**DO★MAR**
PHD PROGRAM IN MARINE SCIENCE, TECHNOLOGY AND MANAGEMENT

## CFT19  Course Title: Experimental Design and Analysis of Multivariate Data

**Modality: Transversal Training Course**

**Dates:**
**28 January – 1 February 2019)**

**Duration**:
Lectures and practical: 7 hours per day (35h total hours)

**Location**:
University of Aveiro, Department of Biology, room 1.1.49. **This is a computer-based course that will not be transmitted by video-conference.**

**Language**: English

**Academic coordinators**:

| Name | Institution | e-mail |
|---|---|---|
| Victor Quintino | Universidade de Aveiro | victor.quintino@ua.pt |

**Lecturers**:

| Name | Institution | e-mail |
|---|---|---|
| Victor Quintino | Universidade de Aveiro | victor.quintino@ua.pt |

**General description:**
The course is lectured in a computer room, using a problem-solving approach and exploiting teaching and learning case studies. The teaching case studies present the baseline theoretical concepts and the software (PRIMER v6 with the add-on PERMANOVA+). The learning case studies use real datasets and allow participants to apply the theoretical concepts and acquire autonomy in the choice and workflow of the methods. PhD students that already have their own data sets should find enough time to exploit their data and discuss the methods.

The course is lectured in a computer room with the appropriate software installed (PRIMER v6 with the add-on PERMANOVA+), with a maximum of 30 participants (up to two per computer).

**Contents:**
1. Introduction. Samples, variables and measurement scales. From univariate to multivariate data collection and analysis.
2. Resemblance. Resemblance functions for the analysis of variables – association and correlation coefficients – and samples – similarity and distance functions. Appropriateness of the resemblance functions to the dataset. Choosing a resemblance function.

3. Clustering. Principle, advantages and disadvantages. The panoply of methods. Agglomerative and divisive methods. Agglomerative hierarchical clustering: single, complete, average and flexible algorithms. Construction and interpretation of dendrograms.
4. Ordination. Principle, advantages and disadvantages. The panoply of methods. Principle coordinate and component analysis (PCO and PCA), correspondence analysis (CA) and non-metric multi-dimensional scaling (MDS). Biplots and interpretation of factorial axes.
5. Multivariate hypothesis testing. Fixed and casual factors, orthogonal and hierarchical designs. Implications on the estimation of variance components. Hypothesis testing with multivariate data: the methods analysis of similarities (ANOSIM) and permutation multivariate analysis of variance (PERMANOVA).

**Teaching methodologies:**
Develop skills to understand the theoretical background of experimental design and data analysis concepts and the practical use of software involved in the analysis of multivariate data. The development of the following skills is expected:
1. ability to produce an experimental design to answer a given question, to identify the factors involved and their relationship, as well as adequate controls;
2. build skills in the exploitation and analysis of multivariate data, namely in the choice of adequate resemblance functions to analyse the variables and the samples;
3. build skills in the use of clustering and ordination methods as well as hypothesis testing using multivariate approaches;
4. build skills in the use of software to achieve the above-mentioned objectives.

**Evaluation system:**
Assessment is restricted to the participants attending doctoral programs and includes group work rendered at the end of the course.

**Briev CV of the lecturers:**
**Victor Quintino** finished the bachelor degree in Biology from the University of Lisbon in 1982, the master and the PhD degrees in Biological Oceanography in 1983 and 1988 respectively, both from the University Pierre et Marie Curie, Paris VI, France. He is currently employed by the University of Aveiro, where he occupies the position of Assistant Professor in the Department of Biology. His domain of specialization includes the study of coastal and estuarine benthic organisms and communities as well as sediment eco-toxicology. His research interests include the study of the trajectories of change of macro-invertebrate benthic communities in response to natural and anthropogenic factors, the integration of environmental, biological and eco-toxicological descriptors in the bioassessment of estuarine and coastal areas, as well as the use of non-intrusive acoustic methods for the remote characterization and mapping of benthic biotopes in coastal systems. His lecturing activities include Bachelor, Master and PhD level students and the courses Experimental Design and Analysis of Multivariate Biological Data, Ecological Quality of Marine Ecosystems and Field Methods in Marine Biology. He is co-author of more than 80 peer-reviewed papers published in indexed international journals and is currently Editor-in-Chief of the journal Marine Pollution Bulletin and Associate Editor for the journal Estuarine, Coastal and Shelf Science.