

# CLASSIFYING N64 IMAGE TEXTURES WITH CONVOLUTIONAL NEURAL NETWORKS.



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# PROJECT DESCRIPTION

- Attempt to use **Convolutional Neural Networks** in order to classify image textures from **Nintendo 64 games** by use in game development or game modding.
- Images are taken from popular Mario modding resource **smwcentral.net**
- Data was **hand labeled** into what I consider to be the most useful categories based on personal experience
- Three **CNN models** were successfully trained and compared based on accuracy



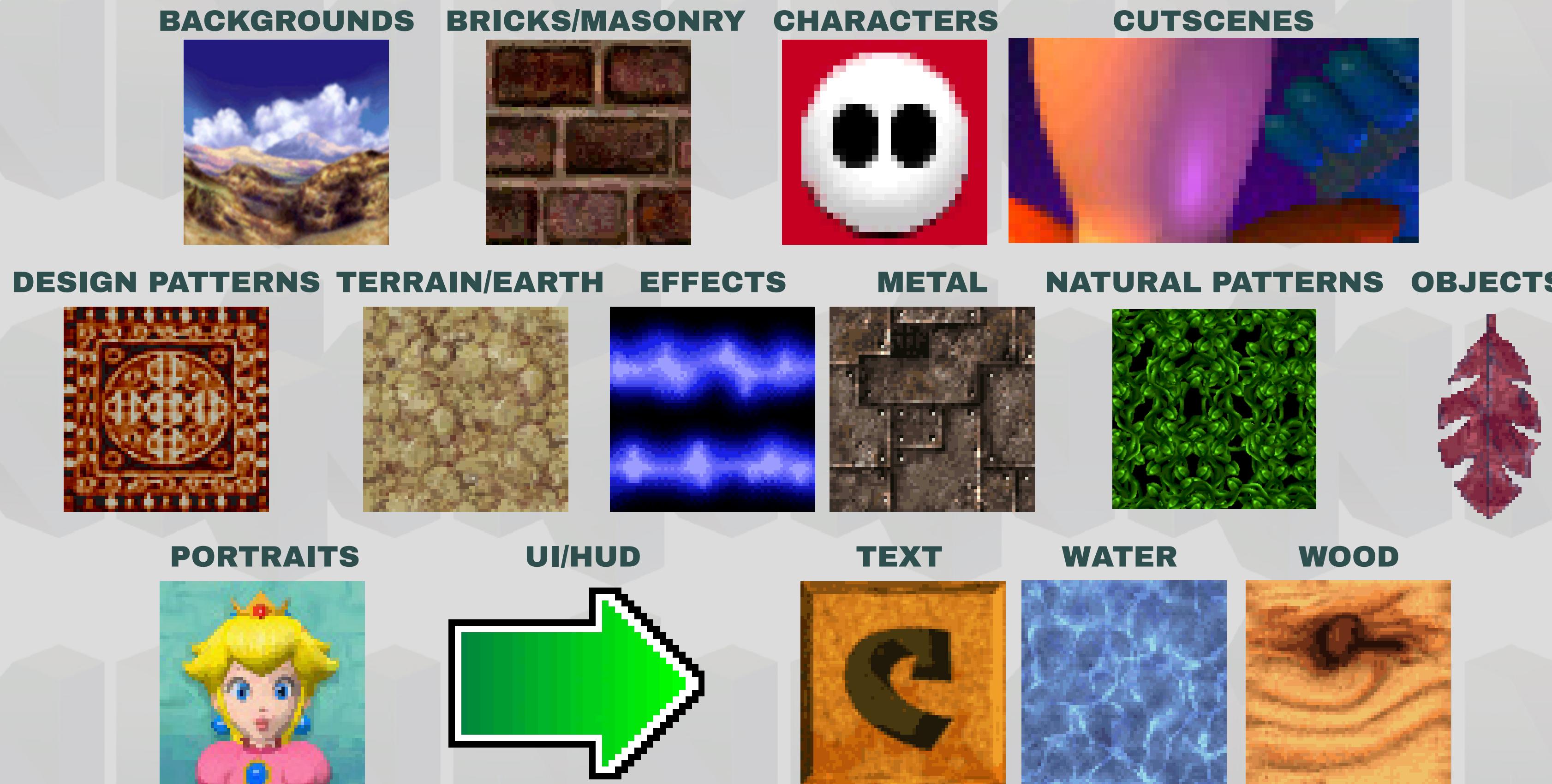
# PROJECT SCOPE

- **Pre-capstone:** Finding data, data cleaning
- **Day One:** Labeling, image generation, baseline model prelim
- **Day Two:** Labeling, baseline model work, building other models, callbacks
- **Day Three:** Tuning hyperparameters, refining callbacks, Google CoLab setup
- **Day Four:** Generating graphs and visuals, presentation work
- **Day Five:** Presentation refinement and rehearsal, Github



# DATA ORGANIZATION

- Around 17,000 .png and .bmp images were taken from [smwcentral.net](http://smwcentral.net)
- Most images were 32x32 pixels in RGBA colorspace
- Around 5,000 images were successfully labeled into 15 categories:



# DATA ISSUES

- Hand labeling is time intensive and inconsistent
- Unbalanced labels
- Differences in artistic style between games
- Differences in texture utility between games
