Otolith Shape Feature Extraction Oriented to Artificial Neural Network Classification

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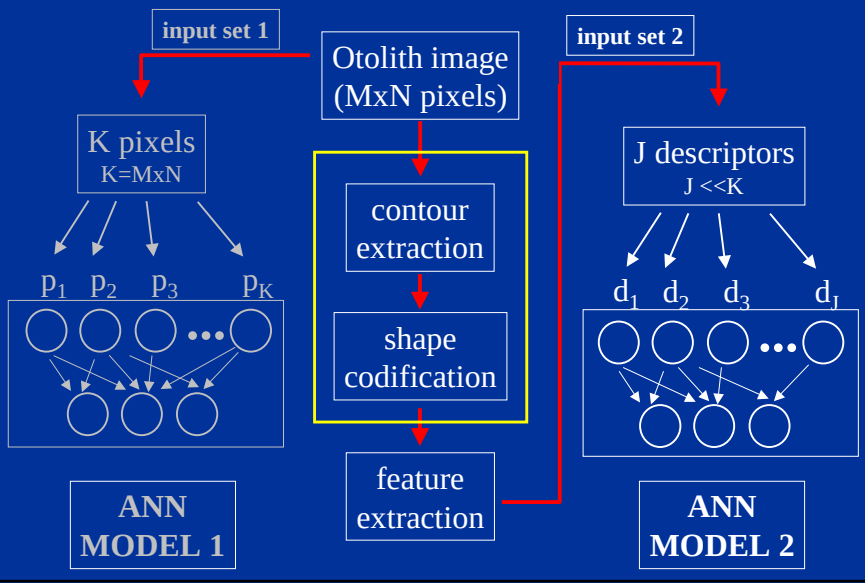
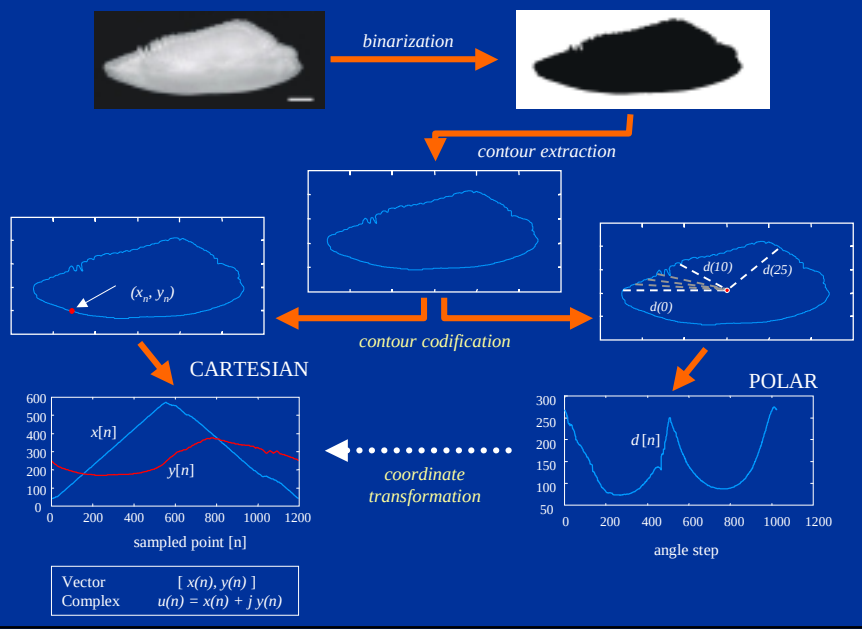
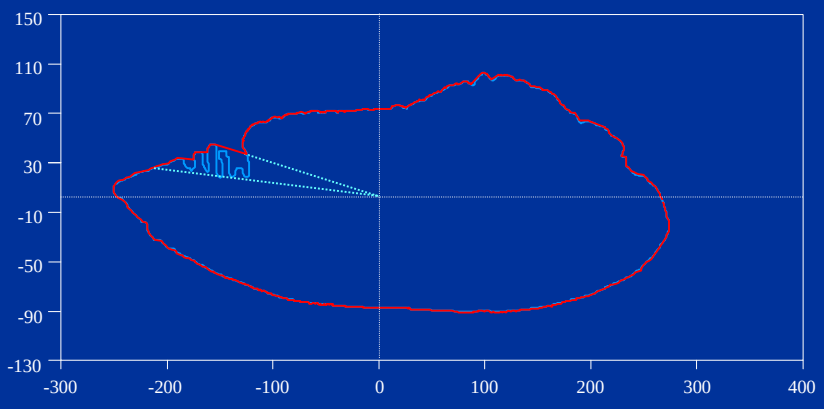
Artificial Neural Network Classification.
Model options



