Development Notes

2023-07-18

Introduction

These are the development notes for scraping data from Top Universities and Times Higher Education. Since, both websites present data as dynamic content they require the use of a headless browser to simulate the user clicking through the sites to generate the content.

The best tool for that kind of scraping in the R ecosystem is RSelenium.

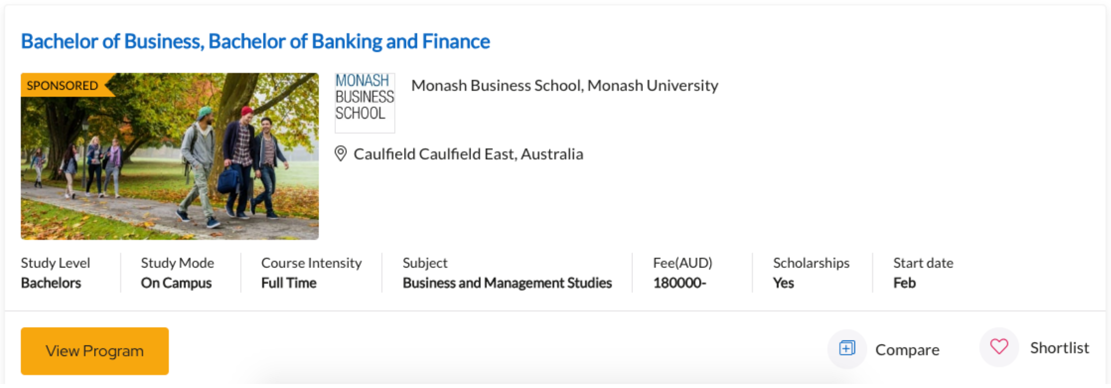
Installing RSelenium

RSelenium requires the `Rjava` package. `Rjava`, in turn, requires access to the Java runtime. I recommend installing Azul Java. Instructions vary with OS.

We also need a browser that works with RSelenium. The provided scripts work with Chrome.

Scraping Top Universities

The topuniversities.com websites provides a programs finder. We used this tool to extract information for programs related to Bioinformatics, Machine Learning and Data Science. This is how the website presents the data:



Bachelor of Business, Bachelor of Banking and Finance

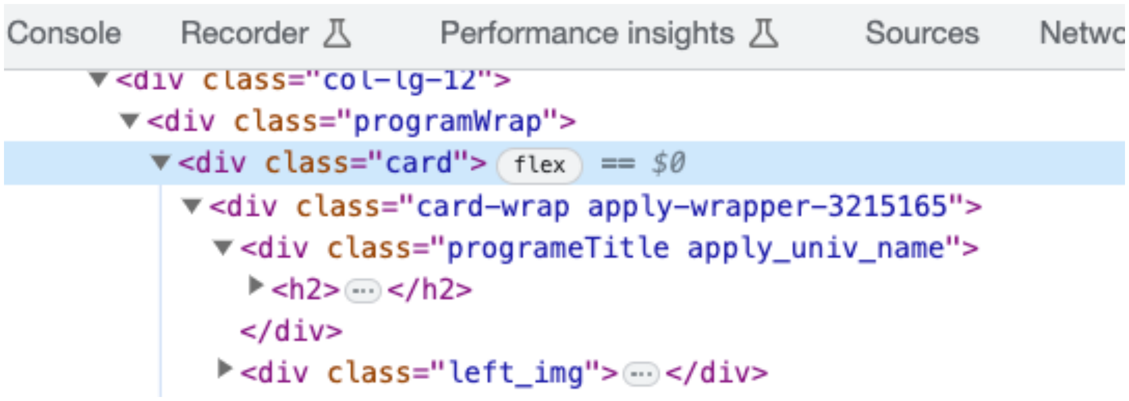
SPONSORED

Monash Business School, Monash University

Caulfield Caulfield East, Australia

Study Level	Study Mode	Course Intensity	Subject	Fee(AUD)	Scholarships	Start date
Bachelors	On Campus	Full Time	Business and Management Studies	180000-	Yes	Feb

To scrap the data, it is necessary to understand the structure of the generated markup in each page. In this case, the data is presented inside a `div` element with a `card` class:



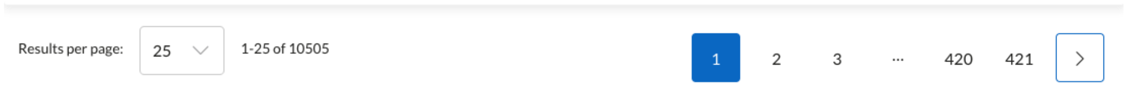
```
▼<div class="col-lg-12">
  ▼<div class="programWrap">
    ▼<div class="card"> flex == $0
      ▼<div class="card-wrap apply-wrapper-3215165">
        ▼<div class="programeTitle apply_univ_name">
          ▶<h2>…</h2>
        </div>
        ▶<div class="left_img">…</div>
```

The findElements method finds all elements with a class of `card`. The helper function `extract_row` is applied to all found cards to extract the required data using css selectors.