- Low resolution prevented the use of some CNN models (Inception)
- Small set of images limits amount of epochs, steps per epochs and validation steps

# MODEL SUMMARIES

- Used **simple sequential model** with 2 convolutional layers as baseline
- Used **deeper sequential model** with more layers as intermediate
- Used **RESNET 34** model as best performing model
- Attempted an **Inception** model, but did not work with the low resolution RGBA images



# MODEL SUMMARIES

## Baseline:

Layer (type)	Output Shape	Param #
conv2d (Conv2D)	(None, 26, 26, 64)	12608
max_pooling2d (MaxPooling2D)	(None, 13, 13, 64)	0
conv2d_1 (Conv2D)	(None, 7, 7, 64)	200768
max_pooling2d_1 (MaxPooling2 (None, 3, 3, 64)	0	
flatten (Flatten)	(None, 576)	0
dense (Dense)	(None, 128)	73856
dropout (Dropout)	(None, 128)	0
dense_1 (Dense)	(None, 64)	8256
dropout_1 (Dropout)	(None, 64)	0
dense_2 (Dense)	(None, 15)	975

Total params: 296,463  
 Trainable params: 296,463  
 Non-trainable params: 0

## Sequential:

Layer (type)	Output Shape	Param #
conv2d_2 (Conv2D)	(None, 30, 30, 64)	2368
max_pooling2d_2 (MaxPooling2 (None, 15, 15, 64)	0	
conv2d_3 (Conv2D)	(None, 13, 13, 64)	36928
max_pooling2d_3 (MaxPooling2 (None, 6, 6, 64)	0	
conv2d_4 (Conv2D)	(None, 4, 4, 64)	36928
max_pooling2d_4 (MaxPooling2 (None, 2, 2, 64)	0	
flatten_1 (Flatten)	(None, 256)	0
dense_3 (Dense)	(None, 128)	32896
dropout_2 (Dropout)	(None, 128)	0
dense_4 (Dense)	(None, 64)	8256
dropout_3 (Dropout)	(None, 64)	0
dense_5 (Dense)	(None, 15)	975

