2015 Summer Undergraduate Research Experience Project Showcase

University of California, Santa Barbara

Funded by the National Science Foundation via an IGERT in Network Science (DGE-1258507)
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Automated Diabetic Retinopathy Detection Using Deep Neural Networks

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Diabetic retinopathy, (DR), is increasingly prevalent in populations. According to the National Eye Institute, "From 2000 to 2010, the number of cases of diabetic retinopathy increased 89 percent from 4.06 million to 7.69 million" within the USA. Due to the high cost of examinations and the lack of physicians, an automated process for early diagnosis of DR is necessary. In this project, we built a model that predicts the different stages of DR based on given retinal fundus images. Recent success in image recognition suggests convolutional neural networks, (CNN), could be utilized for this application. We train multiple CNNs with different objective functions using backpropagation and combined their predictions using a feature fusion algorithm. The method is validated using the Kaggle DR challenge retinal image dataset.

Stability Analysis of Gene Regulatory Networks (GRNs)

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Biological networks are vast and can consist of 102 to 107 nodes (objects) and exponentially as many edges (interactions). In order to understand each edge within a biological network, it requires significant experimentation, which can be time consuming. In our study, we investigated whether there are organizational properties within biological networks, which can be used to understand these networks with limited experimentation. We chose to look specifically at Gene Regulatory Networks (GRNs), which describe how the transcription of genes is controlled.

GRNs are relevant to research in medicine, drug therapy/design, development, and evolution. Using the Saccharomyces cerevisiae (yeast) GRN, we investigated whether network stability, a measure of resilience, is one of the potential organizational properties. We built a model that breaks down GRNs in various ways and tests for stability. We saw that the S. cerevisiae GRN was stable only after being broken apart almost entirely. Further, we will be examining other more stable networks and also checking to see if there is relationship between the stability of GRNs and the underlying biological functionality.