

**Module Code & Title:** CMP9764M Advanced Robotics

**Assessment Item 3:** Robot Learning

**Contribution to Final Module Mark:** 50%

**Description of Assessment Task:**

In this individual assignment, you will further explore and characterise some of the principles of robot learning by demonstrations that have been explored in the lectures and workshops of the learning from demonstration block of the Advanced Robotics module. In addition to this briefing, you should refer to the Assessment Item 1 CRG.

There are two main parts to this assignment. You need to write a report on the topic of your choice:

*Part 1: Conduct a brief literature review on the topic of learning time-invariant dynamical systems.*

The review should contain the following:

- What is a time-invariant dynamical system
- Advantages and disadvantages compared to time-dependent dynamical systems
- Presentation and critical evaluation of three scientific papers
- The presentation should contain the used model for learning the dynamics, the method for achieving stability and convergence and the field of application

*Part 2: Lyapunov stability when training a linear time-invariant dynamical system and the Stable Estimator of Dynamical Systems (SEDS).*

This part should contain:

- Brief presentation of the mathematical formulation of both a linear dynamical system and SEDS
- Examples of demonstrations where the linear time-invariant dynamical system performs well and examples where it does not.
- Examples of demonstrations where SEDS performs well and examples where it does not.
- The methodology that was followed in order to tune the parameters of SEDS (number of Gaussians)

You should select one of the above topics and *write a report* covering the literature review, providing appropriate motivation, justifications, analyses, and discussions.

You can decide to work in a group or individually. For the individual, while you are encouraged to discuss your approaches and results with your course colleagues, the reporting thereon (i.e. the report to be submitted) must be your own work.

**Learning Outcomes Assessed:**

[LO 1] Analyse the “state of the art” in advanced robotics, including an understanding of the mathematical principles and current applications;

Please refer to the Assessment Item 2 CRG for further details.

### **Assessment Submission Instructions:**

You should submit your report as a single “.PDF” file to the “*Assessment Item 1 Upload*” section. Please refer to the Assessment Item 1 CRG for further guidance. You may structure your report as you deem appropriate in order to describe the work that you conducted. However, it would be worth considering at least the following sections in the report:

1. Title
2. Abstract: summarise the topic of your choice from the list of topics which are covered

at the first block of CMP9764M. The abstract should include the problem definition, existing challenges in the problem, existing approaches and their corresponding limitations where each of these parts will be further discussed in the next sections of your report, described below.

3. Introduction: describes the problem statement, the categories of existing solutions, and the open research questions in each category. You can use some illustrative examples from the original paper to describe the work (do not forget to put reference for any materials you borrow from other documents).
4. Literature Review (or Related Work): Select a few related works/papers and

summarise them as follows: start from the problem definition, describes the sequence of (about 10-15) related works (in the recent years, since 2010, e.g.). For each paper, you should include (a) the problem statement, (b) the contribution of the paper, (c) the novelty in that paper, and (d) the shortcoming of the work. You can include the result of each paper to highlight the remarkable features of each approach for comparison purpose.

5. Demonstrations: Use the code developed in the workshops and present the key outcomes of applying a linear time-invariant dynamical system and SEDS on three demonstrated trajectories of various complexity. Present the methodology you followed for deciding on tuning the parameters of SEDS (number of Gaussian components)

Discussion: this section should provide a critical discussion which provide a good understanding of pros and cons of different related works in the domain of interest.

For the report, you should use the IEEE A4 Conference Proceedings template, which is available online (<https://www.ieee.org/conferences/publishing/templates.html>). You may use either the Word or LaTeX templates: your submission should be a PDF document, no more than 4 pages long (including references).

*DO NOT include this briefing document with your submission.*

### **Format for Assessment:**

Your submission should consist of the following:

- 1) A report in PDF format detailing your program structure and solution to the problem (see Assessment Submission Instructions above). You must use the provided template.

For individuals, your report must be NO MORE than 4 pages long (including references) using the supplied template. You can form groups for this assignment (nonetheless, you need to get the confirmation of the module instructor for your group members and topic before the end of week 4).

There may be a penalty applied for reports longer than the page limits, or those that deviate from the supplied template.