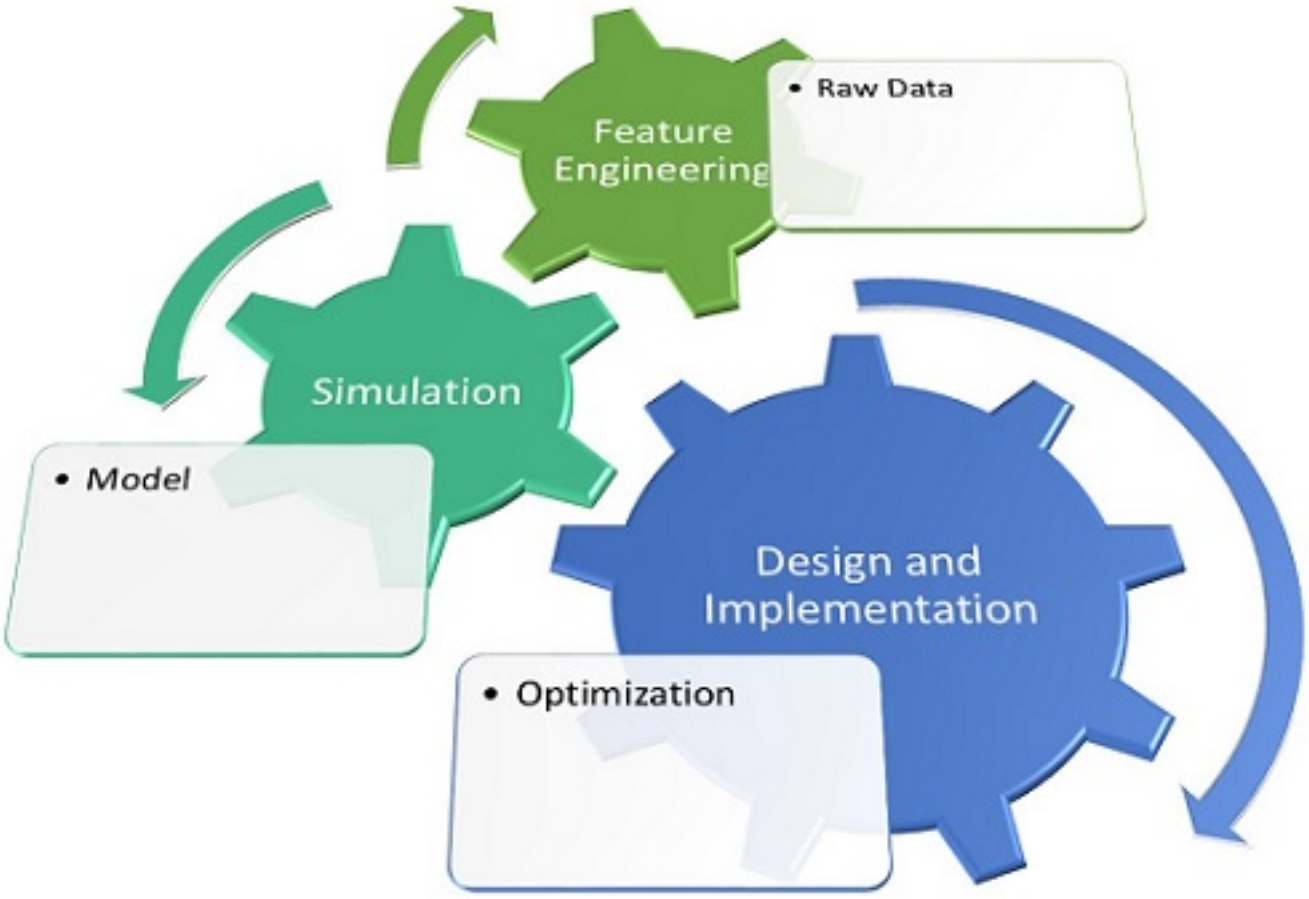
Dunip Tech. has developed new techniques of defining models using Feature Engineering, obtaining models that are simulated using DEVS (Discrete Event Systems Specification) for their study and optimization through (mainly) evolutionary computation techniques.

Sometimes, these systems must be optimized and implemented in hardware. In addition to classic design techniques and hardware implementation, Dunip Tech. has established collaborations to research in the field of evolvable hardware, designing robust systems to unexpected risk situations.

These techniques have already been applied successfully in use cases from areas of Health Sciences and Systems Engineering.



How does it work?

