



Application of Machine Learning and Computer Vision in Building Image Processing

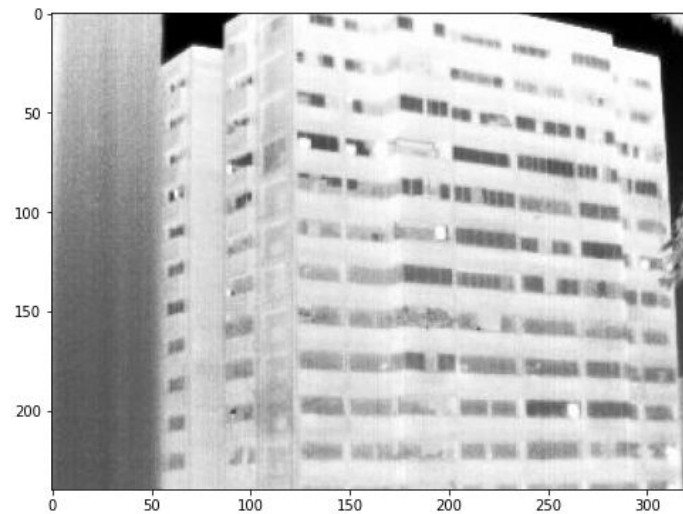
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Biden School of Public Policy and Administration,
University of Delaware

01/19/2021

Image





Model

Random
Forest
Classifier
(RFC)

1-Dimensional
Convolutional
Neural Network
(1D CNN)

3-Dimensional
Convolutional
Neural Network
(3D CNN)

Data Sample 1

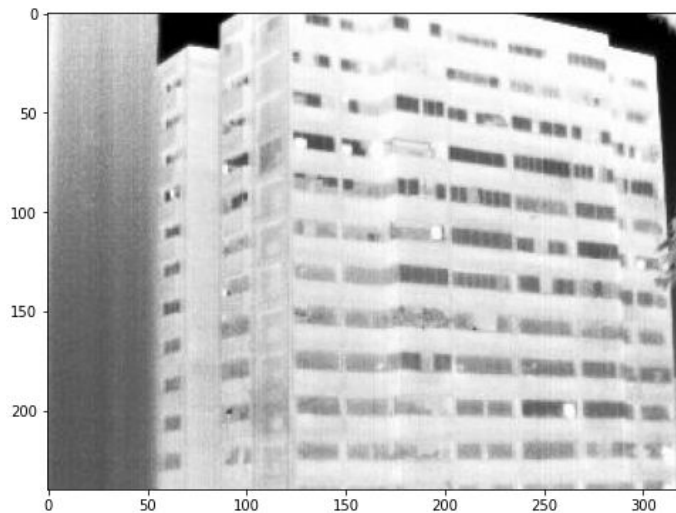
Date: 2020-03-14

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

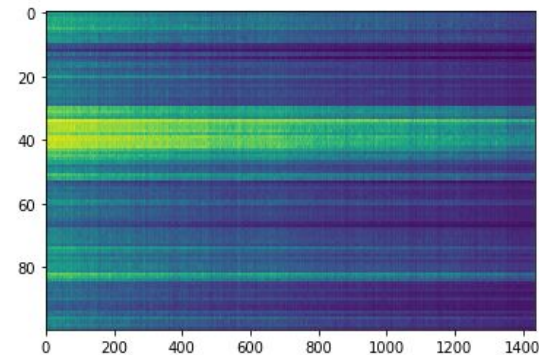
Number of images: 1,435

Number of features: 190

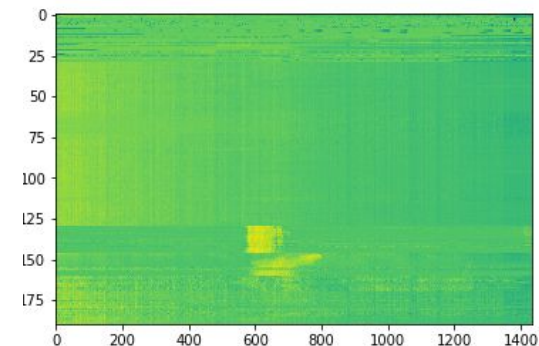
- Air Conditioner: 30
- Building: 100
- Sky: 30
- Window: 30



