



פרויקט סוף בלמידה عمוקה

תאריך הגשה:

3.3.2025

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משימה 1

1.1 רשות CNN ללא שימוש ב-TRANSFER LEARNING

מבנה המודל:

```

128 ## CNN MODEL #####
129 model = keras.Sequential()
130 #first Convolutional Layer
131 model.add(keras.layers.Conv2D(32, (3, 3), padding='same', activation='relu', input_shape=(160, 160, 1)))
132 model.add(keras.layers.BatchNormalization())
133 model.add(keras.layers.MaxPooling2D(pool_size=(2, 2), padding='same'))
134
135 #second Convolutional Layer
136 model.add(keras.layers.Conv2D(64, (3, 3), padding='same', activation='relu'))
137 model.add(keras.layers.BatchNormalization())
138 model.add(keras.layers.MaxPooling2D(pool_size=(2, 2), padding='same'))
139
140 #third Convolutional Layer
141 model.add(keras.layers.Conv2D(128, (3, 3), padding='same', activation='relu'))
142 model.add(keras.layers.BatchNormalization())
143 model.add(keras.layers.MaxPooling2D(pool_size=(2, 2), padding='same'))
144
145 #fourth Convolutional Layer
146 model.add(keras.layers.Conv2D(256, (3, 3), padding='same', activation='relu'))
147 model.add(keras.layers.BatchNormalization())
148 model.add(keras.layers.MaxPooling2D(pool_size=(2, 2), padding='same'))
149
150 #fifth Convolutional Layer
151 model.add(keras.layers.Conv2D(512, (3, 3), padding='same', activation='relu'))
152 model.add(keras.layers.BatchNormalization())
153 model.add(keras.layers.MaxPooling2D(pool_size=(2, 2), padding='same'))
154
155 #flat layer to convert 2D to 1D
156 model.add(keras.layers.Flatten())
157
158 #fully densed layers
159 model.add(keras.layers.Dense(256, activation='relu'))
160 model.add(keras.layers.Dense(64, activation='relu'))
161 model.add(keras.layers.Dense(1, activation='sigmoid')) # Sigmoid activation for binary classification
162 model.summary()

```

תיאור השכבות:

Layer num	Layer type	Description	Input dimension	Output dimension
1	Conv2D	32 filters in size of (3,3)	160*160*1	160*160*32
	BatchNormalization	Normalize the layers	160*160*32	160*160*32
	MaxPooling2D	Pool size (2,2)	160*160*32	80*80*32
2	Conv2D	64 filters in size of (3,3)	80*80*32	80*80*64
	BatchNormalization	Normalize the layers	80*80*64	80*80*64
	MaxPooling2D	Pool size (2,2)	80*80*64	40*40*64
3	Conv2D	128 filters in size of (3,3)	40*40*64	40*40*128
	BatchNormalization	Normalize the layers	40*40*128	40*40*128
	MaxPooling2D	Pool size (2,2)	40*40*128	20*20*128
4	Conv2D	256 filters in size of (3,3)	20*20*128	20*20*256
	BatchNormalization	Normalize the layers	20*20*256	20*20*256
	MaxPooling2D	Pool size (2,2)	20*20*256	10*10*256
5	Conv2D	512 filters in size of (3,3)	10*10*256	10*10*512
	BatchNormalization	Normalize the layers	10*10*512	10*10*512
	MaxPooling2D	Pool size (2,2)	10*10*512	5*5*512
	Flatten	Flattening into 1D from 2D	5*5*512	12800
	Dense	256 perceptrons with activation 'relu'	12800	256
	Dense	64 perceptrons with activation 'relu'	256	64
	Dense	1 perceptron with activation 'sigmoid'	64	1

סיכום המודל מה- Google colab

Layer (type)	Output Shape	Param #
conv2d_25 (Conv2D)	(None, 160, 160, 32)	320
batch_normalization_25 (BatchNormalization)	(None, 160, 160, 32)	128
max_pooling2d_25 (MaxPooling2D)	(None, 80, 80, 32)	0
conv2d_26 (Conv2D)	(None, 80, 80, 64)	18,496
batch_normalization_26 (BatchNormalization)	(None, 80, 80, 64)	256
max_pooling2d_26 (MaxPooling2D)	(None, 40, 40, 64)	0
conv2d_27 (Conv2D)	(None, 40, 40, 128)	73,856
batch_normalization_27 (BatchNormalization)	(None, 40, 40, 128)	512
max_pooling2d_27 (MaxPooling2D)	(None, 20, 20, 128)	0
conv2d_28 (Conv2D)	(None, 20, 20, 256)	295,168
batch_normalization_28 (BatchNormalization)	(None, 20, 20, 256)	1,024
max_pooling2d_28 (MaxPooling2D)	(None, 10, 10, 256)	0
conv2d_29 (Conv2D)	(None, 10, 10, 512)	1,180,160
batch_normalization_29 (BatchNormalization)	(None, 10, 10, 512)	2,048
max_pooling2d_29 (MaxPooling2D)	(None, 5, 5, 512)	0
flatten_5 (Flatten)	(None, 12800)	0
dense_15 (Dense)	(None, 256)	3,277,056
dense_16 (Dense)	(None, 64)	16,448
dense_17 (Dense)	(None, 1)	65

1.2 רשת CNN מבוססת TRANSFER LEARNING

מבנה המודל:

```
133
134 ##### CNN Transfer Learning Model #####
135 ### Q1.2
136 #load the pre-trained MobileNetV2 model without the top layers
137 base_model = tf.keras.applications.MobileNetV2(
138     input_shape=(160, 160, 3),                      #use 3 channels for RGB images
139     include_top=False,
140     weights='imagenet'
141 )
142 base_model.trainable = False                     #freeze the pre-trained layers
143 inputs = tf.keras.Input(shape=(160, 160, 3))
144 x = base_model(inputs, training=False)          #pass inputs through base model
145
146 #add new layers
147 x = layers.Conv2D(32, (3, 3), activation='relu', padding='same')(x)
148 x = layers.MaxPooling2D((2, 2))(x)
149 x = layers.Conv2D(64, (3, 3), activation='relu', padding='same')(x)
150 x = layers.MaxPooling2D((2, 2))(x)
151 #flat and add dense layers
152 x = layers.Flatten()(x)
153 x = layers.Dense(128, activation='relu')(x)
154 outputs = layers.Dense(1, activation='sigmoid')(x)
```

תיאור השכבות:

Layer type	Description	Input dimension	Output dimension
MobileNetV2	Natural network train	160*160*3	5*5*1280
Conv2D	32 filters in size of (3,3)	5*5*1280	5*5*32
MaxPooling2D	Pool size (2,2)	5*5*32	2*2*32
Conv2D	64 filters in size of (3,3)	2*2*32	2*2*64
MaxPooling2D	Pool size (2,2)	2*2*64	1*1*64
Flatten	Flatting into 1D from 2D	1*1*64	64
Dense	128 perceptrons with activation 'relu'	64	128
Dense	1 perceptron with activation 'sigmoid'	128	1

סיכום המודל מה- Google colab

Layer (type)	Output Shape	Param #
input_layer_10 (InputLayer)	(None, 160, 160, 3)	0
mobilenetv2_1.00_160 (Functional)	(None, 5, 5, 1280)	2,257,984
conv2d_37 (Conv2D)	(None, 5, 5, 32)	368,672
max_pooling2d_37 (MaxPooling2D)	(None, 2, 2, 32)	0
conv2d_38 (Conv2D)	(None, 2, 2, 64)	18,496
max_pooling2d_38 (MaxPooling2D)	(None, 1, 1, 64)	0
flatten_8 (Flatten)	(None, 64)	0
dense_23 (Dense)	(None, 128)	8,320
dense_24 (Dense)	(None, 1)	129

Total params: 2,653,601 (10.12 MB)
Trainable params: 395,617 (1.51 MB)
Non-trainable params: 2,257,984 (8.61 MB)

משימה 2

2.1 אימון רשת CNN ללא שימוש ב-TRANSFER LEARNING

בעל אלגוריתם עם הפרמטרים הבאים:

Optimizer : Adagrad

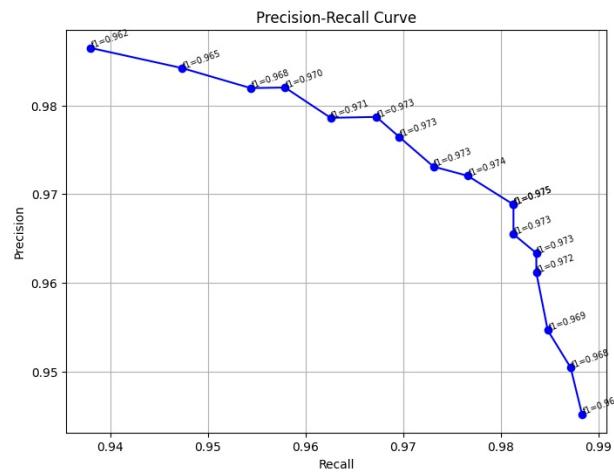
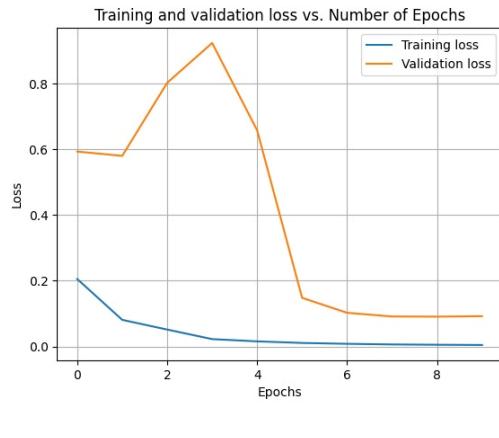
Batch Size: 32

learning_rate=0.001

epochs=10

Test Loss: 0.12386004626750946

Test Accuracy: 0.9624573588371277



The best F1 score is 0.975 with threshold of 0.4

רשות 2.2 : TRANSFER LEARNING CNN מושפעת

על אלגוריתם עם הפרמטרים הבאים:

Optimizer : Adagrad

Batch Size: 32

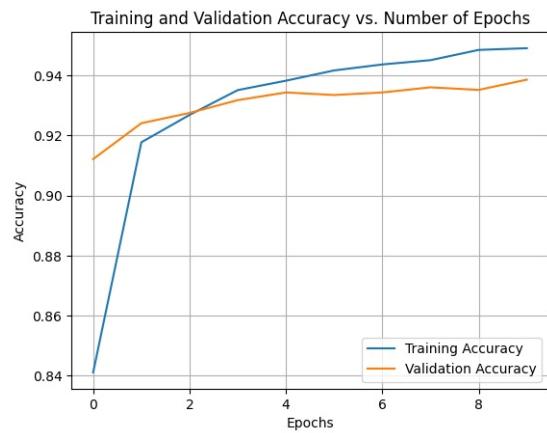
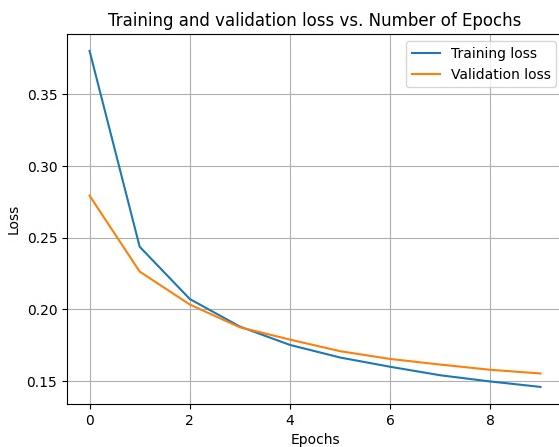
learning_rate=0.001

epochs=10

2.2.1 הקפאת שכבות רשת הבסיס והוספה 2 שכבות:

Test Loss: 0.13912896811962128

Test Accuracy: 0.9488054513931274

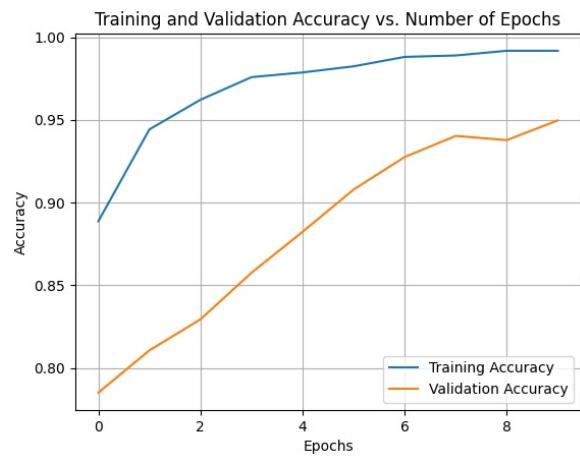
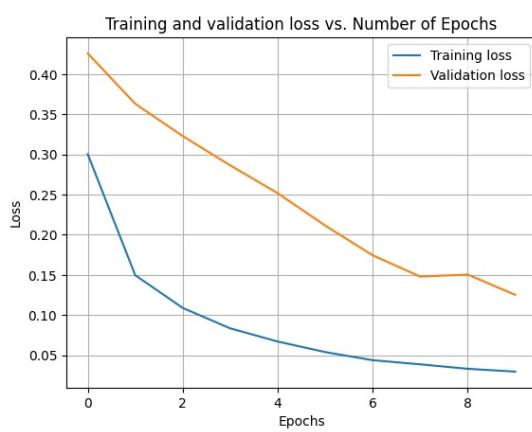


2.2.2 Fine-Tuning

לרשות שהשתמשנו בה הינו 154 שכבות מתוכם הקפינו 80 כלומר אימנו .74.

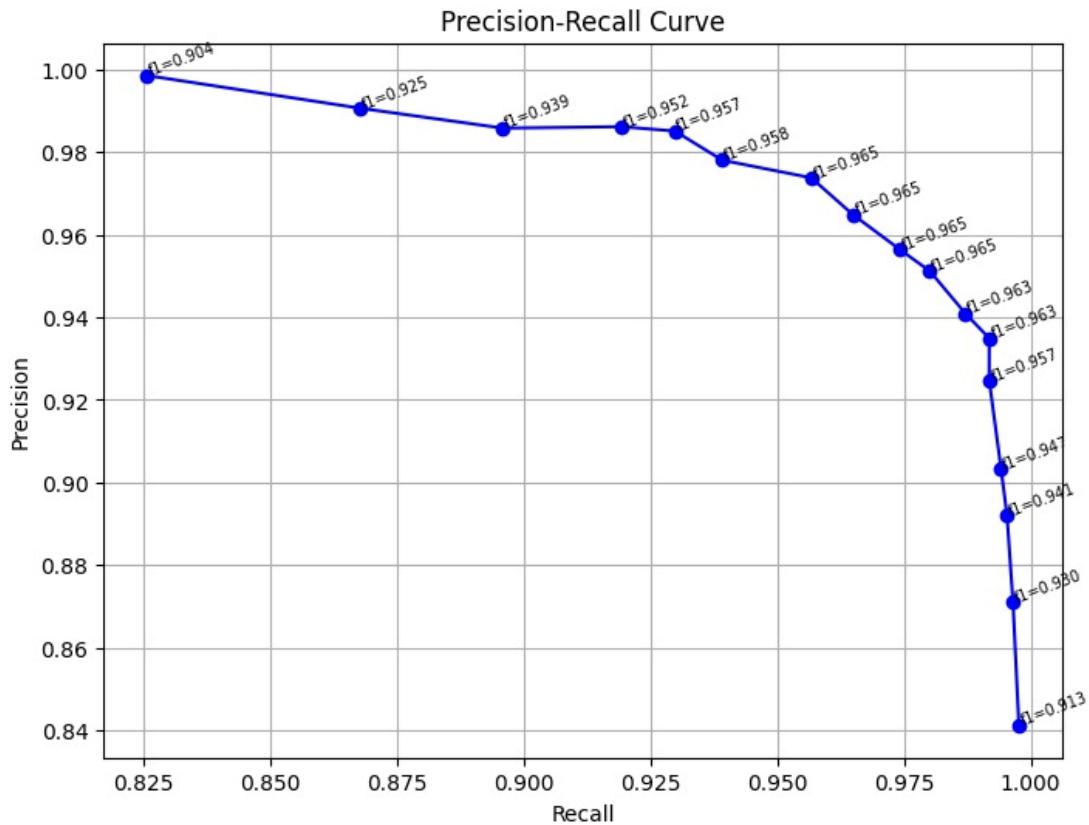
Test Loss: 0.1580778807401657

Test Accuracy: 0.9394198060035706



עבור שיטת אימון מסווג freeze קיבלנו ביצועים טובים יותר.

מציג את גרף ה – Precision-Recall וכן את ערך ספַּף: f_1



The best F1 score is 0.965 with threshold of 0.45

משימה 3

CNN without Transfer Learning

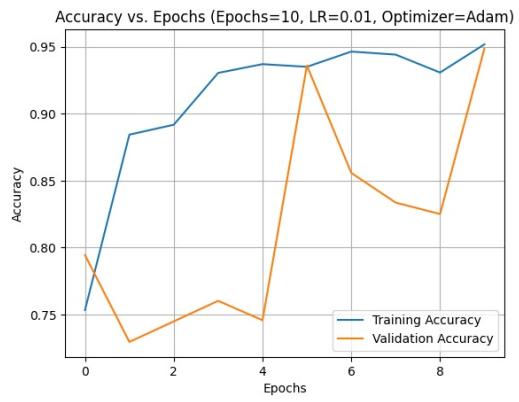
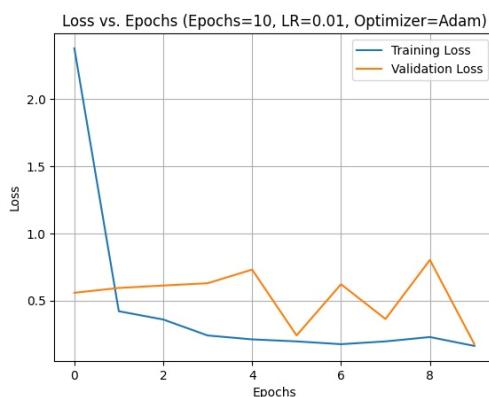
Adam

learning_rate=0.01

epochs=10

Test Loss: 0.17093709111213684

Test Accuracy: 0.9385665655136108

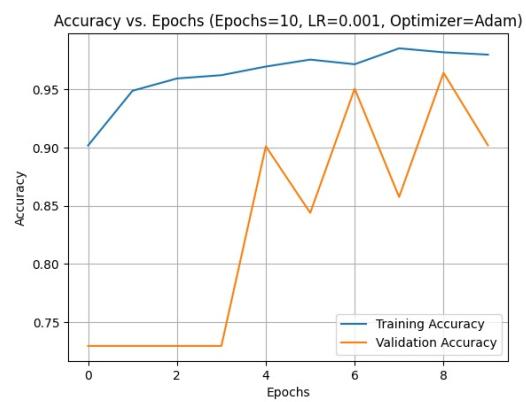


learning_rate=0.001

epochs=10

Test Loss: 0.427635133266449

Test Accuracy: 0.9010238647460938

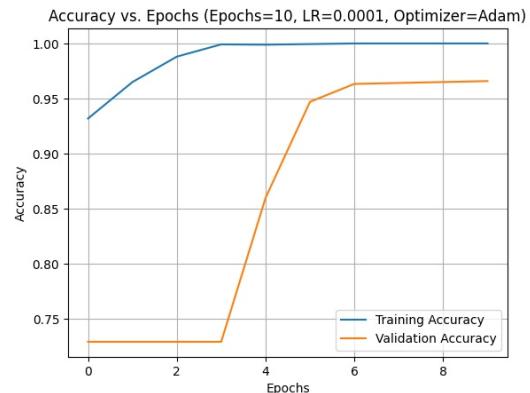
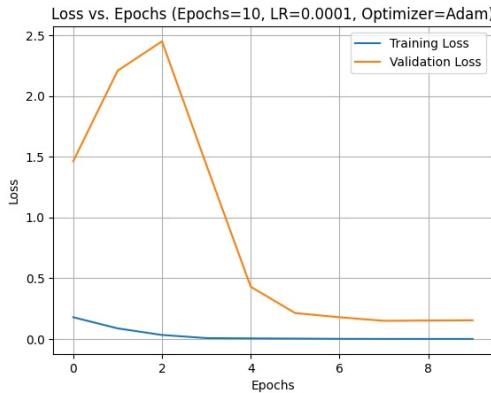


learning_rate=0.0001

epochs=10

Test Loss: 0.14828862249851227

Test Accuracy: 0.967576801776886



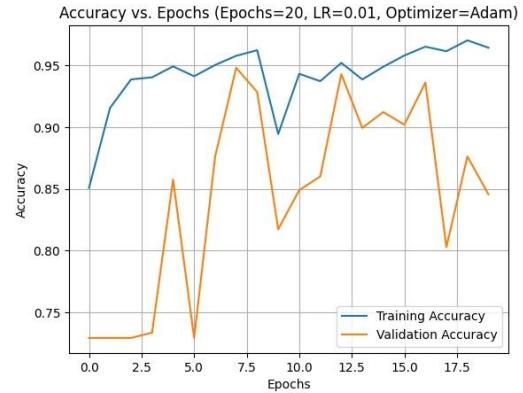
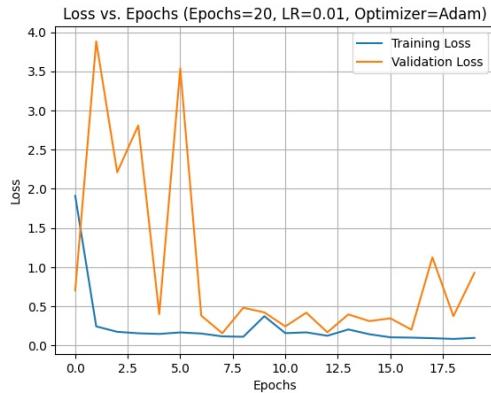
עכשין עבר 20: epochs=20

learning_rate=0.01

epochs=20

Test Loss: 1.0107053518295288

Test Accuracy: 0.8472696542739868

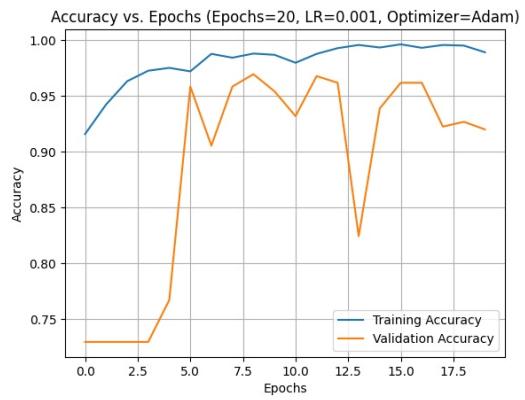
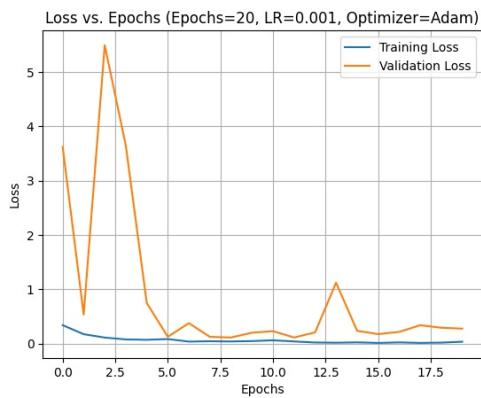


learning_rate=0.001

epochs=20

Test Loss: 0.3229184150695801

Test Accuracy: 0.920648455619812

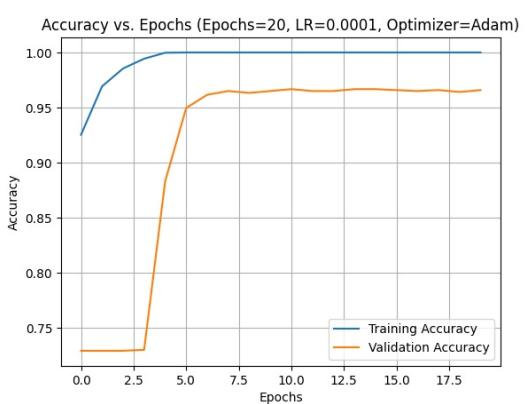
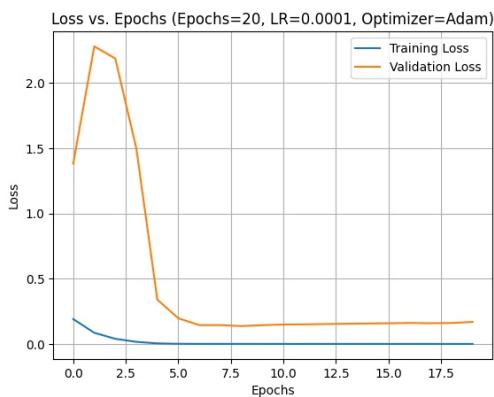


learning_rate=0.0001

epochs=20

Test Loss: 0.16911061108112335

Test Accuracy: 0.9641638398170471



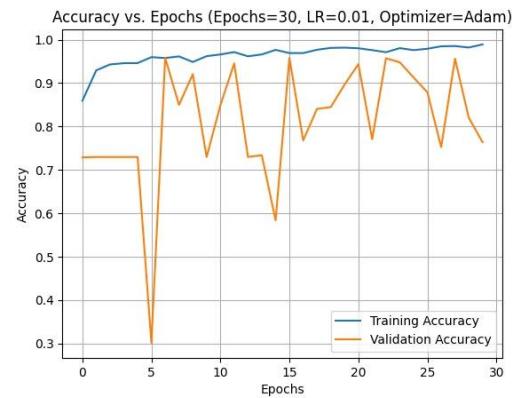
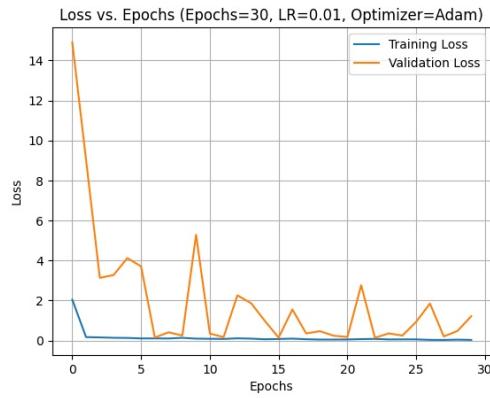
epoch=30

learning_rate=0.01

epochs=30

Test Loss: 1.274810791015625

Test Accuracy: 0.7593856453895569

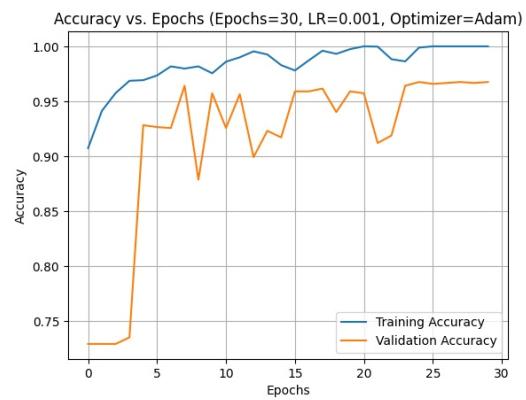
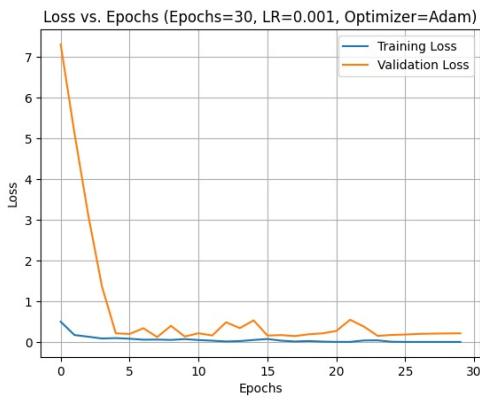


learning_rate=0.001

epochs=30

Test Loss: 0.2544979453086853

Test Accuracy: 0.9641638398170471

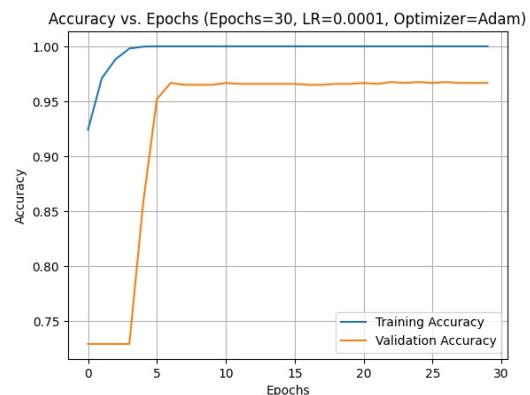
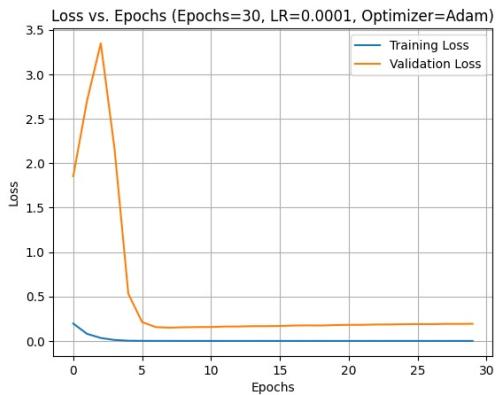


learning_rate=0.0001

epochs=30

Test Loss: 0.17845289409160614

Test Accuracy: 0.9658703207969666





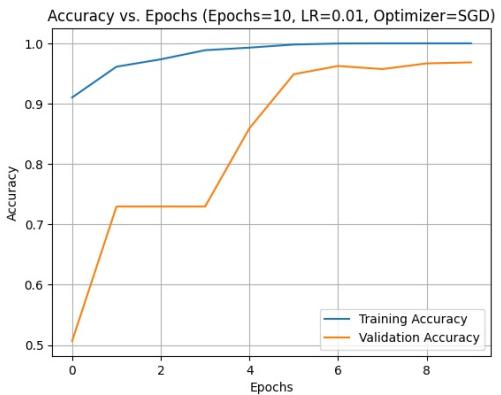
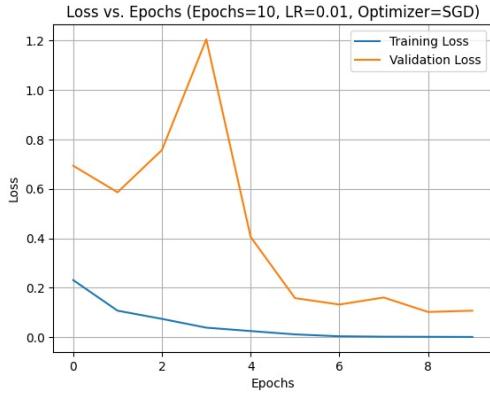
SGD

learning_rate=0.01

epochs=10

Test Loss: 0.12063688784837723

Test Accuracy: 0.9684300422668457

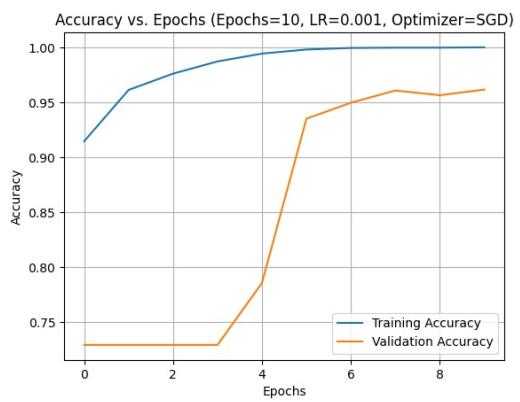
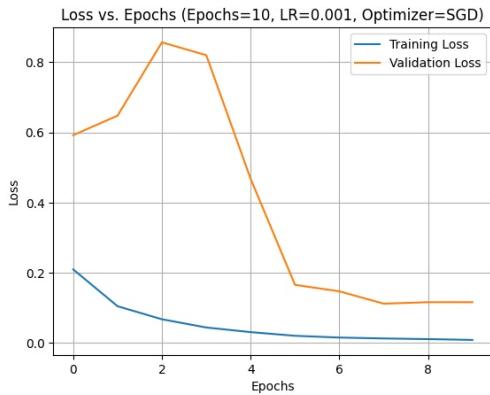


