milan@datajoin.net

http://datajoin.net

DataJoin

# Correlate company data with external data

[Document subtitle]

Milan Patel
5-2-2025

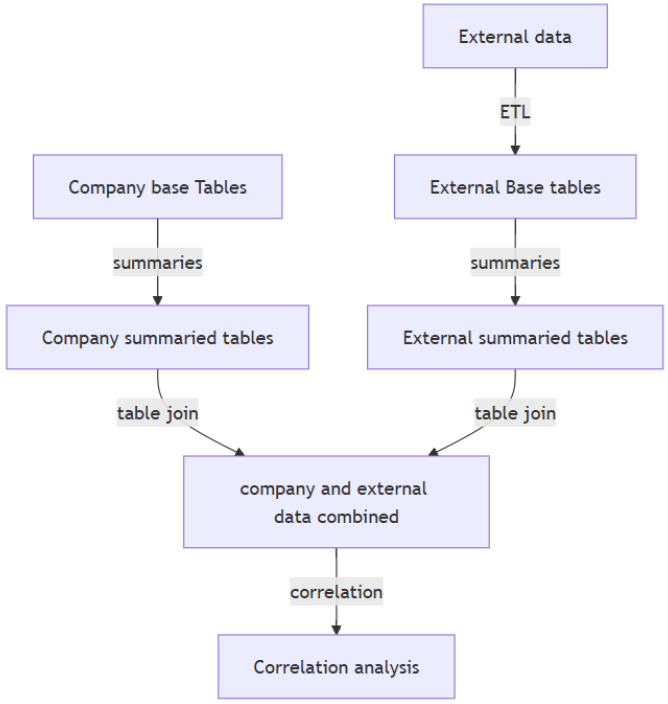
# Table of Contents

## Overview

Problem: Business intelligence (BI) or customer relationship management (CRM) software provides data on regional sales but lacks comprehensive details about the region, which is necessary to understand variations in sales by region. Furthermore, when traveling, house hunting, or starting a business in a specific region, it is essential to obtain more in-depth information about that area.

Solution: Provide comprehensive regional details, including crime rates, education levels, environmental conditions, and local economic factors. This information can be integrated with BI (Business Intelligence) or CRM (Customer Relationship Management) data to identify potential correlations or discrepancies.

DataJoin.net provides in-depth education and consultation on matching CRM data with regional open-source information.



## What should be matched (correlated)

A company's performance measures should be compared / matched / correlated with reginal demographics and other measurements (GDP, Unemployment, etc.)

### Performance measures (dimensions) categories

As per data warehouse star schema, the fact table can be associated with multiple dimensions. Each dimension has a hierarchy that can be used to drill down to find the value at a specific level.

**Examples of dimensions:**
Organization
Product category
Region
Time
Financial
Customer satisfaction
Operation

Each of the above performances can have hierarchy as below.
Example of Time hierarchy: Year – Quarter - Month
Region hierarchy: Country – State - County (USA - New Jersey - Monmouth)

**Standard performance measures in Data warehouse or Business Intelligence**

### Financial Measure

| |
|---|
| Operating Cost |
| Profit |
| Product Cost |
| Sales |
| Turnover |
| Liability |
| Assets |

| Return On Investment |
|---|

## Example Operational performance measure

| Quality |
|---|
| Price |
| Volume |
| Variety |
| Delivery |
| Customer Satisfaction Measure |

There are numerous other operational performance measures.

