

Deficiency Detection

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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**.



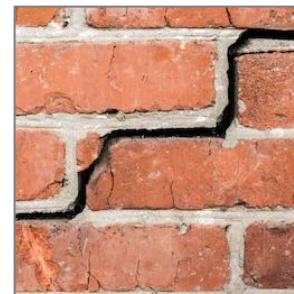
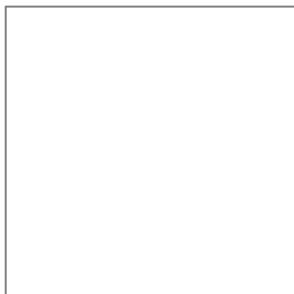
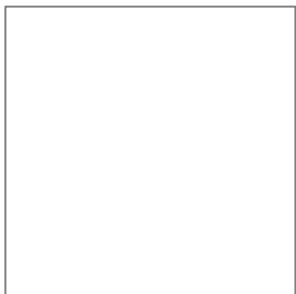
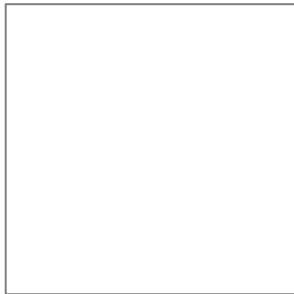
Solution:

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

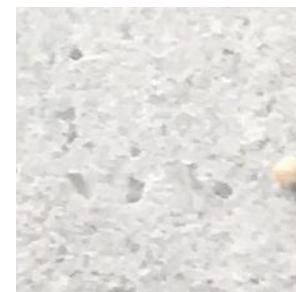


Simple Crack Detection

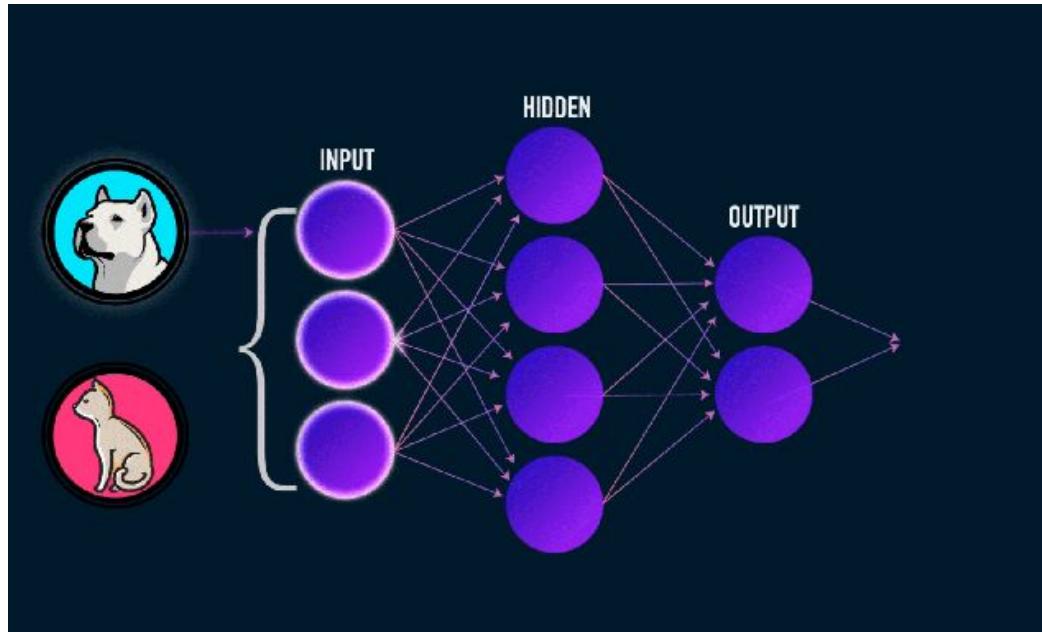
Simple Crack Detection

- **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

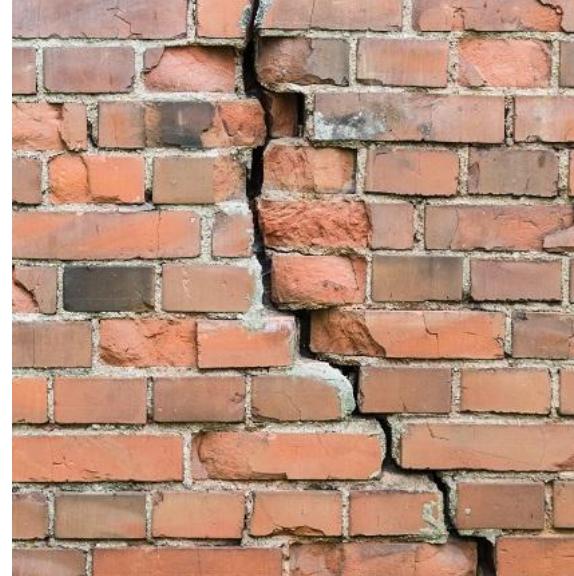
- **1500 images of general progress photos**
- **2500 images of 5 different materials**
 - Brick
 - Concrete
 - Drywall
 - Glass
 - Tile
- **Sources:**
 - Real construction photos
 - Web-scraped photos
 - Self-generated photos

Step One - General Or Specific?

