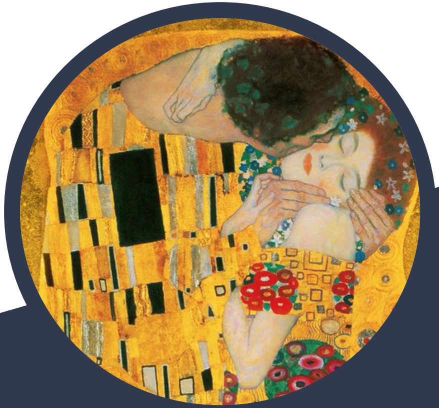
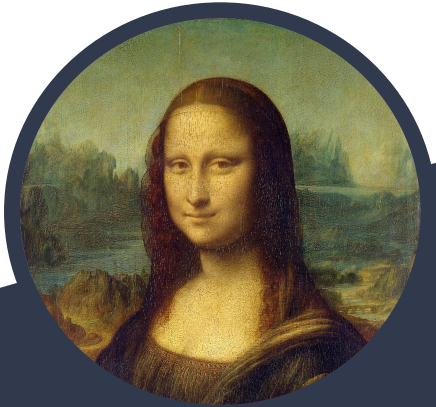
Classifying Paintings by Artistic Genre with Deep Learning





Team #72

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Problem

- The artistic style of a painting describes the visual and historical information about a painting
- Correctly identifying the artistic style of paintings is necessary to index large artistic databases
- Detect artistic style of a painting using the Wikiart database

Data

WikiArt Dataset (Primary)

- 20+ distinct artistic styles
- 80 000+ fine art paintings
- 1 000+ artists
- 1500s to Present

