

# Deficiency Detection

Alexander Cheng



## Problem:

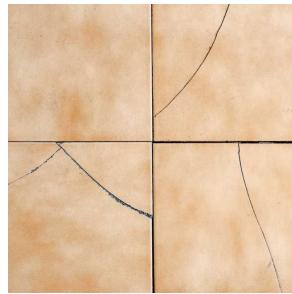
- Architects and engineers visit project sites regularly to identify **deficient work**.
- **Photography** is the primary way to document site conditions.
- If the project is large, then thousands of photos can be taken on a single visit!
- It's very time-consuming to find all images that capture deficient work to make a thorough **field report**.



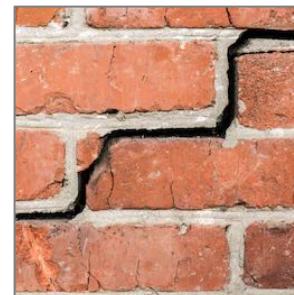
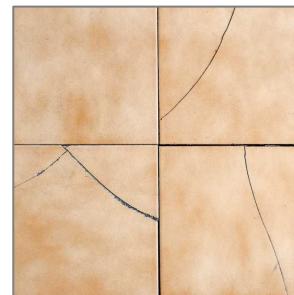
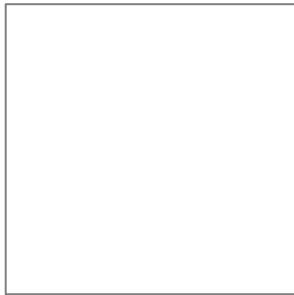
## Solution:

1. We can train an **automated tool** to detect deficient work for us!
2. In a large design firm, this tool would save thousands of hours of labor per year.
3. This saves hundreds of thousands of dollars, which means more profit!

# What Is “Deficient Work?”



# Focus On Cracking Deficiency

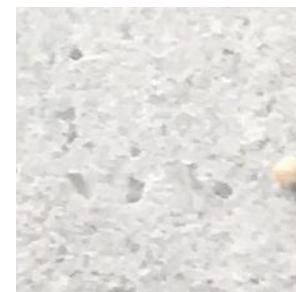


# Simple Crack Detection

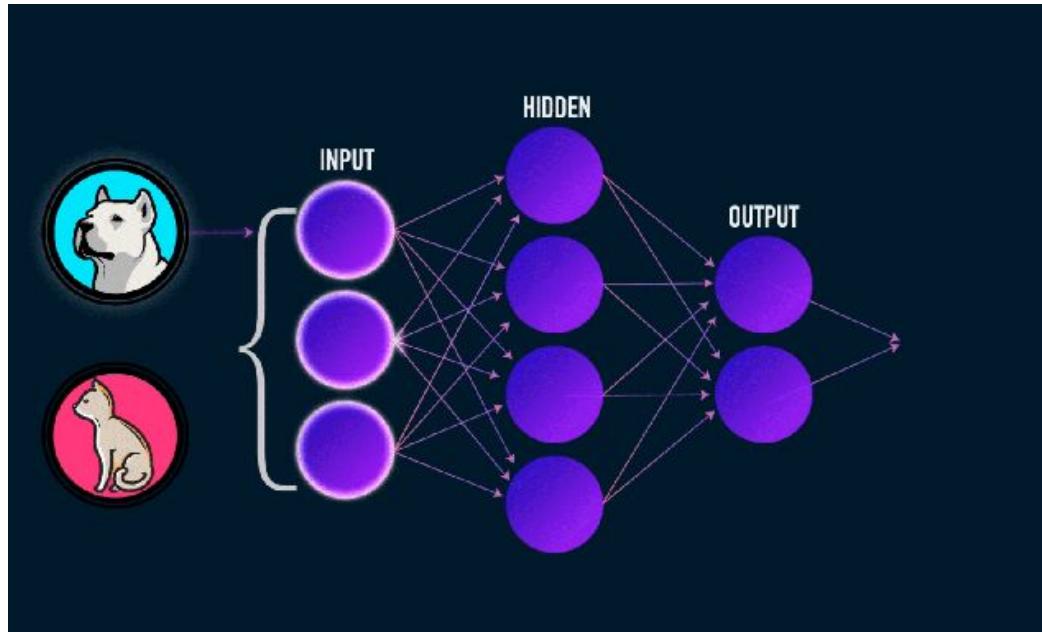
# Simple Crack Detection

- **40,000 images of concrete**
  - 20,000 cracked
  - 20,000 not cracked

# Simple Crack Images



# What Is A Convolutional Neural Network?



Source: [Towards Data Science](#)

# Results

Detection Of “Cracked” Materials  
**99.2%**

Detection Of “Not Cracked” Materials  
**99.6%**

**99.4% OVERALL ACCURACY!**

# PROBLEM SOLVED?

(Nope. Life is not that easy.)

