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Vessel density

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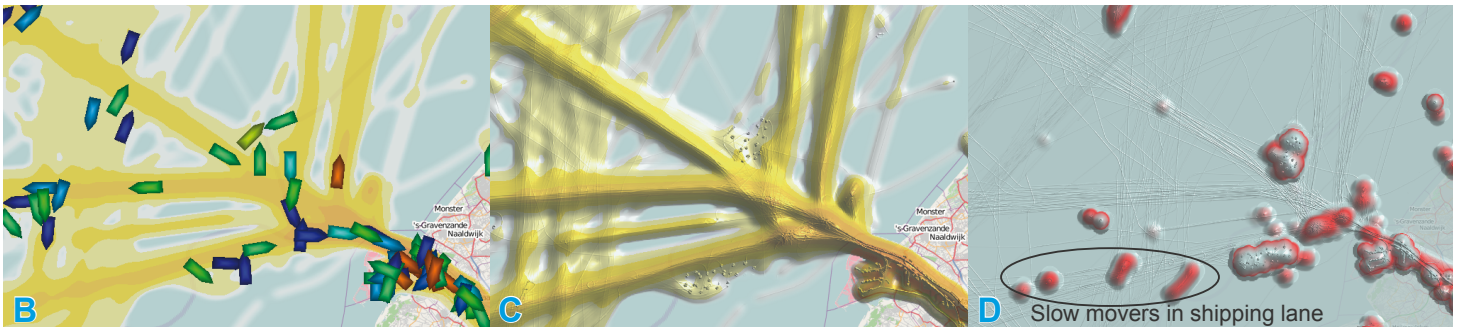
We have presented a method [1] to compute and visualize average behavioral patterns of trajectories. The computational model is a skeletal convolution approach, which smoothes trajectories to find trends in normal behavior. Our method is applied in the maritime domain to establish safety and security with semi-automatic coastal surveillance systems.

How to compute and visualize average behavior from trajectories?

Visualization method

An overview+detail visualization is created by simultaneously displaying densities with a large and a small kernel size. A height field is colored with the large kernel density, and shaded with the weighted sum of both densities (fig. C). Features related to speed popup (fig. E): sea lanes and anchor zones. By filtering trajectories on speed (fig. D, speed smaller than 3 knots), we can find potential risks, such as vessels that move slowly in shipping lanes.



Context

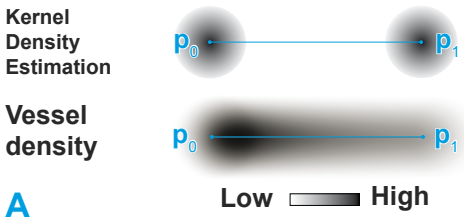
Daily, about 1450 vessels pass the Dutch part of the North Sea, which are all monitored by the Coast Guard. Using an advanced GPS tracker (AIS), professional vessels broadcast their status, such as position, time, and ship type. Operators need tools to detect anomalously behaving vessels in the live AIS signal to ensure safety and security.

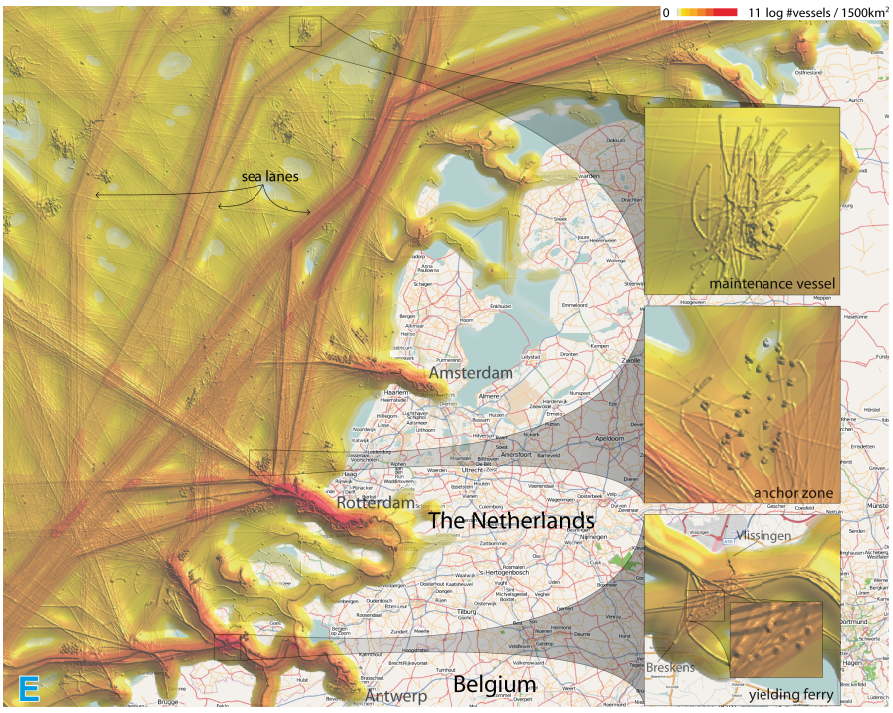
Future work

The visualization will be extended to display other dimensions of trajectory data. The expensive computation will be improved using a simplified model and graphics hardware. The method will cope with unreliable data: sources may pop up, drop down, send wrong data, or partially cover an area.

Computational model

Kernel density estimation (KDE) is a well-known method to find a nonparametric distribution of independent data points. We have adapted KDE to trajectories, which are sequences of dependent data points. Figure A displays the density of one line segment of a vessel that accelerates from $\mathbf{p}_0$ to $\mathbf{p}_1$. At the top, KDE is applied. At the bottom, the density is interpolated between data points, assuming a constant acceleration, and using a constant kernel size. Figure B displays live AIS data on top of color-coded vessel density of one day.





[1] Niels Willems, Huub van de Wetering, and Jarke J. van Wijk, Visualization of vessel movements, Computer Graphics Forum (Proceedings of EuroVis 2009), vol. 28, no. 3, p. 959-966, 2009

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