Deep Neural Network-Guided Design of Orthogonal Trans-Elements for Plant Synthetic Biology

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Project goals:
Establish the scientific knowledge and new technologies to transform the maximum amount of carbon available in bioenergy crops into biofuels and bioproducts.

Synthetic biology tools for integrating complex gene circuits are a necessity for creating high-yielding, deconstructable bioenergy crops. Introducing complex gene circuits and functions into bioenergy crops will require the coordination of multiple cis and trans elements with minimal off-target effects on the plant. Transcription-activator-like effectors (TALEs) offer a useful scaffold for designing targetable synthetic trans-elements for bioenergy crop improvement due to the modular encoding of its DNA-binding site in the protein sequence. We assess the benefits of using different TALEs by targeting orthogonally designed DNA-sequence space and compare its impact on endogenous gene regulatory networks versus using literature-established *trans*-elements such as yeast Gal4. Using machine learning to assist in the identification and design of orthogonal DNA-binding sites, we are able to build synthetic trans-elements and characterize their ability to regulate transgene expression in a targeted manner in model and crop plant systems.

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