Data Integreation

Data integration is the process of combining data from different sources into a unified view so it can be easily analyzed or used by applications.
Example:
A company might have:

- Customer data in a CRM system (Salesforce)
- Sales data in an Excel sheet
- Product data in a database

Data integration means bringing all this together so you can answer questions like:
“Which customers bought which products last month

Why We Need Data Integration

- Data Heterogeneity
    - “Heterogeneous” = “different kinds.”
    - Different sources store data in different formats, structures, and systems.
    - Example: One system might use “customer_id” while another uses “custID” — they mean the same thing but are stored differently.
    - So integration is needed to make all that data work together.
- Knowledge Discovery
    - You can’t find useful patterns or insights if your data is scattered across many systems.
    - Integration allows for data mining and analytics across all data sources.
    - Example: Detecting that “customers who buy X also buy Y” requires all purchase data to be in one place.
- Data ≠ Knowledge
    - Just collecting data doesn’t give you value.
    - The value comes from analyzing and interpreting the data — turning it into knowledge or actionable insights.
    - Analogy:
      Data = raw ingredients
      Knowledge = cooked meal
- Heterogeneity Challenges
    - The main difficulties in data integration come from differences in:
    - Architectures: (relational DB, NoSQL, files, APIs)
    - Access methods: (SQL queries, REST APIs, manual CSV uploads)
    - Data structures: (different column names, data types, hierarchies)

Helper Functions when Connecting to Postgres from R

The Helper Script: psql_queries.R

- psql_select()
  - Purpose: Retrieve (select) data from Postgres into R.
  - What it does: Executes an SQL SELECT query and returns the result as an R data.frame.

```r
data <- psql_select("SELECT * FROM customers;")
head(data)
```

  - Use when you want to *read* or *analyze* data.
- psql_manipulate()
  - Purpose: Perform operations that *change* data or structure in the database.
  - Examples of use:
    - Create tables or schemas
    - Insert, update, or delete row

```r
psql_manipulate("CREATE TABLE sales (id SERIAL, amount NUMERIC);")
```

  - Use when you want to *modify* the database (not fetch data).
- psql_append_df()
  - Purpose: Quickly insert a whole R data.frame into a Postgres table.
  - Why useful: If you have large datasets in R and want to upload them into Postgres.

```r
psql_append_df(my_dataframe, "sales")
```

  - Use when you want to *upload* R data directly to the database.

The Credential Script: .credentials.R

- This file stores your database login information (username, password, host, port, etc.) for different Postgres servers.
- Important Notes:
  - Never store passwords as plain text in a shared or public environment.
  - The dot (.) at the beginning of .credentials.R makes it a hidden file in RStudio.
    - To see it: Go to the *Files* pane → click *More* → select *Show Hidden Files*.
  - If you're using Git, make sure .credentials.R is listed in .gitignore
    - This prevents accidentally uploading your login credentials to GitHub or GitLab.

Connecting through the docker network

Check the available networks in Docker

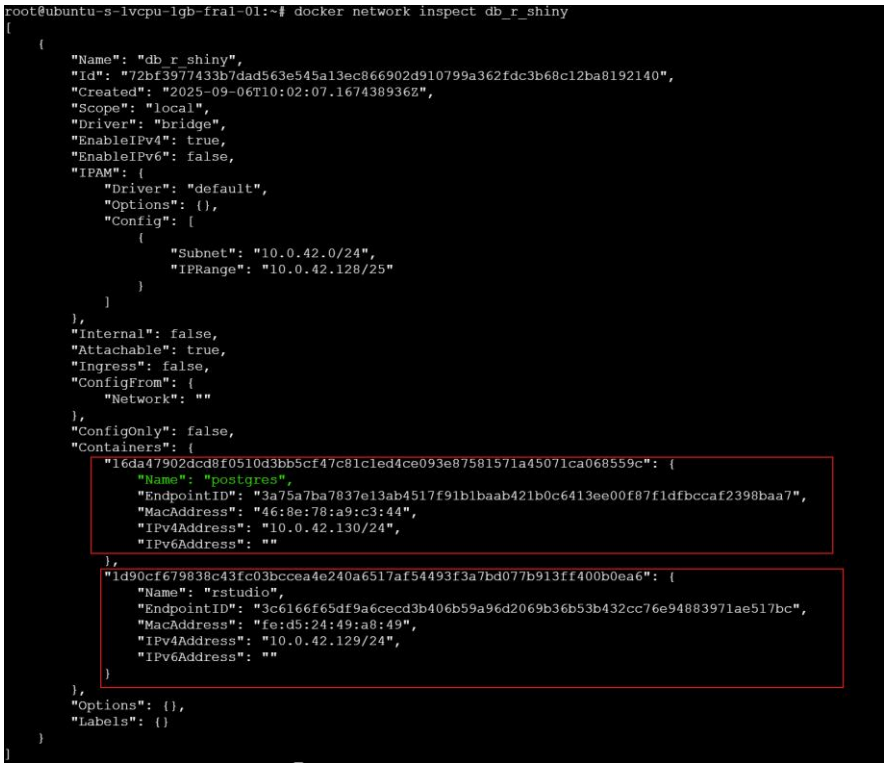
Docker network ls

```
*** System restart required ***
root@ubuntu-s-1vcpu-1gb-fra1-01:~# docker network ls
NETWORK ID     NAME          DRIVER    SCOPE
3aa02e02c60a   bridge        bridge    local
72bf3977433b   db_r_shiny    bridge    local
b8cf7fbcf2f2   host          host      local
63b3015476f2   none          null      local
root@ubuntu-s-1vcpu-1gb-fra1-01:~#
```

Previously, we created a Docker network (db_r_shiny) where our postgres and rstudio containers are attached.

inspect the db_r_shiny network by running

docker network inspect db_r_shiny



```
root@ubuntu-s-1vcpu-1gb-fra1-01:~# docker network inspect db_r_shiny
[
    {
        "Name": "db_r_shiny",
        "Id": "72bf3977433b7dad563e545a13ec866902d910799a362fdc3b68c12ba8192140",
        "Created": "2025-09-06T10:02:07.167438936Z",
        "Scope": "local",
        "Driver": "bridge",
        "EnableIPv4": true,
        "EnableIPv6": false,
        "IPAM": {
            "Driver": "default",
            "Options": {},
            "Config": [
                {
                    "Subnet": "10.0.42.0/24",
                    "IPRange": "10.0.42.128/25"
                }
            ]
        },
        "Internal": false,
        "Attachable": true,
        "Ingress": false,
        "ConfigFrom": {
            "Network": ""
        },
        "ConfigOnly": false,
        "Containers": {
            "16da47902dcd8f0510d3bb5cf47c81c1ed4ce093e87581571a45071ca068559c": {
                "Name": "postgres",
                "EndpointID": "3a75a7ba7837e13ab4517f91b1baab421b0c6413ee00f87f1dfbccaf2398baa7",
                "MacAddress": "46:8e:78:a9:c3:44",
                "IPv4Address": "10.0.42.130/24",
                "IPv6Address": ""
            },
            "1d90cf679838c43fc03bccea4e240a6517af54493f3a7bd077b913ff400b0ea6": {
                "Name": "rstudio",
                "EndpointID": "3c6166f65df9a6cecd3b406b59a96d2069b36b53b432cc76e94883971ae517bc",
                "MacAddress": "fe:d5:24:49:a8:49",
                "IPv4Address": "10.0.42.129/24",
                "IPv6Address": ""
            }
        },
        "Options": {},
        "Labels": {}
    }
]
```

Both your Postgres container and RStudio container are attached to it.

This means they can communicate directly without exposing ports publicly.

When two containers are on the same network (db_r_shiny), you have two options for the host when connecting from R to Postgres:

- *Option 1: Use the container name*
  - *If your Postgres container is named postgres, you can connect like this:*

```r
host = "postgres"
```

- *Option 2: Use the internal IP address*
  - *You can also use the IP shown in the network inspect output:*

