Deliverable – 1

A Summary of Auto Encoders on TMVA DNN

Usage and Additions

- TString layoutString("Layout=Encoder={RESHAPE|1|1|4|FLAT,DENSE|2|SIGMOID}Decoder={DENSE|4|LINEAR}");

- Internally, it is still a sequential architecture i.e a single TDeepNet object

- MethodDL and MethodAE were missing the functions necessary for regression. They have been added and tested

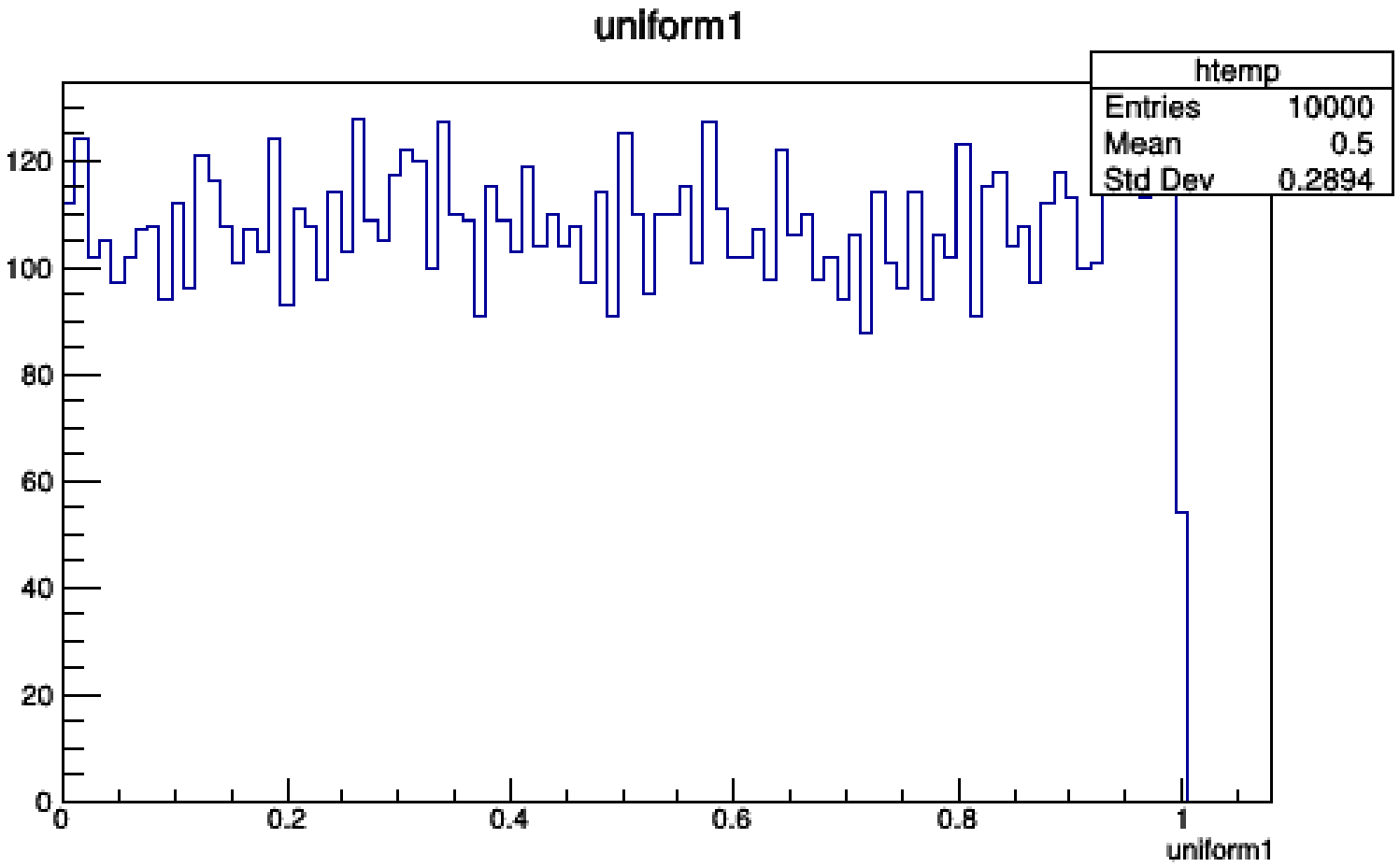
