Fine-Tuning LightningCast for Brazilian Territory:

Exploring Transfer Learning Techniques for Lightning Nowcasting

Aurelienne A. S. Jorge
Visiting Scholar at the **University of Wisconsin (UW)**
Technologist and PhD student at the **National Institute for Space Research (INPE)**

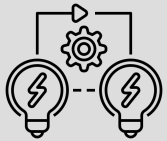
Advisors:
John Cintineo (NOAA/NSSL)
Leonardo Santos (Cemaden)
Izabelly Costa (INPE)

September, 2024

Motivation

Machine Learning (ML) techniques applied to Nowcasting

- **Probsevere LightningCast (LC)** is one example
- Cons: Usually requires **large amounts of data**, which demands time and Computational resources (GPUs, RAM, and storage).

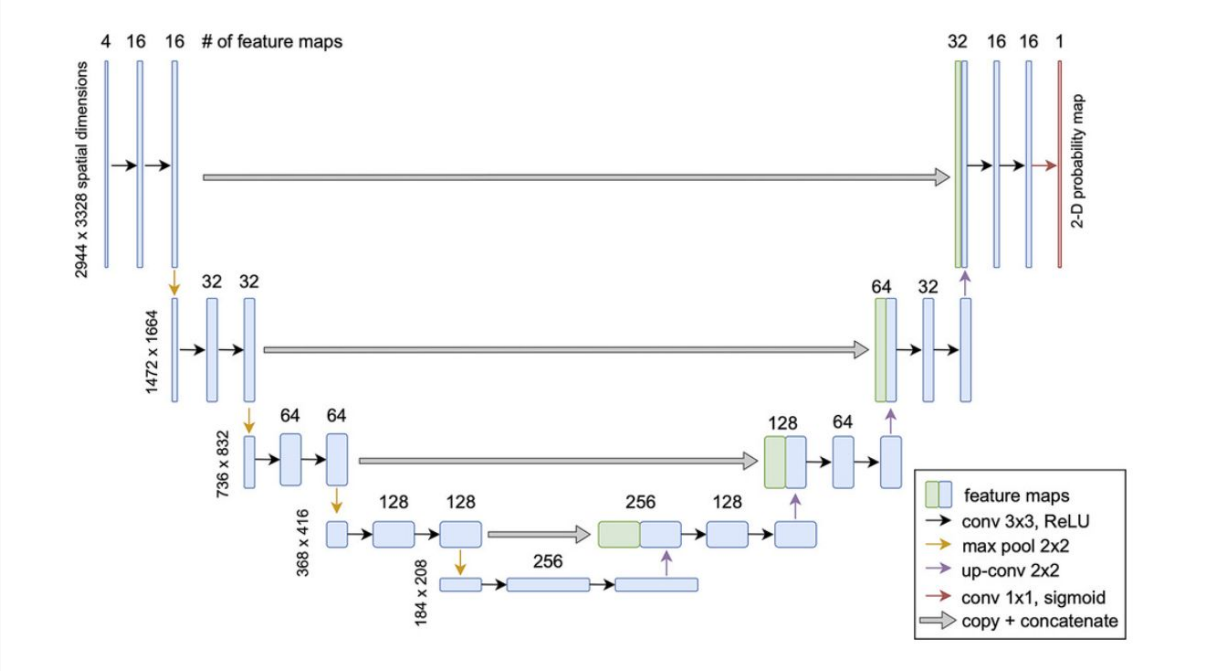


Transfer Learning techniques and its advantages

Involve reusing the knowledge from a pretrained model to a new task or domain.