## Example external data about society (region) in which your company operates

Population
GDP
Income
Unemployment rate
There are many more data available by region (country, state, county, city, zip code)

## Examples of open-source data

https://en.wikipedia.org/wiki/List_of_federal_agencies_in_the_United_States
United States Congress
Federal judiciary of the United States
Executive Office of the President
United States Department of Agriculture (USDA)
United States Department of Commerce
United States Department of Defense (DOD)
United States Department of Education
United States Department of Energy
United States Department of Health and Human Services
United States Department of Homeland Security
United States Department of Housing and Urban Development

United States Department of the Interior (DOI)
United States Department of Justice
United States Department of Labor (DOL)
United States Department of State (DOS)
United States Department of Transportation
United States Department of the Treasury
United States Department of Veterans Affairs
Independent agencies and government-owned corporations
Joint programs and interagency agencies
Special Inspector General Office
Quasi-official agencies

https://www.usa.gov/federal-agencies/e#current-letter

**Example results from the above URL for starting with "B".**
Bureau of Economic Analysis (BEA)
Bureau of Engraving and Printing (BEP)
Bureau of Indian Affairs (BIA)
Bureau of Industry and Security (BIS)
Bureau of International Labor Affairs (ILAB)
Bureau of Justice Statistics (BJS)
Bureau of Labor Statistics (BLS)

**Example results from the above URL for starting with "C".**
Capitol Police
Capitol Visitor Center
Career, Technical, and Adult Education, Office of (OCTAE)
Census Bureau
Center for Food Safety and Applied Nutrition (CFSAN)
Center for Nutrition Policy and Promotion (CNPP)
Center for Parent Information and Resources (CPIR)
Centers for Disease Control and Prevention (CDC)
Etc.

The above is partial list there are other open sources listed at the above URL.

# Basic concept of comparing data at the same level

## Example matching (compare, correlate, etc.) sales by county and year and GDP by county and year

**sales summary by state, county and year**

| product_type | state | county_state | year | thousands of $ |
|---|---|---|---|---|
| laptop | CA | Los Angeles, CA | 2023 | 200 |
| laptop | IL | Cook, IL | 2023 | 300 |
| laptop | TX | Harris, TX | 2023 | 500 |
| laptop | NY | New York, NY | 2023 | 600 |
| laptop | AZ | Maricopa, AZ | 2023 | 100 |
| laptop | CA | Santa Clara, CA | 2023 | 250 |
| laptop | CA | Orange, CA | 2023 | 600 |
| laptop | WA | King, WA | 2023 | 600 |
| laptop | CA | San Diego, CA | 2023 | 200 |
| laptop | TX | Dallas, TX | 2023 | 400 |

**GDP by state and county**

| state | county_state | year | GDP in thousands of $ |
|---|---|---|---|
| CA | Los Angeles, CA | 2023 | 756659481 |
| IL | Cook, IL | 2023 | 396470899 |
| TX | Harris, TX | 2023 | 357130669 |
| NY | New York, NY | 2023 | 343437442 |
| AZ | Maricopa, AZ | 2023 | 312350417 |
| CA | Santa Clara, CA | 2023 | 283522548 |
| CA | Orange, CA | 2023 | 278760587 |
| WA | King, WA | 2023 | 277642267 |
| CA | San Diego, CA | 2023 | 258725373 |
| TX | Dallas, TX | 2023 | 207533772 |

**sales summary by state, county and year matched with GDP**

| product_type | state | county_state | year | thousands of $ | GDP in thousands of $ |
|---|---|---|---|---|---|
| laptop | CA | Los Angeles, CA | 2023 | 200 | 756659481 |
| laptop | IL | Cook, IL | 2023 | 300 | 396470899 |
| laptop | TX | Harris, TX | 2023 | 500 | 357130669 |
| laptop | NY | New York, NY | 2023 | 600 | 343437442 |
| laptop | AZ | Maricopa, AZ | 2023 | 100 | 312350417 |
| laptop | CA | Santa Clara, CA | 2023 | 250 | 283522548 |
| laptop | CA | Orange, CA | 2023 | 600 | 278760587 |
| laptop | WA | King, WA | 2023 | 600 | 277642267 |
| laptop | CA | San Diego, CA | 2023 | 200 | 258725373 |
| laptop | TX | Dallas, TX | 2023 | 400 | 207533772 |

If you have sales of a product type by state, county and year
and
if you have prepared GDP (gross domestic product) by state, county and year
then only, comparison is meaningful.

