

Abstract Submitted
for the DPP20 Meeting of
The American Physical Society

Towards predicting electron beam charge upon phase control in laser wakefield accelerators using supervised learning techniques¹ JINPU LIN, QIAN QIAN, JON MURPHY, Univ of Michigan - Ann Arbor, ABIGAIL HSU, Stony Brook University, ALEXANDER THOMAS, KARL KRUSHELNICK, Univ of Michigan - Ann Arbor, ALFRED HERO, University of Michigan — High-repetition-rate laser systems have been widely used with evolutionary algorithms to solve optimization problems in the field of relativistic laser-plasma interactions. However, these algorithms usually provide little information besides the optimized result, which can be hard to interpret. Machine learning methods can generate predictive models to reveal more information in the dataset and help understand the physics relations. In this work, we measured the electron beam charge from a laser-wakefield accelerator upon changing the laser wavefront using a deformable mirror. Through model training with weight learning, we predict the electron beam charge given the wavefront using four supervised learning methods: random forest, neural networks, deep joint-informed neural networks, and Gaussian process. We show that generating higher beam charge favors specific wavefront by ranking the feature importance. We show that machine learning can help understand the measured data quality as well as recognize irreproducible data and outliers. We also include virtual measurement errors in the dataset to exam the model performance. This work demonstrates how machine learning methods can benefit the data analysis and physics interpretation in a nonlinear LPI problem.

¹Funded by AFOSR FA9550-16-1-0121

Jinpu Lin
Univ of Michigan - Ann Arbor

Date submitted: 01 Jul 2020

Electronic form version 1.4