Combining Imaging and Genomic Data in a Single Deep Learning Model

Motivation
- We'd like to use both imagining and genomic data to understand patients.
- What model to use?
  - Images → convolutional neural networks (CNNs)
  - Genomic data → interpretable graphical models
- Can we combine these frameworks to make an interpretable deep model?

Our Approach
- A contextual explanation network (CEN) combines "contextual" data (C) with an interpretable probabilistic graphical model (PGM) via a context encoder which selects sample-specific parameters ("explanations") as the linear combination of the values stored in a dictionary. The PGM then uses these sample-specific parameters to operate on the sample's attribute data (X) and calculate the final target (Y).

Explanations on Important Tissue Areas

Deep Learning Focuses on Important Tissue Areas
- Ignores background white space
- Ignores nuclear red areas
- Ignores unclear red areas

Conclusions
- Improved predictive performance
  - Task: predict case/control status of patient.
  - Model | Accuracy (%)
  | Train | Valid | Test |
  | Log. Reg. | 90.16 | 90.74 | 90.64 |
  | VGG | 96.55 | 95.79 | 95.24 |
  | ResNet | 98.38 | 96.74 | 96.08 |
  | MoE | 98.50 | 92.05 | 97.32 |
  | CEN | 100.00 | 100.00 | 99.97 |

Explanations Tie Genomic Signatures to Phenotypic Patterns
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References