Getting Data from the Web with R

Part 5: Handling JSON data

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April-May 2014

```
{
  "Name": "Anakin",
  "Gender": "male",
  "Homeworld": "Tatooine",
  "Born": "41.9BBY",
  "Jedi": "yes"
},
{
  "Name": "Luke",
  "Gender": "male",
  "Homeworld": "Tatooine",
  "Born": "19BBY",
  "Jedi": "yes"
},
{
  "Name": "Leia",
  "Gender": "female",
  "Homeworld": "Alderaan",
  "Born": "19BBY",
  "Jedi": "no"
},
{
  "Name": "Obi-Wan",
```

Readme

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JSON Data

Goal

JSON

The goal of these slides is to provide an introduction for **handling JSON data in R**

Synopsis

In a nutshell

We'll cover the following topics:

- JSON Basics
- R packages for JSON data
- Reading JSON data from the Web

Some References

- XML and Web Technlogies for Data Sciences with R
  by Deb Nolan and Duncan Temple Lang
- Introducing JSON

  http://www.json.org/
- R package RJSONIO

  http://cran.r-project.org/web/packages/RJSONIO/index.html
- R package jsonlite

  http://cran.r-project.org/web/packages/jsonlite/vignettes/json-mapping.pdf
- R package rjson

  http://cran.r-project.org/web/packages/rjson/index.html

JSON Basics

Basics First

Fundamentals

JSON stands for **JavaScript Object Notation** and it is a format for representing data

- general purpose format
- lightweight format
- widely popular
- fairly simple

Basics First

Why should we care?

When working with data from the Web, we'll inevitably find some JSON data

- JSON can be used directly in JavaScript code for Web pages
- many Web APIs provide data in JSON format
- R has packages designed to handle JSON data

Understanding JSON

Understanding JSON

JSON Data Types

- `null`
- `true`
- `false`
- `number`
- `string`

JSON Data Containers

- square brackets `[ ]`
- curly brackets `{ }`

JSON Arrays

Unnamed Arrays

Square brackets [ ] are used for **ordered unnamed arrays**

- `[ 1, 2, 3, ... ]`
- `[ true, true, false, ... ]`

Named Arrays

Curly brackets { } are used for **named arrays**

- `{ "dollars" : 5, "euros" : 20, ... }`
- `{ "city" : "Berkeley", "state" : "CA", ... }`

JSON Arrays

Containers can be nested

Example A

```
{
    "name": ["X", "Y", "Z"],
    "grams": [300, 200, 500],
    "qty": [4, 5, null],
    "new": [true, false, true],
}
```

Example B

```
[
    { "name": "X",
      "grams": 300,
      "qty": 4,
      "new": true },
    { "name": "Y",
      "grams": 200,
      "qty": 5,
      "new": false },
    { "name": "Z",
      "grams": 500,
      "qty": null,
      "new": true}
]
```

Data Table Toy Example

Imagine we have some data

Name	Gender	Homeland	Born	Jedi
Anakin	male	Tatooine	41.9BBY	yes
Amidala	female	Naboo	46BBY	no
Luke	male	Tatooine	19BBY	yes
Leia	female	Alderaan	19BBY	no
Obi-Wan	male	Stewjon	57BBY	yes
Han	male	Corellia	29BBY	no
Palpatine	male	Naboo	82BBY	no
R2-D2	unknown	Naboo	33BBY	no

There are several ways to represent this data in JSON format

One way to represent data

```
[
    {
     "Name": "Anakin",
     "Gender": "male",
     "Homeworld": "Tatooine",
     "Born": "41.9BBY",
     "Jedi": "yes"
    },
    ...
    {
     "Name": "R2-D2",
     "Gender": "unknown",
     "Homeworld": "Naboo",
     "Born": "33BBY",
     "Jedi": "no"
    },
]
```


Another way to represent data

```
{
  "Name": [ "Anakin", "Amidala", "Luke", ... , "R2-D2" ],
  "Gender": [ "male", "female", "male", ... , "unknown" ],
  "Homeworld": [ "Tatooine", "Naboo", "Tatooine", ... , "Naboo" ],
  "Born": [ "41.9BBY", "46BBY", "19BBY", ... , "33BBY" ],
  "Jedi": [ "yes", "no", "yes", ... , "no" ]
}
```


JSON R packages

R packages for JSON

R has 3 packages for working with JSON data

- `"RJSONIO"` by Duncan Temple Lang
- `"rjson"` by Alex Couture-Beil
- `"jsonlite"` by Jeroen Ooms, Duncan Temple Lang, Jonathan Wallace

All packages provide 2 main functions —`toJSON()` and `fromJSON()`— that allow conversion **to** and **from** data in JSON format, respectively.

