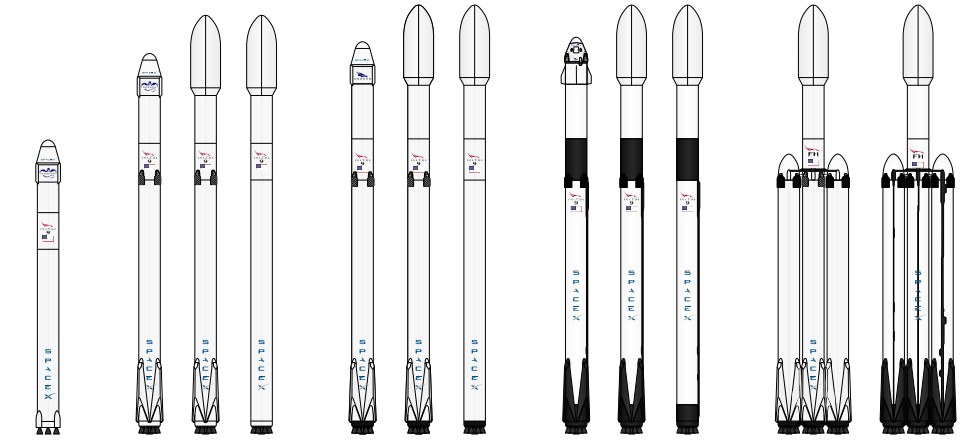
Space X Falcon 9 First Stage Landing Prediction

Hands-on Lab: Complete the Data Collection with Web Scraping lab

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 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.[498] 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 [1]:
```
!pip3 install beautifulsoup4
!pip3 install requests
!pip install pandas
```

```
Requirement already satisfied: beautifulsoup4 in /opt/conda/lib/python
3.11/site-packages (4.12.3)
Requirement already satisfied: soupsieve>1.2 in /opt/conda/lib/python3.
11/site-packages (from beautifulsoup4) (2.5)
Requirement already satisfied: requests in /opt/conda/lib/python3.11/si
te-packages (2.31.0)
Requirement already satisfied: charset-normalizer<4,>=2 in /opt/conda/l
ib/python3.11/site-packages (from requests) (3.3.2)
Requirement already satisfied: idna<4,>=2.5 in /opt/conda/lib/python3.1
1/site-packages (from requests) (3.7)
Requirement already satisfied: urllib3<3,>=1.21.1 in /opt/conda/lib/pyt
hon3.11/site-packages (from requests) (2.2.1)
Requirement already satisfied: certifi>=2017.4.17 in /opt/conda/lib/pyt
hon3.11/site-packages (from requests) (2024.8.30)
Requirement already satisfied: pandas in /opt/conda/lib/python3.11/site
-packages (2.2.3)
Requirement already satisfied: numpy>=1.23.2 in /opt/conda/lib/python3.
11/site-packages (from pandas) (2.1.3)
Requirement already satisfied: python-dateutil>=2.8.2 in /opt/conda/li
b/python3.11/site-packages (from pandas) (2.9.0)
Requirement already satisfied: pytz>=2020.1 in /opt/conda/lib/python3.1
1/site-packages (from pandas) (2024.1)
Requirement already satisfied: tzdata>=2022.7 in /opt/conda/lib/python
3.11/site-packages (from pandas) (2024.2)
Requirement already satisfied: six>=1.5 in /opt/conda/lib/python3.11/si
te-packages (from python-dateutil>=2.8.2->pandas) (1.16.0)
```

In [ ]:

In [2]:
```
import sys

import requests
from bs4 import BeautifulSoup

import re
import unicodedata
import pandas as pd
```

In [ ]:

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

In [3]:
```
def date_time(table_cells):
    """
    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.string
```

```
def booster_version(table_cells):
    """
    This function returns the booster version from the HTML  table cel
    Input: the  element of a table data cell extracts extra row
    """
    out=''.join([booster_version for i,booster_version in enumerate( t
    return out

def landing_status(table_cells):
    """
    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):
    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
    return new_mass


def extract_column_from_header(row):
    """
    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
```

In [ ]:

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 [4]:
```
static_url = "https://en.wikipedia.org/w/index.php?title=List_of_Falco
```

In [ ]:
```

```

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 [5]:
```
# use requests.get() method with the provided static_url
response = requests.get(static_url)
# assign the response to a object
data = response.text
```

In [6]:
```
pip install html5lib
```

```
Requirement already satisfied: html5lib in /opt/conda/lib/python3.11/si
te-packages (1.1)
Requirement already satisfied: six>=1.9 in /opt/conda/lib/python3.11/si
te-packages (from html5lib) (1.16.0)
Requirement already satisfied: webencodings in /opt/conda/lib/python3.1
1/site-packages (from html5lib) (0.5.1)
Note: you may need to restart the kernel to use updated packages.
```

In [ ]:
```

```

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

In [7]:
```
# Use BeautifulSoup() to create a BeautifulSoup object from a response
soup = BeautifulSoup(data, 'html5lib')
```

In [ ]:
```

```

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

In [8]:
```
# Use soup.title attribute
print(soup.title)
```

```
<title>List of Falcon 9 and Falcon Heavy launches - Wikipedia</title>
```

In [ ]:
```

```

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 [9]:
```
html_tables = soup.find_all('table')
```

