

# Smoothing methods for ARGOS trajectories

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Projet long presentation

2015

# Projet Long

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- Project in collaboration with **CLS**
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- Project leader: Jérôme Combanière
- Project team:
  - Jérôme Combanière
  - Anthony Delannoy
  - Benoit Madiot



# Context

- Endangered species:
  - Leatherback turtles
  - Elephant seals
- ARGOS system → monitoring threatened species
- Creation of marine protected areas
- Matlab → Python

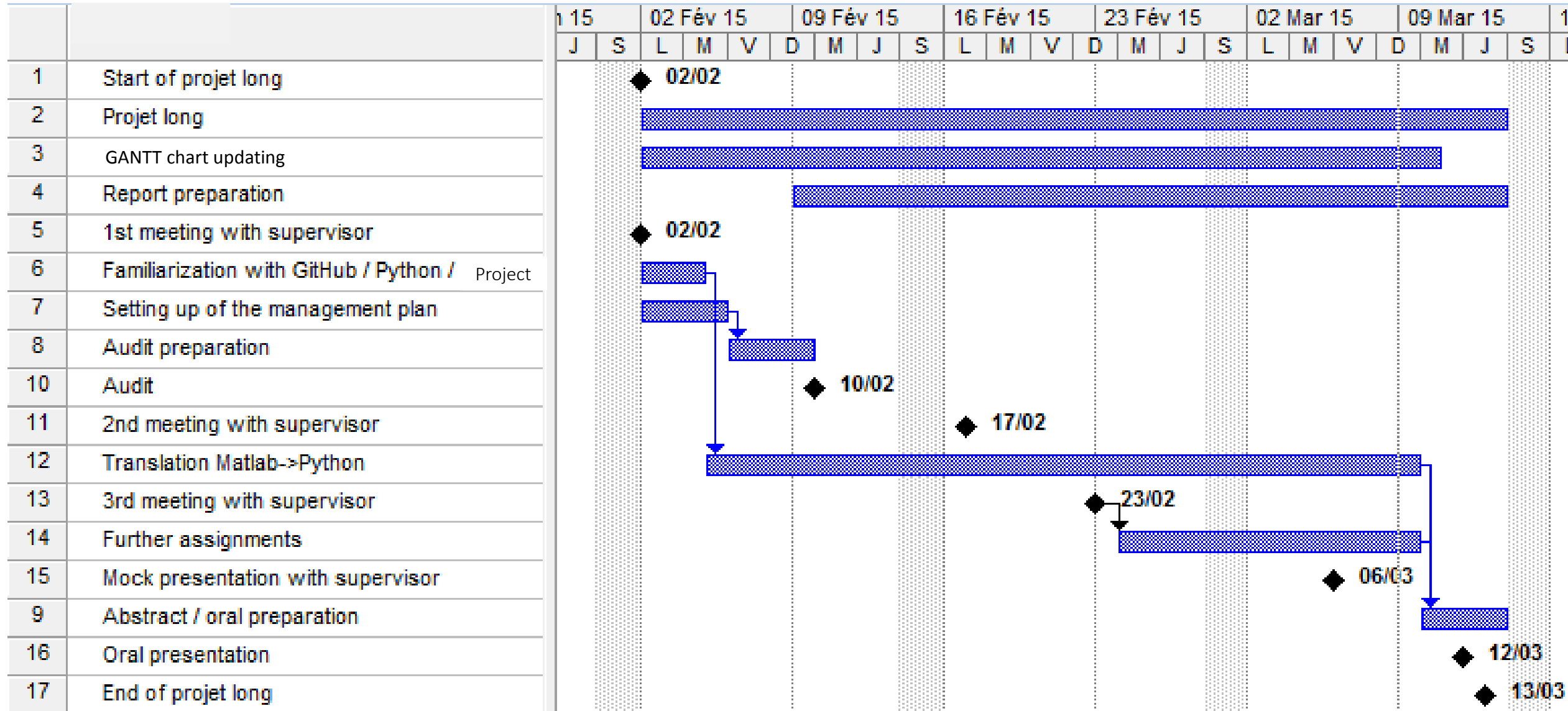


# Contents

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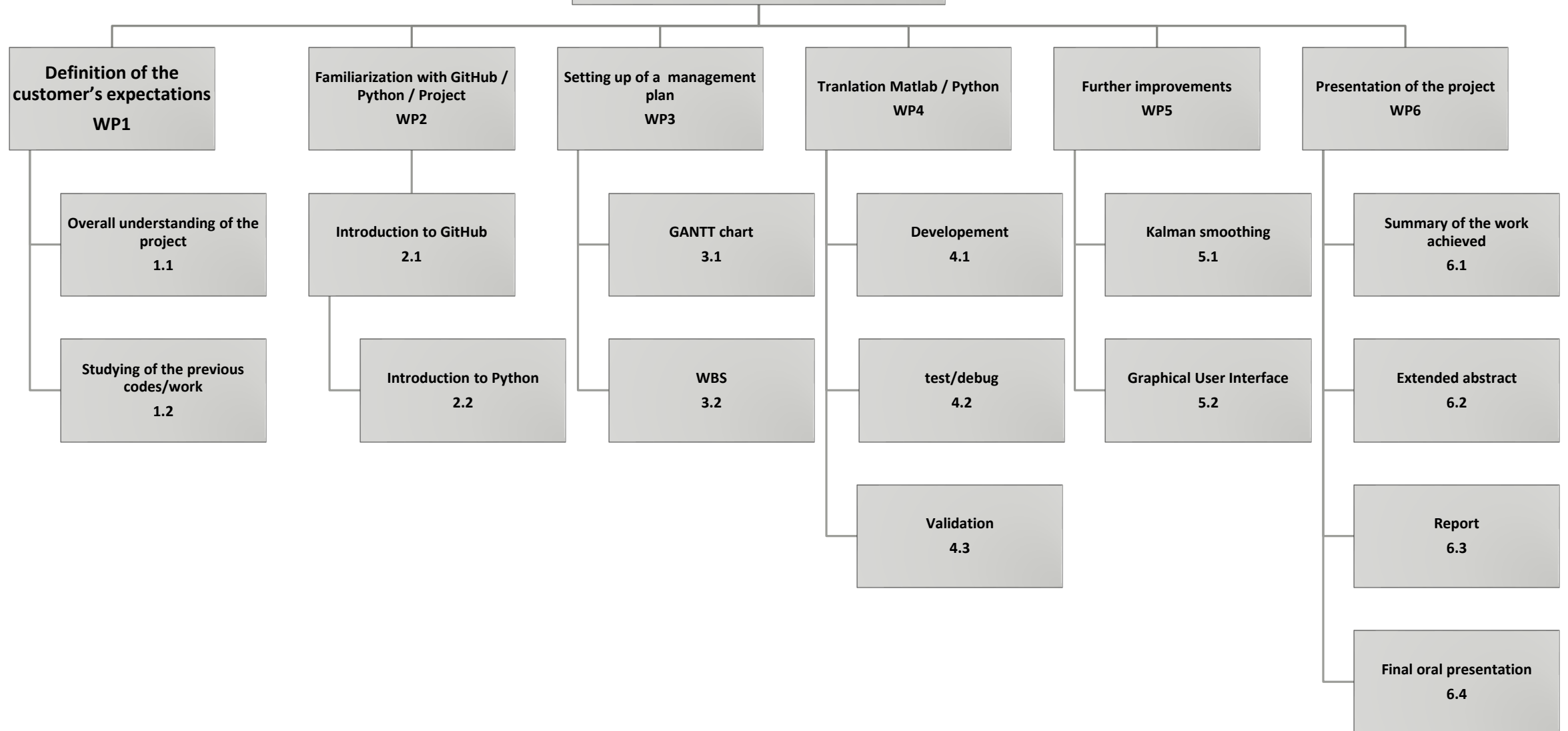
- Project management
- Graphical User Interface (GUI)
- ARGOS system
- Data extraction and common format
- Data processing
- Conclusion