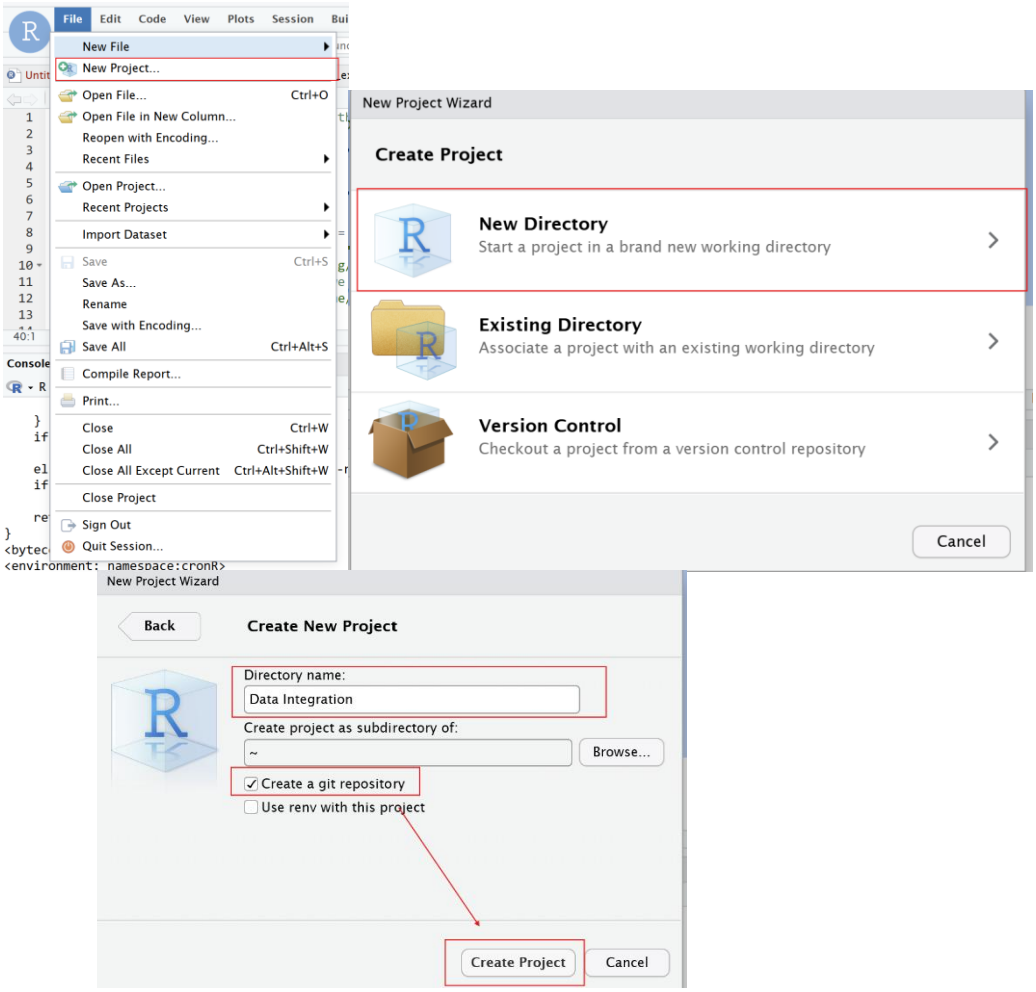
```r
host = "10.0.42.129"
```

Connecting to Postgres from R

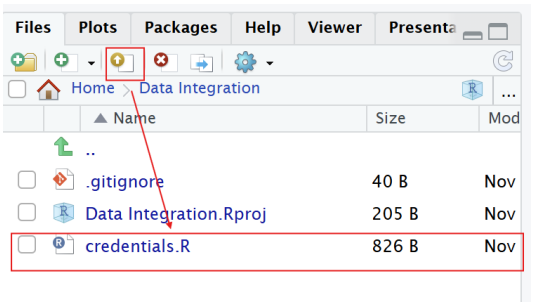
Example of ".credentials.R file"

```
cred_psql_docker <- list(dbname = "postgres",
                         host   = "postgres",
                         user       = 'postgres',
                         pass       = 'you-own-password-for-postgres',
                         port = 5432)

cred_psql_150 <- list(dbname = "databasename-from-brightspace",
                         host   = "159.223.30.236",
                         user       = 'username-from-brightspace',
                         pass       = 'password-from-brightspace',
                         port = 6432)
cred_psql_150_dvd <- list(dbname = "dvdrental",
                          host   = "159.223.30.236",
                          user       = 'username-from-brightspace',
                          pass       = 'password-from-brightspace',
                          port = 6432)
```

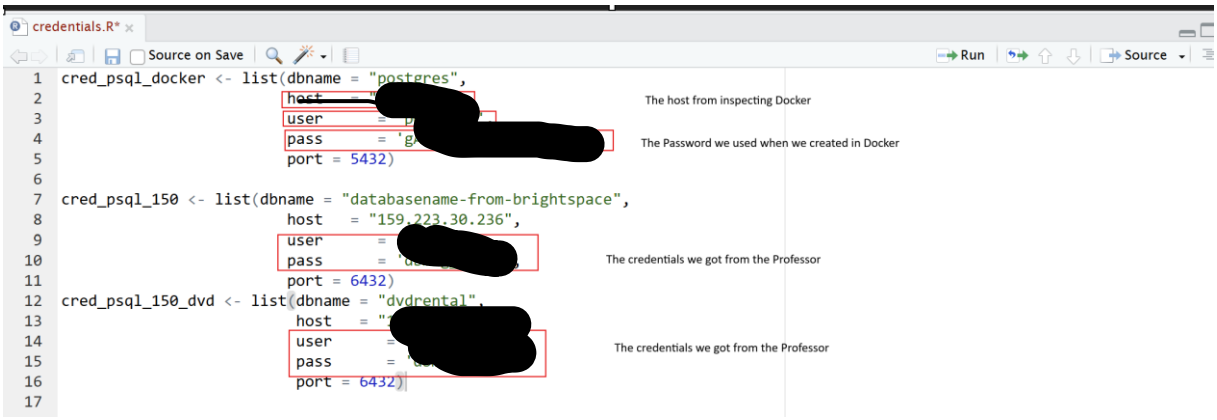
Create a new project



Upload ".credentials.R file" to R

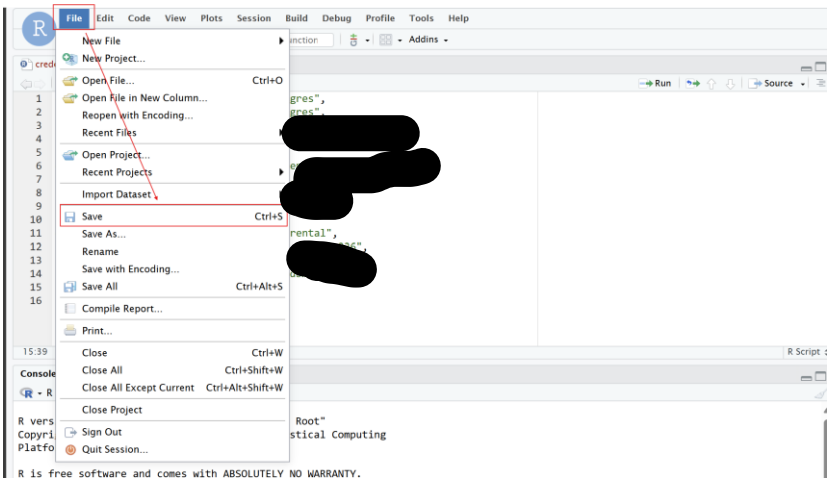


Modify the credentials.R file



Karagic, Dino	user66	user66db	dbmng_dv_66

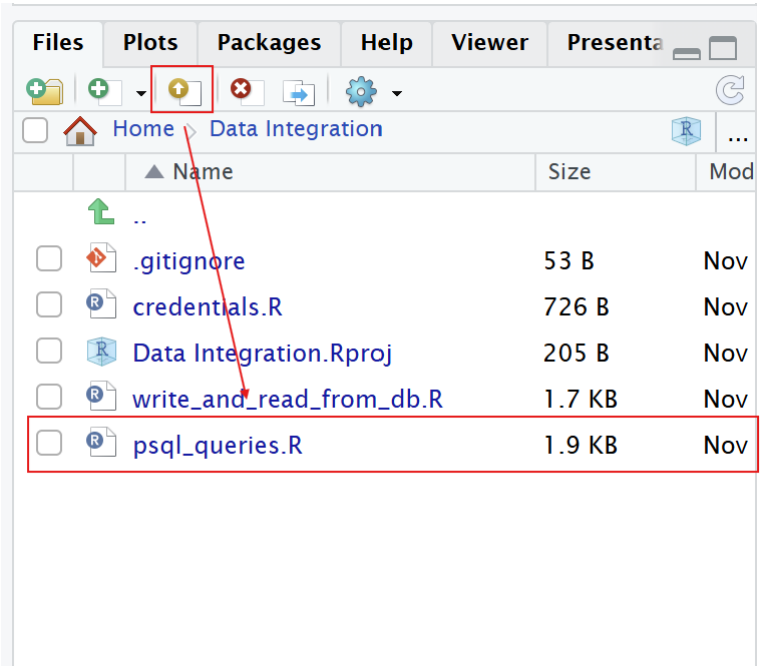
Save changes



add file to the gitignore

Read and write to Postgres

Upload the psql_queris.R



First load the librarys and Function the 2 files credentials.R & psql_queries.R

```
1  library(RPostgres)
2  library(DBI)
3
4  # Put the credentials in this script
5  # Never push credentials to git!! --> use .gitignore on .credentials.R
6  source("credentials.R")
7
8  # Function to send queries to Postgres
9  source("psql_queries.R")
10
```

Create a Schema

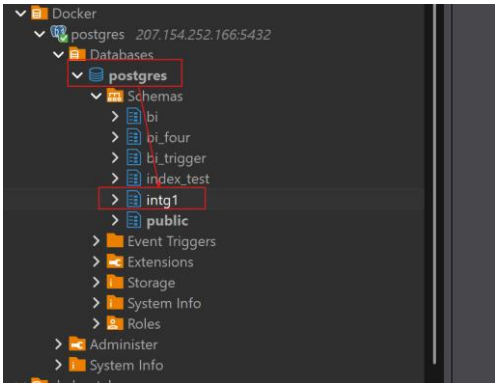
```
12 psql_manipulate(cred = cred_psql_docker,
13                  query_string = "CREATE SCHEMA intg1;")
```

cred_psql_docker is the name we gave the postgres database in the credentials File

FYI: cred_psql_docker from the credentials file

```
1  cred_psql_docker <- list(dbname =
2                           host   =
3                           user
4                           pass
5                           port = 5432)
```

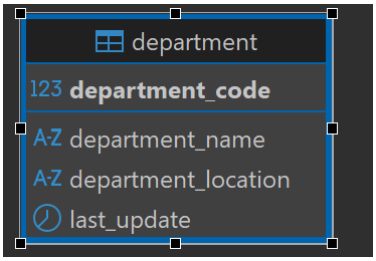
Outcome



Create a table in the new schema

```
# Create a table in the new schema
psql_manipulate(cred = cred_psql_docker,
                query_string =
"create table intg1.Department (
  department_code serial primary key,
  department_name varchar(255),
  department_location varchar(255),
  last_update timestamp(0) without time zone default current_timestamp(0)
);")
```

Outcome



Write rows in the new table

```
# Write rows in the new table
psql_manipulate(cred = cred_psql_docker,
                query_string =
"insert into intg1.Department
  values (default, 'Computer Science', 'Aarhus C')
      ,(default, 'Economics and Business Economics', 'Aarhus V')
      ,(default, 'Law', 'Aarhus C')
      ,(default, 'Medicine', 'Aarhus C');")

```

Outcome

	department_code	department_name	department_location	last_update
1	1	Computer Science	Aarhus C	2025-11-04 09:48:01.000
2	2	Economics and Business Economics	Aarhus V	2025-11-04 09:48:01.000
3	3	Law	Aarhus C	2025-11-04 09:48:01.000
4	4	Medicine	Aarhus C	2025-11-04 09:48:01.000

Create an R dataframe

```
df <- data.frame(department_name = c("Education", "Chemistry"),
                 department_location = c("Aarhus N", "Aarhus C"))
```

- A data.frame is like a table in Excel or a database table.
- It has rows and columns, where each column can have a different type (numbers, text, etc.).
- We do not specify any values for ”department_code” and ”last_update” as these have default vales in the Postgres table.

