Schneider Electric’s Technical Project

Topic: Netflix Model

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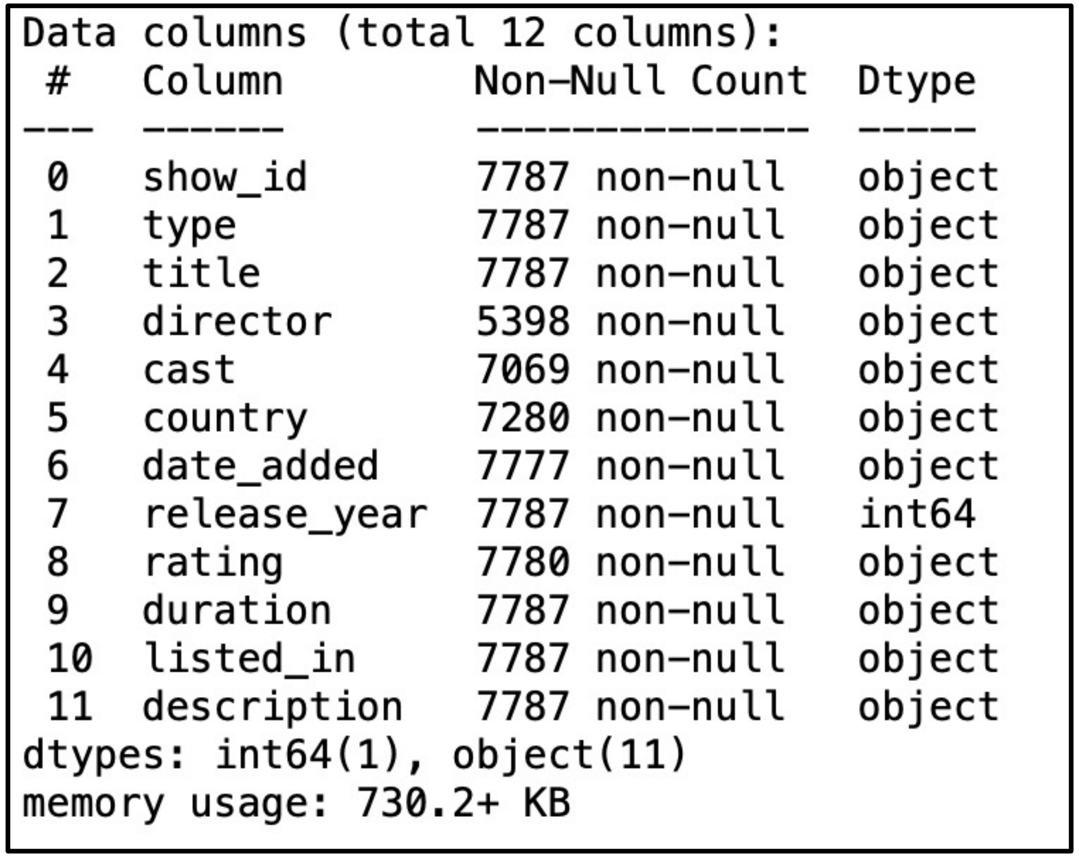
Northeastern University

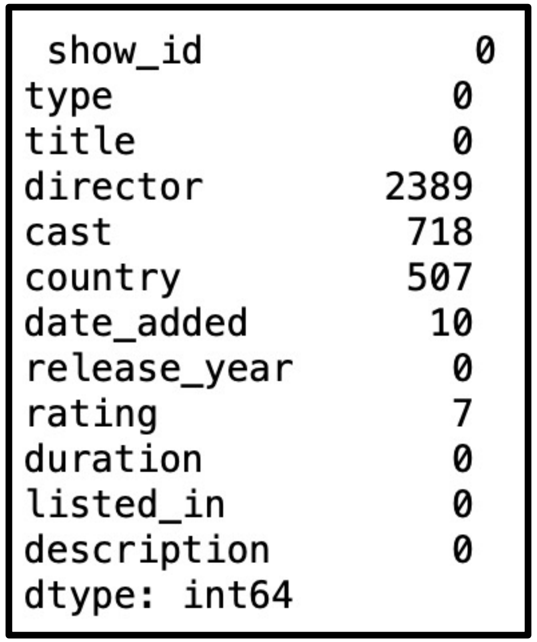
Dataset - Overview



```
Data columns (total 12 columns):
 #   Column        Non-Null Count  Dtype
---  ------        --------------  ------
 0   show_id       7787 non-null   object
 1   type          7787 non-null   object
 2   title         7787 non-null   object
 3   director      5398 non-null   object
 4   cast          7069 non-null   object
 5   country       7280 non-null   object
 6   date_added    7777 non-null   object
 7   release_year  7787 non-null   int64
 8   rating        7780 non-null   object
 9   duration      7787 non-null   object
 10  listed_in     7787 non-null   object
 11  description   7787 non-null   object
dtypes: int64(1), object(11)
memory usage: 730.2+ KB
```

No. of Rows: 7787

No. of Columns: 12



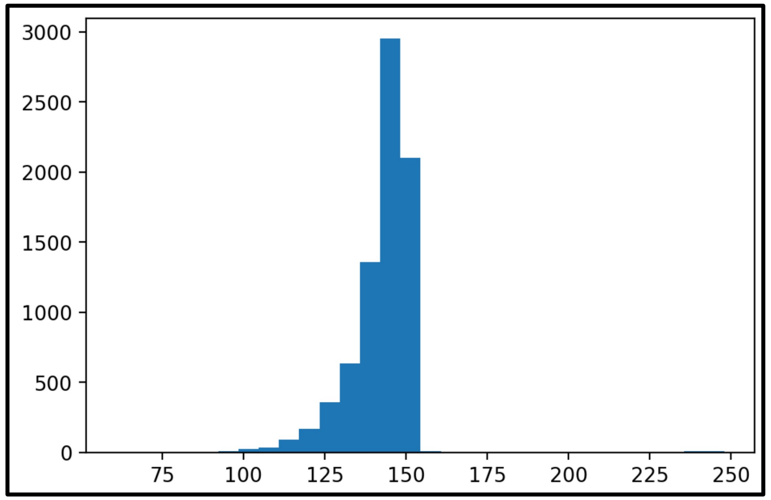
```
 show_id           0
type               0
title              0
director        2389
cast             718
country          507
date_added        10
release_year       0
rating             7
duration           0
listed_in          0
description        0
dtype: int64
```

Missing Data

No Duplicate Entries !!

