Are physics-math-based iteration methods and physics-informed neural network methods in static magnetic field calculation more different or more similar?

G. S. Choe[1,2], Sibaek Yi[2], Minseon Lee[1], Mingyu Jeon[2]

[1]*School of Space Research, Kyung Hee University, Yongin, Korea*
[2]*Department of Astronomy and Space Science, Kyung Hee University, Yongin, Korea*

Physics and math-based iteration methods have long been investigated and used for computation of static coronal magnetic fields with photospheric boundary conditions obtained from vector magnetograms. Recently there have been attempts to solve these problems using physics-informed neural networks (PINNs). We look into these two types of approaches to find out their similarities and differences. The two approaches have quite a few things in common, especially in that they try to solve an optimization problem with the same constraints. A physics-math-based iterative solver usually presents a straightforward path to lead to a solution. The path leading to an approximate solution in PINNs is non-transparent and the procedure does not necessarily guarantee an output which can meaningfully represent the real solution. It is also to be noted that the words“training”or“learning” are often used in a wrong context in the latter just to endow it with a black-box-like image. However, the latter approach is incomparably more capable than the former in solving inverse problems.