First, it is necessary to have a sufficient and representative set of data for which the model must be defined. Subsequently, using techniques coming from Genetic Programming and combined with classic regression algorithms like LARS (Least-Angle Regression) or LASSO (Least Absolute Shrinkage and Selection Operator), we obtain:

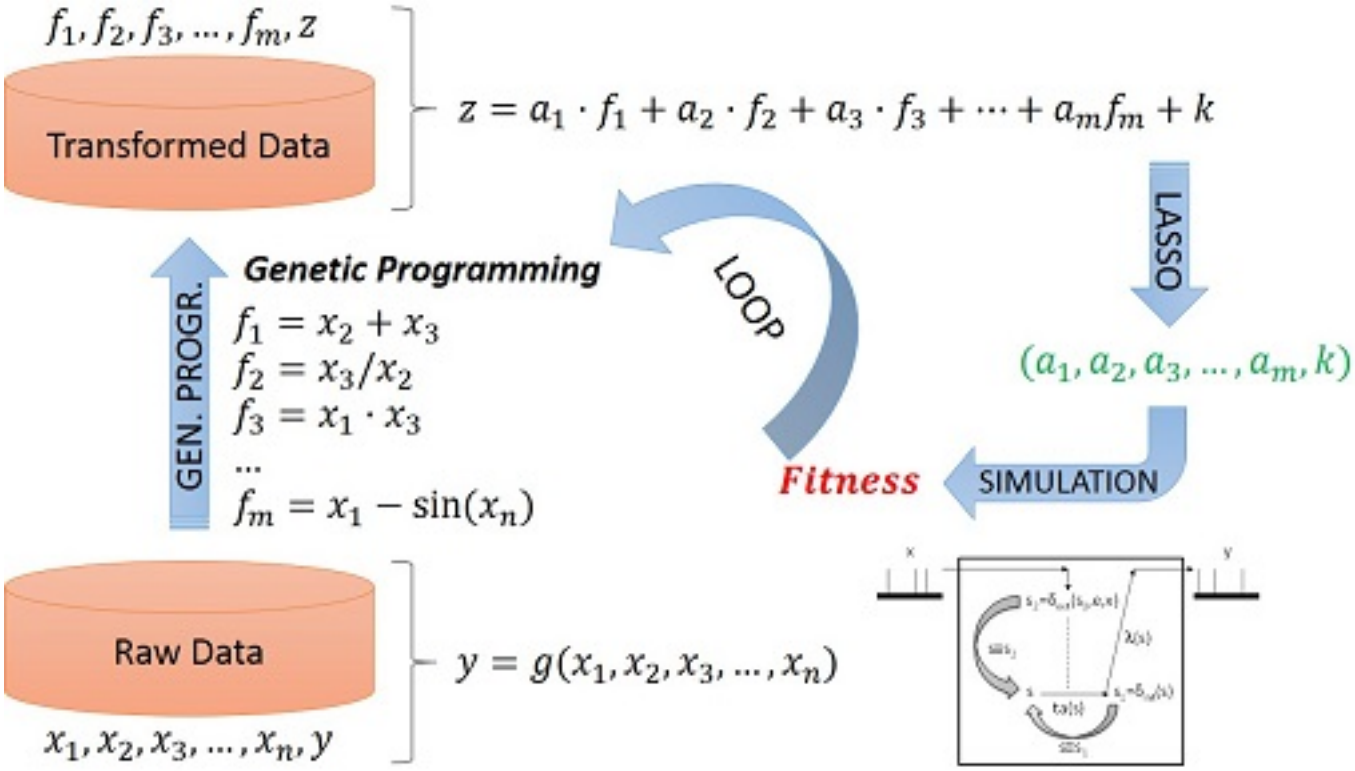
1. the features or combinations of input variables that are representative for the model, and
2. the model itself, which is a function of these features.

Secondly, the model is implemented in software using known techniques for modeling and discrete event system simulation. In particular, DEVS (Discrete Event Systems Specification) is

used. With these models we study the behavior of the system, simultaneously validating its feasibility through simulations in virtual or real time. If the model is substantially large, the DEVS simulation engine allows parallel or distributed simulations in the Cloud.

In many cases, some kind of optimization is needed in the modeled environment or in the model contained therein. Minimization of health risks, energy costs, maximizing performance, etc.., are some examples. To this end, several optimization techniques can be applied: MILP (Mixed Integer Linear Programming), Simulated Annealing, Genetic Algorithms, Particle Swarm, Genetic programming, multi-objective optimization, etc. In some cases, the study leads to the design of a new-robust system that includes adaptive features.

Finally, the system is implemented in hardware. Implementation is gradually performed, integrating both hardware and software models in an environment of co-simulation, checking and validating all the previous studies in a real environment.



Advantages of this method

The design of models using Feature Engineering can explore new models of a system hitherto unknown. In addition, this method supports the incorporation of prior knowledge and experience, which greatly facilitates the understanding and adaptability of these models to the needs of the end user.

The dimensions of the model are not of concern, because using DEVS formalism, model and simulator are completely independent, so parallelization or distribution of the simulations is orthogonal to the implementation of the model.

Adding the benefits of using feature engineering using the foundation of modeling and simulation based on DEVS, for achieving maximum speedup, the final implementation using evolvable hardware is pursued. The development of evolvable hardware introduces a new hardware design concept that easily adapts to unforeseen situations of risk to the system (degradation of sensors, radioactivity, aging, etc..).

