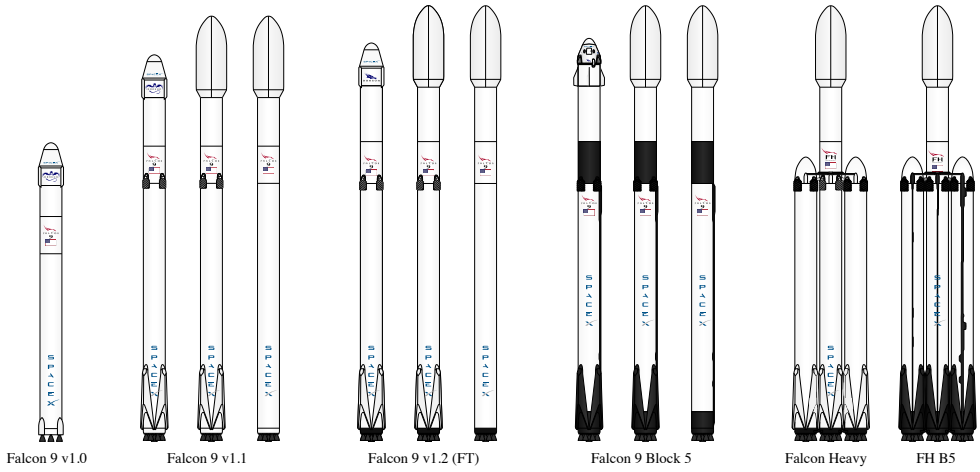
Space X Falcon 9 First Stage Landing Prediction

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 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 [1]:
```
!pip3 install beautifulsoup4
!pip3 install requests
```

```
Requirement already satisfied: beautifulsoup4 in /home/jupyterlab/conda/envs/
python/lib/python3.7/site-packages (4.11.1)
Requirement already satisfied: soupsieve>1.2 in /home/jupyterlab/conda/envs/p
ython/lib/python3.7/site-packages (from beautifulsoup4) (2.3.2.post1)
Requirement already satisfied: requests in /home/jupyterlab/conda/envs/pytho
n/lib/python3.7/site-packages (2.29.0)
Requirement already satisfied: charset-normalizer<4,>=2 in /home/jupyterlab/c
onda/envs/python/lib/python3.7/site-packages (from requests) (3.1.0)
Requirement already satisfied: idna<4,>=2.5 in /home/jupyterlab/conda/envs/py
thon/lib/python3.7/site-packages (from requests) (3.4)
Requirement already satisfied: urllib3<1.27,>=1.21.1 in /home/jupyterlab/cond
a/envs/python/lib/python3.7/site-packages (from requests) (1.26.15)
Requirement already satisfied: certifi>=2017.4.17 in /home/jupyterlab/conda/e
nvs/python/lib/python3.7/site-packages (from requests) (2023.5.7)
```

In [2]:
```
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 [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.strings)][0:

def booster_version(table_cells):
    """
    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):
```

```
    """
    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
```

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

```
response = requests.get(static_url)
```

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

In [6]:
```
# Use BeautifulSoup() to create a BeautifulSoup object from a response text
soup = BeautifulSoup(response.content, 'html.parser')
```

