Deep Learning – Assignment 6
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Project Report

Background and Methods:

Fashion-MNIST: Fashion-MNIST is a dataset of Zalando's article images—consisting of a training set of 60,000 examples and a test set of 10,000 examples. Each example is a 28x28 grayscale image associated with a label from 10 classes. Fashion-MNIST is intended to serve as a direct drop-in replacement of the original MNIST dataset for benchmarking machine learning algorithms.**[1]**

This study proposes machine learning models based on *Auto-Encoders* and *Convolutional Neural Networks* with *SIGMOID/RELU/SOFTMAX* transfer Functions and *Binary Cross-Entropy/Categorical Cross-Entropy* loss functions to classify Fashion-MNIST data.

Pre-processing:

Convolutional Neural Networks	**1.** Reshaped the data to fit the model **2.** One-hot encoding of categorical data **3.** Normalized/Scaled the dataset
Auto-Encoder	**1.** Reshaped the data to fit the model **2.** One-hot encoding of categorical data **3.** Normalized/Scaled the dataset

Justification of Choosing Activation and Loss Function:

MLP Model	Transfer Function	Loss Function	Justification
Convolutional Neural Networks	*RELU/SOFTMAX*	*CATEGORICAL _CROSSENTROPY*	Categorical cross-entropy leveraged for multi-class classification problems where one attribute could belong to one out of many possible classes that the model must decide. The SOFTMAX transfer function is generally recommended for classification with the categorical cross-entropy loss function for better performance.
Auto-Encoder	*RELU/SIGMOID*	*BINARY _CROSSENTROPY*	Binary cross-entropy leveraged for binary classification tasks where one attribute could belong to one out of two classes that the model must decide. RELU with SIGMOID transfer function is recommended with the binary cross-entropy loss function for better performance.

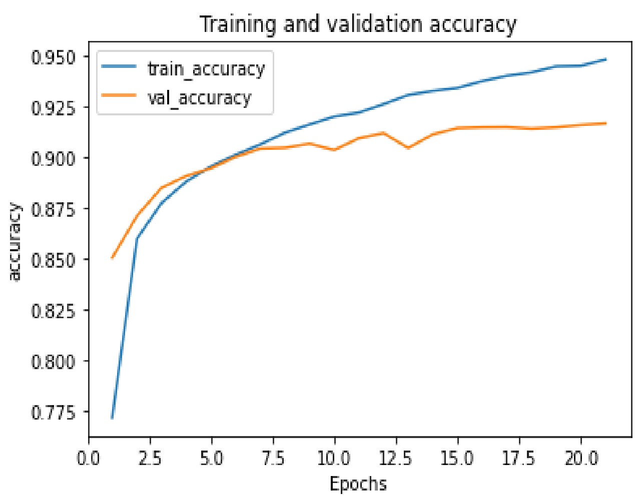
Model Performance:

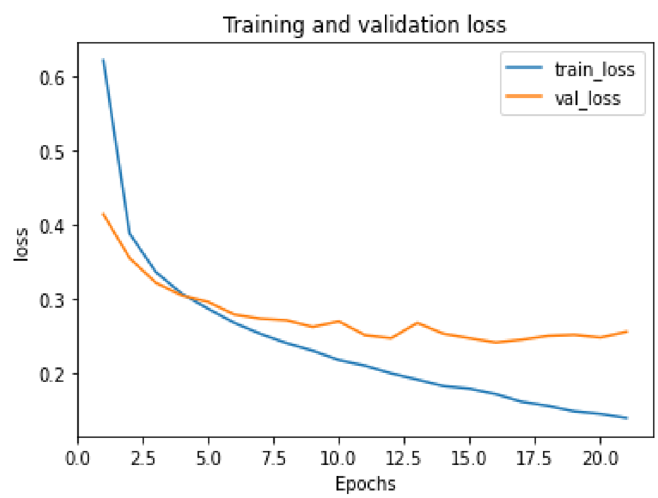
MLP Model	Regularization/Dropout	Justification
Convolutional Neural Networks	Dropout	**L1 regularization** or **dropout** methods are leveraged to improve model performance with training and test sets to overcome the issues of overfitting and bias-variance dilemma.
Auto-Encoder	L1 Regularization	**L1 regularization** or **dropout** methods are leveraged to improve model performance with training and test sets to overcome the issues of overfitting and bias-variance dilemma.

