

# Multi-Class Classification MVP Iteration #3: Embedding Studies Epoch 1

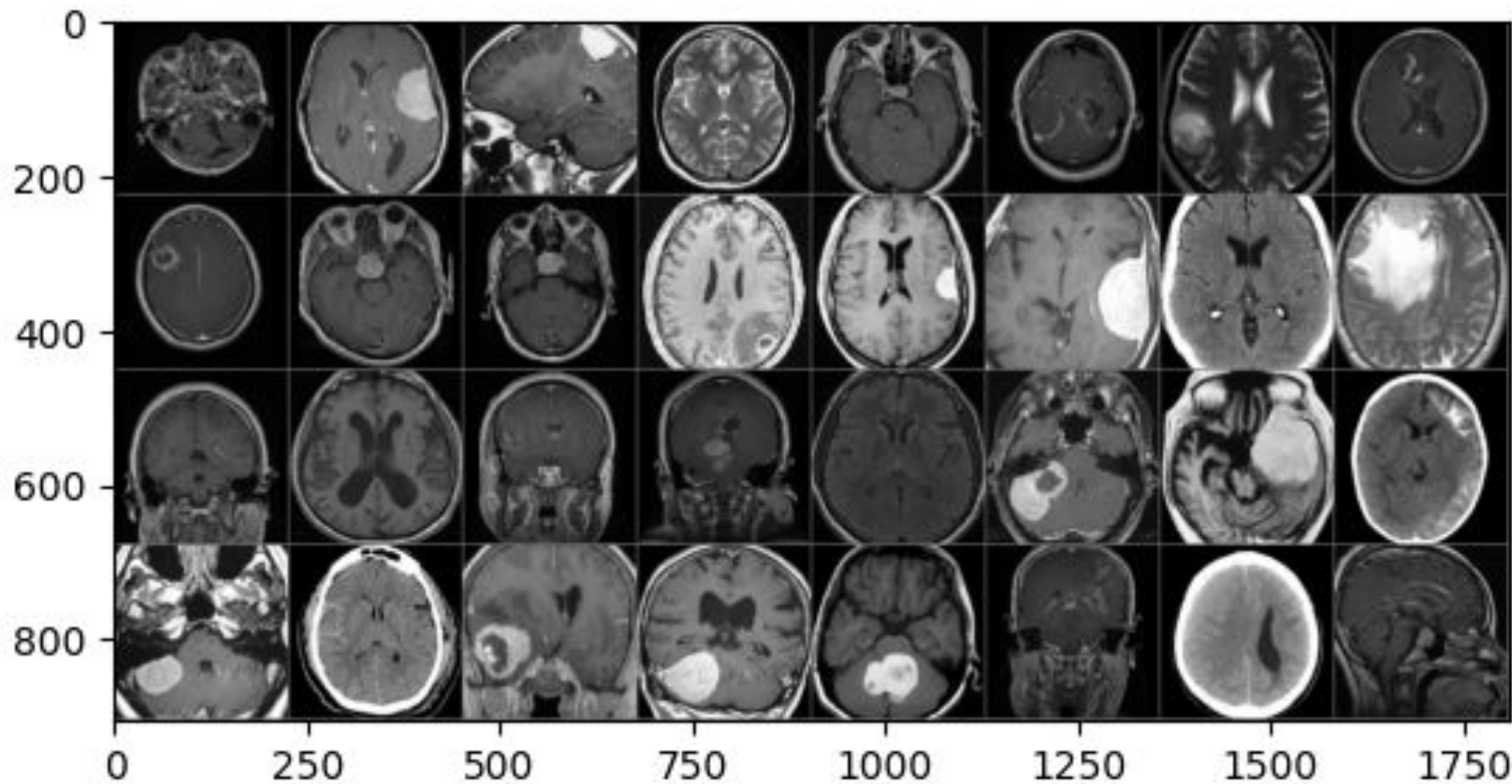
Quantum Circuit	H_Layer	Angle Embedding	Variational Entangling Layer	Variational RY Layer	Runtime	Train loss	Train Accuracy	Validation loss	Validation Accuracy
Iteration #2	Y	Y	Y	Y	3m 27s	1.196	0.499	1.033	0.593
1	N	Y	Y	Y	11m 43s	1.298	0.397	1.221	0.552
2	Y	Y	N	N	1m 50s	1.251	0.451	1.085	0.527
3	Y	N	Y	Y	3m 11s	1.391	0.245	1.383	0.283
4	Y	Y	N	Y	2m 57s	1.261	0.447	1.132	0.471
5	N	Y	N	N	11m 8s	1.226	0.534	1.161	0.610
6	Y	2RY	Y	Y	14m 0s	1.334	0.363	1.265	0.453
7	Y	Y	Y	2RY	5m 44s	1.194	0.495	1.033	0.588
8	Y	Y	Y	RYeRY	5m 35s	1.202	0.500	1.037	0.590
9	Y	Y	Y	3RY	7m 41s	1.193	0.486	1.034	0.592
Quantum Circuit	H_Layer	Amplitude Embedding	Variational Entangling Layer	Variational RY Layer	Runtime	Train loss	Train Accuracy	Validation loss	Validation Accuracy
11	Y	Y	Y	Y	13m 60s	1.378	0.245	1.350	0.283
12	Y	Y	N	N	0m 38s	1.234	0.456	1.168	0.529
13	N	Y	Y	Y	3m 22s	1.297	0.384	1.219	0.477
14	Y	Y	N	Y	2m 58s	1.232	0.443	1.171	0.501
15	Y	Y	N	N	10m 31s <sup>a</sup>	1.292	0.431	1.192	0.542
16	Y	Y	N	N	1m 4s <sup>b</sup>	1.280	0.461	1.261	0.411
17	Y	Y	N	N	2m 18s <sup>c</sup>	1.266	0.413	1.249	0.479
18	Y	Y	N	N	43m 24s <sup>d</sup>	1.255	0.382	1.153	0.472
19	N	Y	N	N	8m 4s	1.290	0.407	1.206	0.501