# Complex Crack Detection

# Complex Crack Detection

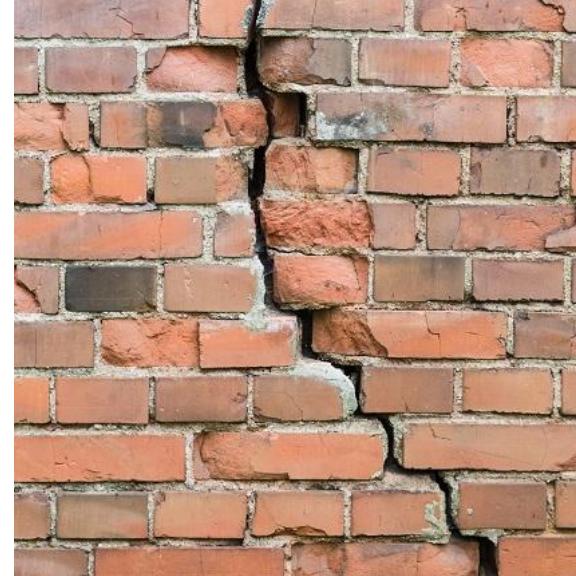
- **1500 images of general progress photos**
- **2500 images of 5 different materials**
  - Brick
  - Concrete
  - Drywall
  - Glass
  - Tile
- **Sources:**
  - Real construction photos
  - Web-scraped photos
  - Self-generated photos

# Step One - General Or Specific?

General



Specific



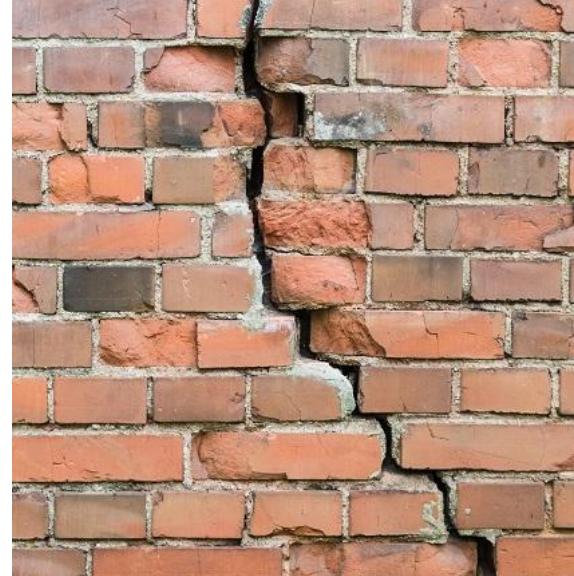
# Step One - General Or Specific?

General



Specific

Material?



# Step Two - Material Type?

Concrete



Brick



Tile



Glass



Drywall



# Step Three - Cracked Or Not Cracked?

Concrete



Brick



Tile



Glass



Drywall



# Results

## Step 1: General Or Specific?

- Detection Of “General” Images: **96.6%**
- Detection Of “Specific” Images: **88.5%**

**90.4% OVERALL ACCURACY!**

## Step 2: Material Type?

**91.2% OVERALL ACCURACY!**

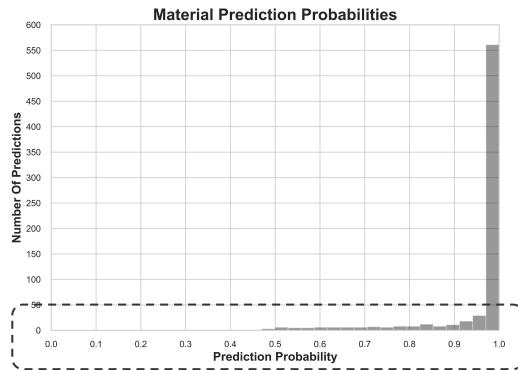
## Step 3: Cracked Or Not Cracked?

- Detection Of “Cracked” Materials: **65.7%**
- Detection Of “Not Cracked” Materials: **90.6%**

**81.4% OVERALL ACCURACY!**

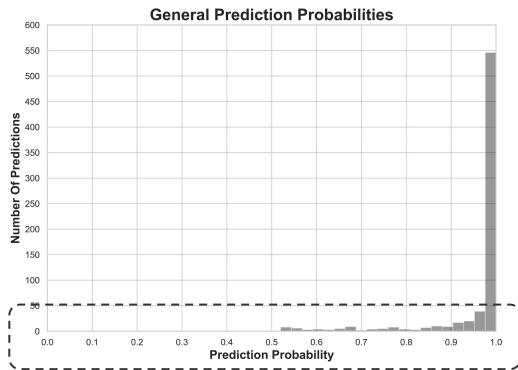
# Step One

General Or Specific?



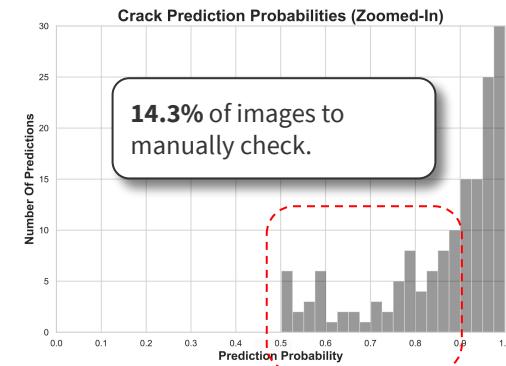
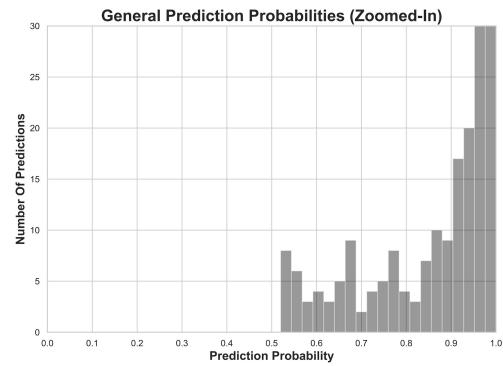
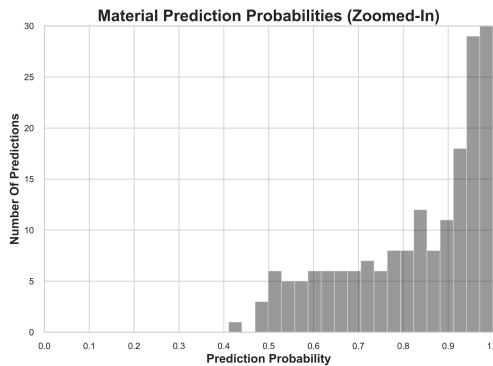
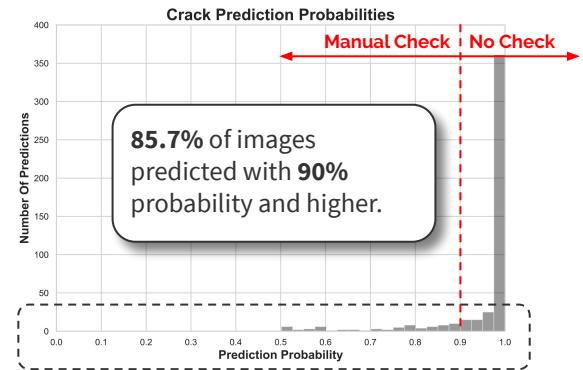
# Step Two

