Exploring Low-Order Aerodynamic Models using Julia

SoCal Julia π-day Meetup

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The Problem

We want to find the force on a wing undergoing some prescribed motion

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Common Reactions

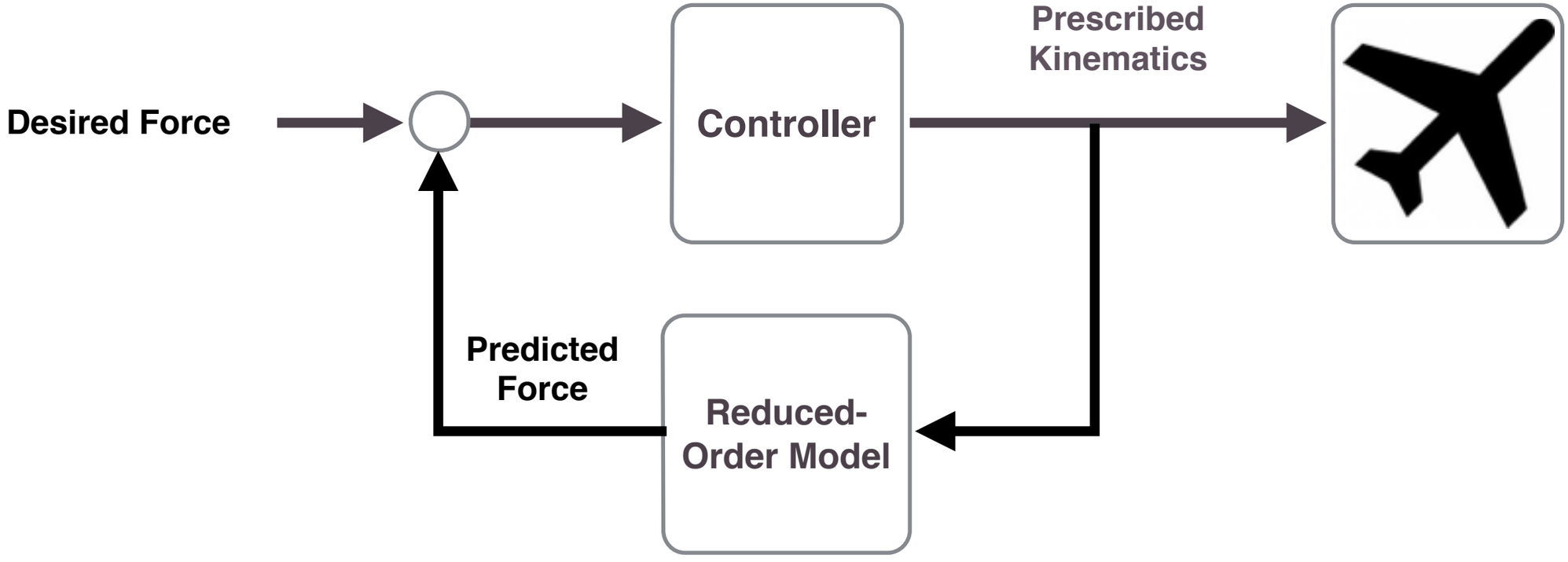
“Wait… are you serious? We don’t know that?”

or

“Easy, just toss it at some CFD software!”

Reduced-Order Modeling

For control purposes, high fidelity CFD is computationally expensive.

