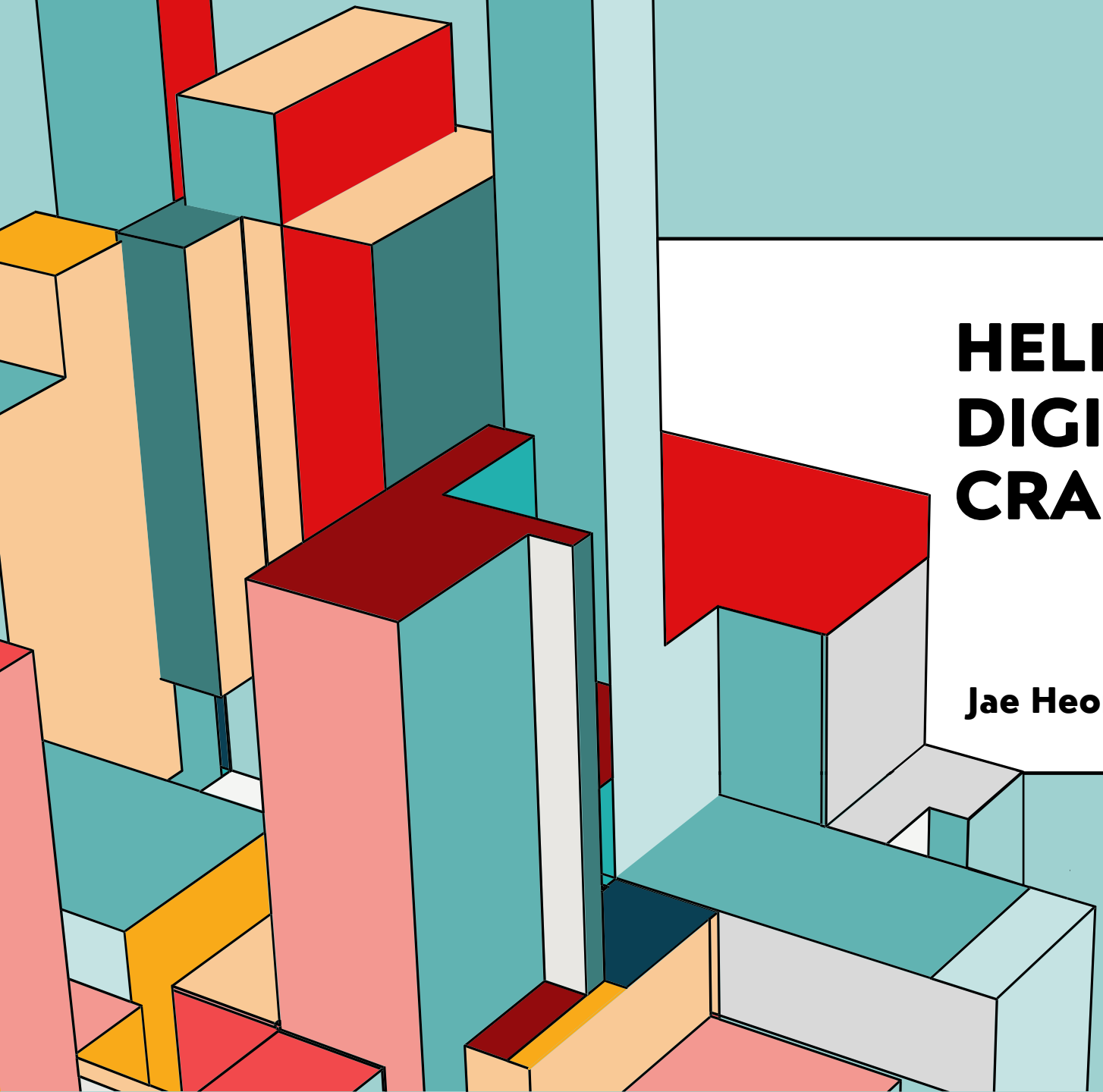
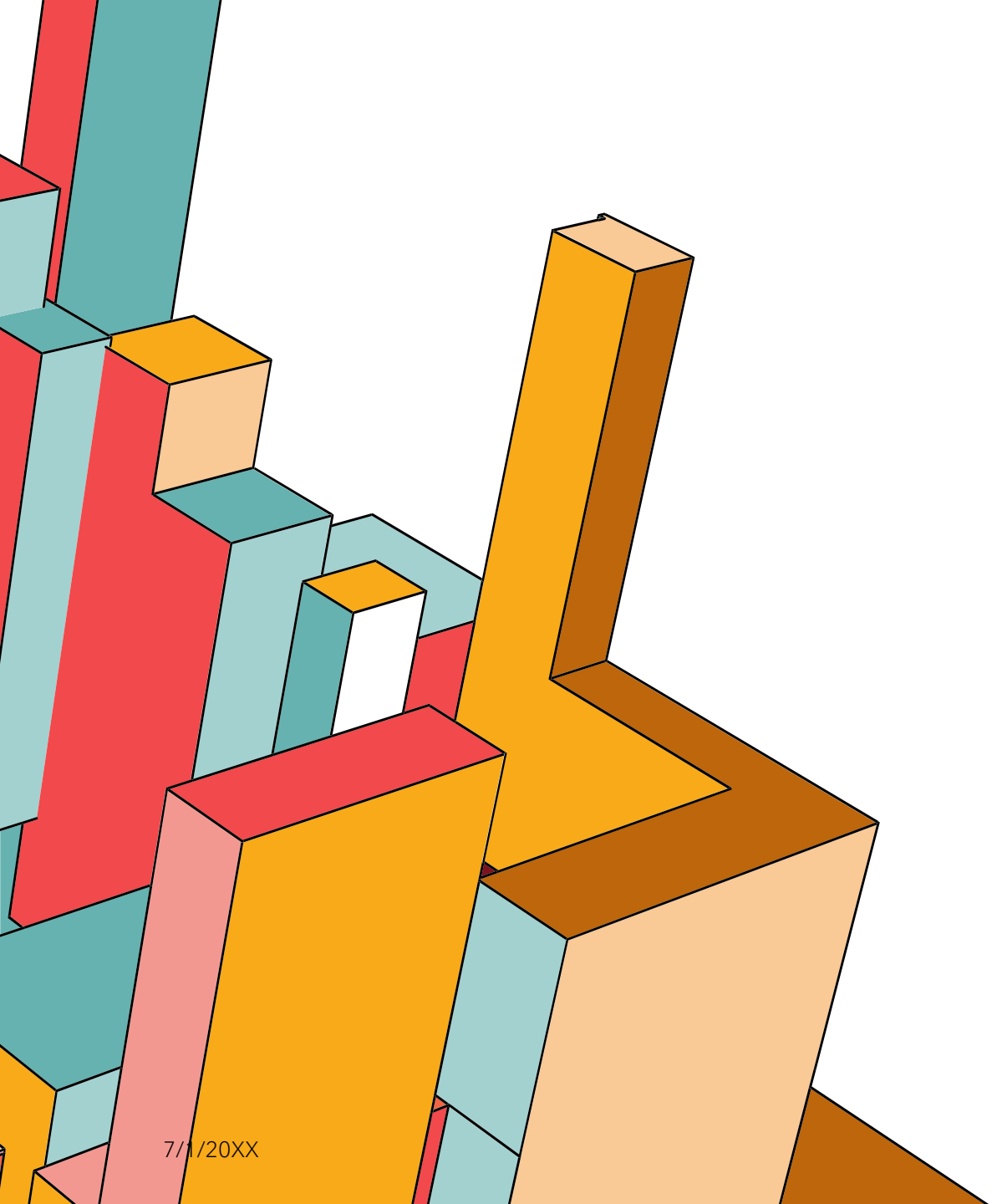