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

In [10]:
```
# 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: 10
0%;">
<tbody><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" t
itle="List of Falcon 9 first-stage boosters">Version,<br/>Booster</a> <
sup class="reference" id="cite_ref-booster_11-0"><a href="#cite_note-bo
oster-11"><span class="cite-bracket">[</span>b<span class="cite-bracke
t">]</span></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"><span class="cite-bracket">[</span>c<sp
an class="cite-bracket">]</span></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" titl
e="Falcon 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
class="reference" id="cite_ref-MuskMay2012_13-0"><a href="#cite_note-Mu
skMay2012-13"><span class="cite-bracket">[</span>7<span class="cite-bra
cket">]</span></a></sup><br/>B0003.1<sup class="reference" id="cite_ref
-block_numbers_14-0"><a href="#cite_note-block_numbers-14"><span class
="cite-bracket">[</span>8<span class="cite-bracket">]</span></a></sup>
</td>
<td><a href="/wiki/Cape_Canaveral_Space_Force_Station" title="Cape Cana
veral Space Force Station">CCAFS</a>,<br/><a href="/wiki/Cape_Canaveral
_Space_Launch_Complex_40" title="Cape Canaveral Space Launch Complex 4
0">SLC-40</a>
</td>
<td><a href="/wiki/Dragon_Spacecraft_Qualification_Unit" title="Dragon
Spacecraft 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; color:black; vert
ical-align: middle; text-align: center;">Success
</td>
<td class="table-failure" style="background: #FFC7C7; color:black; vert
ical-align: middle; text-align: center;">Failure<sup class="reference"
id="cite_ref-ns20110930_15-0"><a href="#cite_note-ns20110930-15"><span
class="cite-bracket">[</span>9<span class="cite-bracket">]</span></a></
sup><sup class="reference" id="cite_ref-16"><a href="#cite_note-16"><sp
an class="cite-bracket">[</span>10<span class="cite-bracket">]</span></
a></sup><br/><small>(parachute)</small>
</td></tr>
<tr>
<td colspan="9">First flight of Falcon 9 v1.0.<sup class="reference" id
="cite_ref-sfn20100604_17-0"><a href="#cite_note-sfn20100604-17"><span
class="cite-bracket">[</span>11<span class="cite-bracket">]</span></a>
</sup> Used a boilerplate version of Dragon capsule which was not desig
ned to separate from the second stage.<small>(<a href="#First_flight_of
_Falcon_9">more details below</a>)</small> Attempted to recover the fir
st stage by parachuting it into the ocean, but it burned up on reentry,
before the parachutes even deployed.<sup class="reference" id="cite_ref
-parachute_18-0"><a href="#cite_note-parachute-18"><span class="cite-br
acket">[</span>12<span class="cite-bracket">]</span></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-space
flightnow_Clark_Launch_Report_19-0"><a href="#cite_note-spaceflightnow_
Clark_Launch_Report-19"><span class="cite-bracket">[</span>13<span clas
s="cite-bracket">]</span></a></sup>
</td>
<td><a href="/wiki/Falcon_9_v1.0" title="Falcon 9 v1.0">F9 v1.0</a><sup
class="reference" id="cite_ref-MuskMay2012_13-1"><a href="#cite_note-Mu
skMay2012-13"><span class="cite-bracket">[</span>7<span class="cite-bra
cket">]</span></a></sup><br/>B0004.1<sup class="reference" id="cite_ref
-block_numbers_14-1"><a href="#cite_note-block_numbers-14"><span class
="cite-bracket">[</span>8<span class="cite-bracket">]</span></a></sup>
</td>
<td><a href="/wiki/Cape_Canaveral_Space_Force_Station" title="Cape Cana
veral Space Force Station">CCAFS</a>,<br/><a href="/wiki/Cape_Canaveral
_Space_Launch_Complex_40" title="Cape Canaveral Space Launch Complex 4
0">SLC-40</a>
</td>
<td><a href="/wiki/SpaceX_Dragon" title="SpaceX Dragon">Dragon</a> <a c
lass="mw-redirect" href="/wiki/COTS_Demo_Flight_1" title="COTS Demo Fli
ght 1">demo 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 Sta
tion">ISS</a>)
</td>
<td><style data-mw-deduplicate="TemplateStyles:r1126788409">.mw-parser-
output .plainlist ol,.mw-parser-output .plainlist ul{line-height:inheri
t;list-style:none;margin:0;padding:0}.mw-parser-output .plainlist ol l
i,.mw-parser-output .plainlist ul li{margin-bottom:0}</style><div class
="plainlist">
<ul><li><a href="/wiki/NASA" title="NASA">NASA</a> (<a href="/wiki/Comm
ercial_Orbital_Transportation_Services" title="Commercial Orbital Trans
portation Services">COTS</a>)</li>
<li><a href="/wiki/National_Reconnaissance_Office" title="National Reco
nnaissance Office">NRO</a></li></ul>
</div>
</td>
<td class="table-success" style="background: #9EFF9E; color:black; vert
ical-align: middle; text-align: center;">Success<sup class="reference"
id="cite_ref-ns20110930_15-1"><a href="#cite_note-ns20110930-15"><span
class="cite-bracket">[</span>9<span class="cite-bracket">]</span></a></
sup>
</td>
<td class="table-failure" style="background: #FFC7C7; color:black; vert
ical-align: middle; text-align: center;">Failure<sup class="reference"
```

id="cite_ref-ns20110930_15-2">[9]</sup>^{[14]}
<small>(parachute)</small>
</td></tr>
<tr>
<td colspan="9">Maiden flight of Dragon capsule, consisting of over 3 hours of testing thruster maneuvering and reentry.^{[15]} Attempted to recover the first stage by parachuting it into the ocean, but it disintegrated upon reentry, before the parachutes were deployed.^{[12]} <small>(more details below)</small> It also included two CubeSats,^{[16]} and a wheel of Brouère cheese.
</td></tr>
<tr>
<th rowspan="2" scope="row" style="text-align:center;">3
</th>
<td>22 May 2012,
07:44^{[17]}
</td>
<td>F9 v1.0^{[7]}
B0005.1^{[8]}
</td>
<td>CCAFS,
SLC-40
</td>
<td>Dragon demo flight C2+^{[18]}
(Dragon C102)
</td>
<td>525 kg (1,157 lb)<sup class="reference" id="cite_ref-25"><a href="#

cite_note-25">[19<span class="cite-br
acket">]</sup>
</td>
<td>LEO (<a
href="/wiki/International_Space_Station" title="International Space Sta
tion">ISS)
</td>
<td>NASA (<a href="/wiki/Commerci
al_Orbital_Transportation_Services" title="Commercial Orbital Transport
ation Services">COTS)
</td>
<td class="table-success" style="background: #9EFF9E; color:black; vert
ical-align: middle; text-align: center;">Success<sup class="reference"
id="cite_ref-26">[</
span>20]</sup>
</td>
<td class="table-noAttempt" style="background: #EEE; color:black; verti
cal-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 was allowed to approach the <a href="/wiki/International_Space_Stati
on" title="International Space Station">International Space Station. Two days later, it became the first commercial spacecraft to board t
he ISS.<sup class="reference" id="cite_ref-BBC_new_era_23-1"><a href="#
cite_note-BBC_new_era-23">[17<span cl
ass="cite-bracket">]</sup> <small>(<a href="#COTS_demo_missi
ons">more details below)</small>
</td></tr>
<tr>
<th rowspan="3" scope="row" style="text-align:center;">4
</th>
<td rowspan="2">8 October 2012,
00:35<sup class="reference" id="cit
e_ref-SFN_LLog_27-0"><span class="cite
-bracket">[21]</sup>
</td>
<td rowspan="2">F9
v1.0<sup class="reference" id="cite_ref-MuskMay2012_13-3"><a href
="#cite_note-MuskMay2012-13">[7<span
class="cite-bracket">]</sup>
B0006.1<sup class="referenc
e" id="cite_ref-block_numbers_14-3"><a href="#cite_note-block_numbers-1
4">[8]</sp
an></sup>
</td>
<td rowspan="2"><a href="/wiki/Cape_Canaveral_Space_Force_Station" titl
e="Cape Canaveral Space Force Station">CCAFS,
<a href="/wiki/Ca
pe_Canaveral_Space_Launch_Complex_40" title="Cape Canaveral Space Launc
h Complex 40">SLC-40
</td>
<td>SpaceX CRS-1<
sup class="reference" id="cite_ref-sxManifest20120925_28-0"><a href="#c