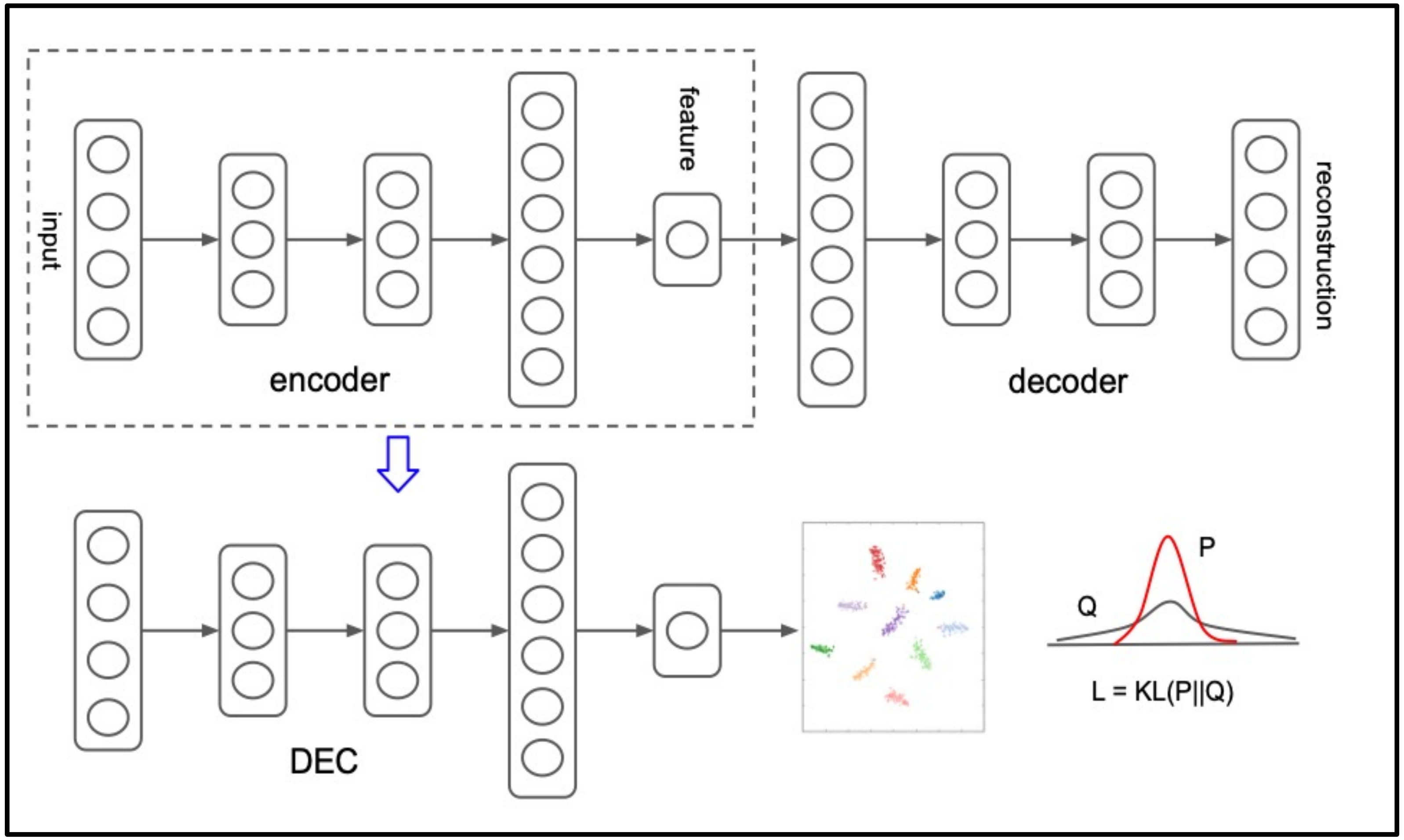
Text - Processing

- Using 'description' text of movies for clustering purposes.
- Tokenizing data with 10000 most frequent words
- Padding resulting sequence to 1500 length.
- Scaling features to the range between 0 and 1



Distribution of Sequence Length

Clustering - Framework

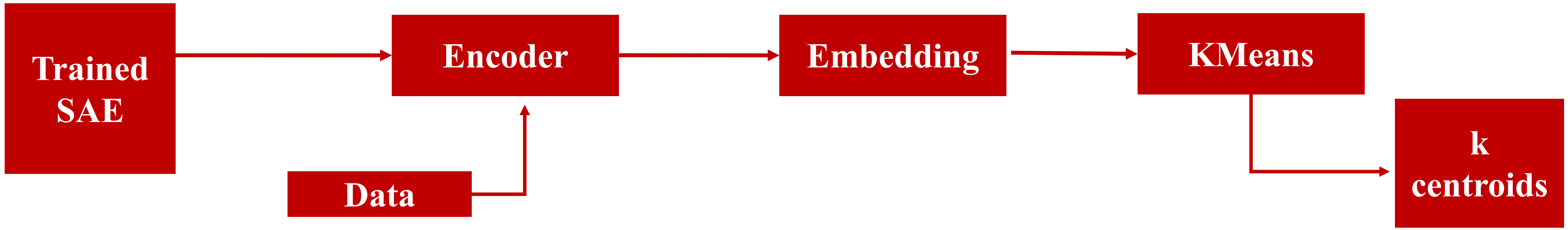


- $f_\theta : X \longrightarrow Z$
- Clusters data by learning k clusters center in Z
- Parameter initialization with a deep autoencoder
- Parameter Optimization

