In [2]:
```
%matplotlib inline
from matplotlib import style
style.use('fivethirtyeight')
import matplotlib.pyplot as plt
```

In [3]:
```
import numpy as np
import pandas as pd
```

In [4]:
```
import datetime as dt
```

Reflect Tables into SQLAlchemy ORM

In [5]:
```
# Python SQL toolkit and Object Relational Mapper
import sqlalchemy
from sqlalchemy.ext.automap import automap_base
from sqlalchemy.orm import Session
from sqlalchemy import create_engine, func
```

In [6]:
```
engine = create_engine("sqlite:///Resources/hawaii.sqlite",echo=False)
```

In [7]:
```
# reflect an existing database into a new model
Base = automap_base()
# reflect the tables
Base.prepare(engine, reflect=True)
```

In [8]:
```
# We can view all of the classes that automap found
Base.classes.keys()
```

Out[8]:
```
['measurement', 'station']
```

In [9]:
```
# Save references to each table
Measurement = Base.classes.measurement
Station = Base.classes.station
```

In [10]:
```
# Create our session (link) from Python to the DB
session = Session(engine)
```

In [11]:
```
first_row=session.query(Measurement).first()
first_row.__dict__
```

Out[11]:
```
{'_sa_instance_state': <sqlalchemy.orm.state.InstanceState at 0x1aa6b9305c0>,
 'prcp': 0.08,
 'station': 'USC00519397',
 'tobs': 65.0,
 'date': '2010-01-01',
 'id': 1}
```

In [12]:
```
station_first_row = session.query(Station).first()
station_first_row.__dict__
```

Out[12]:
```
{'_sa_instance_state': <sqlalchemy.orm.state.InstanceState at 0x1aa6b949278>,
 'id': 1,
 'elevation': 3.0,
 'longitude': -157.8168,
 'name': 'WAIKIKI 717.2, HI US',
 'latitude': 21.2716,
 'station': 'USC00519397'}
```

Exploratory Climate Analysis

In [13]:
```
# Calculate the date 1 year ago from the last data point in the database

last_date=session.query(Measurement.date).order_by(Measurement.date.desc()).fi
rst()[0]
print(last_date)
year_ago=dt.datetime.strptime(last_date, "%Y-%m-%d") - dt.timedelta(days=366)
print(year_ago)
```

```
2017-08-23
2016-08-22 00:00:00
```

In [14]:
```
# Design a query to retrieve the last 12 months of precipitation data and plot
the results
# Perform a query to retrieve the data and precipitation scores
prcp_lastyr= session.query(Measurement.prcp,Measurement.date).filter(Measureme
nt.date>year_ago).all()
print(prcp_lastyr)
```

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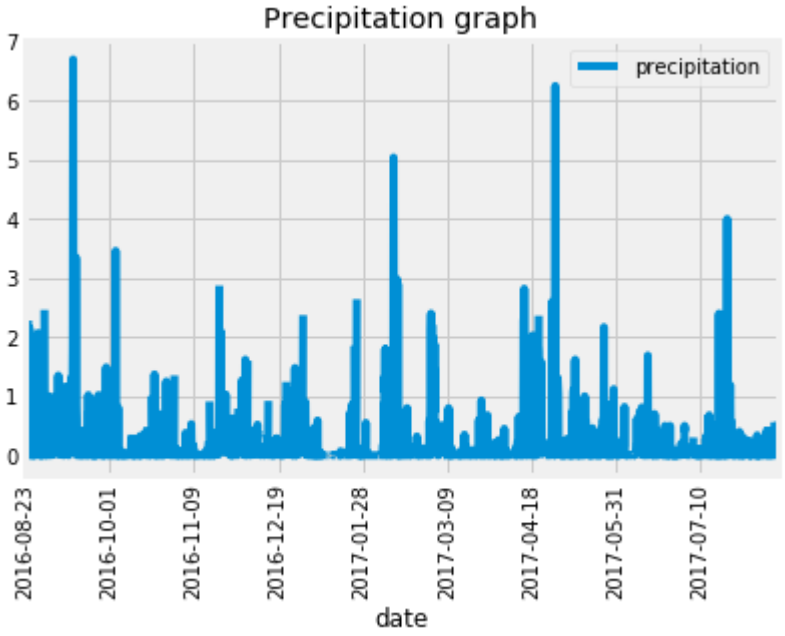
```

In [15]:
```
# Save the query results as a Pandas DataFrame and set the index to the date c
olumn
prcp_df= pd.DataFrame(prcp_lastyr,columns=['precipitation','date'])
```

In [16]:
```
# Sort the dataframe by date
prcp_sortbydate= prcp_df.sort_values(by=['date'],ascending=True).set_index('da
te')
# prcp_sortbydate
```

In [17]:
```
# Use Pandas Plotting with Matplotlib to plot the data
prcp_sortbydate.plot(title="Precipitation graph")
plt.xticks(rotation='vertical')
plt.savefig("12MonthPrecipitation")
```



In [18]:
```
# Use Pandas to calcualte the summary statistics for the precipitation data
prcp_sortbydate.describe()
```

Out[18]:

	precipitation
count	2021.000000
mean	0.177279
std	0.461190
min	0.000000
25%	0.000000
50%	0.020000
75%	0.130000
max	6.700000

In [19]:
```
# Design a query to show how many stations are available in this dataset?
for row in session.query(Measurement.station).distinct():
    print(row)
```

```
('USC00519397',)
('USC00513117',)
('USC00514830',)
('USC00517948',)
('USC00518838',)
('USC00519523',)
('USC00519281',)
('USC00511918',)
('USC00516128',)
```

In [20]:
```
# Design a query to show how many stations are available in this dataset?
for row in session.query(Station.station).all():
    print(row)
```

```
('USC00519397',)
('USC00513117',)
('USC00514830',)
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('USC00511918',)
('USC00516128',)
```

In [21]:
```
# What are the most active stations? (i.e. what stations have the most rows)?
# List the stations and the counts in descending order.
most_active=session.query(Measurement.station, func.count(Measurement.station
)).group_by(Measurement.station).order_by(func.count(Measurement.station).desc
()).first()
most_active
```

Out[21]:
```
('USC00519281', 2772)
```

In [22]:
```
station_num=most_active[0]
station_num
```

Out[22]:
```
'USC00519281'
```

In [23]:
```
# Using the station id from the previous query, calculate the lowest temperatu
re recorded,
# highest temperature recorded, and average temperature of the most active sta
tion?
lowest_temp= session.query(func.min(Measurement.tobs)).filter(Measurement.stat
ion == station_num).all()
highest_temp= session.query(func.max(Measurement.tobs)).filter(Measurement.sta
tion == station_num).all()
avg_temp= session.query(func.avg(Measurement.tobs)).filter(Measurement.station
== station_num).all()
print(f"Temperature recorded in station {station_num} \n Highest is {highest_t
emp}\n Lowest is {lowest_temp} \n Average is {avg_temp}")
```

```
Temperature recorded in station USC00519281
 Highest is [(85.0,)]
 Lowest is [(54.0,)]
 Average is [(71.66378066378067,)]
```

In [24]:
```
most_temp=session.query(Measurement.station, func.count(Measurement.tobs)).gro
up_by(Measurement.station).order_by(func.count(Measurement.tobs).desc()).first
()
most_temp
```

Out[24]:
```
('USC00519281', 2772)
```

In [25]:
```
# Choose the station with the highest number of temperature observations.most_
temp=session.query(Measurement.station, func.count(Measurement.tobs)).group_by
(Measurement.station).order_by(func.count(Measurement.tobs).desc()).first()
most_temp_station=most_temp[0]
most_temp_station
```

Out[25]:
```
'USC00519281'
```

In [26]:
```
# Query the last 12 months of temperature observation data for this station
temp_lastyr= session.query(Measurement.tobs,Measurement.date).filter(Measureme
nt.date>year_ago).filter(Measurement.station == most_temp_station).all()
temp_lastyr
```

Out[26]:
```
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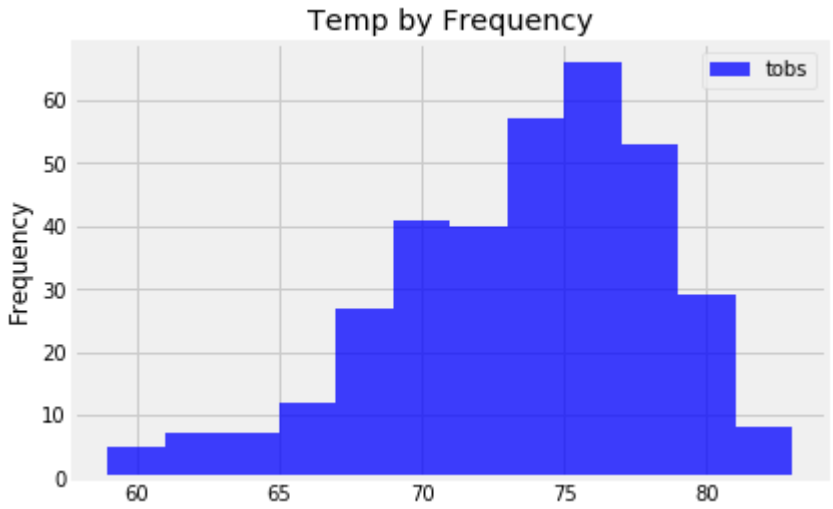
```

In [27]:
```
# convert results into a df
temp_df= pd.DataFrame(temp_lastyr,columns=['tobs','date'])
temp_sortbydate= temp_df.sort_values(by=['date']).set_index('date')
temp_sortbydate.head()
```

Out[27]:

	tobs
date	
2016-08-23	77.0
2016-08-24	77.0
2016-08-25	80.0
2016-08-26	80.0
2016-08-27	75.0

In [28]:
```
#  plot the results as a histogram
temp_sortbydate.plot.hist(title= "Temp by Frequency",bins=12, color='blue',alp
ha=0.75)
plt.show()
```



In [29]:
```
# This function called `calc_temps` will accept start date and end date in the format '%Y-%m-%d'
# and return the minimum, average, and maximum temperatures for that range of dates
def calc_temps(start_date, end_date):
    """TMIN, TAVG, and TMAX for a list of dates.

    Args:
        start_date (string): A date string in the format %Y-%m-%d
        end_date (string): A date string in the format %Y-%m-%d

    Returns:
        TMIN, TAVE, and TMAX
    """

    return session.query(func.min(Measurement.tobs), func.avg(Measurement.tobs), func.max(Measurement.tobs)).\
        filter(Measurement.date >= start_date).filter(Measurement.date <= end_date).all()

# function usage example
print(calc_temps('2012-02-28', '2012-03-05'))
```

```
[(62.0, 69.57142857142857, 74.0)]
```

In [30]:
```
# Use your previous function `calc_temps` to calculate the tmin, tavg, and tmax
# for your trip using the previous year's data for those same dates.
trip_data = calc_temps('2016-02-28','2016-03-05')
trip_data
```

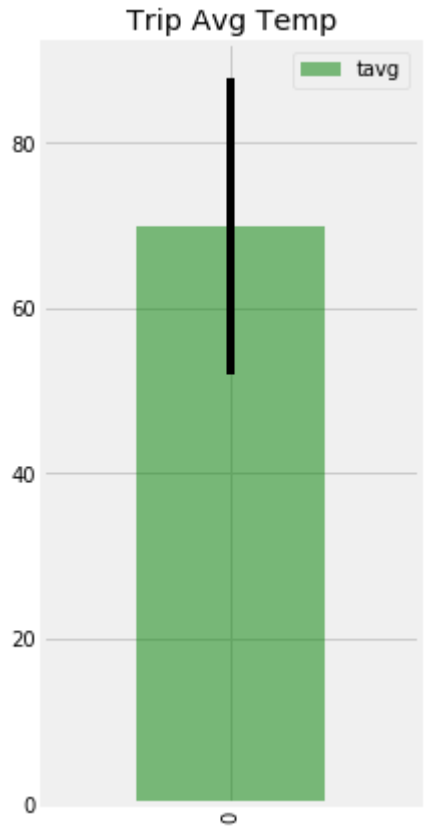
Out[30]:
```
[(62.0, 69.88636363636364, 80.0)]
```

In [31]:
```
trip_df=pd.DataFrame(trip_data,columns=['tmin','tavg','tmax'])
trip_df
```

Out[31]:

	tmin	tavg	tmax
0	62.0	69.886364	80.0

In [32]:
```
# Plot the results from your previous query as a bar chart.
# Use "Trip Avg Temp" as your Title
# Use the average temperature for the y value
# Use the peak-to-peak (tmax-tmin) value as the y error bar (yerr)
y_error= trip_df['tmax']-trip_df['tmin']
y_error
_=trip_df.plot.bar(title='Trip Avg Temp',y='tavg',yerr=y_error,color = 'green'
,alpha=0.5,figsize=(3,7))
plt.show()
plt.savefig("TripAvgTemp")
```




```
<Figure size 432x288 with 0 Axes>
```

In [33]:
```
# Calculate the total amount of rainfall per weather station for your trip dat
es using the previous year's matching dates.
# Sort this in descending order by precipitation amount and list the station,
 name, latitude, longitude, and elevation

def rainfall(start_date, end_date):
    sel=[Measurement.station,Station.name,Station.longitude,Station.elevation,
Measurement.prcp]
    return session.query(*sel).filter(Measurement.station==Station.station).fi
lter(Measurement.date>=start_date).filter(Measurement.date<=end_date).group_by
(Measurement.station).order_by(Measurement.prcp.desc()).all()
print(rainfall('2016-02-28','2016-03-05'))
```

```
[('USC00513117', 'KANEOHE 838.1, HI US', -157.8015, 14.6, 0.0), ('USC0051483
0', 'KUALOA RANCH HEADQUARTERS 886.9, HI US', -157.8374, 7.0, 0.0), ('USC0051
6128', 'MANOA LYON ARBO 785.2, HI US', -157.8025, 152.4, 0.0), ('USC0051928
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'WAIKIKI 717.2, HI US', -157.8168, 3.0, 0.0), ('USC00519523', 'WAIMANALO EXPE
RIMENTAL FARM, HI US', -157.71139, 19.5, 0.0), ('USC00517948', 'PEARL CITY, H
I US', -157.9751, 11.9, None)]
```

Optional Challenge Assignment

In [20]:
```
# Create a query that will calculate the daily normals
# (i.e. the averages for tmin, tmax, and tavg for all historic data matching a
specific month and day)

def daily_normals(date):
    """Daily Normals.

    Args:
        date (str): A date string in the format '%m-%d'

    Returns:
        A list of tuples containing the daily normals, tmin, tavg, and tmax

    """

    sel = [func.min(Measurement.tobs), func.avg(Measurement.tobs), func.max(Me
asurement.tobs)]
    return session.query(*sel).filter(func.strftime("%m-%d", Measurement.date)
== date).all()

daily_normals("01-01")
```

Out[20]:
```
[(62.0, 69.15384615384616, 77.0)]
```

In [21]:
```
# calculate the daily normals for your trip
# push each tuple of calculations into a list called `normals`

# Set the start and end date of the trip

# Use the start and end date to create a range of dates

# Stip off the year and save a list of %m-%d strings

# Loop through the list of %m-%d strings and calculate the normals for each da
te
```

Out[21]:
```
[(62.0, 69.15384615384616, 77.0),
 (60.0, 69.39622641509433, 77.0),
 (62.0, 68.9090909090909, 77.0),
 (58.0, 70.0, 76.0),
 (56.0, 67.96428571428571, 76.0),
 (61.0, 68.96491228070175, 76.0),
 (57.0, 68.54385964912281, 76.0)]
```

In [22]:
```
# Load the previous query results into a Pandas DataFrame and add the `trip_da
tes` range as the `date` index
```

Out[22]:

date	tmin	tavg	tmax
2018-01-01	62.0	69.153846	77.0
2018-01-02	60.0	69.396226	77.0
2018-01-03	62.0	68.909091	77.0
2018-01-04	58.0	70.000000	76.0
2018-01-05	56.0	67.964286	76.0

In [23]:
```
# Plot the daily normals as an area plot with `stacked=False`
```