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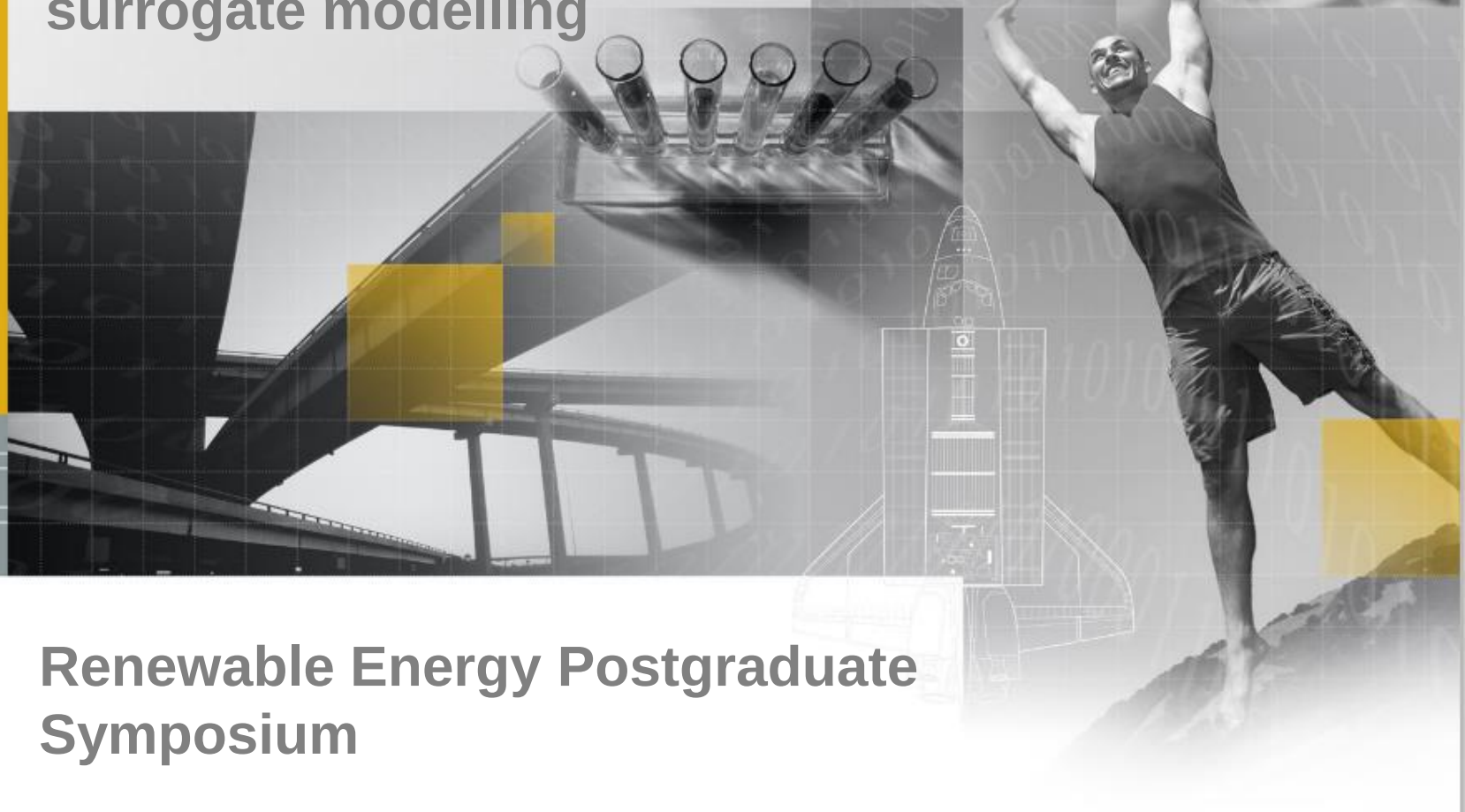
Numerical Optimisation of small scale wind turbine through the use of surrogate modelling



Renewable Energy Postgraduate Symposium

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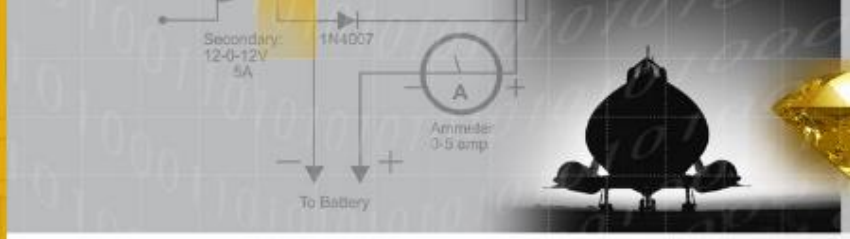

Outline

- Objective
- Background
- Methodology
- Results
- Recommendations

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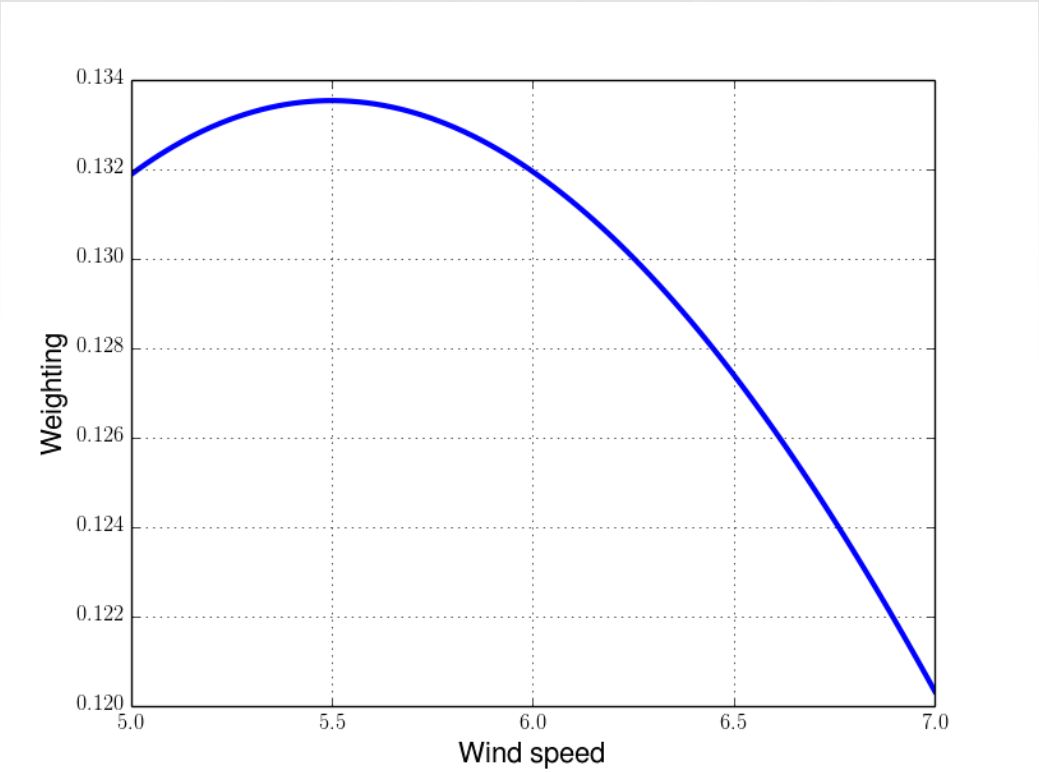
Objective