Material Type?



# Step Three

Cracked Or Not Cracked?



# For 1,000 images, you manually check 140!

( With a 90% prediction probability cutoff point. )

With 95% prediction probability - check 200 images.

With 99% prediction probability - check 310 images.

# Demo!

# Improvements & Future Work

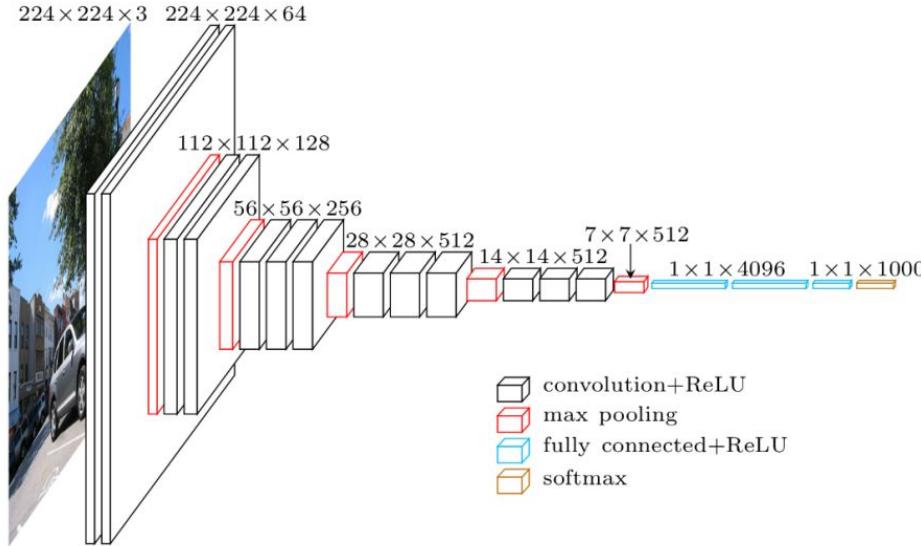
- **Improvements:**
  - Use images with more “**visual noise**” to train on
  - Use images capturing **more types of materials**.
  - Allow model to **train longer** (more rounds of practice).
- **Future Work:**
  - Build more models to detect **other types of deficiencies** besides cracking.
  - Combine these models to build a tool that can detect **all types of deficiencies**.
  - In the future, instead of people, maybe **drones** could take photos of construction sites!
  - Using a more robust version of this tool, drones could **auto-identify** deficient work!