# GANTT chart



# Smoothing methods for ARGOS trajectories

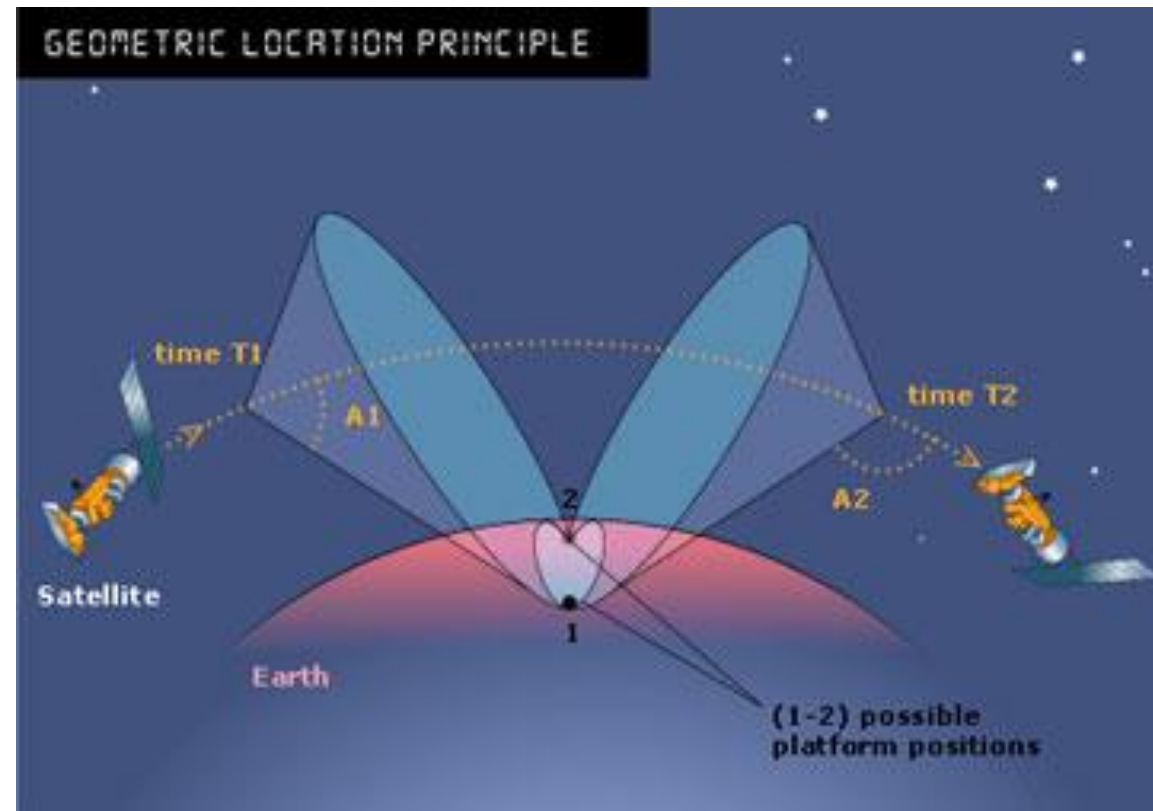
## Work breakdown structure



# Graphical User Interface (GUI)

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# ARGOS system





# Data extraction and common format

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- ARGOS data stored in three different file formats :
  - CSV
  - DIAG
  - DS
- One program to rule them all, one program to find them, one program to bring them all and in the format bind them
- The remaining format is a list of dictionary  $\left[ \text{dico}[1] \quad \text{dico}[2] \quad \dots \quad \text{dico}[n] \right]$

# Data extraction and common format

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- Each transmission data are stored in a dictionary with a unique keys structure

$$\left\{ \begin{array}{l} \text{"date"} \\ \text{"LC"} \\ \text{"lat"} \\ \text{"lon"} \\ \text{"lat\_image"} \\ \text{"lon\_image"} \end{array} \right\}$$

- Key "date" associates to another dictionary

$$\left\{ \begin{array}{l} \text{"annee"} \\ \text{"mois"} \\ \text{"jour"} \\ \text{"heure"} \\ \text{"min"} \\ \text{"sec"} \end{array} \right\}$$

