FEMA

Predicting the “Unpredictable"

ACSE/EDSML MINI-PROJECT

- Team Barry
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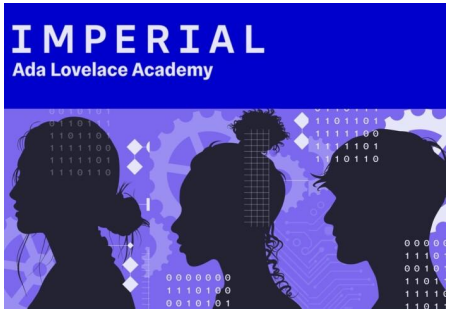
Who are we?

Team Barry

- Founded at Imperial College London in the Ada Lovelace Academy



- Daniel Kaupa
- Xingyu Liu
- Vadim Malz
- Joe Najem
- Aditi Srivastava
- Haitong Wang
- Zewei Zhang
- Xiaorui Zhou

Today's Discussion

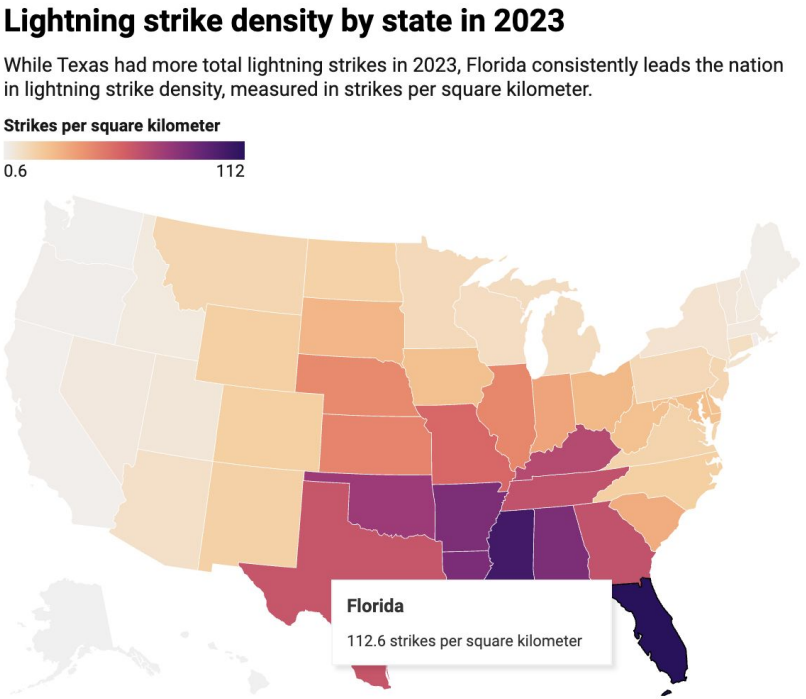
1. Introductions
2. Background & Problem
3. Our Solution
4. Solution Deep Dive
5. Potential Concerns
6. References
7. Conclusion

The Problem:

⚡Lightning⚡

Where will it strike next?

- Economic, natural, and human impact
- Increased frequency



Our Solution:

flash.io

- Harnessing ML to Predict Storms & Lightning Strikes
  - Predicting radar images 1-hour into the future
  - Predicting radar images from other satellite images in the same time period
  - Predicting Lightning Strikes

Feature 1

Goal: Given one hour, predicting the next hour of vertically integrated liquid (radar)

Model Architecture and Training Workflow

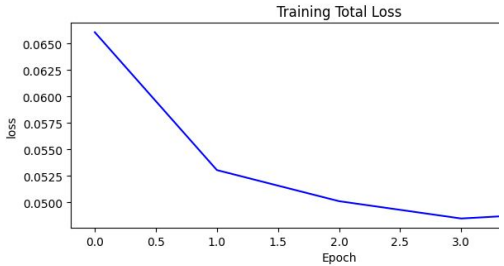
Model → **Training** → **Predictions**

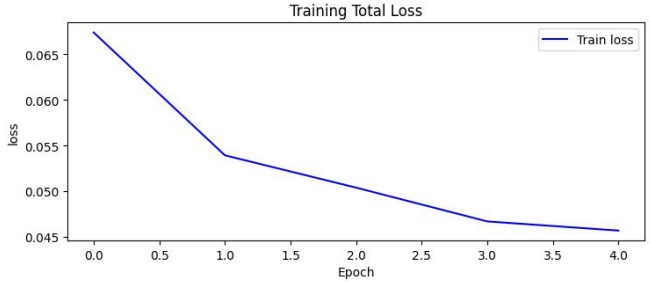
- **ConvLSTM2D**
- Input layer (height, width, time steps, channels)
- **3 ConvLSTM2D** Layers
- Output Layer : **Conv3D**
- For compare, we use the **same model** in A&B