Supplementary Data

- Pedro Torres' Kaggle Dataset
- BryanB's Abstract Art Gallery Dataset

Data Processing

1. Aggregate images from different datasets into labelled folders which express their associated classifications

2. Use python script to shuffle images in folders and select the number of datapoints we want

3. Resize images to 128x128 pixels

4. Split the data into training, validation, and testing sets

5. Compute mean of all pixel values of training set, and then subtract the mean from the pixel values in all the sets

Models

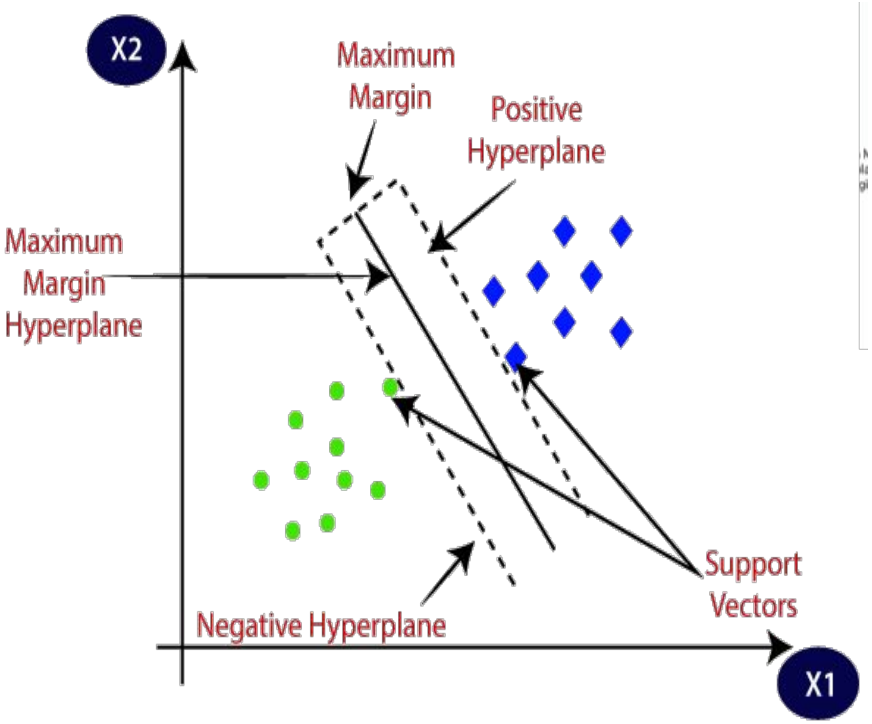
BASELINE

CNN

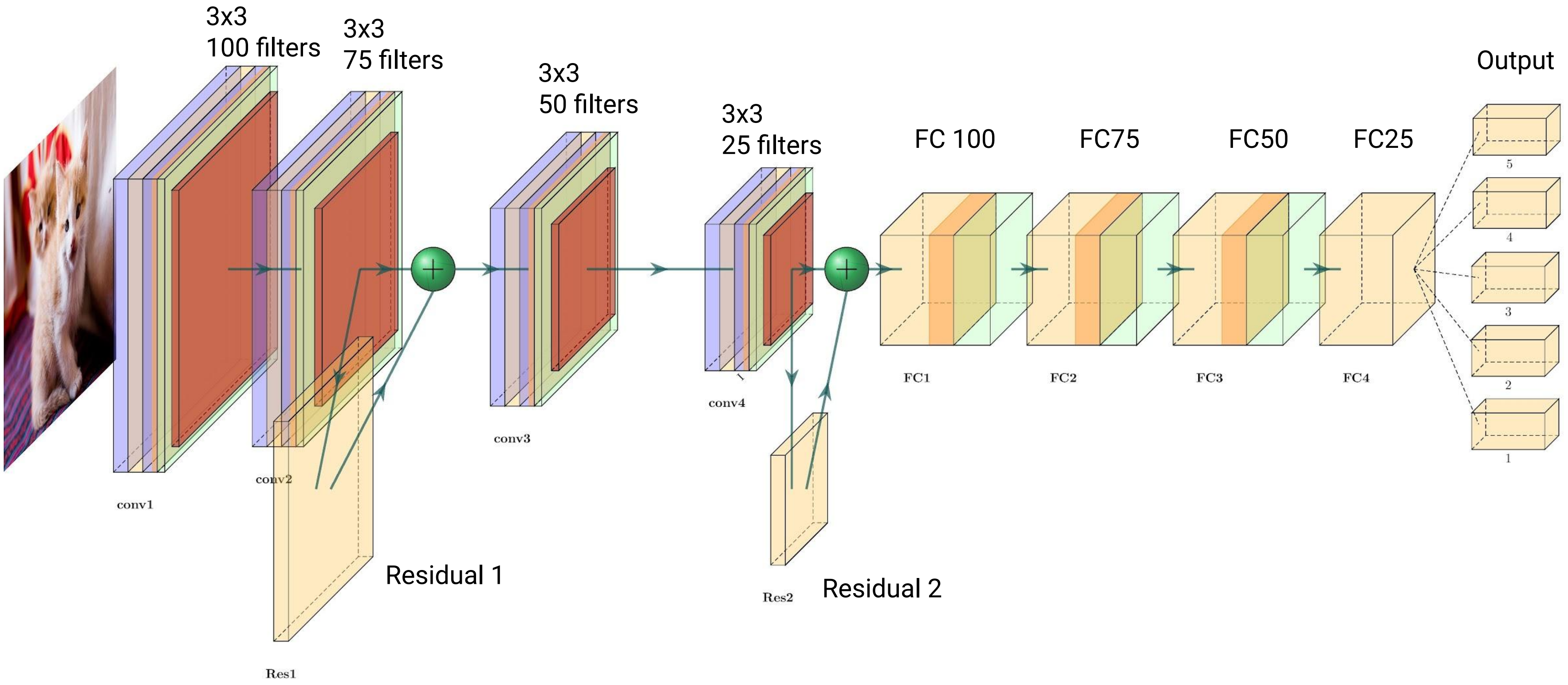
RESNET