# Data extraction and common format

- XML files contain parameters for smoothing methods and are specific to each species
- These parameters are also stored in a dictionary following XML reading.

```
<?xml version="1.0" encoding="utf-8"?>

<!-- Fichier avec les parametres par default -->
<parametres>
  <lovi>
    <!-- Vitesse maximal de la tortue en m/s-->
    <vitesse_max>2.8</vitesse_max>
  </lovi>
  <epan>
    <!-- pourcentage de points a conserver -->
    <ecart_max_pourcentage>95</ecart_max_pourcentage>
    <!-- intervalle en secondes pour l'estimation -->
    <periode>28800</periode>
    <!-- nombre minimal de points dans la fenetre pou l'estimation 1 -->
    <min_estim1>5</min_estim1>
    <!-- nombre minimal de points dans la fenetre pou l'estimation 2 -->
    <min_estim2>5</min_estim2>
    <!-- taille minimale de la demifenetre pour l'estimation 1 -->
    <demi_fenetre_min_estim1>43200</demi_fenetre_min_estim1>
    <!-- taille maximale de la demifenetre pour l'estimation 1 -->
    <demi_fenetre_max_estim1>86400</demi_fenetre_max_estim1>
    <!-- taille minimale de la demifenetre pour l'estimation 2 -->
    <demi_fenetre_min_estim2>86400</demi_fenetre_min_estim2>
    <!-- taille maximale de la demifenetre pour l'estimation 2 -->
    <demi_fenetre_max_estim2>86400</demi_fenetre_max_estim2>
    <!-- nombre miniale de points pour la demifenetre pour l'estimation 1 -->
    <nb_pt_demi_fenetre_estim1>2</nb_pt_demi_fenetre_estim1>
    <!-- nombre miniale de points pour la demifenetre pour l'estimation 2 -->
    <nb_pt_demi_fenetre_estim2>2</nb_pt_demi_fenetre_estim2>
  </epan>
</parametres>
```

# Data processing

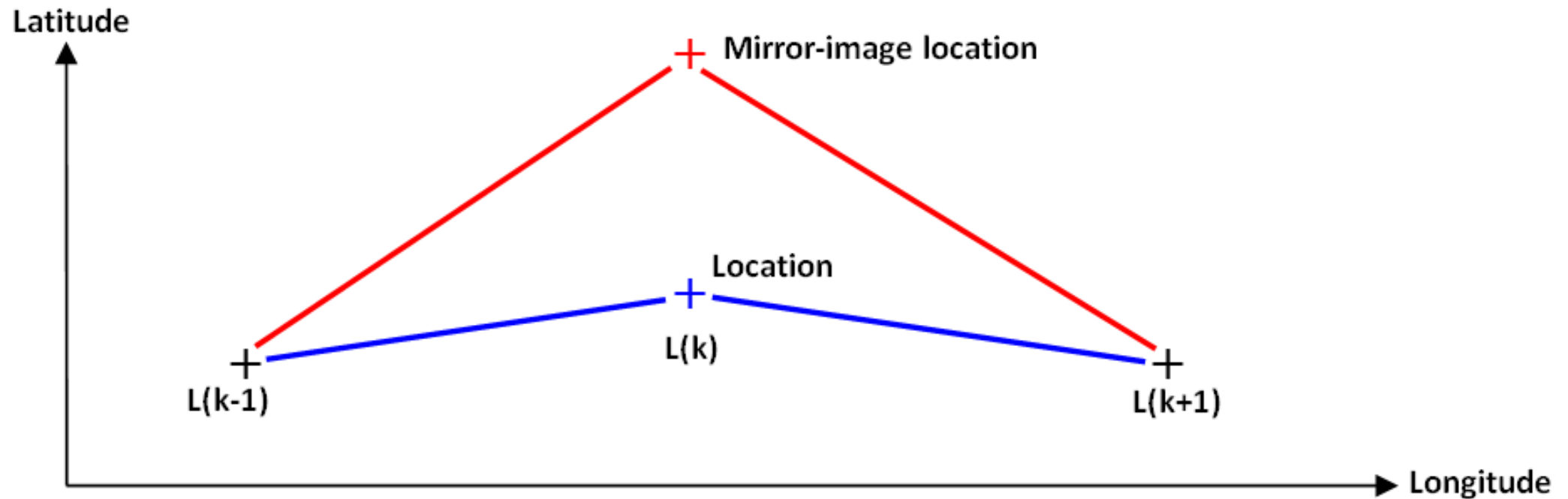
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# Preprocessing

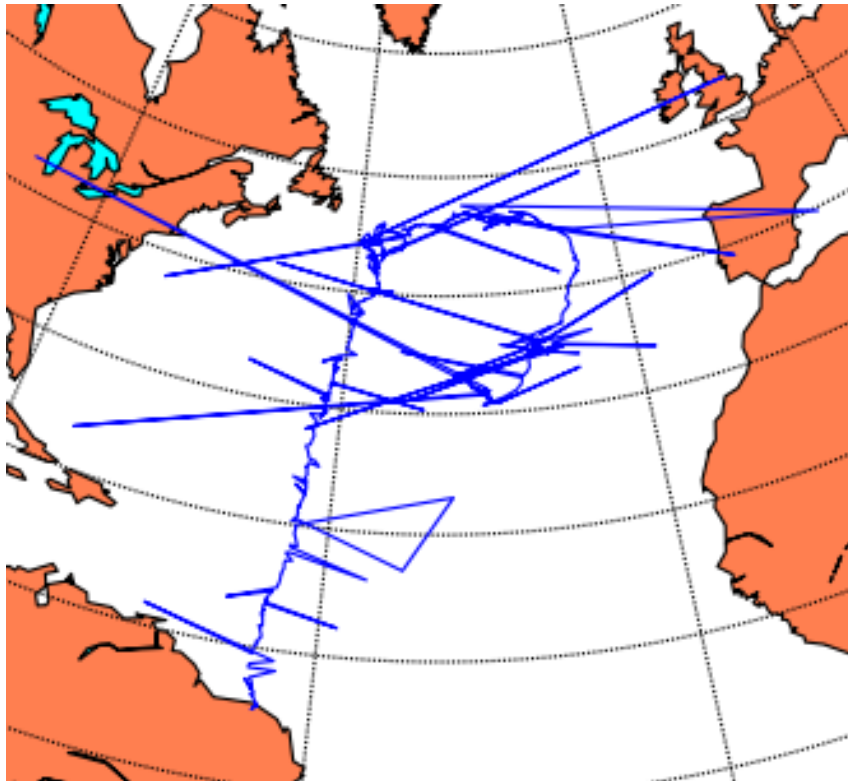
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CHOICE OF LOCATION