learning_rate=0.001

epochs=10

Test Loss: 0.11964099854230881

Test Accuracy: 0.9581910967826843

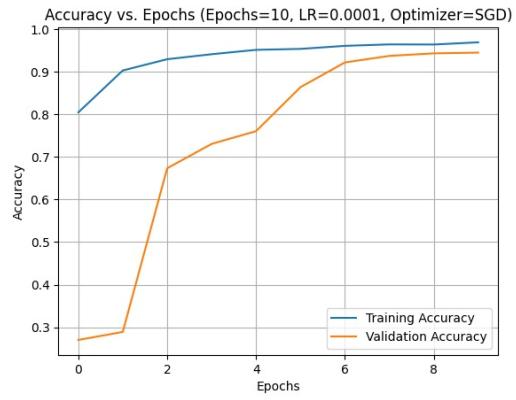
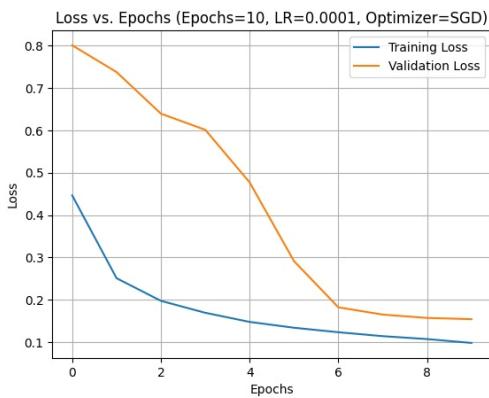


learning_rate=0.0001

epochs=10

Test Loss: 0.14945948123931885

Test Accuracy: 0.9436860084533691



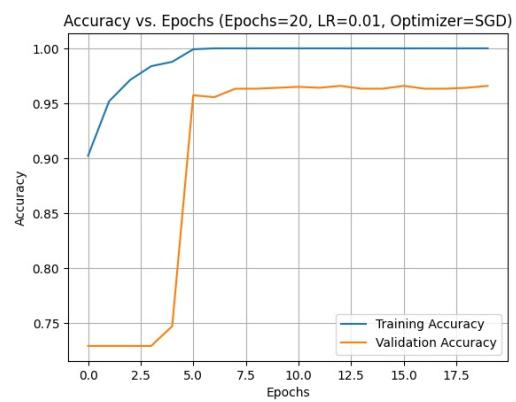
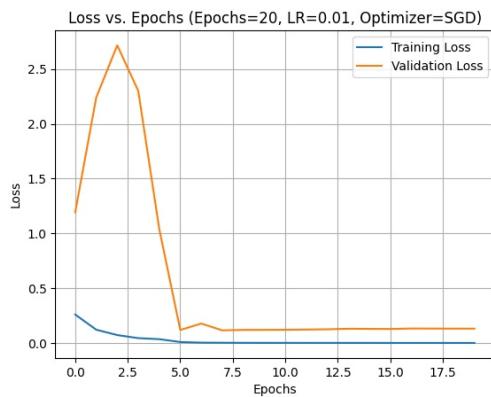
עכשי עבור :epochs=20

learning_rate=0.01

epochs=20

Test Loss: 0.142141655087471

Test Accuracy: 0.9667235612869263

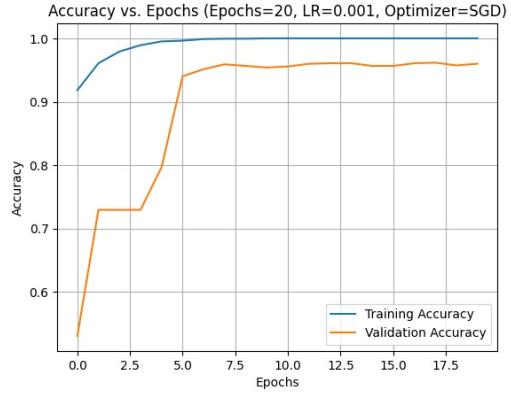
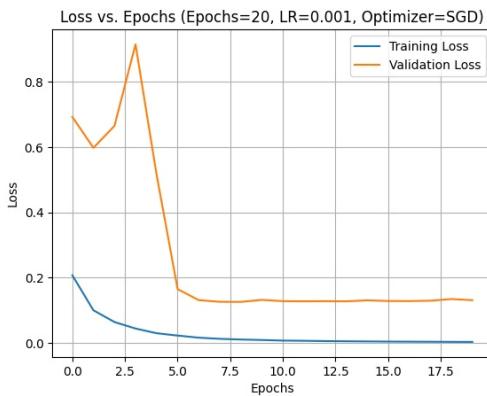


learning_rate=0.001

epochs=20

Test Loss: 0.13118863105773926

Test Accuracy: 0.9598976373672485

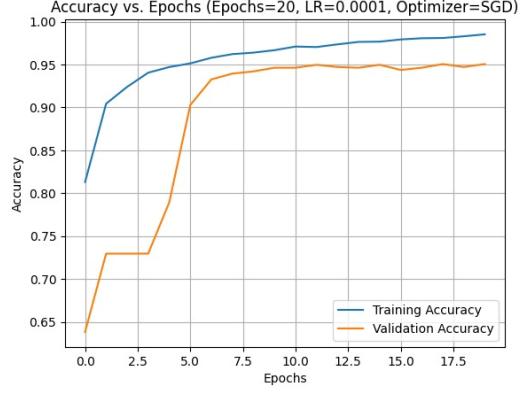
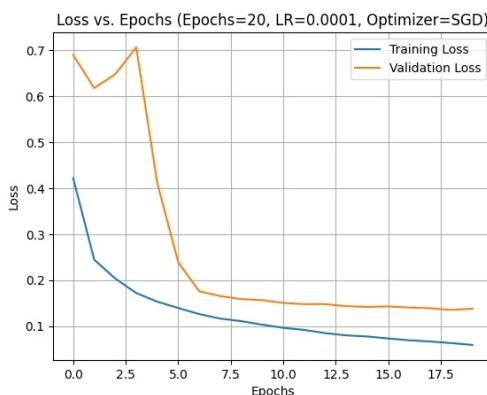


learning_rate=0.0001

epochs=20

Test Loss: 0.1281367540359497

Test Accuracy: 0.9513651728630066



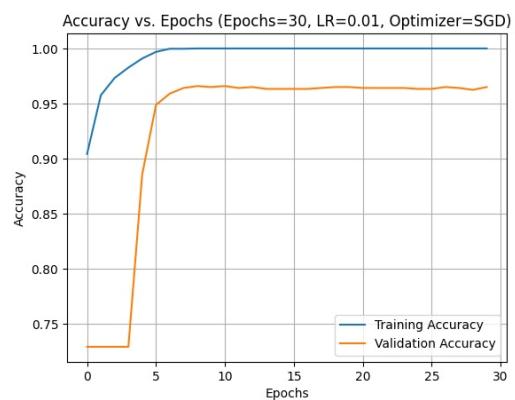
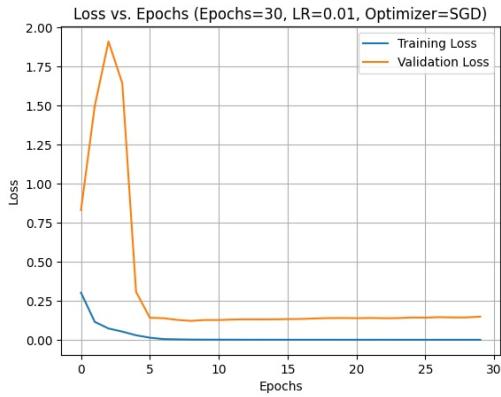
epochs=30

learning_rate=0.01

epochs=30

Test Loss: 0.14470206201076508

Test Accuracy: 0.9658703207969666

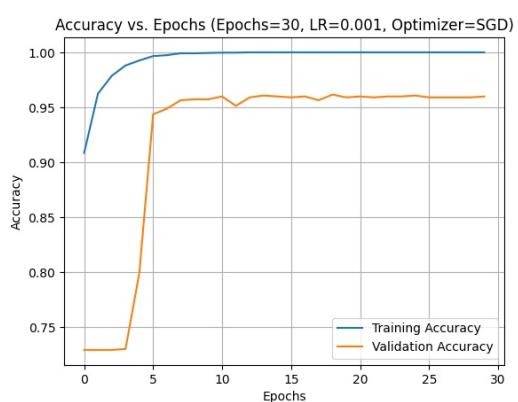
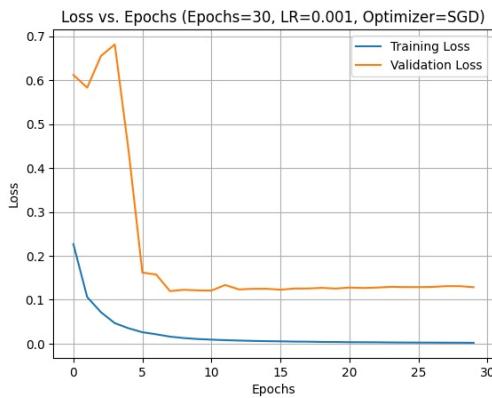


learning_rate=0.001

epochs=30

Test Loss: 0.11938359588384628

Test Accuracy: 0.9556313753128052

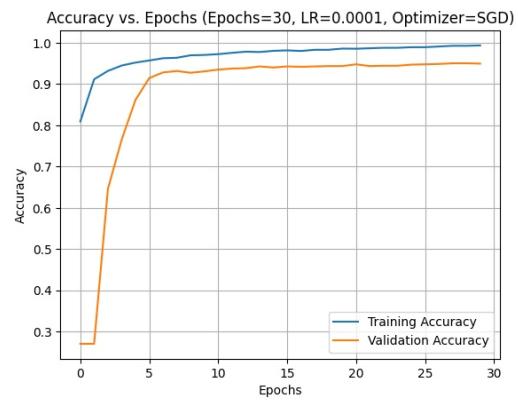
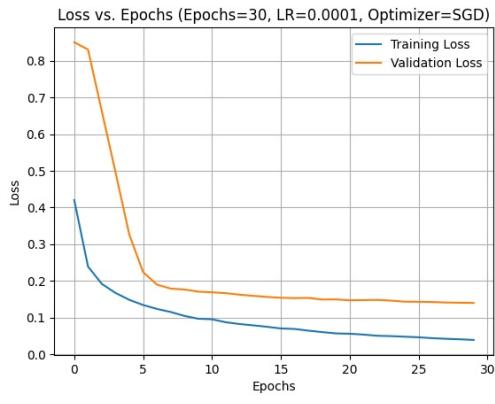


learning_rate=0.0001

epochs=30

Test Loss: 0.13434664905071259

Test Accuracy: 0.947098970413208





SGD with MOMENTUM

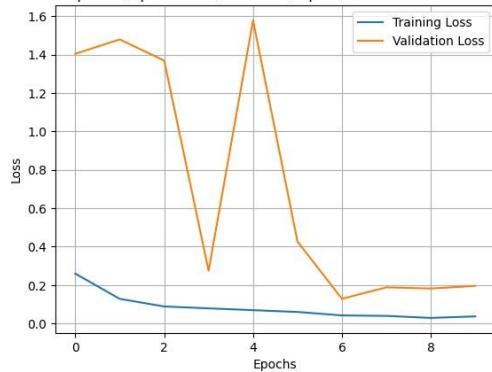
learning_rate=0.01

epochs=10

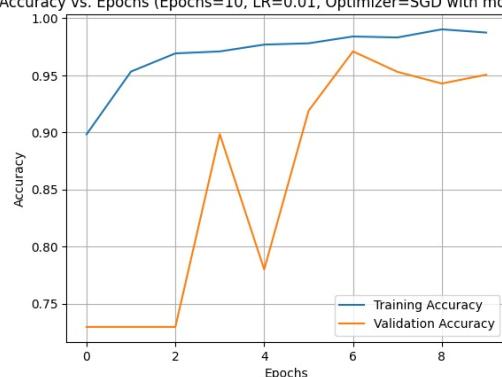
Test Loss: 0.19276031851768494

Test Accuracy: 0.9377133250236511

Loss vs. Epochs (Epochs=10, LR=0.01, Optimizer=SGD with momentum)



Accuracy vs. Epochs (Epochs=10, LR=0.01, Optimizer=SGD with momentum)



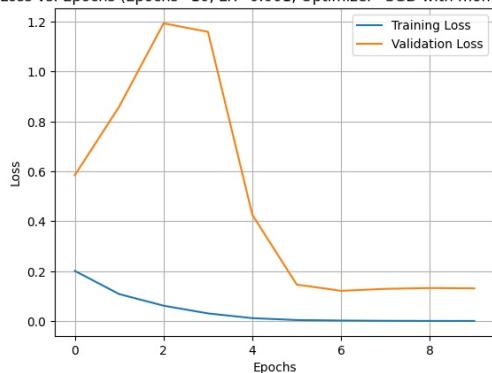
learning_rate=0.001

epochs=10

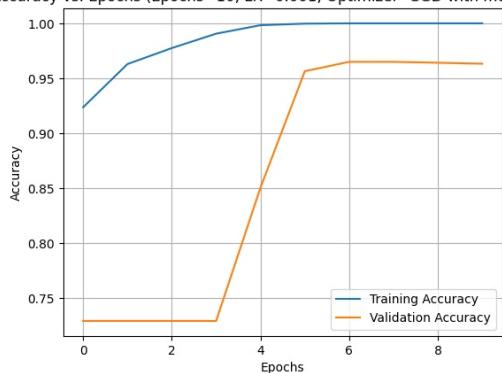
Test Loss: 0.14860840141773224

Test Accuracy: 0.9607508778572083

Loss vs. Epochs (Epochs=10, LR=0.001, Optimizer=SGD with momentum)



Accuracy vs. Epochs (Epochs=10, LR=0.001, Optimizer=SGD with momentum)



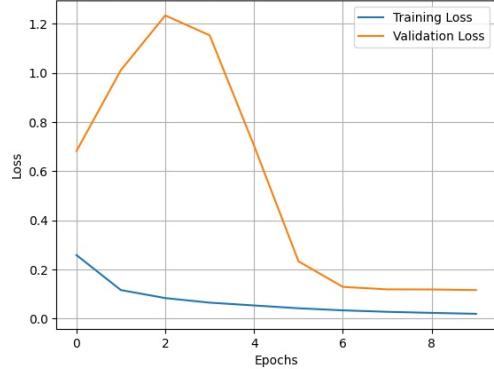
learning_rate=0.0001

epochs=10

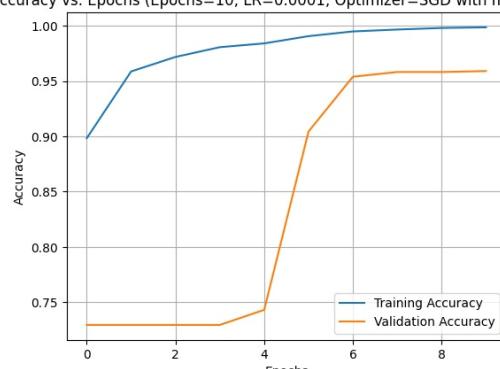
Test Loss: 0.11011970043182373

Test Accuracy: 0.9547781348228455

Loss vs. Epochs (Epochs=10, LR=0.0001, Optimizer=SGD with momentum)



Accuracy vs. Epochs (Epochs=10, LR=0.0001, Optimizer=SGD with momentum)



עכשין עבור epochs=20

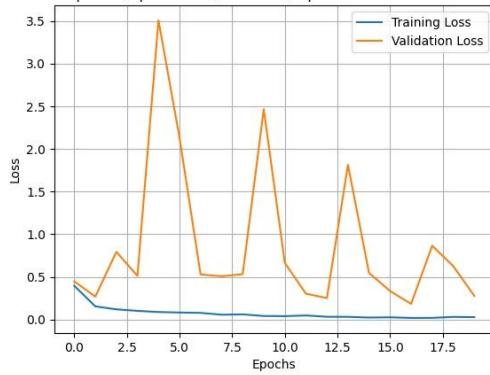
learning_rate=0.01

epochs=20

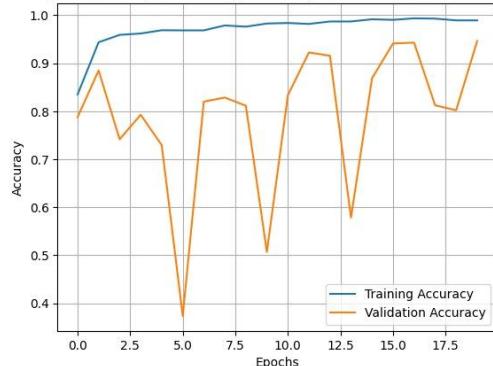
Test Loss: 0.22306562960147858

Test Accuracy: 0.953071653842926

Loss vs. Epochs (Epochs=20, LR=0.01, Optimizer=SGD with momentum)



Accuracy vs. Epochs (Epochs=20, LR=0.01, Optimizer=SGD with momentum)



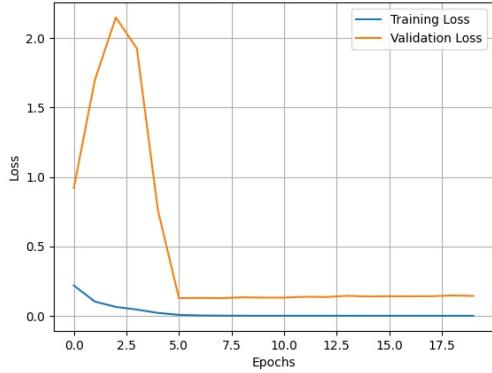
learning_rate=0.001

epochs=20

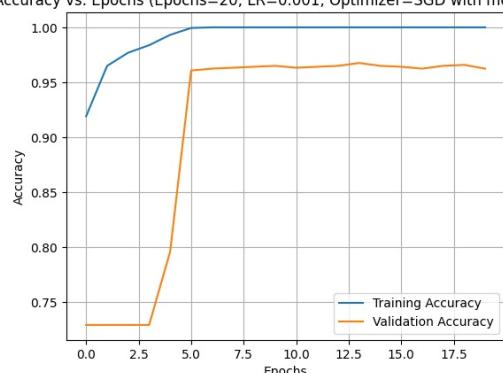
Test Loss: 0.16515684127807617

Test Accuracy: 0.9658703207969666

Loss vs. Epochs (Epochs=20, LR=0.001, Optimizer=SGD with momentum)



Accuracy vs. Epochs (Epochs=20, LR=0.001, Optimizer=SGD with momentum)



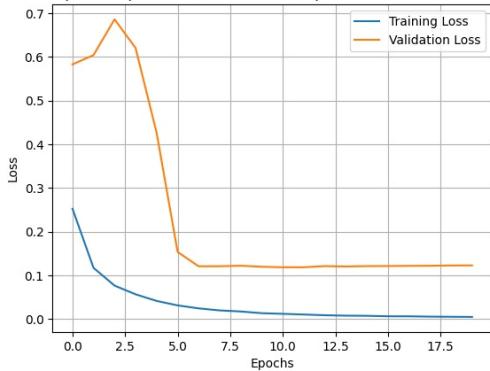
learning_rate=0.0001

epochs=20

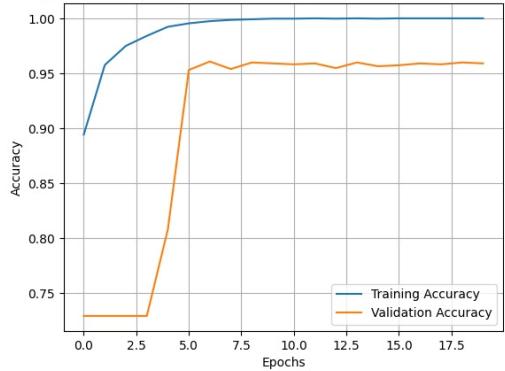
Test Loss: 0.11967112869024277

Test Accuracy: 0.9598976373672485

Loss vs. Epochs (Epochs=20, LR=0.0001, Optimizer=SGD with momentum)



Accuracy vs. Epochs (Epochs=20, LR=0.0001, Optimizer=SGD with momentum)



עכשווי עבר 30 epochs

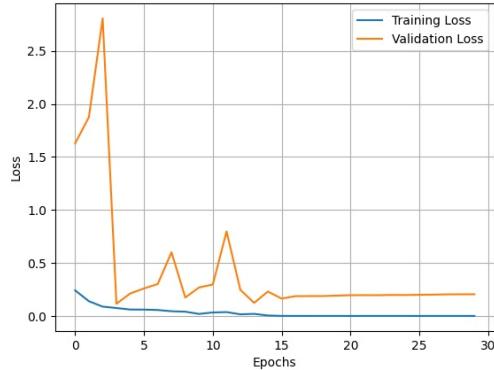
learning_rate=0.01

epochs=30

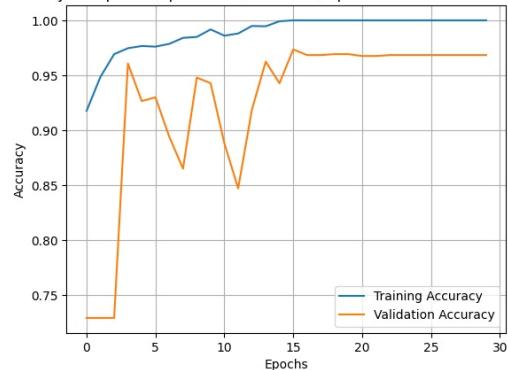
Test Loss: 0.2327541559934616

Test Accuracy: 0.9667235612869263

Loss vs. Epochs (Epochs=30, LR=0.01, Optimizer=SGD with momentum)



Accuracy vs. Epochs (Epochs=30, LR=0.01, Optimizer=SGD with momentum)



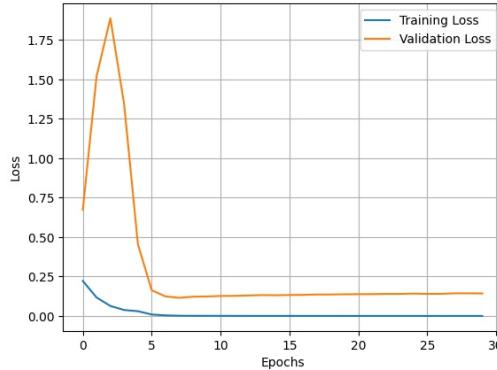
learning_rate=0.001

epochs=30

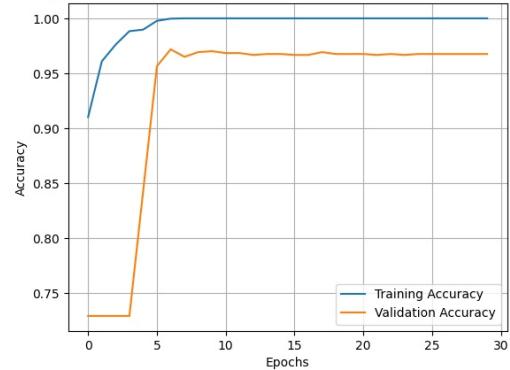
Test Loss: 0.13965676724910736

Test Accuracy: 0.967576801776886

Loss vs. Epochs (Epochs=30, LR=0.001, Optimizer=SGD with momentum)



Accuracy vs. Epochs (Epochs=30, LR=0.001, Optimizer=SGD with momentum)



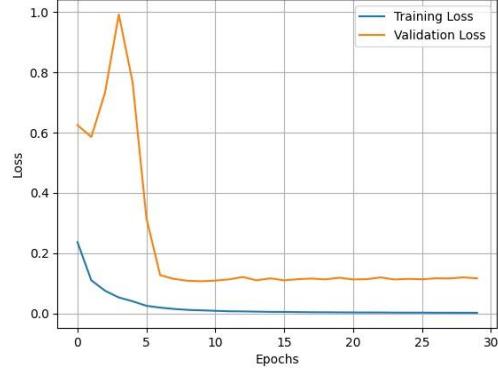
learning_rate=0.0001

epochs=30

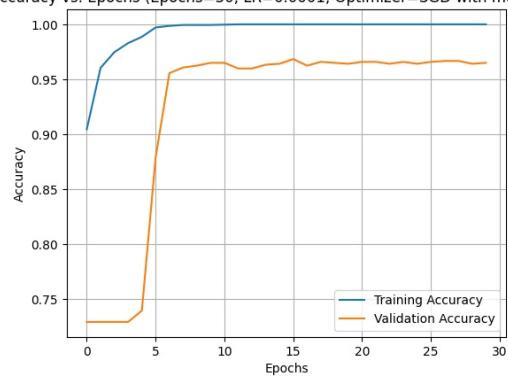
Test Loss: 0.12558941543102264

Test Accuracy: 0.9633105993270874

Loss vs. Epochs (Epochs=30, LR=0.0001, Optimizer=SGD with momentum)



Accuracy vs. Epochs (Epochs=30, LR=0.0001, Optimizer=SGD with momentum)



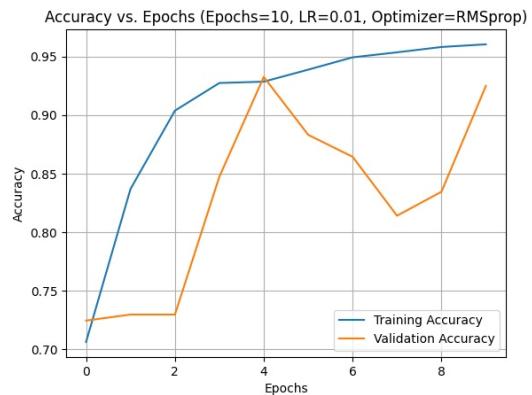
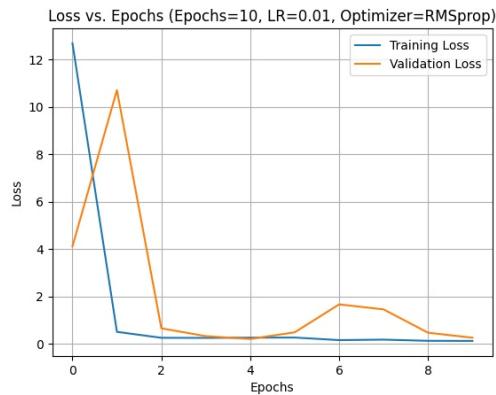
RMSPROP

learning_rate=0.01

epochs=10

Test Loss: 0.2019677758216858

Test Accuracy: 0.9479522109031677

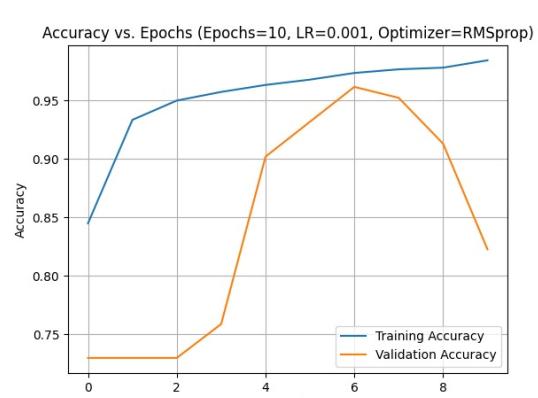
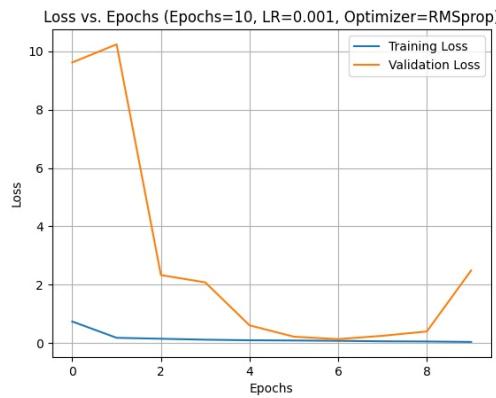


learning_rate=0.001

epochs=10

Test Loss: 2.7141456604003906

Test Accuracy: 0.8199658989906311

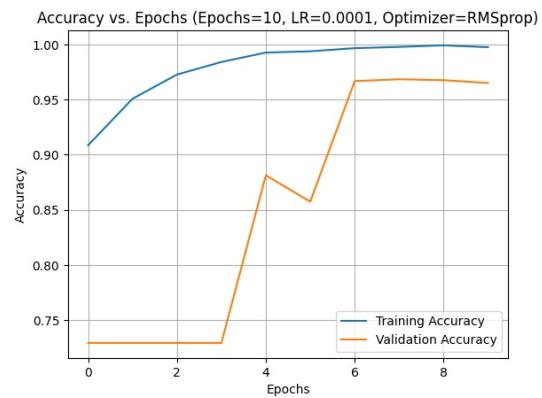
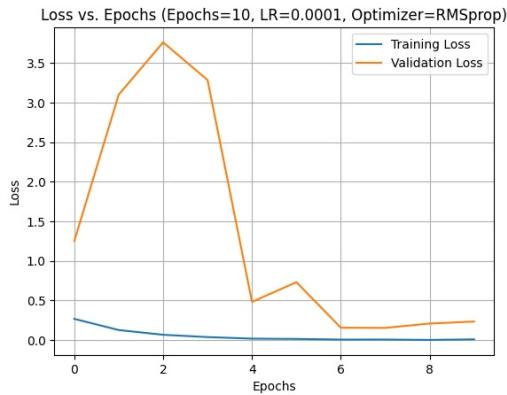


learning_rate=0.0001

epochs=10

Test Loss: 0.2258642464876175

Test Accuracy: 0.9633105993270874



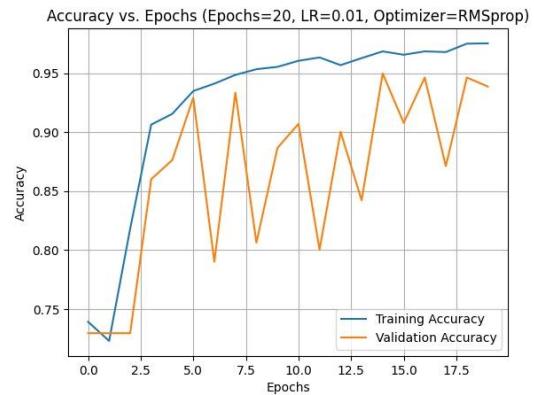
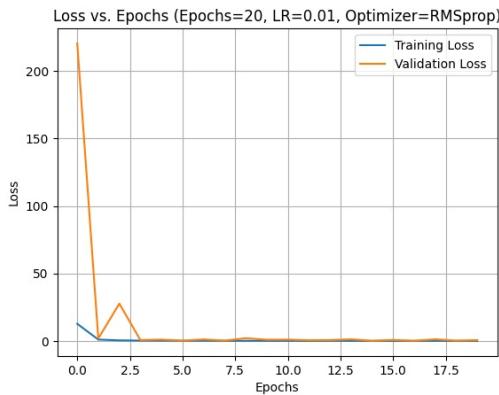
עושים עבוק epochs=20

