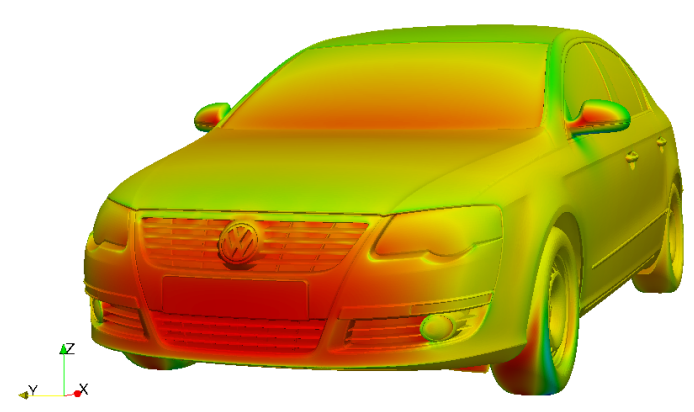


A variable-fidelity surrogate modelling approach

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Motivation



provided by Volkswagen

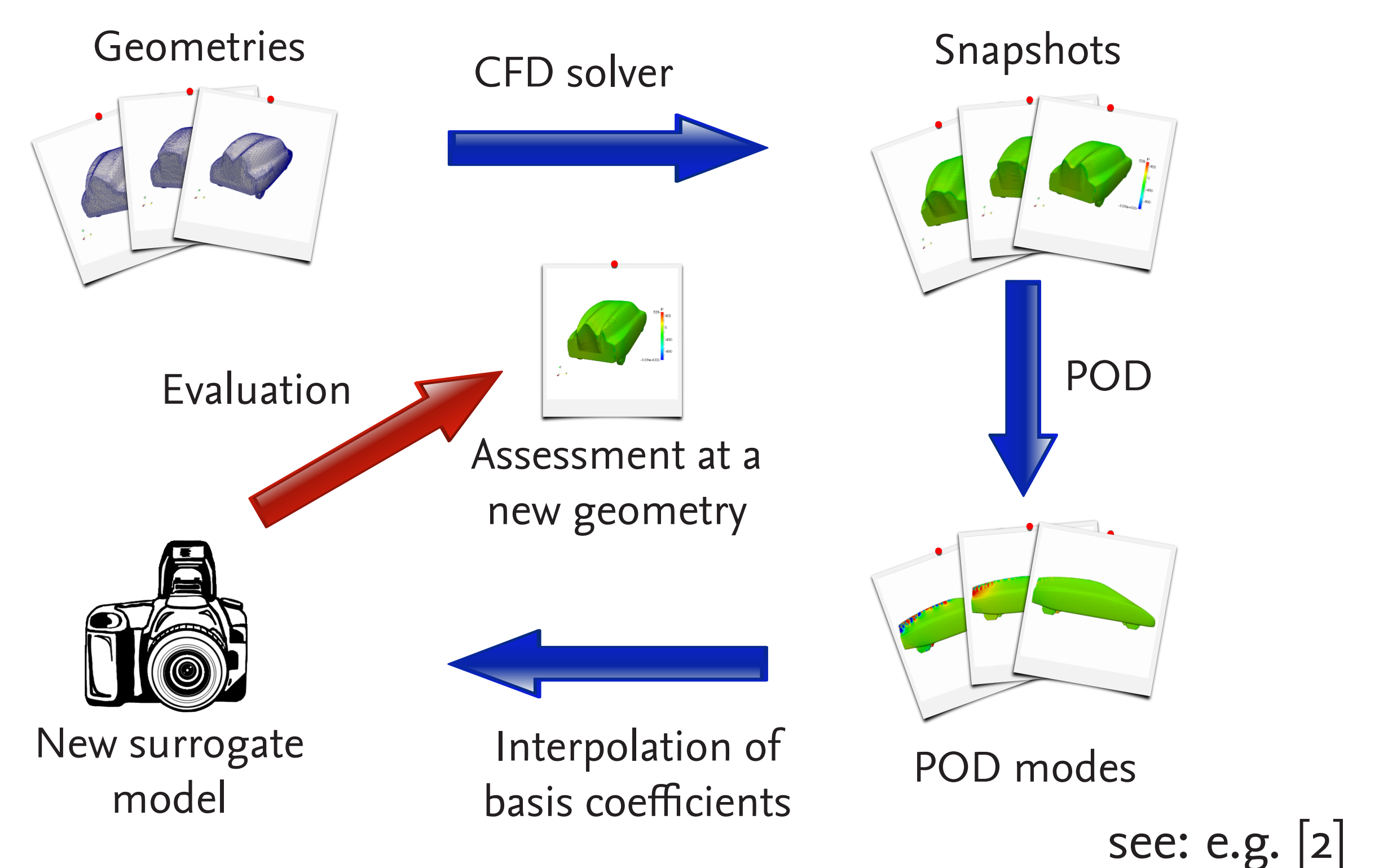
Car shape optimization

Development of an *Interactive Aerodynamic Design* process

→ Approximation of high-dimensional aerodynamic quantities in near-real time

