

Smoothing methods for ARGOS trajectories

Projet long presentation

2015

Projet Long

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



Context

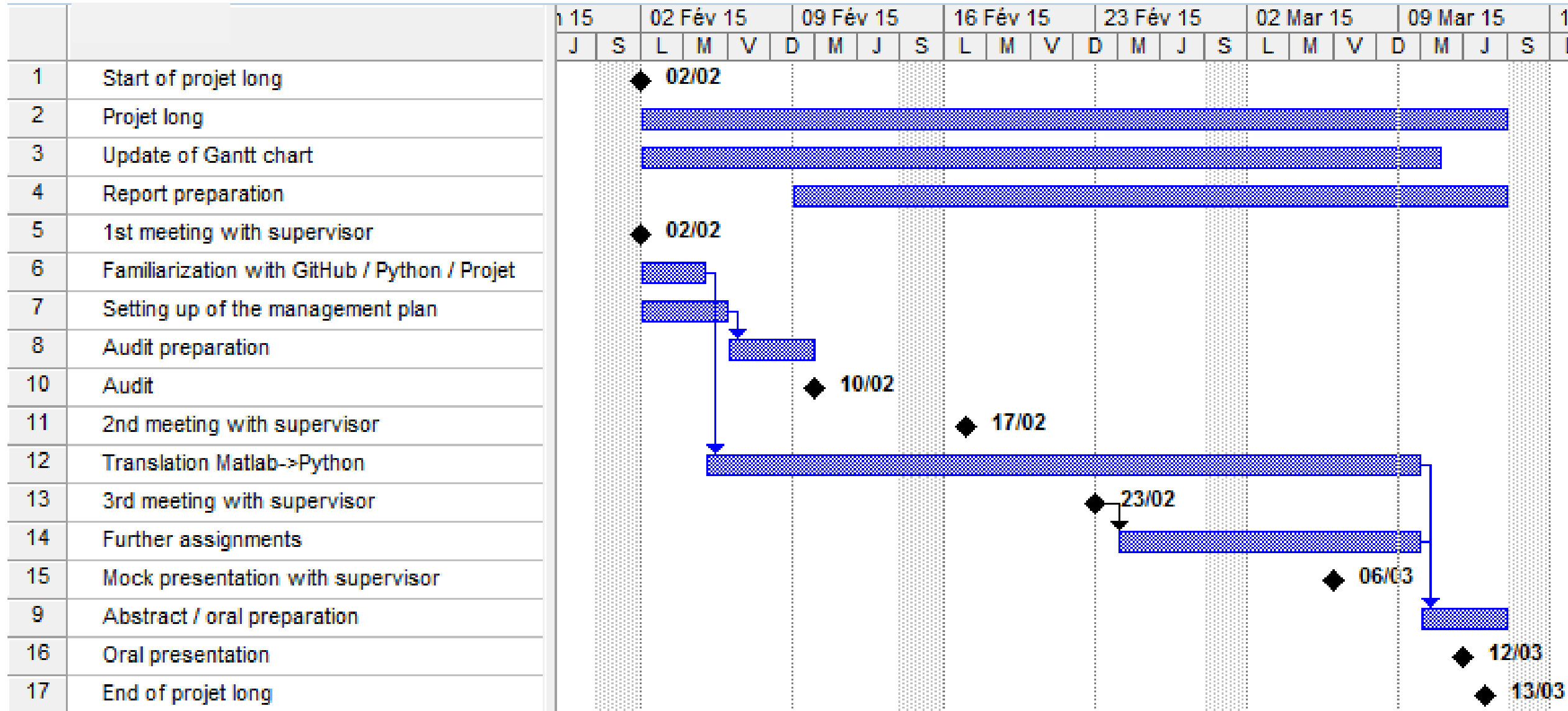
- Endangered species:
 - Leatherback turtles
 - Elephant seals
- ARGOS system → monitoring threatened species
- Creation of marine protected areas
- Matlab → Python



Contents

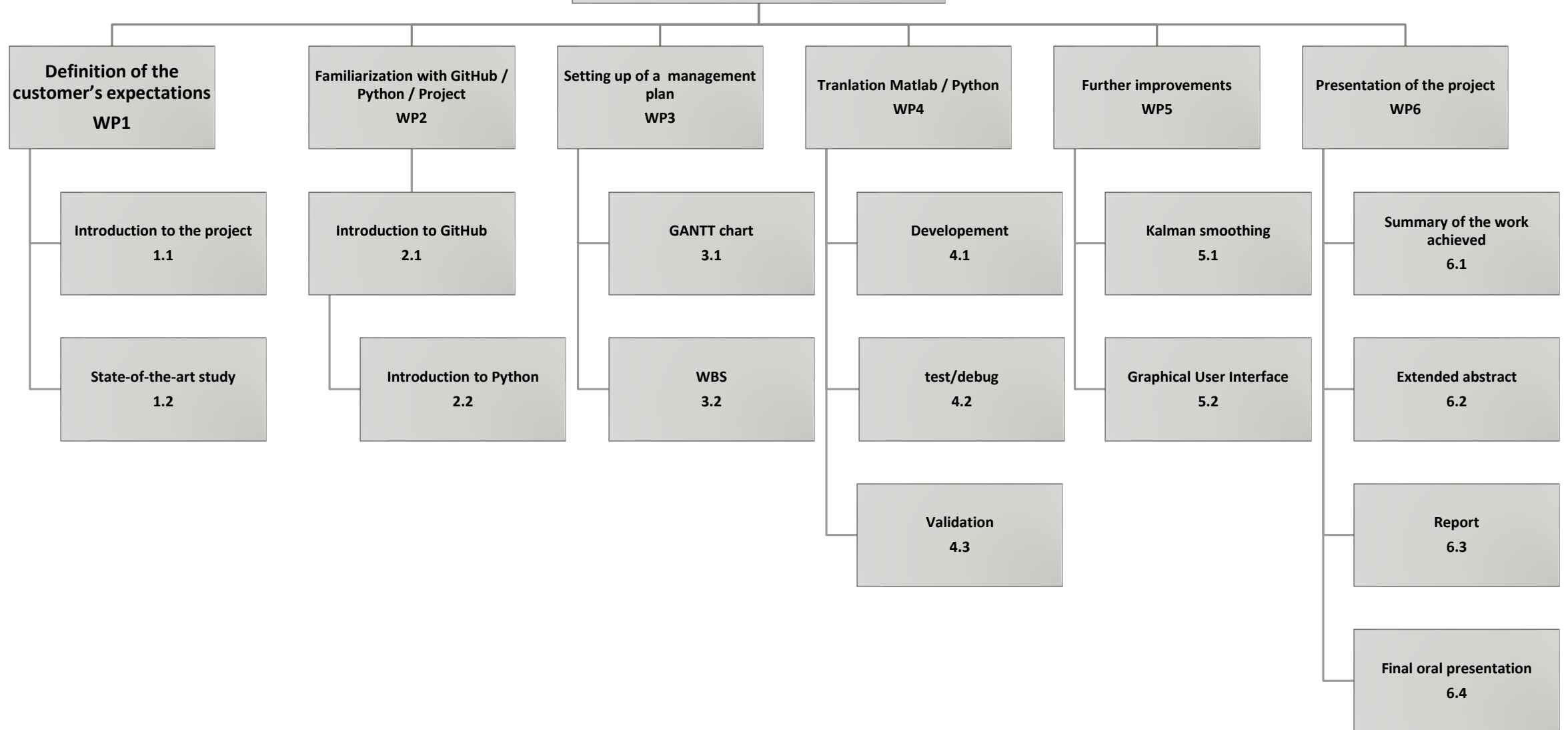
- Project management
- Graphical User Interface (GUI)
- ARGOS system
- Data extraction and common format
- Data processing
- Conclusion