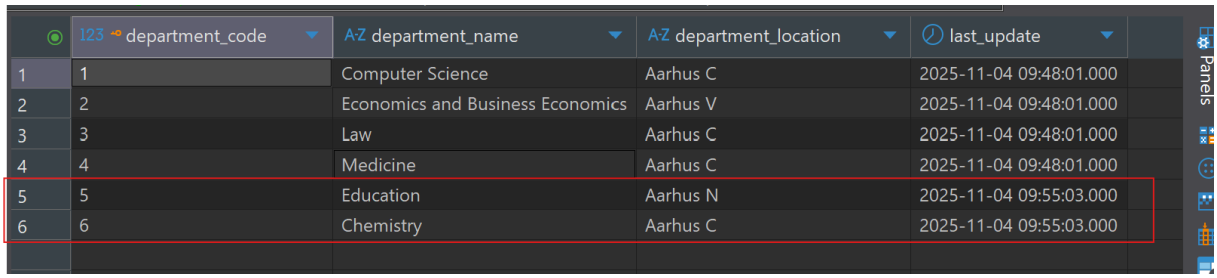
```
> df
  department_name department_location
1       Education            Aarhus N
2       Chemistry            Aarhus C
```

A data.frame in R like your df does not automatically appear in DBeaver

To see it in DBeaver, you need to insert it into a Postgres table. Here’s how it works:

```
# Write the dataframe to a postgres table (columns with default values are skipped)
department <- psql_append_df(cred = cred_psql_docker,
                             schema_name = "intg1",
                             tab_name = "department",
                             df = df)
```

```
[1] "Number of rows inserted: 2"
```



	department_code	department_name	department_location	last_update
1	1	Computer Science	Aarhus C	2025-11-04 09:48:01.000
2	2	Economics and Business Economics	Aarhus V	2025-11-04 09:48:01.000
3	3	Law	Aarhus C	2025-11-04 09:48:01.000
4	4	Medicine	Aarhus C	2025-11-04 09:48:01.000
5	5	Education	Aarhus N	2025-11-04 09:55:03.000
6	6	Chemistry	Aarhus C	2025-11-04 09:55:03.000

Read and write to Postgres

Fetch rows into R

```
45  # Fetching rows into R
46  psql_select(cred = cred_psql_docker,
47              query_string = "select * from intg1.department;")
48
```

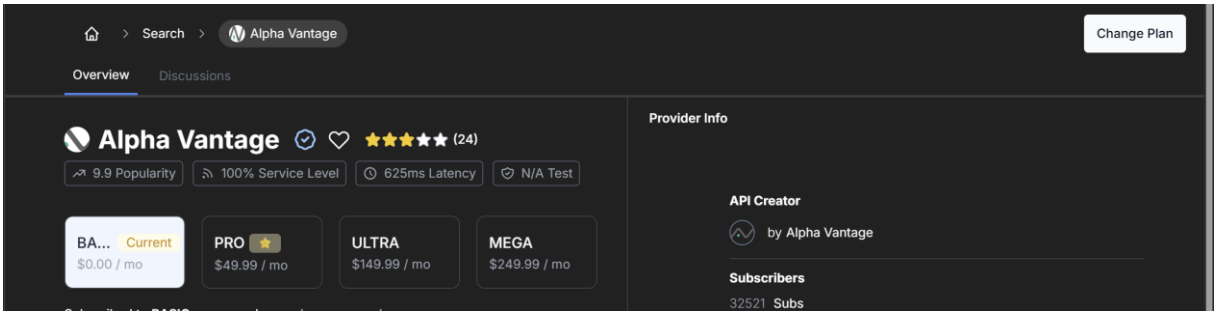
Outcome

```
> # Fetching rows into R
> psql_select(cred = cred_psql_docker,
+             query_string = "select * from intg1.department;")
  department_code                department_name department_location         last_update
1               1                Computer Science           Aarhus C 2025-11-04 09:48:01
2               2 Economics and Business Economics           Aarhus V 2025-11-04 09:48:01
3               3                            Law           Aarhus C 2025-11-04 09:48:01
4               4                       Medicine           Aarhus C 2025-11-04 09:48:01
5               5                      Education           Aarhus N 2025-11-04 09:55:03
6               6                      Chemistry           Aarhus C 2025-11-04 09:55:03
```

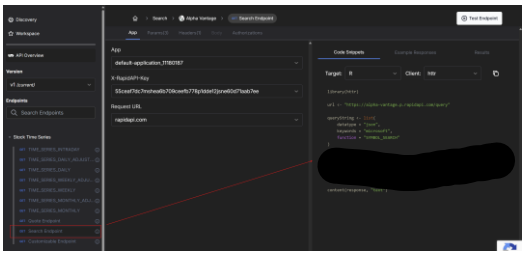
ETL with R

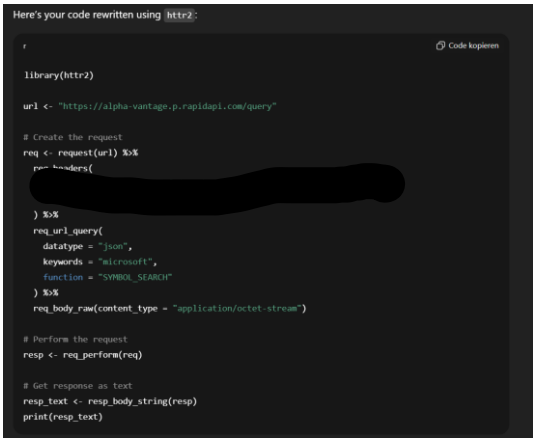
- On Rapidapi.com we will utilize the API called ”Alpha Vantage” • From this API we aim to get intraday stock prices for Microsoft
- First, we will investigate if Alpha Vantage has prices for Microsoft

Go to Rapid.API and subscibre to Alpha Vantage

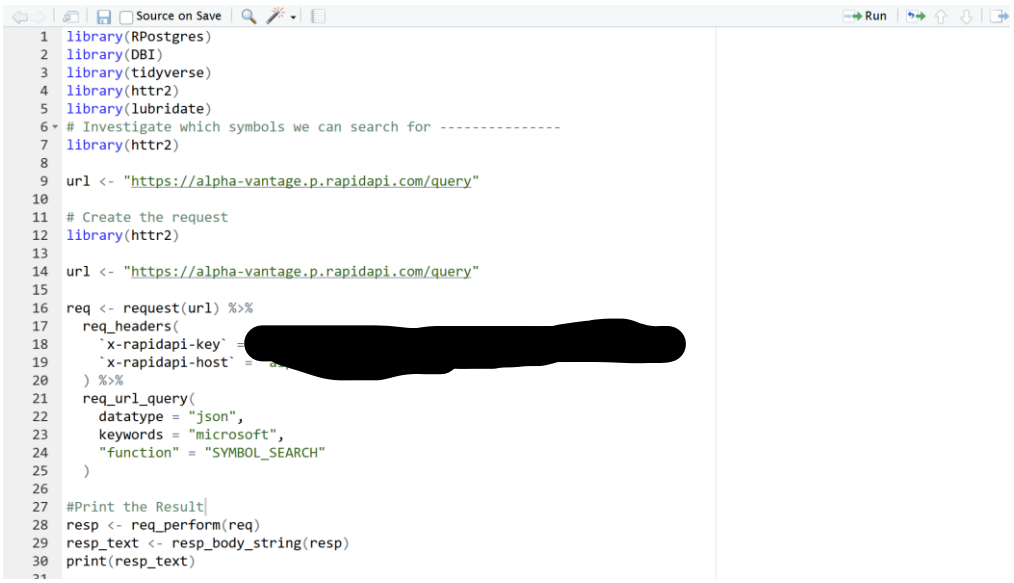


Select search endpoint and ask chatgppt to change to httr2





Copy code into R



Convert to json

```
# convert to json
symbols <- resp %>%
  resp_body_json()
```

See if there is a match

```
#see if there is a Match
symbols$bestMatches[[1]]
symbols$bestMatches[[2]]
```

Outcome

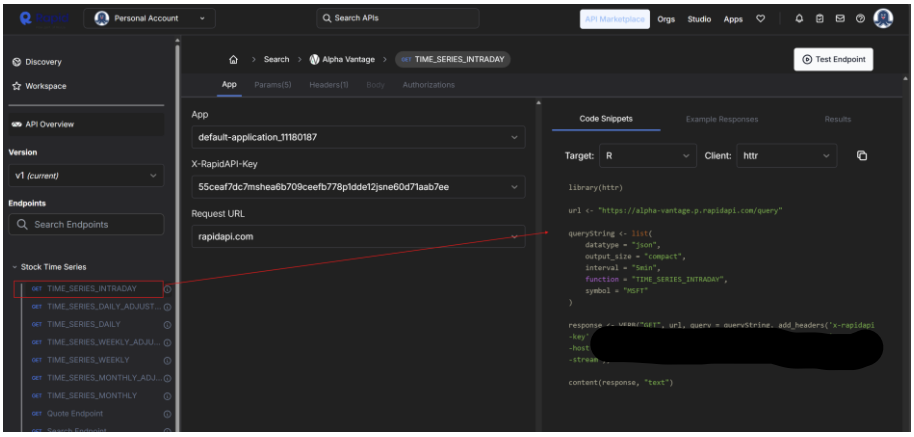
```
> symbols$bestMatches[[1]]
$`1. symbol`
[1] "MSF0.FRK"

$`2. name`
[1] "MICROSOFT CORP. CDR"

$`3. type`
[1] "Equity"

$`4. region`
[1] "Frankfurt"

$`5. marketOpen`
[1] "08:00"

$`6. marketClose`
[1] "20:00"

$`7. timezone`
[1] "UTC+02"

$`8. currency`
[1] "EUR"

$`9. matchScore`
[1] "0.6429"
```

```
> symbols$bestMatches[[2]]
$`1. symbol`
[1] "MSFT"

$`2. name`
[1] "Microsoft Corporation"

$`3. type`
[1] "Equity"

$`4. region`
[1] "United States"

$`5. marketOpen`
[1] "09:30"

$`6. marketClose`
[1] "16:00"

$`7. timezone`
[1] "UTC-04"

$`8. currency`
[1] "USD"

$`9. matchScore`
[1] "0.6154"
```

