Explanation of Used Algorithms

**extractSteadySpeeds**

1) Finding preliminary steady-speed intervals using *fifo\_maxdev* algorithm. This algorithm does not always give good results/intervals. It is, let's say, the first iteration. The resulting intervals are just used for estimating the parameters that will be used in the sieve-algorithm. It is about *referent variance* and *degrees of freedom*. In other words *mm2* and *ff* which will be used in *sieve\_maxdev* function.

1a - In statistical sense, not all the intervals are good. There are intervals which does not satisfy the statistical *F-test* and these intervals are not considered to be 'good'. We find *mm2* as the maximal statistical-dispersion of all good intervals. The corresponding *ff* is a number of totes inside that interval.

1b - The good intervals cannot be considered as optimal. The result of *fifo\_maxdev* algorithm depends on the direction of iterating and they are never best regarding the coverage.

2) Finding steady-speed intervals using the sieve-algorithm.

3) Adjusting the resulting intervals (*adjustDevTouchingIntervals* function). At this point, it is possible to have two neighboring intervals which are both good but not perfect. For example, if we have two touching intervals 100-140 and 140-200, it might be that the more optimal combination would be 100-150 and 150-200. The used criterion for finding the most optimal combination is a classical statistical criterion - minimal sum of squares of deviations. The results after applying *adjustDevTouchingIntervals* function, can be considered optimal.

4) (Optionally) Merging intervals, if we want do that at all. If there are touching intervals whose mean values do not differ more than 1 knots, we can merge these intervals using *mergeSimpleIntervals* function/algorithm.

**extractSteadyHeadings**

1) Finding preliminary steady-course intervals using *fifo\_maxdev* algorithm. Analogous to the algorithm extractSteadySpeeds the resulting intervals are just used for estimating the parameters that will be used in the sieve-algorithm. We find *mm2* as the maximal statistical-dispersion of all good intervals. The corresponding *ff* is a number of totes inside that interval.

2) Finding steady-course intervals using the sieve-algorithm.

3) Adjusting the resulting intervals (*adjustDevTouchingIntervals* function). At this point, it is possible to have two neighboring intervals which are both good but not perfect. For example, if we have two touching intervals 100-140 and 140-200, it might be that the more optimal combination would be 100-150 and 150-200. The used criterion for finding the most optimal combination is a classical statistical criterion - minimal sum of squares of deviations. The results after applying *adjustDevTouchingIntervals* function, can be considered optimal.

