



# SpaceX Falcon 9 first stage Landing Prediction

## Lab 1: Collecting the data

Estimated time needed: **45** minutes

In this capstone, we will predict if the Falcon 9 first stage will land successfully. SpaceX advertises Falcon 9 rocket launches on its website with a cost of 62 million dollars; other providers cost upward of 165 million dollars each, much of the savings is because SpaceX can reuse the first stage. Therefore if we can determine if the first stage will land, we can determine the cost of a launch. This information can be used if an alternate company wants to bid against SpaceX for a rocket launch. In this lab, you will collect and make sure the data is in the correct format from an API. The following is an example of a successful and launch.



Several examples of an unsuccessful landing are shown here:



Most unsuccessful landings are planned. Space X performs a controlled landing in the oceans.

## Objectives

In this lab, you will make a get request to the SpaceX API. You will also do some basic data wrangling and formatting.

- Request to the SpaceX API
- Clean the requested data

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## Import Libraries and Define Auxiliary Functions

We will import the following libraries into the lab

```
In [3]: # Requests allows us to make HTTP requests which we will use to get data from an AP
import requests
# Pandas is a software library written for the Python programming language for data
import pandas as pd
# NumPy is a library for the Python programming language, adding support for large,
import numpy as np
# Datetime is a library that allows us to represent dates
import datetime

# Setting this option will print all columns of a dataframe
pd.set_option('display.max_columns', None)
# Setting this option will print all of the data in a feature
pd.set_option('display.max_colwidth', None)
```

Below we will define a series of helper functions that will help us use the API to extract information using identification numbers in the launch data.

From the `rocket` column we would like to learn the booster name.

```
In [4]: # Takes the dataset and uses the rocket column to call the API and append the data
def getBoosterVersion(data):
    for x in data['rocket']:
        if x:
            response = requests.get("https://api.spacexdata.com/v4/rockets/"+str(x)).json()
            BoosterVersion.append(response['name'])
```

From the `launchpad` we would like to know the name of the launch site being used, the longitude, and the latitude.

```
In [6]: # Takes the dataset and uses the launchpad column to call the API and append the data
def getLaunchSite(data):
    for x in data['launchpad']:
        if x:
            response = requests.get("https://api.spacexdata.com/v4/launchpads/"+str(x)).json()
            Longitude.append(response['longitude'])
            Latitude.append(response['latitude'])
            LaunchSite.append(response['name'])
```

From the `payload` we would like to learn the mass of the payload and the orbit that it is going to.

```
In [7]: # Takes the dataset and uses the payloads column to call the API and append the data
def getPayloadData(data):
    for load in data['payloads']:
        if load:
            response = requests.get("https://api.spacexdata.com/v4/payloads/"+load).json()
            PayloadMass.append(response['mass_kg'])
            Orbit.append(response['orbit'])
```

From `cores` we would like to learn the outcome of the landing, the type of the landing, number of flights with that core, whether gridfins were used, whether the core is reused, whether legs were used, the landing pad used, the block of the core which is a number used to separate version of cores, the number of times this specific core has been reused, and the serial of the core.

```
In [8]: # Takes the dataset and uses the cores column to call the API and append the data
def getCoreData(data):
    for core in data['cores']:
        if core['core'] != None:
            response = requests.get("https://api.spacexdata.com/v4/cores/"+core['core']).json()
            Block.append(response['block'])
            ReusedCount.append(response['reuse_count'])
            Serial.append(response['serial'])
        else:
            Block.append(None)
            ReusedCount.append(None)
            Serial.append(None)
        Outcome.append(str(core['landing_success'])+' '+str(core['landing_type']))
        Flights.append(core['flight'])
        GridFins.append(core['gridfins'])
```

```
Reused.append(core['reused'])  
Legs.append(core['legs'])  
LandingPad.append(core['landpad'])
```

Now let's start requesting rocket launch data from SpaceX API with the following URL:

```
In [9]: spacex_url="https://api.spacexdata.com/v4/launches/past"
```

```
In [10]: response = requests.get(spacex_url)
```

Check the content of the response

```
In [12]: print(response.content)
```

```

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```

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ervatory-blasts-off-after-17-year-wait/","wikipedia":"https://en.wikipedia.org/wiki/
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3 launch contract. First SpaceX launch to put a satellite to an orbit with an orbita
l altitude many times the distance to the Moon: Sun-Earth libration point L1. The fi
rst stage made a test flight descent to an over-ocean landing within 10 m (33 ft) of
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oined launch of a lighter-weight dual-commsat stack that was specifically designed t
o take advantage of the lower-cost SpaceX Falcon 9 launch vehicle. Per satellite, la
unch costs were less than $30 million. The ABS satellite reached its final destinati
on ahead of schedule and started operations on September 10.","crew":[],"ships":
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ontract (not related to NASA CRS or USAF OSP3 contracts). Last launch of the origina
l Falcon 9 v1.1 launch vehicle. The Jason-3 satellite was successfully deployed to t
arget orbit. SpaceX again attempted a recovery of the first stage booster by landing
on an autonomous drone ship; this time located in the Pacific Ocean. The first stage
did achieve a soft-landing on the ship, but a lockout on one of the landing legs fai
led to latch, so that the booster fell over and exploded.", "crew": [], "ships": ["5ea6e
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ed, booster recovery failed: the spent first stage \"landed hard\", but the contro
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and returned significant test data on bringing back high-energy Falcon 9s.", "crew":

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e on flight 16, Falcon again launched two Boeing 702SP gridded ion thruster satellit
es in a dual-stack configuration, with the two customers sharing the rocket and miss
ion costs. First stage landing attempt on drone ship failed on landing due to low th
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following the cancellation of their Dnepr launch contract in 2015. Iridium CEO Matt
Desch disclosed in September 2017 that GRACE-FO would be launched on the sixth Iridi
um NEXT mission. The booster reuse turnaround was a record 4.5 months between flight
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com/2018/06/04/multi-mission-telecom-craft-launched-by-spacex-for-ses/","wikipedi
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t satellite for NSS-6, was successfully launched and deployed on June 4th, completin
g SpaceX's eleventh flight of 2018. According to SES Luxembourg, The SES-12 satellit
e will expand SES's capabilities to provide direct-to-home (DTH) broadca
sting, VSAT, Mobility and High Throughput Satellite (HTS) data connectivity services
in the Middle East and the Asia-Pacific region, including rapidly growing markets su
ch as India and Indonesia. [SES-12] will be co-located with SES-8","crew":[],"ship
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e":"https://spaceflightnow.com/2018/06/29/spacex-launches-ai-enabled-robot-companion
-vegetation-monitor-to-space-station/","wikipedia":"https://en.wikipedia.org/wiki/Sp
aceX_CRS-15"},"static_fire_date_utc":"2018-06-23T21:30:00.000Z","static_fire_date_un
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End Effector. The refurbished booster featured a record 2.5 months period turnaround
from its original launch of the TESS satellite \xe2\x80\x94 the fastest previous was
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f eight launches in a half-a-billion-dollar contract with Iridium. Will use a Block
5 first stage, to be recovered in the Pacific Ocean. Only one mission will be left f
or Iridium, with 10 more satellites. First attempt to recover a Fairing with the upg
raded net. Fairing recovery was not successful.", "crew": [], "ships": ["5ea6ed2f080df40
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(also known as Telkom-4) geostationary communications satellite for Telkom Indonesia. It marked the first reuse of any Block 5 first stage; the booster B1046 had previously launched Bangabandhu-1. The stage was recovered and is expected to become the first Falcon 9 booster to fly three missions.

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s-first-rocket-landing-in-california-after-launching-argentine-satellite/", "wikipedia": "https://en.wikipedia.org/wiki/SAOCOM", "static\_fire\_date\_utc": "2018-10-02T21:00:00.000Z", "static\_fire\_date\_unix": 1538514000, "net": false, "window": 0, "rocket": "5e9d0d95eda69973a809d1ec", "success": true, "failures": [], "details": "SpaceX's seventeenth flight of 2018 was the first launch of the Saocom Earth observation satellite constellation of the Argentine Space Agency CONAE. The second launch of Saocom 1B will happen in 2019. This flight marked the first RTLS launch out of Vandenberg, with a landing on the concrete pad at SLC-4W, very close to the launch pad.", "crew": [], "ships": [], "capsules": [], "payloads": ["5eb0e4c9b6c3bb006eeb22c"], "launchpad": "5e9e4502f509092b78566f87", "flight\_number": 69, "name": "SAOCOM 1A", "date\_utc": "2018-10-08T02:22:00.000Z", "date\_unix": 1538965320, "date\_local": "2018-10-07T19:22:00-07:00", "date\_precision": "hour", "upcoming": false, "cores": [{"core": "5e9e28a5f3591809c03b2658", "flight": 2, "gridfins": true, "legs": true, "reused": true, "landing\_attempt": true, "landing\_success": true, "landing\_type": "RTLS", "landpad": "5e9e3032383ecb554034e7c9"}, {"fairings": {"reused": false, "recovery\_attempt": false, "recovered": false, "ships": []}, "links": {"patch": {"small": "https://images2.imgbox.com/ad/40/cOCTCFYf1\_o.png", "large": "https://images2.imgbox.com/7c/8a/j6Hu3TqR\_o.png"}, "reddit": {"campaign": "https://www.reddit.com/r/spacex/comments/9p82jt/eshail\_2\_launch\_campaign\_thread/", "launch": "https://www.reddit.com/r/spacex/comments/9x9w9v/rspacex\_eshail\_2\_official\_launch\_discussion/", "media": "https://www.reddit.com/r/spacex/comments/9xaa76/rspacex\_eshail\_2\_media\_thread\_videos\_images\_gifs/", "recovery": "https://www.reddit.com/r/spacex/comments/9xmpa7/eshail\_2\_recovery\_thread/"}, "flickr": {"small": [], "original": ["https://farm5.staticflickr.com/4834/32040174268\_b71d703417\_o.jpg", "https://farm5.staticflickr.com/4810/32040174058\_a65fa64e85\_o.jpg", "https://farm5.staticflickr.com/4814/32040173268\_0ab571e7bc\_o.jpg", "https://farm5.staticflickr.com/4899/32040173568\_bb5c991565\_o.jpg", "https://farm5.staticflickr.com/4875/32040173278\_b5578ba6be\_o.jpg", "https://farm5.staticflickr.com/4862/32040173928\_afdfb09939\_o.jpg", "https://farm5.staticflickr.com/4888/32040173048\_b2b29c020f\_o.jpg", "https://farm5.staticflickr.com/4808/32248947038\_dd1cf9e8c3\_o.jpg", "https://farm5.staticflickr.com/4887/31180979107\_da6a935c20\_o.jpg"]}], "presskit": "https://www.spacex.com/sites/spacex/files/eshail-2\_mission\_press\_kit\_11\_14\_2018.pdf", "webcast": "https://www.youtube.com/watch?v=PhTbzc-BqKs&feature=youtu.be", "youtube\_id": "PhTbzc-BqKs", "article": "https://spaceflightnow.com/2018/11/15/spacex-launches-qatars-eshail-2-communications-satellite/", "wikipedia": "https://en.wikipedia.org/wiki/Es%27hailSat", "static\_fire\_date\_utc": "2018-11-12T18:13:00.000Z", "static\_fire\_date\_unix": 1542046380, "net": false, "window": 6180, "rocket": "5e9d0d95eda69973a809d1ec", "success": true, "failures": [], "details": "SpaceX's eighteenth flight of 2018 was its first for Es'hailSat. Es'hail-2 is a communications satellite delivering television and internet to Qatar and the surrounding region. It was launched into a geostationary transfer orbit from LC-39A at Kennedy Space Center. The booster landed on OCISLY.", "crew": [], "ships": ["5ea6ed2f080df4000697c90d", "5ea6ed30080df4000697c913"], "capsules": [], "payloads": ["5eb0e4c9b6c3bb006eeb22d"], "launchpad": "5e9e4502f509094188566f88", "flight\_number": 70, "name": "Es'hail 2", "date\_utc": "2018-11-15T20:46:00.000Z", "date\_unix": 1542314760, "date\_local": "2018-11-15T15:46:00-05:00", "date\_precision": "hour", "upcoming": false, "cores": [{"core": "5e9e28a5f359181eed3b2657", "flight": 2, "gridfins": true, "legs": true, "reused": true, "landing\_attempt": true, "landing\_success": true, "landing\_type": "ASDS", "landpad": "5e9e3032383ecb6bb234e7ca"}, {"fairings": {"reused": false, "recovery\_attempt": true, "recovered": false, "ships": ["5ea6ed2e080df4000697c908"]}], "links": {"patch": {"small": "https://images2.imgbox.com/48/3b/Lg1Qc4uX\_o.png", "large": "https://images2.imgbox.com/3e/87/xYszAJQc\_o.png"}, "reddit": {"campaign": "https://www.reddit.com/r/spacex/comments/9raysi/ssoa\_launch\_campaign\_thread", "launch": "https://www.reddit.com/r/spacex/comments/a0vjff/rspacex\_ssoa\_official\_launch\_discussion\_updates/", "media": "https://old.reddit.com/r/spacex/comments/a0wylf/rspacex\_ssoa\_media\_thread\_videos\_images\_gifs/", "recovery": "https://www.reddit.com/r/spacex/comments/a2tjoe/ssoa\_recovery\_thread/"}, "flickr": {"small": [], "original": ["https://

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nched the first of the new GPS III satellites (Block IIIA) for the United States Air
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tps://spaceflightnow.com/2019/01/11/spacex-begins-2019-with-eighth-and-final-for-upg
raded-iridium-network/", "wikipedia": "https://en.wikipedia.org/wiki/Iridium_satellite
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ht of 2019 will be the eighth and final launch of its planned Iridium flights. Deliv
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the Iridium NEXT constellation. This mission launches from SLC-4E at Vandenberg AFB.
The booster is expected to land on JRTI.", "crew": [], "ships": ["5ea6ed2f080df4000697c9
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hes-space-station-resupply-mission-lands-rocket-on-drone-ship/", "wikipedia":"http
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Resupply Services mission for NASA out of a total of 20 contracted flights, this mis
sion brings essential supplies to the International Space Station using SpaceX's re
usable Dragon 1 spacecraft. The external payloads for this mission include Orbital C
arbon Observatory 3 and Space Test Program-Houston 6. The Falcon 9 launches from SLC
-40 at Cape Canaveral AFS. The booster was expected to land at LZ-1, however, due to
the ongoing investigation and clean-up following the Crew Dragon testing incident, i
t is likely to land on OCISLY instead.\\n    ", "crew":[], "ships":["5ea6ed30080df4000
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ghtnow.com/2019/05/24/spacexs-first-60-starlink-broadband-satellites-deployed-in-orb
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lites from SLC-40, Cape Canaveral AFS. Starlink is a low Earth orbit broadband inter
net constellation developed and owned by SpaceX which will eventually consist of nea
rly 12 000 satellites and will provide low latency internet service to ground termin
als around the world. Two prototype satellites, Microsats 2a and 2b, were launched f
rom Vandenberg AFB in February 2018. The booster for this mission will land on OCISL
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eflightnow.com/2019/06/12/three-canadian-radar-surveillance-satellites-ride-spacex-r
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ilures":[],"details":"SpaceX is launching the three satellite RADARSAT Constellation
Mission into Sun Synchronous orbit from SLC-4E, VAFB. The RCM spacecraft are synthe
tic aperture radar (SAR) Earth observation satellites built by the Canadian space com
pany, MDA, for the Canadian Space Agency. This mission was delayed when the original
ly slated booster failed to land after CRS-16. The booster is expected to return to
LZ-4.", "crew":[],"ships":[],"capsules":["5eb0e4ccb6c3bb0006eeb239"],"l
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C-40 at Cape Canaveral AFS on a Falcon 9, and the first-stage booster is expected to land back at CCAFS LZ-1.", "crew": [], "ships": [], "capsules": ["5e9e2c5cf359188bfb3b266b"], "payloads": ["5eb0e4ceb6c3bb0006eeb24a"], "launchpad": "5e9e4501f509094ba4566f84", "flight\_number": 82, "name": "CRS-18", "date\_utc": "2019-07-25T22:01:00.000Z", "date\_unix": 1564092060, "date\_local": "2019-07-25T18:01:00-04:00", "date\_precision": "hour", "upcoming": false, "cores": [{"core": "5e9e28a7f3591809313b2660", "flight": 2, "gridfins": true, "legs": true, "reused": true, "landing\_attempt": true, "landing\_success": true, "landing\_type": "RTLS", "landpad": "5e9e3032383ecb267a34e7c7"}], "auto\_update": true, "tbd": false, "launch\_library\_id": null, "id": "5eb87d36ffd86e000604b37b"}, {"fairings": {"reused": false, "recovery\_attempt": true, "recovered": true, "ships": ["5ea6ed2e080df4000697c908"]}, "links": {"patch": {"small": "https://images2.imgbox.com/65/c2/MMGkhdcA\_o.png", "large": "https://images2.imgbox.com/9e/6f/oaYZfAoF\_o.png"}, "reddit": {"campaign": "https://www.reddit.com/r/spacex/comments/cjaawx/amos17\_launch\_campaign\_thread", "launch": "https://www.reddit.com/r/spacex/comments/cmmedgn/rspacex\_amos17\_official\_launch\_discussion\_updates", "media": "https://www.reddit.com/r/spacex/comments/cmppne/rspacex\_amos17\_media\_thread\_videos\_images\_gifs", "recovery": null}, "flickr": {"small": [], "original": ["https://live.staticflickr.com/65535/48478269312\_58dd3dc446\_o.jpg", "https://live.staticflickr.com/65535/48478269747\_353dcb2e62\_o.jpg", "https://live.staticflickr.com/65535/48478119901\_2de0441026\_o.jpg", "https://live.staticflickr.com/65535/48478120646\_ab72c2c6c3\_o.jpg", "https://live.staticflickr.com/65535/48478120031\_5aaef6131\_o.jpg", "https://live.staticflickr.com/65535/48478269442\_08479bed36\_o.jpg"]}, "presskit": "https://www.spacex.com/sites/spacex/files/amos-17\_mission\_press\_kit\_8\_6\_2019.pdf", "webcast": "https://youtu.be/fZh82-WcCuo", "youtube\_id": "fZh82-WcCuo", "article": "https://spaceflightnow.com/2019/08/07/spacex-launches-israeli-owned-telecom-satellite/", "wikipedia": "https://en.wikipedia.org/wiki/Spacecom"}, "static\_fire\_date\_utc": "2019-08-01T00:00:00.000Z", "static\_fire\_date\_unix": 1564617600, "net": false, "window": 5280, "rocket": "5e9d0d95eda69973a809d1ec", "success": true, "failures": [], "details": "SpaceX will launch Boeing built Amos-17, a geostationary communications satellite for Israeli company Spacecom. The satellite will be delivered to GTO from KSC LC-39A or possibly CCAFS SLC-40, and will replace the defunct Amos-5 at 17\\xc2\\xb0 E. Amos-17 carries multi-band high throughput and regional beams servicing Africa, Europe and the Middle East. The cost of this launch is covered for Spacecom by SpaceX credit following the Amos-6 incident. A recovery of the booster for this mission is not expected.", "crew": [], "ships": ["5ea6ed2e080df4000697c908", "5ea6ed2e080df4000697c909"], "capsules": [], "payloads": ["5eb0e4cfb6c3bb0006eeb24b"], "launchpad": "5e9e4501f509094ba4566f84", "flight\_number": 83, "name": "Amos-17", "date\_utc": "2019-08-06T22:52:00.000Z", "date\_unix": 1565131920, "date\_local": "2019-08-06T18:52:00-04:00", "date\_precision": "hour", "upcoming": false, "cores": [{"core": "5e9e28a5f359181eed3b2657", "flight": 3, "gridfins": false, "legs": false, "reused": true, "landing\_attempt": false, "landing\_success": null, "landing\_type": null, "landpad": null}], "auto\_update": true, "tbd": false, "launch\_library\_id": null, "id": "5eb87d37ffd86e000604b37c"}, {"fairings": {"reused": true, "recovery\_attempt": false, "recovered": false, "ships": []}, "links": {"patch": {"small": "https://images2.imgbox.com/61/a6/1MnnbXIF\_o.png", "large": "https://images2.imgbox.com/3a/d1/R1MaGiiV\_o.png"}, "reddit": {"campaign": "https://www.reddit.com/r/spacex/comments/dgqcb6/2nd\_starlink\_mission\_launch\_campaign\_thread", "launch": "https://www.reddit.com/r/spacex/comments/du07rt/rspacex\_starlink1\_official\_launch\_discussion", "media": "https://www.reddit.com/r/spacex/comments/durx53/rspacex\_starlink\_1\_media\_thread\_videos\_images", "recovery": "https://www.reddit.com/r/spacex/comments/du1duu/starlink1\_booster\_and\_fairing\_recovery\_discussion"}, "flickr": {"small": [], "original": ["https://live.staticflickr.com/65535/49051988851\_0b422e1603\_o.jpg", "https://live.staticflickr.com/65535/49051988746\_1a97e38ca8\_o.jpg", "https://live.staticflickr.com/65535/49052201452\_c3b01e37f0\_o.jpg", "https://live.staticflickr.com/65535/49051477088\_d86104481d\_o.jpg"]}, "presskit": "https://www.spacex.com/sites/spacex/files/starlink\_press\_kit\_nov2019.pdf", "webcast": "https://youtu.be/pIDuv0Ta0XQ", "youtube\_id": "pIDuv0Ta0XQ", "article": "https://spaceflightnow.com/2019/11/11/successful-launch-continues-deployment-of-spacexs-starlink-network", "wikipedia": "https://

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ceX\'s 20th and final Crew Resupply Mission under the original NASA CRS contract, this mission brings essential supplies to the International Space Station using SpaceX\'s reusable Dragon spacecraft. It is the last scheduled flight of a Dragon 1 capsule. (CRS-21 and up under the new Commercial Resupply Services 2 contract will use Dragon 2.) The external payload for this mission is the Bartolomeo ISS external payload hosting platform. Falcon 9 and Dragon will launch from SLC-40, Cape Canaveral Air Force Station and the booster will land at LZ-1. The mission will be complete with return and recovery of the Dragon capsule and down cargo.", "crew": [], "ships": [], "capsules": [{"5e9e2c5cf359185d753b266f"}, {"5eb0e4d0b6c3bb0006eeb253"}], "launchpad": {"5e9e4501f509094ba4566f84"}, "flight\_number": 91, "name": "CRS-20", "date\_utc": "2020-03-07T04:50:31.000Z", "date\_unix": 1583556631, "date\_local": "2020-03-06T23:50:31-05:00", "date\_precision": "hour", "upcoming": false, "cores": [{"core": {"5e9e28a7f359187afd3b2662"}, "flight": 2, "gridfins": true, "legs": true, "reused": true, "landing\_attempt": true, "landing\_success": true, "landing\_type": "RTLS", "landpad": {"5e9e3032383ecb267a34e7c7"}}, {"auto\_update": true, "tbd": false, "launch\_library\_id": null, "id": {"5eb87d42ffd86e000604b384"}}, {"fairings": {"reused": true, "recovery\_attempt": true, "recovered": false, "ships": [{"5ea6ed2e080df4000697c908"}]}, "links": {"patch": {"small": "https://images2.imgbox.com/dc/14/DLlaYbmF\_o.png", "large": "https://images2.imgbox.com/e4/fd/2NPlCwzs\_o.png"}}, "reddit": {"campaign": "https://www.reddit.com/r/spacex/comments/f8awv0/starlink5\_launch\_campaign\_thread/", "launch": "https://www.reddit.com/r/spacex/comments/fhymy3/rspacex\_starlink5\_official\_launch\_discussion/", "media": "https://www.reddit.com/r/spacex/comments/fizrn1/rspacex\_starlink5\_media\_thread\_videos\_images\_gifs/", "recovery": null}, "flickr": {"small": [], "original": ["https://live.staticflickr.com/65535/49673373182\_93a517e140\_o.jpg", "https://live.staticflickr.com/65535/49672551378\_fabc17ef6f\_o.jpg", "https://live.staticflickr.com/65535/49672551303\_564ce21658\_o.jpg"]}, "presskit": "https://www.spacex.com/sites/spacex/files/sixth\_starlink\_press\_kit.pdf", "webcast": "https://youtu.be/I4sMhHbHYXM", "youtube\_id": "I4sMhHbHYXM", "article": "https://spaceflightnow.com/2020/03/18/falcon-9-rocket-overcomes-engine-failure-to-deploy-starlink-satellites/", "wikipedia": "https://en.wikipedia.org/wiki/Starlink"}, {"static\_fire\_date\_utc": "2020-03-13T18:37:00.000Z", "static\_fire\_date\_unix": 1584124620, "net": false, "window": 0, "rocket": {"5e9d0d95eda69973a809d1ec"}, "success": true, "failures": [], "details": "The sixth Starlink launch overall and the fifth operational batch of Starlink satellites will launch into orbit aboard a Falcon 9 rocket. This mission is expected to deploy all sixty satellites into an elliptical orbit about fifteen minutes into flight. In the weeks following launch the satellites are expected to utilize their onboard ion thrusters to raise their orbits to 550 km in three groups of 20, making use of precession rates to separate themselves into three planes. The booster will land on a drone ship approximately 628 km downrange.", "crew": [], "ships": [{"5ea6ed30080df4000697c913"}, {"5ea6ed2f080df4000697c90d"}], "capsules": [], "payloads": [{"5eb0e4d0b6c3bb0006eeb254"}], "launchpad": {"5e9e4502f509094188566f88"}, "flight\_number": 92, "name": "Starlink-5", "date\_utc": "2020-03-18T12:16:00.000Z", "date\_unix": 1584533760, "date\_local": "2020-03-18T08:16:00-04:00", "date\_precision": "hour", "upcoming": false, "cores": [{"core": {"5e9e28a5f3591809c03b2658"}, "flight": 5, "gridfins": true, "legs": true, "reused": true, "landing\_attempt": true, "landing\_success": false, "landing\_type": "ASDS", "landpad": {"5e9e3032383ecb6bb234e7ca"}}, {"auto\_update": true, "tbd": false, "launch\_library\_id": null, "id": {"5eb87d43ffd86e000604b385"}}, {"fairings": {"reused": true, "recovery\_attempt": false, "recovered": null, "ships": [{"5ea6ed2e080df4000697c908"}, {"5ea6ed2f080df4000697c90d"}]}, "links": {"patch": {"small": "https://images2.imgbox.com/ef/36/h10Ds3kT\_o.png", "large": "https://images2.imgbox.com/ab/12/2cQPNTCZ\_o.png"}}, "reddit": {"campaign": "https://www.reddit.com/r/spacex/comments/fxkc7k/starlink6\_launch\_campaign\_thread/", "launch": "https://www.reddit.com/r/spacex/comments/g5jmx0/rspacex\_starlink6\_official\_launch\_discussion/", "media": "https://www.reddit.com/r/spacex/comments/g5fqka/rspacex\_starlink6\_media\_thread\_photographer/", "recovery": "https://www.reddit.com/r/spacex/comments/g6kztd/rspacex\_starlink\_v1\_l6\_recovery\_discussion/"}, "flickr": {"small": [], "original": ["https://live.staticflickr.com/65535/49673373182\_93a517e140\_o.jpg", "https://live.staticflickr.com/65535/49672551378\_fabc17ef6f\_o.jpg", "https://live.staticflickr.com/65535/49672551303\_564ce2

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\'s first dedicated military communications satellite. Falcon 9 will deliver the satellite to a geostationary transfer orbit. The booster is expected to land downrange on an ASDS.", "crew": [], "ships": ["5ea6ed2e080df4000697c908", "5ea6ed2e080df4000697c907", "5ea6ed2f080df4000697c90b"], "capsules": [], "payloads": ["5eb0e4d2b6c3bb0006eeb25b"], "launchpad": "5e9e4501f509094ba4566f84", "flight\_number": 98, "name": "ANASIS-II", "date\_utc": "2020-07-20T21:30:00.000Z", "date\_unix": 1595280600, "date\_local": "2020-07-20T17:30:00-04:00", "date\_precision": "hour", "upcoming": false, "cores": [{"core": "5e9e28a7f3591817f23b2663", "flight": 2, "gridfins": true, "legs": true, "reused": true, "landing\_attempt": true, "landing\_success": true, "landing\_type": "ASDS", "landpad": "5e9e3033383ecbb9e534e7cc"}], "auto\_update": true, "tbd": false, "launch\_library\_id": null, "id": "5eb87d50fffd86e000604b394"}, {"fairings": {"reused": null, "recovery\_attempt": true, "recovered": true, "ships": ["5ea6ed2e080df4000697c908", "5ea6ed2e080df4000697c907"]}, "links": {"patch": {"small": "https://images2.imgbox.com/ac/ad/FhIfqkTq\_o.png", "large": "https://images2.imgbox.com/2f/4f/Mk46ah9f\_o.png"}, "reddit": {"campaign": "https://www.reddit.com/r/spacex/comments/h8mold/starlink9\_launch\_campaign\_thread/", "launch": "https://www.reddit.com/r/spacex/comments/i4ozw3/rspacex\_starlink9\_launch\_discussion\_updates/", "media": "https://www.reddit.com/r/spacex/comments/hg499n/rspacex\_starlink9\_media\_thread\_photographer/", "recovery": "https://www.reddit.com/r/spacex/comments/i5smhk/starlink\_9blacksky\_recovery\_thread/"}, "flickr": {"small": [], "original": ["https://live.staticflickr.com/65535/50198901143\_0bb53a499e\_o.jpg", "https://live.staticflickr.com/65535/50199448011\_35d0e9c8bf\_o.jpg", "https://live.staticflickr.com/65535/50199715777\_eca6f41d25\_o.jpg"]}, "presskit": null, "webcast": "https://youtu.be/KU6KogxG5BE", "youtube\_id": "KU6KogxG5BE", "article": "https://spaceflightnow.com/2020/08/07/spacex-closes-out-busy-week-with-launch-of-more-starlink-satellites/", "wikipedia": "https://en.wikipedia.org/wiki/Starlink"}, "static\_fire\_date\_utc": "2020-06-24T18:18:00.000Z", "static\_fire\_date\_unix": 1593022680, "net": false, "window": 0, "rocket": "5e9d0d95eda69973a809d1ec", "success": true, "failures": [], "details": "This mission will launch the ninth batch of operational Starlink satellites, which are expected to be version 1.0, from LC-39A, Kennedy Space Center. It is the tenth Starlink launch overall. The satellites will be delivered to low Earth orbit and will spend a few weeks maneuvering to their operational altitude of 550 km. This mission includes a rideshare of two BlackSky satellites on top of the Starlink stack. The booster for this mission is expected to land on an ASDS.", "crew": [], "ships": ["5ea6ed2e080df4000697c908", "5ea6ed2e080df4000697c907", "5ea6ed30080df4000697c913", "5ee68c683c228f36bd5809b5"], "capsules": [], "payloads": ["5ed9858b1f30554030d45c3e", "5ee522e32f1f3d474c758123"], "launchpad": "5e9e4502f509094188566f88", "flight\_number": 99, "name": "Starlink-9 (v1.0) & BlackSky Global 5-6", "date\_utc": "2020-08-07T05:12:00.000Z", "date\_unix": 1596777120, "date\_local": "2020-08-07T01:12:00-04:00", "date\_precision": "hour", "upcoming": false, "cores": [{"core": "5e9e28a6f35918c0803b265c", "flight": 5, "gridfins": true, "legs": true, "reused": true, "landing\_attempt": true, "landing\_success": true, "landing\_type": "ASDS", "landpad": "5e9e3032383ecb6bb234e7ca"}], "auto\_update": true, "tbd": false, "launch\_library\_id": null, "id": "5ed9819a1f30554030d45c29"}, {"fairings": {"reused": true, "recovery\_attempt": true, "recovered": true, "ships": ["5ea6ed2e080df4000697c908", "5ea6ed2e080df4000697c907"]}, "links": {"patch": {"small": "https://images2.imgbox.com/64/b3/CIqV9XMZ\_o.png", "large": "https://images2.imgbox.com/17/e3/ZxklwOk\_r\_o.png"}, "reddit": {"campaign": "https://www.reddit.com/r/spacex/comments/i63bst/starlink\_general\_discussion\_and\_deployment\_thread/", "launch": "https://www.reddit.com/r/spacex/comments/ibacxz/rspacex\_starlink10\_launch\_discussion\_updates/", "media": "https://www.reddit.com/r/spacex/comments/ic46fw/starlink10\_recovery\_updates\_discussion\_thread/", "recovery": "https://www.reddit.com/r/spacex/comments/ic46fw/starlink10\_recovery\_updates\_discussion\_thread/"}, "flickr": {"small": [], "original": ["https://live.staticflickr.com/65535/50241845831\_9a7412e81d\_o.jpg", "https://live.staticflickr.com/65535/50242057637\_ea4f98d517\_o.jpg", "https://live.staticflickr.com/65535/50242057682\_6084977bf7\_o.jpg", "https://live.staticflickr.com/65535/50242057677\_e96fbd46e6\_o.jpg"]}, "presskit": null, "webcast": "https://youtu.be/jTMJK7wb0rM", "youtube\_id": "jTMJK7wb0rM", "article": "https://spaceflightnow.com/2020/08/18/spacex-adds-more-satellites-to-ever-growing-starlink-network/", "wikipedia": "https://en.wikipedia.org/wiki/Starlink"}]



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a synthetic aperture radar Earth observation satellite to support disaster managemen
t. The SAOCOM spacecraft are operated by CONAE, the Argentinian National Space Activ
ities Commission, and are built by INVAP. This mission is also expected to include r
ideshare payloads Sequoia, and GNOMES-1. This will be the first polar launch from th
e Space Coast in 60 years. The launch azimuth will be southward and the booster will
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on brings essential supplies to the International Space Station using the cargo vari
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r and the booster is expected to land on an ASDS. The mission will be complete with
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frica and South Africa. The booster for this mission will be recovered downrange via ASDS.", "crew": [], "ships": ["5ea6ed2f080df4000697c90d", "5ea6ed2f080df4000697c910", "5ea6ed2e080df4000697c907", "5ea6ed2e080df4000697c908"], "capsules": [], "payloads": ["5eb0e4d3b6c3bb0006eeb264"], "launchpad": "5e9e4501f509094ba4566f84", "flight\_number": 113, "name": "Turksat 5A", "date\_utc": "2021-01-08T02:15:00.000Z", "date\_unix": 1610072100, "date\_local": "2021-01-07T21:15:00-05:00", "date\_precision": "hour", "upcoming": false, "cores": [{"core": "5ef670f10059c33cee4a826c", "flight": 4, "gridfins": true, "legs": true, "reused": true, "landing\_attempt": true, "landing\_success": true, "landing\_type": "ASDS", "landpad": "5e9e3033383ecbb9e534e7cc"}], "auto\_update": true, "tbd": false, "launch\_library\_id": null, "id": "5eb87d4fffd86e000604b393", {"fairings": {"reused": true, "recovery\_attempt": true, "recovered": null, "ships": ["5ea6ed2e080df4000697c907", "5ea6ed2e080df4000697c908"]}, "links": {"patch": {"small": "https://images2.imgbox.com/a6/d3/bPczm8gQ\_o.png", "large": "https://images2.imgbox.com/2b/28/fZnNbGqX\_o.png"}, "reddit": {"campaign": "https://www.reddit.com/r/spacex/comments/jhu37i/starlink\_general\_discussion\_and\_deployement\_thread/", "launch": "https://www.reddit.com/r/spacex/comments/kz969o/rspacex\_starlink16\_official\_launch\_discussion/", "media": "https://www.reddit.com/r/spacex/comments/11b5q8/starlink16\_media\_thread\_photographer\_contest/", "recovery": "https://www.reddit.com/r/spacex/comments/k2ts1q/rspacex\_fleet\_updates\_discussion\_thread/"}, "flickr": {"small": [], "original": ["https://live.staticflickr.com/65535/50855737853\_4d290519b4\_o.jpg", "https://live.staticflickr.com/65535/50856457401\_5fd05cddd1\_o.jpg", "https://live.staticflickr.com/65535/50855737933\_bcc65bdf8b\_o.jpg", "https://live.staticflickr.com/65535/50856551642\_5190c59ec1\_o.jpg"]}, "presskit": null, "webcast": "https://youtu.be/84Nct\_Q9Lqw", "youtube\_id": "84Nct\_Q9Lqw", "article": "https://spaceflightnow.com/2021/01/20/spacex-sets-new-rocket-reuse-records-with-successful-starlink-launch/", "wikipedia": "https://en.wikipedia.org/wiki/Starlink"}, "static\_fire\_date\_utc": null, "static\_fire\_date\_unix": null, "net": false, "window": null, "rocket": "5e9d0d95eda69973a809d1ec", "success": true, "failures": [], "details": "This mission launches the sixteenth batch of operational Starlink satellites, which are version 1.0, from SLC-40 or LC-39A. It is the seventeenth Starlink launch overall. The satellites will be delivered to low Earth orbit and will spend a few weeks maneuvering to their operational altitude. The booster is expected to land on an ASDS.", "crew": [], "ships": ["5ea6ed2e080df4000697c907", "5ea6ed2e080df4000697c908", "5ea6ed2f080df4000697c910", "5ea6ed2f080df4000697c90d", "5ea6ed2f080df4000697c90b"], "capsules": [], "payloads": ["5fbfedba54ceb10a5664c813"], "launchpad": "5e9e4502f509094188566f88", "flight\_number": 114, "name": "Starlink-16 (v1.0)", "date\_utc": "2021-01-20T13:02:00.000Z", "date\_unix": 1611147720, "date\_local": "2021-01-20T08:02:00-05:00", "date\_precision": "hour", "upcoming": false, "cores": [{"core": "5e9e28a6f35918c0803b265c", "flight": 8, "gridfins": true, "legs": true, "reused": true, "landing\_attempt": true, "landing\_success": true, "landing\_type": "ASDS", "landpad": "5e9e3033383ecbb9e534e7cc"}], "auto\_update": true, "tbd": false, "launch\_library\_id": null, "id": "5fbfecce54ceb10a5664c80a", {"fairings": {"reused": false, "recovery\_attempt": true, "recovered": true, "ships": ["5ea6ed2e080df4000697c908", "5ea6ed2e080df4000697c907"]}, "links": {"patch": {"small": "https://images2.imgbox.com/58/70/eapAog9v\_o.png", "large": "https://images2.imgbox.com/82/9a/fzsUstOu\_o.png"}, "reddit": {"campaign": "https://www.reddit.com/r/spacex/comments/kt5gds/transporter1\_launch\_campaign\_thread/", "launch": "https://www.reddit.com/r/spacex/comments/l210i3/rspacex\_transporter1\_official\_launch\_discussion/", "media": null, "recovery": "https://www.reddit.com/r/spacex/comments/k2ts1q/rspacex\_fleet\_updates\_discussion\_thread/"}, "flickr": {"small": [], "original": ["https://live.staticflickr.com/65535/50870343533\_e815eb30c4\_o.jpg", "https://live.staticflickr.com/65535/50871151292\_af114a3f9e\_o.jpg", "https://live.staticflickr.com/65535/50871053741\_59a1dbb6cc\_o.jpg", "https://live.staticflickr.com/65535/50871053696\_cd01a7e092\_o.jpg", "https://live.staticflickr.com/65535/50870343763\_1b1ac55eae\_o.jpg"]}, "presskit": null, "webcast": "https://youtu.be/SchI1cbkUv4", "youtube\_id": "SchI1cbkUv4", "article": "https://spaceflightnow.com/2021/01/24/spacex-launches-record-setting-rideshare-mission-with-143-small-satellites/", "wikipedia": null}, "static\_fire\_date\_utc": null, "static\_fire\_date\_unix": null, "net": false, "window": 2520, "rocket": "5e9d0d95eda69973a809d1ec", "success": true, "failures": [], "details": "SpaceX will launch a dedica



ted rideshare mission from SLC-40 or LC-39A. The spacecraft will be delivered into a sun-synchronous orbit. The booster for this mission is expected to land on an ASD

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S.", "crew": [], "ships": ["5ea6ed30080df4000697c913", "5ea6ed2f080df4000697c90c", "5ea6ed2e080df4000697c908", "5ea6ed2e080df4000697c907"], "capsules": [], "payloads": ["5fd3871a7faea57d297c86c6"], "launchpad": "5e9e4501f509094ba4566f84", "flight_number": 115, "name": "Transporter-1", "date_utc": "2021-01-24T15:00:00.000Z", "date_unix": 1611500400, "date_local": "2021-01-24T10:00:00-05:00", "date_precision": "hour", "upcoming": false, "cores": [{"core": "5e9e28a7f3591817f23b2663", "flight": 5, "gridfins": true, "legs": true, "reused": true, "landing_attempt": true, "landing_success": true, "landing_type": "ASDS", "landpad": "5e9e3032383ecb6bb234e7ca"}], "auto_update": true, "tbd": false, "launch_library_id": null, "id": "5fd386aa7faea57d297c86c1"}, {"fairings": {"reused": true, "recovery_attempt": true, "recovered": null, "ships": ["5ea6ed2e080df4000697c908", "5ea6ed2e080df4000697c907"]}, "links": {"patch": {"small": "https://images2.imgbox.com/81/af/UT6KOE53_o.png", "large": "https://images2.imgbox.com/6b/53/ZqAxQPhS_o.png"}, "reddit": {"campaign": "https://www.reddit.com/r/spacex/comments/jhu37i/starlink_general_discussion_and_deployement_thread/", "launch": "https://www.reddit.com/r/spacex/comments/lbjuok/rspacex_starlink18_official_launch_discussion/", "media": null, "recovery": "https://www.reddit.com/r/spacex/comments/k2ts1q/rspacex_fleet_updates_discussion_thread/"}, "flickr": {"small": [], "original": ["https://live.staticflickr.com/65535/50908787351_5733229c09_o.jpg", "https://live.staticflickr.com/65535/50908092893_d254477be0_o.jpg", "https://live.staticflickr.com/65535/50908092833_4cb5833fb9_o.jpg", "https://live.staticflickr.com/65535/50908787221_9cf383a2b4_o.jpg", "https://live.staticflickr.com/65535/50908787166_8dde2e29bd_o.jpg"]}, "presskit": null, "webcast": "https://youtu.be/fe6HBw1y6bA", "youtube_id": "fe6HBw1y6bA", "article": null, "wikipedia": "https://en.wikipedia.org/wiki/Starlink"}, {"static_fire_date_utc": null, "static_fire_date_unix": null, "net": false, "window": null, "rocket": "5e9d0d95eda69973a809d1ec", "success": true, "failures": [], "details": "This mission launches the eighteenth batch of operational Starlink satellites, which are version 1.0, from SLC-40. It is the nineteenth Starlink launch overall. The satellites will be delivered to low Earth orbit and will spend a few weeks maneuvering to their operational altitude. The booster is expected to land on an ASDS.", "crew": [], "ships": ["5ea6ed30080df4000697c913", "601742b20c87b90be7bb7e86", "5ea6ed2e080df4000697c908", "5ea6ed2e080df4000697c907", "5ea6ed2f080df4000697c90b"], "capsules": [], "payloads": ["5ff655769257f579ee3a6c64"], "launchpad": "5e9e4501f509094ba4566f84", "flight_number": 116, "name": "Starlink-18 (v1.0)", "date_utc": "2021-02-04T06:19:00.000Z", "date_unix": 1612419540, "date_local": "2021-02-04T01:19:00-05:00", "date_precision": "hour", "upcoming": false, "cores": [{"core": "5ef670f10059c33cee4a826c", "flight": 5, "gridfins": true, "legs": true, "reused": true, "landing_attempt": true, "landing_success": true, "landing_type": "ASDS", "landpad": "5e9e3032383ecb6bb234e7ca"}], "auto_update": true, "tbd": false, "launch_library_id": "f31702e8-6353-4c9a-932c-5bd104717500", "id": "5ff6554f9257f579ee3a6c5f"}, {"fairings": {"reused": null, "recovery_attempt": true, "recovered": true, "ships": ["5ea6ed2e080df4000697c908", "5ea6ed2e080df4000697c907"]}, "links": {"patch": {"small": "https://images2.imgbox.com/fa/01/EAdaKWgq_o.png", "large": "https://images2.imgbox.com/ec/c1/ex40h2Xp_o.png"}, "reddit": {"campaign": "https://www.reddit.com/r/spacex/comments/jhu37i/starlink_general_discussion_and_deployment_thread/", "launch": "https://www.reddit.com/r/spacex/comments/ljkh7l/rspacex_starlink19_official_launch_discussion/", "media": "https://www.reddit.com/r/spacex/comments/lkwl1g/starlink19_media_thread_photographer_contest/", "recovery": "https://www.reddit.com/r/spacex/comments/k2ts1q/rspacex_fleet_updates_discussion_thread/"}, "flickr": {"small": [], "original": ["https://live.staticflickr.com/65535/50949943433_87e3002307_o.jpg"]}, "presskit": null, "webcast": "https://youtu.be/L0dkyV09Zso", "youtube_id": "L0dkyV09Zso", "article": "https://spaceflightnow.com/2021/02/16/spacex-successfully-deploys-60-more-starlink-satellites-but-loses-booster-on-descent/", "wikipedia": "https://en.wikipedia.org/wiki/Starlink"}, {"static_fire_date_utc": "2021-02-13T18:17:00.000Z", "static_fire_date_unix": 1613240220, "net": false, "window": null, "rocket": "5e9d0d95eda69973a809d1ec", "success": true, "failures": [], "details": "This mission launches the eighteenth batch of operational Starlink satellites, which are version 1.0, from SLC-40. It is the nineteenth Starlink launch ov

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The satellites will be delivered to low Earth orbit and will spend a few weeks maneuvering to their operational altitude. The booster is expected to land on an ASDS.", "crew": [], "ships": ["5ea6ed30080df4000697c913"], "capsules": [], "payloads": ["600f9bc08f798e2a4d5f97a4"], "launchpad": "5e9e4501f509094ba4566f84", "flight_number": 117, "name": "Starlink-19 (v1.0)", "date_utc": "2021-02-16T03:59:00.000Z", "date_unix": 1613447940, "date_local": "2021-02-15T22:59:00-05:00", "date_precision": "hour", "upcoming": false, "cores": [{"core": "5e9e28a7f359187afd3b2662", "flight": 6, "gridfins": true, "legs": true, "reused": true, "landing_attempt": true, "landing_success": false, "landing_type": "ASDS", "landpad": "5e9e3032383ecb6bb234e7ca"}], "auto_update": true, "tbd": false, "launch_library_id": "985f1cc1-82c1-4a89-b2cc-e9dc91829a0e", "id": "600f9a5e8f798e2a4d5f979c"}, {"fairings": {"reused": null, "recovery_attempt": null, "recovered": null, "ships": []}, "links": {"patch": {"small": "https://images2.imgbox.com/ba/a9/Q6APoE8C_o.png", "large": "https://images2.imgbox.com/29/6c/mQwxR0KQ_o.png"}, "reddit": {"campaign": "https://www.reddit.com/r/spacex/comments/jhu37i/starlink_general_discussion_and_deployment_thread/", "launch": "https://www.reddit.com/r/spacex/comments/l8qs23/rspacex_starlink17_official_launch_discussion/", "media": null, "recovery": "https://www.reddit.com/r/spacex/comments/k2ts1q/rspacex_fleet_updates_discussion_thread/"}, "flickr": {"small": [], "original": ["https://live.staticflickr.com/65535/51004598206_9779f08338_o.jpg", "https://live.staticflickr.com/65535/51004598196_b2059799f4_o.jpg"]}, "presskit": null, "webcast": "https://youtu.be/d5DzoKuhdNk", "youtube_id": "d5DzoKuhdNk", "article": "https://spaceflightnow.com/2021/03/04/spacex-sticks-75th-falcon-rocket-landing-after-launching-60-more-starlink-satellites/", "wikipedia": "https://en.wikipedia.org/wiki/Starlink"}, {"static_fire_date_utc": "2021-02-24T12:25:00.000Z", "static_fire_date_unix": 1614169500, "net": false, "window": null, "rocket": "5e9d0d95eda69973a809d1ec", "success": true, "failures": [], "details": "This mission launches the sixteenth batch of operational Starlink satellites, which are version 1.0, from LC-39A. It is the eighteenth Starlink launch overall. The satellites will be delivered to low Earth orbit and will spend a few weeks maneuvering to their operational altitude. 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ion on behalf of NASA, this mission sends essential supplies to the International Space Station using the cargo variant of SpaceX's Dragon 2 spacecraft. The external payload for this mission is the first pair of ISS Roll Out Solar Arrays. Falcon 9 and Dragon launch from LC-39A, Kennedy Space Center and the booster is expected to land on an ASDS. The mission will be complete with splashdown and recovery of the capsule and down cargo.", "crew": [], "ships": ["5ea6ed2f080df4000697c90b", "608c1a06cf7f3d6152666ad4", "5ea6ed30080df4000697c913"], "capsules": ["60b803421f83cc1e59f1644d"], "payloads": ["5fe3b642b3467846b324217b"], "launchpad": "5e9e4502f509094188566f88", "flight\_number": 129, "name": "CRS-22 & IROSA", "date\_utc": "2021-06-03T17:29:00.000Z", "date\_unix": 1622741340, "date\_local": "2021-06-03T13:29:00-04:00", "date\_precision": "hour", "upcoming": false, "cores": [{"core": "60b800111f83cc1e59f16438", "flight": 1, "gridfins": true, "legs": true, "reused": false, "landing\_attempt": true, "landing\_success": true, "landing\_type": "ASDS", "landpad": "5e9e3032383ecb6bb234e7ca"}], "auto\_update": true, "tbd": false, "launch\_library\_id": "89a150ea-6e4b-489f-853c-3603ae684611", "id": "5fe3af84b3467846b3242161"}, {"fairings": {"reused": false, "recovery\_attempt": true, "recovered": true, "ships": ["5ea6ed2f080df4000697c90b", "5ea6ed2e080df4000697c909"]}, "links": {"patch": {"small": "https://images2.imgbox.com/9a/f0/UV16cZ6e\_o.png", "large": "https://images2.imgbox.com/98/c3/8McdwgVu\_o.png"}, "reddit": {"campaign": "https://www.reddit.com/r/spacex/comments/n9llxw/sxm8\_launch\_campaign\_thread/", "launch": "https://www.reddit.com/r/spacex/comments/nss9br/rspacex\_sxm8\_launch\_discussion\_and\_updates\_thread/", "media": null, "recovery": null}, "flickr": {"small": [], "original": []}, "presskit": null, "webcast": "https://youtu.be/bgtDRR2F2wA", "youtube\_id": "bgtDRR2F2wA", "article": null, "wikipedia": "https://en.wikipedia.org/wiki/Sirius\_XM#Satellites"}, "static\_fire\_date\_utc": "2021-06-03T06:32:00.000Z", "static\_fire\_date\_unix": 1622701920, "net": false, "window": 5940, "rocket": "5e9d0d95eda69973a809d1ec", "success": true, "failures": [], "details": "SpaceX launches the second of two next generation satellites for SiriusXM from SLC-40, Cape Canaveral Space Force Station. The spacecraft will be delivered into a sub-synchronous geostationary transfer orbit and will replace XM-4 in geostationary orbit. The booster for this mission will land on an ASDS.", "crew": [], "ships": ["5ee68c683c228f36bd5809b5", "5ea6ed2f080df4000697c910", "5ea6ed2f080df4000697c90b", "5ea6ed2e080df4000697c909"], "capsules": [], "payloads": ["5fe3b57db3467846b324217a"], "launchpad": "5e9e4501f509094ba4566f84", "flight\_number": 130, "name": "SXM-8", "date\_utc": "2021-06-06T04:26:00.000Z", "date\_unix": 1622953560, "date\_local": "2021-06-06T00:26:00-04:00", "date\_precision": "hour", "upcoming": false, "cores": [{"core": "5f57c53d0622a6330279009f", "flight": 3, "gridfins": true, "legs": true, "reused": true, "landing\_attempt": true, "landing\_success": true, "landing\_type": "ASDS", "landpad": "5e9e3033383ecbb9e534e7cc"}], "auto\_update": true, "tbd": false, "launch\_library\_id": "edaf9a8d-d67c-4e0e-8452-a37b111581d5", "id": "5fe3af6db3467846b3242160"}, {"fairings": {"reused": false, "recovery\_attempt": true, "recovered": true, "ships": ["60c8c7a45d4819007ea69871"]}, "links": {"patch": {"small": "https://images2.imgbox.com/d0/66/bCRsHNSZ\_o.png", "large": "https://images2.imgbox.com/2f/6f/ebFS9FDJ\_o.png"}, "reddit": {"campaign": "https://www.reddit.com/r/spacex/comments/nuud0l/gps\_iii\_sv05\_launch\_campaign\_thread/", "launch": "https://www.reddit.com/r/spacex/comments/o0gcng/rspacex\_gps\_iii\_sv05\_launch\_discussion\_and/", "media": null, "recovery": null}, "flickr": {"small": [], "original": ["https://live.staticflickr.com/65535/51254829184\_e6e1d0d79c\_o.jpg", "https://live.staticflickr.com/65535/51253353892\_de82b01e23\_o.jpg", "https://live.staticflickr.com/65535/51254285968\_288383ce6e\_o.jpg", "https://live.staticflickr.com/65535/51254829154\_3c5980c086\_o.jpg", "https://live.staticflickr.com/65535/51253353882\_e59ea4df4f\_o.jpg", "https://live.staticflickr.com/65535/51254829139\_ca68c19689\_o.jpg", "https://live.staticflickr.com/65535/51262926489\_9fbce20e9c\_o.jpg", "https://live.staticflickr.com/65535/51262926469\_974292477d\_o.jpg", "https://live.staticflickr.com/65535/51262179176\_e4302db116\_o.jpg", "https://live.staticflickr.com/65535/51263224735\_3210fb7499\_o.jpg"]}, "presskit": null, "webcast": "https://youtu.be/QJXxVtp3KqI", "youtube\_id": "QJXxVtp3KqI", "article": null, "wikipedia": "https://en.wikipedia.org/wiki/GPS\_Block\_III"}, "static\_fire\_date\_utc": "2021-06-13T19:30:00.000Z", "static\_fire\_date\_unix": 1623612600, "net": false, "window": 900, "rocket": "5e9d0d95eda69973a809d1ec", "success": true, "failures": [], "details": "SpaceX's fourth GPS III launch will use the first



stage from the previous GPS mission. This will be the first time a National Security Space Launch has flown on a flight proven booster. Falcon 9 will launch from SLC-40, Cape Canaveral and the booster will land downrange on a drone ship. GPS III is the third generation of the U.S. Space Force's NAVSTAR Global Positioning System satellites, developed by Lockheed Martin. The GPS III constellation will feature a cross-linked command and control architecture, allowing the entire GPS constellation to be updated simultaneously from a single ground station. A new spot beam capability for enhanced military coverage and increased resistance to hostile jamming will be incorporated.

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This is unusual as the mission is launching from Vandenberg as these missions usually launch from the East Coast.", "crew": [], "ships": ["5ea6ed30080df4000697c913", "5ea6ed30080df4000697c912", "5ea6ed2f080df4000697c90b"], "capsules": [], "payloads": ["61bbac16437241381bf70632"], "launchpa

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irbus Defense and Space's facilities in Toulouse, France, will soon be sent to the
Cape Canaveral Space Launch Station located in Florida, United States. The satellite
will be launched into space onboard the Falcon 9 rocket following pre-launch prepara
tions. With an estimated in-orbit lifetime of 30 years and the aim of securing Turke
y\xe2\x80\x99s orbital and frequency rights, T\xc3\xbcrcsat 5B will be launched into
an orbital slot at 42 degrees East. With 12 kW power, T\xc3\xbcrcsat 5B will provide
TV broadcasting and data communication services over a wide coverage area that reach
es the entire Middle East, the Persian Gulf, the Red Sea, the Mediterranean, North A
frica, East Africa, South Africa and Nigeria. Apart from that, the satellite will al
so provide customized services for airlines and commercial ship operators around the
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```

```

n": "hour", "upcoming": false, "cores": [{"core": "5e9e28a7f3591817f23b2663", "flight": 14, "gridfins": true, "legs": true, "reused": true, "landing_attempt": true, "landing_success": true, "landing_type": "ASDS", "landpad": "5e9e3033383ecb075134e7cd"}], "auto_update": true, "tbd": false, "launch_library_id": "992823ad-f843-4a4a-beca-882b8ce8773a", "id": "62a9f89a20413d2695d8871a"}, {"fairings": {"reused": null, "recovery_attempt": null, "recovered": null, "ships": []}, "links": {"patch": {"small": "https://images2.imgbox.com/a9/9a/NXVKTZCE_o.png", "large": "https://images2.imgbox.com/e3/cc/hN96PmST_o.png"}, "reddit": {"campaign": "https://www.reddit.com/r/spacex/comments/jhu37i/starlink_general_discussion_and_deployment_thread/", "launch": "https://www.reddit.com/r/spacex/comments/xd8vhj/r_spacex_starlink_434_launch_discussion_and/", "media": null, "recovery": "https://www.reddit.com/r/spacex/comments/k2ts1q/rspacex_fleet_updates_discussion_thread/"}, "flickr": {"small": [], "original": []}, "presskit": null, "webcast": "https://youtu.be/ZlQHF_yBkMQ", "youtube_id": "ZlQHF_yBkMQ", "article": null, "wikipedia": null}, "static_fire_date_utc": null, "static_fire_date_unix": null, "net": false, "window": null, "rocket": "5e9d0d95eda69973a809d1ec", "success": true, "failures": [], "details": null, "crew": [], "ships": [], "capsules": [], "payloads": ["63161699ffc78f3b85670719"], "launchpad": "5e9e4501f509094ba4566f84", "flight_number": 185, "name": "Starlink 4-34 (v1.5)", "date_utc": "2022-09-17T01:05:00.000Z", "date_unix": 1663376700, "date_local": "2022-09-16T21:05:00-04:00", "date_precision": "hour", "upcoming": false, "cores": [{"core": "60b80011f83cc1e59f16438", "flight": 6, "gridfins": true, "legs": true, "reused": true, "landing_attempt": true, "landing_success": true, "landing_type": "ASDS", "landpad": "5e9e3033383ecbb9e534e7cc"}], "auto_update": true, "tbd": false, "launch_library_id": "9ba04064-c329-40bf-b477-ff468d7d8058", "id": "63161329ffc78f3b8567070b"}, {"fairings": {"reused": null, "recovery_attempt": null, "recovered": null, "ships": []}, "links": {"patch": {"small": "https://images2.imgbox.com/a9/9a/NXVKTZCE_o.png", "large": "https://images2.imgbox.com/e3/cc/hN96PmST_o.png"}, "reddit": {"campaign": "https://www.reddit.com/r/spacex/comments/jhu37i/starlink_general_discussion_and_deployment_thread/", "launch": "https://www.reddit.com/r/spacex/comments/xn028t/r_spacex_starlink_435_launch_discussion_and/", "media": null, "recovery": "https://www.reddit.com/r/spacex/comments/k2ts1q/rspacex_fleet_updates_discussion_thread/"}, "flickr": {"small": [], "original": []}, "presskit": null, "webcast": "https://youtu.be/VVu2bSJJhgI", "youtube_id": "VVu2bSJJhgI", "article": null, "wikipedia": null}, "static_fire_date_utc": null, "static_fire_date_unix": null, "net": false, "window": null, "rocket": "5e9d0d95eda69973a809d1ec", "success": true, "failures": [], "details": null, "crew": [], "ships": [], "capsules": [], "payloads": ["631616a7ffc78f3b8567071a"], "launchpad": "5e9e4501f509094ba4566f84", "flight_number": 186, "name": "Starlink 4-35 (v1.5)", "date_utc": "2022-09-24T23:30:00.000Z", "date_unix": 1664062200, "date_local": "2022-09-24T19:30:00-04:00", "date_precision": "hour", "upcoming": false, "cores": [{"core": "627843d657b51b752c5c5a53", "flight": 4, "gridfins": true, "legs": true, "reused": true, "landing_attempt": true, "landing_success": true, "landing_type": "ASDS", "landpad": "5e9e3033383ecbb9e534e7cc"}], "auto_update": true, "tbd": false, "launch_library_id": "1c903b65-6667-4fd5-944d-296c5f13e01f", "id": "63161339ffc78f3b8567070c"}, {"fairings": null, "links": {"patch": {"small": "https://images2.imgbox.com/eb/d8/D1Yywp0w_o.png", "large": "https://images2.imgbox.com/33/2e/k6VE4iYl_o.png"}, "reddit": {"campaign": null, "launch": "https://www.reddit.com/r/spacex/comments/xvm76j/rspacex_crew5_launchcoast_docking_discussion_and/", "media": null, "recovery": null}, "flickr": {"small": [], "original": []}, "presskit": null, "webcast": "https://youtu.be/5EwW8ZkArL4", "youtube_id": "5EwW8ZkArL4", "article": null, "wikipedia": "https://en.wikipedia.org/wiki/SpaceX_Crew-5"}, "static_fire_date_utc": null, "static_fire_date_unix": null, "net": false, "window": null, "rocket": "5e9d0d95eda69973a809d1ec", "success": true, "failures": [], "details": null, "crew": ["62dd7196202306255024d13c", "62dd71c9202306255024d13d", "62dd7210202306255024d13e", "62dd7253202306255024d13f"], "ships": [], "capsules": ["617c05591bad2c661a6e2909"], "payloads": ["62dd73ed202306255024d145"], "launchpad": "5e9e4502f509094188566f88", "flight_number": 187, "name": "Crew-5", "date_utc": "2022-10-05T16:00:00.000Z", "date_unix": 1664985600, "date_local": "2022-10-05T12:00:00-04:00", "date_precision": "hour", "upcoming": false, "cores": [{"core": "633d9da635a71d1d9c66797b", "flight": 1, "gridfins": true, "legs": true, "reused": false, "landing_attempt": true, "landing_success": true, "landing_type": "ASDS", "landpad": "5e9e3033383ecbb9e534e7cc"}], "auto_updat

```

```
e":true,"tbd":false,"launch_library_id":"f33d5ece-e825-4cd8-809f-1d4c72a2e0d3","id":"62dd70d5202306255024d139"}]]'
```

You should see the response contains massive information about SpaceX launches. Next, let's try to discover some more relevant information for this project.

## Task 1: Request and parse the SpaceX launch data using the GET request

To make the requested JSON results more consistent, we will use the following static response object for this project:

```
In [13]: static_json_url='https://cf-courses-data.s3.us.cloud-object-storage.appdomain.cloud'
```

We should see that the request was successful with the 200 status response code

```
In [14]: response.status_code
```

```
Out[14]: 200
```

Now we decode the response content as a Json using `.json()` and turn it into a Pandas dataframe using `.json_normalize()`

```
In [15]: # Use json_normalize method to convert the json result into a dataframe
data=pd.json_normalize(response.json())
```

Using the dataframe `data` print the first 5 rows

```
In [16]: # Get the head of the dataframe
print(data.head())
```

	static_fire_date_utc	static_fire_date_unix	net	window	\
0	2006-03-17T00:00:00.000Z	1.142554e+09	False	0.0	
1	None	NaN	False	0.0	
2	None	NaN	False	0.0	
3	2008-09-20T00:00:00.000Z	1.221869e+09	False	0.0	
4	None	NaN	False	0.0	

	rocket	success	\
0	5e9d0d95eda69955f709d1eb	False	
1	5e9d0d95eda69955f709d1eb	False	
2	5e9d0d95eda69955f709d1eb	False	
3	5e9d0d95eda69955f709d1eb	True	
4	5e9d0d95eda69955f709d1eb	True	

```
failures \
0 [{"time": 33, 'altitude': None, 'reason': 'merlin engine failure'}]
1 [{"time": 301, 'altitude': 289, 'reason': 'harmonic oscillation leading to premature engine shutdown'}]
2 [{"time": 140, 'altitude': 35, 'reason': 'residual stage-1 thrust led to collision between stage 1 and stage 2'}]
3
4 []
5 []
```

```
details \
0 Engine failure at 33 seconds and loss of vehicle
1 Successful first stage burn and transition to second stage, maximum altitude 289 km, Premature engine shutdown at T+7 min 30 s, Failed to reach orbit, Failed to recover first stage
2 Residual stage 1 thrust led to collision between stage 1 and stage 2
3 Ratsat was carried to orbit on the first successful orbital launch of any privately funded and developed, liquid-propelled carrier rocket, the SpaceX Falcon 1
4
5 None
```

	crew	ships	capsules	payloads	\
0	[]	[]	[]	[5eb0e4b5b6c3bb0006eeb1e1]	
1	[]	[]	[]	[5eb0e4b6b6c3bb0006eeb1e2]	
2	[]	[]	[]	[5eb0e4b6b6c3bb0006eeb1e3, 5eb0e4b6b6c3bb0006eeb1e4]	
3	[]	[]	[]	[5eb0e4b7b6c3bb0006eeb1e5]	
4	[]	[]	[]	[5eb0e4b7b6c3bb0006eeb1e6]	

	launchpad	flight_number	name	\
0	5e9e4502f5090995de566f86	1	FalconSat	
1	5e9e4502f5090995de566f86	2	DemoSat	
2	5e9e4502f5090995de566f86	3	Trailblazer	
3	5e9e4502f5090995de566f86	4	RatSat	
4	5e9e4502f5090995de566f86	5	RazakSat	

	date_utc	date_unix	date_local \
0	2006-03-24T22:30:00.000Z	1143239400	2006-03-25T10:30:00+12:00
1	2007-03-21T01:10:00.000Z	1174439400	2007-03-21T13:10:00+12:00
2	2008-08-03T03:34:00.000Z	1217734440	2008-08-03T15:34:00+12:00
3	2008-09-28T23:15:00.000Z	1222643700	2008-09-28T11:15:00+12:00
4	2009-07-13T03:35:00.000Z	1247456100	2009-07-13T15:35:00+12:00

	date_precision	upcoming \
0	hour	False
1	hour	False
2	hour	False
3	hour	False
4	hour	False

	cores \
0	[{'core': '5e9e289df35918033d3b2623', 'flight': 1, 'gridfins': False, 'legs': False, 'reused': False, 'landing_attempt': False, 'landing_success': None, 'landing_type': None, 'landpad': None}]
1	[{'core': '5e9e289ef35918416a3b2624', 'flight': 1, 'gridfins': False, 'legs': False, 'reused': False, 'landing_attempt': False, 'landing_success': None, 'landing_type': None, 'landpad': None}]
2	[{'core': '5e9e289ef3591814873b2625', 'flight': 1, 'gridfins': False, 'legs': False, 'reused': False, 'landing_attempt': False, 'landing_success': None, 'landing_type': None, 'landpad': None}]
3	[{'core': '5e9e289ef3591855dc3b2626', 'flight': 1, 'gridfins': False, 'legs': False, 'reused': False, 'landing_attempt': False, 'landing_success': None, 'landing_type': None, 'landpad': None}]
4	[{'core': '5e9e289ef359184f103b2627', 'flight': 1, 'gridfins': False, 'legs': False, 'reused': False, 'landing_attempt': False, 'landing_success': None, 'landing_type': None, 'landpad': None}]

	auto_update	tbd	launch_library_id	id \
0	True	False	None	5eb87cd9fffd86e000604b32a
1	True	False	None	5eb87cdafffd86e000604b32b
2	True	False	None	5eb87cdbfffd86e000604b32c
3	True	False	None	5eb87cdbfffd86e000604b32d
4	True	False	None	5eb87cdcfffd86e000604b32e

	fairings.reused	fairings.recovery_attempt	fairings.recovered	fairings.ships \
0	False	False	False	[]
1	False	False	False	[]
2	False	False	False	[]
3	False	False	False	[]
4	False	False	False	[]

	links.patch.small \
0	https://images2.imgbox.com/94/f2/NN6Ph45r_o.png
1	https://images2.imgbox.com/f9/4a/ZboXReNb_o.png
2	https://images2.imgbox.com/6c/cb/na1tzHs_o.png
3	https://images2.imgbox.com/95/39/sRqN7rsv_o.png
4	https://images2.imgbox.com/ab/5a/Pequxd5d_o.png

	links.patch.large	links.reddit.campaign \
0	https://images2.imgbox.com/5b/02/QcxHUb5V_o.png	None
1	https://images2.imgbox.com/80/a2/bkWoTcIS_o.png	None



2	<a href="https://images2.imgbox.com/4a/80/k1oAkY0k_o.png">https://images2.imgbox.com/4a/80/k1oAkY0k_o.png</a>	None
3	<a href="https://images2.imgbox.com/a3/99/qswRYzE8_o.png">https://images2.imgbox.com/a3/99/qswRYzE8_o.png</a>	None
4	<a href="https://images2.imgbox.com/92/e4/7Cf6MLY0_o.png">https://images2.imgbox.com/92/e4/7Cf6MLY0_o.png</a>	None

	links.reddit.launch	links.reddit.media	links.reddit.recovery	\
0	None	None	None	
1	None	None	None	
2	None	None	None	
3	None	None	None	
4	None	None	None	

	links.flickr.small	links.flickr.original	\
0	[]	[]	
1	[]	[]	
2	[]	[]	
3	[]	[]	
4	[]	[]	

links.presskit \

0	None
1	None
2	None
3	None
4	<a href="http://www.spacex.com/press/2012/12/19/spacexs-falcon-1-successfully-delivers-raz-aksat-satellite-orbit">http://www.spacex.com/press/2012/12/19/spacexs-falcon-1-successfully-delivers-raz-aksat-satellite-orbit</a>

	links.webcast	links.youtube_id	\
0	<a href="https://www.youtube.com/watch?v=0a_00nJ_Y88">https://www.youtube.com/watch?v=0a_00nJ_Y88</a>	0a_00nJ_Y88	
1	<a href="https://www.youtube.com/watch?v=Lk4zQ2wP-Nc">https://www.youtube.com/watch?v=Lk4zQ2wP-Nc</a>	Lk4zQ2wP-Nc	
2	<a href="https://www.youtube.com/watch?v=v0w9p3U8860">https://www.youtube.com/watch?v=v0w9p3U8860</a>	v0w9p3U8860	
3	<a href="https://www.youtube.com/watch?v=dLQ2tZEH6G0">https://www.youtube.com/watch?v=dLQ2tZEH6G0</a>	dLQ2tZEH6G0	
4	<a href="https://www.youtube.com/watch?v=yTaIDooc80g">https://www.youtube.com/watch?v=yTaIDooc80g</a>	yTaIDooc80g	

	links.article	\
0	<a href="https://www.space.com/2196-spacex-inaugural-falcon-1-rocket-lost-launch.html">https://www.space.com/2196-spacex-inaugural-falcon-1-rocket-lost-launch.html</a>	
1	<a href="https://www.space.com/3590-spacex-falcon-1-rocket-fails-reach-orbit.html">https://www.space.com/3590-spacex-falcon-1-rocket-fails-reach-orbit.html</a>	
2	<a href="http://www.spacex.com/news/2013/02/11/falcon-1-flight-3-mission-summary">http://www.spacex.com/news/2013/02/11/falcon-1-flight-3-mission-summary</a>	
3	<a href="https://en.wikipedia.org/wiki/Ratsat">https://en.wikipedia.org/wiki/Ratsat</a>	
4	<a href="http://www.spacex.com/news/2013/02/12/falcon-1-flight-5">http://www.spacex.com/news/2013/02/12/falcon-1-flight-5</a>	

	links.wikipedia	fairings
0	<a href="https://en.wikipedia.org/wiki/DemoSat">https://en.wikipedia.org/wiki/DemoSat</a>	NaN
1	<a href="https://en.wikipedia.org/wiki/DemoSat">https://en.wikipedia.org/wiki/DemoSat</a>	NaN
2	<a href="https://en.wikipedia.org/wiki/Trailblazer_(satellite)">https://en.wikipedia.org/wiki/Trailblazer_(satellite)</a>	NaN
3	<a href="https://en.wikipedia.org/wiki/Ratsat">https://en.wikipedia.org/wiki/Ratsat</a>	NaN
4	<a href="https://en.wikipedia.org/wiki/RazakSAT">https://en.wikipedia.org/wiki/RazakSAT</a>	NaN

You will notice that a lot of the data are IDs. For example the rocket column has no information about the rocket just an identification number.

We will now use the API again to get information about the launches using the IDs given for each launch. Specifically we will be using columns `rocket`, `payloads`, `launchpad`, and `cores`.

```
In [17]: # Lets take a subset of our dataframe keeping only the features we want and the flight number
data = data[['rocket', 'payloads', 'launchpad', 'cores', 'flight_number', 'date_utc']]

# We will remove rows with multiple cores because those are falcon rockets with 2 engines
data = data[data['cores'].map(len)==1]
data = data[data['payloads'].map(len)==1]

# Since payloads and cores are lists of size 1 we will also extract the single values into their own columns
data['cores'] = data['cores'].map(lambda x : x[0])
data['payloads'] = data['payloads'].map(lambda x : x[0])

# We also want to convert the date_utc to a datetime datatype and then extracting the date only
data['date'] = pd.to_datetime(data['date_utc']).dt.date

# Using the date we will restrict the dates of the launches
data = data[data['date'] <= datetime.date(2020, 11, 13)]
```

- From the `rocket` we would like to learn the booster name
- From the `payload` we would like to learn the mass of the payload and the orbit that it is going to
- From the `launchpad` we would like to know the name of the launch site being used, the longitude, and the latitude.
- From `cores` we would like to learn the outcome of the landing, the type of the landing, number of flights with that core, whether gridfins were used, whether the core is reused, whether legs were used, the landing pad used, the block of the core which is a number used to separate version of cores, the number of times this specific core has been reused, and the serial of the core.

The data from these requests will be stored in lists and will be used to create a new dataframe.

```
In [18]: #Global variables
BoosterVersion = []
PayloadMass = []
Orbit = []
LaunchSite = []
Outcome = []
Flights = []
GridFins = []
Reused = []
Legs = []
LandingPad = []
Block = []
```

```

ReusedCount = []
Serial = []
Longitude = []
Latitude = []

```

These functions will apply the outputs globally to the above variables. Let's take a look at `BoosterVersion` variable. Before we apply `getBoosterVersion` the list is empty:

```
In [19]: BoosterVersion
```

```
Out[19]: []
```

Now, let's apply `getBoosterVersion` function method to get the booster version

```
In [20]: # Call getBoosterVersion
getBoosterVersion(data)
```

the list has now been update

```
In [21]: BoosterVersion[0:5]
```

```
Out[21]: ['Falcon 1', 'Falcon 1', 'Falcon 1', 'Falcon 1', 'Falcon 9']
```

we can apply the rest of the functions here:

```
In [22]: # Call getLaunchSite
getLaunchSite(data)
```

```
In [23]: # Call getPayloadData
getPayloadData(data)
```

```
In [24]: # Call getCoreData
getCoreData(data)
```

Finally let's construct our dataset using the data we have obtained. We combine the columns into a dictionary.

```
In [25]: launch_dict = {'FlightNumber': list(data['flight_number']),
                        'Date': list(data['date']),
                        'BoosterVersion':BoosterVersion,
                        'PayloadMass':PayloadMass,
                        'Orbit':Orbit,
                        'LaunchSite':LaunchSite,
                        'Outcome':Outcome,
                        'Flights':Flights,
                        'GridFins':GridFins,
                        'Reused':Reused,
                        'Legs':Legs,
                        'LandingPad':LandingPad,
                        'Block':Block,
                        'ReusedCount':ReusedCount,
                        'Serial':Serial,
```

```
'Longitude': Longitude,
'Latitude': Latitude}
```

Then, we need to create a Pandas data frame from the dictionary launch\_dict.

```
In [26]: # Create a data from launch_dict
df = pd.DataFrame.from_dict(launch_dict)
```

Show the summary of the dataframe

```
In [27]: # Show the head of the dataframe
df.describe()
```

```
Out[27]:
```

	FlightNumber	PayloadMass	Flights	Block	ReusedCount	Longitude	Lati
<b>count</b>	94.000000	88.000000	94.000000	90.000000	94.000000	94.000000	94.00
<b>mean</b>	54.202128	5919.165341	1.755319	3.500000	3.053191	-75.553302	28.58
<b>std</b>	30.589048	4909.689575	1.197544	1.595288	4.153938	53.391880	4.63
<b>min</b>	1.000000	20.000000	1.000000	1.000000	0.000000	-120.610829	9.04
<b>25%</b>	28.250000	2406.250000	1.000000	2.000000	0.000000	-80.603956	28.56
<b>50%</b>	52.500000	4414.000000	1.000000	4.000000	1.000000	-80.577366	28.56
<b>75%</b>	81.500000	9543.750000	2.000000	5.000000	4.000000	-80.577366	28.60
<b>max</b>	106.000000	15600.000000	6.000000	5.000000	13.000000	167.743129	34.63

## Task 2: Filter the dataframe to only include Falcon 9 launches

Finally we will remove the Falcon 1 launches keeping only the Falcon 9 launches. Filter the data dataframe using the `BoosterVersion` column to only keep the Falcon 9 launches. Save the filtered data to a new dataframe called `data_falcon9`.

```
In [28]: # Hint data['BoosterVersion']!='Falcon 1'
data_falcon9 = df[df['BoosterVersion']=='Falcon 9']
```

Now that we have removed some values we should reset the FlightNumber column

```
In [29]: data_falcon9.loc[:, 'FlightNumber'] = list(range(1, data_falcon9.shape[0]+1))
data_falcon9
```

```
/home/jupyterlab/conda/envs/python/lib/python3.7/site-packages/pandas/core/indexing.py:1773: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/stable/user_guide/indexing.html#returning-a-view-versus-a-copy
self._setitem_single_column(ilocs[0], value, pi)
```

Out[29]:

	FlightNumber	Date	BoosterVersion	PayloadMass	Orbit	LaunchSite	Outcome	Fligh
4	1	2010-06-04	Falcon 9	NaN	LEO	CCSFS SLC 40	None	None
5	2	2012-05-22	Falcon 9	525.0	LEO	CCSFS SLC 40	None	None
6	3	2013-03-01	Falcon 9	677.0	ISS	CCSFS SLC 40	None	None
7	4	2013-09-29	Falcon 9	500.0	PO	VAFB SLC 4E	False	Ocean
8	5	2013-12-03	Falcon 9	3170.0	GTO	CCSFS SLC 40	None	None
...	...	...	...	...	...	...	...	...
89	86	2020-09-03	Falcon 9	15600.0	VLEO	KSC LC 39A	True	ASDS
90	87	2020-10-06	Falcon 9	15600.0	VLEO	KSC LC 39A	True	ASDS
91	88	2020-10-18	Falcon 9	15600.0	VLEO	KSC LC 39A	True	ASDS
92	89	2020-10-24	Falcon 9	15600.0	VLEO	CCSFS SLC 40	True	ASDS
93	90	2020-11-05	Falcon 9	3681.0	MEO	CCSFS SLC 40	True	ASDS

90 rows × 17 columns



## Data Wrangling

We can see below that some of the rows are missing values in our dataset.

```
In [30]: data_falcon9.isnull().sum()
```

```
Out[30]: FlightNumber      0
         Date              0
         BoosterVersion    0
         PayloadMass       5
         Orbit             0
         LaunchSite        0
         Outcome           0
         Flights           0
         GridFins          0
         Reused            0
         Legs              0
         LandingPad        26
         Block             0
         ReusedCount       0
         Serial            0
         Longitude         0
         Latitude          0
         dtype: int64
```

Before we can continue we must deal with these missing values. The `LandingPad` column will retain `None` values to represent when landing pads were not used.

### Task 3: Dealing with Missing Values

Calculate below the mean for the `PayloadMass` using the `.mean()`. Then use the mean and the `.replace()` function to replace `np.nan` values in the data with the mean you calculated.

```
In [31]: # Calculate the mean value of PayloadMass column
payloadmassavg = data_falcon9['PayloadMass'].mean()

# Replace the np.nan values with its mean value
data_falcon9['PayloadMass'].replace(np.nan, payloadmassavg, inplace=True)
```

```
/home/jupyterlab/conda/envs/python/lib/python3.7/site-packages/pandas/core/generic.py:6619: SettingWithCopyWarning:
```

```
A value is trying to be set on a copy of a slice from a DataFrame
```

```
See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/stable/user_guide/indexing.html#returning-a-view-versus-a-copy
return self._update_inplace(result)
```

You should see the number of missing values of the `PayloadMass` change to zero.

Now we should have no missing values in our dataset except for in `LandingPad`.

We can now export it to a **CSV** for the next section, but to make the answers consistent, in the next lab we will provide data in a pre-selected date range.

```
data_falcon9.to_csv('dataset_part_1.csv', index=False)
```

## Authors

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## Change Log

Date (YYYY-MM-DD)	Version	Changed By	Change Description
2020-09-20	1.1	Joseph	get result each time you run
2020-09-20	1.1	Azim	Created Part 1 Lab using SpaceX API
2020-09-20	1.0	Joseph	Modified Multiple Areas

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