kayak_explore_scraper

September 17, 2019

The Kayak explore feature uses google maps to display the cheapest flights to international airports across the world at any point within a specified time interval. You can leave the interval blank to find the cheapest flights possible, but in this case we are looking for a good deal within the next summer break (specifically, the beginning of June to the end of August). Our program first uses the python request library to scrape all of the flight data sent to google maps from kayak in JSON format. We then parse the JSON string to get the specific details we are interested in.

```
In [1]: import requests, smtplib, os, datetime
        import pandas as pd
        from bs4 import *
        import urllib.request as ur
        from email.mime.multipart import MIMEMultipart
        from email.mime.text import MIMEText
        from matplotlib import pyplot as plt

        # Specify the beginning and end of the time frame of possible dates as YYYYMMDD
        timeframe_begin = 20200601
        timeframe_end = 20200830

        def scrape_kayak(start='', end='', airport = 'BER'):
            """
            This function scrapes flight information from the kayak explore page.

            Parameters:
            start, end, airport - integer representing earliest possible departure date
            in YYYYMMDD format, integer representing latest return date, string with
            three letter code for starting airport. When both are start and end are
            left blank, results are returned from present date to one year in the
            future.

            Returns:
            df - a data frame containing all destination cities and corresponding
            flight information returned by the scrape
            """

            # Format the beginning and end dates to insert them into the URL
            start = '&depart=' + str(start)
            end = '&return=' + str(end)

            url = "https://www.kayak.com/s/horizon/exploreapi/elasticbox?airport=" + airport +
            "&stopsFilterActive=false&duration=&budget=&topRightLat=68.58212830775821&topRightI
            response = requests.post(url).json()

            df = pd.DataFrame(columns=['City', 'Country', 'Price', 'Airline', 'Airport', 'Date

            for i in range(len(response['destinations'])):
                destination = response['destinations'][i]
                row = list([destination['city']['name'], destination['country']['name'],
                            destination['flightInfo']['price'], destination['airline'],
                            destination['airport']['shortName'], pd.to_datetime(destination['de
                            str('http://kayak.com'+destination['clickoutUrl'])])
                df.loc[i] = row

            city_mins = df.groupby(['City']).idxmin().astype(int)
            df = df.loc[city_mins['Price'].to_list()]
            # There is a glitch where some flights are returned with unrealistically
            # high prices, so we'll remove those entries.
            df = df.where(df['Price']!=999999).dropna()

            return df

        all_flights = scrape_kayak(timeframe_begin, timeframe_end)
        all_flights.head()
```

```
Out[1]:            City               Country   Price             Airline Airport  \
        295  Abbotsford                Canada  1167.0          Air Canada     YXX
        122    Aberdeen        United Kingdom   186.0                 KLM     ABZ
        526   Abu Dhabi  United Arab Emirates   510.0                 KLM     AUH
        8         Abuja               Nigeria   790.0   Turkish Airlines     ABV
        307    Acapulco                Mexico  3603.0  Multiple Airlines     ACA

                   Date                                               Link
        295  2020-07-15  http://kayak.com/flights/TXL-YXX/2020-07-15/20...
        122  2020-07-02  http://kayak.com/flights/TXL-ABZ/2020-07-02/20...
        526  2020-07-02  http://kayak.com/flights/TXL-AUH/2020-07-02/20...
        8    2020-07-02  http://kayak.com/flights/TXL-ABV/2020-07-02/20...
        307  2020-07-02  http://kayak.com/flights/TXL-ACA/2020-07-02/20...
```