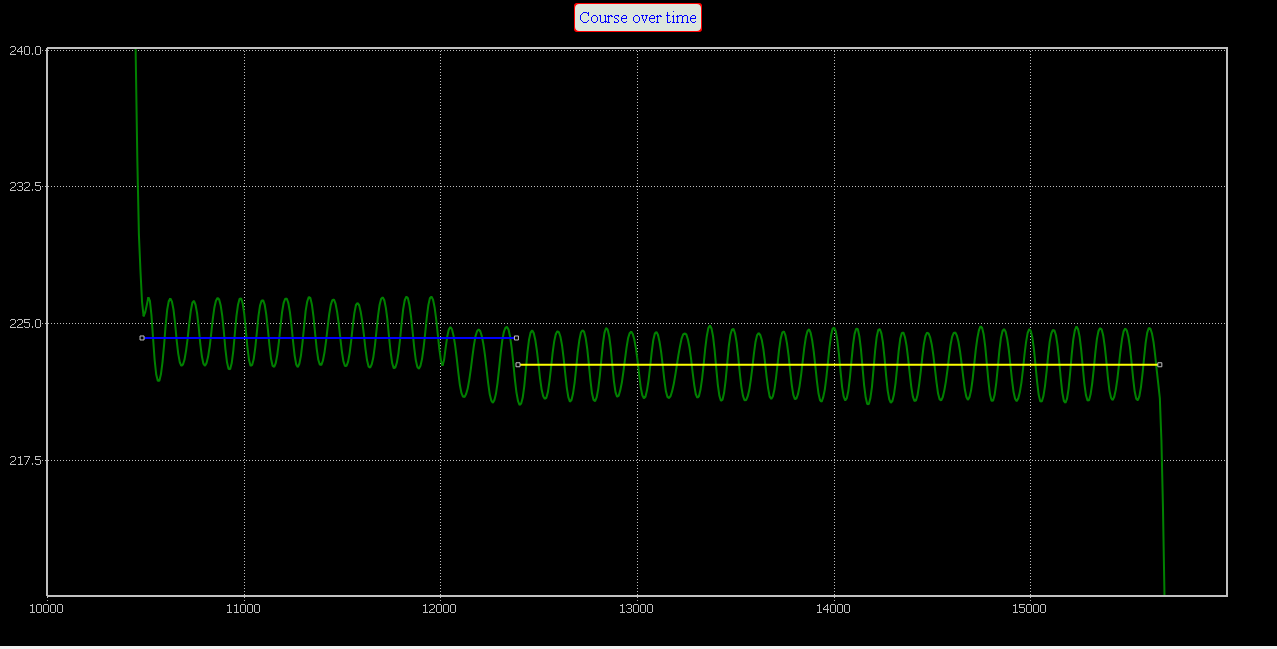


Figure - before AdjustDevTouchingIntervals

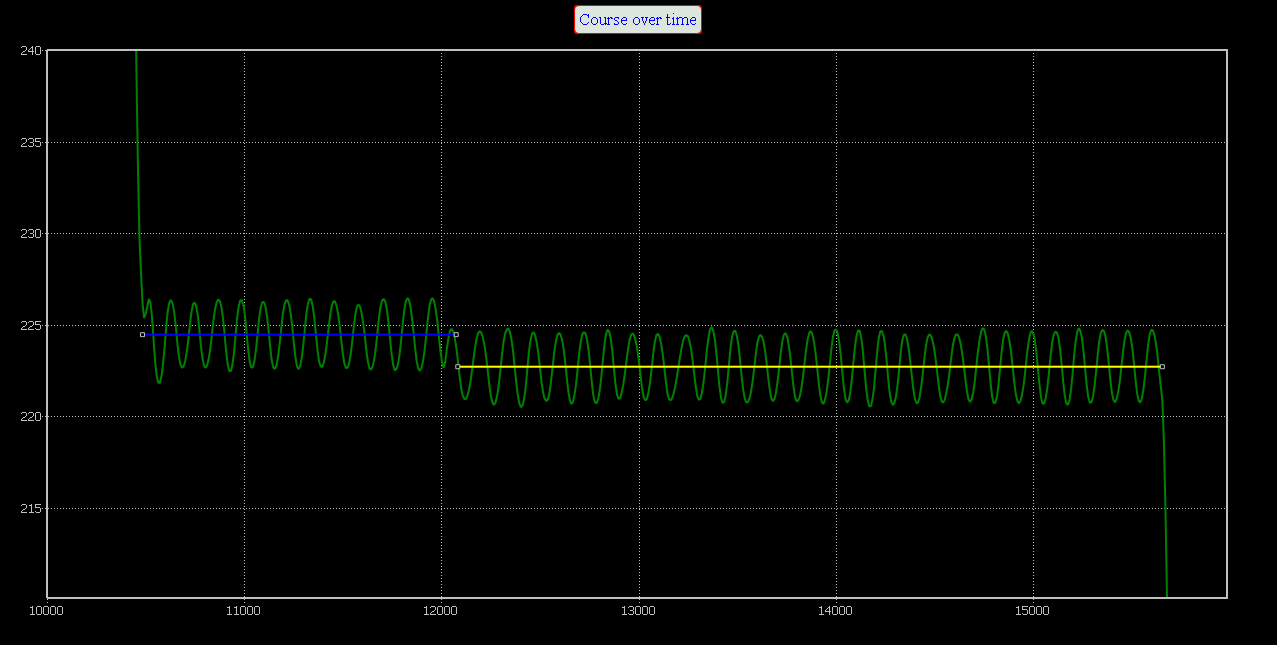


Figure - after AdjustDevTouchingIntervals

4) (Optionally) Merging intervals, if we want do that at all. If there are touching intervals whose mean values do not differ more than 5 degrees, we can merge these intervals using mergeSimpleIntervals function/algorithm.

**fifo\_maxdev**

This functions is used for finding preliminary steady-intervals. The procedure is as follows:

1) The iterating goes from left to right i.e. the iterations start at the tote[0]. The end of the first examined intervals is determined having in mind the request that the elapsed time must be greater than *mintime* parameter (which is 5min at the moment).

2) If the range (maxvalue - minvalue) is less than predefined very small value (0.5 degrees for course; 0.1 knots for speed) we can consider the interval as steady.

3) Otherwise, if the maximal deviation does not exceed the statistically allowed limits, we can consider the interval as steady. The statistical test which is used Student's test:

- the value (heading or speed) which maximally differs from the mean value

- the mean value

- the estimated value of standard deviation

- number of totes in interval

- quantile of Student's distribution with 0.05 significance level and n-2 degrees of freedom

4) If the interval is steady, it must be additionally tested using the regression analysis. The regression analysis test must confirm that the line is horizontal.

5) If the interval is steady, the end index of the interval will be increased and new (increased) interval will be examined. Basically, we are looking for steady-interval with maximal length.

6) If there is no good interval beginning at the start-index, the start-index will be increased and the procedure will be repeated.

**regression analysis**

The goal is to determine the parameters of linear regression and to test statistically whether the line is horizontal (i.e. whether the interval can be considered steady). The mathematical model is: . The parameters of linear regression are estimated using the matrix formula:

Where:

The estimated corrections can be calculated as:

And, the standard deviation of unit's weight is:

The covariance matrix will be:

Accordingly, the standard deviations of estimated parameters can be calculated as:

The first standard deviation (ma) is particularly important. It is used for testing whether the regression line is horizontal using the Student's test:

sieve algorithm

This algorithm is used for finding 'almost optimal' intervals of steady headings or steady speed. The results do not depend upon the direction of iterating and they are optimal concerning coverage.

To be continued ...