

**Context:** Modern technology facilitates the capture of data in sports sciences consisting of complex signals. Such signals represent a single entity (curve) rather than a time series of individual data points. The field of functional data analysis (FDA) provides effective methods for analyzing and interpreting such signals. FDA allows for a unified treatment of dense and sparse curves and could account for covariates defined by the individual characteristics. Despite the growing interest for the use of FDA in sports sciences, there is a need for the development of a new generation of FDA techniques when applied with sport movement data. Several challenges are raised by sport movement data consisting of multivariate, noisy, irregular signals in the presence of many covariates/predictors.

**The topic:** The purpose of the MSc internship project is to initiate the student to some recent FDA procedures and to apply them to real data on swimming performance. The objectives include the extension of the approach introduced by [1] to the context where predictors are available. Next, the purpose is to build mean and the covariance functions estimates in the presence of discrete and continuous predictors. The mean curve and the covariance operator are the usual tools to summarize the information contained in a curve. Letting them to depend on the individual characteristics allows for a much more refined analysis; see [3]. Assessing the effect of the predictors on the mean and covariance functions could be another aspect of interest.

**Student's Profile:** We welcome applications from Master students in their final year of study (Bac+5), with a sound background in Mathematical Statistics. Advanced skills in programming with R and/or Python and some experience with the applications on real data sets are also required.

#### Location and period

- The internship takes place in the CREST Lab, at Ensai.
- Duration: up to 6 months. The internship could start as soon as March 2021.

#### Funding

- The internship is funded by the Graduate School DIGISPORT (Digital Sport Sciences).
- The standard French rules for the monthly wage will be applied.

#### Contact

Applications (CV and application letter) have to be sent to Valentin Patilea (valentin.patilea@ensai.fr) and Eftychia Solea (eftychia.solea@ensai.fr).

#### PhD option

The MSc internship could be continued with a PhD on related topics at Ensai.

## References

- [1] S. Golovkine, N. Klutchnikoff, and V. Patilea. Learning the smoothness of noisy curves with application to online curve estimation. arXiv 2009.03652. 2020.
- [2] P. Kokoszka and M. Reimherr. *Introduction to functional data analysis*. CRC Press, 2017.
- [3] D. Liebl. Inference for sparse and dense functional data with covariate adjustments. *Journal of Multivariate Analysis*, 170:315 – 335, 2019.