We have about 500 rows of flight information, so we really need a good way to summarize the data. Let's return a dataframe showing the cheapest flights from our destination to each continent. Unfortunately, the JSON string returned by Kayak doesn't specify the continent of each destination country, so let's scrape wikipedia to map countries to their respective continents.

```
In [10]: def scrape_wikipedia():
             """
```

```
    This function scrapes and parses several wikipedia pages to map flight
    destination cities to their respective continents. It then cleans the
    resulting data frame.

    Returns:
    df - a data frame containing all cities from the wiki data and the
    continents where they are located
    """

    urls = ['https://en.wikipedia.org/wiki/List_of_African_countries_by_area',
           'https://en.wikipedia.org/wiki/List_of_North_American_countries_by_GDP_(no
           'https://en.wikipedia.org/wiki/List_of_South_American_countries_by_populat
           'https://en.wikipedia.org/wiki/List_of_European_countries_by_area',
           'https://en.wikipedia.org/wiki/List_of_Oceanian_countries_by_population',
           'https://en.wikipedia.org/wiki/List_of_countries_in_Asia-Pacific_by_GDP_(n
           'https://en.wikipedia.org/wiki/List_of_Middle_Eastern_countries_by_populat

    #  We'll count the Middle East as Asia
    continents = ['Africa', 'North America', 'South America', 'Europe',
                  'Oceania', 'Asia', 'Asia']
    all_continents, countries = [], []
    df = pd.DataFrame(columns=['Country', 'Continent'])

    for i in range(len(urls)):
        html = ur.urlopen(urls[i]).read()
        soup = BeautifulSoup(html, 'html.parser')
        table = soup.find_all('table')[0]
        rows = table.find_all('tr')

        for row in rows:
            columns = row.find_all('td')
            if len(columns) > 0:
                country = columns[1].get_text().strip()
                if country not in countries:
                    countries.append(country)
                    all_continents.append(continents[i])

    # Remove all parentheses
    countries = pd.Series(countries).replace(regex=True,
                          to_replace=[r'\d', r'\([^)]*\)', ''], value=r'')
    # Remove brackets and asterisks
    countries = countries.replace(regex=True,
                                  to_replace=[r'\[[^()]*\]', r'[\*]'],
                                  value=r'')
    df['Country'] = countries
    df['Continent'] = pd.Series(all_continents)

    return df
```

```
        # If we've already run the scraper, there's no need to scrape wikipedia a
        # second time.
        if not os.path.isfile('data\continents.csv'):
            all_continents = scrape_wikipedia()
        else:
            all_continents = pd.read_csv('data\continents.csv', index_col=0)

        print(all_continents.head())
```

```
                            Country Continent
0                           Algeria    Africa
1  Democratic Republic of the Congo    Africa
2                             Sudan    Africa
3                             Libya    Africa
4                              Chad    Africa
```

Now that we have the continent for each country, let's find the best deal for each continent, and include two other regional destinations we are interested in to group alongside the continents (Japan and Hawaii).

```
In [3]: def summarize_results(cities):
            """
            This function finds the lowest priced flight to each continent, as well as
            to specific regions we're interested in, in this case Japan and Hawaii.

            Parameters:
            cities - a data frame with scraped kayak flight information with a
            continent mapped to each city.

            Returns:
            deals - a data frame containing flight information for the cheapest flight
            to each destination of interest.
            """

            hi_airports = ['HNL', 'MKK', 'OGG', 'KOA', 'ITO']
            hawaii = cities[cities['Airport'].str.match('LIH')]

            # Create a dataframe with all of the Hawaii flights
            for airport in hi_airports:
                hawaii = hawaii.append(cities[cities['Airport'].str.match(airport)])

            # Doing the same for Japan is a bit easier since we can just grep the
            # country ccolumn
            japan = cities[cities['Country'].str.match('Japan')]
            jp_lowest = japan.loc[japan['Price'].idxmin()].copy()
            jp_lowest['Continent'] = 'Japan*' # Differentiate the Japan flights from Asia flig
```

```
        hi_lowest = hawaii.loc[hawaii['Price'].idxmin()].copy()
        hi_lowest['Continent'] = 'Hawaii*'
        lowest = cities.groupby(['Continent'])['Price'].idxmin()
        deals = cities.iloc[lowest,:]
        deals = deals.append(jp_lowest)
        deals = deals.append(hi_lowest)
        deals = deals.set_index('Continent')

        return deals

    flights_list = all_flights.merge(all_continents, how='left', on='Country')
    results = summarize_results(flights_list)
    print(results.head())
```

```
                    City        Country  Price            Airline Airport  \
Continent
Africa         Marrakesh        Morocco  162.0   TAP AIR PORTUGAL     RAK
Asia               Izmir         Turkey  150.0  Ukraine Intl Air     ADB
Europe            Venice          Italy   69.0            Ryanair     TSF
North America   New York  United States  309.0 Multiple Airlines     JFK
Oceania            Perth      Australia  571.0              Scoot     PER

                     Date                                           Link
Continent
Africa         2020-07-17  http://kayak.com/flights/TXL-RAK/2020-07-17/20...
Asia           2020-07-19  http://kayak.com/flights/TXL-ADB/2020-07-19/20...
Europe         2020-07-15  http://kayak.com/flights/SXF-TSF/2020-07-15/20...
North America  2020-06-02  http://kayak.com/flights/TXL-JFK/2020-06-02/20...
Oceania        2020-08-12  http://kayak.com/flights/TXL-PER/2020-08-12/20...
```

