

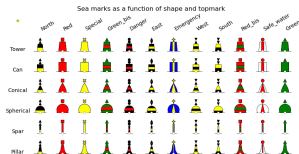
# Python Modules for Marine Navigation

## An alternative to GNSS

Cédric Marchand

Lab-STICC, Université de Bretagne Sud

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- 1 Introduction
- 2 Nautical Marks for Pyplot markers
- 3 Line of Position (LOP) Fix
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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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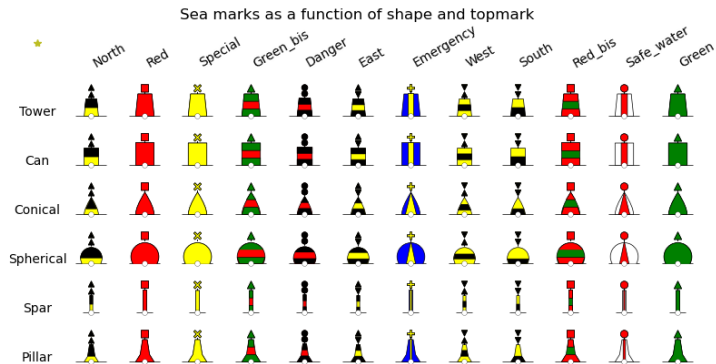


Figure: Sea marks for Matplotlib marker

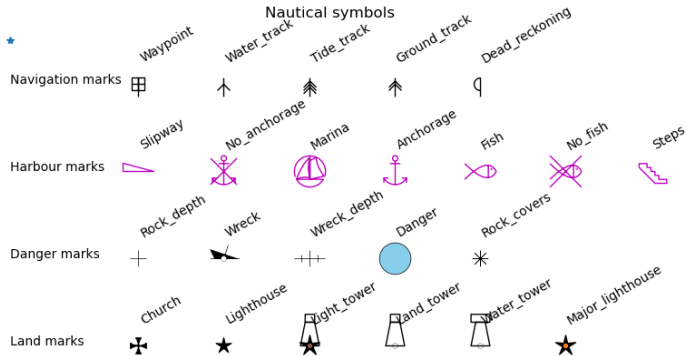
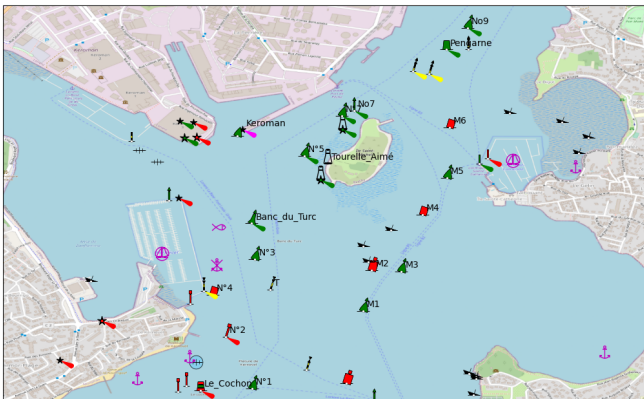