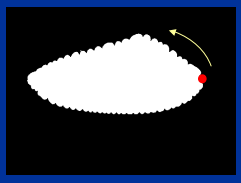
Contour extraction and shape codification

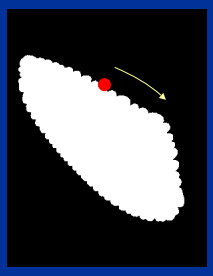


Polar to Cartesian coordinates
Reconstruction limitations



Future applications
Analysis of data from different resources





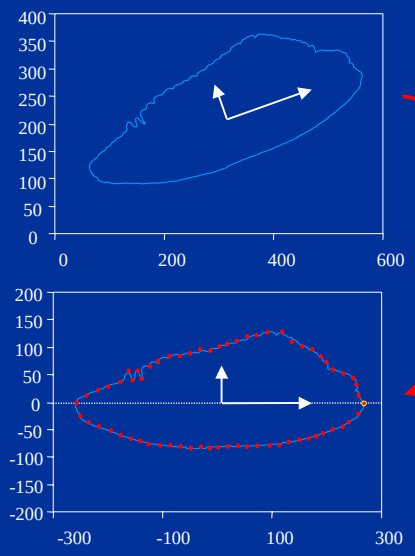
Potential differences on

- Otolith position
- Image resolution
- Origin of reference
- Clockwise / Anticlockwise codification

Goal

- Propose a method for standardizing the codification of contours obtained from different resources
- Evaluate the effect of using different types of codification on the feature extraction process

