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Control volume PINNs: a method for solving inverse problems with hyperbolic PDEs

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In this talk, we introduce a variant of PINNs designed for hyperbolic conservation laws, control volume PINNs (CVPINNs). While standard PINNs works with the strong form of PDEs, CVPINNs instead works with their integral forms. For forward problems, we demonstrate that CVPINNs is able to solve Riemann problems for various hyperbolic PDEs without the heavy regularization needed for standard PINNs. For inverse problems, we use CVPINNs to extract equations of state (EOS) from solutions to the Euler equations. Using DMSC simulations of the Sod shock problem, we demonstrate that we can recover the ideal gas EOS with this method. We conclude by extracting an EOS for copper under shock loading using molecular dynamics simulations of copper impact experiments. Fitted EOS's from this method can be transferred to standard finite volume codes and used to simulate more complex systems.