Handwriting recognition in Bengali

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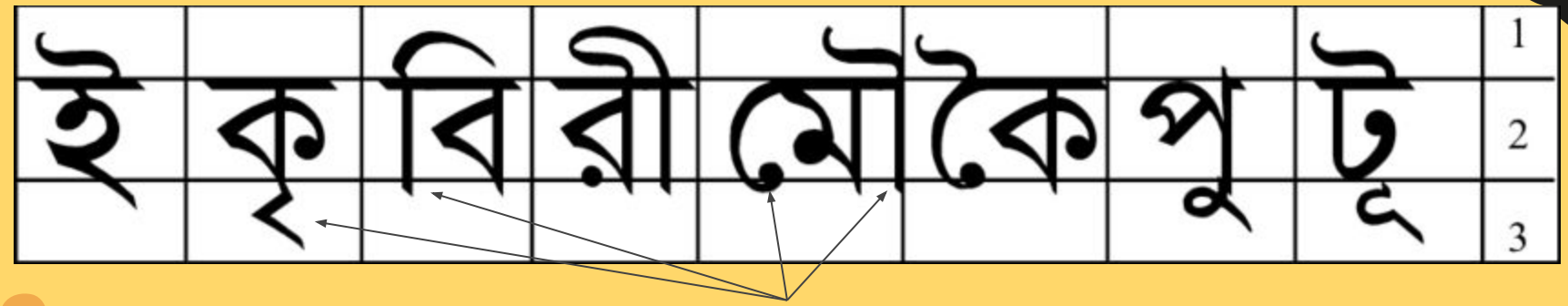
Capstone Project

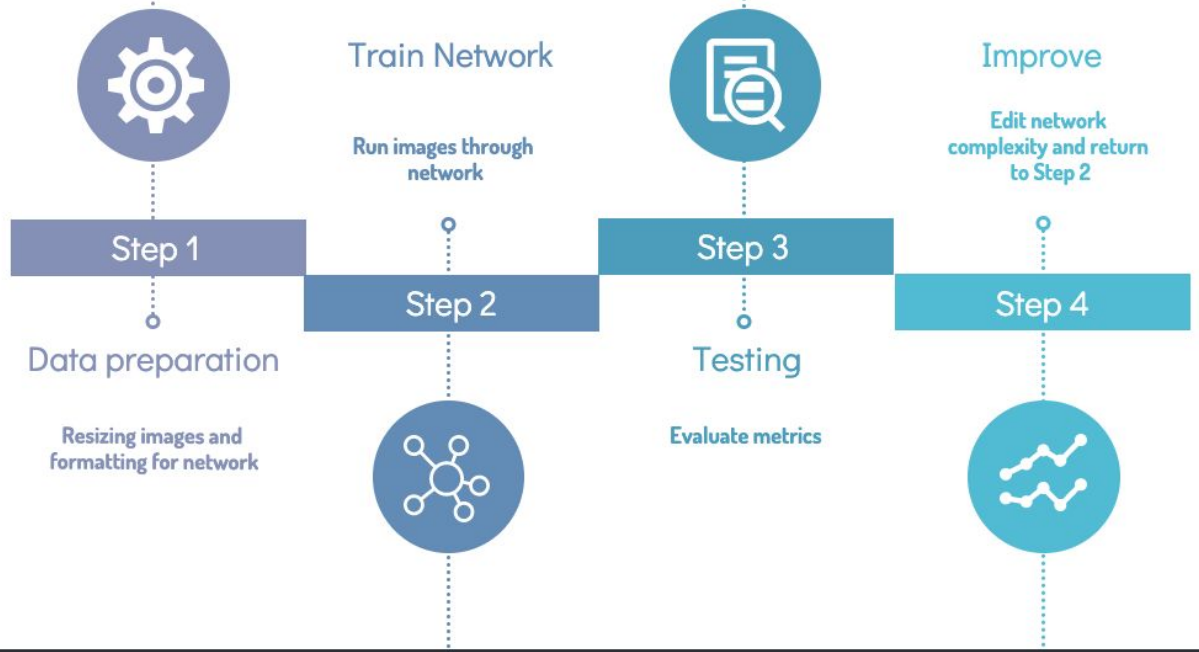
Bengali Characters



Accents can exist below the root, on the left or the right, or on both the left and right

There are over 10,000 combinations of root, vowel and consonant accents. The aim is to use approximately 1000 different combinations to be able to classify the other 9000+ combinations.