HELPING NYC DOB DIGITIZE SURFACE CRACK INSPECTIONS

Jae Heon Kim



OUTLINE

Business Problem

What is the problem for NYC Department of Buildings?

Data

How can we work with data help build models?

Modeling / Evaluation

How useful and good are these models?

Conclusion

How can we benefit from these models?

BUSINESS UNDERSTANDING

Who?

NYC Department of Buildings

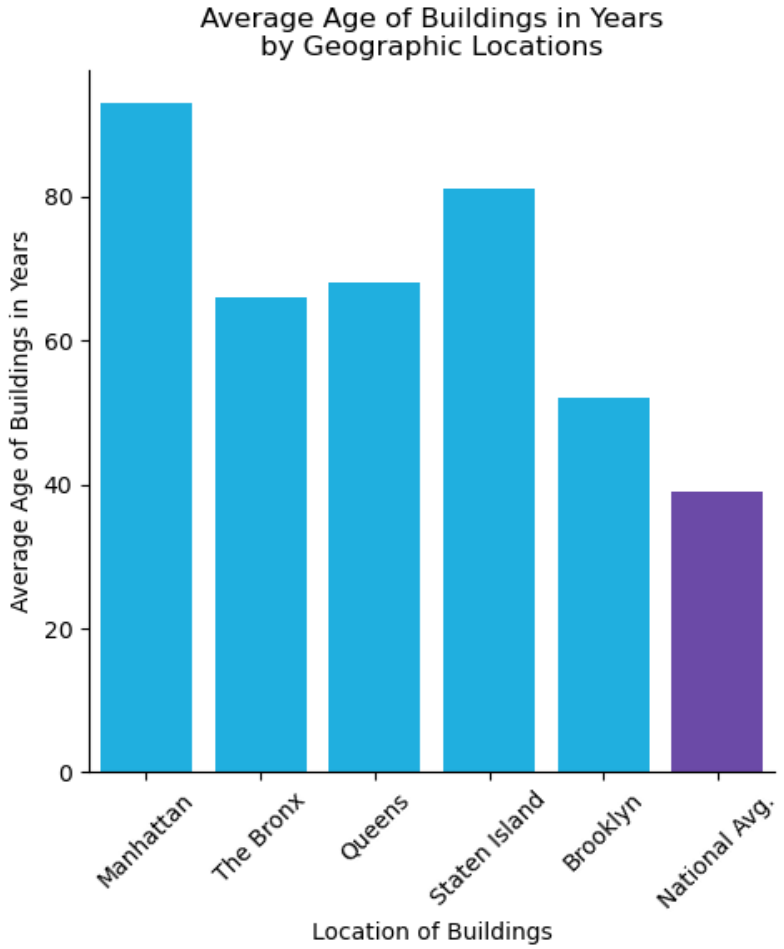
Problem

1. Buildings in NYC are old.
2. Lots of cracked buildings in NYC.
3. Inspection methods are old.

Solution

Building a deep learning model that accurately identify cracked walls by image input

AGE OF NYC BUILDINGS



THIS BUILDING IS 125 YEARS OLD:

11 BROADWAY

CURRENT INSPECTION METHODS

- Relies heavily on human labor 

- Very infrequently done 

Unreliable, Time-consuming, Costly

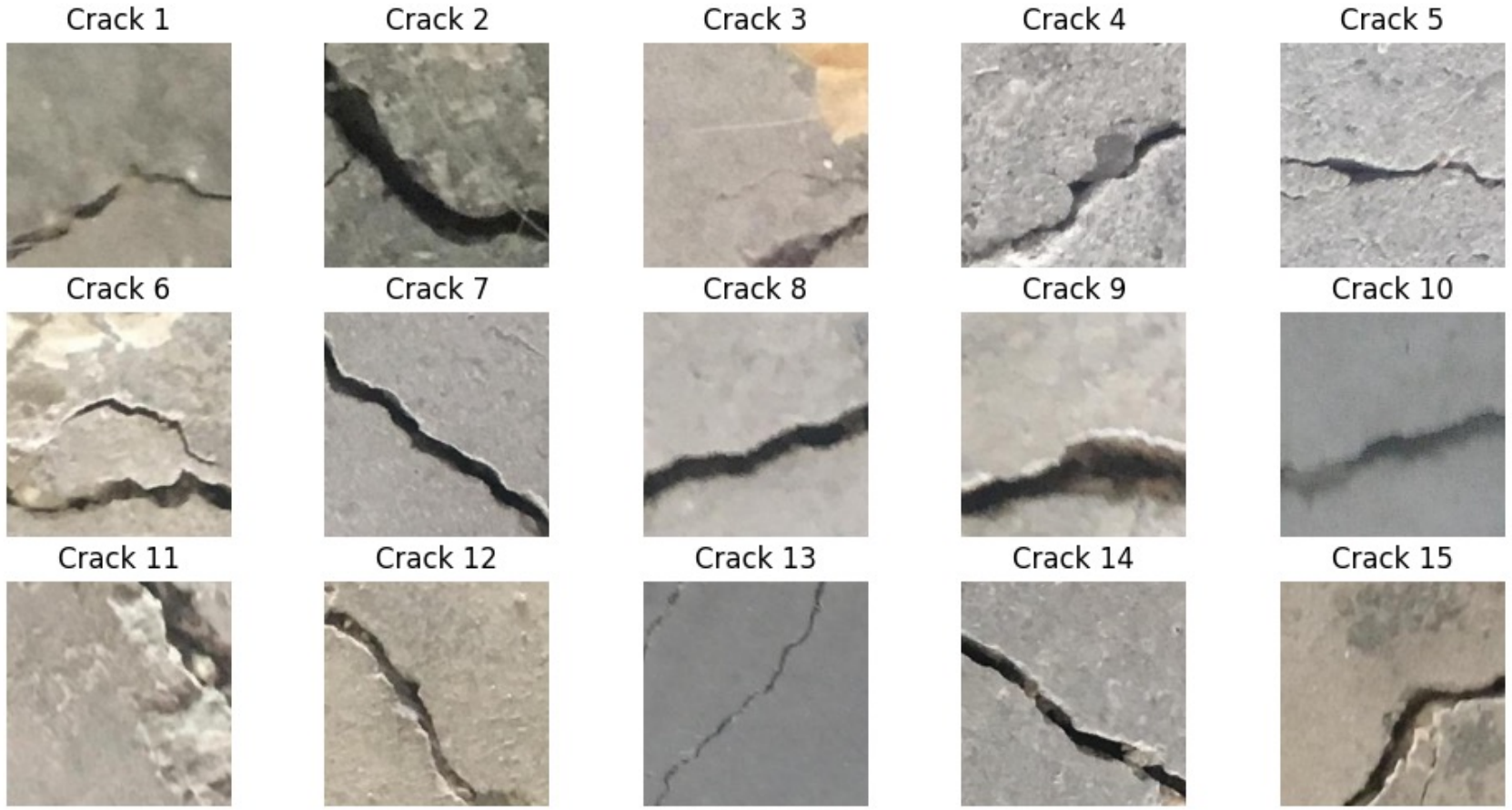
DATA – INTRODUCTION

Description

- 40,000 Wall images
  - 20,000 uncracked wall images
  - 20,000 cracked wall images
- Kaggle Datasets

