Instruction for Processing Mobile Methane Survey Data to Detect Natural Gas Leaks

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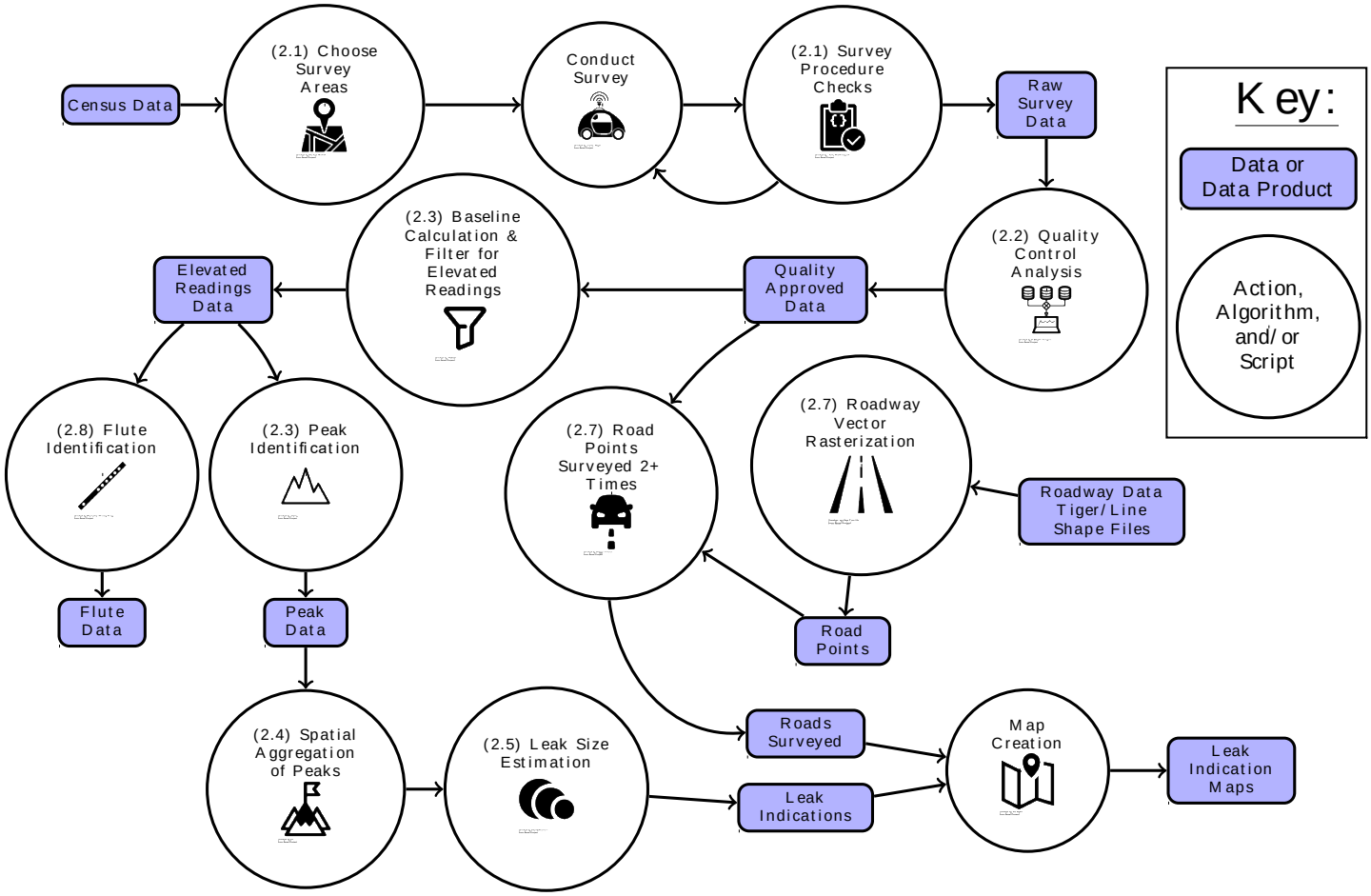
This document explains how to run the implemented version of the algorithm represented in the paper, 'An Updated Algorithm to Detect Natural Gas Leaks from Mobile Methane Survey Data'.

Flowchart of Data Processing Steps



List of Scripts Used in this Document

- ProcessRawData.py : enforces QA/QC threshold to the raw data.
- IdentifyPeaks.py : identifies peaks from the processed data.
- CalculateVerifiedPeaksMaps.py : identifies the location where more than two peaks are observed using ArcGIS.
- CalculateOccasionsPart1.py : converts the processed data into ArcGIS shapefiles.
- CalculateOccasionsPart2.py : calculates number of passes for each road point.

Raw Data Description

Methane concentration was measured by the Picarro CH4 sensor and the Google Street View Car. Below is the list of fields from the raw data (you can find sample data files in ./Scripts/SampleRawData/).

