Predicting Blood Flow Patterns Across Stenoses with a Geometry-Conditioned Physics-Informed Neural Network

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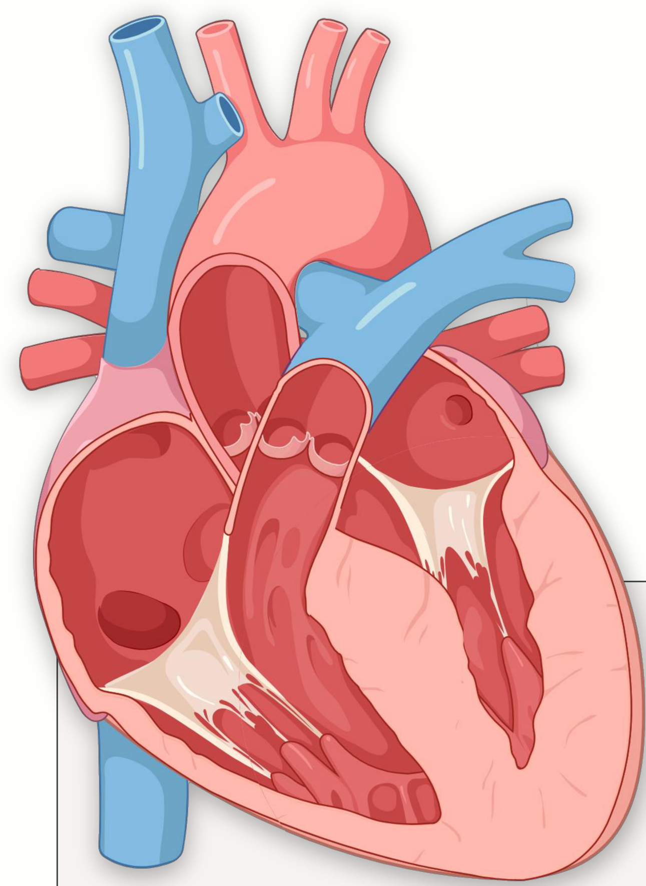
INTRO

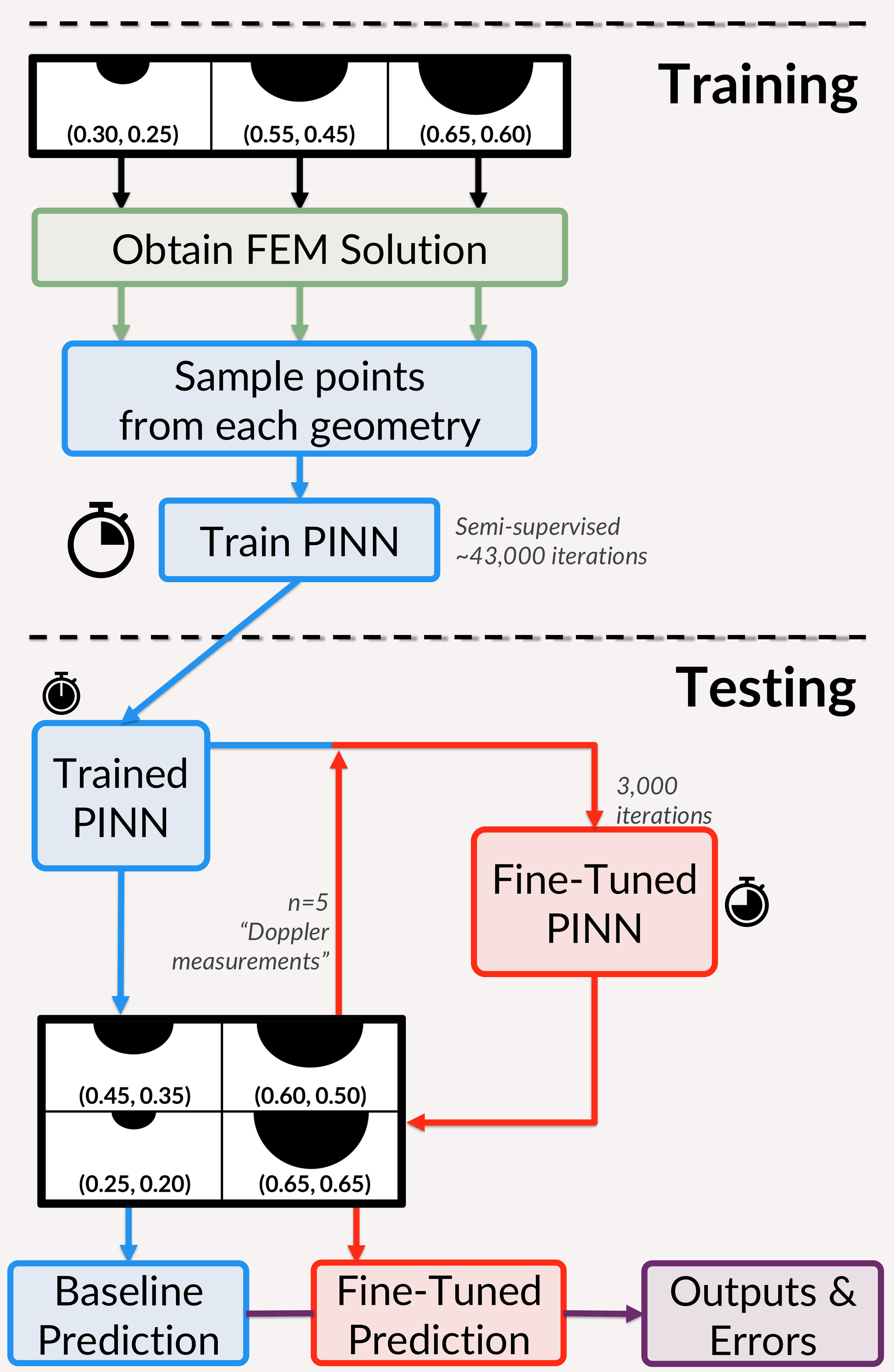
- **Problem:** Patient-specific hemodynamics are critical for treating obstructive cardiovascular conditions, but difficult to measure.
- **Method:** Physics-Informed Neural Networks[1] (PINNs) can help predict hemodynamics, but most work is on single anatomies.
- **Goal:** Build a PINN that can generalize and fine-tune to unseen stenosis anatomies.