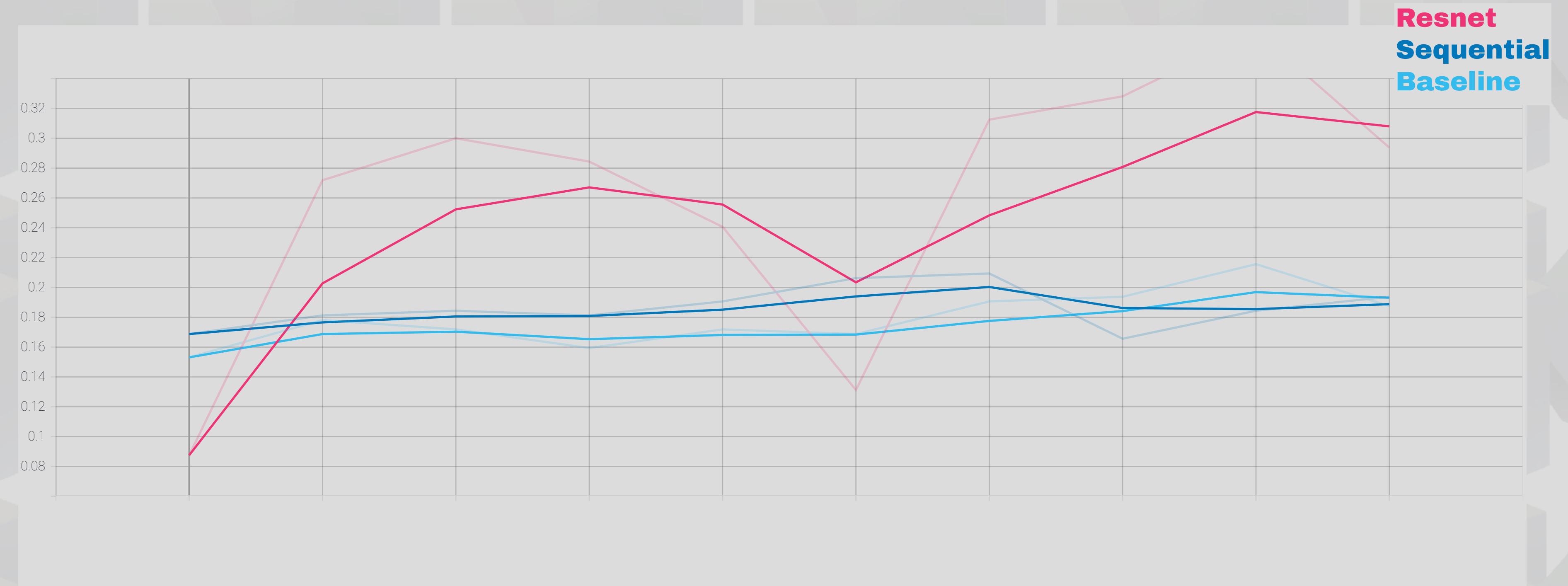
Total params: 118,351  
 Trainable params: 118,351  
 Non-trainable params: 0

## Resnet 34:

Layer (type)	Output Shape	Param #
conv2d_5 (Conv2D)	(None, 16, 16, 64)	12544
batch_normalization (BatchNo (None, 16, 16, 64)	256	
activation (Activation)	(None, 16, 16, 64)	0
max_pooling2d_5 (MaxPooling2 (None, 8, 8, 64)	0	
residual_unit (ResidualUnit) (None, 8, 8, 64)	74240	
residual_unit_1 (ResidualUni (None, 8, 8, 64)	74240	
residual_unit_2 (ResidualUni (None, 8, 8, 64)	74240	
residual_unit_3 (ResidualUni (None, 4, 4, 128)	230912	
residual_unit_4 (ResidualUni (None, 4, 4, 128)	295936	
residual_unit_5 (ResidualUni (None, 4, 4, 128)	295936	
residual_unit_6 (ResidualUni (None, 4, 4, 128)	295936	
residual_unit_7 (ResidualUni (None, 2, 2, 256)	920576	
residual_unit_8 (ResidualUni (None, 2, 2, 256)	1181696	
residual_unit_9 (ResidualUni (None, 2, 2, 256)	1181696	
residual_unit_10 (ResidualUn (None, 2, 2, 256)	1181696	
residual_unit_11 (ResidualUn (None, 2, 2, 256)	1181696	
residual_unit_12 (ResidualUn (None, 2, 2, 256)	1181696	
residual_unit_13 (ResidualUn (None, 1, 1, 512)	3676160	
residual_unit_14 (ResidualUn (None, 1, 1, 512)	4722688	
residual_unit_15 (ResidualUn (None, 1, 1, 512)	4722688	
global_average_pooling2d (GI (None, 512)	0	
flatten_2 (Flatten)	(None, 512)	0
dense_6 (Dense)	(None, 15)	7695