Idea: Combine variable-fidelity interpolation methods with POD to efficiently generate accurate surrogate models.

Combining POD and interpolation



Interpolation method: Kriging

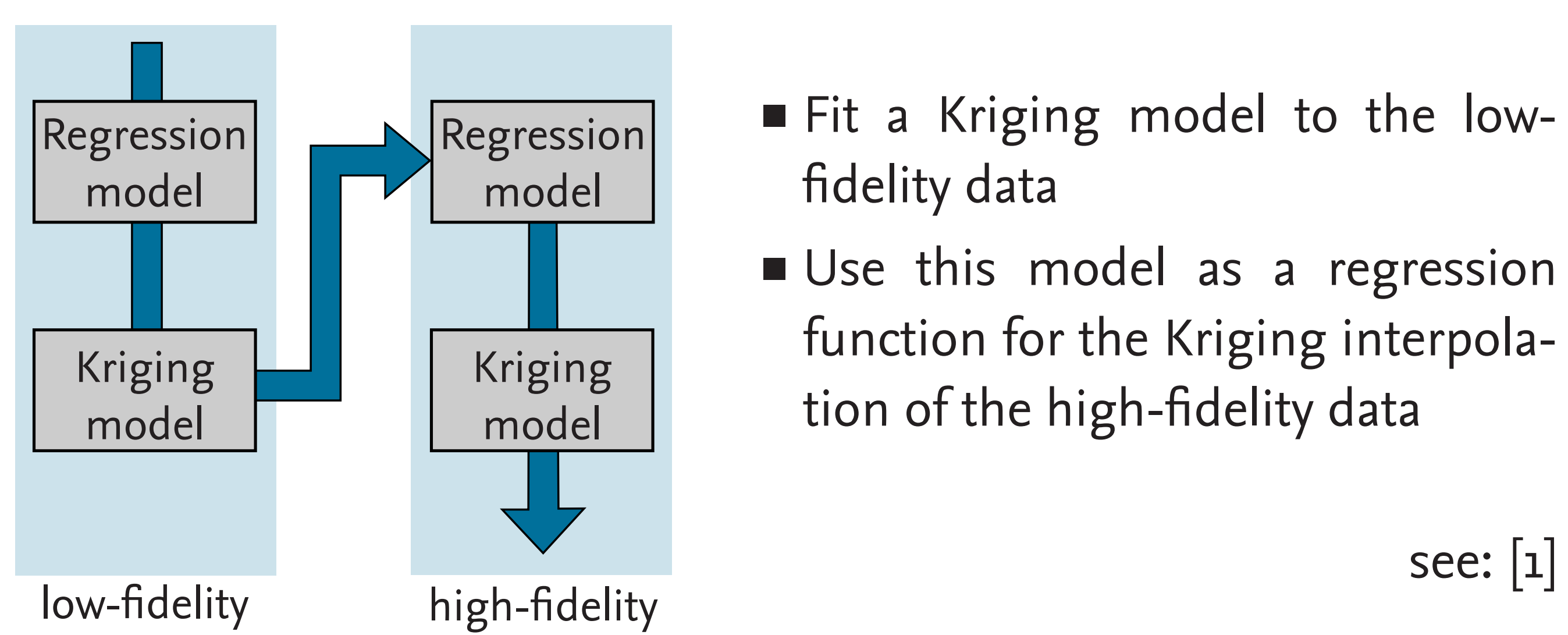
Given: sample points $x^1, \dots, x^n \in \mathbb{R}^d$
sample values $Y := (y_1, \dots, y_n)^T \in \mathbb{R}^n$