GANTT chart



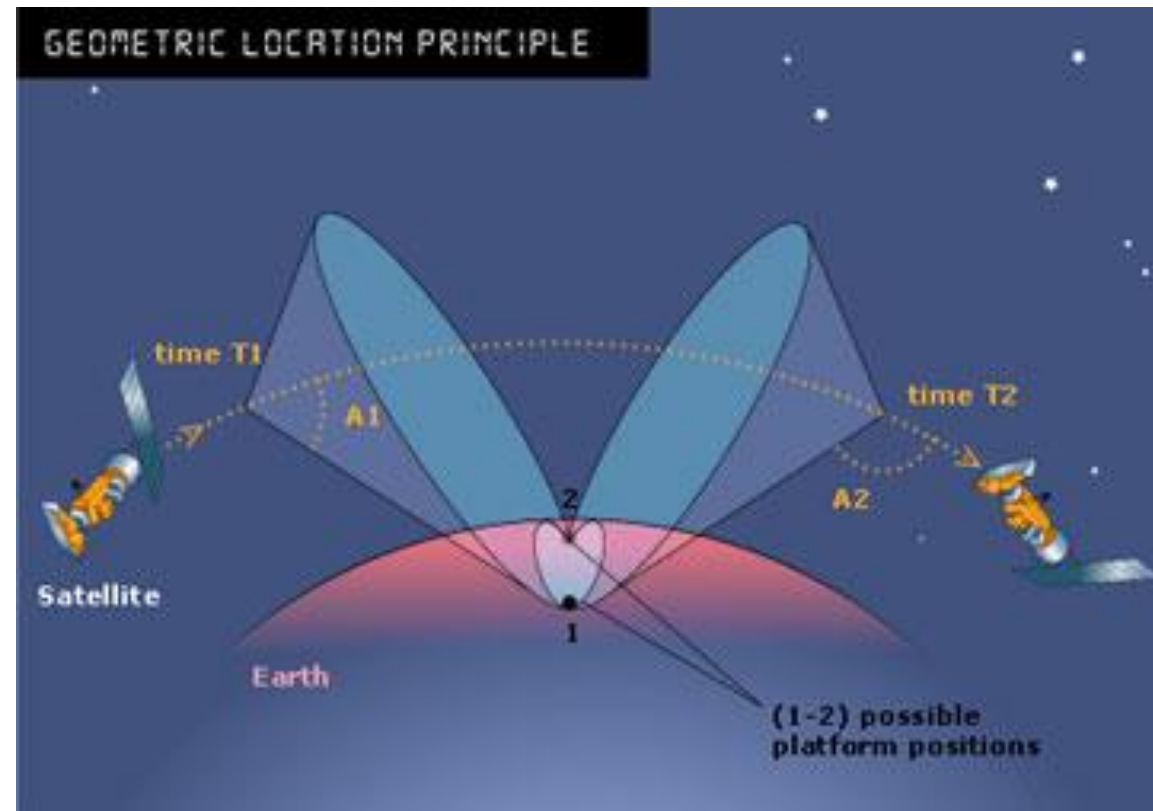
Smoothing methods for ARGOS trajectories

Work breakdown structure



Graphical User Interface (GUI)