General



Specific



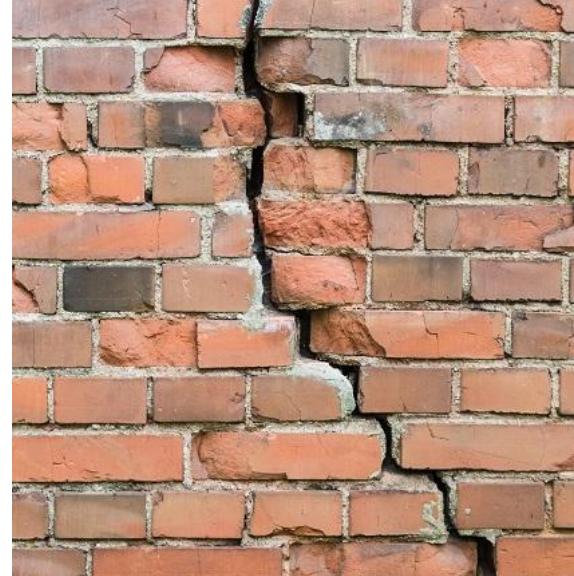
Step One - General Or Specific?

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!

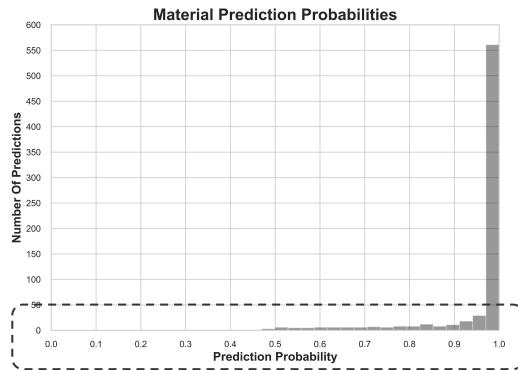
Step 3: Cracked Or Not Cracked?

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

81.4% OVERALL ACCURACY!

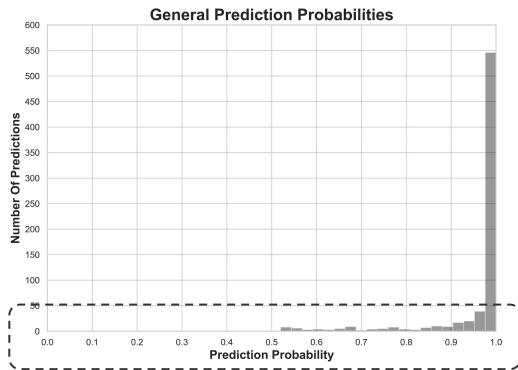
Step One

General Or Specific?



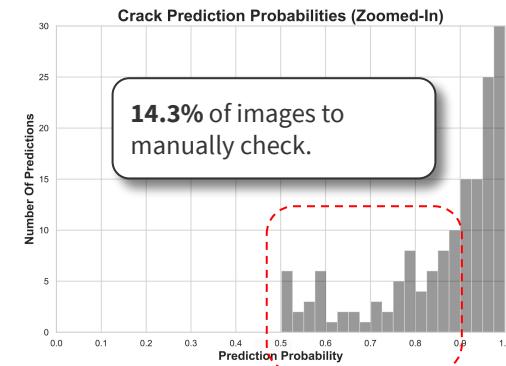
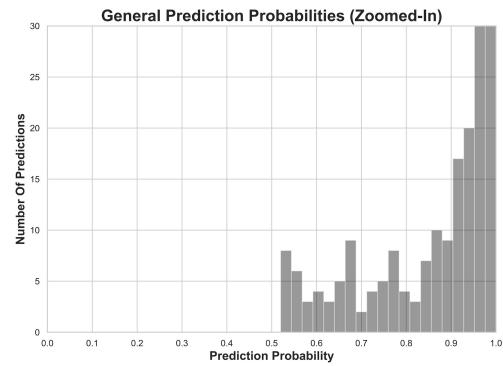
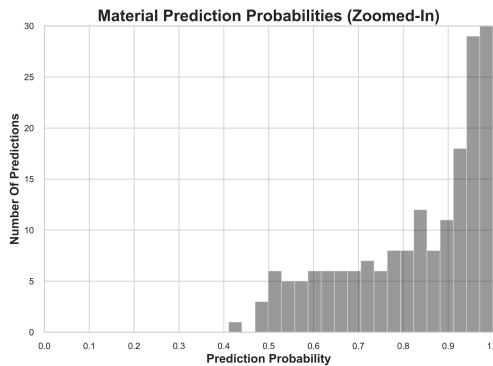
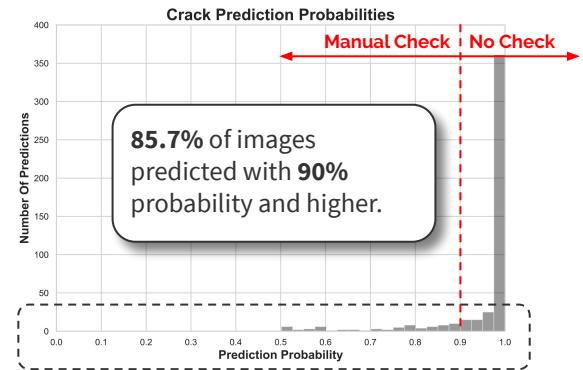
Step Two