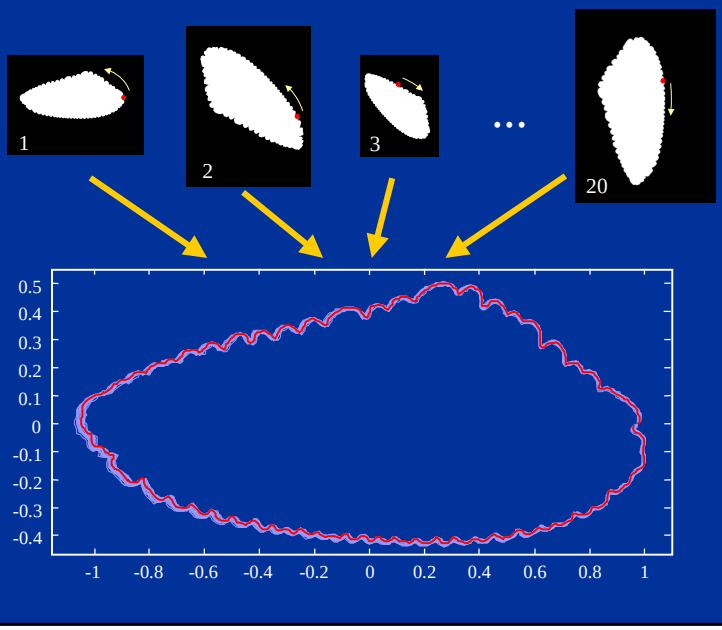
Contour standardization method



KL Transform

512 points

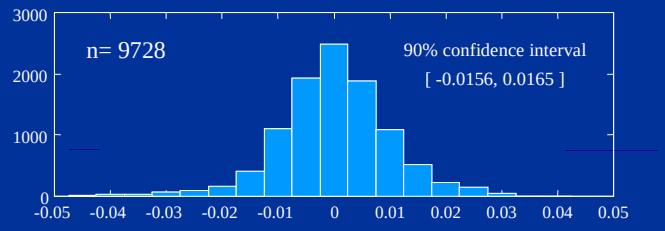
Contour standardization test



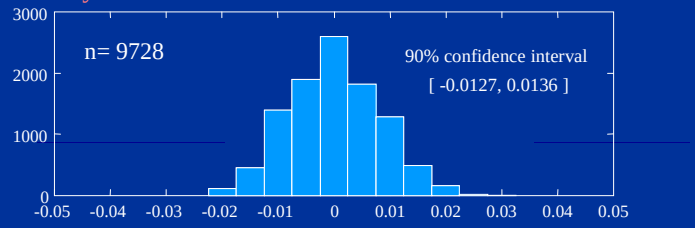
Contour standardization test (II)

Coordinate error

x-coordinate



y-coordinate



Codification effect evaluation

Otolith data set

European hake *Merluccius merluccius* (L.)

	Sex	Maturity stage	length	# samples
Class I	Undetermined	Juvenile 1st year	< 16 cm	24
Class II	Male	Juvenile, after 1st year	[16-28.8] cm	18
Class III	Female	Juvenile, after 1st year	[16-38.0] cm	25
Class IV	Male	Adult	> 28.8 cm	23
Class V	Female	Adult	[38.0-60.0] cm	31
Class VI	Female	Adult	> 60 cm	9

Codification effect evaluation (II)
Feature descriptors

- Morphological (11 features)

  Perimeter, Max chord, Major and Minor Axis, …

- Statistical (27 features)

  Mean, Variance, Fractal dimension, …

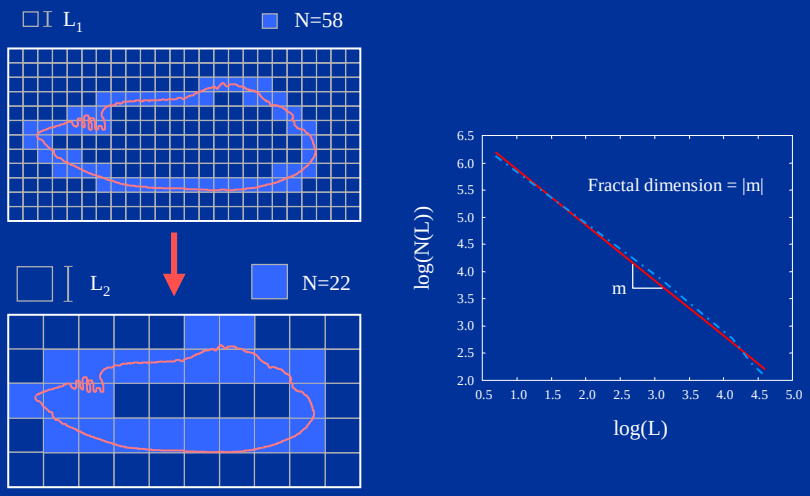
- Spectral (256 features)

  Normalized Fourier descriptors

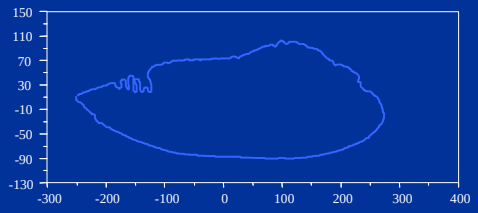
- Multiscale (64 features)

  Normalized Multiscale Bending energy

Fractal dimension
Box-counting method



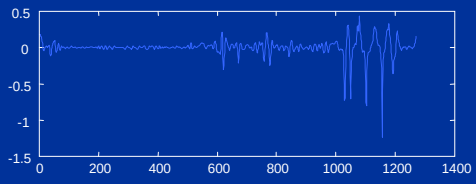
Bending Energy



Curvature

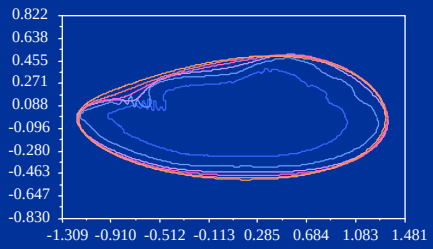
$$k(t)=\frac{\dot{x}(t)\,\ddot{y}(t)-\ddot{x}(t)\,\dot{y}(t)}{\left(\dot{x}(t)^2+\dot{y}(t)^2\right)^{3/2}}$$

