CONVOLUTIONAL LONG-SHORT-TERM MEMORY NETWORKS (CONVLSTM) FOR WEATHER PREDICTION USING RADAR AND SATELLITE IMAGES

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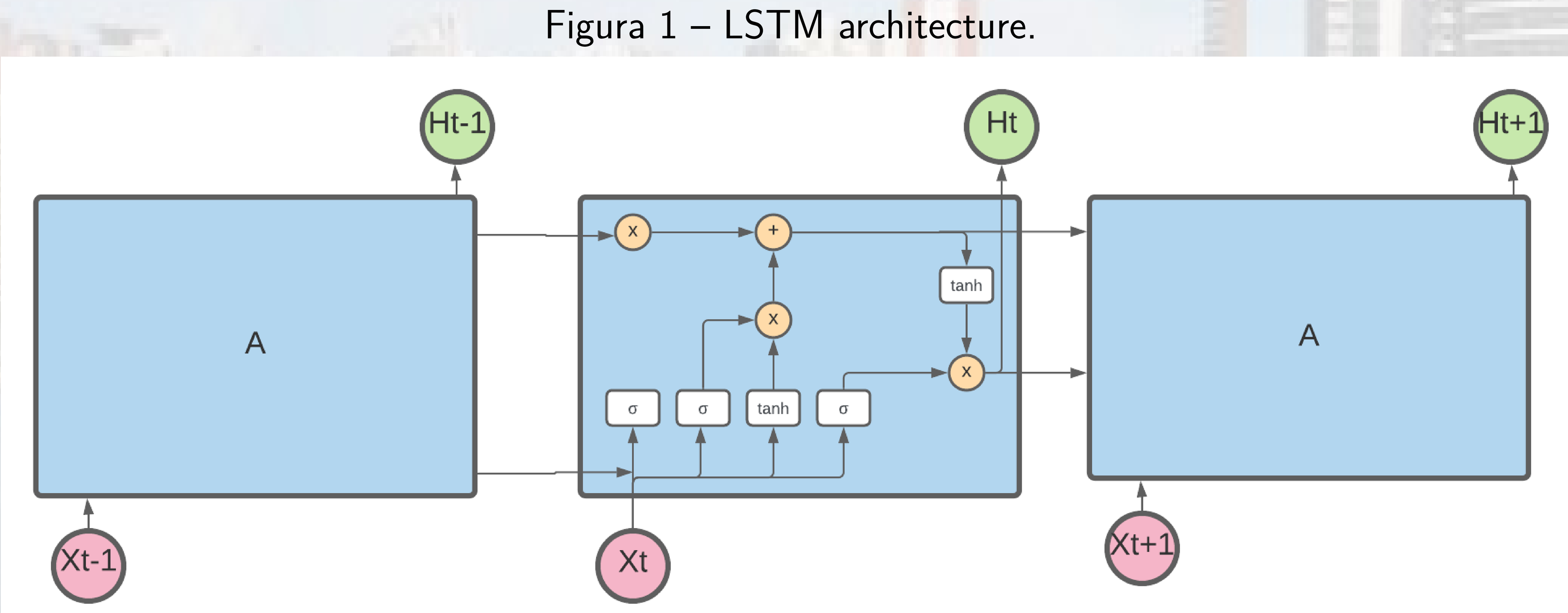
INTRODUCTION AND LITERATURE REVIEW

- (POORNIMA; PUSGPALATHA, 2019) discusses prediction of rainfall using intensified LSTM;
- (RUTTGERS et al., 2019) proposes the prediction of behavior of typhoons and hurricanes using artificial intelligence techniques;
- (WU, 2019) introduces image series prediction using convolutional LSTM applied to precipitation nowcasting;
- (KUMAR et al., 2020) presents a precipitation nowcasting architecture called "Convcast";
- (GAMBOA-VILLAFRUELA et al., 2021) describes a ConvLSTM architecture to predict the 16th precipitation data from a sequence of 15 images and up to a time interval of 180 min.

LONG SHORT-TERM MEMORY (LSTM) NEURAL NETWORKS

LSTM networks are a type of RNN used in deep learning and widely applied to time-series analysis. The main feature which distinguishes it from other types of neural networks is the introduction of a forget gate.

Figura 1 – LSTM architecture.