learning_rate=0.01

epochs=20

Test Loss: 0.8019886612892151

Test Accuracy: 0.9317406415939331

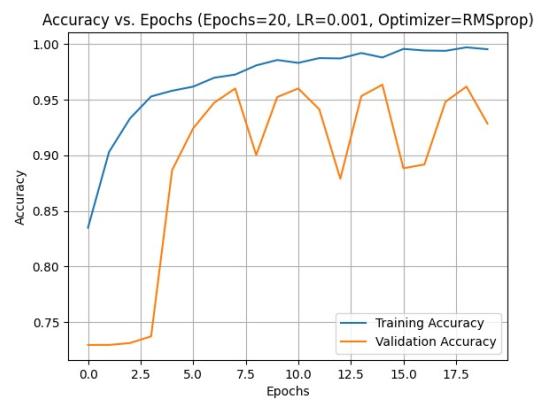
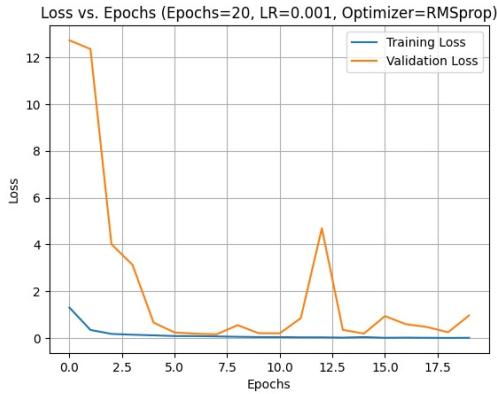


learning_rate=0.001

epochs=20

Test Loss: 0.8419598340988159

Test Accuracy: 0.920648455619812

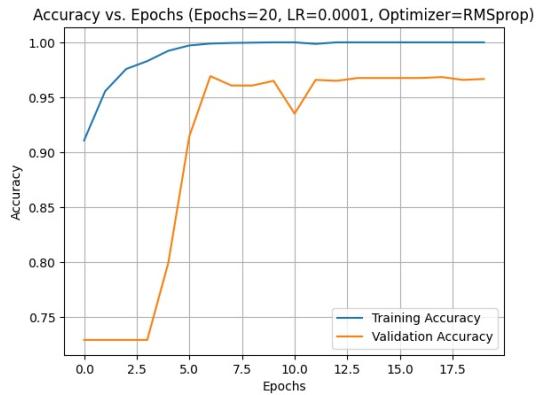
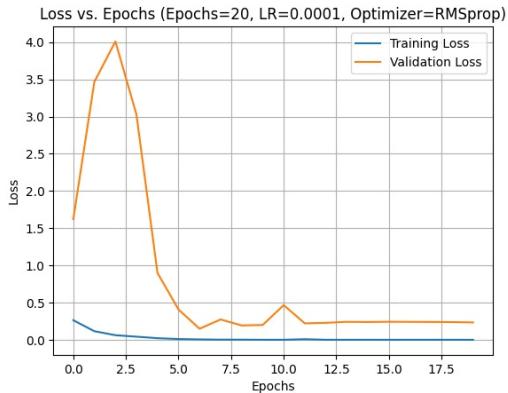


learning_rate=0.0001

epochs=20

Test Loss: 0.23898528516292572

Test Accuracy: 0.9598976373672485



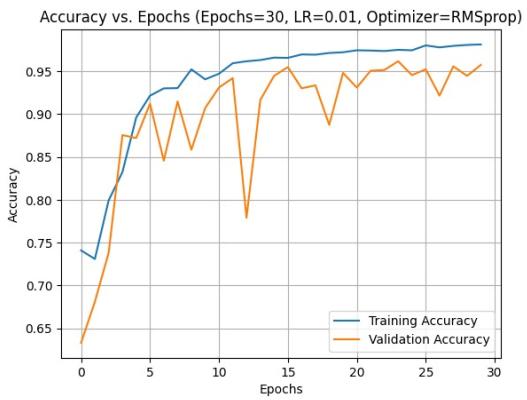
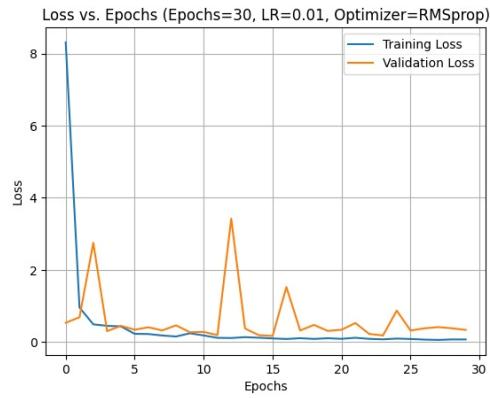
עכשי עבור epochs=30

learning_rate=0.01

epochs=30

Test Loss: 0.37235304713249207

Test Accuracy: 0.953071653842926

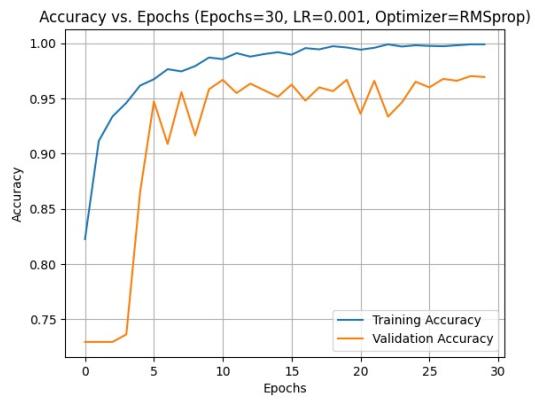
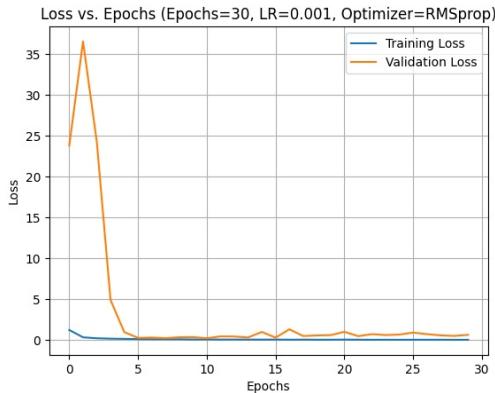


learning_rate=0.001

epochs=30

Test Loss: 0.6496303677558899

Test Accuracy: 0.9658703207969666

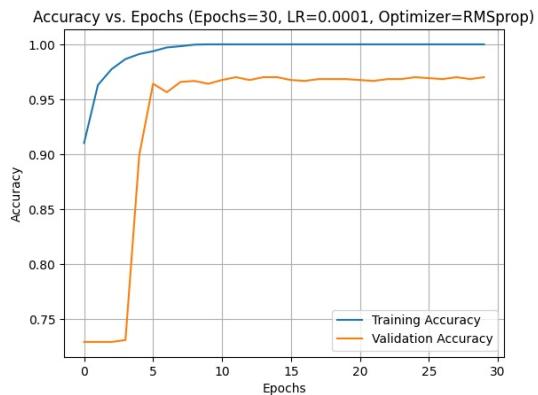
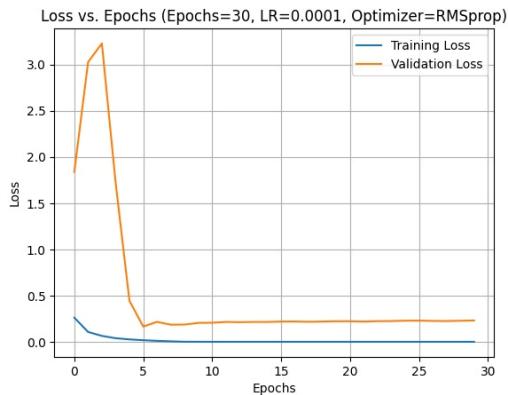


learning_rate=0.0001

epochs=30

Test Loss: 0.24839413166046143

Test Accuracy: 0.9667235612869263



CNN Transfer Learning with freezing

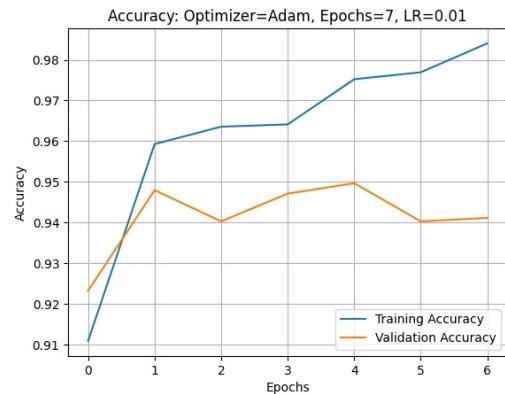
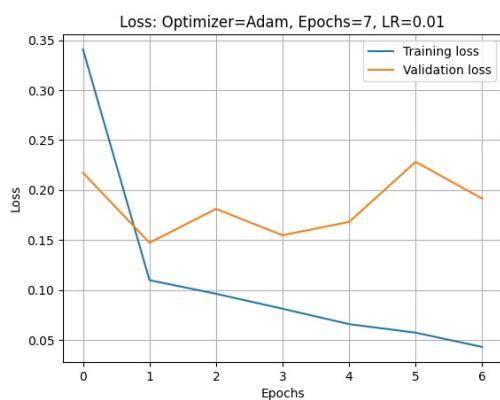
Adam

learning_rate=0.01

epochs=7

Test Loss: 0.1071145236492157

Test Accuracy: 0.9624573588371277

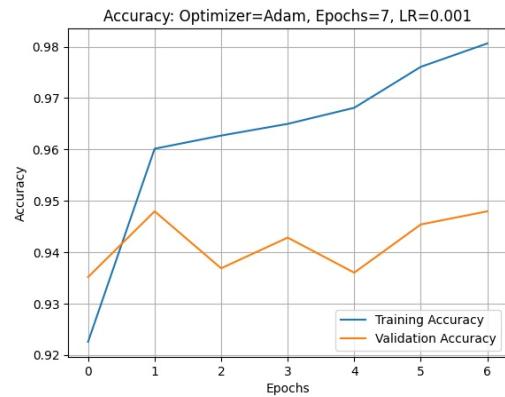
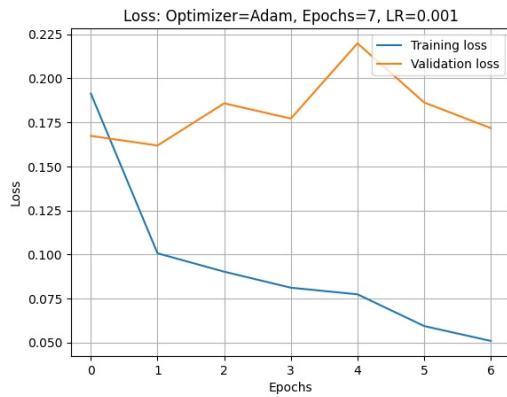


learning_rate=0.001

epochs=7

Test Loss: 0.08897892385721207

Test Accuracy: 0.9709897637367249

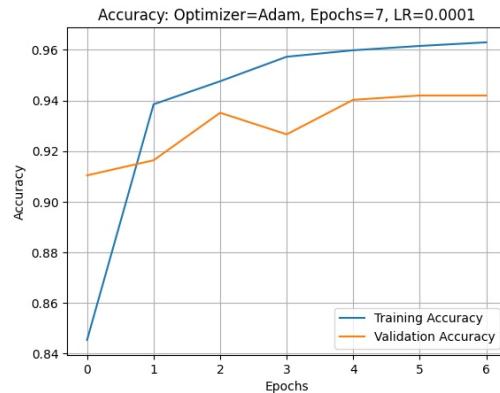
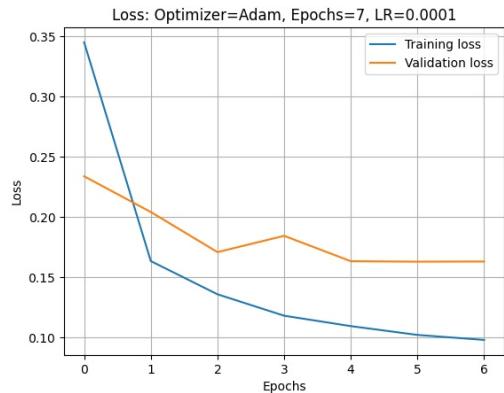


learning_rate=0.001

epochs=7

Test Loss: 0.1110457181930542

Test Accuracy: 0.9598976373672485



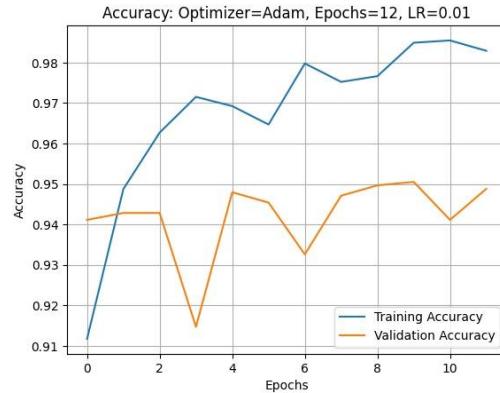
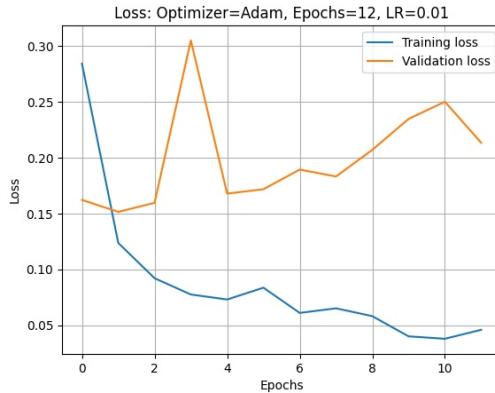
עכשי עבור epochs=12

learning_rate=0.01

epochs=12

Test Loss: 0.13772191107273102

Test Accuracy: 0.9581910967826843

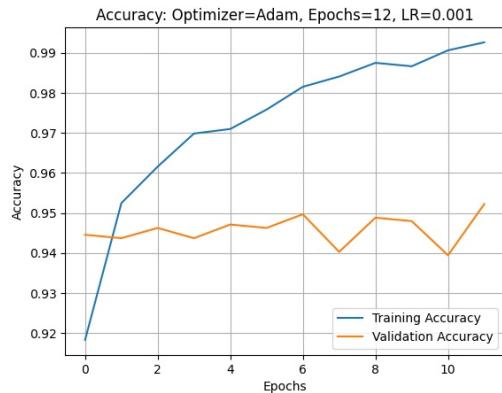
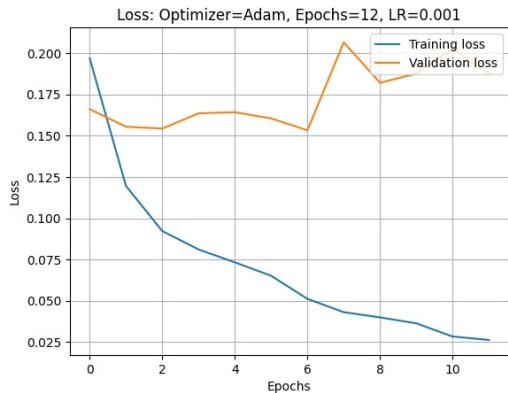


learning_rate=0.001

epochs=12

Test Loss: 0.11628996580839157

Test Accuracy: 0.9581910967826843

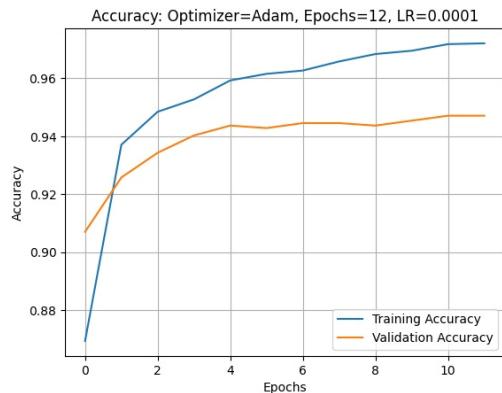
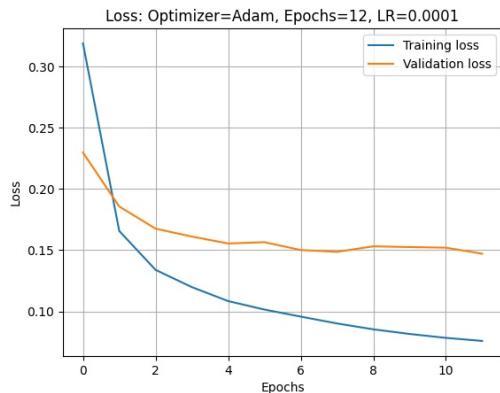


learning_rate=0.0001

epochs=12

Test Loss: 0.09598826617002487

Test Accuracy: 0.9684300422668457



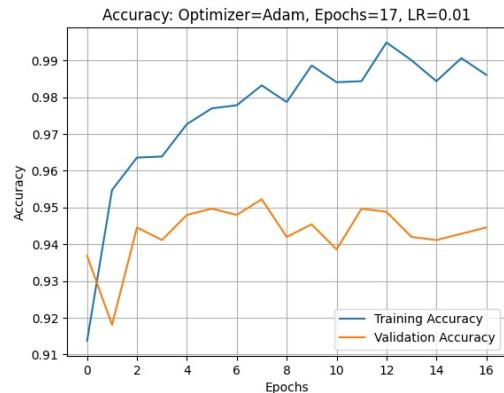
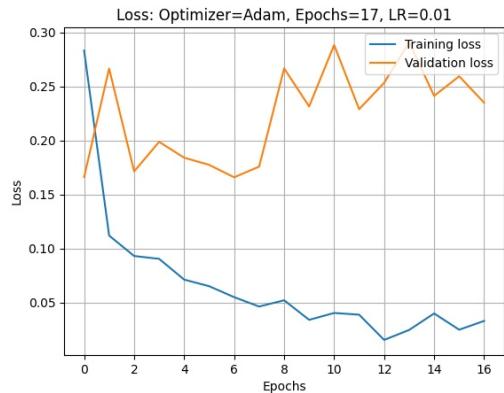
עכשי עבור epochs=17

learning_rate=0.01

epochs=17

Test Loss: 0.12724733352661133

Test Accuracy: 0.9633105993270874

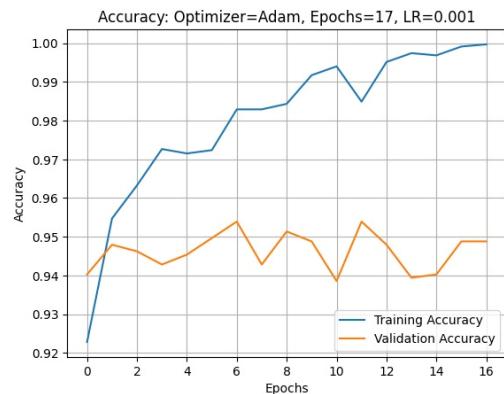
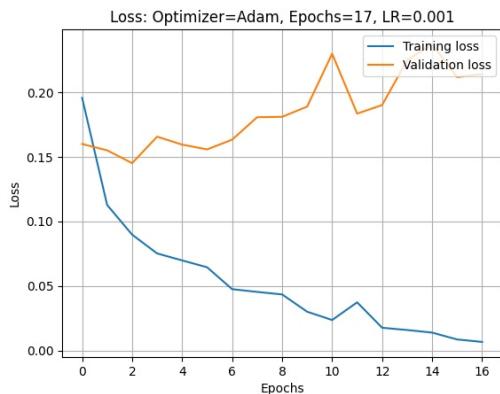


learning_rate=0.001

epochs=17

Test Loss: 0.13839563727378845

Test Accuracy: 0.9564846158027649

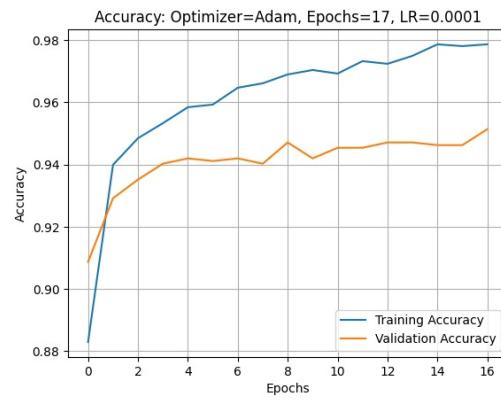
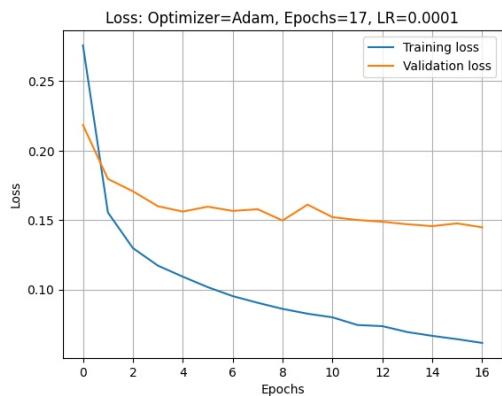


learning_rate=0.0001

epochs=17

Test Loss: 0.09568596631288528

Test Accuracy: 0.9650170803070068





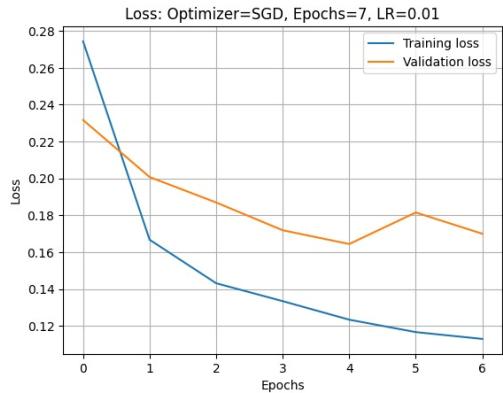
SGD

learning_rate=0.01

epochs=7

Test Loss: 0.12062433362007141

Test Accuracy: 0.9539248943328857

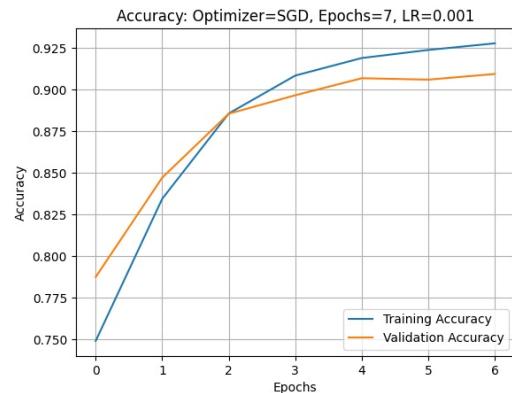
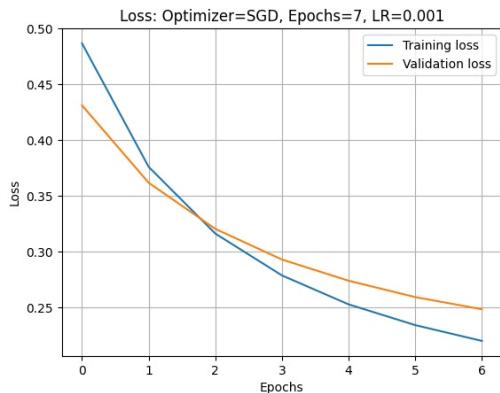


learning_rate=0.001

epochs=7

Test Loss: 0.22729074954986572

Test Accuracy: 0.920648455619812

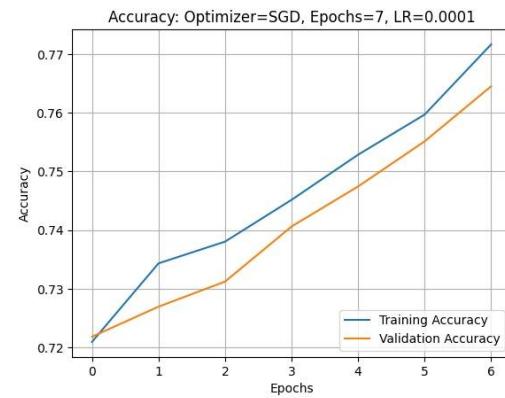
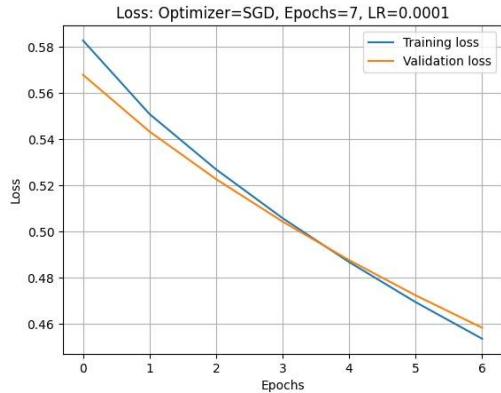


learning_rate=0.0001

epochs=7

Test Loss: 0.44774845242500305

Test Accuracy: 0.7807167172431946



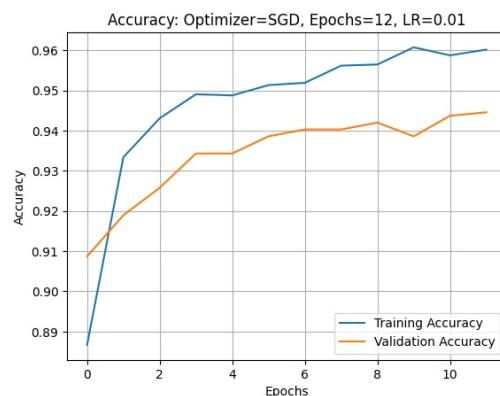
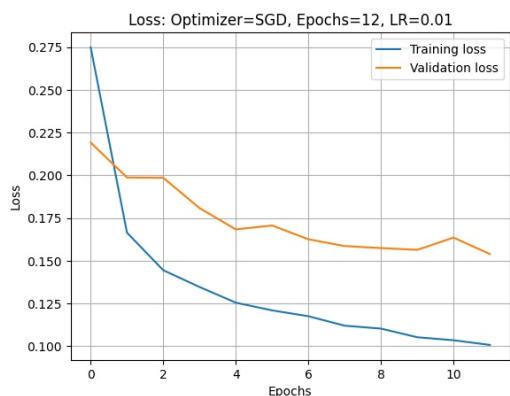
עכשי עבור 12

learning_rate=0.01

epochs=12

Test Loss: 0.10959194600582123

Test Accuracy: 0.9624573588371277

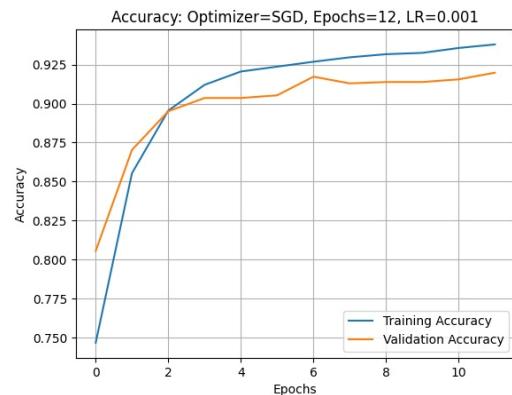
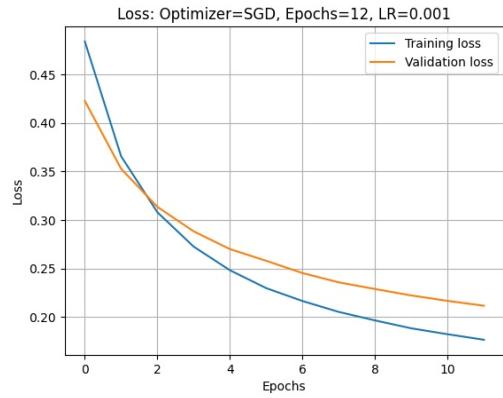


learning_rate=0.001

epochs=12

Test Loss: 0.18434469401836395

Test Accuracy: 0.9385665655136108

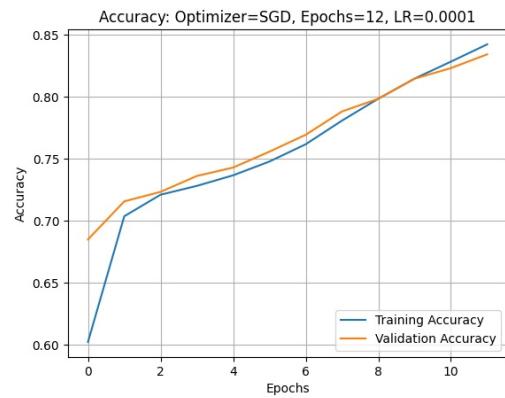
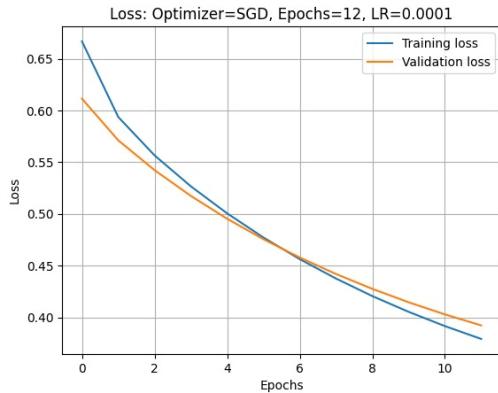


learning_rate=0.0001

epochs=12

Test Loss: 0.3772376477718353

Test Accuracy: 0.8387371897697449



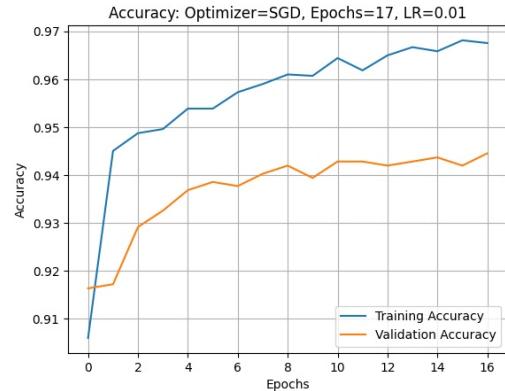
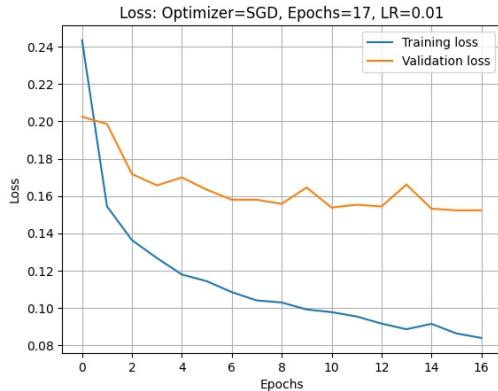
עכשי עבור 17 epochs=17

learning_rate=0.01

epochs=17

Test Loss: 0.10278048366308212

Test Accuracy: 0.9607508778572083

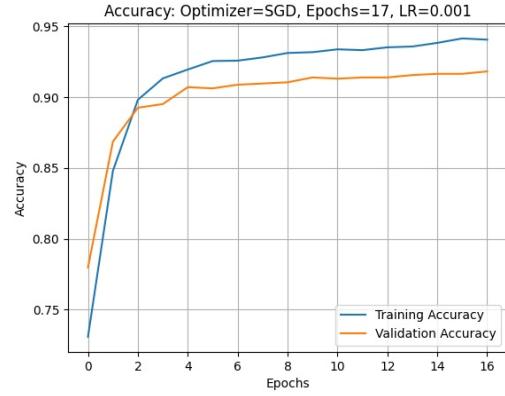
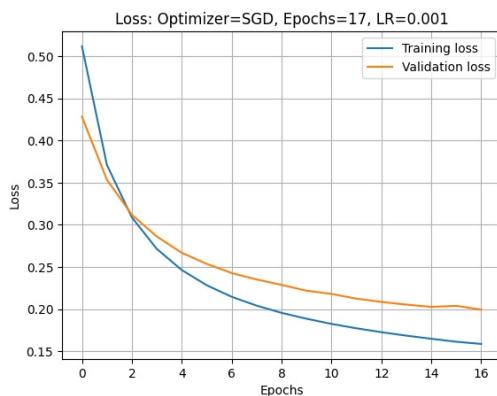