- Multivariate regression works well

Comparision with Keras – Setup

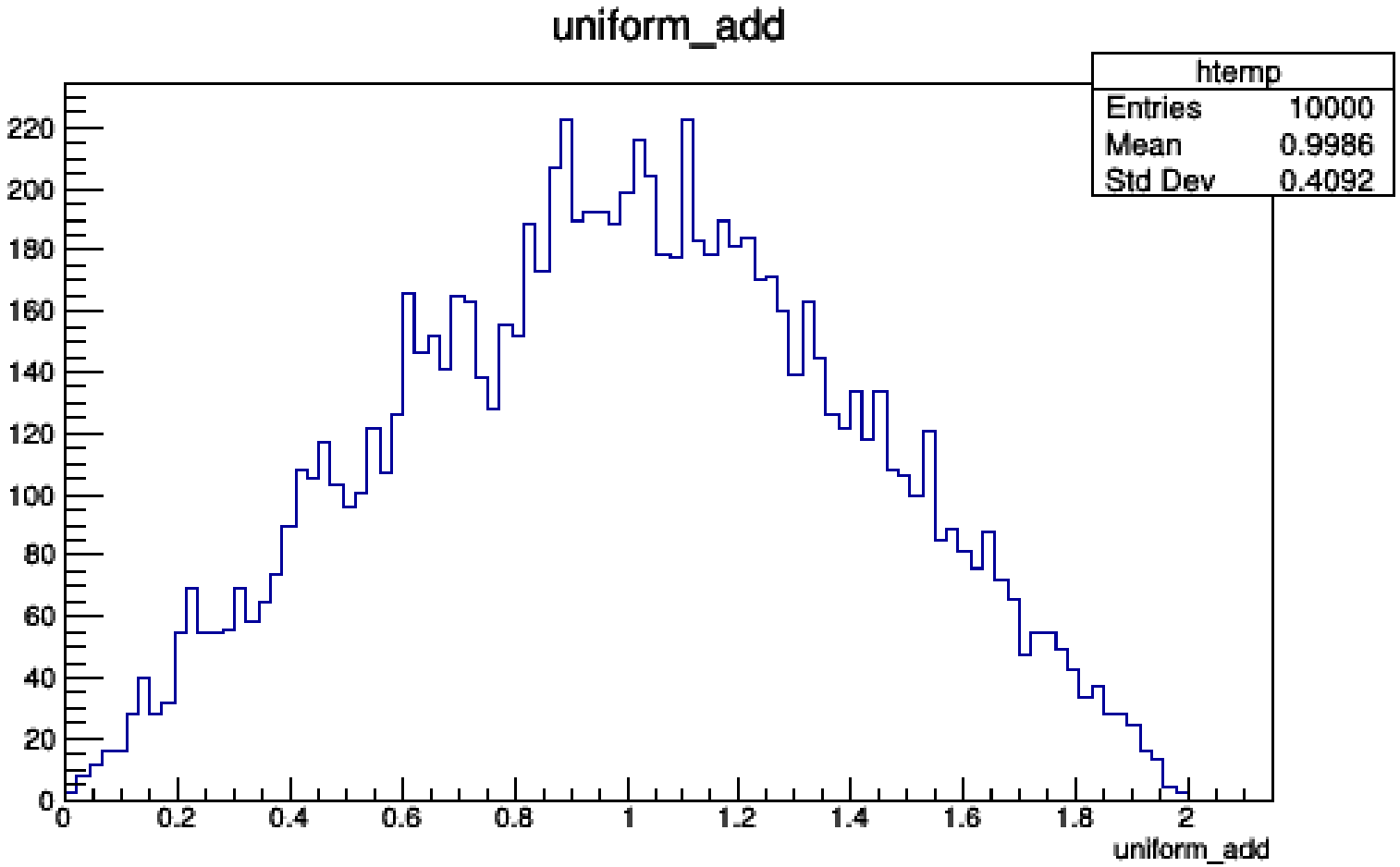
- The test setup consists of 4 features
    - Features 1 and 2 are sampled from a uniform distribution
    - Feature 3 = Feature 1 + Feature 2
    - Feature 4 = Feature 1 – Feature 2

    We're hoping that an Auto Encoder trained on this dataset with encoded dimension of 2 would only have Features 1 and 2 since they are independent.

