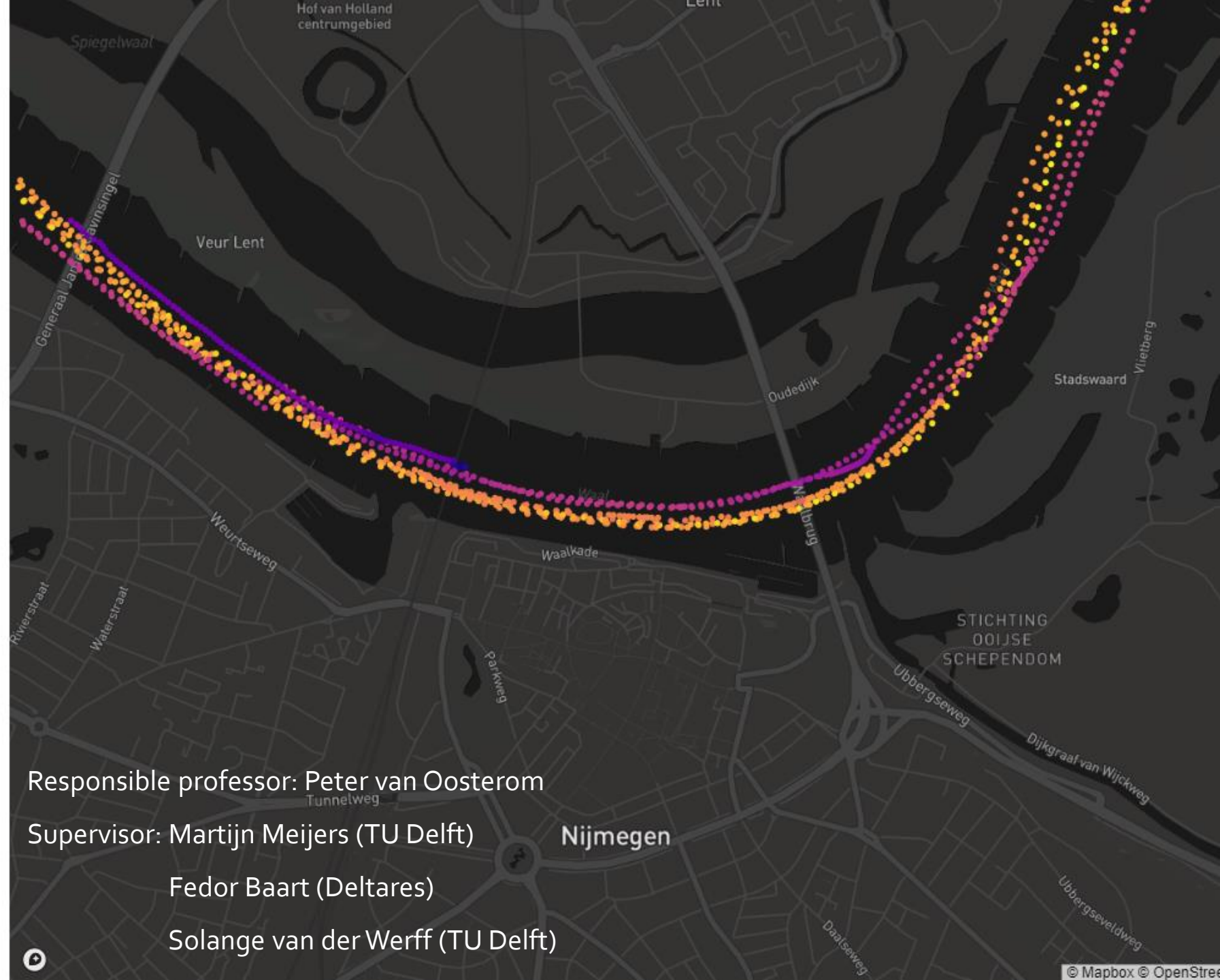


Identify and visualize Dutch inland waterways vessel movement anomalies during low water levels

GIMA MSc thesis

by Chia-Yun, Chang

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Topic background

- Water level fluctuations that affect inland navigation happens from time to time
- Low water level limits vessel traffic and cargo capacity
- Automatic Identification System (AIS) is used to improve safety at sea and inland navigation
- AIS data recorded the movement of vessels in time and space