Optimise a small scale wind turbine

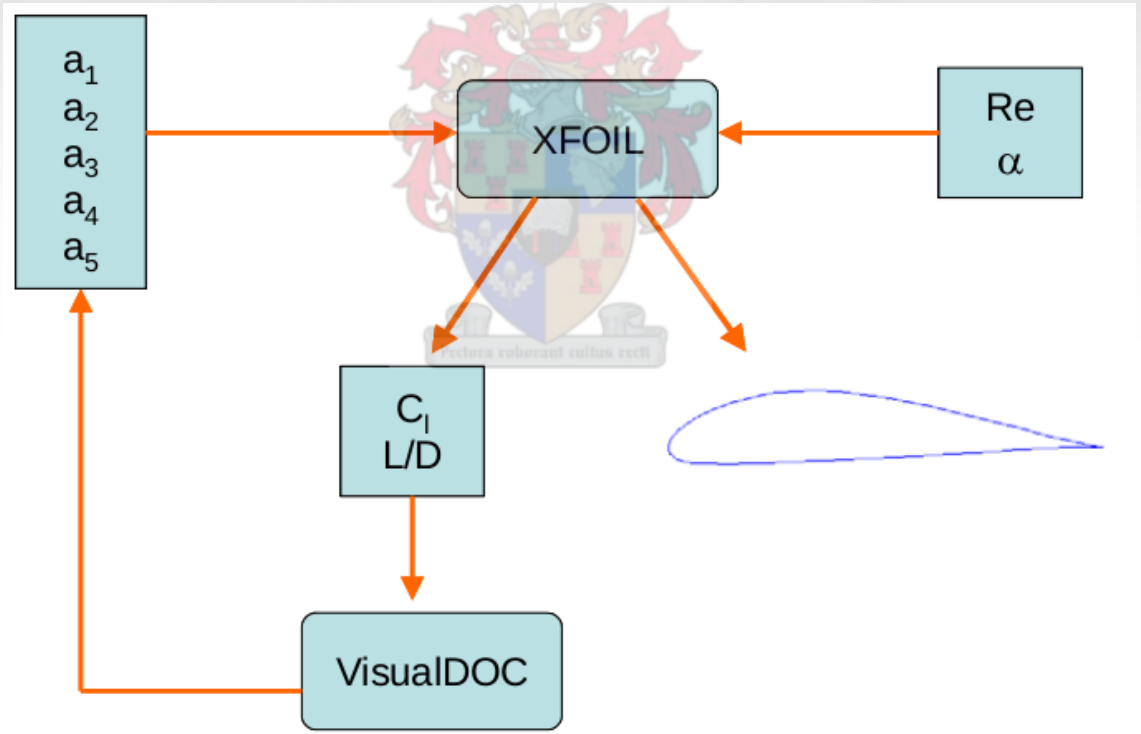
- Range of wind speeds
- Coefficient of power (Cp)
- Betz limit, 0.59



Cencelli (2006)
2 stage optimisation (gradient based and PSO)

2D foil optimisation @ radial stations

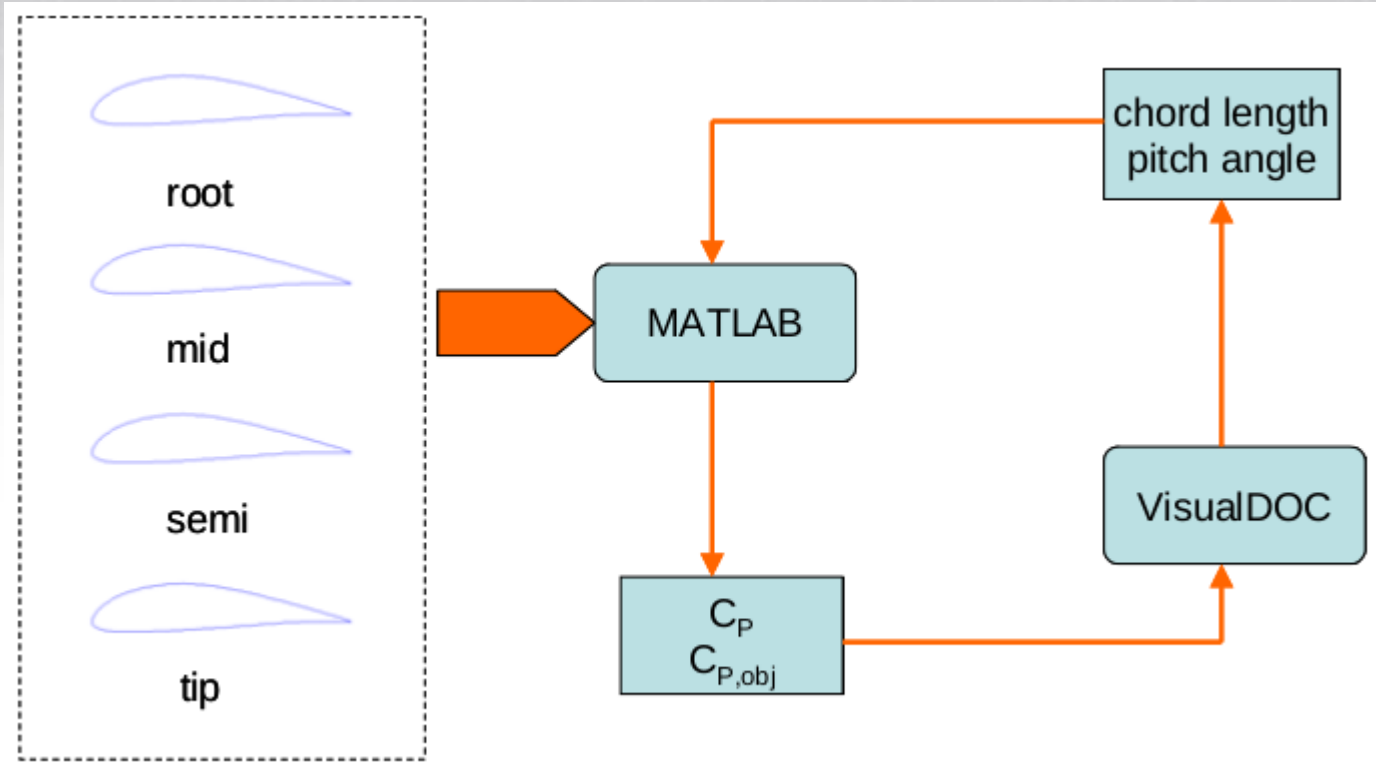
- Generic shape functions and blending fractions
- Up to 5 generic foils



Cencelli (2006)

2 stage optimisation (gradient based and PSO)