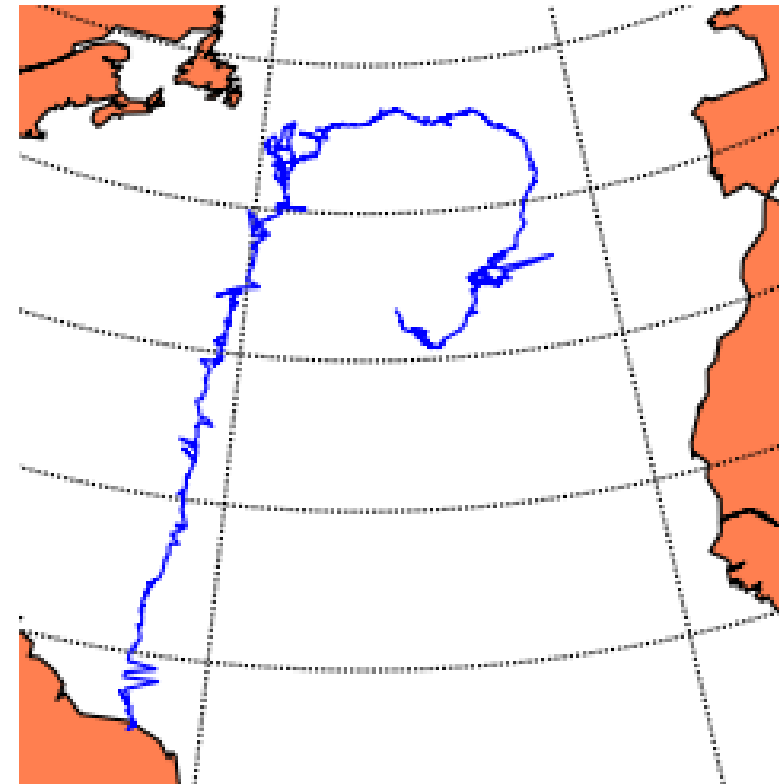
# Choice of location



# Choice of location



Raw data



Data preprocessed with correction of location

# Preprocessing

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DELETION OF EXCESSIVE SPEED

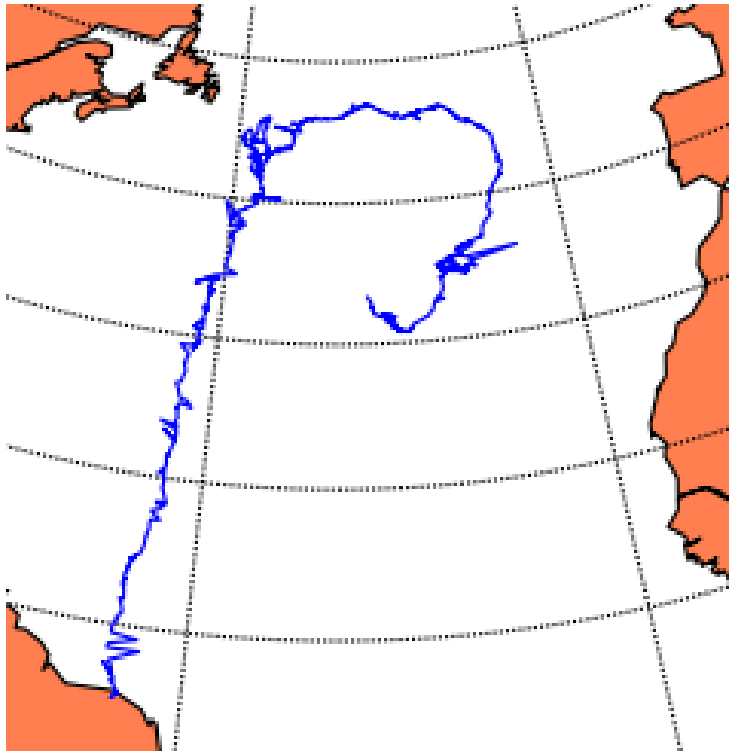


# Deletion of excessive speed

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- Computation of speed between two points
- Criteria of precision of the location
- Comparison with the specie's maximal speed

# Deletion of excessive speed



Data before deletion of  
excessive speed



Data after deletion of excessive  
speed

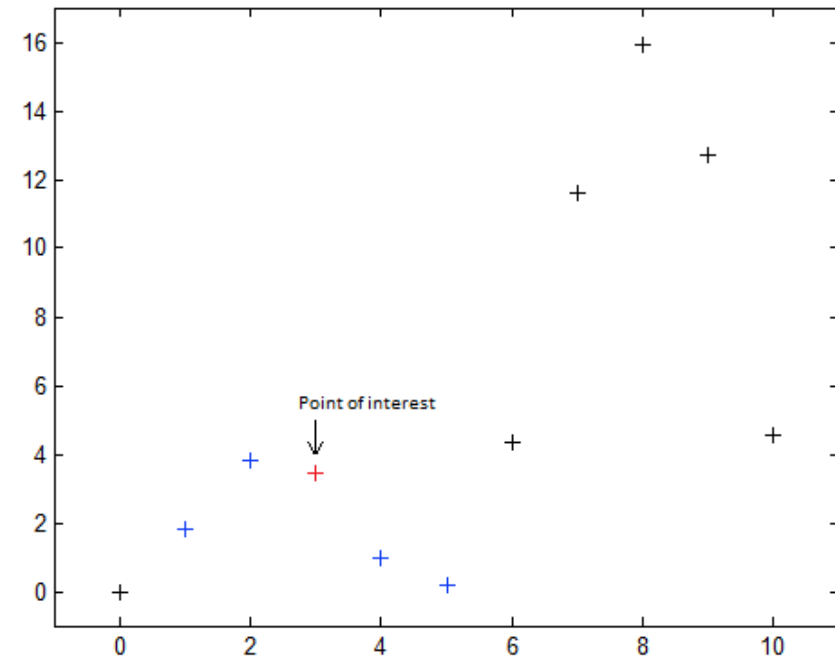
# Data processing

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- Here you estimate one position as the weighted sum of the two previous, current and two following positions

2 different weights :