# Questions?

 <https://github.com/alexwcheng>

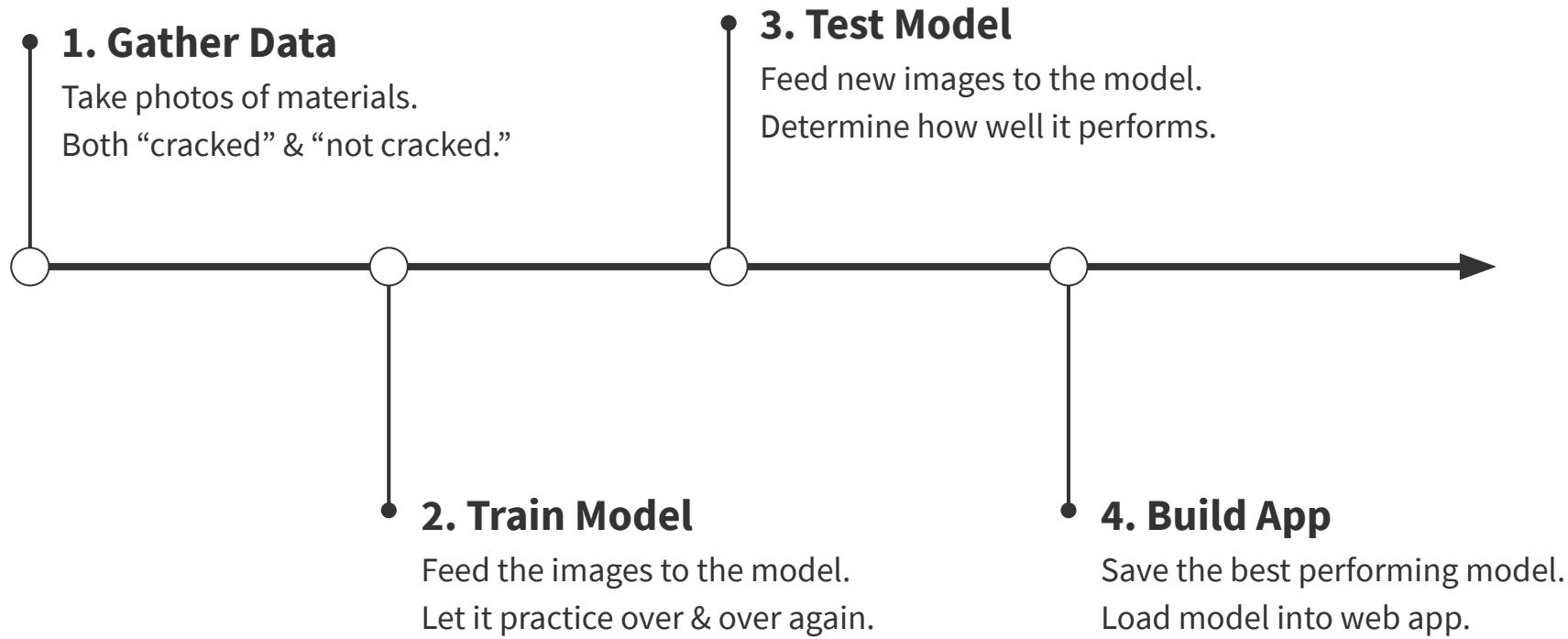
 <https://www.linkedin.com/in/alexanderweicheng>

# Convolutional Neural Network - In Detail

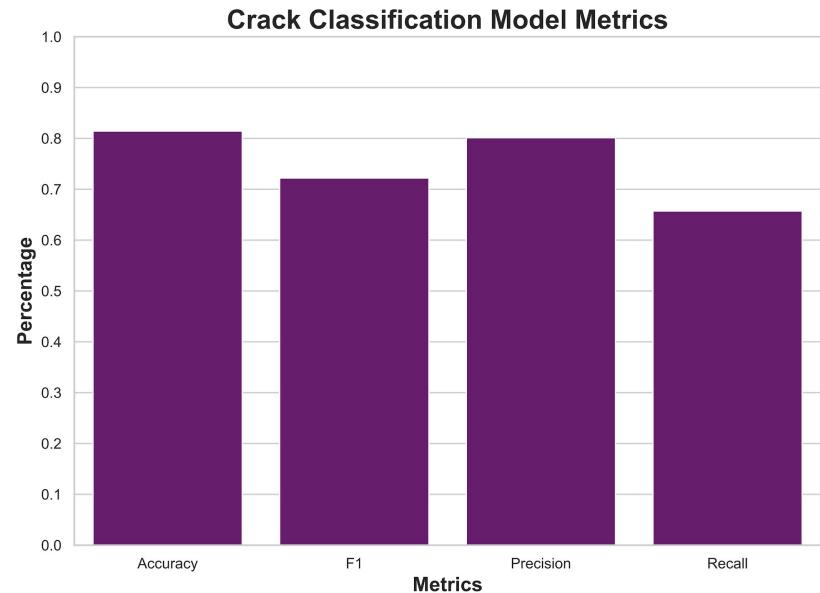
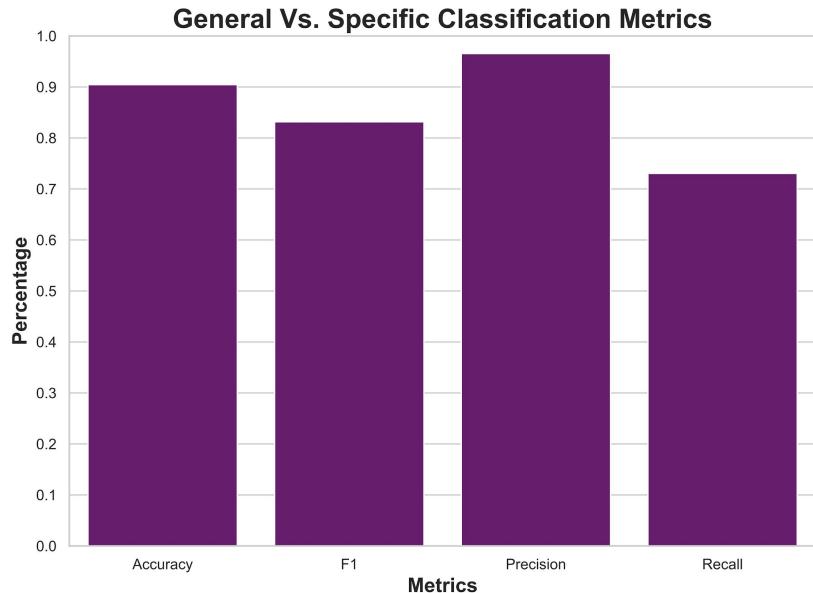


Source: [Towards Data Science](#)