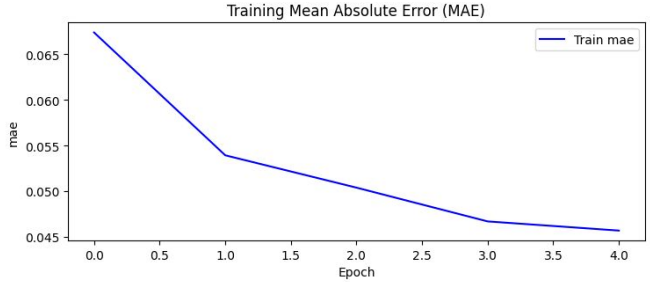
- **7 slide windows**
- **800 * 7** data per epoch
- Train: 70%
- Test: 10%
- Validation:20%
- Optimizer : adam
- Loss : mae
- Saved as **pretrained model**
- Augmentation
- Normalization

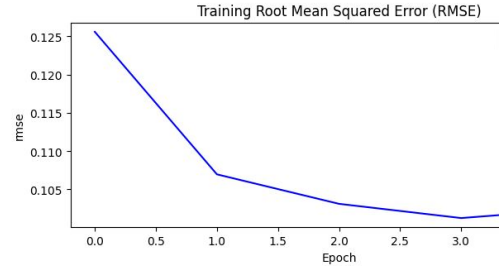
- Predicts **12 future vil frames**
- Metrics: total_loss, mae, rmse, kl_divergence, reconstruction_loss
- **used for** storm tracking, weather forecasting
- **Visualization**: the input, predicted, and actual frames

