Application of Machine Learning and Computer Vision in Building Image Processing

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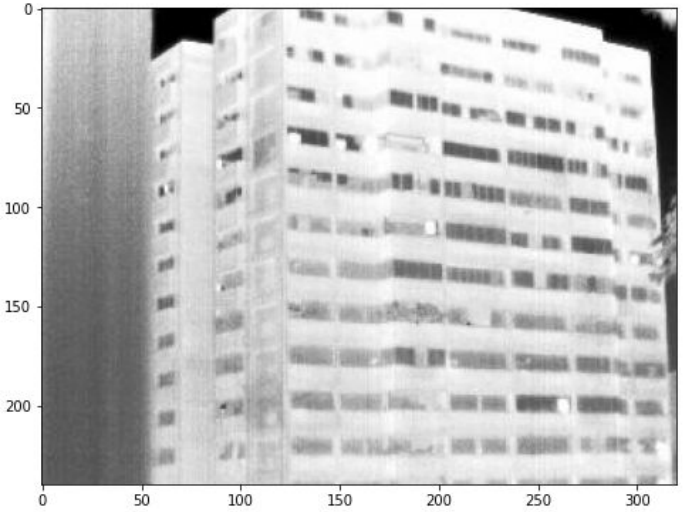
Image



Model

Random Forest Classifier (RFC)

1-Dimensional Convolutional Neural Network (1D CNN)

3-Dimensional Convolutional Neural Network (3D CNN)

Data Sample 1

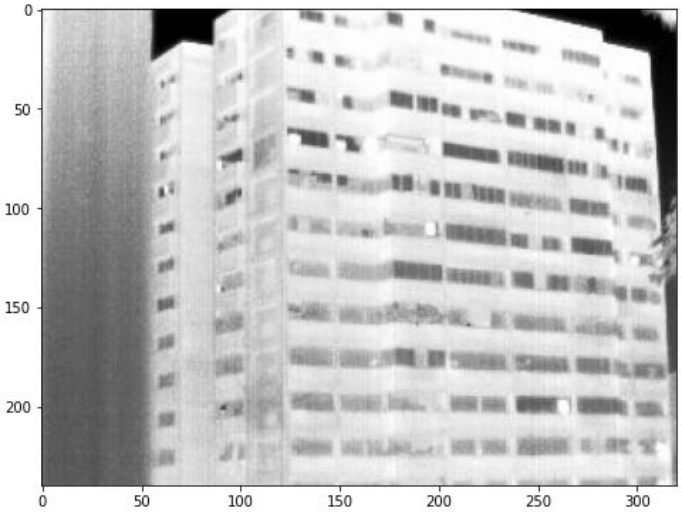
Date: 2020-03-14

Time: 00:00:00 - 04:00:00

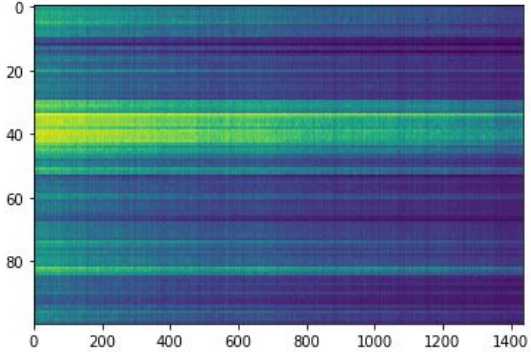
Number of images: 1,435

Number of features: 190

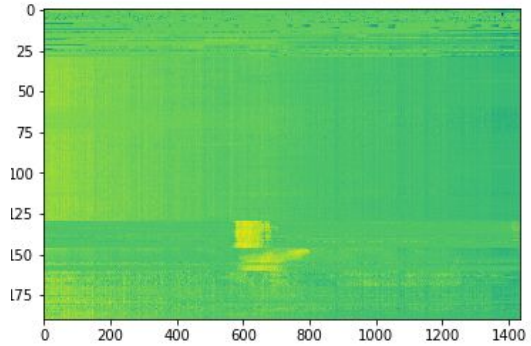
- Air Conditioner: 30
- Building: 100
- Sky: 30
- Window: 30



