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OpenFOAM Dakota interface

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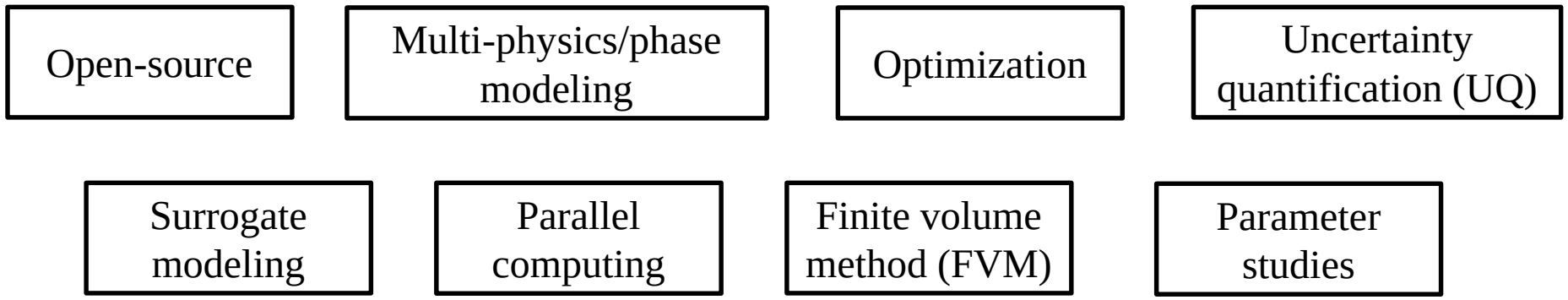
OpenFOAM-Dakota interface



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Scope

Traditionally, multi-physics/phase simulation software programs lack data analytics tools which can provide a richer understanding of model predictions

Growing body of research ⟶ multi-physics/phase simulation software programs + data analytics [1-4]

Study objective: Multi-physics/phase simulation program, OpenFOAM [5] + Data analytics toolbox, Dakota [6]

Impact: Integrating the capabilities of OpenFOAM and Sandia Dakota provides an open-source framework for multi-physics/phase simulations, uncertainty quantification, optimization, surrogate modeling, parallel computing and parameter studies.

Applications of the open-source integrated framework span several industries ranging from aerospace and energy to healthcare and manufacturing

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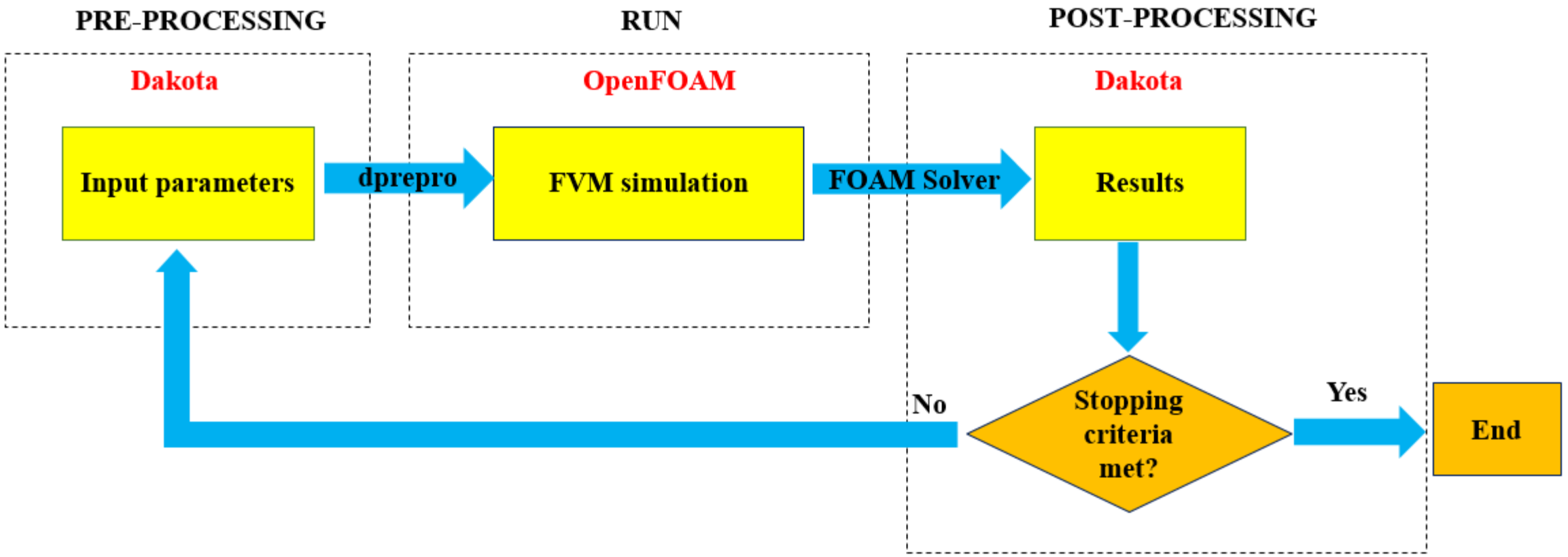
Coupling methodology



