Particle Detection and Prediction using CNNs and LSTMs

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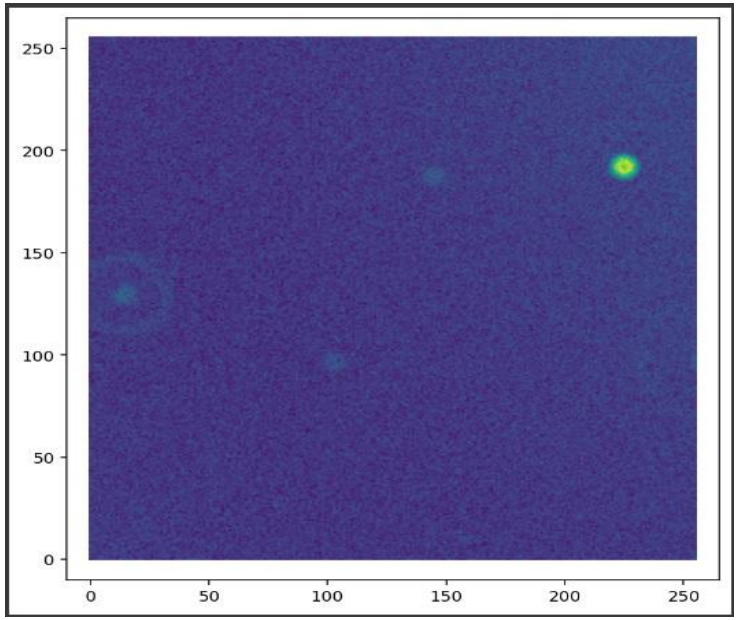
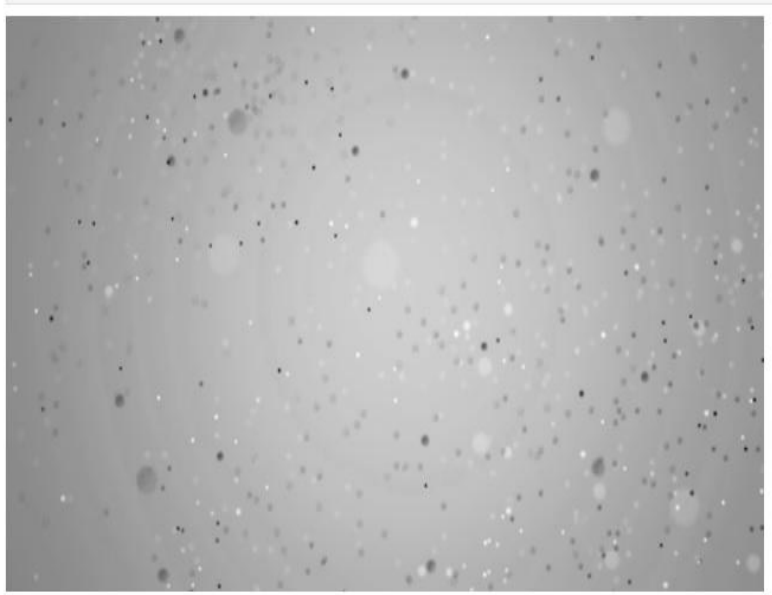
Data Generation

