# SpaceX Falcon 9 First Stage Landing Prediction

Web scraping Falcon 9 and Falcon Heavy Launches Records from Wikipedia

Estimated time needed: **40** minutes

In this lab, you will be performing web scraping to collect Falcon 9 historical launch records from a Wikipedia page titled `List of Falcon 9 and Falcon Heavy launches`

https://en.wikipedia.org/wiki/List_of_Falcon_9_and_Falcon_Heavy_launches

| Falcon 9 v1.0 | Falcon 9 v1.1 | Falcon 9 v1.2 (FT) | Falcon 9 Block 5 | Falcon Heavy | FH B5 |
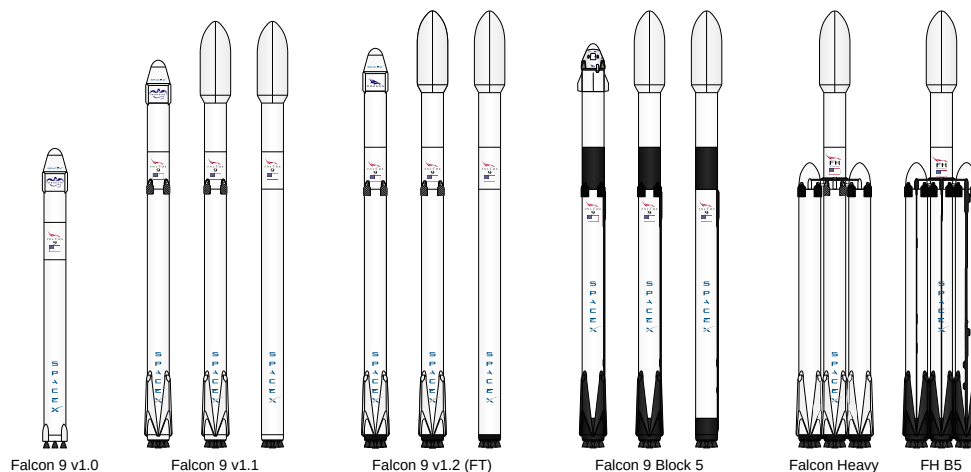
Falcon 9 first stage will land successfully

Several examples of an unsuccessful landing are shown here:

More specifically, the launch records are stored in a HTML table shown below:

2020 [edit]

In late 2019, Gwynne Shotwell stated that SpaceX hoped for as many as 24 launches for Starlink satellites in 2020,[490] in addition to 14 or 15 non-Starlink launches. At 26 launches, 13 of which for Starlink satellites, Falcon 9 had its most prolific year, and Falcon rockets were second most prolific rocket family of 2020, only behind China's Long March rocket family.[491]

[hide] Flight No.	Date and time (UTC)	Version, Booster[b]	Launch site	Payload[c]	Payload mass	Orbit	Customer	Launch outcome	Booster landing
78	7 January 2020, 02:19:21[492]	F9 B5 △ B1049.4	CCAFS, SLC-40	Starlink 2 v1.0 (60 satellites)	15,600 kg (34,400 lb)[5]	LEO	SpaceX	Success	Success (drone ship)
	Third large batch and second operational flight of Starlink constellation. One of the 60 satellites included a test coating to make the satellite less reflective, and thus less likely to interfere with ground-based astronomical observations.[493]								
79	19 January 2020, 15:30[494]	F9 B5 △ B1046.4	KSC, LC-39A	Crew Dragon in-flight abort test[495] (Dragon C205.1)	12,050 kg (26,570 lb)	Sub-orbital[496]	NASA (CTS)[497]	Success	No attempt
	An atmospheric test of the Dragon 2 abort system after Max Q. The capsule fired its SuperDraco engines, reached an apogee of 40 km (25 mi), deployed parachutes after reentry, and splashed down in the ocean 31 km (19 mi) downrange from the launch site. The test was previously slated to be accomplished with the Crew Dragon Demo-1 capsule;[498] but that test article exploded during a ground test of SuperDraco engines on 20 April 2019.[419] The abort test used the capsule originally intended for the first crewed flight.[499] As expected, the booster was destroyed by aerodynamic forces after the capsule aborted.[500] First flight of a Falcon 9 with only one functional stage — the second stage had a mass simulator in place of its engine.								
80	29 January 2020, 14:07[501]	F9 B5 △ B1051.3	CCAFS, SLC-40	Starlink 3 v1.0 (60 satellites)	15,600 kg (34,400 lb)[5]	LEO	SpaceX	Success	Success (drone ship)
	Third operational and fourth large batch of Starlink satellites, deployed in a circular 290 km (180 mi) orbit. One of the fairing halves was caught, while the other was fished out of the ocean.[502]								
81	17 February 2020, 15:05[503]	F9 B5 △ B1056.4	CCAFS, SLC-40	Starlink 4 v1.0 (60 satellites)	15,600 kg (34,400 lb)[5]	LEO	SpaceX	Success	Failure (drone ship)
	Fourth operational and fifth large batch of Starlink satellites. Used a new flight profile which deployed into a 212 km × 386 km (132 mi × 240 mi) elliptical orbit instead of launching into a circular orbit and firing the second stage engine twice. The first stage booster failed to land on the drone ship[504] due to incorrect wind data.[505] This was the first time a flight proven booster failed to land.								
82	7 March 2020, 04:50[506]	F9 B5 △ B1059.2	CCAFS, SLC-40	SpaceX CRS-20 (Dragon C112.3 △)	1,977 kg (4,359 lb)[507]	LEO (ISS)	NASA (CRS)	Success	Success (ground pad)
	Last launch of phase 1 of the CRS contract. Carries Bartolomeo, an ESA platform for hosting external payloads onto ISS.[508] Originally scheduled to launch on 2 March 2020, the launch date was pushed back due to a second stage engine failure. SpaceX decided to swap out the second stage instead of replacing the faulty part.[509] It was SpaceX's 50th successful landing of a first stage booster, the third flight of the Dragon C112 and the last launch of the cargo Dragon spacecraft.								
83	18 March 2020, 12:16[510]	F9 B5 △ B1048.5	KSC, LC-39A	Starlink 5 v1.0 (60 satellites)	15,600 kg (34,400 lb)[5]	LEO	SpaceX	Success	Failure (drone ship)
	Fifth operational launch of Starlink satellites. It was the first time a first stage booster flew for a fifth time and the second time the fairings were reused (Starlink flight in May 2019).[511] Towards the end of the first stage burn, the booster suffered premature shut down of an engine, the first of a Merlin 1D variant and first since the CRS-1 mission in October 2012. However, the payload still reached the targeted orbit.[512] This was the second Starlink launch booster landing failure in a row, later revealed to be caused by residual cleaning fluid trapped inside a sensor.[513]								
84	22 April 2020, 19:30[514]	F9 B5 △ B1051.4	KSC, LC-39A	Starlink 6 v1.0 (60 satellites)	15,600 kg (34,400 lb)[5]	LEO	SpaceX	Success	Success (drone ship)

