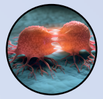

ASSESSMENT OF MULTIMODAL VARIATIONAL AUTO-ENCODERS IN COMBINING INFORMATION FROM BIOLOGICAL DATA TYPES IN CANCER CELLS

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1. Background

- Personalised treatment for cancer benefits from **integrating modalities**
- Correlation with clinical outcome and retrieval is difficult and costly
- **Multimodal Variational Auto-Encoders** (MVAE) can find a common latent representation of multiple modalities
- Potentially bring deeper understanding of cell relations
- **Predict** modalities for less intensive data gathering

2. Research Question

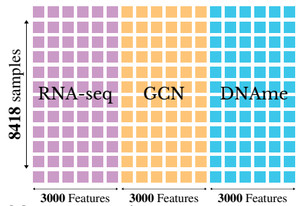
HOW WELL ARE TRAINED MVAE MODELS ABLE TO PREDICT OR RECONSTRUCT MODALITIES IN CANCER CELLS?

3.1 Methods

Comparison based approach of two MVAE Models
>> Mixture-of-Experts[1] and Product-of-Experts[2]

- Based on **reconstruction loss** to MOFA+[3], a linear method for modality integration
- Based on their efficiency in **predicting** modalities based on another modality using two MVAE models

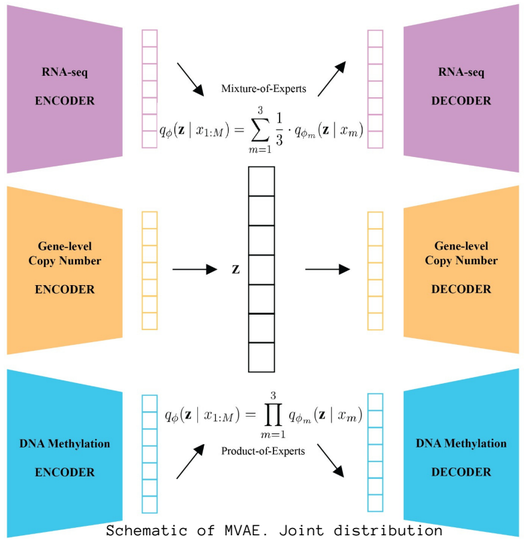
Three Modalities:
- RNA Sequencing
- Gene Copy Number
- DNA Methylation



Real patient data:
>> **8,418** samples from **33** cancer types

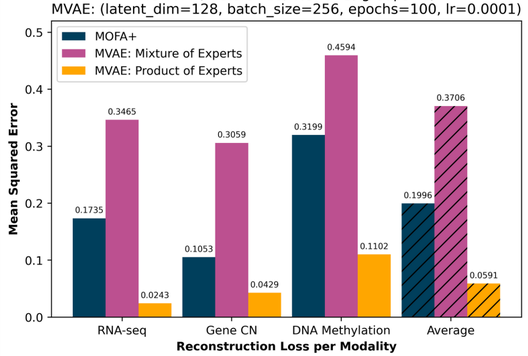
3.2 MVAE Models

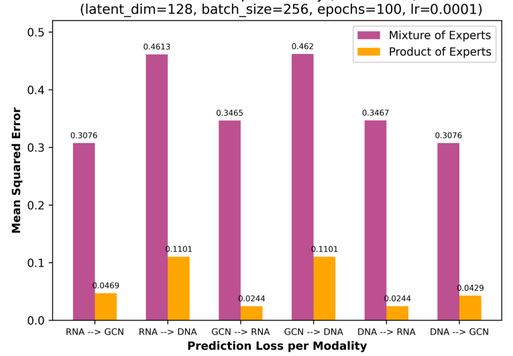
- **70-10-20** data split: training, validation and prediction set



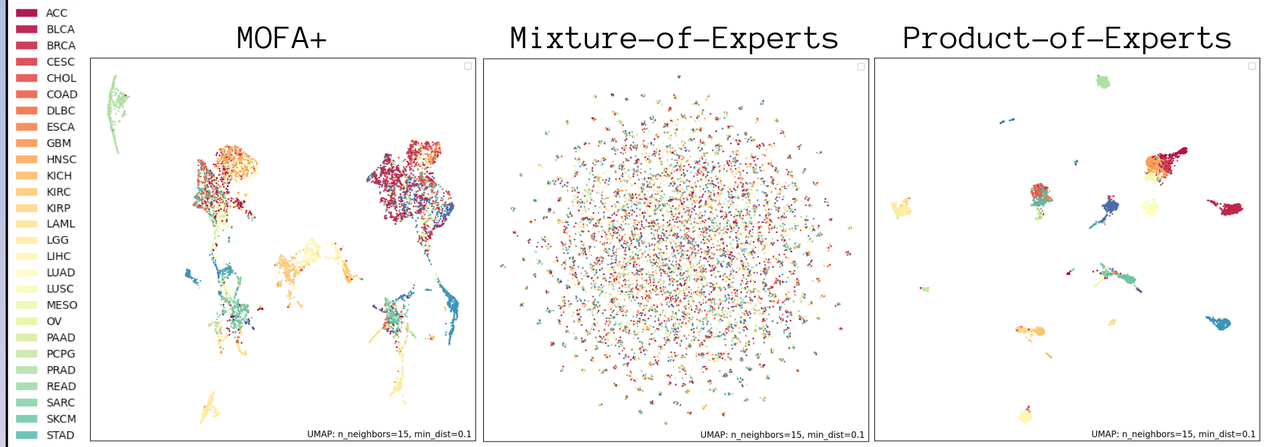
Schematic of MVAE. Joint distribution through either MoE or PoE

4.1 Reconstruction and Prediction Loss





4.2 UMAP Of Model Latent Space



UMAP of the latent space (Z) of each model, coloured by cancer type.
Density of clusters indicates local structure -> good grouping of cancer types
Spread of clusters indicates global structure -> distinction between cancer types

- **UMAP** indicates Product-of-Experts is **learning** representation of cancer types
- Mixture-of-Experts is **not** making any distinction between types

5. Conclusion

Conclusion from Results:
>> PoE has lower reconstruction loss than other models
>> PoE has a substantially lower loss when doing cross-modal predictions compared to MoE
>> DNAme hard to reconstruct/predict for all models

Future work recommendations
>> Reimplementation of Mixture-of-Experts in Product-of-Experts codebase
>> Grid search of different KL-weights with predictions to determine influence on learning

[1] Y. Shi, N. Siddharth, B. Paige, and P. H. S. Torr, "Variational mixture-of-experts autoencoders for multi-modaldeep generative models", 2019
[2] M. Wu and N. D. Goodman, "Multimodal generative models for scalable weakly-supervised learning," CoRR, vol. abs/1802.05335, 2018.
[3] R. Argelaguet *et al.*, "MOFA+ : a statistical framework for comprehensive integration of multi-modal single-cell data, "Genome Biology", vol. 21,no. 111, May 2020.