ISA 401: Business Intelligence & Data Visualization

04: Scraping Webpages in R

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Automated Scheduler for Office Hours

Fall 2024

Quick Refresher from Last Class

- ☑ Subset data in R.
- ☑ Read text-files, binary files (e.g., Excel, SAS, SPSS, Stata, etc), json files, etc.
- ☑ Export data from R.

Learning Objectives for Today's Class

- Understand when can we scrape data (i.e., `robots.txt`)
- Scrape a webpage using R.

Web Technology 

Source: Slides 5-15 are from Dr Earo Wang's STAT 220 Web Scraping Slides, which were adapted from Dr Emi Tanaka's "Communicating with Data" course.

World Wide Web (WWW)

WWW (or the **Web**) is the information system where documents (web pages) are identified by Uniform Resource Locators (**URL**s)

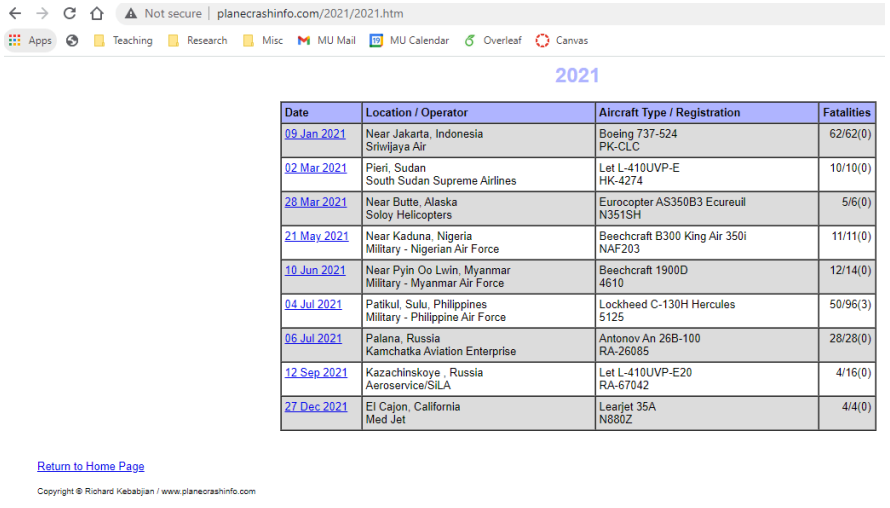
A web page consists of:

- **HTML** provides the basic structure of the web page
- **CSS** controls the look of the web page (optional)
- **JS** is a programming language that can modify the behavior of elements of the web page (optional)

Hypertext Markup Language (HTML)

- with the extension `.html`.
- rendered using a web browser via an URL.
- text files that follows a special syntax that alerts web browsers how to render it.

via a web browser



2021

Date	Location / Operator	Aircraft Type / Registration	Fatalities
09 Jan 2021	Near Jakarta, Indonesia Sriwijaya Air	Boeing 737-524 PK-CLC	62/62(0)
02 Mar 2021	Pieri, Sudan South Sudan Supreme Airlines	Let L-410UVP-E HK-4274	10/10(0)
28 Mar 2021	Near Butte, Alaska Soloy Helicopters	Eurocopter AS350B3 Ecureuil N351SH	5/6(0)
21 May 2021	Near Kaduna, Nigeria Military - Nigerian Air Force	Beechcraft B300 King Air 350i NAF203	11/11(0)
10 Jun 2021	Near Pyin Oo Lwin, Myanmar Military - Myanmar Air Force	Beechcraft 1900D 4610	12/14(0)
04 Jul 2021	Patikul, Sulu, Philippines Military - Philippine Air Force	Lockheed C-130H Hercules 5125	50/96(3)
06 Jul 2021	Palana, Russia Kamchatka Aviation Enterprise	Antonov An 26B-100 RA-26085	28/28(0)
12 Sep 2021	Kazachinskoye , Russia Aeroservice/SiLA	Let L-410UVP-E20 RA-67042	4/16(0)
27 Dec 2021	El Cajon, California Med Jet	Learjet 35A N880Z	4/4(0)

