

# Route\_Dynamics: An open-source package for visualizing and ranking transit routes

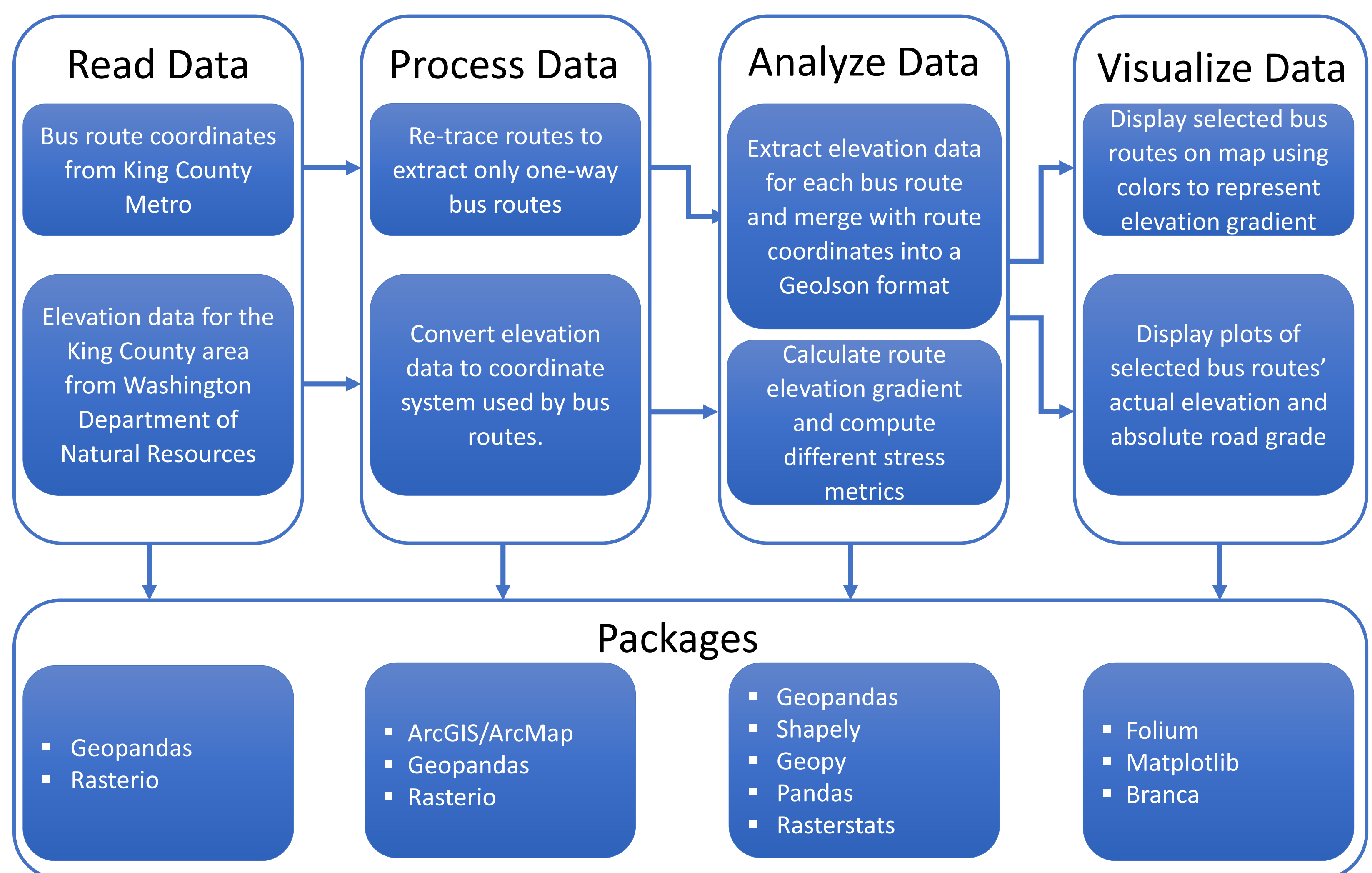
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## Purpose

