Project C **Mathematical Underpinnings**

# Variational Deep Autoencoder (VaDE)

## Evaluation of the method

The goal of this project is to perform clustering using VaDE (Jiang et al), evaluate its clustering performance and compare its latent space with VAE or conditional VAE.
Use the following models:

- VaDE
  Helpful information for VaDE implementation:
  - proper ELBO definition,
  - pretraining the weights and latent space parameters. Random initialization of parameters may not suffice, potentially leading the model to converge to unsatisfactory local minima or struggle to converge. First, you may train simple encoder-decoder model (the autoencoder) and use its weights as starting points. Then you may run a gaussian mixture model on its latent space to get starting values of the mixture components in VaDE.
- VAE/cVAE

The task is to implement VaDE (special attention should be paid to pretraining the weights and latent space parameters), Check the performance on one (*two*[1]) real-world datasets e.g. mnist, fashion-MNIST (the datasets might not be image-based).

## Evaluation of the method

At least two metrics in 1 and 2 must be provided.

1. evaluate the performance of VaDE by comparing the clustering with the true classes using appropriate metrics from sklearn),
2. compare clusters identified in the latent space of VaDE with those of VAE or cVAE (use true classes as clusters) in terms of how well the clusters are defined (for well-defined clusters, observations within the same cluster should be similar, while they should be dissimilar if they are from two different clusters),
3. visualize the latent spaces of VaDE and VAE/cVAE,
4. generate observation from each cluster. For image-based dataset visualise the results. Compare the distance of newly generated samples to nearest observations within and out of the clusters, from which they were generated.

[1] Two-person groups