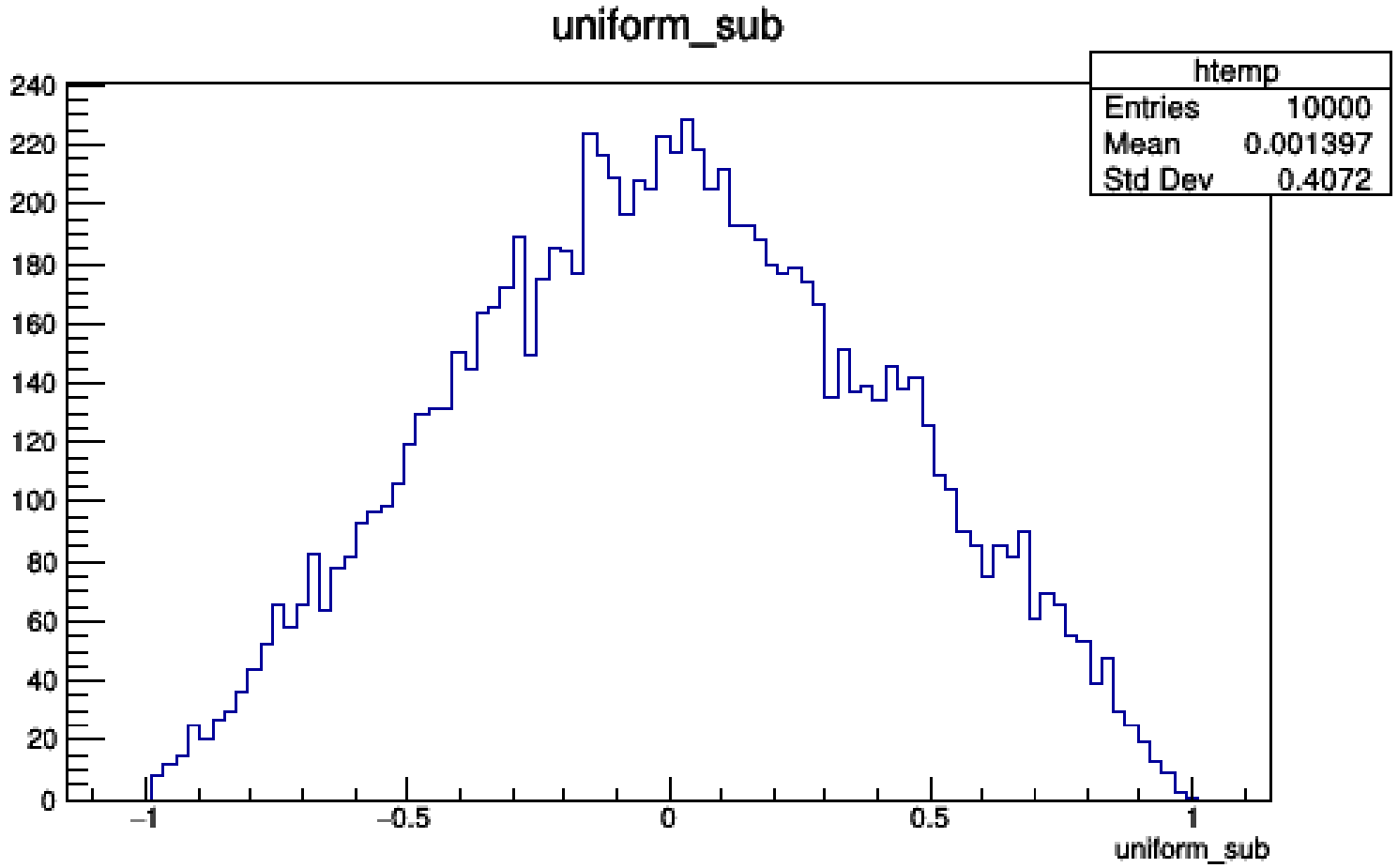
Data Visualization



Data Visualization



Data Visualization



Training Strategy

- Trained with 9000 examples and 1000 examples as test set
- Stochastic Gradient Descent with a learning rate of 0.01, No momentum, No weight decay, Batch size of 16