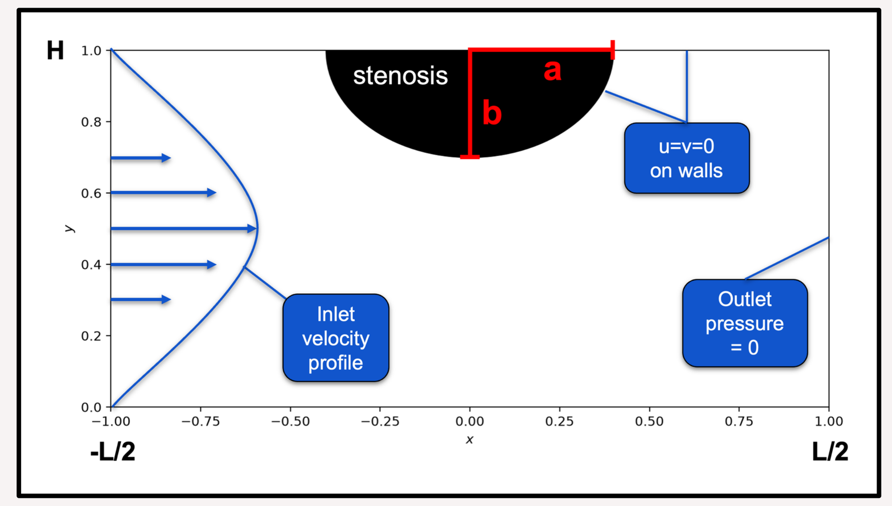


TAKEAWAY

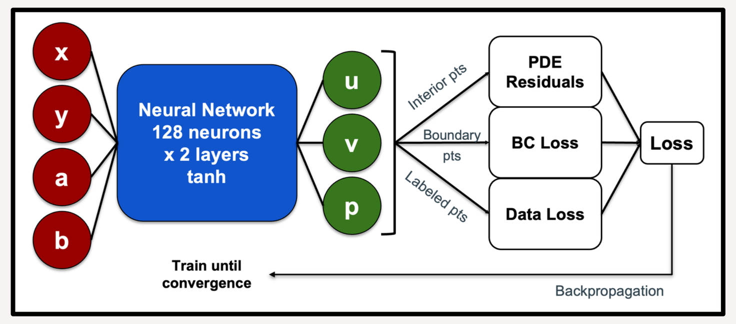
Our proof-of-concept model learned to **predict blood flow** patterns on **unseen stenosis** anatomies. **Fine-tuning** reduced error on **outlier** cases.