learning_rate=0.001

epochs=17

Test Loss: 0.1653282344341278

Test Accuracy: 0.9436860084533691

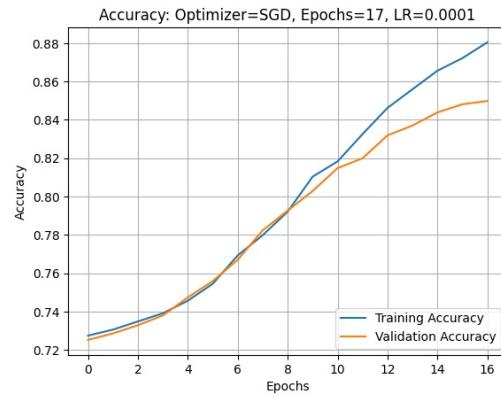
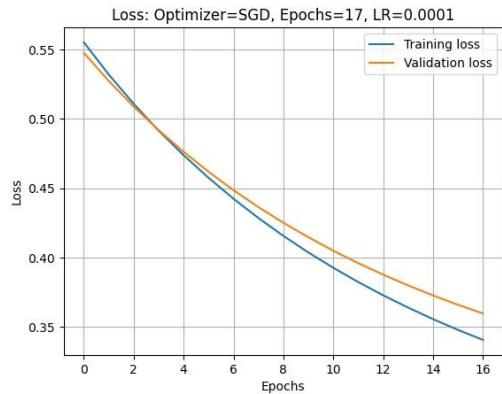


learning_rate=0.0001

epochs=17

Test Loss: 0.3430250585079193

Test Accuracy: 0.8711603879928589





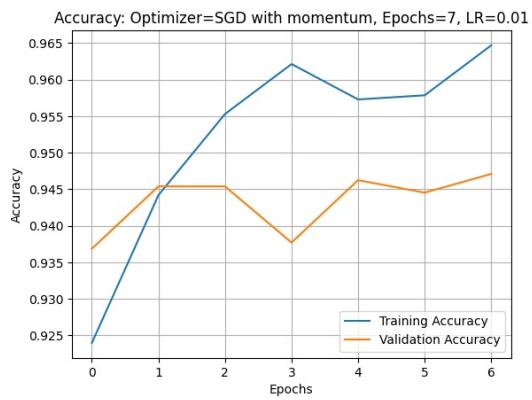
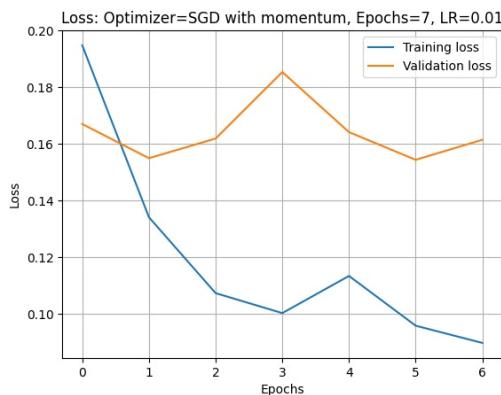
SGD with MOMENTUM

learning_rate=0.01

epochs=7

Test Loss: 0.09730026125907898

Test Accuracy: 0.9650170803070068

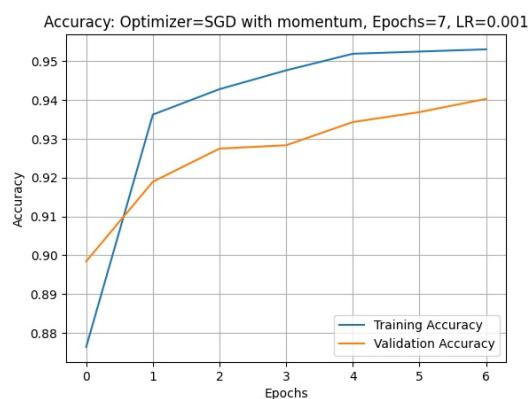
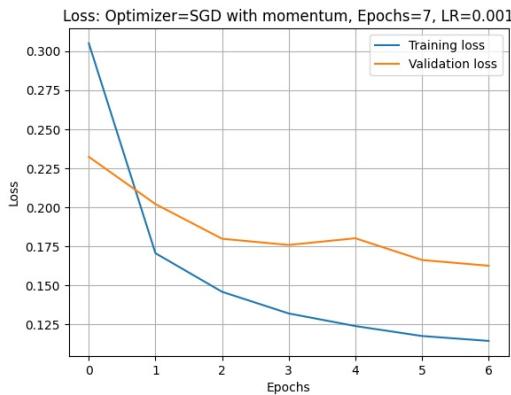


learning_rate=0.001

epochs=7

Test Loss: 0.11512590944766998

Test Accuracy: 0.9573378562927246

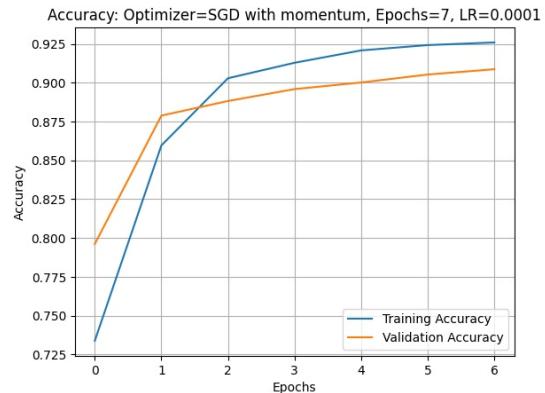
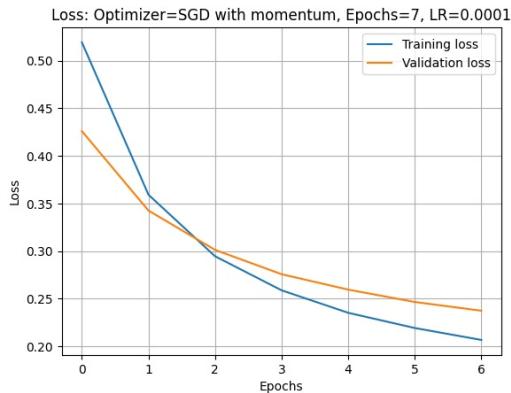


learning_rate=0.0001

epochs=7

Test Loss: 0.203087717294693

Test Accuracy: 0.9317406415939331



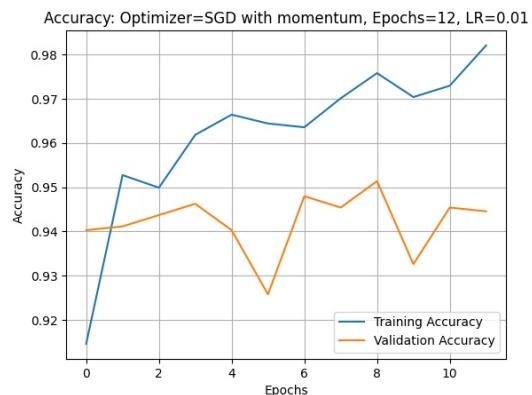
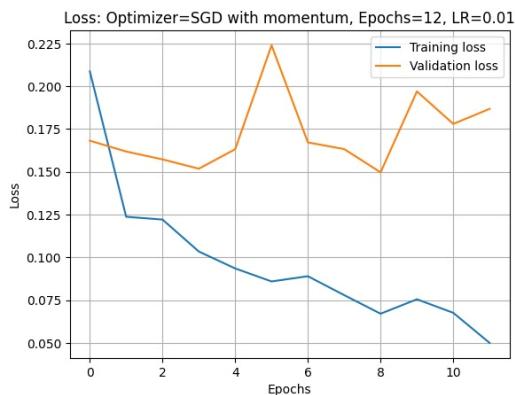
:epochs=12

learning_rate=0.01

epochs=12

Test Loss: 0.10798745602369308

Test Accuracy: 0.9598976373672485

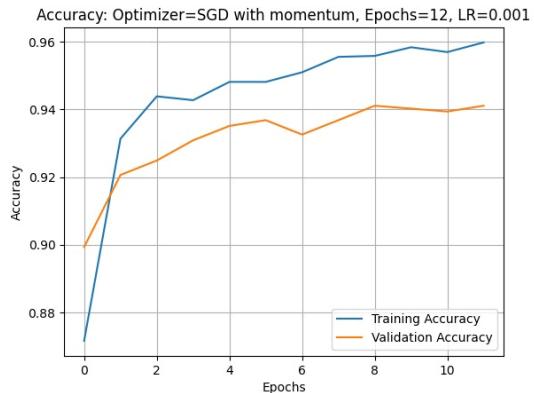
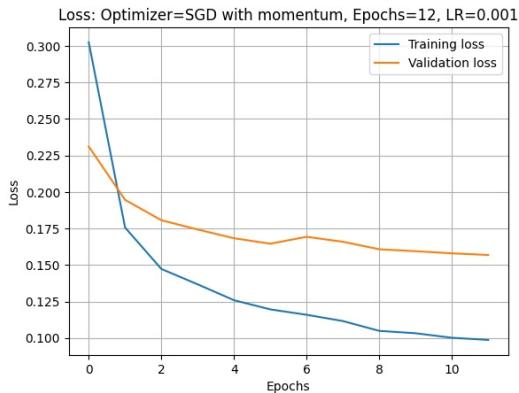


learning_rate=0.001

epochs=12

Test Loss: 0.1032094731926918

Test Accuracy: 0.9607508778572083

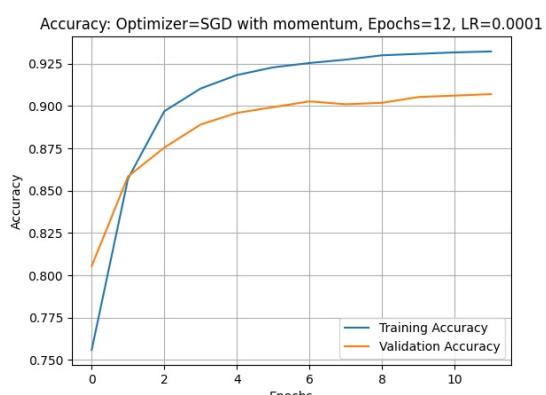
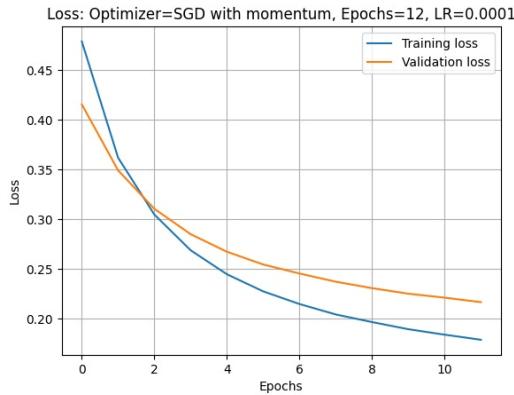


learning_rate=0.0001

epochs=12

Test Loss: 0.18746472895145416

Test Accuracy: 0.9325938820838928



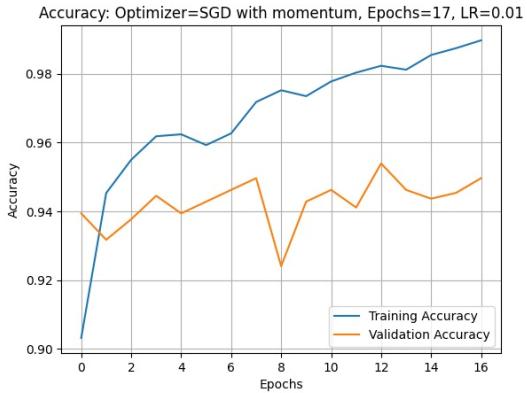
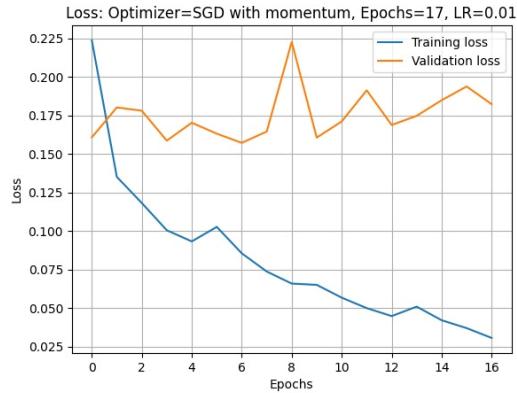
עכשווי עבר 17 epochs=17

learning_rate=0.01

epochs=17

Test Loss: 0.10031522810459137

Test Accuracy: 0.967576801776886

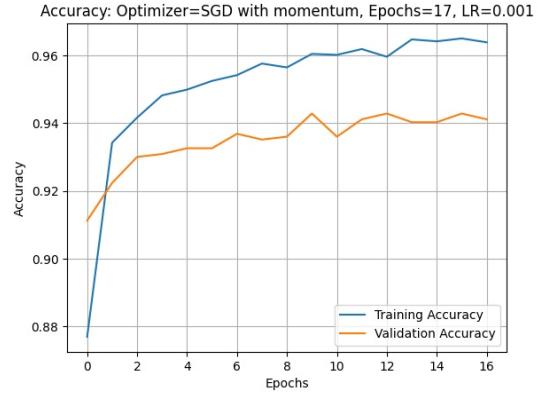
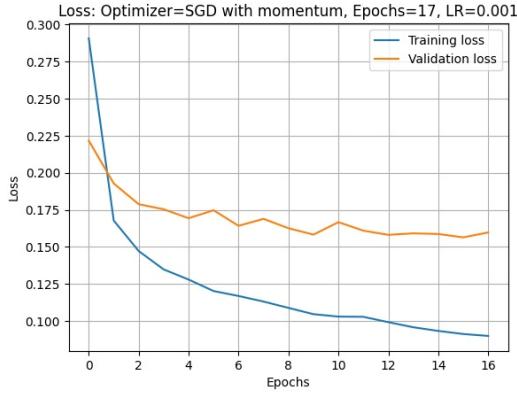


learning_rate=0.001

epochs=17

Test Loss: 0.10602552443742752

Test Accuracy: 0.961604118347168

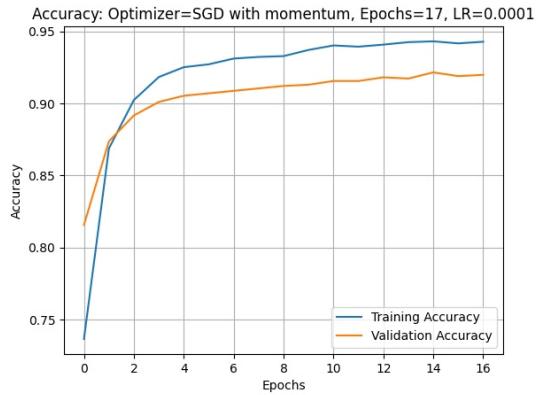
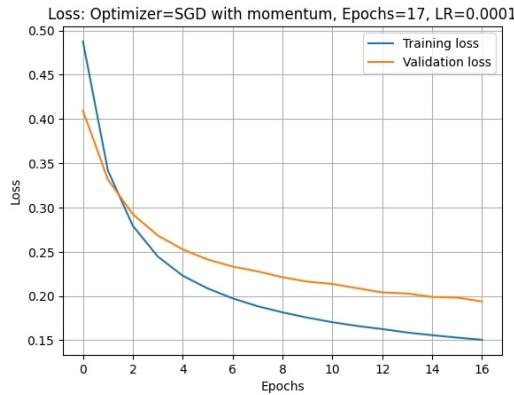


learning_rate=0.0001

epochs=17

Test Loss: 0.1555817574262619

Test Accuracy: 0.947098970413208



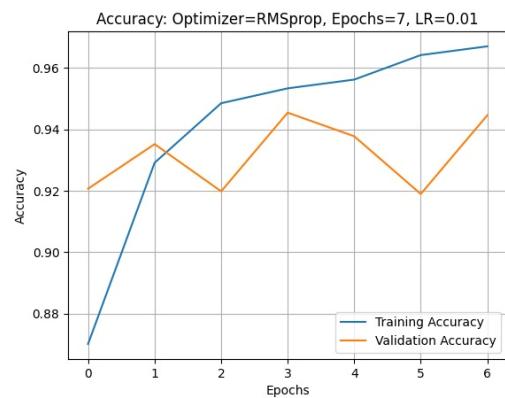
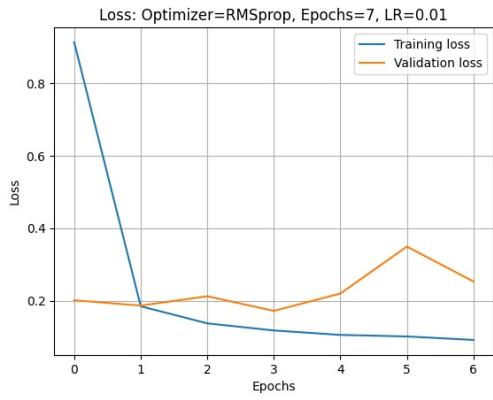
RMSPROP

learning_rate=0.01

epochs=7

Test Loss: 0.13749030232429504

Test Accuracy: 0.9607508778572083

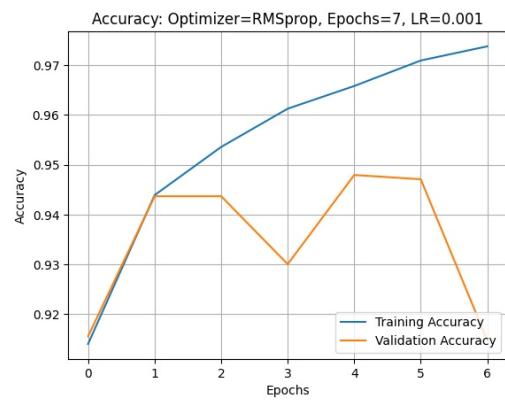
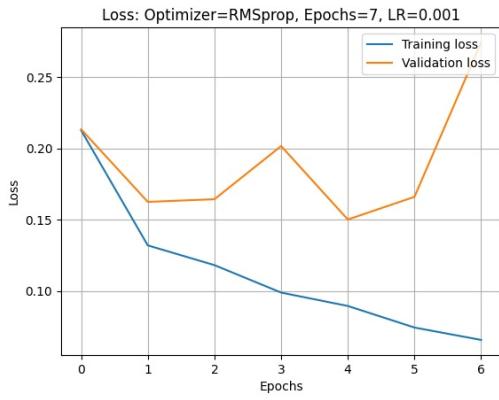


learning_rate=0.001

epochs=7

Test Loss: 0.2330736517906189

Test Accuracy: 0.9180887341499329

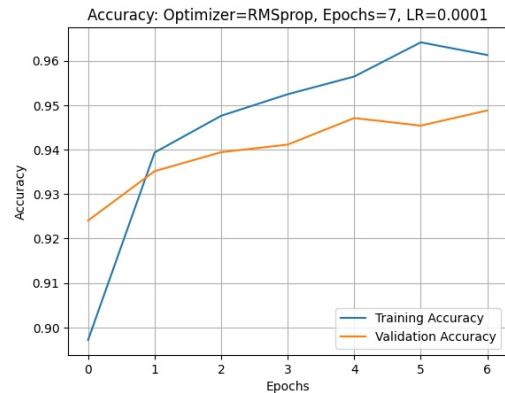
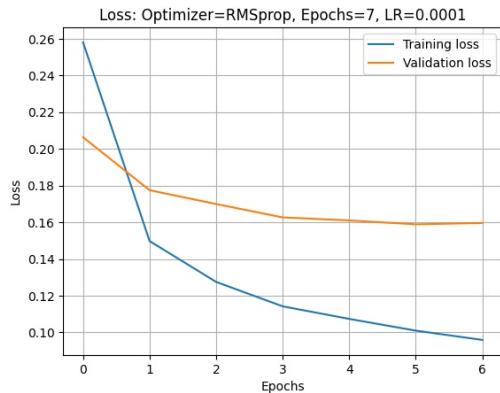


learning_rate=0.0001

epochs=7

Test Loss: 0.10636407136917114

Test Accuracy: 0.9650170803070068



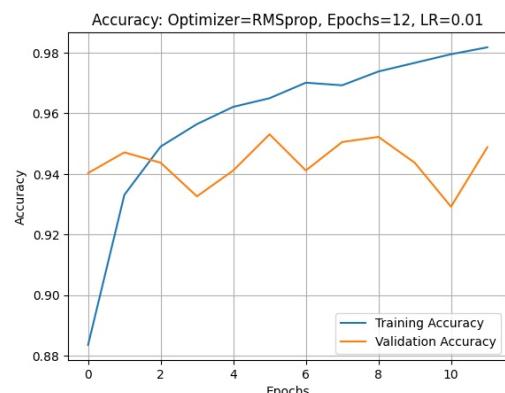
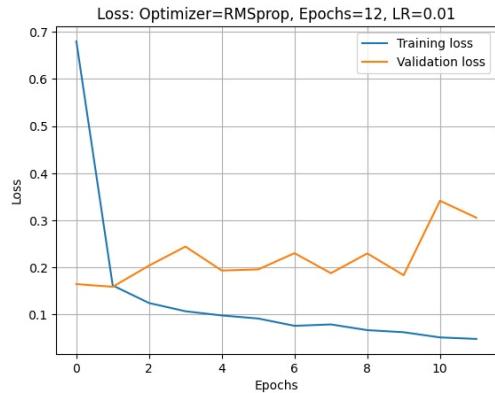
עכשי עבור 12=epochs=12

learning_rate=0.01

epochs=12

Test Loss: 0.16489239037036896

Test Accuracy: 0.967576801776886

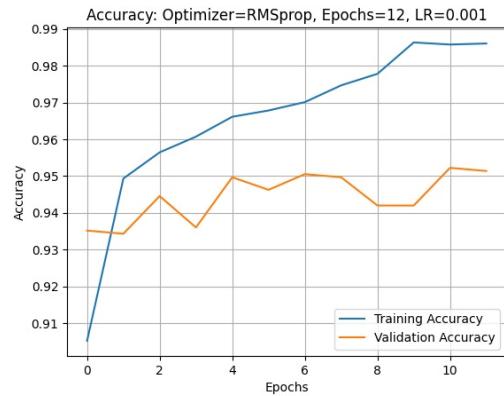
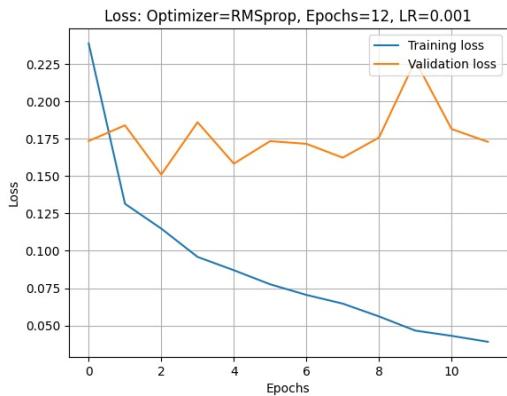


learning_rate=0.001

epochs=12

Test Loss: 0.10675645619630814

Test Accuracy: 0.9650170803070068

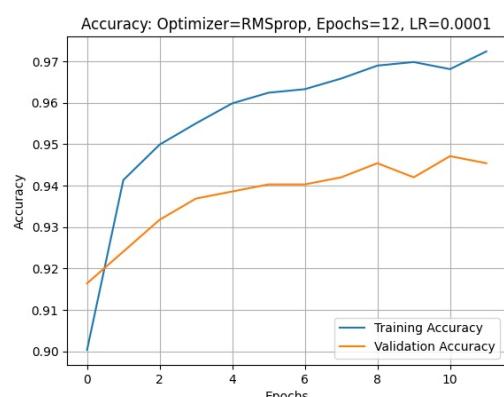
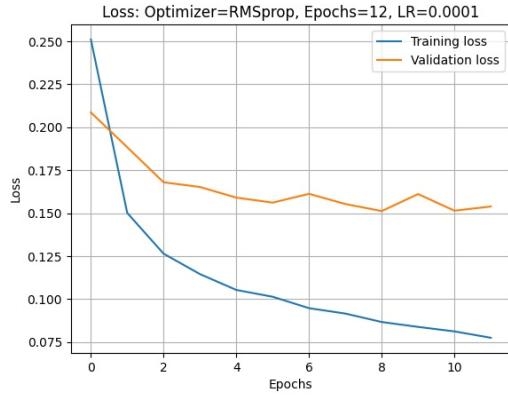


learning_rate=0.0001

epochs=12

Test Loss: 0.09984058141708374

Test Accuracy: 0.9641638398170471



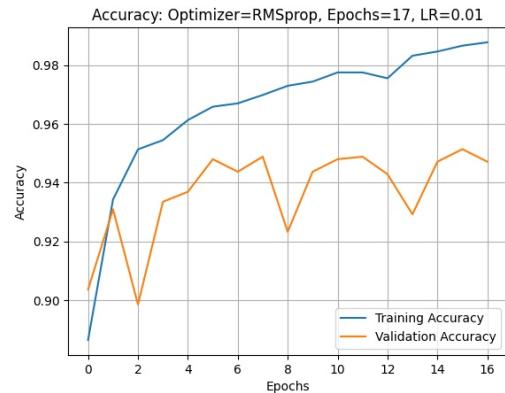
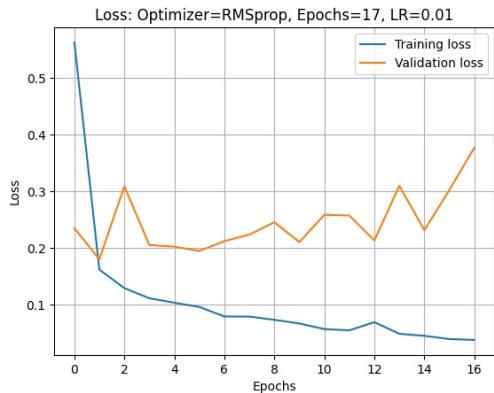
עכשווי עברו 17 epochs

learning_rate=0.01

epochs=17

Test Loss: 0.20297199487686157

Test Accuracy: 0.9650170803070068

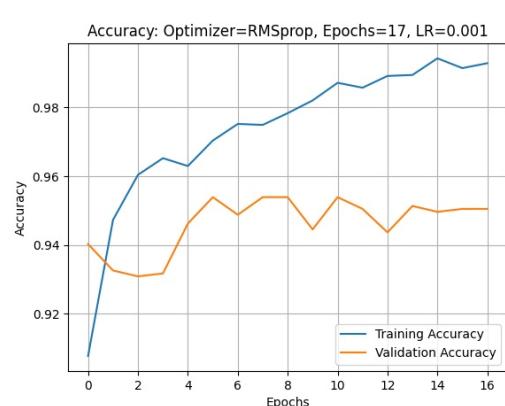
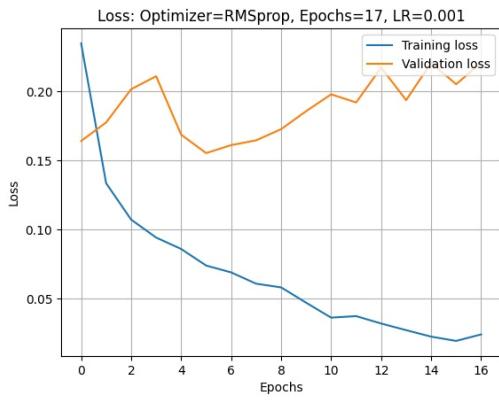


learning_rate=0.001

epochs=17

Test Loss: 0.12241170555353165

Test Accuracy: 0.9692832827568054

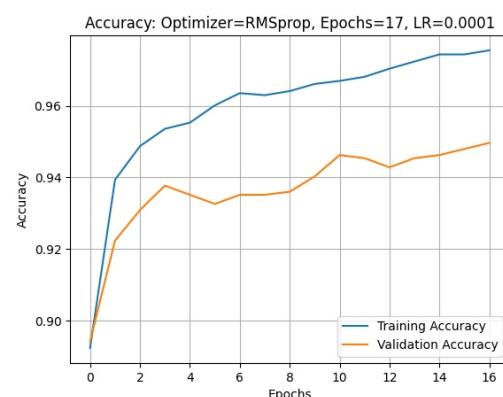
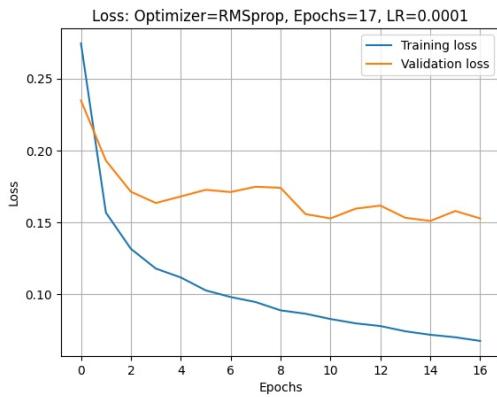


learning_rate=0.0001

epochs=17

Test Loss: 0.09789416193962097

Test Accuracy: 0.9658703207969666



CNN Transfer Learning with FINE-TUNING

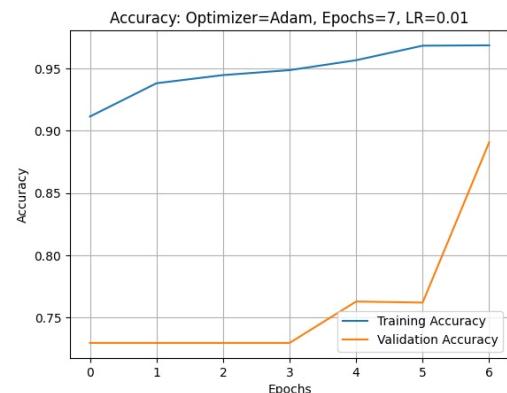
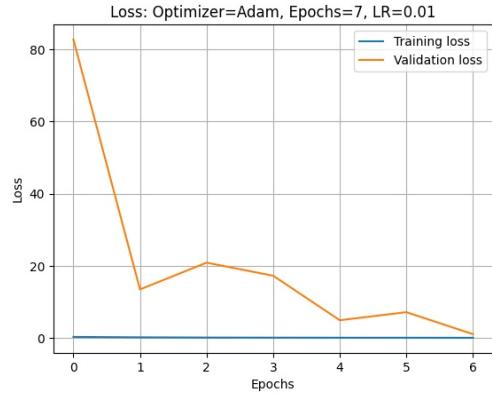
Adam

learning_rate=0.01

epochs=7

Test Loss: 1.0137912034988403

Test Accuracy: 0.9069966077804565

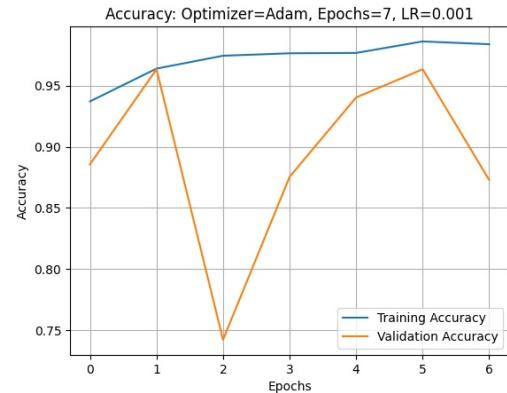
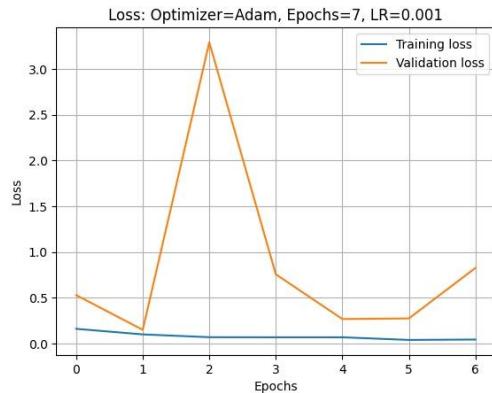