Building feature



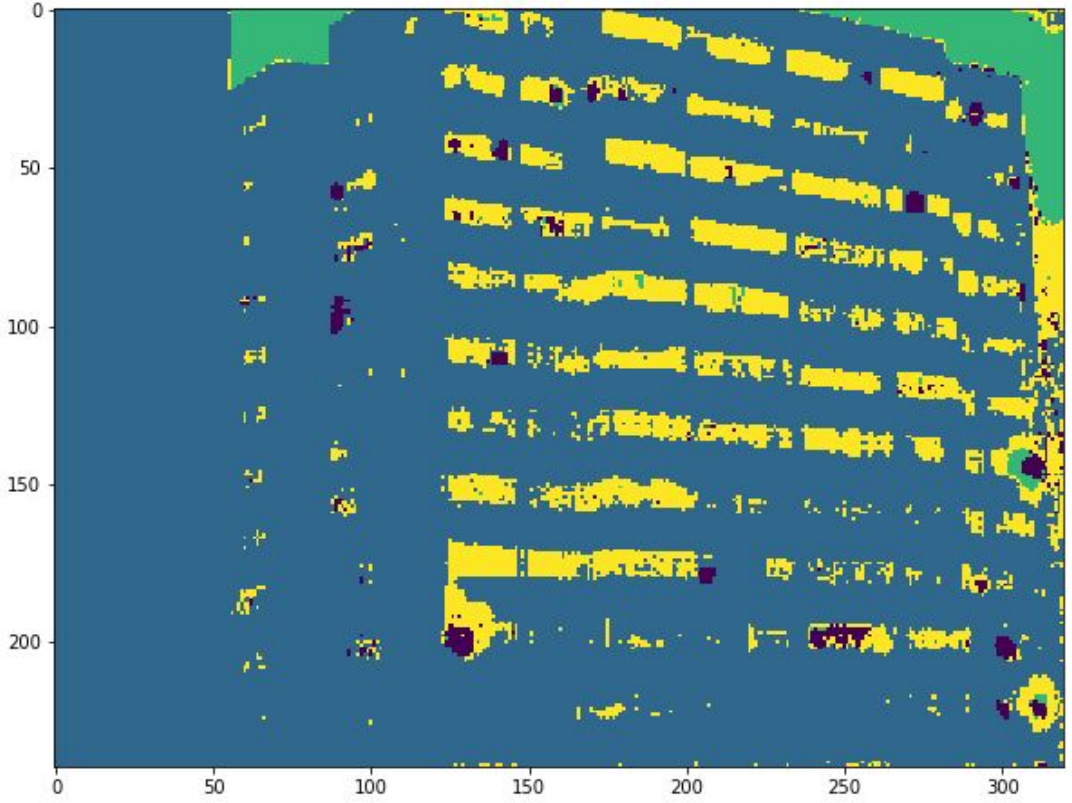
Standardized features



Prediction of RFC

Training accuracy: 0.99~1.0

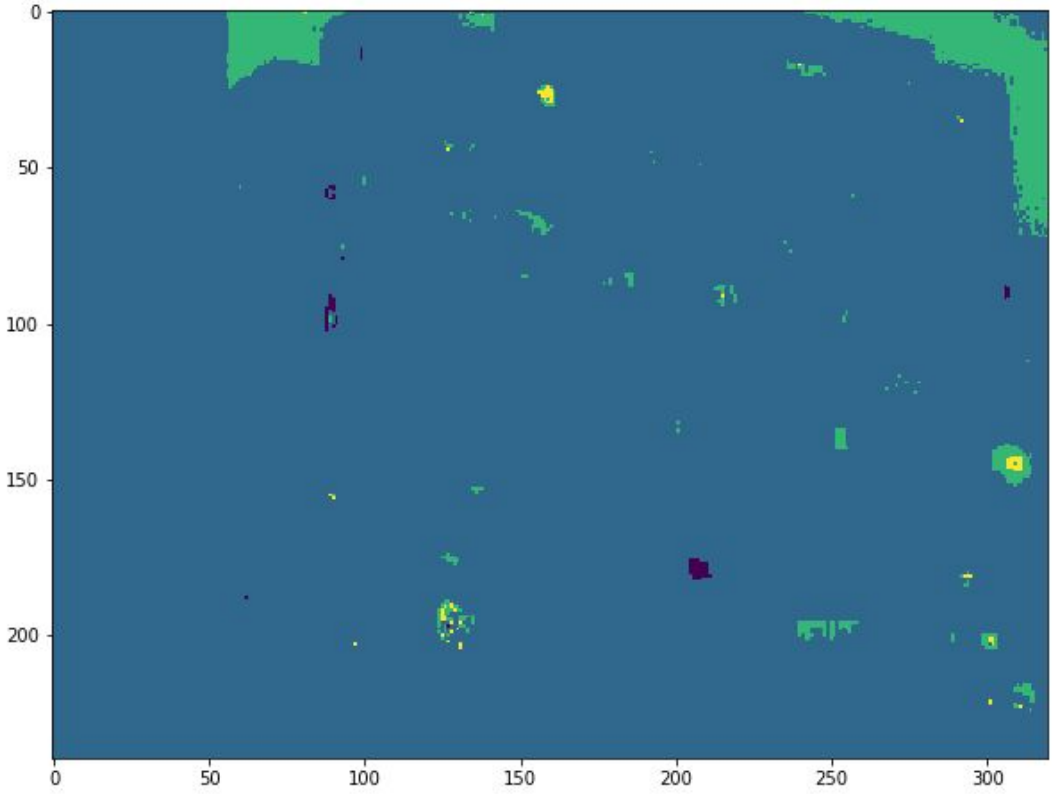
Testing accuracy: 0.91~0.96



Prediction of 1D CNN

Training accuracy: 0.86~0.97

Testing accuracy: 0.79~0.97



Data Sample 2

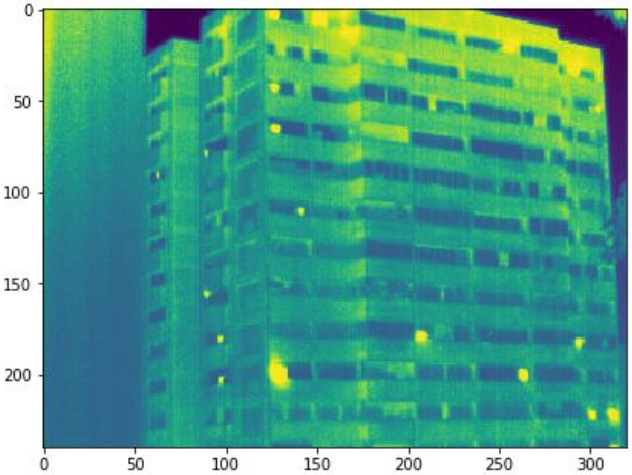
Date: 2020-03-14

Time: 00:00:00 - 04:00:00

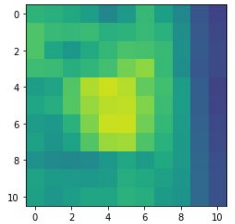
Number of images: 1,00
(the first 100 images)

