

Knots Recognition System

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CS5330

FINAL PROJECT

Introduction

- Goal: Recognize 10 types of practical knots using deep learning.
- Use cases: Climbing, fishing, wilderness survival, load securing.
- Importance: Correct knot-tying can be safety-critical (e.g., climbing)
- Possible Application: Assists in learning and verifying proper knot formation.
- Model: Uses Convolutional Neural Networks (CNNs) for image recognition. 4 models in total.
 - Transfer learning with ResNet50



Related Work

Peer-reviewed papers:

- A review of convolutional neural networks in computer vision
- Evaluation of Transfer Learning Methods for Wood Knot Detection
- Geometric learning of knot topology

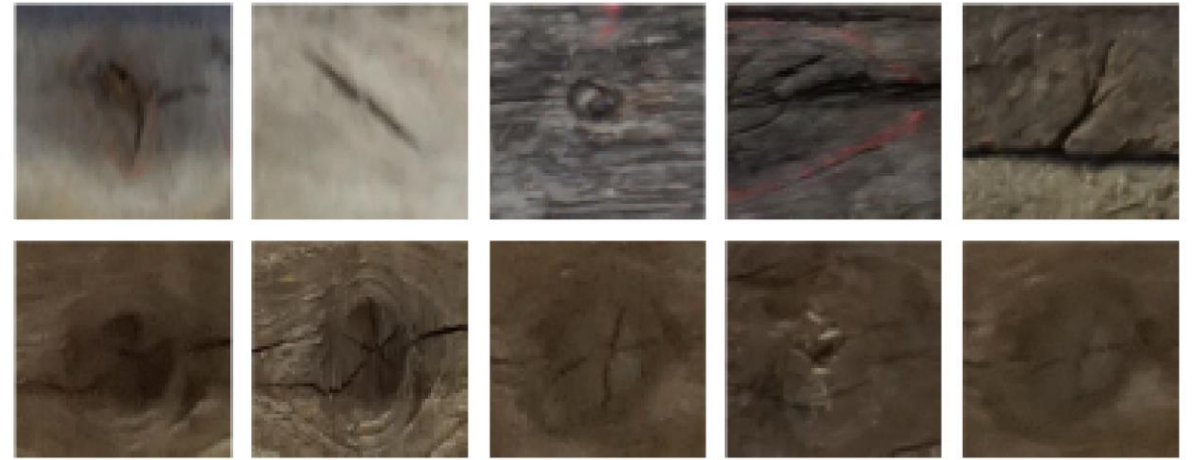


Fig. 2. A selection of wood knot images from the test set of images.

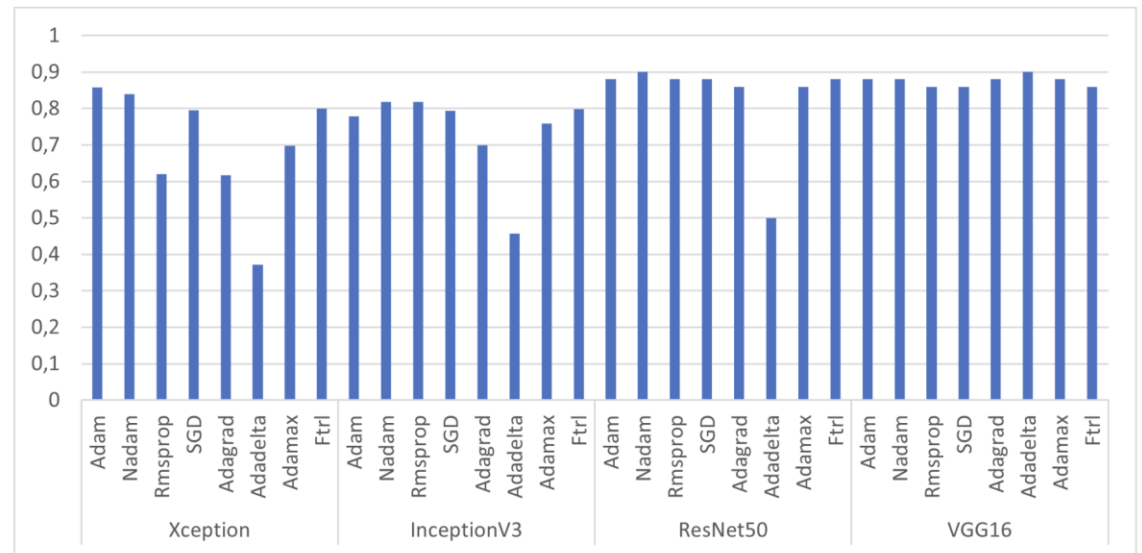


Fig. 6. Comparison of accuracy of classifiers built on four pre-trained networks using eight optimizers.