ARGOS system



Data extraction and common format

- 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

- 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"?>

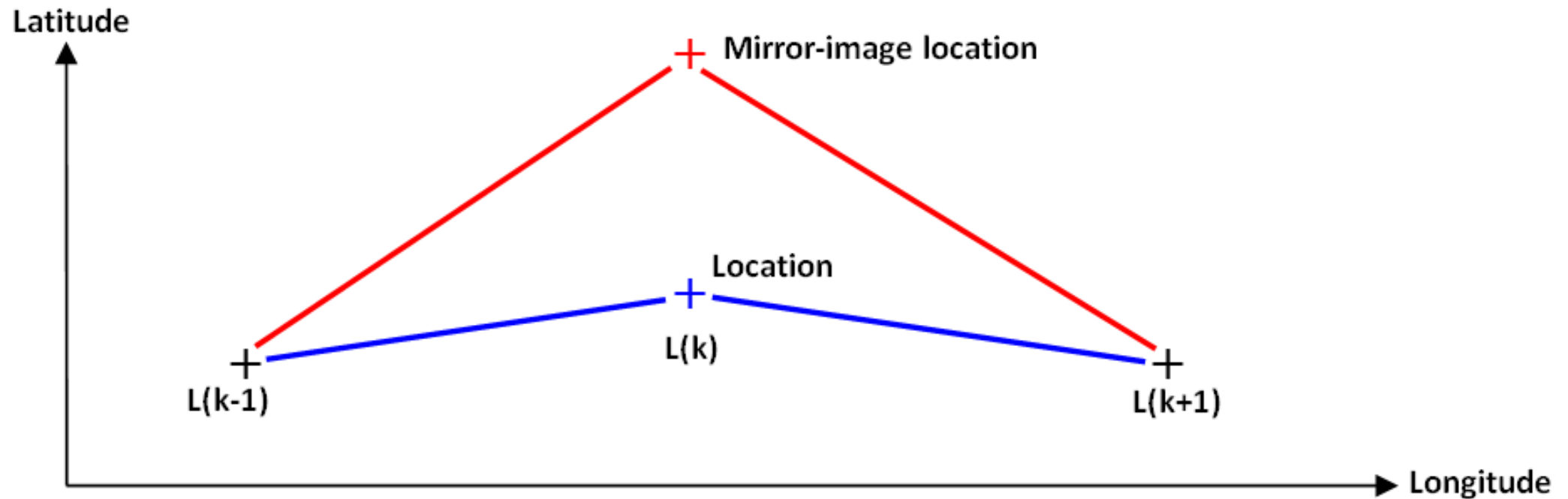
<!-- Fichier avec les parametres par default -->
<parametres>
  <lovi>
    <!-- Vitesse maximal de la tortue en m/s-->
    <vitesse_max>2.8</vitesse_max>
  </lovi>
  <epan>
    <!-- pourcentage de points a conserver -->
    <ecart_max_pourcentage>95</ecart_max_pourcentage>
    <!-- intervalle en secondes 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