ite_note-sxManifest20120925-28">[22<s
pan class="cite-bracket">]</sup>
(Dragon C103)
</td>
<td>4,700 kg (10,400 lb)
</td>
<td>LEO (<a
href="/wiki/International_Space_Station" title="International Space Sta
tion">ISS)
</td>
<td>NASA (<a href="/wiki/Commerci
al_Resupply_Services" title="Commercial Resupply Services">CRS)
</td>
<td class="table-success" style="background: #9EFF9E; color:black; vert
ical-align: middle; text-align: center;">Success
</td>
<td rowspan="2" style="background:#ececec; text-align:center;"><span cl
ass="nowrap">No attempt
</td></tr>
<tr>
<td>Orb
comm-OG2<sup class="reference" id="cite_ref-Orbcomm_29-0"><a href
="#cite_note-Orbcomm-29">[23<span cla
ss="cite-bracket">]</sup>
</td>
<td>172 kg (379 lb)<sup class="reference" id="cite_ref-gunter-og2_30-0"
>[
24]</sup>
</td>
<td>LEO
</td>
<td>Orbcomm
</td>
<td class="table-partial" style="background: #FFB; color:black; vertica
l-align: middle; text-align: center;">Partial failure<sup class="refere
nce" id="cite_ref-nyt-20121030_31-0"><a href="#cite_note-nyt-20121030-3
1">[25]</s
pan></sup>
</td></tr>
<tr>
<td colspan="9">CRS-1 was successful, but the <a href="/wiki/Secondary_
payload" title="Secondary payload">secondary payload was inserted i
nto an abnormally low orbit and subsequently lost. This was due to one
of the nine Merlin
engines shutting down during the launch, and NASA declining a secon
d reignition, as per <a href="/wiki/International_Space_Station" title
="International Space Station">ISS visiting vehicle safety rules, t
he primary payload owner is contractually allowed to decline a second r
eignition. NASA stated that this was because SpaceX could not guarantee
a high enough likelihood of the second stage completing the second burn
successfully which was required to avoid any risk of secondary payload'
s collision with the ISS.<sup class="reference" id="cite_ref-OrbcommTot

```
alLoss_32-0"><a href="#cite_note-OrbcommTotalLoss-32"><span class="cite
-bracket">[</span>26<span class="cite-bracket">]</span></a></sup><sup c
lass="reference" id="cite_ref-sn20121011_33-0"><a href="#cite_note-sn20
121011-33"><span class="cite-bracket">[</span>27<span class="cite-brack
et">]</span></a></sup><sup class="reference" id="cite_ref-34"><a href
="#cite_note-34"><span class="cite-bracket">[</span>28<span class="cite
-bracket">]</span></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
class="reference" id="cite_ref-MuskMay2012_13-4"><a href="#cite_note-Mu
skMay2012-13"><span class="cite-bracket">[</span>7<span class="cite-bra
cket">]</span></a></sup><br/>B0007.1<sup class="reference" id="cite_ref
-block_numbers_14-4"><a href="#cite_note-block_numbers-14"><span class
="cite-bracket">[</span>8<span class="cite-bracket">]</span></a></sup>
</td>
<td><a href="/wiki/Cape_Canaveral_Space_Force_Station" title="Cape Cana
veral Space Force Station">CCAFS</a>,<br/><a href="/wiki/Cape_Canaveral
_Space_Launch_Complex_40" title="Cape Canaveral Space Launch Complex 4
0">SLC-40</a>
</td>
<td><a href="/wiki/SpaceX_CRS-2" title="SpaceX CRS-2">SpaceX CRS-2</a><
sup class="reference" id="cite_ref-sxManifest20120925_28-1"><a href="#c
ite_note-sxManifest20120925-28"><span class="cite-bracket">[</span>22<s
pan class="cite-bracket">]</span></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
class="mw-redirect" href="/wiki/ISS" title="ISS">ISS</a>)
</td>
<td><a href="/wiki/NASA" title="NASA">NASA</a> (<a href="/wiki/Commerci
al_Resupply_Services" title="Commercial Resupply Services">CRS</a>)
</td>
<td class="table-success" style="background: #9EFF9E; color:black; vert
ical-align: middle; text-align: center;">Success
</td>
<td class="table-noAttempt" style="background: #EEE; color:black; verti
cal-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="/wik
i/Launch_vehicle" title="Launch vehicle">launch vehicle</a>, first use
of the unpressurized trunk section of Dragon.<sup class="reference" id
="cite_ref-sxf9_20110321_35-0"><a href="#cite_note-sxf9_20110321-35"><s
pan class="cite-bracket">[</span>29<span class="cite-bracket">]</span>
</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-pa2
0130930_36-0"><a href="#cite_note-pa20130930-36"><span class="cite-brac
ket">[</span>30<span class="cite-bracket">]</span></a></sup>
</td>
<td><a href="/wiki/Falcon_9_v1.1" title="Falcon 9 v1.1">F9 v1.1</a><sup
class="reference" id="cite_ref-MuskMay2012_13-5"><a href="#cite_note-Mu
skMay2012-13"><span class="cite-bracket">[</span>7<span class="cite-bra
cket">]</span></a></sup><br/>B1003<sup class="reference" id="cite_ref-b
lock_numbers_14-5"><a href="#cite_note-block_numbers-14"><span class="c
ite-bracket">[</span>8<span class="cite-bracket">]</span></a></sup>
</td>
<td><a class="mw-redirect" href="/wiki/Vandenberg_Air_Force_Base" title
="Vandenberg Air Force Base">VAFB</a>,<br/><a href="/wiki/Vandenberg_Sp
ace_Launch_Complex_4" title="Vandenberg Space Launch Complex 4">SLC-4E
</a>
</td>
<td><a href="/wiki/CASSIOPE" title="CASSIOPE">CASSIOPE</a><sup class="r
eference" id="cite_ref-sxManifest20120925_28-2"><a href="#cite_note-sxM
anifest20120925-28"><span class="cite-bracket">[</span>22<span class="c
ite-bracket">]</span></a></sup><sup class="reference" id="cite_ref-CASS
IOPE_MDA_37-0"><a href="#cite_note-CASSIOPE_MDA-37"><span class="cite-b
racket">[</span>31<span class="cite-bracket">]</span></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; color:black; vert
ical-align: middle; text-align: center;">Success<sup class="reference"
id="cite_ref-pa20130930_36-1"><a href="#cite_note-pa20130930-36"><span
class="cite-bracket">[</span>30<span class="cite-bracket">]</span></a>
</sup>
</td>
<td class="table-no2" style="background: #FFE3E3; color: black; vertica
l-align: 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"><span class="cite-bracket">[</span>d<spa
n class="cite-bracket">]</span></a></sup>
</td></tr>
<tr>
<td colspan="9">First commercial mission with a private customer, first
launch from Vandenberg, and demonstration flight of Falcon 9 v1.1 with
an improved 13-tonne to LEO capacity.<sup class="reference" id="cite_re
```

f-sxf9_20110321_35-1"><span class
="cite-bracket">[29]</sup>
After separation from the second stage carrying Canadian commercial and
scientific satellites, the first stage booster performed a controlled r
eentry,<sup class="reference" id="cite_ref-39">
[32]</sup> and an <a href="/wiki/Falcon_9_first-stage_landing_tests" t
itle="Falcon 9 first-stage landing tests">ocean touchdown test for
the first time. This provided good test data, even though the booster s
tarted rolling as it neared the ocean, leading to the shutdown of the c
entral engine as the roll depleted it of fuel, resulting in a hard impa
ct with the ocean.<sup class="reference" id="cite_ref-pa20130930_36-2">
[3
0]</sup> This was the first known
attempt of a rocket engine being lit to perform a supersonic retro prop
ulsion, and allowed SpaceX to enter a public-private partnership with <
a href="/wiki/NASA" title="NASA">NASA and its Mars entry, descent,
and landing technologies research projects.<sup class="reference" id="c
ite_ref-40">[
33]</sup> <small>(<a href="#Maide
n_flight_of_v1.1">more details below)</small>
</td></tr>
<tr>
<th rowspan="2" scope="row" style="text-align:center;">7
</th>
<td>3 December 2013,
22:41<sup class="reference" id="cite_ref-sfn_w
wls20130624_41-0"><span class
="cite-bracket">[34]</sup>
</td>
<td>F9 v1.1<br/
>B1004
</td>
<td><a href="/wiki/Cape_Canaveral_Space_Force_Station" title="Cape Cana
veral Space Force Station">CCAFS,
<a href="/wiki/Cape_Canaveral
_Space_Launch_Complex_40" title="Cape Canaveral Space Launch Complex 4
0">SLC-40
</td>
<td>SES-8<sup class="reference"
id="cite_ref-sxManifest20120925_28-3"><a href="#cite_note-sxManifest201
20925-28">[22<span class="cite-bracke
t">]</sup><sup class="reference" id="cite_ref-spx-pr_42-0"><
a href="#cite_note-spx-pr-42">[35<spa
n class="cite-bracket">]</sup><sup class="reference" id="cit
e_ref-aw20110323_43-0"><span class="
cite-bracket">[36]</sup>
</td>
<td>3,170 kg (6,990 lb)
</td>
<td><a href="/wiki/Geostationary_transfer_orbit" title="Geostationary t
ransfer orbit">GTO
</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; color:black; vert
ical-align: middle; text-align: center;">Success<sup class="reference"
id="cite_ref-SNMissionStatus7_44-0"><a href="#cite_note-SNMissionStatus
7-44"><span class="cite-bracket">[</span>37<span class="cite-bracket">]
</span></a></sup>
</td>
<td class="table-noAttempt" style="background: #EEE; color:black; verti
cal-align: middle; white-space: nowrap; text-align: center;">No attempt
<br/><sup class="reference" id="cite_ref-sf10120131203_45-0"><a href="#
cite_note-sf10120131203-45"><span class="cite-bracket">[</span>38<span
class="cite-bracket">]</span></a></sup>
</td></tr>
<tr>
<td colspan="9">First <a href="/wiki/Geostationary_transfer_orbit" titl
e="Geostationary transfer orbit">Geostationary transfer orbit</a> (GTO)
launch for Falcon 9,<sup class="reference" id="cite_ref-spx-pr_42-1"><a
href="#cite_note-spx-pr-42"><span class="cite-bracket">[</span>35<span
class="cite-bracket">]</span></a></sup> and first successful reignition
of the second stage.<sup class="reference" id="cite_ref-46"><a href="#c
ite_note-46"><span class="cite-bracket">[</span>39<span class="cite-bra
cket">]</span></a></sup> SES-8 was inserted into a <a href="/wiki/Geost
ationary_transfer_orbit" title="Geostationary transfer orbit">Super-Syn
chronous Transfer Orbit</a> of 79,341 km (49,300 mi) in apogee with an
<a href="/wiki/Orbital_inclination" title="Orbital inclination">inclina
tion</a> of 20.55° to the <a href="/wiki/Equator" title="Equator">equat
or</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

