

Homework 08







⚠ Before you start ⚠

Duplicate this Jupyter Notebook in your `week-10` folder (right-click -> Duplicate) and then add your last name to the beginning of it (ie. `blevins-hw-08.ipynb` - otherwise you risk having all your work overwritten when you try to sync your GitHub repository with your instructor's repository.

Overview

In this assignment, you'll synthesize some of the Python skills you've learned over the past month or so, including Pandas and Plotly. You'll be analyzing the opening of new businesses in Colorado during the 1940s.

Draw on the following tutorials:

-  Walsh, [Pandas Basics Part 1](#)
-  Walsh, [Pandas Basics Part 2](#)
-  Walsh, [Pandas Basics Part 3](#)
-  [Pandas Concepts](#)
-  [Introduction to Plotly](#)
-  [Cleaning Excel Files](#)

The Data

First, get the necessary data files from our shared course repository:

- Open GitHub Desktop and select your course repository (`lastname-sp25-data-materials`)
- Click `Fetch origin` to check for updates
- Go to `Branch` → `Merge into current branch` → select `upstream/main` -> `Merge`
- Click `Push origin` to sync everything up
- Launch Jupyter Lab and navigate to the `week-10` folder

You should see a single Excel file that you will be working with: `co-new-businesses-1940s.xlsx`. Inside that Excel file, there are two separate sheets: `New CO Businesses` and `Cities 1940`.

- `New CO Businesses`: This is a subset of new businesses that were established in Colorado during the 1940s - a subset of data drawn from [this database](#).
- `Cities 1940`: this contains population statistics for Colorado cities in the 1940 Census.

Import Libraries and Load Data

- Import the necessary libraries:
 - `pandas` (using the alias `pd`)
 - `plotly.express` (using the alias `px`)

```
In [8]: #Your code here
import pandas as pd
import plotly.express as px
```

- Load both sheets from the Excel file:
 - Create a variable called `businesses_df` to store the "New CO Businesses" sheet in the Excel file
 - Create a variable called `cities_df` to store the "Cities 1940" sheet in the Excel file
 - Use `pd.read_excel()` with the appropriate parameters

```
In [10]: #Your code here
businesses_df = pd.read_excel('co-new-businesses-1940s.xlsx', sheet_name='New CO Businesses')
cities_df = pd.read_excel('co-new-businesses-1940s.xlsx', sheet_name='Cities 1940')
```

Familiarize Yourself with the Data

Familiarize yourself with the data:

- Display a sample of 10 rows from each dataframe.
- Check the data types for the columns in each dataframe

```
In [12]: #Your code here
businesses_df.sample(10)
```

Out [12]:

	entityid	Business entity name	Address	city	state	zip_code	Country
274	19871115878	MILE HIGH KENNEL CLUB, INC.	6200 DAHLIA ST	COMMERCE CITY	CO	80022.0	US
13	19871030120	HALLIBURTON ENERGY SERVICES, INC., Delinquent ...	3000 N Sam Houston Pkwy E	Houston	TX	77032.0	US
635	19871114071	RED FEATHER STORAGE AND IRRIGATION COMPANY	58 FIRE HOUSE LN	RED FEATHER LAKES	CO	80545.0	US
545	19871111691	TRAIL CREEK MINING COMPANY, INC., Dissolved Ju...	205 NORTH MURRAY BLVD #48	COLORADO SPRINGS	CO	80916.0	US
884	19871107846	THE PAONIA ASSEMBLIES OF GOD, Delinquent Novem...	7TH AND OAK AVENUE	PAONIA	CO	81428.0	US
278	19871111922	PROFITSYSTEMS, INC.	422 E VERMIJO STE 100	COLORADO SPRINGS	CO	80903.0	US
890	19871109946	THE COWDERY COMPANY	2126 S Gilpin St	Denver	CO	80210.0	US
662	19871114749	LINDA VISTA IRRIGATION COMPANY	NaN	NaN	NaN	NaN	NaN
535	19871111274	GEORGE WASHINGTON LODGE ASSOCIATION	7235 Terrace Place	Boulder	CO	80303.0	US
151	19871011214	NATIONAL BANKERS LIFE INSURANCE COMPANY, Delin...	NaN	NaN	NaN	NaN	NaN

In [13]: cities_df.sample(10)

