# Solar Orbiter Images Challenge

Graphics & Games: Frederico Testagrossa, Mykhailo Levytskyi, Niklas Düser, Athira Sreejith & Jannes Terlau

Organization Among the Team

- Data analysis and preparation was done collectively

- Different network architecture approaches throughout the team

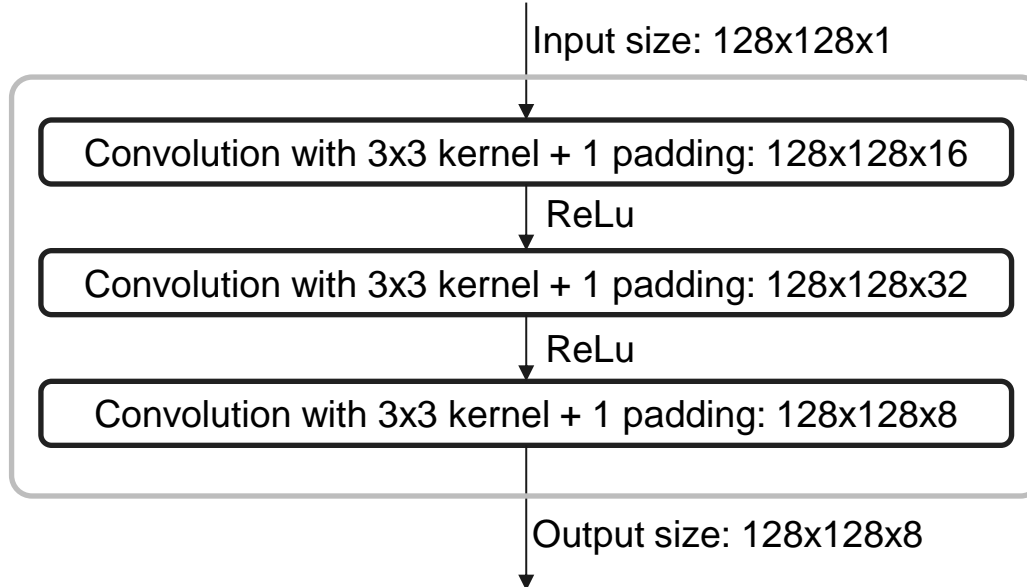- Comparison of individual results + joint pursuit of most "promising" approach
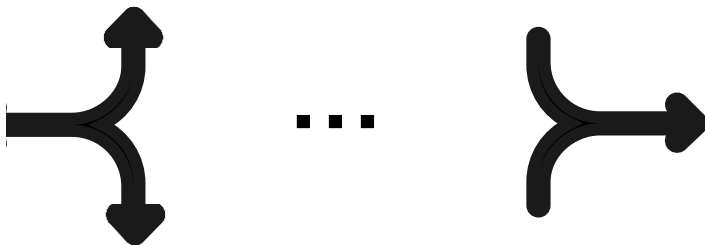
Approach – Data Preparation

- Applied normalization via standardization (global or column-wise)

- 80% training data (~4900 time points) and 20% test and validation data (~1200 time points)

  - Input data dimensions: {time points}x1x128x128

  - Target data dimensions: {time points}x8x128x128

- Preparation of batches with a size of 64 time points per batch

Approach – Network Architecture

- Different network approaches were constructed

    - LeNet-like architecture (target data was flattened)

    - Autoencoder

    - CNN

- Loss function: MSE

- Optimizer: Adam (default settings with learning rate of 1e-2)

Approach – Network Architecture (cont'd)

Input size: 128x128x1

Convolution with 3x3 kernel + 1 padding: 128x128x16

ReLu

Convolution with 3x3 kernel + 1 padding: 128x128x32

ReLu

Convolution with 3x3 kernel + 1 padding: 128x128x8

Output size: 128x128x8

Approach – Training Process

- Employed batches of 64 time points for training

- Training duration approximately 10 minutes

- Different normalization techniques showed different behaviour

```
Epoch [1/5], Loss: 0.0235, Val_oss: 0.0204
Epoch [2/5], Loss: 0.0173, Val_oss: 0.0176
Epoch [3/5], Loss: 0.0165, Val_oss: 0.0173
Epoch [4/5], Loss: 0.0166, Val_oss: 0.0177
Epoch [5/5], Loss: 0.0211, Val_oss: 0.0190
```

Global Normalization

```
Epoch [1/5], Loss: 0.4597, Val_oss: 0.4361
Epoch [2/5], Loss: 0.3878, Val_oss: 0.3308
Epoch [3/5], Loss: 0.3921, Val_oss: 0.3014
Epoch [4/5], Loss: 0.2761, Val_oss: 0.2758
Epoch [5/5], Loss: 0.3024, Val_oss: 0.2804
```
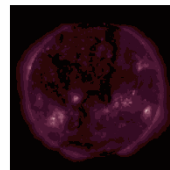
Channel-Wise Normalization

Results

Pred.

