

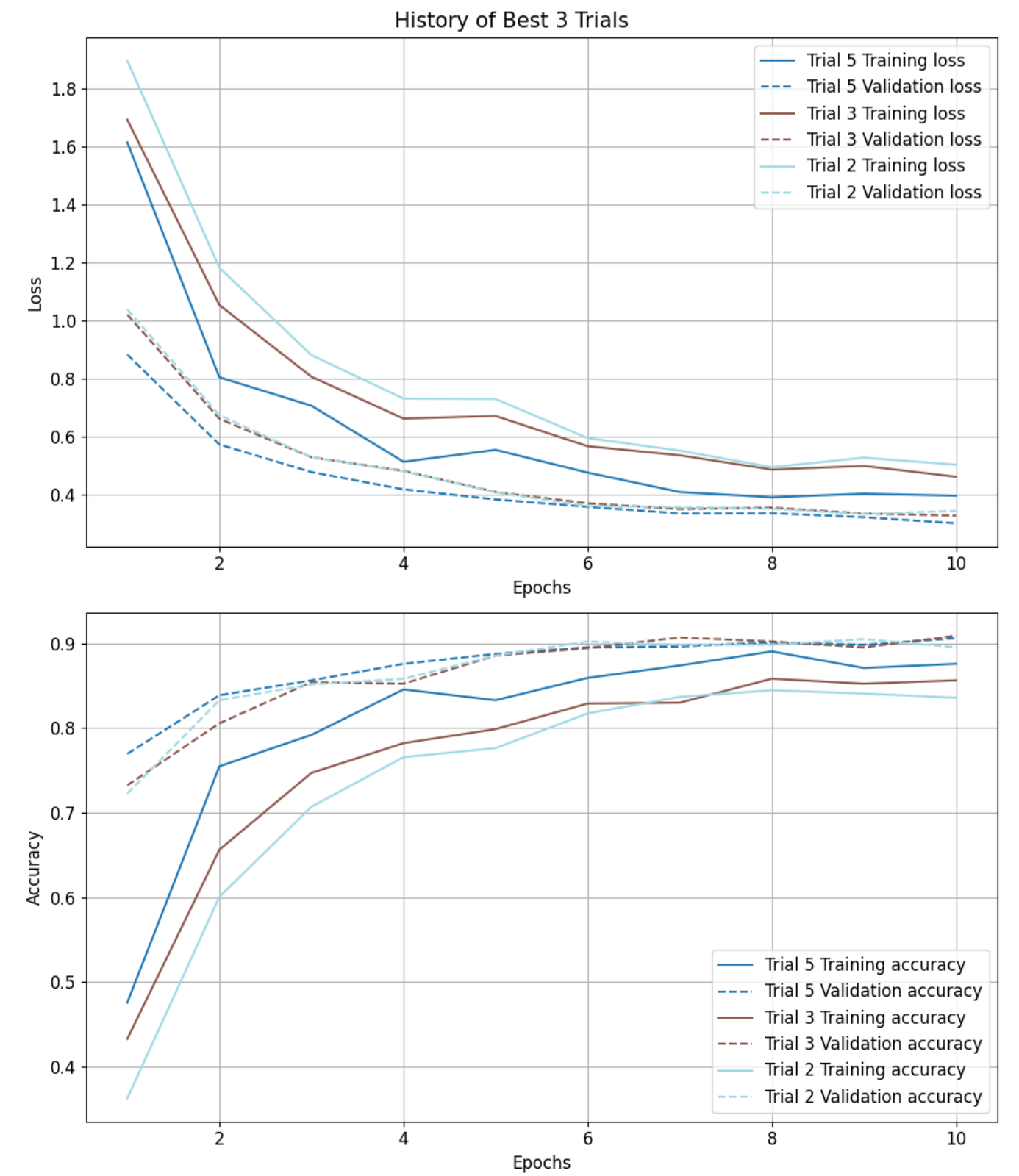
# Experiment Report: MNIST Digits Experiment

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## Metadata

- *Description:* This experiment demonstrates the MultiClassResearcher class using the MNIST digits dataset. It involves a simple feedforward neural network with manually set hyperparameters across multiple trials.
- *Start Time:* 2024-08-01 15:14:27
- *Total Duration:* 0:00:37.225
- *Directory:* [Link](#)

## Initial Visualizations



# Summary

## Hyperparameters

	units1	units2	dropout1	dropout2	learning_rate	Chapters
Trial 5	256	128	0.3000	0.3000	0.0005	<a href="#">Chapter</a>
Trial 3	128	64	0.3000	0.3000	0.0010	<a href="#">Chapter</a>

	units1	units2	dropout1	dropout2	learning_rate	Chapters
Trial 2	256	128	0.5000	0.5000	0.0010	<a href="#">Chapter</a>
Trial 1	128	64	0.5000	0.5000	0.0010	<a href="#">Chapter</a>
Trial 4	128	64	0.5000	0.5000	0.0005	<a href="#">Chapter</a>

Test Results

	accuracy	precision	recall	f1	Chapters
Trial 5	0.9849	0.9494	0.9006	0.9244	<a href="#">Chapter</a>
Trial 3	0.9839	0.9439	0.8918	0.9171	<a href="#">Chapter</a>
Trial 2	0.9819	0.9386	0.8831	0.9100	<a href="#">Chapter</a>
Trial 1	0.9794	0.9421	0.8448	0.8908	<a href="#">Chapter</a>
Trial 4	0.9765	0.9439	0.8104	0.8721	<a href="#">Chapter</a>

Trial 5

- *Start Time:* 2024-08-01 15:14:57
- *Duration:* 07.276
- *Directory:* [Link](#)

Hyperparameters:

Hyperparameter	Value
units1	256
units2	128
dropout1	0.3
dropout2	0.3
learning_rate	0.0005

Evaluation Metrics:

	train	val	test
accuracy	0.9852	0.9841	0.9849
precision	0.9502	0.9487	0.9494
recall	0.9026	0.8987	0.9006
f1	0.9258	0.9230	0.9244

Figures:

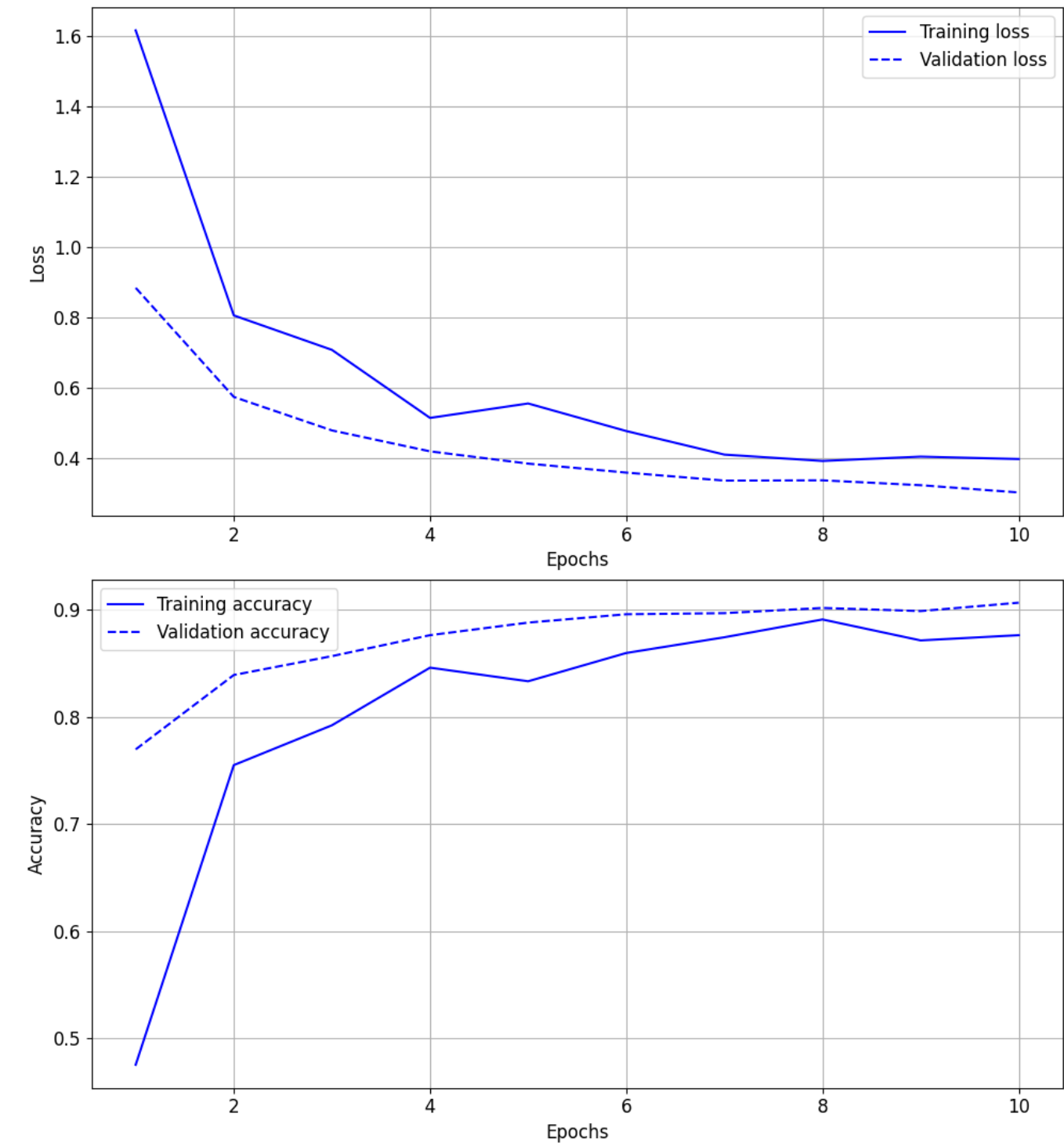
Model Summary

Model: "sequential\_4"

