UNIVERSITEIT GENT

FACULTY OF ENGINEERING

Grid-enabled Adaptive Surrogate Modeling for Computer based Design

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Adaptive Surrogate Modeling

Motivation

Accurate, physics-based **simulation codes** are not always available or too **costly** to use for optimization, design space exploration, parameter sweeping, *what-if* analysis,... Depending on complexity, a single simulation may take many hours on modern hardware. A **cheap approximation** of the system is **needed** to make such tasks feasible.

Goal

Given a black-box simulator, generate a ***global* surrogate model** that captures the complex behavior of the system over the complete design space as accurately and efficiently as possible. This model can then be used by an engineer for optimization, sensitivity analysis, ... or as part of a larger simulation environment (model chaining).

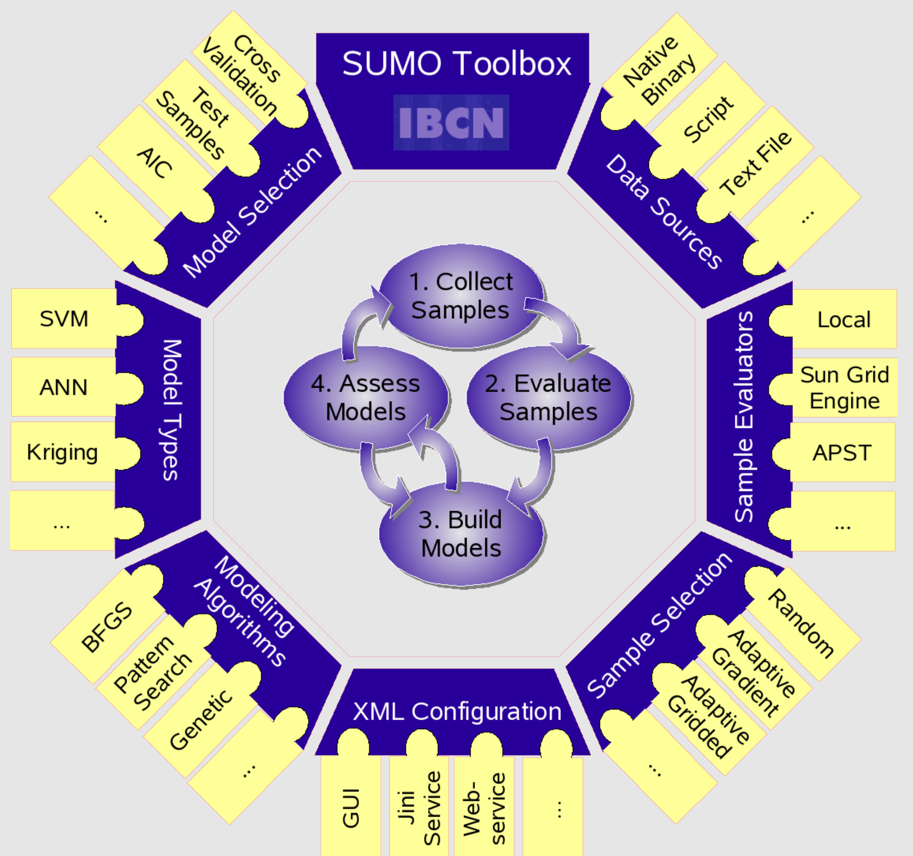
Our Solution

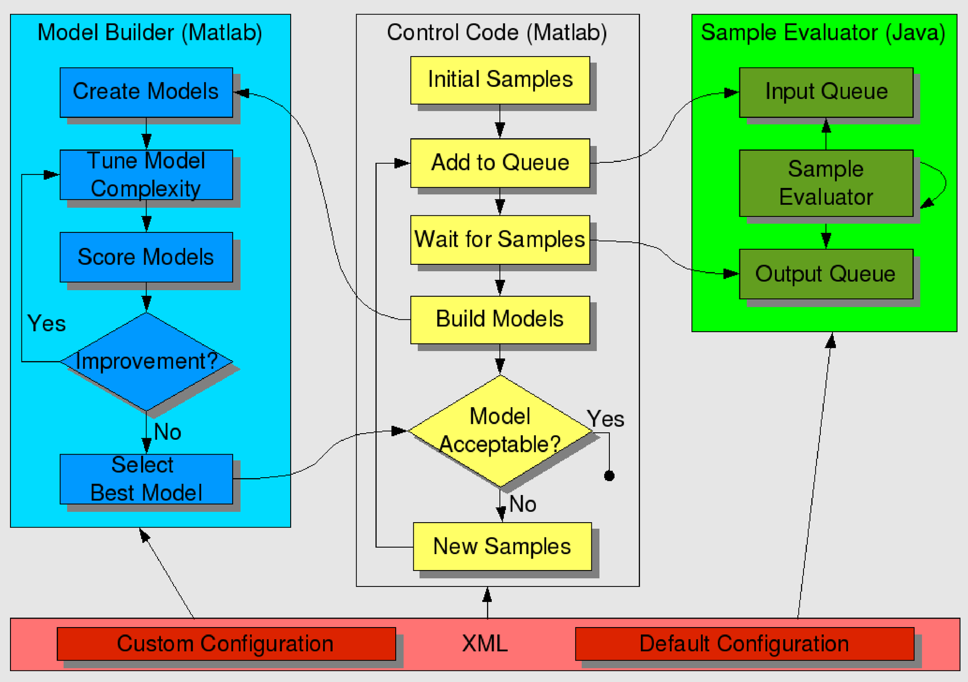
We study and develop fully **automated sequential surrogate modeling** techniques for efficient optimization and design space exploration, which minimize the overall number of computational expensive simulations.

SUrrogate MOdeling toolbox – SUMO Toolbox