METHODOLOGY

	1st Approach	2nd Approach
Number of ConvLSTM Layers	3	3
Activation Function	tanh	ReLU
Convolutional Window/ Kernel Size	7×7	$5 \times 5, 3 \times 3, 1 \times 1$
Number of Output Filters	28, 64, 64, respectively	64
Number of 3DConvLSTM	1	1
Activation Function	ReLU	sigmoid
Convolutional Window	$1 \times 1 \times 1$	$3 \times 3 \times 3$
Number of Output Filters	1	1
Batch Size	2	4
Optimization Function	Adam	Adam
Loss Function	logcosh(x)	Cross-entropy
Input	14 coloured images	10 grayscale images
Number of Epochs	1,000	15
Loss	0.02	0.05

RESULTS

Figura 2 – Frame prediction of the first ConvLSTM approach: comparison between real and predicted frames. The observed (left) and predicted (right) frames are compared side-by-side for 30 and 60 minutes ahead (first row) and 90 and 120 minutes ahead (second row).

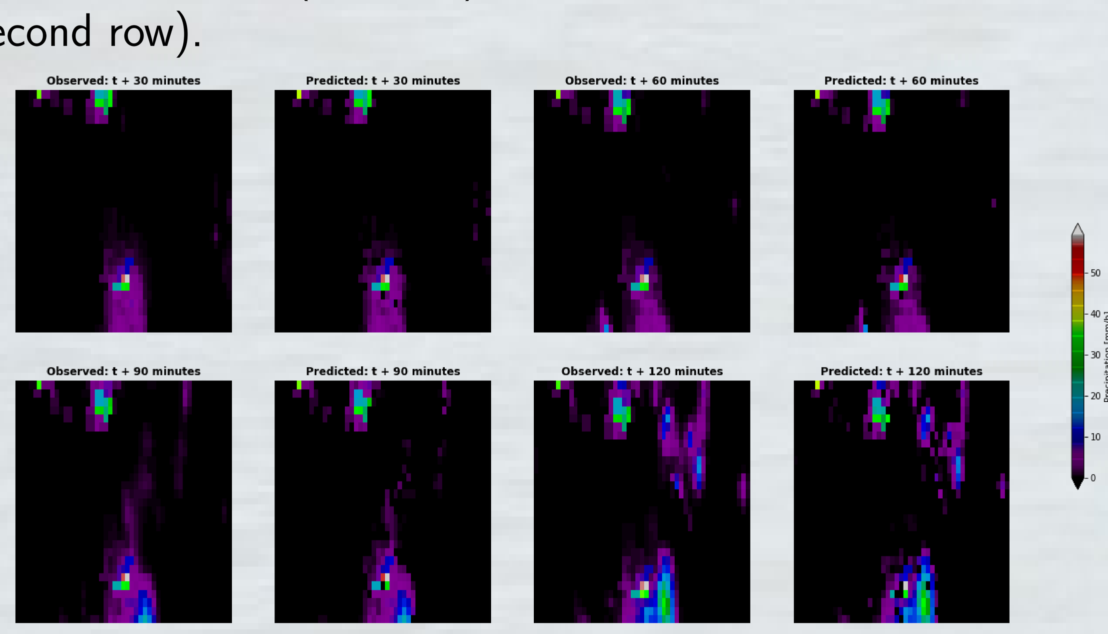


Figura 3 – Frame prediction of the second ConvLSTM approach: comparison between real and predicted frames. The observed frames are shown on the first row and the respective predicted ones are shown on the second row for 8, 15, 23 and 30 minutes ahead.