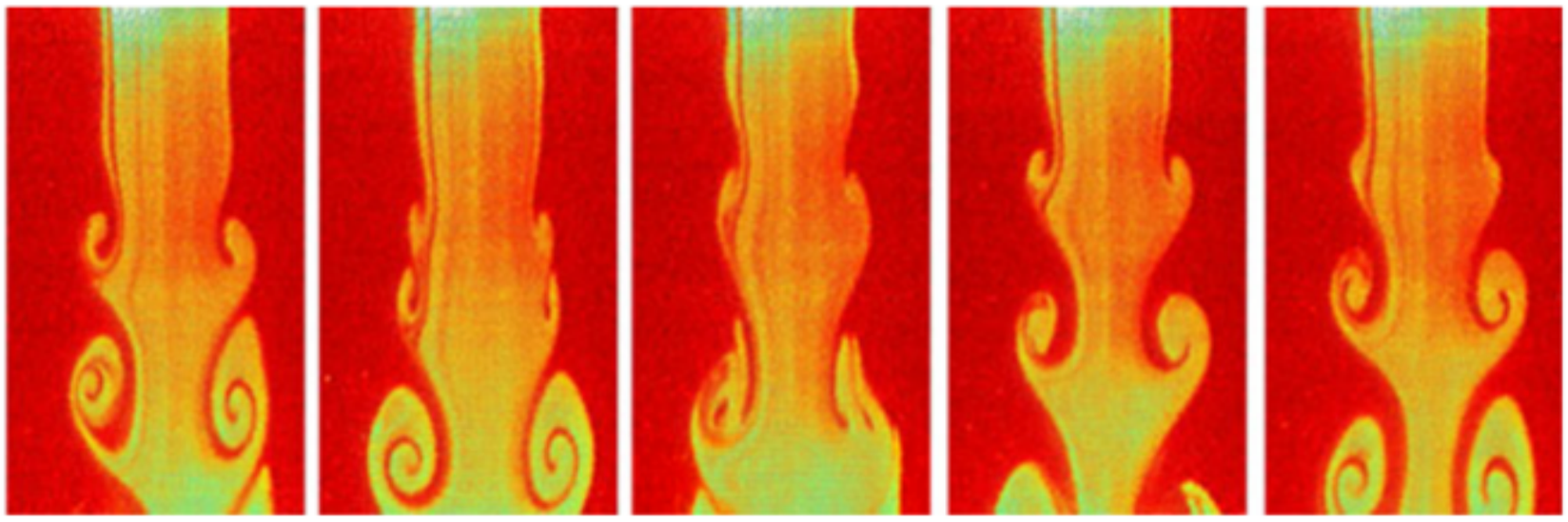


Reduced-Order Modeling

For control purposes, high fidelity CFD is computationally expensive.

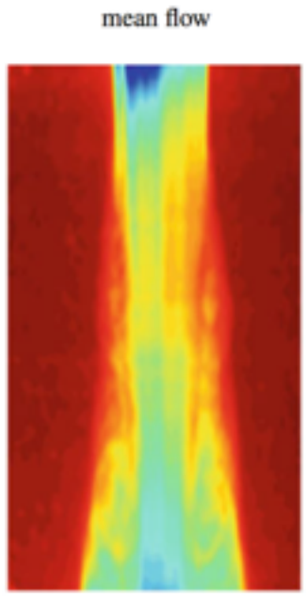
Flapping rate between 50 to 200 times per second

