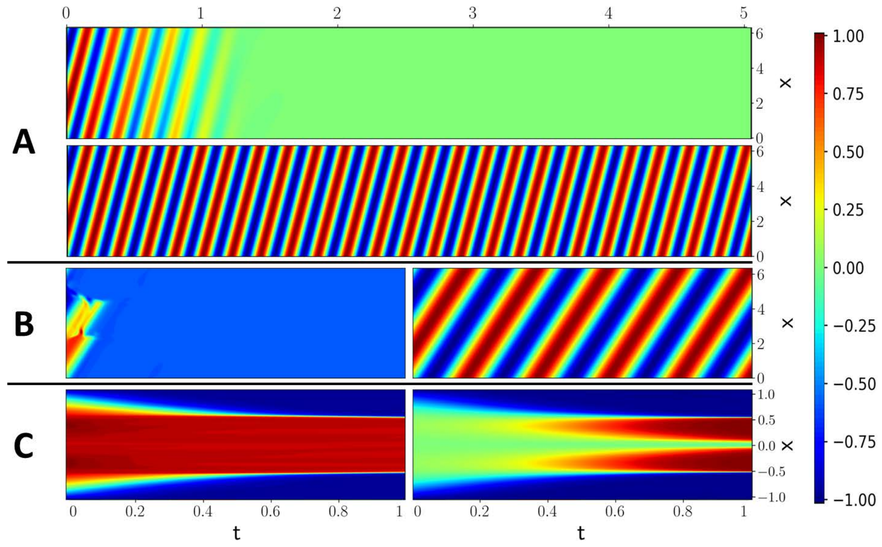
Advances in Physics-Informed Neural Networks

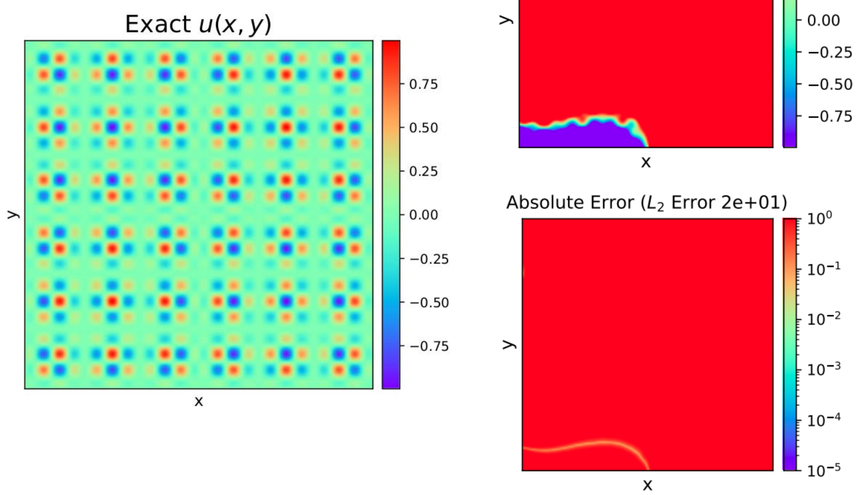
AI^2: Artificial Intelligence, Adaptation, and Innovation Group

Training Challenges for PINNs

A. Converges to zero-solution
B. No information propagation
C. Incorrect information propagation

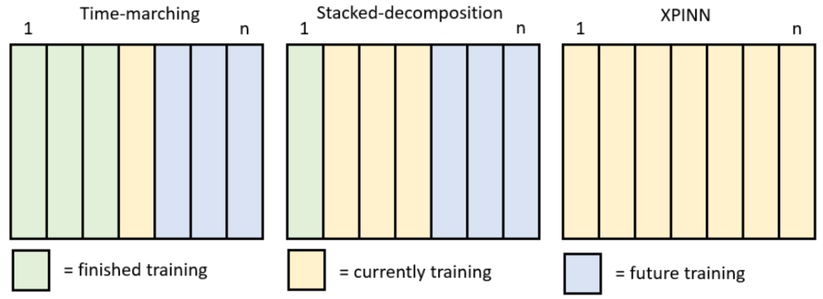


D. High-frequency and multi-scale problems

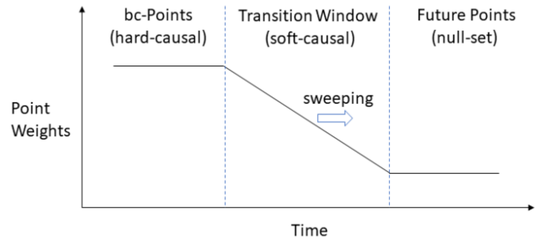


Unified Casualty Enforcement Framework for PINNs and Their Temporal Decompositions

Step 1: Stacked-Decomposition



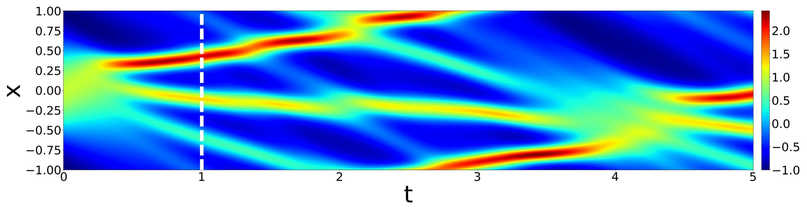
Step 2: Widow-sweeping



- Consider the Korteweg-de Vries (KdV) Equation:

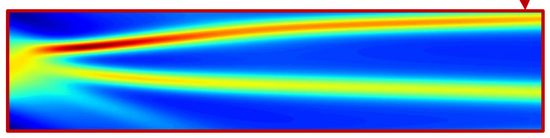
$$\frac{\partial u}{\partial t} + u\frac{\partial u}{\partial x} + 0.0025\frac{\partial^3 u}{\partial x^3} = 0, (t, x) \in T \times [-1,1] \qquad u_0 = \cos(\pi x)$$

Periodic BC's



Numerical Results

Domain	Model Settings	Relative ℓ_2 Error	Training time (s)
$T \in [0,1]$	Vanilla PINN	5.40×10^{-2}	2,030
	s-d + w-s PINN	2.37×10^{-2}	1,806
$T \in [0,5]$	Vanilla PINN	9.85×10^{-1}	15,224
	s-d + w-s PINN	5.15×10^{-2}	7,493



Augmented PINNs with Structured Basis Enhancements