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

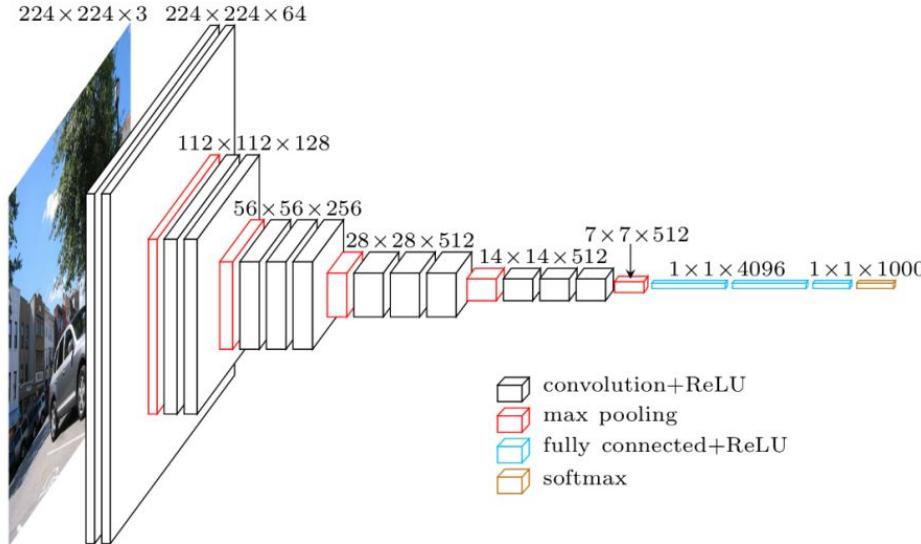
- **Improvements:**
 - Use images with more “**visual noise**” to train on
 - Use images capturing **more types of materials**.
 - Allow model to **train longer** (more rounds of practice).
- **Future Work:**
 - Build more models to detect **other types of deficiencies** besides cracking.
 - Combine 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>

