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Autonomous Experimentation: Coupling Machine Learning with Computer Controlled Microfluidics

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Modelling biological systems is impaired by the cost of experimentally obtaining the data required to build the models. The resources available to perform experiments are typically very limited compared to the size of parameter spaces and the complexity of the systems under investigation. However, the confluence of laboratory automation and the low cost of computing resources make it practicable to apply a closed-loop strategy, where each experimental observation allows the computer to reason the experiment to perform next. By doing so, autonomous experimentation tries to capture the efficiency of experimentalists in navigating a seemingly boundless space of potential experiments. While computers can at most represent a very limited knowledge context in which they interpret their observations, they do have the benefit of being able to contemplate many thousands of hypotheses in parallel.

We will report on the development of an autonomous experimentation setup that devises hypotheses and decides on experiments which are then physically performed on a microfluidic device, all without human interaction. The purpose of our implementation is the investigation of biomolecular substrates for novel computing devices, however our approach is not specific to this application.

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