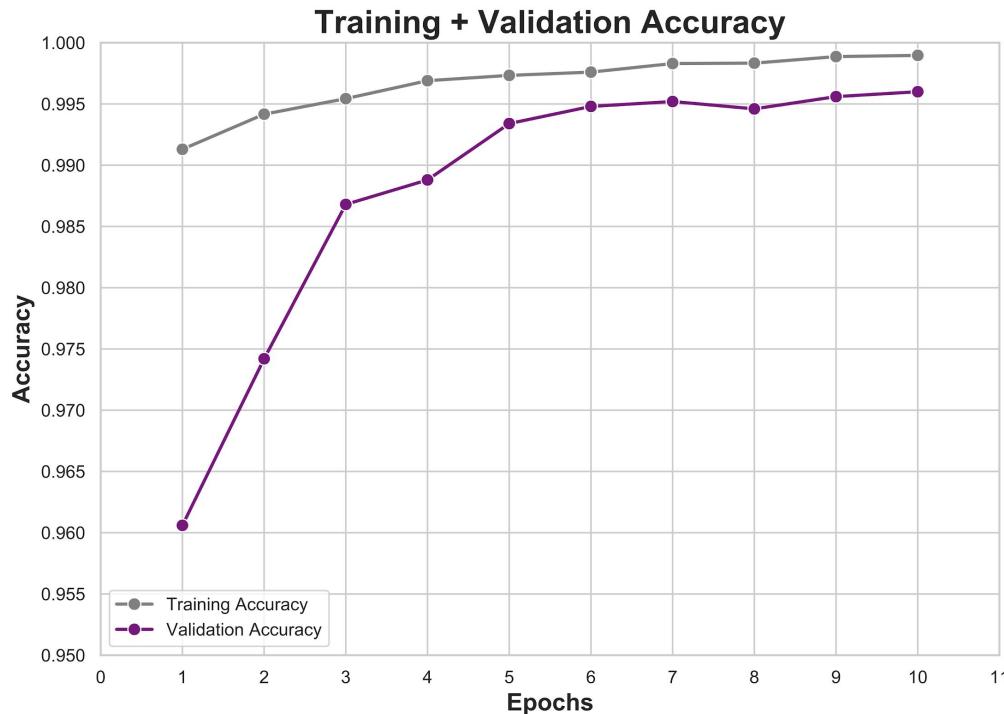
# Process



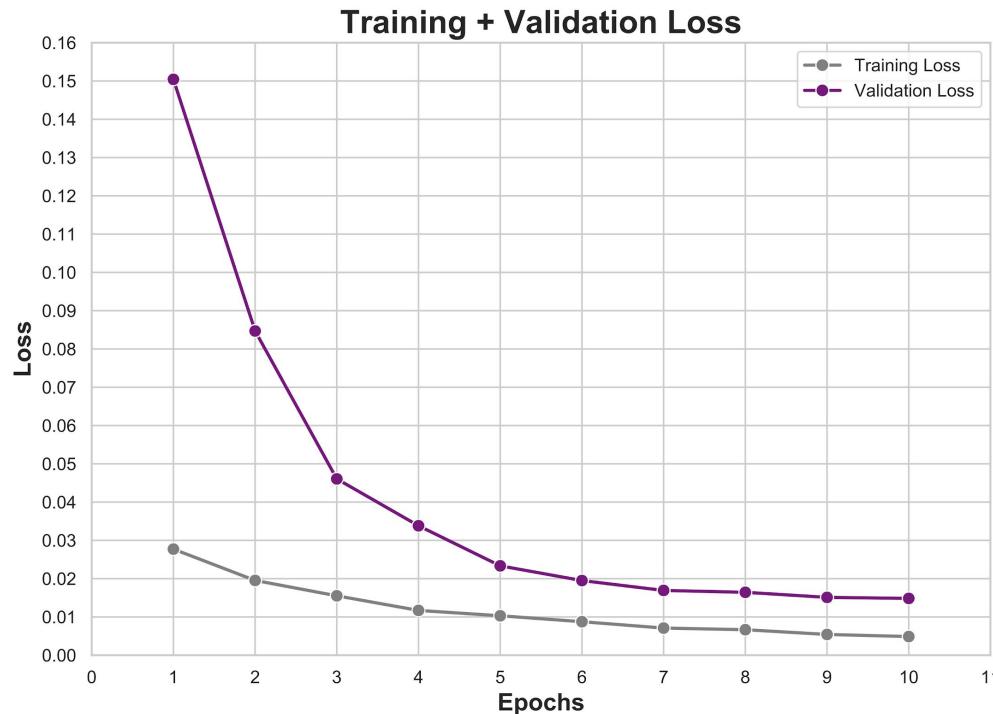
# Model Classification Metrics



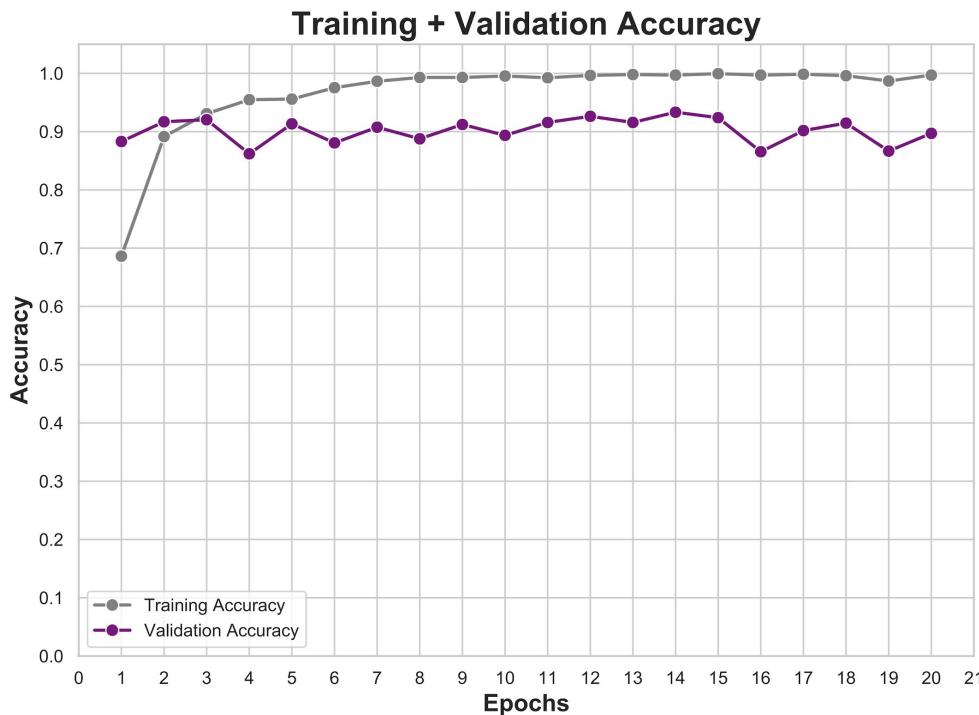