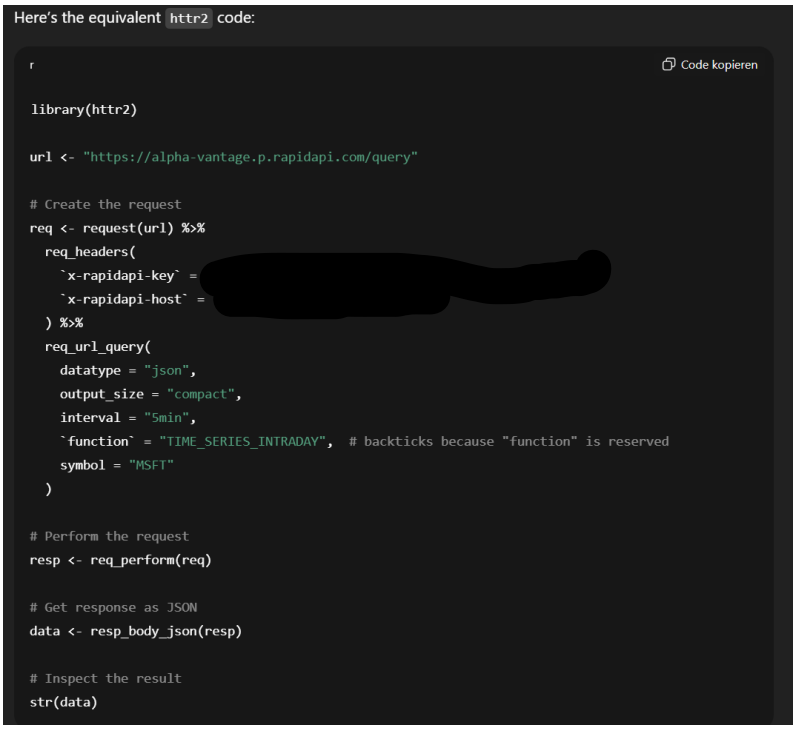
➔ We can see alpha Vantage has prices for the Microsoft stock

Extract with R

Go to Alpha Vantage and copy the code so we can check it minutely



Ask chatgppt to make it httr and output as json



Here's the equivalent `httr2` code:

r — Code kopieren

```r
library(httr2)

url <- "https://alpha-vantage.p.rapidapi.com/query"

# Create the request
req <- request(url) %>%
  req_headers(
    `x-rapidapi-key` = [redacted]
    `x-rapidapi-host` = [redacted]
  ) %>%
  req_url_query(
    datatype = "json",
    output_size = "compact",
    interval = "5min",
    `function` = "TIME_SERIES_INTRADAY",  # backticks because "function" is reserved
    symbol = "MSFT"
  )

# Perform the request
resp <- req_perform(req)

# Get response as JSON
data <- resp_body_json(resp)

# Inspect the result
str(data)
```

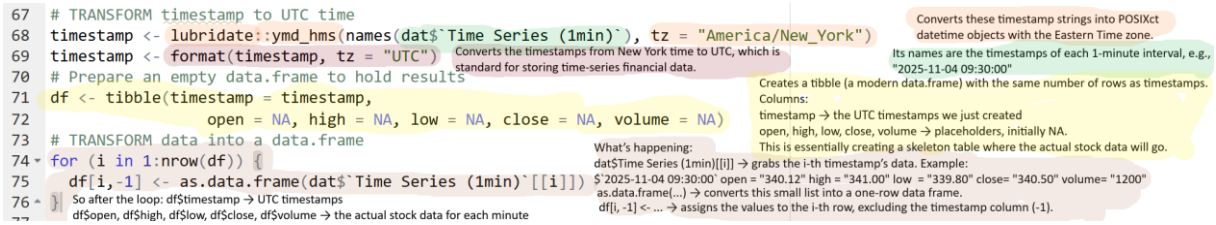
Copy to R we want minutely so we change interval to 1min

```r
# Create the request
req <- request(url) %>%
  req_headers(
    `x-rapidapi-key` = [redacted]
    `x-rapidapi-host` = [redacted]
  ) %>%
  req_url_query(
    datatype = "json",
    output_size = "compact",
    interval = "1min",
    "function" = "TIME_SERIES_INTRADAY",  # backticks because "function" is reserved
    symbol = "MSFT"
  )
# Perform the request
resp <- req_perform(req)
# Get response as JSON
data <- resp_body_json(resp)
# Inspect the result
str(data)
```

Outcome

```
..$ 2025-11-03 18:23:00:List of 5
.. ..$ 1. open  : chr "516.7900"
.. ..$ 2. high  : chr "516.8200"
.. ..$ 3. low   : chr "516.6200"
.. ..$ 4. close : chr "516.8200"
.. ..$ 5. volume: chr "146"
..$ 2025-11-03 18:22:00:List of 5
.. ..$ 1. open  : chr "516.7850"
.. ..$ 2. high  : chr "516.9700"
.. ..$ 3. low   : chr "516.6250"
.. ..$ 4. close : chr "516.7900"
.. ..$ 5. volume: chr "25"
..$ 2025-11-03 18:21:00:List of 5
.. ..$ 1. open  : chr "516.8500"
.. ..$ 2. high  : chr "516.8500"
.. ..$ 3. low   : chr "516.6700"
.. ..$ 4. close : chr "516.8000"
.. ..$ 5. volume: chr "37"
.. [list output truncated]
```

The Microsoft prices are given in America/New_York time. As we might wish to have other price data (given in other time zones), we transform the timestamps to UTC time.

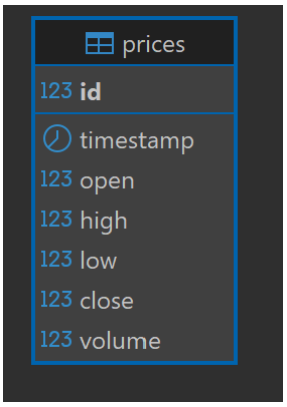



```r
# TRANSFORM timestamp to UTC time
timestamp <- lubridate::ymd_hms(names(dat$`Time Series (1min)`), tz = "America/New_York")
timestamp <- format(timestamp, tz = "UTC")
# Prepare an empty data.frame to hold results
df <- tibble(timestamp = timestamp,
             open = NA, high = NA, low = NA, close = NA, volume = NA)
# TRANSFORM data into a data.frame
for (i in 1:nrow(df)) {
  df[i,-1] <- as.data.frame(dat$`Time Series (1min)`[[i]])
}
```

Intermediate step –
creating a Postgres table (Normally, the table would already exist when doing ETL)

```r
# Create table in Postgres ------------------------------------------------
# Put the credentials in this script
# Never push credentials to git!! --> use .gitignore on .credentials.R
source("credentials.R")
# Function to send queries to Postgres
source("psql_queries.R")
# Create a new schema in Postgres on docker
psql_manipulate(cred = cred_psql_docker,
                query_string = "CREATE SCHEMA intg2;")
# Create a table in the new schema
psql_manipulate(cred = cred_psql_docker,
                query_string =
                  "create table intg2.prices (
  id serial primary key,
  timestamp timestamp(0) without time zone ,
  open numeric(30,4),
  high numeric(30,4),
  low numeric(30,4),
  close numeric(30,4),
  volume numeric(30,4));")
```

Outcome



Load price data into the Table

```
# LOAD price data ------------------------------
psql_append_df(cred = cred_psql_docker,
               schema_name = "intg2",
               tab_name = "prices",
               df = df)
```

```
[1] "Number of rows inserted: 100"
```

Reminder: df is the table we created above

```
# Prepare an empty data.frame to hold results
df <- tibble(timestamp = timestamp,
                  open = NA, high = NA, low = NA, close = NA, volume = NA)
# TRANSFORM data into a data.frame
for (i in 1:nrow(df)) {
  df[i,-1] <- as.data.frame(dat$`Time Series (1min)`[[i]])
}
```

Outcome

	id	timestamp	open	high	low	close	volume
1	1	2025-11-04 00:59:00.000	516.35	516.35	516.01	516.11	420
2	2	2025-11-04 00:58:00.000	516.01	516.35	516.0001	516.0001	667
3	3	2025-11-04 00:57:00.000	516.2	516.2	516	516.0006	208
4	4	2025-11-04 00:56:00.000	516.125	516.2499	516	516.2	436
5	5	2025-11-04 00:55:00.000	516.25	516.2987	516.125	516.125	340
6	6	2025-11-04 00:54:00.000	516.3	516.3	516.2	516.3	82
7	7	2025-11-04 00:53:00.000	516.35	516.35	516.25	516.25	111

Check that we can fetch the data again in R

```
# Check results ------------------------------------------------------------
# Check that we can fetch the data again
psql_select(cred = cred_psql_docker,
            query_string =
              "select * from intg2.prices")
```

Outcome

```
Console  Terminal  Background Jobs
R 4.5.1 · ~/Data Integration/
93   93 2025-11-03 23:27:00 517.0250 517.2300 516.9600 516.9600   1226
94   94 2025-11-03 23:26:00 516.8700 517.0300 516.8201 517.0150    840
95   95 2025-11-03 23:25:00 516.8200 516.9900 516.6300 516.8212    341
96   96 2025-11-03 23:24:00 516.8200 516.8200 516.6200 516.7200     36
97   97 2025-11-03 23:23:00 516.7900 516.8200 516.6200 516.8200    146
98   98 2025-11-03 23:22:00 516.7850 516.9700 516.6250 516.7900     25
99   99 2025-11-03 23:21:00 516.8500 516.8500 516.6700 516.8000     37
100 100 2025-11-03 23:20:00 516.6700 516.9800 516.6200 516.8400     43
```

Delete the schema if wished

```
# If you wish, your can delete the schema (all the price data) from Postgres
psql_manipulate(cred = cred_psql_docker,
                query_string = "drop SCHEMA intg2 cascade;")
```

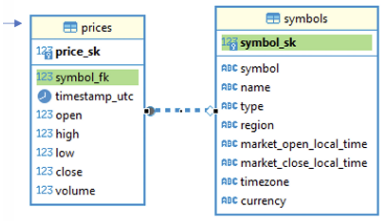
Data Integration II

ETL with Scheduling and Visualization

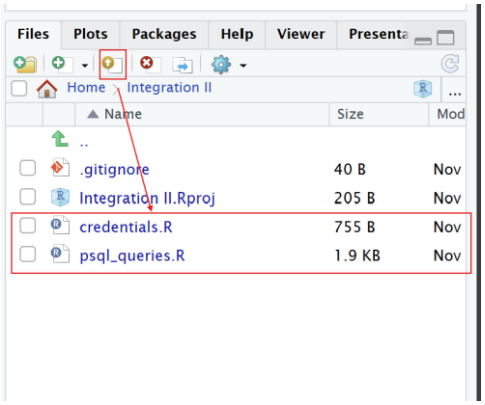
- Goal
  - You want to create a workflow that:
  - Extracts Microsoft (MSFT) and Tesla (TSLA) stock prices from the internet (e.g., Alpha Vantage API).
  - Transforms the data into a clean, usable format.
  - Loads the data into a database (Postgres in your case).
  - Visualizes the stock prices in charts.
  - Automatically updates every 15 minute