Objectives

Web scrap Falcon 9 launch records with `BeautifulSoup` :

- Extract a Falcon 9 launch records HTML table from Wikipedia
- Parse the table and convert it into a Pandas data frame

First let's import required packages for this lab

```
In [ ]:  import sys

         import requests
         from bs4 import BeautifulSoup
         import re
         import unicodedata
         import pandas as pd
```

and we will provide some helper functions for you to process web scraped HTML table

```
In [ ]:  from bs4 import Tag

         def date_time(table_cells: Tag) -> list[str]:
             """
             This function returns the data and time from the HTML  table cell
             Input: the  element of a table data cell extracts extra row
             """
             return [data_time.strip() for data_time in list(table_cells.strings)][0:

         def booster_version(table_cells: Tag) -> str:
             """
             This function returns the booster version from the HTML  table cell
             Input: the  element of a table data cell extracts extra row
             """
             out=''.join([booster_version for i,booster_version in enumerate( table_c
             return out

         def landing_status(table_cells: Tag) -> str:
             """
             This function returns the landing status from the HTML table cell
             Input: the  element of a table data cell extracts extra row
             """
             out=[i for i in table_cells.strings][0]
             return out


         def get_mass(table_cells: Tag) -> str:
             mass=unicodedata.normalize("NFKD", table_cells.text).strip()
             if mass:
                 mass.find("kg")
                 new_mass=mass[0:mass.find("kg")+2]
             else:
                 new_mass=0
```

```python
        return new_mass


def extract_column_from_header(row: Tag) -> str:
    """
    This function returns the landing status from the HTML table cell
    Input: the  element of a table data cell extracts extra row
    """
    if (row.br):
        row.br.extract()
    if row.a:
        row.a.extract()
    if row.sup:
        row.sup.extract()

    colunm_name = ' '.join(row.contents)

    # Filter the digit and empty names
    if not(colunm_name.strip().isdigit()):
        colunm_name = colunm_name.strip()
        return colunm_name
```

To keep the lab tasks consistent, you will be asked to scrape the data from a snapshot of the `List of Falcon 9 and Falcon Heavy launches` Wikipage updated on `9th June 2021`

In [ ]: `static_url = "https://en.wikipedia.org/w/index.php?title=List_of_Falcon_9_ar`

Next, request the HTML page from the above URL and get a `response` object

TASK 1: Request the Falcon9 Launch Wiki page from its URL

First, let's perform an HTTP GET method to request the Falcon9 Launch HTML page, as an HTTP response.

In [ ]:
```python
# Send a request to fetch the page content
response = requests.get(static_url)

# Check if the request was successful
if response.status_code == 200:
    print("Successfully fetched the webpage!")
else:
    print("Failed to fetch the webpage. Status code:", response.status_code)
```

```
Successfully fetched the webpage!
```

Create a `BeautifulSoup` object from the HTML `response`

In [ ]:
```python
# Parse the HTML content using BeautifulSoup
soup = BeautifulSoup(response.text, 'html.parser')
```

Print the page title to verify if the `BeautifulSoup` object was created properly

```
In [ ]:  soup.title
```

```
Out[ ]:  <title>List of Falcon 9 and Falcon Heavy launches - Wikipedia</title>
```