Building feature



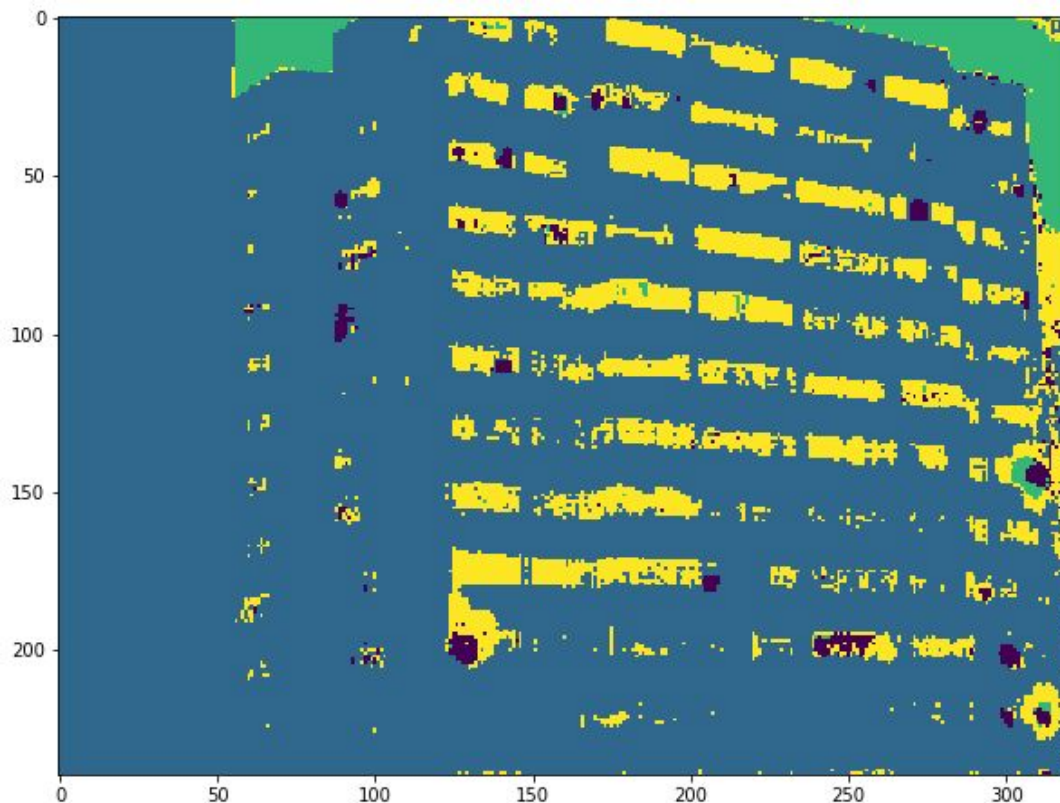
Standardized features



Prediction of RFC

Training accuracy: 0.99~1.0

Testing accuracy: 0.91~0.96

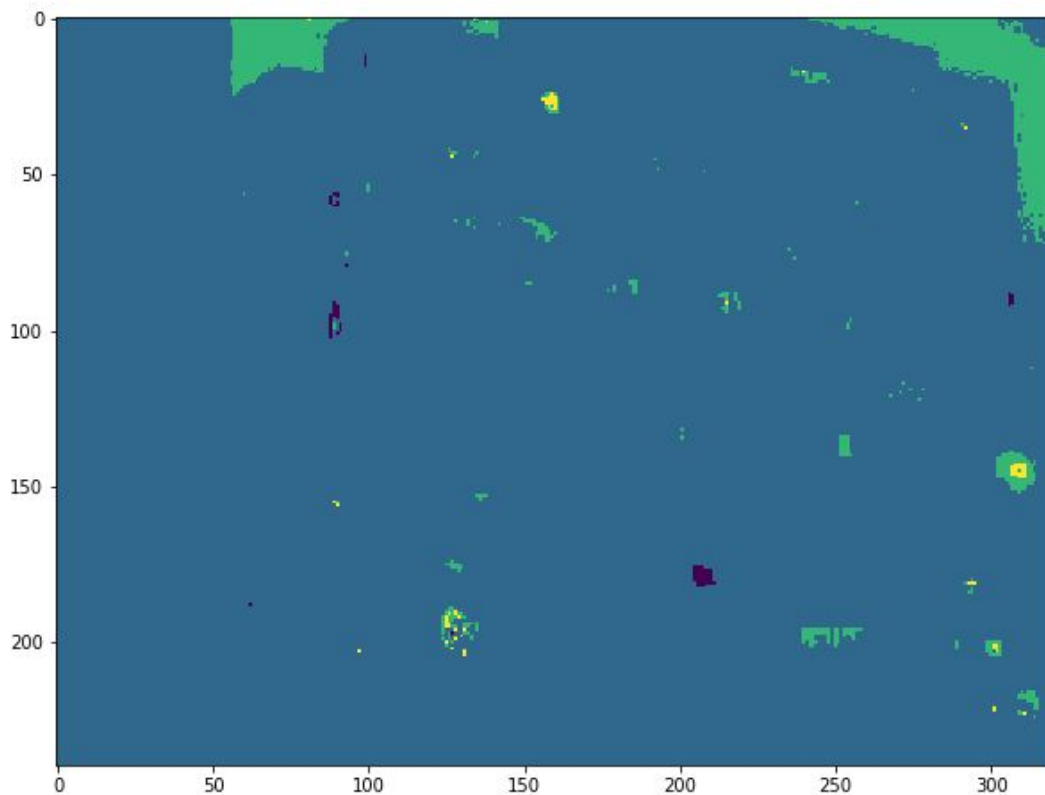




Prediction of 1D CNN

Training accuracy: 0.86~0.97

Testing accuracy: 0.79~0.97



Data Sample 2

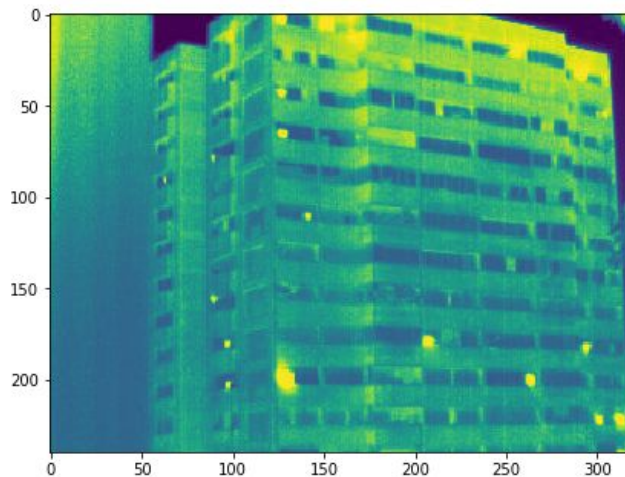
Date: 2020-03-14

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

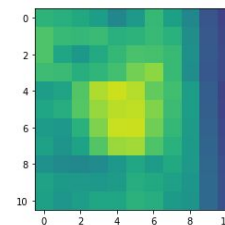
Number of images: 1,00
(the first 100 images)

Number of features: 190

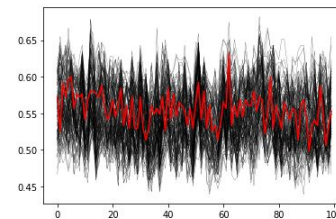
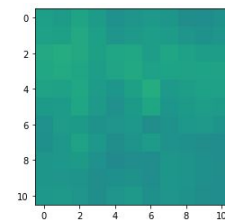
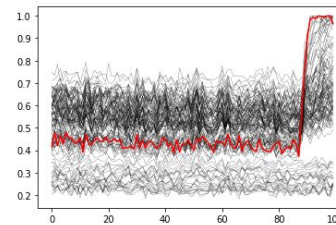
- Air Conditioner: 30
- Building: 100
- Sky: 30
- Window: 30