Dr. Çağlar Fırat Özgenel 🙏

DATA – CRACKED WALL IMAGES



DATA – UNCRACKED WALL IMAGES

DATA PROCESSING

Splitting

80% Train

10% Validation

10% Test

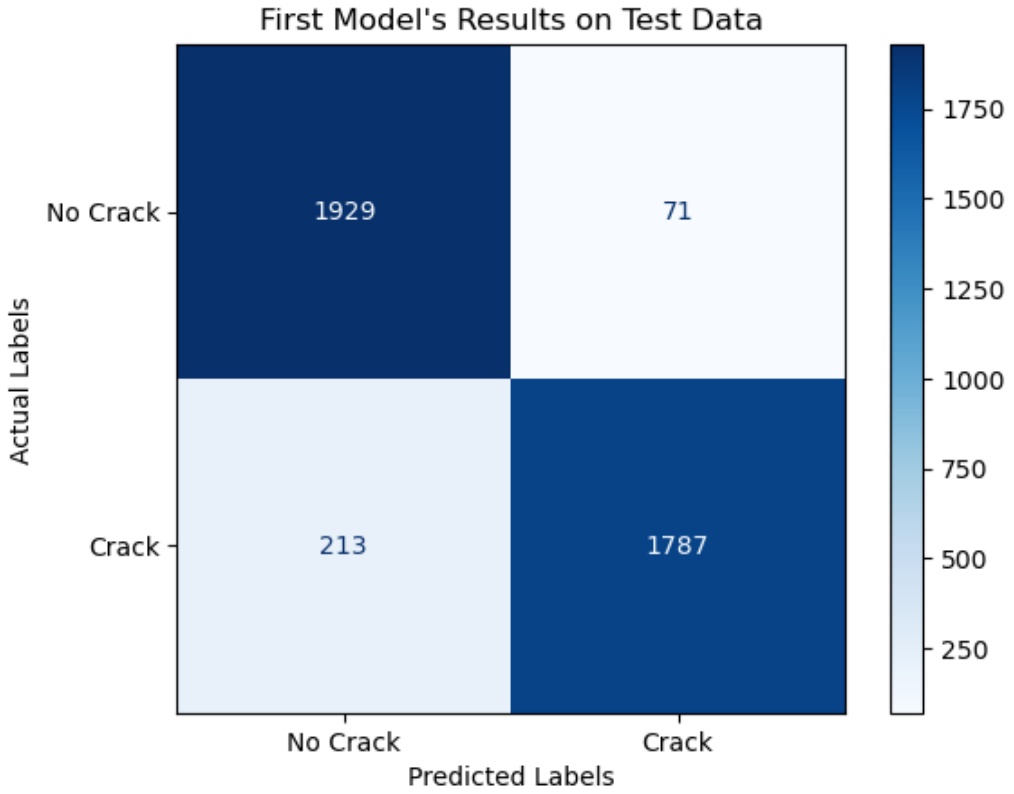
Normalizing Pixel Values

For faster and more effective learning

Data Augmentation

Zooming, Flipping, Gray-Scaling, Rotating, etc..

