

DataEng: Data Integration In-class Assignment

This week you will gain hands-on experience with Data Integration by combining data from two distinct sources into a unified DataFrame for analysis.

Submit: Make a copy of this document and use it to record your results. Store a PDF copy of the document in your git repository along with any needed code before submitting for this week.

Your job is to integrate [county-level COVID-19 data](#) with the [ACS Census Tract data for 2017](#) to build a model that allows you to relate COVID numbers with economic data such as population, per capita income and poverty level. To do this you should build two pandas DataFrames as follows.

County_Info: demographic summaries for each county. This table should have one row per county (there are more than 3000 counties in the USA), and each row must include the following columns:

Name - name of the county

State - name of the state in which the county resides

Population - population of this county

Poverty - % of people in poverty in this county

PerCapitaIncome - per capita personal income for this county

ID - a unique integer ID for the county. You may choose this ID any way you like, it just needs to be unique among all counties and needs to be referenced by the COVID_monthly rows (foreign key lookup).

COVID_monthly: data about COVID cases and deaths for each USA county.

ID - refers to the county found in the County_info table (i.e., this is a foreign key lookup)

Month - integer in range 1..12 indicating the month of the year

Cases - number of COVID cases recorded for the corresponding county during the corresponding month

Deaths - number of COVID-related deaths recorded for the corresponding county during the corresponding month

For this activity you should use whichever development environment is convenient for you to develop with python 3 and pandas. You are not required to use GCP, but you can use it if you prefer.

Submit: use the submission form found on the Materials page of the website.

Discussion Question (do this first)

Within your group, discuss various data sources and how they might be integrated. Then identify two or more of those data sources to integrate to analyze a problem that could not be analyzed or solved without integration of the data sources. The data sources and problems do not need to be related to anything we have done in class and do not even need to be serious. You do not need to describe how to integrate the data sets.

For example, you might say something like, “Integrate historic weather/precipitation data with commodity price data to help develop a system for anticipating future prices of oil and gas.”

<insert up to three of your group’s ideas here>

Data can be integrated by developing data integration software programs and data integration platforms that facilitate an automated data integration process for connecting and routing data from source systems to target systems.

A. Transform the ACS Data

The ACS data is separated into “Census Tracts” which are regions within counties that correspond to groups of approximately 4000 people. The Census Bureau defines these to help organize the actual job of collecting census data. I.e., they did it this way for their convenience, not yours, and this grouping makes your Data Engineering job more challenging. To properly integrate it with the COVID data you must aggregate the per-tract data to the county level of resolution. You must also add an ID column to your County information such that the county can be referred to by the COVID data.

Create a python+pandas program that transforms the ACS data into a one-row-per-county ACS DataFrame called County_info. To do this you will need to think about how to properly aggregate Census Tract-level data into County-level summaries. Your transformation code should also filter the data by eliminating unneeded columns from the ACS data.

Fill the following table using data from your County_info DataFrame:

| County | Population | %poverty | PerCapitalIncome |
|---------------------------|------------|----------|------------------|
| Loudoun County, Virginia | 374558 | 0.066372 | 8298861.0 |
| Washington County, Oregon | 572071 | 0.189906 | 3636965.0 |
| Harlan County, Kentucky | 27548 | 1.330405 | 291194.0 |
| Malheur County, Oregon | 30421 | 0.561783 | 125765.0 |

| | | | |
|------------------------------------|--|--|--|
| <most populous country in the USA> | | | |
| <least populous county in the USA> | | | |

Table I created using pandas

| | | TotalPop | Poverty | Income | Poverty% | Incomepercapita | ID_FK |
|---------|-------------------|----------|---------|-----------|----------|-----------------|-------|
| State | County | | | | | | |
| Alabama | Autauga County | 55036 | 174.7 | 642810.0 | 0.317429 | 11.679810 | 1 |
| | Baldwin County | 203360 | 399.1 | 1634699.0 | 0.196253 | 8.038449 | 2 |
| | Barbour County | 26201 | 249.8 | 294460.0 | 0.953399 | 11.238502 | 3 |
| | Bibb County | 22580 | 55.7 | 178708.0 | 0.246678 | 7.914438 | 4 |
| | Blount County | 57667 | 147.8 | 416930.0 | 0.256299 | 7.229958 | 5 |
| ... | ... | ... | ... | ... | ... | ... | ... |
| Wyoming | Sweetwater County | 44527 | 140.3 | 830800.0 | 0.315090 | 18.658342 | 3216 |
| | Teton County | 22923 | 30.2 | 323392.0 | 0.131745 | 14.107752 | 3217 |
| | Uinta County | 20758 | 44.2 | 178615.0 | 0.212930 | 8.604634 | 3218 |
| | Washakie County | 8253 | 39.2 | 153416.0 | 0.474979 | 18.589119 | 3219 |
| | Weston County | 7117 | 28.4 | 116509.0 | 0.399045 | 16.370521 | 3220 |

3220 rows × 6 columns

B. Transform the COVID Data

Simplify the COVID data along the time dimension. The COVID data set contains day-level resolution data from (approximately) March of 2020 through February of 2021. From this you should produce a **COVID_monthly** DataFrame that has just one row per month per county. Also, you need to add an ID column that is a foreign key lookup to the corresponding ID column in the County_info DataFrame.

