SimNet: An End-to-End AI-Driven Simulation Framework

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developer.nvidia.com/simnet

SimNet Contributions

Existing NNS tools are not successful in solving industrial problems due to gradients and discontinuities caused by complex geometries or physics. SimNet is a novel NNS framework with tools for tackling these challenges, such as SDF loss weighting, flow integral continuity planes, and advanced architectures. SimNet also enables high Re flow simulation in industrial applications using NNS.

Neural Network Solvers

Neural network solution to PDE and the training loss:

\( u_{train}(\theta) = W_{\theta} \left( \phi_{0} - \cdots - \phi_{n} \phi_{n+1} \right) = b_{0} \phi_{0} + b_{1} \phi_{1} + \cdots + b_{n} \phi_{n} = \sigma \left( W_{\theta} x + b_{1} \right) \)

\( L_{train}(\theta) = \sum_{i=1}^{N} \int \left( \frac{\partial u}{\partial x} \right) \left( \frac{\partial \phi_{i}}{\partial x} \right) \left( \frac{\partial u_{train}}{\partial x} \right) \left( \frac{\partial \phi_{i}}{\partial x} \right) d\theta 

\sum_{i=1}^{N} \int \left( \frac{\partial u}{\partial x} \right) \left( \frac{\partial \phi_{i}}{\partial x} \right) \left( \frac{\partial u_{train}}{\partial x} \right) \left( \frac{\partial \phi_{i}}{\partial x} \right) d\theta 

\)

\( \text{Loss curves for flow training} \)

\( \text{Loss curves for heat training} \)

SimNet’s TG module enables the import any tessellated geometry from CAD programs. Here, we simulate the flow inside a patient specific geometry of an aneurysm.

Blood Flow in an Intracranial Aneurysm

NVSwitch Heat Sink Design Optimization

By network parameterization, SimNet solves for simultaneous design configurations in a design space exploration problem significantly more efficient than traditional solvers.

NVSwitch heat sink design optimization.

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