

2025 Spring Semester

Course Work

URL

Unsupervised Learning

Computer Science Departament

Master in Artificial Intelligence - UPC



FIB

Facultat d'Informàtica
de Barcelona

UNIVERSITAT POLITÈCNICA DE CATALUNYA

Unsupervised Learning/Clustering

1.1 The assignment

A task that is usual in research is to compare the methods/algorithms that we propose to other similar/competing methods in order to show empirically the benefits of our approach.

This means to look into the state of the art for the more recent methods in our area and, if there is not an implementation available, to implement the competing algorithms to be able to test and compare them with ours.

The goal of the course is not to develop new algorithms, but we can pick some papers describing current unsupervised machine learning methods, develop an implementation and then test its properties against some well accepted methods. Basically the task is to reproduce and test the results of a paper.

The main tasks of the assignment are:

- Read and understand the references that describe the algorithm that you have chosen
- Implement the algorithms in `python` following `scikit-learn`'s API conventions implementing at least the `fit` and `predict` methods
- Write a report:
 - **Summarizing** the characteristics of the algorithm described on the paper (do not simply copy the text on the paper)
 - **Describing** minimally the implementation
 - **Comparing** experimentally the algorithm from the paper to algorithms from the `scikit-learn` library that implement the ones used on the paper experiments, and others that could be interesting to compare with. You should:
 - * Reproduce the experiments presented on the paper if possible using the artificial/datasets proposed
 - * Propose additional experiments choosing datasets that complement the ones presented on the paper to test its characteristics
 - * Use the validity measures proposed on the paper and extend the evaluation when needed with additional measures chosen from the ones explained in the course

- **Commenting** about the claims of the paper, reproducibility or other issues encountered while implementing the algorithm

In order to obtain a fair running time comparison, you should implement the algorithms **efficiently**. This means to use extensively the numpy/scipy libraries and their array operations. You can use also the optimized data structures and functions implemented in these libraries like, for instance, spatial indexes for nearest neighbour search or distance matrix computations.

This coursework has to be done individually.

The deadline for delivering the report will be **April 21st 2025**. The paper has to be in PDF format and has to be uploaded to the Raco using the assignment delivery application for the course.

1.2 The algorithms

You have available a list of algorithms in:

<https://sites.google.com/upc.edu/mai-url/ul-mai/coursework1>

Each option has one paper describing a new clustering algorithm or a variation of an existing one. You can pick any of the options, but a **maximum of two students** is allowed for option. You have to send an e-mail (javier.bejar@upc.edu) declaring the one that you prefer as soon as possible.

If you want to propose another algorithm related to the course, feel free to contact me, and we will talk about it.

1.3 Evaluation

The evaluation of the work will consider these elements:

- Quality of the description of the implemented algorithms (not just copying the paper)
 - Explain the improvements introduced, its novelty and a give description of the elements of the algorithm (no pseudocode, no cut and paste of the algorithm from the paper)
- Quality of the implementation, mainly the coverage of the characteristics of the reference algorithms and the efficiency of the implementation
 - Describe the implementation and what has been done to make it efficient
- Quality of the experiments performed:
 - Types and relevance of the datasets used
 - Quality of the analysis of the experiments (what is tested, how is tested)
 - Quality of the explanations of the results and their conclusions
 - Additional measures/algorithms/datasets included to test/show some specific characteristics of the algorithm
 - Not just numbers and plots
- Comments about the reproducibility of the results, about the claims and/or inconsistencies of the paper, missing information for the reproducibility (e.g. hyper parameters)

Unsupervised Deep Learning

2.1 The assignment

Another task that is usual in research is to present your work to an audience. In a time when there are more means for dissemination than just writing papers, to prepare a short video presentation is a simple way to reach more broad audiences.

The goal of this task is to record a video presentation about one paper on the topic of unsupervised deep learning. This video has to explain the contribution and main elements of the research, so the viewer gets a general idea about the content of the paper. The video has to be strictly 8-12 minutes long.