Dataset

- 10 different types of knots
 - 4 different z-axis rotations
 - 3 different lighting condition
 - 3 different tensions
 - 2 different background

144 images per knot

1440 images total in dataset

Dataset from Kaggle

Source Light Above Very Loose Bowline Knot



Diffuse Light Set Bowline Knot



- ▼ 10Knots
 - ▼ Alpine Butterfly Knot
 - ▼ DiffuseLight
 - ▶ Loose
 - ▶ Set
 - ▶ VeryLoose
 - ▼ SourceLight-Above
 - ▶ Loose
 - ▶ Set
 - ▶ VeryLoose
 - ▼ SourceLight-Side
 - ▶ Loose
 - ▶ Set
 - ▶ VeryLoose
 - ▶ Bowline Knot
 - ▶ Clove Hitch
 - ▶ Figure-8 Knot
 - ▶ Figure-8 Loop
 - ▶ Fisherman's Knot
 - ▶ Flemish Bend
 - ▶ Overhand Knot
 - ▶ Reef Knot
 - ▶ Slip Knot

Methods

80% of the images will be placed in the training dataset

10% will be utilized for validation during the training process

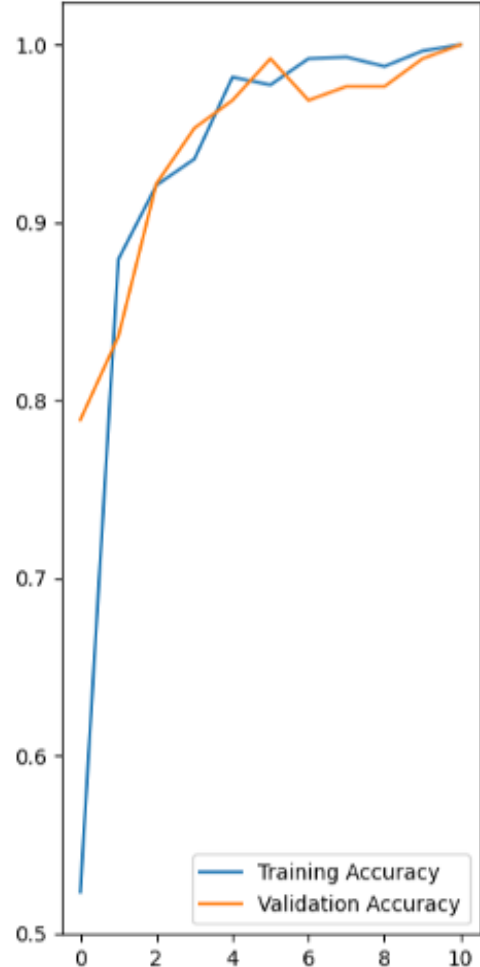
10% will be utilized for the test dataset to test the model after training

There were 4 total models trained:

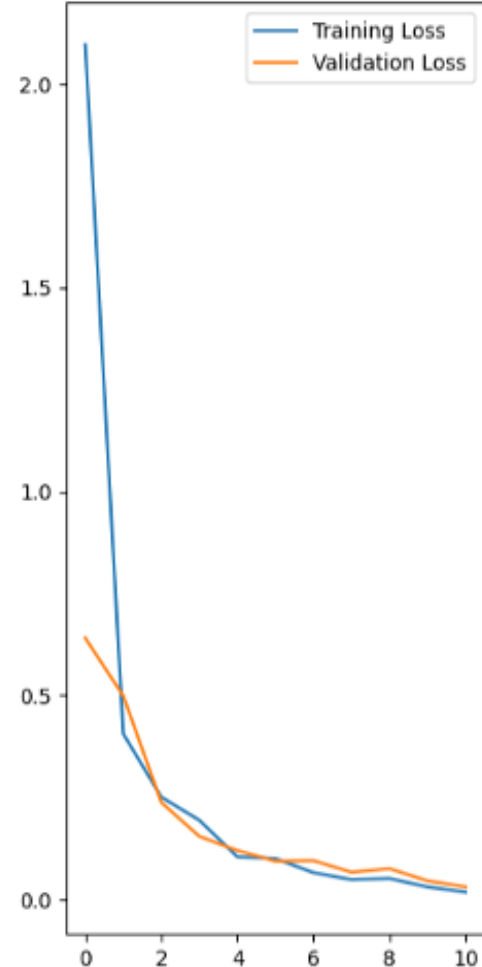
1. A model architecture of codebasics [8].
2. A model architecture of the small convolution layer in Cameron's dissertation [7].
3. A model architecture of the medium convolution layer in Cameron's dissertation [7].
4. A model architecture of the transfer layer on pre-trained ResNet model [5].