Main Goal: Adapt LC, exploring Transfer Learning Techniques

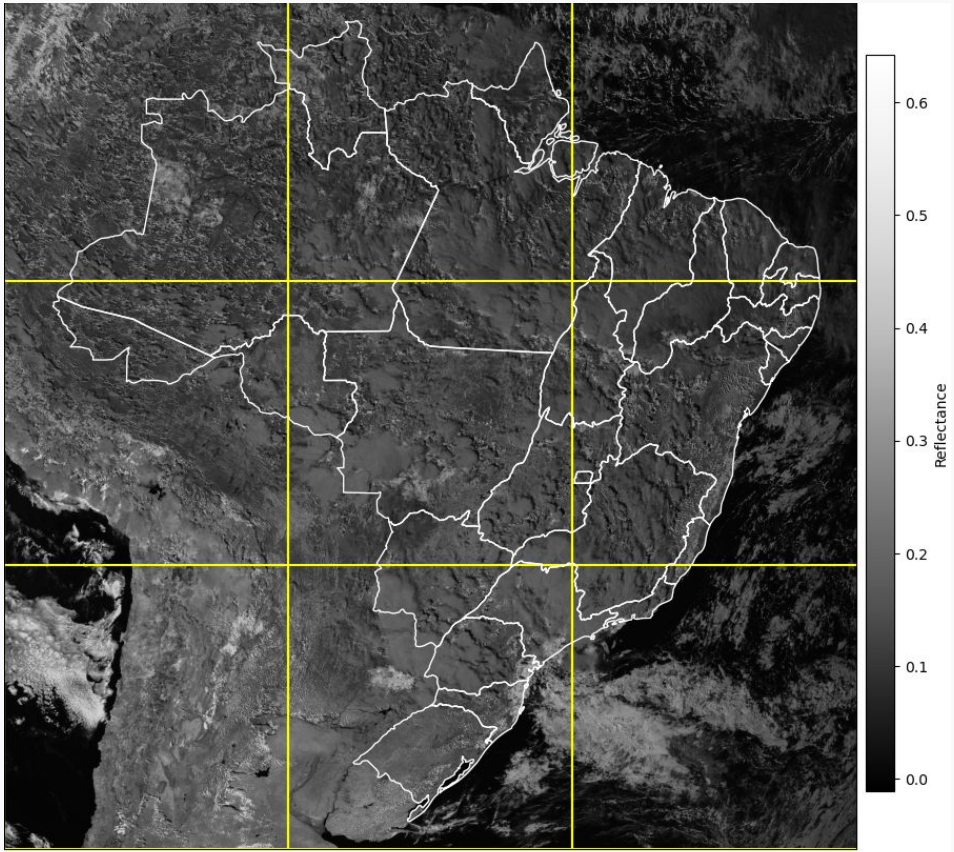
ProbSevere LightningCast



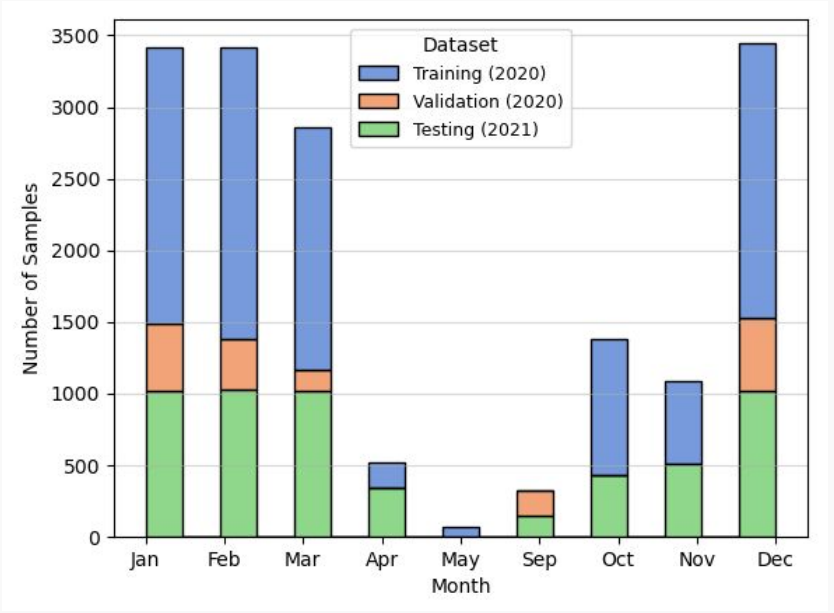
ProbSevere LightningCast Model
Source: [Cintineo et al., 2022]

- ANN model based on U-Net architecture;
- Uses data from four GOES-16 ABI channels as input, and from GLM as target;
- Trained over the GOES-East CONUS sector;
- Forecasts lightning 1 hour ahead.

