Python Modules for Marine Navigation
An alternative to GNSS

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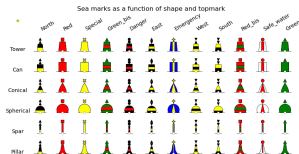

Sea marks as a function of shape and topmark

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Introduction: Alternative to GNSS

What are the alternatives to the
Global Navigation Satellite Systems
(GNSS)

- Celestial navigation
- **Visual-aided navigation**
- Navigation by signal of opportunity (radio, WiFi ...)
- Magnetic navigation
- Bathymetric navigation
- Inertial navigation (dead reckoning)
- ...
- Fusion of previously cited techniques

Introduction: Python module

Why Python?

- Python is used in many projects (machine learning, image recognition)
- lots of libraries (NumPy, Matplotlib, Cartopy, ...)
- No navigation tools (to my knowledge) available in Python

New modules

- to extend the set of markers used in Matplotlib with the nautical symbol
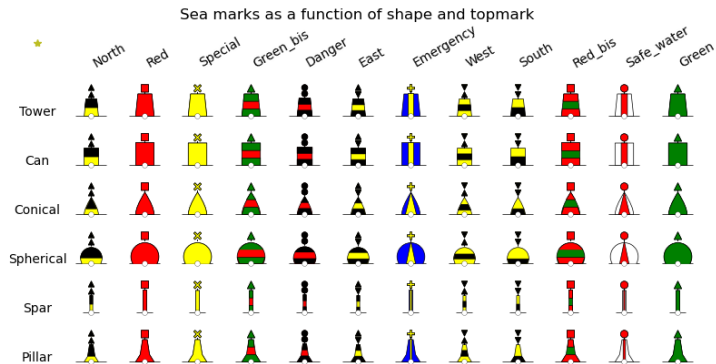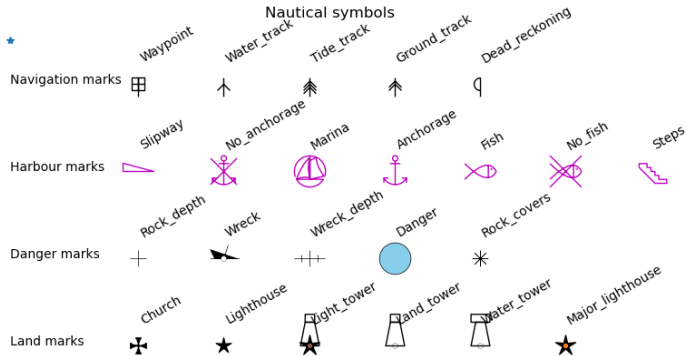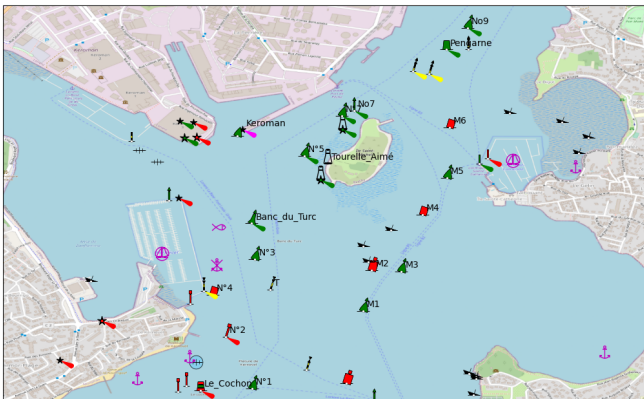- Navigation tools

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Figure: Sea marks for Matplotlib marker

Figure: Nautical symbols for Matplotlib marker

[1] From a CSV file; [2] "Rade de Lorient" from openseamap

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Traditional "cocked hat" 3LOP Fix

3LOP with hat
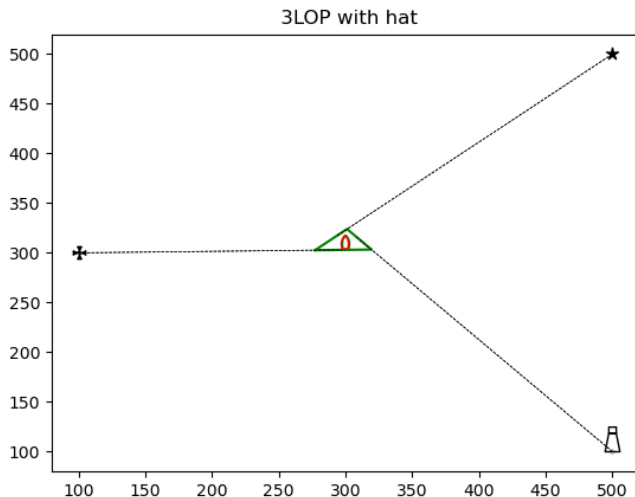
3LOP Fix with error bars [1]

