# Natural Computation Approaches for Interpretable Patient Risk Stratification

*Explorative summary*

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**Problem** The management of congenital heart diseases (CHD) and cardiovascular disease is in constant need of continuous and personalized interventions. Monitoring vital signs plays a crucial role in the early detection of patient deterioration and in the prevention or management of high-risk clinical diseases [2]. However, conventional approaches to patient risk stratification often rely on rigid threshold-based rules or black-box machine learning models, which may lack interpretability but also adaptability to individual patient profiles.

In this context, we propose the development of a supervised classification system based on Natural Computation techniques, specifically Evolutionary Computation, namely Grammatical Evolution (GE). Taking as a reference the Framingham Heart Study Dataset [1] —which includes 16 clinical features such as heart rate, cigarettes per day, systolic and diastolic blood pressure, and others —we aim to build human-readable classification models that predict whether a patient is at clinical risk or not. Clinical risk refers to the presence of physiological indicators that deviate significantly from established healthy ranges, suggesting a potentially compromised or unstable clinical condition. This approach tries to make a step forward with respect to the limitations of traditional methods by generating flexible and interpretable decision strategies directly from clinical data collected from patients.

**Solution** We intend to demonstrate, using the Framingham Heart Study Dataset [1], that GE can generate classification models that, while possibly comparable in predictive performance to standard methods, offer significantly higher interpretability, making them more suitable for clinical practitioners to understand and apply in real-world decision-making. In this framework, Grammatical Evolution (GE) will utilize a predefined grammar to guide the construction of classification rules, ensuring syntactic correctness and medical plausibility. The fitness function will be designed to minimize the classification error, while penalizing excessive model complexity. The candidate models generated by GE will be compared against traditional baseline classifiers (such as Decision Tree or SVM) in terms of accuracy, weighted F1-score, interpretability and other interesting metrics. Through this approach, we aim to demonstrate that Natural Computation techniques can be applied to generate clinically relevant and understandable decision models in the healthcare domain.

**Value Proposition** The proposed solution creates significant value within the digital health domain by introducing an interpretable system for patient risk classification.
First, it promotes early identification of high-risk patients, supporting timely interventions, and potentially reducing the incidence of medical complications and associated healthcare costs.
Second, it transforms clinical data into understandable decision rules, enhancing clinical workflows without adding cognitive load to healthcare providers.
Third, utilizing the flexibility of GE, the system aligns with the principles of personalized and interpretable artificial intelligence, enabling future integration with wearable health monitoring devices, telemedicine platforms, and real-time decision support tools in clinical settings.
Finally, one of our main objectives is to experimentally compare the outcomes obtained through the different Natural Computation approaches and traditional models, in order to identify the most effective and interpretable solution for clinical risk stratification.

# References

[1] National Heart, Lung, and Blood Institute (NHLBI) https://www.framinghamheartstudy.org/

[2] La Russa R, Ferracuti S. Clinical Risk Management: As Modern Tool for Prevention and Management of Care and Prevention Occupational Risk. Int J Environ Res Public Health. 2022 Jan 12;19(2):831. doi: 10.3390/ijerph19020831. PMID: 35055652; PMCID: PMC8776016.