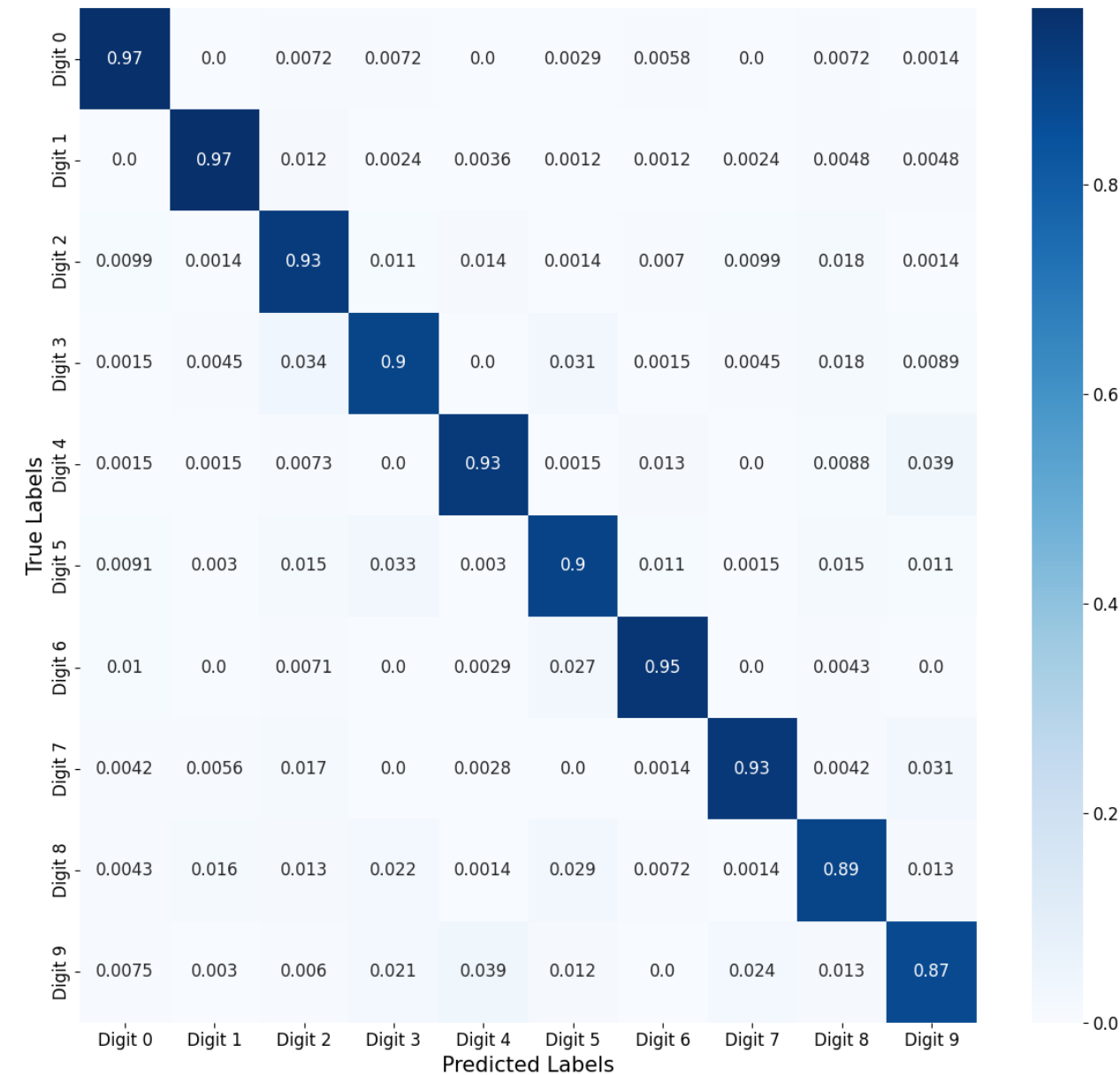
Layer (type)	Output Shape	Param #
flatten_4 (Flatten)	(None, 2352)	0
lambda_4 (Lambda)	(None, 2352)	0
dense_12 (Dense)	(None, 256)	602368
dropout_8 (Dropout)	(None, 256)	0
dense_13 (Dense)	(None, 128)	32896
dropout_9 (Dropout)	(None, 128)	0
dense_14 (Dense)	(None, 10)	1290

=====  
Total params: 636554 (2.43 MB)  
Trainable params: 636554 (2.43 MB)  
Non-trainable params: 0 (0.00 Byte)  
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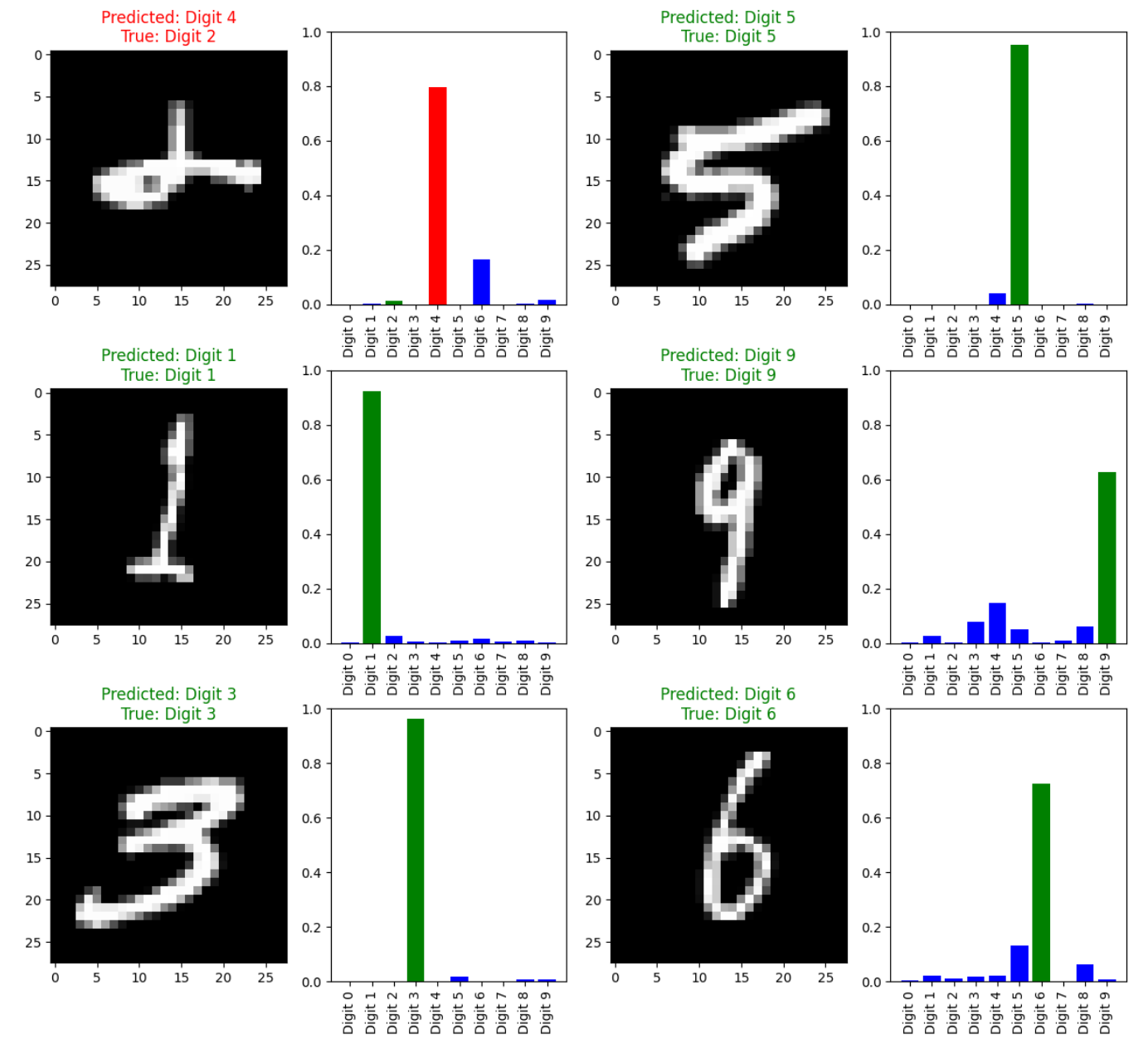
### Training History