Here is a function that determines whether or not to send an email based on the present results.

```
In [13]: def check_df(results, start, end):
             """
             This function compares the results of the current scrape with previous
             results to determine if an email update should be sent.

             Parameters:
             results, start, end - dataframe with summarized scrape results, integer
             representing earliest possible departure date in YYYYMMDD format, integer
             representing latest return date

             Returns:
             msgs, email - list of strings indicating continents for which good deals are
             available, boolean indicating whether an email should be sent
             """
```

```
            filename = 'data/' + str(start) + '_to_' + str(end) + '_kayak_scrape.csv'
            if os.path.isfile(filename):
                df = pd.read_csv(filename)
            else:
                df = pd.DataFrame(columns=['Date'])

            current_scrape = results['Price']

            # Append the current scrape as a row if it isn't a duplicate
            if df.append(current_scrape).drop([
                    'Date'], axis=1).duplicated().any() == False:
                df = df.append(current_scrape)
                now = datetime.datetime.now()
                df.iloc[-1,0] = now
                df.index = range(len(df))

            df.to_csv(filename, index=False)
            msgs = ''
            # Bool indicating if an email will be sent. Will be set to true if good
            # deals are detected
            email = False
            # Percent of average flight price to a given destination; if a current price is
            # under this threshold, an email alert will be generated
            email_threshold = 0.85

            for column in range(1,len(df.columns)):
                col_mean = df.iloc[:,column].mean()
                if col_mean * email_threshold > df.iloc[-1,column]:
                    name = df.columns[column]
                    msg = 'Flights to ' + name + ' right now are abnormally cheap.<br>'
                    msgs += msg
                    email = True

            print(df)

            return msgs, email

        msgs, email = check_df(results, timeframe_begin, timeframe_end)
        print(msgs)
```

```
                         Date  Africa  Asia  Europe  Hawaii*  Japan*  \
0  2019-09-06 21:18:53.349374     149   330      63     1096     525
1  2019-09-06 21:26:08.604121     149   330      63     1096     525
2  2019-09-06 21:40:52.898861     149   330      63     1096     525
3  2019-09-08 09:52:53.051645     195   128      58     1160     728
4  2019-09-09 12:33:22.396911     170   146      64     1441     844
5  2019-09-09 17:31:59.685267     162   144      62     1197     547
6  2019-09-10 09:36:00.039766     159   128      62     1306     618
```

```
7   2019-09-10 17:09:53.544494     253   162      65     1197     618
8   2019-09-10 21:09:37.573083     253   133      65     1197     496
9   2019-09-11 10:29:23.825930     253   154      65     1059     631
10  2019-09-11 21:31:41.159486     170   128      65     1059     529
11  2019-09-11 22:20:12.757514     170   128      65     1059     529
12  2019-09-12 09:09:22.146991     170   128      65     1059     529
13  2019-09-12 11:47:40.541389     170   128      65     1059     558
14  2019-09-12 14:45:01.674894     170   329      65     1059     558
15  2019-09-13 18:44:08.345119     161   133      61     1059     517
16  2019-09-14 07:50:12.079461     161   128      61     1324     517
17  2019-09-14 08:57:42.802206     161   128      61     1324     517
18  2019-09-14 14:58:59.527522     193   133      61     1196     642
19  2019-09-15 10:26:40.968860     165   145      63     1326     541
20  2019-09-15 22:31:52.069036     165   125      61     1054     541
21  2019-09-16 09:49:09.023443     165   125      66     1326     566
22  2019-09-16 12:14:03.513101     165   125      66     1326     566
23  2019-09-16 20:25:28.076240     162   137      66     1196     546
24  2019-09-17 09:49:48.161516     162   138      70     1326     545
25  2019-09-17 13:57:56.650502     162   150      69     1059     545

    North America  Oceania  Oklahoma  South America
0             366      698     563.0            579
1             366      698     520.0            579
2             366      698     551.0            579
3             477      745     544.0            584
4             364      697     551.0            624
5             364      618     552.0            624
6             485      733     531.0            624
7             368      691     560.0            598
8             368      691     560.0            598
9             396      691     567.0            628
10            311      698     282.0            593
11            304      698     282.0            593
12            312      698     557.0            666
13            311      697     539.0            666
14            311      697     529.0            666
15            282      697     523.0            584
16            309      805     525.0            628
17            309      805     519.0            628
18            296      700     525.0            598
19            315      800     519.0            598
20            309      703     525.0            598
21            301      681     519.0            619
22            301      681       NaN            598
23            311      572       NaN            598
24            309      572     529.0            598
25            309      571       NaN            598
Flights to Oceania right now are abnormally cheap.<br>
```