We'll focus on the functions from `"RJSONIO"`

R package RJSONIO

R package "RJSONIO"

If you don't have "RJSONIO" you'll have to install it:

```
# install RJSONIO
install.packages("RJSONIO", dependencies = TRUE)
```


R package RJSONIO

Main functions

There are 2 primary functions in `"RJSONIO"`

- `toJSON()` converts an R object to a string in JSON
- `fromJSON()` converts JSON content to R objects

Function `toJSON()`

```
toJSON(x, container = isContainer(x, asIs, .level),
       collapse = "\n", ...)
```

- `x` the R object to be converted to JSON format
- `container` whether to treat the object as a vector/container or a scalar
- `collapse` string used as separator when combining the individual lines of the generated JSON content
- `...` additional arguments controlling the JSON formatting

Function fromJSON()

```
fromJSON(content, handler = NULL, default.size = 100,
         depth = 150L, allowComments = TRUE, ...)
```

- `content` the JSON content: either a file name or a character string
- `handler` R object responsible for processing each individual token/element
- `deafult.size` size to use for arrays and objects in an effort to avoid reallocating each time we add a new element.
- `depth` maximum number of nested JSON levels
- `allowComments` whether to allow C-style comments within the JSON content
- `...` additional parameters

Data Table Toy Example

Imagine we have some tabular data

Name	Gender	Homeland	Born	Jedi
Anakin	male	Tatooine	41.9BBY	yes
Amidala	female	Naboo	46BBY	no
Luke	male	Tatooine	19BBY	yes
Leia	female	Alderaan	19BBY	no
Obi-Wan	male	Stewjon	57BBY	yes
Han	male	Corellia	29BBY	no
Palpatine	male	Naboo	82BBY	no
R2-D2	unknown	Naboo	33BBY	no

R Data Frame

```
# toy data
sw_data = rbind(
  c("Anakin", "male", "Tatooine", "41.9BBY",  "yes"),
  c("Amidala", "female", "Naboo", "46BBY", "no"),
  c("Luke", "male", "Tatooine", "19BBY", "yes"),
  c("Leia", "female", "Alderaan", "19BBY", "no"),
  c("Obi-Wan",  "male", "Stewjon", "57BBY", "yes"),
  c("Han", "male", "Corellia", "29BBY", "no"),
  c("Palpatine", "male", "Naboo", "82BBY", "no"),
  c("R2-D2", "unknown", "Naboo", "33BBY", "no"))

# convert to data.frame and add column names
swdf = data.frame(sw_data)
names(swdf) = c("Name", "Gender", "Homeworld", "Born", "Jedi")
swdf
```

```
##        Name  Gender Homeworld    Born Jedi
## 1    Anakin    male  Tatooine 41.9BBY  yes
## 2   Amidala  female     Naboo   46BBY   no
## 3      Luke    male  Tatooine   19BBY  yes
## 4      Leia  female  Alderaan   19BBY   no
## 5   Obi-Wan    male   Stewjon   57BBY  yes
## 6       Han    male  Corellia   29BBY   no
## 7 Palpatine    male     Naboo   82BBY   no
## 8     R2-D2 unknown     Naboo   33BBY   no
```

From R to JSON

```
# load RJSONIO
library(RJSONIO)

# convert R data.frame to JSON
sw_json = toJSON(swdf)

# what class?
class(sw_json)


## [1] "character"


# display JSON format
cat(sw_json)


## {
##  "Name": [ "Anakin", "Amidala", "Luke", "Leia", "Obi-Wan", "Han", "Palpatine", "R2-D2" ],
## "Gender": [ "male", "female", "male", "female", "male", "male", "male", "unknown" ],
## "Homeworld": [ "Tatooine", "Naboo", "Tatooine", "Alderaan", "Stewjon", "Corellia", "Naboo", "Naboo" ],
## "Born": [ "41.9BBY", "46BBY", "19BBY", "19BBY", "57BBY", "29BBY", "82BBY", "33BBY" ],
## "Jedi": [ "yes", "no", "yes", "no", "yes", "no", "no", "no" ]
## }
```