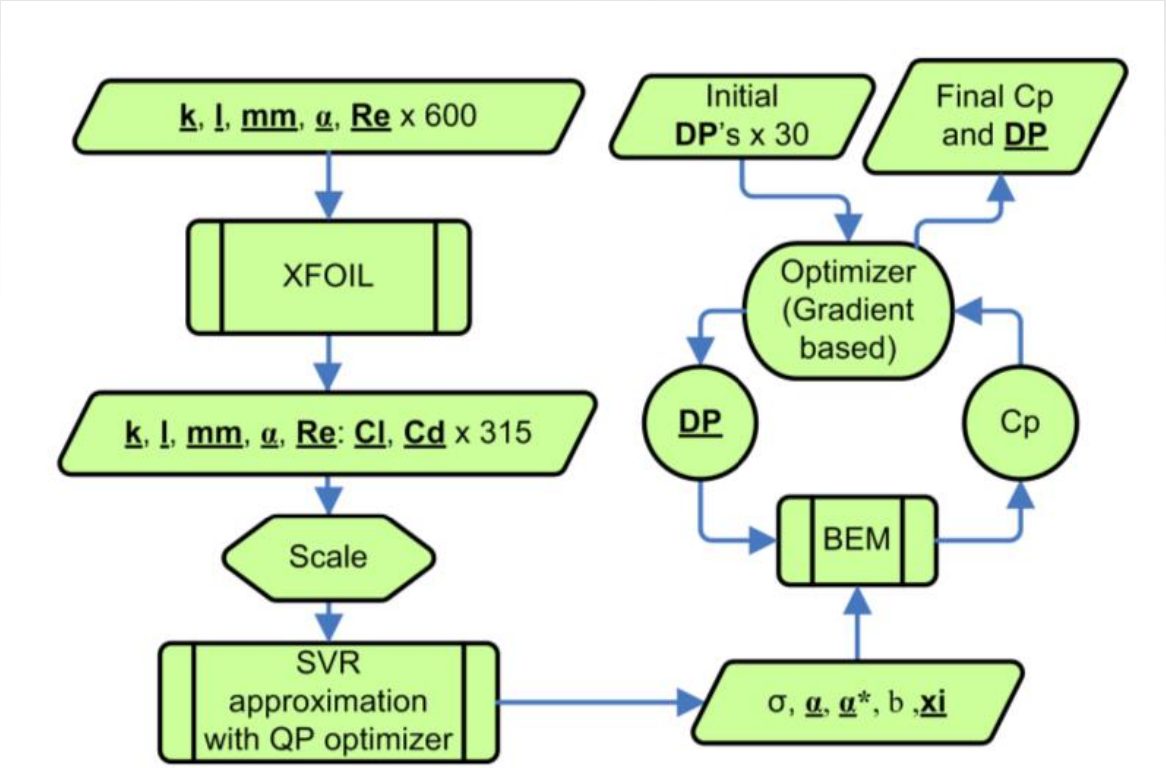
3D optimisation using BEM

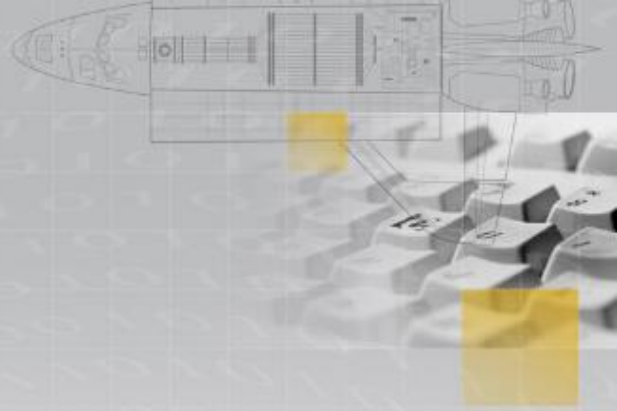


Wise (2008)