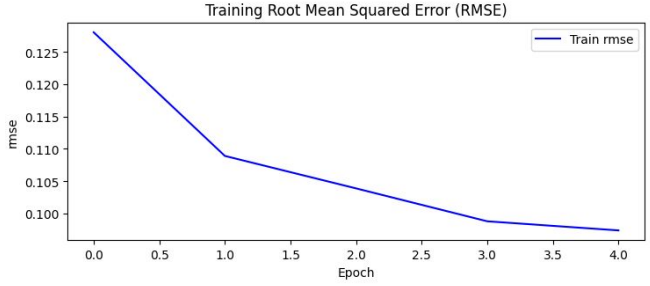
Model Training Monitoring

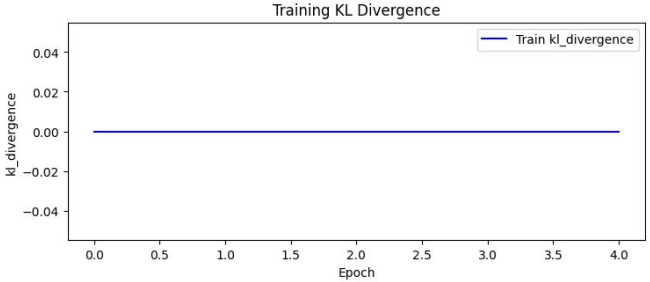


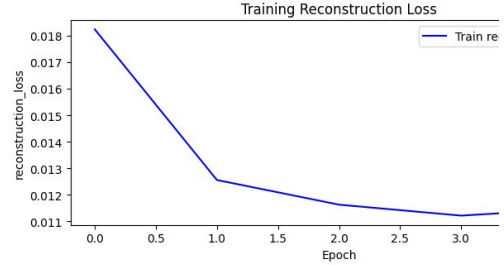










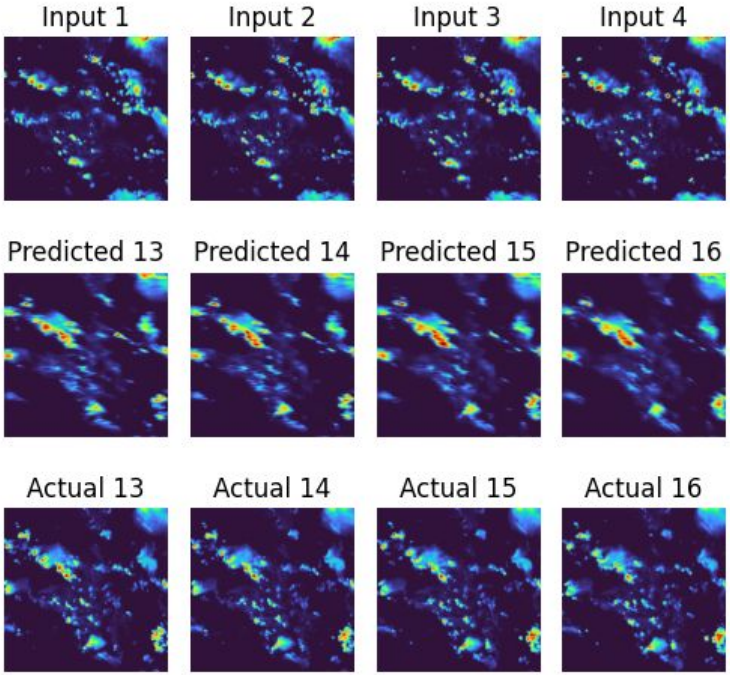


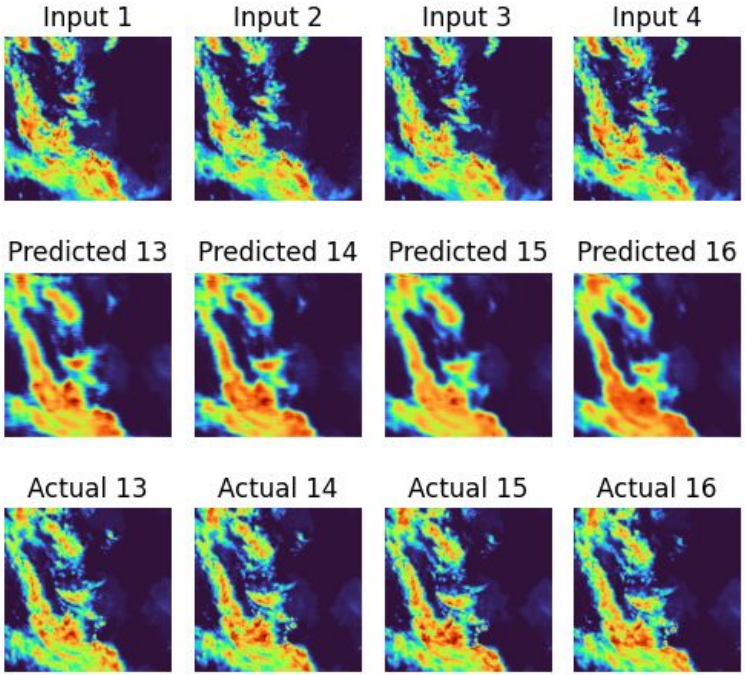
Model Evaluation

Index	Model A	Model B
RMSE	0.09183	0.09582
MAE	0.04197	0.04592
KL	0.06719	0.06502
Reconstruction Loss	0.00929	0.01021
Total Loss	0.07648	0.07522

B is more concerned with the overall structure.