Performance Comparision

	KERAS	TMVA AE
Initial Loss	0.18	0.098
Final Loss	5.15 x 10e-4	1.3577 x 10e-4
Time taken	180 seconds	11.7 seconds

```
Epoch 179/200
9000/9000 [==============================] - 1s 101us/step - loss: 5.3871e-04 - val_loss: 5.2973e-04
Epoch 180/200
9000/9000 [==============================] - 1s 92us/step - loss: 5.3762e-04 - val_loss: 5.2810e-04
Epoch 181/200
9000/9000 [==============================] - 1s 98us/step - loss: 5.3642e-04 - val_loss: 5.2720e-04
Epoch 182/200
9000/9000 [==============================] - 1s 101us/step - loss: 5.3527e-04 - val_loss: 5.2588e-04
Epoch 183/200
9000/9000 [==============================] - 1s 101us/step - loss: 5.3413e-04 - val_loss: 5.2516e-04
Epoch 184/200
9000/9000 [==============================] - 1s 98us/step - loss: 5.3292e-04 - val_loss: 5.2389e-04
Epoch 185/200
9000/9000 [==============================] - 1s 101us/step - loss: 5.3177e-04 - val_loss: 5.2292e-04
Epoch 186/200
9000/9000 [==============================] - 1s 97us/step - loss: 5.3059e-04 - val_loss: 5.2136e-04
Epoch 187/200
9000/9000 [==============================] - 1s 99us/step - loss: 5.2941e-04 - val_loss: 5.2097e-04
Epoch 188/200
9000/9000 [==============================] - 1s 100us/step - loss: 5.2825e-04 - val_loss: 5.2019e-04
Epoch 189/200
9000/9000 [==============================] - 1s 100us/step - loss: 5.2705e-04 - val_loss: 5.1959e-04
Epoch 190/200
9000/9000 [==============================] - 1s 99us/step - loss: 5.2604e-04 - val_loss: 5.1681e-04
Epoch 191/200
9000/9000 [==============================] - 1s 99us/step - loss: 5.2493e-04 - val_loss: 5.1595e-04
Epoch 192/200
9000/9000 [==============================] - 1s 98us/step - loss: 5.2378e-04 - val_loss: 5.1524e-04
Epoch 193/200
9000/9000 [==============================] - 1s 99us/step - loss: 5.2266e-04 - val_loss: 5.1390e-04
Epoch 194/200
9000/9000 [==============================] - 1s 101us/step - loss: 5.2146e-04 - val_loss: 5.1319e-04
Epoch 195/200
9000/9000 [==============================] - 1s 100us/step - loss: 5.2046e-04 - val_loss: 5.1154e-04
Epoch 196/200
9000/9000 [==============================] - 1s 99us/step - loss: 5.1932e-04 - val_loss: 5.1034e-04
Epoch 197/200
9000/9000 [==============================] - 1s 99us/step - loss: 5.1824e-04 - val_loss: 5.1090e-04
Epoch 198/200
9000/9000 [==============================] - 1s 102us/step - loss: 5.1711e-04 - val_loss: 5.1018e-04
Epoch 199/200
9000/9000 [==============================] - 1s 101us/step - loss: 5.1610e-04 - val_loss: 5.0828e-04
Epoch 200/200
9000/9000 [==============================] - 1s 99us/step - loss: 5.1501e-04 - val_loss: 5.0667e-04
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```
                         :       1800 |  0.000145911 0.000140323     98414.5  0.00571054           0   0.0519094    0.052406   0.0571054
                         :       1810 Minimun Test error found - save the configuration
                         :       1810 |  0.000145526 0.000140084     95036.6  0.00591351           0    0.053852   0.0543519   0.0591351
                         :       1820 Minimun Test error found - save the configuration
                         :       1820 |  0.000144968 0.000139542     97379.7  0.00577122           0   0.0524953    0.053026   0.0577122
                         :       1830 Minimun Test error found - save the configuration
                         :       1830 |   0.00014439 0.000138763     98384.2   0.0057123           0   0.0519258   0.0524421    0.057123
                         :       1840 Minimun Test error found - save the configuration
                         :       1840 |  0.000143857 0.000138092     96822.1  0.00580446           0    0.052749   0.0532881   0.0580446
                         :       1850 |  0.000143358 0.000138112     97371.7   0.0057717          10    0.052487   0.0529803    0.057717
                         :       1860 Minimun Test error found - save the configuration
                         :       1860 |  0.000142816 0.000137143     96408.9  0.00582934           0   0.0530497   0.0535992   0.0582934
                         :       1870 Minimun Test error found - save the configuration