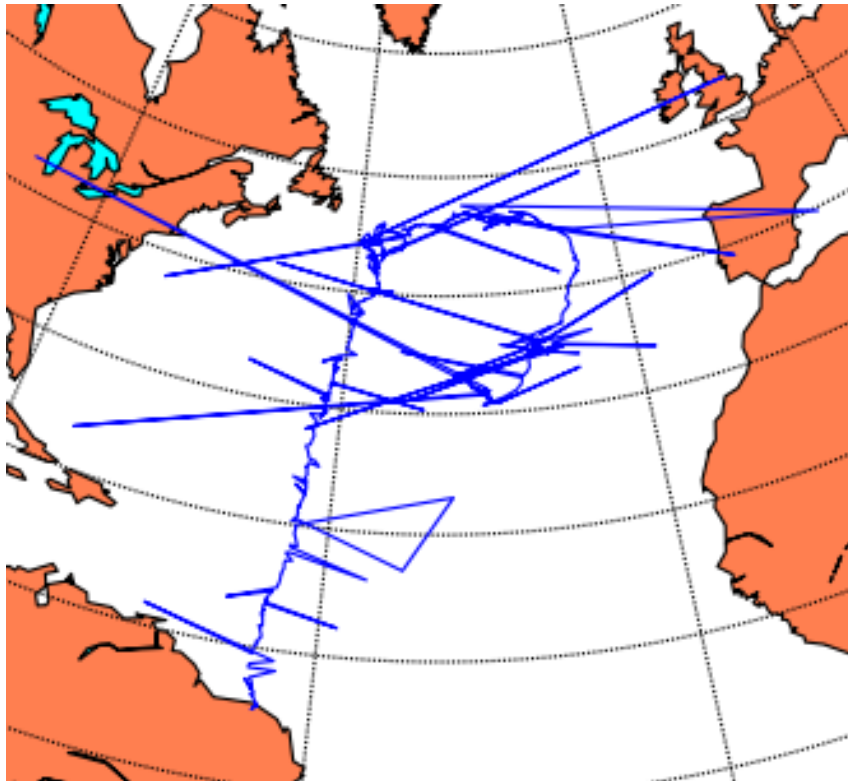
Preprocessing

CHOICE OF LOCATION

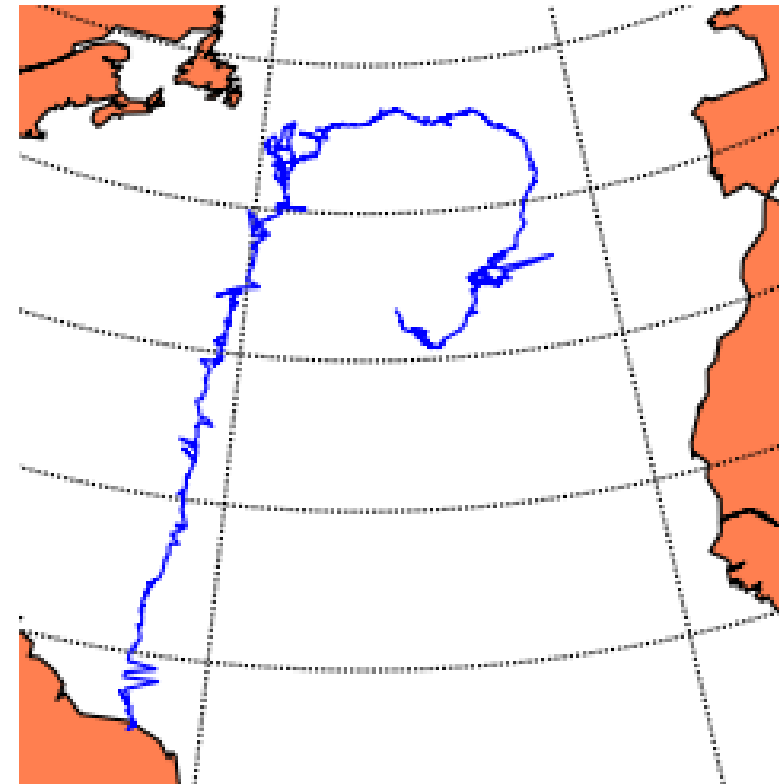
Choice of location



Choice of location



Raw data



Data preprocessed with correction of location

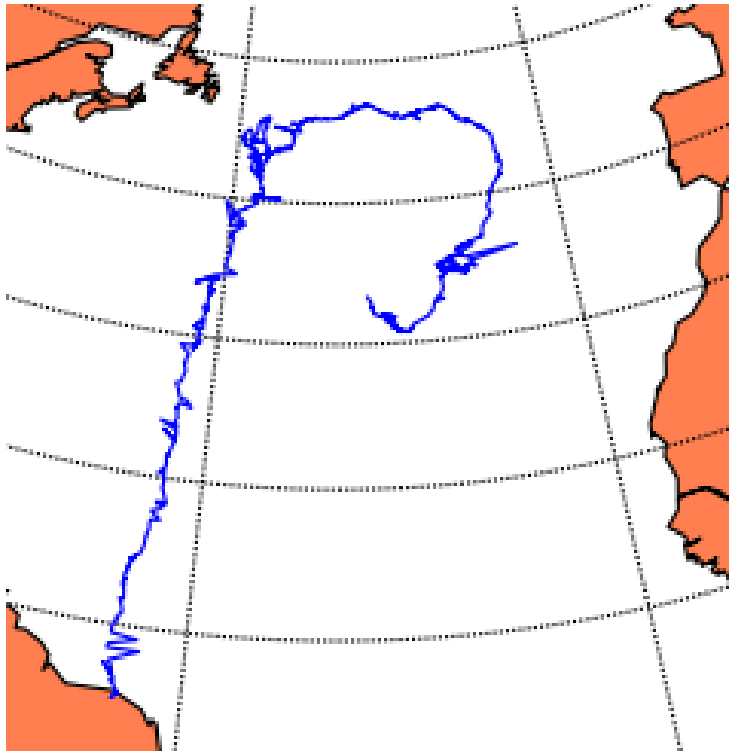
Preprocessing

DELETION OF EXCESSIVE SPEED

Deletion of excessive speed

- 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



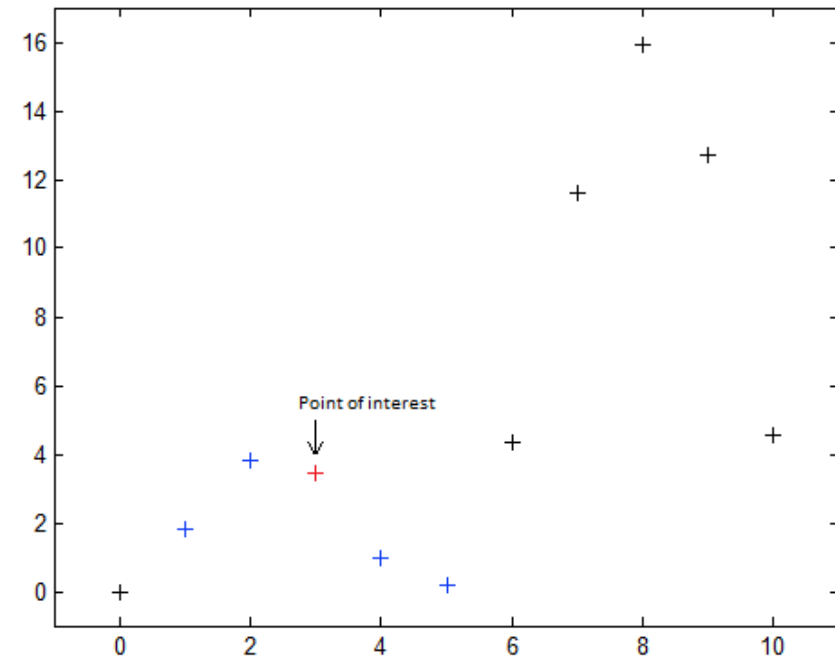
Data after deletion of excessive
speed

Data processing

- 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

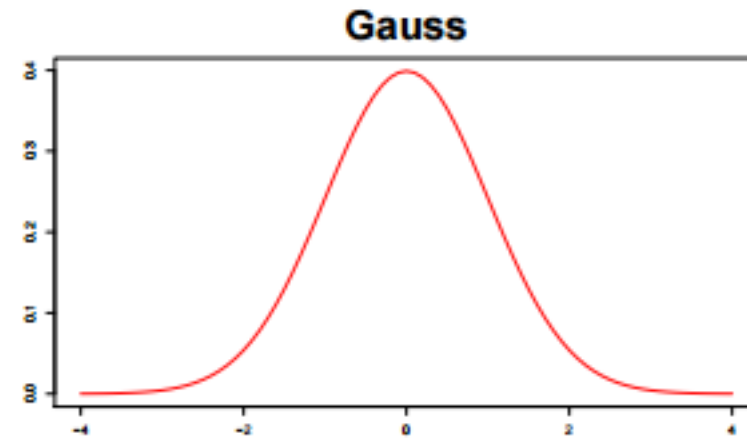
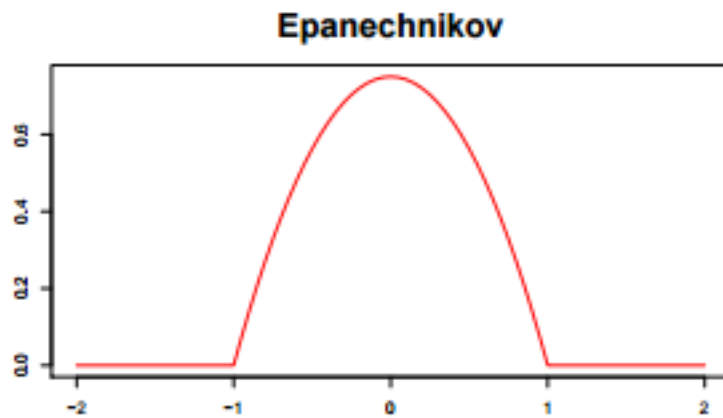


