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Assessing identifiability of dynamical systems for inverse problems: classical sensitivity functions and information gain

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As mathematical models for biological functions become more complex, the number of unknown model parameters typically increases. These parameters must be estimated from a set of measurements (model outputs corrupted by noise) through the formulation of an inverse problem and an appropriate solution methodology. This work concerns with the question of identifiability, *i.e.* whether the parameters of a dynamical system can be reliably estimated given a set of measurements. The proposed methodology is to relate classical sensitivity functions to forward and backward uncertainty propagation. This enables quantification of expected information gain about the parameters given the measurements, leading to a new class of functions called 'information sensitivity functions (ISFs)' [1]. The ISFs are designed so that they can be computed by sensitivity functions alone, thereby keeping the computational costs low. The marginal ISFs relate to mutual information between individual parameters and the measurements. They can therefore be used to assess individual parameter identifiability. They can also be used to assess the effect of increasing measurements noise and measurement frequency on the inverse problem. Finally, the conditional ISFs relate to conditional mutual information between sets of parameters given the measurements and can therefore be used to assess posterior parameter dependencies.

The application of ISFs will be presented in three different biological models: i) a Windkessel model, which is widely used a boundary condition in computational fluid dynamics simulations of haemodynamics; ii) the Hodgkin-Huxley model for a biological neuron, which has formed the basis for a variety of ionic models describing excitable tissues; and iii) a kinetics model for the Influenza A virus.

REFERENCES

[1] Pant, S., 2017. Information sensitivity functions to assess parameter information gain and identifiability of dynamical systems. *arXiv preprint arXiv:1711.08360*, 2017.