**One can explore the question: Is my laptop sales correlated with GDP at county level?**

## Example matching (compare, correlate, etc.) of sales by county and year and population by county

**sales summary**

| product_type | state | county_state | year | thousands of $ |
|---|---|---|---|---|
| laptop | CA | Los Angeles, CA | 2023 | 200 |
| laptop | IL | Cook, IL | 2023 | 300 |
| laptop | TX | Harris, TX | 2023 | 500 |
| laptop | NY | New York, NY | 2023 | 600 |
| laptop | AZ | Maricopa, AZ | 2023 | 100 |
| laptop | CA | Santa Clara, CA | 2023 | 250 |
| laptop | CA | Orange, CA | 2023 | 600 |
| laptop | WA | King, WA | 2023 | 600 |
| laptop | CA | San Diego, CA | 2023 | 200 |
| laptop | TX | Dallas, TX | 2023 | 400 |

**population by state and county**

| state | county_state | population |
|---|---|---|
| CA | Los Angeles County_Cali | 9848406 |
| IL | Cook County_Illinois | 5185812 |
| TX | Harris County_Texas | 4758579 |
| AZ | Maricopa County_Arizon | 4491987 |
| CA | San Diego County_Califo | 3282782 |
| CA | Orange County_Californi | 3164063 |
| FL | Miami-Dade County_Flo | 2685296 |
| NY | Kings County_New York | 2646306 |
| TX | Dallas County_Texas | 2603816 |
| CA | Riverside County_Califor | 2449909 |

**sales summary**

| product_type | state | county_state | year | thousands of $ | population |
|---|---|---|---|---|---|
| laptop | CA | Los Angeles, CA | 2023 | 200 | 9848406 |
| laptop | IL | Cook, IL | 2023 | 300 | 5185812 |
| laptop | TX | Harris, TX | 2023 | 500 | 4758579 |
| laptop | NY | New York, NY | 2023 | 600 | 2646306 |
| laptop | AZ | Maricopa, AZ | 2023 | 100 | 4491987 |
| laptop | CA | Orange, CA | 2023 | 600 | 3164063 |
| laptop | CA | San Diego, CA | 2023 | 200 | 3282782 |
| laptop | TX | Dallas, TX | 2023 | 400 | 2603816 |

If you have sales of a product type by state, county and year

and

if you have prepared population by state and county

then only, comparison is meaningful assuming population is approximately same for number of years.

**One can explore the question: Is my laptop sales correlated with population at county level?**

## Example matching (compare, correlate, etc.) of sales by state and year and GDP by county and year

**sales summary by state and year**

| product_type | state | year | thousands of $ |
|---|---|---|---|
| laptop | CA | 2023 | 2000 |
| laptop | IL | 2023 | 500 |
| laptop | TX | 2023 | 1200 |
| laptop | NY | 2023 | 1300 |
| laptop | AZ | 2023 | 1400 |

**gdp by state by year**

| state | year | gdp in thousands of $ |
|---|---|---|
| CA | 2023 | 7566594810 |
| IL | 2023 | 3964708990 |
| TX | 2023 | 3571306690 |
| NY | 2023 | 3434374420 |
| AZ | 2023 | 3123504170 |

**sales summary by state and year matched with GDP**

| product_type | state | year | thousands of $ | gdp in thousands of $ |
|---|---|---|---|---|
| laptop | CA | 2023 | 2000 | 7566594810 |
| laptop | IL | 2023 | 500 | 3964708990 |
| laptop | TX | 2023 | 1200 | 3571306690 |
| laptop | NY | 2023 | 1300 | 3434374420 |
| laptop | AZ | 2023 | 1400 | 3123504170 |

If you have sales of a product type by state and year
and
you must prepare GDP (gross domestic product) by state and year
then only, comparison is meaningful

**One can explore the question: Is my laptop sales correlated with GDP at state level?**

## Example matching (compare, correlate, etc.) of sales by state and year and population by county

**sales summary by state and year**

| product_type | state | year | thousands of $ |
|---|---|---|---|
| laptop | CA | 2023 | 2000 |
| laptop | IL | 2023 | 500 |
| laptop | TX | 2023 | 1200 |
| laptop | NY | 2023 | 1300 |
| laptop | AZ | 2023 | 1400 |