The *SUrrogate MOdeling toolbox* (SUMO) is a MATLAB® toolkit for adaptive surrogate modeling. Given a datasource, the toolbox will iteratively generate a global approximation using as little datapoints as possible. Its algorithms are fully adaptive, requiring no user interaction and will run until a pre-defined accuracy level is reached.

There is no such thing as a "one-size-fits-all" solution. Each aspect of the toolbox has therefore been implemented with modularity and extensibility in mind and can be easily configured using XML.





Design Goals

- Construct standalone, global surrogate models (metamodels)
- Minimize prior knowledge about the simulator
- Minimize the number of simulator evaluations
- Pre-defined accuracy
- Fully adaptive, minimizing user interaction
- Fully pluggable and extensible
- Easy integration in the design process

Bridging the gap between simulation and engineer

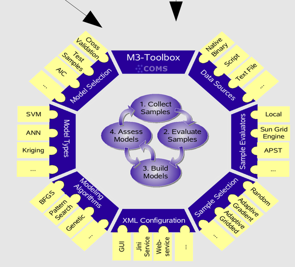
Applications: Chemistry | Aerodynamics | Electro-Magnetism | ...

Data source

input → Real World → response

x_i → Simulation Model → y_i

Adaptive surrogate modeling



SUMO Toolbox

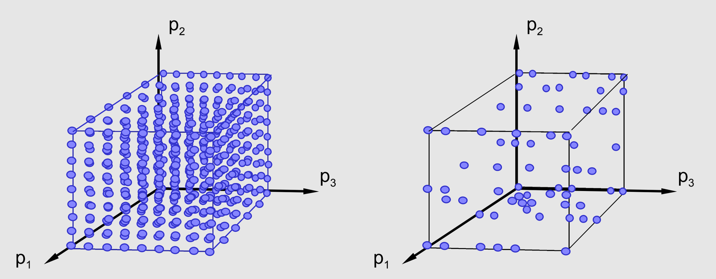
Cheap global surrogate model

x_i → Surrogate Model → y_i

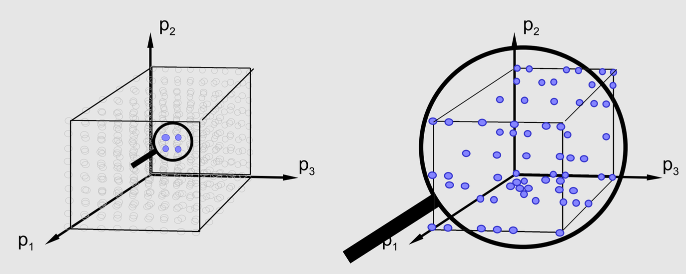
Fully automatic model generation

Integration into the design process: Prototyping | Optimization | What-if Analysis | ...

