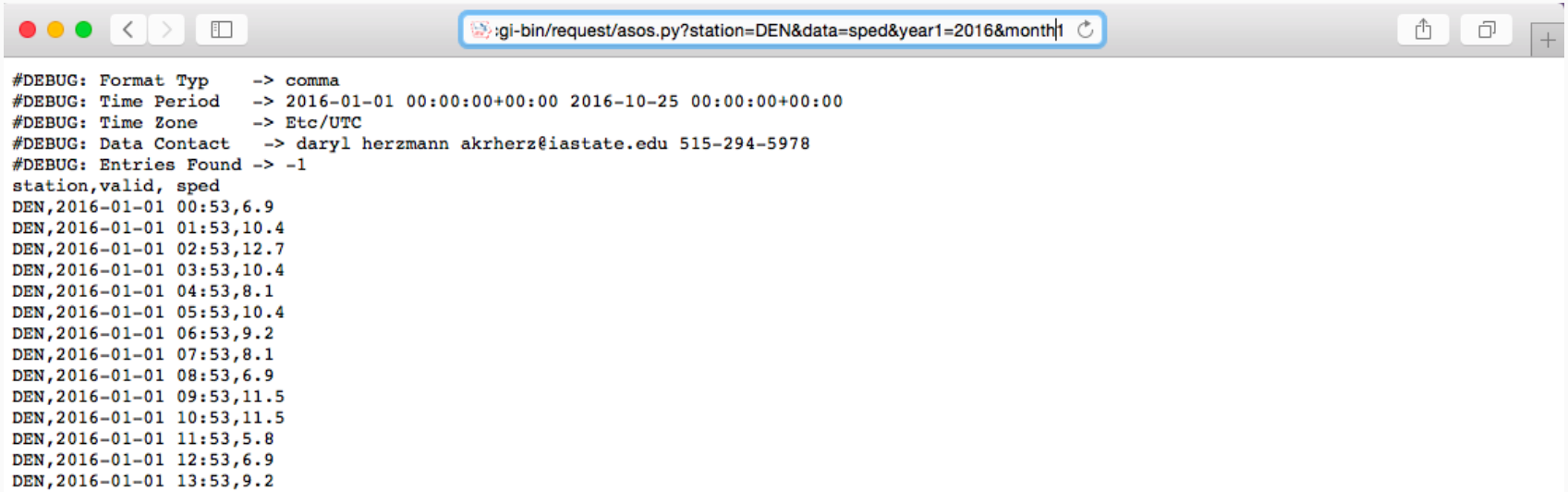
This package allows you to pull weather data from airports around the world directly from the Iowa Environmental Mesonet.

Example– `riem` package

To get a certain set of weather data from the Iowa Environmental Mesonet, you can send an HTTP request specifying a base URL, "https://mesonet.agron.iastate.edu/cgi-bin/request/asos.py/", as well as some parameters describing the subset of dataset you want (e.g., date ranges, weather variables, output format).

Once you know the rules for the names and possible values of these parameters (more on that below), you can submit an HTTP GET request using the `GET` function from the `httr` package.

Example– `riem` package



https://mesonet.agron.iastate.edu/cgi-bin/request/asos.py?station=DEN&data=sknt&year1=2016&month1=6&day1=1&year2=2016&month2=6&day2=30&tz=America%2FDenver&format=comma&latlon=no&direct=no&report_type=1&report_type=2

Using `httr` to get data from a webpage

When you are making an HTTP request using the `GET` or `POST` functions from the `httr` package, you can include the key-value pairs for any query parameters as a list object in the `query` argurment of the function.

```
library(httr)
meso_url <- paste0("https://mesonet.agron.iastate.edu/",
                   "cgi-bin/request/asos.py/")
denver <- GET(url = meso_url,
              query = list(station = "DEN", data = "sped",
                           year1 = "2016", month1 = "6",
                           day1 = "1", year2 = "2016",
                           month2 = "6", day2 = "30",
                           tz = "America/Denver",
                           format = "comma"))
```

