Neural and Evolutionary Learning 2025

Project Guidelines
Prof.: Karina Brotto Rebuli

> *The primary objective of this project is to compare and discuss the behavior, performance, and application of the models studied in the NEL course.*

For this purpose, utilise the dataset located in the `practical_class_01_ML/datamart` folder, file `sustavianfeed.xlsx`.

The dataset contains measurements of chicken carcasses and their respective crude protein content. A description of the variables is provided in the table below. All weights are in grams.

❗ **Important:** This dataset is **private** and must **not** be distributed or used outside the scope of this project unless you receive **written permission** from its owners.

Feature	Definition
wing_tag	Chicken unique ID
weight	The chicken total weight
hot_carcass_weight	The weight of the carcass immediately after slaughter
carcass_weight_with_head_and_legs	The weight of the carcass including the head and legs
cold_carcass_weight	The weight of the carcass after cooling
breast_weight	The weight of the breast meat of the chicken
thigh_weight	The weight of the thigh meat of the chicken
spleen	The weight of the chicken's spleen
liver	The weight of the chicken's liver
heart	The weight of the chicken's heart
intestine	The weight of the chicken's intestine
empty_muscular_stomach	Indicates the presence or absence of the empty muscular stomach of the chicken
glandular_stomach	The weight of the chicken's glandular stomach
crude_protein	The weight of crude protein in the carcass
ether_extract	The weight of ether extract, which measures the total fat in the carcass

Modelling problem

The goal of this project is to **predict the crude protein weight** using the remaining features in the dataset, excluding the animal ID.

Models to be compared

At least the five following models should be compared:

- Genetic Programming (GP)

- Geometric Semantic Geometric Programming (GSGP)

- Semantic Learning algorithm with Inflate and deflate Mutations (SLIM)

- Neural Network (NN)

- NeuroEvolution of Augmenting Topologies (NEAT)

The comparison among the algorithms should be conducted using **statistical analysis**, as outlined in Rainio, O., Teuho, J. & Klén, R. (2024). *Evaluation metrics and statistical tests for machine learning*. Sci Rep 14, 6086.

When writing your results section, consider:

- Was hyperparameter tuning easy or difficult? Why?

- How well do your models generalize?

- How strong is the models' learning performance?

- Are the final models transparent or opaque? If they are transparent, what the model is revealing?

Also, be sure to include your own insights and summary conclusions.

Groups

The project should be done in **groups of 3 or 4 people**. No more, no less 🤓

The **groups should remain the same** for all weekly deliverables and the final project.

Deliverables

Weekly deliverables:

- For each practical class in which the algorithms will be explored, students will have one week to complete the part of project related to that algorithm.

- These weekly deliveries must be submitted **on time**.

- Deliverables must be done as a Python script or Jupyter notebook, zipped and sent to krebuli@novaims.unl.pt.

- Each weekly delivery will contribute **10% of the final project grade**.

- **Late submissions will not be accepted** and will receive a grade of zero.

Final deliverable:

- The **final report** must be submitted by **23h59 on June 8th, 2025** to krebuli@novaims.unl.pt;

- The final code (weekly codes + final parts) must be submitted via e-mail to krebuli@novaims.unl.pt.

- The final report should **be no longer than 4 pages**, including plots and references.

- The final report must focus on results, discussion and model comparison.

- As with weekly deliveries, **late final submissions will not be accepted**.

- AI can be used to improve text writting or studying, but not to write reports or to generate the codes used in the project. A **declaration about the use of generative AI must be included in the final report**: "The following generative AI tools have been used [specify name and version] in order to [specify to what effect you have used the AI tools]." The use of AI tools for mere language support and reference management does not need to be disclosed.

Oral evaluation

- The project oral evaluation will take place on **June 12th** (time and room to be announced).

- The project oral evaluation will be conducted **in person.**

- **All group members must participate**.

- At least one question on the algorithms' comparison or behaviour will be asked to each student.

- At least two additional questions will be asked:

  - One regarding the code implementation;

  - One regarding the model behaviour or results.

- Questions will be assigned either by the professor or randomly based on group composition.

Evaluation Criteria

The table below outlines the evaluation criteria for the project.

Category	Subcategory	Points	Total
Weekly delivearbles	Code organization	0.25 x 5 = 1.25	
	Code efficiency	1.5 x 5 = 7.5	10
	Presentation of the results	0.25 x 5 = 1.25	
Final deliverable	Code organization	0.25	
	Code efficiency	0.25	
	Writting (maximum 4 pages, including references)	0.5	
	Plots	0.5	
	Statistical methods	0.5	3
	Discussion of results	1	
	Optional exercise *	+1	
	Extra page **	-1	
Oral presentation	Working group distribution	1	
	Code implementation discussion	2	
	Algorithms implementation discussion	2	7
	Individual alogorithms comparison discussion	2	
		Final grade	**20**

Obs: * Optional exercise that gives 1 extra point to the students.

** Maximum of 2 extra pages. Reports longer than 6 pages will not be accepted.

Project alternative

Students may submit an **individual research proposal as an alternative to the group project**.

- The **proposal** must include a **feasible deliverable** and must be submitted to Prof. Karina Rebuli by **May 8th**.

- Acceptance is at the professor's discretion.

- The **final deliverable** must include:

  - A **report** formatted as a conference article (format to be discussed)

  - Full **Python code**.

- **Same final delivery deadline: 23h59 on June 8th, 2025** to krebuli@novaims.unl.pt.

Academic Integrity

All work submitted must be **your own**. Any code, text, or ideas taken from external sources must be **properly cited**—this includes code snippets from online forums, libraries beyond standard use, or concepts derived from papers or other students' work.

Plagiarism, in any form, will result in academic consequences in accordance with **University policy**.

When in doubt, cite your sources.