Steps of the Integration and Visualization

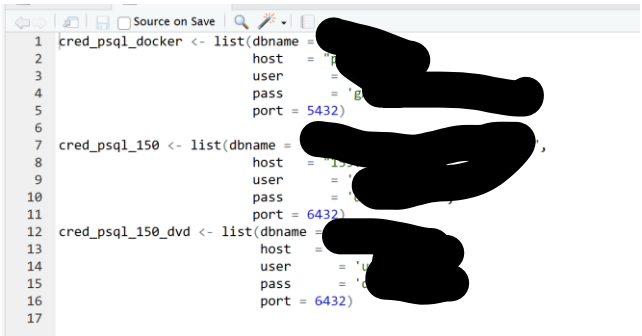
1. Prepare the Tables in Postgres



Upload the files credentials and psql_queries into the Project

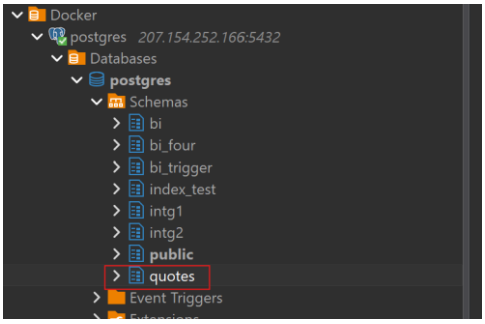


Modify the credentials file



Create a new schema in Postgres on docker

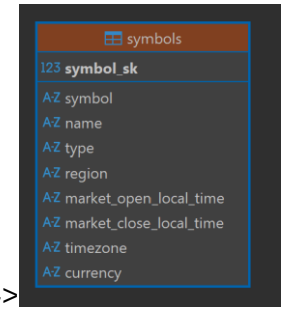
```
psql_manipulate(cred = cred_psql_docker,
                query_string = "CREATE SCHEMA quotes;")
```



Create Tables

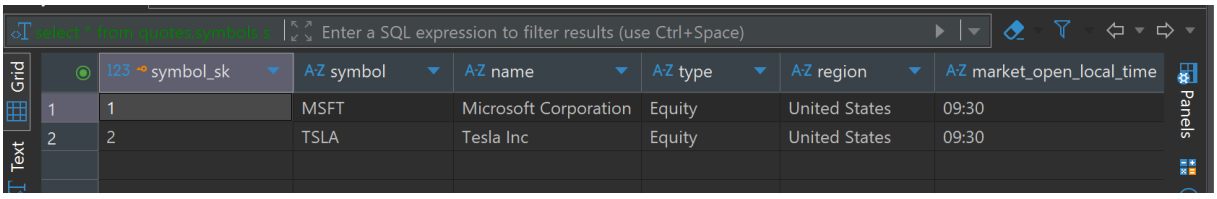
```
# Create symbols table with symbols metadata
psql_manipulate(cred = cred_psql_docker,
                query_string =
                  "create table quotes.symbols (
  symbol_sk serial primary key,
  symbol varchar(50),
  name varchar(150),
  type varchar(50),
  region varchar(100),
  market_open_local_time varchar(20),
  market_close_local_time varchar(20),
  timezone varchar(50),
  currency varchar(20));")
```

->



Populate table with metainformation about Microsoft and Tesla

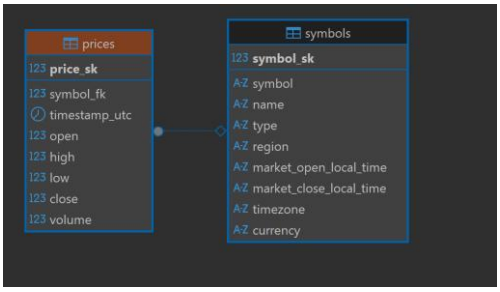
```
# Populate table with metainformation about Microsoft and Tesla ------------------------------
psql_manipulate(cred = cred_psql_docker,
                query_string =
                  "insert into quotes.symbols
                values (default, 'MSFT', 'Microsoft Corporation', 'Equity', 'United States', '09:30', '16:00', 'UTC-04', 'currency'),
                       (default, 'TSLA', 'Tesla Inc', 'Equity', 'United States', '09:30', '16:00', 'UTC-04', 'currency');")
```



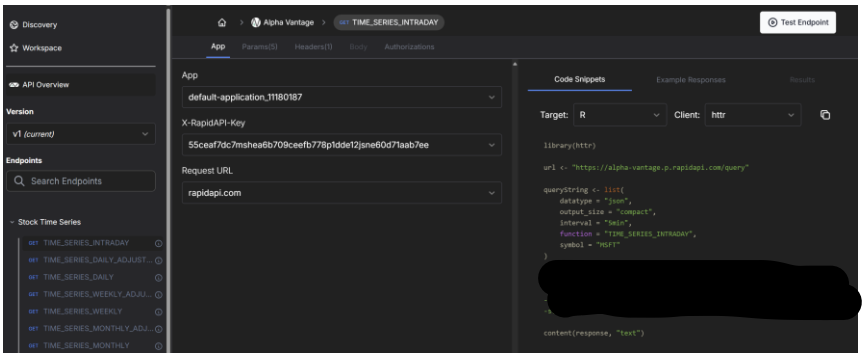
	symbol_sk	symbol	name	type	region	market_open_local_time
1	1	MSFT	Microsoft Corporation	Equity	United States	09:30
2	2	TSLA	Tesla Inc	Equity	United States	09:30

Create table to hold price data

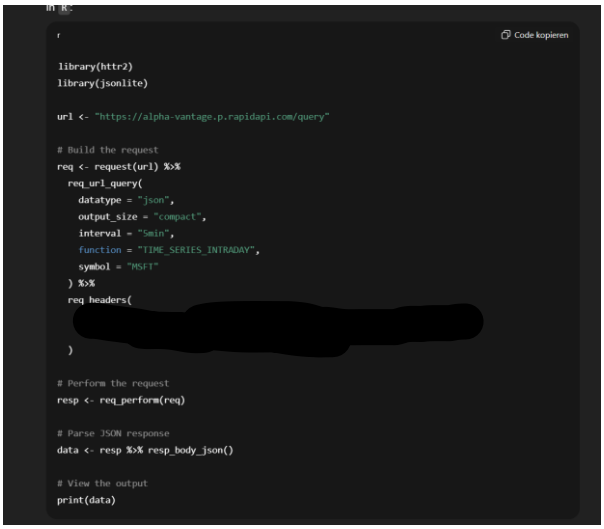
```
# Create table to hold price data ----------------------------------------
psql_manipulate(cred = cred_psql_docker,
                query_string =
                  "create table quotes.prices (
  price_sk serial primary key,
  symbol_fk integer,
  timestamp_utc timestamp(0) without time zone ,
  open numeric(30,4),
  high numeric(30,4),
  low numeric(30,4),
  close numeric(30,4),
  volume numeric(30,4),
  constraint fk_symbol foreign key (symbol_fk)
  references quotes.symbols(symbol_sk));")
```

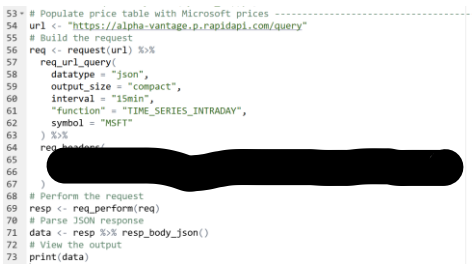


Populate price table with Microsoft prices



(change to httr2 and json output)





```r
# Populate price table with Microsoft prices ----------
url <- "https://alpha-vantage.p.rapidapi.com/query"
# Build the request
req <- request(url) %>%
  req_url_query(
    datatype = "json",
    output_size = "compact",
    interval = "15min",
    "function" = "TIME_SERIES_INTRADAY",
    symbol = "MSFT"
  ) %>%
  req_headers(
  )
# Perform the request
resp <- req_perform(req)
# Parse JSON response
data <- resp %>% resp_body_json()
# View the output
print(data)
```

(transform data to UTC)

```r
# Transform timestamp to UTC time
timestamp <- lubridate::ymd_hms(names(data$`Time Series (15min)`), tz = "America/New_York")
timestamp <- format(timestamp, tz = "UTC")
```

(Prepare data.frame to hold results)

```r
df <- tibble(timestamp_utc = timestamp,
             symbol_fk = 1, #
             open = NA, high = NA, low = NA, close = NA, volume = NA)
```

(TRANSFORM data into a data.frame)

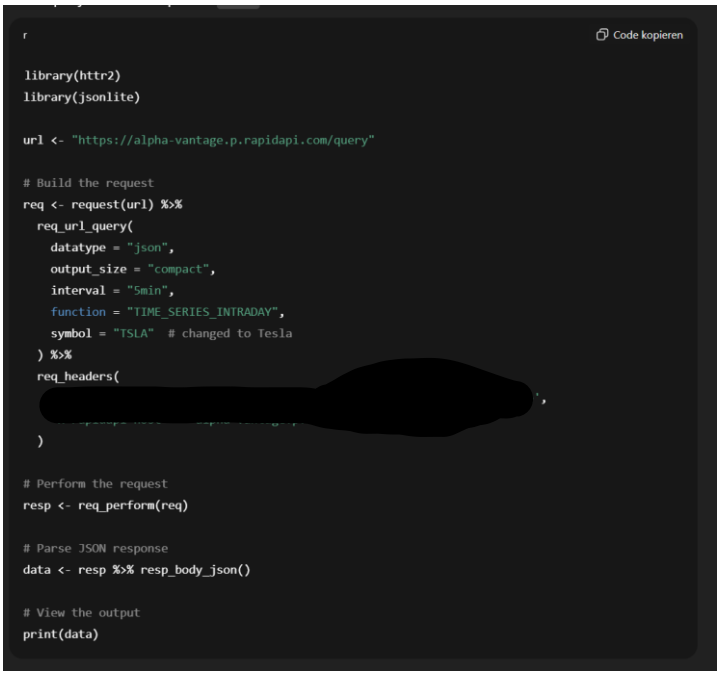
```r
# TRANSFORM data into a data.frame
for (i in 1:nrow(df)) {
  df[i,-c(1,2)] <- as.data.frame(data$`Time Series (15min)`[[i]])
}
```