Total params: 21,312,527  
 Trainable params: 21,295,503  
 Non-trainable params: 17,024

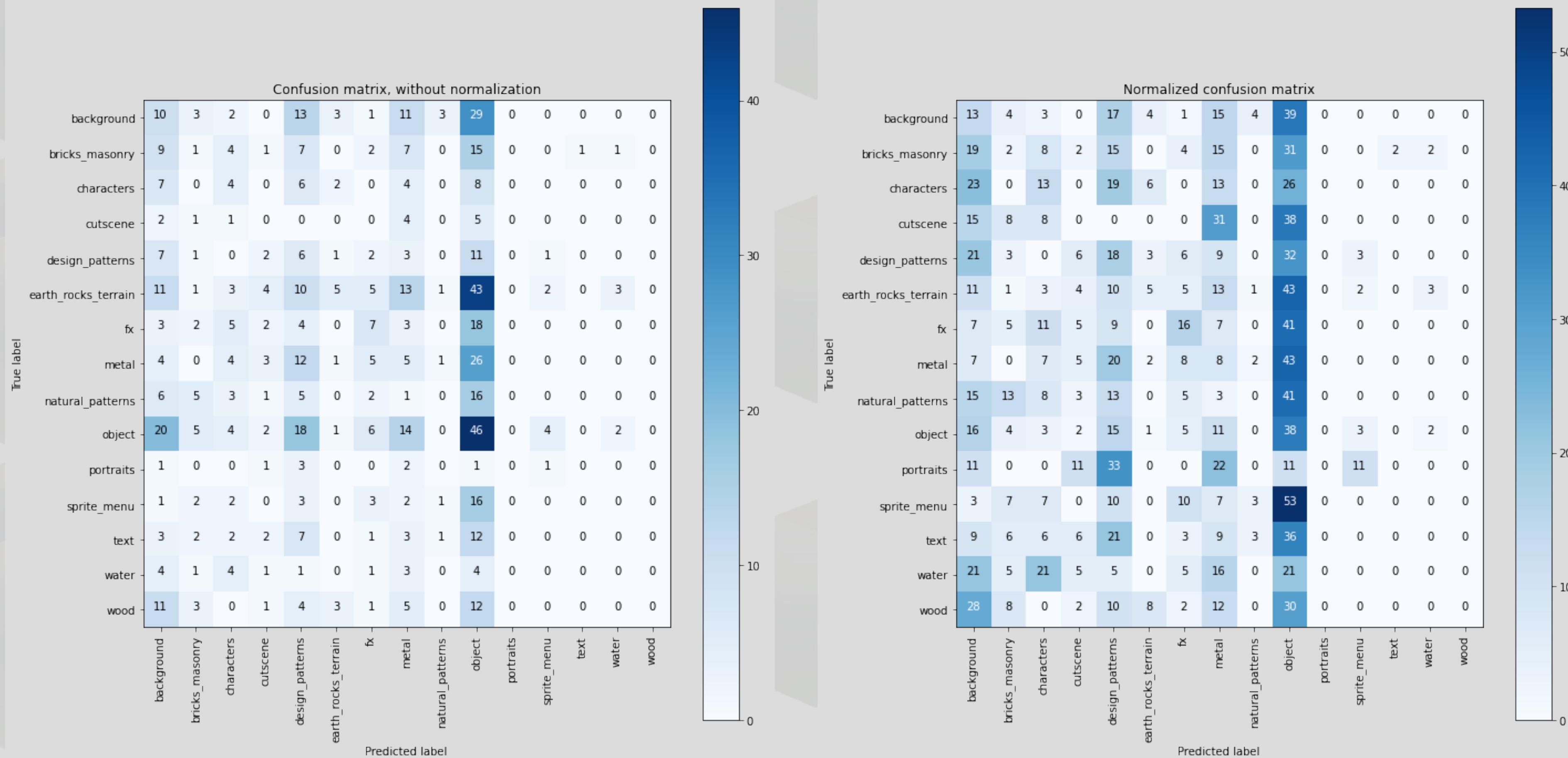
# ACCURACY SCORES



- 80 epochs
