

# Internship Project

## Consistent clustering for muscular synergy analysis

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### Research Project

Bi-clustering is traditionally employed for identifying clusters which are able to group together the rows and the columns of a given matrix. Such a matrix is supposed to contain the samples of a given database (organized column by column), which are described by a certain number of features (organized over the rows of the same matrix). The interest in finding a bi-clustering that is *consistent* is given by the relationships that it could reveal about subsets of samples and subset of features in this database. Such relationships may subsequently be exploited for performing supervised classifications, as well as the selection of relevant features [4, 3].

Consistent bi-clustering was already successfully applied to databases of gene expressions and wine fermentations [4, 5], and recent (still unpublished) results have shown that this approach can be extended for analyzing temporal data. In this project, we are particularly interested in understanding how muscles are coordinated during specified tasks [1, 2]. Motor control theories can indeed explain the way the central nervous system activates muscles to achieve a specified motion, but there is nowadays a lack of methods to experimentally verify and mathematically describe such theories. The application of bi-clustering techniques on experimental data obtained by muscle activity has the potential to reveal the underlying structure of motor control. The obtained results may in fact help us to model the motor control, and to perform motion synthesis.

The main aim of this internship is to develop a Matlab toolbox for performing consistent bi-clustering on temporal data representing recorded muscle activities. The main challenge will consist in adapting previously developed tools for consistent bi-clustering to dynamical data (i.e. data having a temporal component), and in efficiently manipulating the recorded muscle activities for performing the desired analysis. The preliminary validation of the obtained results may potentially have an impact on the implemented methods and algorithms for consistent bi-clustering, that we may need to tailor to this particular application.

### Environment

The candidate will work in the joined Inria/IRISA research centre located in Rennes. Inria ([www.inria.fr](http://www.inria.fr)) and IRISA (<http://www.irisa.fr>) are amongst the leading research centres in Computer Sciences in France. The work will be supervised by members of the MimeTIC team, internationally recognised in the fields of Computer Graphics and Virtual Human Simulation.

## Requirements for candidacy

- Matlab programming skills
- Solid mathematical background; basic knowledge in optimization and linear programming
- Previous experience in the research topic is a plus

## References

- [1] A.L. Cruz Ruiz, C. Pontonnier, J. Levy, G. Dumont, *A Synergybased Control Solution for Overactuated Characters: Application to Throwing*, to appear in Computer Animation and Virtual Worlds, 2018.
- [2] A.L. Cruz Ruiz, C. Pontonnier, A. Sorel, G. Dumont, *Identifying Representative Muscle Synergies in Overhead Football Throws*, Computer Methods in Biomechanics and Biomedical Engineering **18**(sup1), 1918–1919, 2015.
- [3] A. Mucherino, *Extending the Definition of  $\beta$ -Consistent Biclustering for Feature Selection*, IEEE Conference Proceedings, Federated Conference on Computer Science and Information Systems (Fed-CCSIS11), Workshop on Computational Optimization (WCO11), Szczecin, Poland, 269–274, 2011.
- [4] A. Mucherino, L. Liberti, *A VNS-based Heuristic for Feature Selection in Data Mining*. In: “Hybrid Meta-Heuristics”, Studies in Computational Intelligence **434**, E-G. Talbi (Ed.), 353–368, 2013.
- [5] A. Mucherino, A. Urtubia, *Consistent Biclustering and Applications to Agriculture*, IbaI Conference Proceedings, Proceedings of the Industrial Conference on Data Mining (ICDM10), Workshop on Data Mining in Agriculture (DMA10), Berlin, Germany, 105–113, 2010.

## Contacts

We are looking for motivated candidates!

Please send your CV by email, together with a motivation letter and any relevant material:

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