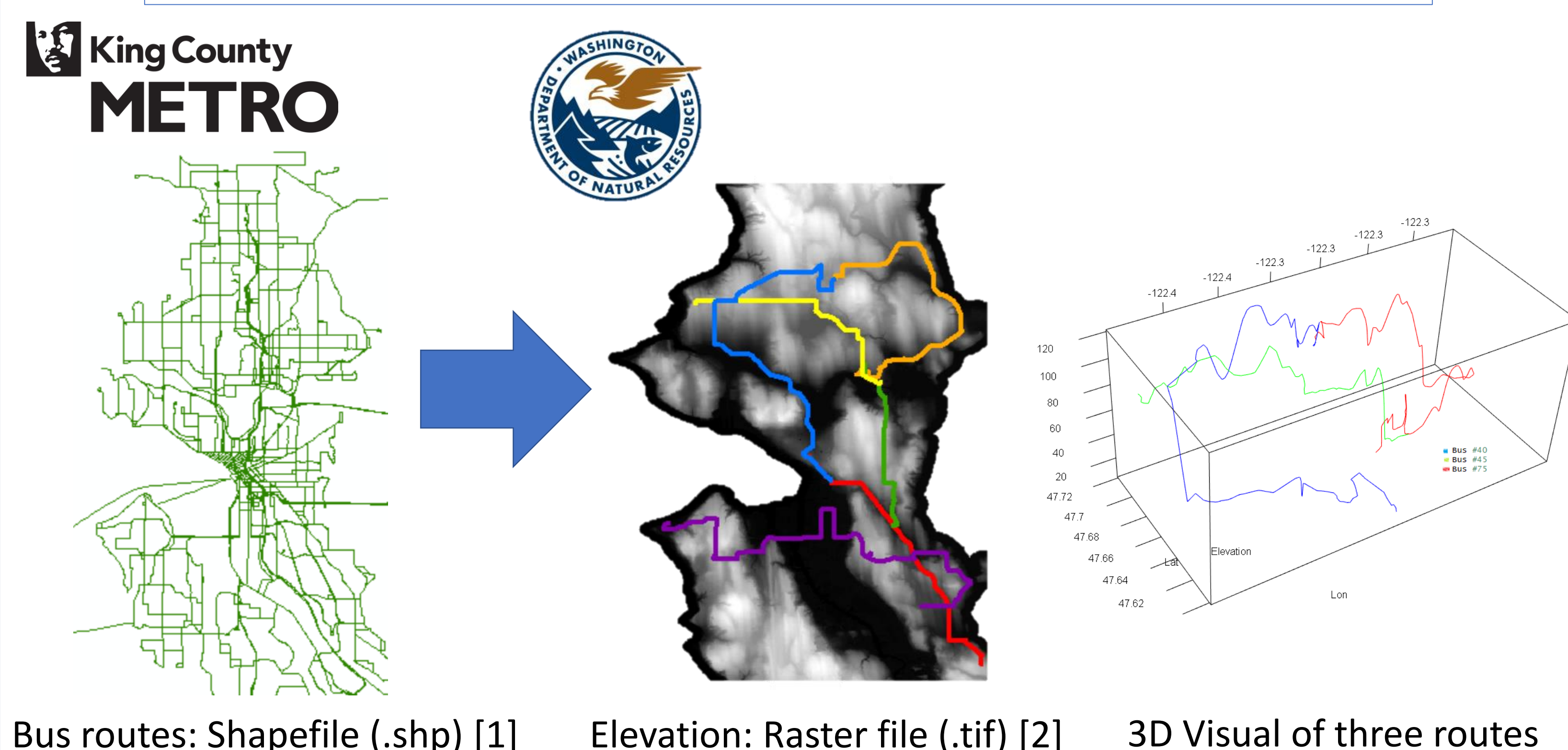
Driving up and down hills is a source of stress for batteries in electrified vehicles due to high charge/discharge rates. This software uses geographic information systems (GIS) data to determine the elevation profiles for King County Metro bus routes and ranks the difficulty based on road grade. This package can also be used as a component for a predictive battery degradation model.