- one from the kernel
- one from the quality of the ARGOS localization

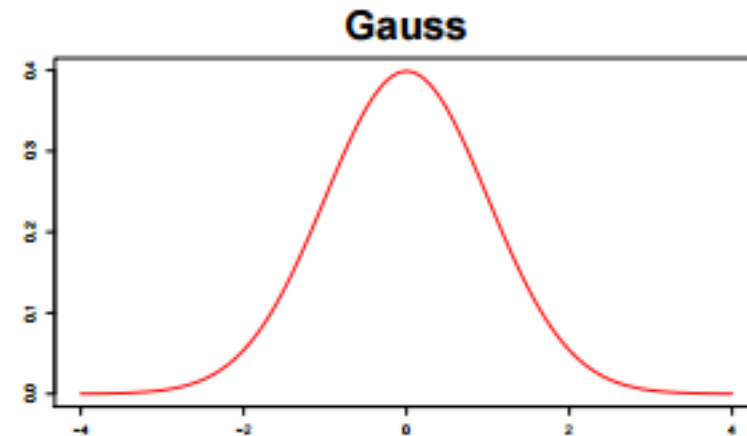
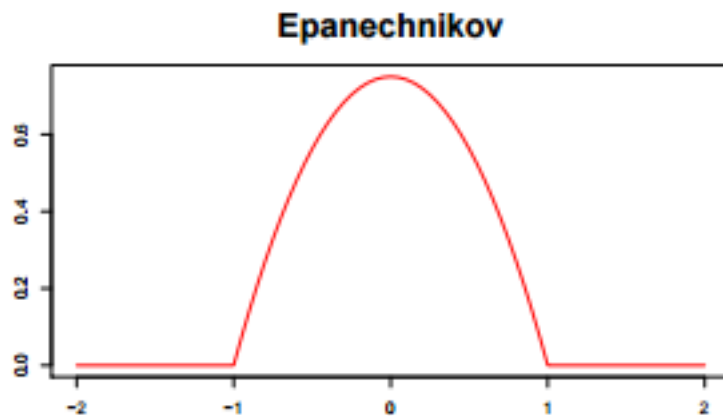


# Data processing

- Adaptable size of the support of the epanechnikov kernel :

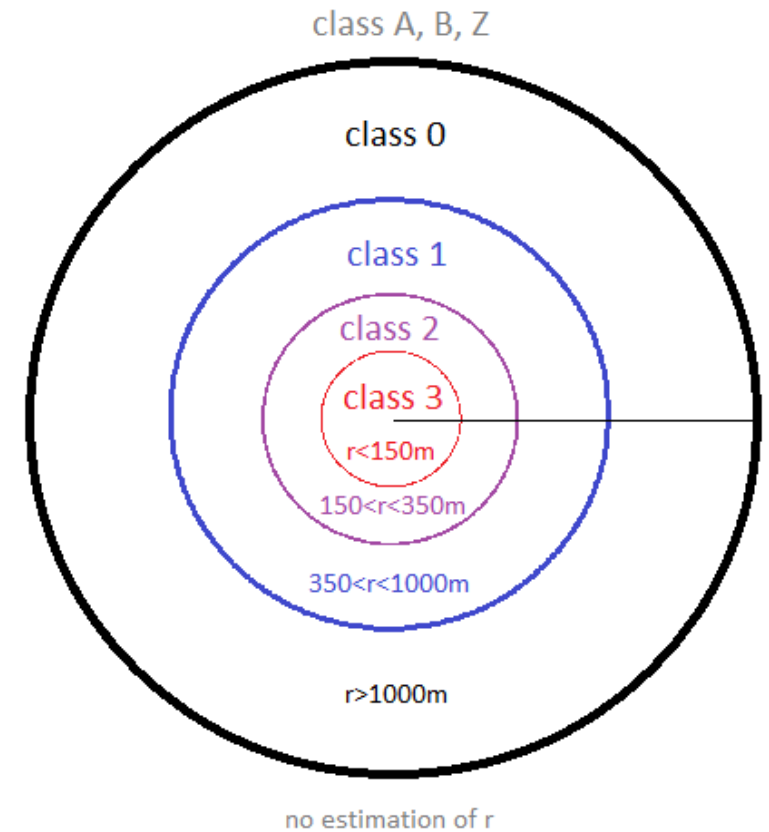
$$\frac{3}{4h} \cdot \left(1 - \frac{x^2}{h}\right) \text{ with } 2h = \text{size of the support}$$

- Epanechnikov kernel minimizes AMISE (Asymptotic Mean Integrated Squared Error) and is therefore optimal.



# Data processing

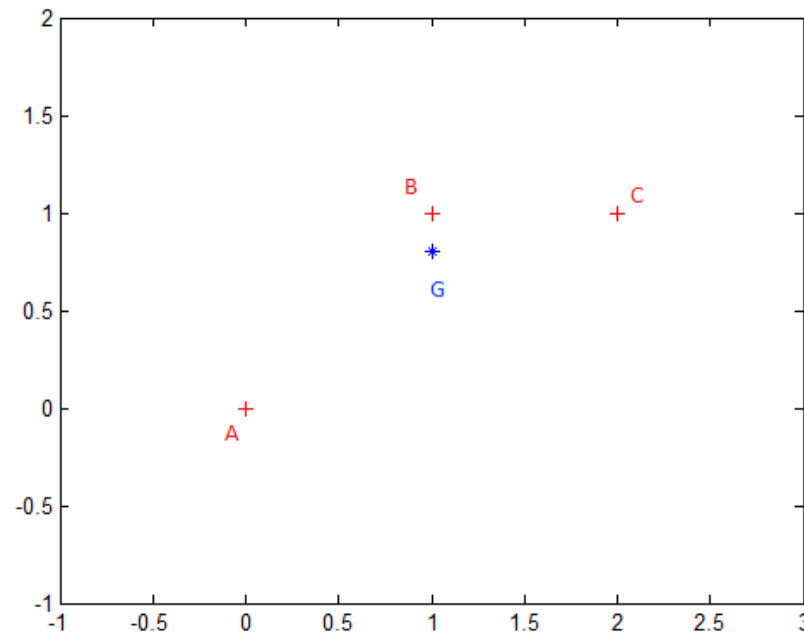
- The weights increase as the precision of measurement increases