TASK 2: Extract all column/variable names from the HTML table header

Next, we want to collect all relevant column names from the HTML table header

Let's try to find all tables on the wiki page first. If you need to refresh your memory about ` BeautifulSoup `, please check the external reference link towards the end of this lab

```
In [ ]:  # Find all tables in the page
         html_tables = soup.find_all("table")
```

Starting from the third table is our target table contains the actual launch records.

```
In [ ]:  # Let's print the third table and check its content
         first_launch_table = html_tables[2]
         print(first_launch_table)
```

```
<table class="wikitable plainrowheaders collapsible" style="width: 100%;">
<tbody><tr>
<th scope="col">Flight No.
</th>
<th scope="col">Date and<br/>time (<a href="/wiki/Coordinated_Universal_Tim
e" title="Coordinated Universal Time">UTC</a>)
</th>
<th scope="col"><a href="/wiki/List_of_Falcon_9_first-stage_boosters" title
="List of Falcon 9 first-stage boosters">Version,<br/>Booster</a> <sup class
="reference" id="cite_ref-booster_11-0"><a href="#cite_note-booster-11">[b]
</a></sup>
</th>
<th scope="col">Launch site
</th>
<th scope="col">Payload<sup class="reference" id="cite_ref-Dragon_12-0"><a h
ref="#cite_note-Dragon-12">[c]</a></sup>
</th>
<th scope="col">Payload mass
</th>
<th scope="col">Orbit
</th>
<th scope="col">Customer
</th>
<th scope="col">Launch<br/>outcome
</th>
<th scope="col"><a href="/wiki/Falcon_9_first-stage_landing_tests" title="Fa
lcon 9 first-stage landing tests">Booster<br/>landing</a>
</th></tr>
<tr>
<th rowspan="2" scope="row" style="text-align:center;">1
</th>
<td>4 June 2010,<br/>18:45
</td>
<td><a href="/wiki/Falcon_9_v1.0" title="Falcon 9 v1.0">F9 v1.0</a><sup clas
s="reference" id="cite_ref-MuskMay2012_13-0"><a href="#cite_note-MuskMay2012
-13">[7]</a></sup><br/>B0003.1<sup class="reference" id="cite_ref-block_numb
ers_14-0"><a href="#cite_note-block_numbers-14">[8]</a></sup>
</td>
<td><a href="/wiki/Cape_Canaveral_Space_Force_Station" title="Cape Canaveral
Space Force Station">CCAFS</a>,<br/><a href="/wiki/Cape_Canaveral_Space_Laun
ch_Complex_40" title="Cape Canaveral Space Launch Complex 40">SLC-40</a>
</td>
<td><a href="/wiki/Dragon_Spacecraft_Qualification_Unit" title="Dragon Space
craft Qualification Unit">Dragon Spacecraft Qualification Unit</a>
</td>
<td>
</td>
<td><a href="/wiki/Low_Earth_orbit" title="Low Earth orbit">LEO</a>
</td>
<td><a href="/wiki/SpaceX" title="SpaceX">SpaceX</a>
</td>
<td class="table-success" style="background: #9EFF9E; vertical-align: middl
e; text-align: center;">Success
</td>
<td class="table-failure" style="background: #FFC7C7; vertical-align: middl
e; text-align: center;">Failure<sup class="reference" id="cite_ref-ns2011093
```

```
0_15-0"><a href="#cite_note-ns20110930-15">[9]</a></sup><sup class="referenc
e" id="cite_ref-16"><a href="#cite_note-16">[10]</a></sup><br/><small>(parac
hute)</small>
</td></tr>
<tr>
<td colspan="9">First flight of Falcon 9 v1.0.<sup class="reference" id="cit
e_ref-sfn20100604_17-0"><a href="#cite_note-sfn20100604-17">[11]</a></sup> U
sed a boilerplate version of Dragon capsule which was not designed to separa
te from the second stage.<small>(<a href="#First_flight_of_Falcon_9">more de
tails below</a>)</small> Attempted to recover the first stage by parachuting
it into the ocean, but it burned up on reentry, before the parachutes even d
eployed.<sup class="reference" id="cite_ref-parachute_18-0"><a href="#cite_n
ote-parachute-18">[12]</a></sup>
</td></tr>
<tr>
<th rowspan="2" scope="row" style="text-align:center;">2
</th>
<td>8 December 2010,<br/>15:43<sup class="reference" id="cite_ref-spacefligh
tnow_Clark_Launch_Report_19-0"><a href="#cite_note-spaceflightnow_Clark_Laun
ch_Report-19">[13]</a></sup>
</td>
<td><a href="/wiki/Falcon_9_v1.0" title="Falcon 9 v1.0">F9 v1.0</a><sup clas
s="reference" id="cite_ref-MuskMay2012_13-1"><a href="#cite_note-MuskMay2012
-13">[7]</a></sup><br/>B0004.1<sup class="reference" id="cite_ref-block_numb
ers_14-1"><a href="#cite_note-block_numbers-14">[8]</a></sup>
</td>
<td><a href="/wiki/Cape_Canaveral_Space_Force_Station" title="Cape Canaveral
Space Force Station">CCAFS</a>,<br/><a href="/wiki/Cape_Canaveral_Space_Laun
ch_Complex_40" title="Cape Canaveral Space Launch Complex 40">SLC-40</a>
</td>
<td><a href="/wiki/SpaceX_Dragon" title="SpaceX Dragon">Dragon</a> <a class
="mw-redirect" href="/wiki/COTS_Demo_Flight_1" title="COTS Demo Flight 1">de
mo flight C1</a><br/>(Dragon C101)
</td>
<td>
</td>
<td><a href="/wiki/Low_Earth_orbit" title="Low Earth orbit">LEO</a> (<a href
="/wiki/International_Space_Station" title="International Space Station">ISS
</a>)
</td>
<td><style data-mw-deduplicate="TemplateStyles:r1126788409">.mw-parser-outpu
t .plainlist ol,.mw-parser-output .plainlist ul{line-height:inherit;list-sty
le:none;margin:0;padding:0}.mw-parser-output .plainlist ol li,.mw-parser-out
