CS 365 FINAL PROJECT: TRANSIT REGINA DATA WRANGLING

JANICE COTCHER

DECEMBER 5, 2025

Data Source: City of Regina Open Data Portal

Dataset: Transit Stops and Routes (November 20, 2025)

DATASET SOURCE & LICENSE

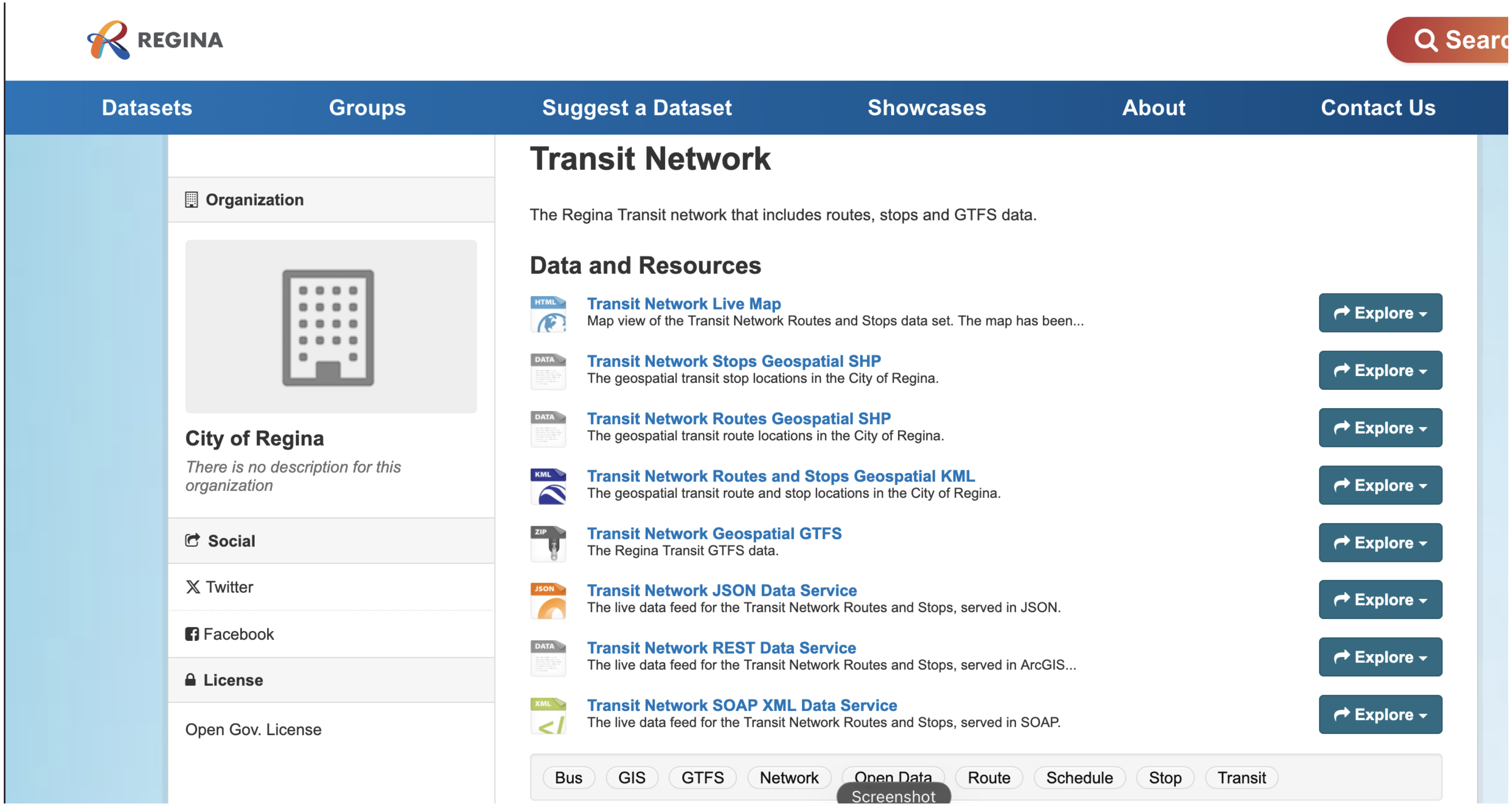
Source: City of Regina Open Data Portal

- Bus Stop Locations (yqrStops.json)
- Transit Routes (yqrRoutes.json)
- General Transit Feed Specification(routes.txt, stops.txt, trips.txt, stop_times.txt)

License: Open Government License - Regina

- Allows educational and commercial use
- No Personally Identifiable Information - only public infrastructure data

Why this matters: Understanding transit accessibility and route coverage for urban planning



Organization

City of Regina

There is no description for this organization

Social

Twitter

Facebook

License

Open Gov. License

Transit Network

The Regina Transit network that includes routes, stops and GTFS data.

Data and Resources

- **Transit Network Live Map** – Map view of the Transit Network Routes and Stops data set. The map has been...
- **Transit Network Stops Geospatial SHP** – The geospatial transit stop locations in the City of Regina.
- **Transit Network Routes Geospatial SHP** – The geospatial transit route locations in the City of Regina.
- **Transit Network Routes and Stops Geospatial KML** – The geospatial transit route and stop locations in the City of Regina.
- **Transit Network Geospatial GTFS** – The Regina Transit GTFS data.
- **Transit Network JSON Data Service** – The live data feed for the Transit Network Routes and Stops, served in JSON.
- **Transit Network REST Data Service** – The live data feed for the Transit Network Routes and Stops, served in ArcGIS...
- **Transit Network SOAP XML Data Service** – The live data feed for the Transit Network Routes and Stops, served in SOAP.

TOOLS

VS CODE EXTENSIONS:

- Python
- Python Environments
- Data Wrangler
- Jupyter

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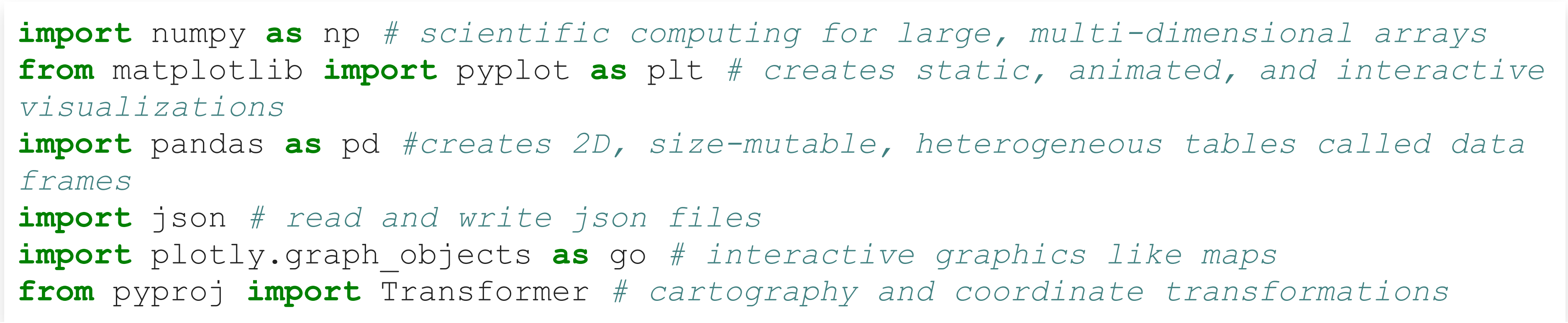
RATIONALE