# Data processing

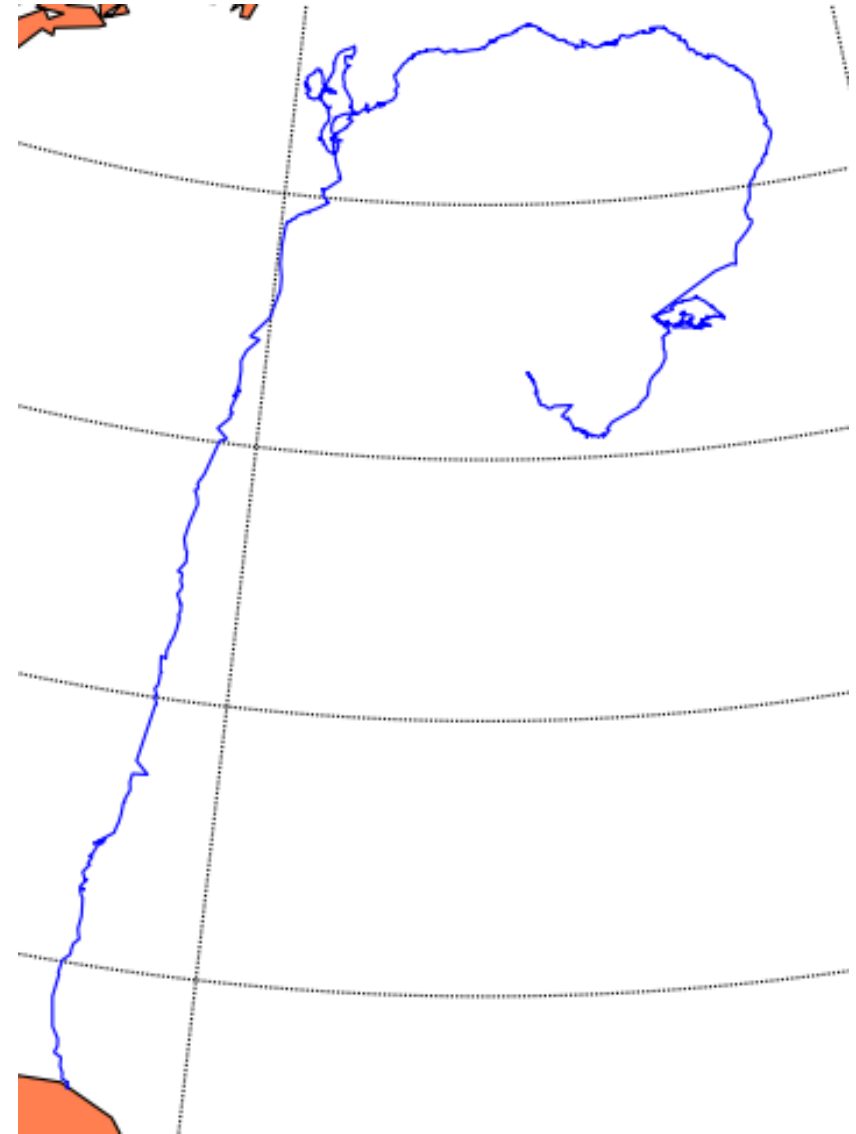
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If the estimated position is too far from the ARGOS position, this position is removed





