# Towards Predicting Electron Beam Charge upon Phase Control in Laser Wakefield Accelerators Using Supervised Learning Techniques

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High-repetition-rate laser systems have been widely used with evolutionary algorithms to solve optimization problems in the field of relativistic laser-plasma interactions[1]. However, evolutionary algorithms usually provide little information other than 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[2]. 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[3], 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.

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**References**

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