- large dataset[1]
- flexibility, memory management
- macOS
- personal expertise

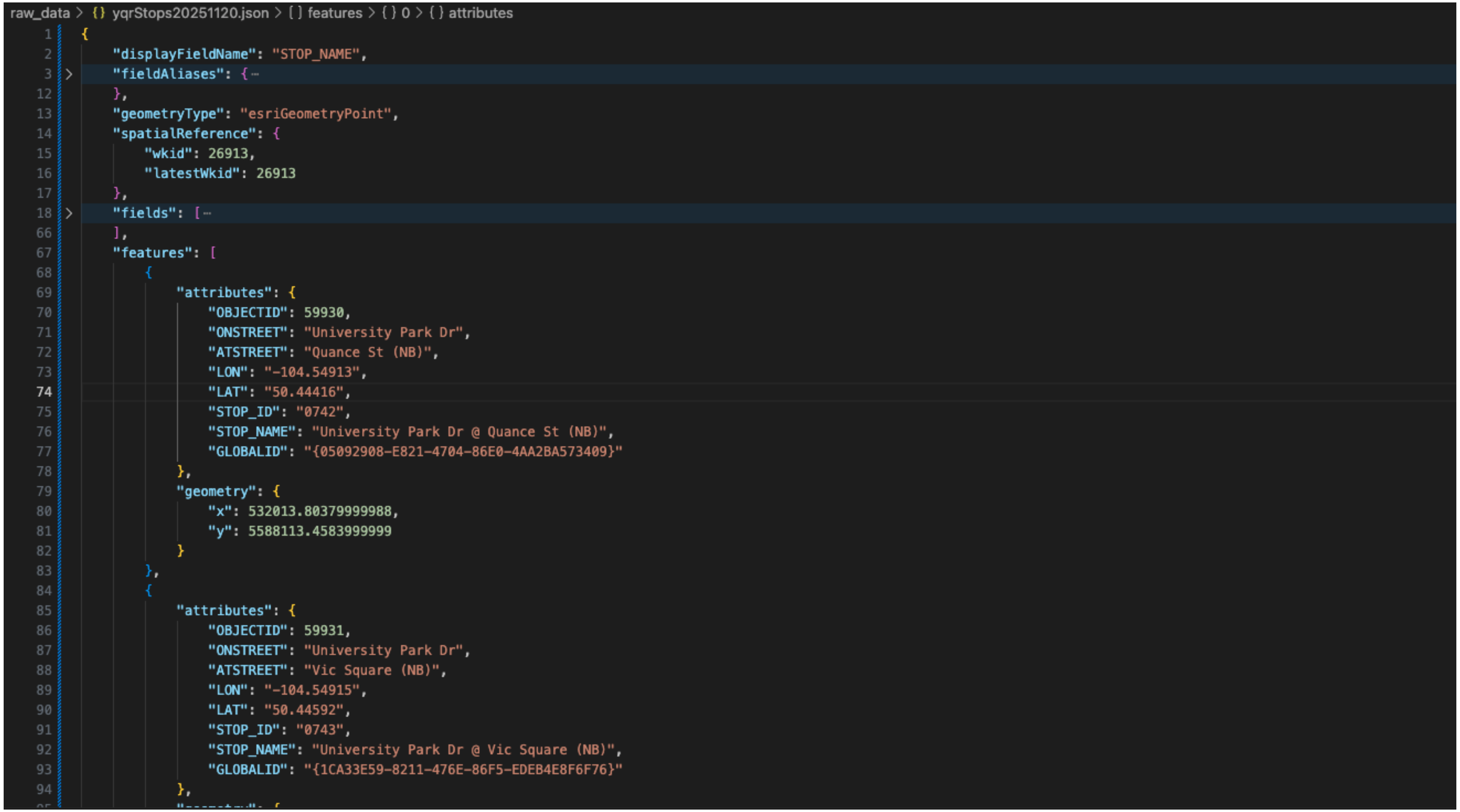
[1] CS 365 - Data Cleaning: Concepts & Algorithms, Lecture 6: September 15, 2025

IMPORTED PYTHON LIBRARIES



```python
import numpy as np # scientific computing for large, multi-dimensional arrays
from matplotlib import pyplot as plt # creates static, animated, and interactive visualizations
import pandas as pd #creates 2D, size-mutable, heterogeneous tables called data frames
import json # read and write json files
import plotly.graph_objects as go # interactive graphics like maps
from pyproj import Transformer # cartography and coordinate transformations
```

RAW DATA SNAPSHOT: BUS STOPS



raw_data > {} yqrStops20251120.json > [ ] features > { } 0 > { } attributes

```
{
    "displayFieldName": "STOP_NAME",
    "fieldAliases": {⋯
    },
    "geometryType": "esriGeometryPoint",
    "spatialReference": {
        "wkid": 26913,
        "latestWkid": 26913
    },
    "fields": [⋯
    ],
    "features": [
        {
            "attributes": {
                "OBJECTID": 59930,
                "ONSTREET": "University Park Dr",
                "ATSTREET": "Quance St (NB)",
                "LON": "-104.54913",
                "LAT": "50.44416",
                "STOP_ID": "0742",
                "STOP_NAME": "University Park Dr @ Quance St (NB)",
                "GLOBALID": "{05092908-E821-4704-86E0-4AA2BA573409}"
            },
            "geometry": {
                "x": 532013.80379999988,
                "y": 5588113.4583999999
            }
        },
        {
            "attributes": {
                "OBJECTID": 59931,
                "ONSTREET": "University Park Dr",
                "ATSTREET": "Vic Square (NB)",
                "LON": "-104.54915",
                "LAT": "50.44592",
                "STOP_ID": "0743",
                "STOP_NAME": "University Park Dr @ Vic Square (NB)",
                "GLOBALID": "{1CA33E59-8211-476E-86F5-EDEB4E8F6F76}"
            },
            "geometry": {
```

```python
# Load JSON data
try:
    with open('raw_data/yqrStops.json', 'r') as f:
        stop_data = json.load(f)
except json.decoder.JSONDecodeError as e:
    print("Invalid JSON", e)

# Normalize nested JSON structure
df_stops = pd.json_normalize(stop_data['features'])
```

DATA PROFILING: QUALITY ASSESSMENT - STOPS

- **Data types** - Are coordinates stored correctly?
- **Missing values** - Which columns have gaps?
- **Duplicates** - Any duplicate stop IDs?
- **Outliers** - Any stops in unexpected locations?
- **Cardinalities** - How many unique stops?