## Work Flow / Packages



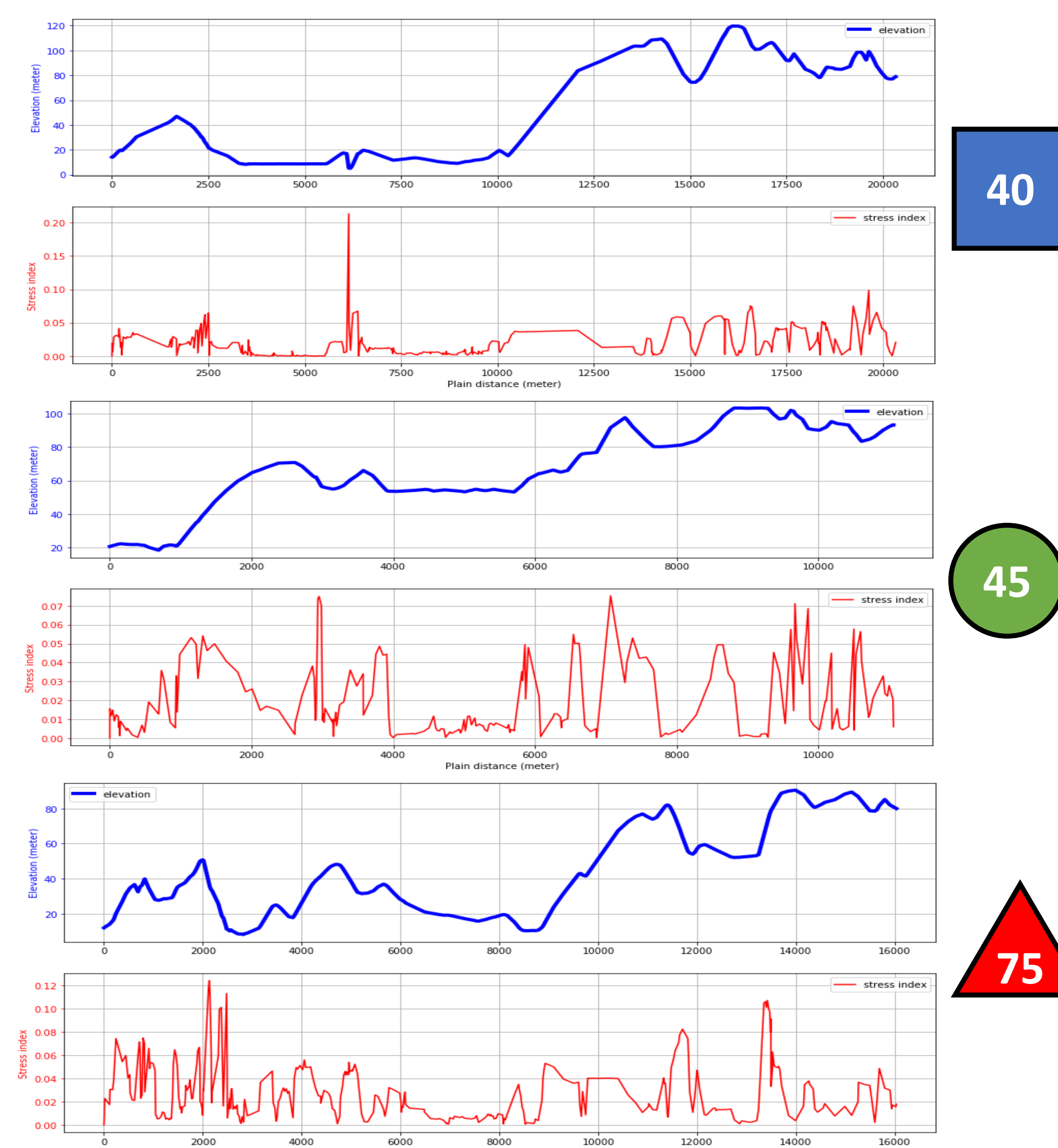
## Input Data Types and Cleaning



Bus routes: Shapefile (.shp) [1] Elevation: Raster file (.tif) [2] 3D Visual of three routes

## Results

### Data Analysis Output



Above: The package produces **elevation profiles** and the absolute **road grade profiles** for each route that is called.

Right: The package experiments with various metrics to rank route difficulty for the bus batteries.