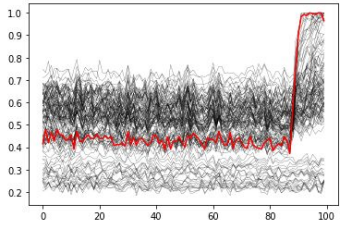
Number of features: 190

- Air Conditioner: 30
- Building: 100
- Sky: 30
- Window: 30

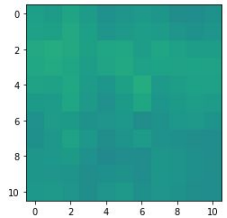


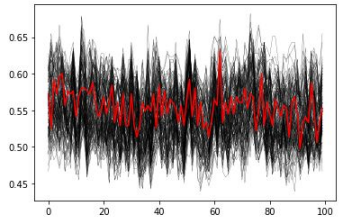
Air conditioner





Building



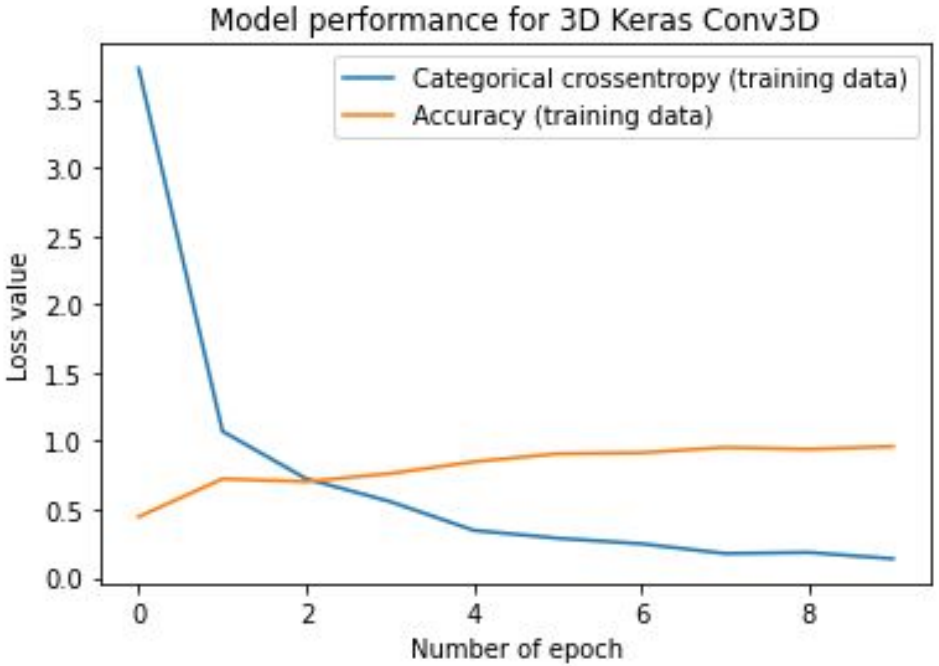


3D CNN model performance

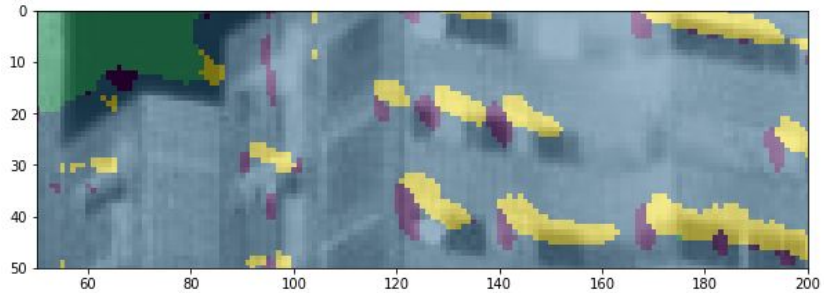
Training accuracy: 0.97~0.99

