

Optimization of the structure and activation functions of deep neural networks with application to airport passenger flows congestion prediction and mitigation.

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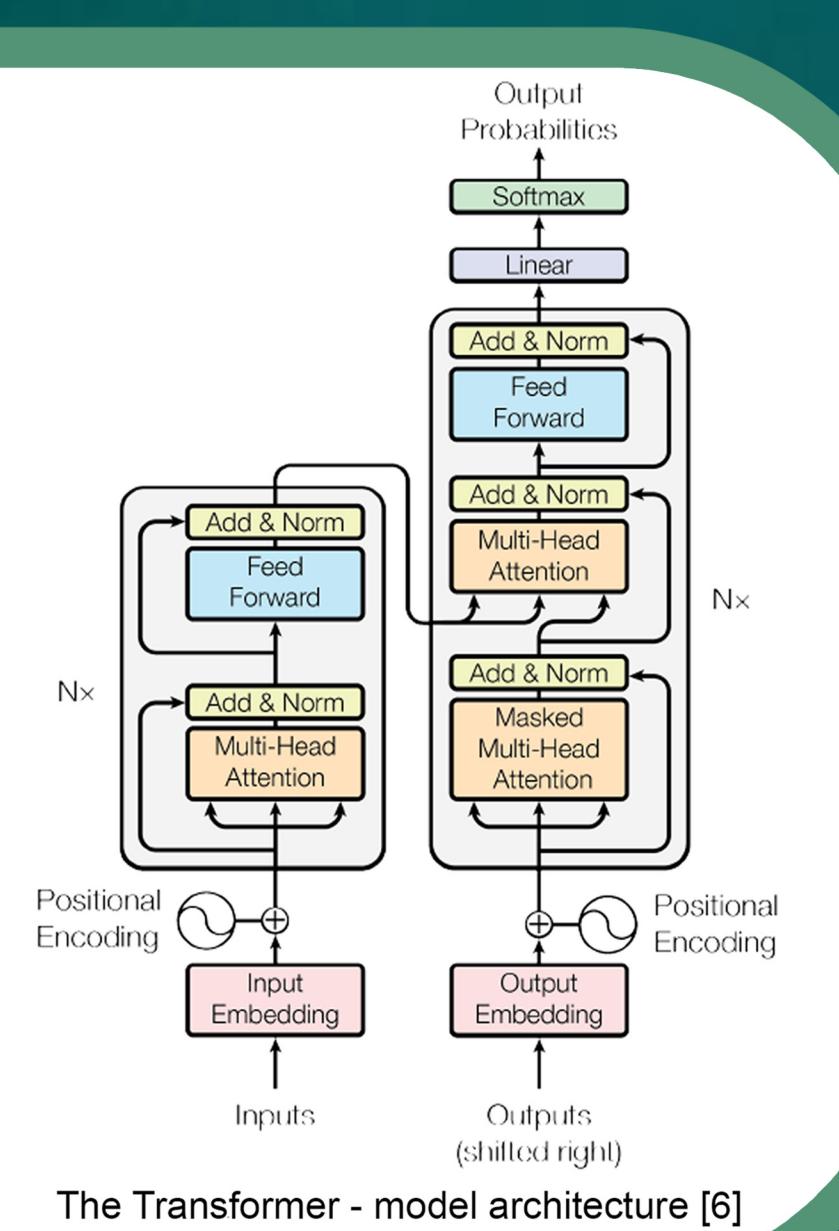
OBJECTIVES

- Development of AI algorithms for prediction the overall passenger flows (in/out) at airport. Based on historical data (aircraft in/Block time, ground transportation accessibility data (train, road, etc.), weather at airport, historical data of the airport load factor, day of the year, day of the week, time of the day, etc.), we propose to develop AI prediction tool in order to estimate the future passenger flows at the tactical level (few hours in advance) and the strategic level (few days, weeks in advance).
- Extend the previous model in order to be able to predict airport passenger flows at some specific locations at the airport (immigration, security checking). The question is then: How the overall airport passenger flow split in the airport from in-bound and out-bound point of view.
- Based on the two previous steps, develop AI decision support tool for agent planning at the immigration and security checking positions, this at the strategic level and at the tactical level.