This function sends an email if the current scrape has any outstanding deals to at least one of our destinations.

```
In [14]: def send_email(flights):
             """
             This function sends an email with the summarized flight data as a data
             frame in html to the specified address.

             Parameters:
             flights - a dataframe of the best deals on flights and the corresponding
             details returned by our scrape.
             """

             password = input('Type your password:')
             message = MIMEMultipart('alternative')
             message.add_header('Content-Type','html')
             sender = 'youremail@domain.com'
             receiver = 'theiremail@domain.com'
             message['Subject'] = "Here is your latest Kayak scrape!"
             message['From'] = sender
             message['To'] = receiver
             html = "<html><head></head><body><p>" + msgs + \
             flights.to_html() + ". </p></body></html>"

             part1 = MIMEText(html, 'html')
             message.attach(part1)
             mail = smtplib.SMTP('smtp.gmail.com', 587)
             mail.ehlo()
             mail.starttls()
             mail.login('your_username', password)
             mail.sendmail(sender, receiver.split(','), message.as_string())
             mail.quit()

         if email:
             #send_email(results)
             pass #  No email in this jupyter version
```

This function saves a dataframe with the data from all flights (not just the best deals), which is useful for producing some charts.

```
In [17]: def save_scrape(flights, start, end):
             """
             This function appends a column containing all of the current scraped prices
             to a dataframe of saved flight price data.

             Parameters:
             flights, start, end - dataframe with all scraped flight results, integer
```

```
    representing earliest possible departure date in YYYYMMDD format, integer
    representing latest return date

    Returns:
    dataframe containing all previously scraped flight data plus the current scrape
    """
    filename = 'data/' + str(start) + '_to_' + str(end) + '_all_flights.csv'
    now = datetime.datetime.now()
    current_prices = flights.set_index('City')['Price']
    current_prices.name = now

    if os.path.isfile(filename):
        df = pd.read_csv(filename, index_col=0)
        df = df.merge(current_prices, how='outer', left_index=True,
                      right_index=True)
    else:
        df = pd.DataFrame(current_prices)
        df['Continent'] = flights_list.set_index('City')['Continent']

    df.to_csv(filename)

    return df.drop('Continent', axis=1).dropna()

historical = save_scrape(flights_list, timeframe_begin, timeframe_end)
print(historical.head())
```

```
           2019-09-11 22:05:24.869258  2019-09-12 09:01:14.631851  \
City
Aberdeen                        563.0                       188.0
Abu Dhabi                       510.0                       510.0
Abuja                          1877.0                      1878.0
Acapulco                       2486.0                      2486.0
Accra                           711.0                       711.0

           2019-09-12 11:36:55.827211  2019-09-12 12:22:00.953972  \
City
Aberdeen                        188.0                       188.0
Abu Dhabi                       510.0                       510.0
Abuja                          1878.0                      1878.0
Acapulco                       2486.0                      2486.0
Accra                           709.0                       709.0

           2019-09-12 12:23:51.262758  2019-09-12 12:47:19.909551  \
City
Aberdeen                        188.0                       188.0
Abu Dhabi                       510.0                       510.0
Abuja                          1878.0                      1878.0
Acapulco                       2486.0                      2486.0
```

```
Accra                            709.0                         709.0

           2019-09-12 14:41:09.103147  2019-09-12 14:43:29.661475  \
City
Aberdeen                         679.0                         679.0
Abu Dhabi                        510.0                         510.0
Abuja                           1878.0                        1878.0
Acapulco                        3591.0                        3591.0
Accra                            669.0                         669.0

           2019-09-13 18:31:06.671201  2019-09-13 18:33:38.926318  ...  \
City                                                               ...
Aberdeen                         185.0                         185.0  ...
Abu Dhabi                        499.0                         499.0  ...
Abuja                           1874.0                        1874.0  ...
Acapulco                        3584.0                        3584.0  ...
Accra                            710.0                         710.0  ...

           2019-09-15 22:29:49.689412  2019-09-16 09:47:06.249882  \
City
Aberdeen                         186.0                         186.0
Abu Dhabi                        502.0                         502.0
Abuja                           1876.0                         790.0
Acapulco                        3587.0                        3587.0
Accra                            643.0                         643.0

           2019-09-16 12:14:03.140103  2019-09-16 20:11:48.235263  \
City
Aberdeen                         186.0                         186.0
Abu Dhabi                        502.0                         510.0
Abuja                            790.0                         790.0
Acapulco                        3587.0                        3587.0
Accra                            465.0                         465.0

           2019-09-16 20:27:21.839269  2019-09-17 09:44:16.044334  \
City
Aberdeen                         186.0                         186.0
Abu Dhabi                        510.0                         510.0
Abuja                            790.0                         790.0
Acapulco                        3587.0                        3587.0
Accra                            465.0                         465.0

           2019-09-17 09:47:57.780076  2019-09-17 14:01:20.505055  \
City
Aberdeen                         186.0                         186.0
Abu Dhabi                        510.0                         510.0
Abuja                            790.0                         790.0
Acapulco                        3587.0                        3603.0
```

```
Accra                         465.0                       717.0

           2019-09-17 14:01:25.940395  2019-09-17 14:01:55.559245
City
Aberdeen                      186.0                       186.0
Abu Dhabi                     510.0                       510.0
Abuja                         790.0                       790.0
Acapulco                     3603.0                      3603.0
Accra                         717.0                       717.0

[5 rows x 29 columns]
```

