Neural Implicit Flow (NIF)

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Problem Statement

- Spatio-temporal data modeled by PDEs is computationally challenging.
- Current reduction methods (SVD, CAE) fail with variable geometry or adaptive meshing.
- Need for a scalable, mesh-agnostic approach for real-time engineering applications.
- Examples: Sea surface temperature modeling, turbulence modeling, sparse sensing.

New Approach: Neural Implicit Flow (NIF)

- Combines two neural networks:
  - **ShapeNet:** Encodes spatial complexity mesh-agnostically.
  - **ParameterNet:** Models temporal and parametric dependencies.
- Provides efficient, nonlinear dimensionality reduction and interpretable representations.

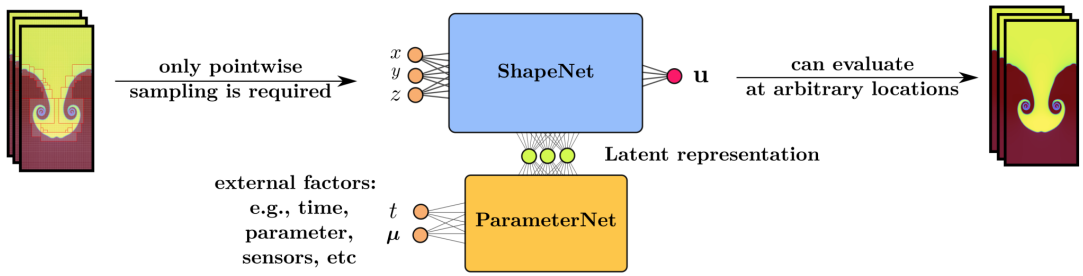

Figure: NIF Hypernetwork Architecture

My Contributions

- Performance tuning of the provided implementation.
- Re-Evaluation of the results
  - 40% better generalization performance
  - Scalable to complex spatio-temporal datasets

My Contributions - Performance tuning

- Performance tuning of the provided implementation.
  - Port from Tensorflow to PyTorch
  - Implementation using upstream SIREN
  - Improving parallelism in learning phase

My Contributions - Result Re-Evaluation

- Re-Evaluation of results - with focus on chaotic systems
  - Comparison to other Hypernetworks / LoRA / etc
  - Comparing the existing results using own implementation