**population by state**

| state | population |
|---|---|
| CA | 98484060 |
| IL | 51858120 |
| TX | 47585790 |
| NY | 26463060 |
| AZ | 44919870 |

**sales summary by state and year matched with population**

| product_type | state | year | thousands of $ | population |
|---|---|---|---|---|
| laptop | CA | 2023 | 2000 | 98484060 |
| laptop | IL | 2023 | 500 | 51858120 |
| laptop | TX | 2023 | 1200 | 47585790 |
| laptop | NY | 2023 | 1300 | 26463060 |
| laptop | AZ | 2023 | 1400 | 44919870 |

If you have sales of a product type by state and year

and

you have prepared population by state and county

then only, comparison is meaningful assuming population is approximately same

**One can explore the question: Is my laptop sales correlated with population at state level?**

## Rank / Scale / Percentile

## GDP and Unemployment rank comparison

Absolute value of a state's GDP is useful. However, it is also necessary to know the rank of state among all other states. The rank is also known as percentile. In the following example, Texas is 64 rank or percentile in GDP in scale of 0 to 100. It is easier to think in terms of scale of 0 to 10, or 0 to 100. It is a simple scale for comparison vs GDP is $4305454 million.

**GDP by state**

| state name | GDP in MM | GDP rank |
|---|---|---|
| California | 6686820 | 100 |
| Texas | 4305454 | 64 |
| New York | 3645422 | 54.02 |
| Florida | 2659164 | 39.12 |
| Illinois | 1781221 | 25.84 |
| Pennsylvania | 1623020 | 23.45 |
| Ohio | 1444748 | 20.76 |
| Washington | 1395673 | 20.02 |
| Georgia | 1392275 | 19.96 |
| New Jersey | 1349103 | 19.31 |

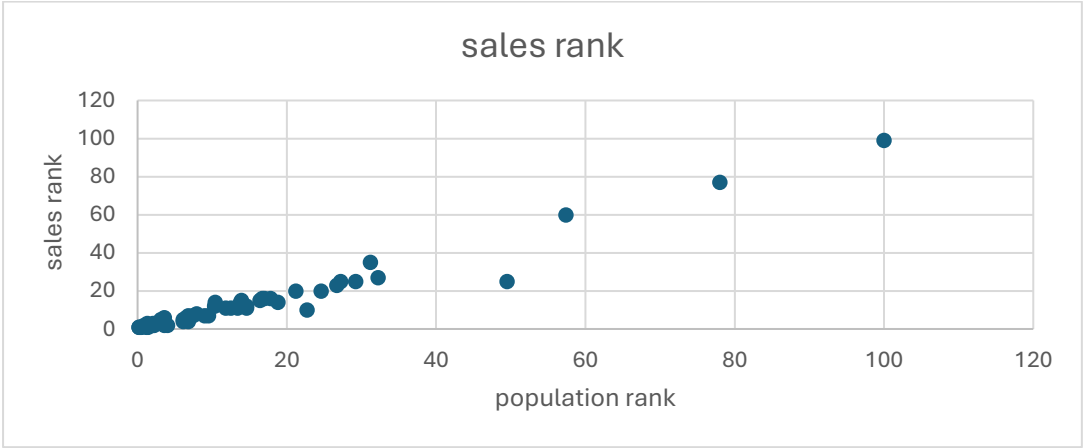
**Unemployment by state**

| state name | unemployment rate | unemployment rank |
|---|---|---|
| District of Columbia | 4.2 | 100 |
| Nevada | 4.1 | 100 |
| California | 4 | 90 |
| Illinois | 4 | 90 |
| Kentucky | 3.7 | 80 |
| Washington | 3.7 | 80 |
| New Jersey | 3.6 | 80 |
| Alaska | 3.4 | 70 |
| Ohio | 3.4 | 70 |
| Rhode Island | 3.4 | 70 |

Once you have GDP in rank and unemployment in rank for states, then, you can answer the following questions:
Are the top 10 (rank/ percentile) states in GDP are also top 10 in unemployment.