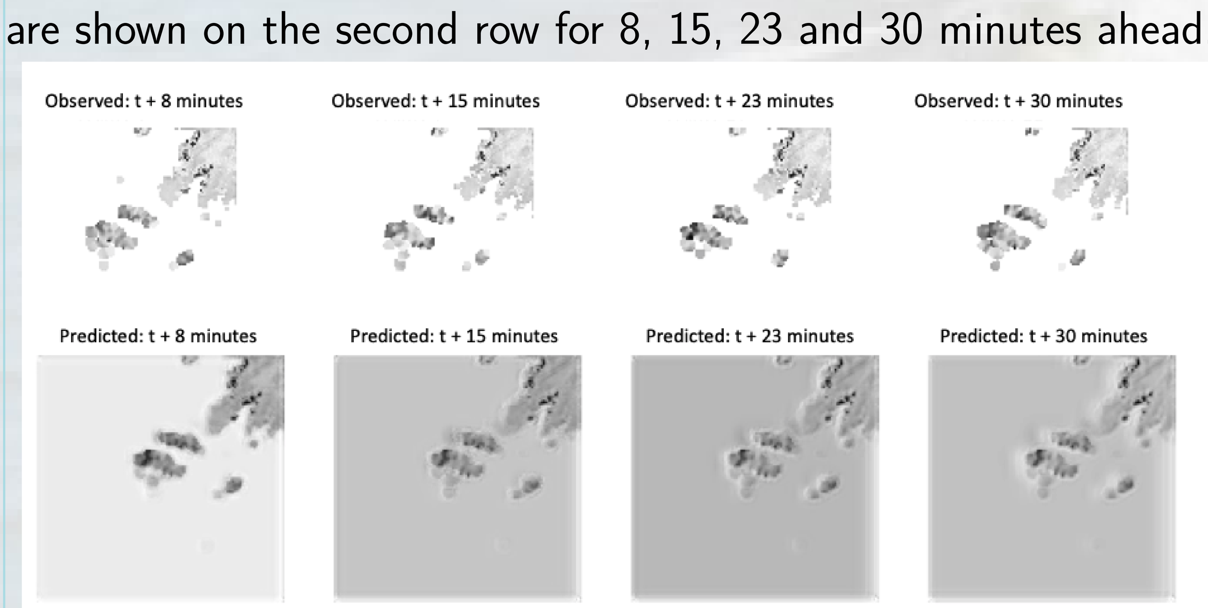
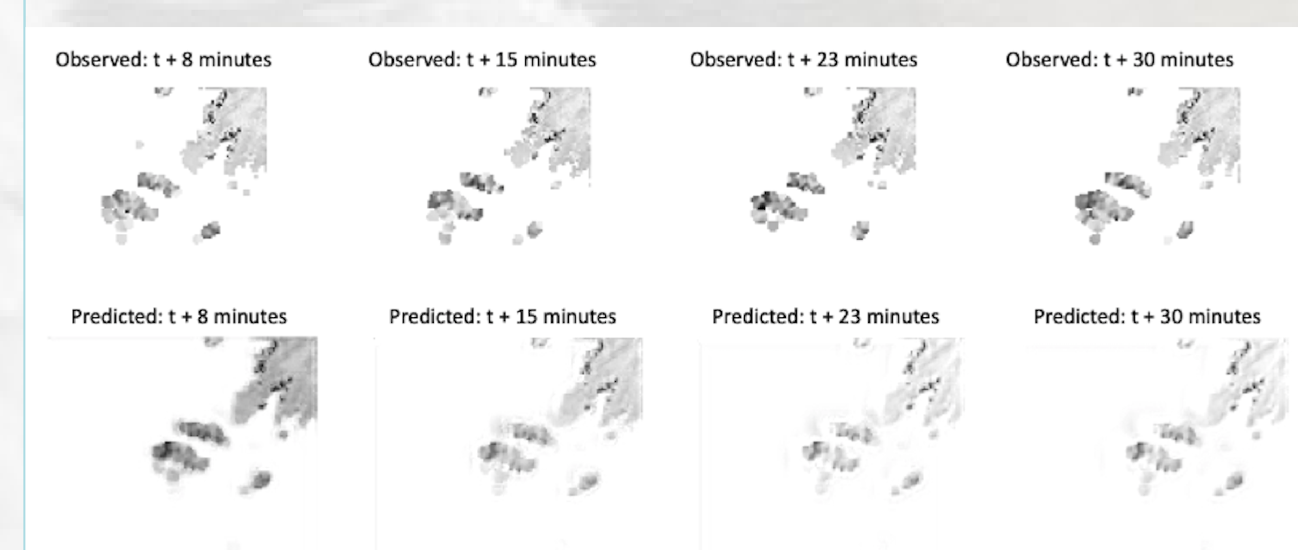


Figura 4 – Frame prediction of the second ConvLSTM approach with filters applied: comparison between real and predicted frames.



CONCLUSIONS

- The ConvLSTM algorithms were shown to provide feasible results with a reduced number of inputs for training and testing, with predicted and actual frames presenting similar profiles.
- The method can be used, for example, for hurricane and typhoon monitoring, allowing early warning on regions under the constant presence of these phenomena.

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