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STOP DATA TYPES

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STOP DATA TYPES

```
attributes.OBJECTID        int64
attributes.ONSTREET       object
attributes.ATSTREET       object
attributes.LON            object
attributes.LAT            object
attributes.STOP_ID        object
attributes.STOP_NAME      object
attributes.GLOBALID       object
geometry.x               float64
geometry.y               float64
dtype: object
```

MISSING VALUES

MISSING VALUES

```
Number of Missing Values: 1
Missing Values
attributes.OBJECTID     0
attributes.ONSTREET     0
attributes.ATSTREET     1
attributes.LON          0
attributes.LAT          0
attributes.STOP_ID      0
attributes.STOP_NAME    0
attributes.GLOBALID     0
geometry.x              0
geometry.y              0
dtype: int64
```

DUPLICATES

DUPLICATES

```
Number of Duplicate Stops - checked by stop ID: 0
```

CLEANING: BUS STOP TEXT STANDARDIZATION & TYPE CONVERSIONS

PROBLEMS IDENTIFIED

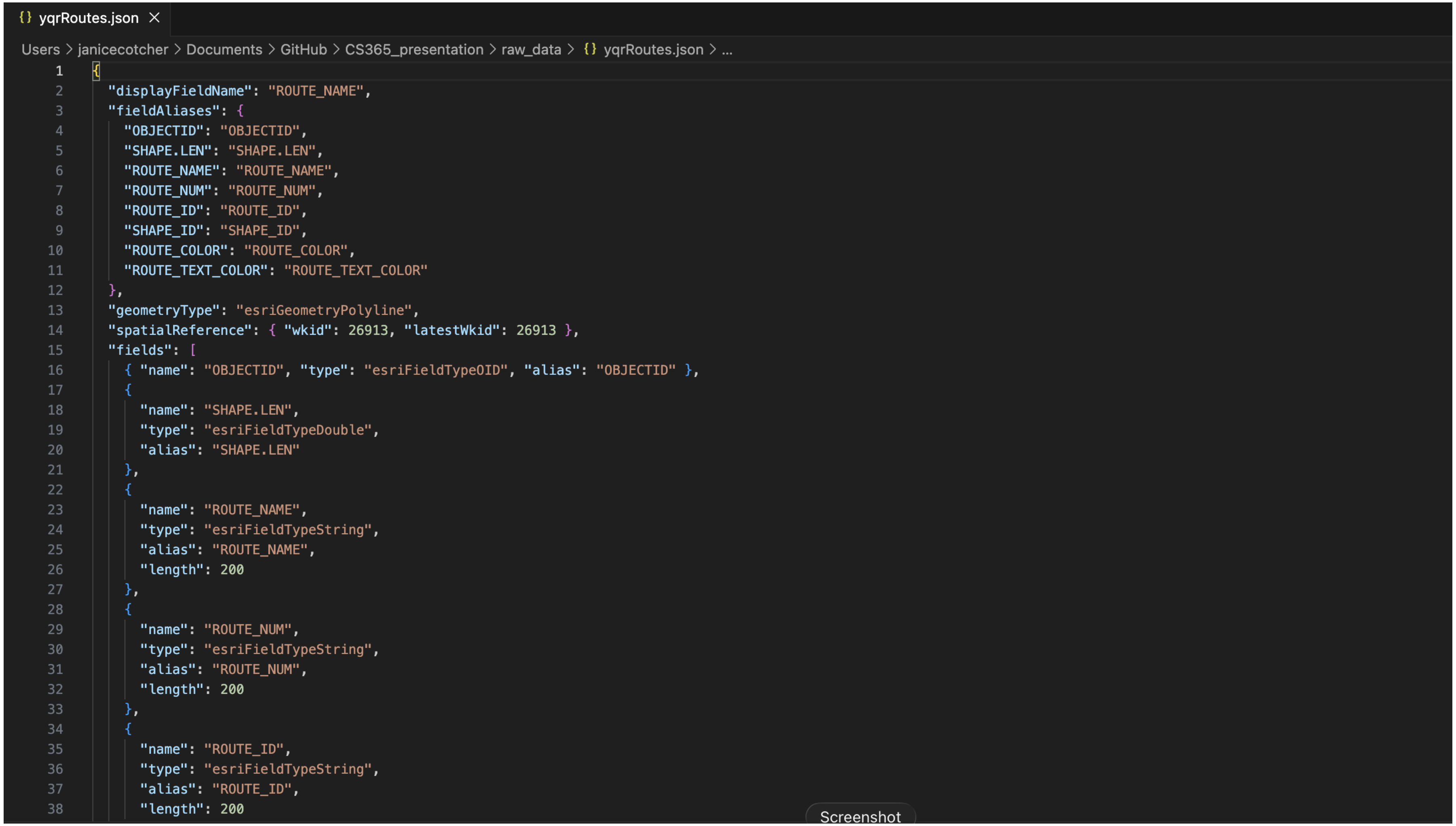
- Inconsistent text formatting (mixed case, whitespace)
- Coordinates stored as strings instead of numeric latitude and longitude
- Missing values in street names

Sample Solutions:

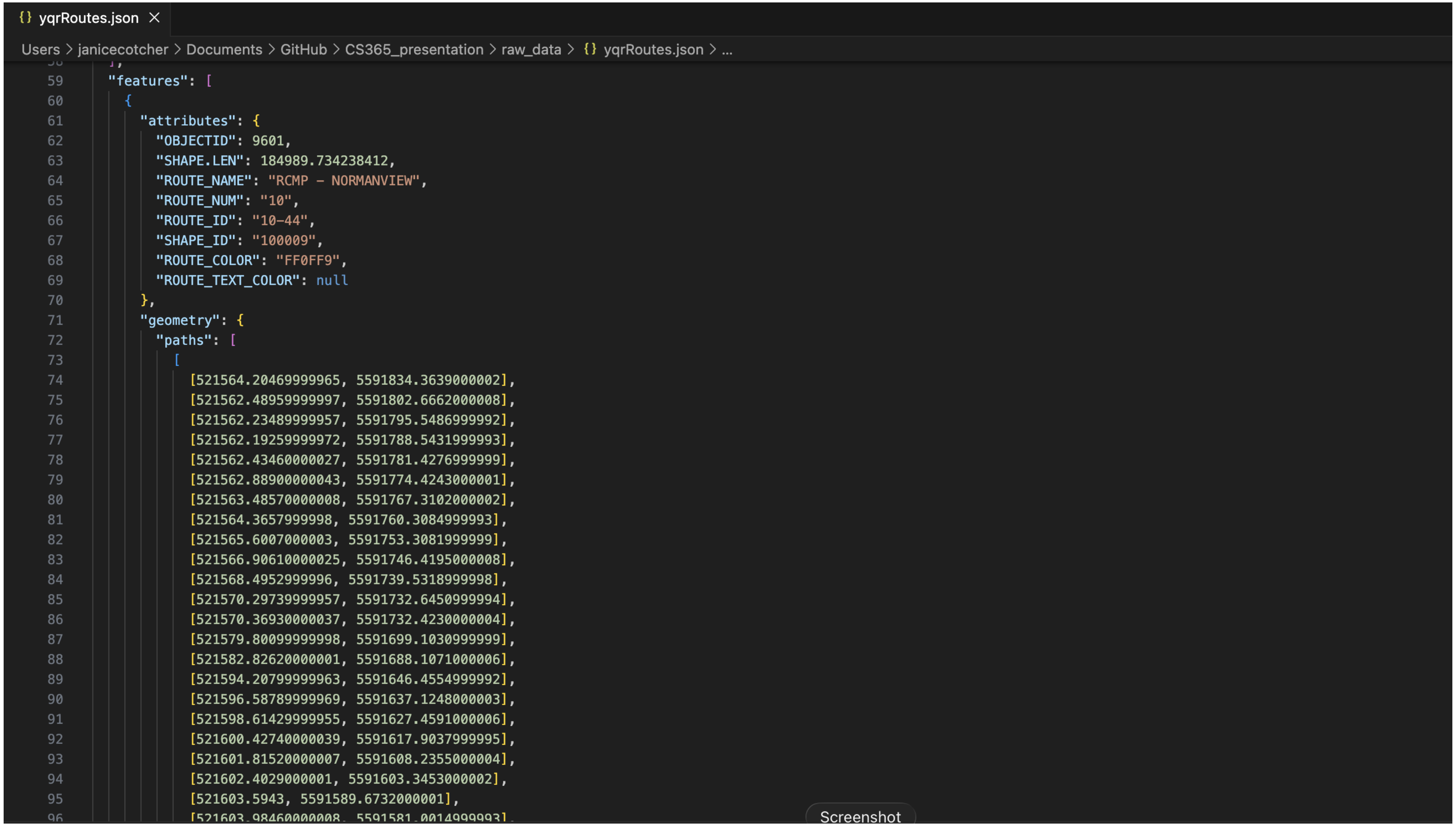
```
# Text standardization
df_stops['attributes.ONSTREET'] = df_stops['attributes.ONSTREET'].str.strip().str.upper()
df_stops['attributes.ATSTREET'] = df_stops['attributes.ATSTREET'].str.strip().str.upper()
...
# Missing value imputation
df_stops = df_stops.fillna({'attributes.ATSTREET': "DOROTHY ST (SB)"})

# Data correction
df_stops['attributes.ONSTREET'] = df_stops['attributes.ONSTREET'].str.replace(
    "1060 DOROTHY ST (SB)", "DOROTHY ST", regex=False
)
```

VISUAL CHECK OF BUS STOPS

RAW DATA SNAPSHOT: BUS ROUTES


{} yqrRoutes.json
Users > janicecotcher > Documents > GitHub > CS365_presentation > raw_data > {} yqrRoutes.json > ...
Screenshot

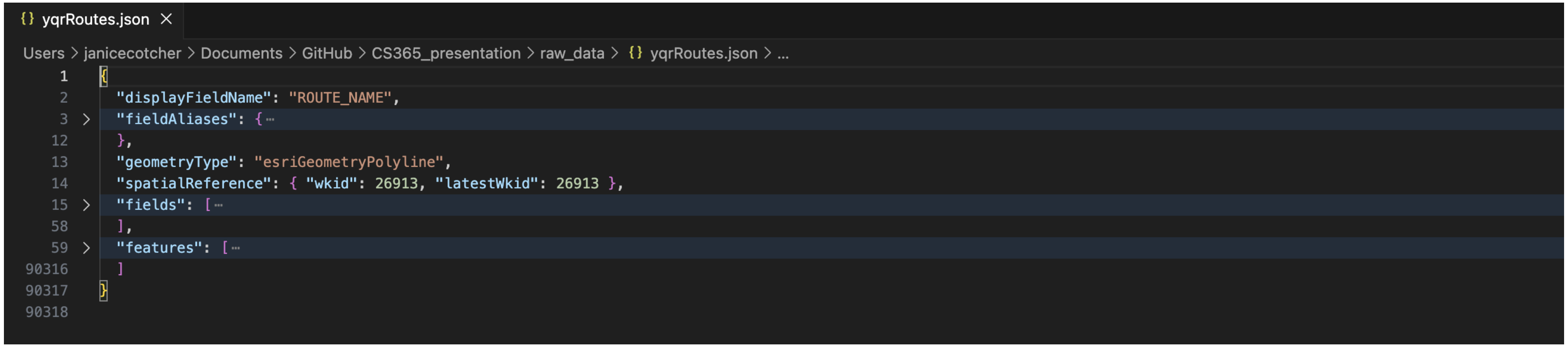
```json
{
  "displayFieldName": "ROUTE_NAME",
  "fieldAliases": {
    "OBJECTID": "OBJECTID",
    "SHAPE.LEN": "SHAPE.LEN",
    "ROUTE_NAME": "ROUTE_NAME",
    "ROUTE_NUM": "ROUTE_NUM",
    "ROUTE_ID": "ROUTE_ID",
    "SHAPE_ID": "SHAPE_ID",
    "ROUTE_COLOR": "ROUTE_COLOR",
    "ROUTE_TEXT_COLOR": "ROUTE_TEXT_COLOR"
  },
  "geometryType": "esriGeometryPolyline",
  "spatialReference": { "wkid": 26913, "latestWkid": 26913 },
  "fields": [
    { "name": "OBJECTID", "type": "esriFieldTypeOID", "alias": "OBJECTID" },
    {
      "name": "SHAPE.LEN",
      "type": "esriFieldTypeDouble",
      "alias": "SHAPE.LEN"
    },
    {
      "name": "ROUTE_NAME",
      "type": "esriFieldTypeString",
      "alias": "ROUTE_NAME",
      "length": 200
    },
    {
      "name": "ROUTE_NUM",
      "type": "esriFieldTypeString",
      "alias": "ROUTE_NUM",
      "length": 200
    },
    {
      "name": "ROUTE_ID",
      "type": "esriFieldTypeString",
      "alias": "ROUTE_ID",
      "length": 200
```