In order to elaborate the video after reading the paper, you should be able to answer this questions:

- What is the area of research of the paper (more specific that unsupervised deep learning)
- What is the problem that is addressed in the paper
- What is the contribution of the paper. Basically, what is proposed on the paper that previous research does not address or what is the improvement
- What are the minimum details that are necessary to understand how the proposed method works
- How the method has been tested (datasets, procedures) and what other competing methods have been used for comparison and why.
- What is the improvement over the competing methods
- What are the limitations of the proposed method
- If it is the case, what experiments have been done to test the different elements that compose the proposed methods (they are usually called ablation studies)
- What conclusions can be taken after analysing the results

This coursework has to be done individually.

The deadline for delivering the video will be **June 9th 2025**. You will have to share the video you have recorded with me (javier.bejar@upc.edu) using Google Drive.

2.2 The papers

You have available a list of papers in:

<https://sites.google.com/upc.edu/mai-url/ul-mai/coursework2>

You can pick any of the options, but a **maximum of two students** is allowed per option. You have to send and e-mail (javier.bejar@upc.edu) declaring the one that you prefer.

2.3 How to record the video

There are plenty of ways for recording presentations. The simplest way is to record a google meet session (or any other video conference software), you can edit it later with a video editing software (or not).

You can also use OBS studio, it has more capabilities, it is not difficult to use and it is also multiplatform. Also, each specific platform has other alternatives available, for instance for windows you can use shareX, camstudio, virtual dub..., for linux you have simple screen recorder or record my desktop.

If you want to edit the video there are also plenty of options like shotcut, kdenlive, vidcutter or openshot.

Recording requirements:

- The video only has to show the presentation (do not show your face)
- The video has to have a resolution of least 720p
- The presentation has to be readable in the video, so you should not compress excessively the video
- The audio has to be audible

2.4 Evaluation

The evaluation of this part will be **peer graded** apart from the professor grade. Each student will be assigned two video presentations to be graded using the assignment rubric. Be fair and sincere when grading.

You will have until **June 16th 2025** to send the grade of the videos you have been assigned.

Score Criteria	Poor [1-2 point]	Good [3-4 points]	Excellent [5 points]
Presentation elements	The presentation is dull, without graphical elements, lots of text per slide, content is sometimes confusing.	The presentation has graphical elements to illustrate the content of the paper, the text in the slides is not always excessive, content can be understood most of the time.	The presentation has a good balance between text and graphical elements, the text is enough to follow the presentation, content is always clear and precise.
Presentation delivery	The delivery is dull and monotonous, the presenter reads the slides, explanations are incomplete or confusing, takes time explaining details that do not seem relevant. The presentation uses verbatim the text of the paper. The presentation is too long. The video has been recorded on several takes.	The delivery is natural (not reading the slides/notes/text of the paper), the explanations are clear and according to the content of the slides, the time used for each element is mostly according to its relevance. The video has been recorded almost in one take.	The delivery is natural and engaging showing an understanding of the topic, explanations are clear and the time for each element of the presentation is according to its relevance. The video has been recorded in one take.
Completeness, Coverage, Understanding	The presentation does not answer all the questions asked in the assignment, it is not clear what is the area of the paper, some elements missing that do not allow to fully understand the paper, purpose of the paper is missing or not clear, explanations of the evaluation do not show what is the improvement, contributions are not clear, the presenter does not seem to fully understand some parts of the paper.	The presentation answers most of the questions asked in the assignment, all the elements to understand the paper are present, the presenter understands most of the elements of the paper.	The presentation answers all the questions asked in the assignment, all the elements to understand the paper are present, and the key elements are explained in more detail, the presenter understands all the elements of the paper.
Clarity, organization	The presentation is poorly organized, there is not a coherent sequence in the presentation and the text/images in the slides do not contribute to the understanding of the presentation (seem a cut and paste of the content of the paper).	The presentation is organized, it follows mostly a clear sequence that helps to understand the research process described in the paper and the key elements of the proposed method, the content of the slides usually helps to the understanding of the presentation.	The presentation is well organized, the sequence of the presentation has been well planned to show the key elements of the paper so it is easy to follow the research process described on the paper, the content of the slides is helpful for understanding the presentation.
Conclusions	A conclusion slide is not present or the content does not cover a minimum to summarize the content of the presentation. The conclusions are taken from the paper verbatim.	A conclusion slide is present and covers most of the elements needed for summarizing the presentation.	The conclusion slide covers all the elements needed for summarizing the presentation, a personal comment about the paper is included.