In [14]:
```
column_names = []

# Apply find_all() function with `th` element on first_launch_table
# Iterate each th element and apply the provided extract_column_from_h
# Append the Non-empty column name (`if name is not None and len(name)

for row in first_launch_table.find_all('th'):
    name = extract_column_from_header(row)
    if(name != None and len(name) > 0):
        column_names.append(name)
```

Check the extracted column names

In [15]:
```
print(column_names)
```

```
['Flight No.', 'Date and time ( )', 'Launch site', 'Payload', 'Payload
mass', '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 [16]:
```
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 [17]:
```
extracted_row = 0
#Extract each table
for table_number,table in enumerate(soup.find_all('table',"wikitable p
   # get table row
    for rows in table.find_all("tr"):
        #check to see if first table heading is as number correspondin
        if rows.th:
            if rows.th.string:
                flight_number=rows.th.string.strip()
                flag=flight_number.isdigit()
        else:
            flag=False
        #get table element
        row=rows.find_all('td')
        #if it is number save cells in a dictonary
        if flag:
            extracted_row += 1
```

```
            # Flight Number value
            # Append the flight_number into launch_dict with key `Flig
            launch_dict["Flight No."].append(flight_number)

            # Date value
            #Append the date into launch_dict with key `Date`
            datatimelist=date_time(row[0])
            date = datatimelist[0].strip(',')
            launch_dict["Date"].append(date)

            # Time value
            #Append the time into launch_dict with key `Time`
            time = datatimelist[1]
            launch_dict["Time"].append(time)

            # Booster version
            #Append the bv into launch_dict with key `Version Booster`
            bv=booster_version(row[1])
            if not(bv):
                bv=row[1].a.string
            launch_dict["Version Booster"].append(bv)

            # Launch Site
            #Append the bv into launch_dict with key `Launch site`
            launch_site = row[2].a.string
            launch_dict['Launch site'].append(launch_site)

            # Payload
            #Append the payload into launch_dict with key `Payload`
            payload = row[3].a.string
            launch_dict['Payload'].append(payload)

            # Payload Mass
            #Append the payload_mass into launch_dict with key `Payloa
            payload_mass = get_mass(row[4])
            launch_dict['Payload mass'].append(payload_mass)

            # Orbit
            #Append the orbit into launch_dict with key `Orbit`
            orbit = row[5].a.string
            launch_dict['Orbit'].append(orbit)

            # Customer
            #Append the customer into launch_dict with key `Customer`
            if row[6].a != None:
                customer = row[6].a.string
            else:
                customer = 'None'

            launch_dict['Customer'].append(customer)
```

```
            # Launch outcome
            #Append the launch_outcome into launch_dict with key `Laun
            launch_outcome = list(row[7].strings)[0]
            launch_dict['Launch outcome'].append(launch_outcome)

            # Booster landing
            #Append the booster landing into launch_dict with key `Boo
            booster_landing = landing_status(row[8])
            launch_dict['Booster landing'].append(booster_landing)


            print(f"Flight Number: {flight_number}, Date: {date}, Time
            Booster Version {bv}, Launch Site: {launch_site} \n \
            Payload: {payload}, Orbit: {orbit} \n \
            Customer: {customer}, Launch Outcome: {launch_outcome}\
            Booster Landing: {booster_landing} \n \
            *** ")
```

```
Flight Number: 1, Date: 4 June 2010, Time: 18:45
             Booster Version F9 v1.07B0003.18, Launch Site: CCAFS
             Payload: Dragon Spacecraft Qualification Unit, Orbit: LEO
             Customer: SpaceX, Launch Outcome: Success
            Booster Landing: Failure
             ***
Flight Number: 2, Date: 8 December 2010, Time: 15:43
             Booster Version F9 v1.07B0004.18, Launch Site: CCAFS
             Payload: Dragon, Orbit: LEO
             Customer: NASA, Launch Outcome: Success            Booster
Landing: Failure
             ***
Flight Number: 3, Date: 22 May 2012, Time: 07:44
             Booster Version F9 v1.07B0005.18, Launch Site: CCAFS
             Payload: Dragon, Orbit: LEO
             Customer: NASA, Launch Outcome: Success            Booster
Landing: No attempt

             ***
Flight Number: 4, Date: 8 October 2012, Time: 00:35
             Booster Version F9 v1.07B0006.18, Launch Site: CCAFS
             Payload: SpaceX CRS-1, Orbit: LEO
             Customer: NASA, Launch Outcome: Success
            Booster Landing: No attempt
             ***
Flight Number: 5, Date: 1 March 2013, Time: 15:10
             Booster Version F9 v1.07B0007.18, Launch Site: CCAFS
             Payload: SpaceX CRS-2, Orbit: LEO
             Customer: NASA, Launch Outcome: Success
            Booster Landing: No attempt

             ***
Flight Number: 6, Date: 29 September 2013, Time: 16:00
```

```
            Booster Version F9 v1.17B10038, Launch Site: VAFB
            Payload: CASSIOPE, Orbit: Polar orbit
            Customer: MDA, Launch Outcome: Success            Booster
Landing: Uncontrolled
            ***
Flight Number: 7, Date: 3 December 2013, Time: 22:41
            Booster Version F9 v1.1, Launch Site: CCAFS
            Payload: SES-8, Orbit: GTO
            Customer: SES, Launch Outcome: Success            Booster
Landing: No attempt
            ***
Flight Number: 8, Date: 6 January 2014, Time: 22:06
            Booster Version F9 v1.1, Launch Site: CCAFS
            Payload: Thaicom 6, Orbit: GTO
            Customer: Thaicom, Launch Outcome: Success            Boos
ter Landing: No attempt
            ***
Flight Number: 9, Date: 18 April 2014, Time: 19:25
            Booster Version F9 v1.1, Launch Site: Cape Canaveral
            Payload: SpaceX CRS-3, Orbit: LEO
            Customer: NASA, Launch Outcome: Success
           Booster Landing: Controlled
            ***
Flight Number: 10, Date: 14 July 2014, Time: 15:15
            Booster Version F9 v1.1, Launch Site: Cape Canaveral
            Payload: Orbcomm-OG2, Orbit: LEO
            Customer: Orbcomm, Launch Outcome: Success            Boos
ter Landing: Controlled
            ***
Flight Number: 11, Date: 5 August 2014, Time: 08:00
            Booster Version F9 v1.1, Launch Site: Cape Canaveral
            Payload: AsiaSat 8, Orbit: GTO
            Customer: AsiaSat, Launch Outcome: Success            Boos
ter Landing: No attempt
            ***
Flight Number: 12, Date: 7 September 2014, Time: 05:00
            Booster Version F9 v1.1[, Launch Site: Cape Canaveral
            Payload: AsiaSat 6, Orbit: GTO
            Customer: AsiaSat, Launch Outcome: Success            Boos
ter Landing: No attempt

            ***
Flight Number: 13, Date: 21 September 2014, Time: 05:52
            Booster Version F9 v1.1[, Launch Site: Cape Canaveral
            Payload: SpaceX CRS-4, Orbit: LEO
            Customer: NASA, Launch Outcome: Success            Booster