BASELINE MODEL



Architecture & Performance

- Single flatten hidden layer
- Accuracy: 92.9%
- Recall: 89.4%

SUBSEQUENT MODELS

Second

- Gray-scaling
- Dense layers with batch normalization

Third

- Data Augmentation
- Dense layers with batch normalization

Fourth

- VGG16
- Data Augmentation
- L2

Fifth

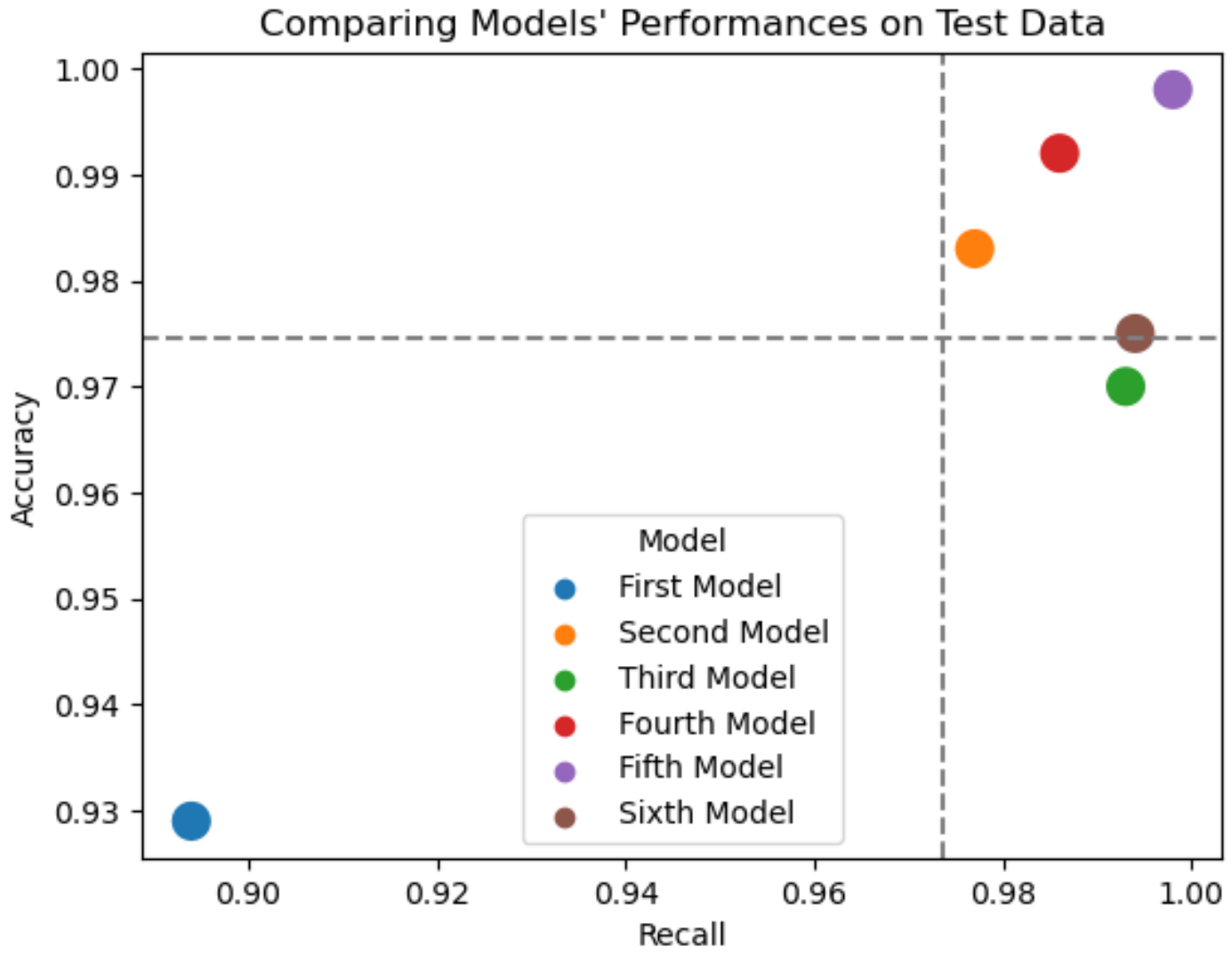
- VGG16
- Data Augmentation
- L2
- Dense layers with batch normalization

Sixth

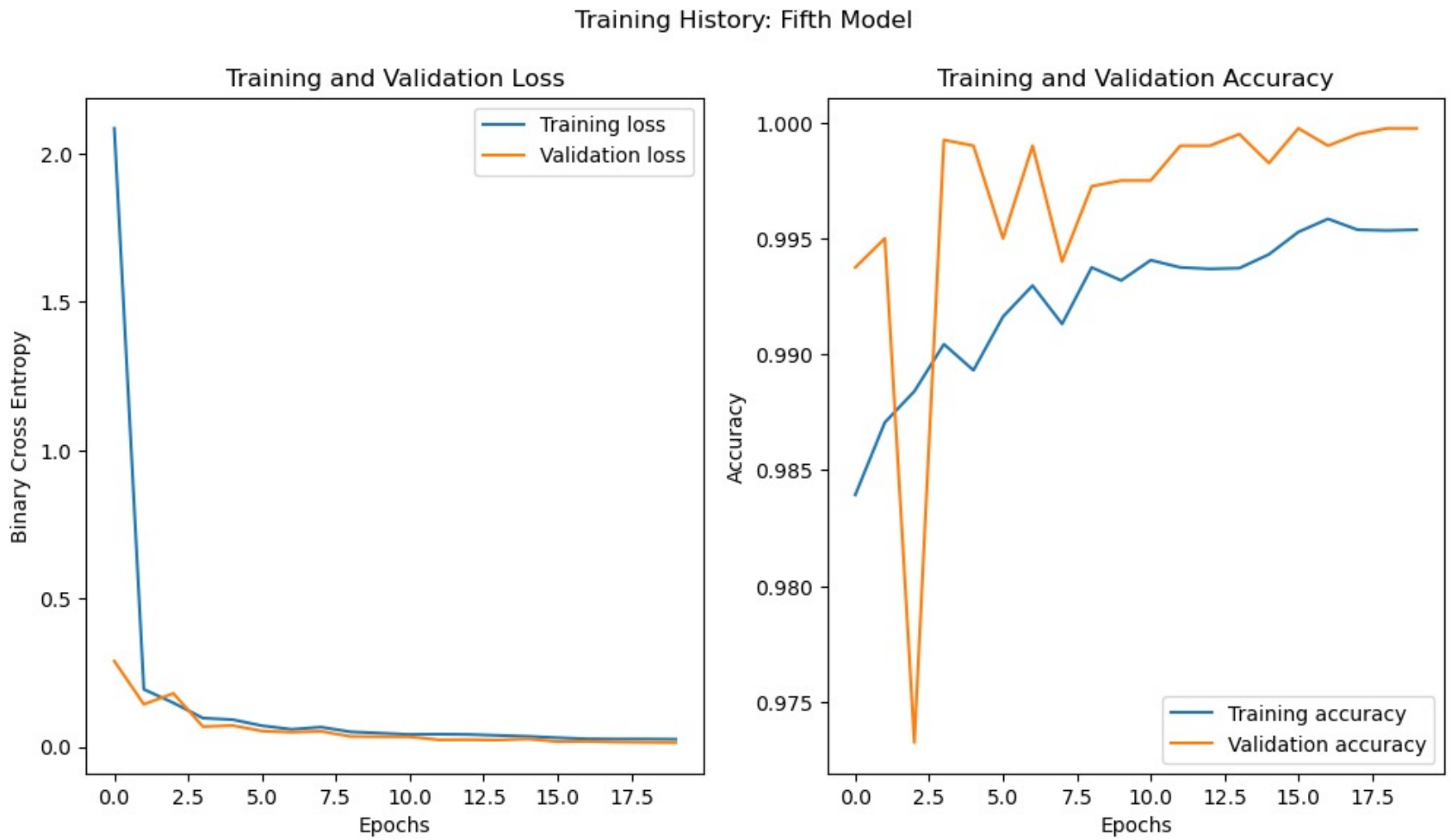
- Resnet50
- Data Augmentation
- L2
- Dense layers with batch normalization