{} yqrRoutes.json
Users > janicecotcher > Documents > GitHub > CS365_presentation > raw_data > {} yqrRoutes.json > ...
Screenshot

```
  ],
  "features": [
    {
      "attributes": {
        "OBJECTID": 9601,
        "SHAPE.LEN": 184989.734238412,
        "ROUTE_NAME": "RCMP - NORMANVIEW",
        "ROUTE_NUM": "10",
        "ROUTE_ID": "10-44",
        "SHAPE_ID": "100009",
        "ROUTE_COLOR": "FF0FF9",
        "ROUTE_TEXT_COLOR": null
      },
      "geometry": {
        "paths": [
          [
            [521564.20469999965, 5591834.3639000002],
            [521562.48959999997, 5591802.6662000008],
            [521562.23489999957, 5591795.5486999992],
            [521562.19259999972, 5591788.5431999993],
            [521562.43460000027, 5591781.4276999999],
            [521562.88900000043, 5591774.4243000001],
            [521563.48570000008, 5591767.3102000002],
            [521564.3657999998, 5591760.3084999993],
            [521565.6007000003, 5591753.3081999999],
            [521566.90610000025, 5591746.4195000008],
            [521568.4952999996, 5591739.5318999998],
            [521570.29739999957, 5591732.6450999994],
            [521570.36930000037, 5591732.4230000004],
            [521579.80099999998, 5591699.1030999999],
            [521582.82620000001, 5591688.1071000006],
            [521594.20799999963, 5591646.4554999992],
            [521596.58789999969, 5591637.1248000003],
            [521598.61429999955, 5591627.4591000006],
            [521600.42740000039, 5591617.9037999995],
            [521601.81520000007, 5591608.2355000004],
            [521602.4029000001, 5591603.3453000002],
            [521603.5943, 5591589.6732000001],
            [521603.98460000008, 5591581.0014999993],
```

OVER 90K LINES, ~4.9MB


{} yqrRoutes.json
Users > janicecotcher > Documents > GitHub > CS365_presentation > raw_data > {} yqrRoutes.json > ...

```
{
  "displayFieldName": "ROUTE_NAME",
  "fieldAliases": {⋯
  },
  "geometryType": "esriGeometryPolyline",
  "spatialReference": { "wkid": 26913, "latestWkid": 26913 },
  "fields": [⋯
  ],
  "features": [⋯
  ]
}
```

LOADING ROUTES DATA

```python
# Load routes data
with open('raw_data/yqrRoutes.json', 'r') as f:
    routes_data = json.load(f)

df_routes = pd.json_normalize(routes_data['features'])
```

LOADING ROUTES DATA

```
# Load routes data
with open('raw_data/yqrRoutes.json', 'r') as f:
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```

	attributes.OBJECTID	attributes.SHAPE.LEN	attributes.ROUTE_NAME	attributes.ROUTE_N
0	9601	184989.734238	RCMP - NORMANVIEW	
1	9602	47401.585527	HARBOUR LANDING - UNIVERSITY	
2	9603	180172.679776	UNIVERSITY - SHERWOOD ESTATES	
3	9604	92096.531471	ALBERT S EXPRESS - ALBERT N EXPRESS	
4	9605	57978.961540	ARCOLA E EXP - ARCOLA DWTN EXP	
5	9606	115065.916376	GLENCAIRN - WHITMORE	
6	9607	664900.169679	DIEPPE/WESTERRA - BROAD NORTH	
7	9608	492246.798973	VARSITY PARK - MOUNT ROYAL	
8	9609	24622.479650	AIRPORT - DOWNTOWN	

9	9610	94968.614798	UNIVERSITY - ARCOLA EAST
10	9611	134424.603144	ARGYLE PARK - WOOD MEADOWS
11	9612	63697.887437	UNIVERSITY - ROCHDALE EXPRESS
12	9613	85020.879476	HILLSDALE - WALSH ACRES
13	9614	47980.063524	HAWKSTONE - LAKERIDGE
14	9615	108643.699393	MAPLE RIDGE WEST - MAPLE RIDGE EAST
15	9616	60200.279881	HERITAGE WEST - HERITAGE EAST
16	9617	90660.507444	PARKRIDGE - ALBERT PARK
17	9618	64226.528459	WESTHILL - ROSS INDUSTRIAL

DATA PROFILE: QUALITY ASSESSMENT - ROUTES

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CLEANING: BUS ROUTE TEXT STANDARDIZATION & TYPE CONVERSIONS

DATA WRANGLER DEMO

BUS ROUTE CLEANING SUMMARY

- inconsistent text formatting
- missing colours
- hex values missing #
- standardize column names

BUS ROUTE CLEANING SUMMARY

- inconsistent text formatting
- missing colours
- hex values missing #
- standardize column names

Cleaned routes:22

	route_num	route_name	route_color
0	10	RCMP - NORMANVIEW	#FF0FF9
1	18	HARBOUR LANDING - UNIVERSITY	#80FF00
2	3	UNIVERSITY - SHERWOOD ESTATES	#A8A800
3	40	ALBERT S EXPRESS - ALBERT N EXPRESS	#00CECE
4	60	ARCOLA E EXP - ARCOLA DWTN EXP	#808000

PREPARE ROUTES FOR VISUALIZATION

```
# Create transformer to convert from UTM to lat/lon
transformer = Transformer.from_crs("EPSG:26913", "EPSG:4326", always_xy=True)
```

VISUAL CHECK OF A BUS ROUTE

TRANSFORMATION STEP 1: LOADING GTFS SCHEDULE DATA

GTFS (General Transit Feed Specification) provides detailed schedule information:

```
# Load GTFS files
stops_gtfs = pd.read_csv('raw_data/gtfs_data/stops.txt')
routes_gtfs = pd.read_csv('raw_data/gtfs_data/routes.txt')
trips_gtfs = pd.read_csv('raw_data/gtfs_data/trips.txt')
times_gtfs = pd.read_csv('raw_data/gtfs_data/stop_times.txt')

# Clean and standardize - sample
stops_gtfs['stop_name'] = stops_gtfs['stop_name'].str.upper().str.strip()
routes_gtfs['route_long_name'] = routes_gtfs['route_long_name'].str.upper().str.strip()
```

GTFS Data Loaded:

- 1400 stops
- 44 routes
- 5078 trips
- 285722 stop times

TRANSFORMATION STEP 2: PARSING DATE/TIME DATA

Problem: Time data stored as strings (HH:MM:SS)

Solution: Parse to datetime and derive time-based features

```python
# Parse time columns
times_gtfs_clean['departure_datetime'] = pd.to_datetime(
    times_gtfs_clean['departure_time'],
    format='%H:%M:%S',
    errors='coerce'
)

times_gtfs_clean['departure_datetime'] = pd.to_datetime(
    times_gtfs_clean['departure_time'],
    format='%H:%M:%S',
    errors='coerce'
)