Air conditioner



Building

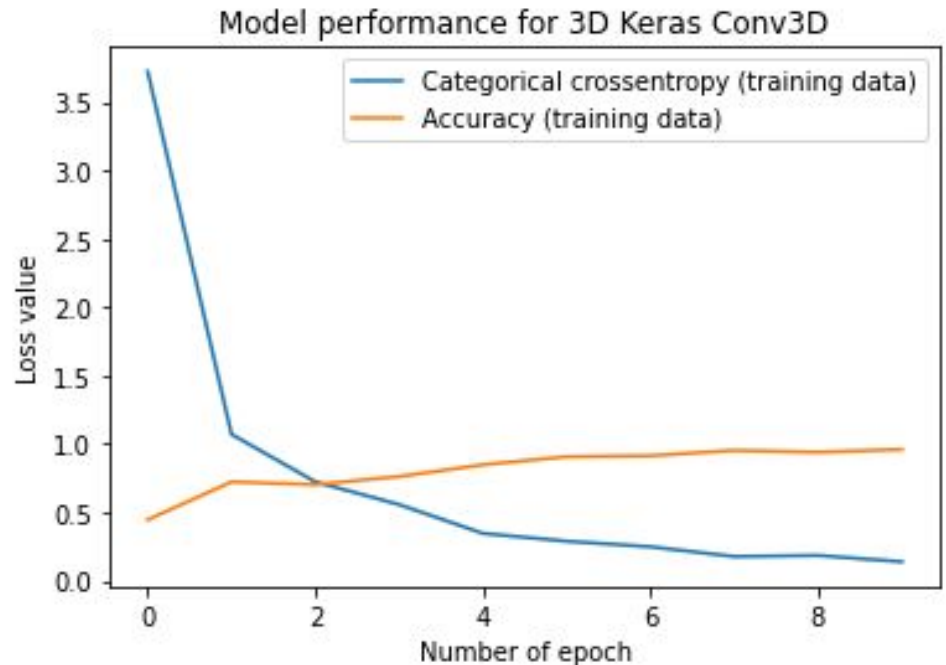


3D CNN model performance

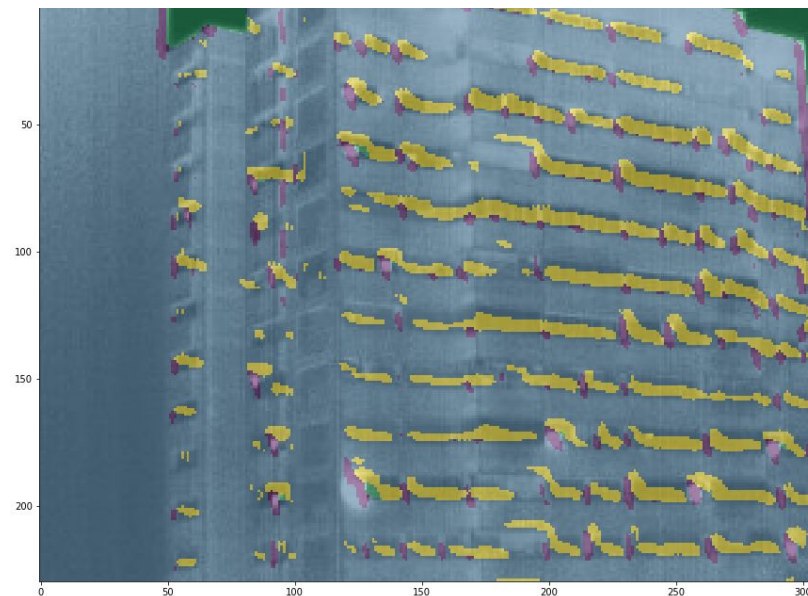
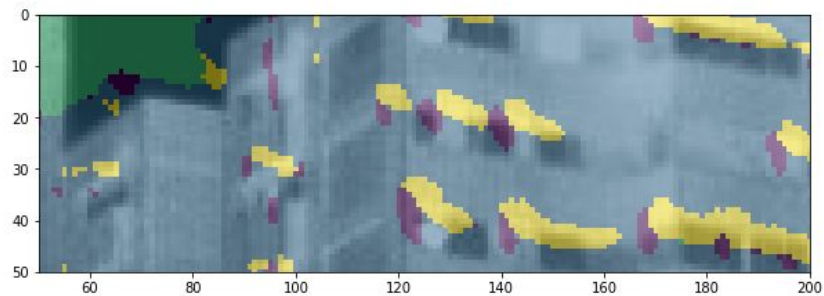
Training accuracy: 0.97~0.99

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

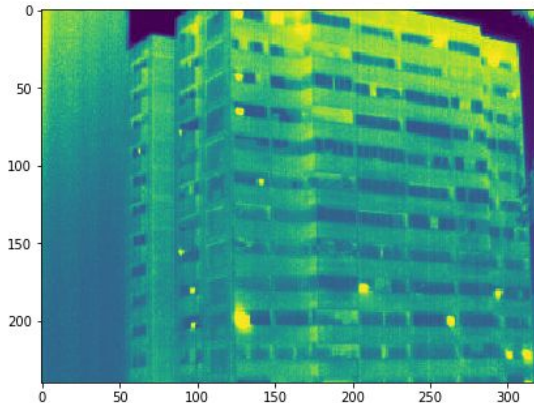
Time: 00:00:00 - 04:00:00

Test examples: 2 sets

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

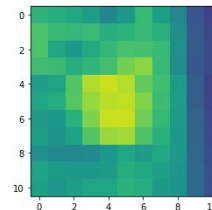
Number of features: 190

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

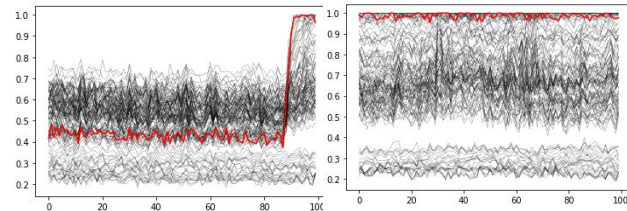
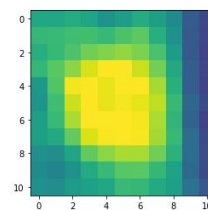


Air conditioner

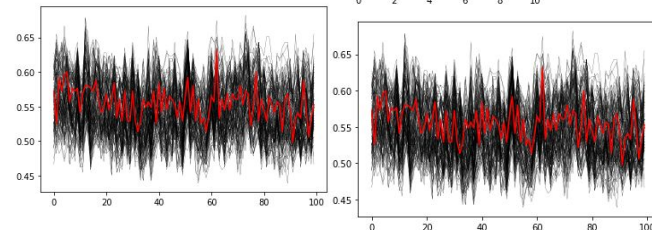
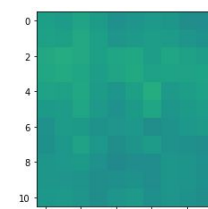
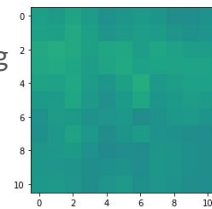
Test set 1