Confusion Matrix



Results



Detailed Report of Test Set:

	precision	recall	f1-score	support
Digit 0	0.9531	0.9683	0.9606	693
Digit 1	0.9709	0.9674	0.9692	829
Digit 2	0.8878	0.9254	0.9062	710
Digit 3	0.9010	0.8957	0.8984	671
Digit 4	0.9324	0.9269	0.9296	684
Digit 5	0.8904	0.8985	0.8944	660
Digit 6	0.9527	0.9486	0.9507	701

	precision	recall	f1-score	support
Digit 7	0.9570	0.9343	0.9455	715
Digit 8	0.9047	0.8929	0.8988	691
Digit 9	0.8839	0.8746	0.8792	670
micro avg	0.9245	0.9245	0.9245	7024
macro avg	0.9234	0.9233	0.9233	7024
weighted avg	0.9247	0.9245	0.9246	7024
samples avg	0.9245	0.9245	0.9245	7024

Trial 3

- *Start Time:* 2024-08-01 15:14:42
- *Duration:* 06.529
- *Directory:* [Link](#)

Hyperparameters:

Hyperparameter	Value
units1	128
units2	64
dropout1	0.3
dropout2	0.3
learning_rate	0.001

Evaluation Metrics:

	train	val	test
accuracy	0.9834	0.9826	0.9839
precision	0.9442	0.9382	0.9439
recall	0.8930	0.8885	0.8918
f1	0.9179	0.9127	0.9171

Figures:



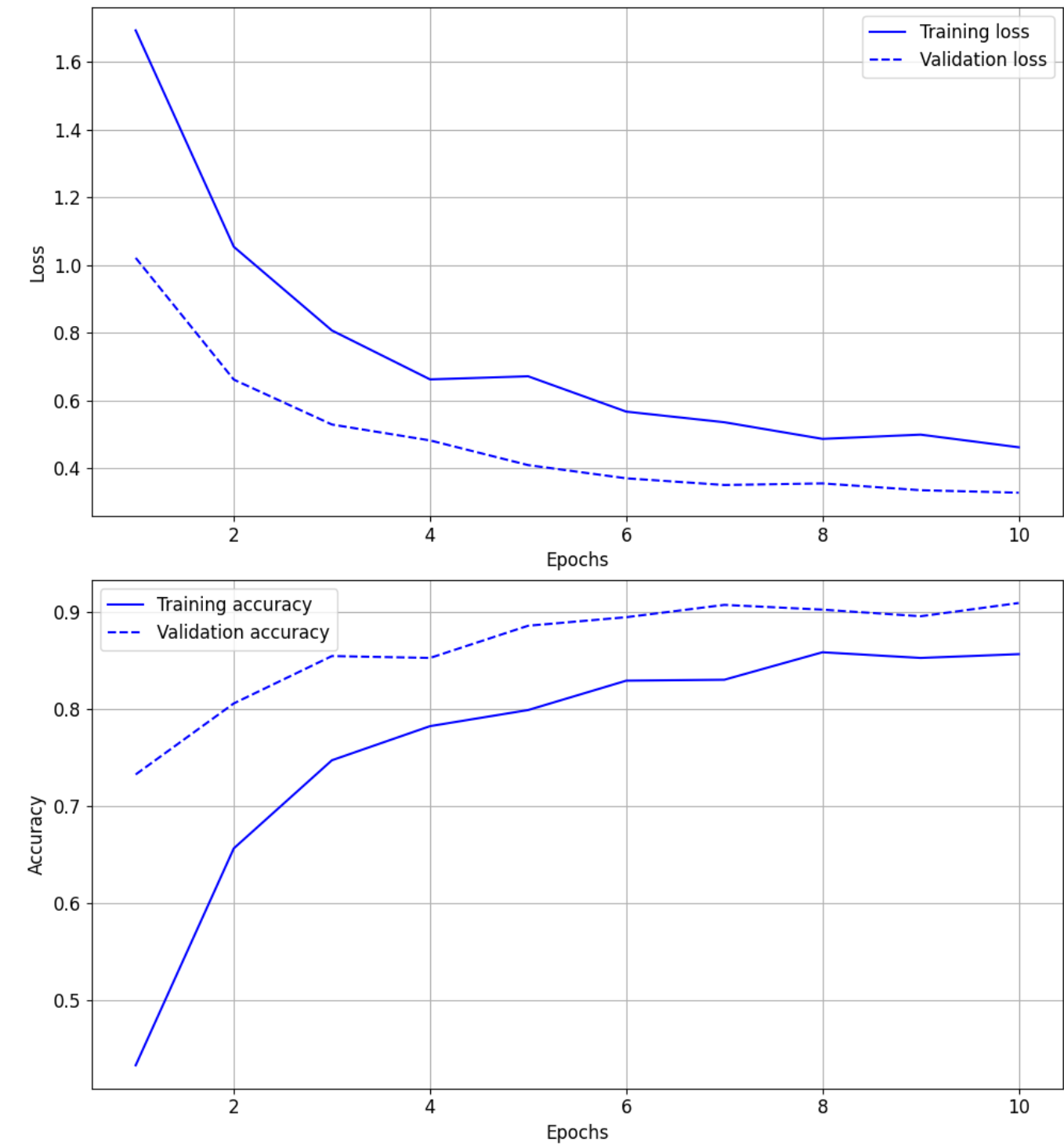
Model Summary

Model: "sequential\_2"

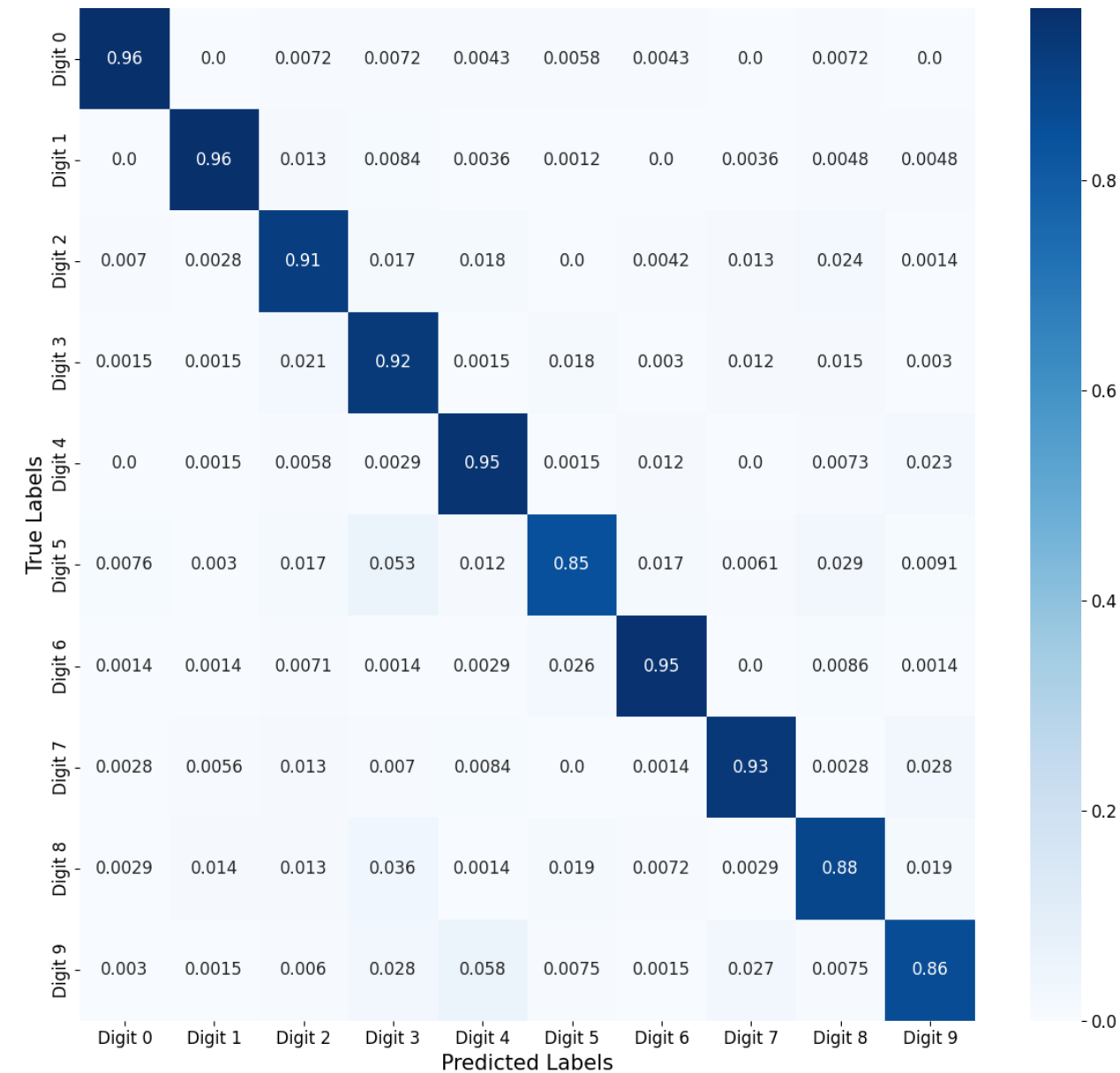
Layer (type)	Output Shape	Param #
flatten_2 (Flatten)	(None, 2352)	0
lambda_2 (Lambda)	(None, 2352)	0
dense_6 (Dense)	(None, 128)	301184
dropout_4 (Dropout)	(None, 128)	0
dense_7 (Dense)	(None, 64)	8256
dropout_5 (Dropout)	(None, 64)	0
dense_8 (Dense)	(None, 10)	650