Landing: Uncontrolled
            ***
Flight Number: 14, Date: 10 January 2015, Time: 09:47
            Booster Version F9 v1.1[, Launch Site: Cape Canaveral
            Payload: SpaceX CRS-5, Orbit: LEO
```

```
            Customer: NASA, Launch Outcome: Success           Booster
Landing: Failure
            ***
Flight Number: 15, Date: 11 February 2015, Time: 23:03
            Booster Version F9 v1.1[, Launch Site: Cape Canaveral
            Payload: DSCOVR, Orbit: HEO
            Customer: USAF, Launch Outcome: Success
           Booster Landing: Controlled
            ***
Flight Number: 16, Date: 2 March 2015, Time: 03:50
            Booster Version F9 v1.1[, Launch Site: Cape Canaveral
            Payload: ABS-3A, Orbit: GTO
            Customer: ABS, Launch Outcome: Success
           Booster Landing: No attempt
            ***
Flight Number: 17, Date: 14 April 2015, Time: 20:10
            Booster Version F9 v1.1[, Launch Site: Cape Canaveral
            Payload: SpaceX CRS-6, Orbit: LEO
            Customer: NASA, Launch Outcome: Success
           Booster Landing: Failure
            ***
Flight Number: 18, Date: 27 April 2015, Time: 23:03
            Booster Version F9 v1.1[, Launch Site: Cape Canaveral
            Payload: TürkmenÄlem 52°E / MonacoSAT, Orbit: GTO
            Customer: None, Launch Outcome: Success
           Booster Landing: No attempt
            ***
Flight Number: 19, Date: 28 June 2015, Time: 14:21
            Booster Version F9 v1.1[, Launch Site: Cape Canaveral
            Payload: SpaceX CRS-7, Orbit: LEO
            Customer: NASA, Launch Outcome: Failure           Booster
Landing: Precluded
            ***
Flight Number: 20, Date: 22 December 2015, Time: 01:29
            Booster Version F9 FT[, Launch Site: Cape Canaveral
            Payload: Orbcomm-OG2, Orbit: LEO
            Customer: Orbcomm, Launch Outcome: Success
           Booster Landing: Success
            ***
Flight Number: 21, Date: 17 January 2016, Time: 18:42
            Booster Version F9 v1.1[, Launch Site: VAFB
            Payload: Jason-3, Orbit: LEO
            Customer: NASA, Launch Outcome: Success
           Booster Landing: Failure
            ***
Flight Number: 22, Date: 4 March 2016, Time: 23:35
            Booster Version F9 FT[, Launch Site: Cape Canaveral
            Payload: SES-9, Orbit: GTO
            Customer: SES, Launch Outcome: Success
           Booster Landing: Failure
            ***
```

```
Flight Number: 23, Date: 8 April 2016, Time: 20:43
             Booster Version F9 FT[, Launch Site: Cape Canaveral
             Payload: SpaceX CRS-8, Orbit: LEO
             Customer: NASA, Launch Outcome: Success            Booster
Landing: Success
             ***
Flight Number: 24, Date: 6 May 2016, Time: 05:21
             Booster Version F9 FT[, Launch Site: Cape Canaveral
             Payload: JCSAT-14, Orbit: GTO
             Customer: SKY Perfect JSAT Group, Launch Outcome: Success
            Booster Landing: Success
             ***
Flight Number: 25, Date: 27 May 2016, Time: 21:39
             Booster Version F9 FT[, Launch Site: Cape Canaveral
             Payload: Thaicom 8, Orbit: GTO
             Customer: Thaicom, Launch Outcome: Success
            Booster Landing: Success
             ***
Flight Number: 26, Date: 15 June 2016, Time: 14:29
             Booster Version F9 FT[, Launch Site: Cape Canaveral
             Payload: ABS-2A, Orbit: GTO
             Customer: ABS, Launch Outcome: Success
            Booster Landing: Failure
             ***
Flight Number: 27, Date: 18 July 2016, Time: 04:45
             Booster Version F9 FT[, Launch Site: Cape Canaveral
             Payload: SpaceX CRS-9, Orbit: LEO
             Customer: NASA, Launch Outcome: Success
            Booster Landing: Success
             ***
Flight Number: 28, Date: 14 August 2016, Time: 05:26
             Booster Version F9 FT[, Launch Site: Cape Canaveral
             Payload: JCSAT-16, Orbit: GTO
             Customer: SKY Perfect JSAT Group, Launch Outcome: Success
            Booster Landing: Success
             ***
Flight Number: 29, Date: 14 January 2017, Time: 17:54
             Booster Version F9 FT[, Launch Site: VAFB
             Payload: Iridium NEXT, Orbit: Polar
             Customer: Iridium Communications, Launch Outcome: Success
            Booster Landing: Success
             ***
Flight Number: 30, Date: 19 February 2017, Time: 14:39
             Booster Version F9 FT[, Launch Site: KSC
             Payload: SpaceX CRS-10, Orbit: LEO
             Customer: NASA, Launch Outcome: Success
            Booster Landing: Success
             ***
Flight Number: 31, Date: 16 March 2017, Time: 06:00
             Booster Version F9 FT[, Launch Site: KSC
             Payload: EchoStar 23, Orbit: GTO
```

```
            Customer: EchoStar, Launch Outcome: Success
           Booster Landing: No attempt
            ***
Flight Number: 32, Date: 30 March 2017, Time: 22:27
            Booster Version F9 FT♺[, Launch Site: KSC
            Payload: SES-10, Orbit: GTO
            Customer: SES, Launch Outcome: Success           Booster
Landing: Success
            ***
Flight Number: 33, Date: 1 May 2017, Time: 11:15
            Booster Version F9 FT[, Launch Site: KSC
            Payload: NROL-76, Orbit: LEO
            Customer: NRO, Launch Outcome: Success
           Booster Landing: Success
            ***
Flight Number: 34, Date: 15 May 2017, Time: 23:21
            Booster Version F9 FT[, Launch Site: KSC
            Payload: Inmarsat-5 F4, Orbit: GTO
            Customer: Inmarsat, Launch Outcome: Success
           Booster Landing: No attempt
            ***
Flight Number: 35, Date: 3 June 2017, Time: 21:07
            Booster Version F9 FT[, Launch Site: KSC
            Payload: SpaceX CRS-11, Orbit: LEO
            Customer: NASA, Launch Outcome: Success
           Booster Landing: Success
            ***
Flight Number: 36, Date: 23 June 2017, Time: 19:10
            Booster Version F9 FTB1029.2195, Launch Site: KSC
            Payload: BulgariaSat-1, Orbit: GTO
            Customer: Bulsatcom, Launch Outcome: Success
           Booster Landing: Success
            ***
Flight Number: 37, Date: 25 June 2017, Time: 20:25
            Booster Version F9 FT[, Launch Site: VAFB
            Payload: Iridium NEXT, Orbit: LEO
            Customer: Iridium Communications, Launch Outcome: Success
           Booster Landing: Success
            ***
Flight Number: 38, Date: 5 July 2017, Time: 23:38
            Booster Version F9 FT[, Launch Site: KSC
            Payload: Intelsat 35e, Orbit: GTO
            Customer: Intelsat, Launch Outcome: Success
           Booster Landing: No attempt
            ***
Flight Number: 39, Date: 14 August 2017, Time: 16:31
            Booster Version F9 B4[, Launch Site: KSC
            Payload: SpaceX CRS-12, Orbit: LEO
            Customer: NASA, Launch Outcome: Success
           Booster Landing: Success
            ***
```

```
Flight Number: 40, Date: 24 August 2017, Time: 18:51
             Booster Version F9 FT[, Launch Site: VAFB
             Payload: Formosat-5, Orbit: SSO
             Customer: NSPO, Launch Outcome: Success
            Booster Landing: Success
             ***
Flight Number: 41, Date: 7 September 2017, Time: 14:00
             Booster Version F9 B4[, Launch Site: KSC
             Payload: Boeing X-37B, Orbit: LEO
