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AN INTRODUCTION TO INVERSE PROBLEMS IN FUSION

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In science an inverse problem can be defined in full generality as the task of calculating from a set of observations the factors that generated them. Such problems are called inverse because they are meant to derive the causes from their effects. They can therefore be considered the opposite of forward problems, whose objective is calculating the effects of causes. Many data-centric problems in fusion are 'inverse'in nature, i.e. they involve extracting unknown parameters and causes from observations. First many fundamental measurements, being based on the plasma natural emission, require some form of inversion to be interpreted and provide the required physical information: the measurements to obtain the magnetic topology, tomographies, videos and nuclear detectors are just some examples. A second class of activities, often performed by plasma scientists, consists of relating physical quantities to the observations forming experimental databases. Linear and nonlinear fitting, to identify scaling laws for example, are cases in point. These families of tasks are often addressed separately but in reality, being instances of inverse problems, they have a lot in common. Indeed, both activities require solving mathematically ill posed inversions and therefore face the same types of issues such as: estimating the confidence intervals in the results, dealing with the consequences of noise, minimising bias effects. Some approaches to address these difficulties in both the measurement and the modelling settings will be discussed.

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