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

In [7]:
```
# Use soup.title attribute
soup.title
```

Out[7]:
```
<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 [8]:
```
# Use the find_all function in the BeautifulSoup object, with element type `
# Assign the result to a list called `html_tables`
html_tables = soup.find_all('table')
```

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

In [9]:
```
# 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_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 hr
ef="#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="Fal
con 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-MuskMay2012-1
3">[7]</a></sup><br/>B0003.1<sup class="reference" id="cite_ref-block_numbers
_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_Launc
h_Complex_40" title="Cape Canaveral Space Launch Complex 40">SLC-40</a>
</td>
<td><a href="/wiki/Dragon_Spacecraft_Qualification_Unit" title="Dragon Spacec
raft 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: middle;
text-align: center;">Success
</td>
<td class="table-failure" style="background: #FFC7C7; vertical-align: middle;
text-align: center;">Failure<sup class="reference" id="cite_ref-ns20110930_15
```

-0">[9]</sup><sup class="reference" id
="cite_ref-16">[10]</sup>
<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">[11]</sup> Use
d a boilerplate version of Dragon capsule which was not designed to separate
from the second stage.<small>(more detail
s below)</small> Attempted to recover the first stage by parachuting it i
nto the ocean, but it burned up on reentry, before the parachutes even deploy
ed.<sup class="reference" id="cite_ref-parachute_18-0"><a href="#cite_note-pa
rachute-18">[12]</sup>
</td></tr>
<tr>
<th rowspan="2" scope="row" style="text-align:center;">2
</th>
<td>8 December 2010,
15:43<sup class="reference" id="cite_ref-spaceflight
now_Clark_Launch_Report_19-0"><a href="#cite_note-spaceflightnow_Clark_Launch
_Report-19">[13]</sup>
</td>
<td>F9 v1.0<sup class
="reference" id="cite_ref-MuskMay2012_13-1"><a href="#cite_note-MuskMay2012-1
3">[7]</sup>
B0004.1<sup class="reference" id="cite_ref-block_numbers
_14-1">[8]</sup>
</td>
<td><a href="/wiki/Cape_Canaveral_Space_Force_Station" title="Cape Canaveral
Space Force Station">CCAFS,
<a href="/wiki/Cape_Canaveral_Space_Launc
h_Complex_40" title="Cape Canaveral Space Launch Complex 40">SLC-40
</td>
<td>Dragon <a class
="mw-redirect" href="/wiki/COTS_Demo_Flight_1" title="COTS Demo Flight 1">dem
o flight C1
(Dragon C101)
</td>
<td>
</td>
<td>LEO (<a href
="/wiki/International_Space_Station" title="International Space Station">ISS
)
</td>
<td><style data-mw-deduplicate="TemplateStyles:r1126788409">.mw-parser-output
.plainlist ol,.mw-parser-output .plainlist ul{line-height:inherit;list-style:
none;margin:0;padding:0}.mw-parser-output .plainlist ol li,.mw-parser-output
.plainlist ul li{margin-bottom:0}</style>
NASA (<a href="/wiki/Commercial
_Orbital_Transportation_Services" title="Commercial Orbital Transportation Se
rvices">COTS)
<a href="/wiki/National_Reconnaissance_Office" title="National Reconnaiss
ance Office">NRO

</td>
<td class="table-success" style="background: #9EFF9E; vertical-align: middle;
text-align: center;">Success<sup class="reference" id="cite_ref-ns20110930_15
-1">[9]</sup>
</td>
<td class="table-failure" style="background: #FFC7C7; vertical-align: middle;

```
text-align: center;">Failure<sup class="reference" id="cite_ref-ns20110930_15
-2"><a href="#cite_note-ns20110930-15">[9]</a></sup><sup class="reference" id
="cite_ref-20"><a href="#cite_note-20">[14]</a></sup><br/><small>(parachute)
</small>
</td></tr>
<tr>
<td colspan="9">Maiden flight of <a class="mw-redirect" href="/wiki/Dragon_ca
psule" title="Dragon capsule">Dragon capsule</a>, consisting of over 3 hours
of testing thruster maneuvering and reentry.<sup class="reference" id="cite_r
ef-spaceflightnow_Clark_unleashing_Dragon_21-0"><a href="#cite_note-spaceflig
htnow_Clark_unleashing_Dragon-21">[15]</a></sup> Attempted to recover the fir
st stage by parachuting it into the ocean, but it disintegrated upon reentry,
before the parachutes were deployed.<sup class="reference" id="cite_ref-parac
hute_18-1"><a href="#cite_note-parachute-18">[12]</a></sup> <small>(<a href
="#COTS_demo_missions">more details below</a>)</small> It also included two <
a href="/wiki/CubeSat" title="CubeSat">CubeSats</a>,<sup class="reference" id
="cite_ref-NRO_Taps_Boeing_for_Next_Batch_of_CubeSats_22-0"><a href="#cite_no
te-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> cheese.
</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 class
="reference" id="cite_ref-MuskMay2012_13-2"><a href="#cite_note-MuskMay2012-1
3">[7]</a></sup><br/>B0005.1<sup class="reference" id="cite_ref-block_numbers
_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_Launc
h_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">[1
8]</a></sup><br/>(Dragon C102)
</td>
<td>525 kg (1,157 lb)<sup class="reference" id="cite_ref-25"><a href="#cite_n
ote-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_Orb
ital_Transportation_Services" title="Commercial Orbital Transportation Servic
es">COTS</a>)
</td>
<td class="table-success" style="background: #9EFF9E; vertical-align: middle;
text-align: center;">Success<sup class="reference" id="cite_ref-26"><a href
="#cite_note-26">[20]</a></sup>
</td>
<td class="table-noAttempt" style="background: #EEE; vertical-align: middle;
```