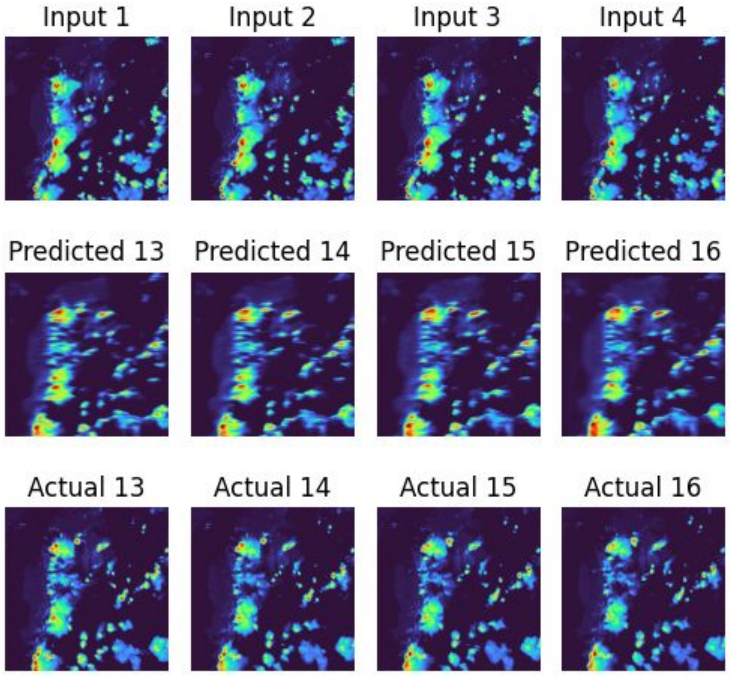
Model A output - Training

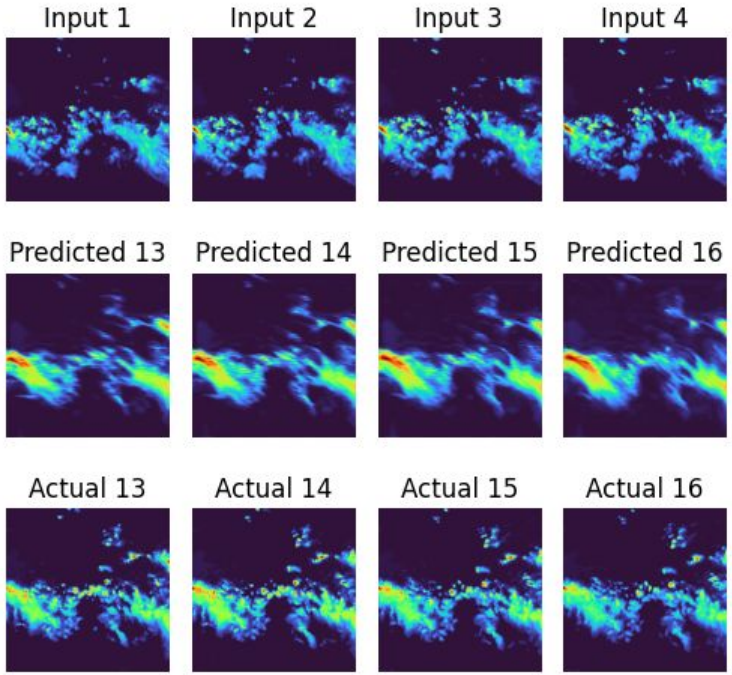




Good ! But...

Model B output - Training

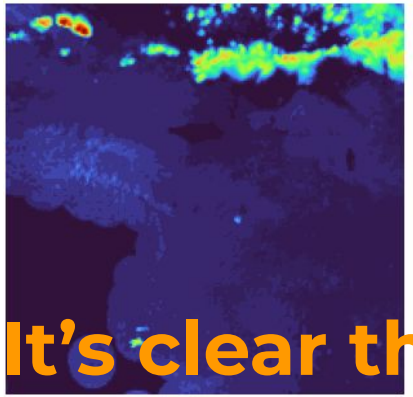




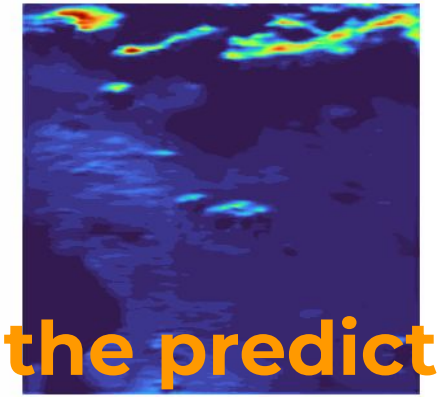
More reasonable !!