METHODS

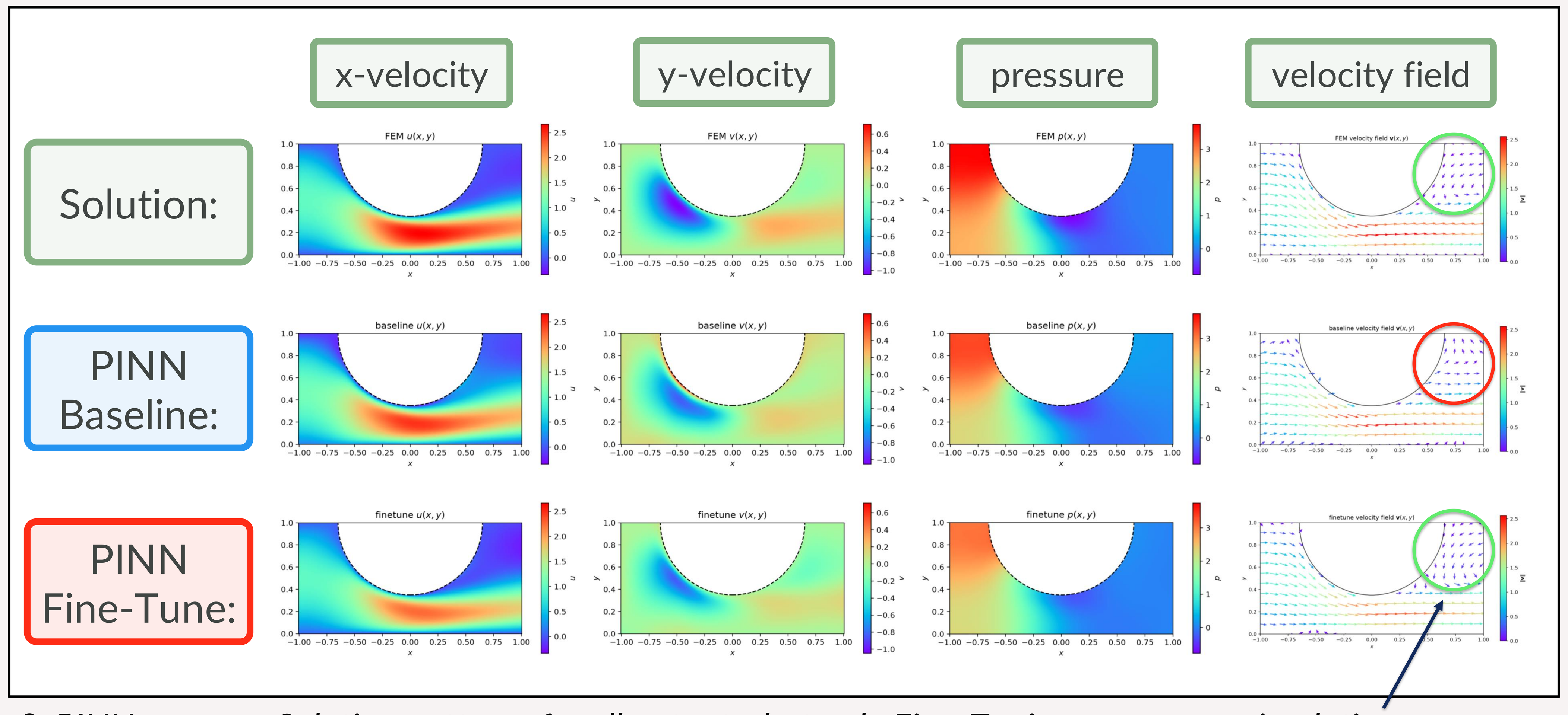




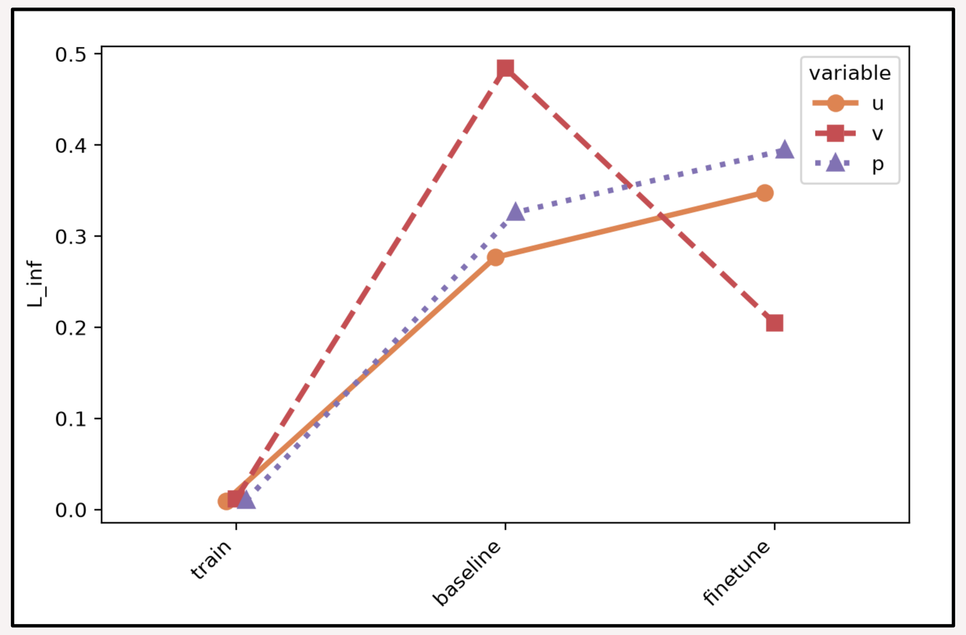
1. Problem Setup with Boundary Conditions