```
white-space: nowrap; text-align: center;">Not attempted
</td></tr>
<tr>
<td colspan="9">Dragon spacecraft demonstrated a series of tests before it wa
s allowed to approach the <a href="/wiki/International_Space_Station" title
="International Space Station">International Space Station</a>. Two days late
r, it became the first commercial spacecraft to board the ISS.<sup class="ref
erence" id="cite_ref-BBC_new_era_23-1"><a href="#cite_note-BBC_new_era-23">[1
7]</a></sup> <small>(<a href="#COTS_demo_missions">more details below</a>)</s
mall>
</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_note-M
uskMay2012-13">[7]</a></sup><br/>B0006.1<sup class="reference" id="cite_ref-b
lock_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="Cap
e Canaveral Space Force Station">CCAFS</a>,<br/><a href="/wiki/Cape_Canaveral
_Space_Launch_Complex_40" title="Cape Canaveral Space Launch Complex 40">SLC-
40</a>
</td>
<td><a href="/wiki/SpaceX_CRS-1" title="SpaceX CRS-1">SpaceX CRS-1</a><sup cl
ass="reference" id="cite_ref-sxManifest20120925_28-0"><a href="#cite_note-sxM
anifest20120925-28">[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_Res
upply_Services" title="Commercial Resupply Services">CRS</a>)
</td>
<td class="table-success" style="background: #9EFF9E; vertical-align: middle;
text-align: center;">Success
</td>
<td rowspan="2" style="background:#ececec; text-align:center;"><span class="n
owrap">No attempt</span>
</td></tr>
<tr>
<td><a href="/wiki/Orbcomm_(satellite)" title="Orbcomm (satellite)">Orbcomm-O
G2</a><sup class="reference" id="cite_ref-Orbcomm_29-0"><a href="#cite_note-O
rbcomm-29">[23]</a></sup>
</td>
<td>172 kg (379 lb)<sup class="reference" id="cite_ref-gunter-og2_30-0"><a hr
ef="#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; te
xt-align: center;">Partial failure<sup class="reference" id="cite_ref-nyt-201
21030_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_payloa
d" title="Secondary payload">secondary payload</a> was inserted into an abnor
mally low orbit and subsequently lost. This was due to one of the nine <a hre
f="/wiki/SpaceX_Merlin" title="SpaceX Merlin">Merlin engines</a> shutting dow
n during the launch, and NASA declining a second reignition, as per <a href
="/wiki/International_Space_Station" title="International Space Station">ISS
</a> visiting vehicle safety rules, the primary payload owner is contractuall
y allowed to decline a second reignition. NASA stated that this was because S
paceX could not guarantee a high enough likelihood of the second stage comple
ting the second burn successfully which was required to avoid any risk of sec
ondary payload's collision with the ISS.<sup class="reference" id="cite_ref-O
rbcommTotalLoss_32-0"><a href="#cite_note-OrbcommTotalLoss-32">[26]</a></sup>
<sup class="reference" id="cite_ref-sn20121011_33-0"><a href="#cite_note-sn20
121011-33">[27]</a></sup><sup class="reference" id="cite_ref-34"><a href="#ci
te_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 class
="reference" id="cite_ref-MuskMay2012_13-4"><a href="#cite_note-MuskMay2012-1
3">[7]</a></sup><br/>B0007.1<sup class="reference" id="cite_ref-block_numbers
_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_Launc
h_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 cl
ass="reference" id="cite_ref-sxManifest20120925_28-1"><a href="#cite_note-sxM
anifest20120925-28">[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 class
="mw-redirect" href="/wiki/ISS" title="ISS">ISS</a>)
</td>
<td><a href="/wiki/NASA" title="NASA">NASA</a> (<a href="/wiki/Commercial_Res
upply_Services" title="Commercial Resupply Services">CRS</a>)
</td>
<td class="table-success" style="background: #9EFF9E; vertical-align: middle;
text-align: center;">Success
</td>
<td class="table-noAttempt" style="background: #EEE; vertical-align: middle;
white-space: nowrap; text-align: center;">Not attempted
</td></tr>
<tr>
```