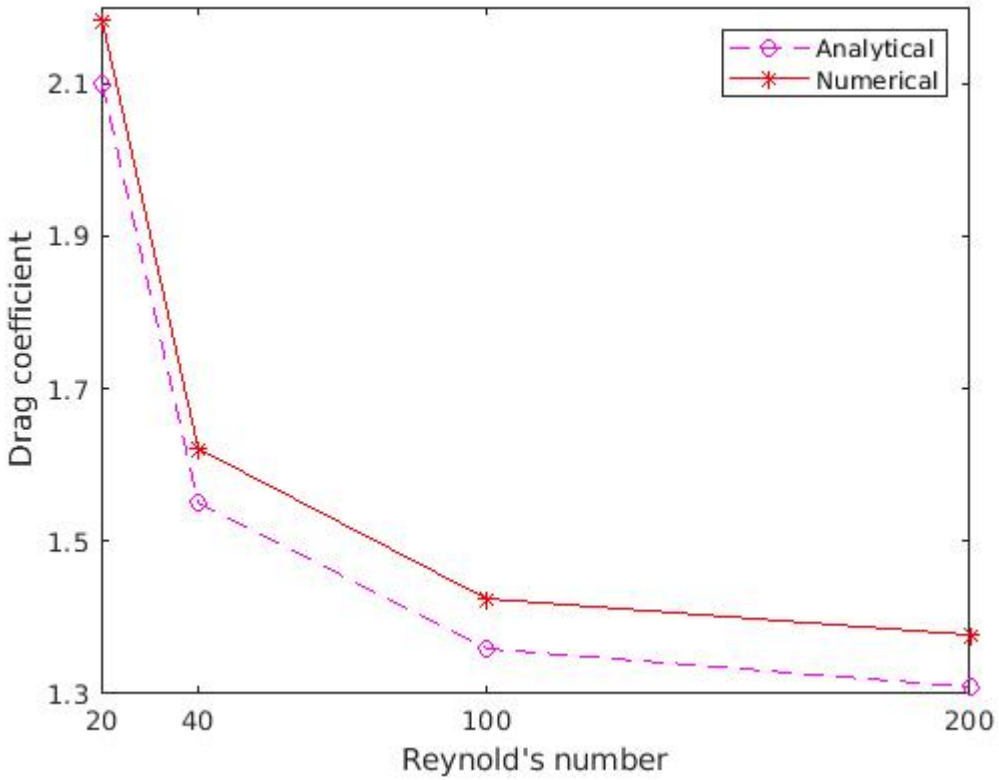
Yellow: Changes every evaluation

Blue: Operations

Source code along with test cases can be found here: https://github.com/AnjaliSandip/OpenFoam-Dakota

Benchmark 1: Vortex Shedding (2D, Transient)