Out [13]:

	city	year	total population
14	blanca	1940	407
106	jamestown	1940	190
79	georgetown	1940	391
172	pueblo	1940	52162
41	crook	1940	236
218	woodland park	1940	372
2	alma	1940	469
96	holly	1940	864
176	ridgway	1940	354
150	nucla	1940	361

In [14]:

```
print(businesses_df.dtypes)
print(cities_df.dtypes)
```

```
entityid                int64
Business entity name    object
Address                 object
city                   object
state                  object
zip_code               float64
Country                object
date_entity_formed     object
year_entity_formed     int64
dtype: object
city                   object
year                  int64
total population       int64
dtype: object
```

Data Cleaning and Preparation

Cleaning column names

For both datasets, you want to clean and standardize the column names (headers):

- Change column names to all lowercase
- Replace any whitespace with an underscore (`_`) - ex. `some column` becomes `some_column`

- Hint: Use `str.lower()` and `str.replace()`
- Show the first 10 rows of your dataframe to make sure it worked

```
In [16]: #Your code here
businesses_df.columns = [col.strip().lower().replace(' ', '_').replace('-', '_') for col in businesses_df.columns]
cities_df.columns = [col.strip().lower().replace(' ', '_') for col in cities_df.columns]
cities_df.head(10)
```

```
Out[16]:
```

	city	year	total_population
0	akron	1940	1417
1	alamosa	1940	5613
2	alma	1940	469
3	antonito	1940	1220
4	arriba	1940	286
5	arvada	1940	1482
6	aspen	1940	777
7	aurora	1940	3437
8	basalt	1940	212
9	bayfield	1940	372

Standardize and clean data for cities

- Standardize city names in the business data so that it **removes any trailing or leading whitespace** and **changes the values to all lowercase** (hint: use `.str.strip()` and `.str.lower()`)
- Show the first 10 rows of your dataframe to make sure it worked

```
In [18]: #Your code here
businesses_df['city'] = businesses_df['city'].str.strip().str.lower()
cities_df['city'] = cities_df['city'].str.strip().str.lower()
businesses_df.head(10)
```

Out [18]:

	entityid	business_entity_name	address	city	state	zip_code	country
0	19871004753	ALAMOSA CREDIT UNION	2437 MAIN ST	alamosa	CO	81101.0	US
1	19871241137	THE UNITED METHODIST CHURCH OF STEAMBOAT SPRINGS	736 OAK ST	steamboat springs	CO	80487.0	US
2	19871275274	ALLIED JEWISH FEDERATION OF COLORADO	300 S. Dahlia St.	denver	CO	80246.0	US
3	19871127721	Iglesia CRISTO REY + Christ the King, ELCA	2300 S Patton Ct	denver	CO	80219.0	US
4	19871117433	LYNCH-COTTEN POST NO. 190, THE AMERICAN LEGION	425 Highway 92	crawford	CO	81415.0	US
5	19871105155	THE BEAR RIVER VALLEY FARMERS COOPERATIVE	193 E Jefferson Ave	hayden	CO	81639.0	US
6	19871162072	Belmar Baptist Church	460 S Kipling St	lakewood	CO	80226.0	US
7	19871110810	Bethel Lutheran Church of Windsor, Colorado	328 Walnut St	windsor	CO	80550.0	US
8	19871116977	BLACKINTON AND DECKER, INC., Delinquent Novemb...	424 LIPAN	denver	CO	80204.0	US
9	19871113871	BOW-MAR OWNERS, INC.	5380 Lakeshore Dr	littleton	CO	80123.0	US

Categorize Cities

Define your function

Create a function called `categorize_city_size` that does the following:

- Takes in a number that corresponds to the population for a city and returns the following based on the size of the city:
 - `Small Town` if population is less than 1,000
 - `Medium Town` if population is between 1,000 to 5,000

- `Large Town` if population is between 5,000 to 20,000
- `City` if population greater than or equal to 20,000

```
In [20]: #Your code here
def categorize_city_size(size):
    if size < 1000:
        return "Small Town"
    elif size >= 1000 and size < 5000:
        return "Medium Town"
    elif size >= 5000 and size < 20000:
        return "Large Town"
    elif size >= 20000:
        return "City"
```

Test Your Function

Test out the function on a single number (`2,000`) to make sure it returns `Medium Town`

```
In [22]: #Your code here
categorize_city_size(2000)
```

```
Out[22]: 'Medium Town'
```