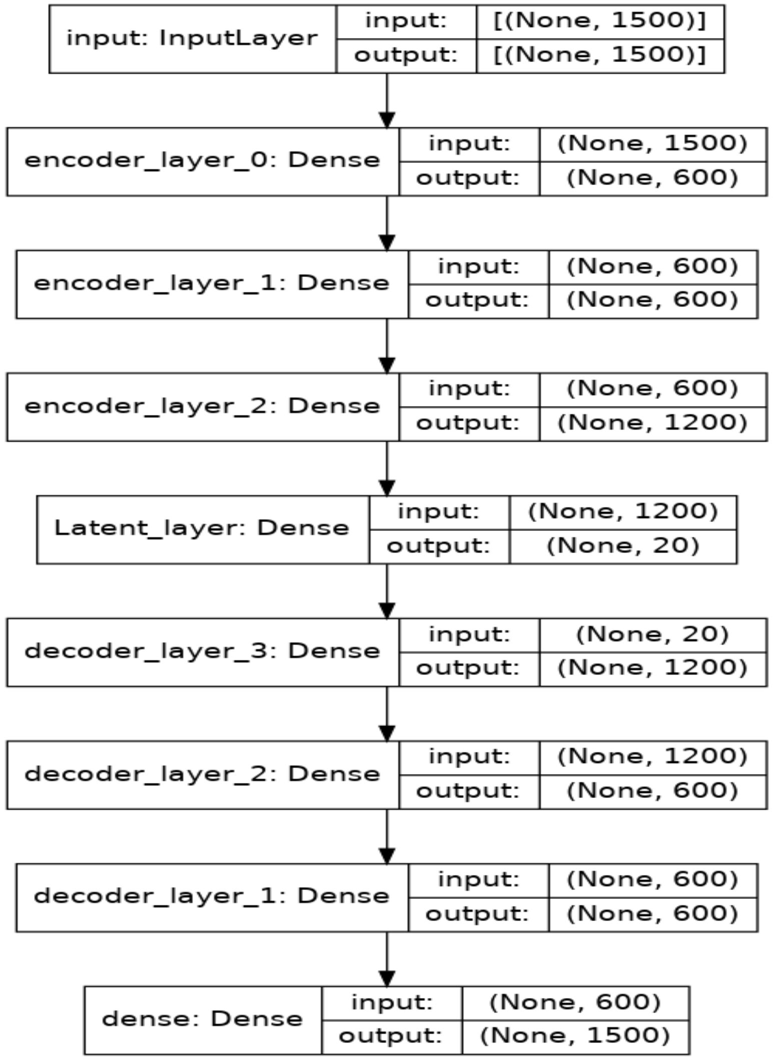
Xie, Junyuan et al. "Unsupervised Deep Embedding for Clustering Analysis." *ArXiv*abs/1511.06335 (2016): n. pag.

Clustering – Parameter Initialization

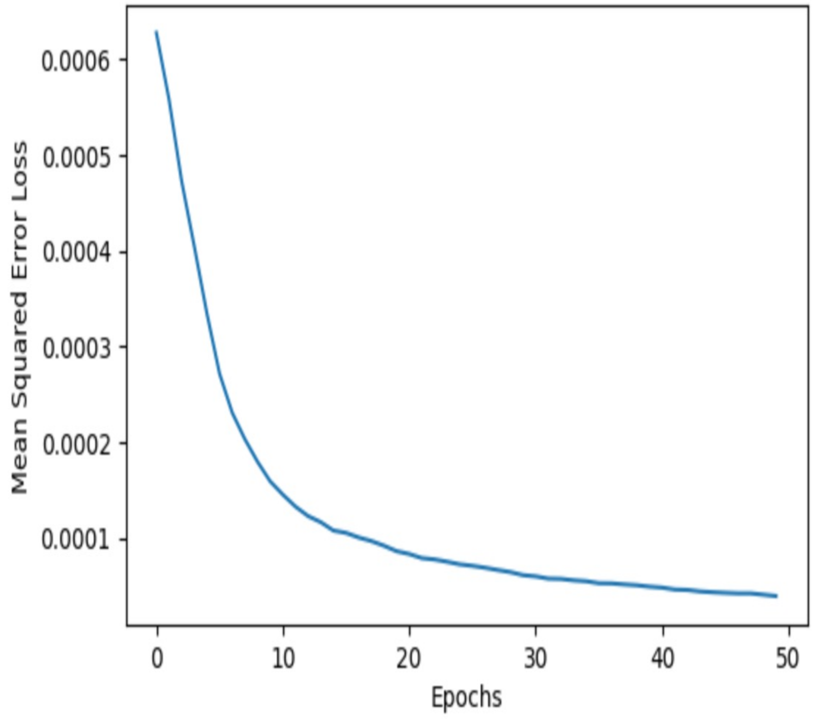
- DEC initialized by stacked Auto Encoder
- AE trained by minimizing the MSE loss
- Discard ***decoder*** after training to use ***encoder*** for initial mapping: $\boldsymbol{X} \longrightarrow \boldsymbol{Z}$
- ***k*** initial centroids obtained by ***kmeans*** on embedded data points $\mathbf{Z}$



Clustering – Stacked Autoencoder



Layer		Shape
input: InputLayer	input:	[(None, 1500)]
	output:	[(None, 1500)]
encoder_layer_0: Dense	input:	(None, 1500)
	output:	(None, 600)
encoder_layer_1: Dense	input:	(None, 600)
	output:	(None, 600)
encoder_layer_2: Dense	input:	(None, 600)
	output:	(None, 1200)
Latent_layer: Dense	input:	(None, 1200)
	output:	(None, 20)
decoder_layer_3: Dense	input:	(None, 20)
	output:	(None, 1200)
decoder_layer_2: Dense	input:	(None, 1200)
	output:	(None, 600)
decoder_layer_1: Dense	input:	(None, 600)
	output:	(None, 600)
dense: Dense	input:	(None, 600)
	output:	(None, 1500)



- **Activation Function:** ReLU
- **Batch Size:** 128
- **Epochs:** 50
- **Optimizer:** RMSprop
- **Learning Rate:** 0.001
- **Momentum:** 0.9
- **Loss:** MSE