Test set 2



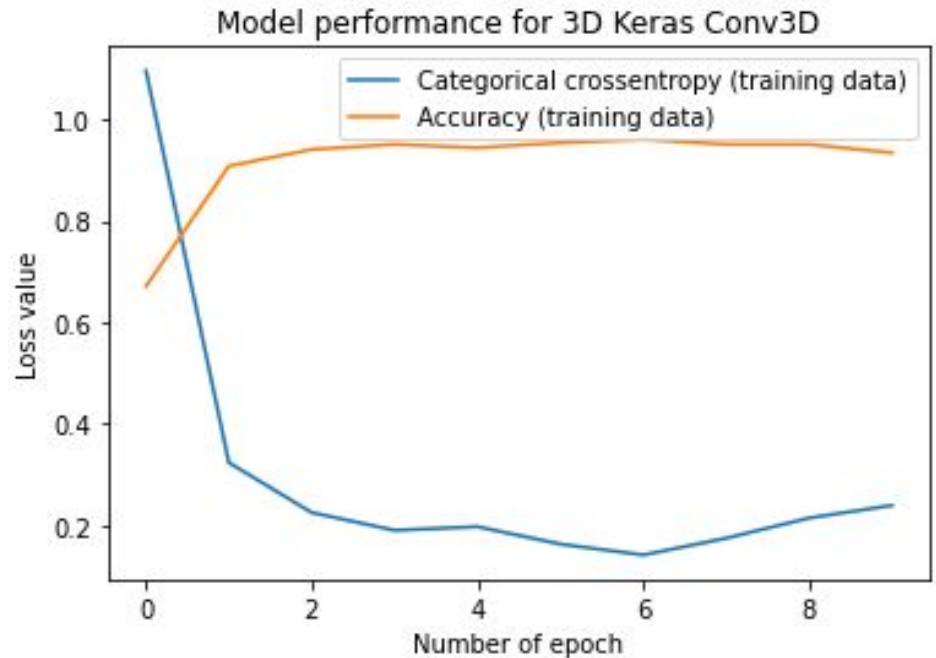
Building



3D CNN model performance - 2 test sets

Training accuracy: 0.84~0.98

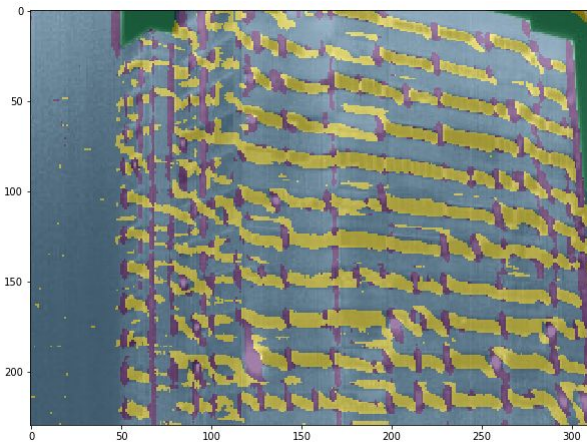
Testing accuracy: 0.90~0.97



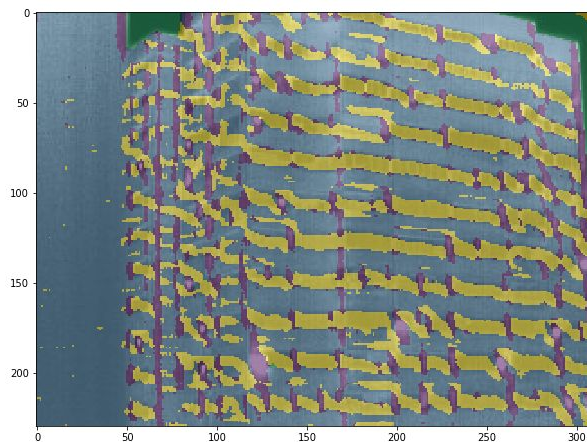
Prediction of 3D CNN

- 2 test sets

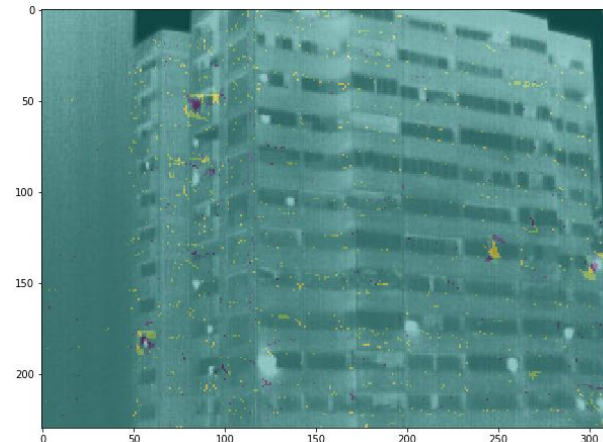
Test set 1



Test set 2



Differences



Data Sample 4

Date: 2020-03-14

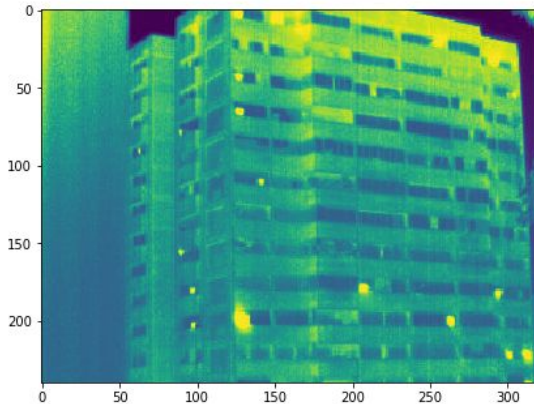
Time: 00:00:00 - 04:00:00

Test examples: 2 sets

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

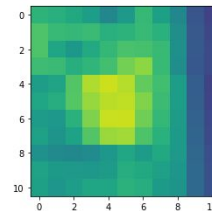
Number of features: 360

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

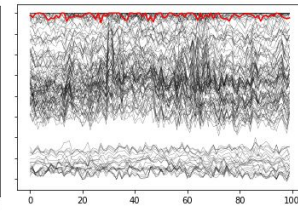
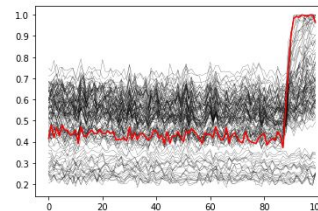
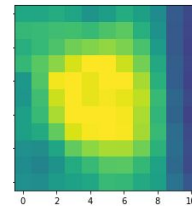