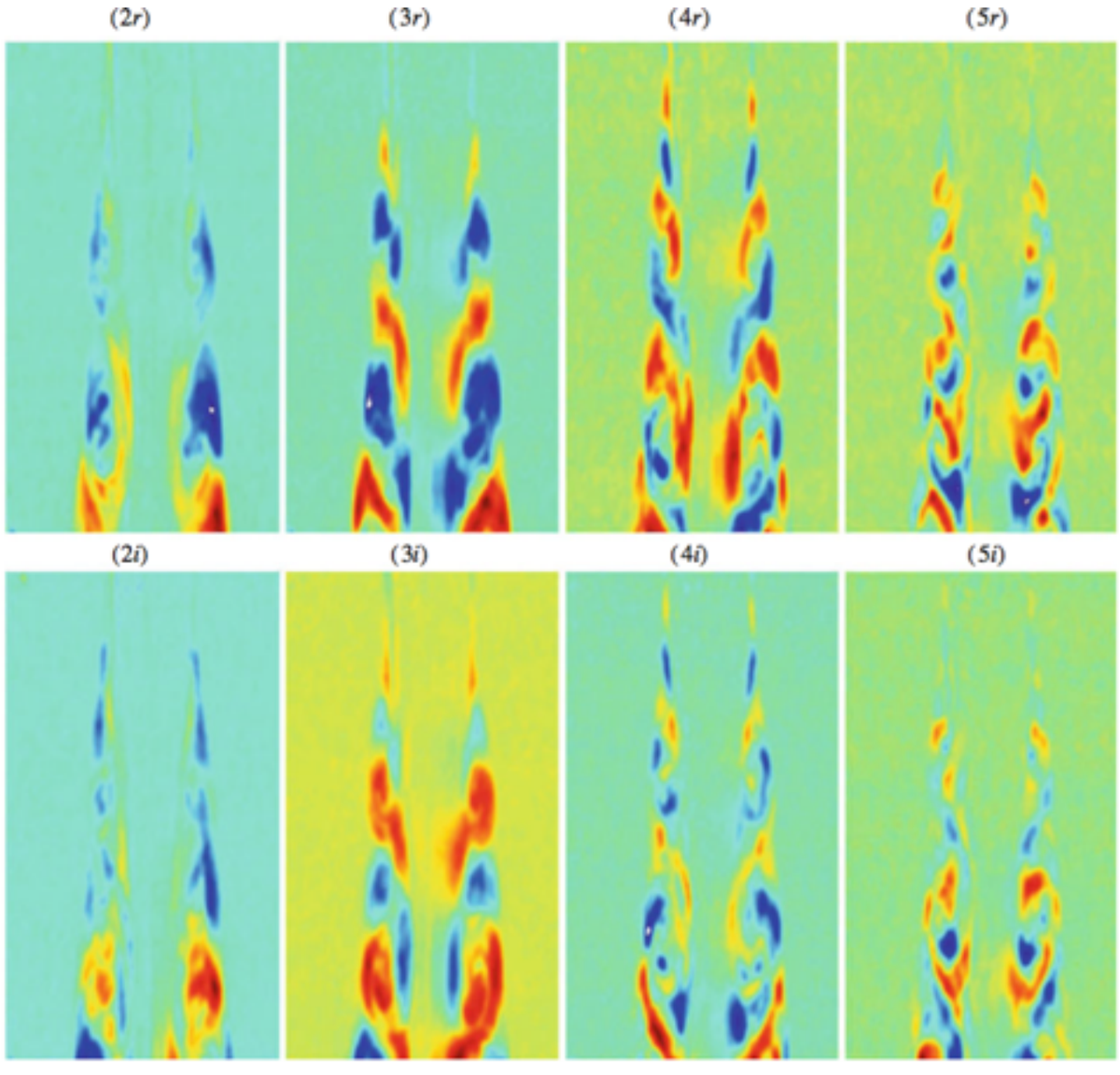
Mathematical Reduced-Order Modeling



Schmid, Peter J. "Application of the dynamic mode decomposition to experimental data." *Experiments in fluids* 50.4 (2011): 1123-1130.