Clustering – Parameter Optimization

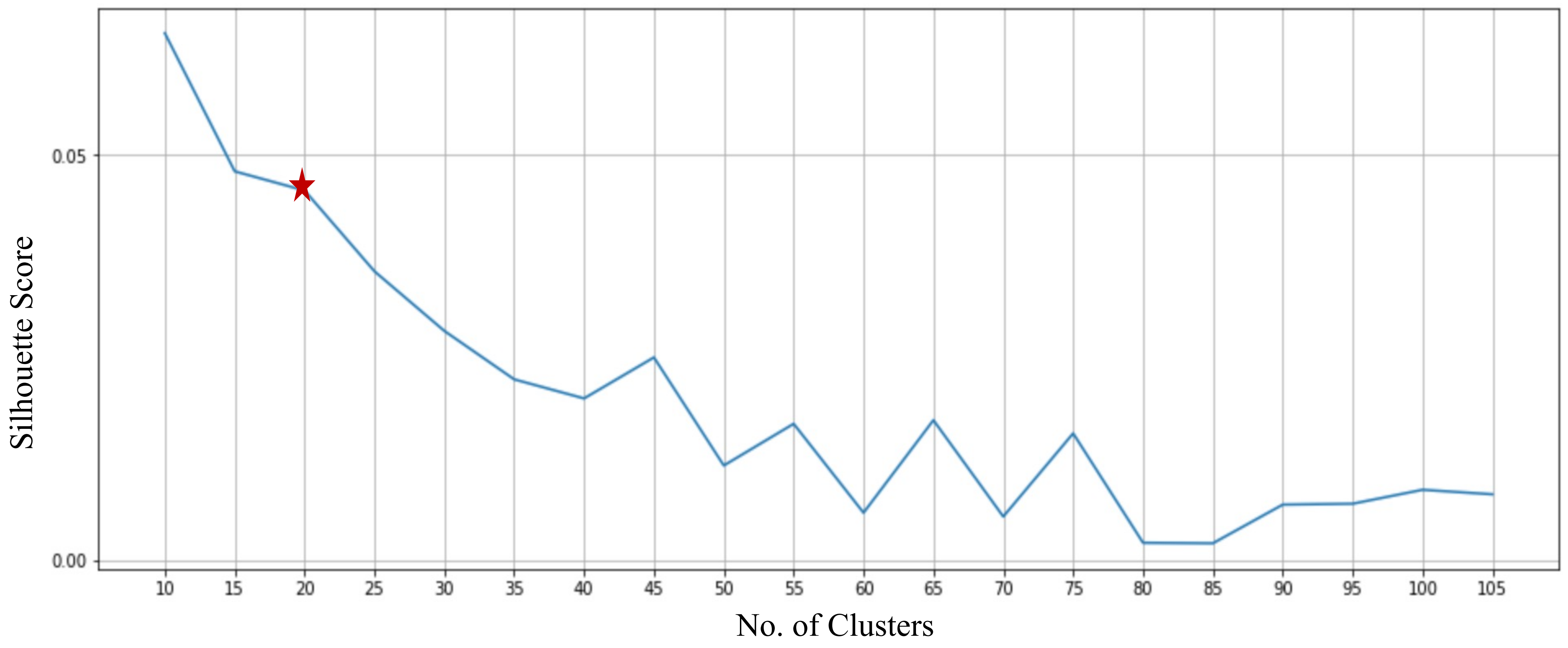
- Parameter Optimization by alternating two steps:
  - *Soft Assignments* between embedded points and cluster centroids
  - *Refinement* of embedding and cluster centroids by learning target distribution

- *Soft Assignments:* Probability of assigning sample *i* to cluster *j*

$$q_{ij} = \frac{(1 + \|z_i - \mu_j\|^2/\alpha)^{-\frac{\alpha+1}{2}}}{\sum_{j'}(1 + \|z_i - \mu_{j'}\|^2/\alpha)^{-\frac{\alpha+1}{2}}}$$

- *Refinement* of clusters involves matching of soft assignment to target distribution via minimizing KL divergence loss.

Clustering – Optimal Number of Clusters



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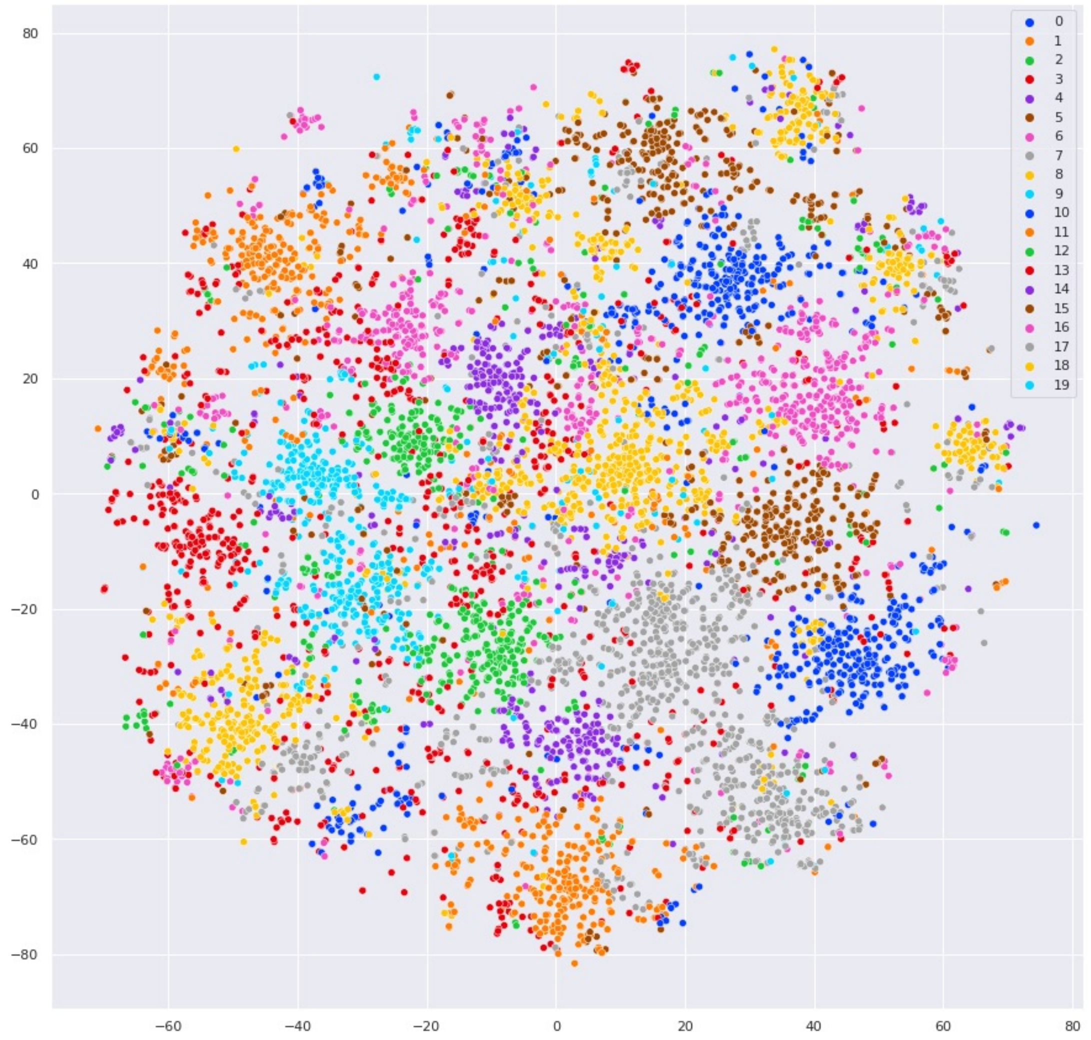
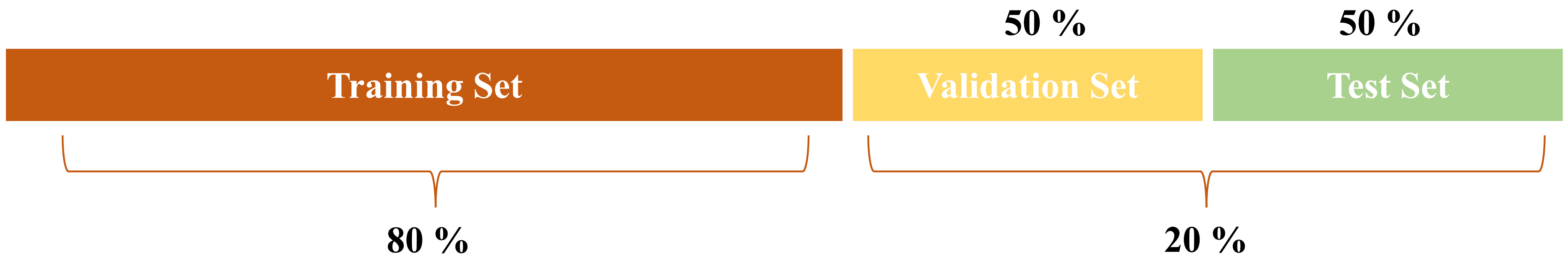
Clustering – Results