Using `httr` to get data from a webpage

The `GET` call will return a special type of list object with elements that include the url you queried and the content of the page at that url:

```
str(denver, max.level = 1, list.len = 6)
```

```
## List of 10
##  $ url        : chr "https://mesonet.agron.iastate.edu/cgi-bi
##  $ status_code: int 200
##  $ headers    :List of 6
##   ..- attr(*, "class")= chr [1:2] "insensitive" "list"
##  $ all_headers:List of 1
##  $ cookies    :'data.frame': 0 obs. of  7 variables:
##  $ content    : raw [1:230652] 23 44 45 42 ...
##   [list output truncated]
##  - attr(*, "class")= chr "response"
```

Using `httr` to get data from a webpage

The `httr` package includes functions to pull out elements of this list object, including:

- `headers`: Pull out the header information
- `content`: Pull out the content returned from the page
- `status_code`: Pull out the status code from the `GET` request (e.g., 200: okay; 404: not found)

Note: For some fun examples of 404 pages, see https://www.creativebloq.com/web-design/best-404-pages-812505

Using `httr` to get data from a webpage

You can use `content` from `httr` to retrieve the contents of the HTTP request we made. For this particular web data, the requested data is a comma-separated file, so you can convert it to a dataframe with `read_csv`:

```
denver %>% content() %>%
  read_csv(skip = 5, na = "M") %>%
  slice(1:3)
```

```
## # A tibble: 3 x 3
##   station valid                sped
##   <chr>   <dttm>              <dbl>
## 1 DEN     2016-06-01 00:00:00   9.2
## 2 DEN     2016-06-01 00:05:00   9.2
## 3 DEN     2016-06-01 00:10:00   6.9
```

Example– `riem` package

The `riem` package wraps up this whole process, so you can call a single function to get in the data you want from the API:

```
library(riem)
denver_2 <- riem_measures(station = "DEN",
                          date_start = "2016-06-01",
                          date_end = "2016-06-30")
denver_2 %>% slice(1:3)
```

```
## # A tibble: 3 x 24
##   station valid                lon   lat  tmpf  dwpf  relh  drct  sknt
##   <chr>   <dttm>             <dbl> <dbl> <dbl> <dbl> <dbl> <dbl> <dbl>
## 1 DEN     2016-06-01 00:00:00 -105.  39.8    NA    NA    NA    70     7
## 2 DEN     2016-06-01 00:05:00 -105.  39.8    NA    NA    NA    80     8
## 3 DEN     2016-06-01 00:10:00 -105.  39.8    NA    NA    NA    80     9
## # ... with 15 more variables: p01i <dbl>, alti <dbl>, mslp <dbl>,
## #   vsby <dbl>, gust <dbl>, skyc1 <chr>, skyc2 <chr>, skyc3 <chr>,
## #   skyc4 <chr>, skyl1 <dbl>, skyl2 <dbl>, skyl3 <dbl>, skyl4 <dbl>,
## #   wxcodes <chr>, metar <chr>
```

