

Towards a fully automated algorithm driven platform for biosystems design

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Project goals:

To achieve full automation of the Design-Build-Test-Learn process for biosystems design via an integrated robotic system coupled with machine learning algorithms.

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Abstract:

Large-scale data acquisition and analysis are often required in the successful implementation of the design, build, test, and learn (DBTL) cycle in biosystems design. However, it has long been hindered by experimental cost, variability, biases, and missed insights from traditional analysis methods. Here, we report the application of an integrated robotic system coupled with machine learning algorithms to fully automate the DBTL process for biosystems design. As proof of concept, we have demonstrated its capacity by optimizing the lycopene bio-synthetic pathway. This fully-automated robotic platform, BioAutomata, evaluates less than 1% of possible variants while outperforming random screening by 77%. A paired predictive model and Bayesian algorithm select experiments which are performed by Illinois Biological Foundry for Advanced Biomanufacturing (iBioFAB). BioAutomata excels with black-box optimization problems, where experiments are expensive and noisy and the success of the experiment is not dependent on extensive prior knowledge of biological mechanisms.

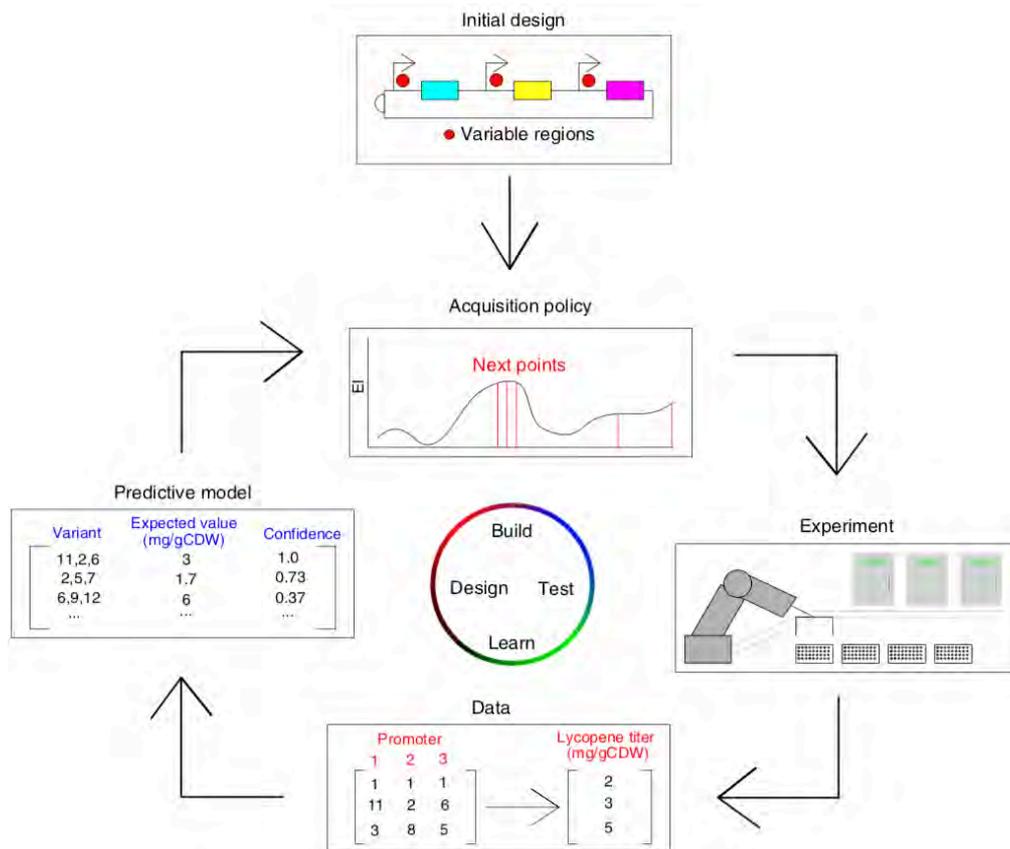


Figure 1: The overall workflow of BioAutomata. After setting the initial parameters, designing the sequence space of variable regions (such as promoter variants in a combinatorial pathway assembly), and defining the objective function, BioAutomata selects which experiments are expected to result in the highest improvement of yield, performs those experiments, generates data and learns from it, updating its predictive model given the newly presented evidence. It will then decide on the next experiments to perform to reach the goal set by the user while trying to minimize the number of experiments and the cost of the project

References:

1. HamediRad, M., Chao, R., Weisberg, S. *et al.* Towards a fully automated algorithm driven platform for biosystems design. *Nat Commun* **10**, 5150 (2019). <https://doi.org/10.1038/s41467-019-13189-z>

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