Classification – Data Splitting

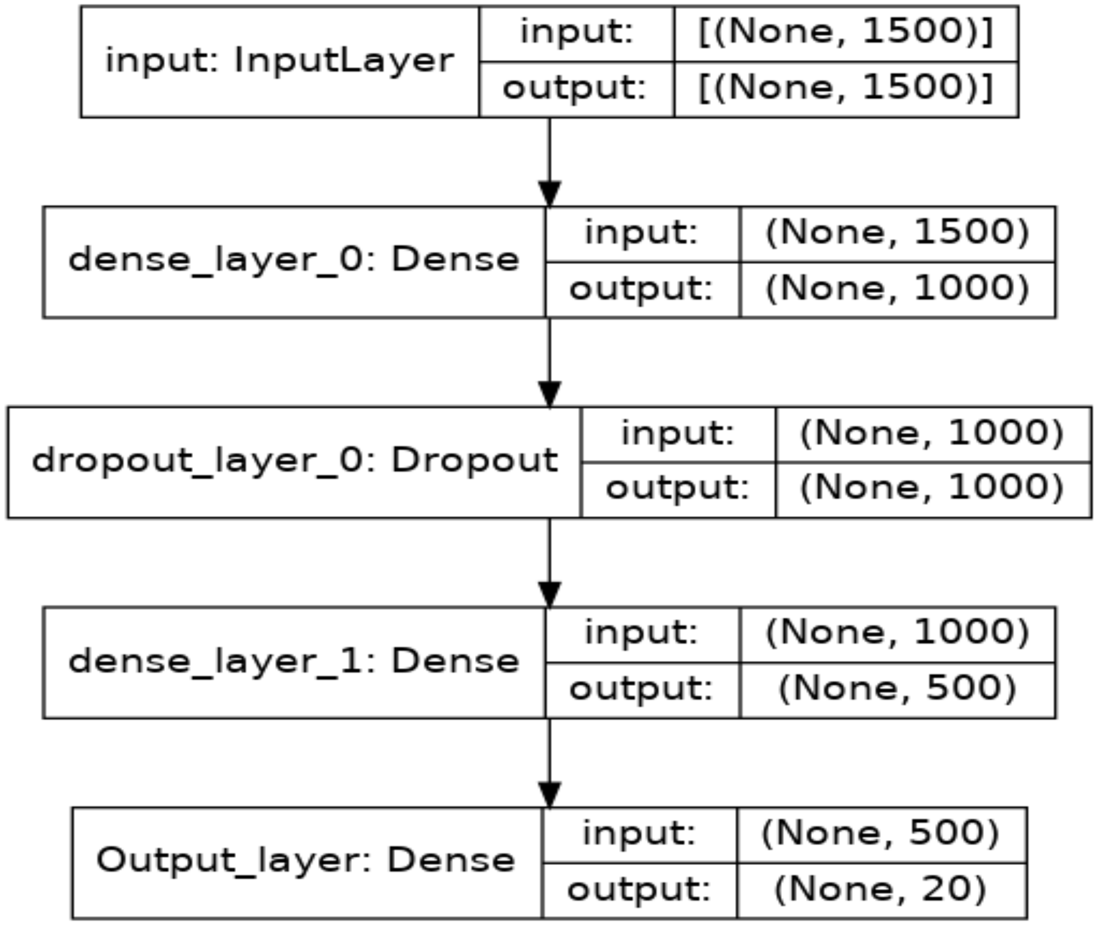


Training Set: X {6229, 1500}, Y {6229, 20}

Validation Set: X {779, 1500}, Y {779, 20}

Test Set: X {779, 1500}, Y {779, 20}

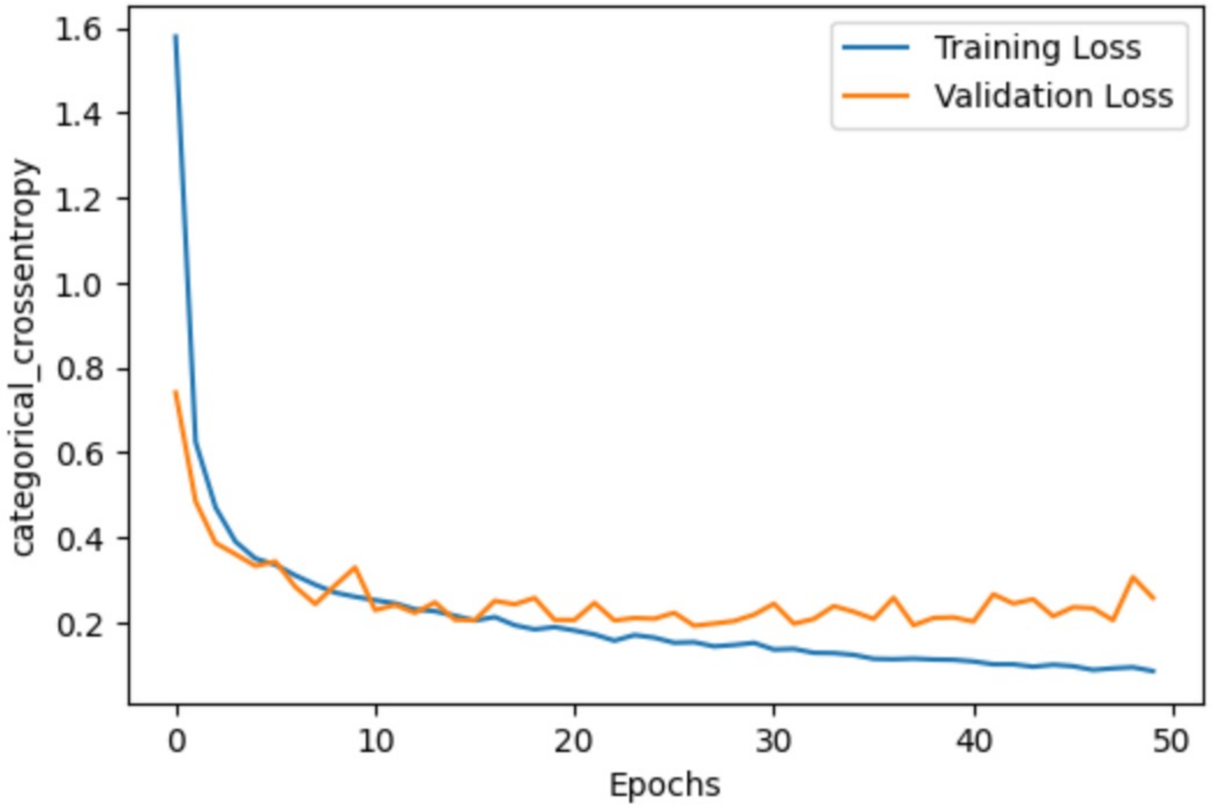
Classification – Deep Neural Network



Layer		Shape
input: InputLayer	input:	[(None, 1500)]
	output:	[(None, 1500)]
dense_layer_0: Dense	input:	(None, 1500)
	output:	(None, 1000)
dropout_layer_0: Dropout	input:	(None, 1000)
	output:	(None, 1000)
dense_layer_1: Dense	input:	(None, 1000)
	output:	(None, 500)
Output_layer: Dense	input:	(None, 500)
	output:	(None, 20)

- **Activation Function:** ReLU
- **Activation Function (Output):** Softmax
- **Batch Size:** 128
- **Epochs:** 50
- **Optimizer:** RMSprop
- **Learning Rate:** 0.001
- **Momentum:** 0.9