Air conditioner

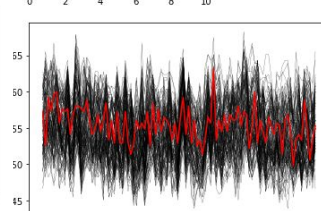
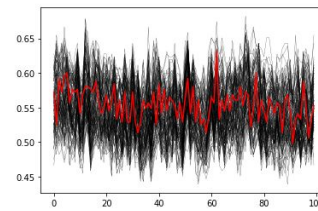
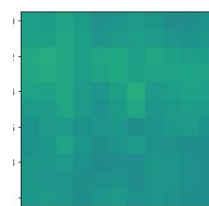
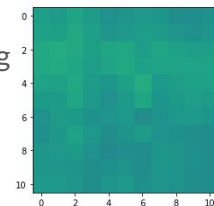
Test set 1



Test set 2



Building

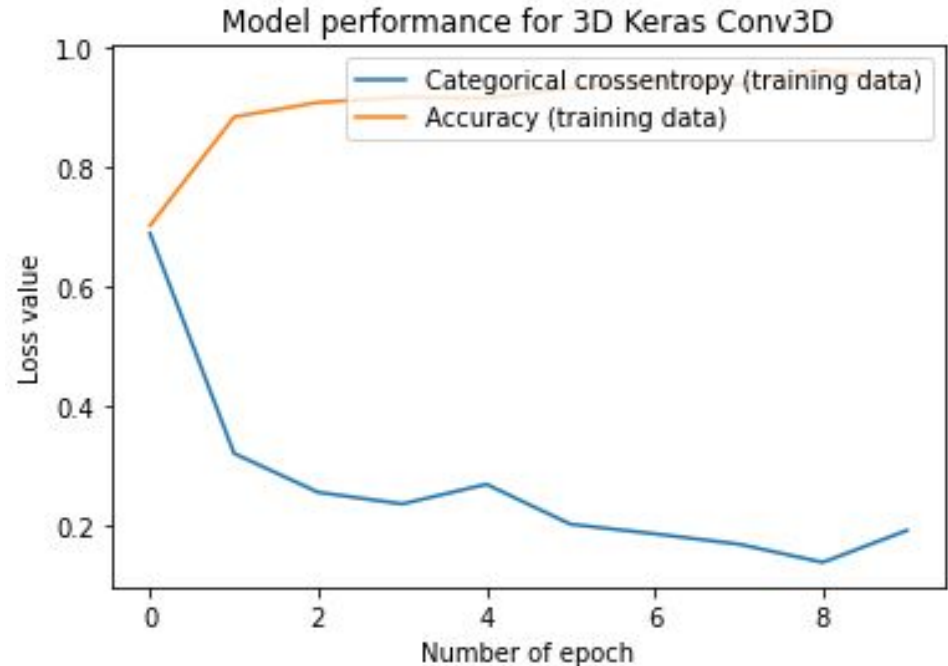


3D CNN model performance

- 2 test sets
- increased labels

Training accuracy: 0.97

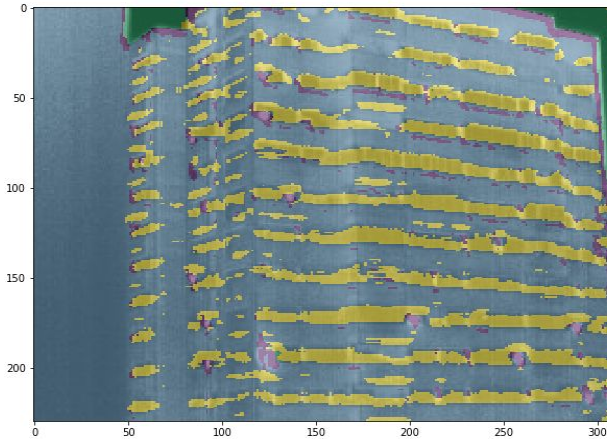
Testing accuracy: 0.99



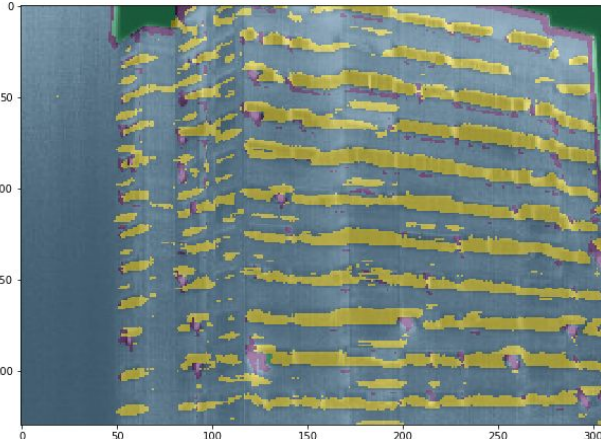
