



**Aquitaine –Karnataka collaboration
Scientific Project for Pre-PhD student exchange**

Scientific Proposal

Project Title	Black-Box Models for Complex CFD functions
Scientific domain	Surrogate Modelling, Aerospace Technology.
Summary (ca. 10 lines)	<p>Approximation models for complex CFD functions can be constructed to reduce the computational time and power required for the solution of the actual CFD functions. Kriging is one of the approaches which can be used to construct surrogate models.</p> <p>Methodology: Initially, the expensive computer based simulations will be conducted at some of the design points within the defined design space. The design point is a group of variables which will influence the response value(s). The range of values of the design variables will define the design space. Once the data are obtained at the defined number of design points, then the data can be used to train the approximation model which can be constructed using Ordinary Kriging approach.</p> <p>Construction of surrogate models: The geometry (airfoil/Wing) should be parameterized using some suitable parameterizations schemes. The structural and flow conditions around the geometry has to be defined using the aerodynamic flow and structural parameters. The geometrical and flow parameters will serve as the design variables to the problem. Once the design variables are defined, then the location of design points within the design space defined by the design variables can be selected arbitrarily or using some Design Of Experiments techniques. Then the actual CFD simulations can be performed at these design points. The design points and the corresponding response values will serve as the data for the surrogate models to imitate the behavior of the complex CFD algorithms. Ordinary Kriging approach will manipulate the data so that it can construct a model which will actually approximate the function by which the actual data have been obtained. Then the surrogate model can be used in the place of actual CFD algorithms in processes like aerodynamic shape optimization.</p> <p>Validation: The constructed surrogate model can be validated using some of the standard approaches like cross-validation.</p>

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Student profile wished	Aerospace Technology, Computer Science, Computational Fluid Dynamics.	
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Timing & duration for project (give approximate ranges)	From 6 to 8 months, Any period in the year	
Selected Publications	<p>Boussouf, L., "Surrogate Based Optimization for Multidisciplinary Design," SAE Technical Paper 2011-01-2507, 2011, DOI:10.4271/2011-01-2507.</p> <p>Selvakumar Ulaganathan, Ivo Couckuyt, Tom Dhaene, Joris Degroote, Eric Laermans, "Performance study of gradient-enhanced Kriging", Engineering with Computers, DOI:10.1007/s00366-015-0397-y, 2015.</p>	

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