Single stage optimisation – gradient based

- NACA 4 digit family
- Surrogate model
  - SVR 315 training points





Methodology

Extend foil selection

- NURBS

Surrogate model

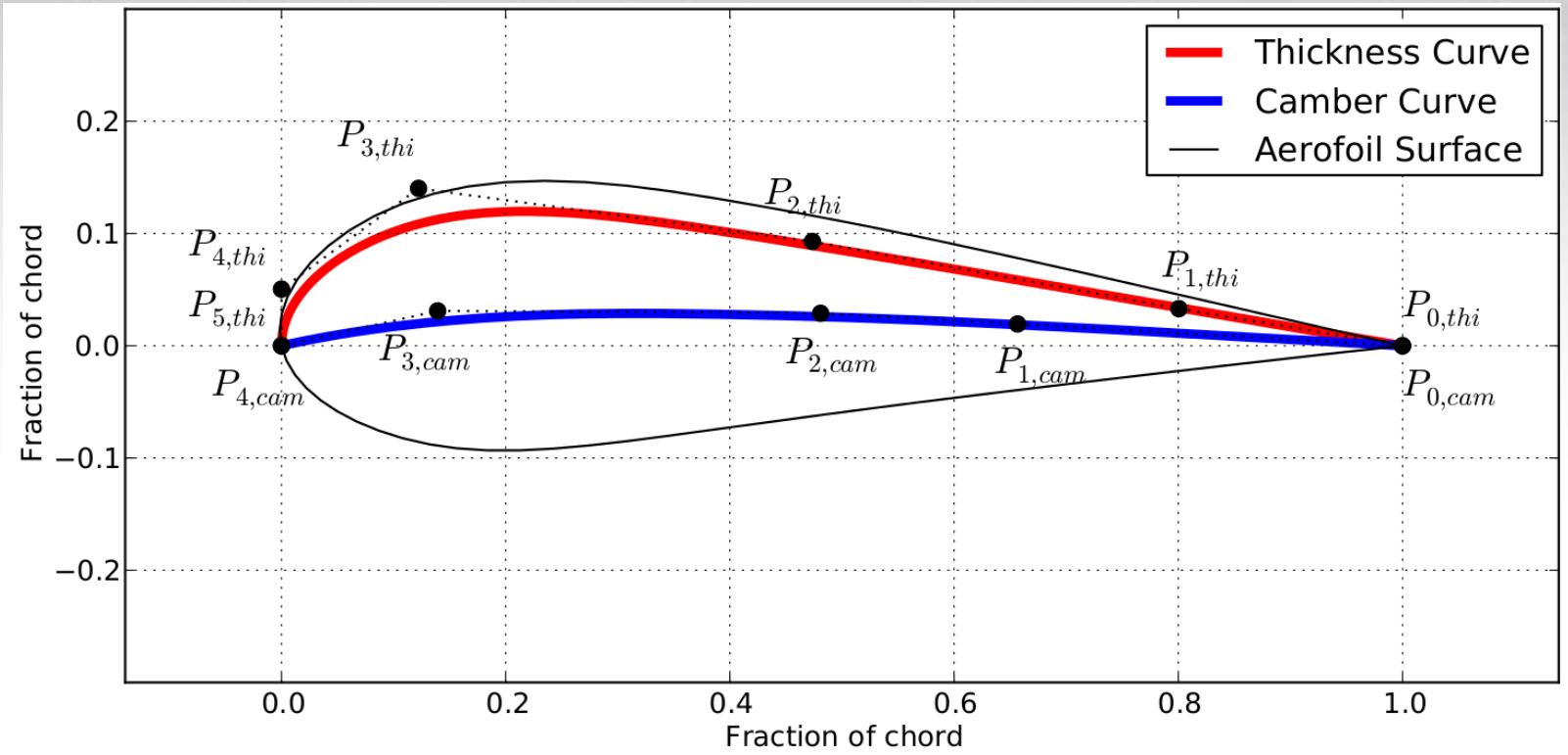
- SVR

Optimisation

- Genetic algorithm

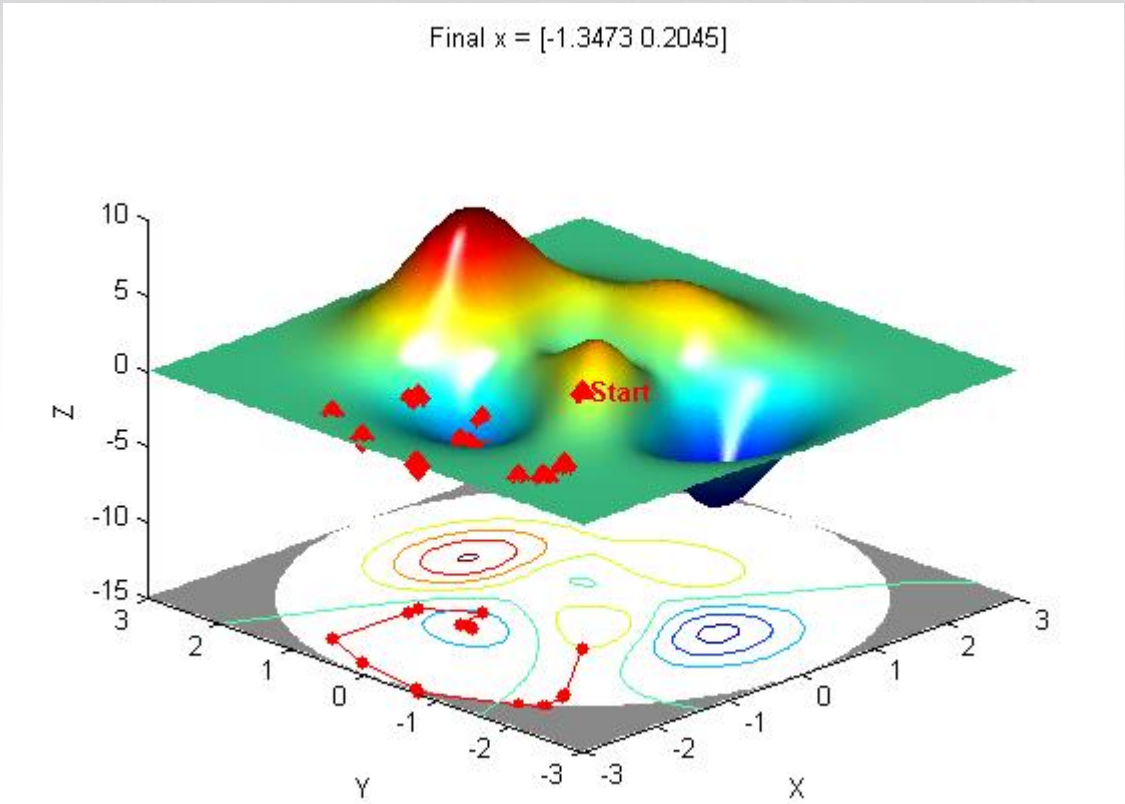
Methodology

NURBS (Wessels, 2012)



Methodology

Genetic algorithm



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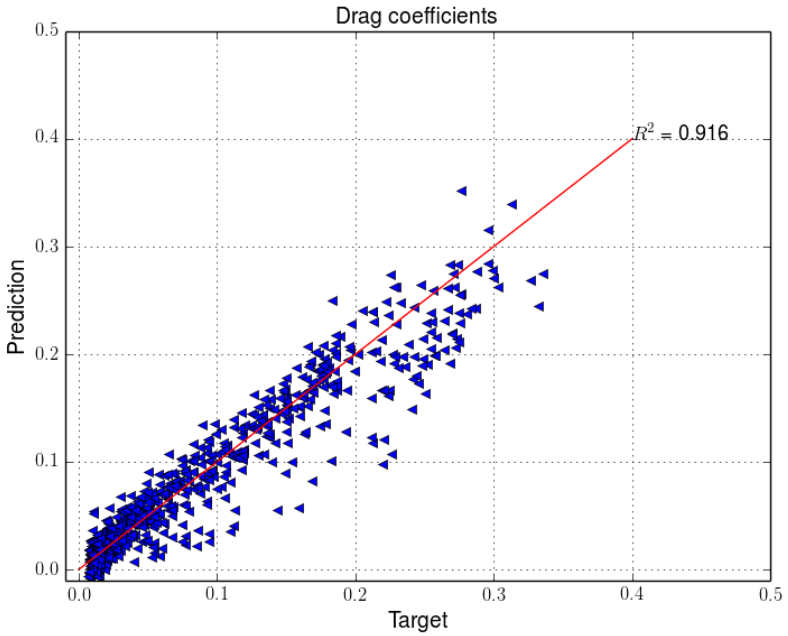
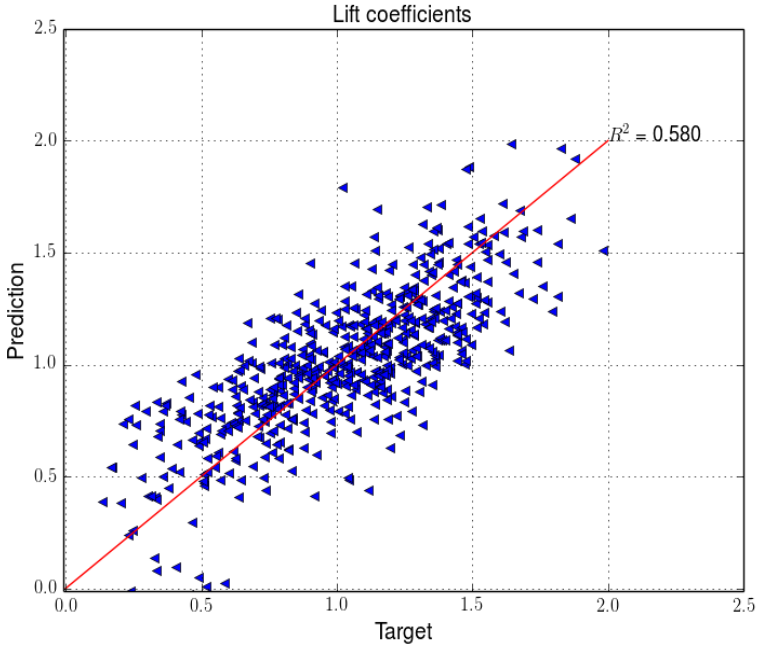
Methodology