             Customer: USAF, Launch Outcome: Success
            Booster Landing: Success
             ***
Flight Number: 42, Date: 9 October 2017, Time: 12:37
             Booster Version F9 B4[, Launch Site: VAFB
             Payload: Iridium NEXT, Orbit: Polar
             Customer: Iridium Communications, Launch Outcome: Success
            Booster Landing: Success
             ***
Flight Number: 43, Date: 11 October 2017, Time: 22:53:00
             Booster Version F9 FTB1031.2220, Launch Site: KSC
             Payload: SES-11, Orbit: GTO
             Customer: SES S.A., Launch Outcome: Success
            Booster Landing: Success
             ***
Flight Number: 44, Date: 30 October 2017, Time: 19:34
             Booster Version F9 B4[, Launch Site: KSC
             Payload: Koreasat 5A, Orbit: GTO
             Customer: KT Corporation, Launch Outcome: Success
            Booster Landing: Success
             ***
Flight Number: 45, Date: 15 December 2017, Time: 15:36
             Booster Version F9 FTB1035.2227, Launch Site: Cape Canaver
al
             Payload: SpaceX CRS-13, Orbit: LEO
             Customer: NASA, Launch Outcome: Success
            Booster Landing: Success
             ***
Flight Number: 46, Date: 23 December 2017, Time: 01:27
             Booster Version F9 FTB1036.2227, Launch Site: VAFB
             Payload: Iridium NEXT, Orbit: Polar
             Customer: Iridium Communications, Launch Outcome: Success
Booster Landing: Controlled
             ***
Flight Number: 47, Date: 8 January 2018, Time: 01:00
             Booster Version F9 B4[, Launch Site: CCAFS
             Payload: Zuma, Orbit: LEO
             Customer: Northrop Grumman, Launch Outcome: Success
Booster Landing: Success
             ***
Flight Number: 48, Date: 31 January 2018, Time: 21:25
             Booster Version F9 FTB1032.2245, Launch Site: CCAFS
```

```
            Payload: GovSat-1, Orbit: GTO
            Customer: SES, Launch Outcome: Success            Booster
Landing: Controlled
            ***
Flight Number: 49, Date: 22 February 2018, Time: 14:17
            Booster Version F9 FTB1038.2268, Launch Site: VAFB
            Payload: Paz, Orbit: SSO
            Customer: Hisdesat, Launch Outcome: Success           Boo
ster Landing: No attempt
            ***
Flight Number: 50, Date: 6 March 2018, Time: 05:33
            Booster Version F9 B4[, Launch Site: CCAFS
            Payload: Hispasat 30W-6, Orbit: GTO
            Customer: Hispasat, Launch Outcome: Success           Boo
ster Landing: No attempt
            ***
Flight Number: 51, Date: 30 March 2018, Time: 14:14
            Booster Version F9 B4B1041.2268, Launch Site: VAFB
            Payload: Iridium NEXT, Orbit: Polar
            Customer: Iridium Communications, Launch Outcome: Success
Booster Landing: No attempt
            ***
Flight Number: 52, Date: 2 April 2018, Time: 20:30
            Booster Version F9 B4B1039.2292, Launch Site: CCAFS
            Payload: SpaceX CRS-14, Orbit: LEO
            Customer: NASA, Launch Outcome: Success           Booster
Landing: No attempt
            ***
Flight Number: 53, Date: 18 April 2018, Time: 22:51
            Booster Version F9 B4[, Launch Site: CCAFS
            Payload: Transiting Exoplanet Survey Satellite, Orbit: HEO
            Customer: NASA, Launch Outcome: Success           Booster
Landing: Success
            ***
Flight Number: 54, Date: 11 May 2018, Time: 20:14
            Booster Version F9 B5311B1046.1268, Launch Site: KSC
            Payload: Bangabandhu-1, Orbit: GTO
            Customer: Thales-Alenia, Launch Outcome: Success
Booster Landing: Success
            ***
Flight Number: 55, Date: 22 May 2018, Time: 19:47
            Booster Version F9 B4B1043.2322, Launch Site: VAFB
            Payload: Iridium NEXT, Orbit: Polar
            Customer: Iridium Communications, Launch Outcome: Success
Booster Landing: No attempt
            ***
Flight Number: 56, Date: 4 June 2018, Time: 04:45
            Booster Version F9 B4B1040.2268, Launch Site: CCAFS
            Payload: SES-12, Orbit: GTO
            Customer: SES, Launch Outcome: Success            Booster
Landing: No attempt
```

```
            ***
Flight Number: 57, Date: 29 June 2018, Time: 09:42
            Booster Version F9 B4B1045.2336, Launch Site: CCAFS
            Payload: SpaceX CRS-15, Orbit: LEO
            Customer: NASA, Launch Outcome: Success           Booster
Landing: No attempt
            ***
Flight Number: 58, Date: 22 July 2018, Time: 05:50
            Booster Version F9 B5, Launch Site: CCAFS
            Payload: Telstar 19V, Orbit: GTO
            Customer: Telesat, Launch Outcome: Success           Boos
ter Landing: Success
            ***
Flight Number: 59, Date: 25 July 2018, Time: 11:39
            Booster Version F9 B5349B1048[, Launch Site: VAFB
            Payload: Iridium NEXT, Orbit: Polar
            Customer: Iridium Communications, Launch Outcome: Success
Booster Landing: Success
            ***
Flight Number: 60, Date: 7 August 2018, Time: 05:18
            Booster Version F9 B5B1046.2354, Launch Site: CCAFS
            Payload: Merah Putih, Orbit: GTO
            Customer: Telkom Indonesia, Launch Outcome: Success
Booster Landing: Success
            ***
Flight Number: 61, Date: 10 September 2018, Time: 04:45
            Booster Version F9 B5[, Launch Site: CCAFS
            Payload: Telstar 18V, Orbit: GTO
            Customer: Telesat, Launch Outcome: Success           Boos
ter Landing: Success
            ***
Flight Number: 62, Date: 8 October 2018, Time: 02:22
            Booster Version F9 B5B1048.2364, Launch Site: VAFB
            Payload: SAOCOM 1A, Orbit: SSO
            Customer: CONAE, Launch Outcome: Success           Booste
r Landing: Success
            ***
Flight Number: 63, Date: 15 November 2018, Time: 20:46
            Booster Version F9 B5B1047.2268, Launch Site: KSC
            Payload: Es'hail 2, Orbit: GTO
            Customer: Es'hailSat, Launch Outcome: Success           B
ooster Landing: Success
            ***
Flight Number: 64, Date: 3 December 2018, Time: 18:34:05
            Booster Version F9 B5B1046.3268, Launch Site: VAFB
            Payload: SSO-A, Orbit: SSO
            Customer: Spaceflight Industries, Launch Outcome: Success
Booster Landing: Success
            ***
Flight Number: 65, Date: 5 December 2018, Time: 18:16
            Booster Version F9 B5[, Launch Site: CCAFS
```

```
             Payload: SpaceX CRS-16, Orbit: LEO
             Customer: NASA, Launch Outcome: Success
            Booster Landing: Failure
             ***
Flight Number: 66, Date: 23 December 2018, Time: 13:51
             Booster Version F9 B5[, Launch Site: CCAFS
             Payload: GPS III, Orbit: MEO
             Customer: USAF, Launch Outcome: Success            Booster
Landing: No attempt
             ***
Flight Number: 67, Date: 11 January 2019, Time: 15:31
             Booster Version F9 B5B1049.2397, Launch Site: VAFB
             Payload: Iridium NEXT, Orbit: Polar
             Customer: Iridium Communications, Launch Outcome: Success
            Booster Landing: Success
             ***
Flight Number: 68, Date: 22 February 2019, Time: 01:45
             Booster Version F9 B5B1048.3399, Launch Site: CCAFS
             Payload: Nusantara Satu, Orbit: GTO
             Customer: PSN, Launch Outcome: Success