```
<td colspan="9">Last launch of the original Falcon 9 v1.0 <a href="/wiki/Laun
ch_vehicle" title="Launch vehicle">launch vehicle</a>, first use of the unpre
ssurized trunk section of Dragon.<sup class="reference" id="cite_ref-sxf9_201
10321_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-pa2013093
0_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 class
="reference" id="cite_ref-MuskMay2012_13-5"><a href="#cite_note-MuskMay2012-1
3">[7]</a></sup><br/>B1003<sup class="reference" id="cite_ref-block_numbers_1
4-5"><a href="#cite_note-block_numbers-14">[8]</a></sup>
</td>
<td><a class="mw-redirect" href="/wiki/Vandenberg_Air_Force_Base" title="Vand
enberg Air Force Base">VAFB</a>,<br/><a href="/wiki/Vandenberg_Space_Launch_C
omplex_4" title="Vandenberg Space Launch Complex 4">SLC-4E</a>
</td>
<td><a href="/wiki/CASSIOPE" title="CASSIOPE">CASSIOPE</a><sup class="referen
ce" id="cite_ref-sxManifest20120925_28-2"><a href="#cite_note-sxManifest20120
925-28">[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: middle;
text-align: center;">Success<sup class="reference" id="cite_ref-pa20130930_36
-1"><a href="#cite_note-pa20130930-36">[30]</a></sup>
</td>
<td class="table-no2" style="background: #FFE3E3; color: black; vertical-alig
n: middle; text-align: center;">Uncontrolled<br/><small>(ocean)</small><sup c
lass="reference" id="cite_ref-ocean_landing_38-0"><a href="#cite_note-ocean_l
anding-38">[d]</a></sup>
</td></tr>
<tr>
<td colspan="9">First commercial mission with a private customer, first launc
h from Vandenberg, and demonstration flight of Falcon 9 v1.1 with an improved
13-tonne to LEO capacity.<sup class="reference" id="cite_ref-sxf9_20110321_35
-1"><a href="#cite_note-sxf9_20110321-35">[29]</a></sup> After separation fro
m the second stage carrying Canadian commercial and scientific satellites, th
e first stage booster performed a controlled reentry,<sup class="reference" i
d="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 landing test
s">ocean touchdown test</a> for the first time. This provided good test data,
even though the booster started rolling as it neared the ocean, leading to th
e shutdown of the central engine as the roll depleted it of fuel, resulting i
n a hard impact with the ocean.<sup class="reference" id="cite_ref-pa20130930
_36-2"><a href="#cite_note-pa20130930-36">[30]</a></sup> This was the first k
nown attempt of a rocket engine being lit to perform a supersonic retro propu
```

```
lsion, and allowed SpaceX to enter a public–private partnership with <a href
="/wiki/NASA" title="NASA">NASA</a> and its Mars entry, descent, and landing
technologies research projects.<sup class="reference" id="cite_ref-40"><a hre
f="#cite_note-40">[33]</a></sup> <small>(<a href="#Maiden_flight_of_v1.1">mor
e 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_wwls201
30624_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/>B1004
</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_Launc
h_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="c
ite_ref-sxManifest20120925_28-3"><a href="#cite_note-sxManifest20120925-28">
[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-aw20110323
_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 transfe
r orbit">GTO</a>
</td>
<td><a href="/wiki/SES_S.A." title="SES S.A.">SES</a>
</td>
<td class="table-success" style="background: #9EFF9E; vertical-align: middle;
text-align: center;">Success<sup class="reference" id="cite_ref-SNMissionStat
us7_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;">Not attempted<br/><sup class="refer
ence" 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="Geo
stationary 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">[35]</a></sup> and first successful reignition of the second stag
e.<sup class="reference" id="cite_ref-46"><a href="#cite_note-46">[39]</a></s
up> SES-8 was inserted into a <a href="/wiki/Geostationary_transfer_orbit" ti
tle="Geostationary transfer orbit">Super-Synchronous Transfer Orbit</a> of 7
9,341 km (49,300 mi) in apogee with an <a href="/wiki/Orbital_inclination" ti
tle="Orbital inclination">inclination</a> of 20.55° to the <a href="/wiki/Equ
ator" 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

In [10]:
```
column_names = []

# Apply find_all() function with `th` element on first_launch_table
flt = first_launch_table.find_all('th')

# Iterate each th element and apply the provided extract_column_from_header(
# Append the Non-empty column name (`if name is not None and len(name) > 0`)

for i in flt:
    name = extract_column_from_header(i)
    if (name != None and len(name) != 0):
        column_names.append(extract_column_from_header(i))
```