Current ranking metrics included in software:

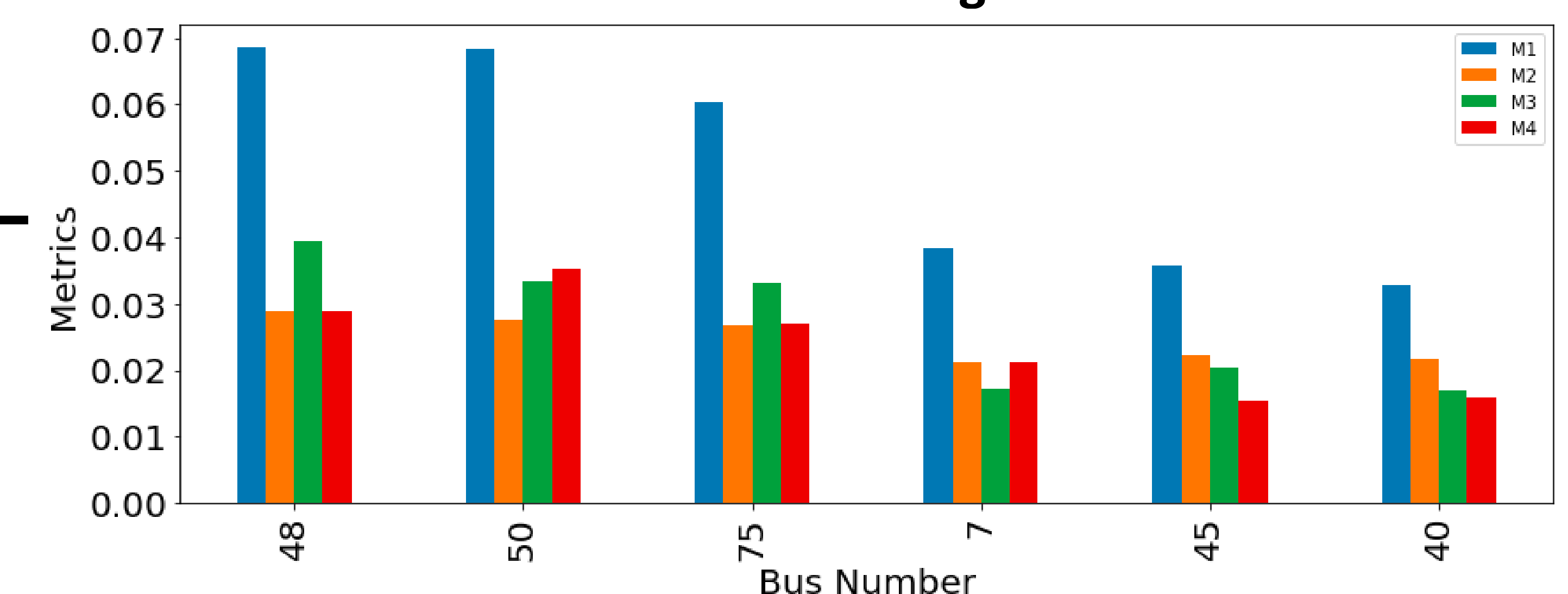
- $Metric\ 1 = \frac{\sum grade}{route\ distance}$
- $Metric\ 2 = \frac{\sum [Elevation\ difference\ between\ points]}{route\ distance}$
- $Metric\ 3 = \frac{\sum Uphill\ grade}{route\ distance}$
- $Metric\ 4 = \frac{\sum Downhill\ grade}{route\ distance}$

### Visualization Output



Above: The package produces a map, either within a notebook or saved as an HTML file, that shows the selected routes and road grade.

### Route Ranking



## Future Work

- Add more points (e.g. interpolation) for higher resolution along the route for a smoother elevation profile and more accurate ranking metric
- Combine elevation surface and terrain models to account for bridges and overpasses
- Create Python package for data cleaning to minimize the need for ArcMap
- Add more stress parameters (mass, velocity, acceleration, weather conditions) to get a better estimate of battery fatigue

References: [1] King County GIS Data Portal. (2017, April), [2] WA Department of Natural Resources, Lidar Portal. (2016)