# Simple Crack Detection - Model Accuracy



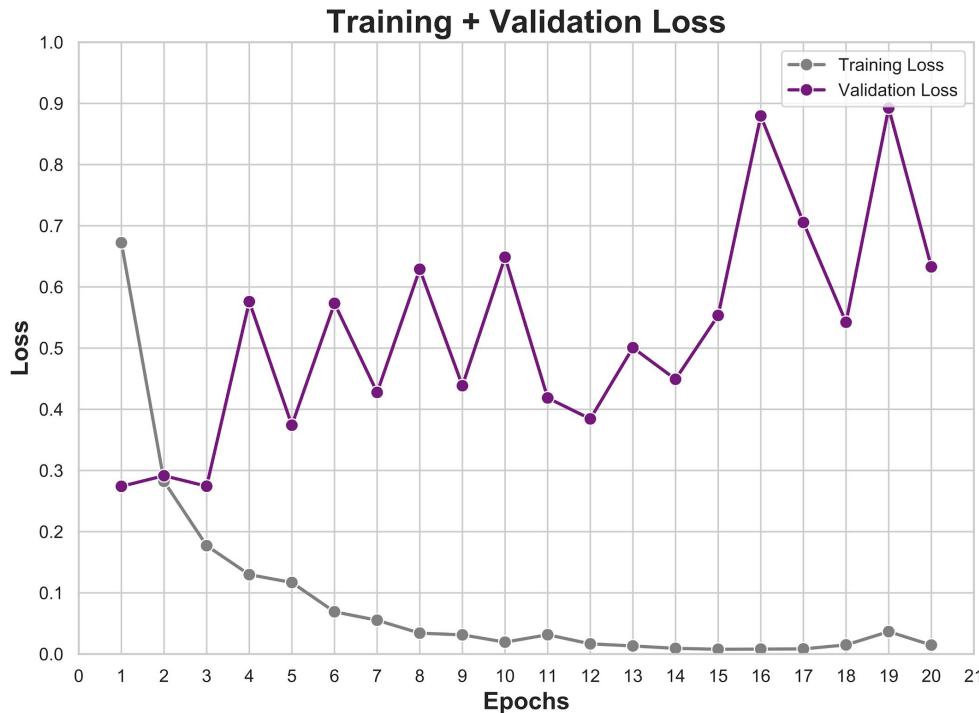
# Simple Crack Detection - Model Loss



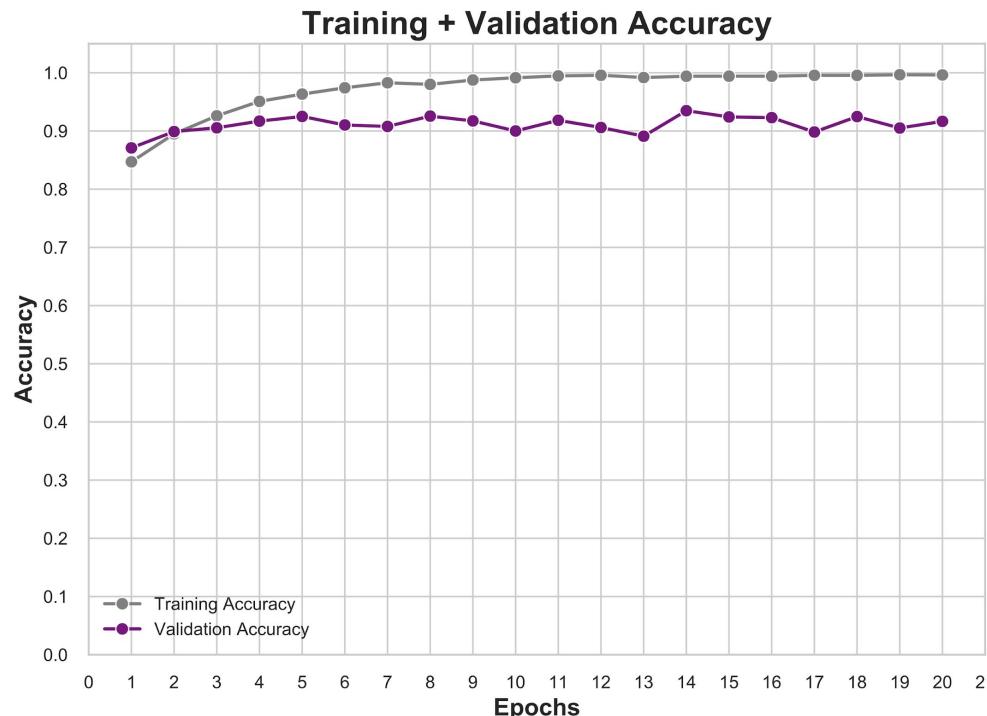
# General Image Detection - Model Accuracy



