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Embedding Neural Networks in ODEs to Learn Linear Cosmological Physics

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The ΛCDM cosmological model has been very successful, but cosmological data indicate that extensions are still highly motivated. Past explorations of extensions have largely been restricted to adding a small number of parameters to models of fixed mathematical form. Neural networks can account for more flexible model extensions and can capture unknown physics at the level of differential equation models. I will present evidence that it is possible to learn missing physics in this way at the level of linear cosmological perturbation theory as well as quantify uncertainty on these neural network predictions. This is accomplished through Bolt, the first differentiable Boltzmann solver code - the gradients provided by Bolt allow for efficient inference of neural network and cosmological parameters. Time permitting, I will also present other aspects of Bolt, such as the use of iterative methods of solution, choice of automatic differentiation algorithm, and stiff ODE solver performance.

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