University of Stuttgart
Institute of Fluid Mechanics
and Hydraulic Machinery

Transferable Model for Shape Optimization subject to Physical Constraints

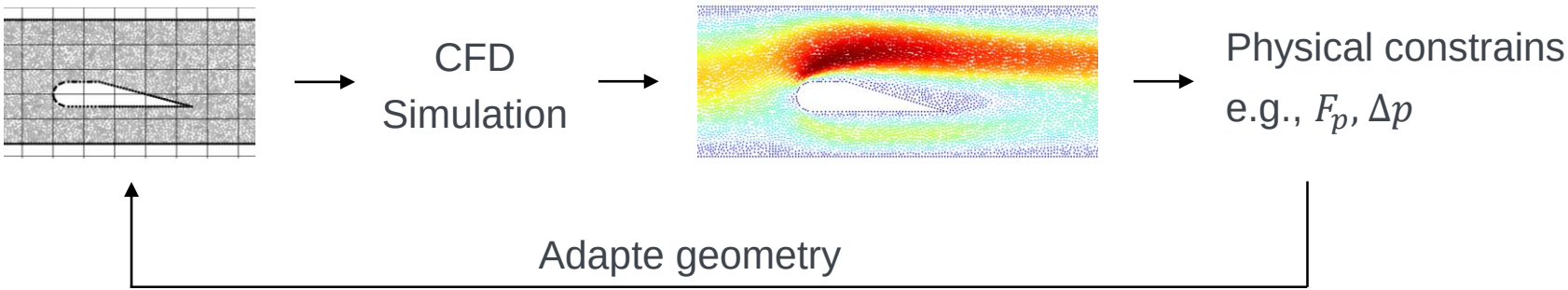
Lukas Harsch, 15.01.2021

IHS

Motivation

Given: Fluid dynamical quantities

Target: Airfoil geometry



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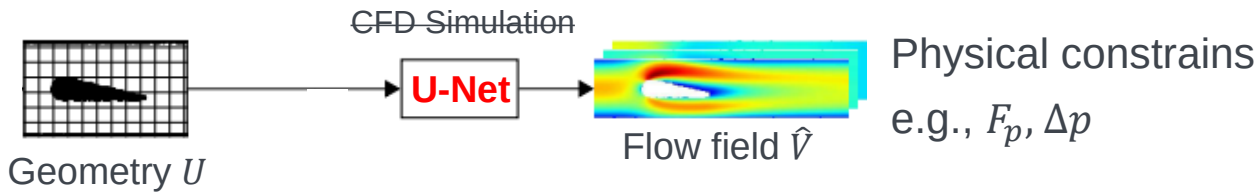