=====  
Total params: 310090 (1.18 MB)  
Trainable params: 310090 (1.18 MB)  
Non-trainable params: 0 (0.00 Byte)  
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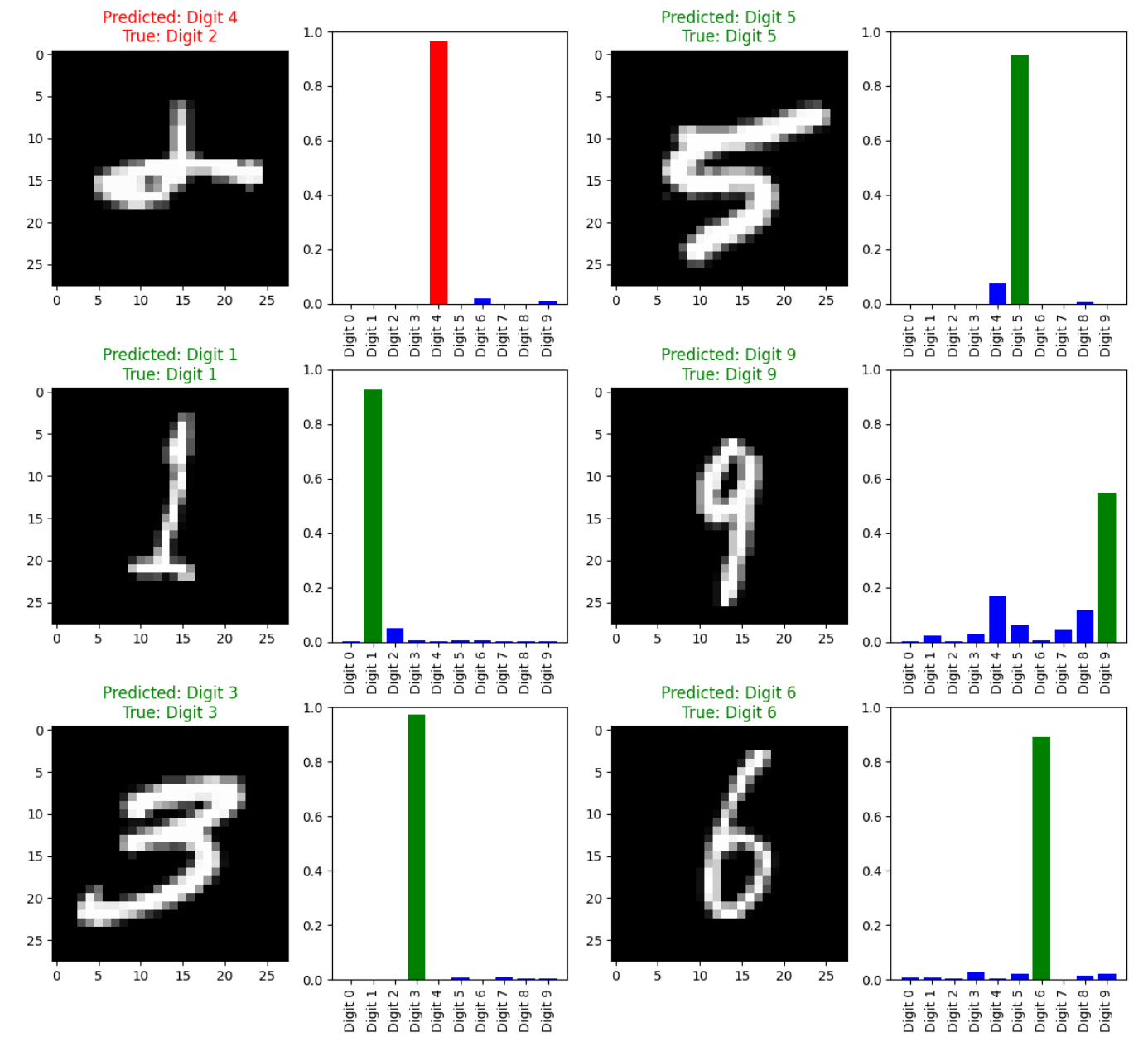
### Training History



Confusion Matrix



Results



Detailed Report of Test Set:

	precision	recall	f1-score	support
Digit 0	0.9738	0.9639	0.9688	693
Digit 1	0.9731	0.9602	0.9666	829
Digit 2	0.9000	0.9127	0.9063	710
Digit 3	0.8482	0.9240	0.8845	671
Digit 4	0.8949	0.9459	0.9197	684
Digit 5	0.9119	0.8470	0.8782	660
Digit 6	0.9514	0.9501	0.9507	701

	precision	recall	f1-score	support
Digit 7	0.9380	0.9315	0.9347	715
Digit 8	0.8933	0.8842	0.8887	691
Digit 9	0.9014	0.8597	0.8801	670
micro avg	0.9193	0.9193	0.9193	7024
macro avg	0.9186	0.9179	0.9178	7024
weighted avg	0.9200	0.9193	0.9193	7024
samples avg	0.9193	0.9193	0.9193	7024

Trial 2

- *Start Time:* 2024-08-01 15:14:35
- *Duration:* 07.216
- *Directory:* [Link](#)

Hyperparameters:

Hyperparameter	Value
units1	256
units2	128
dropout1	0.5
dropout2	0.5
learning_rate	0.001

Evaluation Metrics:

	train	val	test
accuracy	0.9816	0.9812	0.9819
precision	0.9361	0.9336	0.9386
recall	0.8819	0.8772	0.8831
f1	0.9082	0.9045	0.9100

Figures:

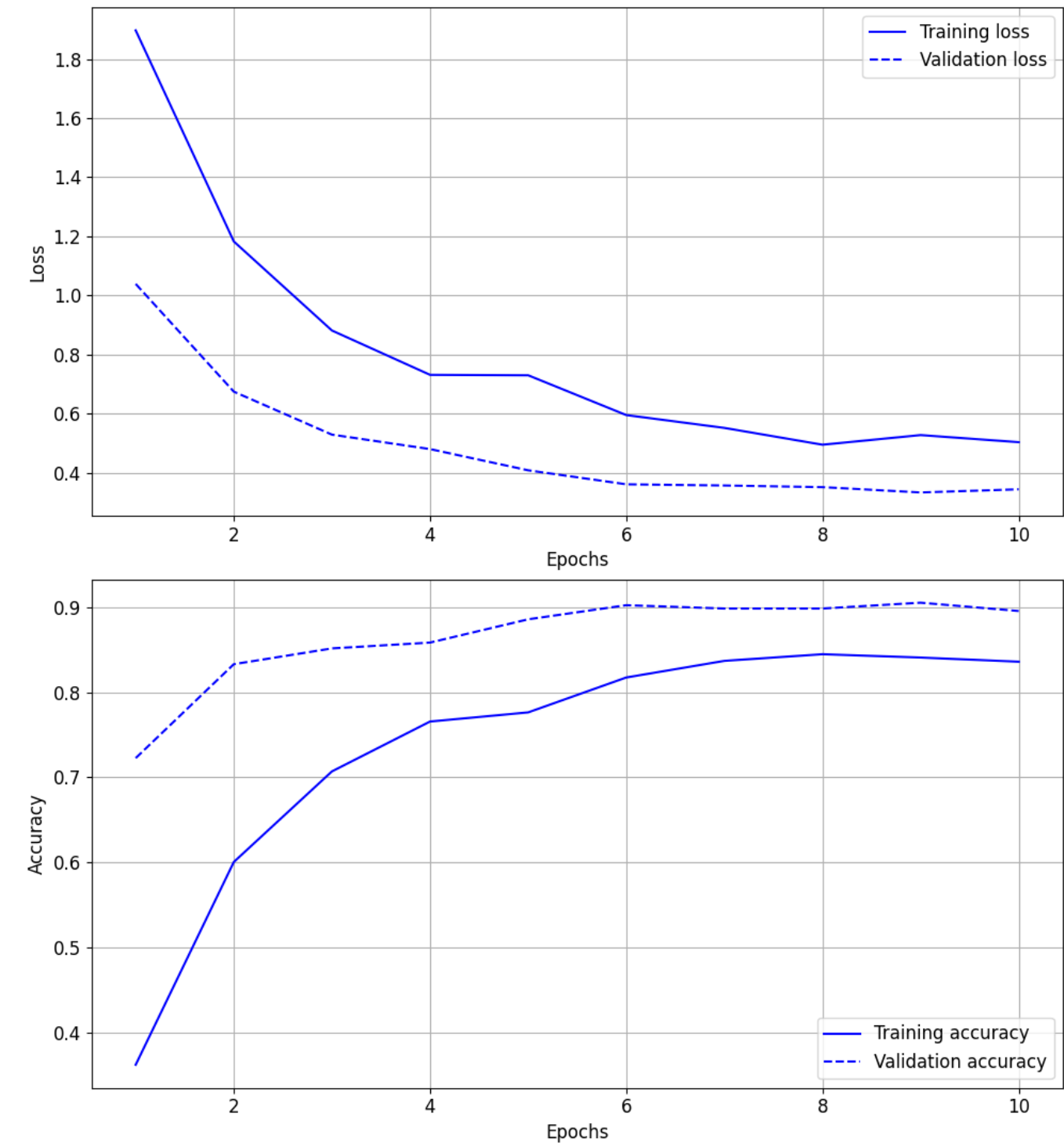
# Model Summary

Model: "sequential\_1"