COMPARING MODELS

- Fifth model is the best performer
- Dotted lines are average values of accuracy and recall for all models



FINAL MODEL'S TRAINING HISTORY



FINAL MODEL'S ARCHITECTURE

Pixel Normalization

Data Augmentation:
flipping, rotating, zooming, shifting

VGG16:
13 conv. layers
3 dense layers

Fully Connected Layer:
- dense layer 512 nodes (relu)
- batch-normalization
- dropout (0.5)
-l2 regularization

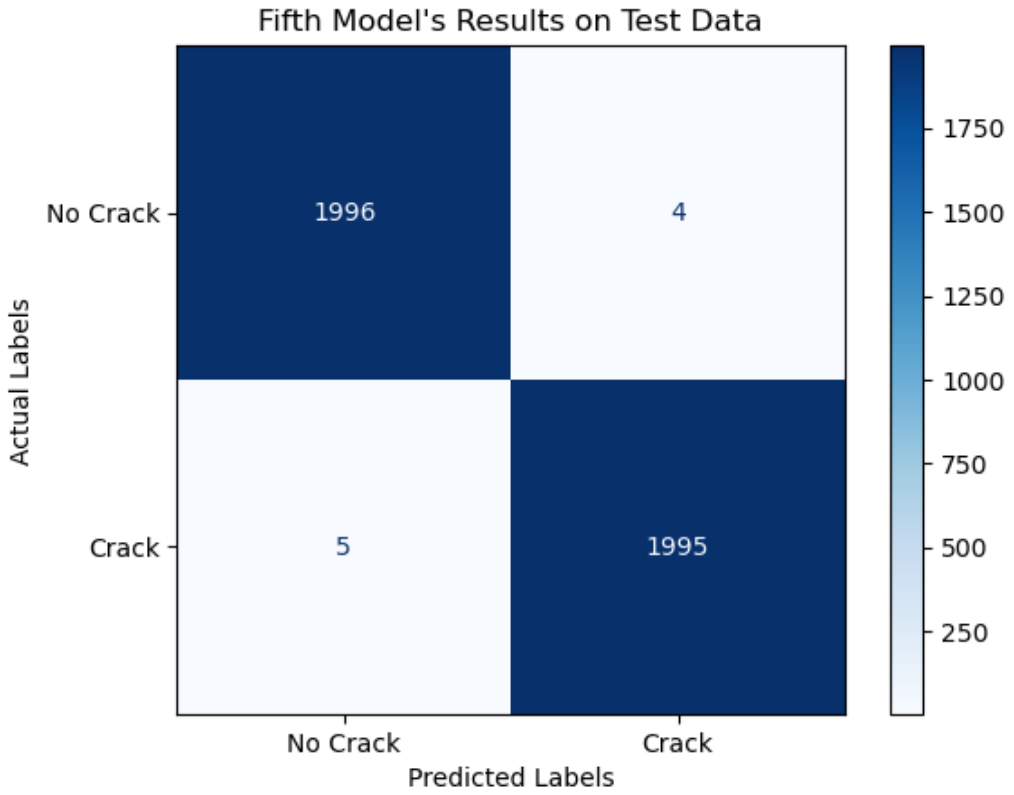
Fully Connected Layer:
- dense layer 256 nodes (relu)
- batch-normalization
- dropout (0.5)
-l2 regularization

Fully Connected Layer:
- dense layer 128 nodes (relu)
- batch-normalization
-dropout (0.5)
-l2 regularization