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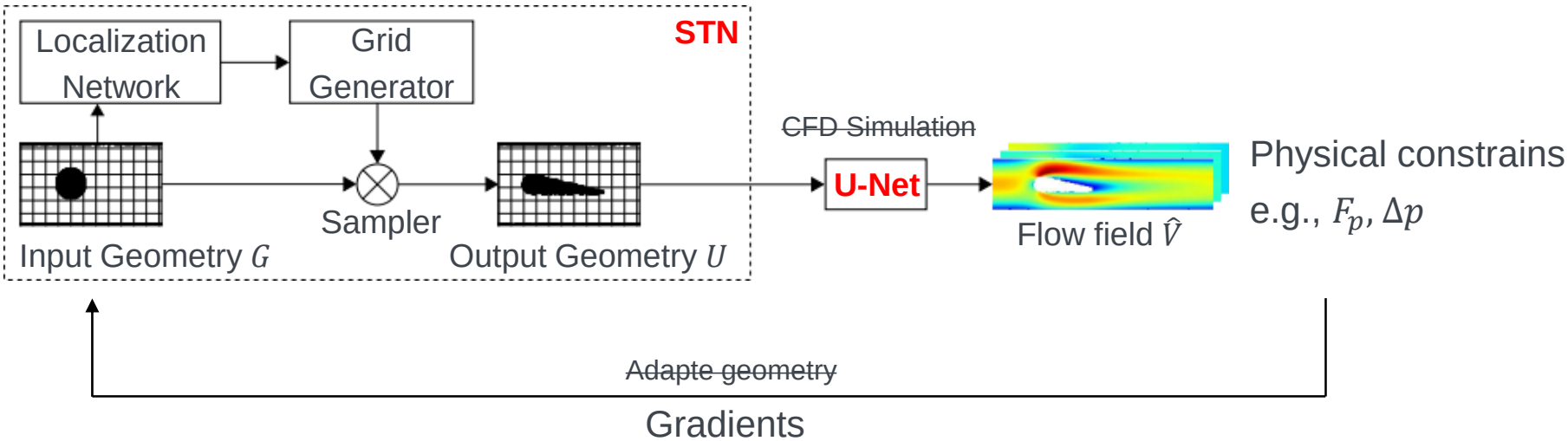
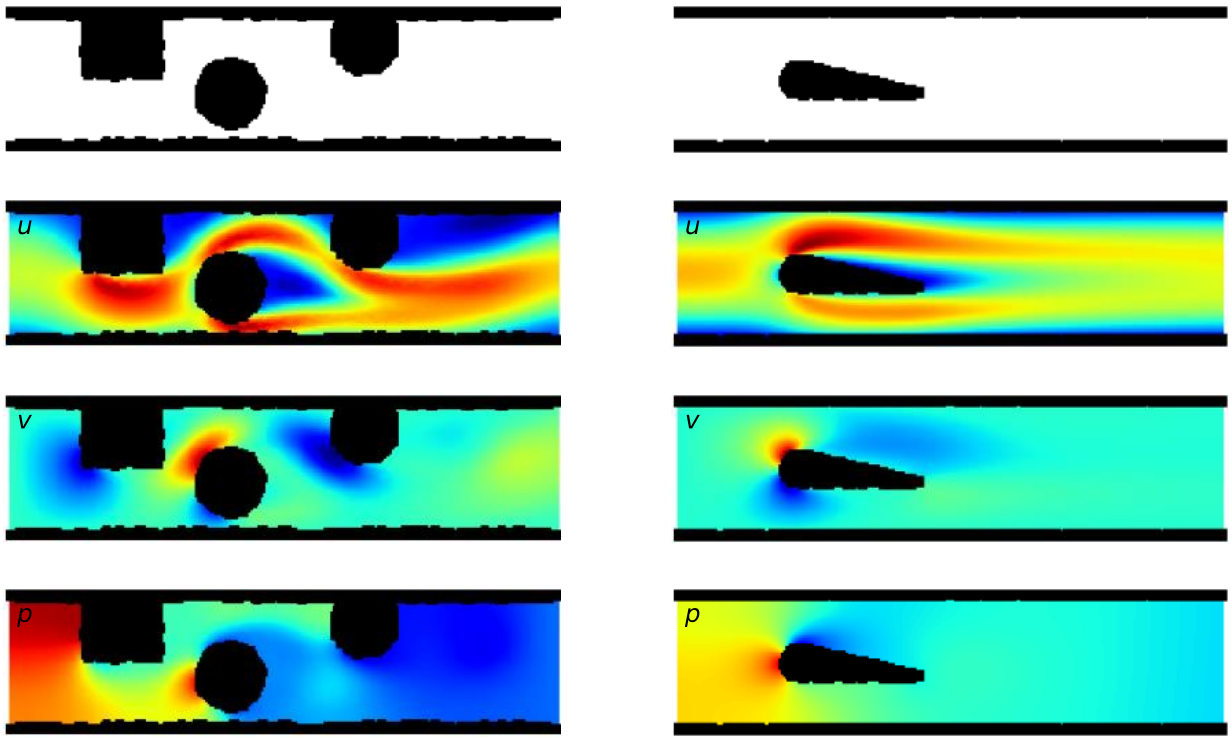
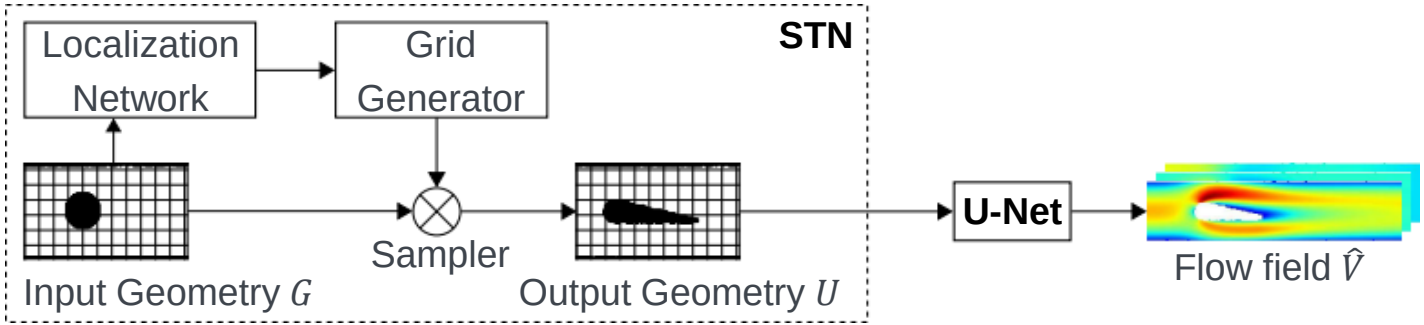