Prediction of 3D CNN

- 2 test sets
- increased labels

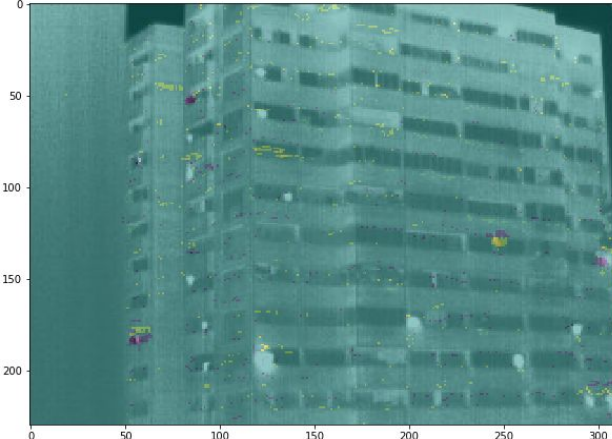
Test set 1



Test set 2

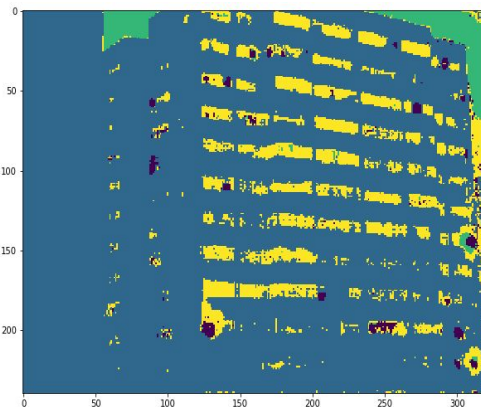


Differences

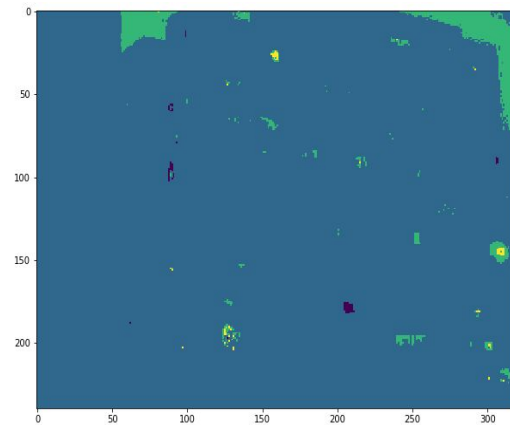


Comparison of Results

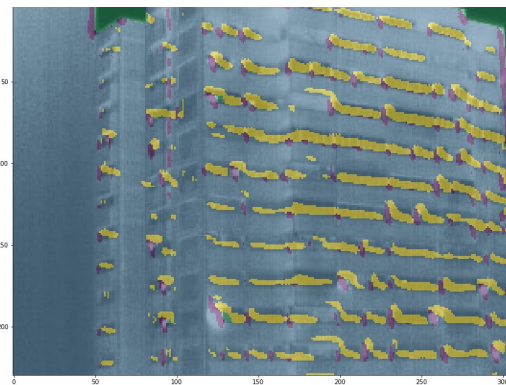
RFC



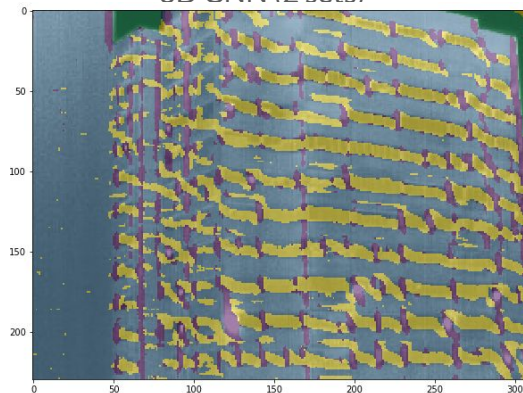
1D CNN



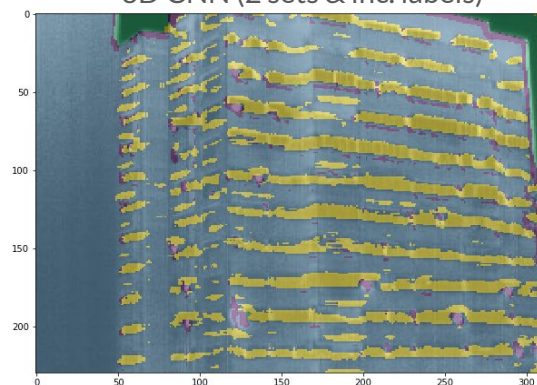
3D CNN



3D CNN (2 sets)



3D CNN (2 sets & inc. labels)