Org.

Results

Pred.

| Channel: 131A | Channel: 171A | Channel: 193A | Channel: 211A | Channel: 304A | Channel: 335A | Channel: 1600A | Channel: 1700A |

Org.
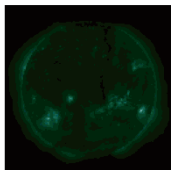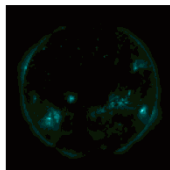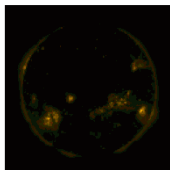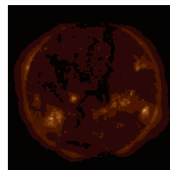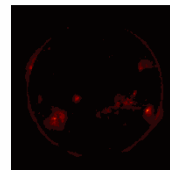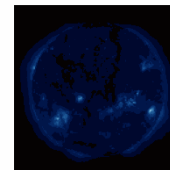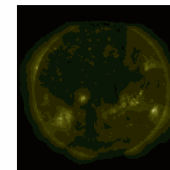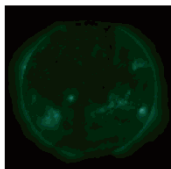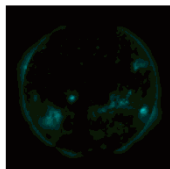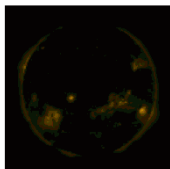
| Pred: 131A | Pred: 171A | Pred: 193A | Pred: 211A | Pred: 304A | Pred: 335A | Pred: 1600A | Pred: 1700A |
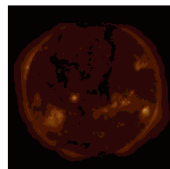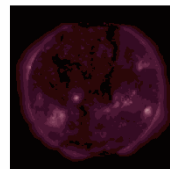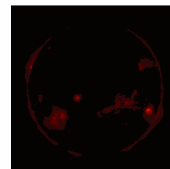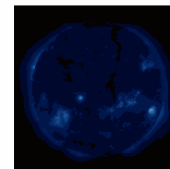
Results (cont'd)

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Pred.

Org.

Results (cont'd)

Pred.

Org.

Results (cont'd)

Model prediction: Channel 1700A

Relative error (NN - true)/true: Channel 1700A

Results (cont'd)