Apply the function

- Take your `cities_df` dataframe and add a new column called `city_category` that applies your function to the `total_population` column of the dataframe.
- *Hint: use `apply()`*
- Show the first 10 rows of your dataframe to make sure it worked

```
In [24]: #Your code here
cities_df['city_category'] = cities_df['total_population'].apply(categorize_
cities_df.head(10)
```

Out [24]:

	city	year	total_population	city_category
0	akron	1940	1417	Medium Town
1	alamosa	1940	5613	Large Town
2	alma	1940	469	Small Town
3	antonito	1940	1220	Medium Town
4	arriba	1940	286	Small Town
5	arvada	1940	1482	Medium Town
6	aspen	1940	777	Small Town
7	aurora	1940	3437	Medium Town
8	basalt	1940	212	Small Town
9	bayfield	1940	372	Small Town

Analyze Businesses by Year

Let's take a look at how many new businesses were formed in Colorado in each year during the 1940s:

Calculate new businesses by year

Create a variable called `businesses_per_year` by:

- Counting the number of new businesses based on `year_entity_formed`
- Hint: use `value_counts()` and `reset_index()`
- Show the first 10 rows of your dataframe

```
In [26]: #Your code here
businesses_per_year = businesses_df['year_entity_formed'].value_counts().reset_index()
businesses_per_year.head(10)
```


Out [26]:

	year_entity_formed	count
0	1947	161
1	1948	156
2	1946	153
3	1949	133
4	1945	87
5	1940	72
6	1941	69
7	1943	47
8	1944	43
9	1942	35

Visualize new businesses by year

Create a bar chart using Plotly Express showing new businesses per year:

- Set x-axis to the year
- Set y-axis to the number of new businesses
- Add an appropriate title and labels
- Display text on each bar
- Hint: Use `px.bar()`

```
In [28]: #Your code here
fig = px.bar(businesses_per_year, x='year_entity_formed', y='count',
             title="Frequency of new businesses in Colorado during the 1940",
             hover_data=['year_entity_formed', 'count'],
             labels={'year_entity_formed': 'Year of opening', 'count': 'Amount'},
             height=400)

fig.show()
```

Analyze Businesses by City

Let's take a look at how many new businesses were formed in each Colorado city during the 1940s:

Calculate number of new businesses by city

Create a new variable called `city_businesses` that contains:

- A dataframe with counts of the number of new businesses in each city
- *Hint: Use `value_counts()` and `reset_index()`*
- Show the first 10 rows of your dataframe

```
In [30]: #Your code here
city_businesses = businesses_df['city'].value_counts().reset_index().head(10)
city_businesses.head(10)
```

Out [30]:

	city	count
0	denver	152
1	colorado springs	34
2	lakewood	22
3	pueblo	20
4	arvada	14
5	grand junction	14
6	fort collins	13
7	greeley	13
8	centennial	12
9	englewood	12

Visualize new businesses by city

Create a bar chart with Plotly Express showing the top 10 cities with the most new businesses created during the 1940s:

- Filter to only show the top 10 cities (hint: use `.head()`)
- Set x-axis to `city`
- Set y-axis to `count`
- Add an appropriate title and labels

```
In [32]: #Your code here
fig = px.bar(city_businesses, x='city', y='count',
             title="1940s Colorado cities with the most new businesses",
             hover_data=['city', 'count'],
             labels={'city': 'City', 'count': 'Amount of new businesses'},
             height=400)


fig.show()
```

Combine Business and City Data

We have two datasets, both of which contain information about Colorado cities. Let's combine the two into a single dataframe that contains both information about new businesses and their population in the 1940 census.

Merge dataframes

Merge the two dataframes together:

- Create a new variable called `merged_df`
- Use `pd.merge()` on the `city_businesses` and `cities_df` dataframes
- Figure out which column is shared between the two to use as your "key" to merge them
-  **Note: use the `how='inner'` parameter for your merge**
- Show the first 10 rows of your new dataframe

```
In [34]: #Your code here
merged_df = pd.merge(
    cities_df,
```

```

    city_businesses,
    on='city',
    how='inner'
)

merged_df.head(10)

