

Ship Navigation Data

Description

Data collected with five minutes frequency about the CO₂ emissions and the ship operating conditions of a Ro-pax ship during navigation. Data are courtesy of the Italian shipping company Grimaldi Group. For confidentiality reason, unless specified differently in the variable description below, numerical variables have been scaled by dividing their values by the maximum absolute value, so that all observations are between -1 and 1. Moreover, port names are omitted and labeled as A, B, C, etc. All the data refer to the same Ro-Pax cruise ship, which transports both passengers and vehicles. Each voyage of the ship connects a departure port to an arrival port. The considered ship has two engine sets, each with two main engines for propulsion with a variable pitch propeller and a shaft generator (keyed on a gearbox) for electric power. Then, the ship has four main engines for propulsion with two variable pitch propellers, three diesel generators and two shaft generators for electric power. So sometimes the main engine power is used both for propulsion and electrical generation through the shaft generators. Moreover there are also three diesel generators for electric power, since the on-board electrical energy production is critical a black out should always be avoided.

Data format

A data frame with 259188 rows and the following 28 columns:

- `datetime`: Time passed from the moment the first observation is available to the time of the current row, linearly scaled so that data are between 0 and 1.
- `sog`: Speed of the vessel relative to the surface of the earth. This variable is available on its original scale and is measured in knots.
- `p_p`: Power delivered along the shaft to the port propeller by two of four main engines.
- `p_s`: Power delivered along the shaft to the starboard propeller by two of four main engines.
- `sg_p`: Electric power delivered along the port shaft generator by two of four main engines.
- `sg_s`: Electric power delivered along the starboard shaft generator by two of four main engines.
- `draft_a`: Draft of the ship measured at aft.
- `draft_p`: Draft of the ship measured at port.
- `draft_s`: Draft of the ship measured at starboard.
- `Draft_f`: Draft of the ship measured at fore.
- `trim`: Trim of the ship, calculated based on the difference between the forward and aft draft.
- `temp1`: Temperature of charge air entering in main engine 1. This variable is available on the original scale and is measured in Celsius degrees.
- `temp2`: Temperature of charge air entering in main engine 2. This variable is available on the original scale and is measured in Celsius degrees.
- `temp3`: Temperature of charge air entering in main engine 2. This variable is available on the original scale and is measured in Celsius degrees.
- `temp4`: Temperature of charge air entering in main engine 4. This variable is available on the original scale and is measured in Celsius degrees.

- **position:** Route travelled by the ship, for example, if on a given voyage the ship travels from port A to port B, then the position is A -> B.
- **nautic_miles:** Distance travelled by the ship from the position corresponding to the previous row to the position corresponding to the current row.
- **VN:** Voyage number. Character vector consisting in an incremental identification code that identifies subsequent voyages of the ship.
- **departure_port:** Departure port from which the ship is travelling on the current voyage.
- **arrival_port:** Arrival port to which the ship is travelling on the current voyage.
- **cumulative_miles:** Cumulative distance traveled by the ship from the beginning of the voyage corresponding to the current row, to the position of the ship, corresponding to the current row.
- **cumulative_h:** Cumulative time passed from the beginning of the voyage corresponding to the current row, to the instant corresponding to the current row.
- **`fraction of distance travelled`:** Fraction of distance traveled by the ship from the beginning of the voyage corresponding to the current row, to the position of the ship, corresponding to the current row, with respect to the total distance traveled during the current voyage.
- **percent_seconds:** Fraction of distance traveled by the ship from the beginning of the voyage corresponding to the current row, to the position of the ship, corresponding to the current row, with respect to the total distance traveled during the current voyage.
- **w_long:** Component of the wind longitudinal to the direction of navigation of the ship. This variable is available on the original scale and is measured in knots.
- **w_trasv:** Component of the wind transversal to the direction of navigation of the ship. This variable is available on the original scale and is measured in knots.
- **CO2_emissions:** CO₂ emissions due to navigation, produced over the time interval between the time corresponding to the previous row to the time corresponding to the current row.
- **`predicted fraction of distance travelled`:** Estimation of the fraction of distance traveled by the ship from the beginning of the voyage corresponding to the current row, to the position of the ship, corresponding to the current row, with respect to the total distance traveled during the current voyage. The estimation is necessary for real-time monitoring of functional data, because in the middle of a voyage, the total distance traveled by the ship over the voyage is not known yet. The estimation procedure is detailed in Capezza et al. (2020).

References

- Capezza C, Lepore A, Menafoglio A, Palumbo B, Vantini S. (2020) Control charts for monitoring ship operating conditions and CO₂ emissions based on scalar-on-function regression. *Applied Stochastic Models in Business and Industry*, 36(3):477--500. doi:10.1002/asmb.2507