SVR

- Training points - 583
- Score

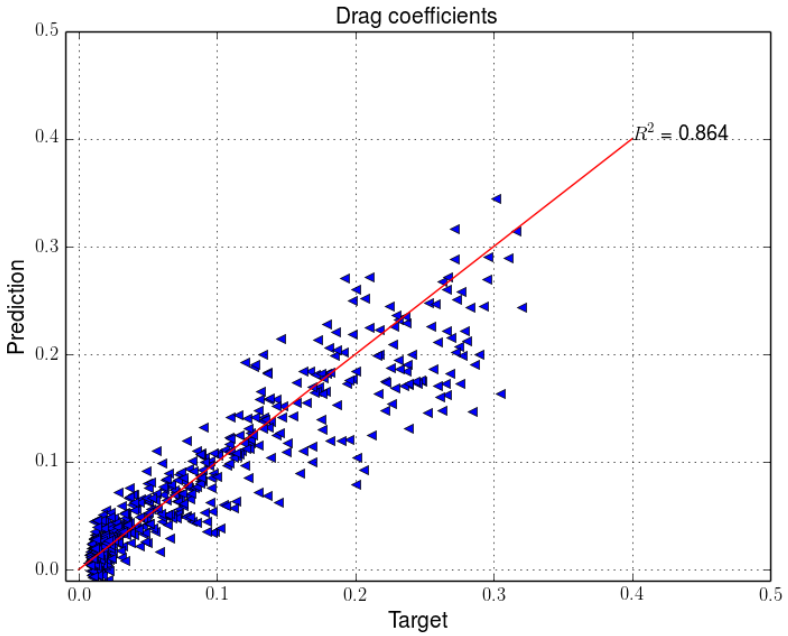


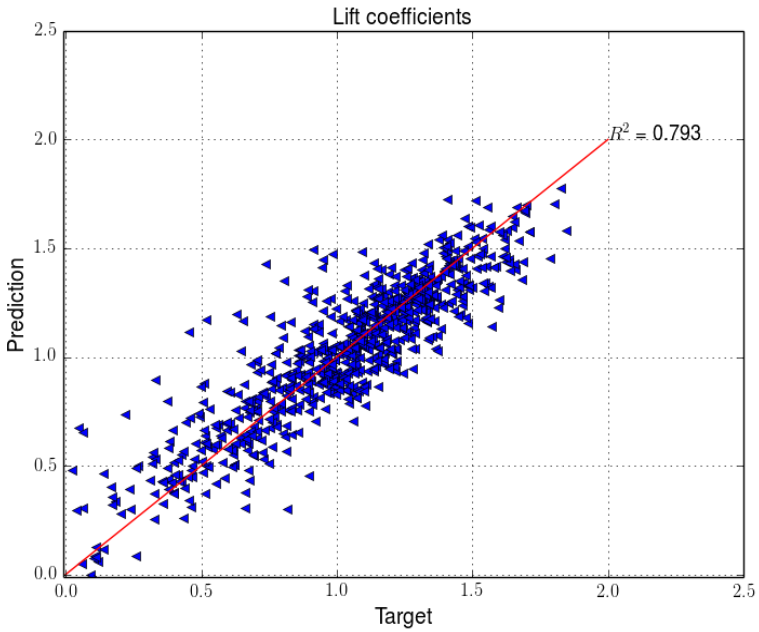


Methodology

SVR

- Training points - 882
- Score

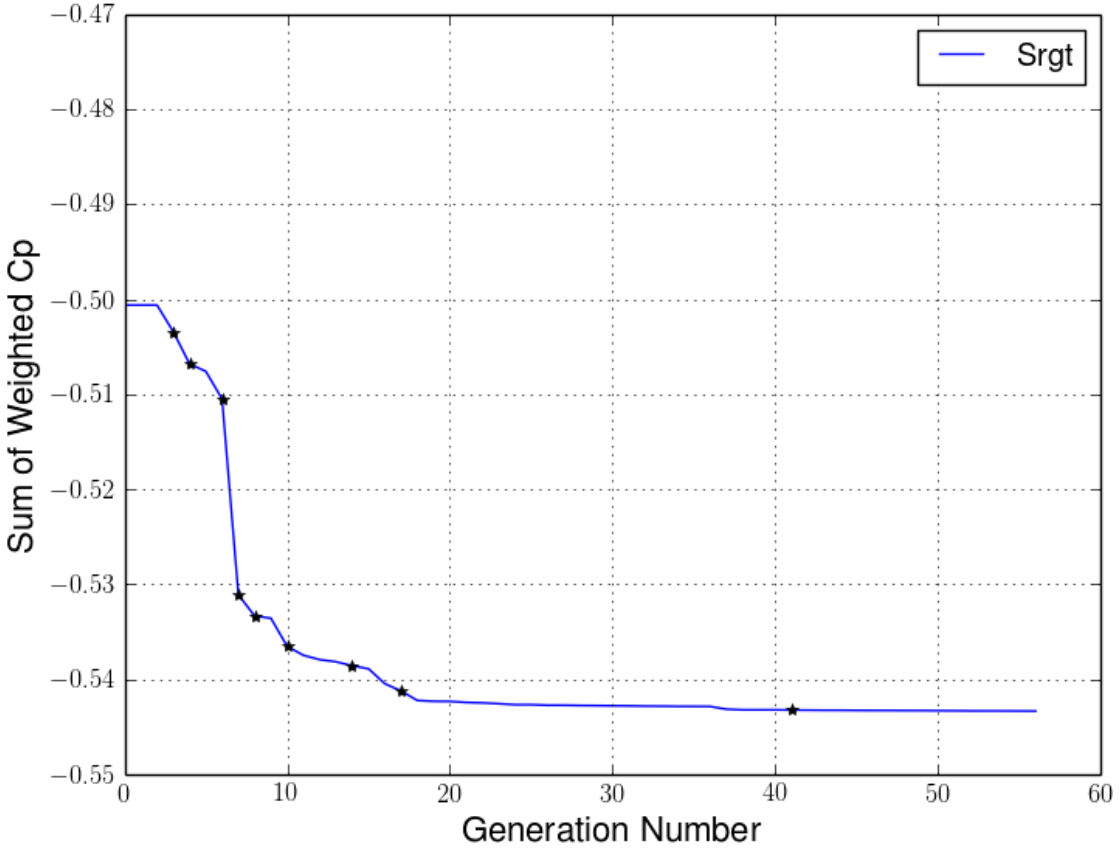




Results

Cp history

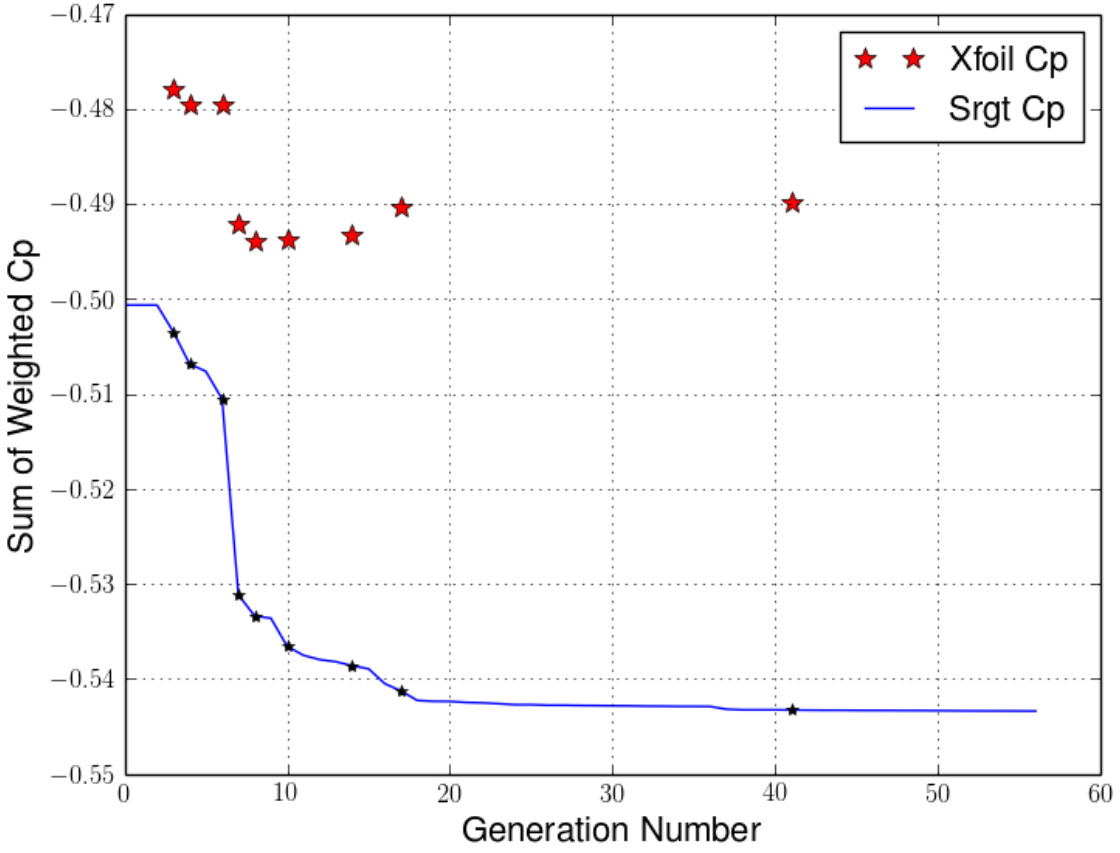
- Single run, starting Cp 0.474



Results