- 10 epoch steps
- 10 validation steps

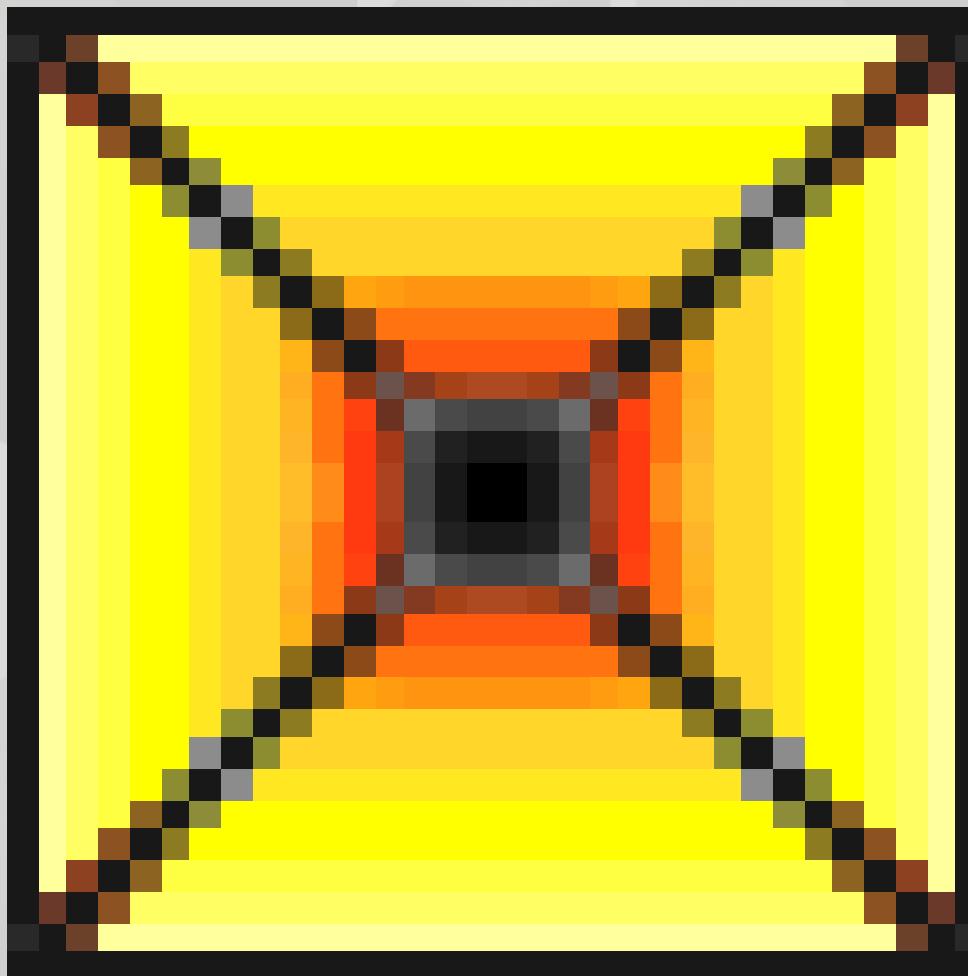
- Baseline accuracy: 0.19
- Sequential accuracy: 0.2
- Resnet accuracy: 0.32