Objective: interpolate and take spatial correlation into account

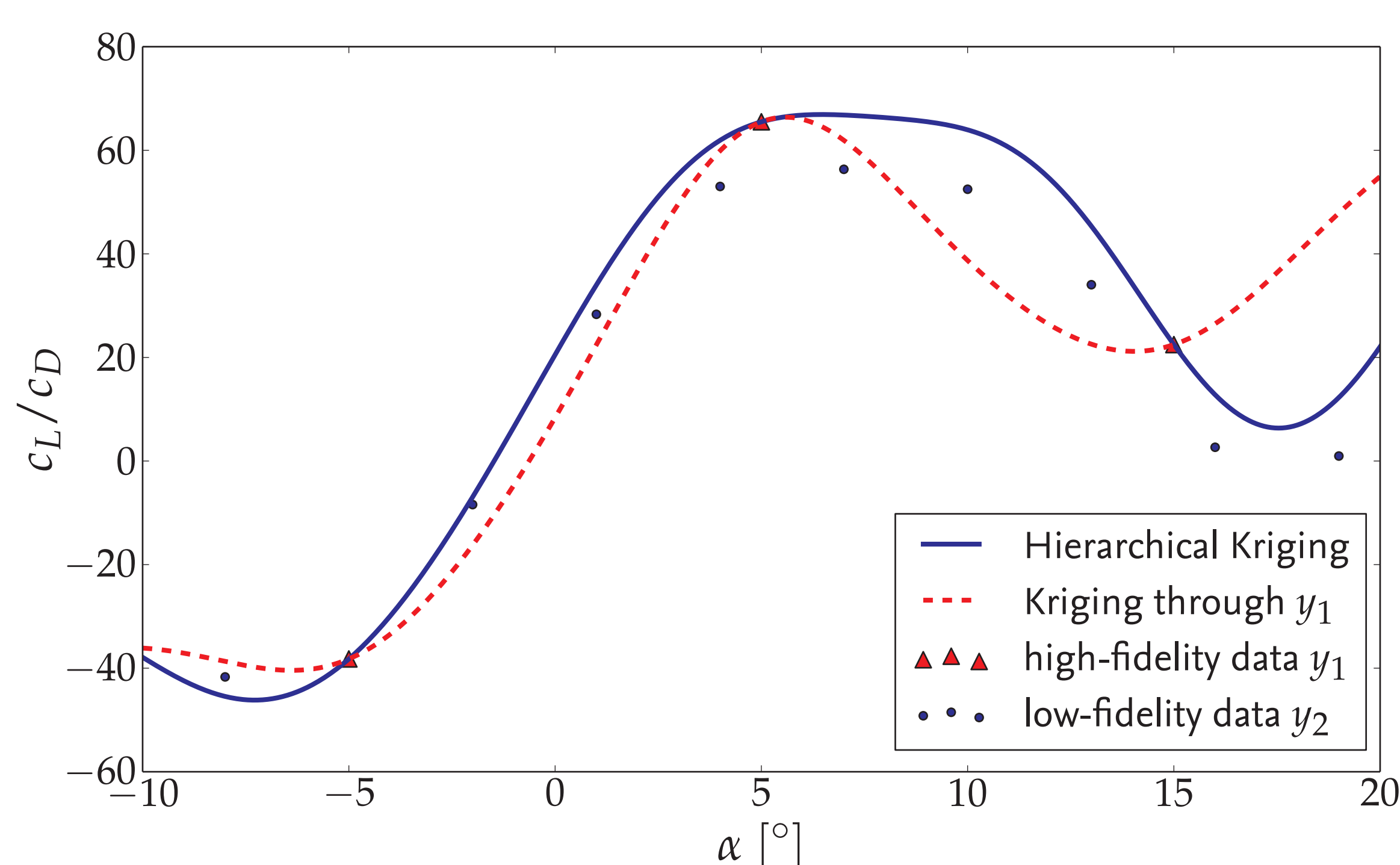
Assumption: true function $y(x) = f(x)^T \beta + \varepsilon(x)$
 regression function regression param. norm. distr. error

Kriging leads to the **B**est **L**inear **U**nbiased **E**stimator (**BLUE**).