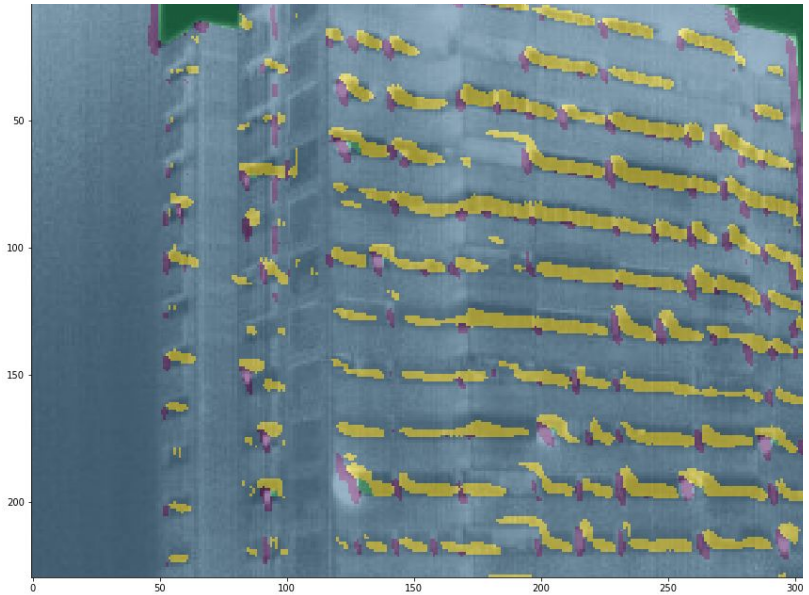
Testing accuracy: 0.94~0.95

*Accuracy is increased when the number of image is increased to 300



Prediction of 3D-CNN





Data Sample 3

Date: 2020-03-14

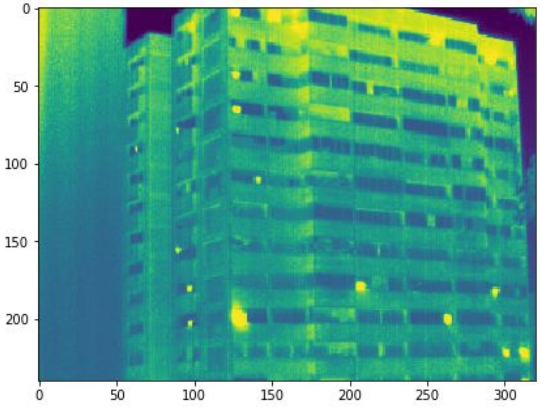
Time: 00:00:00 - 04:00:00

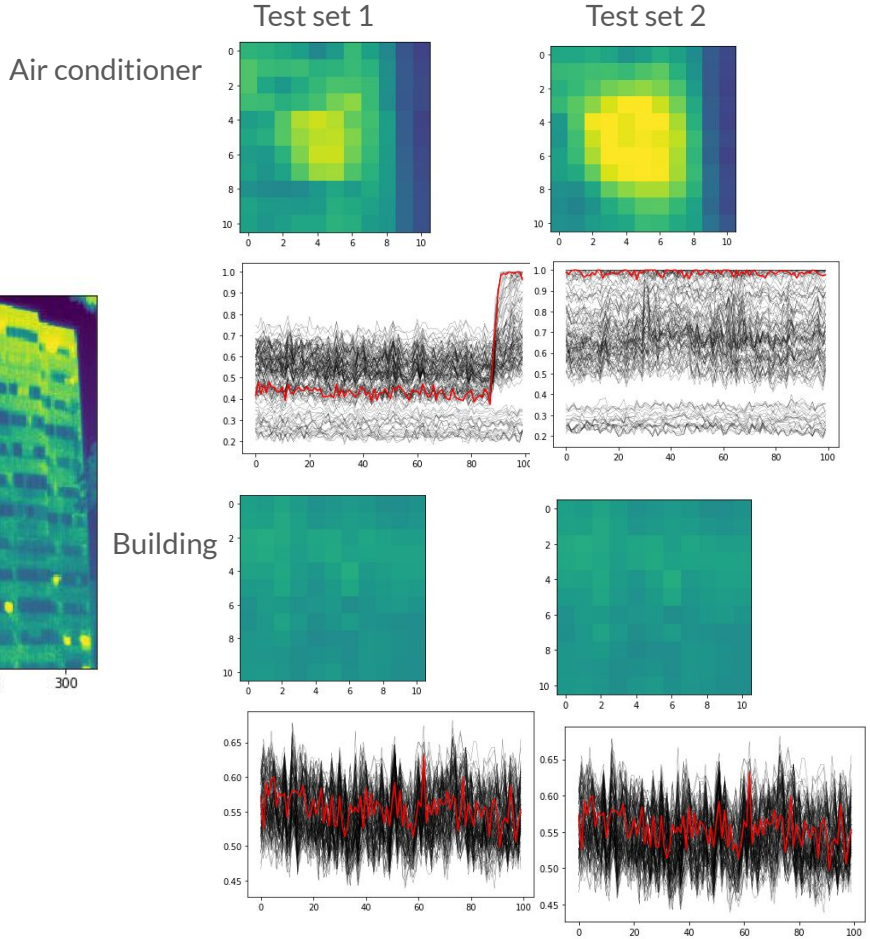
Test examples: 2 sets

Number of images:
100 for each set (200 in total)