put .plainlist ul li{margin-bottom:0}</style><div class="plainlist">
<ul><li><a href="/wiki/NASA" title="NASA">NASA</a> (<a href="/wiki/Commercia
l_Orbital_Transportation_Services" title="Commercial Orbital Transportation
Services">COTS</a>)</li>
<li><a href="/wiki/National_Reconnaissance_Office" title="National Reconnais
sance Office">NRO</a></li></ul>
</div>
</td>
<td class="table-success" style="background: #9EFF9E; vertical-align: middl
e; text-align: center;">Success<sup class="reference" id="cite_ref-ns2011093
0_15-1"><a href="#cite_note-ns20110930-15">[9]</a></sup>
</td>
<td class="table-failure" style="background: #FFC7C7; vertical-align: middl
```

```
e; text-align: center;">Failure<sup class="reference" id="cite_ref-ns2011093
0_15-2"><a href="#cite_note-ns20110930-15">[9]</a></sup><sup class="referenc
e" id="cite_ref-20"><a href="#cite_note-20">[14]</a></sup><br/><small>(parac
hute)</small>
</td></tr>
<tr>
<td colspan="9">Maiden flight of <a class="mw-redirect" href="/wiki/Dragon_c
apsule" title="Dragon capsule">Dragon capsule</a>, consisting of over 3 hour
s of testing thruster maneuvering and reentry.<sup class="reference" id="cit
e_ref-spaceflightnow_Clark_unleashing_Dragon_21-0"><a href="#cite_note-space
flightnow_Clark_unleashing_Dragon-21">[15]</a></sup> Attempted to recover th
e first stage by parachuting it into the ocean, but it disintegrated upon re
entry, before the parachutes were deployed.<sup class="reference" id="cite_r
ef-parachute_18-1"><a href="#cite_note-parachute-18">[12]</a></sup> <small>
(<a href="#COTS_demo_missions">more details below</a>)</small> It also inclu
ded two <a href="/wiki/CubeSat" title="CubeSat">CubeSats</a>,<sup class="ref
erence" id="cite_ref-NRO_Taps_Boeing_for_Next_Batch_of_CubeSats_22-0"><a hre
f="#cite_note-NRO_Taps_Boeing_for_Next_Batch_of_CubeSats-22">[16]</a></sup>
and a wheel of <a href="/wiki/Brou%C3%A8re" title="Brouère">Brouère</a> chee
se.
</td></tr>
<tr>
<th rowspan="2" scope="row" style="text-align:center;">3
</th>
<td>22 May 2012,<br/>07:44<sup class="reference" id="cite_ref-BBC_new_era_23
-0"><a href="#cite_note-BBC_new_era-23">[17]</a></sup>
</td>
<td><a href="/wiki/Falcon_9_v1.0" title="Falcon 9 v1.0">F9 v1.0</a><sup clas
s="reference" id="cite_ref-MuskMay2012_13-2"><a href="#cite_note-MuskMay2012
-13">[7]</a></sup><br/>B0005.1<sup class="reference" id="cite_ref-block_numb
ers_14-2"><a href="#cite_note-block_numbers-14">[8]</a></sup>
</td>
<td><a href="/wiki/Cape_Canaveral_Space_Force_Station" title="Cape Canaveral
Space Force Station">CCAFS</a>,<br/><a href="/wiki/Cape_Canaveral_Space_Laun
ch_Complex_40" title="Cape Canaveral Space Launch Complex 40">SLC-40</a>
</td>
<td><a href="/wiki/SpaceX_Dragon" title="SpaceX Dragon">Dragon</a> <a class
="mw-redirect" href="/wiki/Dragon_C2%2B" title="Dragon C2+">demo flight C2+
</a><sup class="reference" id="cite_ref-C2_24-0"><a href="#cite_note-C2-24">
[18]</a></sup><br/>(Dragon C102)
</td>
<td>525 kg (1,157 lb)<sup class="reference" id="cite_ref-25"><a href="#cite_
note-25">[19]</a></sup>
</td>
<td><a href="/wiki/Low_Earth_orbit" title="Low Earth orbit">LEO</a> (<a href
="/wiki/International_Space_Station" title="International Space Station">ISS
</a>)
</td>
<td><a href="/wiki/NASA" title="NASA">NASA</a> (<a href="/wiki/Commercial_Or
bital_Transportation_Services" title="Commercial Orbital Transportation Serv
ices">COTS</a>)
</td>
<td class="table-success" style="background: #9EFF9E; vertical-align: middl
e; text-align: center;">Success<sup class="reference" id="cite_ref-26"><a hr
ef="#cite_note-26">[20]</a></sup>
</td>
```

```
<td class="table-noAttempt" style="background: #EEE; vertical-align: middle;
white-space: nowrap; text-align: center;">No attempt
</td></tr>
<tr>
<td colspan="9">Dragon spacecraft demonstrated a series of tests before it w
as allowed to approach the <a href="/wiki/International_Space_Station" title
="International Space Station">International Space Station</a>. Two days lat
er, it became the first commercial spacecraft to board the ISS.<sup class="r
eference" id="cite_ref-BBC_new_era_23-1"><a href="#cite_note-BBC_new_era-2
3">[17]</a></sup> <small>(<a href="#COTS_demo_missions">more details below</
a>)</small>
</td></tr>
<tr>
<th rowspan="3" scope="row" style="text-align:center;">4
</th>
<td rowspan="2">8 October 2012,<br/>00:35<sup class="reference" id="cite_ref
-SFN_LLog_27-0"><a href="#cite_note-SFN_LLog-27">[21]</a></sup>
</td>
<td rowspan="2"><a href="/wiki/Falcon_9_v1.0" title="Falcon 9 v1.0">F9 v1.0
</a><sup class="reference" id="cite_ref-MuskMay2012_13-3"><a href="#cite_not
e-MuskMay2012-13">[7]</a></sup><br/>B0006.1<sup class="reference" id="cite_r
ef-block_numbers_14-3"><a href="#cite_note-block_numbers-14">[8]</a></sup>
</td>
<td rowspan="2"><a href="/wiki/Cape_Canaveral_Space_Force_Station" title="Ca
pe Canaveral Space Force Station">CCAFS</a>,<br/><a href="/wiki/Cape_Canaver
al_Space_Launch_Complex_40" title="Cape Canaveral Space Launch Complex 40">S
LC-40</a>