Return to Home Page

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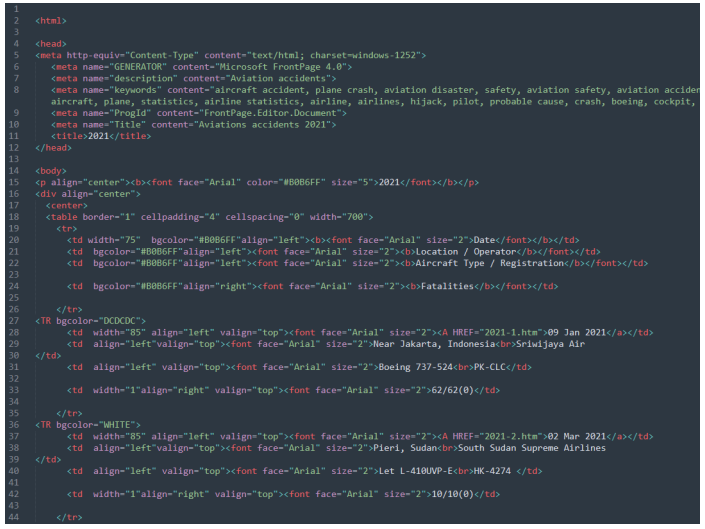
via a text editor



```
<html>

<head>
<meta http-equiv="Content-Type" content="text/html; charset=windows-1252">
  <meta name="GENERATOR" content="Microsoft FrontPage 4.0">
  <meta name="description" content="Aviation accidents">
  <meta name="keywords" content="aircraft accident, plane crash, aviation disaster, safety, aviation safety, aviation accider
  aircraft, plane, statistics, airline statistics, airline, airlines, hijack, pilot, probable cause, crash, boeing, cockpit,
  <meta name="ProgId" content="FrontPage.Editor.Document">
  <meta name="Title" content="Aviations accidents 2021">
  <title>2021</title>
</head>

<body>
<p align="center"><b><font face="Arial" color="#B0B6FF" size="5">2021</font></b></p>
<div align="center">
  <center>
  <table border="1" cellpadding="4" cellspacing="0" width="700">
    <tr>
      <td width="75"  bgcolor="#B0B6FF"align="left"><b><font face="Arial" size="2">Date</font></b></td>
      <td  bgcolor="#B0B6FF"align="left"><font face="Arial" size="2"><b>Location / Operator</b></font></td>
      <td  bgcolor="#B0B6FF"align="left"><font face="Arial" size="2"><b>Aircraft Type / Registration</b></font></td>

      <td  bgcolor="#B0B6FF"align="right"><font face="Arial" size="2"><b>Fatalities</b></font></td>

    </tr>
<TR bgcolor="DCDCDC">
      <td  width="85" align="left" valign="top"><font face="Arial" size="2"><A HREF="2021-1.htm">09 Jan 2021</a></td>
      <td  align="left"valign="top"><font face="Arial" size="2">Near Jakarta, Indonesia<br>Sriwijaya Air
</td>
      <td  align="left" valign="top"><font face="Arial" size="2">Boeing 737-524<br>PK-CLC</td>

      <td  width="1"align="right" valign="top"><font face="Arial" size="2">62/62(0)</td>

    </tr>
<TR bgcolor="WHITE">
      <td  width="85" align="left" valign="top"><font face="Arial" size="2"><A HREF="2021-2.htm">02 Mar 2021</a></td>
      <td  align="left"valign="top"><font face="Arial" size="2">Pieri, Sudan<br>South Sudan Supreme Airlines
</td>
      <td  align="left" valign="top"><font face="Arial" size="2">Let L-410UVP-E<br>HK-4274 </td>

      <td  width="1"align="right" valign="top"><font face="Arial" size="2">10/10(0)</td>

    </tr>
```

HTML Structure

```
<!DOCTYPE html>

<html>
  <!--This is a comment and ignored by web client.-->
  <head>
    <!--This section contains web page metadata.-->
    <title>ISA 401: Business Intelligence and Data Viz</title>
    <meta name="author" content="Fadel Megahed">
    <link rel="stylesheet" href="css/styles.css">
  </head>

  <body>
    <!--This section contains what you want to display on your web page.-->
    <h1>I'm a first level header</h1>
    <p>This is a <b>paragraph</b>.</p>
  </body>
</html>
```

HTML Syntax

`<span style="color:blue;">Author content</span>` Author content

start tag:	`<span style="color:blue;">Author content</span>`
end tag:	`<span style="color:blue;">Author content</span>`
content:	`<span style="color:blue;">Author content</span>`
element name:	`<span style="color:blue;">Author content</span>`
attribute:	`<span style="color:blue;">Author content</span>`
attribute name:	`<span style="color:blue;">Author content</span>`
attribute value:	`<span style="color:blue;">Author content</span>`

