First WEST experimental data analysis using machine learning algorithms

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WEST (tungsten –W– Experimental Steady-state Tokamak) is a device specialized for long pulse operation in a tungsten environment. Its main purpose is to study the plasma-wall interactions in a metallic environment and to be a test bed for ITER plasma facing components [1]. Several dozens of diagnostics are used to characterize WEST plasmas, in total 50 different diagnostics will be installed. A large heterogeneous amount of data is produced and a significant effort is being made to unify data storage and to improve data access and traceability. To this end we are using the IMAS (Integrated Modelling and Analysis Suite) infrastructure to manage WEST experimental data [2]. As a first step we built a unified database suited for machine learning algorithms using a limited set of diagnostics. Two main objectives drive the initial analysis. First the parameter space explored in the previous WEST campaigns is studied with the objective of finding outliers that could indicate sensor malfunctions or better, a plasma state bifurcation. The second objective is to carry out, as a starting point, a sensitivity analysis on the plasma confinement time to find the main parameters driving WEST tokamak performances.

The constructed reduced database is composed of statistical moments describing steady-states reached by the plasma. A steady-state is consider to be reached when the plasma current, total power and density vary less than 5% of their median value in a time window of at least 0.5 seconds. Taking into account these criteria a database composed of approximatively one thousand steady-state plasma entries is built. The target quantity is the plasma confinement time. Using a principal component analysis algorithm and autoencoders neural networks [3] a reduction of dimensionality is performed to identify the main parameters that account for the largest amount of variance on the target. Finally the identified principal parameters are compared to the standard scaling law for L-mode confinement time in tokamaks.

[1] J. Bucalossi et al. 2014, Fusion Eng. Des. 89 907

[2] F. Imbeaux et al. 2015, Nucl. Fus. 55 123006

[3] Y. Wang et al. 2016, Neurocomp. 184 232-242

‡http://west.cea.fr