1) Losses and accuracies reported are Epoch 1 2) RYeRY = Entangling layer between two RY gates 3) Increased circuit width starting at a<b<c<d 4) Iteration #2 Epoch 30 val loss/acc = 0.464/0.851 1/3



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Dataset Loading: 4 Classes - 32/1572 Total Images Shown  
Glioma, Meningioma, Pituitary, Notumor

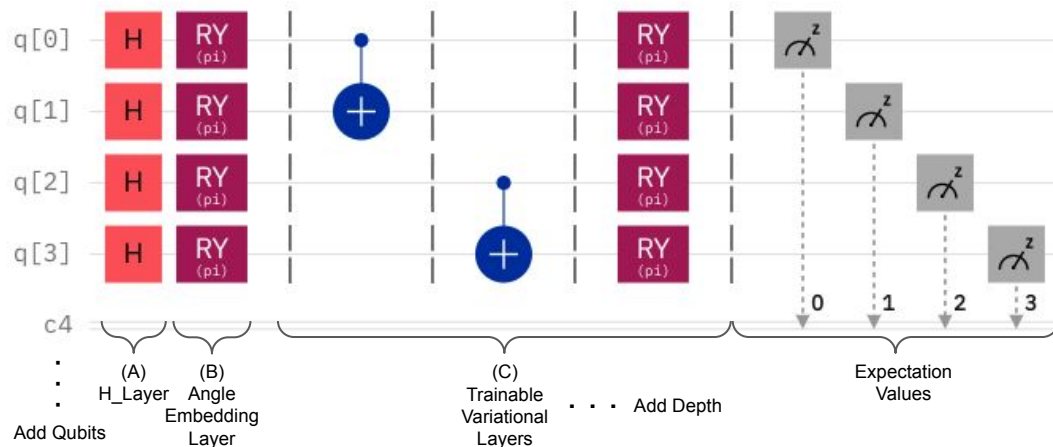
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## Angle Encoding

Iteration #2

Iteration #3

Circuits: #1 - #9



## Amplitude Encoding

Iteration #3

Circuits: #11 - #19

Credit: Qiskit Composer