This chart summarizes the distribution of prices to each continent from the current scrape.

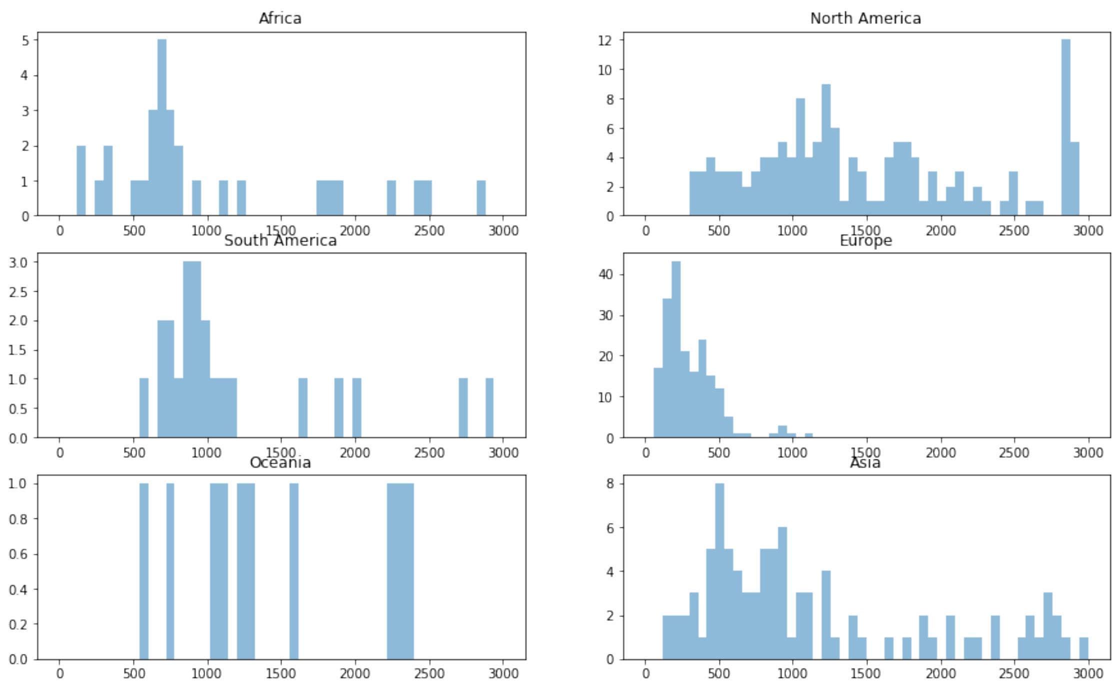
```
In [22]: %matplotlib inline
         %pylab inline
         pylab.rcParams['figure.figsize'] = (15, 9)

         continents = ['Africa', 'North America', 'South America',
                       'Europe', 'Oceania', 'Asia']
         plot_num = 1

         for continent in continents:
             plt.subplot(3,2,plot_num)
             df = flights_list.where(flights_list['Continent']==continent).dropna()
             plt.hist(df['Price'], bins=50, alpha=0.5, range=(0,3000))
             title = plt.gca().set_title(continent)
             plot_num += 1

         plt.show()
```

```
Populating the interactive namespace from numpy and matplotlib
```