Model output - surprise storms

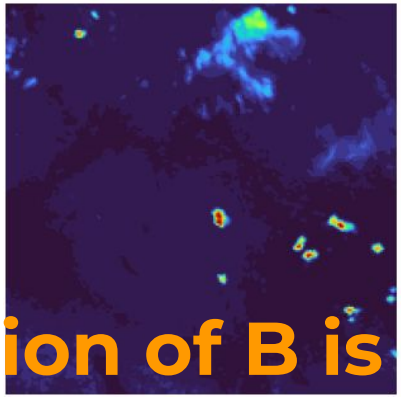
S844398 - Input Frame 1



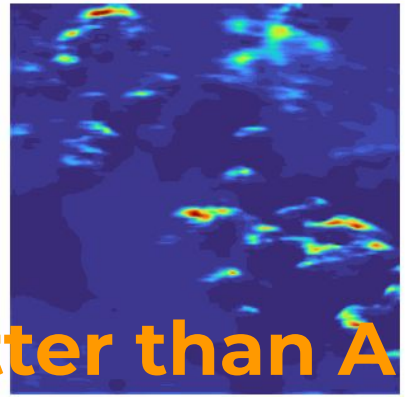
S844398 - Task 1A Prediction Frame 1



S837416 - Input Frame 1

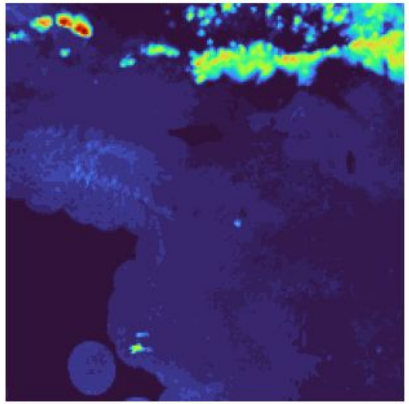


S837416 - Task 1A Prediction Frame 1

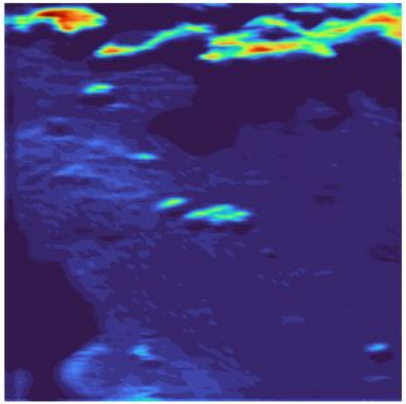


It’s clear that the prediction of B is better than A

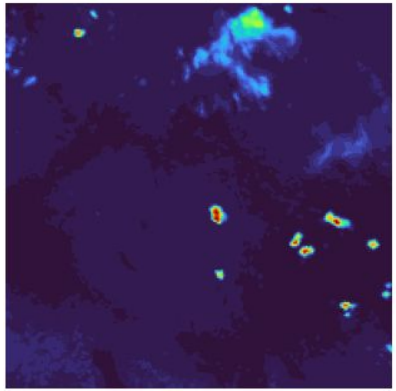
S844398 - Input Frame 1



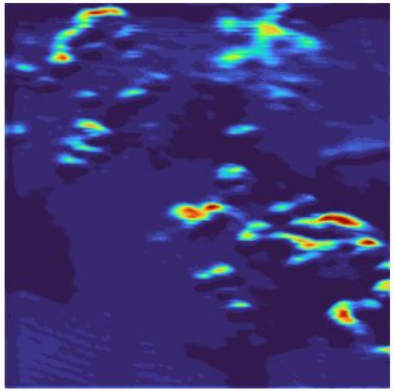
S844398 - Task 1B Prediction Frame 1



S837416 - Input Frame 1



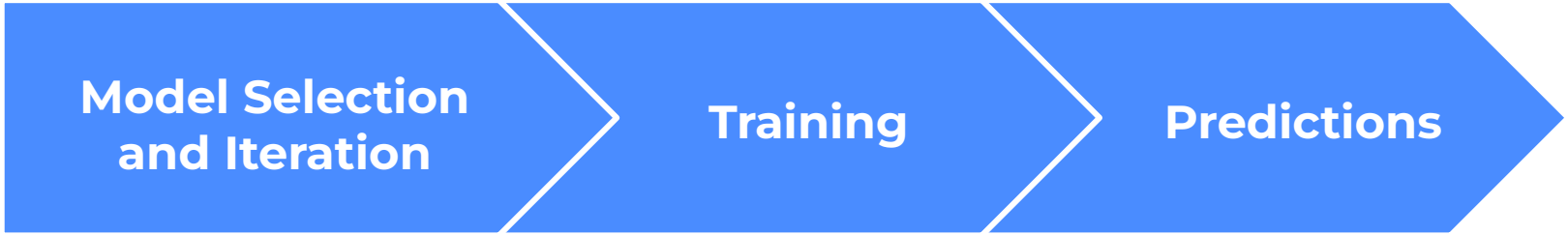
S837416 - Task 1B Prediction Frame 1



Feature 2

Goal: predicting vertically integrated liquid (radar) images when missing

Iteratively develop our task

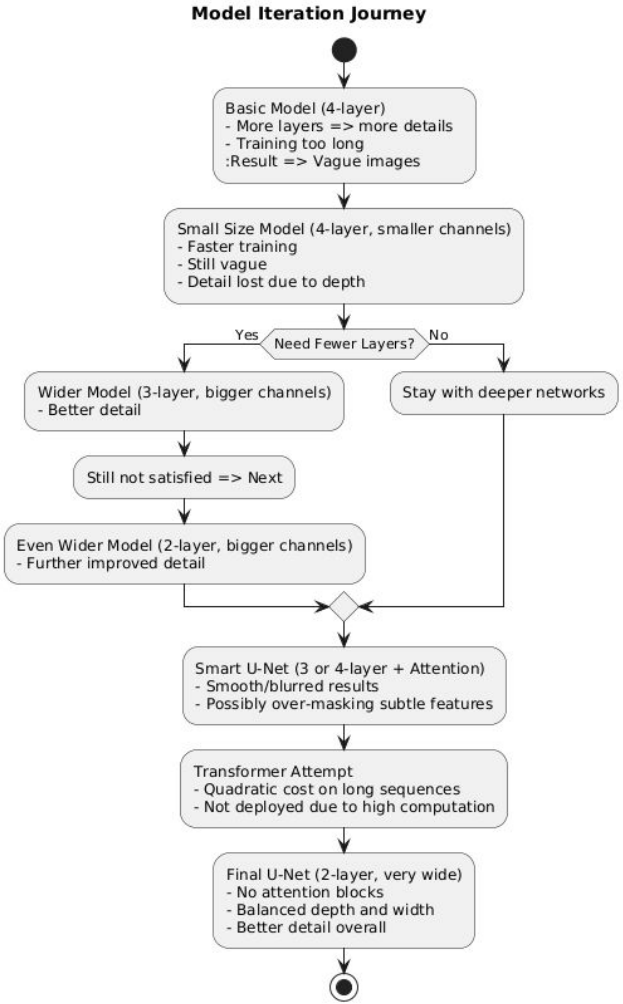


- Determine the main objective
- Design model that solve the task well
- Iteratively update the structure of the model

- Training the model based on different loss, parameter and epoch.
- Iteratively feedback to the model selection and design

- Using the trained model to predict the data.