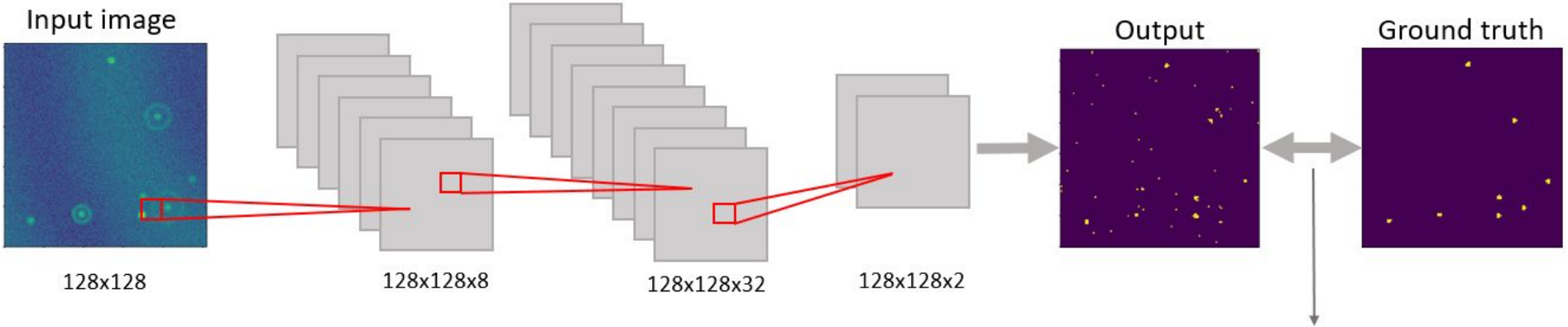
Method 1



Method 2

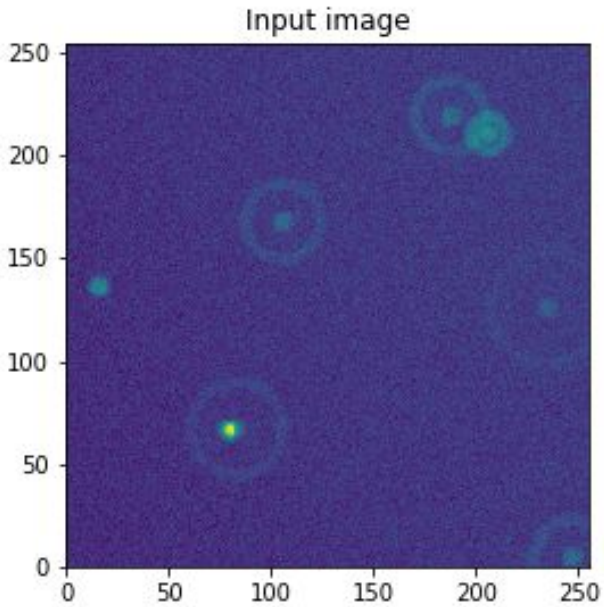


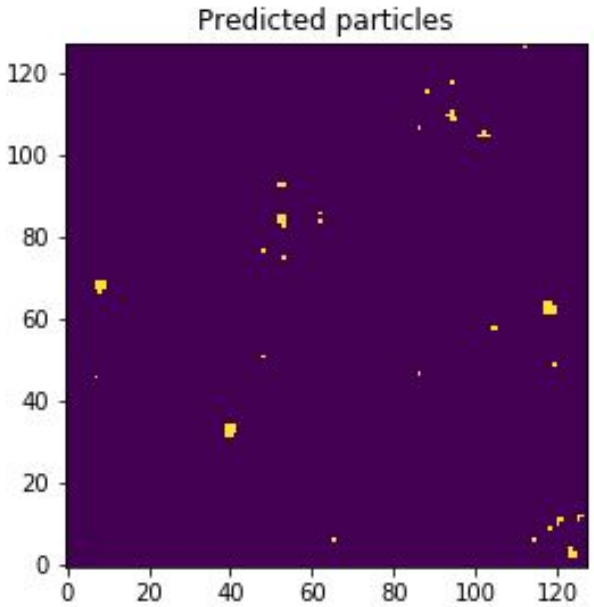
Particle Detection using CNNs

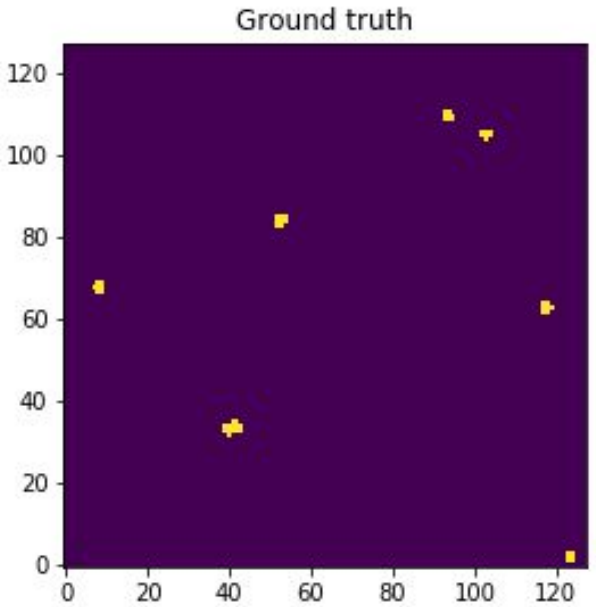


$$L_{CE} = -\frac{1}{N}\sum_{i=1}^{N} \beta y_i log(\hat{y}_i) + (1-\beta)(1-y_i) log(1-\hat{y}_i)$$

Particle Detection - Results







Predicting Future Positions

LSTM: Long-Short Term Memory

- First proposed by Hochreiter and Schmidhuber (1997)
- Efficient for time series forecasting
- Extension of Recurrent Neural Networks
- Solves the problem of vanishing gradients.