Output Layer:
- Sigmoid

Prediction

FINAL MODEL'S PERFORMANCE

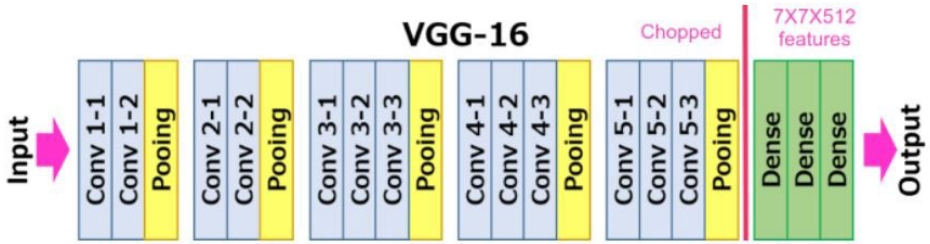


On Test Data:

- Accuracy: 99.8%
  - Up 6.9% from baseline
- Recall: 99.8%
  - Up 10.4% from baseline
- Significant improvement

LITTLE MORE ABOUT VGG16

Architecture



Blog post on VGG16

Jae Heon Kim

Apr 10 · 4 min read · Listen

[Concept] VGG16: Power of Transfer Learning on Image Classification

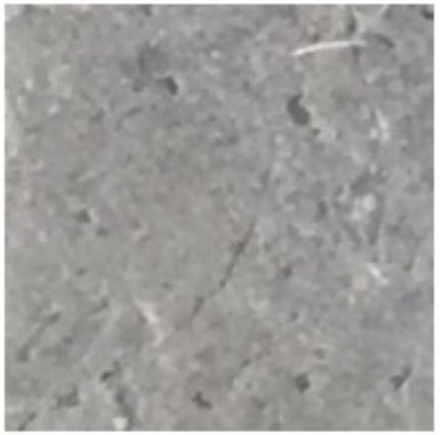
This blog post is to briefly discuss VGG16, which is a pre-trained deep convolutional neural network architecture that is widely used for image recognition and classification tasks, and can be used for transfer learning by reusing its pre-trained weights on a different dataset. I have been working on two different image classification projects and this brought a game-changing result to my study so I thought this technique was worth posting under its own name as title.

FINAL MODEL'S FALSE NEGATIVES

False Negative 1

False Negative 2

False Negative 3



False Negative 4

False Negative 5

FINAL MODEL'S FALSE POSITIVES

False Positive 1

False Positive 2

False Positive 3

False Positive 4

DEPLOYMENT

Image Classification App by Jae

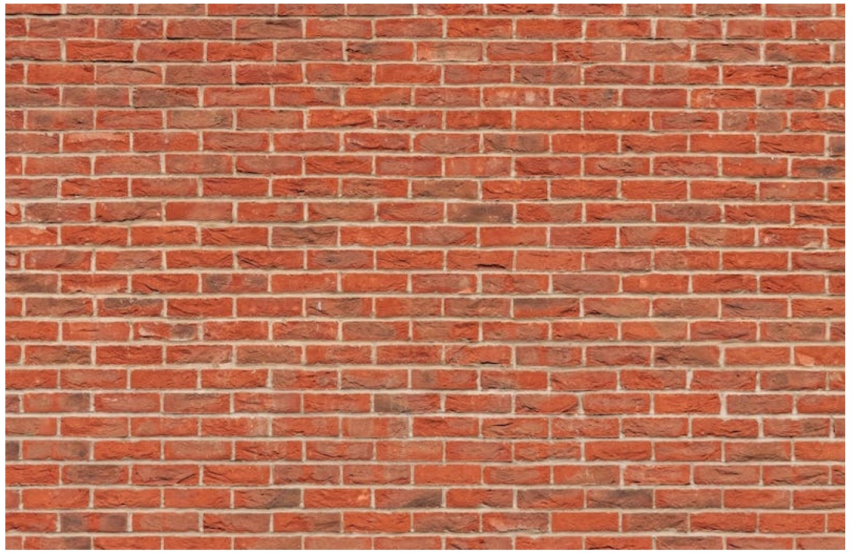
Identifying Cracks in Wall Images

Upload an image and get a prediction of whether the wall has a crack or not

Upload an image

Drag and drop file here
Limit 200MB per file • JPG, JPEG, PNG

Browse files



Uploaded a wall image

Prediction: NO CRACK

BUSINESS RECOMMENDATIONS

Avoid deploying overqualified, costly personnel for simple inspection tasks

Leverage NYC Department of Buildings' power to gather more building data for future applications

Develop more models using time-series data

NEXT STEPS

Collect more data

Collect data with more obstacles or from more distances so that model can be further trained.

Develop 3D model

3D model is more useful in deployment. Instead of taking image inputs, taking video inputs can bring greater application.