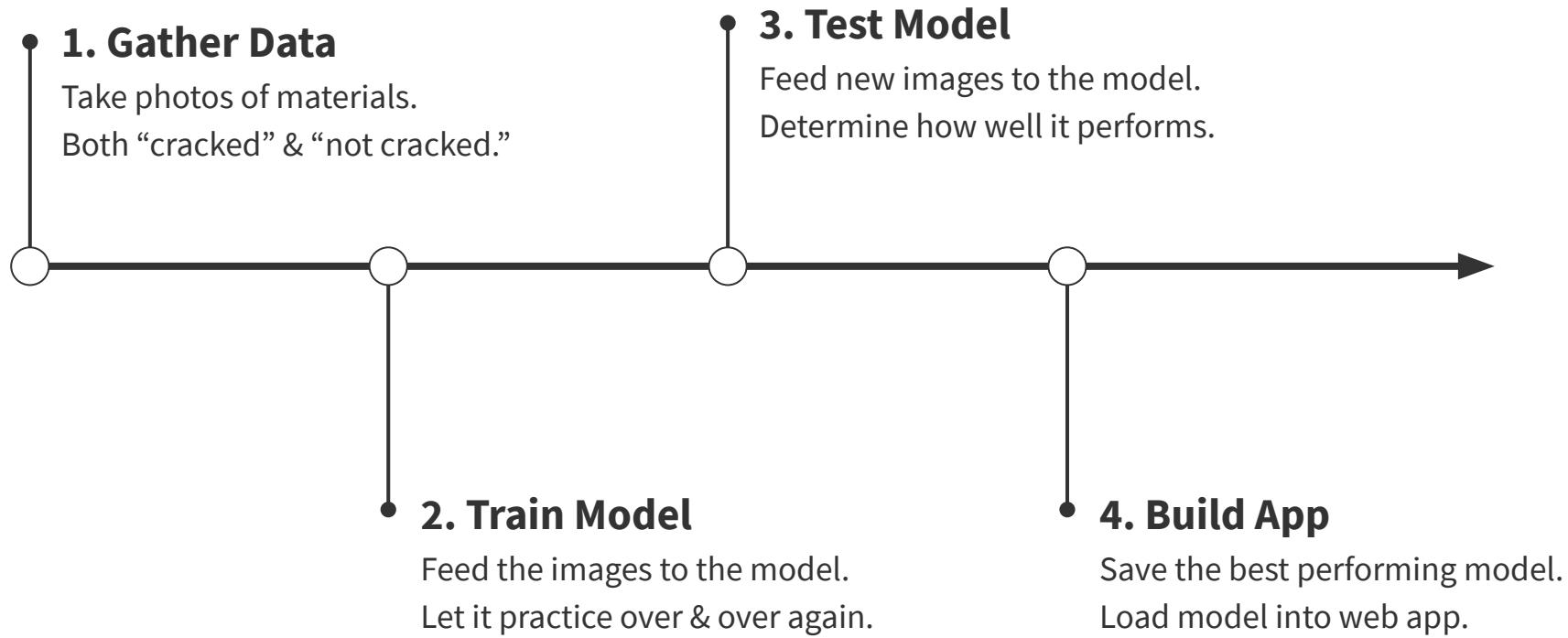
 <https://www.linkedin.com/in/alexanderweicheng>

Convolutional Neural Network - In Detail

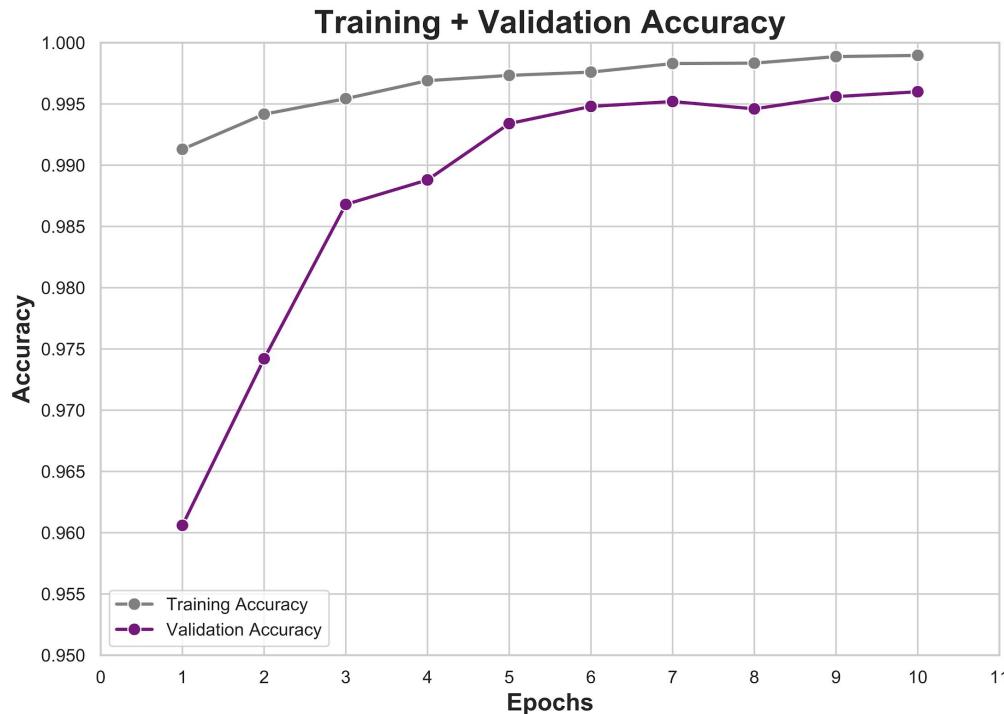


Source: [Towards Data Science](#)

