LSTM Tagger

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The Setup

Goal

Train a binary neural-network based classifier that can distinguish between b- and non-b-jets, using the raw jet data as input.

- use *tracks* as the primary source of information
- number of tracks is unknown a-priori $\rightarrow$ cannot use an architecture that expects a fixed number of inputs
- currently looking into recurrent neural networks / LSTM networks

Recurrent Neural Networks

The Workflow

Training

- match tracks to their associated jets (contained in different ROOT trees)
- for each track in the jet, feed all 8 available track parameters into the classifier network during training
  - use p_T ordering, i.e. hardest track first
- supervised training: provide a binary (0/1) output value for each jet (from MC)

Now running on Piz Daint:

- roughly 2-3 $\times$ improvement in execution speed compared to PSI/Tier-3
- limited by Jet-Track-matching, which is handled by the CPU
- possible workaround: train multiple classifiers during the same run "in parallel"

The Workflow

Evaluation

- compare performance to cMVA tagger as “gold-standard”
- obtain ROC curves for both classifiers, correlation plots of the outputs
- currently: validation data is disjoint from training data, but from the same MC-run (i.e. contains a similar event signature)

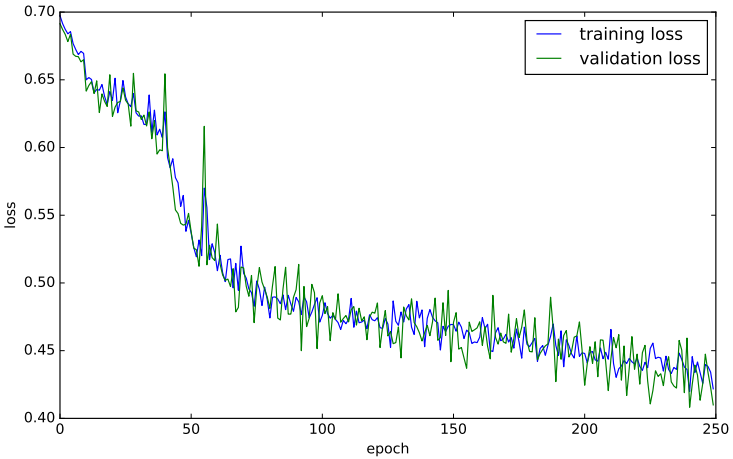
Results so far

- trained a number of LSTM networks, scanned the hyperparameters:
  - number of nodes in each layer
  - number of layers
  - number of training epochs

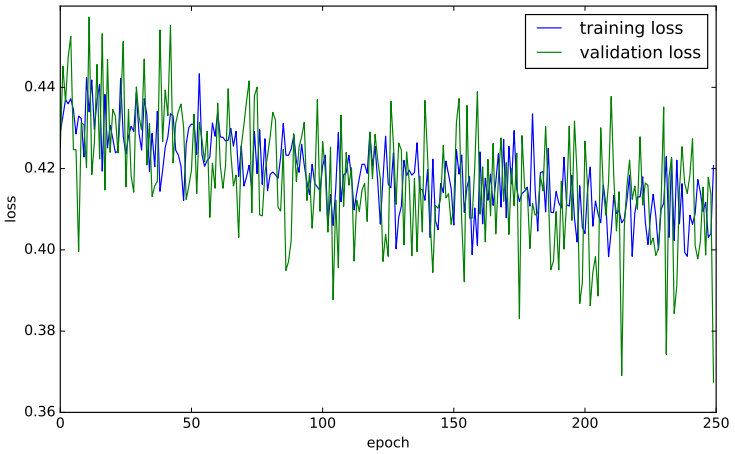
Details of the training:

- read training data in chunks of 10k jets
- use 8k jets for training, 2k jets to monitor performance during each epoch

64 nodes / layer, 1 layer



(a)

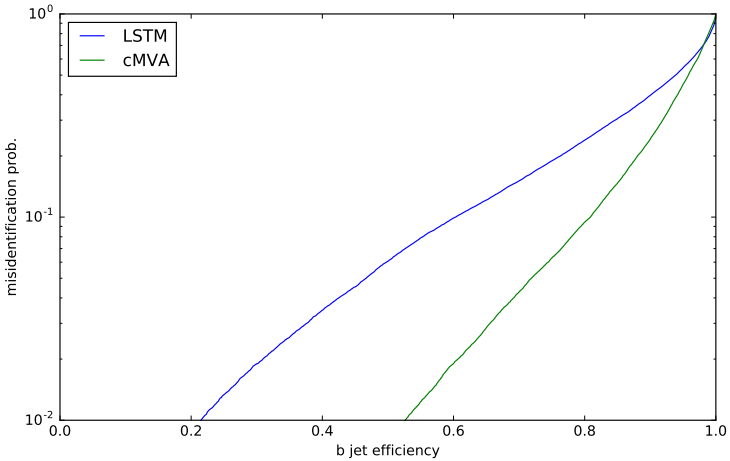


(b)

