CAPTCHA Code Detection

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Agenda

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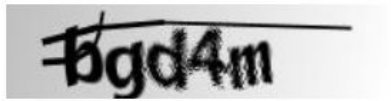
The Goal of the Project

- The goal of this project is to design and implement a Convolutional Recurrent Neural Network (CRNN) to predict the text content within CAPTCHA code.
- The 1st portion will processing the visual information through convolutional layers to capture the spatial hierarchies in the images.
- Then the 2nd portion will utilizing recurrent layers to decode the sequential information into a string of text.
- The project aims to handle a variety of CAPTCHA styles and complexities with high accuracy.

About the Dataset

- Open source dataset: link
- Properties of the Dataset
  - The dataset contains 1070 captcha images.
  - All the images have the original labels as a file name.
  - Each of the images contains a 5-digit captcha code.
- Example Images:

		
2pfpn	3ny45	bgd4m

Implementation Process

Three phases of the implementation:-

1. Pre-processing
2. Model Training and Prediction
3. Post-processing

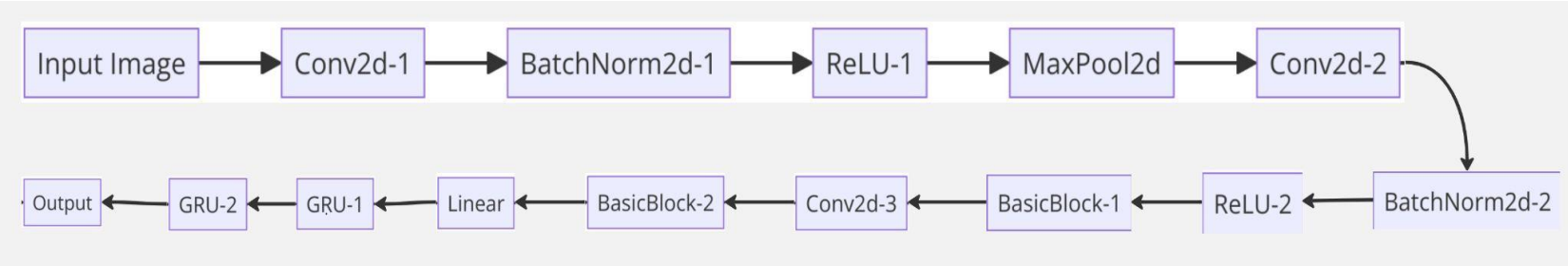
Implementation Process: Pre-Processing

There are several process included in the pre-processing section:

1. Image Loading and Label Extraction
2. Data Set Splitting
3. Creating Data-loader objects

Implementation Process: Model Training

- **Model Architecture:**



- **Component of the Architecture:**
  - **Pretrained ResNet-18 Backbone**
  - **Custom CNN Layers**
  - **Custom RNN Layer**
  - **Linear Transformation**

Model Training (continue…)

Initialization and Training

- **Weight Initialization:**
  - Xavier initialization for linear and convolutional layers
  - Normal distribution for batch normalization layers
- **Training Setup:**
  - Batch Size: 16
  - Number of Epochs: 50
  - Learning Rate and Weight Decay: 0.001
  - Loss Function: CTCLoss
  - Optimizer: Adam
  - Learning Scheduler: ReduceLROnPlateau

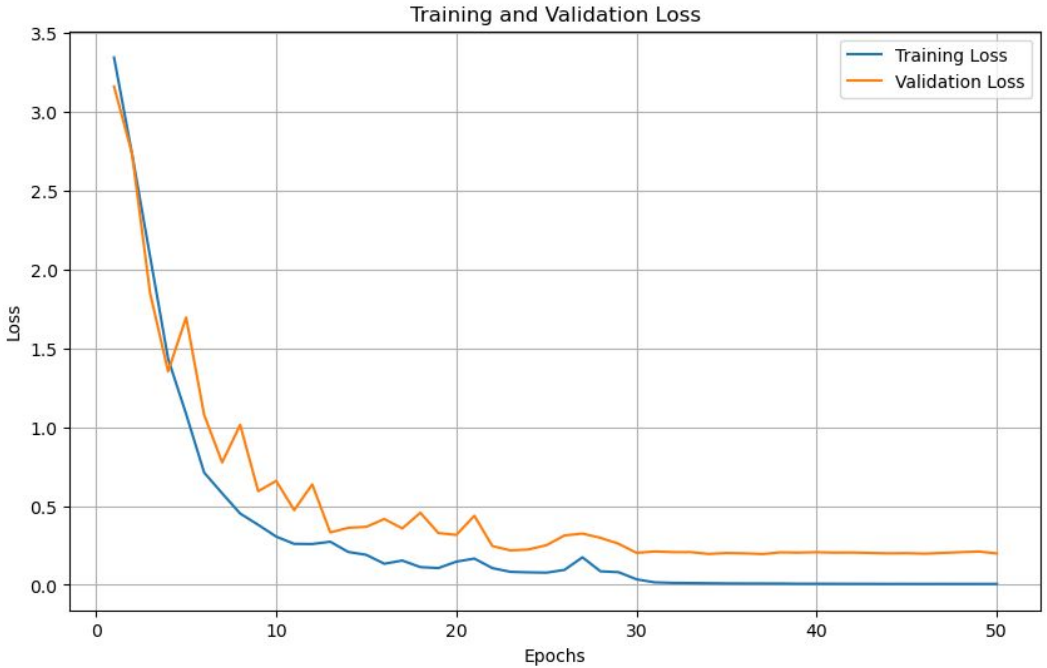
Implementation Process: Post-Processing

Post-processing pipeline:

- Prediction Results Gathering
- Duplicate Character Removal
- Post-processing Correction

Result Analysis

Loss Curve for both training and validation set:



Result Analysis (Continue)

actual	prediction	prediction_corrected
w4cdc	w4----cd-c	w4cdc
n4xx5	n4----xx-5	n4x5
e76n4	e7----6n-4	e76n4
ddcdd	dd--d-cd-d	ddcdd
bbymy	bb----ymmy	bymy

Correct Prediction

actual	prediction	prediction_corrected
n4xx5	n4----xx-5	n4x5
bbymy	bb----ymmy	bymy
yyg5g	yy----g55g	yg5g
emwpn	em-----wpp	emwp
mx8bb	m-x----8bb	mx8b

Wrong Prediction

Model Accuracy

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Model Accuracy on training set:  0.999

Model Accuracy on validation set:  0.806

Model Accuracy on test set:  0.813

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Conclusion

- The model has achieved impressive accuracy of 99.9% on the training set with an accuracy.
- But the performance on the validation and test sets is lower, with accuracies of 80.6% and 81.3%, respectively.
- This suggesting a gap in the model's ability to generalize to unseen data compared to its performance on the training data.

References/Links

1. https://www.kaggle.com/datasets/fournierp/captcha-version-2-images
2. Project Link: https://github.com/AhmedDiderRahat/captcha_detection/tree/main

Thank You