The Physics of Data. Part X

The Physics of Data. Part X | Alfonso R. Reyes

It's not that the neural network is solving physics. The solving is done by a differential equation solver. You use the neural network to find the right values of the Differential Equations parameters, or confirm a state variable -or variables-, in the equation based on some minimal data. It's more like calibration than really learning.

The beauty of combining a neural network with Physics is that it uses auto differentiation, so common in machine learning libraries such as PyTorch or TensorFlow, and Julia to confirm or validate the spatial temporal collocation points, in other words, the data.

There has been software for computationally solving Differential Equations for more than 40-50 years. This is nothing new.

What is happening now is that some physicists found out that they can use the modern machine learning libraries with GPU support, such as PyTorch, TensorFlow, Julia as (1) functional approximators; (2) as validators of the actual data points that are being supplied; (3) as minimization tools on the loss function to find the parameters of the differential equations; (4) discovery tools of Hidden Physics within the data. (5) as a new instrument to reduce the dependency on huge amounts of data.

The real revolutionary fact is that PINNs - and their cousins - do not need huge amounts of data or Big Data to perform reliable predictions, because the model and the data are constrained by the laws of physics. The world of PINNs is of Small Data.

The big challenge ahead is getting the expertise to spot the latent differential equation variables; their order; the number of simultaneous differential equations; the type - if ordinary, ODE, or partial, PDE, -, the right dimension - 1D, 2D, or 3D , and identifying the data thread-or stream- that needs a differential equation. Usually the most of nonlinear characteristics.

Most of the challenges in data science and machine learning will remain unsolved until the subject matter expertise and Physics combined, address them. It will not be an easy feat because requires understanding of physics, Computational Physics, advanced calculus, where machine learning plays just a little bit part of it.

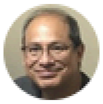
PINNs have nothing to do -yet- with artificial intelligence. They involve more physics and differential equations than machine learning. Like 95% to 5% ratio. Actually, the neural networks is the easy part.

So, PINNs are not your typical weekend data science or machine learning project. The current Artificial Intelligence wave does not involve any physics at all; just huge amounts of data producing very fragile predictions.

What lies ahead is a world awaiting for human intelligence to apply laws of nature to dynamical systems to reign in on the data.

You can get a taste of it by browsing any paper on PINNs.

hashtags:: Physics Of Data Machine Learning Petroleum Engineering SPE Data Science digital Transformation SciML SEG Oil and Gas Energy Engineering Artificial Lift AI



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You can get Neural Networks to solve Physics.

Here's how ↓ …more