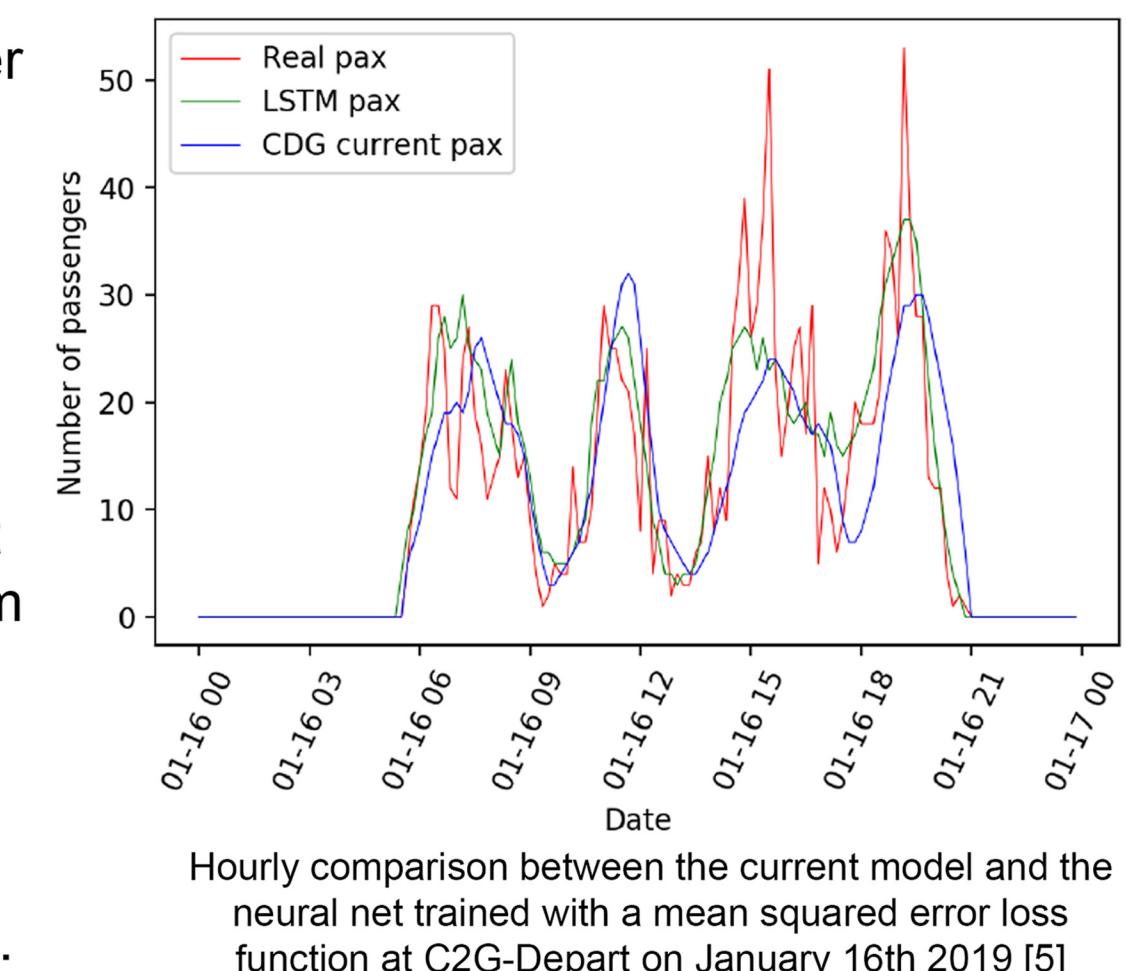
TRANSFORMERS

- In 2017 a team from the Google Brain Lab created a new network structure with the goal of creating a more powerful translation program than what was then available. This new structure called "Transformers" is based on the "attention" mechanism that allows the network to better identify the links between a word and all the words that precede it in the sentence rather than simply with the preceding word as was the case with recurrent networks. Moreover, this new structure can be easily parallelized contrary to recurrent networks, which allows a great acceleration of the learning and more important learning with a very high number of parameters.
- Transformers are now the reference in terms of translation and text generation. Since the major advance brought by Transformers in the processing of sequential data allows us to consider significant improvements in the current time series prediction programs which until now were based on recurrent networks and LSTM cells.
- To our knowledge, Transformers have not yet been used in passenger flow prediction.



