

# Bridging the gap from thoughts to reality: a practical course for the design and control of bioinspired soft robots

*Full-day Tutorial*

## Abstract

Bioinspiration is a long-lasting approach adopted to develop novel, emerging technologies that interact more safely with natural unstructured, dynamic environments and living beings. Biological systems are taken as models to suggest strategies for new robot capabilities of online adaptation, such as morphing, elongating, growing, distributed and collective intelligence, physical intelligence, sensing, learning, and computation. However, methodologies for extracting working principles from living beings are challenging to be standardized, and the artificial translation of a natural mechanism remains a highly hand-made operation. Several questions must be addressed during nature-to-artificial translation. Which is the level we intend to observe the natural system? Which is the level of abstraction to reach? Is the artificial model sufficiently representative of the biological one? To what extent does the artificial representation behave like the natural model? A joint effort among multiple disciplines is the premise for a successful translation from nature to robotics. This tutorial intends to pose fundamental questions to the audience and stimulate discussions by challenging participants through hands-on experience. Attendees from different backgrounds are encouraged to participate. Participants will be challenged in bioinspired design, creative thinking, and robot implementation. Techniques of fast prototyping, manufacturing, embedded systems, and control will be introduced and experimented with. This experience aims to feed a curiosity-driven approach to research, stimulate critical thinking, and improve awareness about the need to integrate multiple competencies to successfully realize a bioinspired/biomimetic robotic system to have relevance for both engineering and biology.

## Organizers



Dr. Emanuela Del Dottore [»](#)  
 Researcher  
 Bioinspired Soft Robotics  
 Istituto Italiano di Tecnologia



Prof. Ali Sadeghi [»](#)  
 Assistant Professor  
 Department of Biomechanical  
 Engineering  
 University of Twente



Dr. Virgilio Mattoli [»](#)  
 Researcher Technologist  
 Istituto Italiano di Tecnologia

## Aim and content of the tutorial

This tutorial targets the involvement of a multi-disciplinary audience for a constructive discussion about the bioinspired/biomimetic approach in robotics. Despite the longevity of the approach, its definition still seems foggy. Often, the relationships between a natural system and its artificial counterpart are unclearly reported in the literature, with poor details about methodologies adopted for interpretation and translation. Due to the variety of models and functionalities, standardization of observation methods and representation strategies cannot be probably reached. However, a systematic methodology that considers a few benchmark positions can be implemented to define the goodness of representation. These include determining the proper natural model, level of observation, the target level of abstraction, generality and accuracy of representation, performance to match, and type of representation. First, defining the scenario of use, then selecting adequate materials, components, control strategies, and manufacturing approaches are the essential steps in the artificial model realization. This tutorial will go through these steps and foster a methodological translation of natural principles into artifacts, letting the audience learn by experience.

The tutorial will be organized over four key sessions to guide the passage from a theoretical basis to hands-on experience. The entire event will implement an interactive character to facilitate the involvement of participants and stimulate discussions.

### *Tentative schedule\**

- |            |  |
|------------|--|
| 9:00-9:15  | Welcome  |
| 9:15-9:45  | Session A: Introduction and groups division                            |
| 9:45-13:00 | Session B: Interactive lectures and hands-on-experience on the topics: |
- Methodological approach to bioinspiration
  - Design and manufacturing of bioinspired soft robots
  - Embedded control and electronics
  - Front-end for debugging and control

Lunch break

- |             |  |
|-------------|--|
| 14:30-16:30 | Session C: Design and prototype of new solutions |
| 16:60-17:30 | Session D: Results and discussions               |

*\*Time may vary according to the conference schedule*

During Session A, the organizers will introduce the theoretical framework and split the audience into multiple teams. The attendees will be grouped based on their competencies to enhance multi-disciplinarity within each group as much as possible. In Session B, the attendees will be guided through different topics with interactive lectures where they will get the occasion to put their hands-on experience to practicing design, manufacturing, and control of bioinspired systems. Session C will challenge participants to design and prototype new solutions to improve or enhance the performances of their prototypes. Raw materials and basic components will be provided. Participants will be supported by the organizers all the time. Results achieved by the teams will be presented in Session D, with final discussions and remarks.

The tutorial mostly targets young researchers and Ph.D. students in bioinspired, biomimetic, and soft robotics communities. All interested scientists are more than welcome to participate.

Please, visit the conference website to [register](#), and welcome on board!

**LIVING  
MACHINES**