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

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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 Al labs, i.e., IDSIA in
Switzerland

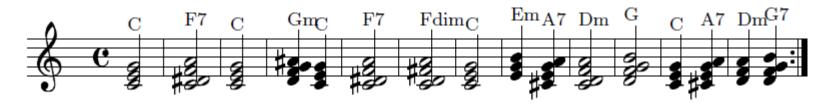
¹ Y. Bengio, P. Simard, and P. Frasconi. Learning Long-Term Dependencies with Gradient Descent is Difficult, IEEE Transactions on Neural Networks, VOL. 5, NO. 2, MARCH 1994

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)