1) DATE
2) TIME
3) FRAC_DAYS_SINCE_JAN1
4) FRAC_HRS_SINCE_JAN1
5) JULIAN_DAYS
6) EPOCH_TIME
7) ALARM_STATUS
8) INST_STATUS
9) CavityPressure
10) CavityTemp
11) DasTemp
12) EtalonTemp
13) WarmBoxTemp
14) Species
15) MPVPosition
16) OutletValve
17) solenoid_valves
18) CO2
19) CO2_dry
20) CH4
21) CH4_dry
22) H2O
23) GPS_ABS_LAT
24) GPS_ABS_LONG
25) GPS_FIT
26) WS_WIND_LON
27) WS_WIND_LAT
28) WS_COS_HEADING
29) WS_SIN_HEADING
30) WIND_N
31) WIND_E
32) WIND_DIR_SDEV
33) WS_ROTATION
34) CAR_SPEED

Steps for Detecting Natural Gas Leak from Mobile Methane Survey Data (Verified Peak Analysis)

1. Run 'ProcessRawData.py'
    a. Change input directory (where raw data files are stored) and output directory (where you want to store processed data) in the main function.
    b. Execute the script.
2. Run 'IdentifyPeaks.py'
    a. Change input directory (where processed data files from Step 1 are stored) and output directory (where you want to store peaks data) in the main function.
    b. Execute the script.
3. Run 'CalculateVerifiedPeaksMaps.py'
    a. Change input directory (where peaks data files from Step 2 are stored) and output directory (where you want to store the result shapefiles) in the beginning of the script.
    b. Change 'lstCFADS2274', 'sCity', and 'sCar' parameters if needed.
    c. Execute the script until line 41 by commenting out rest of the script.
    d. Manually merge shapefiles generated from step c in ArcMap, and save it as '[sCity]_LeakPoints.shp'.
    e. Execute the script from line 42 to line 94 by commenting out rest of the script.
    f. Manually spatially join '[sCity]StaticLeakPoints' and '[sCity]fnStaticLeakPointsBuff2', and save the result as '[sCity]_StaticLeakPoints2.shp'.
    g. Execute the rest of the script.
4. Examine the result
    a. '[sCity]_StaticLeakPoints2.shp' : Observed Peaks
        1) PEAK_NUM : Peak Identification Number
        2) FREQUENCY : Number of elevated readings in the observed peak
        3) MAX_PEAK_D : Length of the peak in meters
        4) MEAN_CH4 : Mean of CH4 values within the observed peak
        5) MAX_CH4 : Maximum CH4 value within the observed peak
        6) MIN_CH4 : Minimum CH4 value within the observed peak
        7) D : Observed date
    b. '[sCity]_StaticLeakBuffFCentroidsFinal' : Verified Peaks
        1) ORIG_FID : Peak Identification Number
        2) FREQUENCY : Number of observed peaks in the verified peak
        3) MIN_D : First observed date
        4) MAX_D : Last observed date
        5) MEAN_MAX_C : Mean of maximum CH4 value of observed peaks
        6) SUM_wLat : Latitude of verified peak, adjusted based on CH4 concentration
        7) SUM_wLon : Longitude of verified peak, adjusted based on CH4 concentration
        8) FlowRate2 : Flowrate estimation (L/min)

Steps for Calculating Road Miles Driven 2+ Times (Road Points Analysis)

1. Generate the Road Points Shapefile
    a. Download 'All Roads' shapefile of the county you want to analyze from the TIGER/Line® page of United States Census website.
    b. Use 'Densify' tool (20 meters) in ArcMap to add feature vertices to the shapefile from Step a.
    c. Use 'Feature Vertices to Points' tool in ArcMap to create the road points shapefile.
    d. If there is a drive plan, use 'Select by Location' tool to exclude irrelevant areas.
    e. Save the shapefile as '[sCity]_RoadPoints.shp'.
2. Run 'CalculateOccasionsPart1.py'
    a. Change input directory (where processed data files are stored) in the beginning of the script.
    b. Change 'lstCFADS2274', 'sCity', and 'sCar' parameters if needed.
    c. Execute the script.
    d. Manually merge shapefiles from Step c, and save it as '[sCity]_AllOccasions.shp'.
3. Run 'CalculateOccasionsPart2.py'
    a. Change input directory (where '[sCity]_RoadPoints.shp' and '[sCity]_AllOccasions.shp' are stored) in the beginning of the script.
    b. Change 'sCity' parameter if needed.
    c. Execute the script.
4. Examine the result
    a. 'NumOccs' field in the road points shapefile means that the road point was passed by the vehicle 'NumOccs' times.
    b. Use 'Select by Attribute' tool to exclude 'NumOccs' less than 2.
    c. Use 'Points to Line' tool to convert points to lines in ArcMap.
    d. Open the data table, and add a new field.
    e. Use 'Calculate Geometry' tool to calculate distance of each line.
    f. Use 'Statistics' tool to see sum of the distances.