</td>
<td><a href="/wiki/SpaceX_CRS-1" title="SpaceX CRS-1">SpaceX CRS-1</a><sup c
lass="reference" id="cite_ref-sxManifest20120925_28-0"><a href="#cite_note-s
xManifest20120925-28">[22]</a></sup><br/>(Dragon C103)
</td>
<td>4,700 kg (10,400 lb)
</td>
<td><a href="/wiki/Low_Earth_orbit" title="Low Earth orbit">LEO</a> (<a href
="/wiki/International_Space_Station" title="International Space Station">ISS
</a>)
</td>
<td><a href="/wiki/NASA" title="NASA">NASA</a> (<a href="/wiki/Commercial_Re
supply_Services" title="Commercial Resupply Services">CRS</a>)
</td>
<td class="table-success" style="background: #9EFF9E; vertical-align: middl
e; text-align: center;">Success
</td>
<td rowspan="2" style="background:#ececec; text-align:center;"><span class
="nowrap">No attempt</span>
</td></tr>
<tr>
<td><a href="/wiki/Orbcomm_(satellite)" title="Orbcomm (satellite)">Orbcomm-
OG2</a><sup class="reference" id="cite_ref-Orbcomm_29-0"><a href="#cite_note
-Orbcomm-29">[23]</a></sup>
</td>
<td>172 kg (379 lb)<sup class="reference" id="cite_ref-gunter-og2_30-0"><a h
ref="#cite_note-gunter-og2-30">[24]</a></sup>
</td>
<td><a href="/wiki/Low_Earth_orbit" title="Low Earth orbit">LEO</a>
```

```
</td>
<td><a href="/wiki/Orbcomm" title="Orbcomm">Orbcomm</a>
</td>
<td class="table-partial" style="background: #FE9; vertical-align: middle; t
ext-align: center;">Partial failure<sup class="reference" id="cite_ref-nyt-2
0121030_31-0"><a href="#cite_note-nyt-20121030-31">[25]</a></sup>
</td></tr>
<tr>
<td colspan="9">CRS-1 was successful, but the <a href="/wiki/Secondary_paylo
ad" title="Secondary payload">secondary payload</a> was inserted into an abn
ormally low orbit and subsequently lost. This was due to one of the nine <a
href="/wiki/SpaceX_Merlin" title="SpaceX Merlin">Merlin engines</a> shutting
down during the launch, and NASA declining a second reignition, as per <a hr
ef="/wiki/International_Space_Station" title="International Space Station">I
SS</a> visiting vehicle safety rules, the primary payload owner is contractu
ally allowed to decline a second reignition. NASA stated that this was becau
se SpaceX could not guarantee a high enough likelihood of the second stage c
ompleting the second burn successfully which was required to avoid any risk
of secondary payload's collision with the ISS.<sup class="reference" id="cit
e_ref-OrbcommTotalLoss_32-0"><a href="#cite_note-OrbcommTotalLoss-32">[26]</
a></sup><sup class="reference" id="cite_ref-sn20121011_33-0"><a href="#cite_
note-sn20121011-33">[27]</a></sup><sup class="reference" id="cite_ref-34"><a
href="#cite_note-34">[28]</a></sup>
</td></tr>
<tr>
<th rowspan="2" scope="row" style="text-align:center;">5
</th>
<td>1 March 2013,<br/>15:10
</td>
<td><a href="/wiki/Falcon_9_v1.0" title="Falcon 9 v1.0">F9 v1.0</a><sup clas
s="reference" id="cite_ref-MuskMay2012_13-4"><a href="#cite_note-MuskMay2012
-13">[7]</a></sup><br/>B0007.1<sup class="reference" id="cite_ref-block_numb
ers_14-4"><a href="#cite_note-block_numbers-14">[8]</a></sup>
</td>
<td><a href="/wiki/Cape_Canaveral_Space_Force_Station" title="Cape Canaveral
Space Force Station">CCAFS</a>,<br/><a href="/wiki/Cape_Canaveral_Space_Laun
ch_Complex_40" title="Cape Canaveral Space Launch Complex 40">SLC-40</a>
</td>
<td><a href="/wiki/SpaceX_CRS-2" title="SpaceX CRS-2">SpaceX CRS-2</a><sup c
lass="reference" id="cite_ref-sxManifest20120925_28-1"><a href="#cite_note-s
xManifest20120925-28">[22]</a></sup><br/>(Dragon C104)
</td>
<td>4,877 kg (10,752 lb)
</td>
<td><a href="/wiki/Low_Earth_orbit" title="Low Earth orbit">LEO</a> (<a clas
s="mw-redirect" href="/wiki/ISS" title="ISS">ISS</a>)
</td>
<td><a href="/wiki/NASA" title="NASA">NASA</a> (<a href="/wiki/Commercial_Re
supply_Services" title="Commercial Resupply Services">CRS</a>)
</td>
<td class="table-success" style="background: #9EFF9E; vertical-align: middl
e; text-align: center;">Success
</td>
<td class="table-noAttempt" style="background: #EEE; vertical-align: middle;
white-space: nowrap; text-align: center;">No attempt
</td></tr>
```

```
<tr>
<td colspan="9">Last launch of the original Falcon 9 v1.0 <a href="/wiki/Lau
nch_vehicle" title="Launch vehicle">launch vehicle</a>, first use of the unp
ressurized trunk section of Dragon.<sup class="reference" id="cite_ref-sxf9_
20110321_35-0"><a href="#cite_note-sxf9_20110321-35">[29]</a></sup>
</td></tr>
<tr>
<th rowspan="2" scope="row" style="text-align:center;">6
</th>
<td>29 September 2013,<br/>16:00<sup class="reference" id="cite_ref-pa201309
30_36-0"><a href="#cite_note-pa20130930-36">[30]</a></sup>
</td>
<td><a href="/wiki/Falcon_9_v1.1" title="Falcon 9 v1.1">F9 v1.1</a><sup clas
s="reference" id="cite_ref-MuskMay2012_13-5"><a href="#cite_note-MuskMay2012
-13">[7]</a></sup><br/>B1003<sup class="reference" id="cite_ref-block_number
s_14-5"><a href="#cite_note-block_numbers-14">[8]</a></sup>
</td>
<td><a class="mw-redirect" href="/wiki/Vandenberg_Air_Force_Base" title="Van