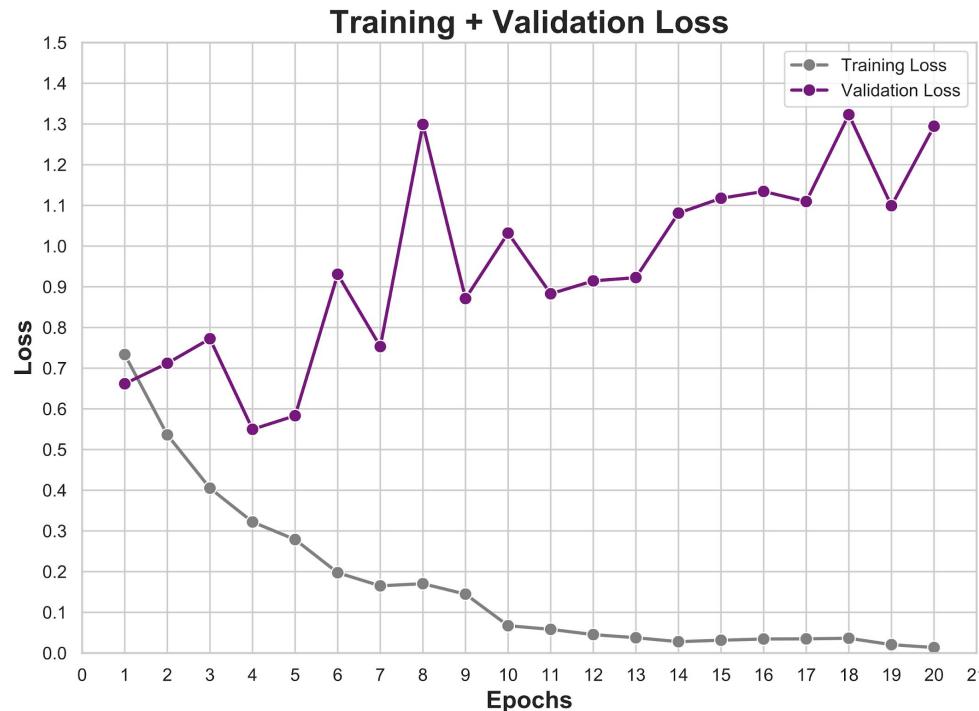
Process



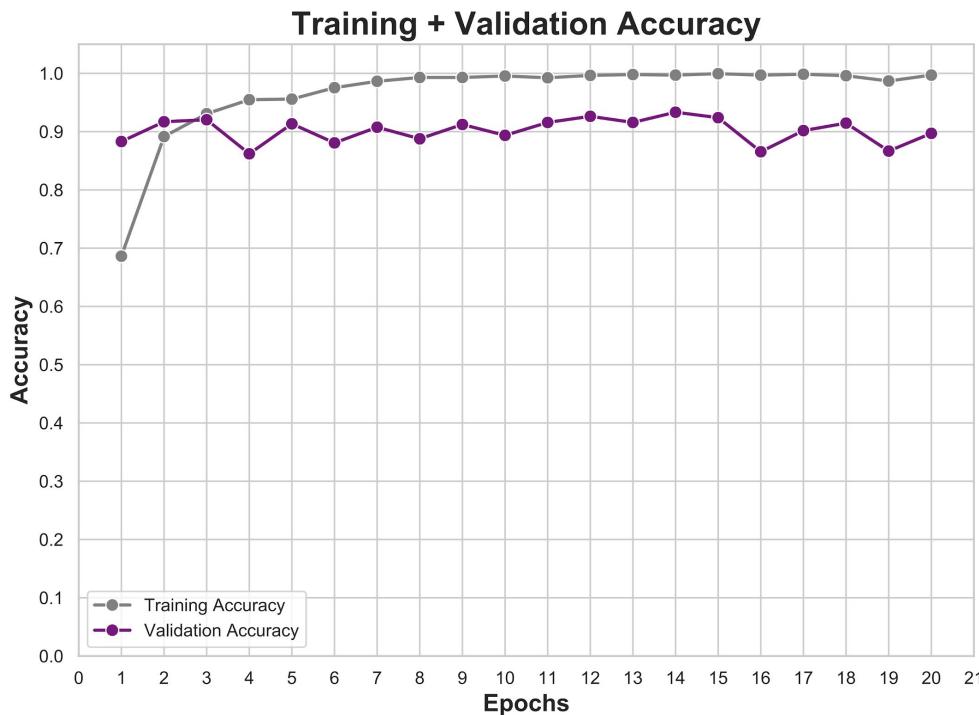
Simple Crack Detection - Model Accuracy