Mathematical Reduced-Order Modeling





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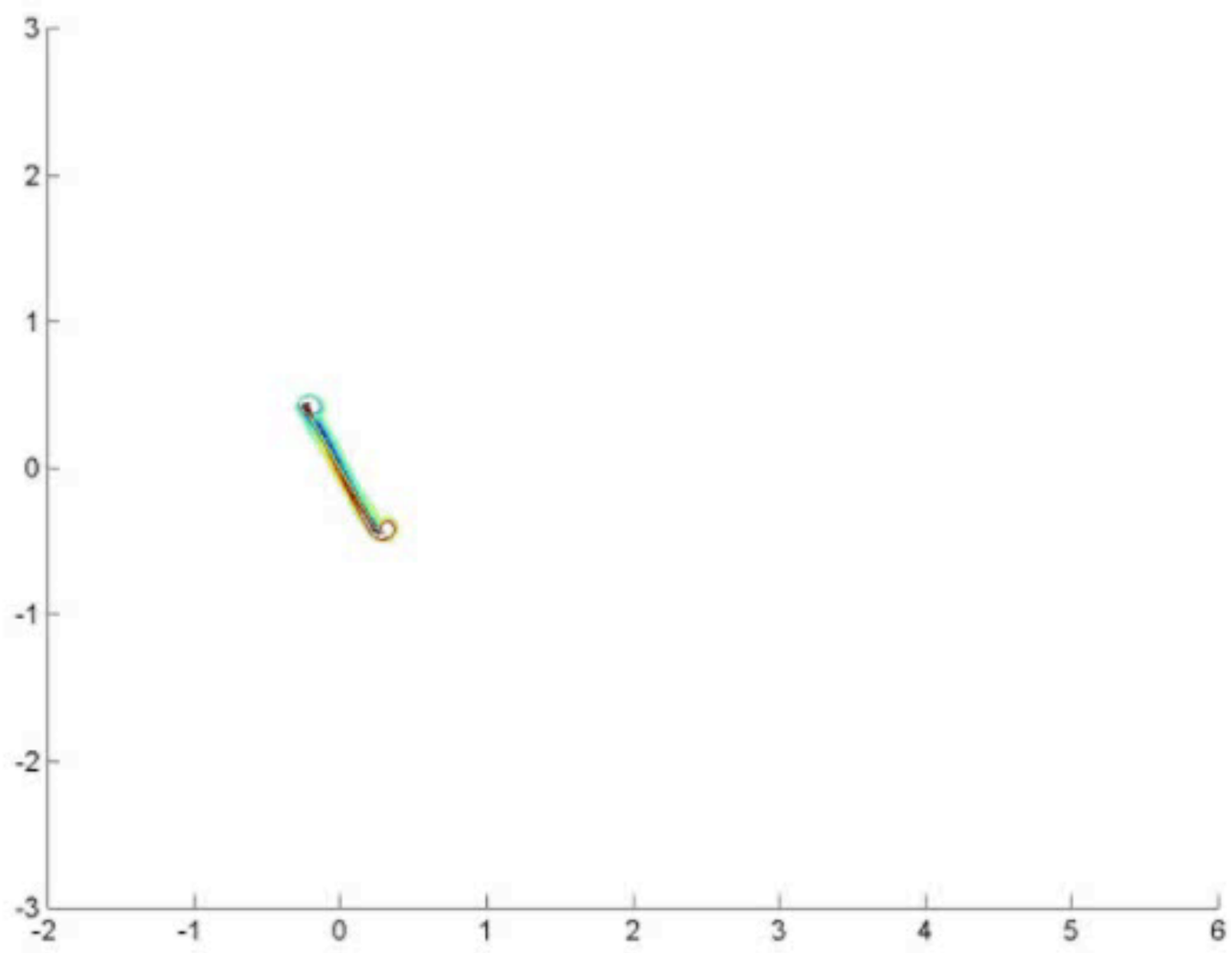
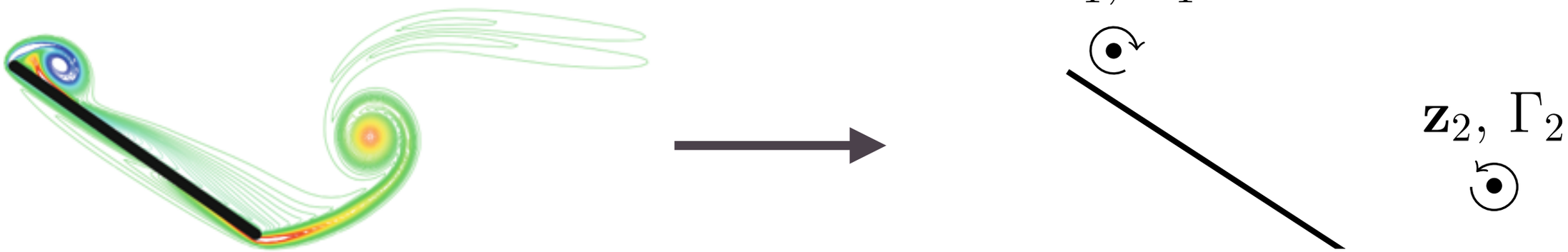
Physics-Based Reduced-Order Modeling