denberg Air Force Base">VAFB</a>,<br/><a href="/wiki/Vandenberg_Space_Launch
_Complex_4" title="Vandenberg Space Launch Complex 4">SLC-4E</a>
</td>
<td><a href="/wiki/CASSIOPE" title="CASSIOPE">CASSIOPE</a><sup class="refere
nce" id="cite_ref-sxManifest20120925_28-2"><a href="#cite_note-sxManifest201
20925-28">[22]</a></sup><sup class="reference" id="cite_ref-CASSIOPE_MDA_37-
0"><a href="#cite_note-CASSIOPE_MDA-37">[31]</a></sup>
</td>
<td>500 kg (1,100 lb)
</td>
<td><a href="/wiki/Polar_orbit" title="Polar orbit">Polar orbit</a> <a href
="/wiki/Low_Earth_orbit" title="Low Earth orbit">LEO</a>
</td>
<td><a href="/wiki/Maxar_Technologies" title="Maxar Technologies">MDA</a>
</td>
<td class="table-success" style="background: #9EFF9E; vertical-align: middl
e; text-align: center;">Success<sup class="reference" id="cite_ref-pa2013093
0_36-1"><a href="#cite_note-pa20130930-36">[30]</a></sup>
</td>
<td class="table-no2" style="background: #FFE3E3; color: black; vertical-ali
gn: middle; text-align: center;">Uncontrolled<br/><small>(ocean)</small><sup
class="reference" id="cite_ref-ocean_landing_38-0"><a href="#cite_note-ocean
_landing-38">[d]</a></sup>
</td></tr>
<tr>
<td colspan="9">First commercial mission with a private customer, first laun
ch from Vandenberg, and demonstration flight of Falcon 9 v1.1 with an improv
ed 13-tonne to LEO capacity.<sup class="reference" id="cite_ref-sxf9_2011032
1_35-1"><a href="#cite_note-sxf9_20110321-35">[29]</a></sup> After separatio
n from the second stage carrying Canadian commercial and scientific satellit
es, the first stage booster performed a controlled reentry,<sup class="refer
ence" id="cite_ref-39"><a href="#cite_note-39">[32]</a></sup> and an <a href
="/wiki/Falcon_9_first-stage_landing_tests" title="Falcon 9 first-stage land
ing tests">ocean touchdown test</a> for the first time. This provided good t
est data, even though the booster started rolling as it neared the ocean, le
ading to the shutdown of the central engine as the roll depleted it of fuel,
resulting in a hard impact with the ocean.<sup class="reference" id="cite_re
f-pa20130930_36-2"><a href="#cite_note-pa20130930-36">[30]</a></sup> This wa
```

```
s the first known attempt of a rocket engine being lit to perform a superson
ic retro propulsion, and allowed SpaceX to enter a public-private partnershi
p with <a href="/wiki/NASA" title="NASA">NASA</a> and its Mars entry, descen
t, and landing technologies research projects.<sup class="reference" id="cit
e_ref-40"><a href="#cite_note-40">[33]</a></sup> <small>(<a href="#Maiden_fl
ight_of_v1.1">more details below</a>)</small>
</td></tr>
<tr>
<th rowspan="2" scope="row" style="text-align:center;">7
</th>
<td>3 December 2013,<br/>22:41<sup class="reference" id="cite_ref-sfn_wwls20
130624_41-0"><a href="#cite_note-sfn_wwls20130624-41">[34]</a></sup>
</td>
<td><a href="/wiki/Falcon_9_v1.1" title="Falcon 9 v1.1">F9 v1.1</a><br/>B100
4
</td>
<td><a href="/wiki/Cape_Canaveral_Space_Force_Station" title="Cape Canaveral
Space Force Station">CCAFS</a>,<br/><a href="/wiki/Cape_Canaveral_Space_Laun
ch_Complex_40" title="Cape Canaveral Space Launch Complex 40">SLC-40</a>
</td>
<td><a href="/wiki/SES-8" title="SES-8">SES-8</a><sup class="reference" id
="cite_ref-sxManifest20120925_28-3"><a href="#cite_note-sxManifest20120925-2
8">[22]</a></sup><sup class="reference" id="cite_ref-spx-pr_42-0"><a href="#
cite_note-spx-pr-42">[35]</a></sup><sup class="reference" id="cite_ref-aw201
10323_43-0"><a href="#cite_note-aw20110323-43">[36]</a></sup>
</td>
<td>3,170 kg (6,990 lb)
</td>
<td><a href="/wiki/Geostationary_transfer_orbit" title="Geostationary transf
er orbit">GTO</a>
</td>
<td><a class="mw-redirect" href="/wiki/SES_S.A." title="SES S.A.">SES</a>
</td>
<td class="table-success" style="background: #9EFF9E; vertical-align: middl
e; text-align: center;">Success<sup class="reference" id="cite_ref-SNMission
Status7_44-0"><a href="#cite_note-SNMissionStatus7-44">[37]</a></sup>
</td>
<td class="table-noAttempt" style="background: #EEE; vertical-align: middle;
white-space: nowrap; text-align: center;">No attempt<br/><sup class="referen
ce" id="cite_ref-sf10120131203_45-0"><a href="#cite_note-sf10120131203-45">
[38]</a></sup>
</td></tr>
<tr>
<td colspan="9">First <a href="/wiki/Geostationary_transfer_orbit" title="Ge
ostationary transfer orbit">Geostationary transfer orbit</a> (GTO) launch fo
r Falcon 9,<sup class="reference" id="cite_ref-spx-pr_42-1"><a href="#cite_n
ote-spx-pr-42">[35]</a></sup> and first successful reignition of the second
stage.<sup class="reference" id="cite_ref-46"><a href="#cite_note-46">[39]</
a></sup> SES-8 was inserted into a <a href="/wiki/Geostationary_transfer_orb
it" title="Geostationary transfer orbit">Super-Synchronous Transfer Orbit</a
> of 79,341 km (49,300 mi) in apogee with an <a href="/wiki/Orbital_inclinat
ion" title="Orbital inclination">inclination</a> of 20.55° to the <a href="/
wiki/Equator" title="Equator">equator</a>.
</td></tr></tbody></table>
```