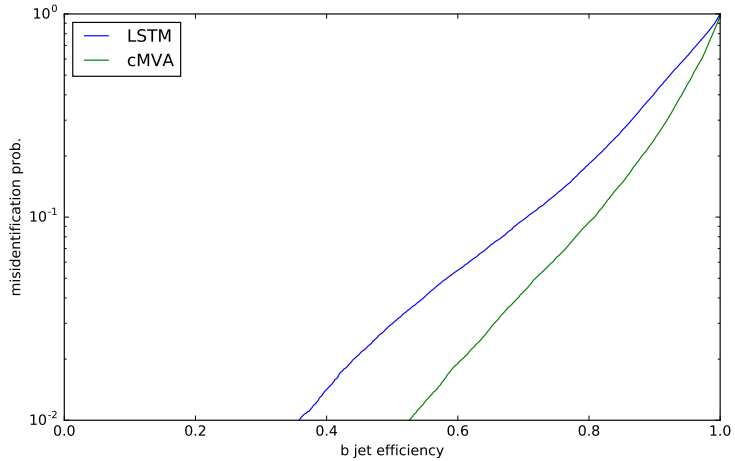
Figure: test

- AUC(cMVA) = asdf
- AUC(RNN) = asdf

64 nodes / layer, 1 layer



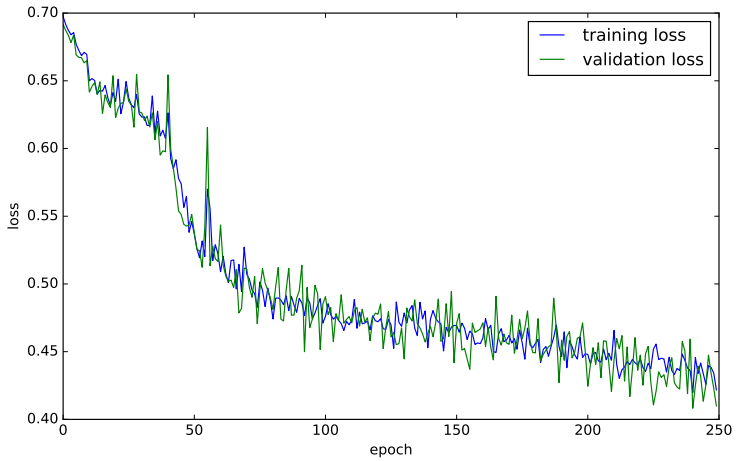
(a)



(b)

Figure: test

64 nodes / layer, 3 layers



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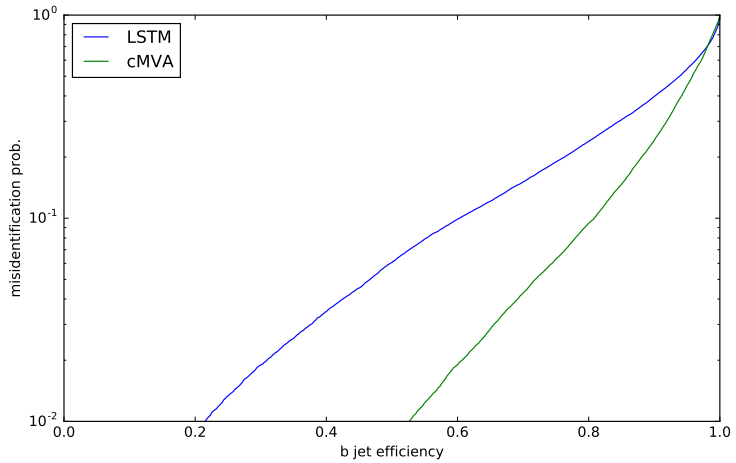
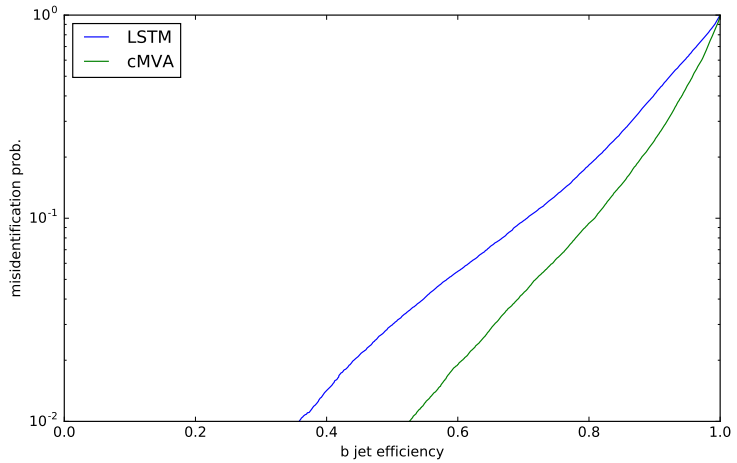


(a)