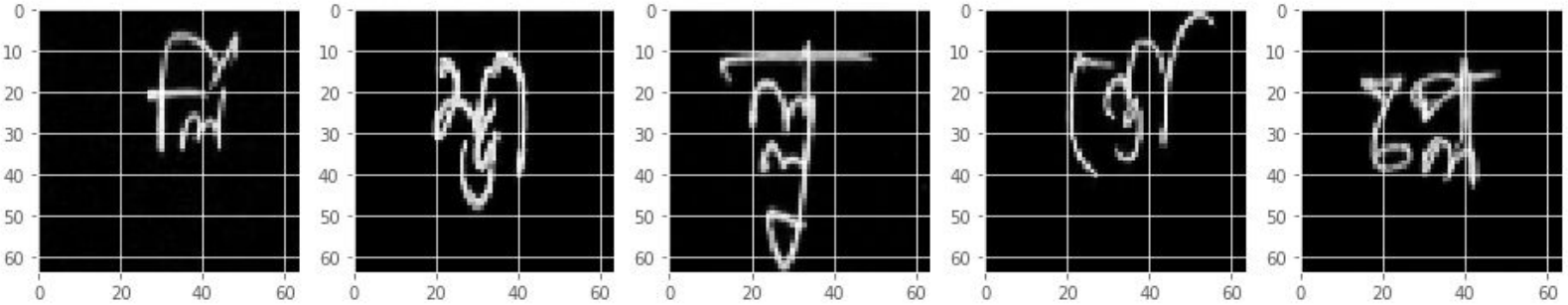
Convolutional Neural Network



Model performance

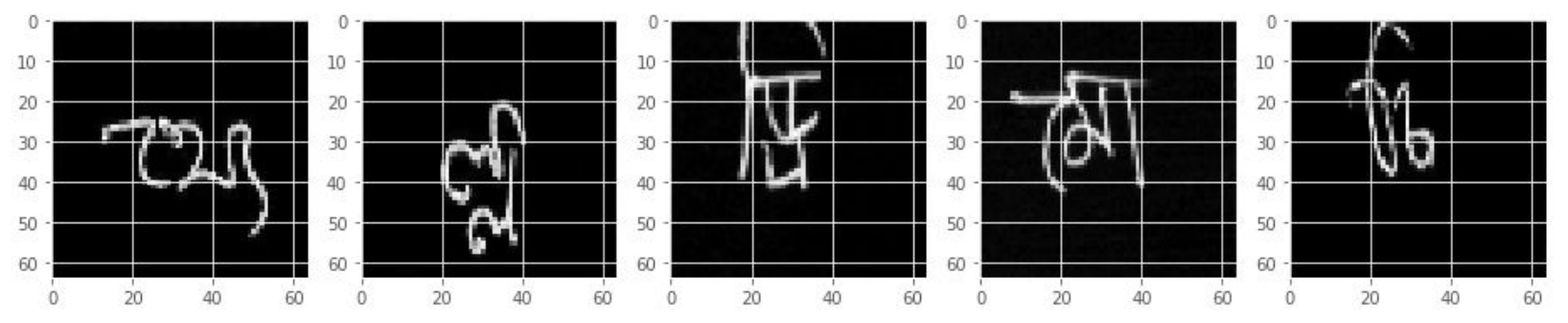
How well are the characters identified?

First Model



	predicted						true					
	root	r_comp	vowel	v_comp	consonant	c_comp	root	r_comp	vowel	v_comp	consonant	c_comp
image_0	72	দ	2	ি	2	ব্	124	ল	2	ি	2	ব্
image_1	119	ম্ভ	1	া	0	0	119	ম্ভ	1	া	0	0
image_2	132	ল্ল	4	ু	0	0	132	ল্ল	4	ু	0	0
image_3	71	থ	9	ো	2	ব্	86	ন্ত	9	ো	0	0
image_4	153	স্প	7	ে	0	0	101	প্প	7	ে	0	0

Final Model



	predicted						true					
	root	r_comp	vowel	v_comp	consonant	c_comp	root	r_comp	vowel	v_comp	consonant	c_comp
image_0	71	থ	7	ে	4	া	71	থ	7	ে	4	া
image_1	132	ল্ল	0	0	0	0	132	ল্ল	0	0	0	0
image_2	56	ড	2	ি	5	্র	56	ড	2	ি	5	্র
image_3	115	ম	9	ো	0	0	115	ম	9	ো	0	0
image_4	38	চ	2	ি	0	0	38	চ	2	ি	0	0

