

Building Fast High-Performance Recognition Systems with Recurrent Neural Networks and LSTM

*Thomas Breuel, Volkmar Frinken,
Marcus Liwicki*



German Research
Center for Artificial
Intelligence GmbH



Brief History



Yoshua: Training RNNs
with BPTT is difficult¹

Jürgen: Learning RNNs for
your problems is trivial²

Both: Gradient Descent is
difficult but LSTM is good³



Yoshua Bengio, PhD 1991
Canada Research Chair in
Statistical Learning
Algorithms

Jürgen Schmidhuber, PhD 1991
Head of one of the world's top
10 AI labs, i.e., IDSIA in
Switzerland

¹ Y. Bengio, P. Simard, and P. Frasconi. Learning Long-Term Dependencies with Gradient Descent is Difficult, IEEE Transactions on Neural Networks, VOL. 5, NO. 2, MARCH 1994

² S. Hochreiter, J. Schmidhuber. LSTM can Solve Hard Long Time Lag Problems, NIPS'9, 1997

³ S. Hochreiter, Y. Bengio, P. Frasconi, and J. Schmidhuber. Gradient flow in recurrent nets: the difficulty of learning long-term dependencies. IEEE Press, 2001.

From Then on LSTM Has Been Applied to Many Tasks

- Reinforcement learning robots
- Protein structure prediction
- Blues learning and improvisation



- Speech recognition¹
- Handwriting recognition^{2,3}
- Other DAR applications

¹ Alex Graves, Jürgen Schmidhuber. Framewise phoneme classification with bidirectional LSTM and other neural network architectures, Neural Networks, 2005
² M Liwicki, A Graves, H Bunke, J Schmidhuber. A novel approach to on-line handwriting recognition based on bidirectional long short-term memory networks, ICDAR 2007
³ A Graves, M Liwicki, S Fernández, R Bertolami, H Bunke, J Schmidhuber. A novel connectionist system for unconstrained handwriting recognition, TPAMI, 2009

Schedule

1. Introduction (Marcus)
 2. RNN & LSTM Architecture (Volkmar)
 3. CTC & Training (Volkmar)
 4. Test Cases, Behaviour, and Internal States (Thomas)
 - Discussion & Break (10:00-10:30)
 5. Extensions: BLSTM and MDLSTM (Marcus)
 6. Applications
 - Online and Offline HWR (Marcus)
 - OCR and Other Applications (Thomas)
 7. Toolkits
 - Final Discussion
- Material available at: <http://lstm.iupr.com/>

Thanks

- ICDAR organizers
- LSTM developers and users
- Our PhD students & colleagues
- All of you (>50 participants)