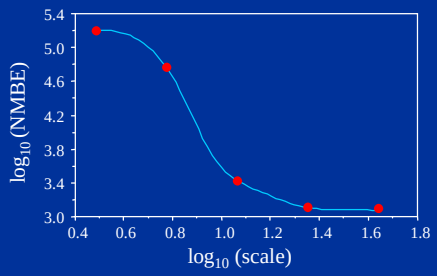
Bending Energy

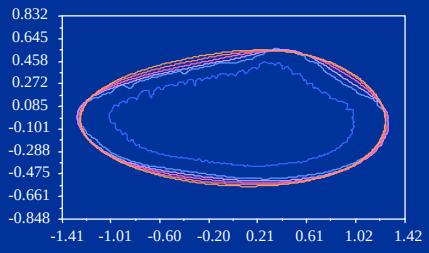


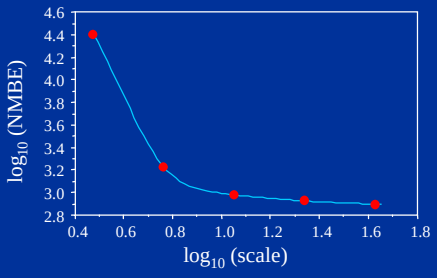
$$B=\frac{1}{N}\sum_{n=0}^{N-1}k[n]^2$$

Normalized multiscale bending energy NMBE



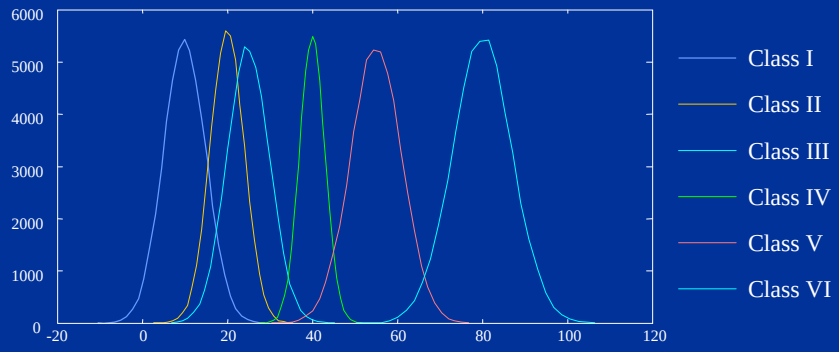






Class Separation Distance (CSD)

Value distribution for feature *m*

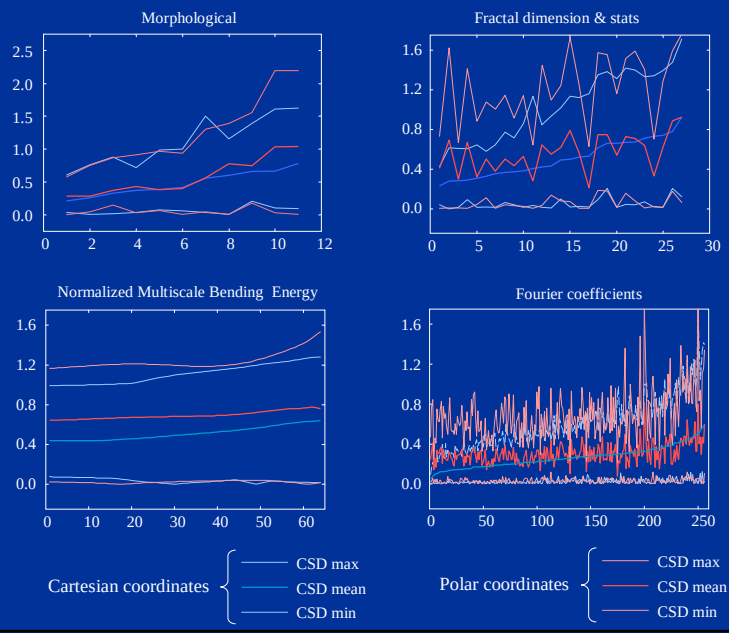


Class Separation Distance (CSD) between the *l* and *k* classes with respect to the m^{th} feature

$$CSD_{l,k,m} = \frac{|\mu_{l,m} - \mu_{k,m}|}{\sqrt{\sigma_{l,m}^2 + \sigma_{k,m}^2}}$$