Classification – Deep Neural Network Performance



```
              precision    recall  f1-score   support

           0       0.97      0.88      0.92        32
           1       0.97      0.80      0.88        41
           2       0.82      1.00      0.90        23
           3       0.96      0.92      0.94        50
           4       0.85      0.81      0.83        21
           5       0.96      0.82      0.89        33
           6       0.87      0.92      0.89        36
           7       0.94      0.93      0.94        72
           8       0.94      0.83      0.88        36
           9       0.88      0.95      0.91        22
          10       1.00      0.94      0.97        48
          11       0.90      1.00      0.95        37
          12       0.88      0.93      0.90        30
          13       0.93      1.00      0.96        37
          14       0.86      0.86      0.86        29
          15       0.86      0.98      0.92        50
          16       0.95      0.93      0.94        40
          17       0.89      0.94      0.91        33
          18       0.89      0.92      0.90        83
          19       0.96      0.88      0.92        26

    accuracy                           0.92       779
   macro avg       0.91      0.91      0.91       779
weighted avg       0.92      0.92      0.91       779
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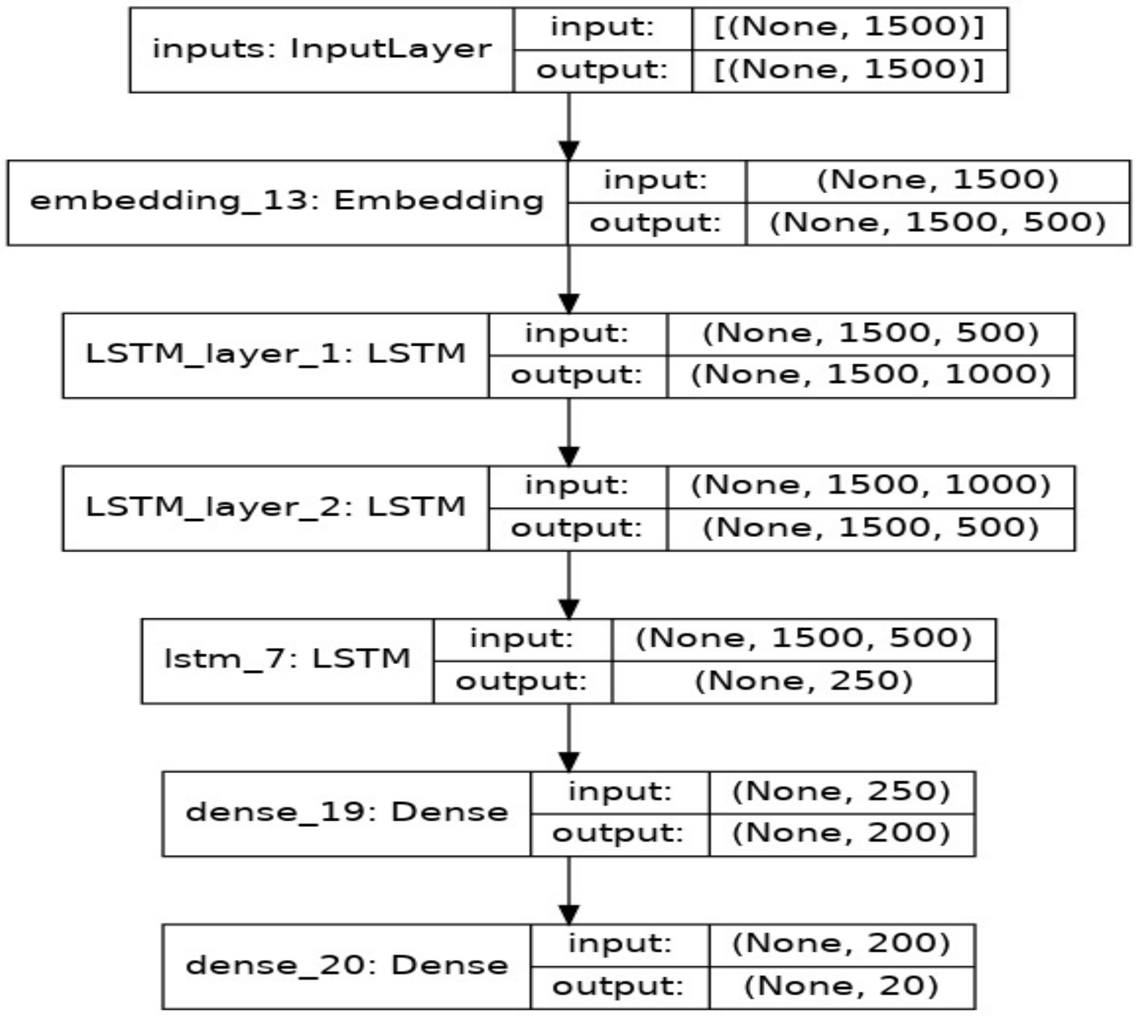
Classification – Deep LSTM Network



- **Activation Function:** ReLU
- **Activation Function (Output):** Softmax