# RESNET CONFUSION MATRICES

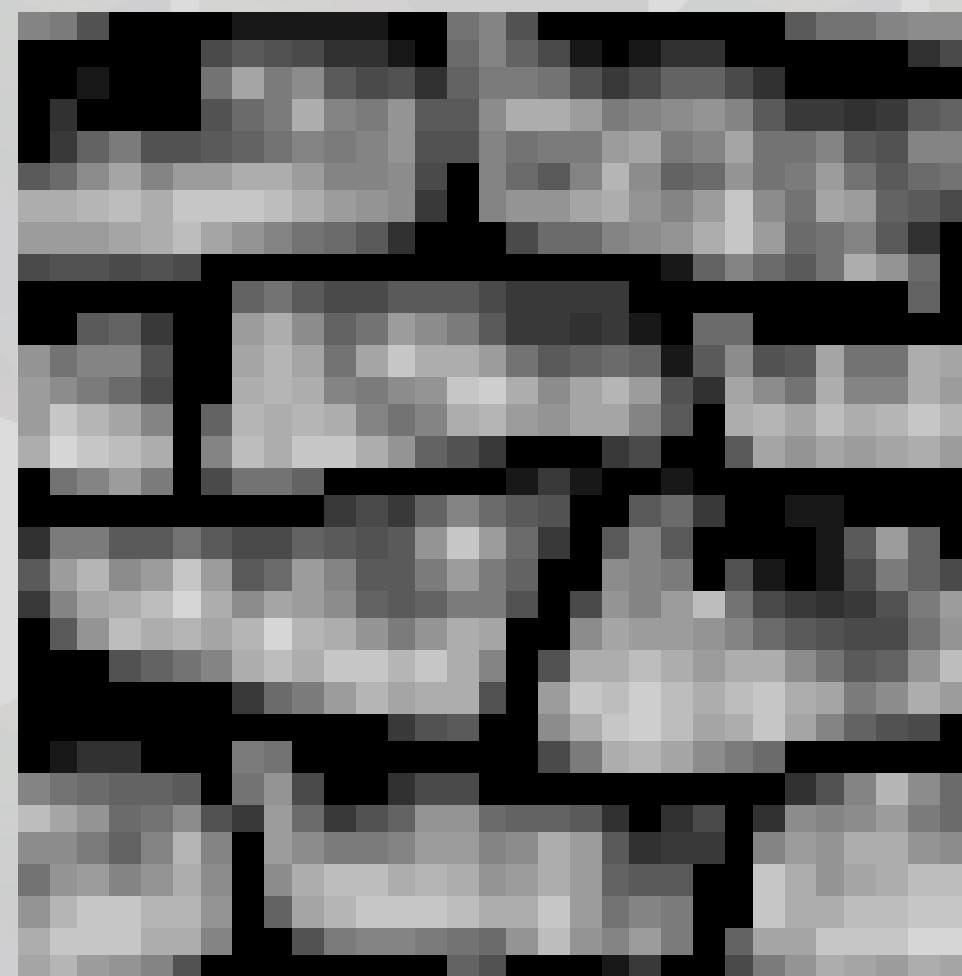


# PREDICTION SAMPLES

Predicted: object  
Actual: object  
Confidence:0.6



Predicted: bricks\_masonry  
Actual: bricks\_masonry  
Confidence:0.17



Predicted: object  
Actual: metal  
Confidence:0.6



Predicted: bricks\_masonry  
Actual: object  
Confidence:0.17



# NEXT STEPS

- Find a comparable CCO or open source set of image textures
- Reassess categories
- Try more advanced models (pretrained models)
- Generate new image textures from trained models