Baseline: Support Vector Machine

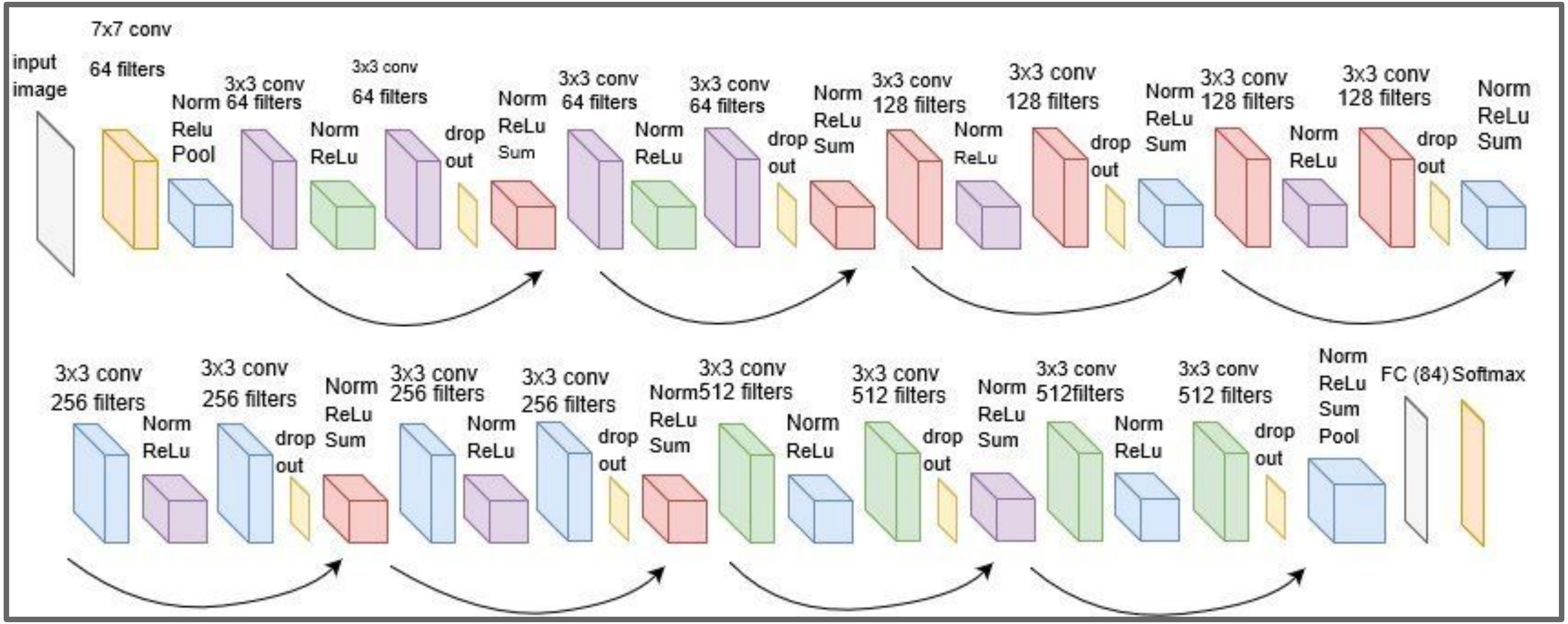
- Linear Kernel
- L2 penalty
- Squared-Hinge loss
- Dual optimization
- One-vs-Rest multi-class classification



CNN Architecture



ResNet-18 Architecture



Baseline Qualitative and Quantitative Results

Baseline Testing 5 Styles Confusion Matrix

Confusion Matrix -- Testing:

	a_Romanticism_2000	a_Cubism_2000	a_Expressionism_2000	a_Symbolism_2000	a_Impressionism_2000
p_Romanticism_2000	104.0	54.0	62.0	52.0	55.0
p_Cubism_2000	54.0	52.0	62.0	51.0	53.0
p_Expressionism_2000	37.0	61.0	69.0	42.0	43.0
p_Symbolism_2000	47.0	45.0	43.0	73.0	51.0
p_Impressionism_2000	68.0	76.0	60.0	75.0	111.0