            Booster Landing: Success
             ***
Flight Number: 69, Date: 2 March 2019, Time: 07:49
             Booster Version F9 B5[]413, Launch Site: KSC
             Payload: Crew Dragon Demo-1, Orbit: LEO
             Customer: NASA, Launch Outcome: Success
            Booster Landing: Success
             ***
Flight Number: 70, Date: 4 May 2019, Time: 06:48
             Booster Version F9 B5[, Launch Site: CCAFS
             Payload: SpaceX CRS-17, Orbit: LEO
             Customer: NASA, Launch Outcome: Success
            Booster Landing: Success
             ***
Flight Number: 71, Date: 24 May 2019, Time: 02:30
             Booster Version F9 B5B1049.3434, Launch Site: CCAFS
             Payload: Starlink, Orbit: LEO
             Customer: SpaceX, Launch Outcome: Success
            Booster Landing: Success
             ***
Flight Number: 72, Date: 12 June 2019, Time: 14:17
             Booster Version F9 B5B1051.2420, Launch Site: VAFB
             Payload: RADARSAT Constellation, Orbit: SSO
             Customer: Canadian Space Agency, Launch Outcome: Success
            Booster Landing: Success
             ***
Flight Number: 73, Date: 25 July 2019, Time: 22:01
             Booster Version F9 B5B1056.2465, Launch Site: CCAFS
             Payload: SpaceX CRS-18, Orbit: LEO
             Customer: NASA, Launch Outcome: Success
            Booster Landing: Success
```

```
             ***
Flight Number: 74, Date: 6 August 2019, Time: 23:23
             Booster Version F9 B5B1047.3472, Launch Site: CCAFS
             Payload: AMOS-17, Orbit: GTO
             Customer: Spacecom, Launch Outcome: Success
            Booster Landing: No attempt
             ***
Flight Number: 75, Date: 11 November 2019, Time: 14:56
             Booster Version F9 B5, Launch Site: CCAFS
             Payload: Starlink, Orbit: LEO
             Customer: SpaceX, Launch Outcome: Success
            Booster Landing: Success
             ***
Flight Number: 76, Date: 5 December 2019, Time: 17:29
             Booster Version F9 B5[, Launch Site: CCAFS
             Payload: SpaceX CRS-19, Orbit: LEO
             Customer: NASA, Launch Outcome: Success
            Booster Landing: Success
             ***
Flight Number: 77, Date: 17 December 2019, Time: 00:10
             Booster Version F9 B5B1056.3482, Launch Site: CCAFS
             Payload: JCSat-18, Orbit: GTO
             Customer: Sky Perfect JSAT, Launch Outcome: Success
            Booster Landing: Success
             ***
Flight Number: 78, Date: 7 January 2020, Time: 02:19:21
             Booster Version F9 B5, Launch Site: CCAFS
             Payload: Starlink, Orbit: LEO
             Customer: SpaceX, Launch Outcome: Success
            Booster Landing: Success
             ***
Flight Number: 79, Date: 19 January 2020, Time: 15:30
             Booster Version F9 B5, Launch Site: KSC
             Payload: Crew Dragon in-flight abort test, Orbit: Sub-orbi
tal
             Customer: NASA, Launch Outcome: Success
            Booster Landing: No attempt


             ***
Flight Number: 80, Date: 29 January 2020, Time: 14:07
             Booster Version F9 B5, Launch Site: CCAFS
             Payload: Starlink, Orbit: LEO
             Customer: SpaceX, Launch Outcome: Success
            Booster Landing: Success
             ***
Flight Number: 81, Date: 17 February 2020, Time: 15:05
             Booster Version F9 B5, Launch Site: CCAFS
             Payload: Starlink, Orbit: LEO
             Customer: SpaceX, Launch Outcome: Success
            Booster Landing: Failure
             ***
```

```
Flight Number: 82, Date: 7 March 2020, Time: 04:50
             Booster Version F9 B5, Launch Site: CCAFS
             Payload: SpaceX CRS-20, Orbit: LEO
             Customer: NASA, Launch Outcome: Success
            Booster Landing: Success
             ***
Flight Number: 83, Date: 18 March 2020, Time: 12:16
             Booster Version F9 B5, Launch Site: KSC
             Payload: Starlink, Orbit: LEO
             Customer: SpaceX, Launch Outcome: Success
            Booster Landing: Failure
             ***
Flight Number: 84, Date: 22 April 2020, Time: 19:30
             Booster Version F9 B5, Launch Site: KSC
             Payload: Starlink, Orbit: LEO
             Customer: SpaceX, Launch Outcome: Success
            Booster Landing: Success
             ***
Flight Number: 85, Date: 30 May 2020, Time: 19:22
             Booster Version F9 B5[, Launch Site: KSC
             Payload: Crew Dragon Demo-2, Orbit: LEO
             Customer: NASA, Launch Outcome: Success
            Booster Landing: Success
             ***
Flight Number: 86, Date: 4 June 2020, Time: 01:25
             Booster Version F9 B5, Launch Site: CCAFS
             Payload: Starlink, Orbit: LEO
             Customer: SpaceX, Launch Outcome: Success
            Booster Landing: Success
             ***
Flight Number: 87, Date: 13 June 2020, Time: 09:21
             Booster Version F9 B5, Launch Site: CCAFS
             Payload: Starlink, Orbit: LEO
             Customer: SpaceX, Launch Outcome: Success
            Booster Landing: Success
             ***
Flight Number: 88, Date: 30 June 2020, Time: 20:10:46
             Booster Version F9 B5, Launch Site: CCAFS
             Payload: GPS III, Orbit: MEO
             Customer: U.S. Space Force, Launch Outcome: Success
            Booster Landing: Success
             ***
Flight Number: 89, Date: 20 July 2020, Time: 21:30
             Booster Version F9 B5B1058.2544, Launch Site: CCAFS
             Payload: ANASIS-II, Orbit: GTO
             Customer: Republic of Korea Army, Launch Outcome: Success
            Booster Landing: Success
             ***
Flight Number: 90, Date: 7 August 2020, Time: 05:12
             Booster Version F9 B5, Launch Site: KSC
             Payload: Starlink, Orbit: LEO
```

```
             Customer: SpaceX, Launch Outcome: Success
            Booster Landing: Success
             ***
Flight Number: 91, Date: 18 August 2020, Time: 14:31
             Booster Version F9 B5B1049.6544, Launch Site: CCAFS
             Payload: Starlink, Orbit: LEO
             Customer: SpaceX, Launch Outcome: Success
            Booster Landing: Success
             ***
Flight Number: 92, Date: 30 August 2020, Time: 23:18
             Booster Version F9 B5, Launch Site: CCAFS
             Payload: SAOCOM 1B, Orbit: SSO
             Customer: CONAE, Launch Outcome: Success
            Booster Landing: Success
             ***
Flight Number: 93, Date: 3 September 2020, Time: 12:46:14
             Booster Version F9 B5B1060.2563, Launch Site: KSC
             Payload: Starlink, Orbit: LEO
             Customer: SpaceX, Launch Outcome: Success
            Booster Landing: Success
             ***
Flight Number: 94, Date: 6 October 2020, Time: 11:29:34
             Booster Version F9 B5B1058.3565, Launch Site: KSC
             Payload: Starlink, Orbit: LEO
             Customer: SpaceX, Launch Outcome: Success
            Booster Landing: Success
             ***
Flight Number: 95, Date: 18 October 2020, Time: 12:25:57
             Booster Version F9 B5B1051.6568, Launch Site: KSC
             Payload: Starlink, Orbit: LEO
             Customer: SpaceX, Launch Outcome: Success
            Booster Landing: Success
             ***
Flight Number: 96, Date: 24 October 2020, Time: 15:31:34