To start scraping the website, we use RSelenium's `rsDriver` to connect to a browser:

Once the connection with the browser is established, we navigate to the starting url.

This url encodes a starting query of the programs we are interested in, filtering programs with the subjects of Biological Sciences, Computer Science and Information Systems, Data Science, Genetics, Mathematics, Medicine Related Studies, Pharmacology, Pharmacy and Pharmacology, Physics and Astronomy, Statistics and Operational Research in Bahrain, Cyprus, Egypt, Iran, Iraq, Israel, Jordan, Kuwait, Lebanon, Oman, Palestine, Qatar, Saudi Arabia, Syria, Turkey, United Arab Emirates (UAE) and Yemen. The website presents the data in pages of 25 elements:



The scripts queries one page at a time and downloads the data for each. The function `scrap_page(i)` scraps page i from this query. The 25 results from each page are saved to the `temp` folder.

Since the requirements information for each program are not available in this page, we save a link to the program's page to scrap the data from requirements and tuition in a second pass.

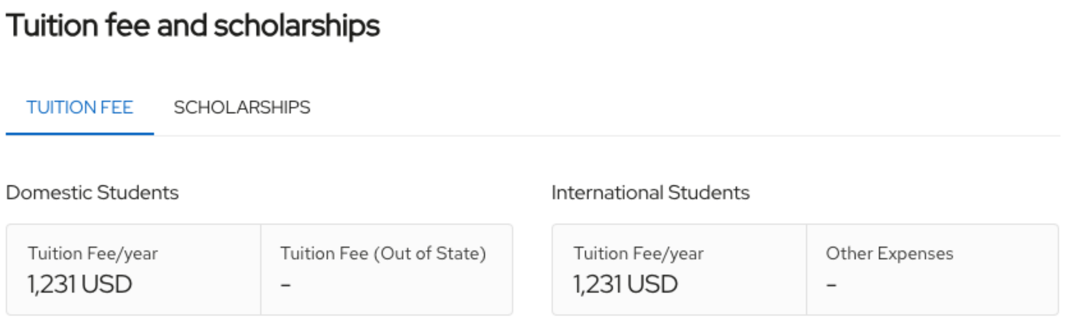
After scraping all the pages, we merge all the programs into a single data frame and save it:

Scraping the requirements and tuitions data

The script `scrap_programs_tution_fees.R` takes the list of urls scraped previously and downloads the tuition fee and requirements data from the program pages.

Since these are static html pages, it is not necessary to use a browser to access this data. The html pages are downloaded with `rvest::read_html`.

This is how the webpages presents the tution fee data:



Tuition fee and scholarships

TUITION FEE SCHOLARSHIPS

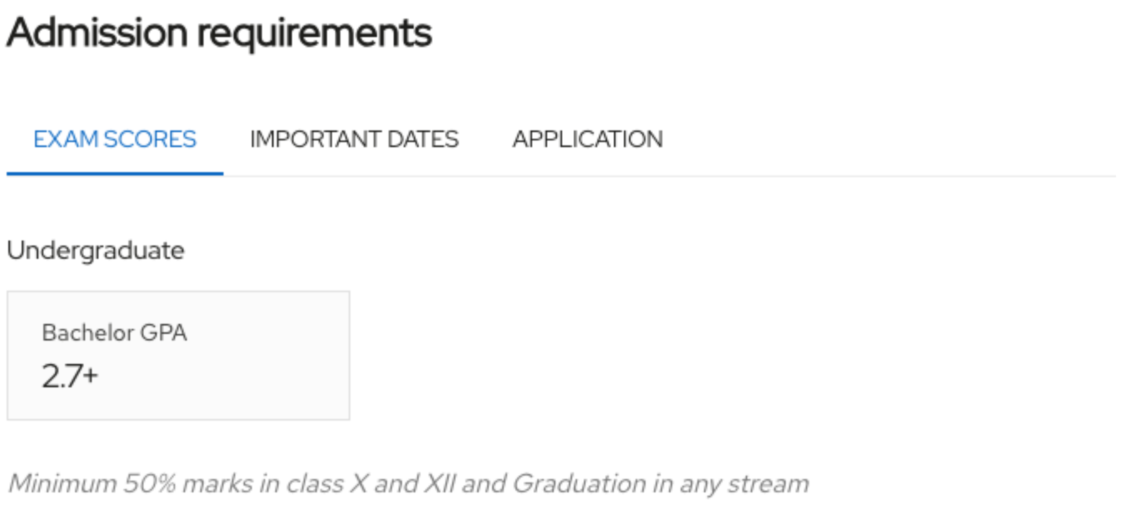
Domestic Students

Tuition Fee/year	Tuition Fee (Out of State)
1,231 USD	-

International Students

Tuition Fee/year	Other Expenses
1,231 USD	-

And the requirements:



Admission requirements

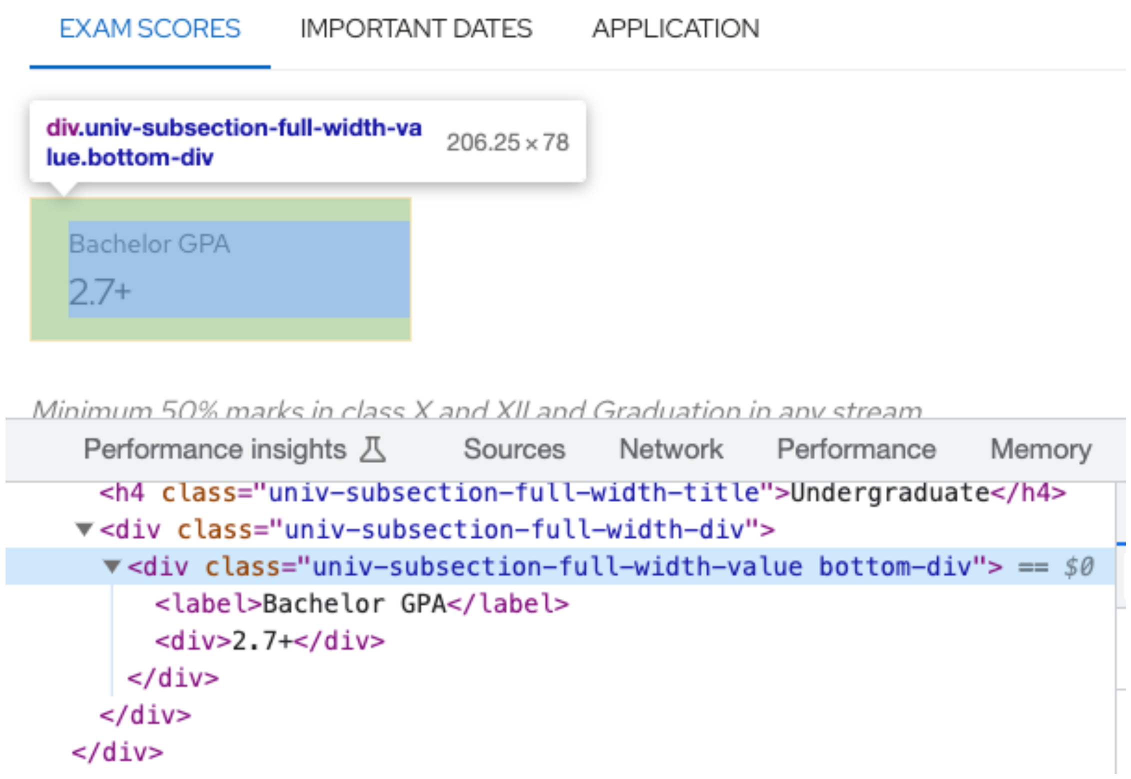
EXAM SCORES IMPORTANT DATES APPLICATION

Undergraduate

Bachelor GPA
2.7+

Minimum 50% marks in class X and XII and Graduation in any stream

The associated markup:



```
  <h4 class="univ-subsection-full-width-title">Undergraduate</h4>
▼<div class="univ-subsection-full-width-div">
  ▼<div class="univ-subsection-full-width-value bottom-div"> == $0
      <label>Bachelor GPA</label>
      <div>2.7+</div>
    </div>
  </div>
</div>
```

To extract the necessary information, we download the html page using `read_html`, and then we specify css selectors that have the information we need to the `html_elements`.

Cleaning up the data

After scraping the data from all the programs, it is necessary to clean it by removing duplicates, parsing the requirements information and converting tuition fees to the same currency (British Pounds), removing programs that are not related to Machine Learning and Data Science.

Parsing each programs requirements involves taking the string from the html webpage and converting it to columns in our dataset. Each column corresponds to a requirement (TOEFL, IELTS, etc.). The value for each program in the column represents the minimum requirement of the program.