Dataset – 2D Channel Flow



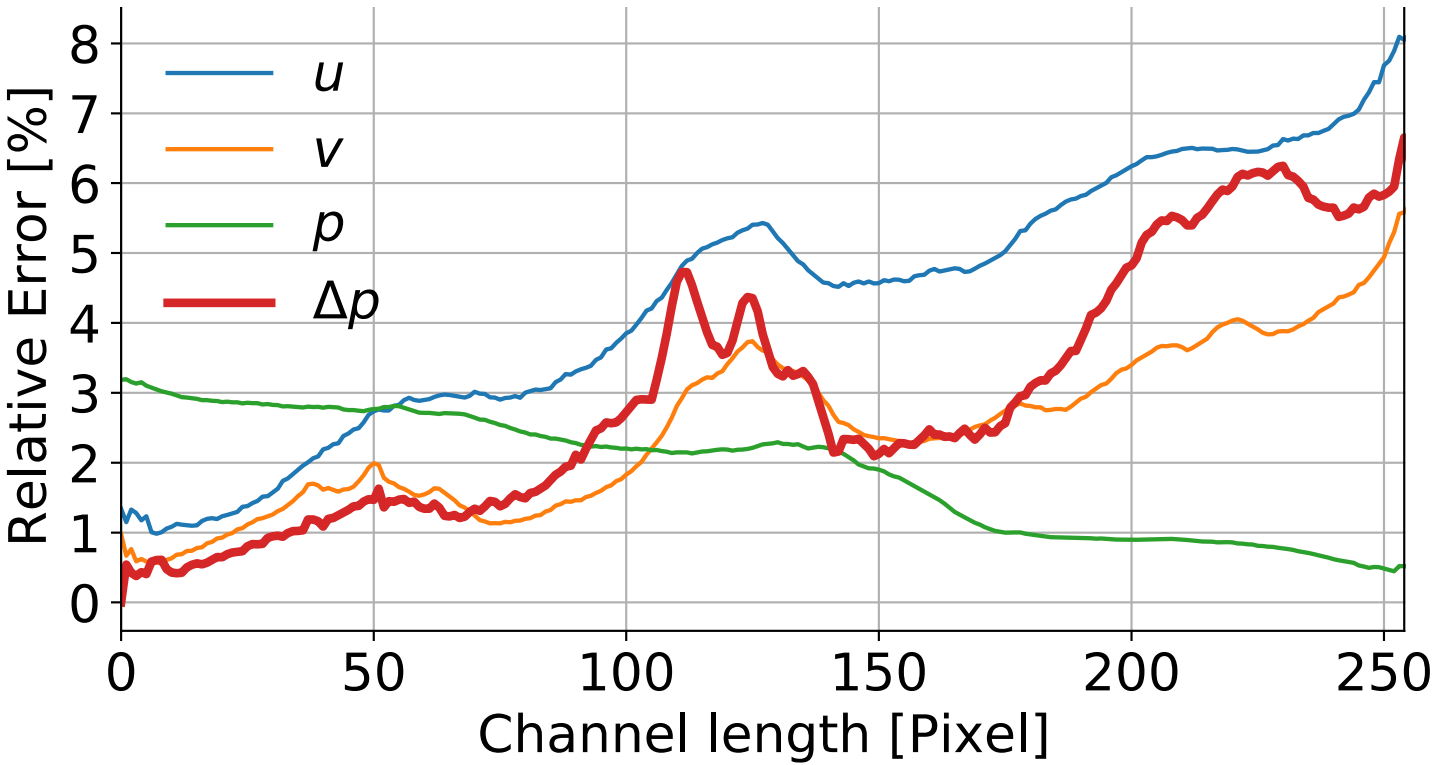
- Geomety map $G \epsilon \mathbb{R}^{HxWx1}$
- Flow field $V \epsilon \mathbb{R}^{HxWxC}$
- $N_{train} = 1050$
- $N_{test} = 300$