Number of features: 190

- Air Conditioner: 30
- Building: 100
- Sky: 30
- Window: 30

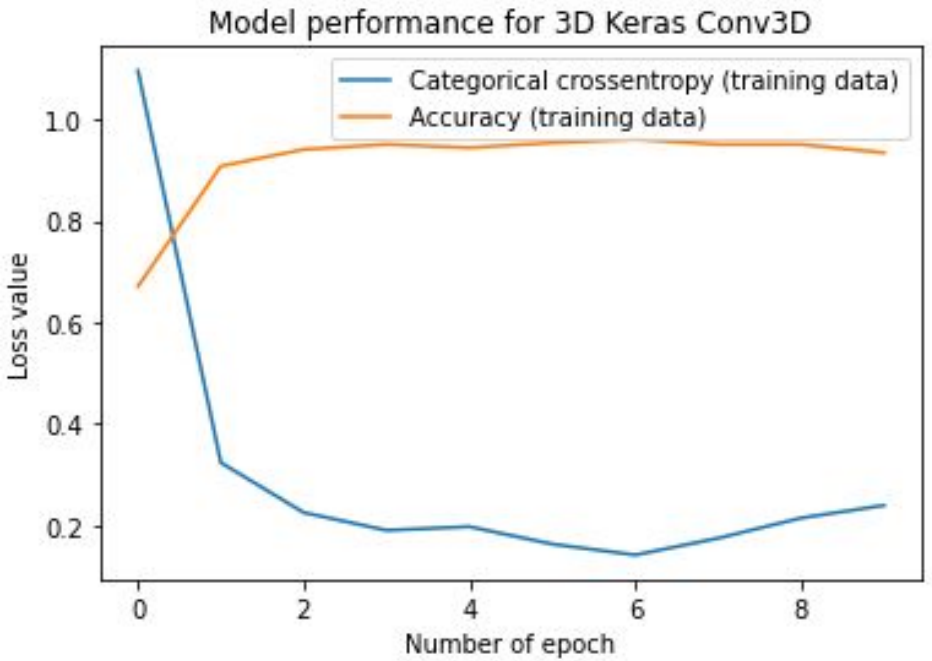




3D CNN model performance - 2 test sets

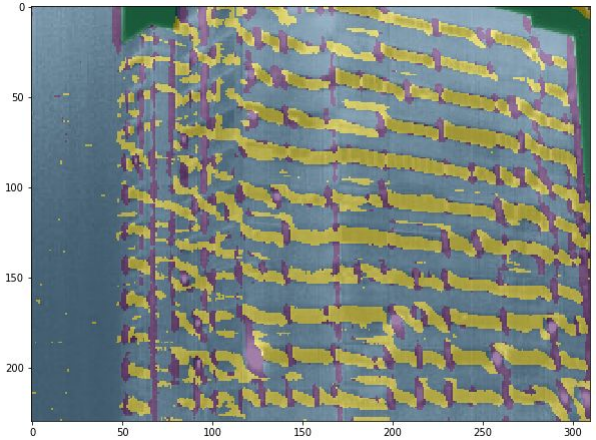
Training accuracy: 0.84~0.98

Testing accuracy: 0.90~0.97

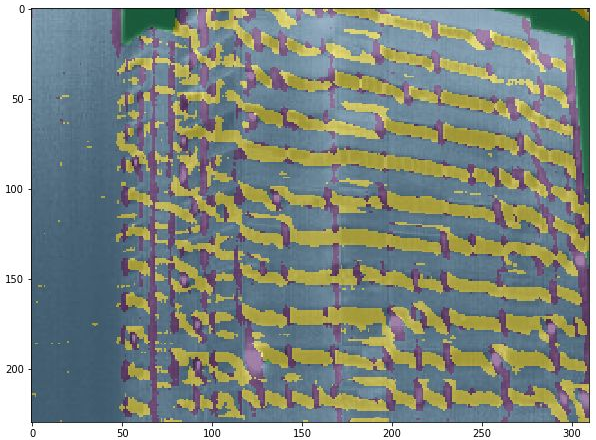


Prediction of 3D CNN
- 2 test sets

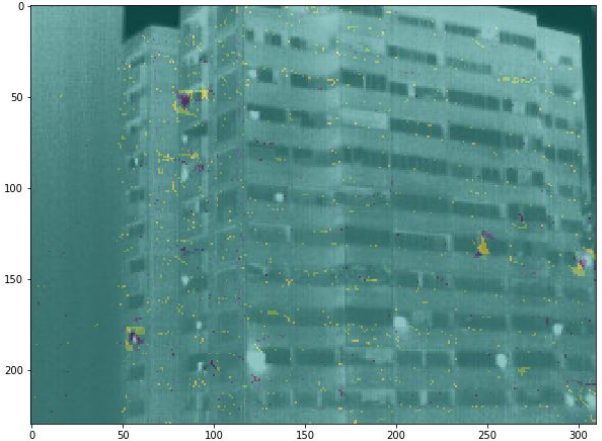