Data processing

- Adaptable size of the support of the epanechnikov kernel :

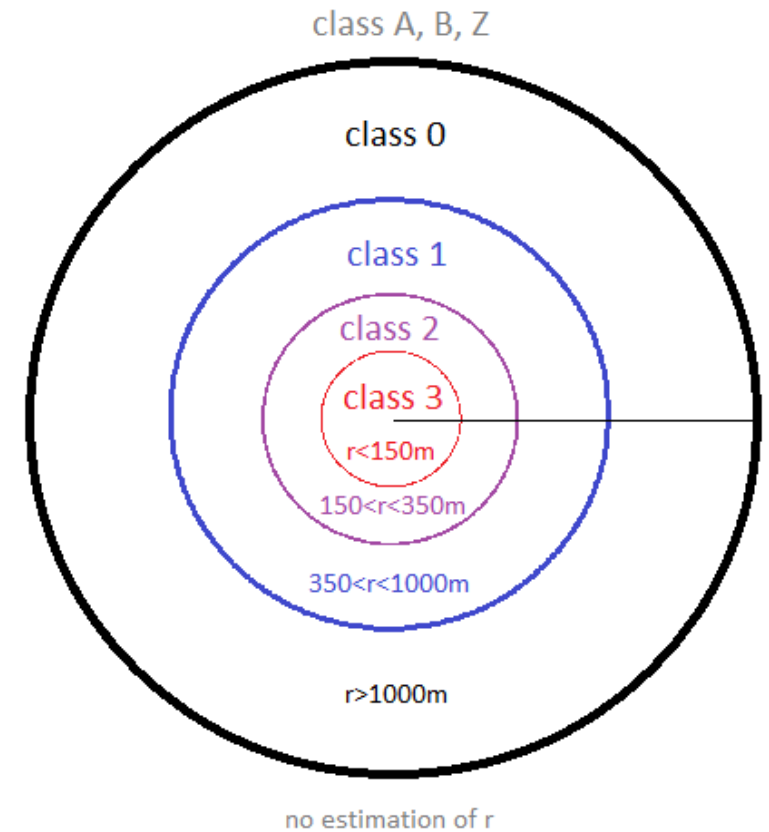
$$\frac{3}{4h} \cdot \left(1 - \frac{x^2}{h}\right) \text{ with } 2h = \text{size of the support}$$

