Czech Technical University in Prag
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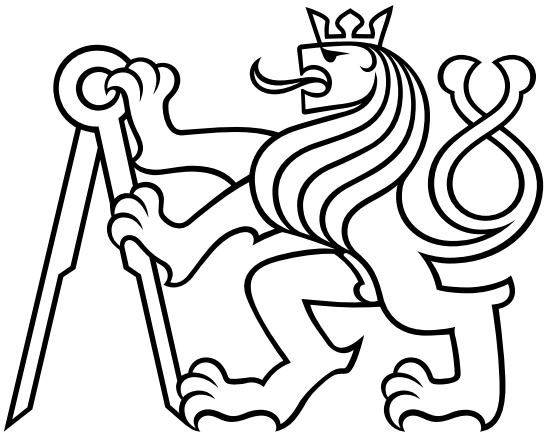

Master Thesis

Title

Subtitle

February 2, 2021 **Roman Dušek**

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References

1. BIANCHI, Filippo Maria; JENSSEN, Robert; KAMPFFMEYER, Michael C.; MAIORINO, Enrico; RIZZI, Antonello. *Recurrent Neural Networks for Short-Term Load Forecasting: An Overview and Comparative Analysis*. 1st ed. 2017. Cham: Springer International Publishing : Imprint: Springer, 2017. SpringerBriefs in Computer Science. ISBN 978-3-319-70338-1. Available from DOI: 10.1007/978-3-319-70338-1.
2. BUKOVSKÝ, Ivo. *Nonconventional Neural Architectures and their Advantages for Technical Applications*. 2012. Habilitation thesis. Faculty of Mechanical Engineering, Czech Technical University in Prague.
3. DESKER, L.R.; JAIN, L.C. *Recurrent Neural Netowrks Design and Applications*. [N.d.].
4. GOODFELLOW, Ian; BENGIO, Yoshua; COURVILLE, Aaron. *Deep Learning*. [N.d.].
5. GUPTA, M. Madan; BUKOVSKY, Ivo. Fundamentals of Higher Order Neural Networks for Modeling and Simulation. In: *Fundamentals of Higher Order Neural Networks for Modeling and Simulation*. IGI Global, [n.d.], vol. 2012.
6. LAZYPROGRAMMER. *Recurrent Neural Networks in Python*. [N.d.].
7. MANDIC, Danilo; CHAMBERS, Jonathon A. Recurrent Neural Networks for Prediction Learning Algorithms, Architectures, and Stability by Danilo Mandic, Jonathon Chambers. [N.d.].
8. MANDIC, Danilo P.; CHAMBERS, Jonathon A. *Recurrent Neural Networks for Prediction*. Ed. by HAYKIN, Simon. Chichester, UK: John Wiley & Sons, Ltd, 2001. Wiley Series in Adaptive and Learning Systems for Signal Processing, Communications, and Control. ISBN 978-0-471-49517-8 978-0-470-84535-6. Available from DOI: 10.1002/047084535X.
9. OLAH, Christopher. *Understanding LSTM Networks* [online]. 2015-08.
10. RIOS, Jorge D.; ALANIS, Alma Y.; ARANA-DANIEL, Nancy; LOPEZ-FRANCO, Carlos; SANCHEZ, Edgar N. *Neural Networks Modeling and Control: Applications for Unknown Nonlinear Delayed Systems in Discrete Time*. First. Waltham: Elsevier, 2019. ISBN 978-0-12-817078-6.
11. ZHANG, Ming. *Artificial Higher Order Neural Networks for Economics and Business*. IGI Global, 2008. ISBN 978-1-59904-897-0.

Appendix