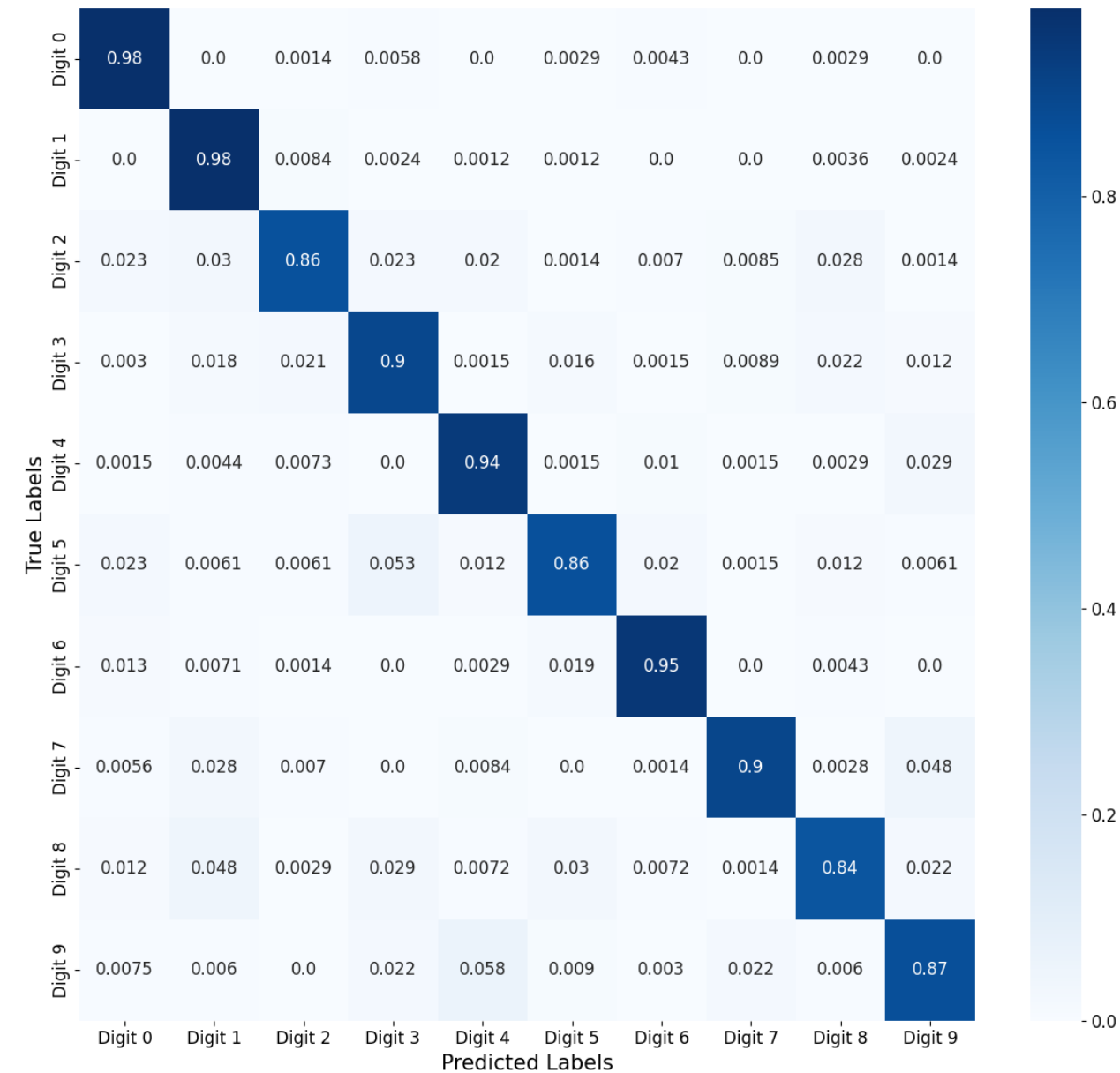
Layer (type)	Output Shape	Param #
flatten_1 (Flatten)	(None, 2352)	0
lambda_1 (Lambda)	(None, 2352)	0
dense_3 (Dense)	(None, 256)	602368
dropout_2 (Dropout)	(None, 256)	0
dense_4 (Dense)	(None, 128)	32896
dropout_3 (Dropout)	(None, 128)	0
dense_5 (Dense)	(None, 10)	1290

=====  
Total params: 636554 (2.43 MB)  
Trainable params: 636554 (2.43 MB)  
Non-trainable params: 0 (0.00 Byte)  
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### Training History

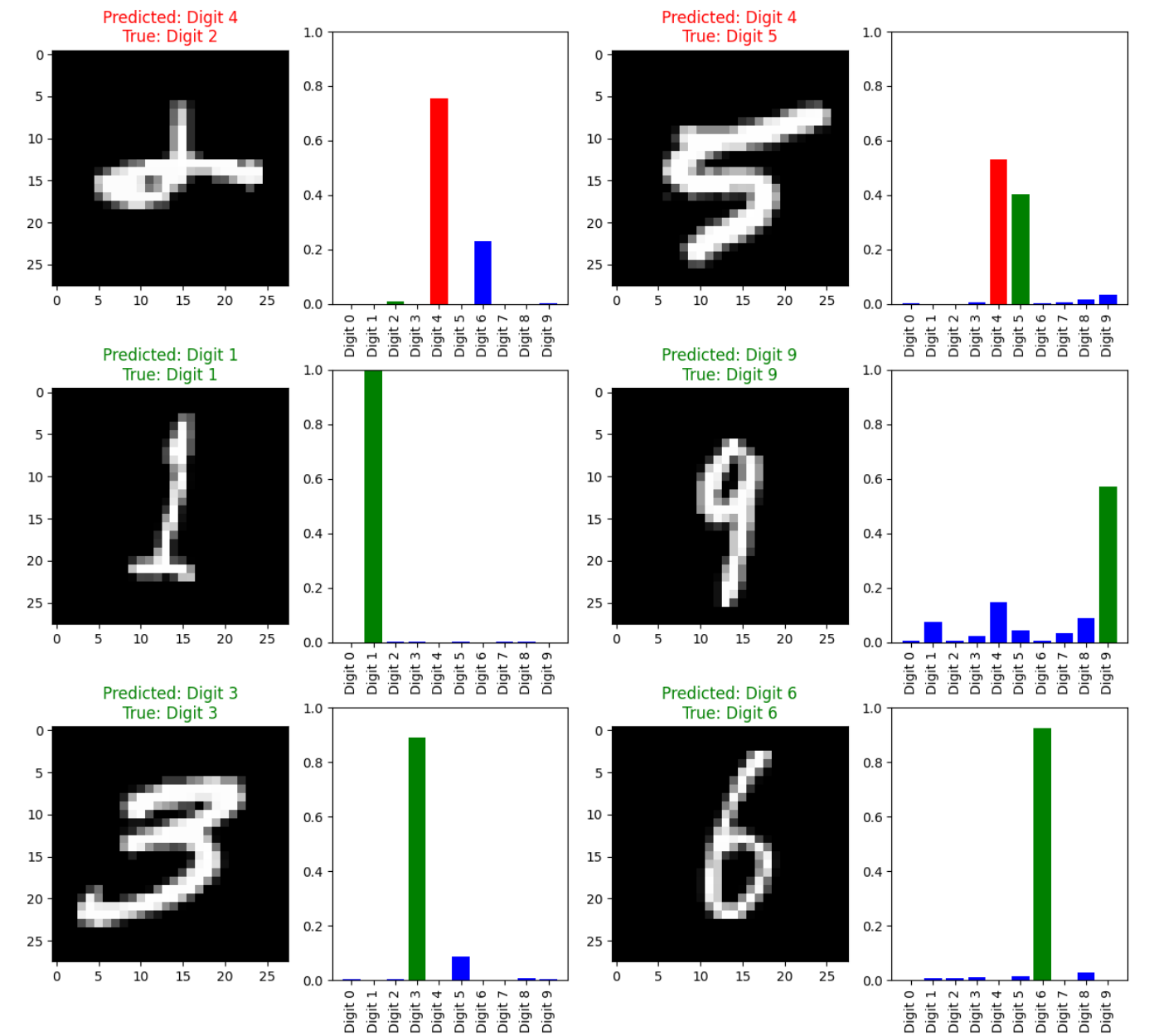


Confusion Matrix





Results



Detailed Report of Test Set:

	precision	recall	f1-score	support
Digit 0	0.9190	0.9827	0.9498	693
Digit 1	0.8885	0.9807	0.9323	829
Digit 2	0.9399	0.8592	0.8977	710
Digit 3	0.8672	0.8957	0.8812	671
Digit 4	0.8944	0.9415	0.9174	684
Digit 5	0.9103	0.8606	0.8847	660
Digit 6	0.9475	0.9529	0.9502	701

	precision	recall	f1-score	support
Digit 7	0.9554	0.8993	0.9265	715
Digit 8	0.9078	0.8408	0.8730	691
Digit 9	0.8735	0.8657	0.8696	670
micro avg	0.9096	0.9096	0.9096	7024
macro avg	0.9104	0.9079	0.9083	7024
weighted avg	0.9105	0.9096	0.9091	7024
samples avg	0.9096	0.9096	0.9096	7024