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



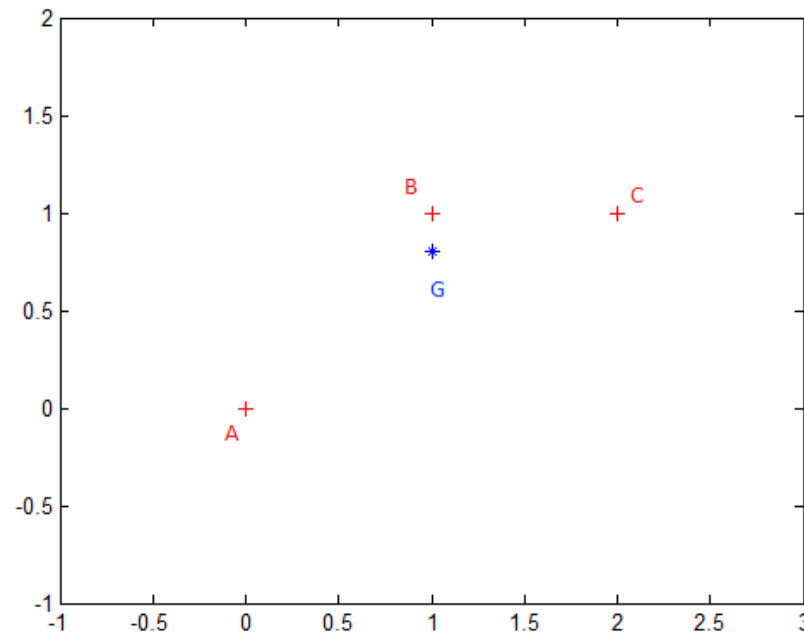
Data processing

- The weights increase as the precision of measurement increases



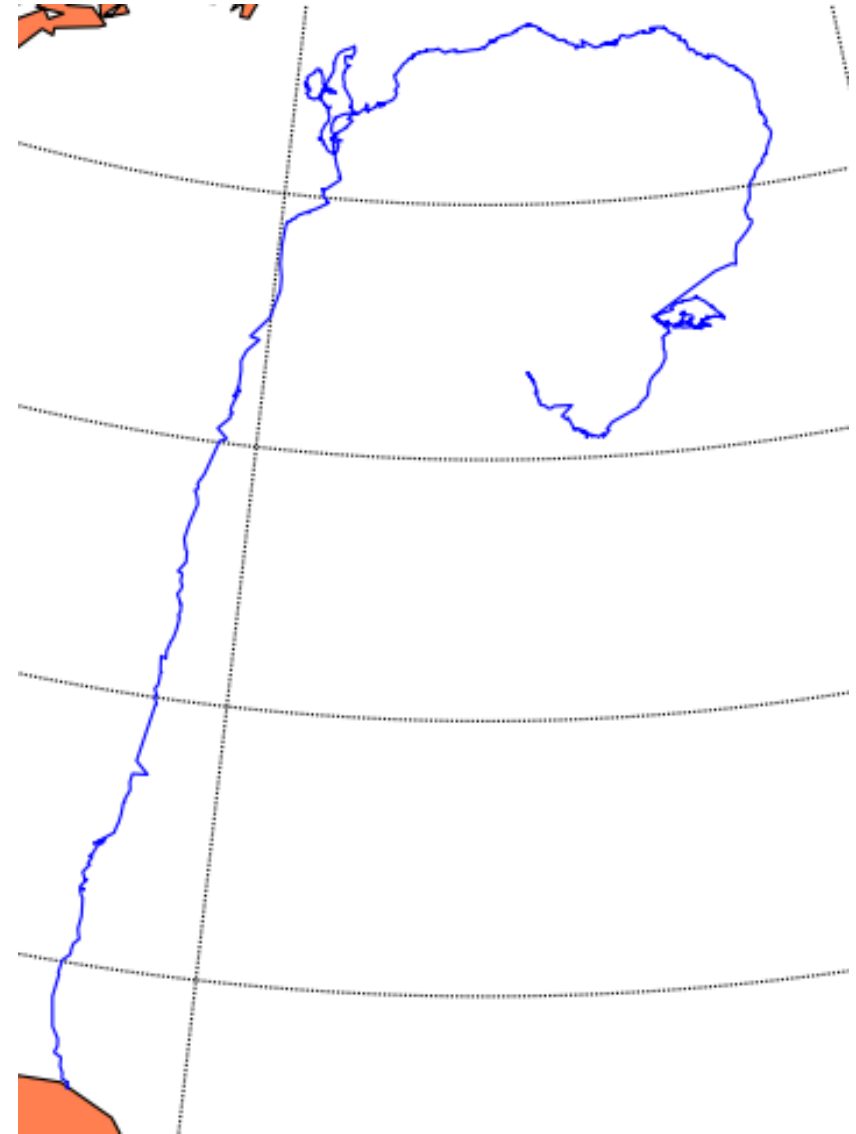
Data processing

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





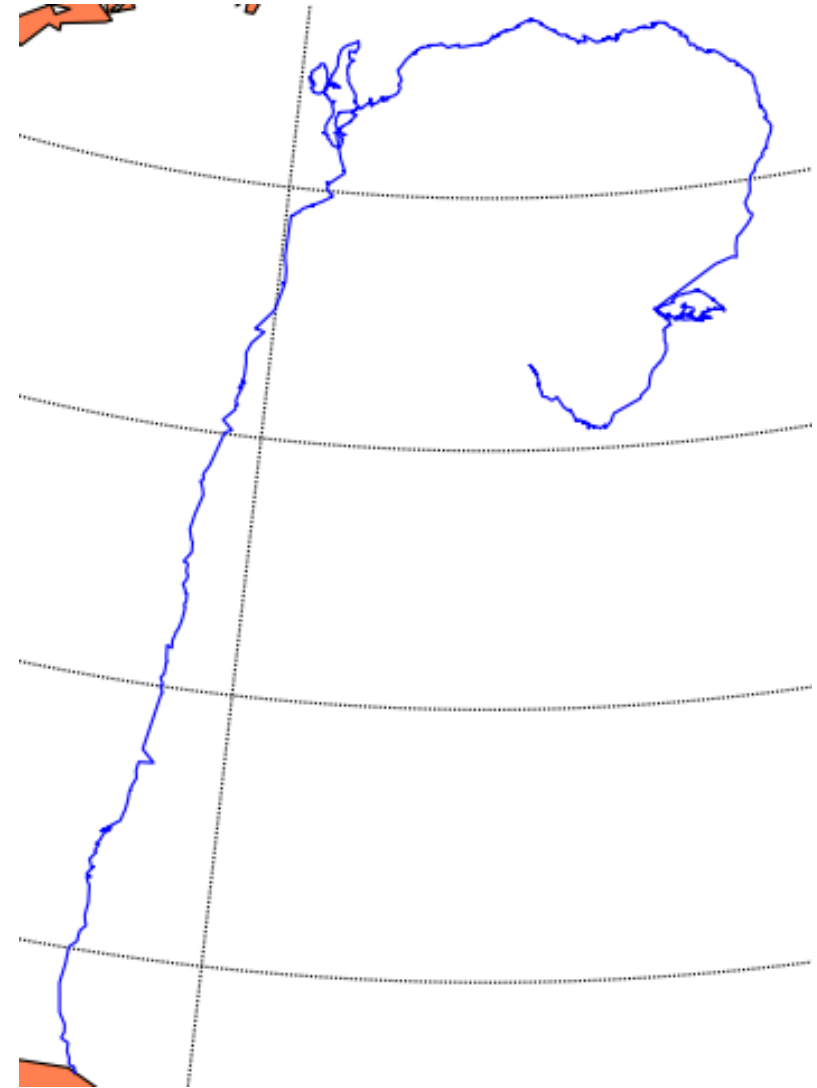
Trajectory before the estimation



