Contextual Explanation Networks Enable Integrated Analysis of Imaging and Genomic Data

Abstract:
A fundamental goal of precision medicine is to use multiple types of data to generate a high-quality understanding of a patient's disease. For datatypes which have well-understood effects on the outcome of interest, it is straightforward to incorporate this data directly in a probabilistic graphical model. However, complex datatypes can be difficult to incorporate. To overcome this challenge, we present a deep learning framework which incorporates complex covariate data (e.g., histology images) into an interpretable graphical model framework by using Contextual Explanation Networks to encode the covariate data into sample-specific “contexts" which determine interpretable parameters for a graphical model. We apply the framework to a dataset of Kidney Renal Clear Cell Carcinoma patients and find that the use of imaging contexts improves performance of case/control status by logistic regression from a baseline of 95% to over 99% predictive accuracy. Finally, we investigate the learned contexts to uncover molecular subtypes of the disease.