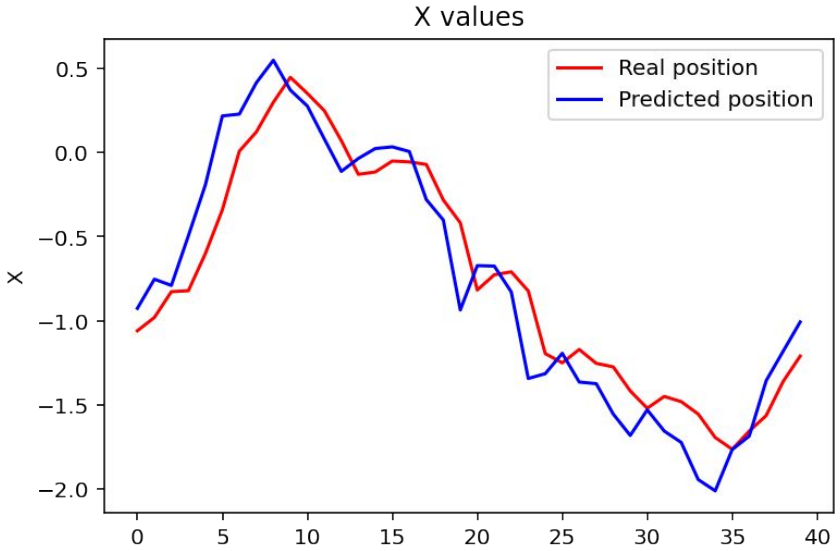
Dropout

- Srivastava and colleagues (2014).
- Temporarily remove neurons, creating new network architecture
- Prevent overfitting

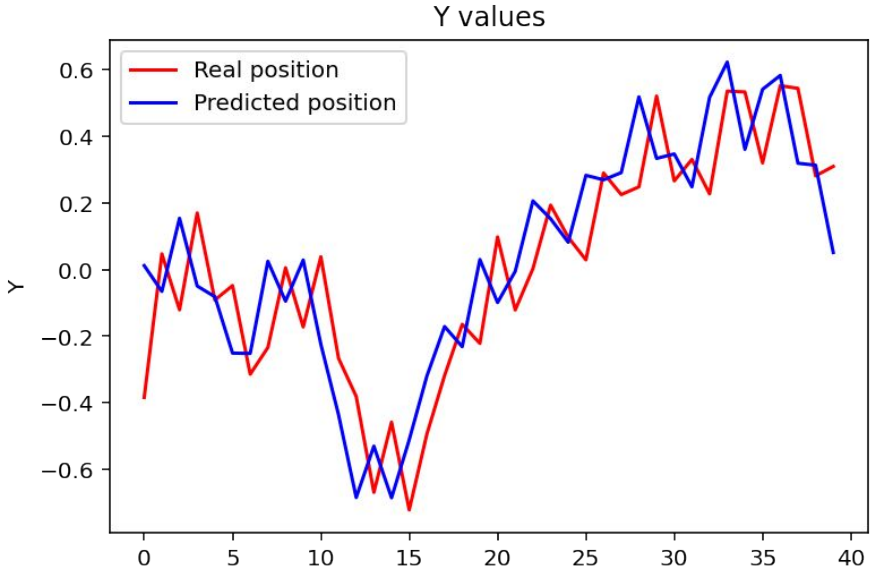
```
Model: "sequential_35"
_________________________________________________________________
 Layer (type)                 Output Shape              Param #
=================================================================
 cu_dnnlstm_128 (CuDNNLSTM)   (None, 10, 128)           67072

 dropout_51 (Dropout)         (None, 10, 128)           0

 cu_dnnlstm_129 (CuDNNLSTM)   (None, 10, 64)            49664

 dropout_52 (Dropout)         (None, 10, 64)            0

 flatten_33 (Flatten)         (None, 640)               0

 dense_33 (Dense)             (None, 1)                 641

=================================================================
Total params: 117,377
Trainable params: 117,377
Non-trainable params: 0
_________________________________________________________________
```

Predicting Future Positions

X-coordinates: MSE = 0.239565



Y-coordinates: MSE = 0.190686



Questions?

References

1. Hochreiter, S., & Schmidhuber, J. (1997). Long short-term memory. Neural computation, 9(8), 1735-1780.
2. Srivastava, N., Hinton, G., Krizhevsky, A., Sutskever, I., & Salakhutdinov, R. (2014). Dropout: a simple way to prevent neural networks from overfitting. *The journal of machine learning research*, *15*(1), 1929-1958.

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