(Load Microsoft price data into prices)

```r
# Load Microsoft price data into prices
psql_append_df(cred = cred_psql_docker,
               schema_name = "quotes",
               tab_name = "prices",
               df = df)
```

Do the same with Tesla

(ask chatgpt to change the Rapidapi to Tesla)



```r
library(httr2)
library(jsonlite)

url <- "https://alpha-vantage.p.rapidapi.com/query"

# Build the request
req <- request(url) %>%
  req_url_query(
    datatype = "json",
    output_size = "compact",
    interval = "5min",
    function = "TIME_SERIES_INTRADAY",
    symbol = "TSLA"  # changed to Tesla
  ) %>%
  req_headers(
    [redacted]
  )

# Perform the request
resp <- req_perform(req)

# Parse JSON response
data <- resp %>% resp_body_json()

# View the output
print(data)
```

```r
# Populate price table with Tesla prices ----------------------------------

url <- "https://alpha-vantage.p.rapidapi.com/query"
# Build the request
req <- request(url) %>%
  req_url_query(
    datatype = "json",
    output_size = "compact",
    interval = "15min",
    "function" = "TIME_SERIES_INTRADAY",
    symbol = "TSLA"  # changed to Tesla
  ) %>%
  req_headers(
    'x-rapidapi-key' [redacted]
    'x-rapidapi-host'
  )
# Perform the request
resp <- req_perform(req)
# Parse JSON response
data <- resp %>% resp_body_json()
# View the output
print(data)
```

Transform timestamp to UTC time

```r
# Transform timestamp to UTC time
timestamp <- lubridate::ymd_hms(names(data$`Time Series (15min)`), tz = "America/New_York")
timestamp <- format(timestamp, tz = "UTC")
```

Prepare data.frame to hold results

```r
# Prepare data.frame to hold results
df <- tibble(timestamp_utc = timestamp,
             symbol_fk = 2, #
             open = NA, high = NA, low = NA, close = NA, volume = NA)
```

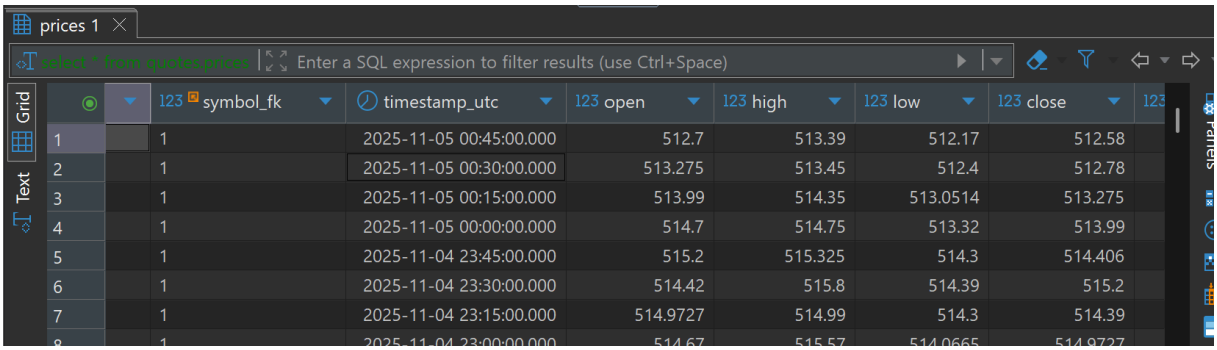
transform data into a data.frame

```r
# transform data into a data.frame
for (i in 1:nrow(df)) {
  df[i,-c(1,2)] <- as.data.frame(data$`Time Series (15min)`[[i]])
}
```

Load Tesla price data into prices

```r
# Load Tesla price data into prices
psql_append_df(cred = cred_psql_docker,
               schema_name = "quotes",
               tab_name = "prices",
               df = df)
```

Check if it worked



prices 1

Enter a SQL expression to filter results (use Ctrl+Space)

	symbol_fk	timestamp_utc	open	high	low	close
1	1	2025-11-05 00:45:00.000	512.7	513.39	512.17	512.58
2	1	2025-11-05 00:30:00.000	513.275	513.45	512.4	512.78
3	1	2025-11-05 00:15:00.000	513.99	514.35	513.0514	513.275
4	1	2025-11-05 00:00:00.000	514.7	514.75	513.32	513.99
5	1	2025-11-04 23:45:00.000	515.2	515.325	514.3	514.406
6	1	2025-11-04 23:30:00.000	514.42	515.8	514.39	515.2
7	1	2025-11-04 23:15:00.000	514.9727	514.99	514.3	514.39

Or

```
130 # Check that we have populated the tables as intended --------
131 psql_select(cred = cred_psql_docker,
132              query_string = "select * from quotes.prices")
133
```

Console | Terminal | Background Jobs

R 4.5.1 · ~/Integration II/

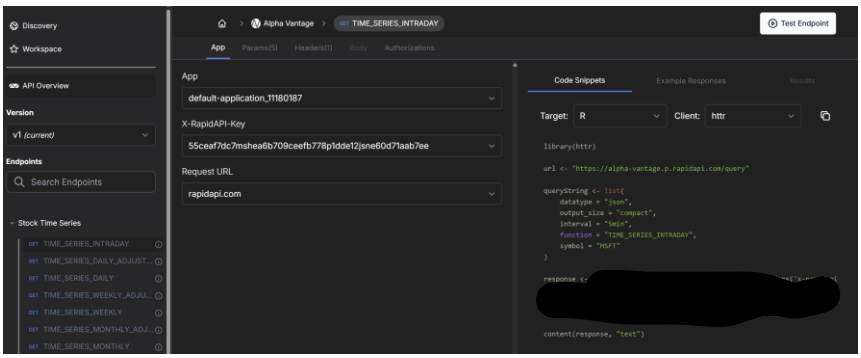
```
    108     108          2 2025-11-04 23:00:00 443.4900 444.0000 442.0800 442.7700    54320
109 109 2 2025-11-04 22:45:00 443.4000 443.9000 443.2100 443.4700 36284
110 110 2 2025-11-04 22:30:00 444.2632 444.3100 443.2100 443.4200 54370
111 111 2 2025-11-04 22:15:00 444.2000 463.1606 415.8999 444.2600 52774
112 112 2 2025-11-04 22:00:00 443.8000 444.5000 443.8000 444.1500 96877
113 113 2 2025-11-04 21:45:00 443.0400 444.3900 442.3800 443.8650 133682
114 114 2 2025-11-04 21:30:00 442.8000 445.2856 442.0000 443.0500 163903
115 115 2 2025-11-04 21:15:00 444.2600 449.9690 442.1000 442.7200 173487
116 116 2 2025-11-04 21:00:00 444.2200 468.3700 442.0000 442.3400 12144173
117 117 2 2025-11-04 20:45:00 448.5764 449.4617 443.6000 444.2300 5279086
118 118 2 2025-11-04 20:30:00 448.5200 448.8476 447.1875 448.5501 2083579
119 119 2 2025-11-04 20:15:00 447.3900 448.8500 446.6100 448.5000 1882475
120 120 2 2025-11-04 20:00:00 446.4100 448.1000 446.0300 447.3800 2929479
121 121 2 2025-11-04 19:45:00 446.1600 446.7400 443.8600 446.4200 3381652
122 122 2 2025-11-04 19:30:00 449.2800 449.4300 446.0110 446.1900 2076762
123 123 2 2025-11-04 19:15:00 448.2900 450.5500 448.0600 449.3300 1865227
124 124 2 2025-11-04 19:00:00 450.2800 450.9700 448.1450 448.3292 1819178
125 125 2 2025-11-04 18:45:00 448.3350 451.5400 447.8800 450.2700 2513351
[ reached 'max' / getOption("max.print") -- omitted 75 rows ]
```

2. Script to be scheduled

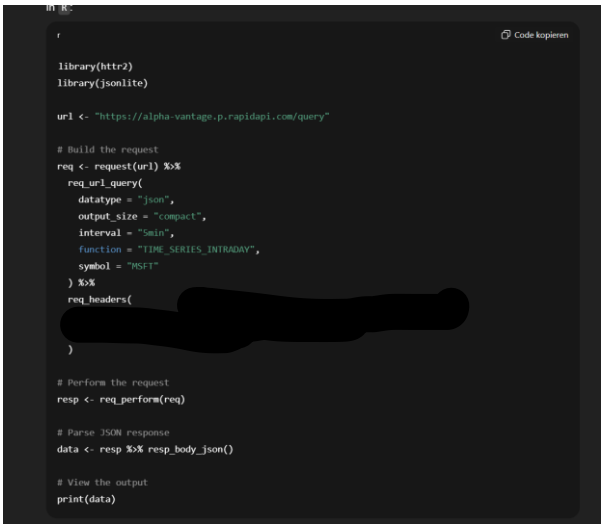
Load functions to communicate with Postgres

```
6 # Load credentials
7 source("credentials.R")
8 # Load functions to communicate with Postgres
9 source("psql_queries.R")
```

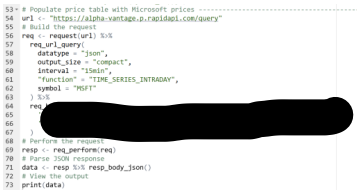
Extract Microsoft prices



(change to httr2 and json output)



```r
library(httr2)
library(jsonlite)

url <- "https://alpha-vantage.p.rapidapi.com/query"

# Build the request
req <- request(url) %>%
  req_url_query(
    datatype = "json",
    output_size = "compact",
    interval = "5min",
    function = "TIME_SERIES_INTRADAY",
    symbol = "MSFT"
  ) %>%
  req_headers(
    [redacted]
  )

# Perform the request
resp <- req_perform(req)

# Parse JSON response
data <- resp %>% resp_body_json()

# View the output
print(data)
```