From JSON to R

```
# convert JSON string to R list
sw_R = fromJSON(sw_json)

# what class?
class(sw_R)


## [1] "list"


# display JSON format
sw_R


## $Name
## [1] "Anakin"    "Amidala"   "Luke"      "Leia"      "Obi-Wan"   "Han"
## [7] "Palpatine" "R2-D2"
##
## $Gender
## [1] "male"    "female"  "male"    "female"  "male"    "male"    "male"
## [8] "unknown"
##
## $Homeworld
## [1] "Tatooine" "Naboo"    "Tatooine" "Alderaan" "Stewjon"  "Corellia"
## [7] "Naboo"    "Naboo"
##
## $Born
## [1] "41.9BBY" "46BBY"   "19BBY"   "19BBY"   "57BBY"   "29BBY"   "82BBY"
## [8] "33BBY"
##
## $Jedi
## [1] "yes" "no"  "yes" "no"  "yes" "no"  "no"  "no"
```

Reading JSON Data

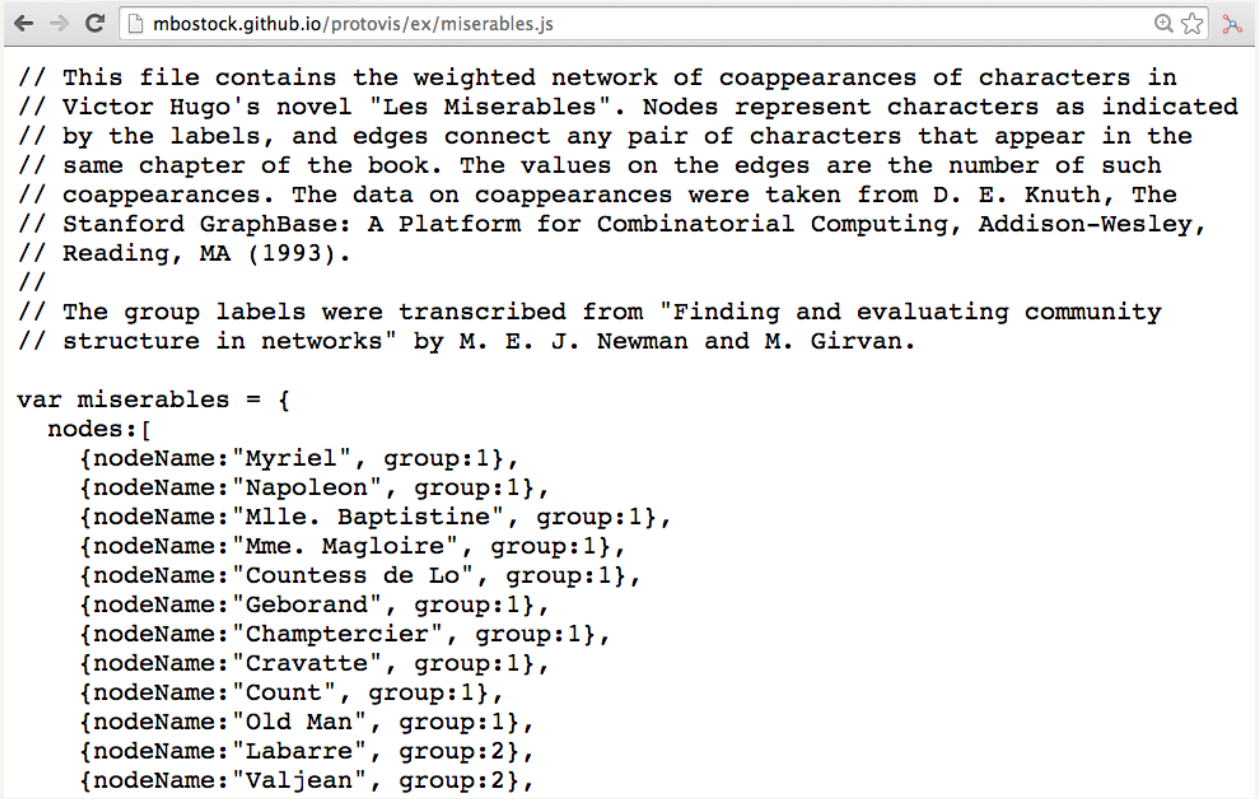
JSON Data from the Web

How do we read JSON data from the Web?