Trajectory with an Epanechnikov kernel



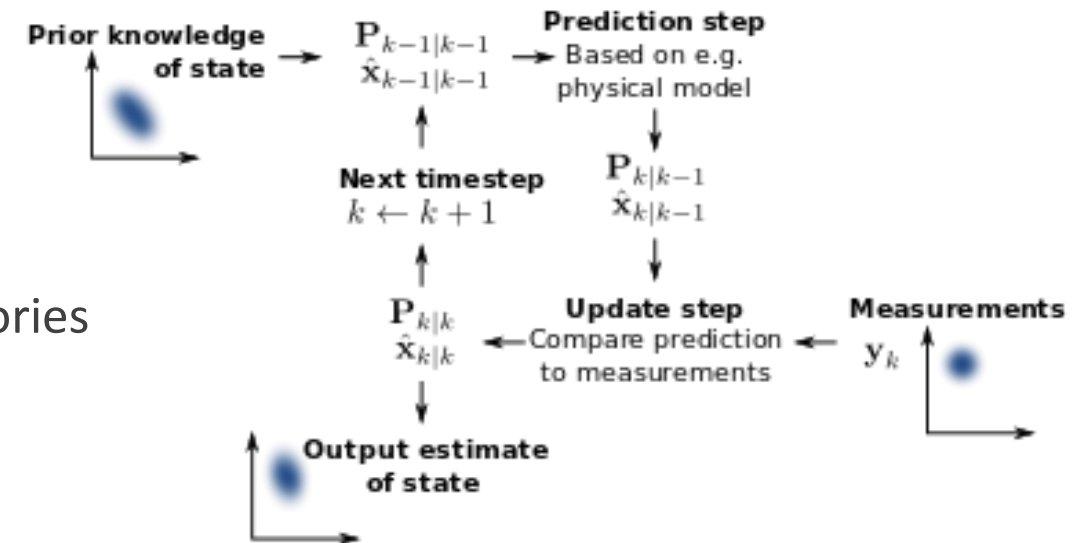
Trajectory before the estimation



Trajectory with a Gaussian kernel

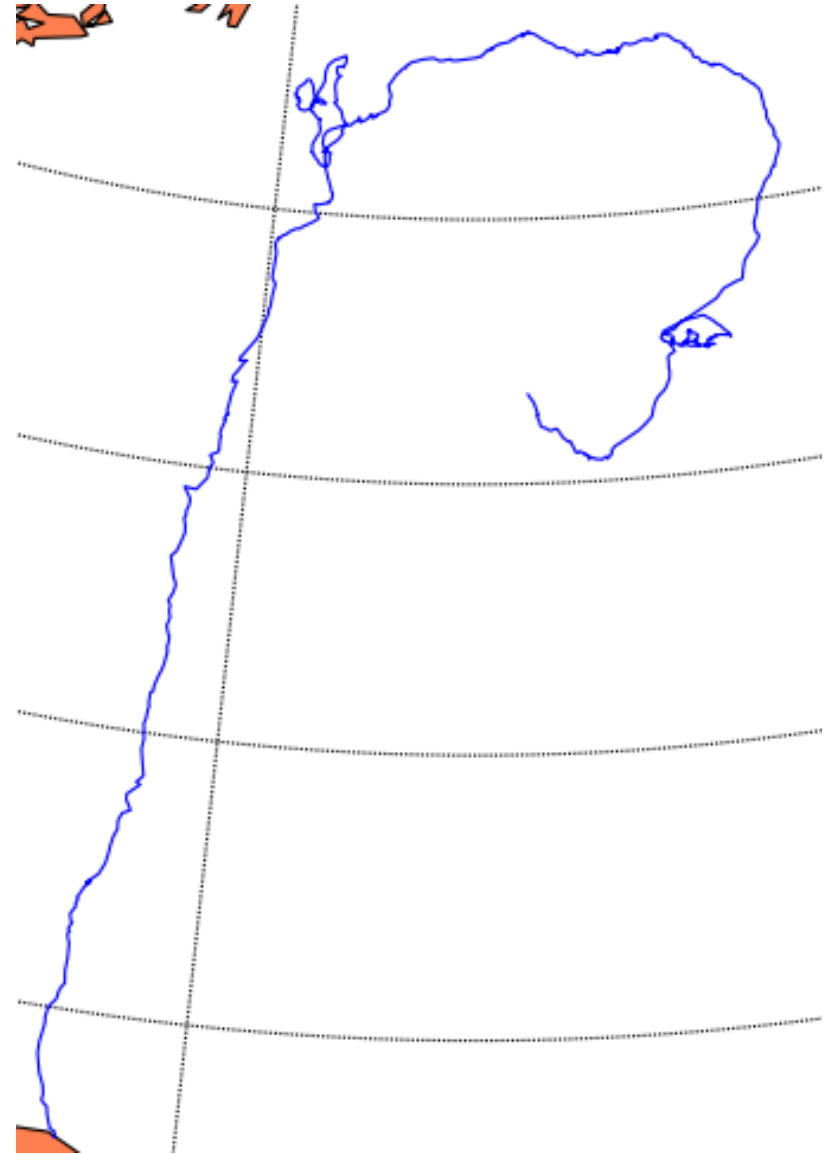
Kalman smoothing

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





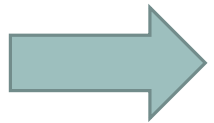
Trajectory before Kalman smoothing