MLP Model Evaluation:
One way to measure models' performance is to compare the predictions' error for the actual values with training, test, and validation accuracy and loss. Please refer to the **MLP Model Summary Table** in the appendix below for details on model performance.

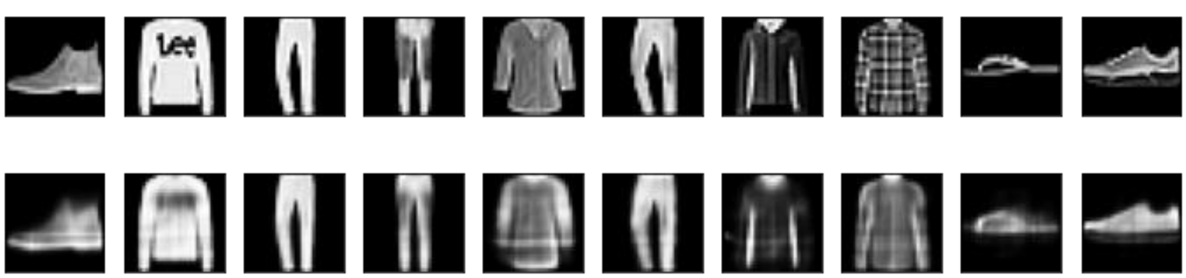
Summary:
After comparing models' output, it turned out that accuracy, loss, and the score for training, validation, and test data play a crucial role in evaluating the model performance. The goals were to build MLP models to demonstrate the power of the Deep Neural Network in terms of classification high dimensional data. The observations-based models' outputs are as follows:

Convolutional Neural Networks with categorical cross-entropy and MaxPooling performed well with high accuracy and lower loss rate to classify the Fashion-MNIST data. It seems the model performance is promising in classifying Fashion-MNIST data.

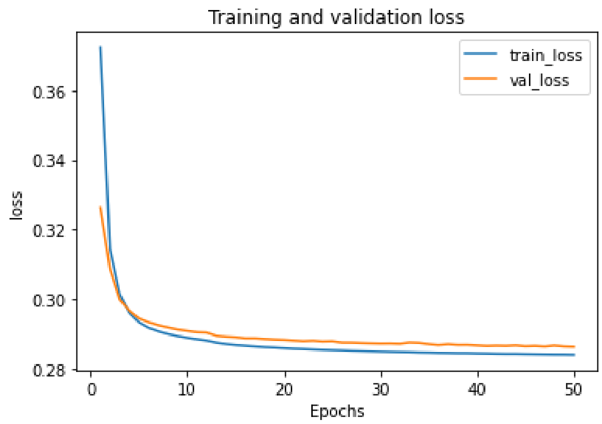




Auto-Encoder with binary cross-entropy also performed well to reconstruct actual images with defined encoder and decoder layers, as demonstrated below.



Auto-Encoder Training and Validation Loss:



Reference:

[1] Xiao, H., Rasul, K. & Vollgraf, R. (2017). Fashion-MNIST: a Novel Image Dataset for Benchmarking Machine Learning Algorithms (cite arxiv:1708.07747Comment: Dataset is freely available at https://github.com/zalandoresearch/fashion-mnist Benchmark is available at http://fashion-mnist.s3-website.eu-central-1.amazonaws.com/)

APPENDIX:

Model Summary:

Model Summary			**Train Score**		**Validation Score**		**Test Score**	
MLP Model	**Loss Function**	**Transfer Function**	**Score**	**Loss**	**Accuracy**	**Loss**	**Accuracy**	**Loss**
Convolutional Neural Networks	*Categorical _crossentropy*	*SOFTMAX ADAM RELU*	**96.05**	**10.95**	**91.44**	**16**	**91.63**	**25.61**
Diabetes Prediction	*Binary _crossentropy*	*SIGMOID ADAM RELU*	**N/A**	**28.87**	**N/A**	**28.97**	**N/A**	**N/A**