You should able to see the columns names embedded in the table header elements `<th>` as follows:

```
<tr>
<th scope="col">Flight No.
</th>
<th scope="col">Date and<br/>time (<a
href="/wiki/Coordinated_Universal_Time" title="Coordinated
Universal Time">UTC</a>)
</th>
<th scope="col"><a href="/wiki/List_of_Falcon_9_first-
stage_boosters" title="List of Falcon 9 first-stage
boosters">Version,<br/>Booster</a> <sup class="reference"
id="cite_ref-booster_11-0"><a href="#cite_note-booster-11">
[b]</a></sup>
</th>
<th scope="col">Launch site
</th>
<th scope="col">Payload<sup class="reference" id="cite_ref-
Dragon_12-0"><a href="#cite_note-Dragon-12">[c]</a></sup>
</th>
<th scope="col">Payload mass
</th>
<th scope="col">Orbit
</th>
<th scope="col">Customer
</th>
<th scope="col">Launch<br/>outcome
</th>
<th scope="col"><a href="/wiki/Falcon_9_first-
stage_landing_tests" title="Falcon 9 first-stage landing
tests">Booster<br/>landing</a>
</th></tr>
```

Next, we just need to iterate through the `<th>` elements and apply the provided `extract_column_from_header()` to extract column name one by one

```python
In [ ]:  # Initialize an empty list to store column names
         column_names = []

         # Apply find_all() function with `th` element on the first table in html_tab
         th_elements = first_launch_table.find_all('th')

         # Iterate each th element and apply the provided extract_column_from_header(
         for th in th_elements:
             name = extract_column_from_header(th)
             # Append the non-empty column name into the list
             if name is not None and len(name) > 0:
                 column_names.append(name)
```