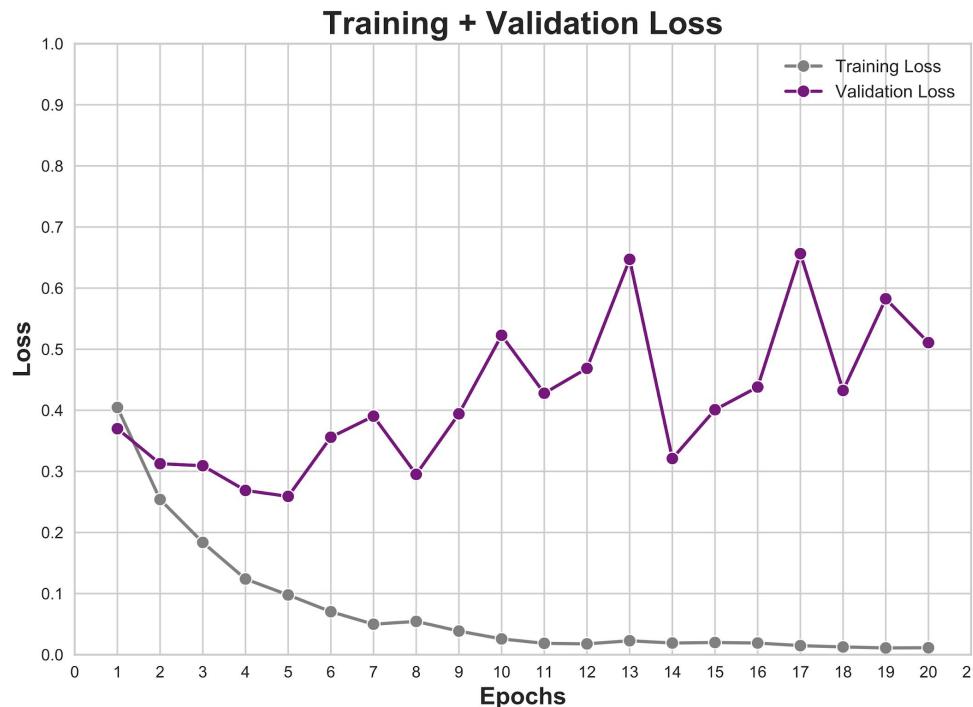
# General Image Detection - Model Loss



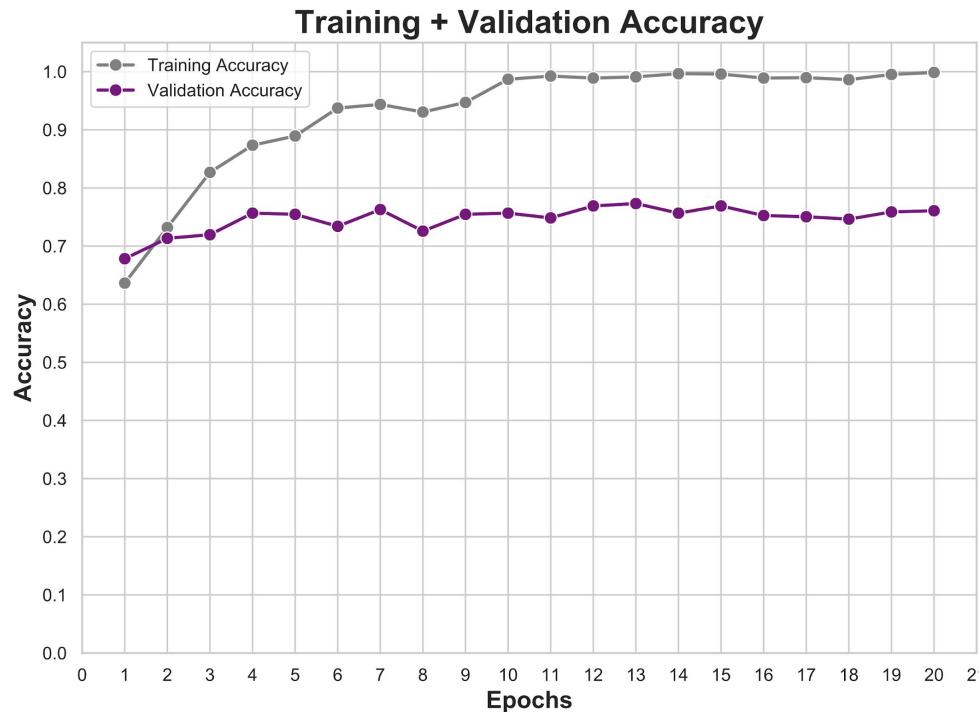
# Material Type Detection - Model Accuracy