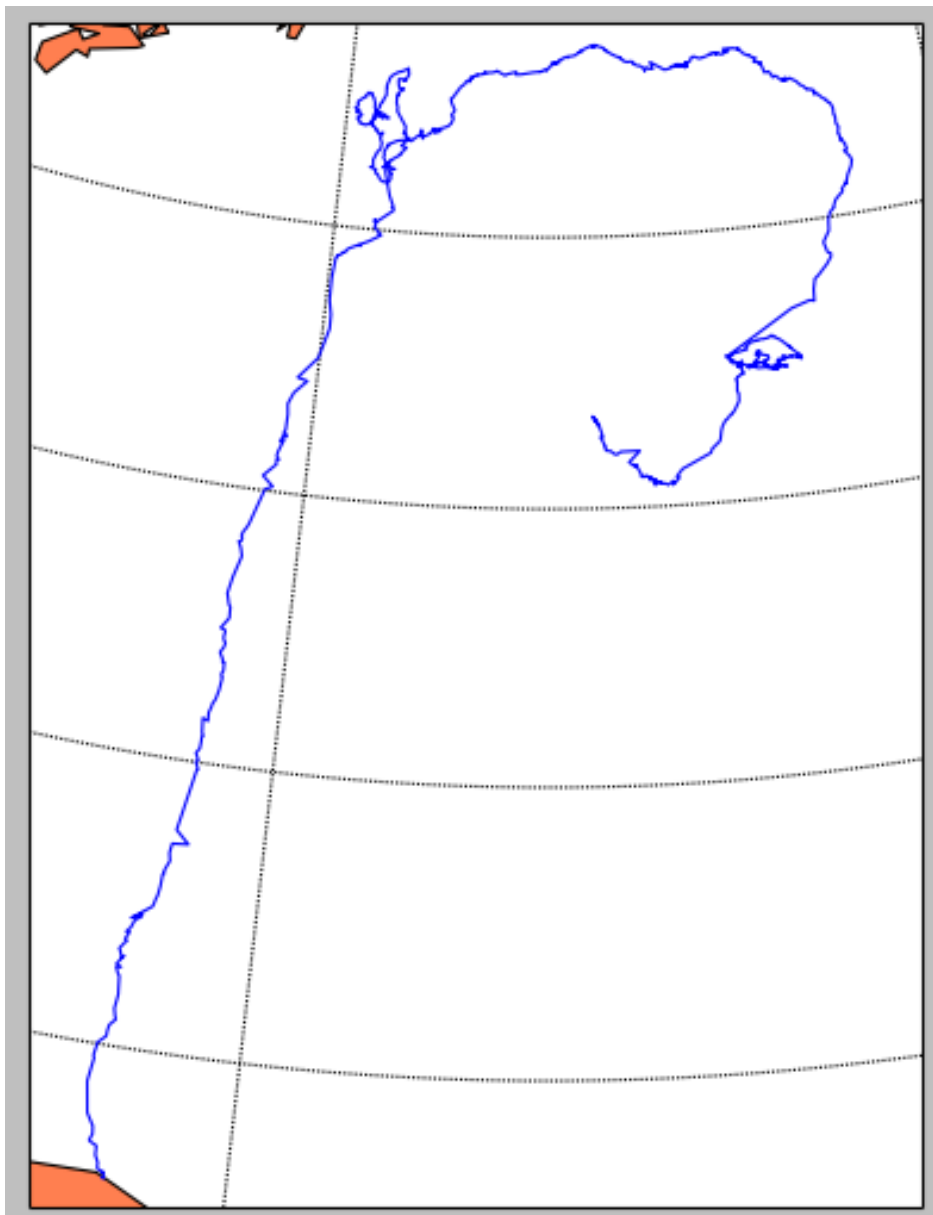
Trajectory after Kalman smoothing

2nd estimation

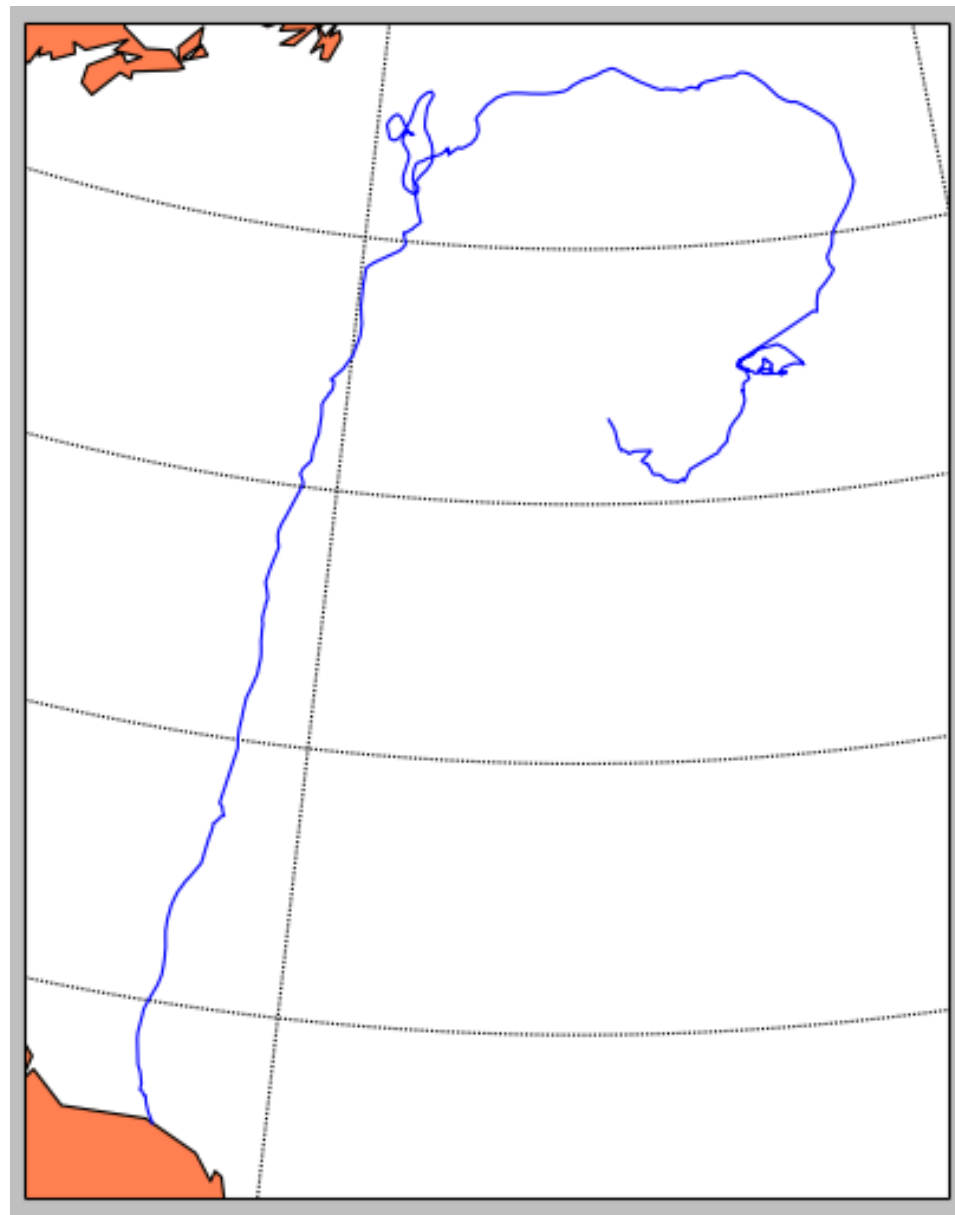
- Linear regression
- Resampling trajectory



Points spaced with a constant time step size



Output without the 2nd estimation



Output with the 2nd estimation

Conclusion

- 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