Check the extracted column names

In [11]:
```
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 [12]:
```
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 [13]:
```
extracted_row = 0
#Extract each table
for table_number,table in enumerate(soup.find_all('table',"wikitable plainrc
   # get table row
    for rows in table.find_all("tr"):
        #check to see if first table heading is as number corresponding to l
        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
                # TODO: Append the flight_number into launch_dict with key `Flig
                launch_dict['Flight No.'].append(flight_number)
                print(flight_number)
                datatimelist=date_time(row[0])

                # Date value
                date = datatimelist[0].strip(',')
                # TODO: Append the date into launch_dict with key `Date`
                launch_dict['Date'].append(date)
                #print(date)

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

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

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

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

                # Payload Mass
                # TODO: Append the payload_mass into launch_dict with key `Paylo
                payload_mass = get_mass(row[4])
                launch_dict['Payload mass'].append(payload_mass)
                #print(payload)

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

```
            #print(orbit)

            # Customer
            # TODO: Append the customer into launch_dict with key `Customer`
            customer = row[6].text.strip()
            launch_dict['Customer'].append(customer)
            #print(customer)

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

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

```
1
F9 v1.0B0003.1
2
F9 v1.0B0004.1
3
F9 v1.0B0005.1
4
F9 v1.0B0006.1
5
F9 v1.0B0007.1
6
F9 v1.1B1003
7
F9 v1.1
8
F9 v1.1
9
F9 v1.1
10
F9 v1.1
11
F9 v1.1
12
F9 v1.1
13
F9 v1.1
14
F9 v1.1
15
F9 v1.1
16
F9 v1.1
17
F9 v1.1
18
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19
F9 v1.1
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F9 FT
21
F9 v1.1
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F9 FT
23
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24
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F9 FT
27
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28
F9 FT
```

```
29
F9 FT
30
F9 FT
31
F9 FT
32
F9 FT♺
33
F9 FT
34
F9 FT
35
F9 FT
36
F9 FTB1029.2
37
F9 FT
38
F9 FT
39
F9 B4
40
F9 FT
41
F9 B4
42
F9 B4
43
F9 FTB1031.2
44
F9 B4
45
F9 FTB1035.2
46
F9 FTB1036.2
47
F9 B4
48
F9 FTB1032.2
49
F9 FTB1038.2
50
F9 B4
51
F9 B4B1041.2
52
F9 B4B1039.2
53
F9 B4
54
F9 B5B1046.1
55
F9 B4B1043.2
56
F9 B4B1040.2
```

```
57
F9 B4B1045.2
58
F9 B5
59
F9 B5B1048
60
F9 B5B1046.2
61
F9 B5
62
F9 B5B1048.2
63
F9 B5B1047.2
64
F9 B5B1046.3
65
F9 B5
66
F9 B5
67
F9 B5B1049.2
68
F9 B5B1048.3
69
F9 B5[268]
70
F9 B5
71
F9 B5B1049.3
72
F9 B5B1051.2
73
F9 B5B1056.2
74
F9 B5B1047.3
75
F9 B5
76
F9 B5
77
F9 B5B1056.3
78
F9 B5
79
F9 B5
80
F9 B5
81
F9 B5
82
F9 B5
83
F9 B5
84
F9 B5
```

```
85
F9 B5
86
F9 B5
87
F9 B5
88
F9 B5
89
F9 B5B1058.2
90
F9 B5
91
F9 B5B1049.6
92
F9 B5
93
F9 B5B1060.2
94
F9 B5B1058.3
95
F9 B5B1051.6
96
F9 B5
97
F9 B5
98
F9 B5
99
F9 B5
100
F9 B5 ♺
101
F9 B5 ♺
102
F9 B5 ♺
103
F9 B5 ♺
104
F9 B5
105
F9 B5B1051.8
106
F9 B5B1058.5
107
F9 B5 ♺
108
F9 B5 ♺
109
F9 B5 ♺
110
F9 B5 ♺
111
F9 B5 ♺
112
F9 B5B1060.6
```

```
113
F9 B5 ♺
114
F9 B5B1061.2
115
F9 B5B1060.7
116
F9 B5B1049.9
117
F9 B5B1051.10
118
F9 B5B1058.8
119
F9 B5B1063.2
120
F9 B5B1067.1
121
F9 B5
```