This is a common benchmark test in fluid-structure interaction problems [7]
OpenFOAM solver: icoFOAM
Dakota/Data analysis: Listed parameter study [6]
Input parameter: Reynold's number -- between 0 and 200
Output parameter: Drag coefficient at the final time step
The results from this study were in good agreement (max. discrepancy, 5%) with literature data [7-13]



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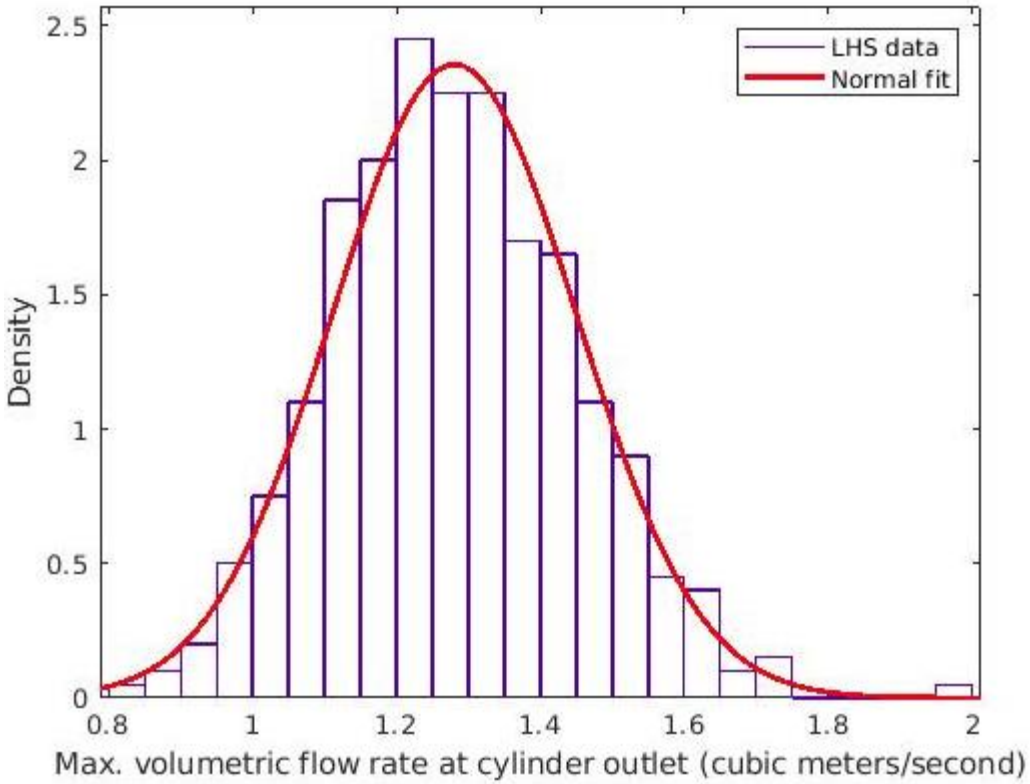
Benchmark 2: Hagen - Poiseuille equation (2D, Transient)

- Describes the relationship between pressure, flow rate and fluidic resistance for fluid flowing through circular tubes [14]
- OpenFOAM solver: icoFOAM
- Dakota/Data analysis: Latin hypercube sampling study [6]
- Input parameters: Length (10 +/- 0.04)m and radius (0.5 +/- 0.02)m of the cylinder
- Output parameters: Max. volumetric flow rate at the cylinder outlet (cubic meters/second)
- Numerical velocity profile at cylinder outlet agreed well with the analytical results for the same

Probability density function



[14] Gooch, J. W. (2011). Snell's Law.

Conclusion

Study objective: Integrate open-source software programs, OpenFOAM for multi-physics/phase simulations and DAKOTA for optimization and uncertainty quantification, and apply it to benchmarks - *achieved*

Impact: Applications of this open-source framework span several industries ranging from aerospace and energy to healthcare and manufacturing.