learning_rate=0.001

epochs=7

Test Loss: 0.8719995617866516

Test Accuracy: 0.8745733499526978

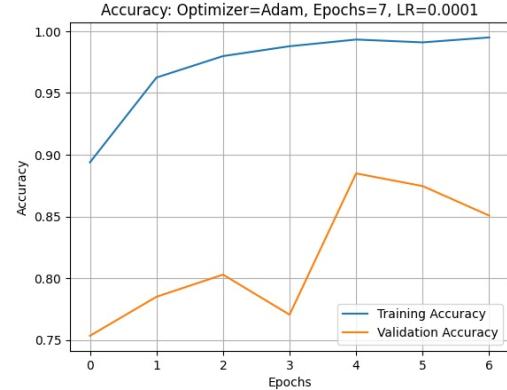
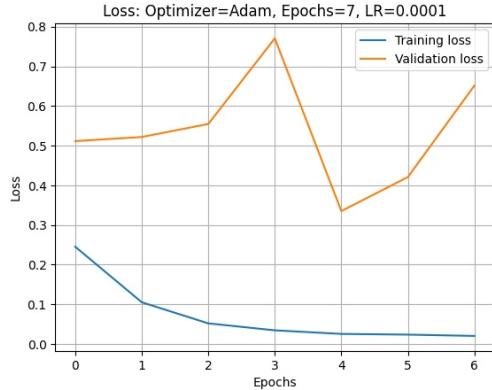


learning_rate=0.0001

epochs=7

Test Loss: 0.6619549989700317

Test Accuracy: 0.8481228947639465



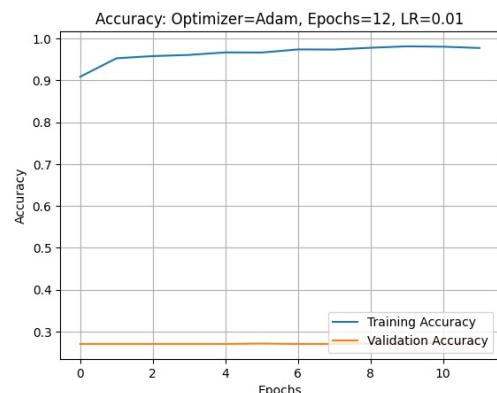
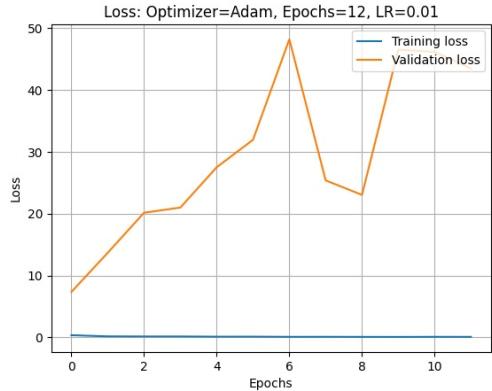
עכשי עבור epochs=12

learning_rate=0.01

epochs=12

Test Loss: 43.493995666503906

Test Accuracy: 0.2704778015613556

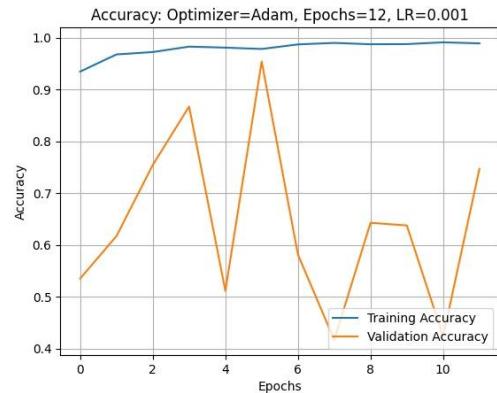
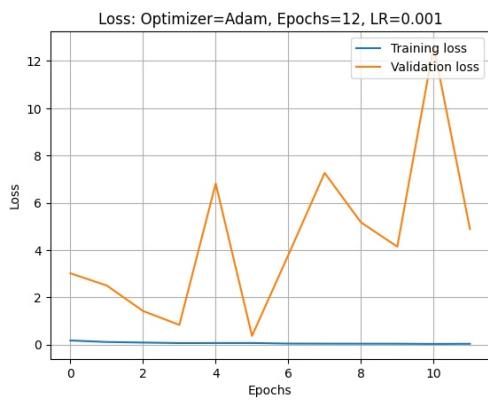


learning_rate=0.001

epochs=12

Test Loss: 4.467203140258789

Test Accuracy: 0.7593856453895569

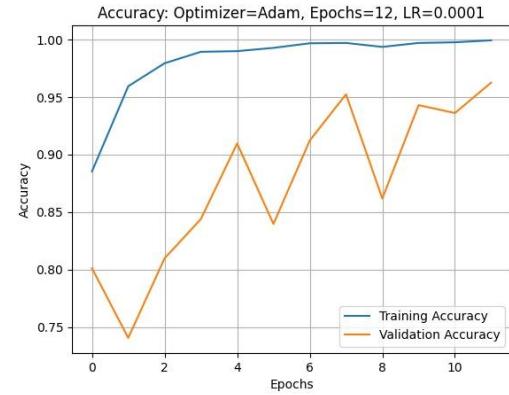
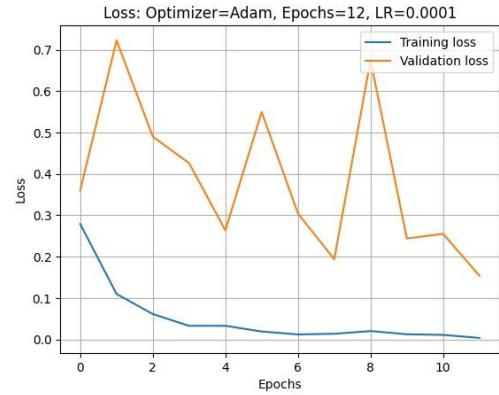


learning_rate=0.0001

epochs=12

Test Loss: 0.16631339490413666

Test Accuracy: 0.9573378562927246



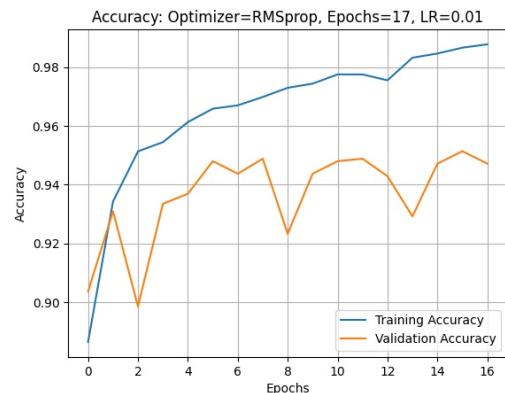
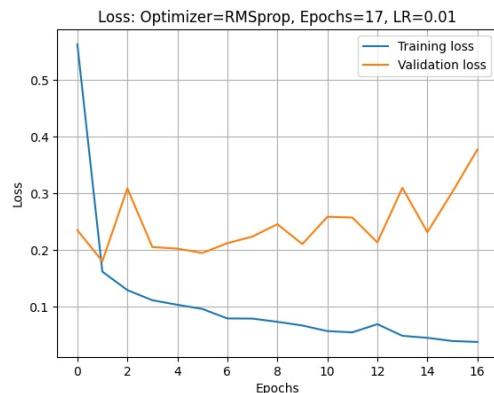
עכשו עבר :epochs=17

learning_rate=0.01

epochs=17

Test Loss: 0.20297199487686157

Test Accuracy: 0.9650170803070068

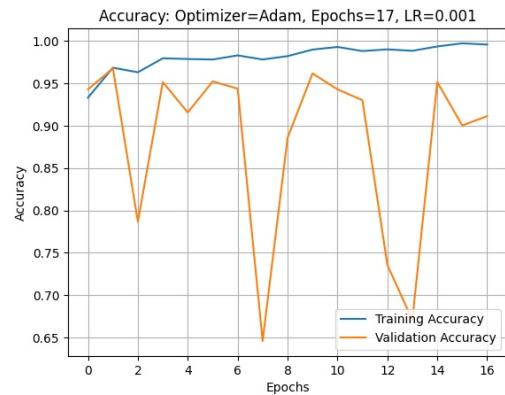
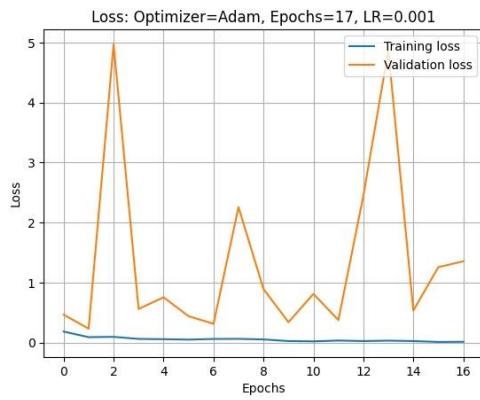


learning_rate=0.001

epochs=17

Test Loss: 1.2155697345733643

Test Accuracy: 0.9197952151298523

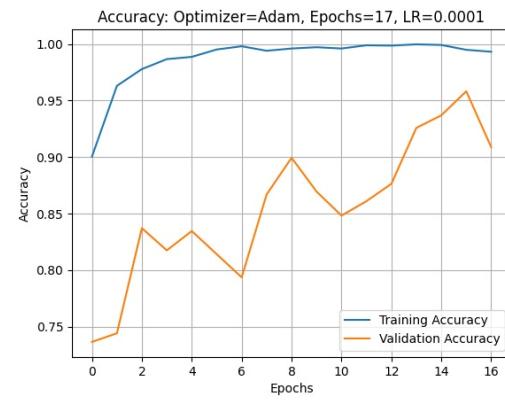
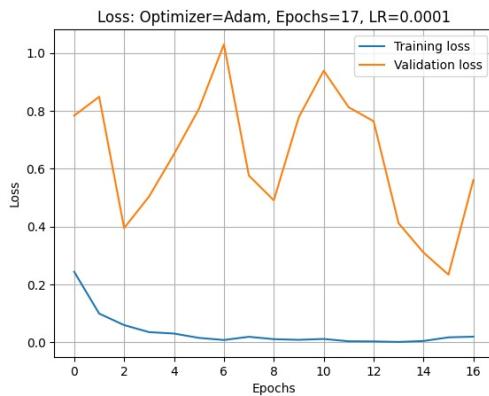


learning_rate=0.0001

epochs=17

Test Loss: 0.6906249523162842

Test Accuracy: 0.9018771052360535





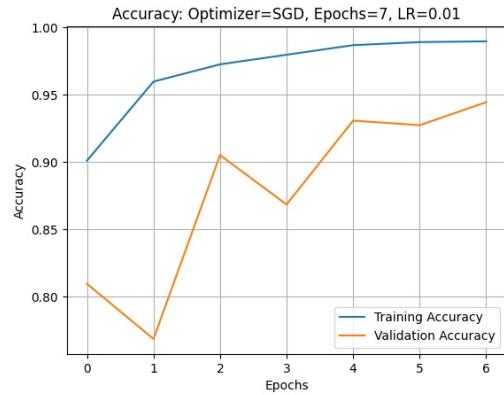
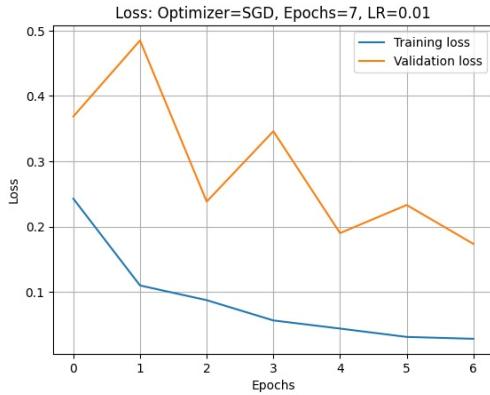
SGD

learning_rate=0.01

epochs=7

Test Loss: 0.18464873731136322

Test Accuracy: 0.9419795274734497

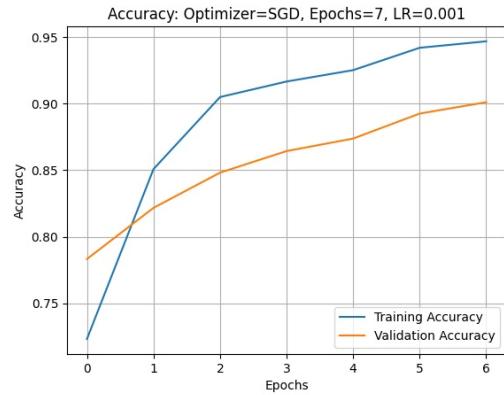
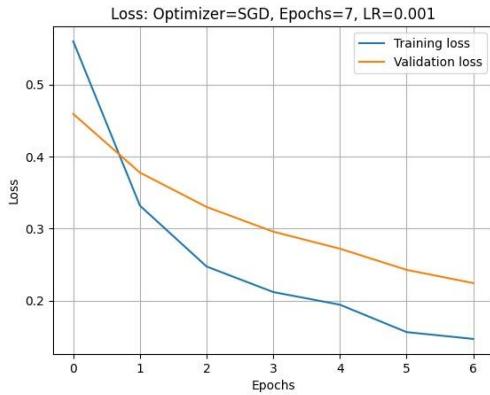


learning_rate=0.001

epochs=7

Test Loss: 0.23402941226959229

Test Accuracy: 0.8916382193565369

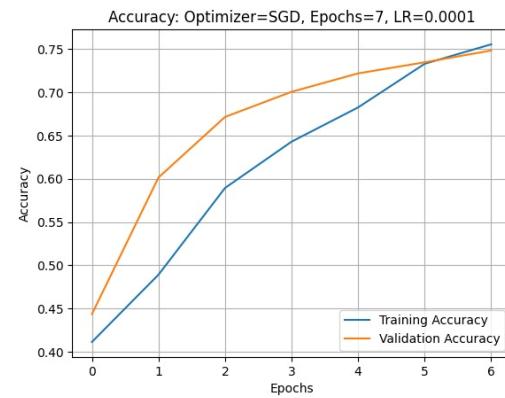
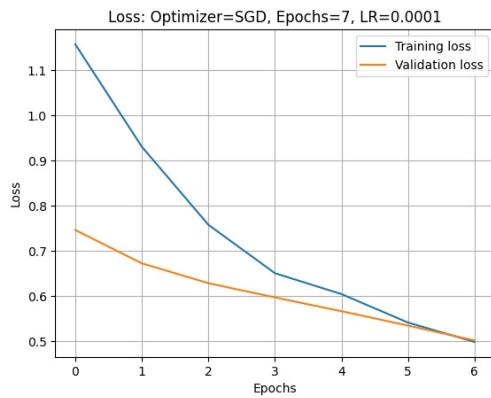


learning_rate=0.0001

epochs=7

Test Loss: 0.5084802508354187

Test Accuracy: 0.7508532404899597



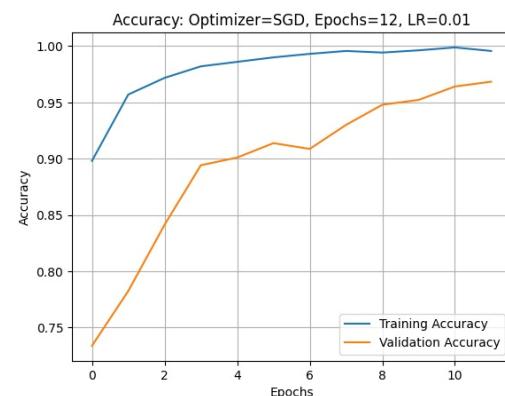
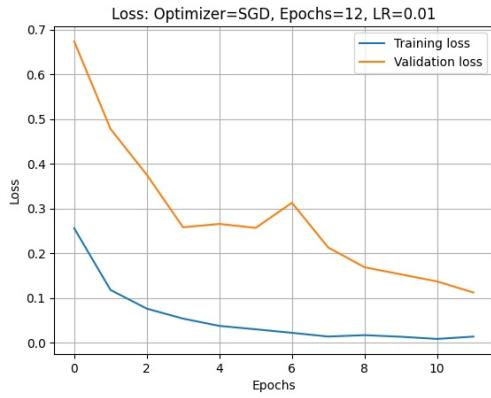
עכשי עבור 12

learning_rate=0.01

epochs=12

Test Loss: 0.1415218710899353

Test Accuracy: 0.9633105993270874

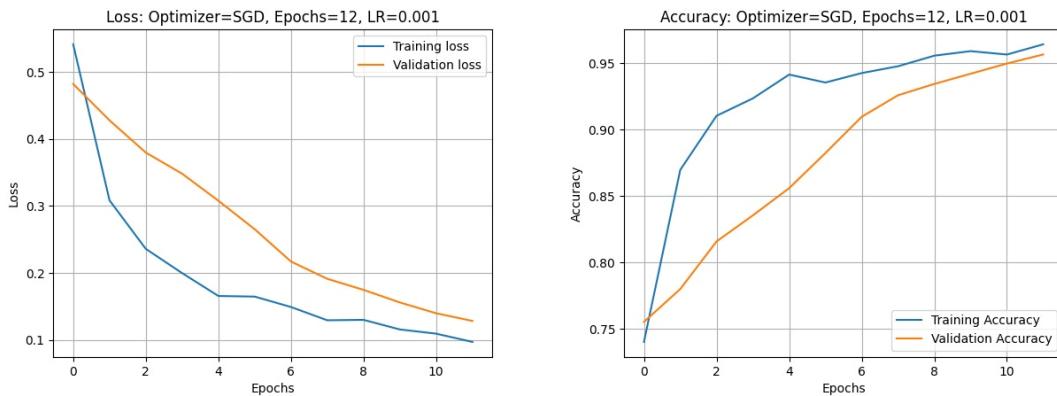


learning_rate=0.001

epochs=12

Test Loss: 0.14290770888328552

Test Accuracy: 0.947098970413208

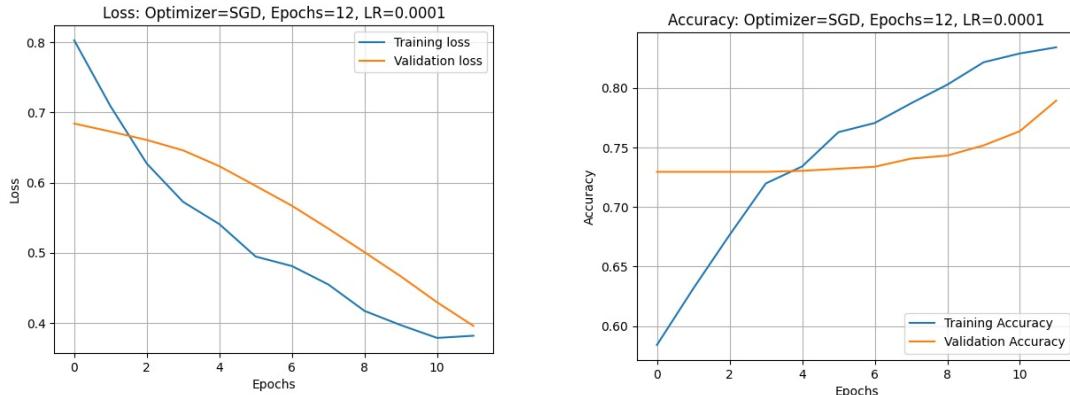


learning_rate=0.0001

epochs=12

Test Loss: 0.3944798707962036

Test Accuracy: 0.7909556031227112



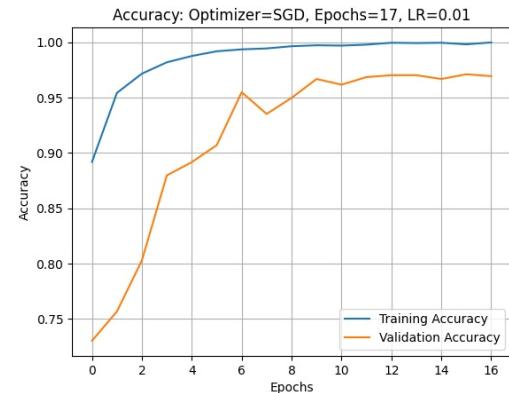
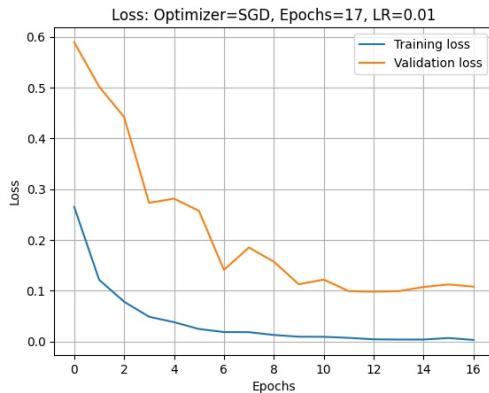
עכשווי עברו epoch=17

learning_rate=0.01

epochs=17

Test Loss: 0.15515348315238953

Test Accuracy: 0.9650170803070068

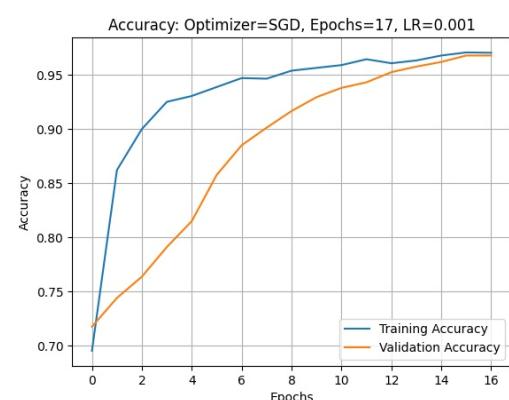
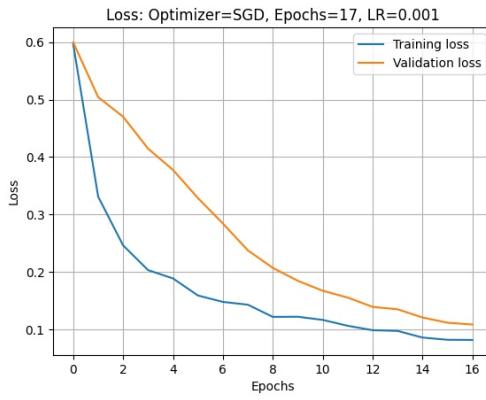


learning_rate=0.001

epochs=17

Test Loss: 0.12721514701843262

Test Accuracy: 0.9564846158027649

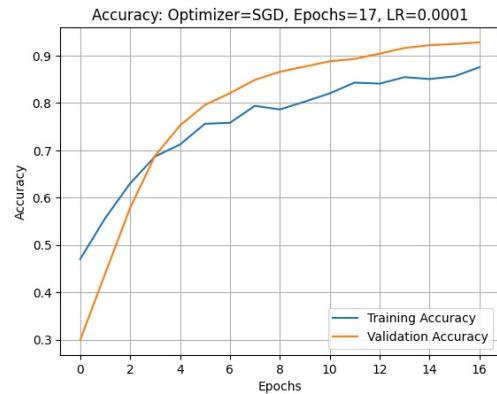
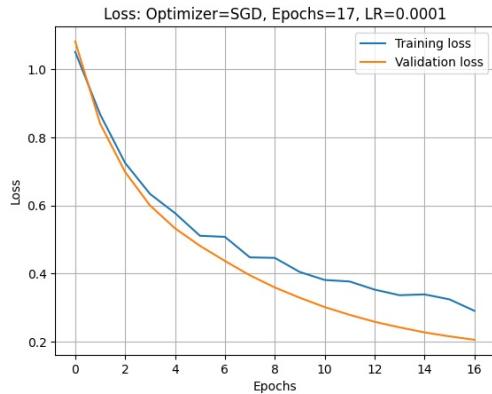


learning_rate=0.0001

epochs=17

Test Loss: 0.21949402987957

Test Accuracy: 0.9138225317001343





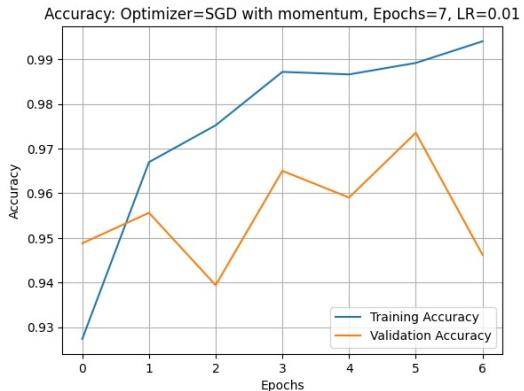
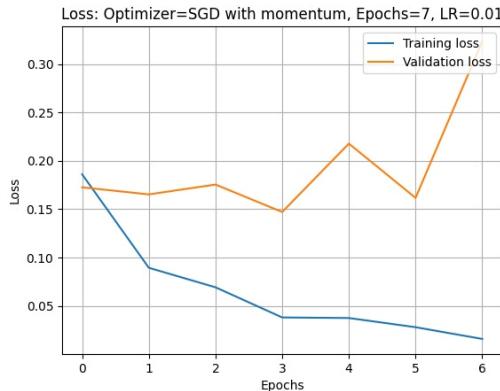
SGD with MOMENTUM

learning_rate=0.01

epochs=7

Test Loss: 0.41339102387428284

Test Accuracy: 0.9377133250236511

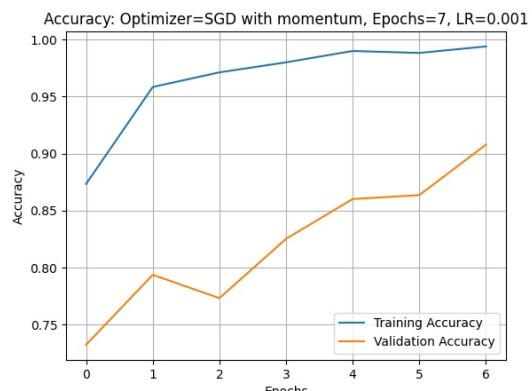
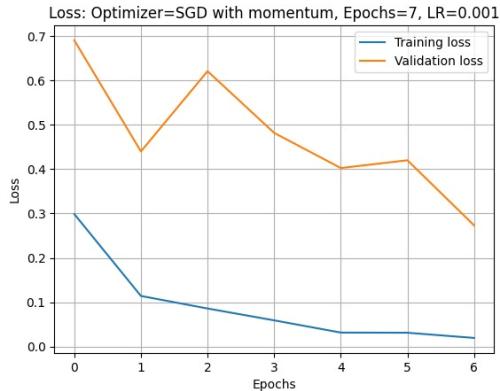


learning_rate=0.001

epochs=7

Test Loss: 0.2805638313293457

Test Accuracy: 0.908703088760376

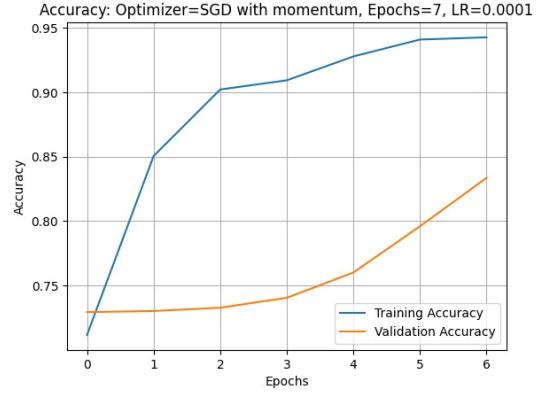
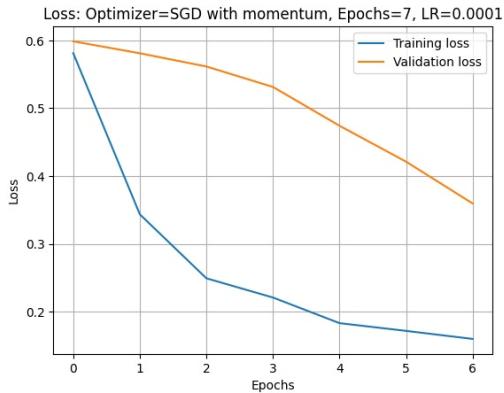


learning_rate=0.0001

epochs=7

Test Loss: 0.37195637822151184

Test Accuracy: 0.8191125988960266



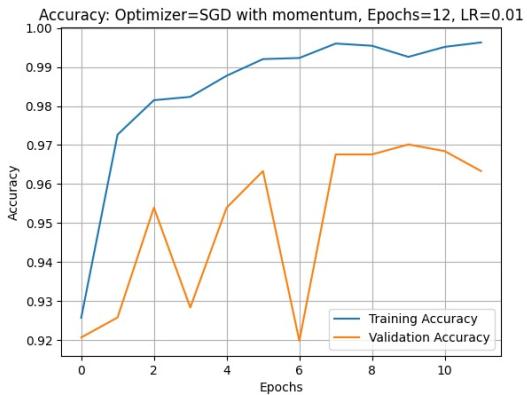
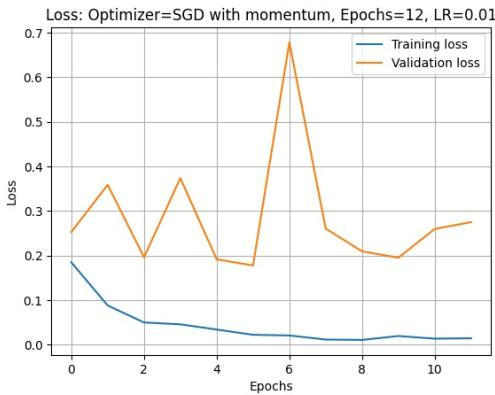
עכשי עבור 12

learning_rate=0.01

epochs=12

Test Loss: 0.3403971493244171

Test Accuracy: 0.9667235612869263

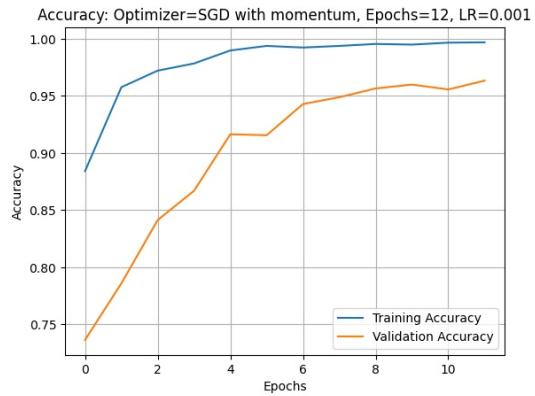
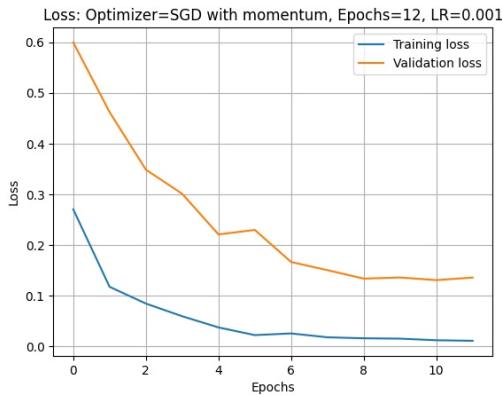