Model

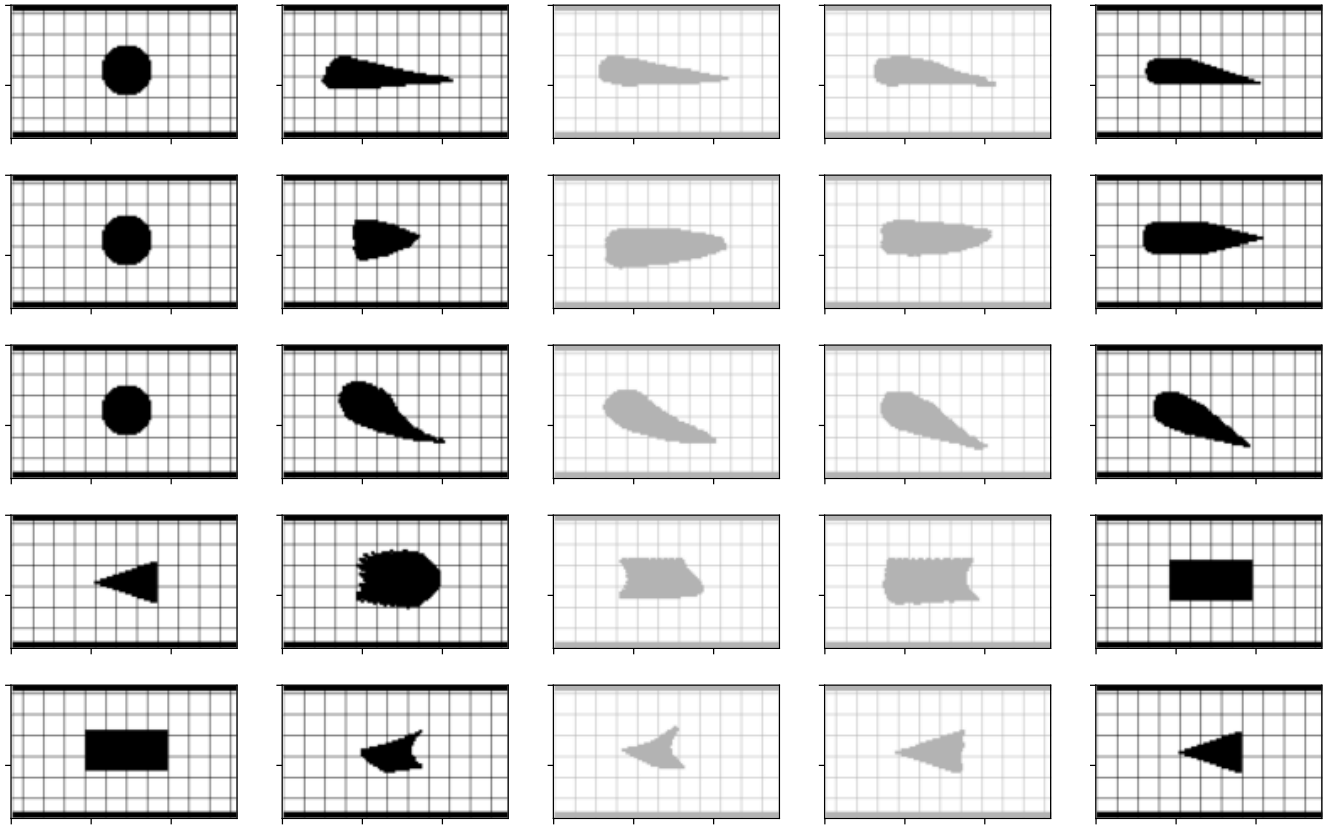


- Train **U-Net** $U \rightarrow \hat{V}$ via $SSE(V, \hat{V})$
- Train **STN** $G \rightarrow U$ via physical constraints
  - Pressure forces $F_i = \int_{A_i} p_i dA_i$
  - Total pressure difference $\Delta p = \left(\frac{\rho}{2}(|u_2 + v_2|^2) + p_2\right) - \left(\frac{\rho}{2}(|u_1 + v_1|^2) + p_1\right)$