Cp history

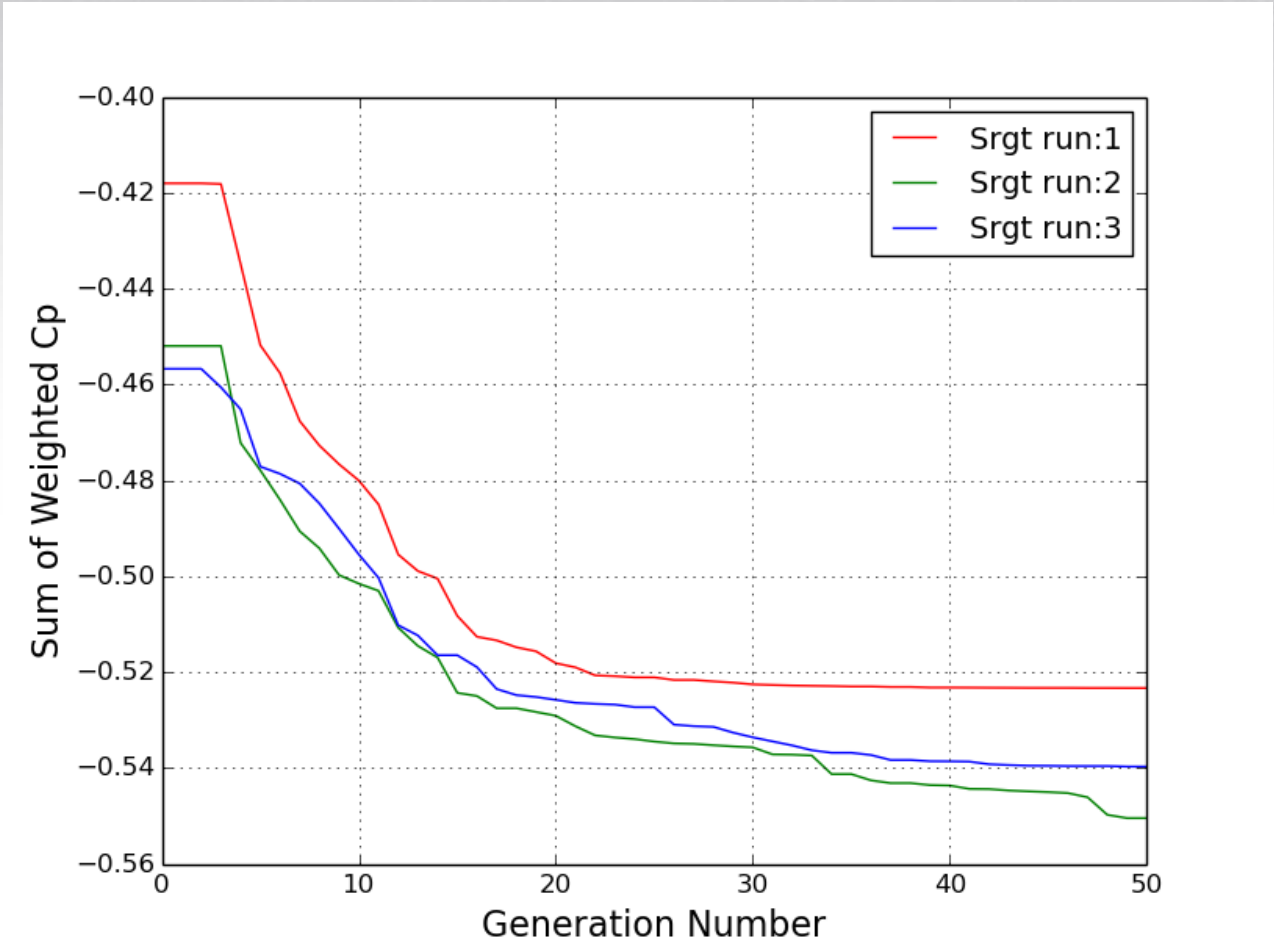
- Single run



Results

Cp history

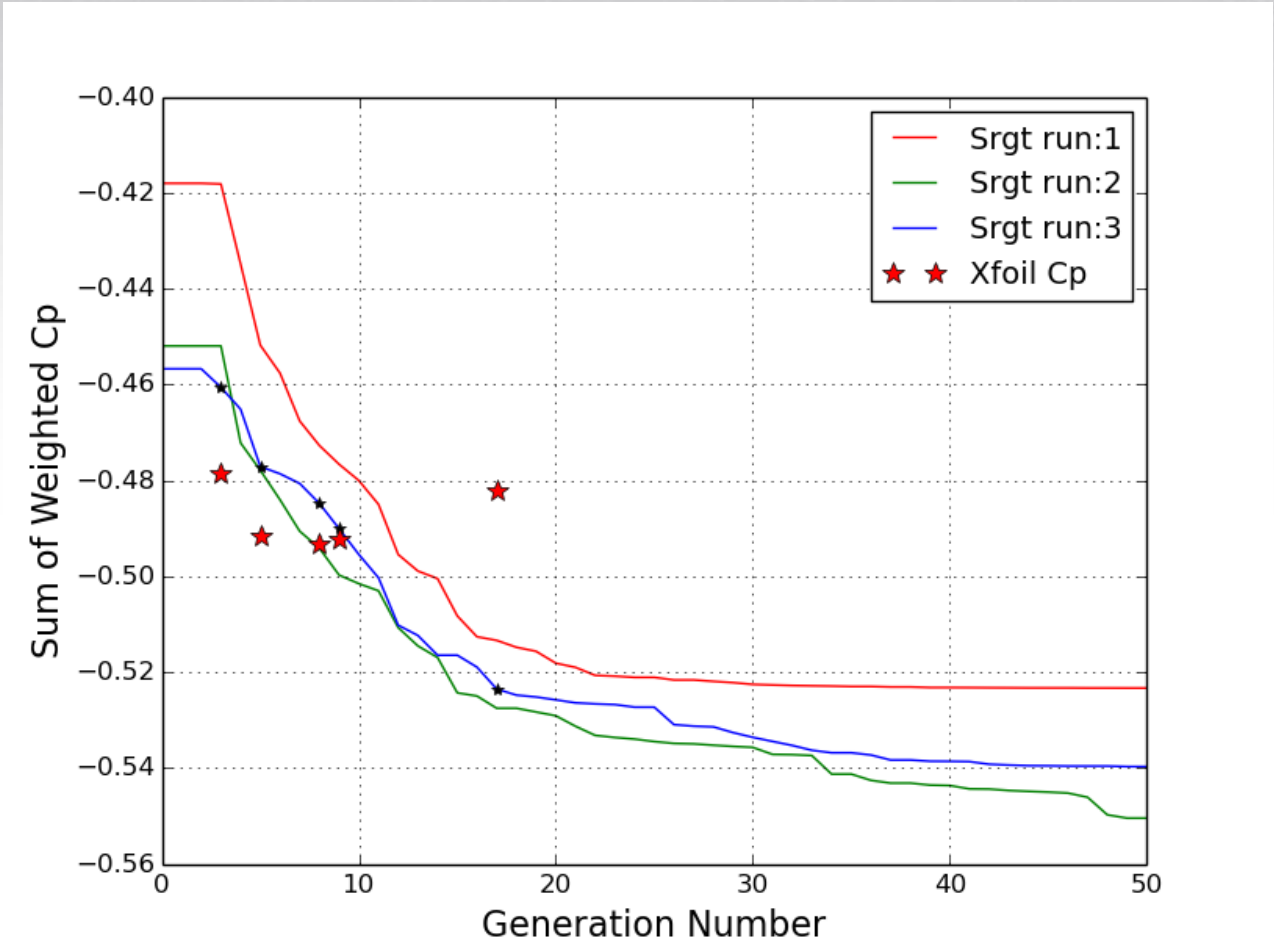
- Update runs



Results

Cp history

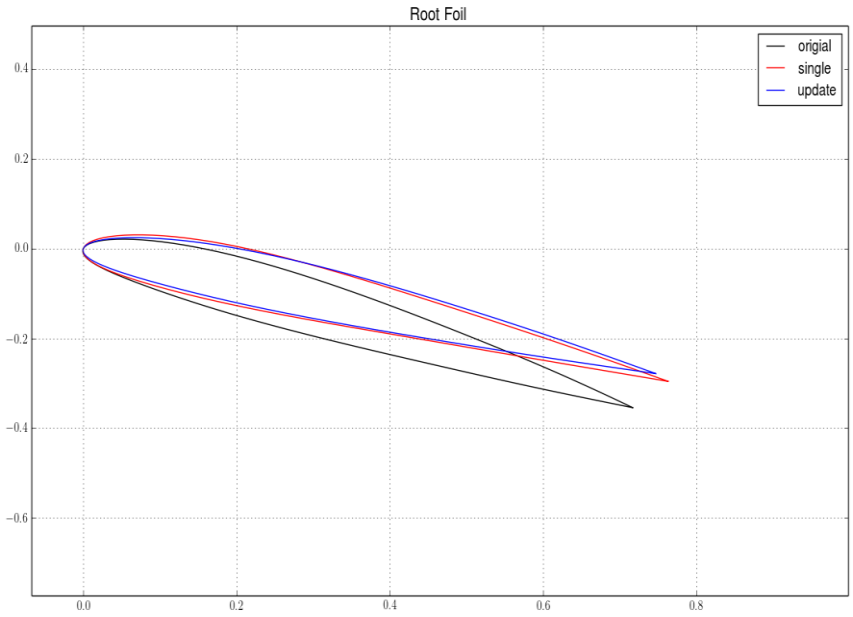
- Update runs

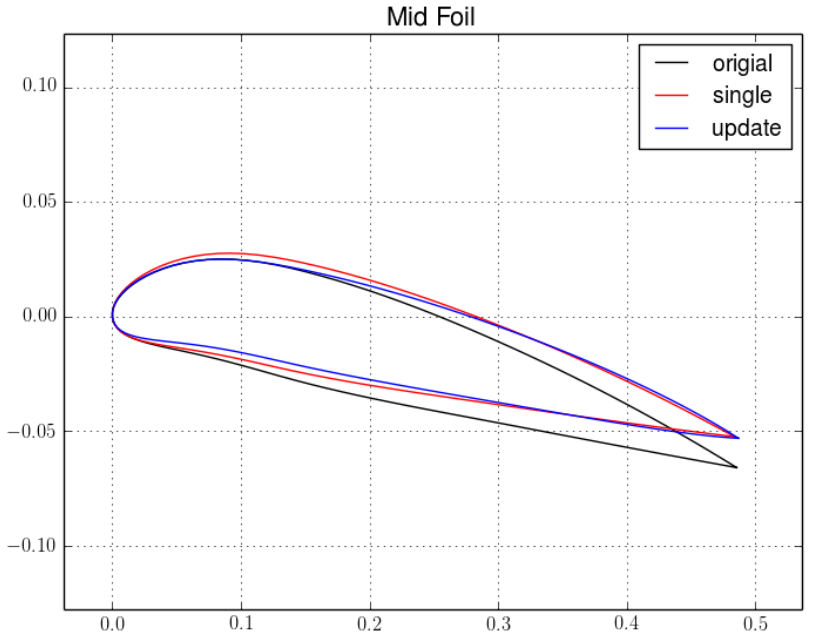


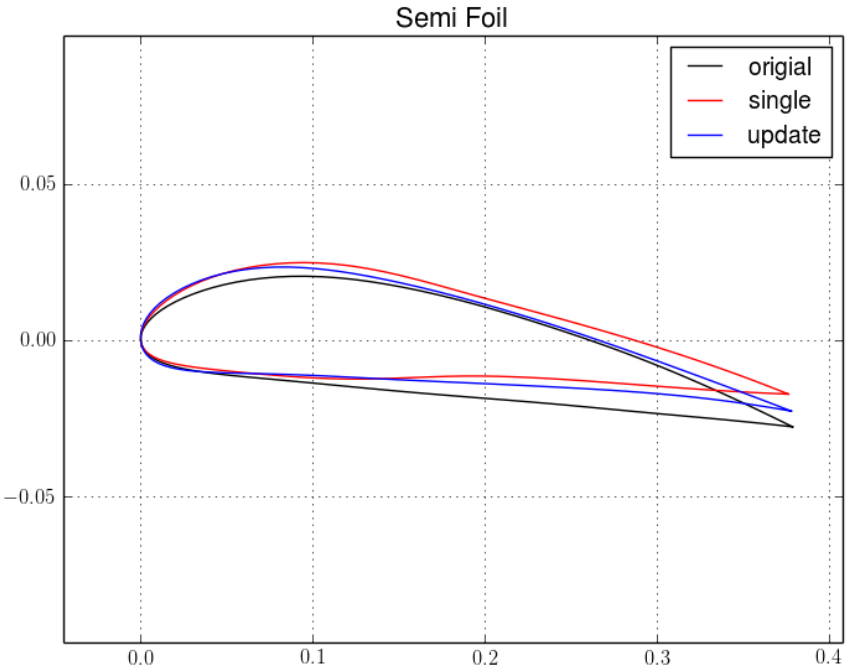
Results