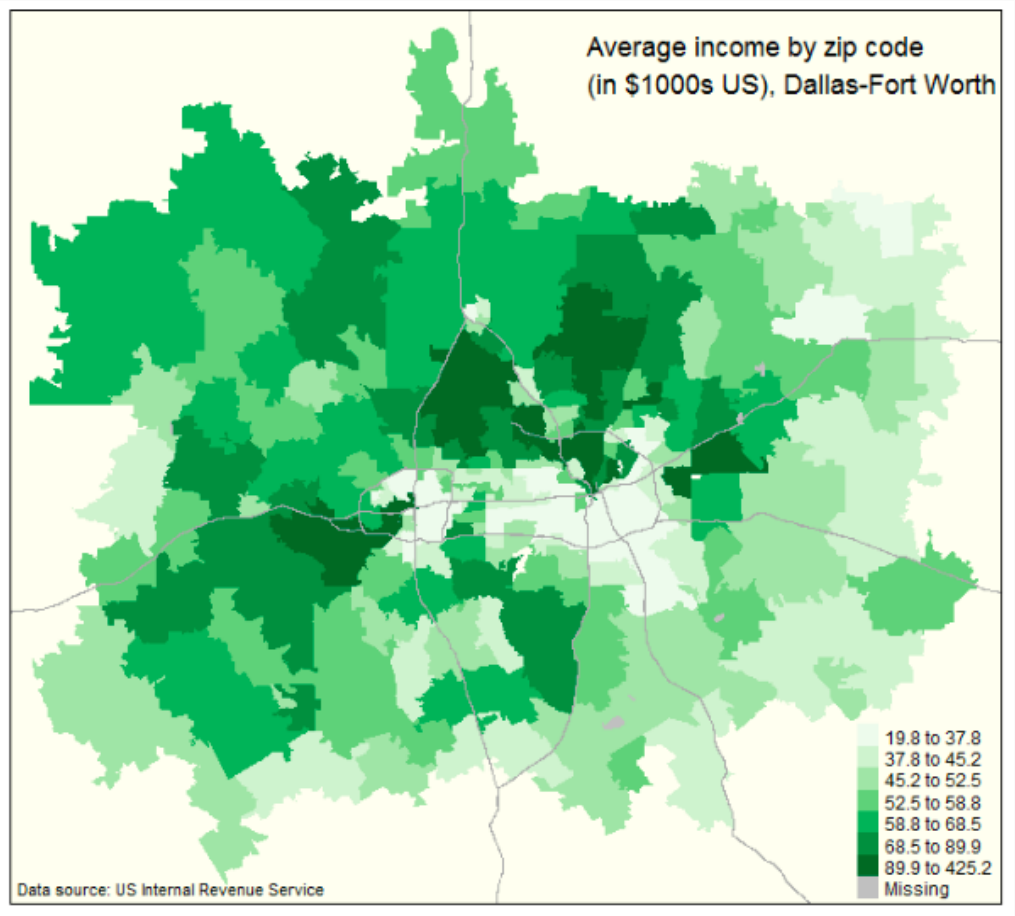
Example R API wrappers

`tigris` package

- Location boundaries
  - States
  - Counties
  - Blocks
  - Tracks
  - School districts
  - Congressional districts
- Roads
  - Primary roads
  - Primary and secondary roads
- Water
  - Area-water
  - Linear-water
  - Coastline
- Other
  - Landmarks
  - Military

`tigris` package

Example from: Kyle Walker. 2016. "tigris: An R Package to Access and Work with Geographic Data from the US Census Bureau". The R Journal.



US Census packages

A number of other R packages also help you access and use data from the U.S. Census:

- `acs`: Download, manipulate, and present American Community Survey and Decennial data from the US Census (see "Working with the American Community Survey in R: A Guide to Using the acs Package", a book available free online through the CSU library)
- `USABoundaries`: Historical and contemporary boundaries of the United States of America
- `idbr`: R interface to the US Census Bureau International Data Base API (e.g., populations of other countries)

rOpenSci

rOpenSci (https://ropensci.org):

> *"At rOpenSci we are creating packages that allow access to data repositories through the R statistical programming environment that is already a familiar part of the workflow of many scientists. Our tools not only facilitate drawing data into an environment where it can readily be manipulated, but also one in which those analyses and methods can be easily shared, replicated, and extended by other researchers."*

rOpenSci

rOpenSci collects a number of packages for tapping into open data for research: https://ropensci.org/packages

Some examples (all descriptions from rOpenSci):

- `AntWeb`: Access data from the world's largest ant database
- `chromer`: Interact with the chromosome counts database (CCDB)
- `gender`: Encodes gender based on names and dates of birth
- `musemeta`: R Client for Scraping Museum Metadata, including The Metropolitan Museum of Art, the Canadian Science & Technology Museum Corporation, the National Gallery of Art, and the Getty Museum, and more to come.
- `rusda`: Interface to some USDA databases
- `webchem`: Retrieve chemical information from many sources. Currently includes: Chemical Identifier Resolver, ChemSpider, PubChem, and Chemical Translation Service.