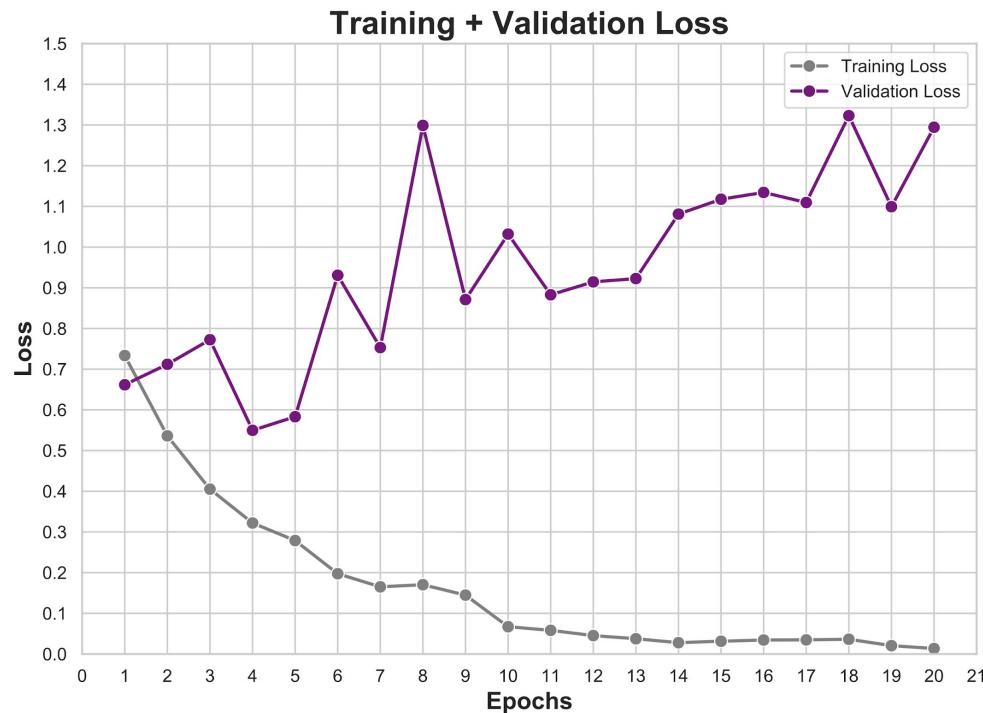
# Material Type Detection - Model Loss



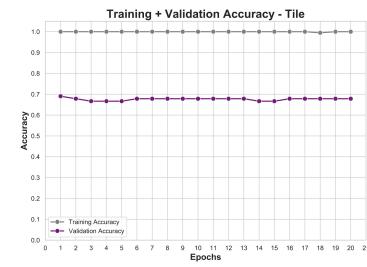
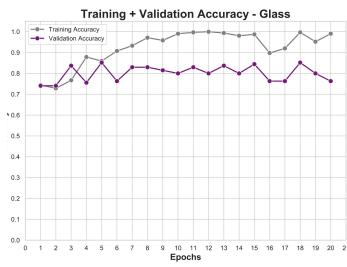
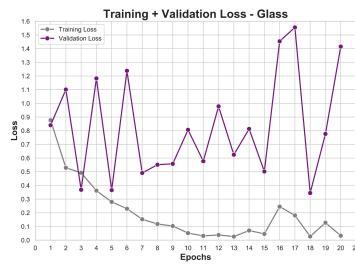
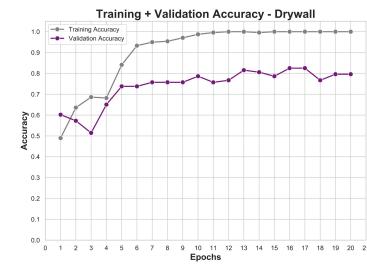
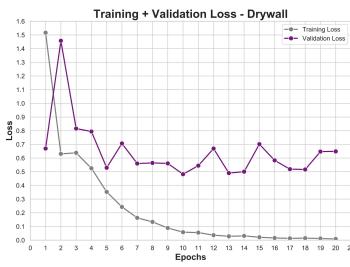
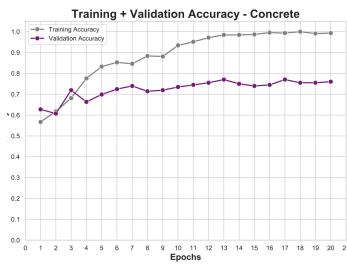
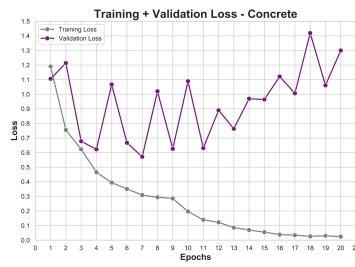
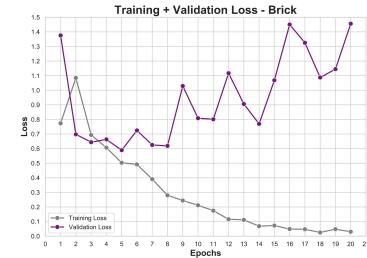
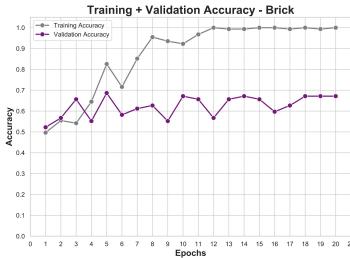
# Complex Crack Detection - Model Accuracy



# Complex Crack Detection - Model Loss



# Separate Models Per Material For Classification



# Accuracy - Separate Models

Concrete

Brick

Tile

Glass

Drywall

77.9%

62.5%

71.4%

79.6%

72.1%

# Accuracy - One Model

Materials

81.4%