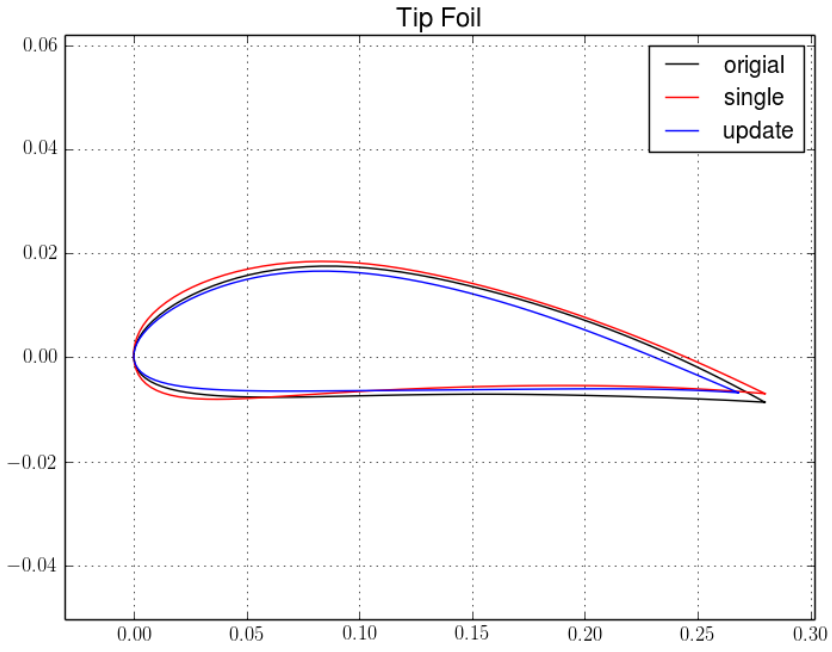
Original blade Cp: 0.474

	Surrogate	# Points	Xfoil
Single	0.531	822	0.493
Update	0.487	887	0.493

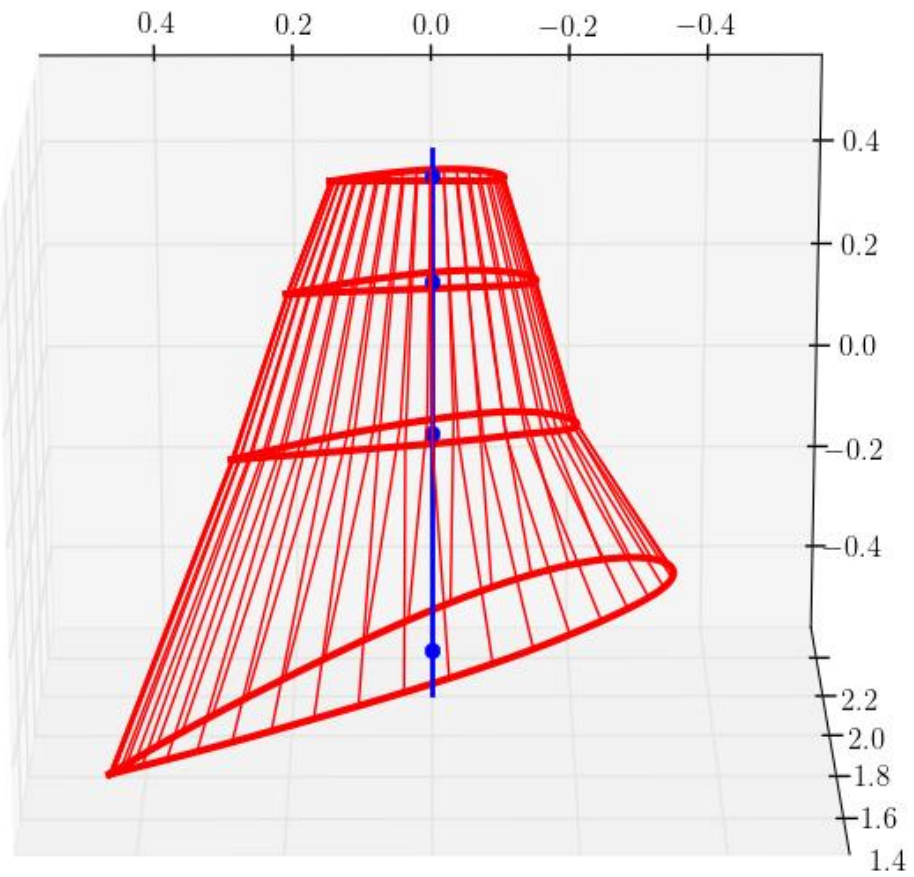

Root Foil
origial
single
update


Mid Foil
origial
single
update

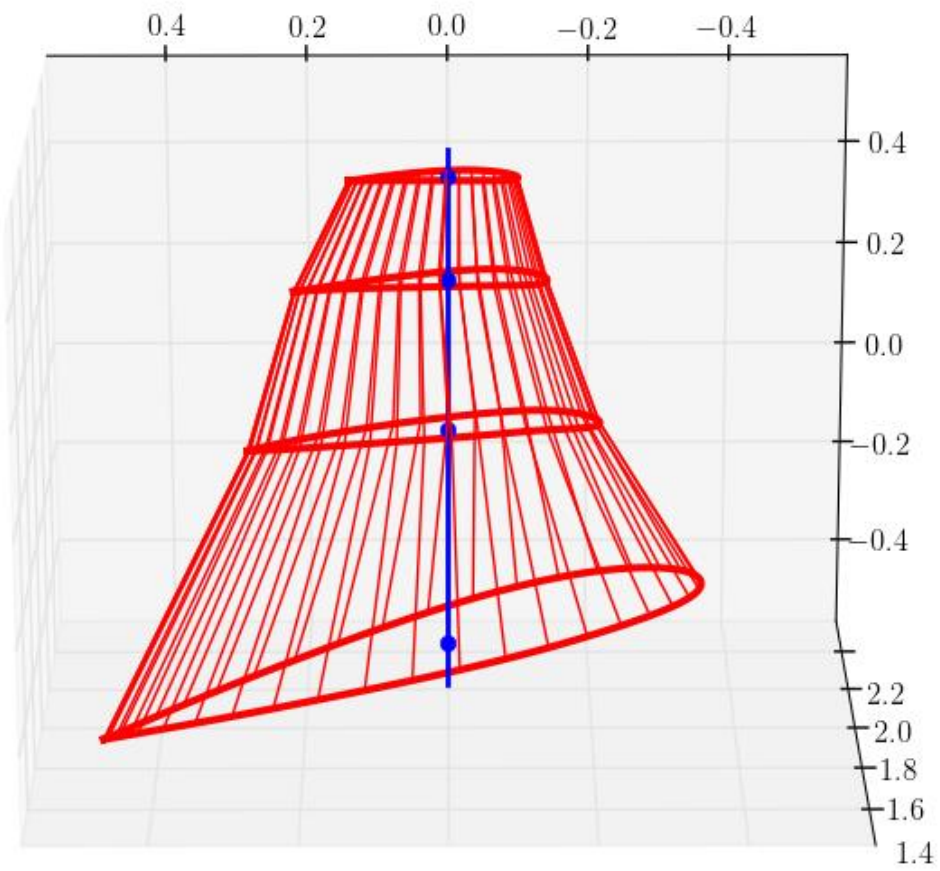

Semi Foil
origial
single
update


Tip Foil
origial