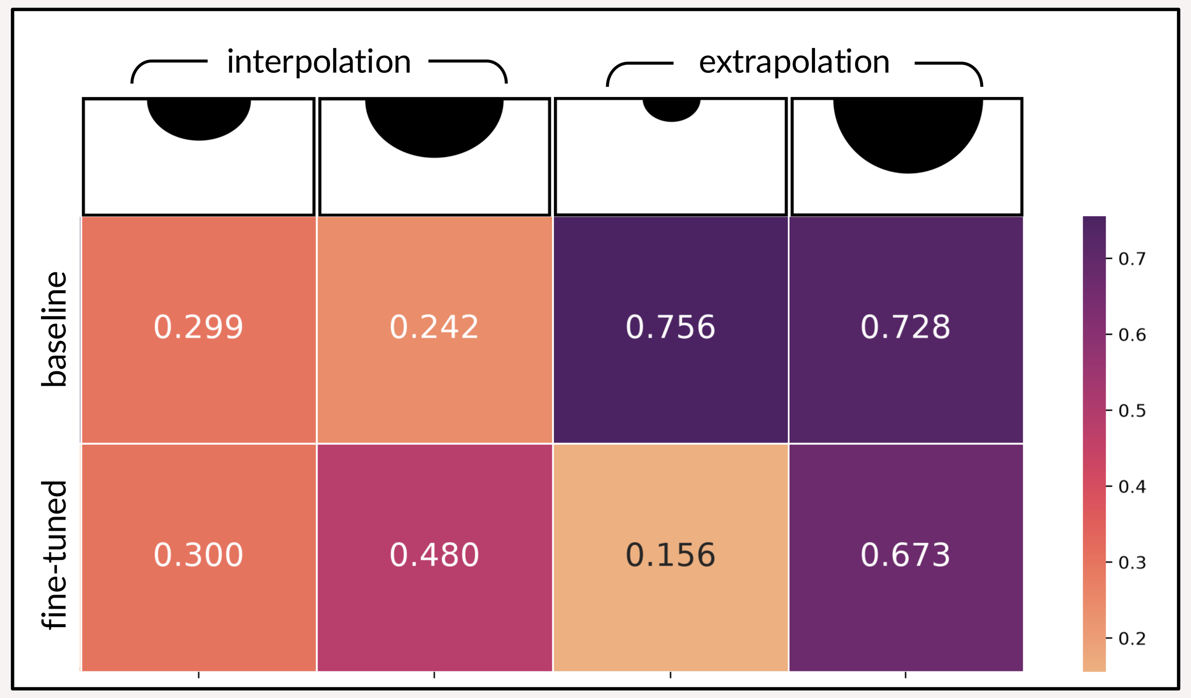
2. PINN Model Architecture



3. PINN recovers Solution patterns for all outputs, but only Fine-Tuning recovers recirculation



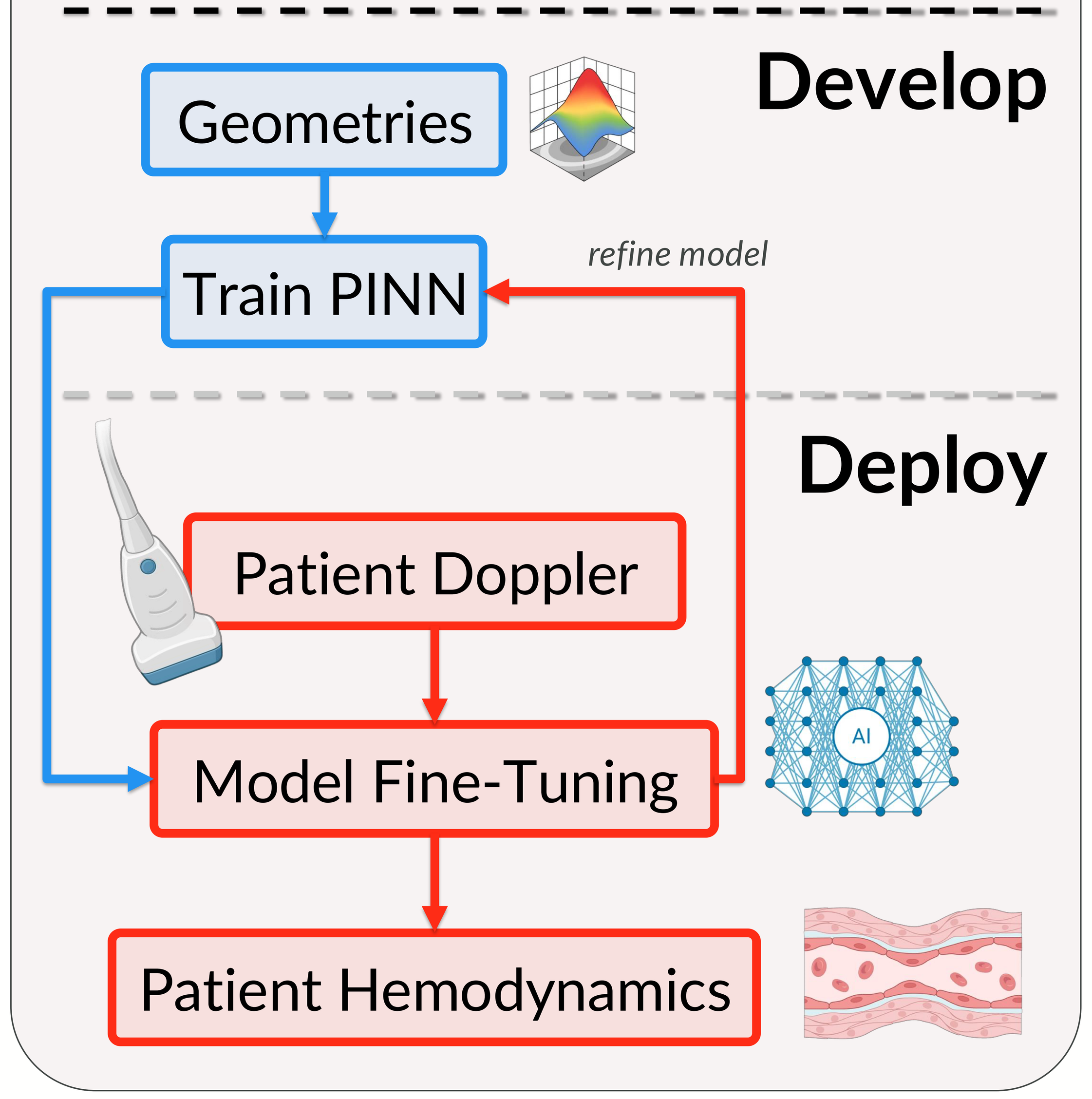
*4. Fine-Tuning with simulated Doppler readings (v-labeled points) reduces Max Absolute Error in **v**, at the cost of **u** and **p***



5. Fine-Tuning reduces Max Absolute Error on Extrapolation Anatomies ("unique patients")

CONCLUSIONS

- **Implications:** Unique patient anatomies could benefit from **fine-tuning** as a prediction strategy.
- **Future Work:** Include more realistic anatomies, more complex flows, and more advanced model architectures.
- **Significance:** A trained PINN could be deployed as a **clinical tool** (see below).



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References:
[1] Raissi, M. et al. (2019). Physics-informed neural networks: A deep learning framework for solving forward and inverse problems involving nonlinear partial differential equations. *Journal of Computational physics.*