learning_rate=0.001

epochs=12

Test Loss: 0.16550712287425995

Test Accuracy: 0.9556313753128052

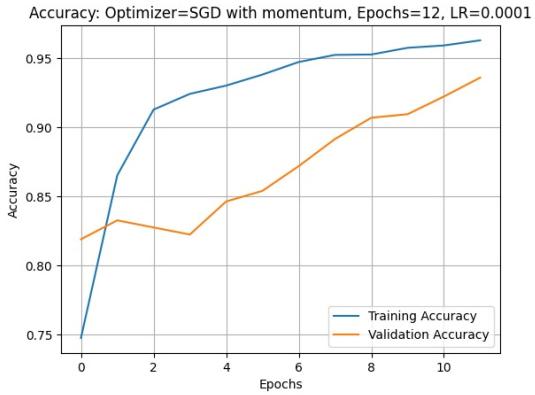
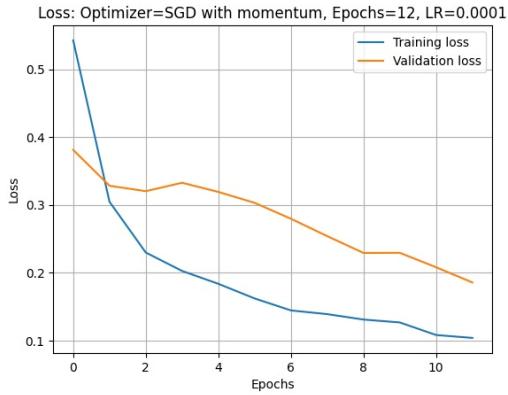


learning_rate=0.0001

epochs=12

Test Loss: 0.19287849962711334

Test Accuracy: 0.9257678985595703



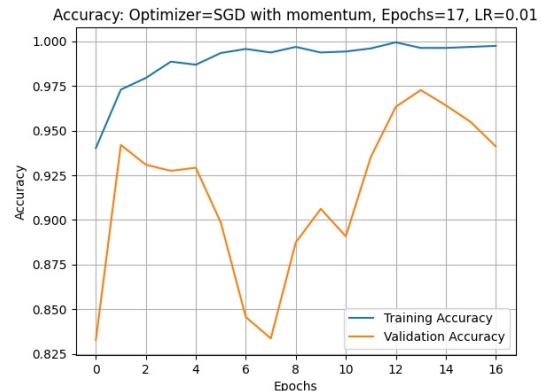
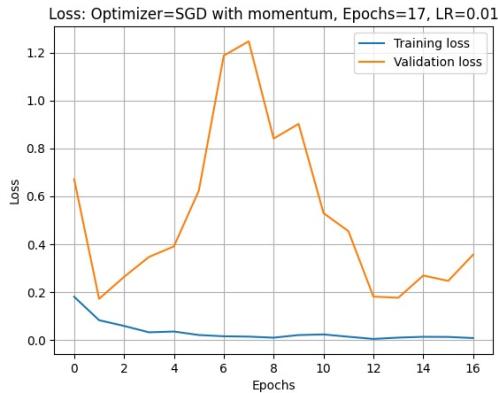
עכשי עבור epochs=17

learning_rate=0.01

epochs=17

Test Loss: 0.31121155619621277

Test Accuracy: 0.9522184133529663

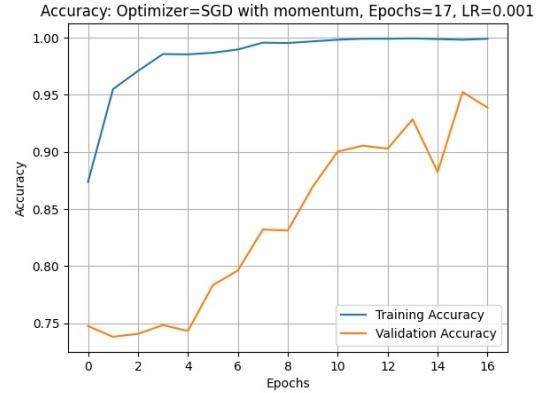
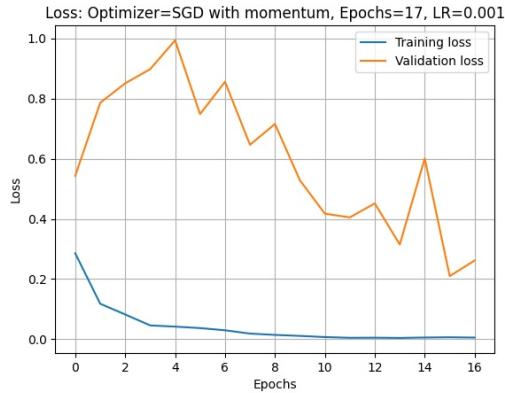


learning_rate=0.001

epochs=17

Test Loss: 0.2872624695301056

Test Accuracy: 0.9428327679634094

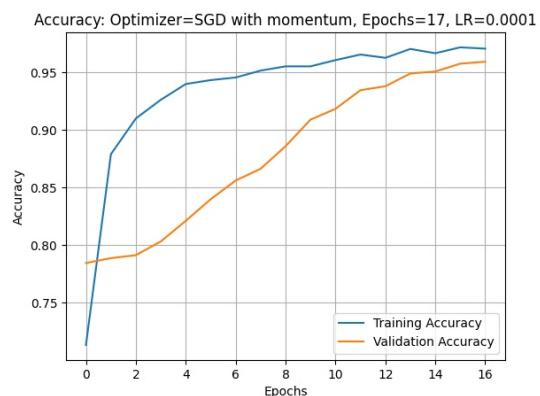
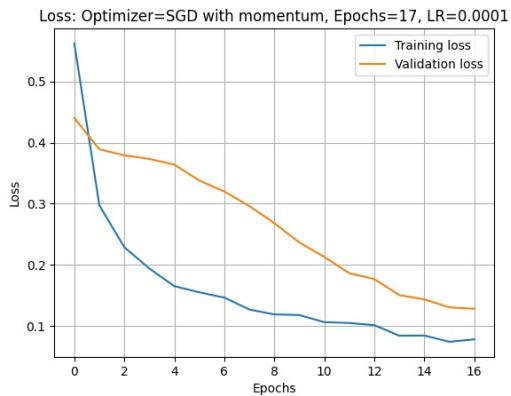


learning_rate=0.0001

epochs=17

Test Loss: 0.14705592393875122

Test Accuracy: 0.9505119323730469



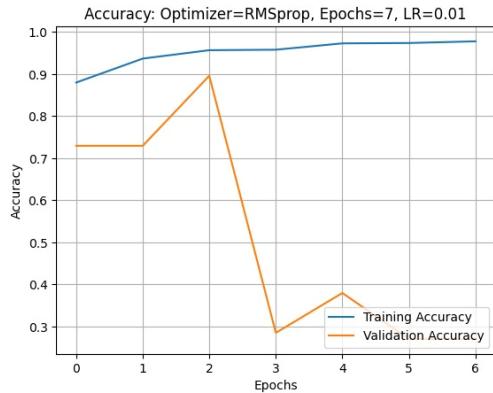
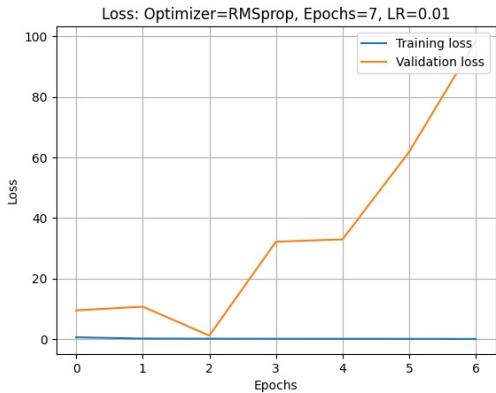
RMSPROP

learning_rate=0.01

epochs=7

Test Loss: 98.50114440917969

Test Accuracy: 0.2704778015613556

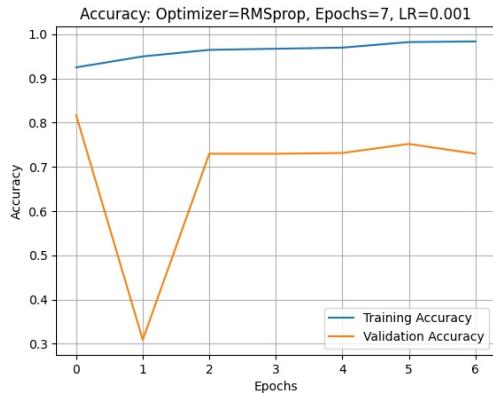
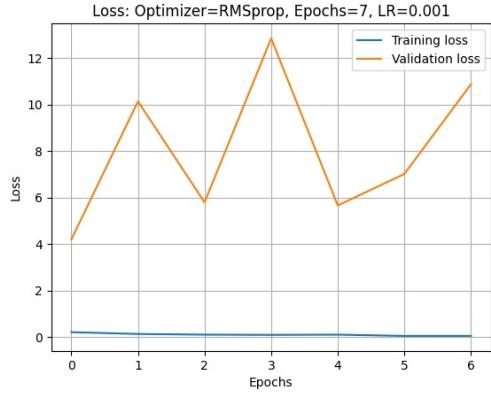


learning_rate=0.001

epochs=7

Test Loss: 10.762426376342773

Test Accuracy: 0.729522168636322

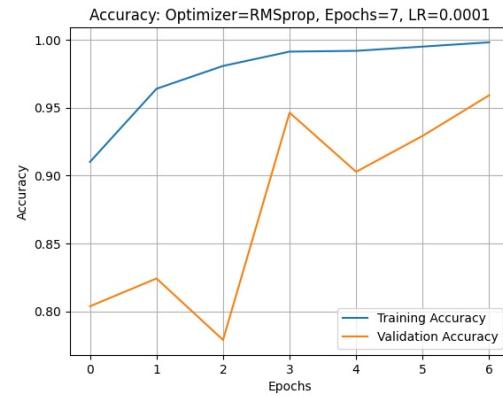
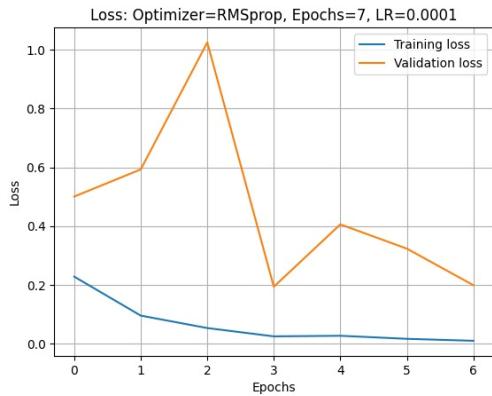


learning_rate=0.0001

epochs=7

Test Loss: 0.2426196187734604

Test Accuracy: 0.9488054513931274



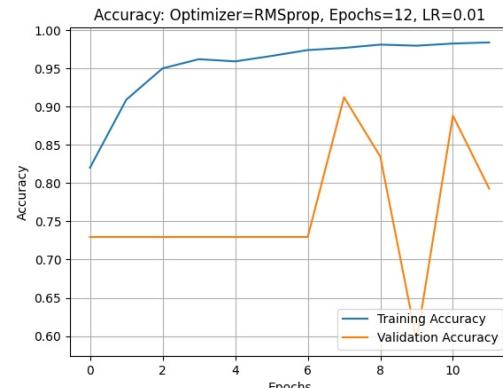
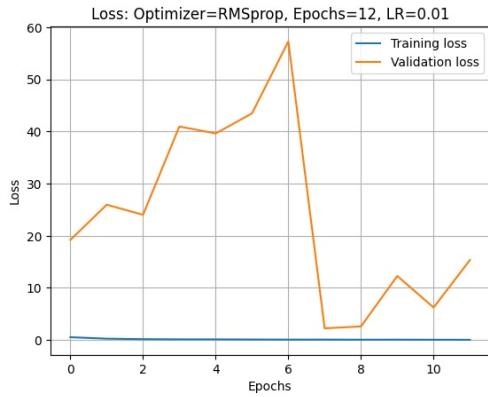
עכשי עבור 12

learning_rate=0.01

epochs=12

Test Loss: 15.713332176208496

Test Accuracy: 0.7798634767532349

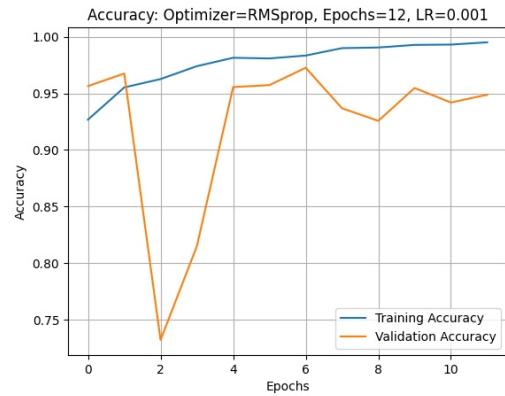
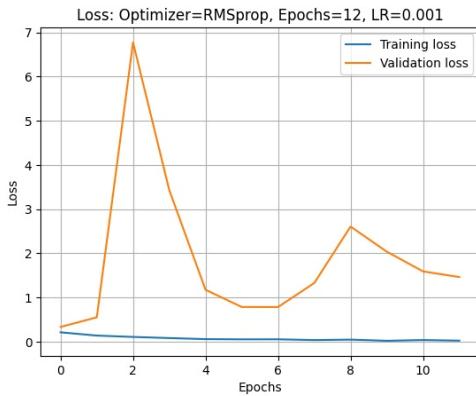


learning_rate=0.001

epochs=12

Test Loss: 1.6557902097702026

Test Accuracy: 0.9488054513931274

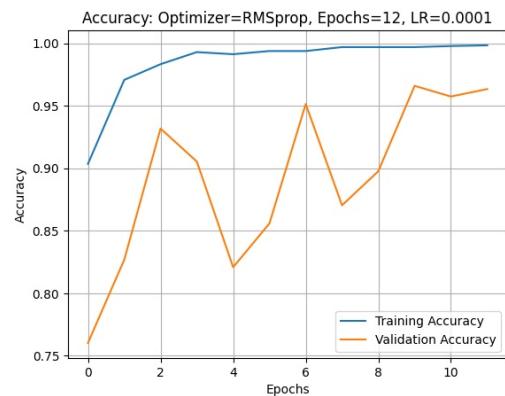
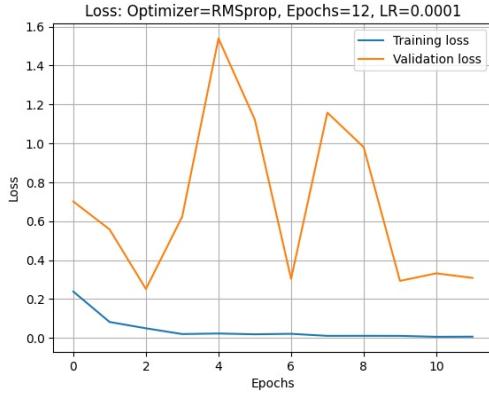


learning_rate=0.0001

epochs=12

Test Loss: 0.31618690490722656

Test Accuracy: 0.9684300422668457



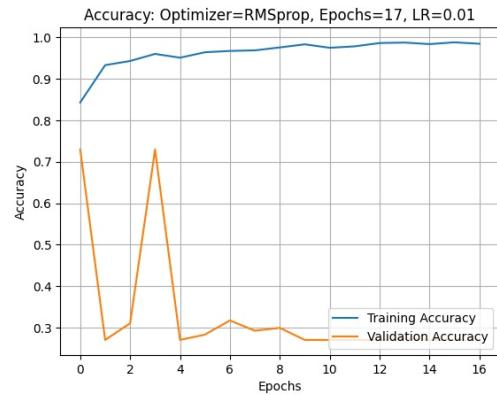
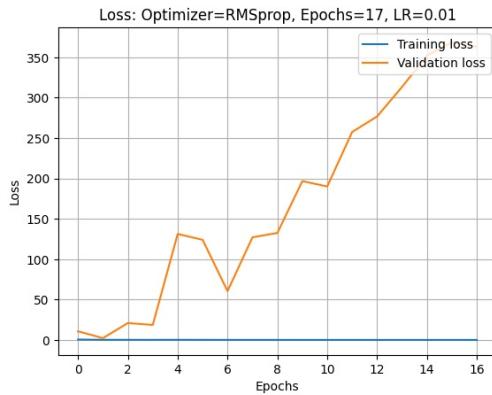
עכשווי עברו epoch=17

learning_rate=0.01

epoches=17

Test Loss: 361.9633483886719

Test Accuracy: 0.2704778015613556

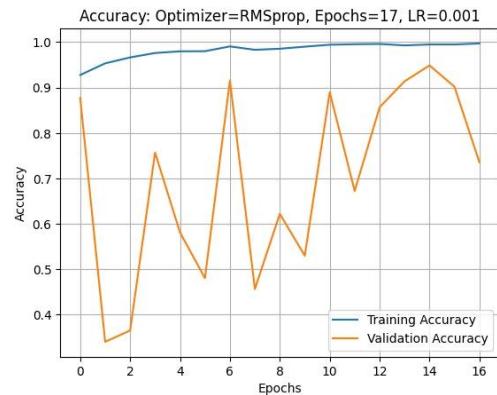
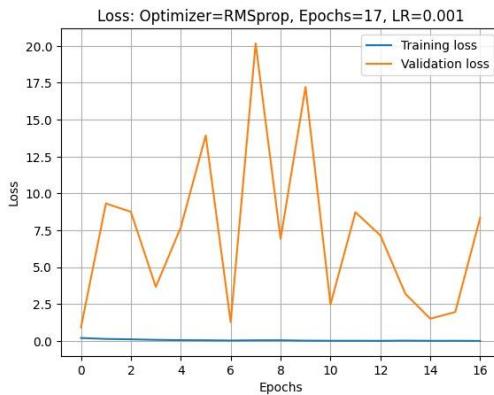


learning_rate=0.001

epoches=17

Test Loss: 8.43376636505127

Test Accuracy: 0.7397611141204834

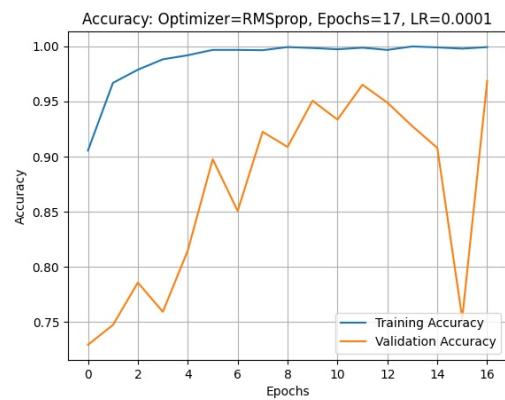
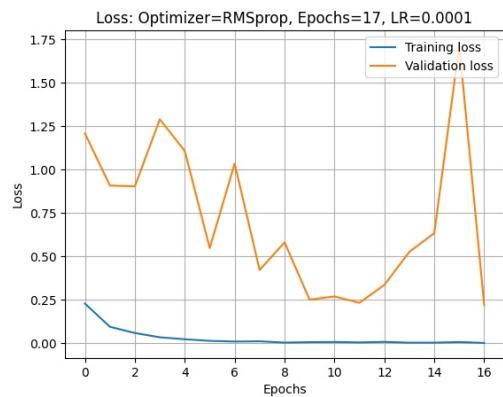


learning_rate=0.0001

epochs=17

Test Loss: 0.2863878607749939

Test Accuracy: 0.9633105993270874



CNN with no transfer learning

Epochs	10			20			30		
Learning rate	0.01	0.001	0.0001	0.01	0.001	0.0001	0.01	0.001	0.0001
ADAM	0.93856	0.90102	0.96757	0.84726	0.92064	0.96416	0.75938	0.96416	0.96587
SGD	0.96843	0.95819	0.94368	0.96672	0.95989	0.95136	0.96587	0.95563	0.94709
SGD with Momentum	0.93771	0.96075	0.95477	0.95307	0.96587	0.95989	0.96672	0.96757	0.96331
RSMprop	0.94795	0.81996	0.96331	0.93174	0.92064	0.95989	0.95307	0.96587	0.96672

CNN with transfer learning- freeze

Epochs	7			12			17		
Learning rate	0.01	0.001	0.0001	0.01	0.001	0.0001	0.01	0.001	0.0001
ADAM	0.96245	0.97098	0.95989	0.95819	0.95819	0.96843	0.96331	0.95648	0.96501
SGD	0.95392	0.92064	0.78071	0.96245	0.93856	0.83873	0.96075	0.94368	0.87116
SGD with Momentum	0.96501	0.95733	0.931740	0.95989	0.96075	0.93259	0.96757	0.96160	0.94709
RSMprop	0.96075	0.91808	0.96501	0.96757	0.96501	0.96416	0.96501	0.96928	0.96587

CNN with transfer learning- fine tuning

Epochs	7			12			17		
Learning rate	0.01	0.001	0.0001	0.01	0.001	0.0001	0.01	0.001	0.0001
ADAM	0.90699	0.8745	0.84812	0.270477	0.75938	0.957337	0.83703	0.919795	0.90187
SGD	0.94197	0.89163	0.75085	0.96331	0.94709	0.79095	0.965017	0.95648	0.913822
SGD with Momentum	0.937713	0.908703	0.81911	0.96672	0.95563	0.92576	0.952218	0.942832	0.950511
RSMprop	0.27047	0.72952	0.94880	0.779863	0.94880	0.96843	0.270477	0.73976	0.96331

עבור על רשות נבחר באלגוריתם שהביא למתואמת הטובה ביותר.

עבור הפרמטרים של אלגוריתם זה, ניישם את שיטת EARLY STOPPING על מנת לבדוק אם היה שיפור בתוצאה.

CNN with no transfer learning EARLY STOPPING:

נريץ את המודל עבור הפרמטרים הבאים:

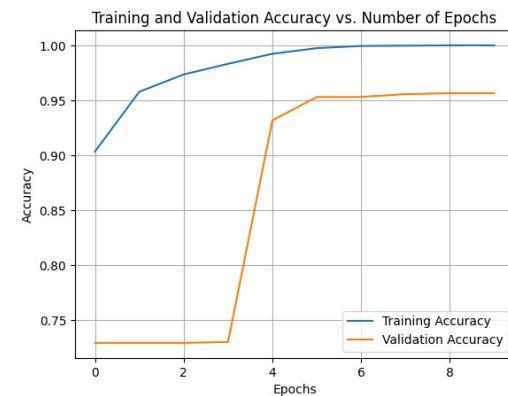
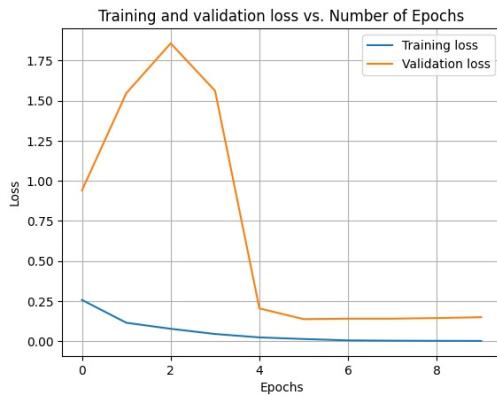
Optimizer: SGD

Epochs: 10

Learning rate: 0.01

```

110/110      18s 85ms/step - accuracy: 0.8277 - loss: 0.4766 - val_accuracy: 0.7295 - val_loss: 0.9401
Epoch 2/10
110/110      1s 9ms/step - accuracy: 0.9607 - loss: 0.1096 - val_accuracy: 0.7295 - val_loss: 1.5470
Epoch 3/10
110/110      1s 9ms/step - accuracy: 0.9738 - loss: 0.0739 - val_accuracy: 0.7295 - val_loss: 1.8577
Epoch 4/10
110/110      1s 9ms/step - accuracy: 0.9869 - loss: 0.0407 - val_accuracy: 0.7304 - val_loss: 1.5616
Epoch 5/10
110/110      1s 9ms/step - accuracy: 0.9926 - loss: 0.0253 - val_accuracy: 0.9317 - val_loss: 0.2038
Epoch 6/10
110/110      1s 9ms/step - accuracy: 0.9958 - loss: 0.0151 - val_accuracy: 0.9531 - val_loss: 0.1370
Epoch 7/10
110/110      1s 9ms/step - accuracy: 0.9988 - loss: 0.0061 - val_accuracy: 0.9531 - val_loss: 0.1400
Epoch 8/10
110/110      1s 9ms/step - accuracy: 0.9998 - loss: 0.0024 - val_accuracy: 0.9556 - val_loss: 0.1399
Epoch 9/10
110/110      1s 9ms/step - accuracy: 1.0000 - loss: 0.0017 - val_accuracy: 0.9565 - val_loss: 0.1438
Epoch 10/10
110/110      1s 9ms/step - accuracy: 1.0000 - loss: 0.0012 - val_accuracy: 0.9565 - val_loss: 0.1490
Restoring model weights from the end of the best epoch: 6.
37/37      0s 4ms/step - accuracy: 0.9291 - loss: 0.2460
  
```



Test Loss: 0.12206590175628662

Test Accuracy: 0.9650170803070068

במנגנון זה יש ירידת קטנה באיכות של הדיווק, הדיווק עמד 0.96843

ניתן לומר שההתוצאות נותרו טובות.

CNN with transfer learning- freeze EARLY STOPPING:

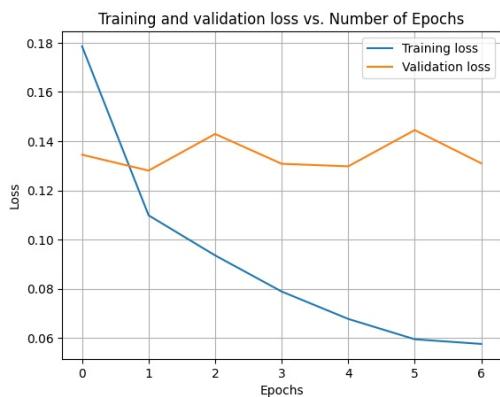
נريץ את המודל עבור הפרמטרים הבאים:

Optimizer: ADAM

Epochs: 7

Learning rate: 0.001

```
Epoch 1/7
110/110      35s 194ms/step - accuracy: 0.8995 - loss: 0.2324 - val_accuracy: 0.9497 - val_loss: 0.1345
Epoch 2/7
110/110      1s 12ms/step - accuracy: 0.9599 - loss: 0.1022 - val_accuracy: 0.9548 - val_loss: 0.1281
Epoch 3/7
110/110      1s 11ms/step - accuracy: 0.9648 - loss: 0.0893 - val_accuracy: 0.9480 - val_loss: 0.1429
Epoch 4/7
110/110      1s 12ms/step - accuracy: 0.9713 - loss: 0.0746 - val_accuracy: 0.9514 - val_loss: 0.1308
Epoch 5/7
110/110      1s 11ms/step - accuracy: 0.9791 - loss: 0.0654 - val_accuracy: 0.9548 - val_loss: 0.1298
Epoch 6/7
110/110      1s 12ms/step - accuracy: 0.9765 - loss: 0.0575 - val_accuracy: 0.9522 - val_loss: 0.1445
Epoch 7/7
110/110      1s 11ms/step - accuracy: 0.9778 - loss: 0.0547 - val_accuracy: 0.9556 - val_loss: 0.1310
Epoch 7: early stopping
Restoring model weights from the end of the best epoch: 2.
37/37      0s 9ms/step - accuracy: 0.9222 - loss: 0.1977
```



Test Loss: 0.11362248659133911

Test Accuracy: 0.9564846158027649

במנגנון זה יש ירידה קטנה באיכות של הדיק, הדיק עמד 0.97098

ניתן לומר שההתוצאות נותרו טובות.

CNN with transfer learning- fine tuning EARLY STOPPING:

נريץ את המודל עבור הפרמטרים הבאים:

Optimizer: RMSPROP

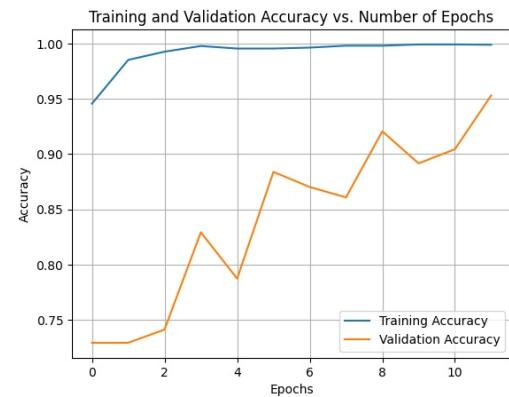
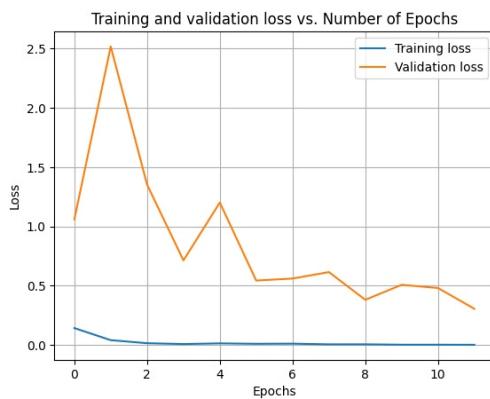
Epochs: 12

Learning rate: 0.0001

```

Epoch 1/12
110/110      40s 166ms/step - accuracy: 0.9242 - loss: 0.1839 - val_accuracy: 0.7295 - val_loss: 1.0593
Epoch 2/12
110/110      2s 15ms/step - accuracy: 0.9880 - loss: 0.0388 - val_accuracy: 0.7295 - val_loss: 2.5175
Epoch 3/12
110/110      2s 14ms/step - accuracy: 0.9923 - loss: 0.0140 - val_accuracy: 0.7415 - val_loss: 1.3524
Epoch 4/12
110/110      2s 15ms/step - accuracy: 0.9976 - loss: 0.0083 - val_accuracy: 0.8294 - val_loss: 0.7139
Epoch 5/12
110/110      2s 14ms/step - accuracy: 0.9977 - loss: 0.0083 - val_accuracy: 0.7875 - val_loss: 1.2016
Epoch 6/12
110/110      2s 15ms/step - accuracy: 0.9958 - loss: 0.0110 - val_accuracy: 0.8840 - val_loss: 0.5440
Epoch 7/12
110/110      2s 14ms/step - accuracy: 0.9974 - loss: 0.0105 - val_accuracy: 0.8703 - val_loss: 0.5606
Epoch 8/12
110/110      2s 14ms/step - accuracy: 0.9993 - loss: 0.0041 - val_accuracy: 0.8609 - val_loss: 0.6152
Epoch 9/12
110/110      2s 15ms/step - accuracy: 0.9990 - loss: 0.0037 - val_accuracy: 0.9206 - val_loss: 0.3817
Epoch 10/12
110/110      2s 14ms/step - accuracy: 0.9993 - loss: 0.0037 - val_accuracy: 0.8916 - val_loss: 0.5078
Epoch 11/12
110/110      2s 14ms/step - accuracy: 0.9995 - loss: 0.0019 - val_accuracy: 0.9044 - val_loss: 0.4811
Epoch 12/12
110/110      2s 15ms/step - accuracy: 0.9986 - loss: 0.0030 - val_accuracy: 0.9531 - val_loss: 0.3058
Restoring model weights from the end of the best epoch: 12.
Input shape: (None, 160, 160, 3)
Output shape: (None, 1)
37/37      0s 8ms/step - accuracy: 0.9052 - loss: 0.6007

```



Test Loss: 0.2599334418773651

Test Accuracy: 0.9598976373672485

במנגנון זה יש ירידה קצרה באיכות של הדיוון, הדיוון עמד 0.96843

ניתן לומר שההתוצאות נותרו טובות.