Figure: Nautical symbols for Matplotlib marker



# Marker on a map [1]

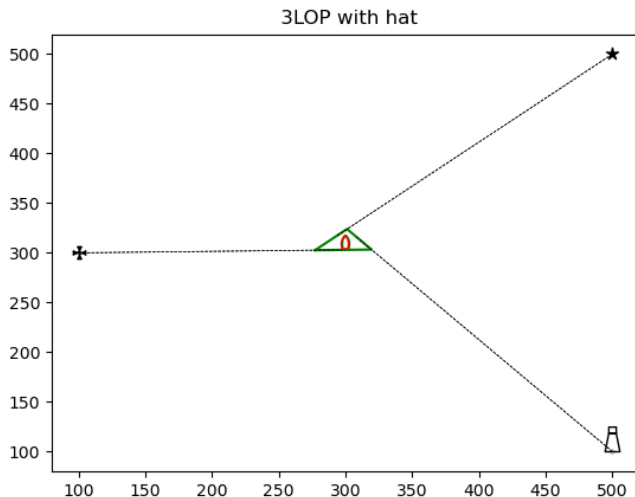


[1] openseamap

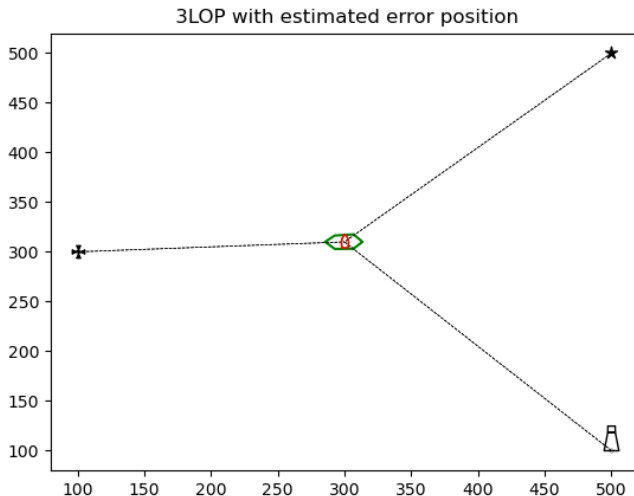
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# Traditional "cocked hat" 3LOP Fix



# 3LOP Fix with error bars [1]



# 3LOP Fix: "Cocked Hat" Versus "Error bars" fix

Figure: Traditional cocked hat

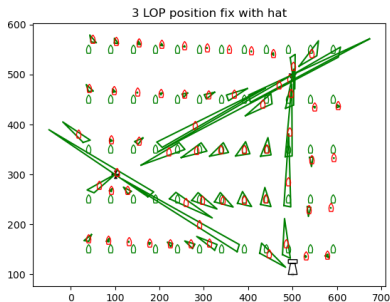
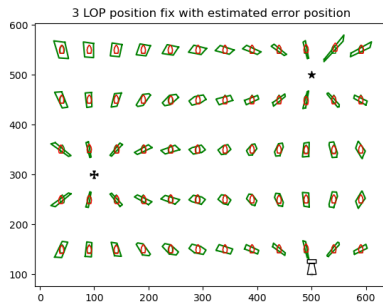
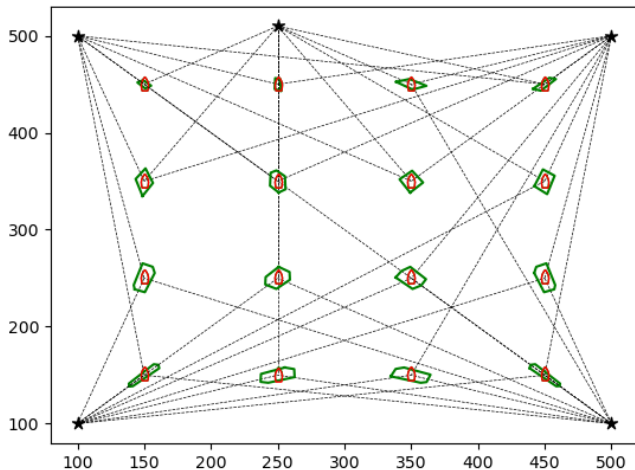


Figure: Error bar



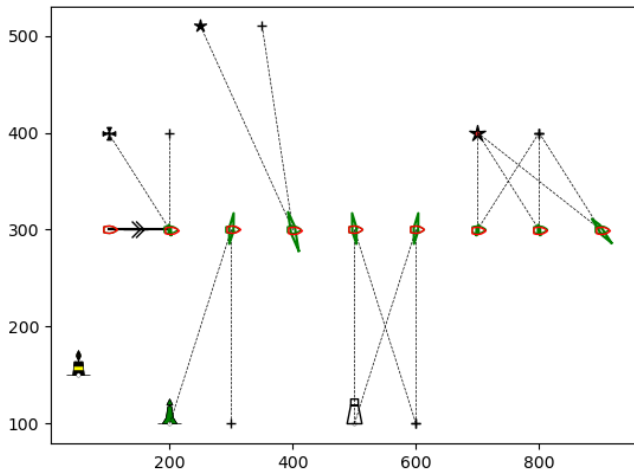
# Select best 3LOP



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# Running Fix



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



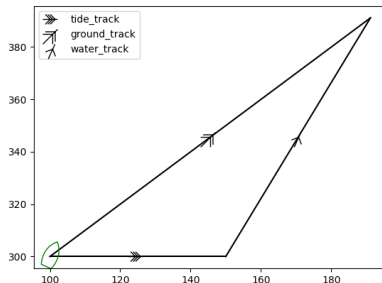
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# Course of steer

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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## 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
- Promotion, valorization, publication, license
- Add collision avoidance
- Fusion with IMU
- Comparison with state-of-the-art
- Back end for celestial navigation
- ...