92.15%

Root prediction accuracy

98.00%

Vowel prediction accuracy

97.84%

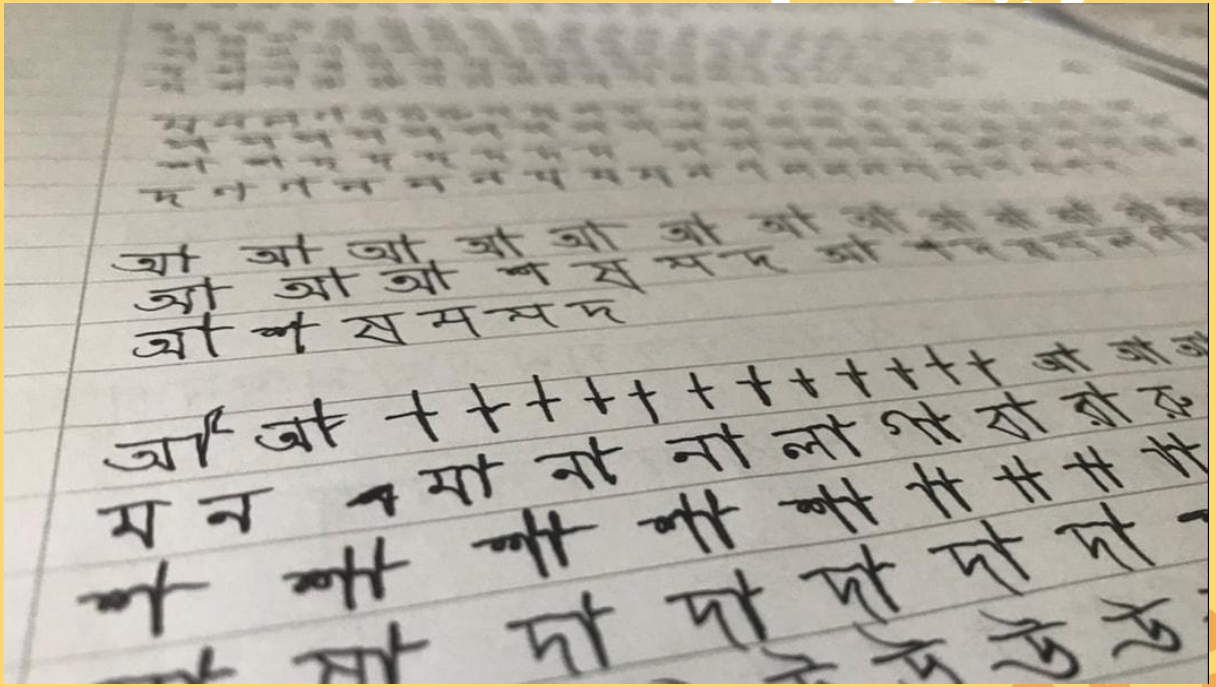
Consonant prediction accuracy

Why?

- Handwriting recognition systems can help digitally input information to streamline operations (bank cheques, postal addresses)
- Can also be used in translation applications

Thanks!

Any questions?



Appendix

Network Structure

```
inputs = Input(shape = (64, 64, 1))

model = Conv2D(filters=32, kernel_size=(3, 3), padding='SAME', activation='relu', input_shape=(64, 64, 1))(inputs)
model = Conv2D(filters=32, kernel_size= (3,3), padding='SAME', activation='relu')(model)
model = BatchNormalization(momentum=0.15)(model)
model = MaxPool2D(pool_size=(2, 2))(model)
model = Conv2D(filters=32, kernel_size= (5,5), padding='SAME', activation='relu')(model)
model = BatchNormalization(momentum=0.15)(model)
model = Dropout(rate=0.2)(model)

model = Conv2D(filters=64, kernel_size=(3, 3), padding='SAME', activation='relu')(model)
model = BatchNormalization(momentum=0.15)(model)
model = MaxPool2D(pool_size=(2, 2))(model)
model = Conv2D(filters=64, kernel_size= (5,5), padding='SAME', activation='relu')(model)
model = BatchNormalization(momentum=0.15)(model)
model = Dropout(rate=0.2)(model)

model = Conv2D(filters=128, kernel_size=(3, 3), padding='SAME', activation='relu')(model)
model = BatchNormalization(momentum=0.15)(model)
model = Conv2D(filters=128, kernel_size= (5,5), padding='SAME', activation='relu')(model)
model = BatchNormalization(momentum=0.15)(model)
model = MaxPool2D(pool_size=(2, 2))(model)
model = Dropout(rate=0.2)(model)

model = Flatten()(model)
model = Dense(1024, activation = "relu")(model)
model = Dropout(rate=0.3)(model)
dense = Dense(512, activation = 'relu')(model)

root = Dense(168, activation = 'softmax')(dense)
vowel = Dense(11, activation = 'softmax')(dense)
consonant = Dense(7, activation = 'softmax')(dense)

model = Model(inputs=inputs, outputs=[root, vowel, consonant])
```

Network improvement