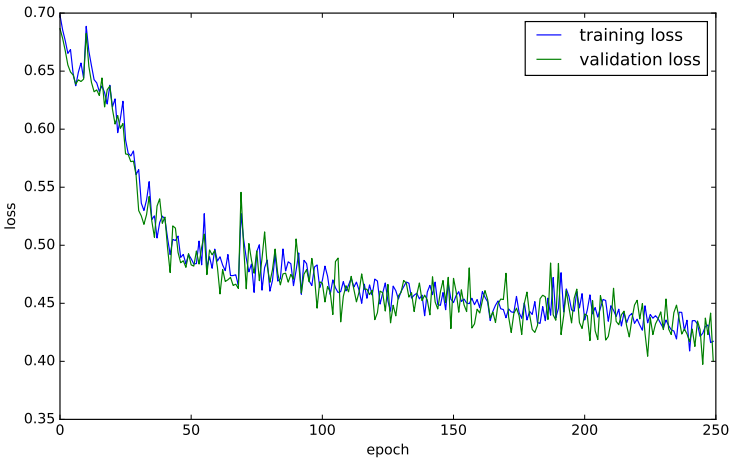


(b)

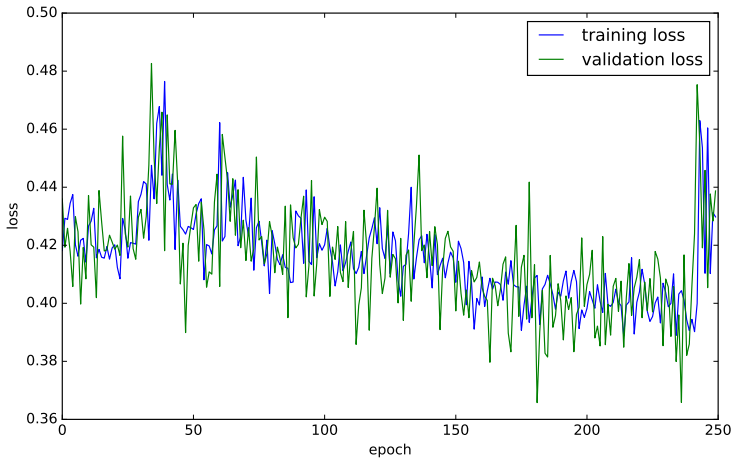
Figure: test

- AUC(cMVA) = asdf
- AUC(RNN) = asdf

128 nodes / layer, 1 layer



(a)



(b)

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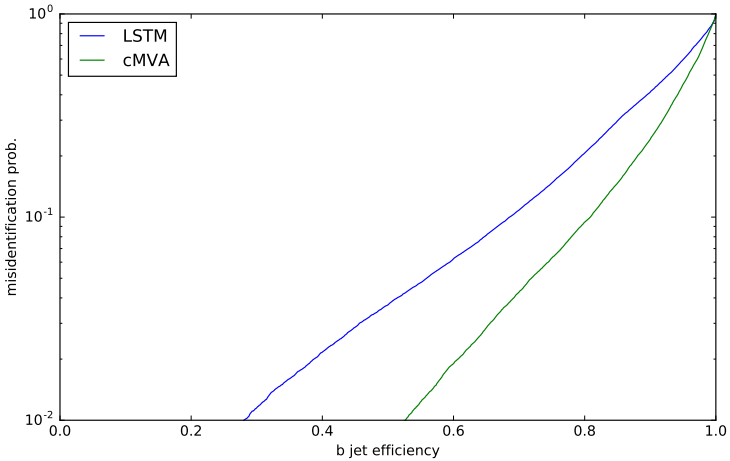
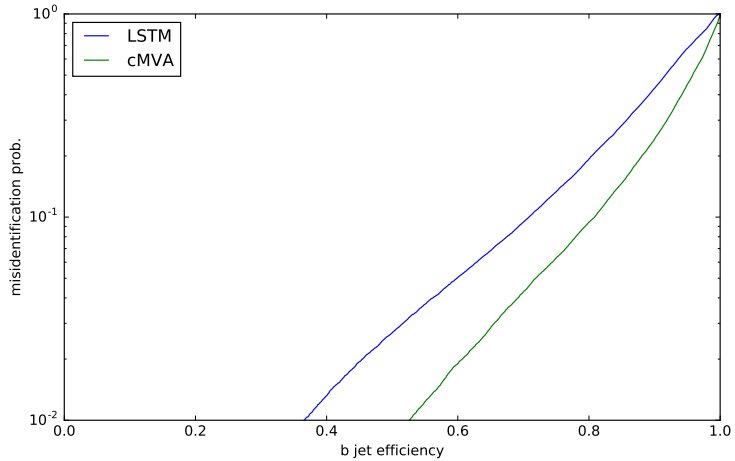


(a)



(b)

Figure: test

Future Experiments

-
- try removing track parameters to see how performance degrades
- more sophisticated preprocessing?
- different representation (other than the raw track data)?

Conclusions