## Sales and population rank comparison

| state_name | population | rank | sales$ in thousands | sales rank | diffrence in rank |
|---|---|---|---|---|---|
| Alabama | 5108468 | 11.8 | 2200 | 11 | 0.8 |
| Alaska | 733406 | 0.4 | 200 | 1 | -0.6 |
| Arizona | 7431344 | 17.8 | 3200 | 16 | 1.8 |
| Arkansas | 3067732 | 6.5 | 1200 | 6 | 0.5 |
| California | 38965193 | 100 | 19800 | 99 | 1 |
| Colorado | 5877610 | 13.8 | 2800 | 14 | -0.2 |
| Connecticut | 3617176 | 7.9 | 1600 | 8 | -0.1 |
| Delaware | 1031890 | 1.2 | 200 | 1 | 0.2 |
| District of Col | 678972 | 0.2 | 200 | 1 | -0.8 |
| Florida | 22610726 | 57.4 | 12000 | 60 | -2.6 |
| Georgia | 11029227 | 27.2 | 5000 | 25 | 2.2 |
| Hawaii | 1435138 | 2.2 | 400 | 2 | 0.2 |
| Idaho | 1964726 | 3.6 | 1200 | 6 | -2.4 |
| Illinois | 12549689 | 31.2 | 7000 | 35 | -3.8 |
| Indiana | 6862199 | 16.4 | 3000 | 15 | 1.4 |
| Iowa | 3207004 | 6.8 | 1400 | 7 | -0.2 |
| Kansas | 2940546 | 6.1 | 1000 | 5 | 1.1 |
| Kentucky | 4526154 | 10.3 | 2400 | 12 | -1.7 |
| Louisiana | 4573749 | 10.4 | 2800 | 14 | -3.6 |
| Maine | 1395722 | 2.1 | 600 | 3 | -0.9 |
| Maryland | 6180253 | 14.6 | 2400 | 12 | 2.6 |
| Massachuset | 7001399 | 16.7 | 3200 | 16 | 0.7 |
| Michigan | 10037261 | 24.6 | 4000 | 20 | 4.6 |
| Minnesota | 5737915 | 13.4 | 2200 | 11 | 2.4 |
| Mississippi | 2939690 | 6.1 | 800 | 4 | 2.1 |
| Missouri | 6196156 | 14.6 | 2200 | 11 | 3.6 |
| Montana | 1132812 | 1.4 | 200 | 1 | 0.4 |
| Nebraska | 1978379 | 3.6 | 400 | 2 | 1.6 |
| Nevada | 3194176 | 6.8 | 1000 | 5 | 1.8 |
| New Hampsh | 1402054 | 2.1 | 400 | 2 | 0.1 |
| New Jersey | 9290841 | 22.7 | 2000 | 10 | 12.7 |
| New Mexico | 2114371 | 4 | 400 | 2 | 2 |
| New York | 19571216 | 49.5 | 5000 | 25 | 24.5 |
| North Carolin | 10835491 | 26.7 | 4600 | 23 | 3.7 |
| North Dakota | 783926 | 0.5 | 200 | 1 | -0.5 |
| Ohio | 11785935 | 29.2 | 5000 | 25 | 4.2 |
| Oklahoma | 4053824 | 9 | 1400 | 7 | 2 |
| Oregon | 4233358 | 9.5 | 1400 | 7 | 2.5 |
| Pennsylvania | 12961683 | 32.2 | 5400 | 27 | 5.2 |
| Puerto Rico | 3205691 | 6.8 | 800 | 4 | 2.8 |
| Rhode Island | 1095962 | 1.3 | 600 | 3 | -1.7 |
| South Carolin | 5373555 | 12.5 | 2200 | 11 | 1.5 |
| South Dakota | 919318 | 0.9 | 400 | 2 | -1.1 |
| Tennessee | 7126489 | 17 | 3200 | 16 | 1 |
| Texas | 30503301 | 78 | 15400 | 77 | 1 |
| Utah | 3417734 | 7.4 | 1400 | 7 | 0.4 |
| Vermont | 647464 | 0.2 | 200 | 1 | -0.8 |
| Virginia | 8715698 | 21.2 | 4000 | 20 | 1.2 |
| Washington | 7812880 | 18.8 | 2800 | 14 | 4.8 |
| West Virginia | 1770071 | 3.1 | 1000 | 5 | -1.9 |
| Wisconsin | 5910955 | 13.9 | 3000 | 15 | -1.1 |