Not all HTML tags have an end tag, for example:

`<img height="40px" src="https://tinyurl.com/rlogo-svg">` → 

HTML Elements

block element:	`<div>content</div>`
inline element:	`<span>content</span>`
paragraph:	`<p>content</p>`
header level 1:	`<h1>content</h1>`
header level 2:	`<h2>content</h2>`
italic:	`<i>content</i>`
emphasised text:	`<em>content</em>`
strong importance:	`<strong>content</strong>`
link:	`<a href="https://github.com/fmegahed/isa401">content</a>`

unordered list:	`<ul>`
	`<li>item 1</li>`
	`<li>item 2</li>`
	`</ul>`

Cascading Style Sheet (CSS)

- with the extension `.css`
- 3 ways to style elements in HTML:
  - **inline** by using the `style` attribute inside HTML start tag:

```
<h1 style="color:blue;">Blue Header</h1>
```

  - **externally** by using the `<link>` element:

```
<link rel="stylesheet" href="styles.css">
```

  - **internally** by defining within `<style>` element:

```
<style type="text/css">
h1 { color: blue; }
</style>
```

By convention, the `<style>` and `<link>` elements tend to go into the `<head>` section of the HTML document.

CSS Syntax

```
<style type="text/css">
h1 { color: blue; }
</style>
<h1>This is a header</h1>
```

This is a header

selector:	`h1 { color: blue; }`
property:	`h1 { color: blue; }`
property name:	`h1 { color: blue; }`
property value:	`h1 { color: blue; }`

You may have multiple properties for a single selector. ➡️

```
h1 {
  color: blue;
  font-size: 16pt;
}
```

CSS Properties

```
<div>Sample text</div>
```

background color:	`div { background-color: yellow; }`	Sample text
text color:	`div { color: purple; }`	Sample text
border:	`div { border: 1px dashed brown; }`	Sample text
left border only:	`div { border-left: 10px solid pink; }`	Sample text
text size:	`div { font-size: 10pt; }`	Sample text
padding:	`div { background-color: yellow; padding: 10px; }`	Sample text
margin:	`div { background-color: yellow; margin: 10px; }`	Sample text

CSS Properties

```
<div>Sample text</div>
```

center align text:	`div { background-color: yellow; padding-top: 20px; text-align: center; }`	Sample text
font family:	`div { font-family: Marker Felt, times; }`	Sample text
strike:	`div { text-decoration: line-through; }`	~~Sample text~~
underline:	`div { text-decoration: underline; }`	Sample text
opacity:	`div { opacity: 0.3 }`	Sample text

CSS Selector

`*`	selects all elements
`div`	selects all `<div>` elements
`div, p`	selects all `<div>` and `<p>` elements
`div p`	selects all `<p>` within `<div>`
`div > p`	selects all `<p>` one level deep in `<div>`
`div + p`	selects all `<p>` immediately after a `<div>`
`div ~ p`	selects all `<p>` preceded by a `<div>`

```
<h1>This is a sample html</h1>

<blockquote>
<p>Maybe stories are just data with a soul.</p>
<footer>—Brene Brown</footer>
</blockquote>

<div id="p1" class="parent">
Hmm
<p>Hi!</p>
How are you?
<div class="child nice">
  <p>Hello!</p>
</div>
</div>

<p>Household 1</p>

<div class="parent">
<p>Hi!</p>
<blockquote class="child rebel">
  <p>Don't talk to me!</p>
</blockquote>
</div>

<span class="child">
<span class="parent child rebel">
  <p>Clean your room!</p>
</span>
</span>

<p>End of households</p>
```

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Ignores inline elements like `span`, `i`, `b`,...

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  <p>Clean your room!</p>
</span>
</span>

<p>End of households</p>
```

CSS Selector

`.classname`	selects all elements with the attribute `class="classname"`.
`.c1.c2`	selects all elements with *both* `c1` and `c2` within its class attribute.
`.c1 .c2`	selects all elements with class `c2` that is a descendant of an element with class `c1`.
`#idname`	selects all elements with the attribute `id="idname"`.

