RNN-based traffic prediction for pro-active scaling of the AMF

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Objective

Early reaction to congestion by pro-actively scaling in or out the Access and Mobility Function (AMF) in a way to absorb the congestion induced by massive access of Internet of Things (IoT) devices in 5G networks.

Context

- The upcoming mobile core network (5G) is expected to support Enhanced Mobile Broadband, Massive Machine Type Communication (MTC) and Ultra-low latency, within the same infrastructure [1].
- Network Functions Virtualization (NFV) and Software Defined Networks (SDN) are key enablers for the requirements of 5G.
- AMF in the New Generation Core (NGC) [2] architecture is often overloaded due to the fact of being the only access component over the control plane for a huge number of connected devices. This will be particularly exacerbated with regard to the expected number of IoT devices, which will be handled by future mobile networks.

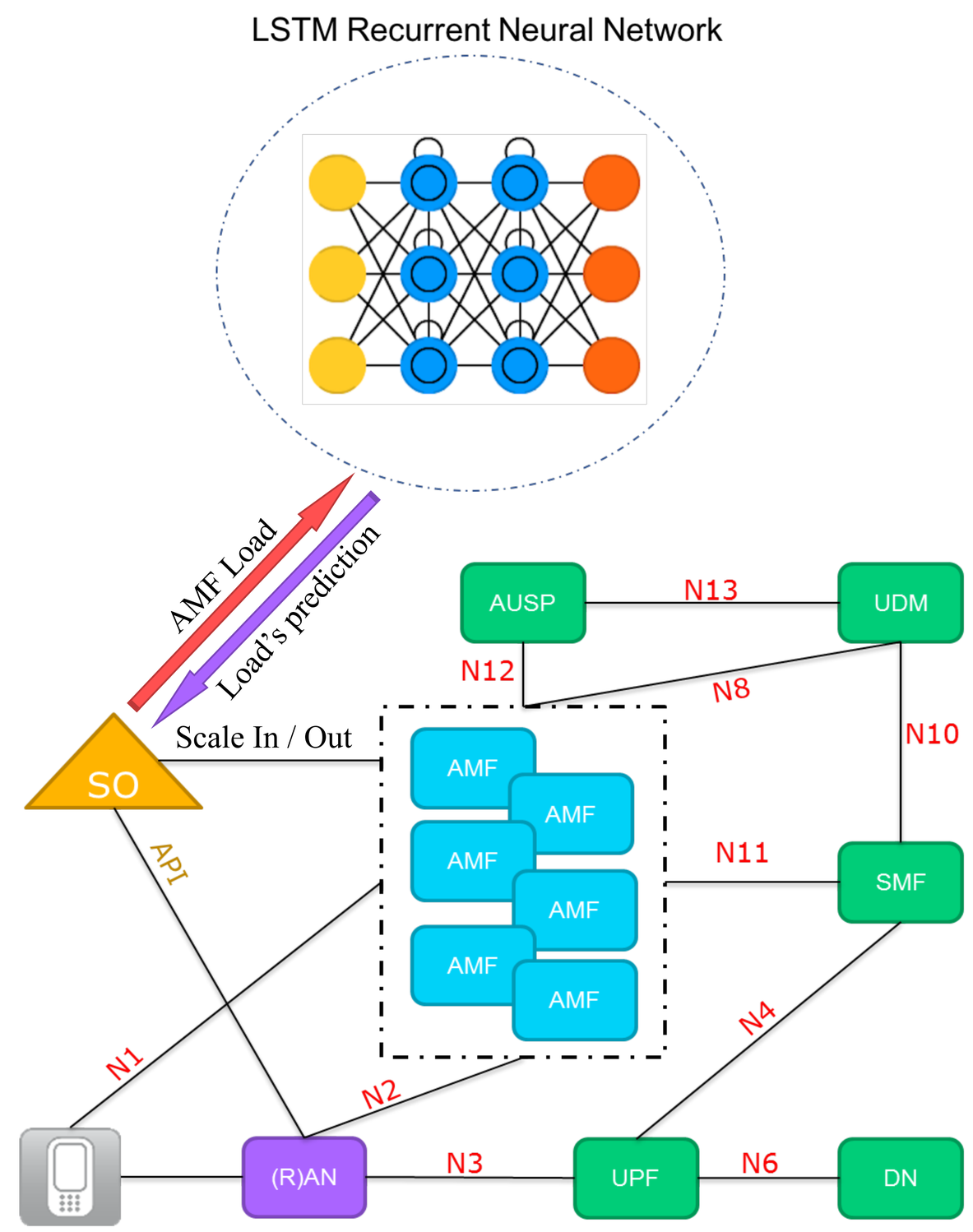
Motivations & Problem Statement