Train to inspect other things

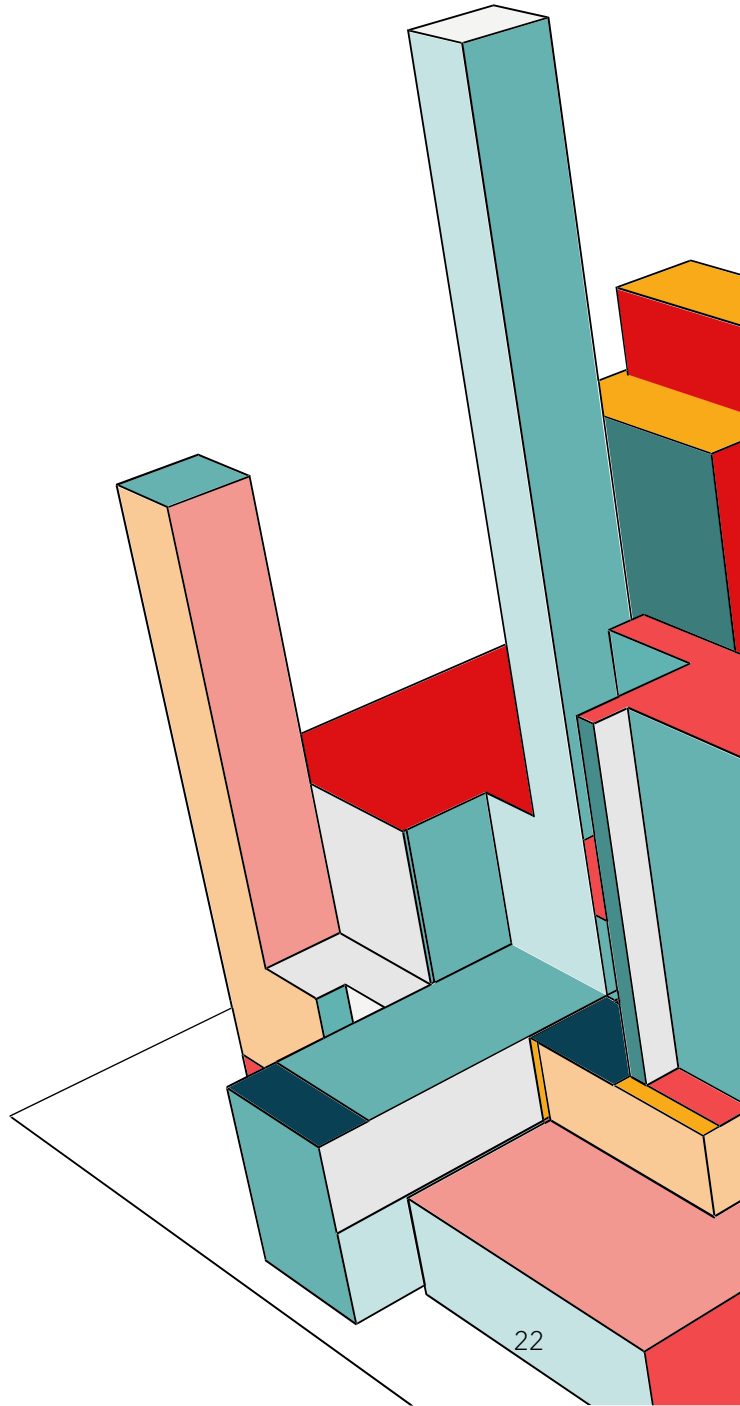
Apart from surface cracks, there is more information to be obtained through image-processing.

Create an ensemble model

Create ensemble models such as voting classifier using some of my best models for better performance.

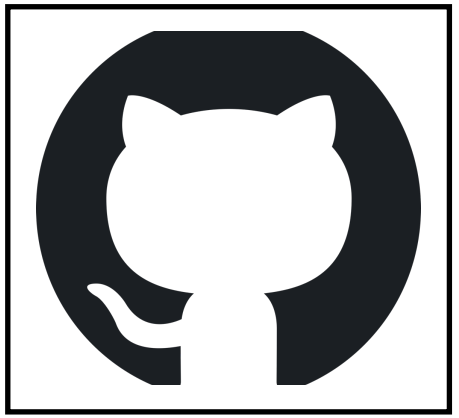
Train model to classify wall

The current model takes wall images as input but being able to take any image and then classifying whether it's a wall image can help model's usefulness.



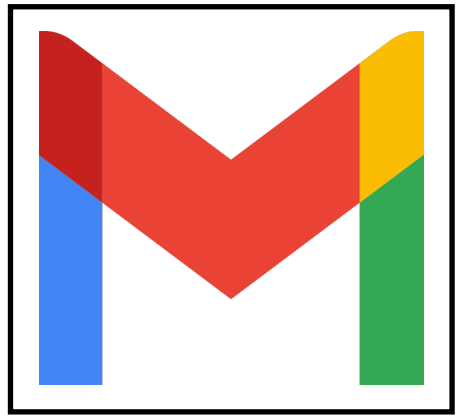
THANK YOU!

Please connect with me for more exciting business opportunities



Check out my other interesting projects

My blog is the best way to see how I think



Write to me about any questions you have