```
<h1>This is a sample html</h1>

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<span class="child">
<span class="parent child rebel">
  <p>Clean your room!</p>
</span>
</span>

<p>End of households</p>
```

CSS Selector

`.parent`	selects all elements with the attribute `class="parent"`.
`.c1.c2`	selects all elements with *both* `c1` and `c2` within its class attribute.
`.c1 .c2`	selects all elements with class `c2` that is a descendant of an element with class `c1`.
`#idname`	selects all elements with the attribute `id="idname"`.

Note some offspring do not inherit class from their parents.

```
<h1>This is a sample htr

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</span>
</span>

<p>End of households</p>
```

CSS Selector

`.classname`	selects all elements with the attribute `class="classname"`.
`.child.rebel`	selects all elements with *both* `child` and `rebel` within its class attribute.
`.c1 .c2`	selects all elements with class `c2` that is a descendant of an element with class `c1`.
`#idname`	selects all elements with the attribute `id="idname"`.

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```

CSS Selector

`.classname`		selects all elements with the attribute `class="classname"`.
`.c1.c2`		selects all elements with *both* `c1` and `c2` within its class attribute.
`.parent .rebel`		selects all elements with class `rebel` that is a descendant of an element with class `parent`.
`#idname`		selects all elements with the attribute `id="idname"`.

```
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`.c1 .c2`		selects all elements with class `c2` that is a descendant of an element with class `c1`.
`#p1`		selects all elements with the attribute `id="p1"`.

Unlike `class`, you can only have one `id` value and must be unique in the whole HTML document.

```
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</div>
</div>

<p>Household 1</p>

<div class="parent">
<p>Hi!</p>
<blockquote class="child rebel">
  <p>Don't talk to me!</p>
</blockquote>
</div>

<span class="child">
<span class="parent child rebel">
  <p>Clean your room!</p>
</span>
</span>

<p>End of households</p>
```

JavaScript (JS)*

- JS is a programming language and enable interactive components in HTML documents.
- 2 ways to insert JS into a HTML document:
  - **internally** by defining within `<script>` element:

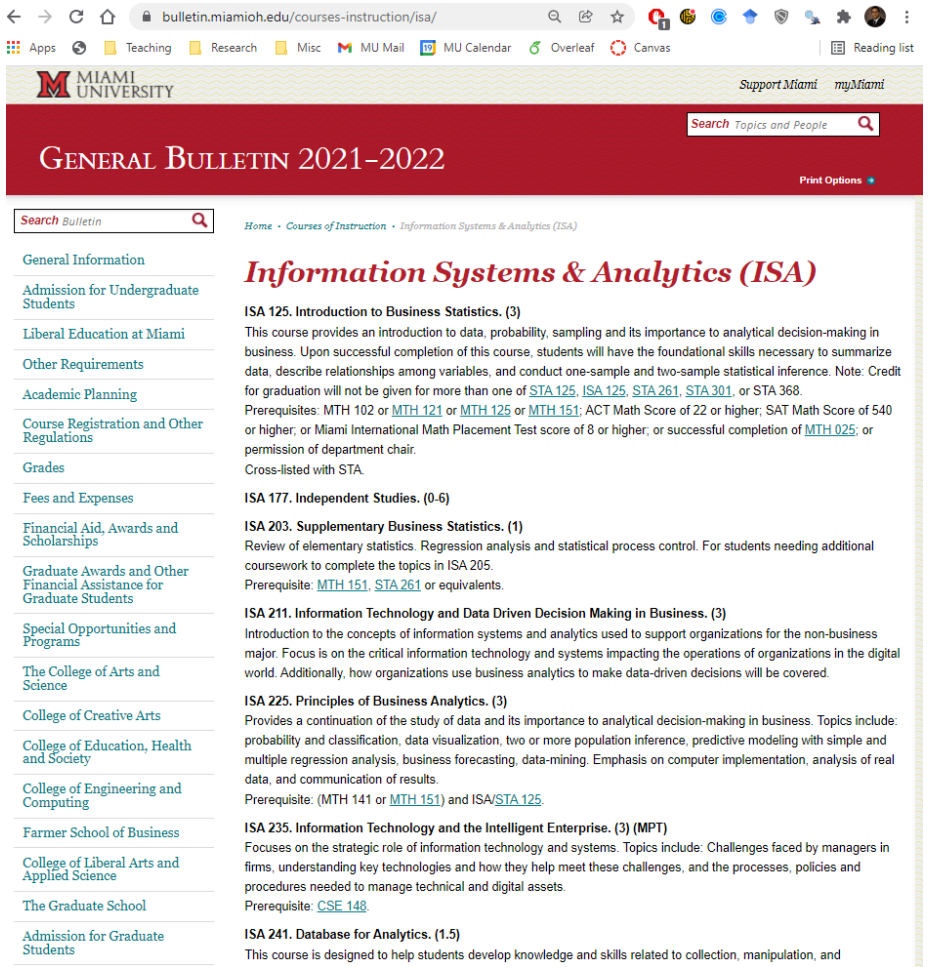
```
<script>
document.getElementById("p1").innerHTML = "content";
</script>
```