# Derive hour and minute features
times_gtfs_clean['arrival_hour'] = times_gtfs_clean['arrival_datetime'].dt.hour
times_gtfs_clean['arrival_minute'] = times_gtfs_clean['arrival_datetime'].dt.minute
times_gtfs_clean['departure_hour'] = times_gtfs_clean['departure_datetime'].dt.hour
times_gtfs_clean['departure_minute'] = times_gtfs_clean['departure_datetime'].dt.minute
```

Parsed time data and derived hour/minute features

	arrival_time	arrival_datetime	arrival_hour	arrival_minute	departure_datetime	departure
0	06:10:00	1900-01-01 06:10:00	6	10	1900-01-01 06:10:00	06
1	06:11:00	1900-01-01 06:11:00	6	11	1900-01-01 06:11:00	06
2	06:12:00	1900-01-01 06:12:00	6	12	1900-01-01 06:12:00	06
3	06:13:00	1900-01-01 06:13:00	6	13	1900-01-01 06:13:00	06
4	06:14:00	1900-01-01 06:14:00	6	14	1900-01-01 06:14:00	06
5	06:15:00	1900-01-01 06:15:00	6	15	1900-01-01 06:15:00	06
6	06:15:00	1900-01-01 06:15:00	6	15	1900-01-01 06:15:00	06
7	06:16:00	1900-01-01 06:16:00	6	16	1900-01-01 06:16:00	06
8	06:17:00	1900-01-01 06:17:00	6	17	1900-01-01 06:17:00	06
9	06:18:00	1900-01-01 06:18:00	6	18	1900-01-01 06:18:00	06

TRANSFORMATION STEP 3: MERGE/JOIN OPERATIONS

- 1400 stops
- Open Regina ASP.NET limit of 1000
- GTFS data contains some fields
- Imputation for the remaining

```python
# Find stops in GTFS but not in geographic JSON data
missing_stops = stops_gtfs_clean[
    ~stops_gtfs_clean['stop_id'].isin(clean_stops['stop_id'])
]

# Merge datasets
merged_stops = pd.concat([clean_stops, missing_stops], ignore_index=True, sort=Fal
se)

# Impute missing street names from stop_name
for index, stop in merged_stops.iterrows():
    if pd.isna(stop['on_street']):
        merged_stops.at[index, 'on_street'] = stop['stop_name'].split(' @')[0]
    if pd.isna(stop['at_street']):
        merged_stops.at[index, 'at_street'] = stop['stop_name'].split('@ ')[-1]
```

```
1224 new stops added
```

Found stops in GTFS data:*1224

Total stops after merge: 2224 (1224 added)

	object_id	on_street	at_street	lon	lat	stop_id	stop_name	g
0	59930.0	UNIVERSITY PARK DR	QUANCE ST (NB)	-104.54913	50.44416	0742	UNIVERSITY PARK DR @ QUANCE ST (NB)	{05 E8 4AA2BA
1	59931.0	UNIVERSITY PARK DR	VIC SQUARE (NB)	-104.54915	50.44592	0743	UNIVERSITY PARK DR @ VIC SQUARE (NB)	{1C 82 EDEB4
2	59932.0	FLEET ST	NORTH SERVICE RD (NB)	-104.549126	50.448609	0744	FLEET ST @ NORTH SERVICE RD (NB)	{AF 583 3DD54
3	59933.0	FLEET ST	FINES DR (NB)	-104.549111	50.449614	0745	FLEET ST @ FINES DR (NB)	{63 70 6FC74F
4	59934.0	CAMBRIDGE AVE	MILFORD CRES (WB)	-104.5513	50.45041	0746	CAMBRIDGE AVE @ MILFORD CRES (WB)	{E 6F 4A928E

TRANSFORMATION: FEATURE DERIVATION - GEOGRAPHIC REGIONS

Divide the city into four quadrants based on approximate city centre coordinates (Albert St & Victoria Ave Intersection)

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Divide the city into four quadrants based on approximate city centre coordinates (Albert St & Victoria Ave Intersection)

```python
city_centre_lon = -104.618
city_centre_lat = 50.447
merged_stops_clean['region'] = ''

# Assign quadrants (NE, NW, SE, SW)
for stop in range(len(merged_stops_clean)):
    if float(merged_stops_clean['lat'].iloc[stop]) > city_centre_lat:
        if float(merged_stops_clean['lon'].iloc[stop]) > city_centre_lon:
            merged_stops_clean.at[stop, 'region'] = "NE"
        else:
            merged_stops_clean.at[stop, 'region'] = "NW"
    else:
        if float(merged_stops_clean['lon'].iloc[stop]) > city_centre_lon:
            merged_stops_clean.at[stop, 'region'] = "SE"
        else:
            merged_stops_clean.at[stop, 'region'] = "SW"
```

Derived regional classifications for all stops

Stop distribution by region:

- NW: 333 stops
- NE: 224 stops
- SW: 1403 stops
- SE: 264 stops

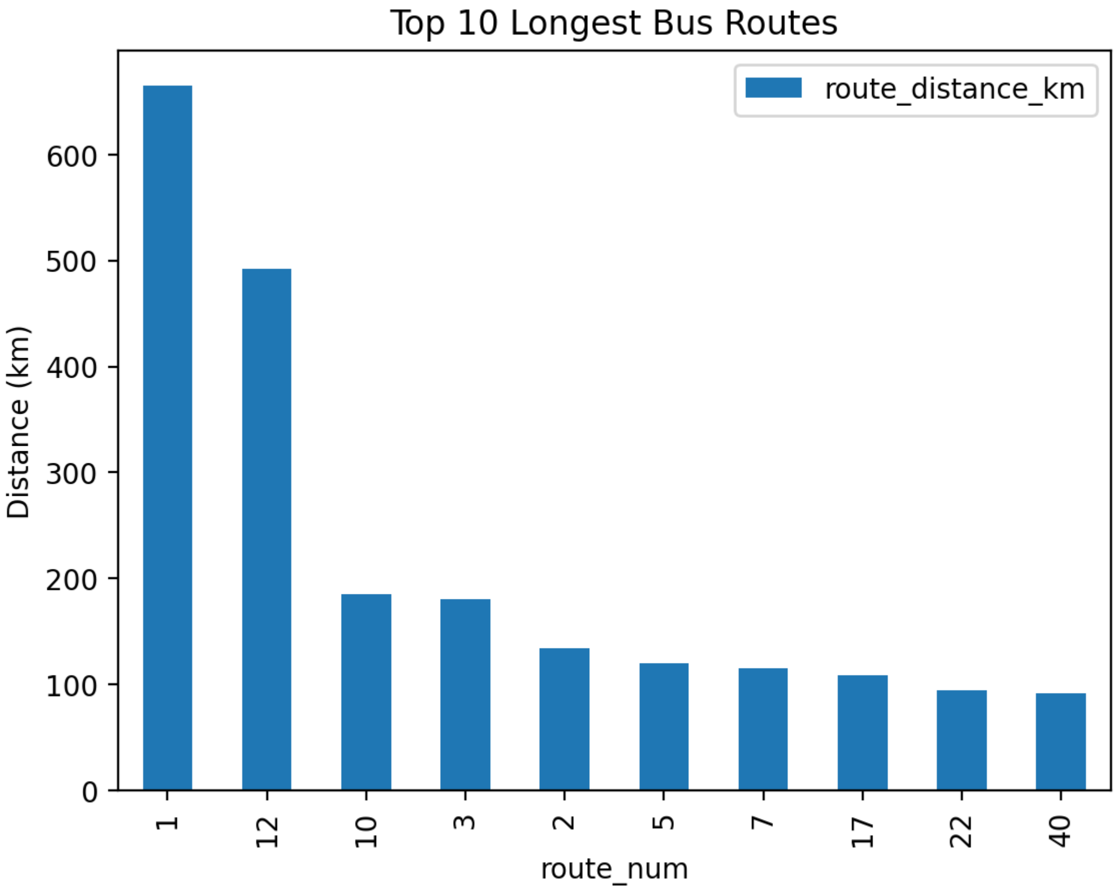
TRANSFORMATION 5: FEATURE DERIVATION - DISTANCE CALCULATIONS

- In ArcGIS/GIS systems, shape.len (shape length) represents the total length of the geometry in metres