Data

- Anonymized AIS data provided by Rijkswaterstaat, with privacy conditions that the data cannot be saved in a personal disk.
- The datasets are stored in Azure cloud under TU Delft.
- A glimpse of the dataset:

	sog	headingValid	callsign	vesseltype	rot	hazardouscargo	eni	timestamplast	imo	latitude	...	cog	heading	tobow	width
179509	0.0	511	PH17730	0	0.0	5	2017730.0	2017-12-01 00:00:00+00:00	1773000	51.8	...	360.000000	0.0	NaN	NaN
179510	0.0	511	PH78900	0	0.0	5	2078900.0	2017-12-01 00:00:00+00:00	7890000	51.8	...	92.599998	0.0	NaN	NaN
179511	10.6	511	PH90900	0	0.0	5	2090900.0	2017-12-01 00:00:00+00:00	9090000	51.8	...	285.299988	0.0	NaN	NaN
179512	8.6	511	PH42900	0	0.0	5	2042900.0	2017-12-01 00:00:00+00:00	4290000	51.9	...	300.200012	0.0	NaN	NaN
179513	0.0	511	PH57100	0	0.0	5	2057100.0	2017-12-01 00:00:00+00:00	5710000	51.8	...	0.000000	0.0	NaN	NaN

	Original size (rows)	After cleaning	Only cargo & tanker vessels
2016-10	35,064,275	14,928,190	11,907,144
2016-12	31,179,509	10,545,315	8,848,795
2017-10	29,656,997	12,556,967	9,841,820
2017-12	29,840,546	10,000,559	7,907,469

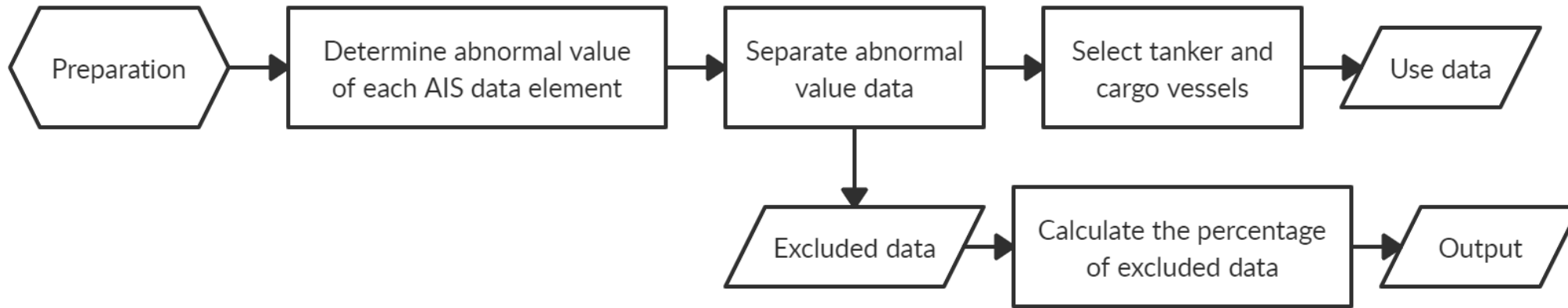
Toolsets

- Azure cloud storage
- Anaconda
- Python
- Jupyter Notebook

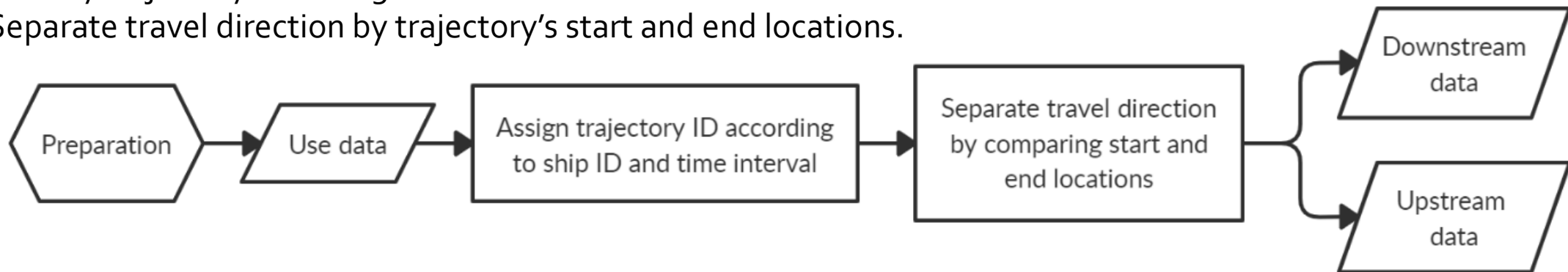
Python modules:

- Pandas
- Dask
- GeoPandas
- Matplotlib
- hvPlot
- HoloViews
- Plotly Express
- Shapely
- GeographicLib

Data cleaning and preparation



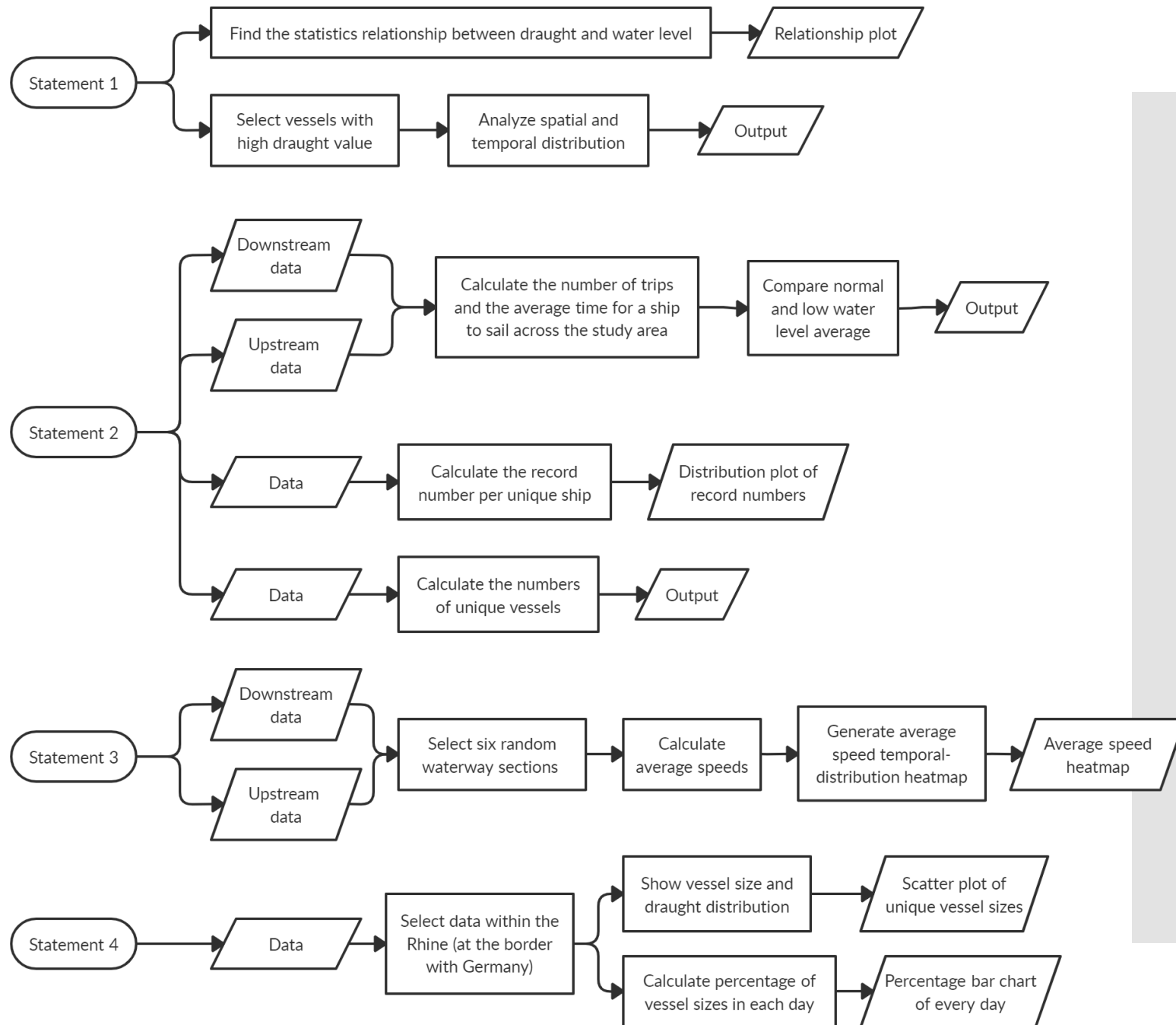
Identify trajectory and assign ID.
Separate travel direction by trajectory's start and end locations.



Validate Market Observations

Four Statements:

1. Ships have less cargo capacity
2. The waterway is busier than usual
3. Ships reduce speed to minimize the dynamic draft
4. Smaller vessels shift operation area to the Rhine





Visualize wrong-side encounter hotspot