  - **externally** by using the `src` attribute to refer to the external file:

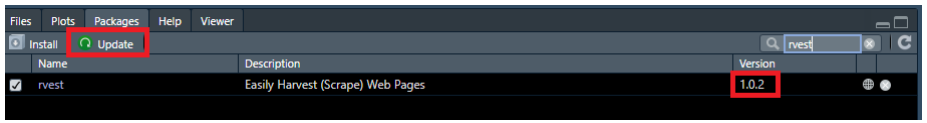
```
<script src="js/myjs.js"></script>
```

Web Scraping 

rvest: Step 1 - Reading Static HTML Pages



Use {rvest} `>= v1.0.2` (if not, update)

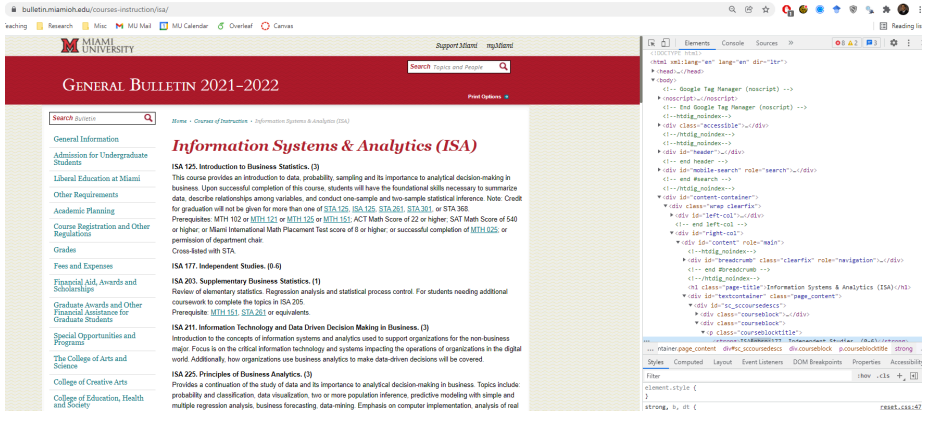



```
if(require(pacman)==FALSE) install.packag
pacman::p_load(rvest)
isa_courses = read_html("http://bulletin.
isa_courses
```

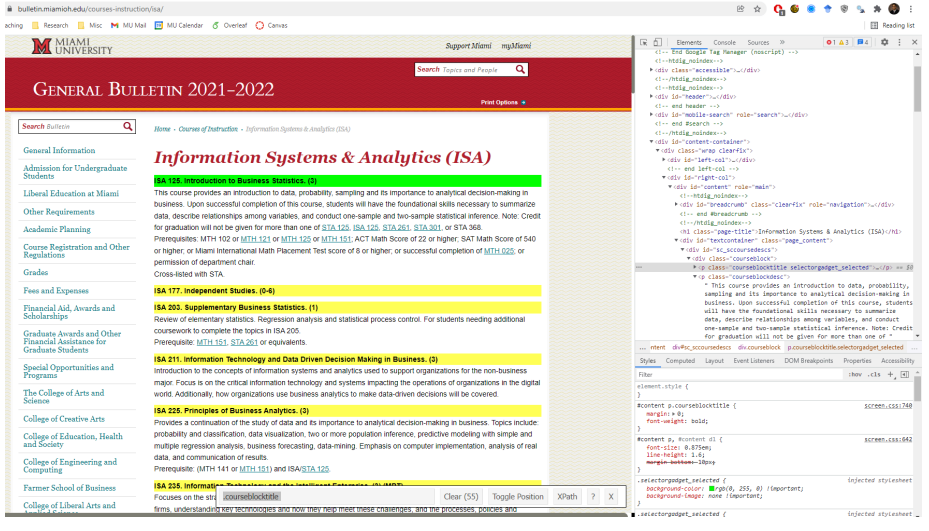
```
## {html_document}
## <html xml:lang="en" lang="en" dir="ltr
## [1] <head>\n<title>Information System
## [2] <body>\n\n\n\n\n\n<!-- Google Tag
```