Model prediction: Channel 1700A

Relative error (NN - true)/true: Channel 1700A
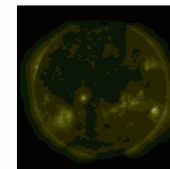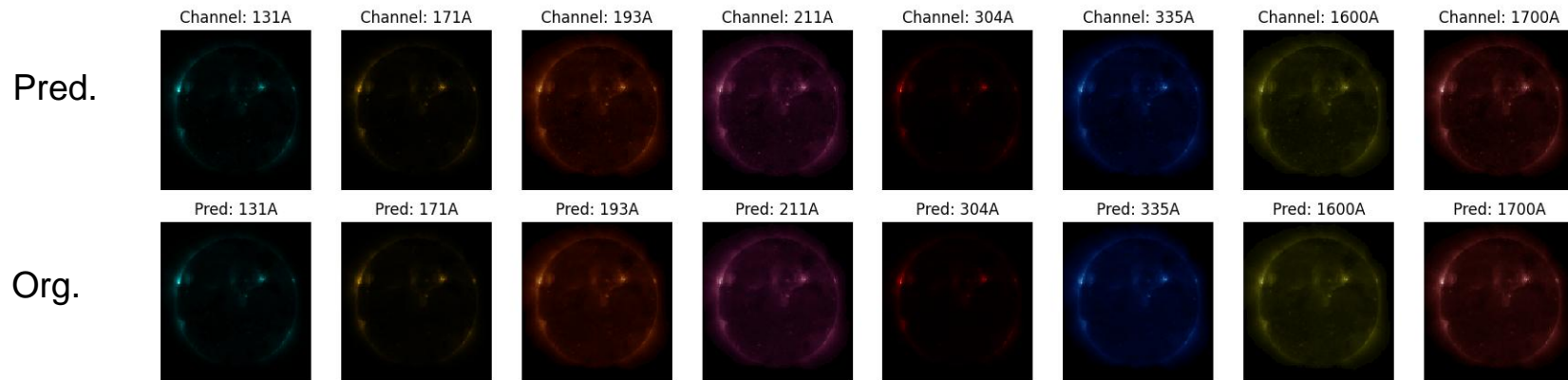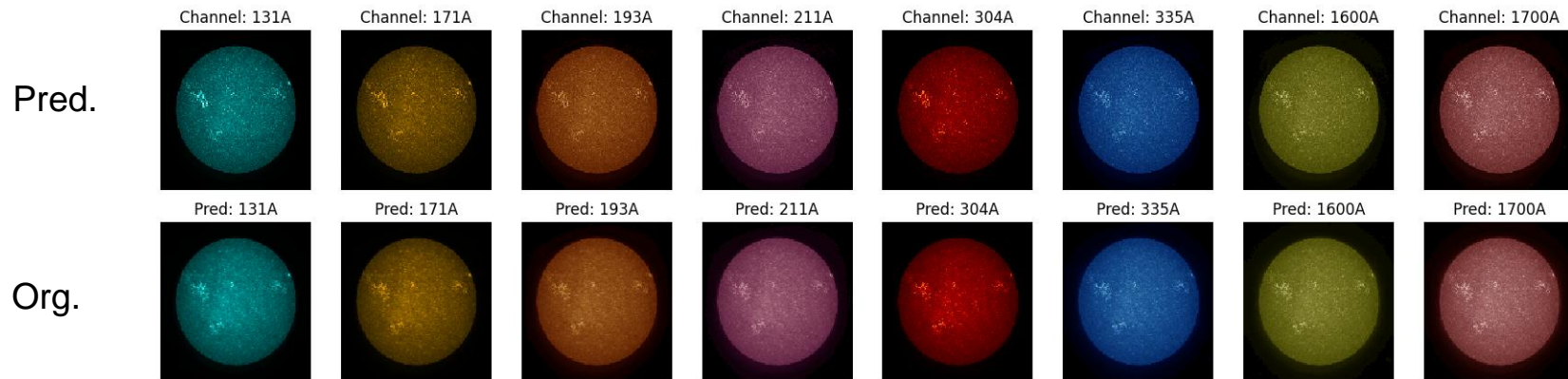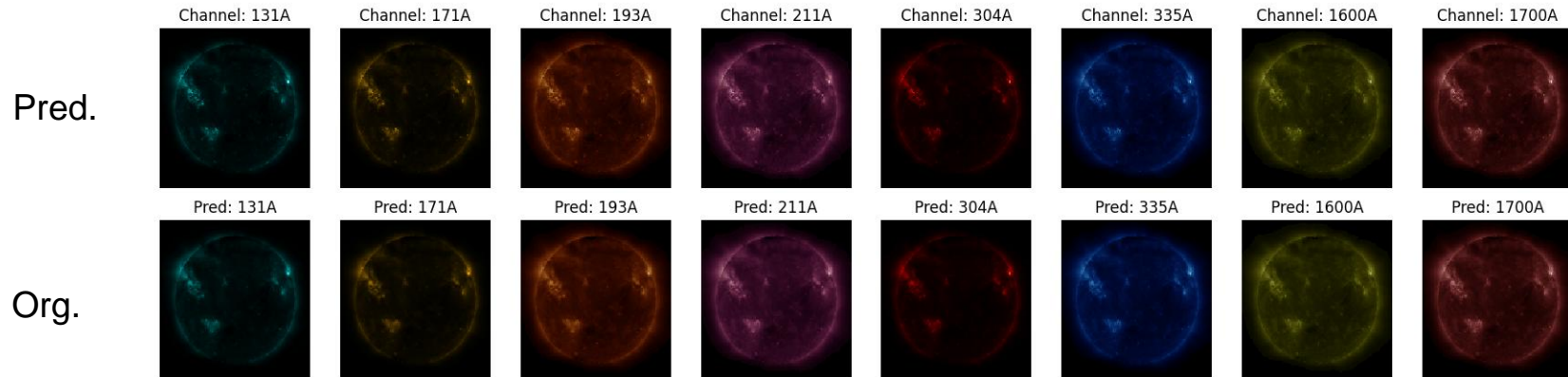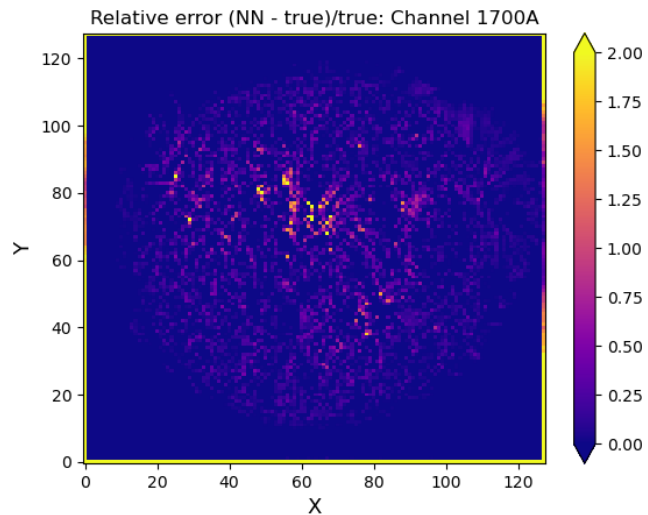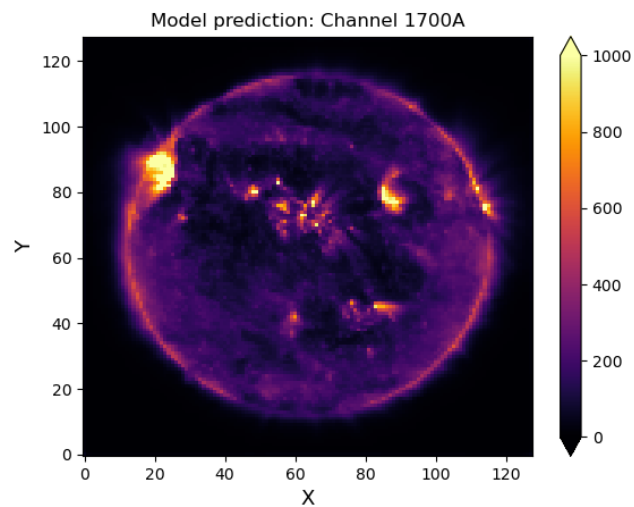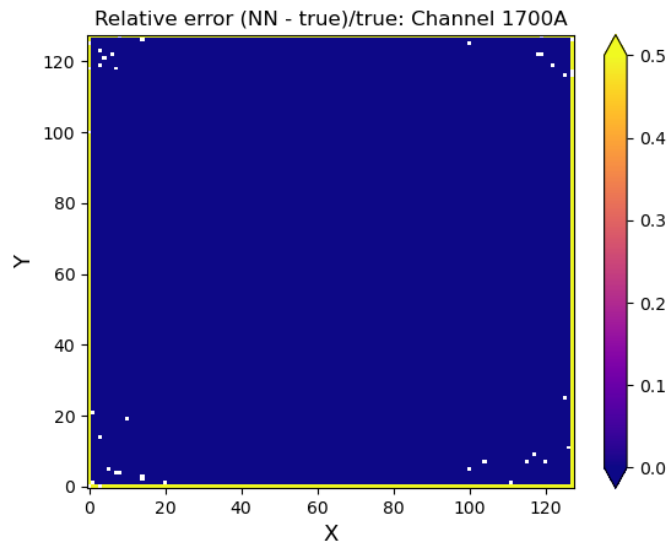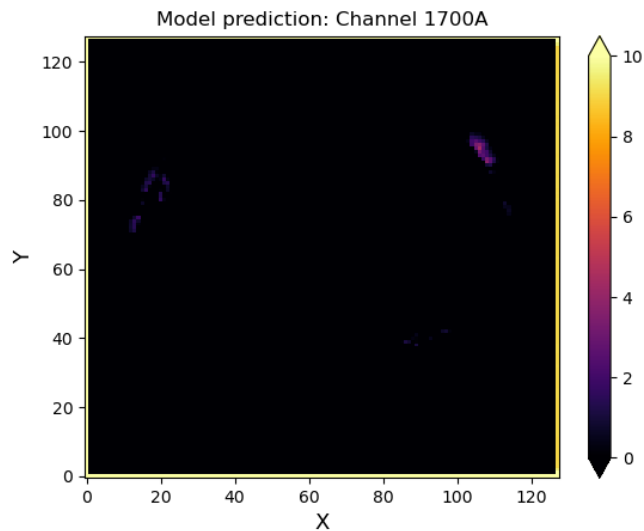
Environmental Impact

- Simple structure and low epochs

- Trained on 20 threads of CPU for 90s

- Analysis based on codecarbon

- Training process took approximately 1 Wh for 5 epochs (0.000679 kg of CO_2)

Outlook

- Adding fully connected layers in network architecture

- Downsize image size throughout network for faster training process

- Tuning of various hyperparameters (learning rate, batch size, …)