About the Dataset



The Study Area



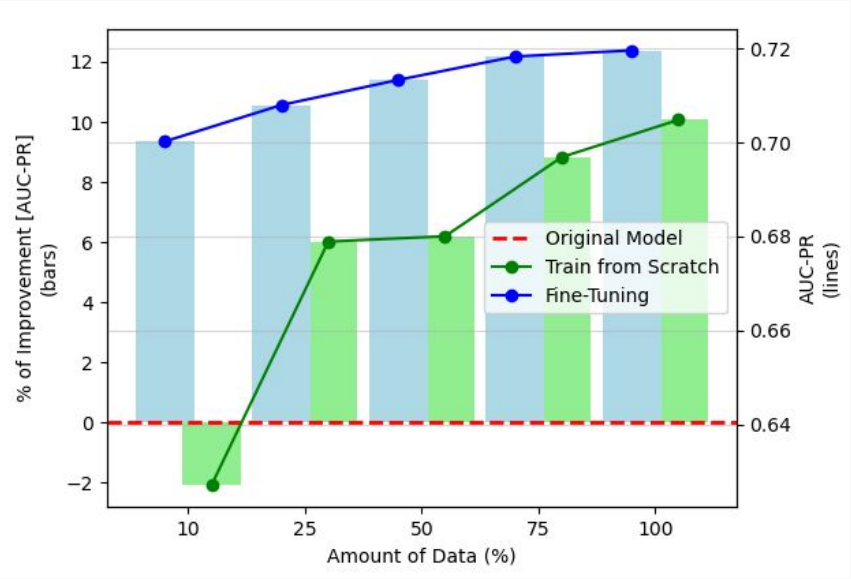
Training: 9354 patches from 66 days
Validation: 1643 patches from 11 days
Test: 5524 patches from 34 days

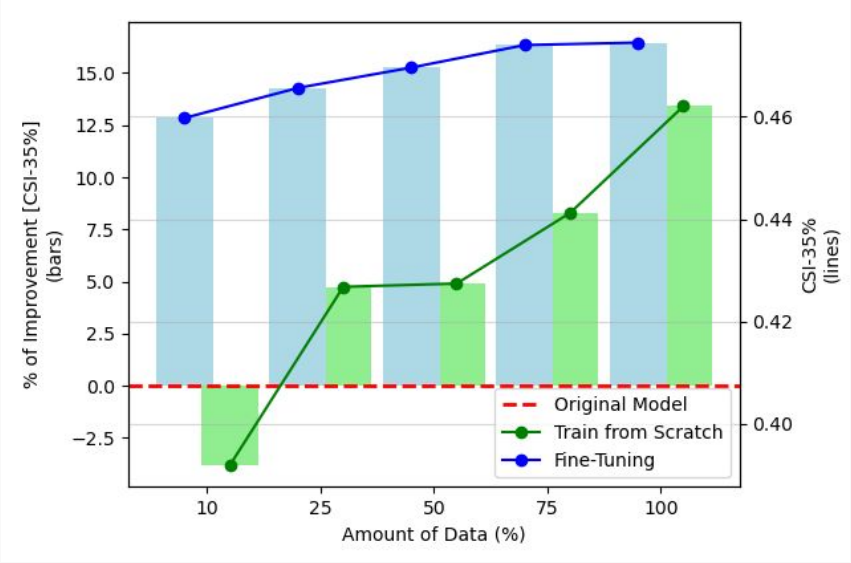
[Original LC Model:
Training Dataset: 76 031]

About Transfer Learning

- ➔ We employed **fine-tuning** techniques, which involves unfreezing some or all of the model layers (weights) to fit it again using a new dataset. [Chollet, 2021]
- ➔ The idea is to reuse the pretrained knowledge (weights) and optimize it for the new domain;
- ➔ We experimented with fine-tuning different parts of the LC model, but full fine-tuning (retrain all layers) achieved the best performance.