Currencies reported for the tuition fees are reportes in Euro, US Dollars, British Pounds and Singapore Dollars. I used the following exchange rates to convert currencies to British Pounds:

Currency	Exchange
USD	1.30
EUR	1.16
SGD	1.72

The final dataset:

Data summary

Name	df
Number of rows	5356
Number of columns	35
Column type frequency:	
character	13
numeric	22
Group variables	None

Variable type: character

skim_variable	n_missing	complete_rate	min	max	empty	n_unique	whitespace
university	0	1.00	3	46	0	149	0
university_link	0	1.00	48	104	0	154	0
requirements	0	1.00	8	203	0	1837	0
study_level	0	1.00	3	9	0	3	0
location	0	1.00	0	97	1231	187	0
program_title	0	1.00	7	134	0	4618	0
program_link	0	1.00	61	176	0	5353	0
subject	0	1.00	7	42	0	39	0
study_mode	3776	0.29	6	9	0	3	0
course_intensity	2704	0.50	9	9	0	2	0
duration	825	0.85	8	10	0	31	0
currency	2851	0.47	3	3	0	4	0
duration_units	825	0.85	6	6	0	1	0

Variable type: numeric

skim_variable	n_missing	complete_rate	mean	sd	p0	p25	p50	p75	p100	hist
fee	2851	0.47	20964.14	14131.95	1190	9250.00	14700.0	33250	124318.0	▇▇▁▁▁
duration_length	825	0.85	36.63	16.64	1	24.00	36.0	48	216.0	▇▇▁▁▁
fee_gbp	2851	0.47	2138	1563	11	925	147	33	1616	▇▁

skim_variable	n_missing	complete_rate	mean	sd	p0	p25	p50	p75	p100	hist
			8.79	8.57	90	0.00	00.0	250	13.4	▁▁▁
toefl	2001	0.63	85.44	19.90	0	79.00	87.0	90	550.0	▇▁▁▁▁
ielts	23	1.00	6.15	2.48	2	6.00	6.0	6	185.0	▇▁▁▁▁
bachelor_gpa	4054	0.24	2.61	1.95	2	2.00	2.7	3	70.0	▇▁▁▁▁
cambridge_cae_advanced	3108	0.42	171.91	18.37	0	169.00	176.0	176	193.0	▁▁▁▁▇
pte_academic	2570	0.52	58.87	6.79	0	54.00	59.0	62	176.0	▁▇▁▁▁
a_levels	3488	0.35	9.14	28.51	0	0.00	0.0	0	128.0	▇▁▁▁▁
international_baccalaureate	3010	0.44	29.91	23.37	0	27.25	30.0	34	1090.0	▇▁▁▁▁
ucas_tariff	4083	0.24	94.48	38.40	0	80.00	104.0	112	440.0	▂▇▁▁▁
atar	4817	0.10	85.70	7.70	70	80.00	85.0	92	99.0	▃▅▇▇▂
sat	4175	0.22	1058.66	375.89	0	1100.00	1100.0	1290	1500.0	▂▁▁▇▅
act	5238	0.02	25.18	1.39	23	25.00	25.0	26	28.0	▅▇▃▂▁
gre	5343	0.00	234.62	78.09	150	150.00	304.0	304	304.0	▇▁▁▁▇
gpa	5318	0.01	2.80	0.37	2	2.71	3.0	3	3.0	▂▁▁▂▇
btec_qualifications	4236	0.21	4.17	19.76	0	0.00	0.0	0	128.0	▇▁▁▁▁
op	5292	0.01	18.81	6.29	1	21.00	21.0	21	21.0	▁▁▁

skim_variable	n_missing	complete_rate	mean	sd	p0	p25	p50	p75	p100	hist
sqa_highers	4991	0.07	17.75	38.96	0	0.00	0.0	0	128.0	▁▇▇▁▁▁▁
sqa_advanced	5271	0.02	1.41	13.02	0	0.00	0.0	0	120.0	▇▁▁▁▁
as_levels	5302	0.01	27.85	38.21	0	0.00	20.0	20	120.0	▇▁▁▁
year_12_scores	5353	0.00	60.00	0.00	60	60.00	60.0	60	60.0	▂▁▁▇▁▁

Scraping timeshighereducation.com

The relevant data from this website is in two pages:

The website also renders data dynamically, so we connect to it through a browser. The data is presented in a single page, so it is easier to scrap. The script that does this job is `scrap_rankings.R`.

Geocoding and merging

To geocode the downloaded data, we used the Google Maps API and the `tidygeocoder` package. The script that does this is `geocode_programs.R`. The Google maps API requires an API key.

The final data for the Shiny app requires merging the data from different sources. Some of the university names are different, so a little bit of manual processing was necessary. That is achieved in the `merge_the_topuniversities.R` script.