Class Metric Scores -- Testing:

	Romanticism_2000	Cubism_2000	Expressionism_2000	Symbolism_2000	Impressionism_2000
Recall	0.335484	0.180556	0.233108	0.249147	0.354633
Precision	0.318043	0.191176	0.273810	0.281853	0.284615
F1-Score	0.326531	0.185714	0.251825	0.264493	0.315789

Micro F1-Score -- Testing: 0.27
Macro F1-Score -- Testing: 0.27
Weighted F1-Score -- Testing: 0.27
Final Testing Accuracy (Baseline Model -- Support Vector Machine [Linear Kernel]): 27.0%

Low accuracy indicates intrinsically difficult problem

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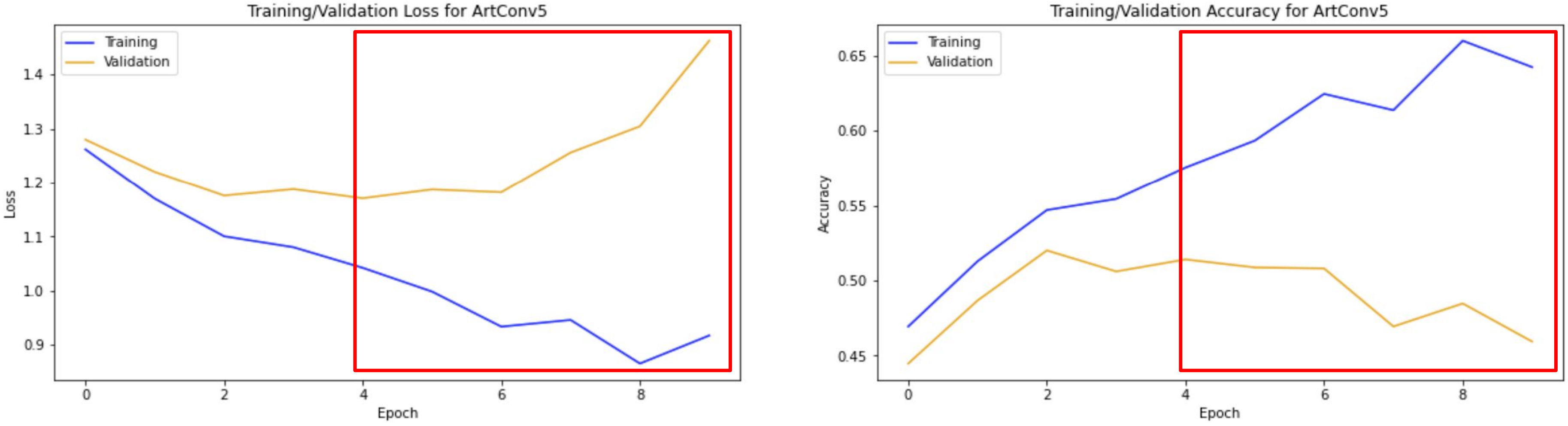
Cubism was worst predicted despite distinct features