3LOP with estimated error position

[1] David brush, "Notes on Bearing Accuracy"
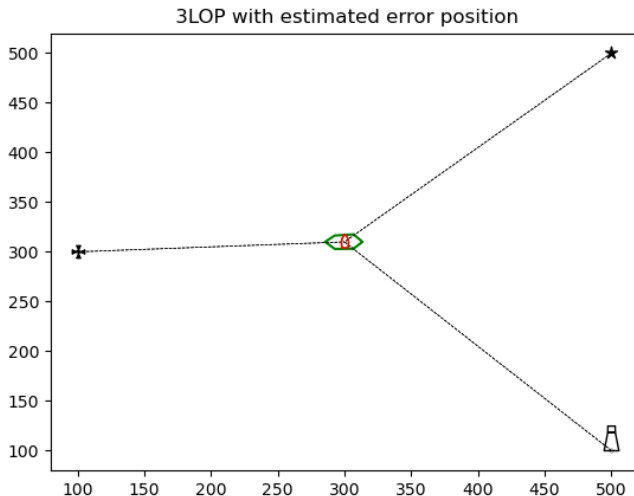
Figure: Traditional cocked hat

3 LOP position fix with hat

Figure: Error bar

3 LOP position fix with estimated error position
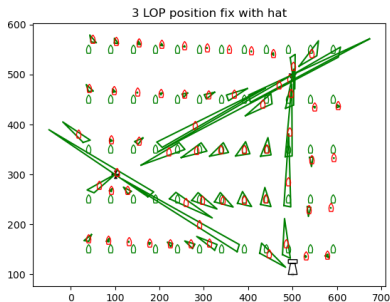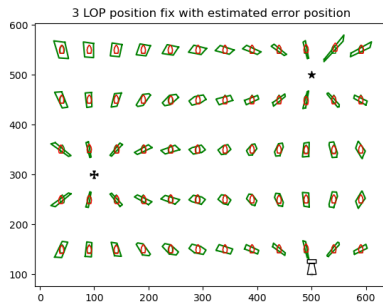
Select best 3LOP

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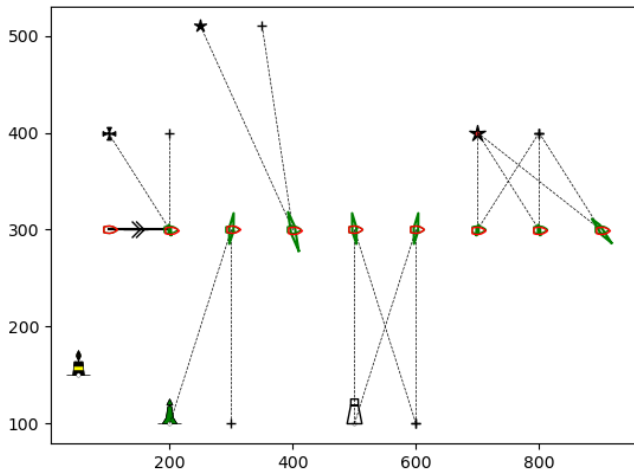
Running Fix

Running fix with select of mark closest to a 90-degree angle

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Course of steer

A course to steer is a method of calculating what heading the boat needs to be pointing at in order to get successfully to its way-point considering the effects of tide and leeway.

- $>>>$ Tide vector
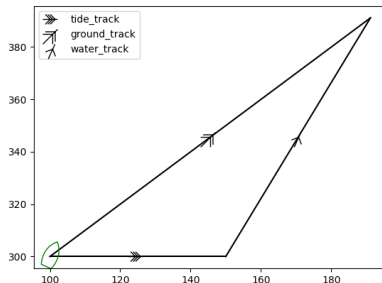- $>>$ Ground vector
- $>$ Water vector

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Waypoints

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Conclusion

Python modules for

- Nautical marks
  - Sea marks
  - Symbol marks
- Backend marine navigation
  - 3LOP fix
  - Running Fix
  - Course of steer
  - Waypoints
- Python modules available on GitHub
  - https://github.com/cedricomarchando/navigation

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Future work

- More nautical marks, add light period, improve graphic quality
- More maps, wrapper to use existing maps
- Unit choice and conversion (mph, knots, miles, km, ms ...)
- Wrapper to add existing mark positions, coastline, depth
- Nautical navigation front end (bearing, mark detection, etc.)
- Improve position estimate
- Add collision avoidance
- Add LOP with distance
- Add IMU, Kalman filter
- Fusion of position results
- Comparison with state-of-the-art
- Promotion, valorization, publication, license
- Add celestial navigation
- ...

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