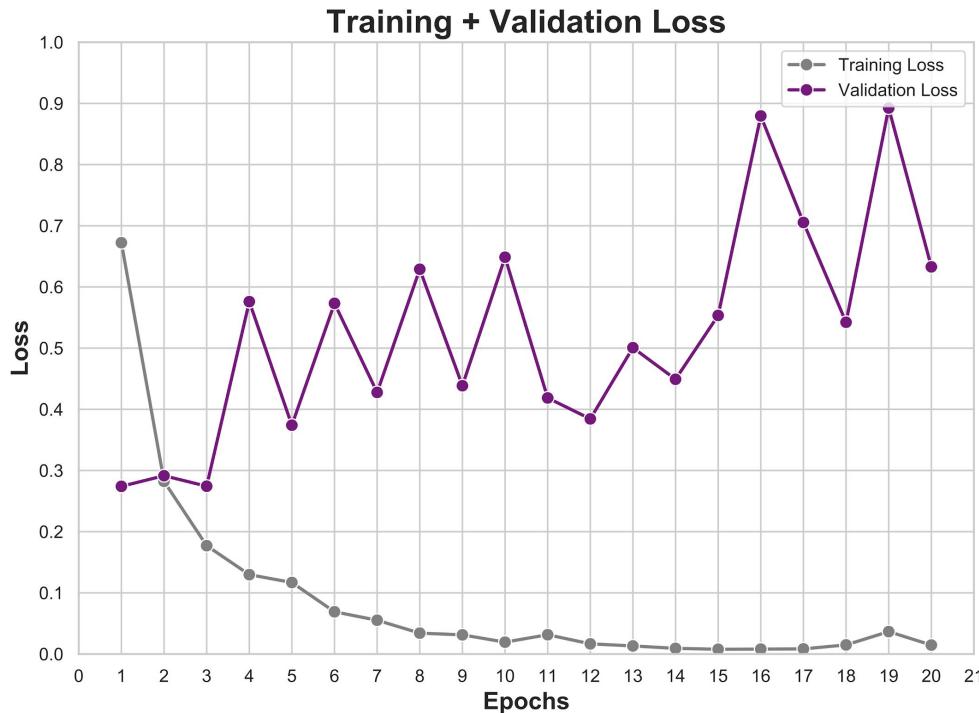
Simple Crack Detection - Model Loss



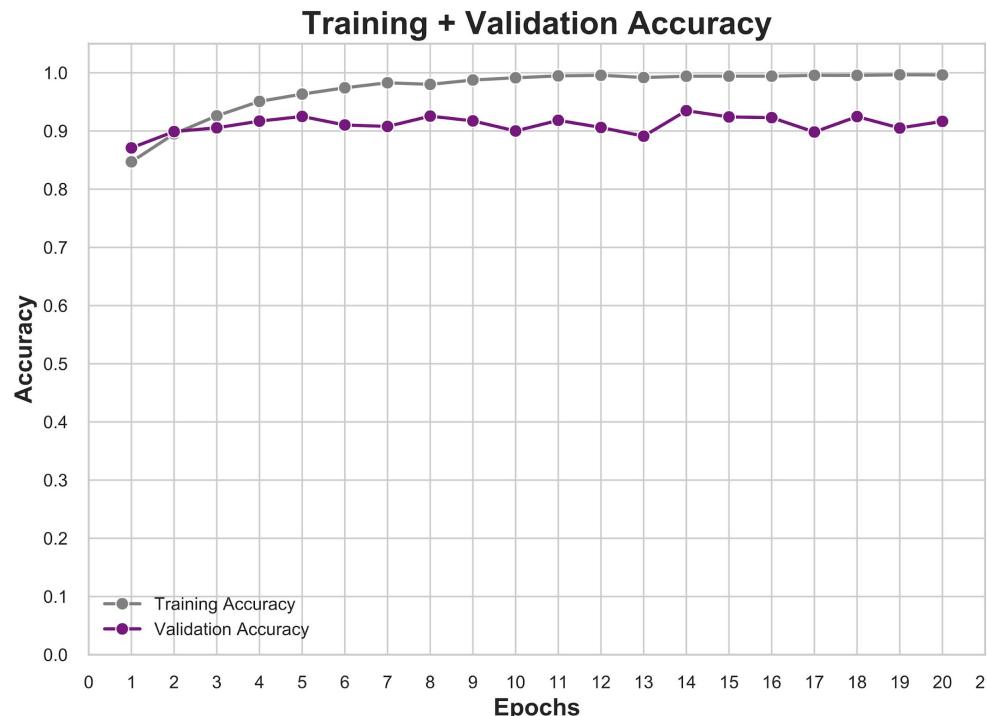
General Image Detection - Model Accuracy



