File - main

```
/Users/garytang/Desktop/WGU/capstone/fruits-and-vegetables/.venv/bin/python /Users/garytang/Desktop/WGU/capstone/fruits-and-vegetables/main.py
number of classes in train folder : 37
number of classes in validation folder : 37
number of classes in test folder : 37
Number of samples in train : 3115
Number of samples in validation : 351
Number of samples test : 359
Found 3115 validated image filenames belonging to 36 classes.
Found 351 validated image filenames belonging to 36 classes.
Found 359 validated image filenames belonging to 36 classes.
input_layer
Conv1
bn_Conv1
Conv1_relu
expanded_conv_depthwise
expanded_conv_depthwise_BN
expanded_conv_depthwise_relu
expanded_conv_project
expanded_conv_project_BN
block_1_expand
block_1_expand_BN
block_1_expand_relu
block_1_pad
block_1_depthwise
block_1_depthwise_BN
block_1_depthwise_relu
block_1_project
block_1_project_BN
block_2_expand
block_2_expand_BN
block_2_expand_relu
block_2_depthwise
block_2_depthwise_BN
block_2_depthwise_relu
block_2_project
block_2_project_BN
block_2_add
block_3_expand
block_3_expand_BN
block_3_expand_relu
block_3_pad
block_3_depthwise
block_3_depthwise_BN
block_3_depthwise_relu
block_3_project
block_3_project_BN
block_4_expand
block_4_expand_BN
block_4_expand_relu
block_4_depthwise
block_4_depthwise_BN
block_4_depthwise_relu
block_4_project
block_4_project_BN
block_4_add
block_5_expand
block_5_expand_BN
block_5_expand_relu
block_5_depthwise
block_5_depthwise_BN
block_5_depthwise_relu
block_5_project
block_5_project_BN
block_5_add
block_6_expand
block_6_expand_BN
block_6_expand_relu
block_6_pad
block_6_depthwise
block_6_depthwise_BN
block_6_depthwise_relu
block_6_project
block_6_project_BN
block_7_expand
block_7_expand_BN
block_7_expand_relu
block_7_depthwise
block_7_depthwise_BN
block_7_depthwise_relu
block_7_project
block_7_project_BN
block_7_add
```

File - main

```
 83 block_8_expand
 84 block_8_expand_BN
 85 block_8_expand_relu
 86 block_8_depthwise
 87 block_8_depthwise_BN
 88 block_8_depthwise_relu
 89 block_8_project
 90 block_8_project_BN
 91 block_8_add
 92 block_9_expand
 93 block_9_expand_BN
 94 block_9_expand_relu
 95 block_9_depthwise
 96 block_9_depthwise_BN
 97 block_9_depthwise_relu
 98 block_9_project
 99 block_9_project_BN
100 block_9_add
101 block_10_expand
102 block_10_expand_BN
103 block_10_expand_relu
104 block_10_depthwise
105 block_10_depthwise_BN
106 block_10_depthwise_relu
107 block_10_project
108 block_10_project_BN
109 block_11_expand
110 block_11_expand_BN
111 block_11_expand_relu
112 block_11_depthwise
113 block_11_depthwise_BN
114 block_11_depthwise_relu
115 block_11_project
116 block_11_project_BN
117 block_11_add
118 block_12_expand
119 block_12_expand_BN
120 block_12_expand_relu
121 block_12_depthwise
122 block_12_depthwise_BN
123 block_12_depthwise_relu
124 block_12_project
125 block_12_project_BN
126 block_12_add
127 block_13_expand
128 block_13_expand_BN
129 block_13_expand_relu
130 block_13_pad
131 block_13_depthwise
132 block_13_depthwise_BN
133 block_13_depthwise_relu
134 block_13_project
135 block_13_project_BN
136 block_14_expand
137 block_14_expand_BN
138 block_14_expand_relu