- Following a previous work [3], the AMF overload was proven.
- Scaling issue was addressed using a Control Theory model allowing to scale in /out the AMF depending on the overall load.
- However, the scaling model is not enough to bypass the congestion especially from the moment when applying scaling decisions is not instantaneous.
- Therefore the motivation to explore a pro-active solution based on prediction using machine learning to recognize automatically the traffic pattern related to access requests.

Methodology

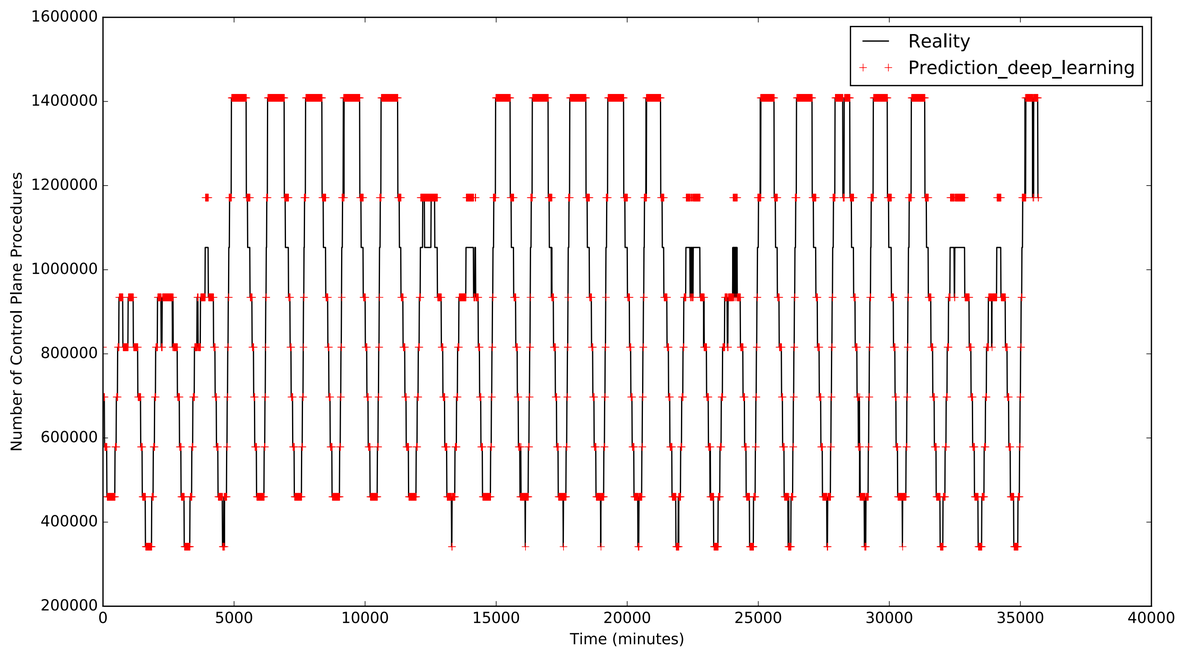
- Real dataset : Hourly phone calls, SMS and Internet communication of an entire city provided by “Telecom Italia Big Data Challenge” [4].
- Prediction issue is tackled using classification solutions.
- Data is pre-processed in a way to improve the performance of the learning.
- 60% of the dataset are used to train the neural networks and the 40% left are used for testing.
- Deep Neural Network (DNN) is composed of three hidden layers.
- The Recurrent Neural Network (RNN) is formed by one Long Short Term Memory (LSTM) cell.

