

# DataEng S24: Data Transformation

## In-Class Assignment

**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. Submit the in-class activity submission form by Friday at 10:00 pm.

### A. [MUST] Initial Discussion Questions

Discuss the following questions among your working group members at the beginning of the week and place your own response into this space. If desired, also include responses from your group members.

1. In the lecture we mentioned the benefits of Data Transformation, but can you think of any problems that might arise with Data Transformation?

Ans: While data translation offers several benefits, it also comes with challenges such as potential data loss, increased complexity, issues related to data quality, dependence on source systems, versioning conflicts, security vulnerabilities, performance limitations, and governance concerns.

2. Should data transformation occur before data validation in your data pipeline or after?

Ans: In a data pipeline, it is essential to conduct data validation both prior to and following data transformation. Validation should take place at every phase of the data engineering process. Pre-transformation validation ensures the accuracy of incoming data and identifies errors early on to prevent issues downstream. Post-transformation validation verifies that the data has been correctly modified, maintaining integrity and reliability throughout the pipeline.

### B. [MUST] Small Sample of TriMet data

Here is sample data for one trip of one TriMet bus on one day (February 15, 2023):

[bc\\_trip259172515\\_230215.csv](#) It's in .csv format not json format, but otherwise, the data is a typical subset of the data that you are using for your class project.

We recommend that you use google Colab or a Jupyter notebook for this assignment, though any python environment should suffice.

Use the [pandas.read\\_csv\(\)](#) method to read the data into a DataFrame.

## C. [MUST] Filtering

Some of the columns in our TriMet data are not generally useful for our class project. For example, our contact at TriMet told us that the EVENT\_NO\_STOP column is not used and can be safely eliminated for any type of analysis of the data.

Use [pandas.DataFrame.drop\(\)](#) to filter the EVENT\_NO\_STOP column.

For this in-class assignment we won't need the GPS\_SATELLITES or GPS\_HDOP columns, so drop them as well.

Next, start over and this time try filtering these same columns using the usecols parameter of the read\_csv() method.

Why might we want to filter columns this way instead of using drop()?

Ans: When reading data, utilizing the usecols argument for column filtering is more efficient and preferable to using pandas.DropDataFrame(). This approach, by specifying the required columns in advance, optimizes memory usage, enhances performance, and increases code clarity.

## D. [MUST] Decoding

Notice that the timestamp for each breadcrumb record is encoded in an odd way that might make analysis difficult. The breadcrumb timestamps are represented by two columns, OPD\_DATE and ACT\_TIME. OPD\_DATE merely represents the date on which the bus ran, and it should be constant, unchanging for all breadcrumb records for a single day. The ACT\_TIME field indicates an offset, specifically the number of seconds elapsed since midnight on that day.

We're not sure why TriMet represents the breadcrumb timestamps this way. We do know that this encoding of the timestamps makes automated analysis difficult. So your job is to decode TriMet's representation and create a new "TIMESTAMP" column containing a [pandas.Timestamp](#) value for each breadcrumb.

Suggestions:

- Use DataFrame.apply() to apply a function to all rows of your DataFrame
- The applied function should input the two to-be-decoded columns, then it should:
  - create a datetime value from the OPD\_DATE input using datetime.strptime()
  - create a timedelta value from the ACT\_TIME
  - add the timedelta value to the datetime value to produce the resulting timestamp

## E. [MUST] More Filtering

Now that you have decoded the timestamp you no longer need the OPD\_DATE and ACT\_TIME columns. Delete them from the DataFrame.

## F. [MUST] Enhance

Create a new column, called SPEED, that is a calculation of meters traveled per second. Calculate SPEED for each breadcrumb using the breadcrumb's METERS and TIMESTAMP values along with the METERS and TIMESTAMP values for the immediately preceding breadcrumb record.

Utilize the [pandas.DataFrame.diff\(\)](#) method for this calculation. diff() allows you to calculate the difference between a cell value and the preceding row's value for that same column. Use diff() to create a new dMETERS column and then again to create a new dTIMESTAMP column. Then use apply() (with a lambda function) to calculate  $SPEED = dMETERS / dTIMESTAMP$ . Finally, drop the unneeded dMETERS And dTIMESTAMP columns.

**Question:** What is the minimum, maximum and average speed for this bus on this trip? (Suggestion: use the DataFrame.describe() method to find these statistics)

Ans: Minimum speed: 0.0  
Maximum speed: 17.4  
Average speed: 7.227205815018314

## G. [SHOULD] Larger Data Set

Here is breadcrumb data for the same bus TriMet for the entire day (February 15, 2023):  
[bc veh4223 230215.csv](#)

Do the same transformations (parts C through F) for this larger data set. Be careful, you might need to treat each trip separately. For example, you might need to find all of the unique values for the EVENT\_NO\_TRIP column and then do the transformations separately on each trip.

### Questions:

What was the maximum speed for vehicle #4223 on February 15, 2023?

Where and when did this maximum speed occur?

What was the median speed for this vehicle on this day?

Ans:

Maximum speed for vehicle #4223 on February 15, 2023: 17.4

Location (Longitude, Latitude): -122.660822 45.505452

Time of occurrence: 2023-02-15 05:44:49

Median speed for vehicle #4223 on February 15, 2023: 7.2

## H. [ASPIRE] Full Data Set

Here is breadcrumb data for all TriMet vehicles for the entire day (February 15, 2023):

[bc\\_230215.csv](#)

Do the same transformations (parts C through F) for the entire data set. Again, beware that simple transformations developed in parts C through F probably will need to be modified for the full data set which contains interleaved breadcrumbs from many vehicles.

### Questions:

What was the maximum speed for any vehicle on February 15, 2023?

Where and when did this maximum speed occur?

Which vehicle had the fastest mean speed for any single trip on this day? Which vehicle and which trip achieved this fastest average speed?

Ans: Maximum speed for any vehicle: 200.33333333333334

Location: 45.509918 -122.879553

Timestamp: 2023-02-15 18:05:38

Fastest vehicle: 3419

Fastest trip: 258614729