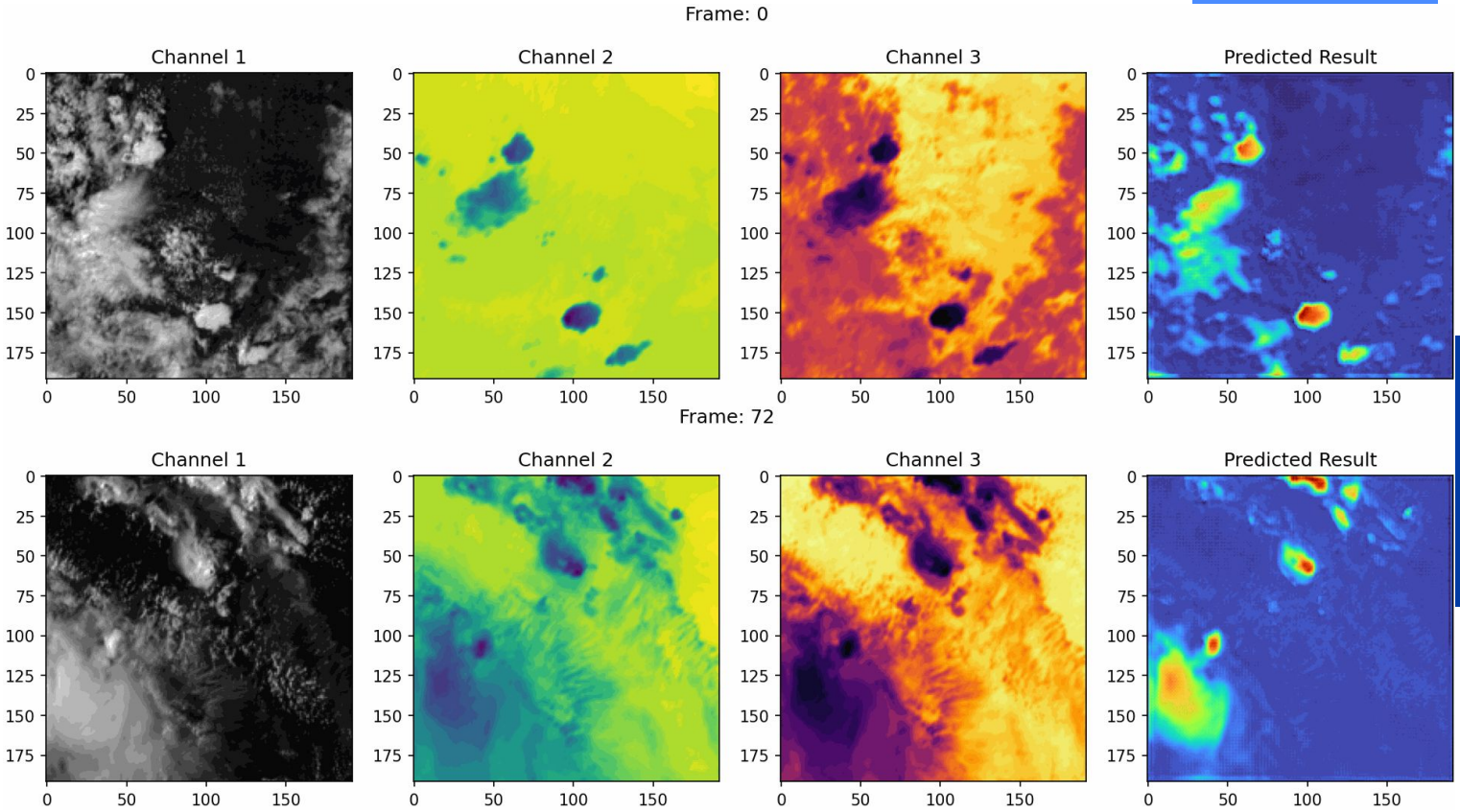
Model Selection and iteration



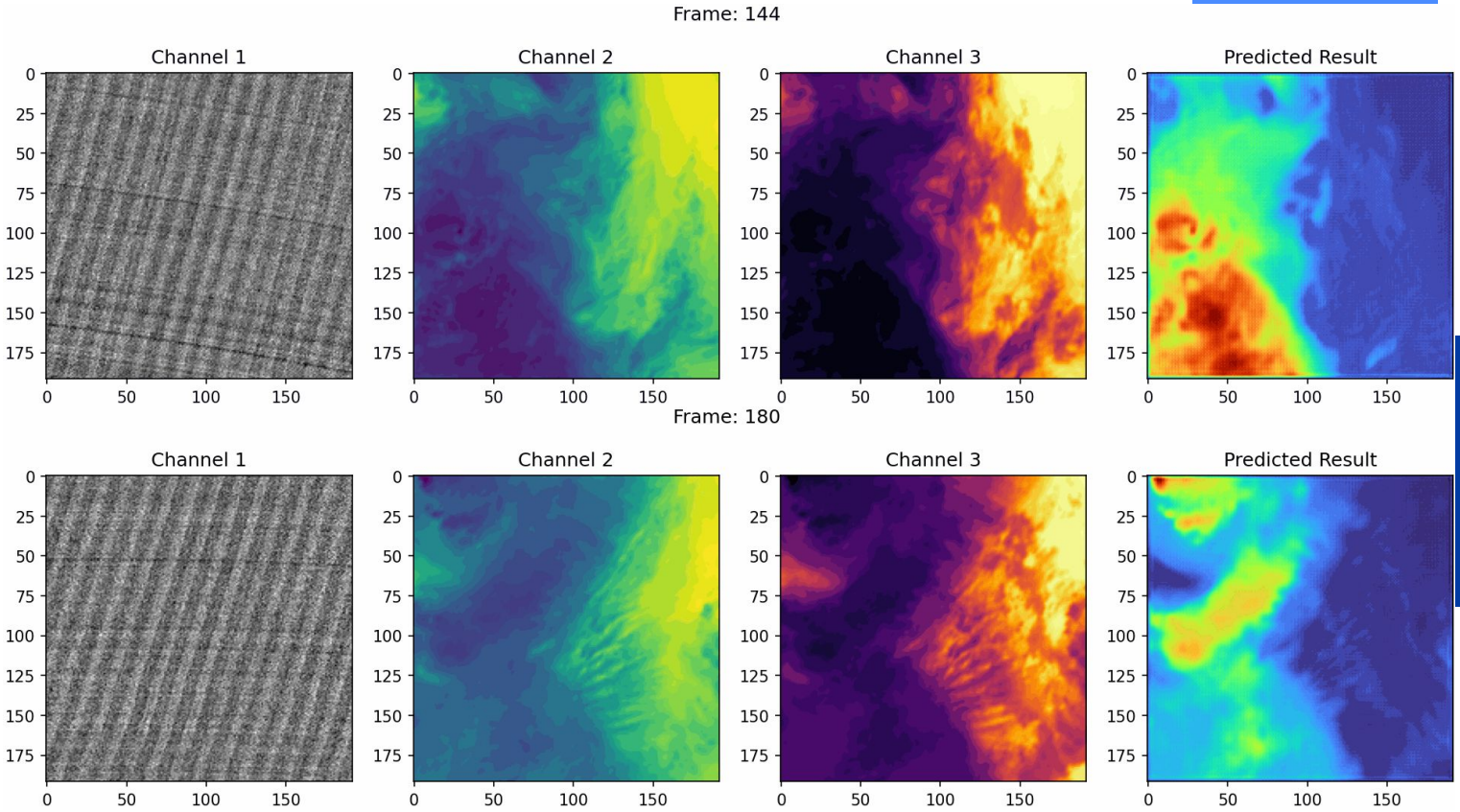
Model Training

Epochs = 30
Loss: MSE
Parameters:
Optimised: Adam

Model output



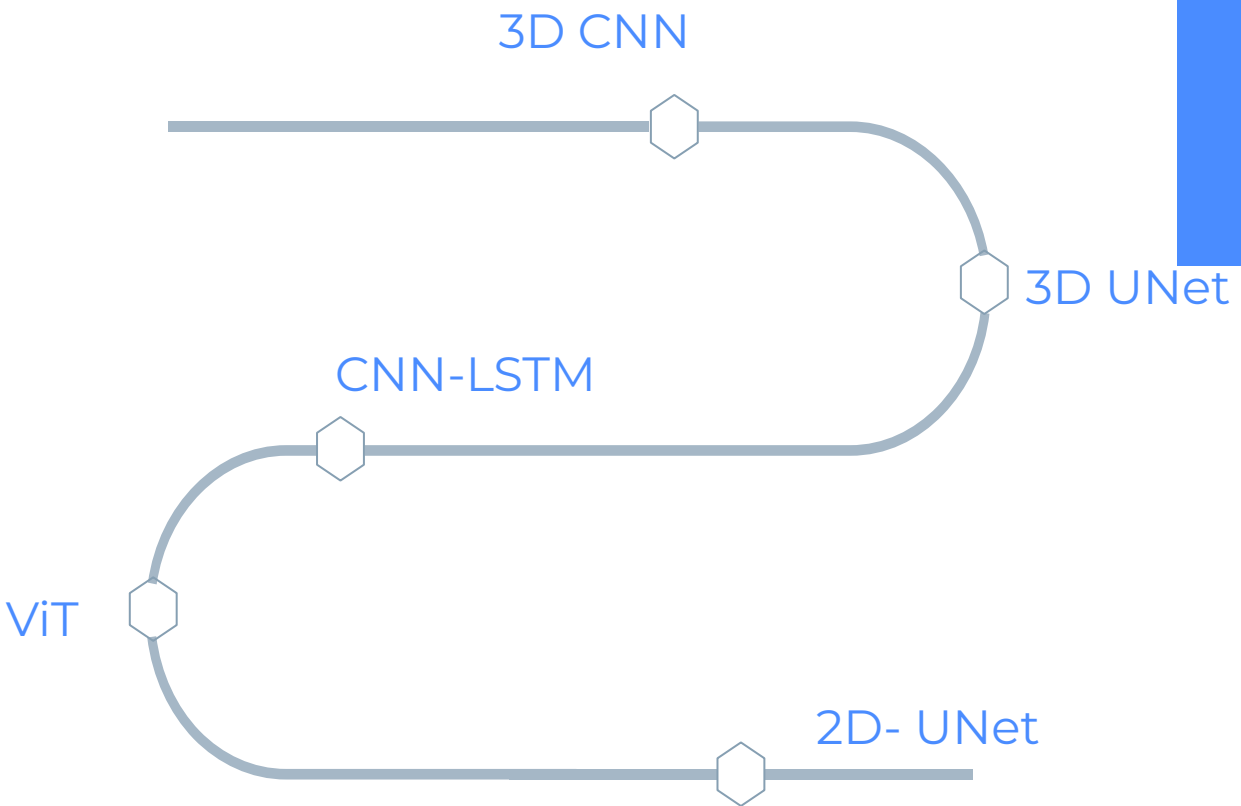
Model output



Feature 3

Given a set of 4 different bands of satellite images, predict lightning locations.

Model Selection and iteration



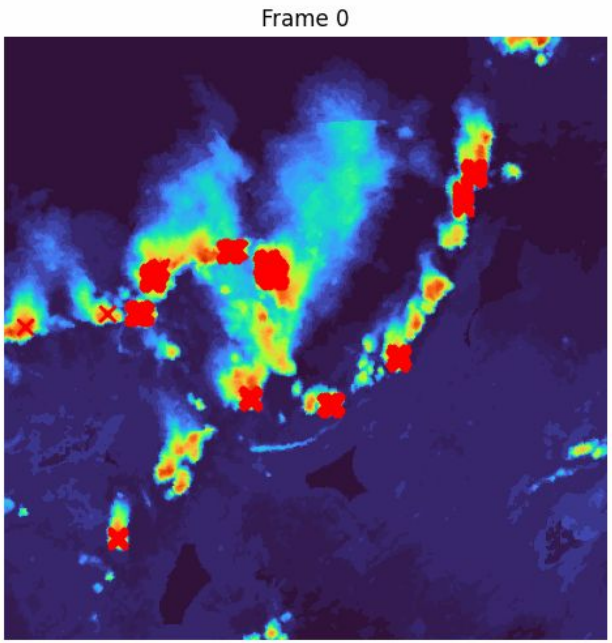
Data Gathering Survey

- Normalize images using local Min Max
- Upsized the IR images
- Grouped lightnings in frames

- UNet Architecture
- Skip Connections
- Dice Loss
- Relu

- Outputs x,y grid of pixels locations.
- One specific frame
- Time of lightning in 5 min frames

Predicted Outputs



Lightning events predictions of Storm Surprise over the 36 frames of VIL band.

- Train Loss: 0.9968
- Val Loss: 0.9989

Potential Concerns

1. Data Quality and Availability
2. Real Time Performance
3. Integration with Existing Systems
4. Dependency on Weather Data Sources

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References

- https://www.fastcompany.com/91041966/us-yearly-lightning-ground-strikes-damage-prevention
- https://www.livescience.com/planet-earth/weather/electrifying-time-lapse-image-captures-100-lightning-bolts-torching-the-sky-over-turkey

- GITHUB: https://github.com/ese-ada-lovelace-2024/acds-storm-prediction-barry

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Conclusion

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Thanks!

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