Future Study

- Add more dates
- Change time
- Time series analysis

Data Sample 5

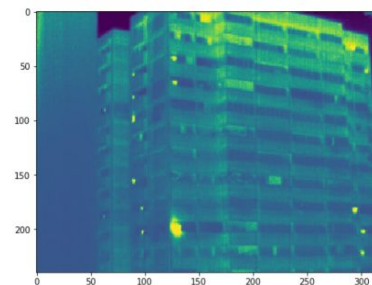
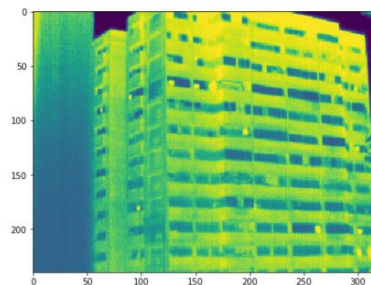
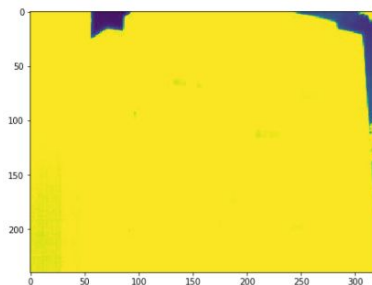
Date: 2020-03-14 ~ 2020-03-15

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

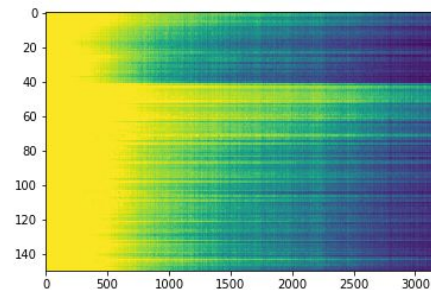
Number of images: 3,228

Number of features: 360

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

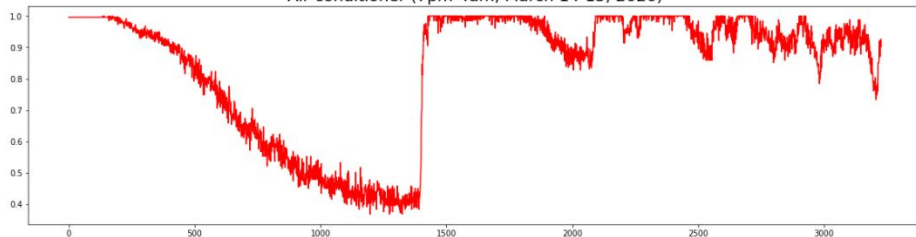


Building feature

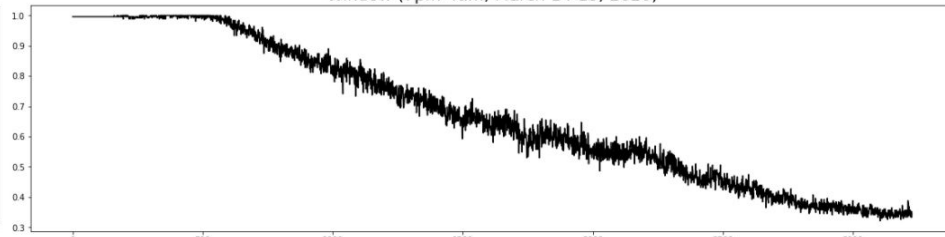


Time series analysis

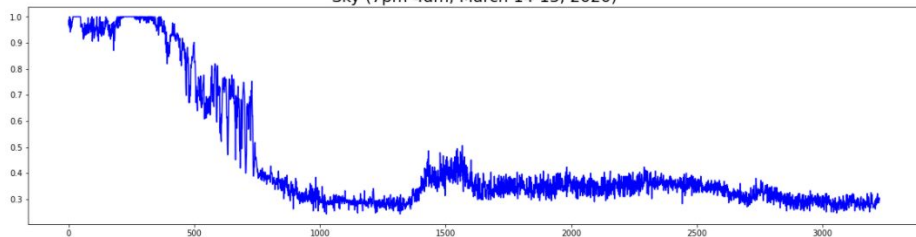
Air conditioner (7pm-4am, March 14-15, 2020)



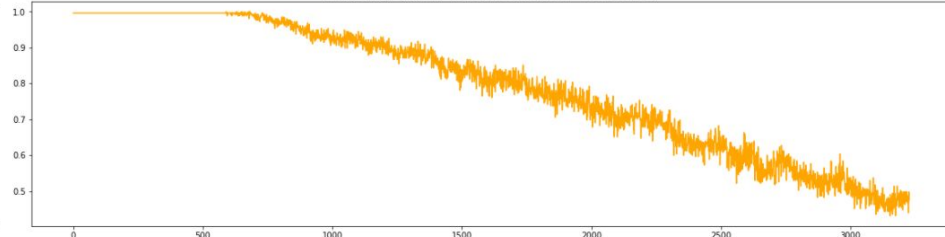
Window (7pm-4am, March 14-15, 2020)



Sky (7pm-4am, March 14-15, 2020)



Building (7pm-4am, March 14-15, 2020)





Thank you!