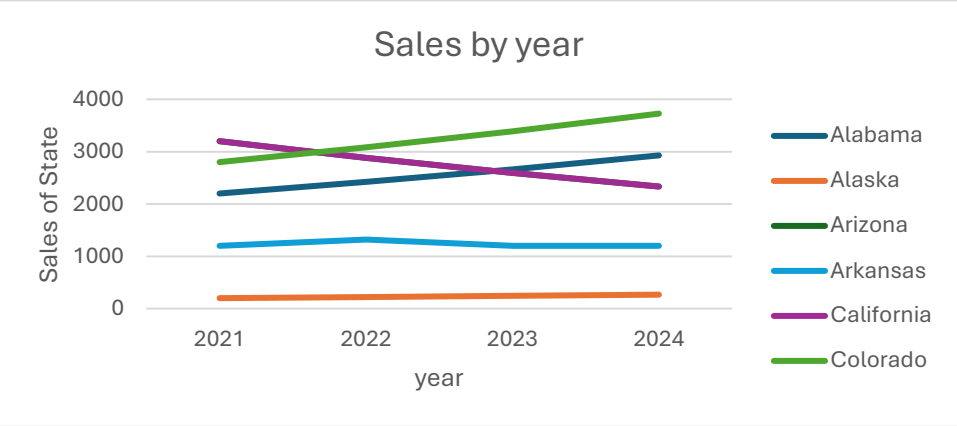



Use XY chart to see if two ranked variables are correlated. If two variables are correlated, then, the XY chart will be straight line at 45 degrees. Also, difference in large rank value means that state sales and state population are not correlated.

## Trend over time

This is classic analysis for any measurement. One can compare two more variables against time.

| state_name | Alabama | Alaska | Arizona | Arkansas | California | Colorado |
|---|---|---|---|---|---|---|
| 2021 | 2200 | 200 | 3200 | 1200 | 19800 | 2800 |
| 2022 | 2420 | 220 | 2880 | 1320 | 17820 | 3080 |
| 2023 | 2662 | 242 | 2592 | 1200 | 16038 | 3388 |
| 2024 | 2928.2 | 266.2 | 2332.8 | 1200 | 14434.2 | 3726.8 |




Example Sales by state by year
If your sales depend on population, then, you need to find out why a region's sales are down when the population is up.

## Knowledge based on history vs hypothesis

**Historical knowledge scenario:**
It is possible that a company knows that the sales are directly correlated to population when all other factors are in steady state. If the population is increasing but the sales are down means, the customers are not preferring your product or salespeople are not doing the job in that region.

**Hypothesis:**
Assume or hypothesize that sales are correlated to population. Then, check the trend over time for population and sales, and then reject or do not reject the hypothesis.

To compare your sales or cost data, it needs to be summarized by time period (year, quarter, month) and region Country, state, county, zip code. A company's CRM or ERP data and external data must be transformed into proper format so that they can be correlated.

## Principal Component Analysis

Each of the regional (state, county, city, etc.) measurements such as GDP, population, unemployment, income level, education level can be considered as independent variables and company sales can be dependent variables. Principal Component analysis can show contribution by variables towards the sales. Use AI_ML_intro-to-pca-t-sne-umap.py for principal component analysis.