Trajectory before the estimation



Trajectory with an Epanechnikov kernel



Trajectory before the estimation

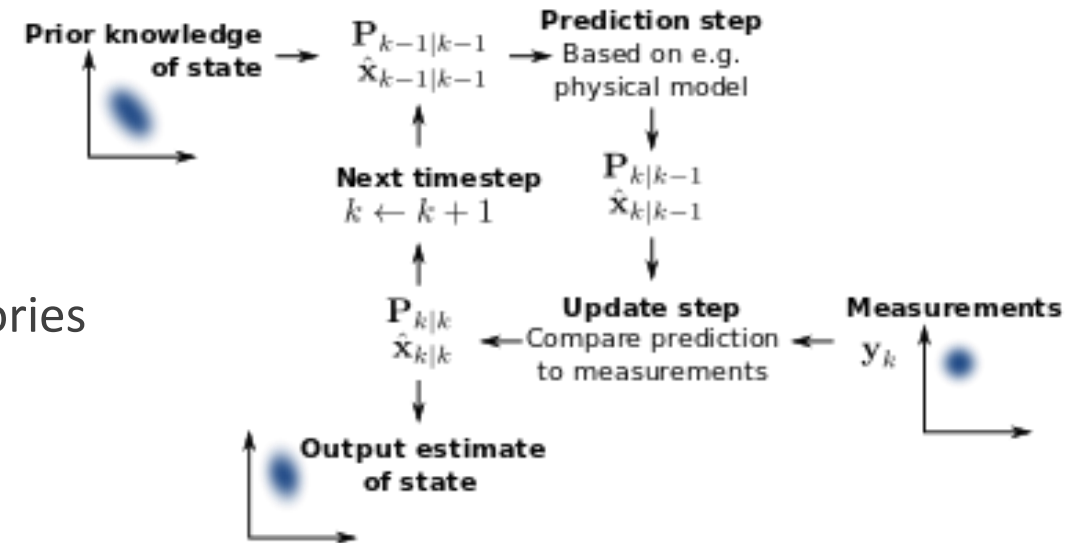


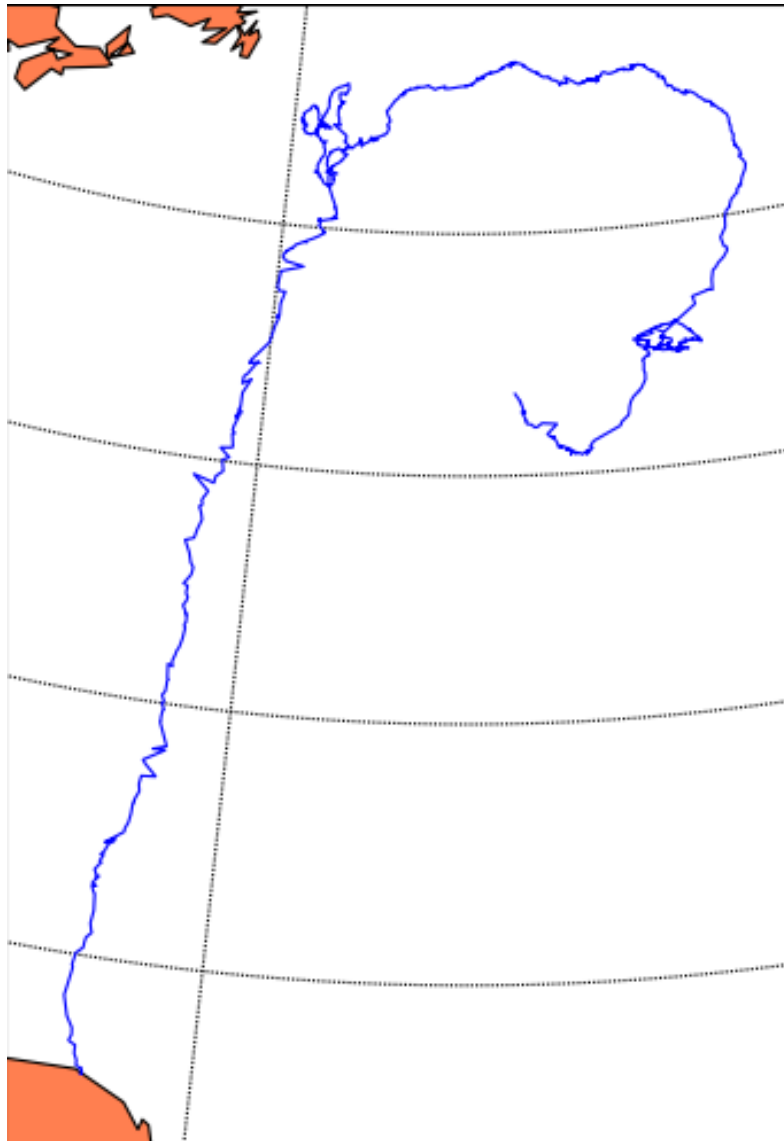
Trajectory with a Gaussian kernel



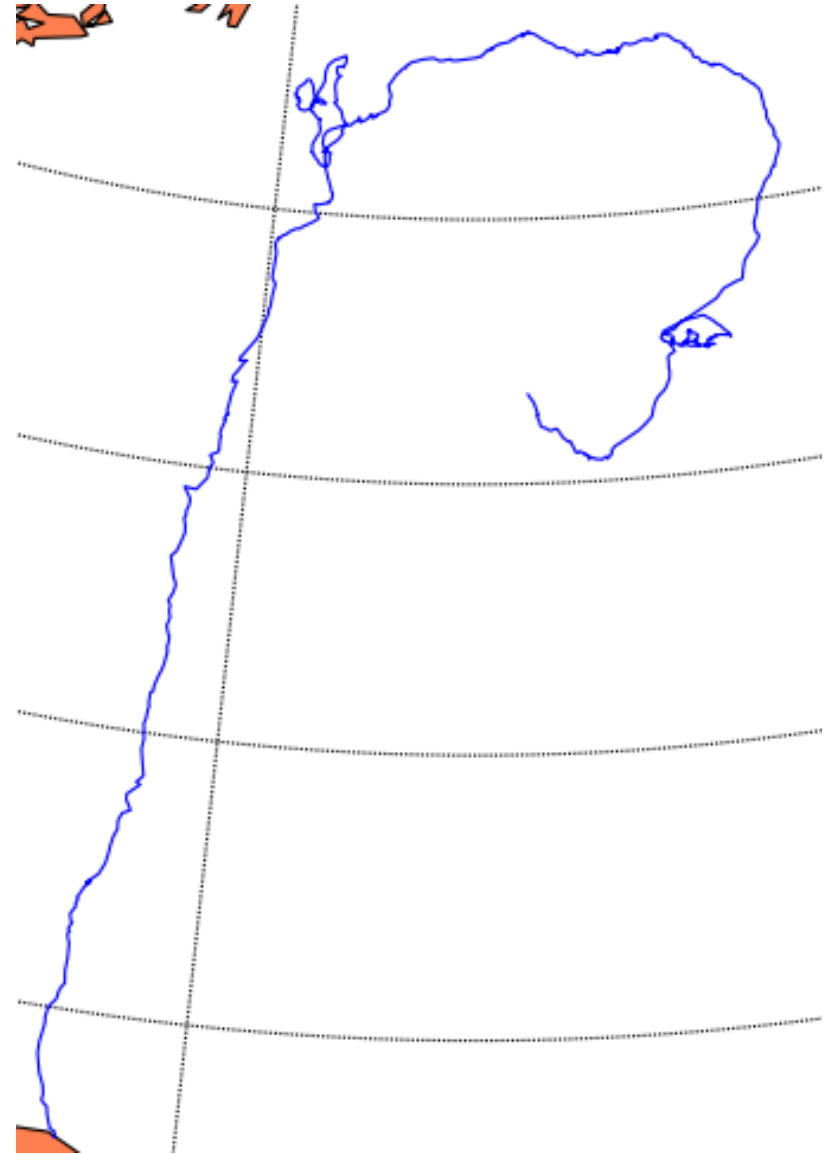
# Kalman smoothing

- An EM algorithm estimates the transition matrix
- Use of all the data in order to smooth the trajectories