Technologies and Examples

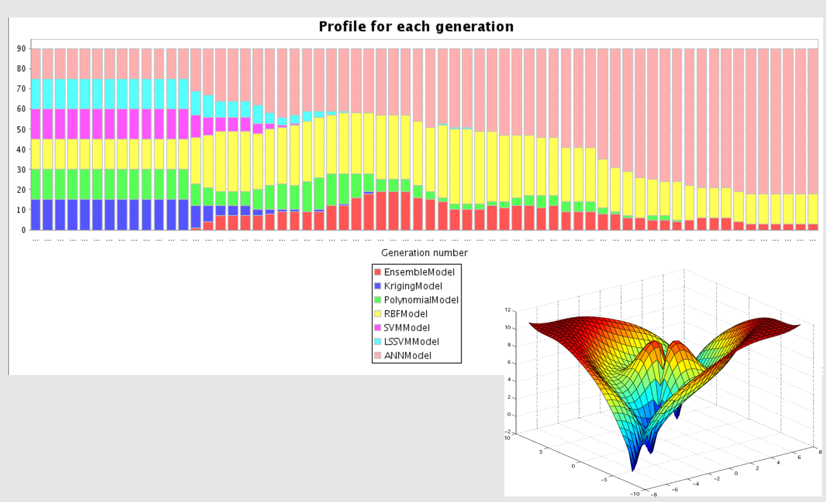


Adaptive Sampling

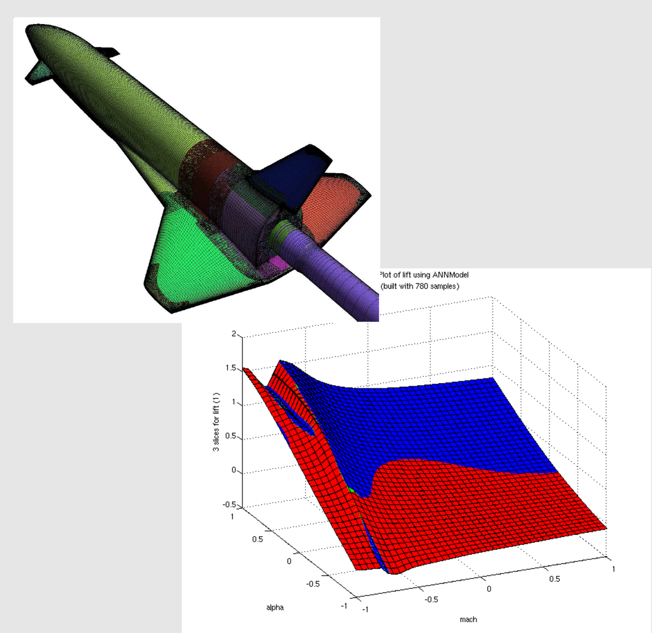


Adaptive Modeling

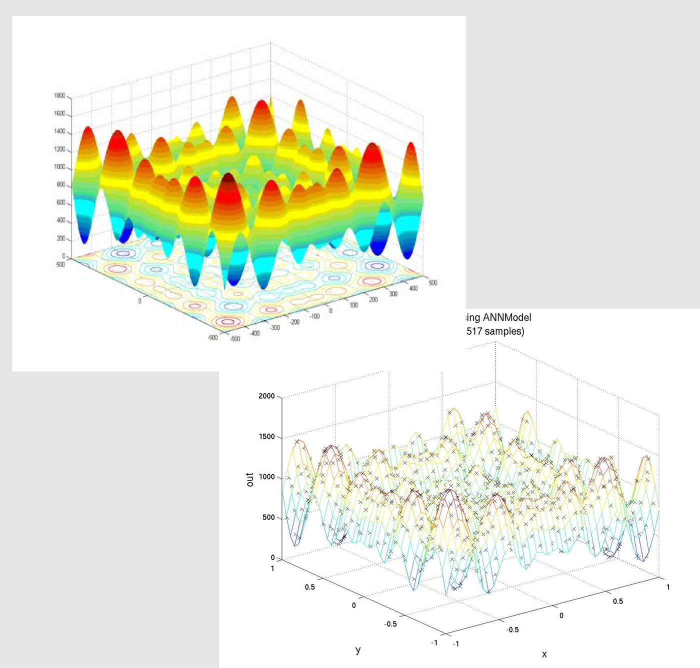
Distributed Computing



Automatic Model Type Selection



Aerodynamics



Schwefel Function

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visit http://sumo.intec.ugent.be