Test set 1



Test set 2



Differences



Data Sample 4

Date: 2020-03-14

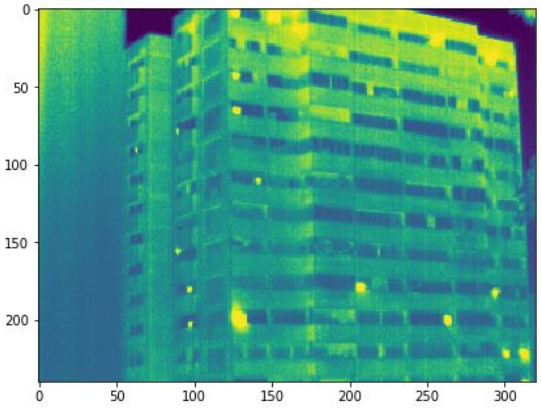
Time: 00:00:00 - 04:00:00

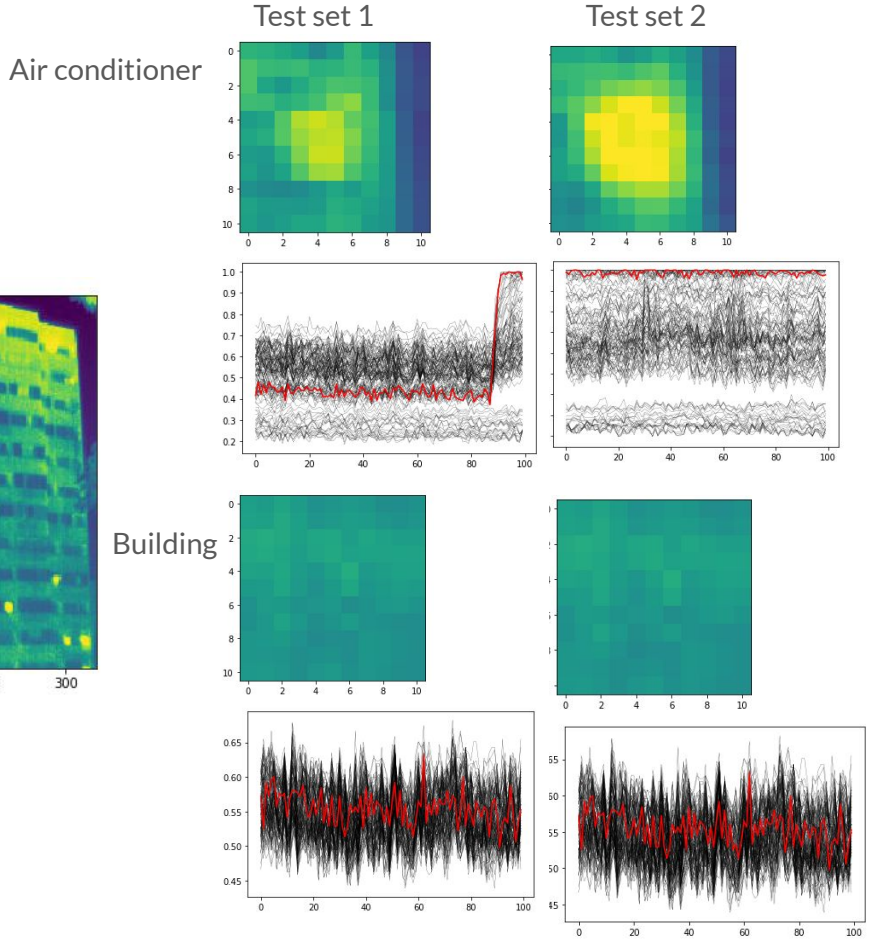
Test examples: 2 sets

Number of images:
100 for each set (200 in total)

Number of features: 360

- Air Conditioner: 30
- Building: 150 (from 100)
- Sky: 30
- Window: 150 (from 30)