Trajectory before Kalman smoothing

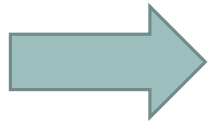


Trajectory after Kalman smoothing

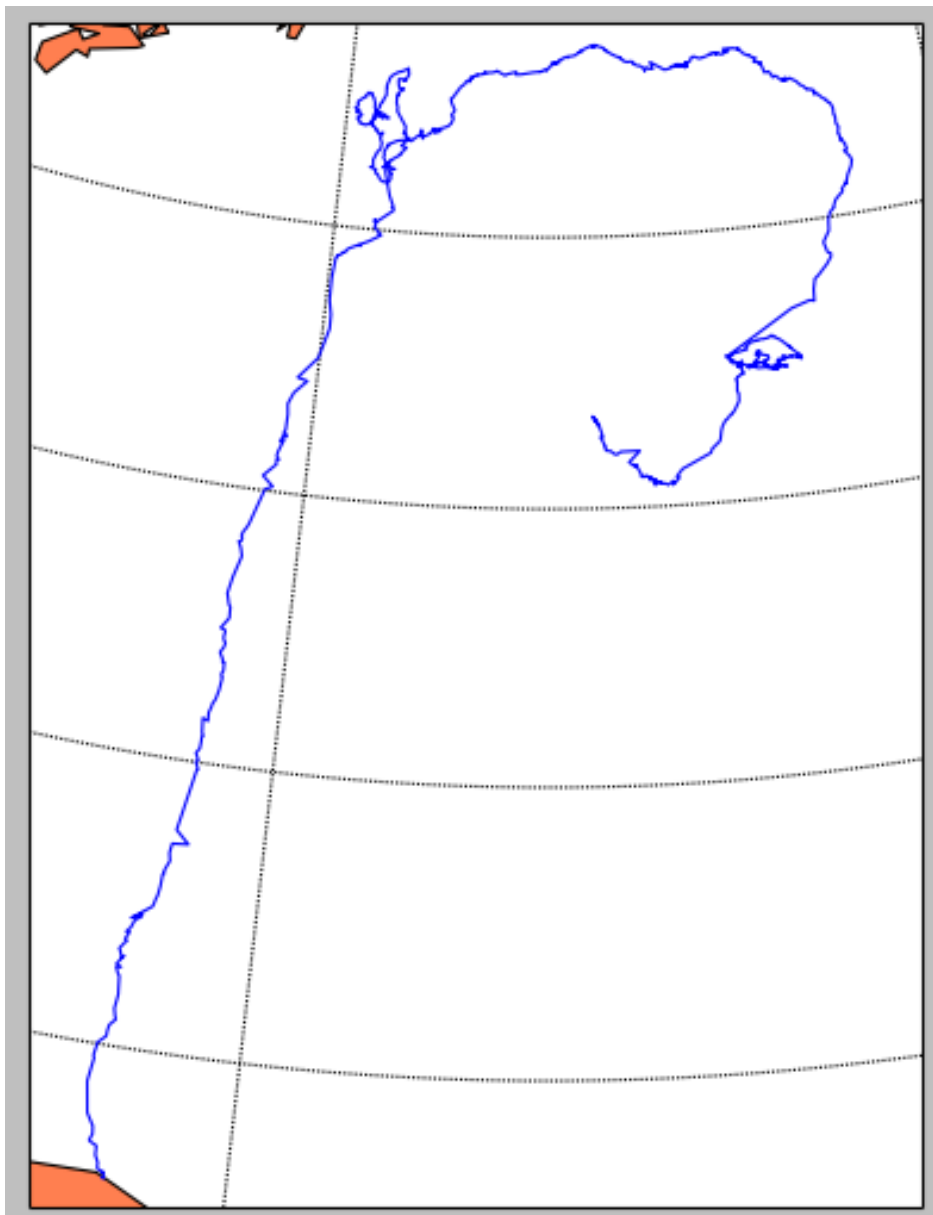
# 2<sup>nd</sup> estimation

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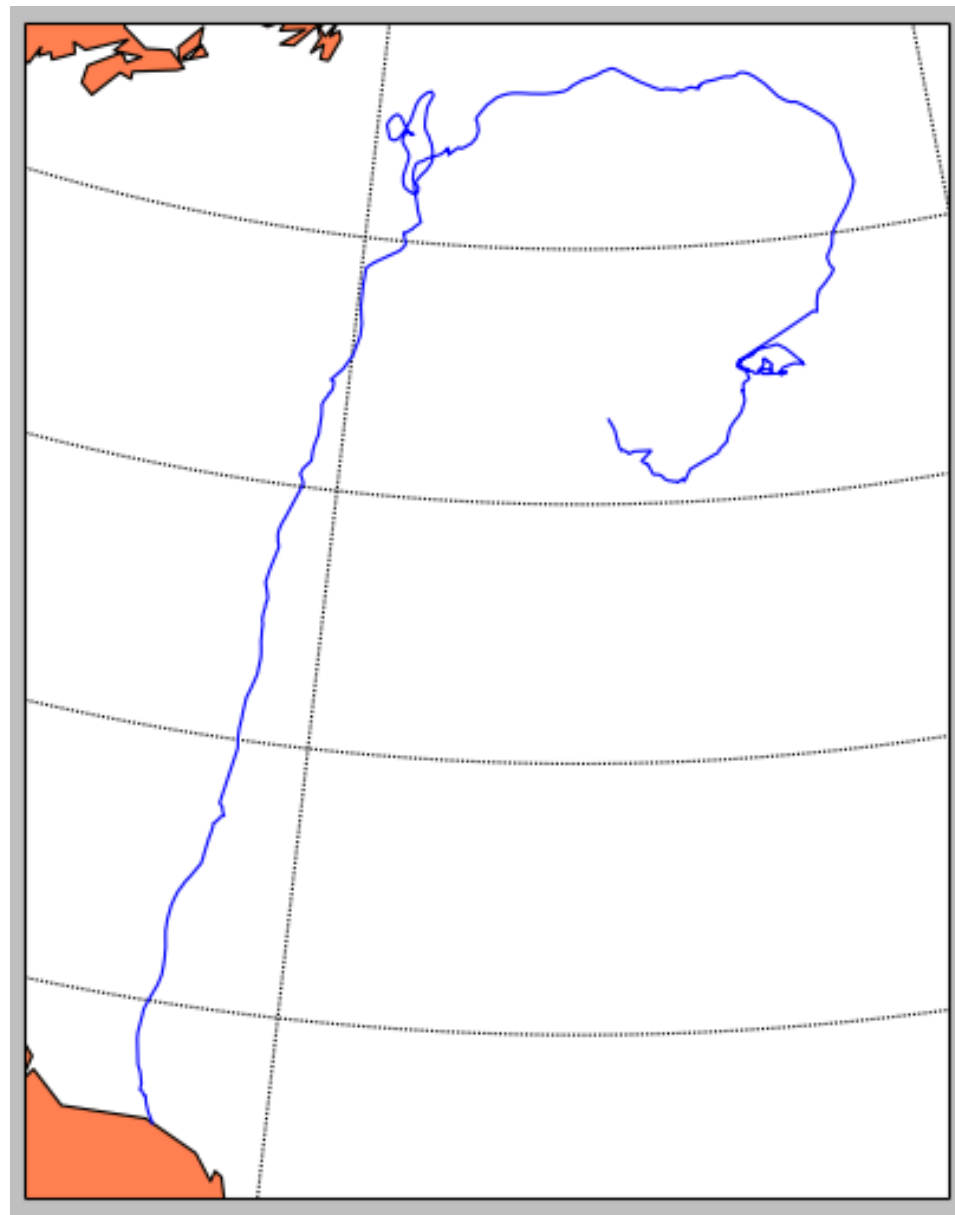
- Linear regression
- Resampling trajectory



Points spaced with a constant time step size



Output without the 2<sup>nd</sup> estimation



Output with the 2<sup>nd</sup> estimation

# Conclusion

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- Efficient and reliable algorithms
- Work achieve intends to monitor endangered species
- Trajectories can be plotted and exploited using the GUI
- Further improvements:
  - Comparison with GPS data
  - Handle new ARGOS data