CNN For 5 Styles Training Results

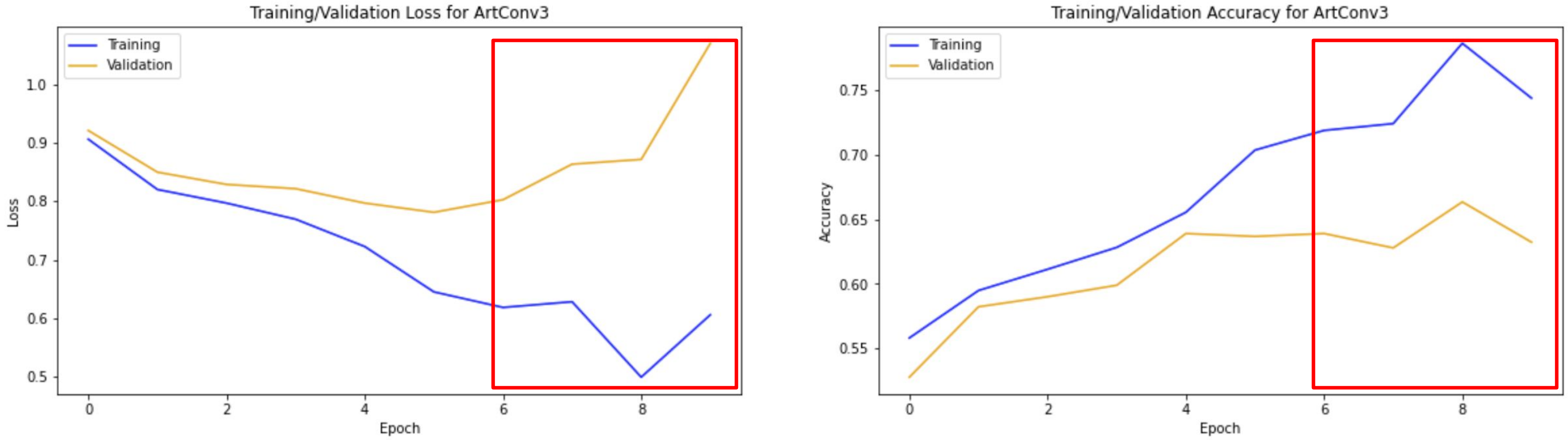
```
Final Training Loss/Accuracy for ArtConv5: 0.9171773252162067 / 0.6424796457648907
Final Validation Loss/Accuracy for ArtConv5: 1.4625743329524994 / 0.4593333333333333
```



Noticeable overfitting occurs at epoch 4

CNN For 3 Styles Training Results

```
Final Training Loss/Accuracy for ArtConv3: 0.6060431518337943 / 0.7436874702239161
Final Validation Loss/Accuracy for ArtConv3: 1.0698586543401083 / 0.6322222222222222
```



Noticeable overfitting occurs at epoch 6

CNN Qualitative and Quantitative Results

CNN 5 Styles Testing Confusion Matrix

```
Confusion Matrix -- Testing:
```

	a_Cubism_2000	a_Symbolism_2000	a_Expressionism_2000	a_Impressionism_2000	a_Romanticism_2000
p_Cubism_2000	194.0	9.0	62.0	15.0	5.0
p_Symbolism_2000	22.0	92.0	32.0	33.0	17.0
p_Expressionism_2000	101.0	40.0	109.0	34.0	18.0
p_Impressionism_2000	13.0	34.0	29.0	156.0	43.0
p_Romanticism_2000	6.0	90.0	47.0	92.0	207.0

```
Class Metric Scores -- Testing:
```

	Cubism_2000	Symbolism_2000	Expressionism_2000	Impressionism_2000	Romanticism_2000
Recall	0.577381	0.347170	0.390681	0.472727	0.713793
Precision	0.680702	0.469388	0.360927	0.567273	0.468326
F1-Score	0.624799	0.399132	0.375215	0.515702	0.565574

```
Macro F1-Score -- Testing: 0.5
Weighted F1-Score -- Testing: 0.5
Final Testing Accuracy for ArtConv5: 51.0%
```