Fill the following table using data from your COVID_monthly DataFrame:

| County | Month | # cases | # deaths |
|------------------------|---------------|---------|----------|
| Malheur County, Oregon | February 2020 | 125 | 0 |
| Malheur County, Oregon | August 2020 | 28163 | 459 |
| Malheur County, Oregon | January 2021 | 96297 | 1627 |

Table I created using pandas

| | | | | cases | deaths | ID_FK |
|---------|---------|-------|------|--------|--------|-------|
| state | county | month | year | | | |
| Alabama | Autauga | 1 | 2021 | 156700 | 1773.0 | 1 |
| | | 10 | 2020 | 60844 | 893.0 | 2 |
| | | 11 | 2020 | 73997 | 1072.0 | 3 |
| | | 12 | 2020 | 108652 | 1355.0 | 4 |
| | | 2 | 2021 | 118573 | 1586.0 | 5 |
| ... | ... | ... | ... | ... | ... | ... |
| Wyoming | Weston | 5 | 2020 | 5 | 0.0 | 37253 |
| | | 6 | 2020 | 32 | 0.0 | 37254 |
| | | 7 | 2020 | 93 | 0.0 | 37255 |
| | | 8 | 2020 | 288 | 0.0 | 37256 |
| | | 9 | 2020 | 747 | 0.0 | 37257 |

C. Integrate COVID Data with ACS Data

Create a new single pandas DataFrame called COVID_summary containing one row per county. It should have these columns:

ID - integer identifier for the county

Population, Poverty, PerCapitaIncome - these should all be the same as from the County_info DataFrame

TotalCases, TotalDeaths - these two values should come from the COVID_monthly data and summed over all months

TotalCasesPer100K, TotalDeathsPer100K - these two values should be computed by dividing the the TotalCases and TotalDeaths (respectively) by (Population / 100000)

Fill the following table using data from your COVID_summary DataFrame:

| County | Poverty % | TotalCasesPer100K |
|---------------------------|-----------|-------------------|
| Washington County, Oregon | 0.189906 | |
| Malheur County, Oregon | 0.561783 | |
| Loudoun County, Virginia | 0.066372 | |
| Harlan County, Kentucky | 1.330405 | |

D. Analysis

For each of the following, determine the strength of the correlation between each pair of variables. Compute the correlation strength by calculating the Pearson correlation coefficient R for pairs of columns in your DataFrame. For example, if you have a DataFrame df with each row representing a distinct county, and columns named 'TotalCasesPer100K' and 'Poverty', then you can compute R like this:

```
R = df[ 'TotalCasesPer100K' ].corr(df[ 'Poverty' ])
```

1. Compute the correlation coefficient for the following relationships for all Oregon counties
 1. COVID total cases vs. % population in poverty
 2. COVID total deaths vs. % population in poverty
 3. COVID total cases vs. Per Capita Income level
 4. COVID total deaths vs. Per Capita Income level
2. Across all of the counties in the entire USA
 - a. COVID total cases vs. % population in poverty
 - b. COVID total deaths vs. % population in poverty
 - c. COVID total cases vs. Per Capita Income level
 - d. COVID total deaths vs. Per Capita Income level

Fill the following table using data from your analysis. Add more rows to the table if you find additional interesting information:

| County | R value |
|--|---------|
| For Oregon Counties only: correlation between % poverty and COVID cases | |
| For all counties: correlation between population and COVID cases | |
| For Oregon counties only: correlation between PerCapitaIncome and COVID deaths | |
| For all USA counties: correlation between PerCapitaIncome and COVID cases | |
| <explore at least one other correlation computation that is made possible by this integrated data set> | |

For any R that is > 0.5 or < -0.5 also display a scatter plot (see [pandas scatterplot](#) and [seaborn documentation](#) for information about how to display scatter plots from DataFrame data).

Note that this assignment does not constitute a competent, thorough statistical analysis of the relationships between immunological data and demographic data. It is just an illustration of the types of computations that might be accomplished with an integrated data set.