(transform data to UTC)

```r
# Transform timestamp to UTC time
timestamp <- lubridate::ymd_hms(names(data$`Time Series (15min)`), tz = "America/New_York")
timestamp <- format(timestamp, tz = "UTC")
```

(Prepare data.frame to hold results)

```r
df <- tibble(timestamp_utc = timestamp,
             symbol_fk = 1, #
             open = NA, high = NA, low = NA, close = NA, volume = NA)
```

(TRANSFORM data into a data.frame)

```r
# TRANSFORM data into a data.frame
for (i in 1:nrow(df)) {
  df[i,-c(1,2)] <- as.data.frame(data$`Time Series (15min)`[[i]])
}
```

From our database, we fetch the most recent timestamp for a Microsoft price

```r
latest_tmstmp <- psql_select(cred = cred_psql_docker,
                             query_string =
                               "select timestamp_utc
                                from quotes.prices
                                where symbol_fk = 1
                                order by timestamp_utc desc
                                limit 1;")
```

Limit 1

Only new datapoints should be loaded to database

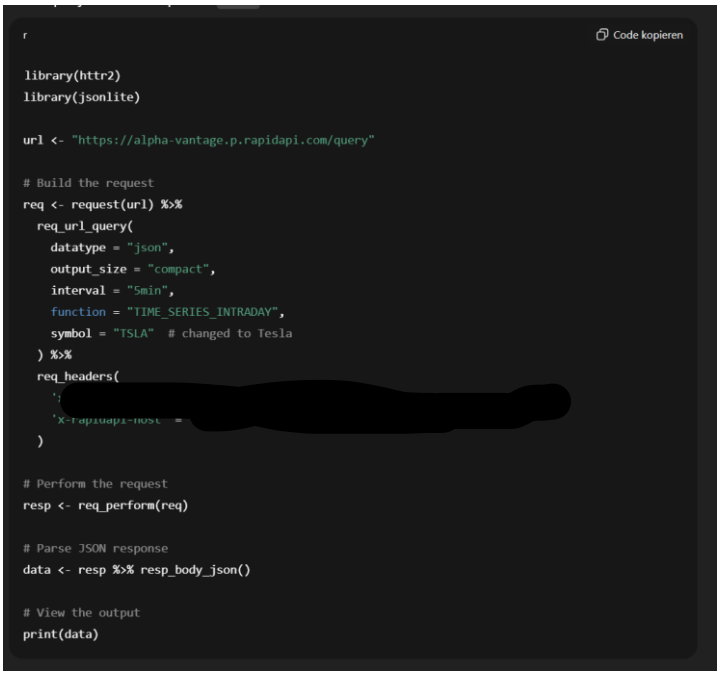
```r
# Only new datapoints should be loaded to database
df <- df[df$timestamp_utc > latest_tmstmp[[1]],]
```

Insert new Microsoft price data into the database

```r
# Load price data
print(paste0(round(Sys.time()), ": Updating Microsoft prices"))

psql_append_df(cred = cred_psql_docker,
               schema_name = "quotes",
               tab_name = "prices",
               df = df)
```

Do the same with Tesla

(ask chatgpt to change the Rapidapi to Tesla)



```r
library(httr2)
library(jsonlite)

url <- "https://alpha-vantage.p.rapidapi.com/query"

# Build the request
req <- request(url) %>%
  req_url_query(
    datatype = "json",
    output_size = "compact",
    interval = "5min",
    function = "TIME_SERIES_INTRADAY",
    symbol = "TSLA"  # changed to Tesla
  ) %>%
  req_headers(
    '[redacted]'
  )

# Perform the request
resp <- req_perform(req)

# Parse JSON response
data <- resp %>% resp_body_json()

# View the output
print(data)
```

```r
# Populate price table with Tesla prices ----------------------------------

url <- "https://alpha-vantage.p.rapidapi.com/query"
# Build the request
req <- request(url) %>%
  req_url_query(
    datatype = "json",
    output_size = "compact",
    interval = "15min",
    "function" = "TIME_SERIES_INTRADAY",
    symbol = "TSLA"  # changed to Tesla
  ) %>%
  req_h[redacted]
  )
# Perform the request
resp <- req_perform(req)
# Parse JSON response
data <- resp %>% resp_body_json()
# View the output
print(data)
```

Transform timestamp to UTC time

```r
# Transform timestamp to UTC time
timestamp <- lubridate::ymd_hms(names(data$`Time Series (15min)`), tz = "America/New_York")
timestamp <- format(timestamp, tz = "UTC")
```

Prepare data.frame to hold results

```r
# Prepare data.frame to hold results
df <- tibble(timestamp_utc = timestamp,
             symbol_fk = 2, #
             open = NA, high = NA, low = NA, close = NA, volume = NA)
```

transform data into a data.frame

```r
# transform data into a data.frame
for (i in 1:nrow(df)) {
  df[i,-c(1,2)] <- as.data.frame(data$`Time Series (15min)`[[i]])
}
```

Get most recent datapoint from database

```r
# Get most recent datapoint from database
latest_tmstmp <- psql_select(cred = cred_psql_docker,
                             query_string =
                               "select timestamp_utc
                                from quotes.prices
                                where symbol_fk = 2
                                order by timestamp_utc desc
                                limit 1;")
```

Only new datapoints should be loaded to database

```
df <- df[df$timestamp_utc > latest_tmstmp[[1]],]
```

Load price data

```
print(paste0(round(Sys.time()), ": Updating Tesla prices"))

psql_append_df(cred = cred_psql_docker,
               schema_name = "quotes",
               tab_name = "prices",
               df = df)
```

3. Test the script to be scheduled

Before sending a code to production, you should always perform tests to validate the code

Load functions

```
# Load credentials
source("credentials.R")
# Load functions to communicate with Postgres
source("psql_queries.R")
```

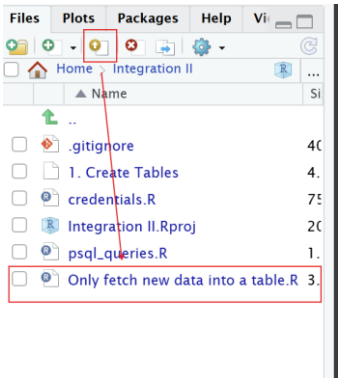
Delete some observations from the table Microsoft

```
psql_manipulate(cred = cred_psql_docker,
                query_string =
                  "delete
                   from quotes.prices
                   where
                   price_sk = (select price_sk
                               from quotes.prices
                               where symbol_fk = 1
                               order by timestamp_utc desc
                               limit 1);")
```

Check most recent prices

```
# Check most recent prices
psql_select(cred = cred_psql_docker,
            query_string =
              "select timestamp_utc
               from quotes.prices
               where symbol_fk = 1
               order by timestamp_utc desc
               limit 5;")
```

Upload the file we created above for fetching new data



Run the scheduled function 1 time

```
source("Only fetch new data into a table.R")
```

Check that things has been reinserted

```
psql_select(cred = cred_psql_docker,
            query_string =
              "select *
               from quotes.prices
               where symbol_fk = 1
               order by timestamp_utc desc
               limit 5;")
```

```
  price_sk symbol_fk       timestamp_utc    open    high      low   close volume
1      201         1 2025-11-05 00:45:00 512.700 513.390 512.1700 512.580  13871
2        2         1 2025-11-05 00:30:00 513.275 513.450 512.4000 512.780   6338
3        3         1 2025-11-05 00:15:00 513.990 514.350 513.0514 513.275   6467
4        4         1 2025-11-05 00:00:00 514.700 514.750 513.3200 513.990   4816
5        5         1 2025-11-04 23:45:00 515.200 515.325 514.3000 514.406   6431
>
```

Check updating Tesla

Delete some observations from the table

```
# Delete some observations from the table
psql_manipulate(cred = cred_psql_docker,
                query_string =
                  "delete
                   from quotes.prices
                   where
                   price_sk = (select price_sk
                               from quotes.prices
                               where symbol_fk = 2
                               order by timestamp_utc desc
                               limit 1);")
```

Check most recent prices

```
# Check most recent prices
psql_select(cred = cred_psql_docker,
            query_string =
              "select *
               from quotes.prices
               where symbol_fk = 2
               order by timestamp_utc desc
               limit 5;")
```

```
  price_sk symbol_fk       timestamp_utc    open     high    low  close volume
1      102         2 2025-11-05 00:30:00 441.050 441.1100 440.00 440.00  90483
2      103         2 2025-11-05 00:15:00 441.500 441.8111 440.91 441.09  59937
3      104         2 2025-11-05 00:00:00 441.949 442.2200 441.00 441.50  66933
4      105         2 2025-11-04 23:45:00 442.000 442.3500 441.42 441.90  70457
5      106         2 2025-11-04 23:30:00 442.570 442.7267 441.66 441.96 122507
```

Run the scheduled function 1 time

```
60  # Run the scheduled function 1 time
61  source("Only fetch new data into a table.R")
```

```
[1] "2025-11-05 17:13:06: Updating Tesla prices"
[1] "Number of rows inserted: 1"
```

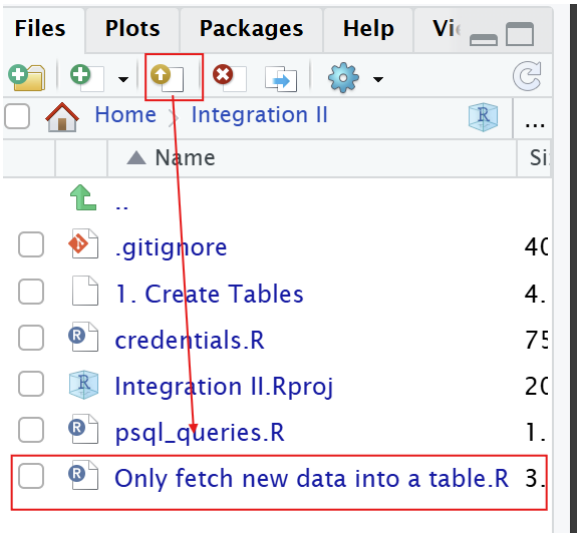
Check that things has been reinserted

```
63  psql_select(cred = cred_psql_docker,
64              query_string =
65                "select *
66                 from quotes.prices
67                 where symbol_fk = 2
68                 order by timestamp_utc desc
69                 limit 5;")
```

	price_sk	symbol_fk	timestamp_utc	open	high	low	close	volume
1	202	2	2025-11-05 00:45:00	440.070	441.0000	439.45	439.50	175999
2	102	2	2025-11-05 00:30:00	441.050	441.1100	440.00	440.00	90483
3	103	2	2025-11-05 00:15:00	441.500	441.8111	440.91	441.09	59937
4	104	2	2025-11-05 00:00:00	441.949	442.2200	441.00	441.50	66933
5	105	2	2025-11-04 23:45:00	442.000	442.3500	441.42	441.90	70457