Trial 1

- *Start Time:* 2024-08-01 15:14:27
- *Duration:* 06.936
- *Directory:* [Link](#)

Hyperparameters:

Hyperparameter	Value
units1	128
units2	64
dropout1	0.5
dropout2	0.5
learning_rate	0.001

Evaluation Metrics:

	train	val	test
accuracy	0.9795	0.9794	0.9794
precision	0.9418	0.9384	0.9421
recall	0.8444	0.8415	0.8448
f1	0.8905	0.8873	0.8908

Figures:

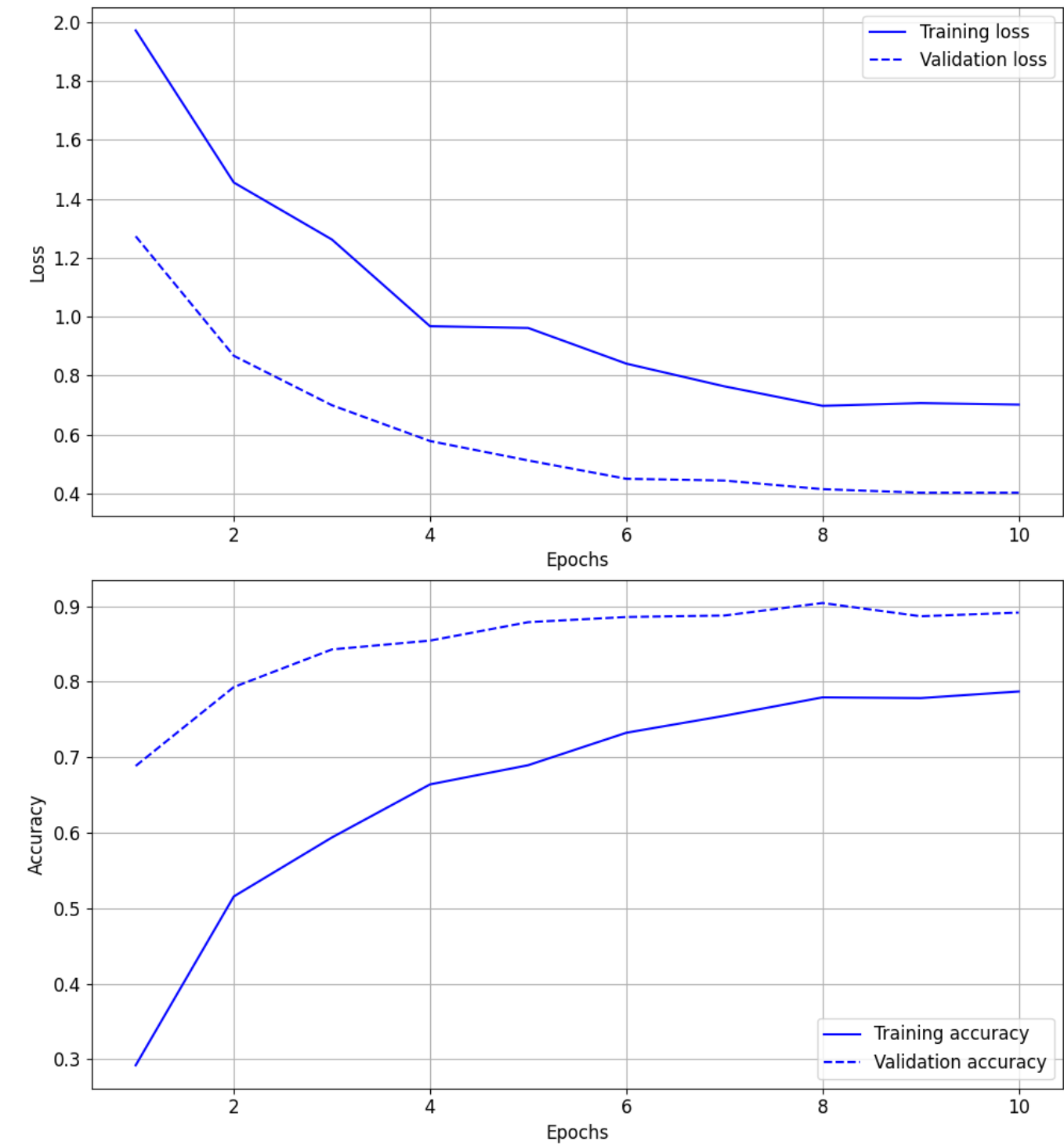
Model Summary

Model: "sequential"

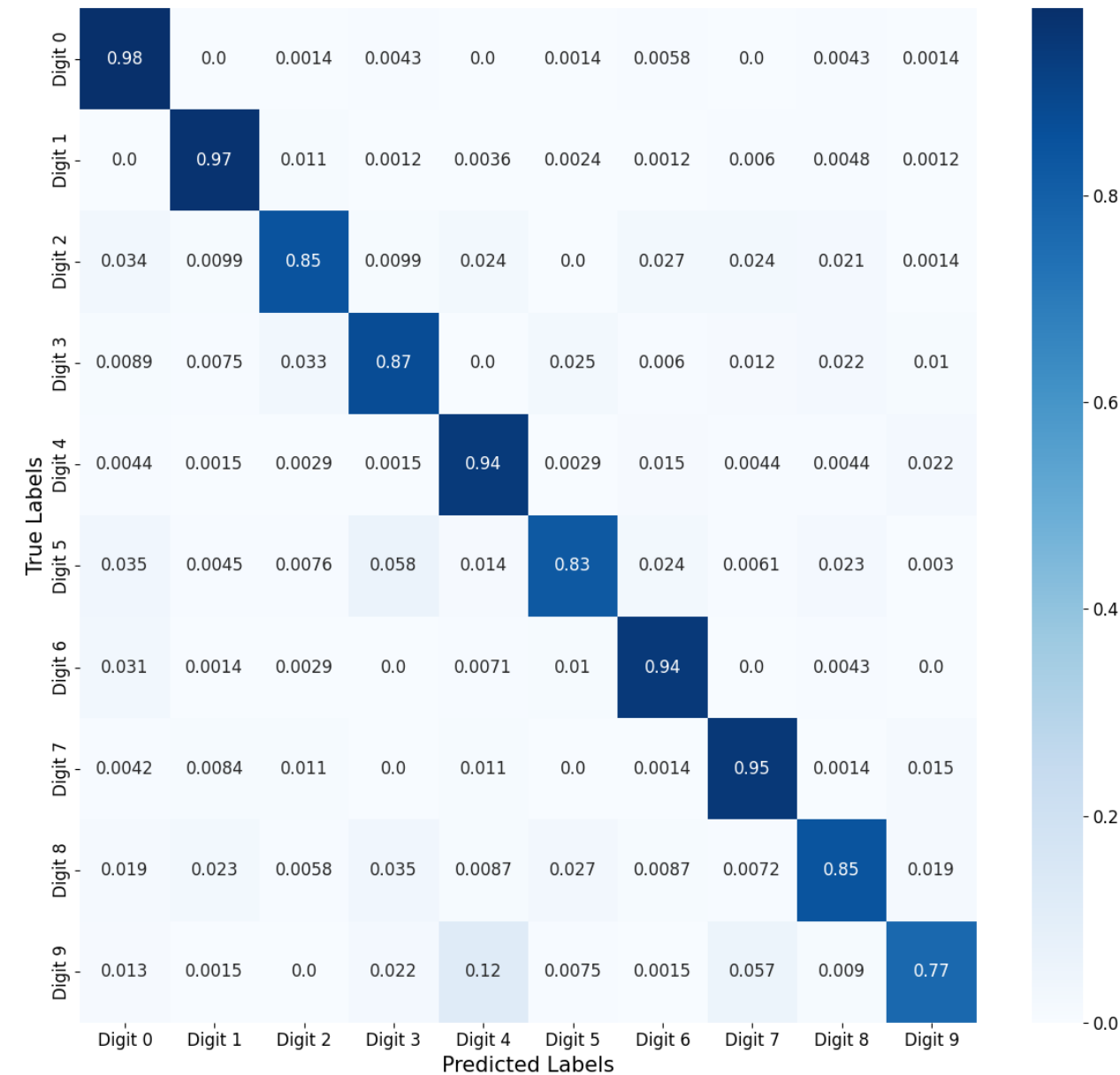
Layer (type)	Output Shape	Param #
flatten (Flatten)	(None, 2352)	0
lambda (Lambda)	(None, 2352)	0
dense (Dense)	(None, 128)	301184
dropout (Dropout)	(None, 128)	0
dense_1 (Dense)	(None, 64)	8256
dropout_1 (Dropout)	(None, 64)	0
dense_2 (Dense)	(None, 10)	650