Check the extracted column names

```
In [ ]:  print(column_names)
```

```
['Flight No.', 'Date and time ( )', 'Launch site', 'Payload', 'Payload mas
s', 'Orbit', 'Customer', 'Launch outcome']
```

TASK 3: Create a data frame by parsing the launch HTML tables

We will create an empty dictionary with keys from the extracted column names in the previous task. Later, this dictionary will be converted into a Pandas dataframe

```
In [ ]:  launch_dict= dict.fromkeys(column_names)

         # Remove an irrelvant column
         del launch_dict['Date and time ( )']

         # Let's initial the launch_dict with each value to be an empty list
         launch_dict['Flight No.'] = []
         launch_dict['Launch Site'] = []
         launch_dict['Payload'] = []
         launch_dict['Payload mass'] = []
         launch_dict['Orbit'] = []
         # launch_dict['Customer'] = []
         launch_dict['Launch outcome'] = []
         # Added some new columns
         launch_dict['Version Booster']=[]
         launch_dict['Booster landing']=[]
         launch_dict['Date']=[]
         launch_dict['Time']=[]
```

Next, we just need to fill up the `launch_dict` with launch records extracted from table rows.

Usually, HTML tables in Wiki pages are likely to contain unexpected annotations and other types of noises, such as reference links `B0004.1[8]`, missing values `N/A [e]`, inconsistent formatting, etc.

To simplify the parsing process, we have provided an incomplete code snippet below to help you to fill up the `launch_dict`. Please complete the following code snippet with TODOs or you can choose to write your own logic to parse all launch tables:

```
In [ ]:  extracted_row = 0

         # Extract each table
         for table_number, table in enumerate(soup.find_all('table', "wikitable plain
             # Get table rows
             for rows in table.find_all("tr"):
                 # Check to see if the first table heading is a number corresponding
```

```python
            if rows.th:
                if rows.th.string:
                    flight_number = rows.th.string.strip()
                    flag = flight_number.isdigit()
            else:
                flag = False
            # Get table elements
            row = rows.find_all('td')
            # If it is a number, save cells in a dictionary
            if flag:
                extracted_row += 1
                # Flight Number value
                launch_dict["Flight No."].append(flight_number)

                datatimelist = date_time(row[0])

                # Date value
                date = datatimelist[0].strip(',')
                launch_dict["Date"].append(date)

                # Time value
                time = datatimelist[1]
                launch_dict["Time"].append(time)

                # Booster version
                bv = booster_version(row[1])
                if not(bv):
                    bv = row[1].a.string
                launch_dict["Version Booster"].append(bv)

                # Launch Site
                launch_site = row[2].a.string
                launch_dict["Launch Site"].append(launch_site)

                # Payload
                payload = row[3].a.string
                launch_dict["Payload"].append(payload)

                # Payload Mass
                payload_mass = get_mass(row[4])
                launch_dict["Payload mass"].append(payload_mass)

                # Orbit
                orbit = row[5].a.string
                launch_dict["Orbit"].append(orbit)

                # Customer
                # customer = row[6].a.string if row[6].a else None
                # launch_dict["Customer"].append(customer)

                # Launch outcome
                launch_outcome = list(row[7].strings)[0].strip()
                launch_dict["Launch outcome"].append(launch_outcome)

                # Booster landing
                booster_landing = landing_status(row[8])
```

```python
            launch_dict["Booster landing"].append(booster_landing)

# Create a DataFrame from the dictionary
df = pd.DataFrame(launch_dict)

# Display the first few rows of the DataFrame to verify the extracted data
df.head()
```

Out[ ]:

	Flight No.	Launch site	Payload	Payload mass	Orbit	Customer	Launch outcome	Launch Site	Version Booster
0	1	None	Dragon Spacecraft Qualification Unit	0	LEO	None	Success	CCAFS	F9 v1.0B0003.1
1	2	None	Dragon	0	LEO	None	Success	CCAFS	F9 v1.0B0004.1
2	3	None	Dragon	525 kg	LEO	None	Success	CCAFS	F9 v1.0B0005.1
3	4	None	SpaceX CRS-1	4,700 kg	LEO	None	Success	CCAFS	F9 v1.0B0006.1
4	5	None	SpaceX CRS-2	4,877 kg	LEO	None	Success	CCAFS	F9 v1.0B0007.1

In [ ]:
```python
df.to_csv('spacex_wiki.csv')
```

In [ ]: