A simple Pandas example

```
# Load Pandas
import pandas as pd
# Import W20529's rides in Q4 2017
rides = pd.read_csv('capital-onebike.csv')
```

A simple Pandas example

```python
# See our data
print(rides.head(3))
```

```
           Start date            End date                   Start station  \
0 2017-10-01 15:23:25 2017-10-01 15:26:26             Glebe Rd & 11th St N
1 2017-10-01 15:42:57 2017-10-01 17:49:59  George Mason Dr & Wilson Blvd
2 2017-10-02 06:37:10 2017-10-02 06:42:53  George Mason Dr & Wilson Blvd

                        End station Bike number Member type
0          George Mason Dr & Wilson Blvd      W20529      Member
1          George Mason Dr & Wilson Blvd      W20529      Casual
2  Ballston Metro / N Stuart & 9th St N      W20529      Member
```

A simple Pandas example

```
rides['Start date']
```

```
0     2017-10-01 15:23:25
1     2017-10-01 15:42:57
...
Name: Start date, Length: 290, dtype: object
```

```
rides.iloc[2]
```

```
Start date                                2017-10-02 06:37:10
End date                                  2017-10-02 06:42:53
...
Name: 1, dtype: object
```

Loading datetimes with parse_dates

```
# Import W20529's rides in Q4 2017
rides = pd.read_csv('capital-onebike.csv',
                    parse_dates = ['Start date', 'End date'])
# Or:
rides['Start date'] = pd.to_datetime(rides['Start date'],
                                     format = "%Y-%m-%d %H:%M:%S")
```

Loading datetimes with parse_dates

```
# Select Start date for row 2
rides['Start date'].iloc[2]
```

```
Timestamp('2017-10-02 06:37:10')
```

Timezone-aware arithmetic

```python
# Create a duration column
rides['Duration'] = rides['End date'] - rides['Start date']
# Print the first 5 rows
print(rides['Duration'].head(5))
```

```
0   00:03:01
1   02:07:02
2   00:05:43
3   00:21:18
4   00:21:17
Name: Duration, dtype: timedelta64[ns]
```

Loading datetimes with parse_dates

```
rides['Duration']\
  .dt.total_seconds()\
  .head(5)
```

Pandas
Method Chaining

```
0     181.0
1    7622.0
2     343.0
3    1278.0
4    1277.0
Name: Duration, dtype: float64
```

Reading date and time data in Pandas

WORKING WITH DATES AND TIMES IN PYTHON

Summarizing data in Pandas

```
# Average time out of the dock
rides['Duration'].mean()
```

```
Timedelta('0 days 00:19:38.931034')
```

```
# Total time out of the dock
rides['Duration'].sum()
```

```
Timedelta('3 days 22:58:10')
```

Summarizing data in Pandas

```python
# Percent of time out of the dock
rides['Duration'].sum() / timedelta(days=91)
```

```
0.04348417785917786
```

Summarizing data in Pandas

```
# Count how many time the bike started at each station
rides['Member type'].value_counts()
```

```
Member    236
Casual     54
Name: Member type, dtype: int64
```

```
# Percent of rides by member
rides['Member type'].value_counts() / len(rides)
```

```
Member    0.813793
Casual    0.186207
Name: Member type, dtype: float64
```

Summarizing datetime in Pandas

```
# Add duration (in seconds) column
rides['Duration seconds'] = rides['Duration'].dt.total_seconds()
# Average duration per member type
rides.groupby('Member type')['Duration seconds'].mean()
```

```
Member type
Casual    1994.666667
Member     992.279661
Name: Duration seconds, dtype: float64
```

Summarizing datetime in Pandas

```
# Average duration by month
rides.resample('M', on = 'Start date')['Duration seconds'].mean()
```

```
Start date
2017-10-31    1886.453704
2017-11-30     854.174757
2017-12-31     635.101266
Freq: M, Name: Duration seconds, dtype: float64
```

Summarizing datetime in Pandas

```python
# Size per group
rides.groupby('Member type').size()
```

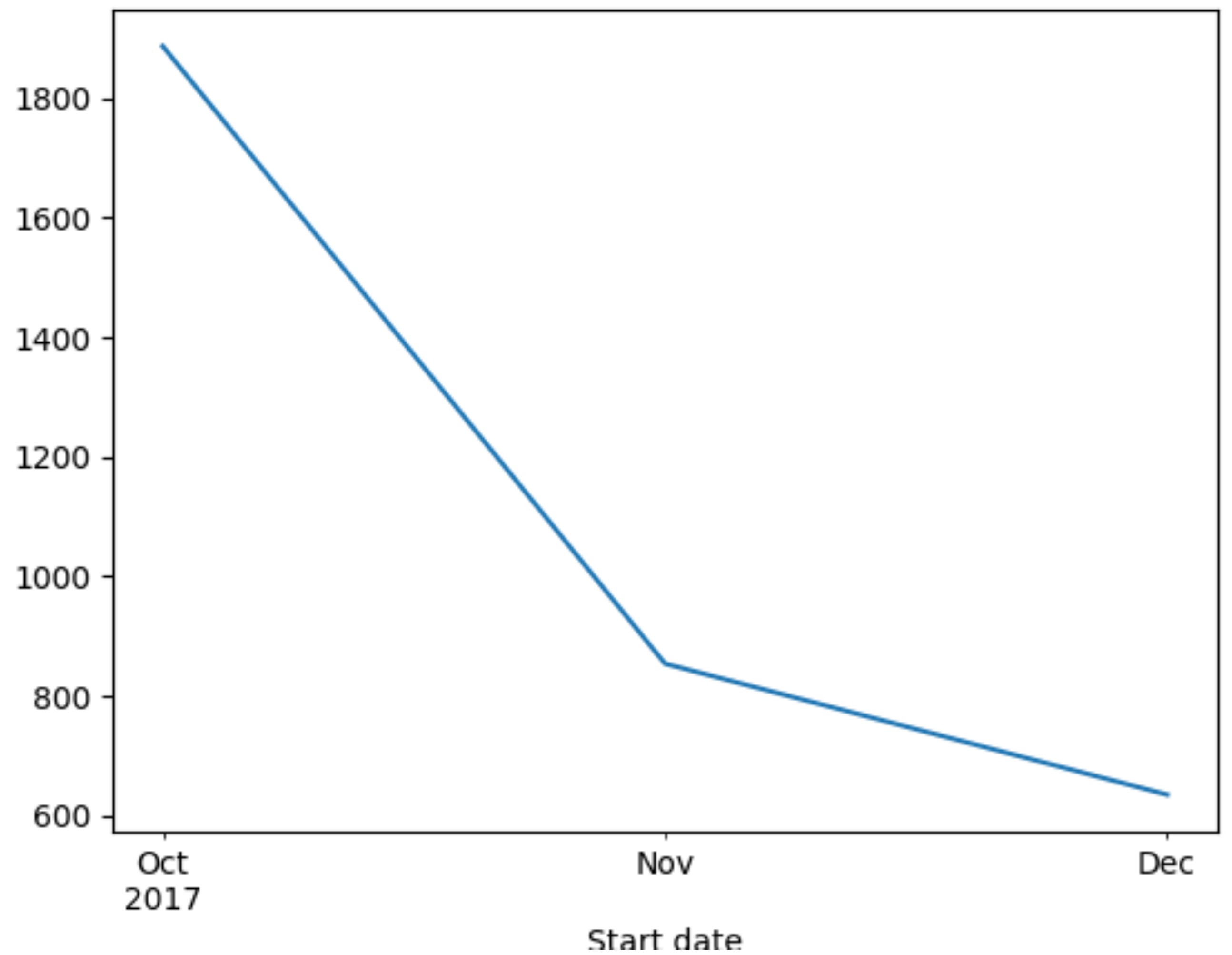
```
Member type
Casual      54
Member     236
dtype: int64
```

```python
# First ride per group
rides.groupby('Member type').first()
```

```
            Duration     ...
Member type              ...
Casual      02:07:02     ...
Member      00:03:01     ...
```

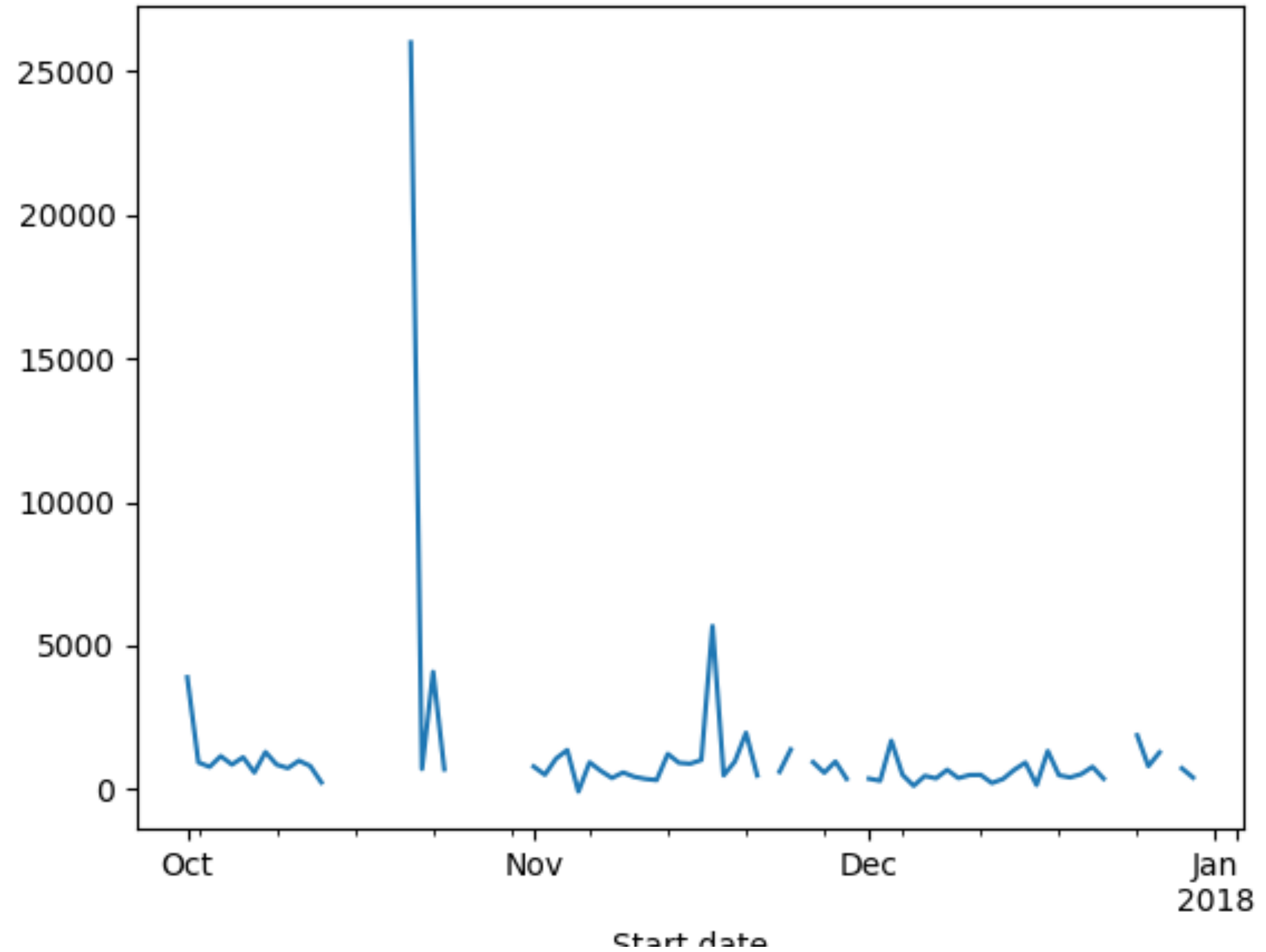
Summarizing datetime in Pandas

```
rides\
  .resample('M', on = 'Start date')\
  ['Duration seconds']\
  .mean()\
  .plot()
```



Summarizing datetime in Pandas

```
rides\
  .resample('D', on = 'Start date')\
  ['Duration seconds']\
  .mean()\
  .plot()
```



Summarizing datetime data in Pandas

WORKING WITH DATES AND TIMES IN PYTHON

Timezones in Pandas

```
rides['Duration'].dt.total_seconds().min()
```

```
-3346.0
```

Timezones in Pandas

```
rides['Start date'].head(3)
```

```
0   2017-10-01 15:23:25
1   2017-10-01 15:42:57
2   2017-10-02 06:37:10
Name: Start date, dtype: datetime64[ns]
```

```
rides['Start date'].head(3)\
  .dt.tz_localize('America/New_York')
```

```
0   2017-10-01 15:23:25-04:00
1   2017-10-01 15:42:57-04:00
2   2017-10-02 06:37:10-04:00
Name: Start date, dtype: datetime64[ns, America/New_York]
```

Timezones in Pandas

```python
# Try to set a timezone...
rides['Start date'] = rides['Start date']\
  .dt.tz_localize('America/New_York')
```

```
AmbiguousTimeError: Cannot infer dst time from '2017-11-05 01:56:50',
try using the 'ambiguous' argument
```

```python
# Handle ambiguous datetimes
rides['Start date'] = rides['Start date']\
  .dt.tz_localize('America/New_York', ambiguous='NaT')

rides['End date'] = rides['End date']\
  .dt.tz_localize('America/New_York', ambiguous='NaT')
```

Timezones in Pandas

```
# Re-calculate duration, ignoring bad row
rides['Duration'] = rides['Start date'] - rides['End date']
# Find the minimum again
rides['Duration'].dt.total_seconds().min()
```

```
116.0
```

Timezones in Pandas

```
# Look at problematic row
rides.iloc[129]
```

```
Duration                                NaT
Start date                              NaT
End date                                NaT
Start station                 6th & H St NE
End station                   3rd & M St NE
Bike number                          W20529
Member type                          Member
Name: 129, dtype: object
```

Other datetime operations in Pandas

```python
# Year of first three rows
rides['Start date']\
  .head(3)\
  .dt.year
```

```
0    2017
1    2017
2    2017
Name: Start date, dtype: int64
```

```python
# See weekdays for first three rides
rides['Start date']\
  .head(3)\
  .dt.weekday_name
```

```
0    Sunday
1    Sunday
2    Monday
Name: Start date, dtype: object
```

Other parts of Pandas

```
# Shift the indexes forward one, padding with NaT
rides['End date'].shift(1).head(3)
```

```
0                          NaT
1    2017-10-01 15:26:26-04:00
2    2017-10-01 17:49:59-04:00
Name: End date, dtype: datetime64[ns, America/New_York]
```

Additional datetime methods in Pandas

WORKING WITH DATES AND TIMES IN PYTHON

Recap: Dates and Calendars

- The `date()` class takes a year, month, and day as arguments
- A `date` object has accessors like `.year` , and also methods like `.weekday()`
- `date` objects can be compared like numbers, using `min()` , `max()` , and `sort()`
- You can subtract one `date` from another to get a `timedelta`
- To turn `date` objects into strings, use the `.isoformat()` or `.strftime()` methods

Recap: Combining Dates and Times

- The `datetime()` class takes all the arguments of `date()` , plus an hour, minute, second, and microsecond
- All of the additional arguments are optional; otherwise, they're set to zero by default
- You can replace any value in a `datetime` with the `.replace()` method
- Convert a `timedelta` into an integer with its `.total_seconds()` method
- Turn strings into dates with `.strptime()` and dates into strings with `.strftime()`

Recap: Timezones and Daylight Saving

- A `datetime` is "timezone aware" when it has its `tzinfo` set. Otherwise it is "timezone naive"
- Setting a timezone tells a `datetime` how to align itself to UTC, the universal time standard
- Use the `.replace()` method to change the timezone of a `datetime`, leaving the date and time the same
- Use the `.astimezone()` method to shift the date and time to match the new timezone
- `dateutil.tz` provides a comprehensive, updated timezone database

Recap: Easy and Powerful Timestamps in Pandas

- When reading a csv, set the `parse_dates` argument to be the list of columns which should be parsed as datetimes
- If setting `parse_dates` doesn't work, use the `pd.to_datetime()` function
- Grouping rows with `.groupby()` lets you calculate aggregates per group. For example, `.first()` , `.min()` or `.mean()`
- `.resample()` groups rows on the basis of a `datetime` column, by year, month, day, and so on
- Use `.tz_localize()` to set a timezone, keeping the date and time the same
- Use `.tz_convert()` to change the date and time to match a new timezone

Congratulations!

WORKING WITH DATES AND TIMES IN PYTHON