משימה 4

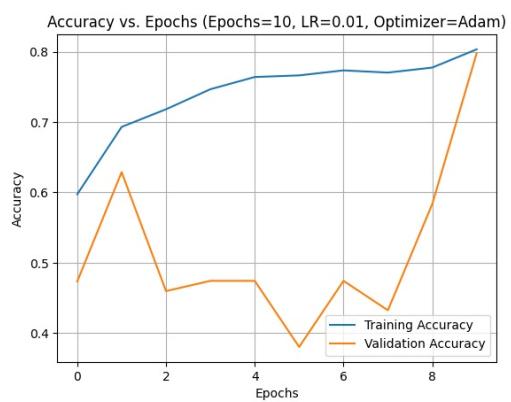
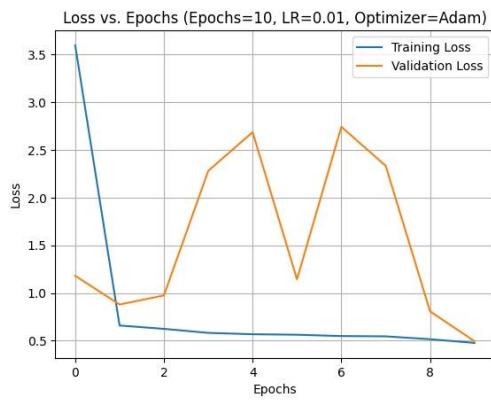
במשימה זו ניקח את המודל CNN with no transfer learning ואת הנתונים (תמונהות רנטגן של ריאות) לשולש תוויות - אין מחלת, בקטירה, וירוס.

ADAM: Epochs=10

Learning rate: 0.01

Test Loss: 0.5332090854644775

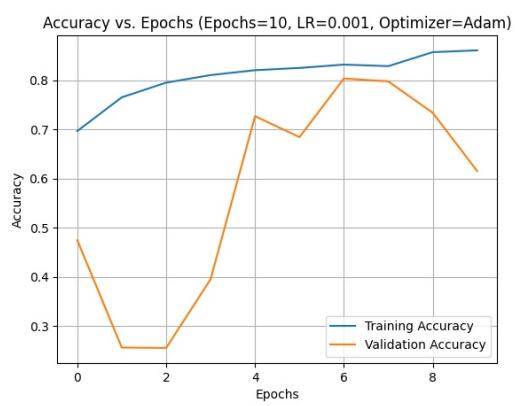
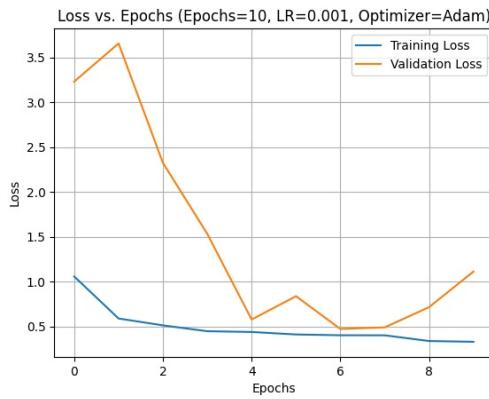
Test Accuracy: 0.7730375528335571



Learning rate: 0.001

Test Loss: 1.1692981719970703

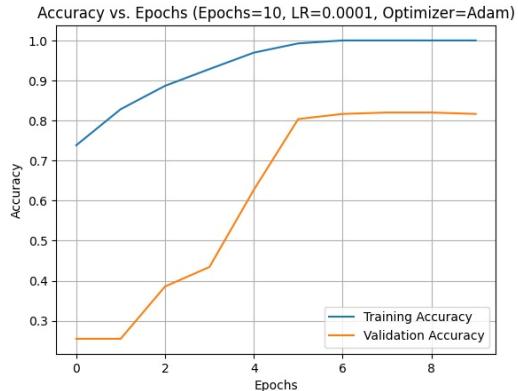
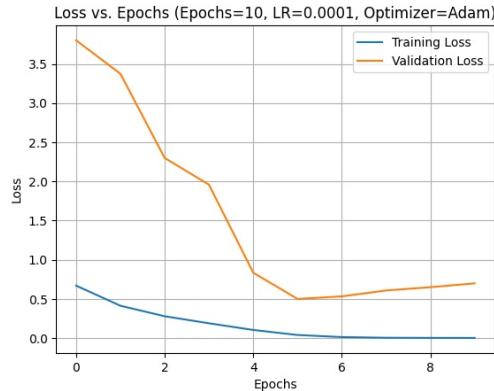
Test Accuracy: 0.6092150211334229



Learning rate: 0.0001

Test Loss: 0.6925401091575623

Test Accuracy: 0.8250853419303894

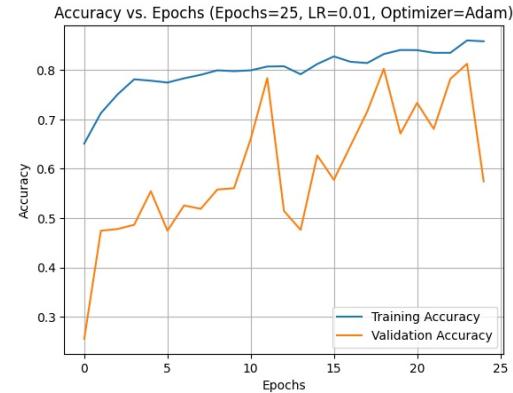
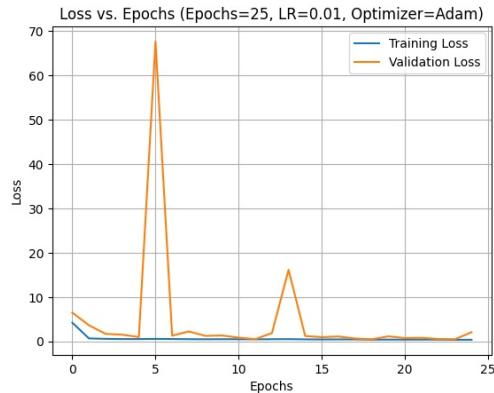


ADAM: Epochs=25

Learning rate: 0.01

Test Loss: 2.1267592906951904

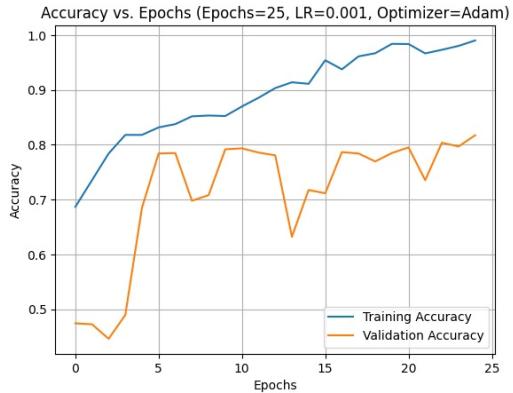
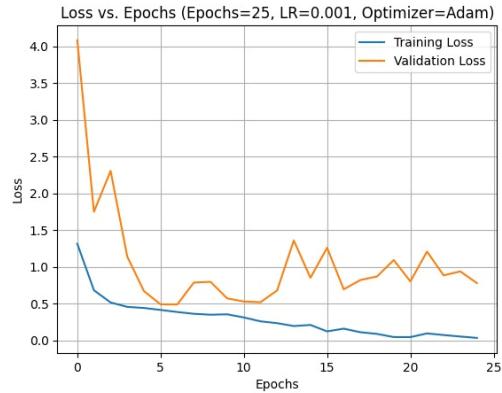
Test Accuracy: 0.5580204725265503



Learning rate: 0.001

Test Loss: 0.8564661145210266

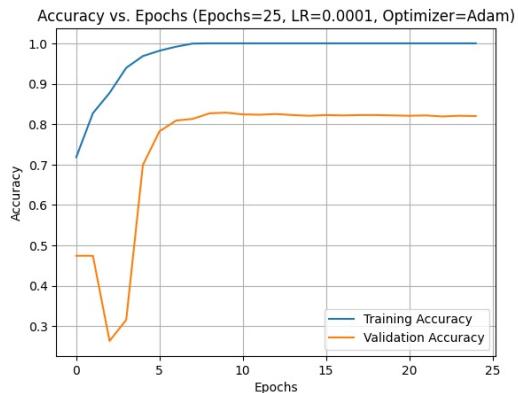
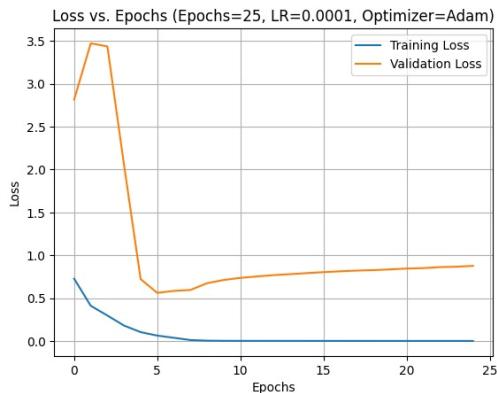
Test Accuracy: 0.8046075105667114



Learning rate: 0.0001

Test Loss: 0.8984946012496948

Test Accuracy: 0.8097269535064697

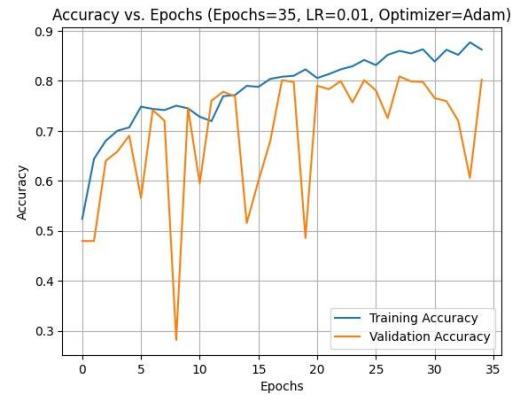
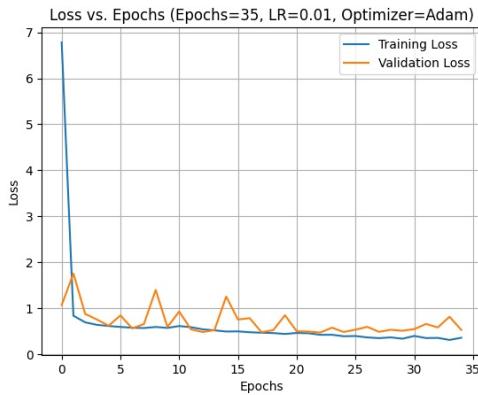


ADAM: Epochs=35

Learning rate: 0.01

Test Loss: 0.5905344486236572

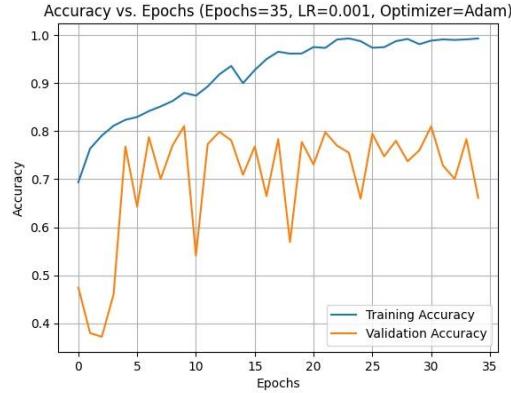
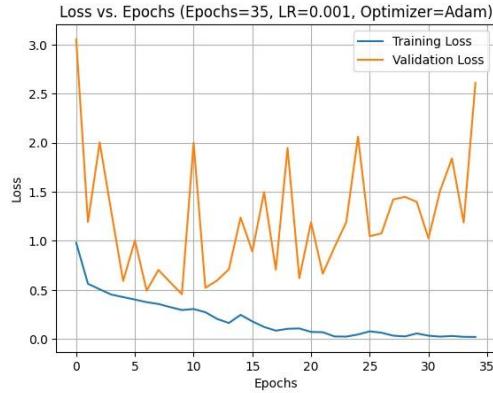
Test Accuracy: 0.7909556031227112,



Learning rate: 0.001

Test Loss: 2.3921823501586914

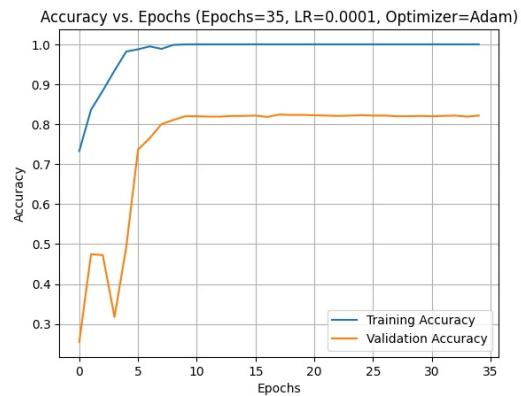
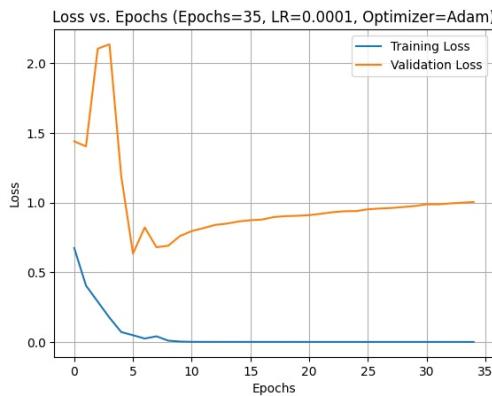
Test Accuracy: 0.6936860084533691\



Learning rate: 0.0001

Test Loss: 1.0690735578536987

Test Accuracy: 0.8054607510566711

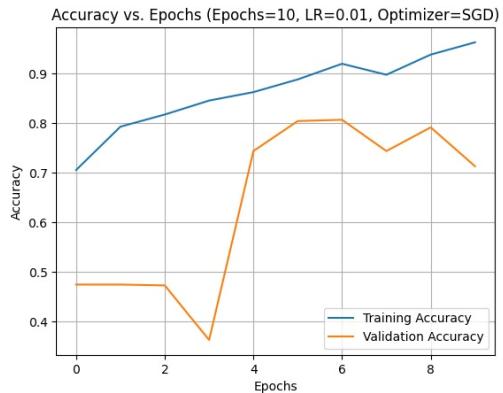
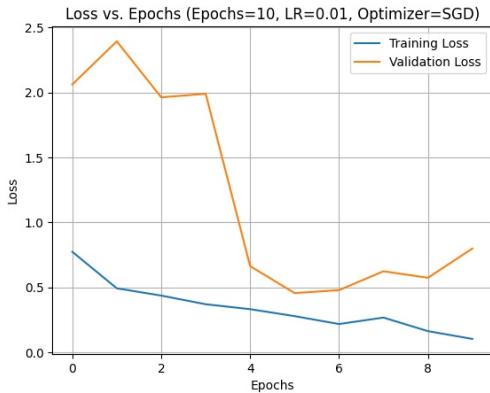


SGD: Epochs=10

Learning rate: 0.01

Test Loss: 0.7764061689376831

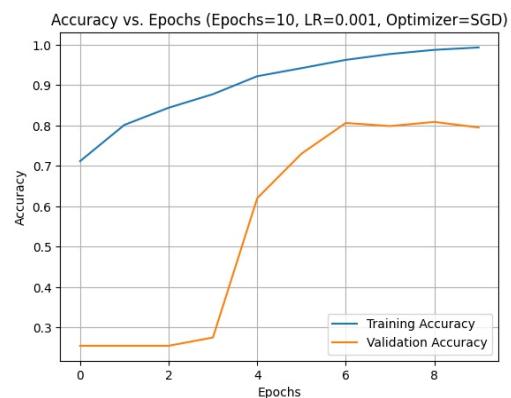
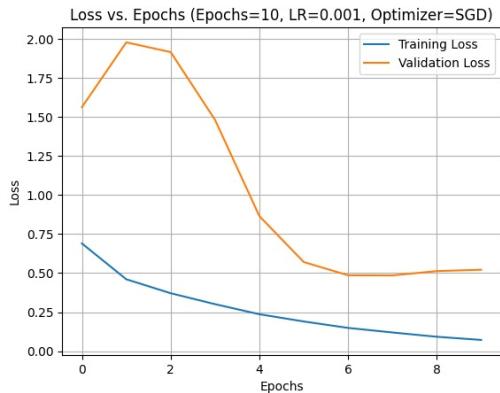
Test Accuracy: 0.7107508778572083



Learning rate: 0.001

Test Loss: 0.530935525894165

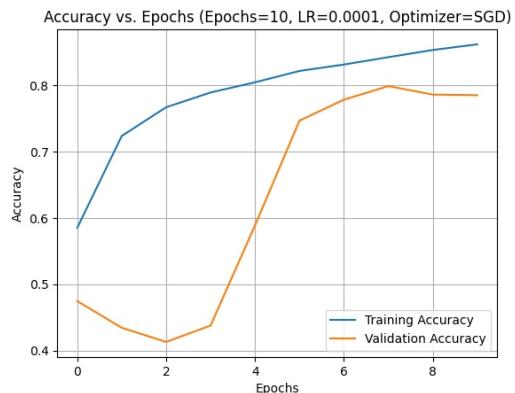
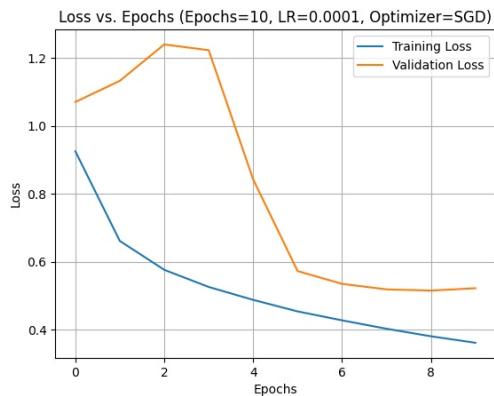
Test Accuracy: 0.7858361601829529



Learning rate: 0.0001

Test Loss: 0.5694575905799866

Test Accuracy: 0.7713310718536377

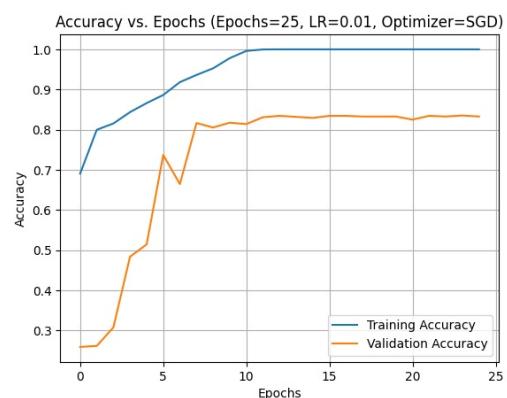
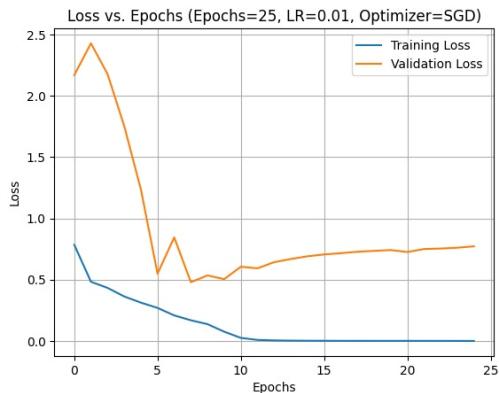


SGD: Epochs=25

Learning rate: 0.01

Test Loss: 0.8891793489456177

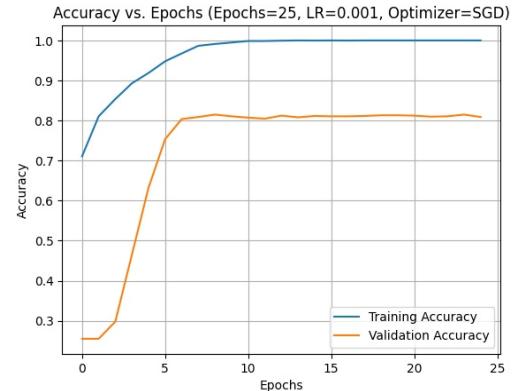
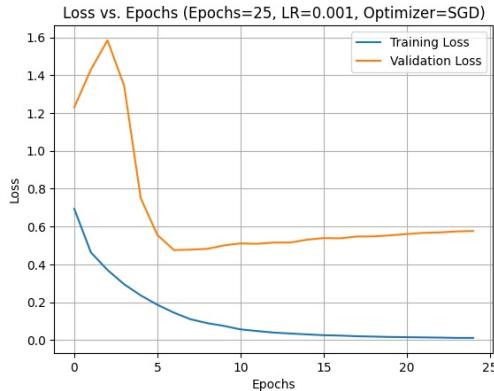
Test Accuracy: 0.8063139915466309



Learning rate: 0.001

Test Loss: 0.6454553604125977

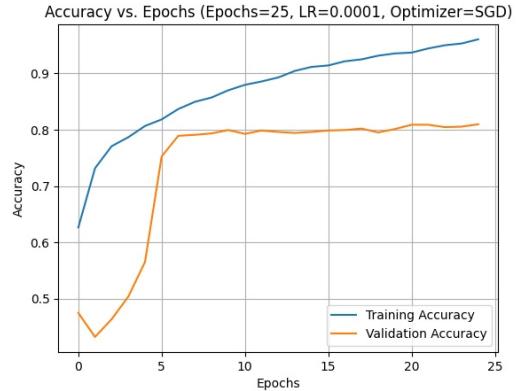
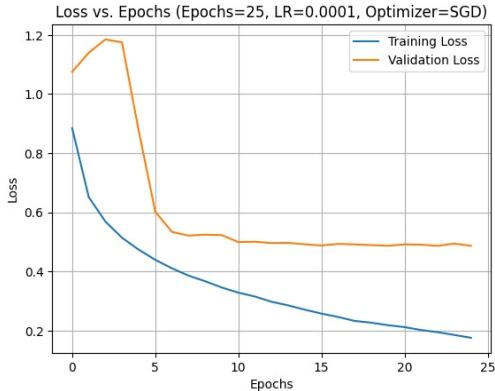
Test Accuracy: 0.796928346157074



Learning rate: 0.0001

Test Loss: 0.5231698155403137

Test Accuracy: 0.7901023626327515

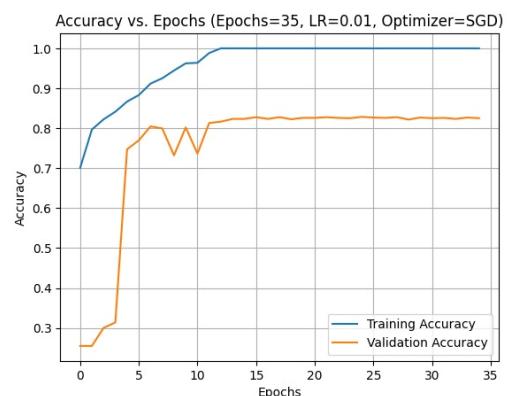
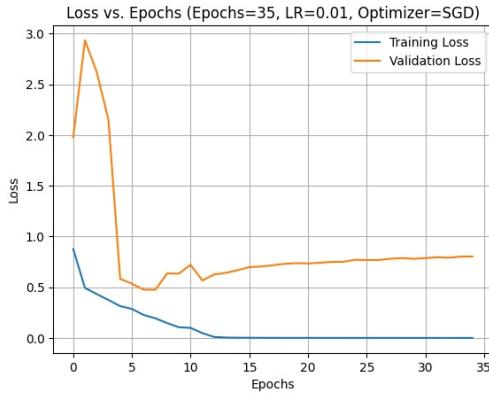


SGD: Epochs=35

Learning rate: 0.01

Test Loss: 0.90957111120224

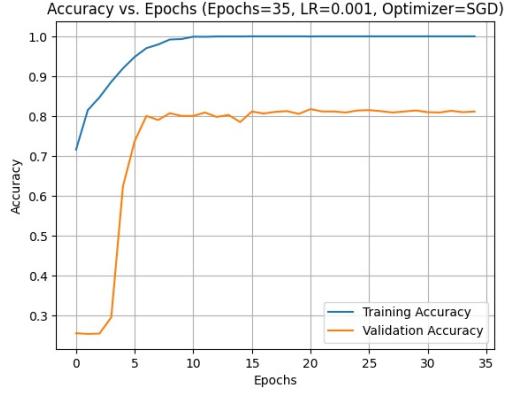
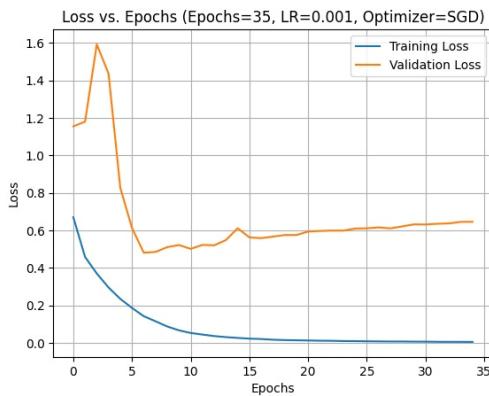
Test Accuracy: 0.8156996369361877



Learning rate: 0.001

Test Loss: 0.6631495952606201

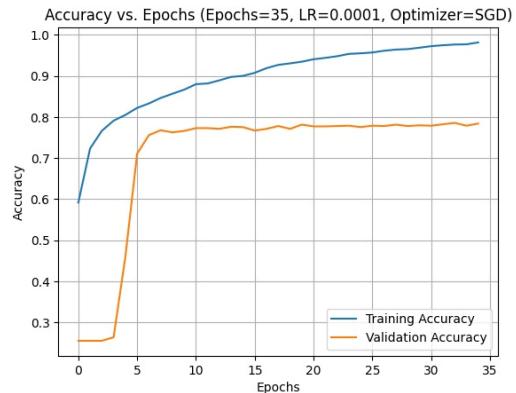
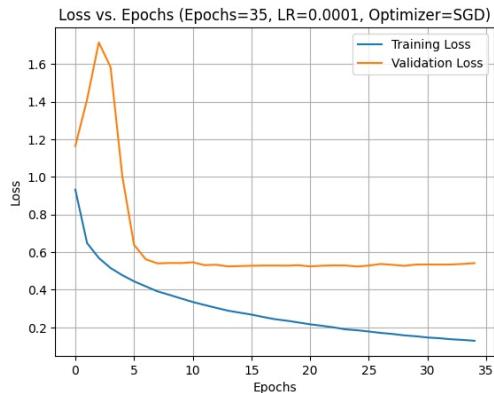
Test Accuracy: 0.8003413081169128



Learning rate: 0.0001

Test Loss: 0.5603514313697815

Test Accuracy: 0.7755972743034363

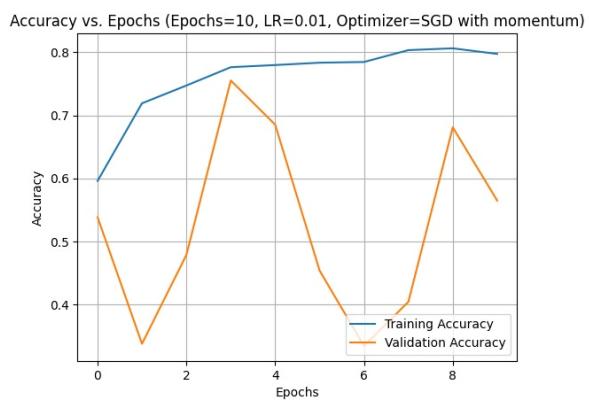
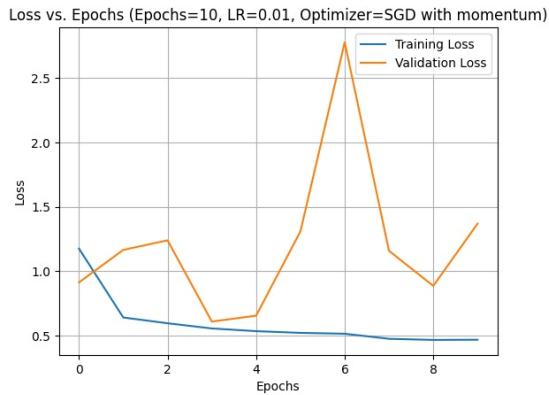


SGD with MOMENTUM: Epochs=10

Learning rate: 0.01

Test Loss: 1.4013991355895996

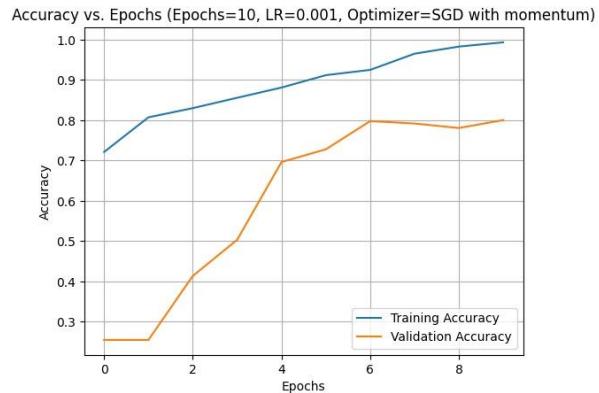
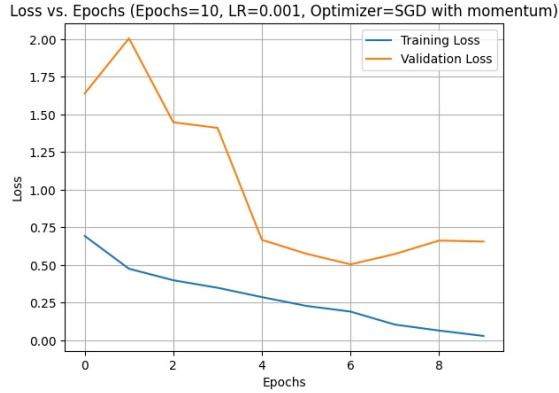
Test Accuracy: 0.5563139915466309



Learning rate: 0.001

Test Loss: 0.6302399635314941

Test Accuracy: 0.80887371301651

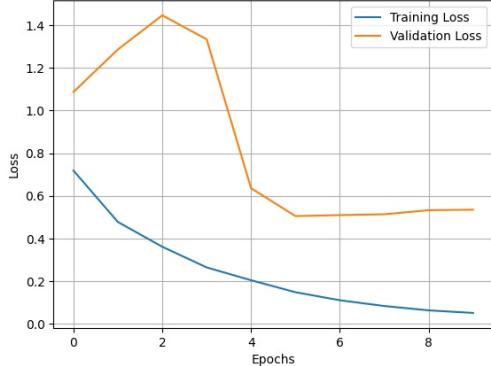


Learning rate: 0.0001

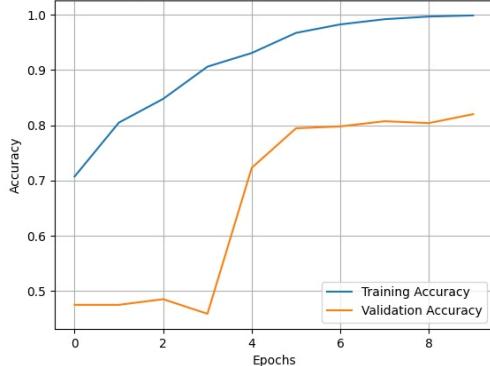
Test Loss: 0.5571592450141907

Test Accuracy: 0.8011945486068726

Loss vs. Epochs (Epochs=10, LR=0.0001, Optimizer=SGD with momentum)