We read JSON data in several ways. One way is to pass the url directly to `fromJSON()`. Another way is by passing `fromJSON()` the name of the file with the JSON content as a single string.

File: miserables.js

We'll read the *miserables* dataset from:
http://mbostock.github.io/protovis/ex/miserables.js



Reading Issues

Houston we have a problem ...

The data is in a file that contains several javascript comments and some other javascript notation.

Unfortunately, we cannot use any of the `fromJSON()` functions directly on this type of content.

Instead, we need to read the content as text, get rid of the comments, and change some characters before using `fromJSON()`

Reading miserables.js

```
# load RJSONIO and jsonlite
library(RJSONIO)
library(jsonlite)

# url with JSON content
miser = "http://mbostock.github.io/protovis/ex/miserables.js"

# import content as text (character vector)
miserables = readLines(miser)

# eliminate first 11 lines (containing comments)
miserables = miserables[-c(1:11)]
```

Now check the first and the last lines:

```
# first line
miserables[1]


## [1] "var miserables = {"


# last line
miserables[length(miserables)]


## [1] "};"
```

Preparing JSON content

We need to modify the first and last lines so they don't contain non-JSON javascript notation

```
# open curly bracket in first line
miserables[1] = "{"

# closing curly bracket in last line
miserables[length(miserables)] = "}"
```

Now we must concatenate all the content into a single string:

```
# JSON content in one single string
miserables_str = paste(miserables, collapse = "")
```

Once we have the JSON content in the proper shape, we can parse it with `fromJSON()`.

Parsing JSON content

`fromJSON()` from package "RJSONIO":

```
# fromJSON() in package RJSONIO
mis1 = RJSONIO::fromJSON(miserables_str)

# class
class(mis1)


## [1] "list"


# how many elements
length(mis1)


## [1] 2


# names
names(mis1)


## [1] "ode" "ink"
```

```
# class of each element
lapply(mi1, class)


## Error:  object 'mi1' not found

# how many elements in each list component
lapply(mis1, length)


## $ode
## [1] 77
##
## $ink
## [1] 254
```

Parsing JSON content

```
# take a peek at nodes
head(mis1[[1]], n = 3)
```

```
## [[1]]
## [[1]]$odeNam
## [1] "Myriel"
##
## [[1]]$rou
## [1] 1
##
##
## [[2]]
## [[2]]$odeNam
## [1] "Napoleon"
##
## [[2]]$rou
## [1] 1
##
##
## [[3]]
## [[3]]$odeNam
## [1] "Mlle. Baptistine"
##
## [[3]]$rou
## [1] 1
```

```
# take a peek at links
head(mis1[[2]], n = 3)
```

```
## [[1]]
## ourc arge  alu
##    1    0    1
##
## [[2]]
## ourc arge  alu
##    2    0    8
##
## [[3]]
## ourc arge  alu
##    3    0   10
```

Parsing JSON content

`fromJSON()` from package "jsonlite":

```
# fromJSON() in package jsonlite
mis2 = jsonlite::fromJSON(miserables_str)

# class
class(mis2)


## [1] "list"


# how many elements
length(mis2)


## [1] 2


# names
names(mis2)


## [1] "ode" "ink"
```

```
# class of each element
lapply(mis2, class)


## $ode
## [1] "data.frame"
##
## $ink
## [1] "data.frame"


# dimensions of each element
lapply(mis2, dim)


## $ode
## [1] 77  2
##
## $ink
## [1] 254   3
```

Parsing JSON content

```
# take a peek at nodes
head(mis2[[1]], n = 5)
```

```
##             odeNam rou
## 1           Myriel   1
## 2         Napoleon   1
## 3 Mlle. Baptistine   1
## 4    Mme. Magloire   1
## 5   Countess de Lo   1
```

```
# take a peek at links
head(mis2[[2]], n = 5)
```

```
##   ourc arge alu
## 1    1    0   1
## 2    2    0   8
## 3    3    0  10
## 4    3    2   6
## 5    4    0   1
```

Parsing Differences

"RJSONIO" -vs- "jsonlite"

The package "jsonlite" is a fork of "RJSONIO". However, "jsonlite" implements a smarter mapping between JSON data and R classes.

From the previous example, we saw that "jsonlite" returns a list of data frames instead of the list of lists returned by "RJSONIO"