Flow Field Prediction

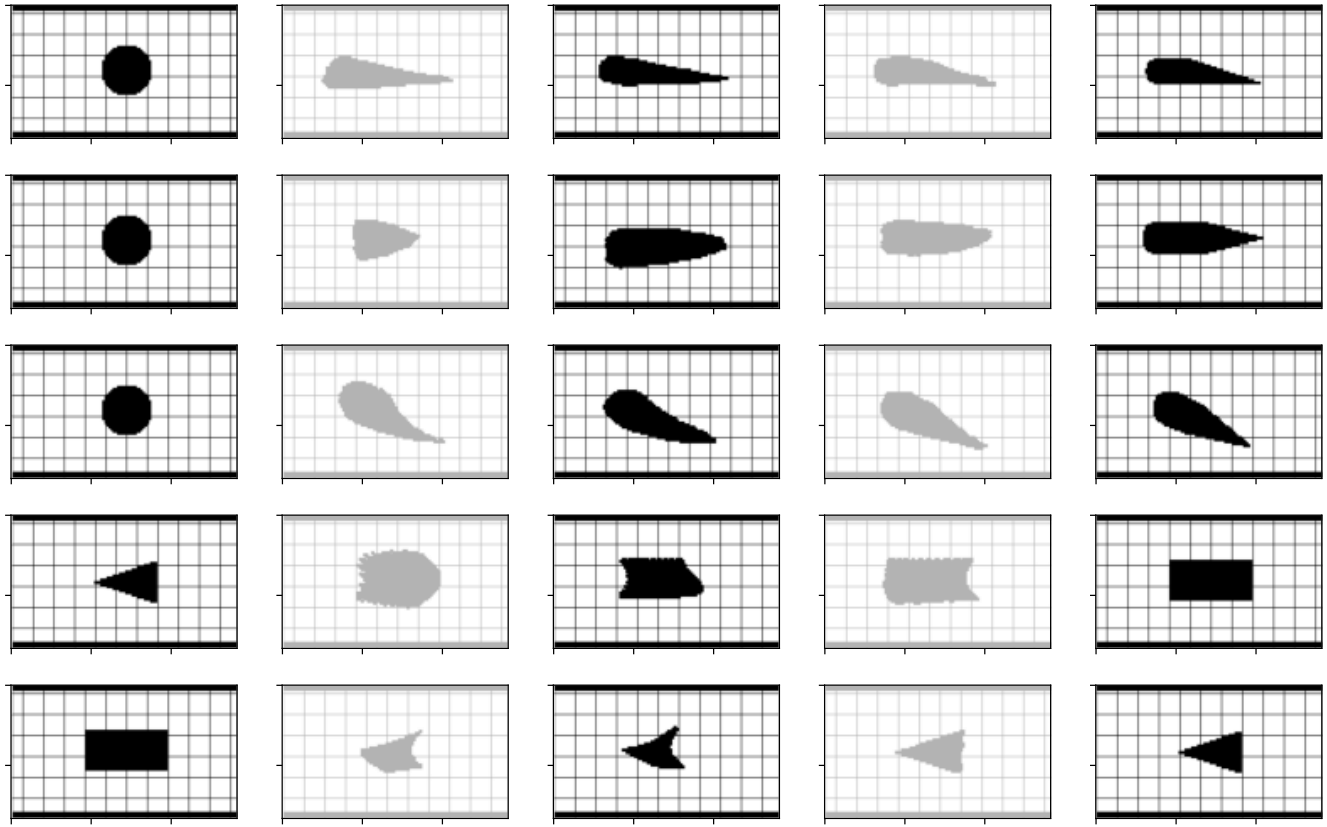


Shape Transformation



(a) Inital (b) $\Delta p, F_i$ (c) $\Delta p, F_i, L$ H, COM (d) SSE (e) Target

Shape Transformation



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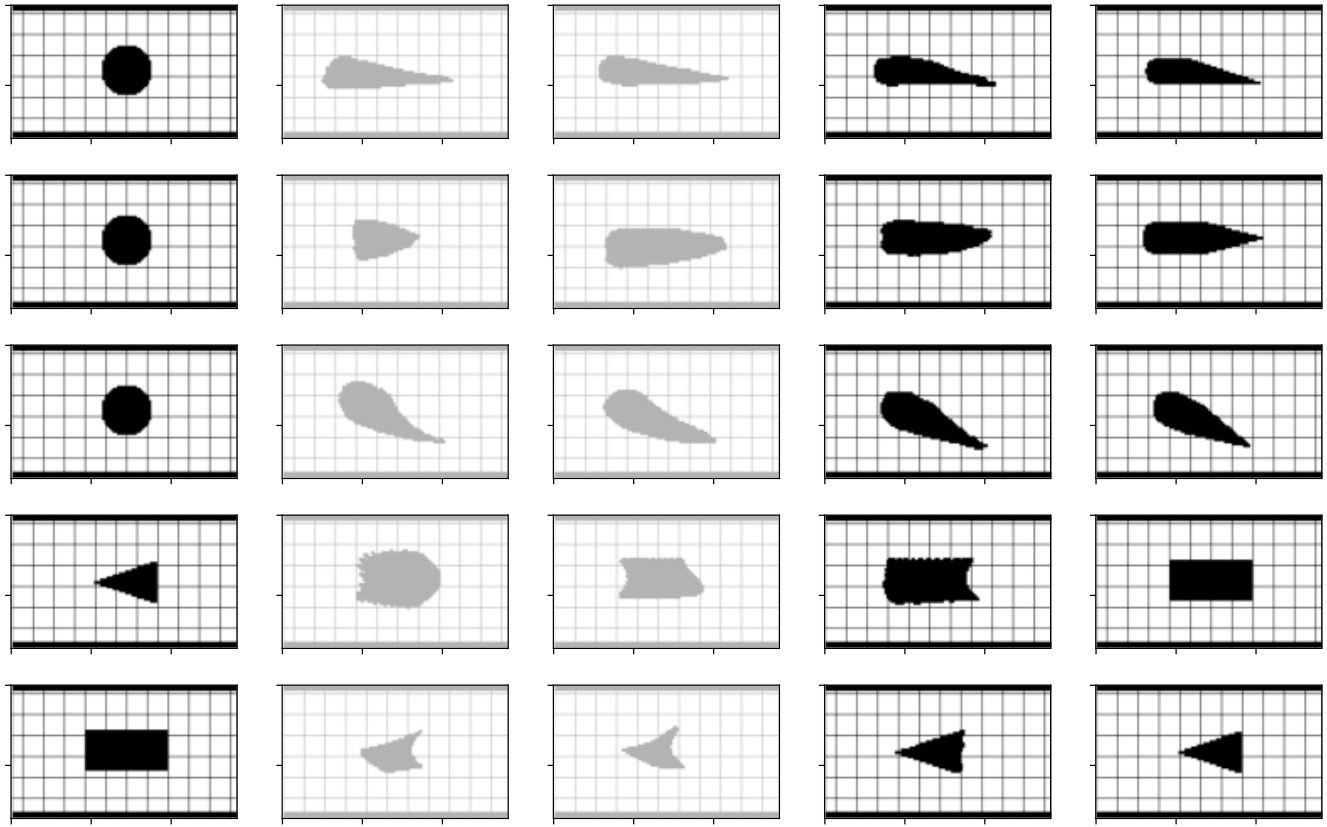