- The use of recurrent neural networks allows the prediction of time series. In our case these time series represent the number of passengers at Charles de Gaulle airport throughout the day. The use of more advanced recurrent neural networks: LSTM (Long Short-Term Memory) allowed a team led by Daniel Delahaye in 2019 to improve the prediction system of the number of passengers at the airport.

- However, a major drawback of this type of architecture is that each neuron needs the result of the previous neuron to perform its calculation. Thus, learning cannot be parallelized with this type of network and the learning time can be particularly long. In order to keep the computation time reasonable, the number of parameters to be trained in the network had to be reduced, which decreases the accuracy of the network on complex data.



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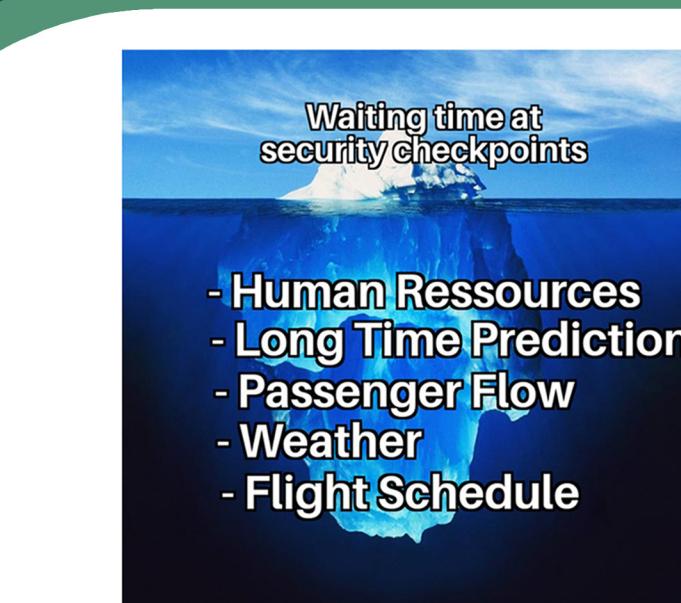
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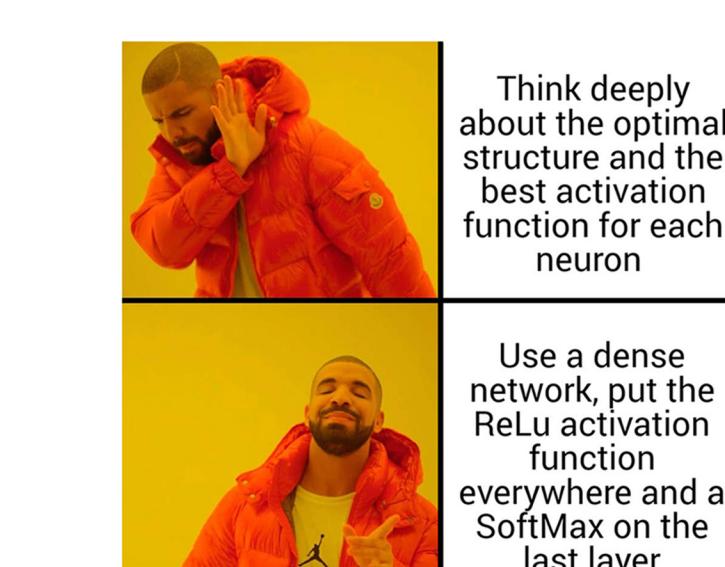
[6] Ashish Vaswani, Noam Shazeer, Niki Parmar, Jakob Uszkoreit, Llion Jones, Aidan N. Gomez, Łukasz Kaiser, and Illia Polosukhin. Attention is all you need. June 2017

CONTEXT



Passenger flow prediction has been investigated for a longtime in transportation areas,

In the machine learning field, regression models such as Support Vector Machines [1],[2] or Neural Networks [3], [4] were used to forecast passenger flow. Nevertheless, an airport passenger flow is a complex process. Extra features could be added in order to enhance the model performance.



Optimization of security checkpoints at a tactical level has also been thoroughly investigated. Finally, a recent approach based on AI has been developed to predict passengers flows at Paris CDG airport [5].

Neural networks are currently capable of competing with or even surpassing humans in games and control issues. However, these networks are often built by replicating the same structure over a set of fairly homogeneous layers.

PREDICTION PASSENGER

REFERENCES