Results - Training From Scratch vs Fine-Tuning



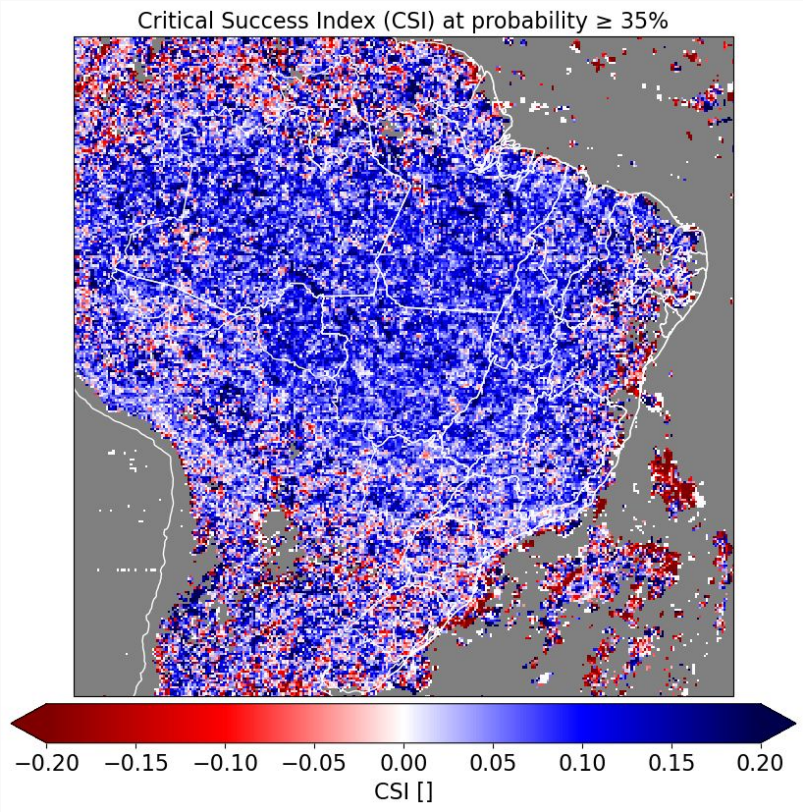


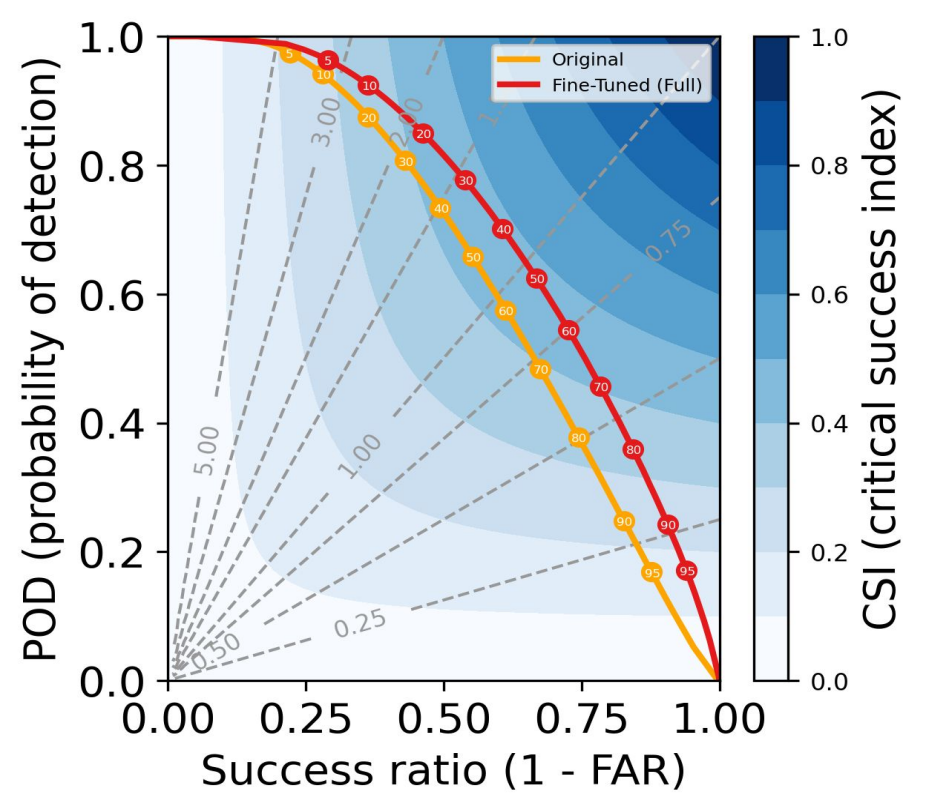
Training Time (100%):

Training from Scratch ≅ **38 hours**

Fine-Tuning ≅ **16 hours**

Results - Original Model vs Full Fine-Tuned





Final Remarks

- Fine-tuning proved to be more effective than training from scratch when only small amounts of data are available.
- The results show that fine-tuning effectively leverages the knowledge from the original pre-trained model.
- Future Works: Fine-Tuned LC operational at INPE

Thanks!

Do you have any questions?

souzajorge@wisc.edu
aurelienne@gmail.com