Noticeable improvement over baseline

CNN Qualitative and Quantitative Results

CNN 5 Styles Testing Confusion Matrix

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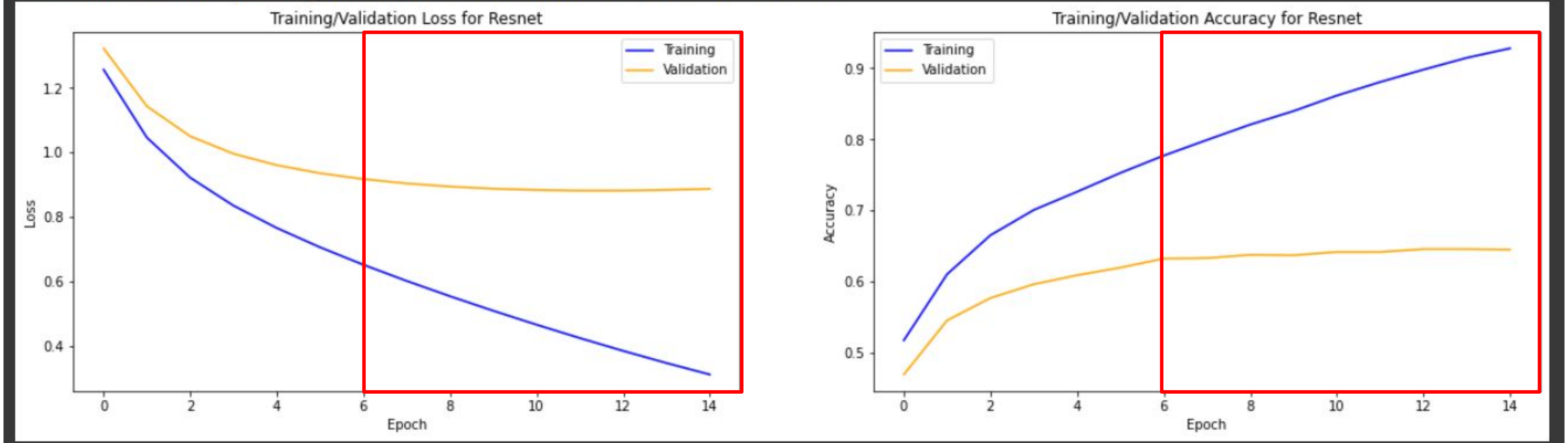
Macro F1-Score -- Testing: 0.5
Weighted F1-Score -- Testing: 0.5
Final Testing Accuracy for ArtConv5: 51.0%

Cubism and Romanticism were predicted the best

ResNet-18 For 5 Styles Results

```
Final Training Loss/Accuracy for Resnet: 0.31021001853726127 / 0.92772461076989
Final Validation Loss/Accuracy for Resnet: 0.8867542942365011 / 0.6453333333333333
```



Noticeable overfitting at epoch 6

Validation accuracy levels off at 60%

ResNet-18 5 Styles Test Results

ResNet-18 5 Styles Testing Confusion Matrix

Confusion Matrix -- Testing:

	actual_Impressionism_2000	actual_Expressionism_2000	actual_Symbolism_2000	actual_Cubism_2000	actual_Romanticism_2000
predicted_Impressionism_2000	239.0	17.0	46.0	3.0	37.0
predicted_Expressionism_2000	26.0	161.0	56.0	46.0	18.0
predicted_Symbolism_2000	22.0	20.0	153.0	8.0	28.0
predicted_Cubism_2000	6.0	47.0	12.0	228.0	1.0
predicted_Romanticism_2000	28.0	33.0	60.0	0.0	205.0

Class Metric Scores -- Testing:

	Impressionism_2000	Expressionism_2000	Symbolism_2000	Cubism_2000	Romanticism_2000
Recall	0.744548	0.579137	0.467890	0.800000	0.709343
Precision	0.698830	0.524430	0.662338	0.775510	0.628834
F1-Score	0.720965	0.550427	0.548387	0.787565	0.666667

Test Accuracy: 0.658

Test Accuracy of 65.8% is much better than baseline

ResNet-18 5 Styles Test Results

ResNet-18 5 Styles Testing Confusion Matrix

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Test Accuracy: 0.658

Cubism was best predicted due to distinct features
(Sharp lines, block-shaped objects)