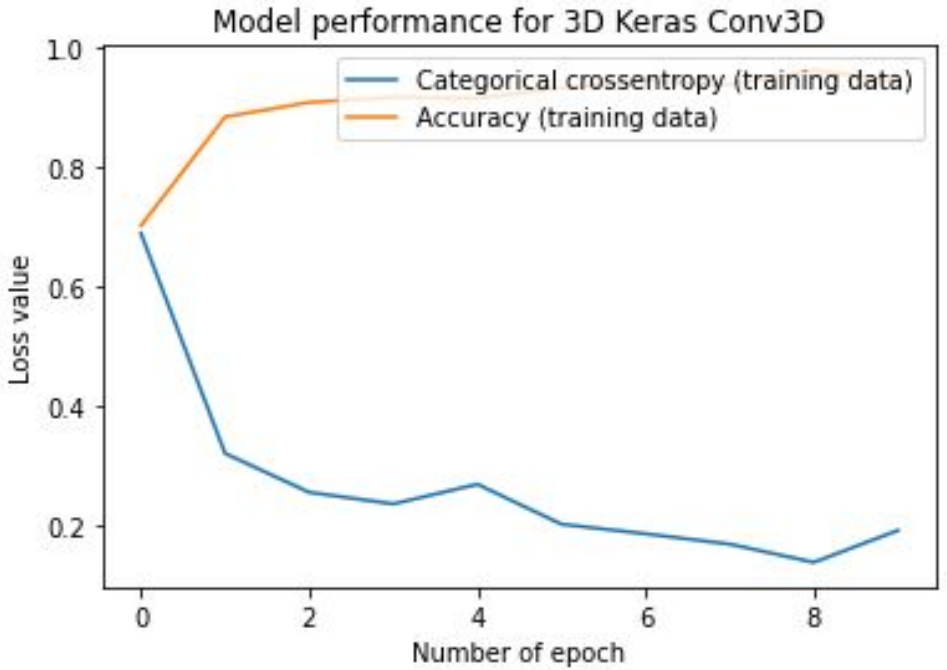




3D CNN model performance
- 2 test sets
- increased labels

Training accuracy: 0.97

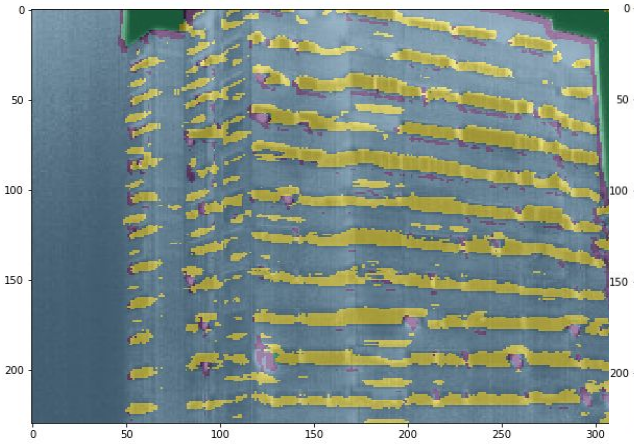
Testing accuracy: 0.99



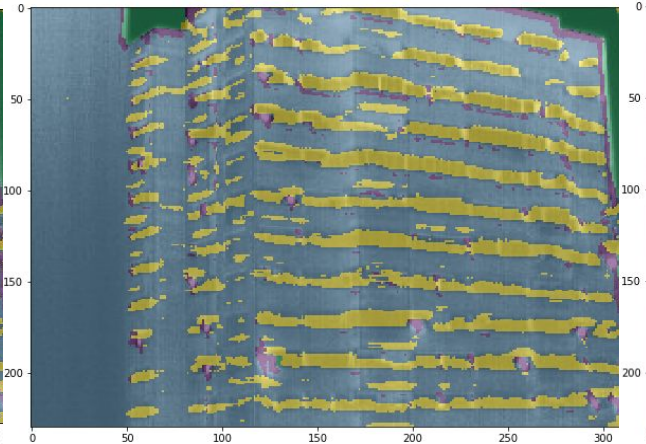
Prediction of 3D CNN

- 2 test sets
- increased labels

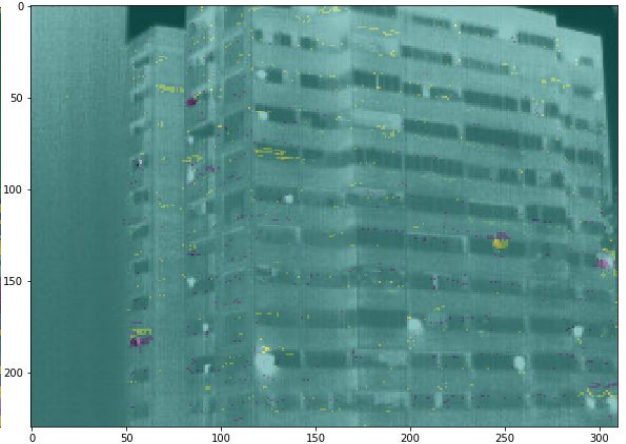
Test set 1



Test set 2

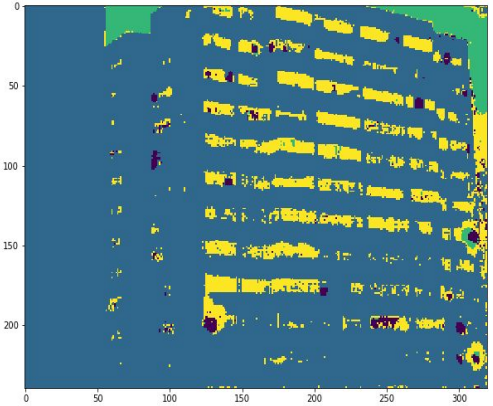


Differences

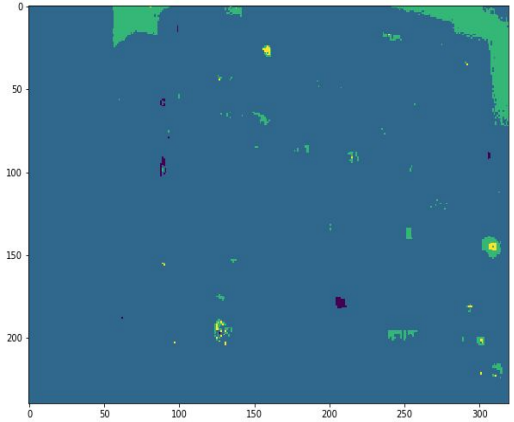


Comparison of Results

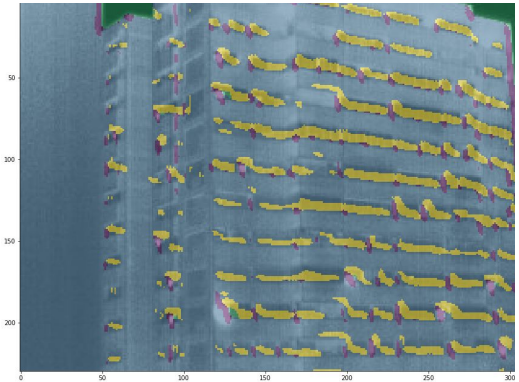
RFC



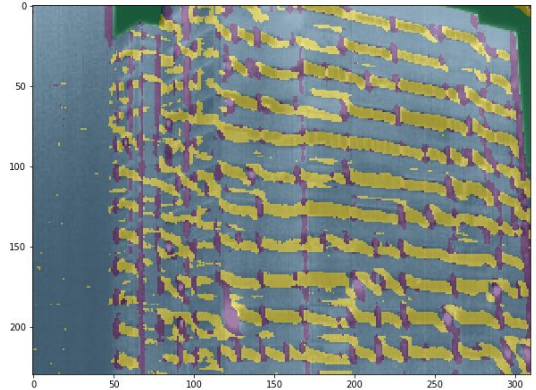
1D CNN



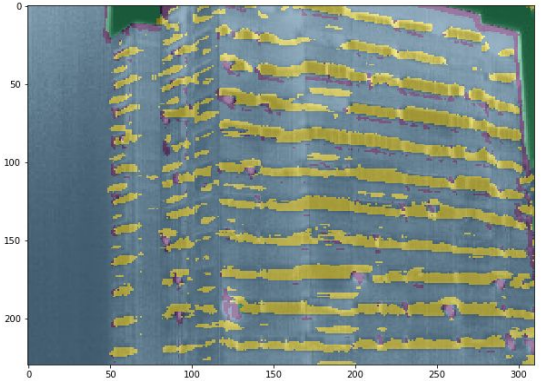
3D CNN



3D CNN (2 sets)



3D CNN (2 sets & inc. labels)