single
update

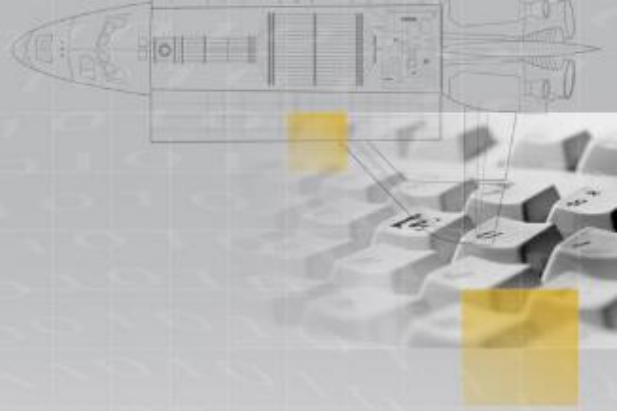
Results



Results



Recommendation



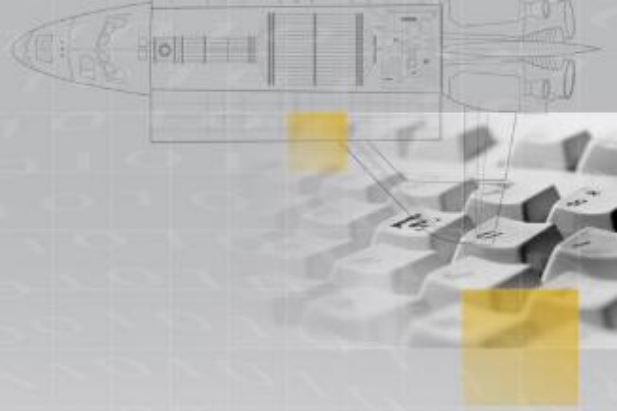
Improve surrogate modelling technique

- **Alternative regression models**

Build custom libraries

- **Python limitations**

Questions



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