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Total params: 310090 (1.18 MB)  
Trainable params: 310090 (1.18 MB)  
Non-trainable params: 0 (0.00 Byte)  
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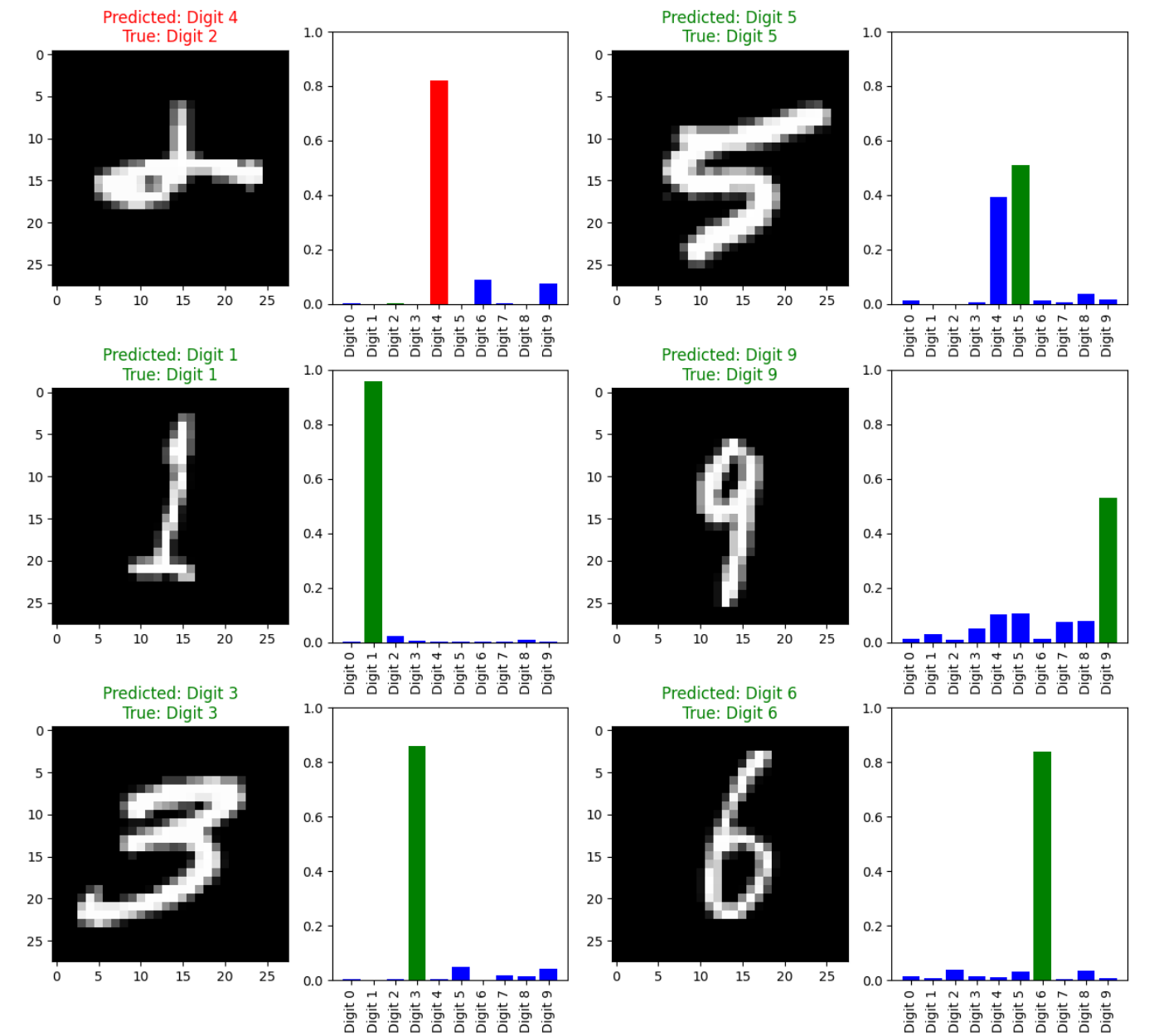
### Training History



Confusion Matrix



Results



Detailed Report of Test Set:

	precision	recall	f1-score	support
Digit 0	0.8685	0.9812	0.9214	693
Digit 1	0.9526	0.9686	0.9605	829
Digit 2	0.9192	0.8493	0.8829	710
Digit 3	0.8683	0.8748	0.8716	671
Digit 4	0.8342	0.9415	0.8846	684
Digit 5	0.9114	0.8258	0.8665	660
Digit 6	0.9142	0.9429	0.9284	701

	precision	recall	f1-score	support
Digit 7	0.8943	0.9469	0.9198	715
Digit 8	0.9000	0.8466	0.8725	691
Digit 9	0.9099	0.7687	0.8333	670
micro avg	0.8969	0.8969	0.8969	7024
macro avg	0.8973	0.8946	0.8941	7024
weighted avg	0.8985	0.8969	0.8959	7024
samples avg	0.8969	0.8969	0.8969	7024

Trial 4

- *Start Time:* 2024-08-01 15:14:49
- *Duration:* 06.831
- *Directory:* [Link](#)

Hyperparameters:

Hyperparameter	Value
units1	128
units2	64
dropout1	0.5
dropout2	0.5
learning_rate	0.0005

Evaluation Metrics:

	train	val	test
accuracy	0.9770	0.9768	0.9765
precision	0.9444	0.9383	0.9439
recall	0.8036	0.8002	0.8104
f1	0.8683	0.8638	0.8721

Figures:

Model Summary

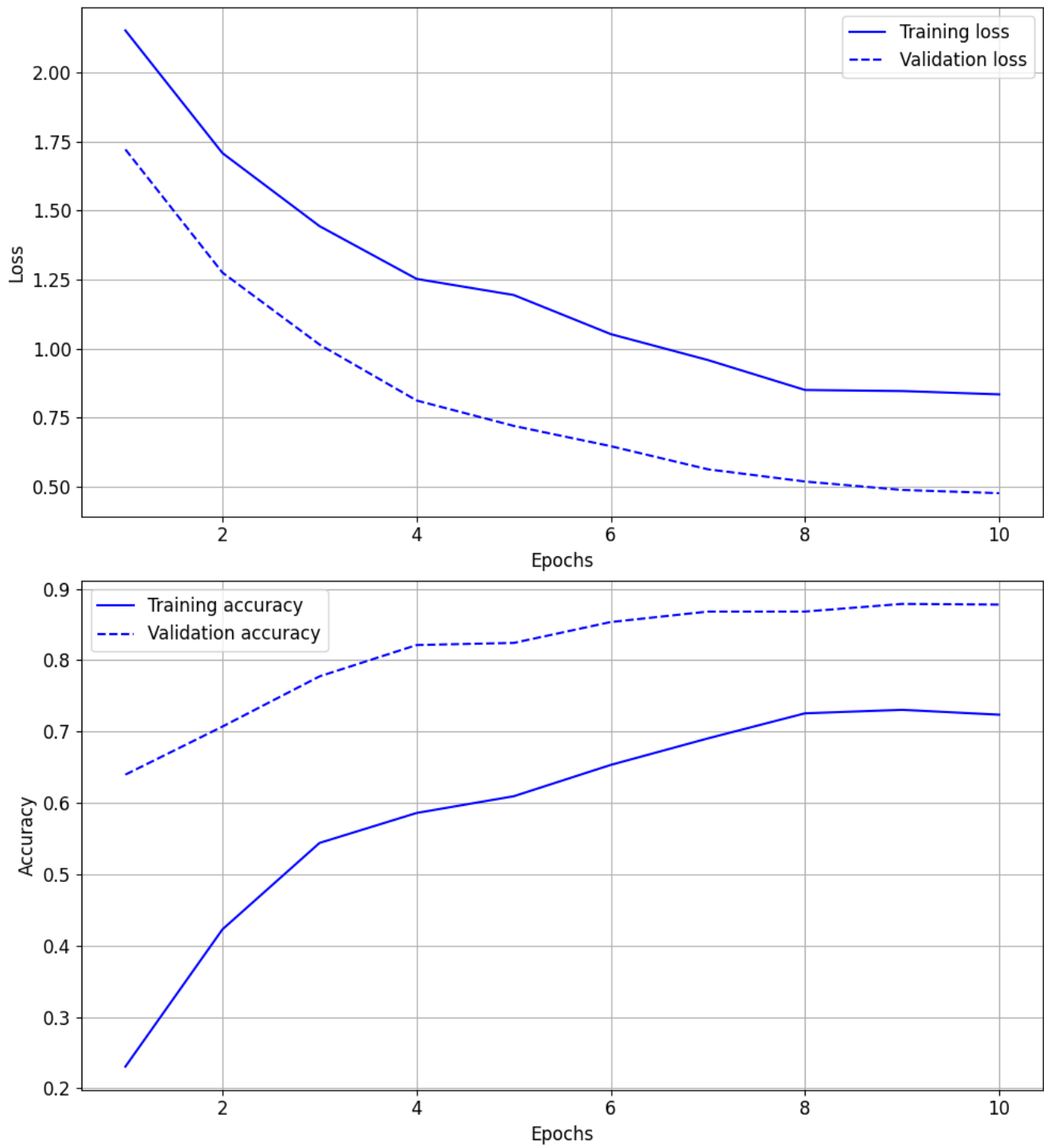
Model: "sequential\_3"