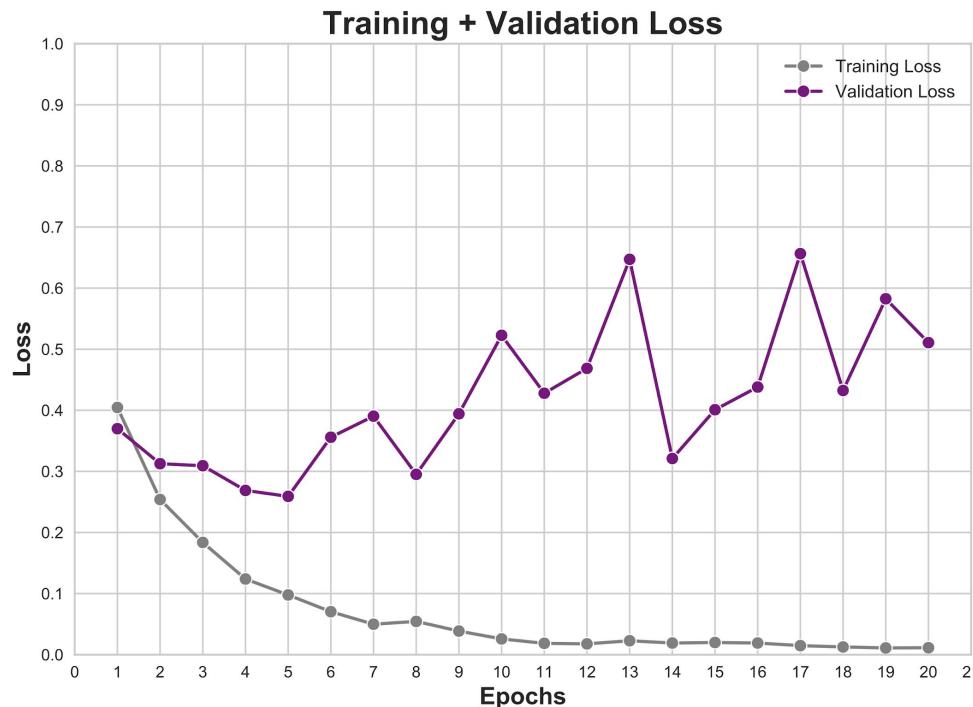
General Image Detection - Model Loss



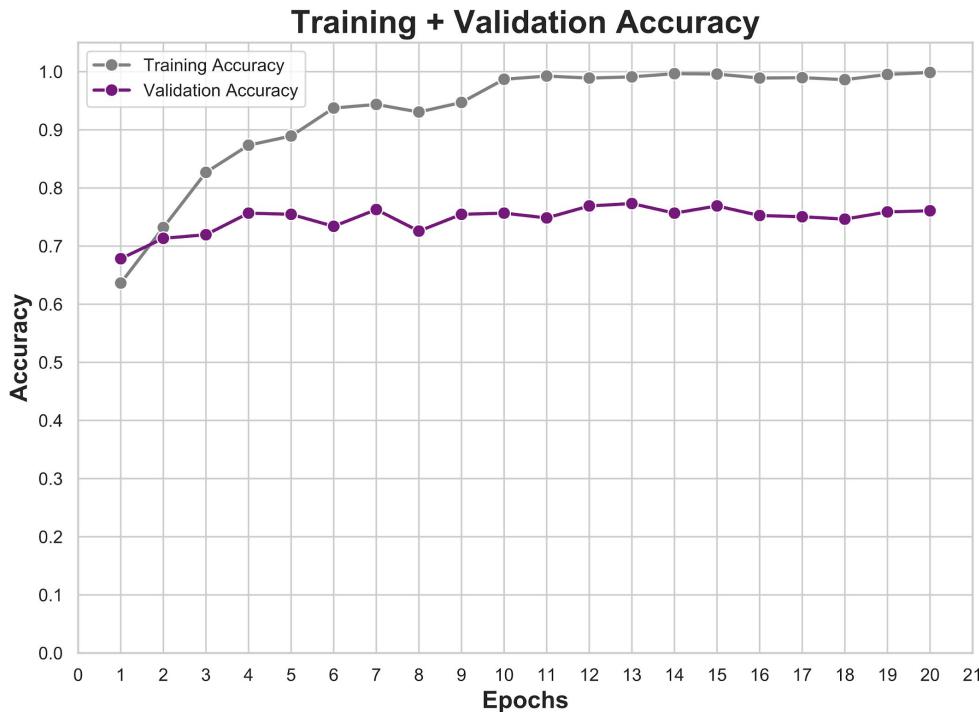
Material Type Detection - Model Accuracy