Accuracy vs. Epochs (Epochs=10, LR=0.0001, Optimizer=SGD with momentum)



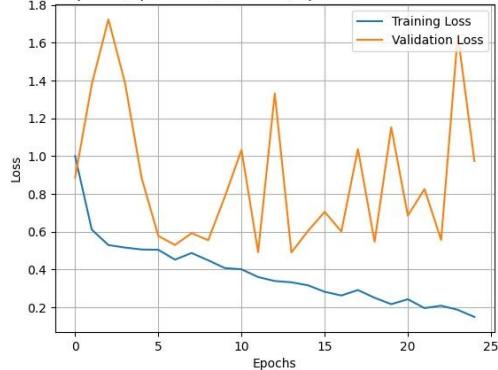
SGD with MOMENTUM: Epochs=25

Learning rate: 0.01

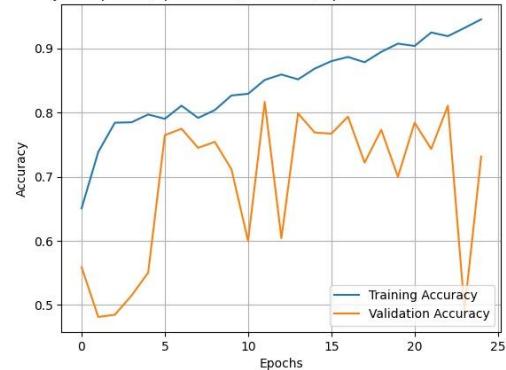
Test Loss: 1.0281145572662354

Test Accuracy: 0.7226962447166443

Loss vs. Epochs (Epochs=25, LR=0.01, Optimizer=SGD with momentum)



Accuracy vs. Epochs (Epochs=25, LR=0.01, Optimizer=SGD with momentum)

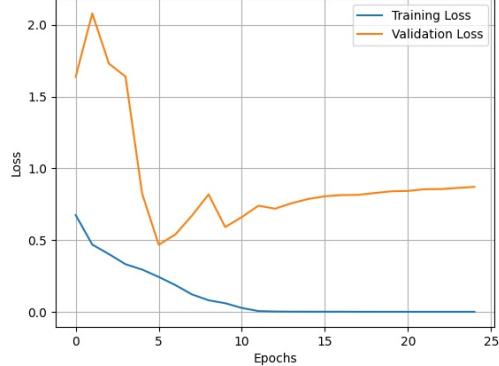


Learning rate: 0.001

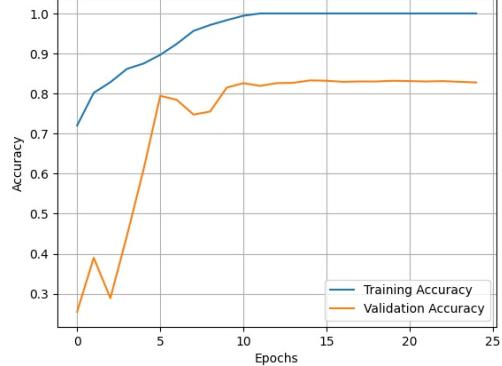
Test Loss: 0.9503329992294312

Test Accuracy: 0.8105801939964294

Loss vs. Epochs (Epochs=25, LR=0.001, Optimizer=SGD with momentum)



Accuracy vs. Epochs (Epochs=25, LR=0.001, Optimizer=SGD with momentum)

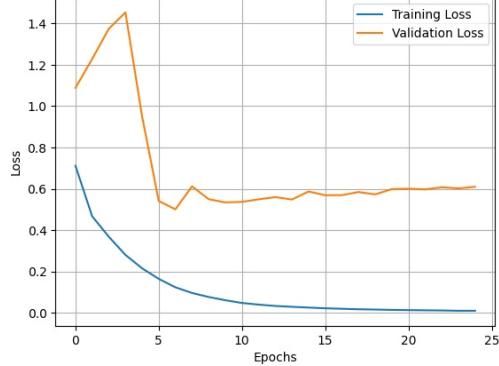


Learning rate: 0.0001

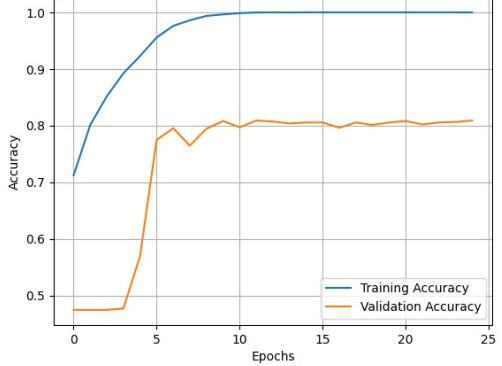
Test Loss: 0.6599909663200378

Test Accuracy: 0.8011945486068726

Loss vs. Epochs (Epochs=25, LR=0.0001, Optimizer=SGD with momentum)



Accuracy vs. Epochs (Epochs=25, LR=0.0001, Optimizer=SGD with momentum)

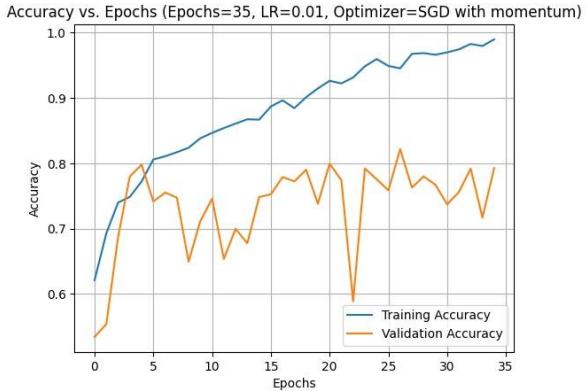
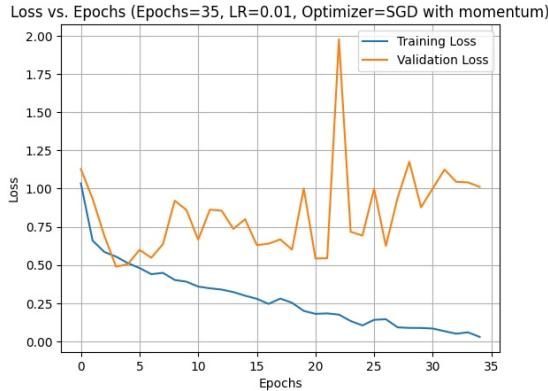


SGD with MOMENTUM: Epochs=35

Learning rate: 0.01

Test Loss: 0.9811405539512634

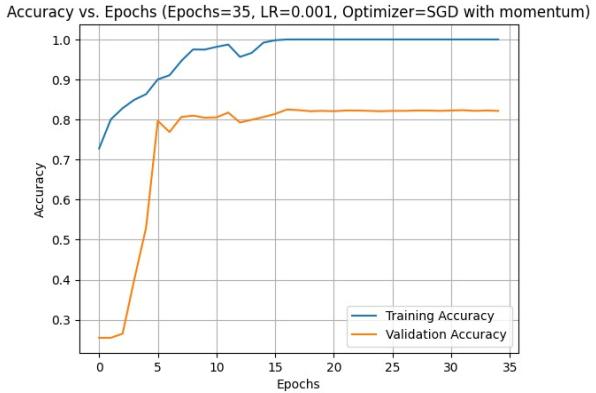
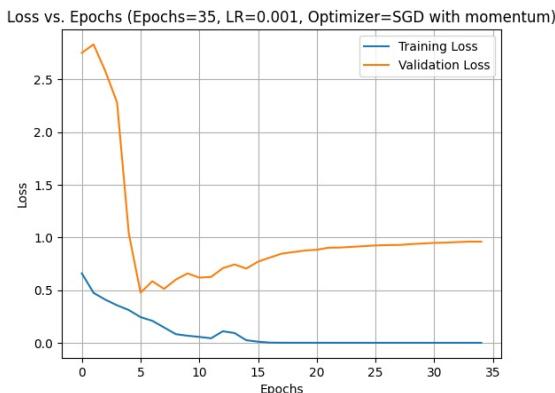
Test Accuracy: 0.7986348271369934



Learning rate: 0.001

Test Loss: 1.0077838897705078

Test Accuracy: 0.8156996369361877

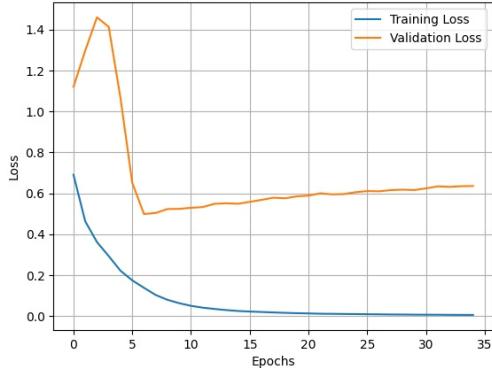


Learning rate: 0.0001

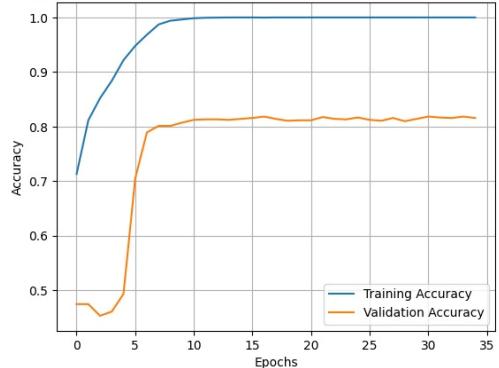
Test Loss: 0.6845228672027588

Test Accuracy: 0.8080204725265503

Loss vs. Epochs (Epochs=35, LR=0.0001, Optimizer=SGD with momentum)



Accuracy vs. Epochs (Epochs=35, LR=0.0001, Optimizer=SGD with momentum)

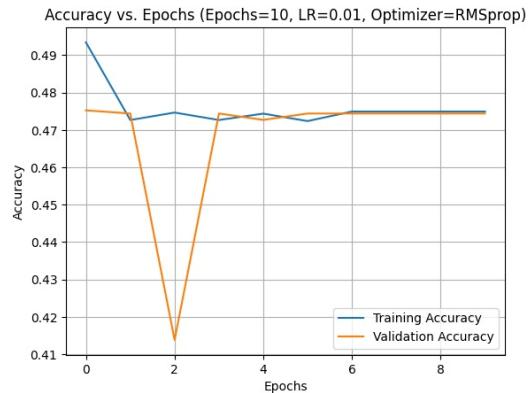
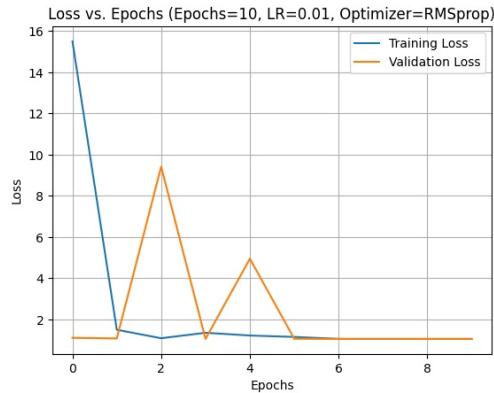


RMSPROP: Epochs=10

Learning rate: 0.01

Test Loss: 1.056215524673462

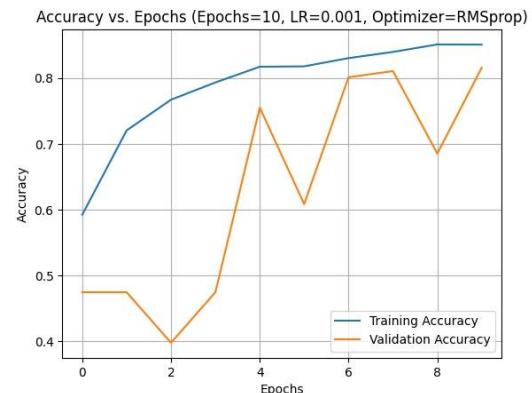
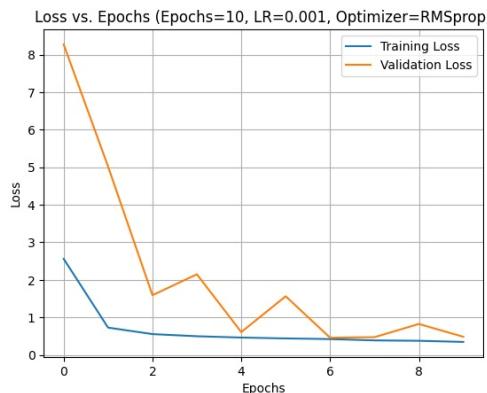
Test Accuracy: 0.4744027256965637



Learning rate: 0.001

Test Loss: 0.5108274221420288

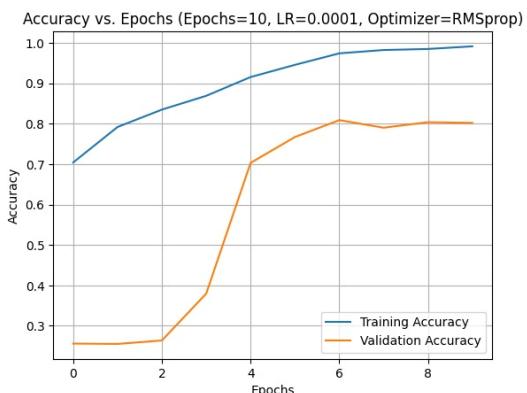
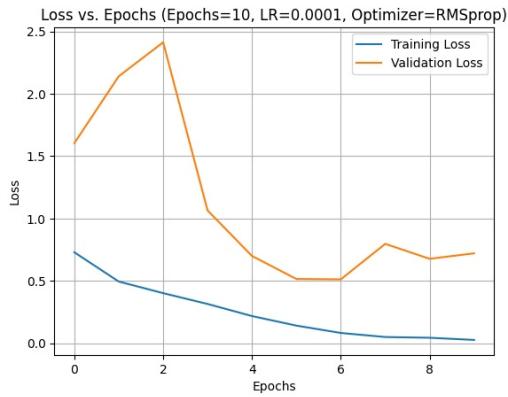
Test Accuracy: 0.8131399154663086



Learning rate: 0.0001

Test Loss: 0.7725282311439514

Test Accuracy: 0.8046075105667114

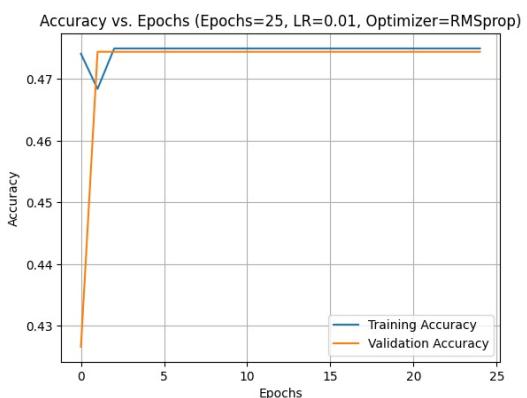
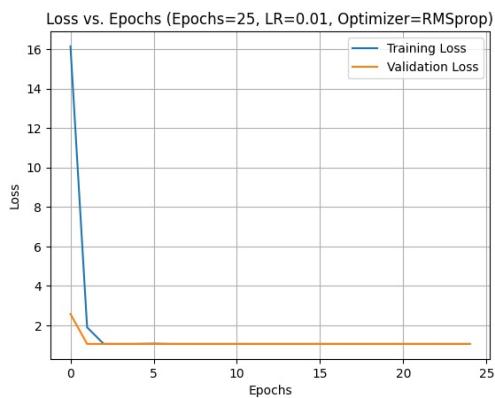


RMSPROP: Epochs=25

Learning rate: 0.01

Test Loss: 1.0562145709991455

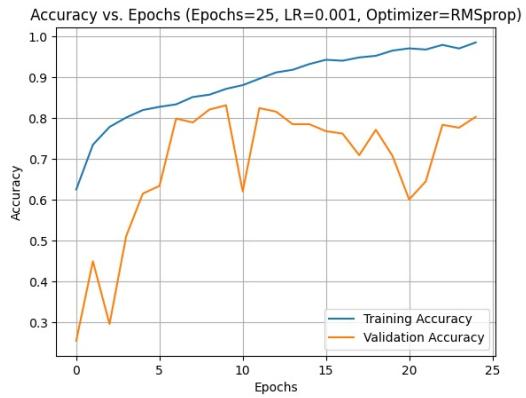
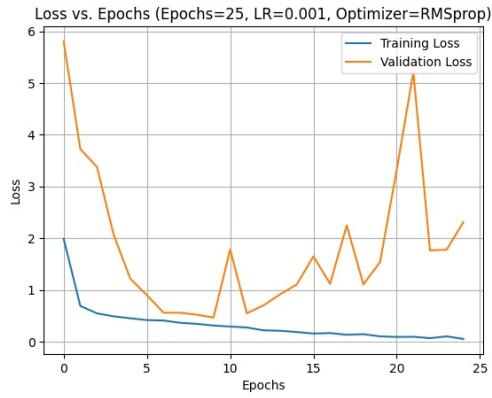
Test Accuracy: 0.4744027256965637



Learning rate: 0.001

Test Loss: 2.238797426223755

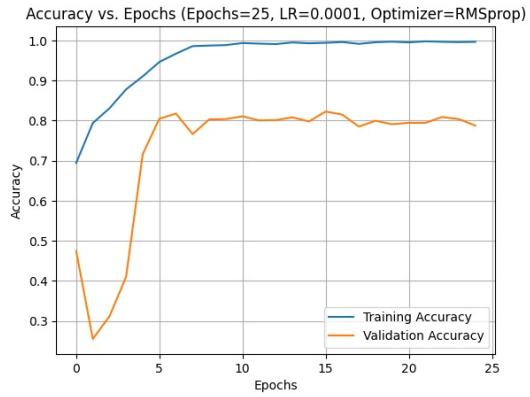
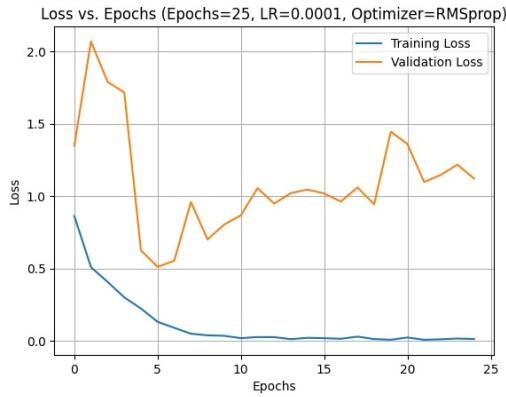
Test Accuracy: 0.8046075105667114



Learning rate: 0.0001

Test Loss: 1.1363117694854736

Test Accuracy: 0.7909556031227112

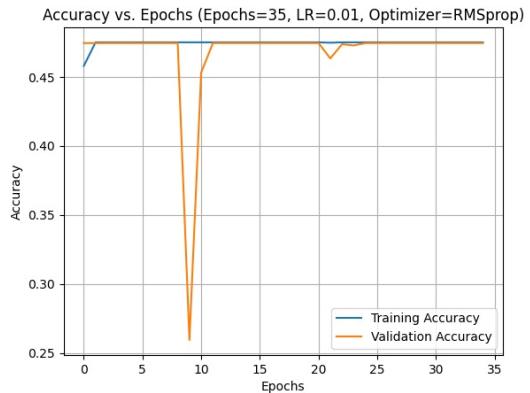
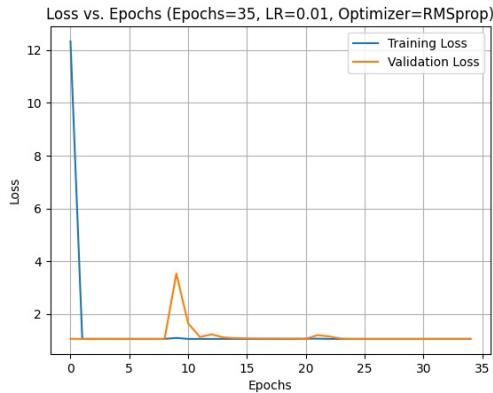


RMSPROP: Epochs=35

Learning rate: 0.01

Test Loss: 1.0562163591384888

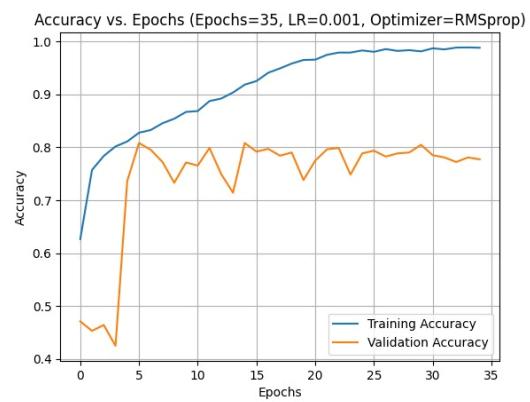
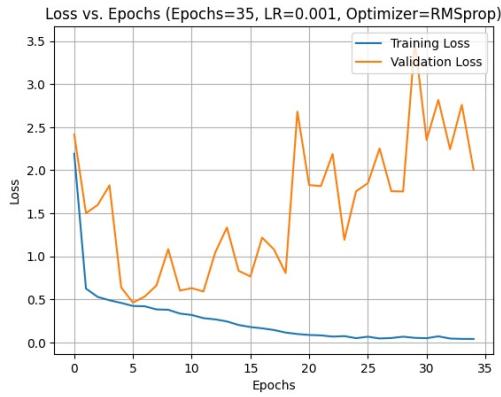
Test Accuracy: 0.4744027256965637



Learning rate: 0.001

Test Loss: 1.828440546989441

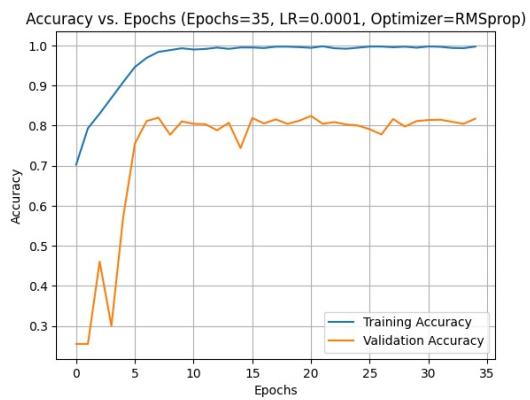
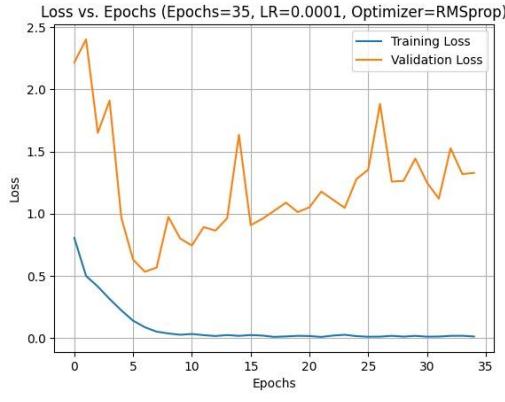
Test Accuracy: 0.7790102362632751



Learning rate: 0.001

Test Loss: 1.3830876350402832

Test Accuracy: 0.8097269535064697



סיכום התוצאות

Epochs	10			25			35		
Learning rate	0.01	0.001	0.0001	0.01	0.001	0.0001	0.01	0.001	0.0001
ADAM	0.77303	0.60921	0.82508	0.55802	0.80460	0.80972	0.79095	0.69368	0.80546
SGD	0.71075	0.78583	0.77133	0.80631	0.79692	0.79010	0.81569	0.80034	0.77559
SGD with Momentum	0.55631	0.80887	0.80119	0.72269	0.81058	0.80119	0.79863	0.81569	0.80802
RSMprop	0.47440	0.81313	0.80460	0.47440	0.80460	0.79095	0.47440	0.77901	0.80972

ניתן לראות כי הפרמטרים עבורם התוצאה הטובה ביותר הם:

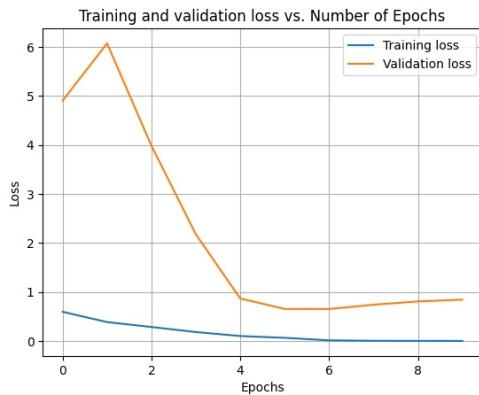
Optimizer: ADAM

Epochs: 10

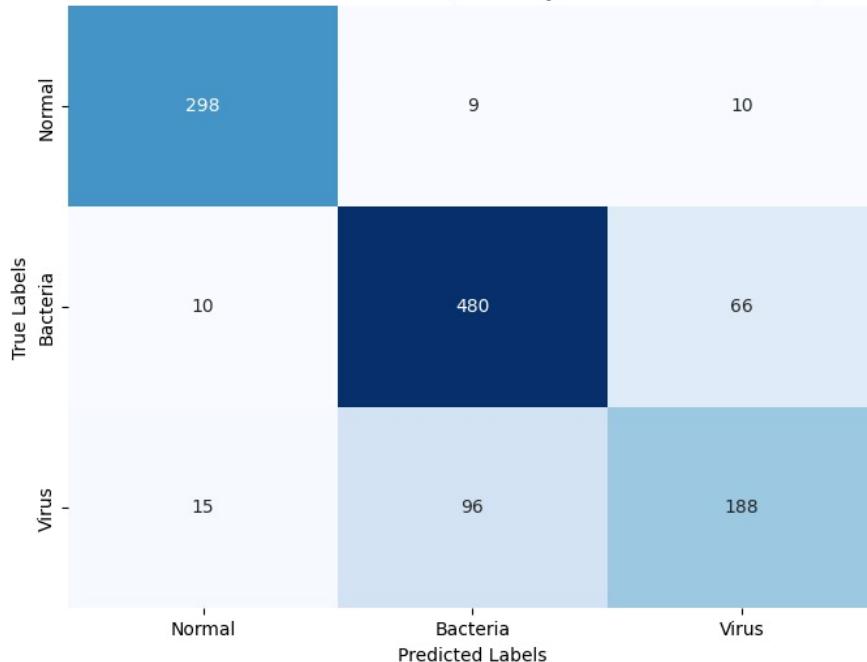
Learning rate : 0.0001

Test Loss: 0.7170082330703735

Test Accuracy: 0.8242321014404297



Confusion Matrix - Best Model (Accuracy=0.8242321014404297)



Normal-0

Bacteria-1

Virus-2

כעת נריץ את המודל עם הפרמטרים עבוריים התוצאה הייתה הטובה ביותר (accuracy=0.8242)

נosiפ את מנגנון :early stopping

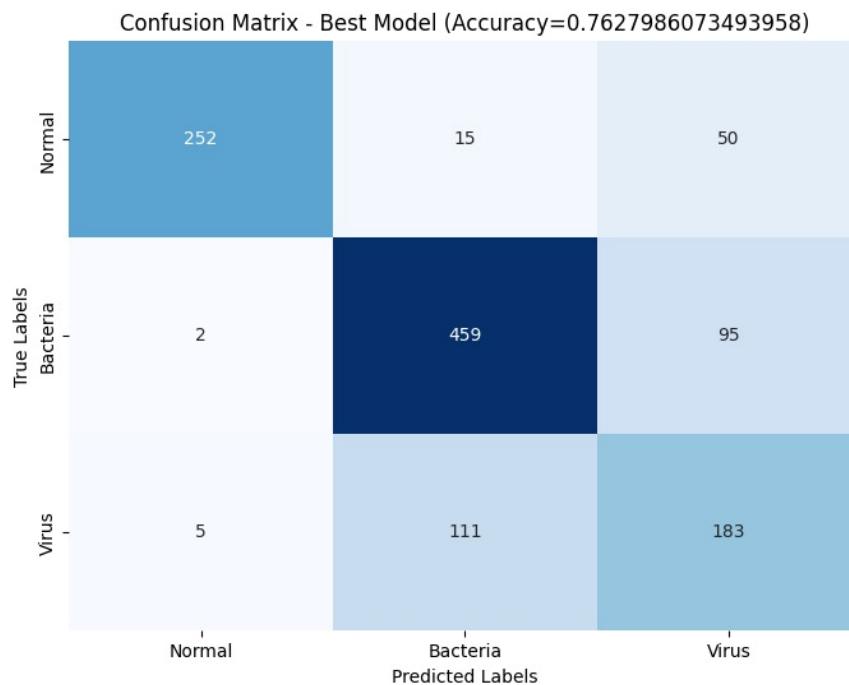
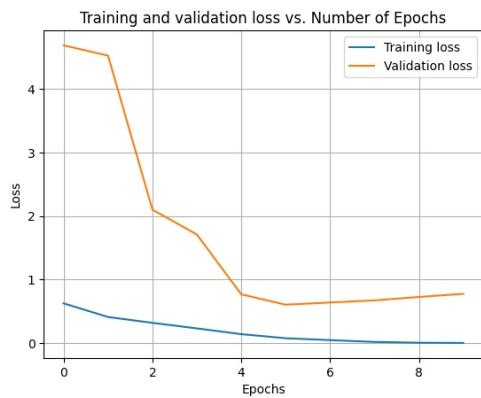
```
Non-trainable params: 1,984 (7.75 KB)
Epoch 1/10
110/110 1s 49ms/step - accuracy: 0.6822 - loss: 0.8614 - val_accuracy: 0.2551 - val_loss: 4.6890
Epoch 2/10
110/110 1s 10ms/step - accuracy: 0.8257 - loss: 0.3975 - val_accuracy: 0.2551 - val_loss: 4.5269
Epoch 3/10
110/110 1s 10ms/step - accuracy: 0.8810 - loss: 0.2952 - val_accuracy: 0.2628 - val_loss: 2.0997
Epoch 4/10
110/110 1s 10ms/step - accuracy: 0.9173 - loss: 0.2282 - val_accuracy: 0.3311 - val_loss: 1.7097
Epoch 5/10
110/110 1s 10ms/step - accuracy: 0.9557 - loss: 0.1453 - val_accuracy: 0.6980 - val_loss: 0.7668
Epoch 6/10
110/110 1s 10ms/step - accuracy: 0.9795 - loss: 0.0742 - val_accuracy: 0.7637 - val_loss: 0.6035
Epoch 7/10
110/110 1s 10ms/step - accuracy: 0.9886 - loss: 0.0448 - val_accuracy: 0.7688 - val_loss: 0.6384
Epoch 8/10
110/110 1s 10ms/step - accuracy: 0.9976 - loss: 0.0181 - val_accuracy: 0.8097 - val_loss: 0.6712
Epoch 9/10
110/110 1s 10ms/step - accuracy: 0.9999 - loss: 0.0043 - val_accuracy: 0.8080 - val_loss: 0.7255
Epoch 10/10
110/110 1s 10ms/step - accuracy: 1.0000 - loss: 0.0016 - val_accuracy: 0.8123 - val_loss: 0.7745
Restoring model weights from the end of the best epoch: 6.
37/37 0s 4ms/step - accuracy: 0.7989 - loss: 0.6039
```

Test Loss: 0.6038618087768555

Test Accuracy: 0.7627986073493958

ניתן לראות כי הריצה עצמה לאחר 6 אפוקים (Epochs) מתוך 10.

הבדיקה ירד אבל עדין ניתן לומר שההתוצאה סבירה.



Normal-0

Bacteria-1

Virus-2