## ETL (extract, transform, and load) Steps for external data

### Task1 Use API to get data in Json, xml, or csv format

A government agency may have its website and API such as BEA (Bureau of Economic Analysis), BLS (Bureau of Labor Statistics). A government agency may be using common website and or API to publish their data. (https://dev.socrata.com/ or https://docs.ckan.org/en/2.8/api/). Contact milan@datajoin.net for python code.

## Task2 Convert Json or xml format to csv format

Some API provide data in Json or xml format and not in csv format. Thus, it is necessary to convert to csv file. CSV is more suitable for data operation in batch using python. If data is received in CSV format, then, this task is not necessary. Contact milan@datajoin.net for python code.

## Task3 Copy and or add attributes

Necessity to copy an attribute (field or column). The original column is available just in case the data operation did not work as expected. It may also be necessary to add default value columns such as Country or Units of measurement. Contact milan@datajoin.net for python code.

## Task4 Transform values in attributes

There are at least three types of transformations:
Format change for date
Change label using lookup values
Split column in two or more if county and city are in the same column. For example, Newark NJ. Contact milan@datajoin.net for python code.

## Task5 Upload base table

It is necessary to have this base table available to create two or more summary tables depending upon need. For example, one summary table can be for state and another summary table can be for State and County combination.
Use datajoin_generic_task5createtable.py to create database table directly from csv file.

## Task6 Create summary table with rank/ percentile / scaled column

Summary tables are necessary to join them for correlation. Use datajoin_generic_task6sum_scale_v3.py to create summary table.

There is multiple python program for each of the above tasks depending upon API and output of a step.
Refer Agents (workflow) to carry out the above tasks using python (https://github.com/milan888-design/ai-agents-workflow)

## Python code to new table with sum and rank

datajoin_generic_task6sum_scale_v3.py

```
#for sales table
#arg1='sales_by_county_state_year'
#arg2='sales_by_county_state_year_summary'
#arg3='sales_in_thousand'
#arg4='select state,year,sum(cast(sales_in_thousand as numeric(10,1))) as sales_in_thousand from sales_by_county_state_year group by state,year'
#arg5='postgresql://postgres:pass@localhost:5432/test_correlate'
#arg6='postgresql://postgres:pass@localhost:5432/test_correlate'

#for gdp table
arg1='gdp_by_county_state_year'
arg2='gdp_by_county_state_year_summary'
arg3='gdp_in_thousand'
arg4='select state,year,sum(cast(gdp_in_thousand as numeric(10,1))) as gdp_in_thousand from gdp_by_county_state_year group by state,year'
arg5='postgresql://postgres:pass@localhost:5432/test_correlate'
arg6='postgresql://postgres:pass@localhost:5432/test_correlate'
```

## Task 7 Join table to study correlation

Use sum scale query for test_correlate db.sql to join sales table and gdp table.
--join sales and gdp tables

```
SELECT
 salessum.state
 ,salessum.year
 ,salessum.sales_in_thousand
  ,salessum.sales_in_thousand_scaled
   ,gdpsum.gdp_in_thousand
  ,gdpsum.gdp_in_thousand_scaled
```

```
FROM sales_by_county_state_year_summary salessum
,gdp_by_county_state_year_summary gdpsum
 WHERE
 salessum.state=gdpsum.state
  and salessum.year=gdpsum.year
```

Result from the above SQL.

| state | year | sales_in_thousand | sales_in_thousand_scaled | gdp_in_thousand | gdp_in_thousand_scaled |
|---|---|---|---|---|---|
| AZ | 2023 | 100 | 0 | 312350417 | 2.67 |
| CA | 2023 | 1250 | 100 | 1577667989 | 100 |
| IL | 2023 | 300 | 17.39 | 396470899 | 9.14 |
| NY | 2023 | 600 | 43.48 | 343437442 | 5.06 |
| TX | 2023 | 900 | 69.57 | 564664441 | 22.08 |
| WA | 2023 | 600 | 43.48 | 277642267 | 0 |