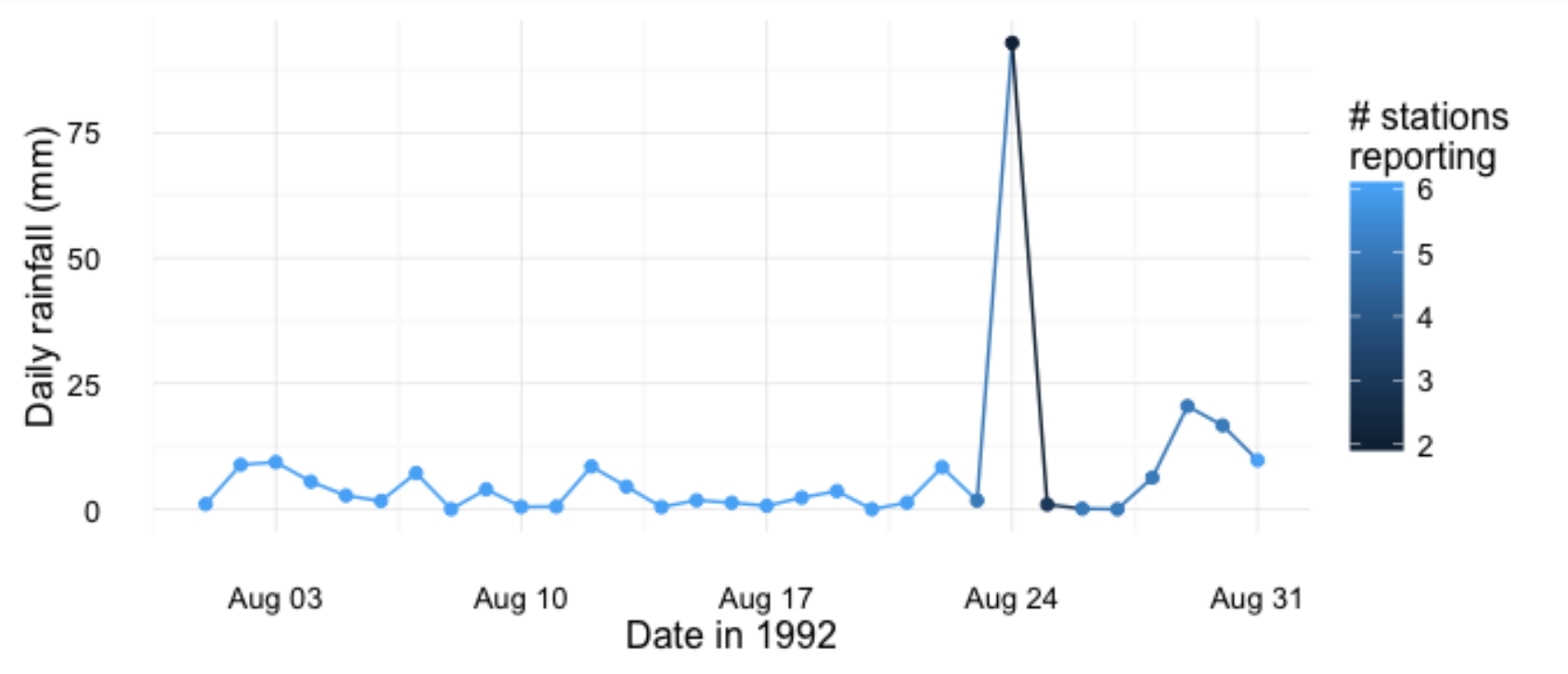
rnoaa

"Access climate data from NOAA, including temperature and precipitation, as well as sea ice cover data, and extreme weather events"