Layer (type)	Output Shape	Param #
flatten_3 (Flatten)	(None, 2352)	0
lambda_3 (Lambda)	(None, 2352)	0
dense_9 (Dense)	(None, 128)	301184
dropout_6 (Dropout)	(None, 128)	0
dense_10 (Dense)	(None, 64)	8256
dropout_7 (Dropout)	(None, 64)	0
dense_11 (Dense)	(None, 10)	650

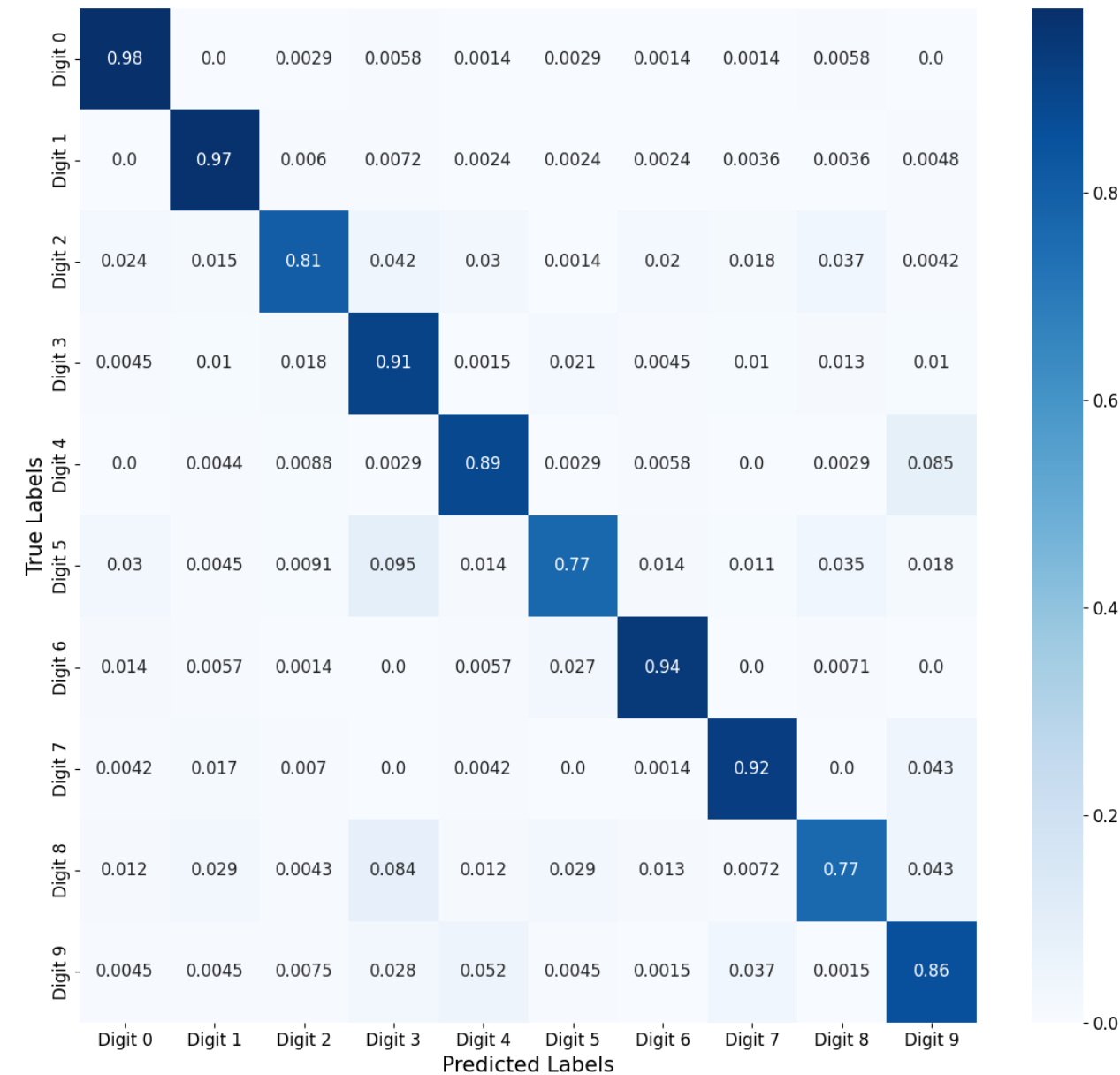
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Total params: 310090 (1.18 MB)  
Trainable params: 310090 (1.18 MB)  
Non-trainable params: 0 (0.00 Byte)  
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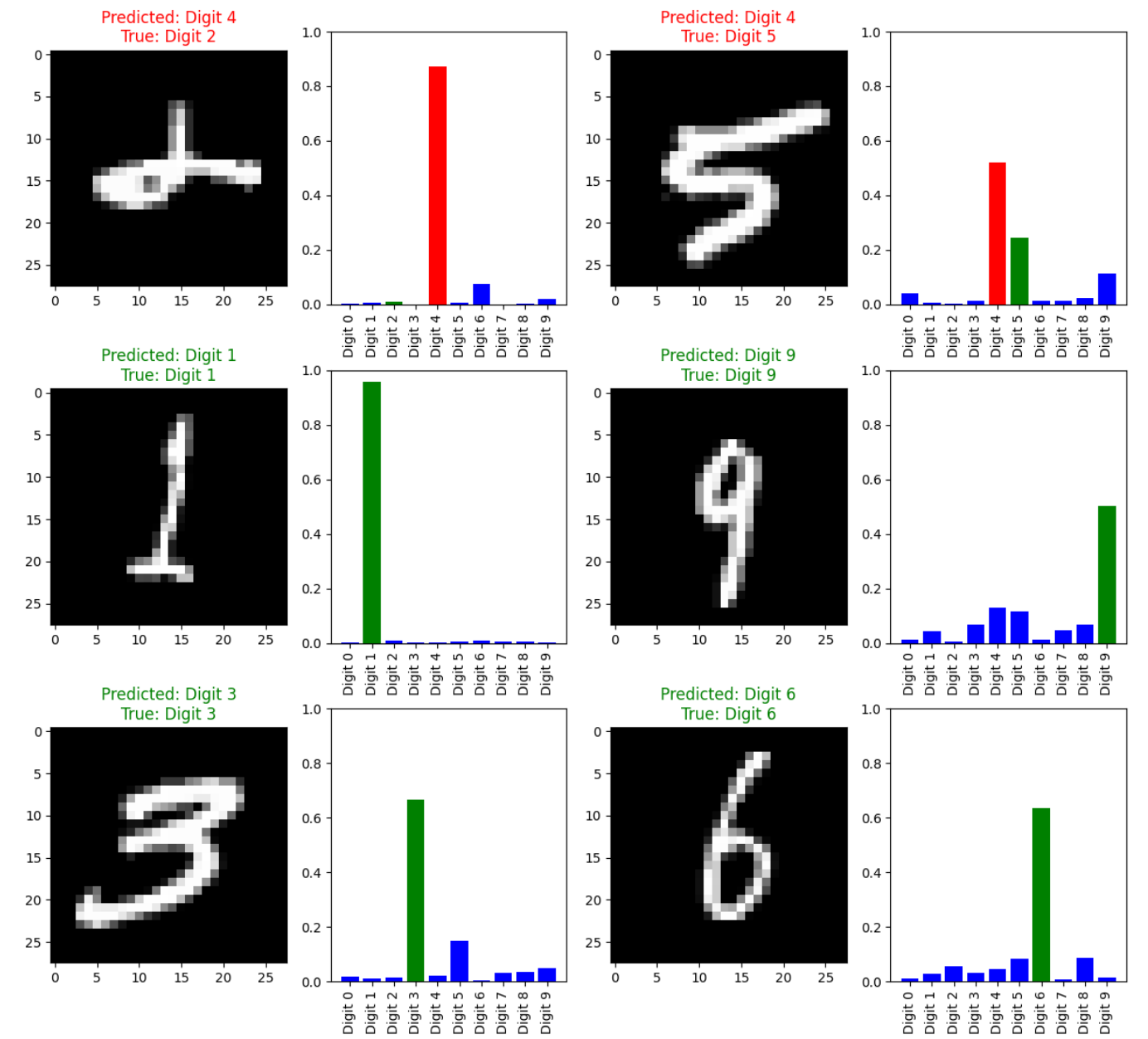
### Training History



Confusion Matrix



Results



Detailed Report of Test Set:

	precision	recall	f1-score	support
Digit 0	0.9137	0.9784	0.9449	693
Digit 1	0.9272	0.9674	0.9469	829
Digit 2	0.9273	0.8085	0.8638	710
Digit 3	0.7696	0.9061	0.8323	671
Digit 4	0.8784	0.8874	0.8829	684
Digit 5	0.8897	0.7697	0.8253	660
Digit 6	0.9373	0.9387	0.9380	701

	precision	recall	f1-score	support
Digit 7	0.9154	0.9231	0.9192	715
Digit 8	0.8789	0.7670	0.8192	691
Digit 9	0.7986	0.8582	0.8273	670
micro avg	0.8827	0.8827	0.8827	7024
macro avg	0.8836	0.8804	0.8800	7024
weighted avg	0.8853	0.8827	0.8820	7024
samples avg	0.8827	0.8827	0.8827	7024