Vessel and Port Efficiency Metrics through Validated AIS data

Global OCEANS 2020

Tomaž Martinčič  Dejan Štepec  Joao Pita Costa  Kristjan Čagran  Athanasios Chaldeakis
XLAB d.o.o.  XLAB d.o.o.  XLAB d.o.o.  XLAB d.o.o.  Piraeus Port Authority
AI Enabled Port Operations

- Growth across all the major cargo types
- More than 90% of the world’s trade
- Expected to annually expand 3.5% (2019 - 2024)
- Increasing pressure on ports - turnaround times
- Digitalization in the ports (PCS)

Vessel turnaround time is one of the main indicators of ports efficiency and trade competitiveness*

*J. Hoffmann and S. Sirimanne, “Review of maritime transport,” in United Nations Conference on Trade and Development, 2019.
Automatic Identification System - AIS

- Required for:
  - vessels above 300 GT
  - passenger vessels
- Collision prevention
- Vessel location, type, speed, identification number, course direction, navigational status …
- Multiple times a minute
AIS Data has errors ... lot's of them

- Manually entered data
  - Wrong values
  - Late or missing change
- Automatic data
  - Uncovered areas
  - Noise

More than 30 % of reported navigational status are wrong*

*Harati-Mokhtari, Abbas, et al. "Automatic Identification System (AIS): data reliability and human error implications." The Journal of Navigation 60.3 (2007): 373-389.
Validating Navigational Status
Validating Navigational Status

Polygons

- Manually provided polygons:
  - Terminals (yellow)
  - Anchorage areas (blue)

+ Accurate
+ Split a port into multiple areas
- Manually drawn polygons
- Possibility of anchoring outside of polygons
Validating Navigational Status

Vessel movements

+ No manual drawn polygons
- Not accurate for shorter stops
Validating Navigational Status

Machine learning

- Clustering:
  - HDBSCAN
- Classification:
  - CatBoost
  - K-Nearest Neighbours

+ No need for manually drawn polygons
- Reduced accuracy
Extracting Voyages
Vessels Arrivals Analysis

Number of daily arrivals

Jul 2019 | Sep 2019 | Nov 2019 | Jan 2020 | Mar 2020 | May 2020 | Jul 2020
--- | --- | --- | --- | --- | --- | ---
Passenger vessels | Cargo vessels | Tankers | Strikes | Strong winds

XLAB
### Route Reliability

| MMSI | vessel_size | vessel_type | arrival_time | departure_time | time_moving | time_moored | average_speed_when_moving |
|------|-------------|-------------|--------------|----------------|-------------|-------------|--------------------------|
| 0    | 2396580000 | 93.0        | 2019-09-11 14:07:41 | 2019-09-12 04:22:02 | 00:15:12   | 0 days 13:59:09 | 8.325000                |
| 1    | 2396580000 | 93.0        | 2019-09-12 14:27:26 | 2019-09-13 04:25:06 | 00:11:27   | 0 days 13:46:13 | 7.700000                |
| 2    | 2396580000 | 93.0        | 2019-09-13 15:41:34 | 2019-09-15 04:20:56 | 00:12:52   | 1 days 12:26:30 | 7.388889                |
| 3    | 2396580000 | 93.0        | 2019-09-15 16:17:09 | 2019-09-16 04:22:46 | 00:18:15   | 0 days 11:47:22 | 6.866667                |
| 4    | 2396580000 | 93.0        | 2019-09-16 14:14:27 | 2019-09-17 04:22:04 | 00:14:56   | 0 days 13:52:41 | 7.840000                |
| 5    | 2396580000 | 93.0        | 2019-09-17 13:53:31 | 2019-09-18 04:22:17 | 00:14:39   | 0 days 14:14:07 | 7.670000                |
| 6    | 2396580000 | 93.0        | 2019-09-18 13:57:51 | 2019-09-19 04:22:32 | 00:18:42   | 0 days 14:05:59 | 5.733333                |
| 7    | 2396580000 | 93.0        | 2019-09-19 13:52:29 | 2019-09-20 04:22:07 | 00:14:59   | 0 days 14:14:39 | 7.370000                |
| 8    | 2396580000 | 93.0        | 2019-09-20 14:03:26 | 2019-09-21 04:20:51 | 00:11:59   | 0 days 14:05:26 | 7.644444                |
| 9    | 2396580000 | 93.0        | 2019-09-21 14:33:38 | 2019-09-22 04:21:26 | 00:16:41   | 0 days 13:31:07 | 6.536364                |
| 10   | 2396580000 | 93.0        | 2019-09-22 14:34:46 | 2019-09-23 04:22:22 | 00:13:15   | 0 days 13:34:21 | 6.250000                |
| 11   | 2396580000 | 93.0        | 2019-09-23 13:57:10 | 2019-09-25 04:21:26 | 00:14:35   | 1 days 14:09:41 | 7.440000                |
| 12   | 2396580000 | 93.0        | 2019-09-25 14:09:55 | 2019-09-26 04:22:08 | 00:15:16   | 0 days 13:56:57 | 7.190000                |
| 13   | 2396580000 | 93.0        | 2019-09-26 13:46:52 | 2019-09-27 04:22:03 | 00:14:00   | 0 days 14:21:11 | 7.720000                |
| 14   | 2396580000 | 93.0        | 2019-09-27 13:45:52 | 2019-09-28 04:20:17 | 00:13:37   | 0 days 14:20:48 | 7.800000                |
| 15   | 2396580000 | 93.0        | 2019-09-28 13:55:36 | 2019-09-29 04:21:26 | 00:15:04   | 0 days 14:10:46 | 7.420000                |
Conclusion

- We presented 3 different methods for navigational status validation
- We presented a method for extracting voyages
- The demo of the PARES tool is available on ports.xlab.si
Get IT done.