New Generation Core: The Architecture

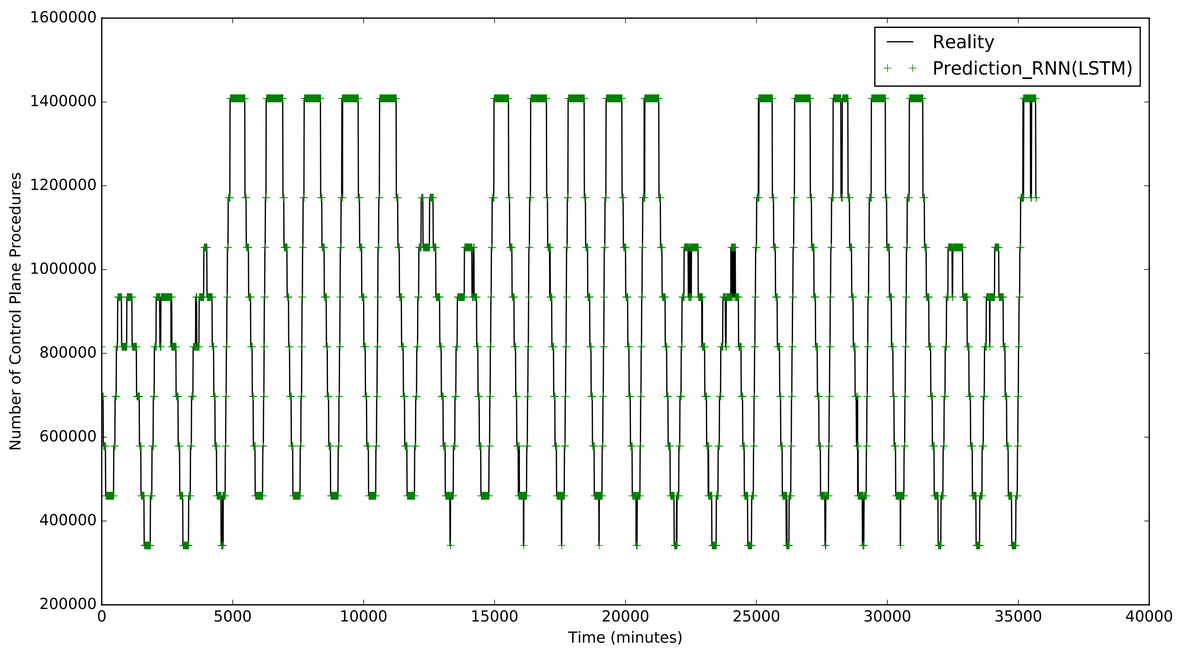


Main Results

Deep Neural Network (DNN) Prediction vs Reality Accuracy up to 79%



Recurrent Neural Network (RNN[LSTM]) Prediction Vs Reality Accuracy up to 88%



Conclusions

- RNN (LSTM) performs better than DNN with such type of dataset.
- Prediction accuracy with RNN clearly shows the potential of applying such type of approaches in predicting complex data patterns.
- Future work will focus on testing and optimizing different types of RNN/NN for predicting the control plane procedures’ load in future 5G networks.

References

[1] NGMN 5G White Paper: “https://www.ngmn.org/5g-white-paper.html”
[2] 3GPP, System Architecture for the 5G System: “http://www.3gpp.org/ftp/specs/archive/23_series/23.501/”
[3] Alawe Imad; Ksentini Adlen; Hadjadj-Aoul Yassine; Bertin Philippe; Kerbellec Amelie: On Evaluating Different Trends for Virtualized and SDN-ready Mobile Network, CloudNet 2017 proceedings, p71 – p76
[4] Mobile phone activity in a city : “https://www.kaggle.com/marcodena/mobile-phone-activity”