Rain Nowcasting using transformer neural networks

5-6 month internship at Sorbonne University LIP6 lab (Jussieu, Center of Paris)
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Scientific context

Precipitation forecasting at a short and mid-term horizon, also named rain nowcasting, is a complicated problem in Numerical Weather Prediction due to the high non-stationarity of the rain processes. Real life applications for example address severe events anticipation [1] (short term horizon, lower than 2 hours) or agriculture management [2] (longer horizon, up to 4 hours). Traditionally and in the operational centers, forecasts are produced based on the combination of physics based numerical models and observations (e.g. from radar, satellite), this method is called Data Assimilation [3, 4].
Basically, it estimates the motion field in order to advect observed storm cells. But the creation/dissipation process of these cells is not well understood and hard to model. However, over the past decade, Machine learning and more precisely Deep Learning have shown great abilities to model complex spatio-temporal dependencies [5] that usually require the use of differential equations.

Objective

Recently, a literature on Rain Nowcasting NN based has emerged [6,7,8,9] using various architectures (ConvLSTM, Gru, Unet, Gan, …) with various performances. This internship starts from a past research [10] on data coming from the Meteo France radar network [11]. We propose to investigate promising architectures based on attention networks and transformer networks to the problem of short-term rain precipitation estimation. Performances will be compared with the literature.

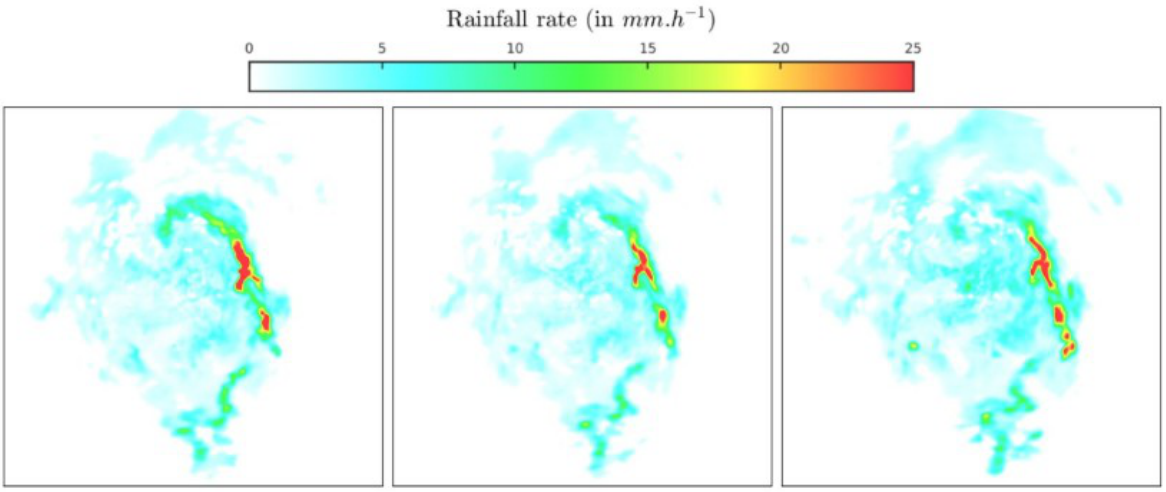

Fig 1: Example of three successive Radar acquisitions of precipitations.

References

[1], Joe et al, 2012, Automated processing of doppler radar data for severe weather warnings, In book: Doppler Radar Observations - Weather Radar, Wind Profiler, Ionospheric Radar, and Other Advanced Applications
[2], Stigter et al, 2000, Agrometeorology in the 21st century: workshop summary and recommendations on needs and perspectives, in Agricultural and Forest Meteorology, 103(1/2):209–227
[3], Marc Bocquet, 2018, Introduction to the principles and methods of data assimilation in the geoscience, Lecture notes
[4], Bereziat et al, 2018, Motion and acceleration from image assimilation with evolution models, in DSP
[5], He et al, 2015, Deep Residual Learning for Image Recognition, arXiv
[6], Shi et al, 2015, Convolutional LSTM Network: A Machine Learning Approach for Precipitation Nowcasting, arXiv
[7], Shi et al, 2016, Deep Learning for Precipitation Nowcasting: A Benchmark and A New Model, arXiv
[8] Lei Han et al, 2021. “Convective Precipitation Nowcasting Using U-Net Model”. In : IEEE Transactions on Geoscience and Remote Sensing
[9] Suman V. Ravuri et al, 201. “Skilful precipitation nowcasting using deep generative models of radar”. In : Nature 597
[10] Vincent Bouget et al, 2021. “Fusion of Rain Radar Images and Wind Forecasts in a Deep Learning Model Applied to Rain Nowcasting”. In : Remote Sensing
[11] Larvor, G.; Berthomier, L.; Chabot, V.; Le Pape, B.; Pradel, B.; Perez, L. MeteoNet, an open reference weather dataset by Meteo-France, 2020. https://meteonet.umr-cnrm.fr/

Skills :

- Machine Learning, Deep learning, Image processing, Data Analysis
- Python programming, Pytorch is a plus
- Interest for climate applications