Unsupervised clustering is a very relevant, open area of research in machine learning with many applications in the real world. Learning the manifold in which images lie and measuring the proximity distance of the sample points to the clusters in their latent space is non-trivial. Recent deep learning methods have proposed the use of autoencoders for manifold learning and dimensionality reduction in an effort to better cluster image samples. However, offline training of autoencoders is cumbersome and rather tedious to update. We introduce a novel method that uses a triplet network architecture in order to replace autoencoders, thus avoiding the need to pre-train autoencoders offline. Because our framework can be trained online, we can train our network with data augmented pairs which allows us to build a more robust encoder and improve accuracy. Our method remains competitive compared with other current methods while we obtain state of the art results on Fashion-MNIST dataset. (Received September 17, 2019)