rvest: Step 2 - Selecting HTML Elements

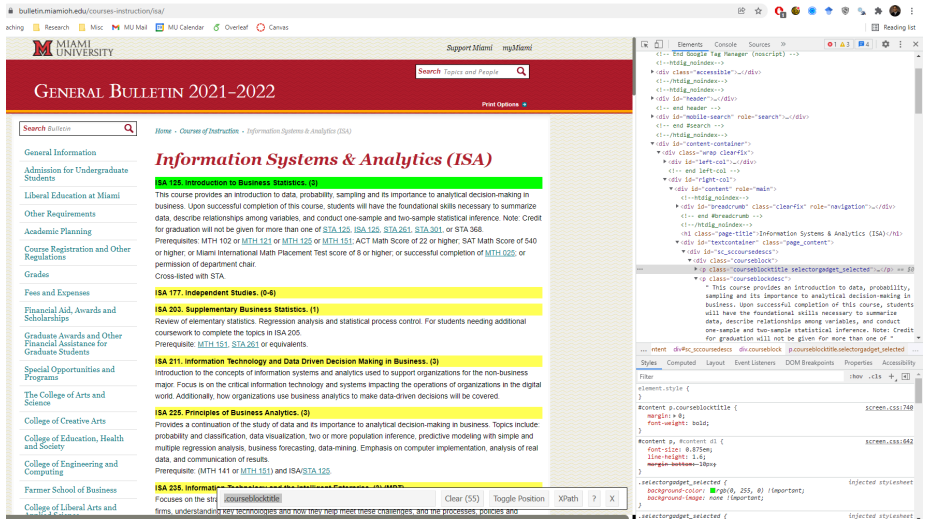
Inspector



Selector Gadget



rvest: Step 2 - Selecting HTML Elements

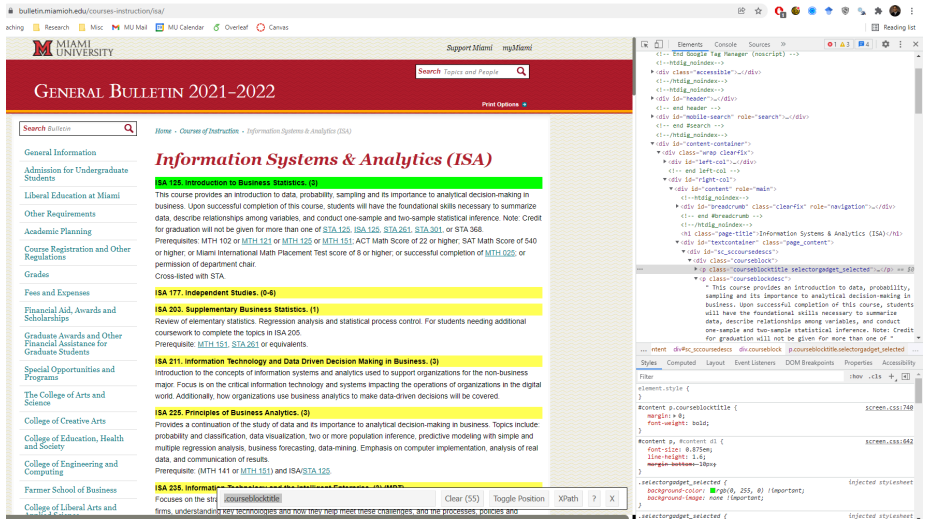



```
isa_course_titles = isa_courses |>
  html_elements(css = "p.courseblocktitle

isa_course_titles
```

```
## {xml_nodeset (50)}
##  [1] <p class="courseblocktitle"><str
##  [2] <p class="courseblocktitle"><str
##  [3] <p class="courseblocktitle"><str
##  [4] <p class="courseblocktitle"><str
##  [5] <p class="courseblocktitle"><str
##  [6] <p class="courseblocktitle"><str
##  [7] <p class="courseblocktitle"><str
##  [8] <p class="courseblocktitle"><str
##  [9] <p class="courseblocktitle"><str
## [10] <p class="courseblocktitle"><str
## [11] <p class="courseblocktitle"><str
## [12] <p class="courseblocktitle"><str
## [13] <p class="courseblocktitle"><str
## [14] <p class="courseblocktitle"><str
## [15] <p class="courseblocktitle"><str
```