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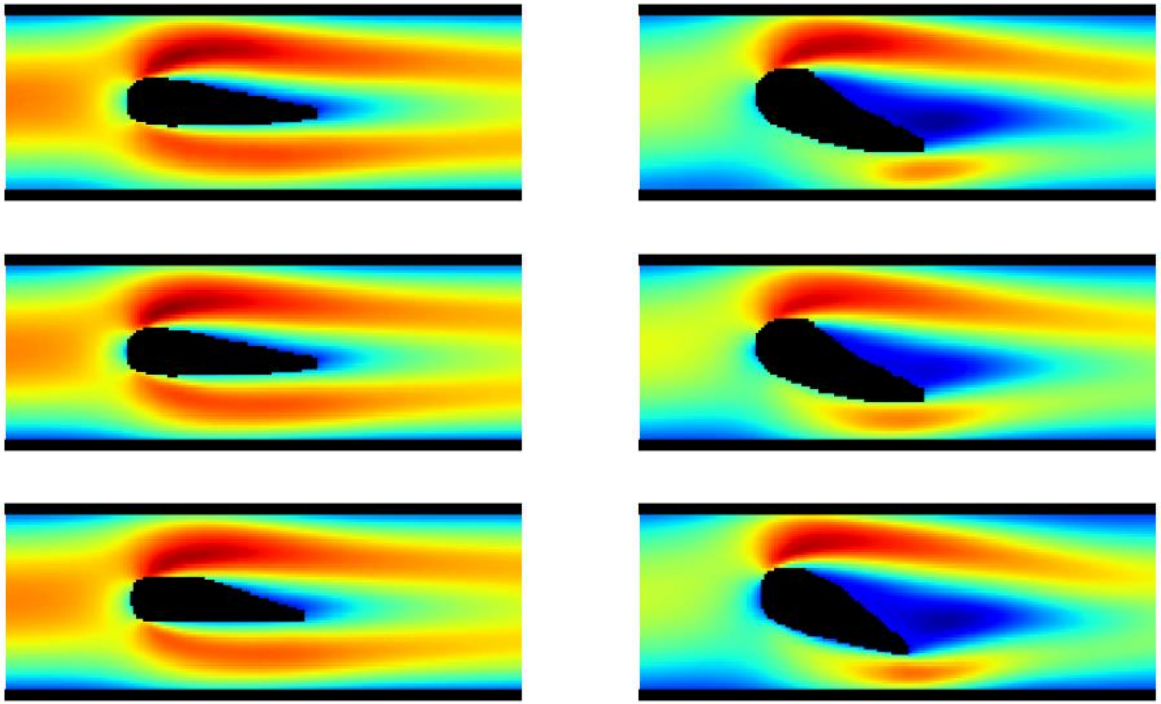
Comparison with CFD-Simuation



Transformed Geometry $\rightarrow \hat{u}$

Transformed Geometry $\rightarrow u_{CFD}$

Target Geometry $\rightarrow u_{CFD}$

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Thank you!

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