             Booster Version F9 B5, Launch Site: CCAFS
             Payload: Starlink, Orbit: LEO
             Customer: SpaceX, Launch Outcome: Success
            Booster Landing: Success
             ***
Flight Number: 97, Date: 5 November 2020, Time: 23:24:23
             Booster Version F9 B5, Launch Site: CCAFS
             Payload: GPS III, Orbit: MEO
             Customer: USSF, Launch Outcome: Success
            Booster Landing: Success
             ***
Flight Number: 98, Date: 16 November 2020, Time: 00:27
             Booster Version F9 B5[, Launch Site: KSC
             Payload: Crew-1, Orbit: LEO
             Customer: NASA, Launch Outcome: Success
            Booster Landing: Success
             ***
```

```
Flight Number: 99, Date: 21 November 2020, Time: 17:17:08
             Booster Version F9 B5, Launch Site: VAFB
             Payload: Sentinel-6 Michael Freilich (Jason-CS A), Orbit:
LEO
             Customer: NASA, Launch Outcome: Success
            Booster Landing: Success
             ***
Flight Number: 100, Date: 25 November 2020, Time: 02:13
             Booster Version F9 B5 ♺[, Launch Site: CCAFS
             Payload: Starlink, Orbit: LEO
             Customer: SpaceX, Launch Outcome: Success
            Booster Landing: Success
             ***
Flight Number: 101, Date: 6 December 2020, Time: 16:17:08
             Booster Version F9 B5 ♺[, Launch Site: KSC
             Payload: SpaceX CRS-21, Orbit: LEO
             Customer: NASA, Launch Outcome: Success
            Booster Landing: Success
             ***
Flight Number: 102, Date: 13 December 2020, Time: 17:30:00
             Booster Version F9 B5 ♺, Launch Site: CCSFS
             Payload: SXM-7, Orbit: GTO
             Customer: Sirius XM, Launch Outcome: Success
            Booster Landing: Success
             ***
Flight Number: 103, Date: 19 December 2020, Time: 14:00:00
             Booster Version F9 B5 ♺, Launch Site: KSC
             Payload: NROL-108, Orbit: LEO
             Customer: NRO, Launch Outcome: Success
            Booster Landing: Success
             ***
Flight Number: 104, Date: 8 January 2021, Time: 02:15
             Booster Version F9 B5, Launch Site: CCSFS
             Payload: Türksat 5A, Orbit: GTO
             Customer: Türksat, Launch Outcome: Success
            Booster Landing: Success
             ***
Flight Number: 105, Date: 20 January 2021, Time: 13:02
             Booster Version F9 B5B1051.8609, Launch Site: KSC
             Payload: Starlink, Orbit: LEO
             Customer: SpaceX, Launch Outcome: Success
            Booster Landing: Success
             ***
Flight Number: 106, Date: 24 January 2021, Time: 15:00
             Booster Version F9 B5B1058.5613, Launch Site: CCSFS
             Payload: Transporter-1, Orbit: SSO
             Customer: None, Launch Outcome: Success
            Booster Landing: Success
             ***
Flight Number: 107, Date: 4 February 2021, Time: 06:19
             Booster Version F9 B5 ♺[, Launch Site: CCSFS
```

```
             Payload: Starlink, Orbit: LEO
             Customer: SpaceX, Launch Outcome: Success
            Booster Landing: Success
             ***
Flight Number: 108, Date: 16 February 2021, Time: 03:59:37
             Booster Version F9 B5 ♺, Launch Site: CCSFS
             Payload: Starlink, Orbit: LEO
             Customer: SpaceX, Launch Outcome: Success
            Booster Landing: Failure
             ***
Flight Number: 109, Date: 4 March 2021, Time: 08:24
             Booster Version F9 B5 ♺[, Launch Site: KSC
             Payload: Starlink, Orbit: LEO
             Customer: SpaceX, Launch Outcome: Success
            Booster Landing: Success
             ***
Flight Number: 110, Date: 11 March 2021, Time: 08:13:29
             Booster Version F9 B5 ♺[, Launch Site: CCSFS
             Payload: Starlink, Orbit: LEO
             Customer: SpaceX, Launch Outcome: Success
            Booster Landing: Success
             ***
Flight Number: 111, Date: 14 March 2021, Time: 10:01
             Booster Version F9 B5 ♺, Launch Site: KSC
             Payload: Starlink, Orbit: LEO
             Customer: SpaceX, Launch Outcome: Success
            Booster Landing: Success
             ***
Flight Number: 112, Date: 24 March 2021, Time: 08:28
             Booster Version F9 B5B1060.6643, Launch Site: CCSFS
             Payload: Starlink, Orbit: LEO
             Customer: SpaceX, Launch Outcome: Success
            Booster Landing: Success
             ***
Flight Number: 113, Date: 7 April 2021, Time: 16:34
             Booster Version F9 B5 ♺, Launch Site: CCSFS
             Payload: Starlink, Orbit: LEO
             Customer: SpaceX, Launch Outcome: Success
            Booster Landing: Success
             ***
Flight Number: 114, Date: 23 April 2021, Time: 9:49
             Booster Version F9 B5B1061.2647, Launch Site: KSC
             Payload: Crew-2, Orbit: LEO
             Customer: NASA, Launch Outcome: Success
            Booster Landing: Success
             ***
Flight Number: 115, Date: 29 April 2021, Time: 03:44
             Booster Version F9 B5B1060.7652, Launch Site: CCSFS
             Payload: Starlink, Orbit: LEO
             Customer: SpaceX, Launch Outcome: Success
            Booster Landing: Success
```

```
             ***
Flight Number: 116, Date: 4 May 2021, Time: 19:01
             Booster Version F9 B5B1049.9655, Launch Site: KSC
             Payload: Starlink, Orbit: LEO
             Customer: SpaceX, Launch Outcome: Success
            Booster Landing: Success
             ***
Flight Number: 117, Date: 9 May 2021, Time: 06:42
             Booster Version F9 B5B1051.10657, Launch Site: CCSFS
             Payload: Starlink, Orbit: LEO
             Customer: SpaceX, Launch Outcome: Success
            Booster Landing: Success
             ***
Flight Number: 118, Date: 15 May 2021, Time: 22:56
             Booster Version F9 B5B1058.8660, Launch Site: KSC
             Payload: Starlink, Orbit: LEO
             Customer: SpaceX, Launch Outcome: Success
            Booster Landing: Success
             ***
Flight Number: 119, Date: 26 May 2021, Time: 18:59
             Booster Version F9 B5B1063.2665, Launch Site: CCSFS
             Payload: Starlink, Orbit: LEO
             Customer: SpaceX, Launch Outcome: Success
            Booster Landing: Success
             ***
Flight Number: 120, Date: 3 June 2021, Time: 17:29
             Booster Version F9 B5B1067.1668, Launch Site: KSC
             Payload: SpaceX CRS-22, Orbit: LEO
             Customer: NASA, Launch Outcome: Success
            Booster Landing: Success
             ***
Flight Number: 121, Date: 6 June 2021, Time: 04:26
             Booster Version F9 B5, Launch Site: CCSFS
             Payload: SXM-8, Orbit: GTO
             Customer: Sirius XM, Launch Outcome: Success
            Booster Landing: Success
             ***
```

After you have fill in the parsed launch record values into `launch_dict`, you can create a dataframe from it.

In [18]:
```
df= pd.DataFrame({ key:pd.Series(value) for key, value in launch_dict.
```

We can now export it to a CSV for the next section, but to make the answers consistent and in case you have difficulties finishing this lab.

Following labs will be using a provided dataset to make each lab independent.

```
df.to_csv('spacex_web_scraped.csv', index=False)
```

In [ ]:

Authors

Yan Luo

Nayef Abou Tayoun