Where has this method been applied

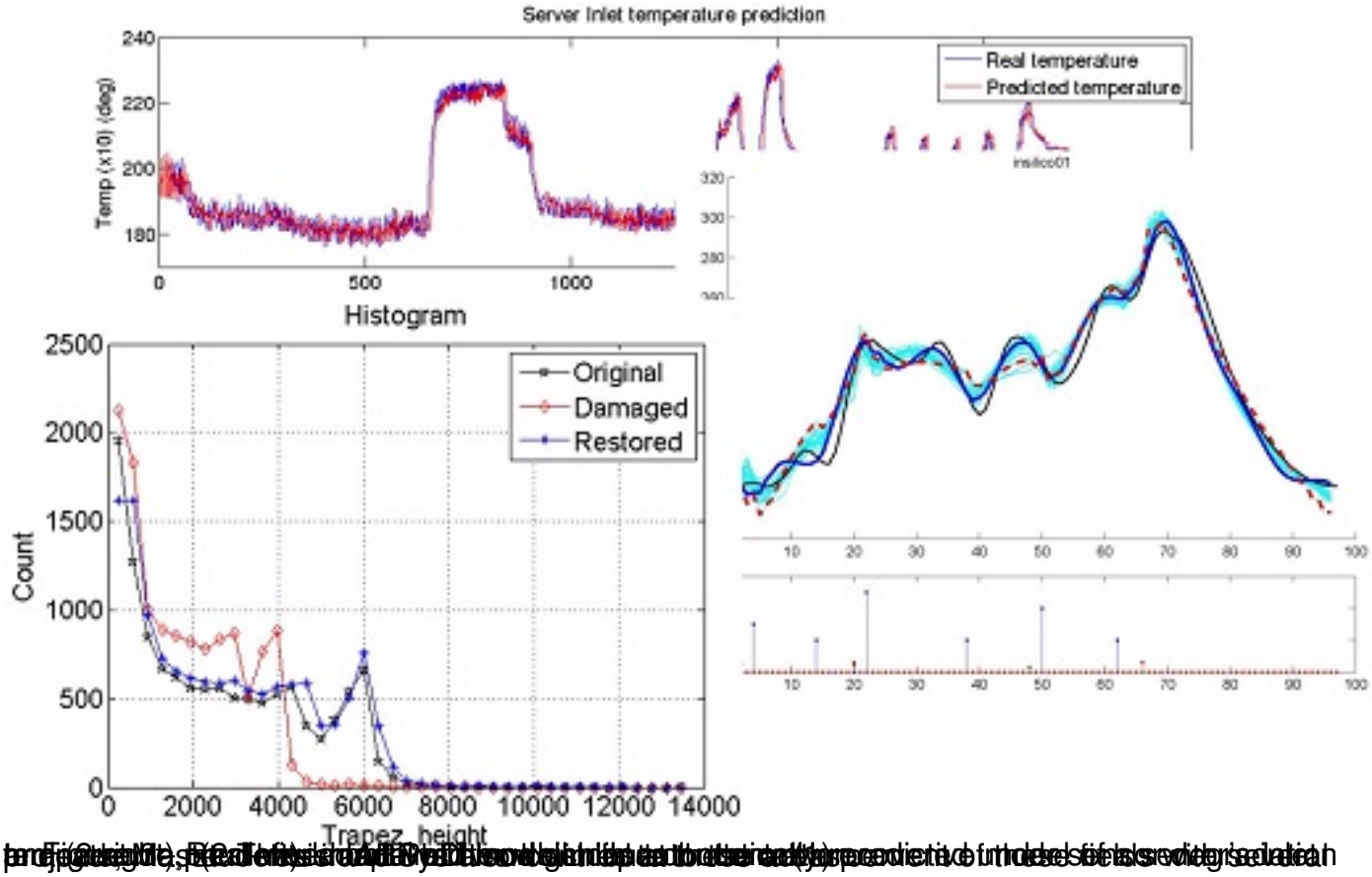
Dunip Tech., in collaboration with the Adaptive and Bioinspired Systems (**ABSys**) research

group, has developed several studies on the blood glucose concentration, based on feature engineering, with two Spanish hospitals.

We have also applied feature engineering in collaboration with the research group **GreenDisc** for Centro de Supercomputación y Visualización de Madrid (**CeSViMa**) in order to obtain prediction models for energy consumption.

Dunip Tech. applies DEVS-based M&S research in this field in collaboration with ABSys and ACIMS (Arizona Center for Integrative Modeling and Simulation, http://acims.asu.edu/), at the University of Arizona.

In the optimization area, Dunip Tech. has experience and a repo of tools with a variety of methods for numerical and non-numerical optimization, with emphasized research in the areas of Evolutionary Computation and Soft Computing.


Server Inlet temperature prediction
Temp (x10) (deg)
Real temperature
Predicted temperature
Histogram
Original
Damaged
Restored
Count
Trapez_height