ResNet-18 5 Styles Test Results

ResNet-18 5 Styles Testing Confusion Matrix

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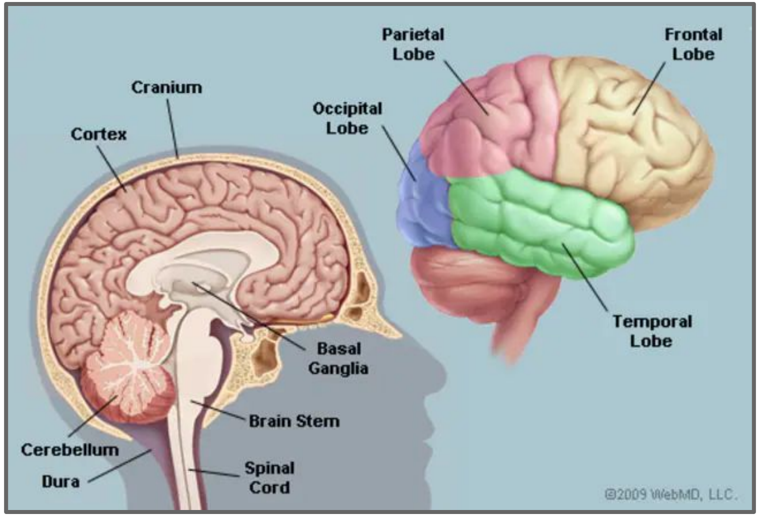
F1-Score	0.720965	0.550427	0.548387	0.787565	0.666667

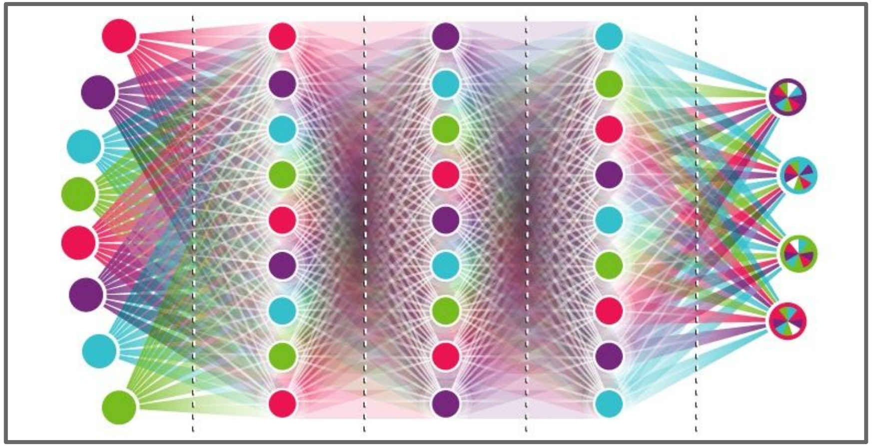
Test Accuracy: 0.658

Expressionism and Symbolism were worst predicted due to ambiguous features

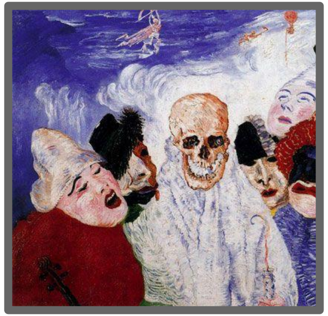
Takeaways

- Learning art styles is an intrinsically difficult problem to solve
- Resources can limit how well of a model one can train in a reasonable amount of time
- Neural networks have a long way to go



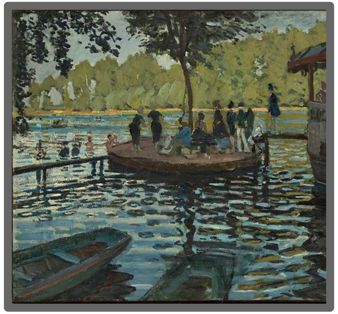


Demonstration



Symbolism

Cubism



Impressionism

Expressionism

Romanticism

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