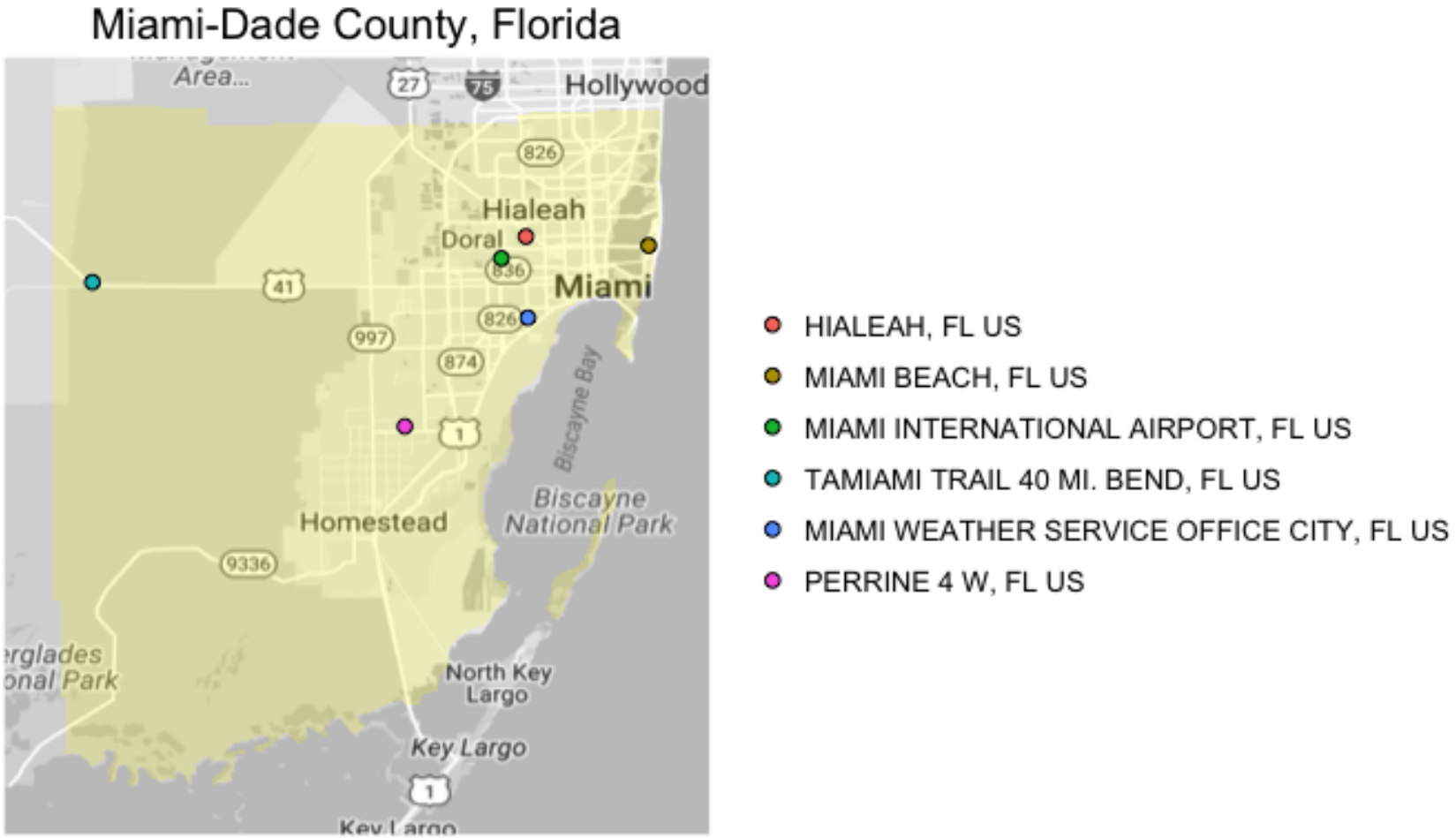
- Buoy data from the National Buoy Data Center
- Historical Observing Metadata Repository (HOMR))— climate station metadata
- National Climatic Data Center weather station data
- Sea ice data
- International Best Track Archive for Climate Stewardship (IBTrACS)— tropical cyclone tracking data
- Severe Weather Data Inventory (SWDI)

countyweather

The `countyweather` package wraps the `rnoaa` package to let you pull and aggregate weather at the county level in the U.S. For example, you can pull all data from Miami during Hurricane Andrew:



When you pull the data for a county, the package also maps the contributing weather stations:



USGS-R Packages

USGS has a very nice collection of R packages that wrap USGS open data APIs: https://owi.usgs.gov/R/

> *"USGS-R is a community of support for users of the R scientific programming language. USGS-R resources include R training materials, R tools for the retrieval and analysis of USGS data, and support for a growing group of USGS-R developers."*

USGS R Packages

USGS R packages include:

- `dataRetrieval`: Obtain water quality sample data, streamflow data, and metadata directly from either the USGS or EPA
- `EGRET`: Analysis of long-term changes in water quality and streamflow, including the water-quality method Weighted Regressions on Time, Discharge, and Season (WRTDS)
- `laketemps`: Lake temperature data package for Global Lake Temperature Collaboration Project
- `lakeattributes`: Common useful lake attribute data
- `soilmoisturetools`: Tools for soil moisture data retrieval and visualization

Other R API wrappers

Here are some examples of other R packages that faciliate use of an API for open data:

- `twitteR`: Twitter
- `Quandl`: Quandl (financial data)
- `RGoogleAnalytics`: Google Analytics
- `WDI`, `wbstats`: World Bank
- `GuardianR`, `rdian`: The Guardian Media Group
- `blsAPI`: Bureau of Labor Statistics
- `rtimes`: New York Times

R and APIs

Find out more about writing API packages with this vignette for the httr package: https://cran.r-project.org/web/packages/httr/vignettes/api-packages.html.

This document includes advice on error handling within R code that accesses data through an open API.