rvest: Step 3 - Getting HTML Text




```
isa_course_titles_en =  isa_course_titles
  html_text2()

isa_course_titles_en
```

```
##   [1] "ISA 125. Introduction to Busines
##   [2] "ISA 177. Independent Studies. (0
##   [3] "ISA 211. Information Technology
##   [4] "ISA 225. Principles of Business
##   [5] "ISA 235. Information Technology
##   [6] "ISA 241. Database for Analytics.
##   [7] "ISA 242. Programming for Analyti
##   [8] "ISA 245. Database Systems and Da
##   [9] "ISA 250. Basic Math for Analytic
##  [10] "ISA 277. Independent Studies. (0
##  [11] "ISA 281. Concepts in Business Pr
##  [12] "ISA 291. Applied Regression Anal
##  [13] "ISA 301. Business Data Communica
##  [14] "ISA 303. Enterprise Systems. (3)
##  [15] "ISA 305. Information Technology
##  [16] "ISA 321. Optimization in Busines
```

Demo: Scraping the Course Descriptions

- We will build on the previous example and we will scrape the **course descriptions** associated with these courses.
- Then, we will create a **data frame** containing **both** the **course titles** and **descriptions**
- Then, we will **export the results to a CSV** so that we can analyze that in a separate program if we wanted to.

Non-Graded Class Activity

04:00

Activity | Your Solution | My Solution

- Go to this database on plane crashes
- Scrape the HTML table. **Note the difference from text elements:**
  - The CSS selector for `html_elements()` will be different.
  - You will extract a table (in its **entirety**) and hence:
  - we will use `html_table()` instead of `html_text2()`
- Store the scraped data in an appropriate location on your computer (e.g., within the data folder for ISA 401)

Non-Graded Class Activity

04:00

Activity | Your Solution | My Solution

> *Over the next 4 minutes, use a R script file to perform the tasks outlined in the activity panel.*

Non-Graded Class Activity

04:00

Activity | Your Solution | My Solution

Please refer to our discussion in class

Legal and Ethical Issues with Web Scraping

Robots.txt

When scraping/crawling the web you need to be aware of `robots.txt`.

> *The robots exclusion standard, also known as the robots exclusion protocol or simply robots.txt, is a standard used by websites to communicate with web crawlers and other web robots. The standard specifies how to inform the web robot about which areas of the website should not be processed or scanned.* --- Wikipedia

Using the excellent robotstxt 📦 to check if scraping/crawling a specific directory is allowed.

```
if(require(robotstxt)==FALSE) install.packages("robotstxt")

robotstxt::paths_allowed(paths  = "2024/", domain = "planecrashinfo.com", bot    = "*")
```

```
## [1] TRUE
```

Terms of Service

Most large companies have **terms of service** that supplement what is permitted and/or disallowed on their `robots.txt` file. Examples include:

- Yelp's US Terms of Service
- LinkedIn Terms of Service

Ethical/Legal Considerations

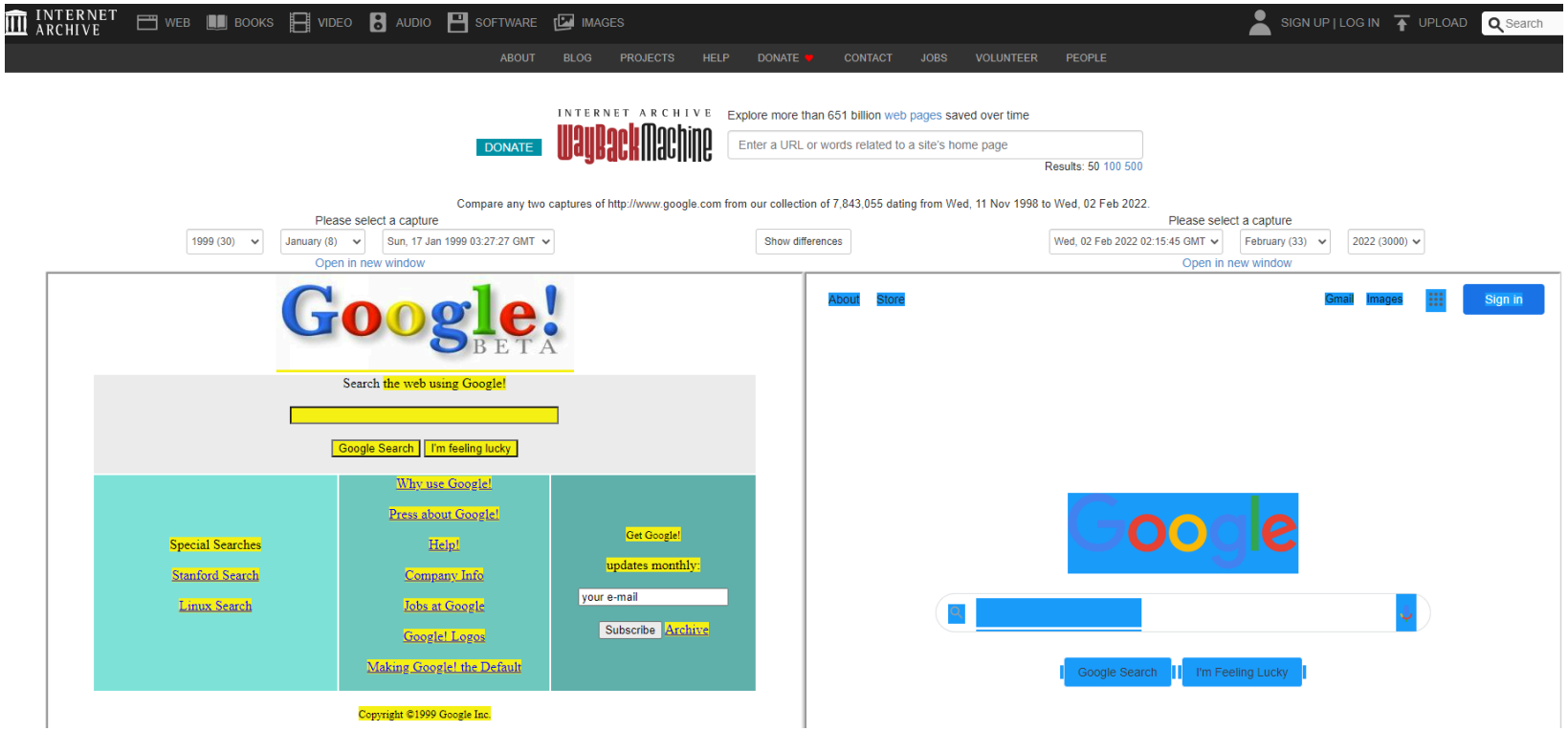
- **Use of publicly available reviews as a part of your service:** Would you classify the Yelp vs Google Feud as such an example?

Ethical/Legal Considerations

- **Use of publicly available profiles as a part of your service:**
  - LinkedIn vs Hiq Labs: Ninth Circuit Decision in 2019
  - Revival of Case in 2021 by Supreme Court

Ethical/Legal Considerations

- **What about scraping entire websites/webpages for the purpose of archiving the internet?**



The evolution of the home page for Google per the Wayback Machine

Recap

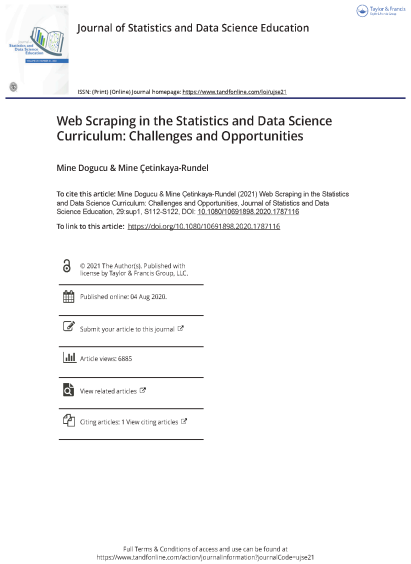
Summary of Main Points

By now, you should be able to do the following:

- Understand when can we scrape data (i.e., `robots.txt`)
- Scrape a webpage using R.

Things to Do to Prepare for Next Class

- Go over your notes, read through the supplementary material (below) and complete Assignment 04 on Canvas.



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Web Scraping in the Statistics and Data Science Curriculum: Challenges and Opportunities

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