Hierarchical Kriging is a variable-fidelity extension of Kriging:



Example for Hierarchical Kriging

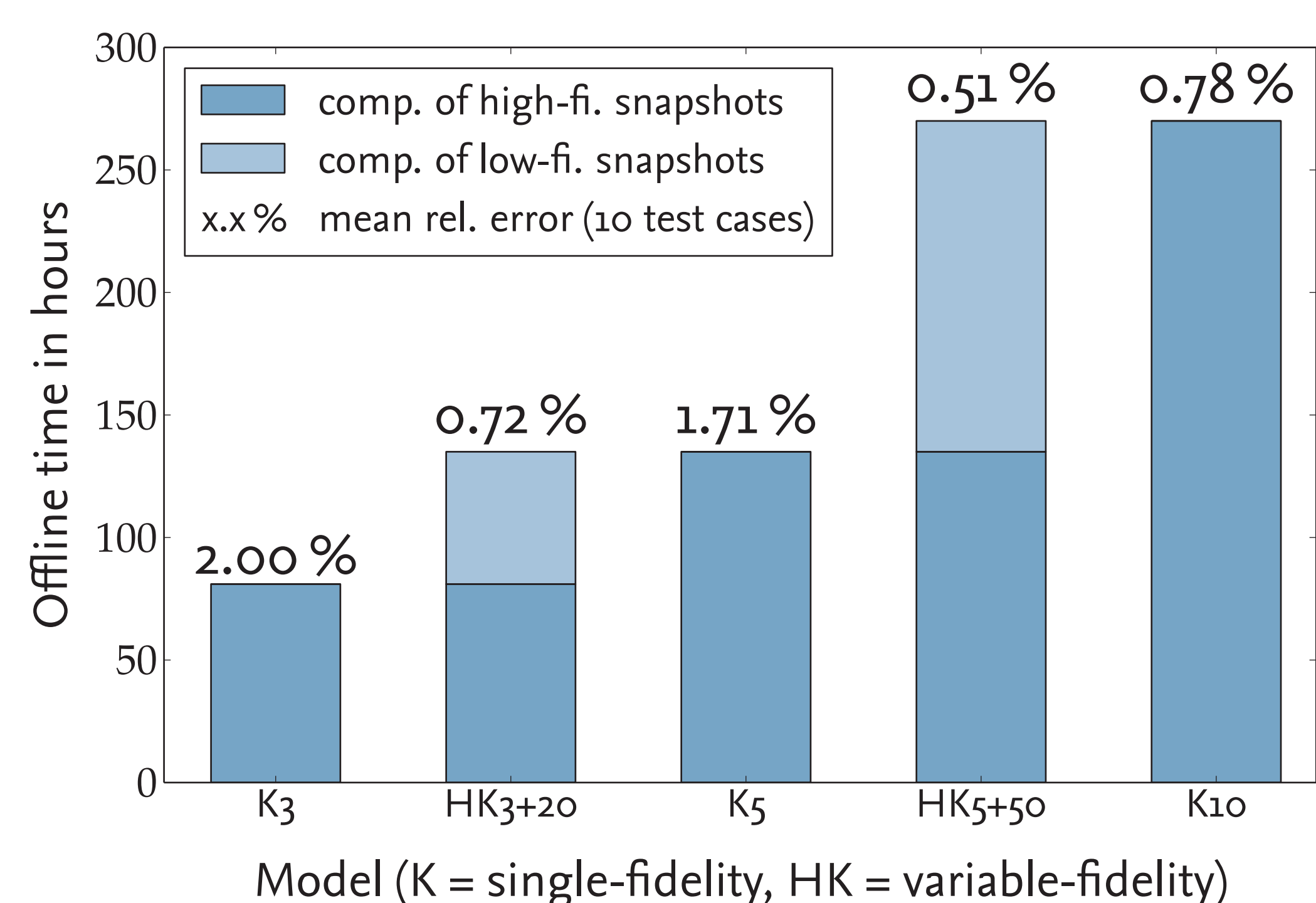


Industrial test case

VW Passat B6, 5 design param. at the rear, realistic deform. of ± 2 cm

- 404603 cells
- inflow velocity: $33.33 \frac{m}{s}$
- high-fi. CFD sim.: 27 h
- low-fi. CFD sim.: 2.7 h

Objective: Approx. of the pressure distribution onto the cars body



References

- [1] Z.-H. Han and S. Görtz, *Hierarchical Kriging Model for Variable-Fidelity Surrogate Modeling*, AIAA Journal Vol. 50 No. 9, pp. 1885–1896 (2012)
- [2] T. Braconnier, M. Ferrier, J.-C. Jouhaud, M. Montagnac and P. Sagaut, *Towards an adaptive POD/SVD surrogate model for aeronautic design*, Computers & Fluids Vol. 40 No. 1, pp. 195–209 (2011)