Results: Transfer Learning ResNet50

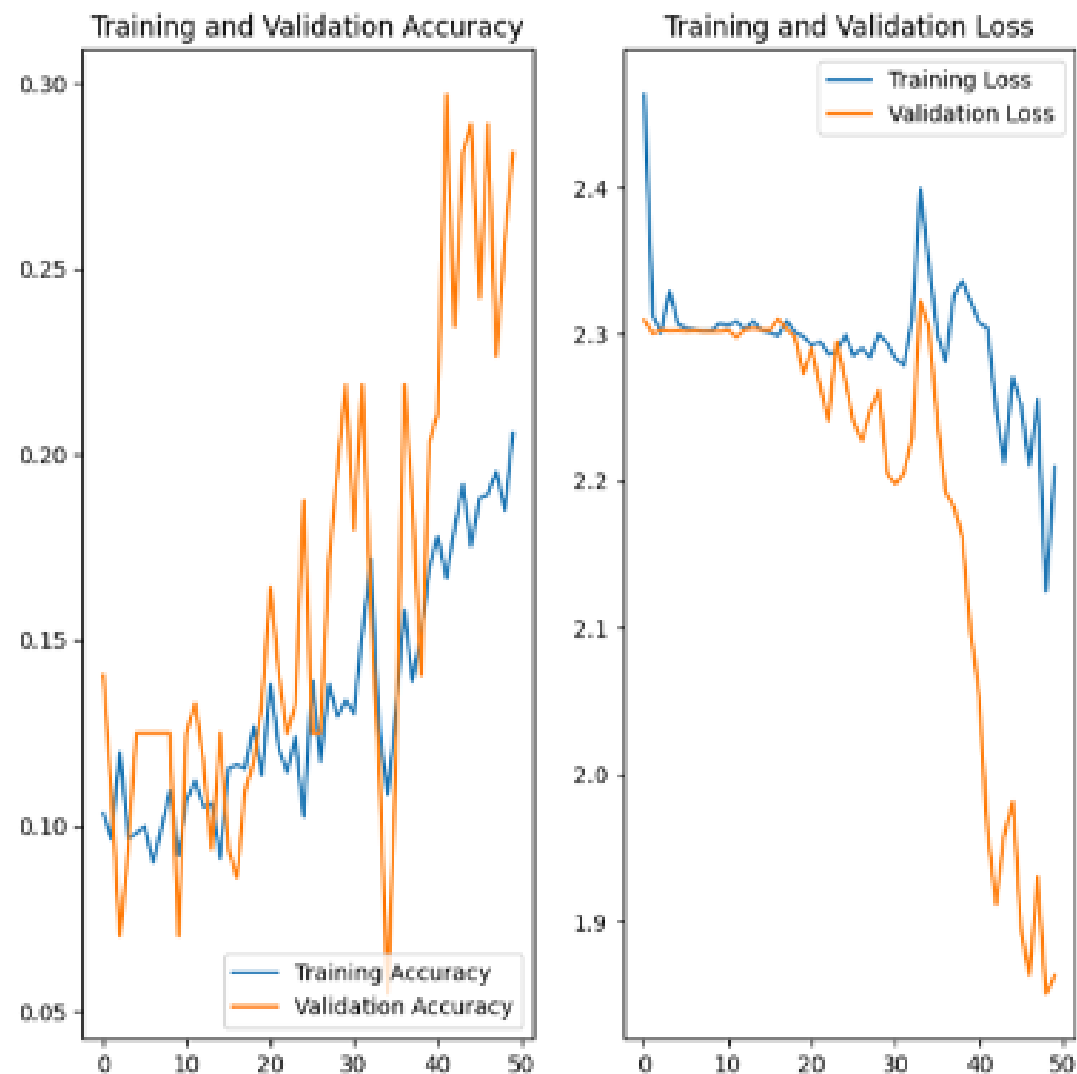
Training and Validation Accuracy



Training and Validation Loss



Results: Model 3 Medium CNN





Demo