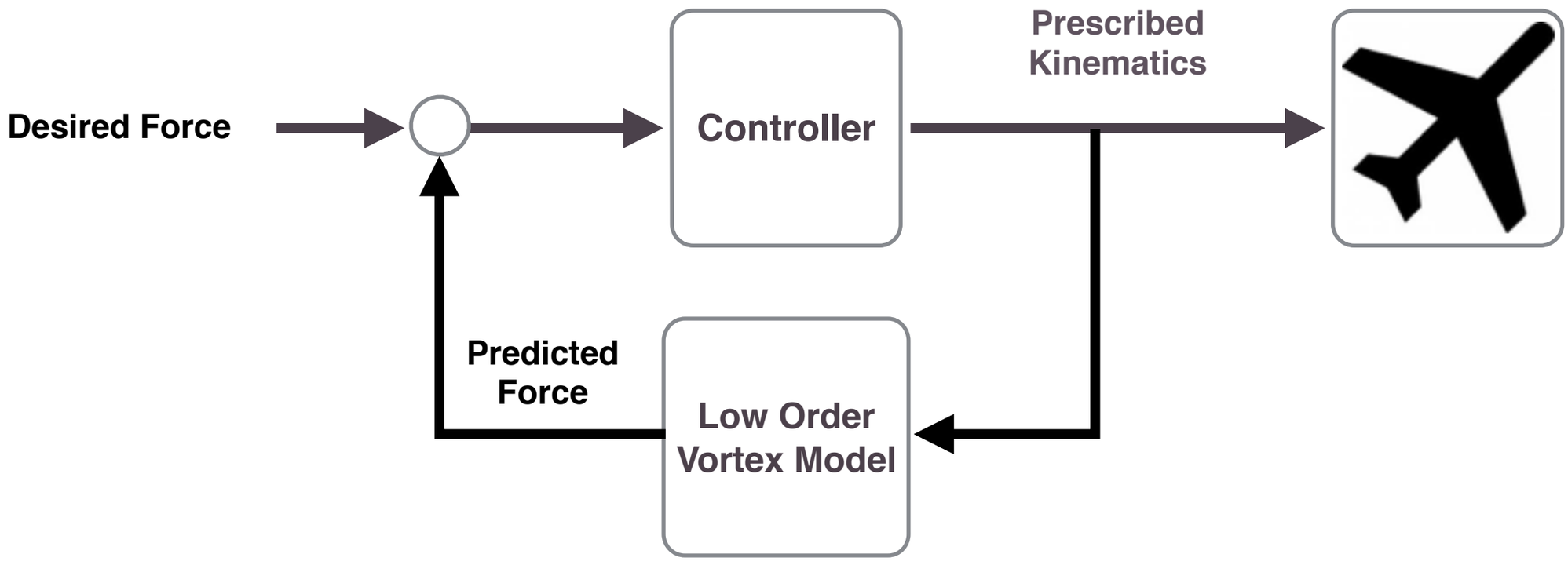


Physics-Based Reduced-Order Modeling



Wang, Chengjie, and Jeff D. Eldredge. "Low-order phenomenological modeling of leading-edge vortex formation." *Theoretical and Computational Fluid Dynamics* 27.5 (2013): 577-598.

Physics-Based Reduced-Order Modeling



Why Julia?

Keeping in mind that most ideas will end up failing

- Faster transition between pen/paper to code
- Un-vectorized code can be fast
- Modification and borrowing code from libraries
- Unicode identifiers!

Makes it much faster to discover and reject bad ideas!

Demo