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Avoiding sensor induced disruptions with use of machine learning

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Control is necessary to keep fusion plasmas stable. This requests a set of real-time diagnostics. These sensors and/or data acquisition systems are prone to failure, especially under the demanding environments of a fusion reactor that has cryogenic and extreme hot conditions, high neutron production and high magnetic fields. Current real-time control algorithm assume the sensors as correct within given error bars. Algorithms that can check and variate each sensor as the plasma evolves (or in between discharges) in minutes/hours is hard to implant and is labor intensive which introducing human error. A promising approach is machine learning based design, where the control/analysis structure is trained using a combination of good and bad data (available or made up). We explain how these ML algorithms can be robust and can avoid the brittleness of hand written code. We present the example of NSTX-U equilibrium reconstruction using robust ML algorithms (NF 2022, in review). The achieved reconstruction makes NSTX-U robust against magnetic sensor failures while at the same time getting rid of the requirement that a human input on which sensors are good. Another benefit of the ML reconstruction is higher quality compared to rt-EFIT. Given the immense sensor fusion task, the high cost of disruptions and the relative low human resource availability at ITER, robust and easy to train ML-based sensor fusion might prove valuable for ITER and future reactors.

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