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

In [14]:
```
launch_dict
```

Out[14]:

```
{'Flight No.': ['1',
                '2',
                '3',
                '4',
                '5',
                '6',
                '7',
                '8',
                '9',
                '10',
                '11',
                '12',
                '13',
                '14',
                '15',
                '16',
                '17',
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'57',
'58',
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'110',
'111',
'112',
```

```
 '113',
 '114',
 '115',
 '116',
 '117',
 '118',
 '119',
 '120',
 '121'],
'Launch site': ['CCAFS',
 'CCAFS',
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 'Cape Canaveral',
 'VAFB',
 'CCAFS',
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```
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 'CCSFS',
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 'KSC',
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'Payload': ['Dragon Spacecraft Qualification Unit',
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 'Dragon',
 'SpaceX CRS-1',
 'SpaceX CRS-2',
 'CASSIOPE',
 'SES-8',
 'Thaicom 6',
 'SpaceX CRS-3',
 'Orbcomm-OG2',
 'AsiaSat 8',
 'AsiaSat 6',
 'SpaceX CRS-4',
 'SpaceX CRS-5',
 'DSCOVR',
 'ABS-3A',
 'SpaceX CRS-6',
 'TürkmenÄlem 52°E / MonacoSAT',
 'SpaceX CRS-7',
 'Orbcomm-OG2',
 'Jason-3',
 'SES-9',
 'SpaceX CRS-8',
 'JCSAT-14',
 'Thaicom 8',
 'ABS-2A',
 'SpaceX CRS-9',
 'JCSAT-16',
 'Iridium NEXT',
 'SpaceX CRS-10',
 'EchoStar 23',
 'SES-10',
 'NROL-76',
 'Inmarsat-5 F4',
 'SpaceX CRS-11',
 'BulgariaSat-1',
 'Iridium NEXT',
 'Intelsat 35e',
```

```
'SpaceX CRS-12',
'Formosat-5',
'Boeing X-37B',
'Iridium NEXT',
'SES-11',
'Koreasat 5A',
'SpaceX CRS-13',
'Iridium NEXT',
'Zuma',
'GovSat-1',
'Paz',
'Hispasat 30W-6',
'Iridium NEXT',
'SpaceX CRS-14',
'Transiting Exoplanet Survey Satellite',
'Bangabandhu-1',
'Iridium NEXT',
'SES-12',
'SpaceX CRS-15',
'Telstar 19V',
'Iridium NEXT',
'Merah Putih',
'Telstar 18V',
'SAOCOM 1A',
"Es'hail 2",
'SSO-A',
'SpaceX CRS-16',
'GPS III',
'Iridium NEXT',
'Nusantara Satu',
'Crew Dragon Demo-1',
'SpaceX CRS-17',
'Starlink',
'RADARSAT Constellation',
'SpaceX CRS-18',
'AMOS-17',
'Starlink',
'SpaceX CRS-19',
'JCSat-18',
'Starlink',
'Crew Dragon in-flight abort test',
'Starlink',
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In [15]:
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df= pd.DataFrame({ key:pd.Series(value) for key, value in launch_dict.items(
df
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Out[15]:

	Flight No.	Launch site	Payload	Payload mass	Orbit	Customer	Launch outcome	Version Booster
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1	2	CCAFS	Dragon	0	LEO	NASA (COTS)\nNRO	Success	F9 v1.0B0004.1
2	3	CCAFS	Dragon	525 kg	LEO	NASA (COTS)	Success	F9 v1.0B0005.1
3	4	CCAFS	SpaceX CRS-1	4,700 kg	LEO	NASA (CRS)	Success\n	F9 v1.0B0006.1
4	5	CCAFS	SpaceX CRS-2	4,877 kg	LEO	NASA (CRS)	Success\n	F9 v1.0B0007.1
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116	117	CCSFS	Starlink	15,600 kg	LEO	SpaceX	Success\n	F9 B5B1051.10
117	118	KSC	Starlink	~14,000 kg	LEO	SpaceX Capella Space and Tyvak	Success\n	F9 B5B1058.8
118	119	CCSFS	Starlink	15,600 kg	LEO	SpaceX	Success\n	F9 B5B1063.2
119	120	KSC	SpaceX CRS-22	3,328 kg	LEO	NASA (CRS)	Success\n	F9 B5B1067.1
120	121	CCSFS	SXM-8	7,000 kg	GTO	Sirius XM	Success\n	F9 B5

121 rows × 11 columns

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.

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

In [16]:
```
df.to_csv('spacex_web_scraped.csv', index=False)
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Authors

Yan Luo

Nayef Abou Tayoun

Change Log

Date (YYYY-MM-DD)	Version	Changed By	Change Description
2021-06-09	1.0	Yan Luo	Tasks updates
2020-11-10	1.0	Nayef	Created the initial version

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