→ Mean CSD_m
Max CSD_m
Min CSD_m

Changes on CSD statistics using different codifications

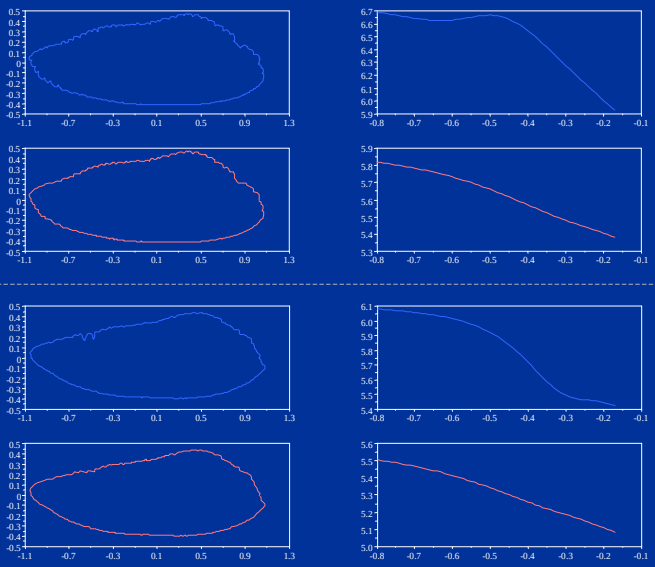


Effect of codification method

Example: NMBE

Cartesian coordinates

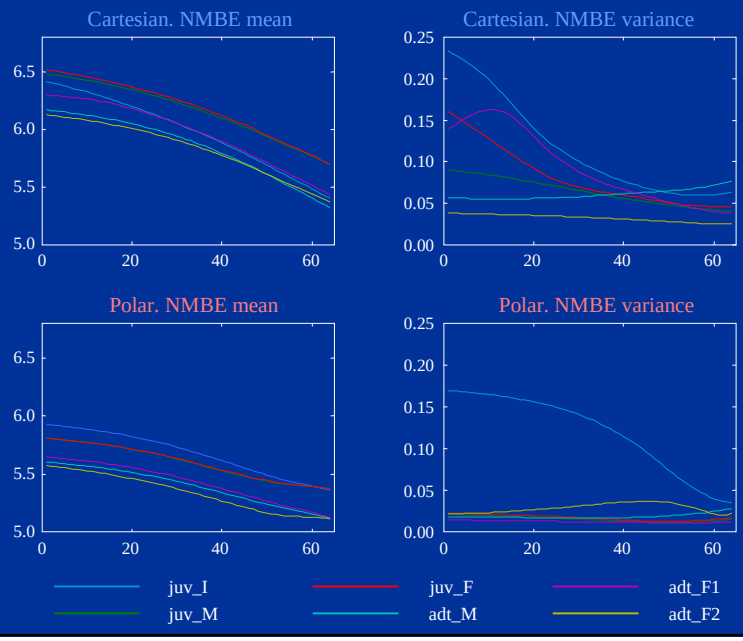
Polar coordinates



Cartesian coordinates

Polar coordinates

Effect of codification method: Statistics of NMBE



Conclusions

- The KL transform derived method allows standardizing coordinates of otolith shape data.
- The classification may depend on the selected codification method.
- Proposal: Establish a standard data format within Shape Analysis Community Research.

Acknowledgments

European Union

Beatriz Morales Coordinator of IBACS project
Antoni Cruz (ICM, CSIC) Image acquisition
Albert Marti (EPSC, UPC) Software development