```
# convert shape_length into km
clean_routes['route_distance_km'] = clean_routes['shape_length'] / 1000
```

	route_num	route_distance_km
0	10	184.989734
1	18	47.401586
2	3	180.172680
3	40	92.096531
4	60	57.978962
5	7	115.065916
6	1	664.900170
7	12	492.246799
8	24	24.622480
9	22	94.968615
10	2	134.424603
11	30	63.697887
12	4	85.020879
13	16	47.980064
14	17	108.643699
15	15	60.200280
16	9	90.660507
17	6	64.226528
18	8	89.851981
19	5	119.587762
20	21	68.741318

21	50	40.124363

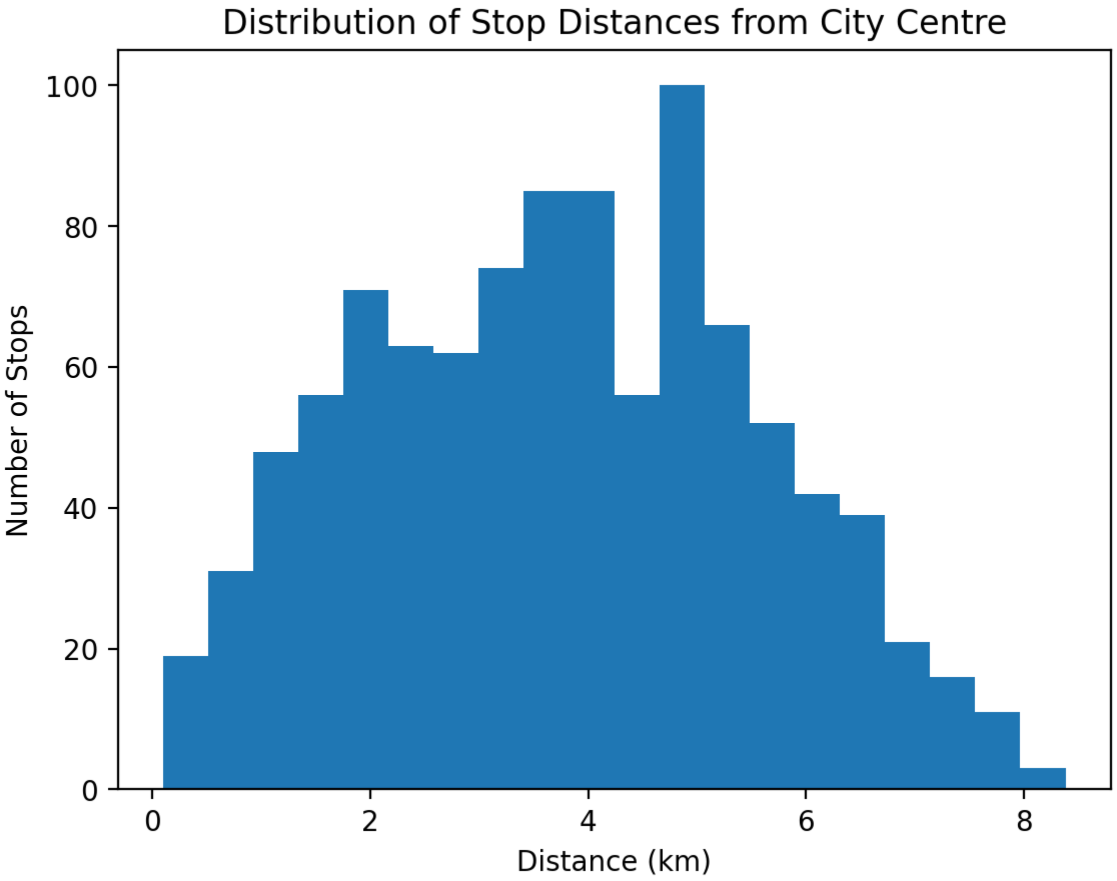

Top 10 Longest Bus Routes
route_distance_km
Distance (km)
0
100
200
300
400
500
600
1
12
10
3
2
5
7
17
22
40
route_num

Calculate distance from city centre using coordinate geometry:

```python
# Approximate conversion: ~111 km per degree latitude, ~85 km per degree longitude at this latitude
# Euclidean distance
merged_stops_clean['distance_from_centre_km'] = np.sqrt(
    ((merged_stops_clean['lat'].astype(float) - city_centre_lat) * 111)**2 +
    ((merged_stops_clean['lon'].astype(float) - city_centre_lon) * 85)**2
)
```