Future Study

- Add more dates
- Change time
- Time series analysis

Data Sample 5

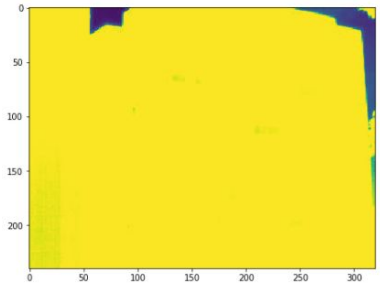
Date: 2020-03-14 ~ 2020-03-15

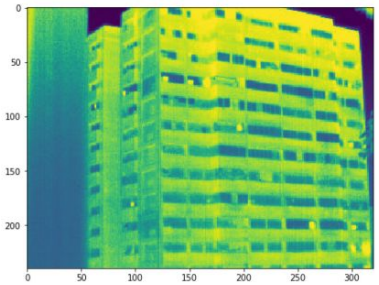
Time: 19:00:00 - 04:00:00

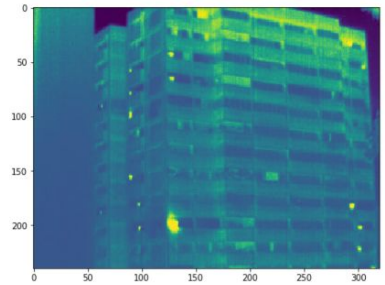
Number of images: 3,228

Number of features: 360

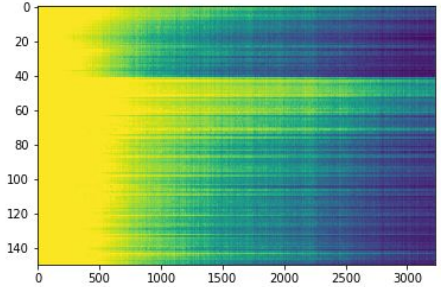
- Air Conditioner: 30
- Building: 150
- Sky: 30
- Window: 150



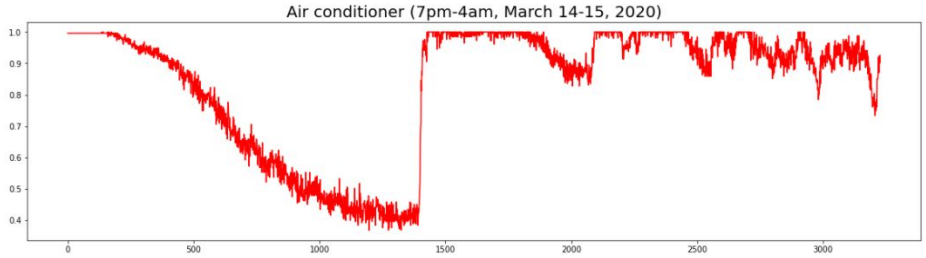


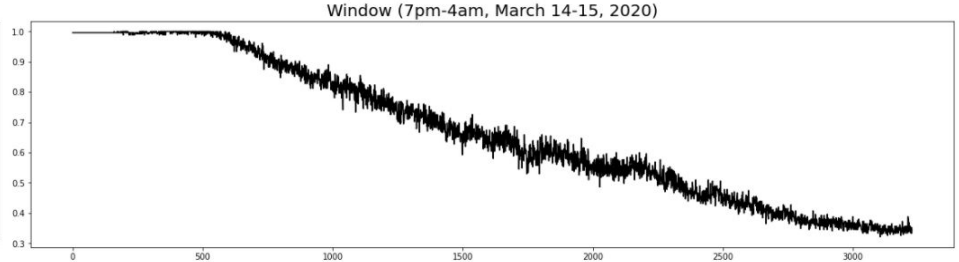


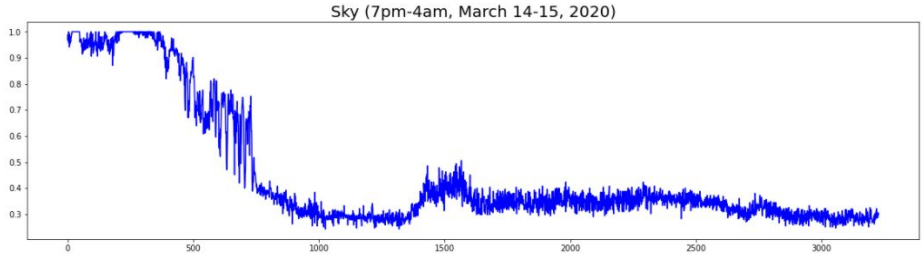
Building feature

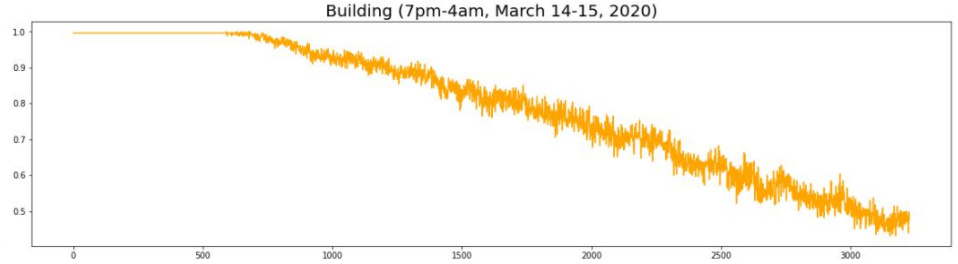


Time series analysis









Thank you!