```

Out[34]:

	city	year	total_population	city_category	count
0	arvada	1940	1482	Medium Town	14
1	colorado springs	1940	36789	City	34
2	denver	1940	322412	City	152
3	englewood	1940	9680	Large Town	12
4	fort collins	1940	12251	Large Town	13
5	grand junction	1940	12479	Large Town	14
6	greeley	1940	15995	Large Town	13
7	pueblo	1940	52162	City	20

Filter out missing values

You'll note that several rows of data contain `NaN` or missing values - this means that there was a city listed in the businesses dataframe but it didn't have a corresponding match in the population dataframe. For now, remove these from the `merged_df` dataframe:

- Filter out rows where `total_population` is `NaN`
- *Hint: use a filter + `.notna()`*

```

In [36]: #Your code here
filtered_merged_df['total_population'] = merged_df['total_population'].notna()
filtered_merged_df.head(10)

```

```

-----
NameError                                Traceback (most recent call last)
Cell In[36], line 2
      1 #Your code here
----> 2 filtered_merged_df['total_population'] = merged_df['total_population'].notna()
      3 filtered_merged_df.head(10)

NameError: name 'filtered_merged_df' is not defined

```

Calculate new businesses on a per capita rate

To make it easier to compare larger cities with smaller cities, you're going to calculate a new column for each city: the number of new businesses per 1,000 residents.

- Add a new column to `merged_df` called `biz_per_thousand` that is filled with:
 - A calculation dividing the `count` column by the `total_population` column and multiplying by 1,000
- Sort the merged dataframe by `biz_per_thousand` in descending order
- Show the first 10 rows of the dataframe to check if it worked

In []: *#Your code here*

```
merged_df['biz_per_thousand'] = (merged_df['count']/merged_df['total_population'])*1000
merged_df = merged_df.sort_values(by='biz_per_thousand', ascending=False).head(10)
merged_df
```

Visualize new business creation by city

Let's say we want to see the cities with the highest *rate* of business creation (ie. new businesses per thousand residents)

- Create a bar chart in Plotly of `merged_df` :
 - Filter to only show the top 10 cities (use `.head(10)`)
 - Set x-axis to `city`
 - Set y-axis to `biz_per_thousand`
 - Use `city_category` for color
 - Add an appropriate title and labels

In []: *#Your code here*

```
fig = px.bar(merged_df, x='city', y='biz_per_thousand',
             title="1940s Colorado Cities ranked by new businesses per capita",
             hover_data=['city', 'biz_per_thousand'], color='city_category',
             labels={'city':'City', 'biz_per_thousand':'New businesses per thousand residents'},
             height=400)

fig.show()
```

Bonus: New businesses by city category

Let's say we want to compare different size categories to see whether new businesses were cropping up in smaller places or bigger cities.

Create a new dataframe

First, you'll need to create a new dataframe that consists of four rows, with each row a different category of city containing the total number of businesses created within that category of city.

- Create a new dataframe called `city_category_totals`
- Start with `merged_df`
- Group by `city_category`
- Add up (`sum()`) the `count` column
- Use `.reset_index()`

```
In [ ]: #Your code here
city_category_totals = merged_df.groupby(['city_category']).sum('count').reset_index()
city_category_totals
```

Visualize businesses by city category

- Create a [pie chart](#) in Plotly:
 - Use `px.pie()` with appropriate parameters
 - Use `city_category_totals` as your dataframe
 - Use `count` for your values
 - Use `city_category` for your names
 - Add an appropriate title and labels

```
In [ ]: #Your code here
fig = px.pie(city_category_totals, values='count', names='city_category',
             title="1940s Colorado Cities ranked by new businesses per capita")
fig.show()
```

Bonus Challenge: Create a Scatterplot

Create a scatter plot in Plotly showing:

- The relationship between city population (x-axis) and new businesses (y-axis)
- Only data for towns with a population of 2,000 or more people.
- Dots sized according to the number of new businesses in that city
- Dots colored according to their size category

```
In [ ]: #Your code here
```

```
big_towns = merged_df["total_population"]>2000

fig = px.scatter(big_towns, x="total_population", y="biz_per_thousand", color=
                 size='biz_per_thousand', hover_data=['total_population'])

fig.show() # Couldnt figure this one out if you wanna give some feedback. Th
```

Submission Guidelines

- Run all code cells and make sure it is outputting without errors
- Submit both the notebook file (.ipynb) and a PDF export of your notebook [on Canvas](#)
- Note: the PDF probably won't display the Plotly figures - that's okay