```
Distance statistics (km):
count    1000.000000
mean        3.775980
std         1.791905
min         0.098964
25%         2.319224
50%         3.785285
75%         5.068146
max         8.381130
Name: distance_from_centre_km, dtype: float64
```

Calculated distance from city centre for all stops


Distribution of Stop Distances from City Centre
Number of Stops
100
80
60
40
20
0
0
2
4
6
8
Distance (km)

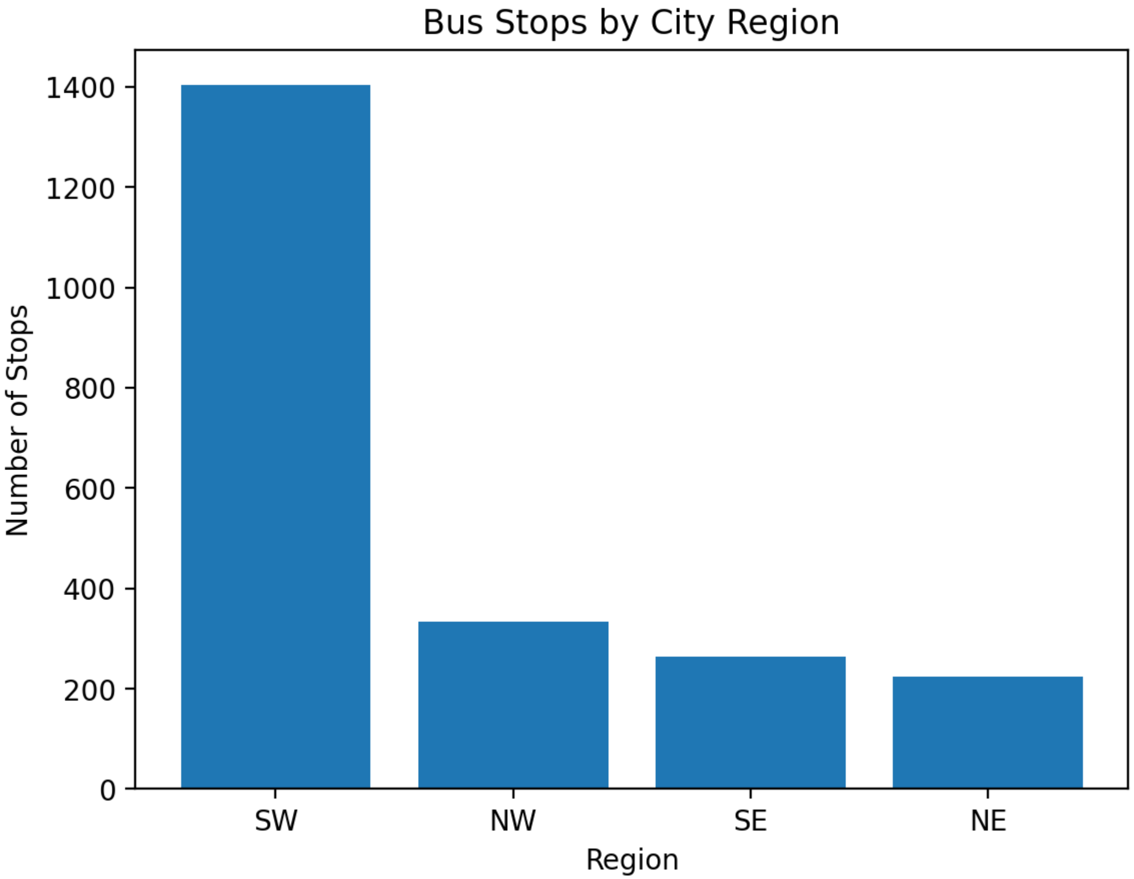
TRANSFORMATION 6: AGGREGATION

Aggregate stops by region to understand service distribution:

```
region_summary = clean_stops.groupby('region').agg({
    'stop_id': 'count',
    'distance_from_centre_km': ['mean', 'max']
}).reset_index()
```

```
       stop_id distance_from_centre_km                    
         count                    mean       min       max
region                                                    
NE         224                4.113674  0.132092  7.650399
NW         333                3.994900  0.306790  8.381130
SE         264                3.926796  0.286489  7.536191
SW        1403                2.723696  0.098964  5.336768
```

Regional Summary Statistics:


Bus Stops by City Region
Number of Stops
1400
1200
1000
800
600
400
200
0
SW
NW
SE
NE
Region

TRANSFORMATION 7: RESHAPE (PIVOT)

Pivot analysis: How many stops does each route serve in each region?

```
# Join stop times → trips → stops to get route-region relationships
route_stops = (
    times_gtfs_clean
    .merge(trips_gtfs_clean[['trip_id', 'route_id']], on='trip_id')
    .merge(merged_stops_clean[['stop_id', 'region']], left_on='stop_id', right_on=
'stop_id')
    .groupby(['route_id', 'region'])
    .size()
    .reset_index(name='stop_count')
)

# Pivot to wide format
route_region_pivot = route_stops.pivot(
    index='route_id',
    columns='region',
    values='stop_count'
).fillna(0)
```

Routes by Region (Pivoted):

region	NE	NW	SE	SW
route_id				
1-44	0.0	0.0	0.0	11105.0
1-45	0.0	0.0	0.0	10997.0
10-44	222.0	1966.0	0.0	6468.0
10-45	210.0	1862.0	0.0	6124.0
12-44	0.0	1400.0	1536.0	8978.0
12-45	0.0	1400.0	1536.0	8978.0
15-44	28.0	0.0	316.0	766.0
15-45	28.0	0.0	316.0	766.0
16-44	0.0	56.0	0.0	388.0
16-45	0.0	56.0	0.0	388.0

PROFILING: OUTLIERS & CARDINALITIES

```
Found 0 outlier stops
```

Outlier Detection: Identify stops unusually far from city centre

Stops beyond 15km from city centre:

```
Unique stops: 2224
Unique routes: 44
Unique regions: 4
Unique trips: 5078
```

Cardinality Analysis: Count unique values in key dimensions

BEFORE/AFTER EVIDENCE

QUANTITATIVE COMPARISON OF DATA QUALITY IMPROVEMENTS:

```
Stop rows: 1000
Route rows: 22
Missing ATSTREET: 1
Coordinate type: object (string)
Stop ID type: object (string)
Features: 8 columns
Stop rows: 2224 (+1224 from GTFS)
Route rows: 22
Missing ATSTREET: 0
Coordinate type: object (numeric-ready)
Stop ID type: object (int32)
Features: 20 columns
New derived features: region, route_distance_km, distance_from_centre_km
Parsed time features: arrival_hour, arrival_minute, departure_hour, depart
ure_minute
```

BEFORE (RAW DATA)

AFTER (CLEANED & TRANSFORMED)

SUMMARY OF TRANSFORMATIONS

COMPLETED TRANSFORMATIONS (8 OPERATIONS ACROSS 5 CATEGORIES):

1. Type Fixes & Parsing

- Converted stop_id from string to int32
- Parsed arrival/departure times to datetime
- Derived hour and minute features

2. Text Cleanup

- Stripped whitespace from all text columns
- Converted to uppercase for consistency
- Fixed malformed addresses

3. Missing Data Handling

- Imputed missing ATSTREET values
- Generated street names from stop names for GTFS stops

4. Join/Merge

- Merged geographic stops with GTFS schedule data
- Joined stop times → trips → routes → stops

5. Feature Derivation

REPRODUCIBILITY

HOW TO REPRODUCE THIS ANALYSIS:

1. Install dependencies:

```
pip install pandas plotly pyproj numpy jupyter
```

2. Directory structure:

```
project/
├── presentation.ipynb
├── transit_data.ipynb
├── raw_data/
│   ├── yqrStops.json
│   ├── yqrRoutes.json
│   └── gtfs_data/
│       ├── stops.txt
│       ├── routes.txt
│       ├── trips.txt
│       └── stop_times.txt
└── README.md
```

3. Run notebook:

- Command line: jupyter notebook transit_data.ipynb
- In VS Code: Execute all cells sequentially
- Or run with Mercury: `mercury run presentation.ipynb`