- **Batch Size:** 128
- **Epochs:** 100
- **Optimizer:** SGD
- **Learning Rate:** 0.1
- **Momentum:** 0.9

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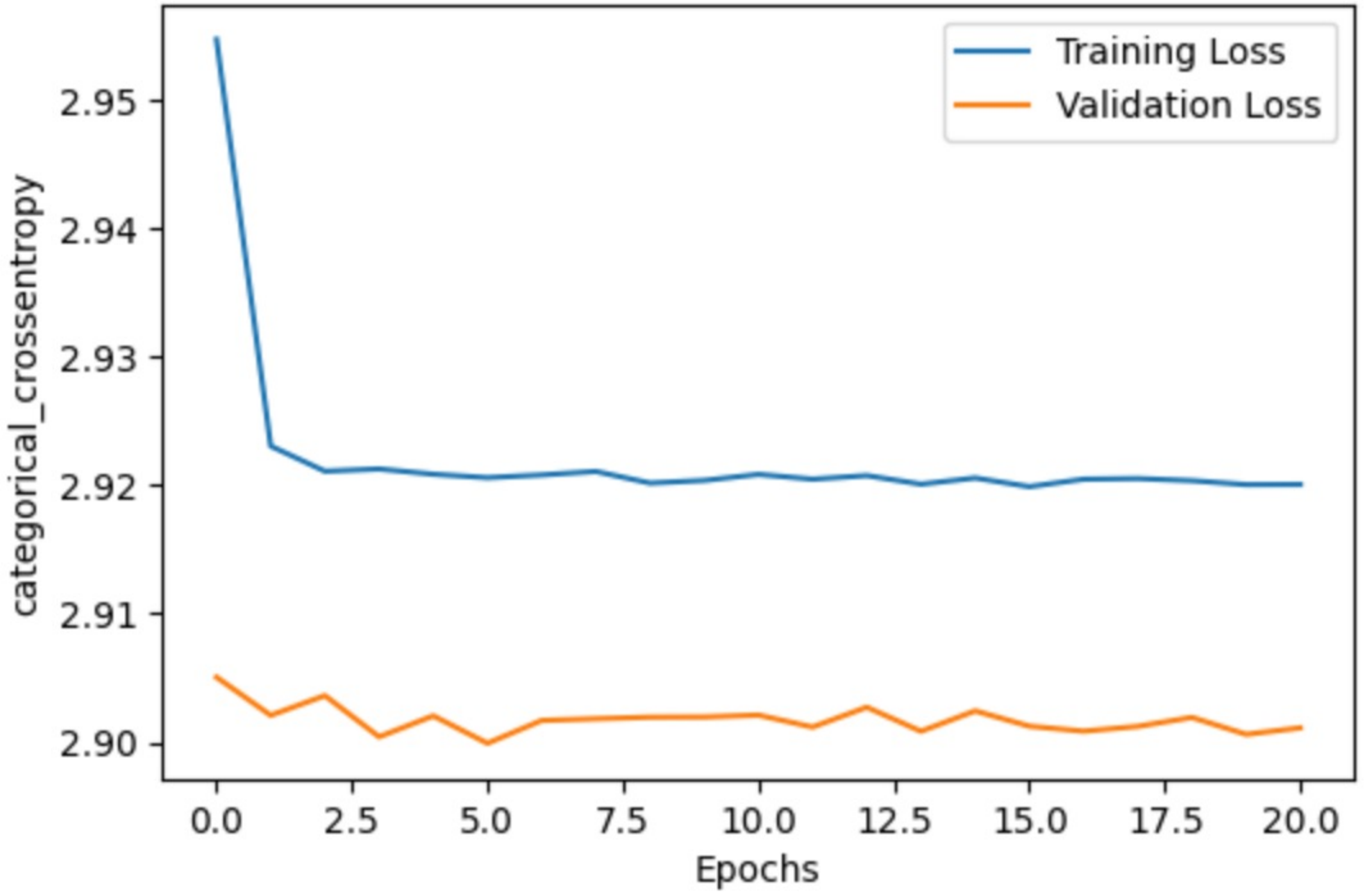
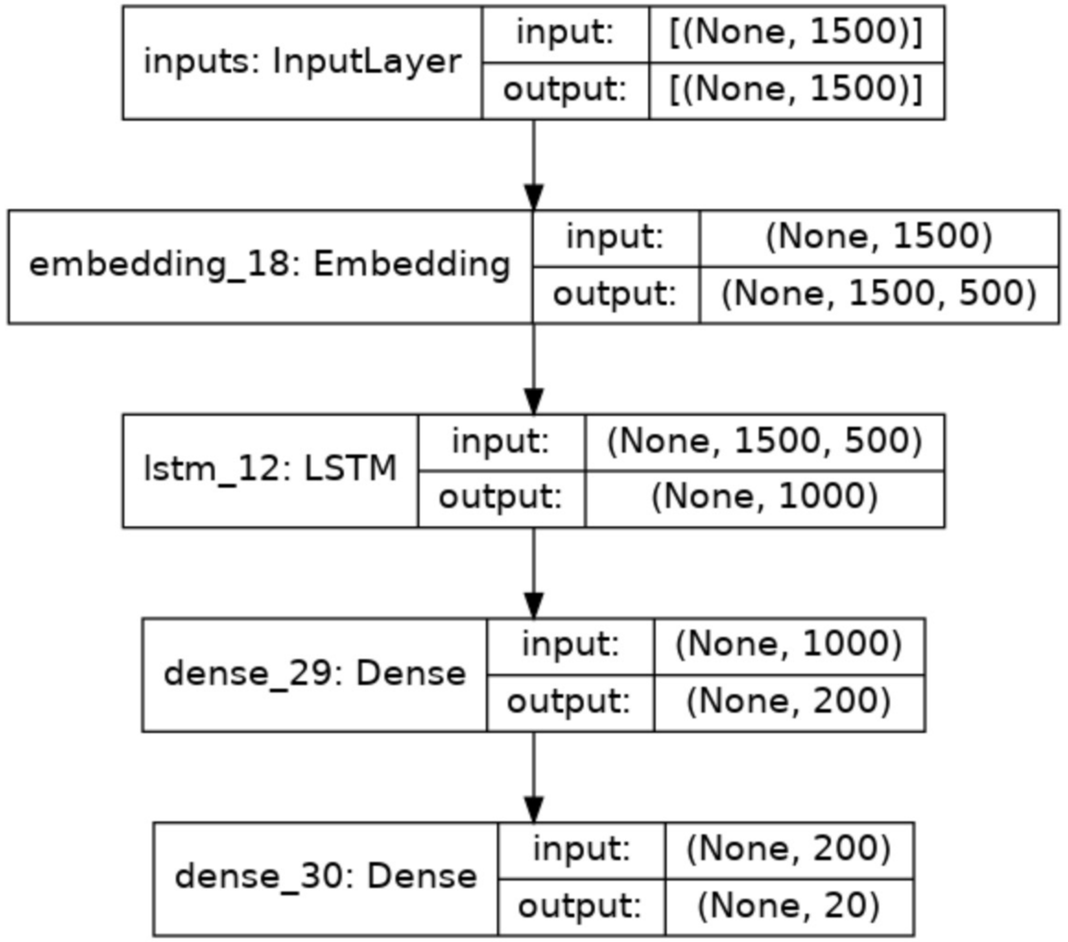
Classification – Deep LSTM Performance



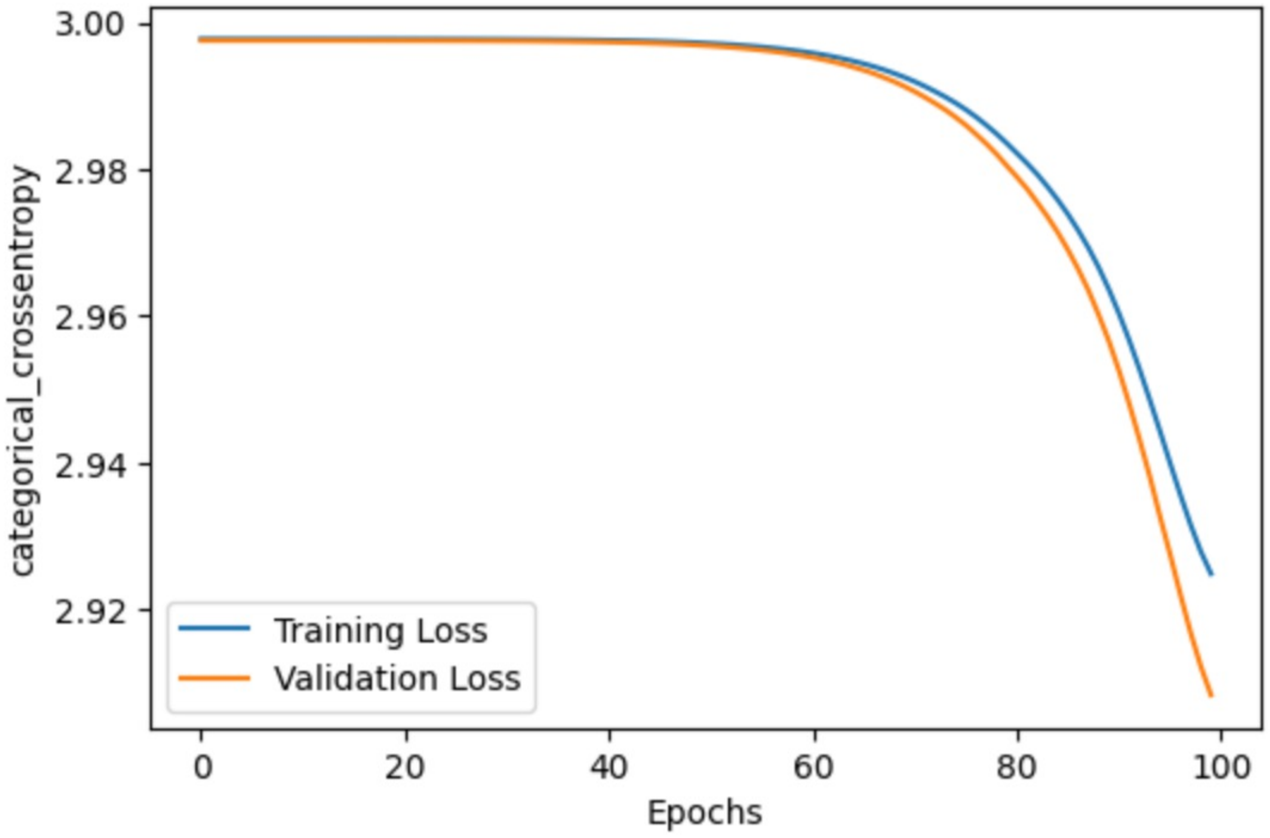
High Bias !!

Classification – Shallow LSTM Network



- **Activation Function:** ReLU
- **Activation Function (Output):** Softmax
- **Batch Size:** 128
- **Epochs:** 100
- **Optimizer:** SGD
- **Learning Rate:** 0.1
- **Momentum:** 0.9

Classification – Shallow LSTM Performance



Slow Training !!

- Requires more training iterations.
- Losses tend to decrease significantly from 60th epoch. But stopped early due to no further improvements.

THANK YOU!!