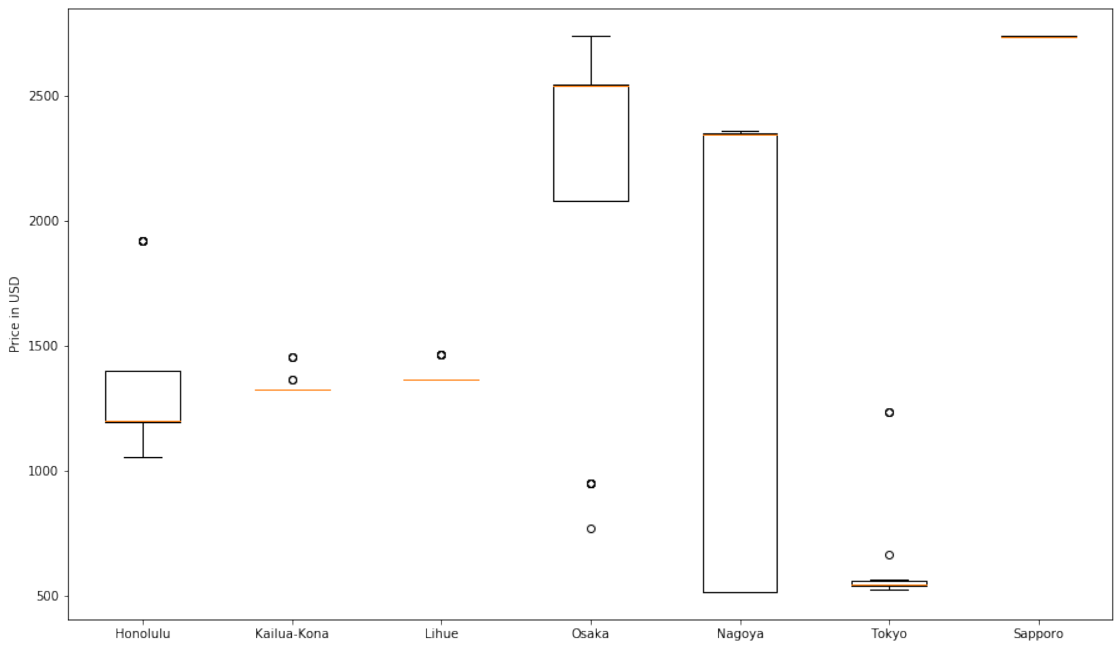
The next chart is possibly more useful, because it tells us which cities in our regional destinations have a wide variability in flight prices. Cities for which the boxes are long or have many outliers may be worth paying additional attention to.

```
In [21]: dest_prices, labels = [], []

         # This lists cities from Hawaii and Japan to which flights are present in our
         # data frame.
         bp_cities = ['Honolulu', 'Kailua-Kona', 'Kahului', 'Lihue', 'Osaka', 'Nagoya',
                     'Tokyo', 'Sapporo', 'Okinawa']

         for city in bp_cities:
                 df = historical[historical.index.str.match(city)].T
                 if df.shape[1] > 0:
                     df = pd.Series(df[city]).tolist()
                     dest_prices.append(df)
                     labels.append(city)

         fig, ax = plt.subplots()
         ax.boxplot(dest_prices, labels=labels, whis=2)
         plt.ylabel('Price in USD')
         plt.show()
```


2500
2000
1500
1000
500
Price in USD
Honolulu
Kailua-Kona
Lihue
Osaka
Nagoya
Tokyo
Sapporo