4. Setting the schedule

Upload the script from step 2



Add cron job for fetching price data

```
3  cmd <- cron_rscript(rscript = "Only fetch new data into a table.R")
```

Must run every 15 minutes

```
5  cron_add(cmd, frequency = '0,15,30,45 * * * *', id = 'job3')
```

Check the schedule

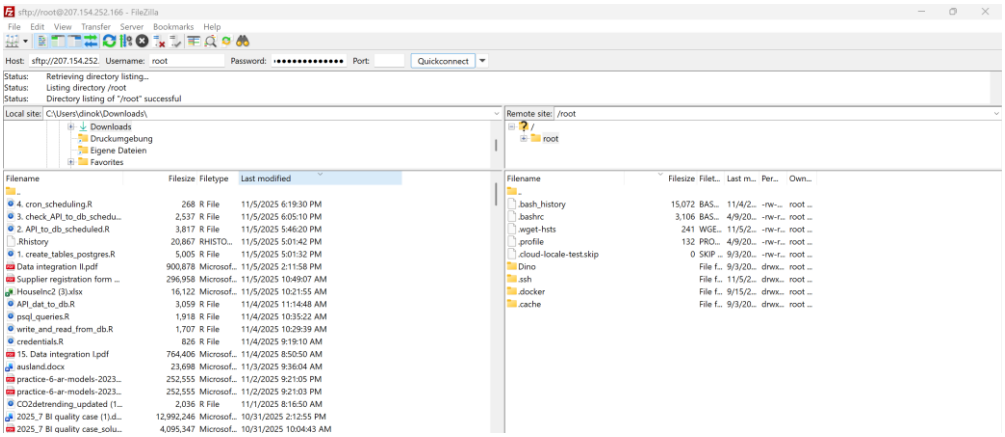
```
7  cron_ls()
```

```
> cron_ls()

## cronR job
## id:   job3
## tags:
## desc:
0,15,30,45 * * * * /usr/local/lib/R/bin/Rscript '/home/rstudio/Integration II/Only fetch new data into a table.R'  >> '/home/rstudio/Integration II/Only fetch new data into a table.log' 2>&1

>
```

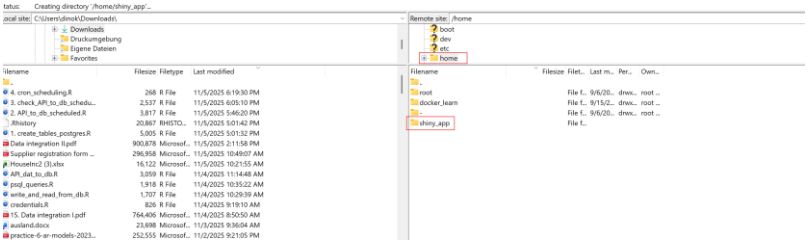
- We have now automated the data integration task
- We will automatically get new price data written to our database
- More symbols could be added (but then we would likely reach our API limit for our free API)
- To complete the pipeline, we will set up a shiny server to visualize our stock data
- It is not important how the Shinyapp itself is setup – you will get more into this when Martin takes over next week
- The way we build the new image and run the container is, however, instructive for this part of the course
- The Shiny server will fetch the data from the PostgreSQL server and expose the data on a web address

5. Setting up the Shiny server

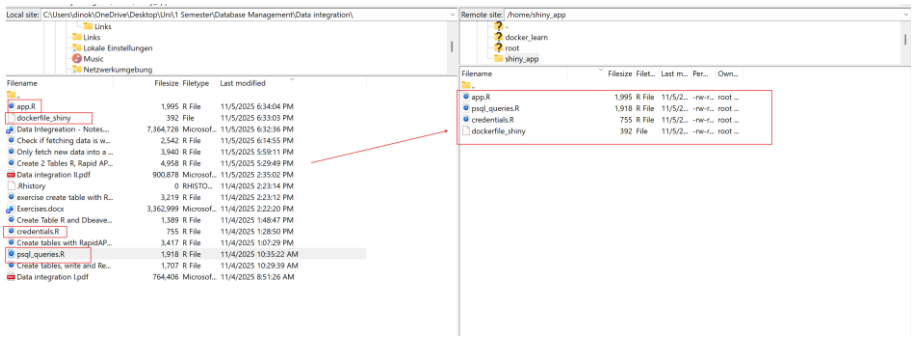
Connect to filezella



Create a directory (e.g. using FileZilla) called “shiny_app” under the “home” directory on the droplet



Move the files “.credentials.R”, “app.R”, “dockerfile_shiny”, and “psql_queries.R” into this folder



If you have an existing “rshiny” container running, then remove it using “docker rm -f rshiny” (using the droplet console)

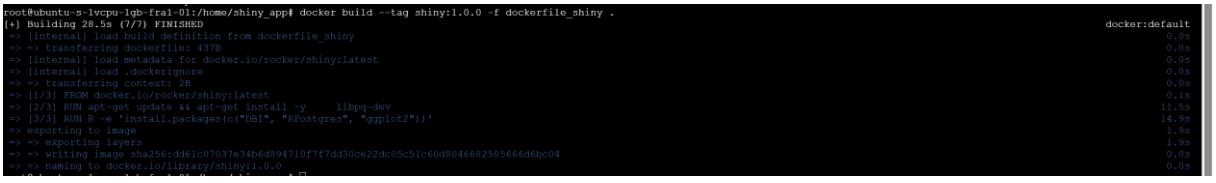
```
Run 'docker --help' for more information
root@ubuntu-s-1vcpu-1gb-fra1-01:/home/shiny_app# docker ps -a
CONTAINER ID   IMAGE          COMMAND                  CREATED         STATUS         PORTS                                                  NAMES
1d90cf679838   rstudio:1.0.3  "/init"                  7 days ago      Up 7 days      0.0.0.0:8787->8787/tcp, [::]:8787->8787/tcp            rstudio
16da47902dcd   postgres       "docker-entrypoint.s…"   6 weeks ago     Up 6 weeks     0.0.0.0:5432->5432/tcp, [::]:5432->5432/tcp            postgres
7e30e982ce93   rocker/shiny   "/init"                  2 months ago    Up 2 months    0.0.0.0:3838->3838/tcp, [::]:3838->3838/tcp            rshiny
```

➔ R shiny container there so remove

Navigate to “/home/shiny_app”

```
root@ubuntu-s-1vcpu-1gb-fra1-01:/# cd ..
root@ubuntu-s-1vcpu-1gb-fra1-01:/# ls -l
total 64
lrwxrwxrwx   1 root root     7 Apr  9  2025 bin -> usr/bin
drwxr-xr-x   5 root root  4096 Nov  5 06:49 boot
drwxr-xr-x  18 root root  3920 Sep  3 10:44 dev
drwxr-xr-x 117 root root  4096 Oct 31 06:27 etc
drwxr-xr-x   6 root root  4096 Nov  5 17:31 home
lrwxrwxrwx   1 root root     7 Apr  9  2025 lib -> usr/lib
lrwxrwxrwx   1 root root     9 Apr  9  2025 lib64 -> usr/lib64
drwx------   2 root root 16384 Jul  1 19:57 lost+found
drwxr-xr-x   2 root root  4096 Jul  1 19:54 media
drwxr-xr-x   2 root root  4096 Jul  1 19:54 mnt
drwxr-xr-x   4 root root  4096 Sep  3 12:40 opt
dr-xr-xr-x 201 root root     0 Sep  3 10:44 proc
drwx------   6 root root  4096 Sep 15 08:52 root
drwxr-xr-x  34 root root  1080 Nov  5 17:37 run
lrwxrwxrwx   1 root root     8 Apr  9  2025 sbin -> usr/sbin
drwxr-xr-x   2 root root  4096 Oct 29 16:17 scheduling
drwxr-xr-x   2 root root  4096 Sep  3 10:44 snap
drwxr-xr-x   2 root root  4096 Jul  1 19:54 srv
dr-xr-xr-x  13 root root     0 Sep  6 06:51 sys
drwxrwxrwt   7 root root   140 Nov  5 15:26 tmp
drwxr-xr-x  12 root root  4096 Sep  6 07:35 usr
drwxr-xr-x  13 root root  4096 Sep  3 10:44 var
root@ubuntu-s-1vcpu-1gb-fra1-01:/# cd home
root@ubuntu-s-1vcpu-1gb-fra1-01:/home# ls -l
total 16
drwxr-xr-x 2 root root 4096 Sep  6 12:44 -
drwxr-xr-x 2 root root 4096 Sep 15 20:05 docker_learn
drwxr-xr-x 3 root root 4096 Sep  6 09:10 root
drwxr-xr-x 2 root root 4096 Nov  5 17:36 shiny_app
root@ubuntu-s-1vcpu-1gb-fra1-01:/home# cd shiny_app
root@ubuntu-s-1vcpu-1gb-fra1-01:/home/shiny_app#
```

build the image by running “docker build --tag shiny:1.0.0 -f dockerfile_shiny .”



Run a shiny container using “docker run -d -p 3838:3838 --network db_r_shiny --name rshiny -v /home/shiny_app:/srv/shiny-server shiny:1.0.0”

```
root@ubuntu-s-1vcpu-1gb-fra1-01:/home/shiny_app# docker run -d -p 3838:3838 --network db_r_shiny --name rshiny -v /home/shiny_app:/srv/shiny-server shiny:1.0.0
1ad08269d531129382b32329330df563995e54796b4fa86b4ff993a73cc86f79
```

- In the above command, we mounted the host directory “/home/shiny_app” to the Shiny server container.
- “/home/shiny_app” is the directory where you located the files “.credentials.R”, “app.R”, and “psql_queries.R”. The Shiny-server uses these files to create the Shinyapp.

Copy the ipv from droplet

Paste into URL with port : 3838 for rshiny