                         :       1870 |  0.000142122 0.000136588     96258.4  0.00583845           0   0.0531174   0.0536286   0.0583845
                         :       1880 Minimun Test error found - save the configuration
                         :       1880 |  0.000141767 0.000136439     96136.7  0.00584584           0   0.0532859   0.0537863   0.0584584
                         :       1890 Minimun Test error found - save the configuration
                         :       1890 |  0.000141267 0.000135909     94819.7  0.00592704           0   0.0540808   0.0546186   0.0592704
                         :       1900 Minimun Test error found - save the configuration
                         :       1900 |  0.000140737  0.00013523     97672.7  0.00575391           0   0.0522488   0.0527728   0.0575391
                         :       1910 Minimun Test error found - save the configuration
                         :       1910 |  0.000140055 0.000134924     96465.1  0.00582594           0   0.0530055   0.0535337   0.0582594
                         :       1920 Minimun Test error found - save the configuration
                         :       1920 |  0.000139612 0.000134737     98258.4  0.00571961           0   0.0519358    0.052437   0.0571961
                         :       1930 Minimun Test error found - save the configuration
                         :       1930 |  0.000139268 0.000133983     99147.2  0.00566834           0   0.0515486   0.0520492   0.0566834
                         :       1940 Minimun Test error found - save the configuration
                         :       1940 |  0.000138712 0.000133444     99050.3  0.00567388           0   0.0515391   0.0520641   0.0567388
                         :       1950 Minimun Test error found - save the configuration
                         :       1950 |  0.000138126  0.00013288     97862.8  0.00574274           0   0.0522463   0.0527526   0.0574274
                         :       1960 Minimun Test error found - save the configuration
                         :       1960 |  0.000137733 0.000132544     98285.2  0.00571805           0   0.0519738   0.0524858   0.0571805
                         :       1970 Minimun Test error found - save the configuration
                         :       1970 |  0.000137271 0.000131844     96757.8  0.00580832           0   0.0527527   0.0532635   0.0580832
                         :       1980 Minimun Test error found - save the configuration
                         :       1980 |  0.000136505 0.000131367     91815.1    0.006121           0   0.0532698     0.05378     0.06121
                         :       1990 Minimun Test error found - save the configuration
                         :       1990 |  0.000136271 0.000131086     92160.7  0.00609804           0   0.0557296   0.0562499   0.0609804
                         :       2000 Minimun Test error found - save the configuration
                         :       2000 |  0.000135777 0.000130669     96663.7  0.00581397           0    0.052614   0.0531366   0.0581397
                         :
                         : Elapsed time for training with 9000 events: 11.7 sec
                         : Dataset[dataset] : Create results for training
                         : Dataset[dataset] : Evaluation of AE_CPU on training sample
                         : Dataset[dataset] : Elapsed time for evaluation of 9000 events: 0.0113 sec
                         : Create variable histograms
                         : Create regression target histograms
                         : Create regression average deviation
                         : Results created
                         : Creating xml weight file: dataset/weights/TMVARegression_AE_CPU.weights.xml
Factory                  : Training finished
                         :
Factory                  : === Destroy and recreate all methods via weight files for testing ===
                         :
                         : Reading weight file: dataset/weights/TMVARegression_AE_CPU.weights.xml
READ DL network from XML
lossfunction is R
==> Wrote root file: TMVA_DNN.root
==> TMVARegression is done!
```