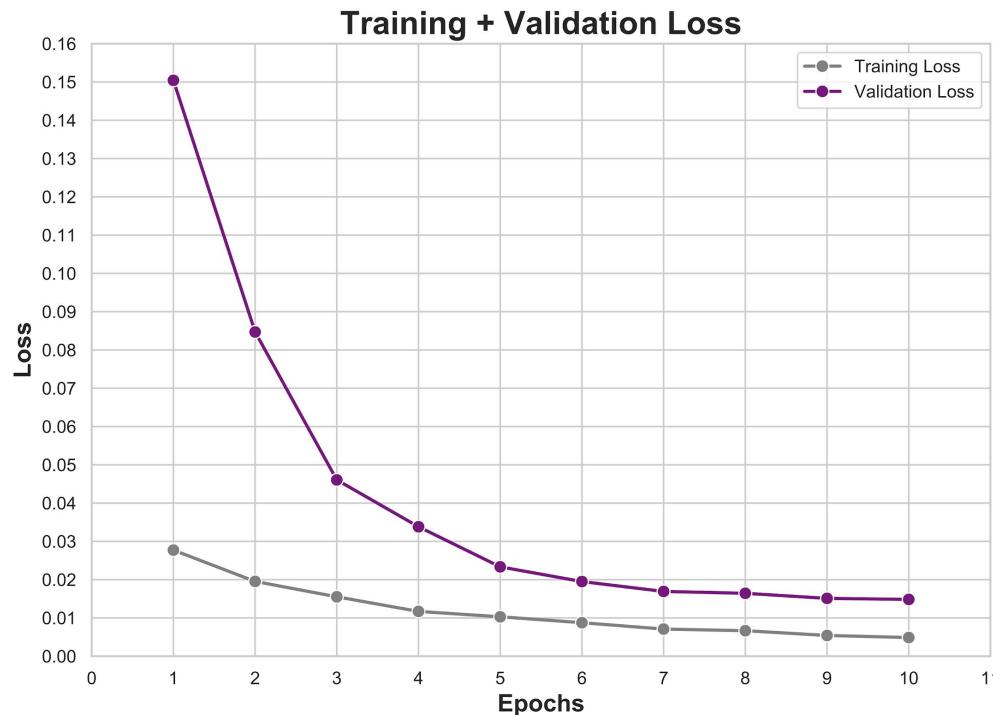
Material Type Detection - Model Loss



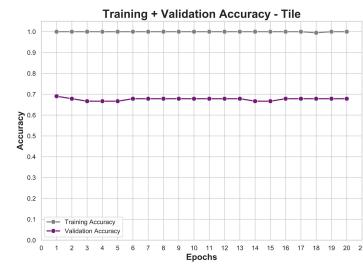
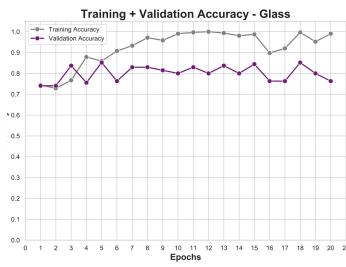
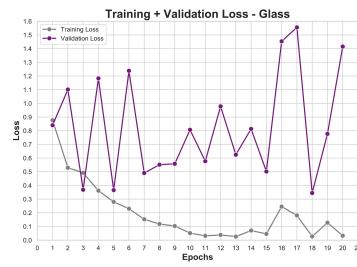
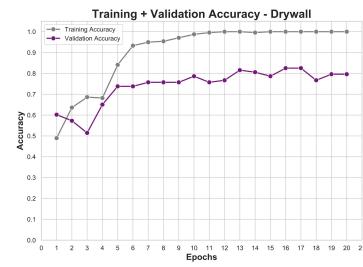
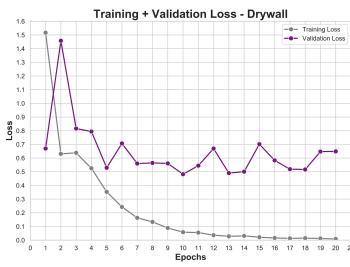
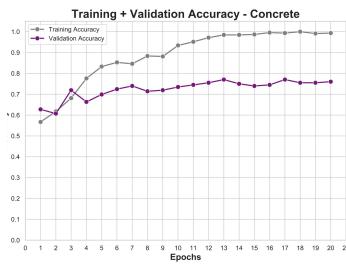
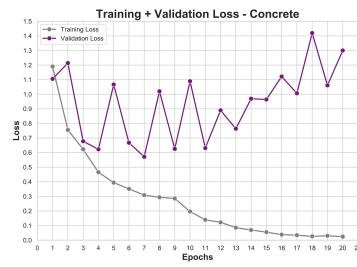
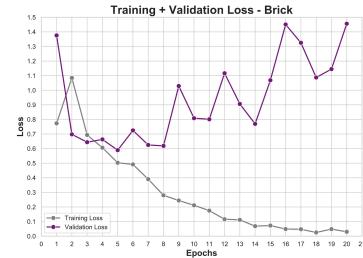
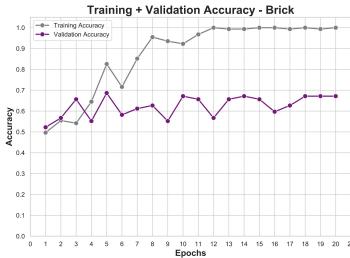
Complex Crack Detection - Model Accuracy



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%