139 block_14_depthwise
140 block_14_depthwise_BN
141 block_14_depthwise_relu
142 block_14_project
143 block_14_project_BN
144 block_14_add
145 block_15_expand
146 block_15_expand_BN
147 block_15_expand_relu
148 block_15_depthwise
149 block_15_depthwise_BN
150 block_15_depthwise_relu
151 block_15_project
152 block_15_project_BN
153 block_15_add
154 block_16_expand
155 block_16_expand_BN
156 block_16_expand_relu
157 block_16_depthwise
158 block_16_depthwise_BN
159 block_16_depthwise_relu
160 block_16_project
161 block_16_project_BN
162 Conv_1
163 Conv_1_bn
164 out_relu
165 global_average_pooling2d
```

```
Model: "sequential"
```

Layer (type)	Output Shape	Param #
mobilenetv2_1.00_224 (Functional)	(None, 1280)	2,257,984
flatten (Flatten)	(None, 1280)	0
dense (Dense)	(None, 256)	327,936
dense_1 (Dense)	(None, 128)	32,896
dense_2 (Dense)	(None, 36)	4,644

```
 Total params: 2,623,460 (10.01 MB)
 Trainable params: 1,251,556 (4.77 MB)
 Non-trainable params: 1,371,904 (5.23 MB)
Epoch 1/100
98/98 ━━━━━━━━━━━━━━━━━━━━ 61s 599ms/step - accuracy: 0.4416 - loss: 2.1309 - val_accuracy: 0.6581 - val_loss:
    1.5772 - learning_rate: 0.0010 - lr: 0.0010
Epoch 2/100
98/98 ━━━━━━━━━━━━━━━━━━━━ 57s 580ms/step - accuracy: 0.7710 - loss: 0.7610 - val_accuracy: 0.7293 - val_loss:
    1.3458 - learning_rate: 0.0010 - lr: 0.0010
Epoch 3/100
98/98 ━━━━━━━━━━━━━━━━━━━━ 57s 580ms/step - accuracy: 0.8082 - loss: 0.5644 - val_accuracy: 0.7151 - val_loss:
    1.8837 - learning_rate: 0.0010 - lr: 0.0010
Epoch 4/100
98/98 ━━━━━━━━━━━━━━━━━━━━ 56s 569ms/step - accuracy: 0.8385 - loss: 0.4659 - val_accuracy: 0.6553 - val_loss:
    2.0850 - learning_rate: 0.0010 - lr: 0.0010
Epoch 5/100
98/98 ━━━━━━━━━━━━━━━━━━━━ 57s 577ms/step - accuracy: 0.8740 - loss: 0.3759 - val_accuracy: 0.7350 - val_loss:
    1.9366 - learning_rate: 0.0010 - lr: 5.0000e-04
Epoch 6/100
98/98 ━━━━━━━━━━━━━━━━━━━━ 56s 574ms/step - accuracy: 0.8910 - loss: 0.3213 - val_accuracy: 0.8234 - val_loss:
    0.9073 - learning_rate: 5.0000e-04 - lr: 5.0000e-04
Epoch 7/100
98/98 ━━━━━━━━━━━━━━━━━━━━ 57s 580ms/step - accuracy: 0.9142 - loss: 0.2318 - val_accuracy: 0.8746 - val_loss:
    0.6739 - learning_rate: 5.0000e-04 - lr: 5.0000e-04
Epoch 8/100
98/98 ━━━━━━━━━━━━━━━━━━━━ 57s 576ms/step - accuracy: 0.9317 - loss: 0.1737 - val_accuracy: 0.8718 - val_loss:
    0.6402 - learning_rate: 5.0000e-04 - lr: 5.0000e-04
Epoch 9/100
98/98 ━━━━━━━━━━━━━━━━━━━━ 57s 579ms/step - accuracy: 0.9376 - loss: 0.1715 - val_accuracy: 0.8974 - val_loss:
    0.5780 - learning_rate: 5.0000e-04 - lr: 5.0000e-04
Epoch 10/100
98/98 ━━━━━━━━━━━━━━━━━━━━ 57s 583ms/step - accuracy: 0.9341 - loss: 0.1707 - val_accuracy: 0.8575 - val_loss:
    0.8300 - learning_rate: 5.0000e-04 - lr: 5.0000e-04
Epoch 11/100
98/98 ━━━━━━━━━━━━━━━━━━━━ 59s 597ms/step - accuracy: 0.9550 - loss: 0.1464 - val_accuracy: 0.8832 - val_loss:
    0.6204 - learning_rate: 5.0000e-04 - lr: 5.0000e-04
Epoch 12/100
98/98 ━━━━━━━━━━━━━━━━━━━━ 57s 580ms/step - accuracy: 0.9543 - loss: 0.1555 - val_accuracy: 0.9174 - val_loss:
    0.4319 - learning_rate: 5.0000e-04 - lr: 5.0000e-04
Epoch 13/100
98/98 ━━━━━━━━━━━━━━━━━━━━ 59s 604ms/step - accuracy: 0.9554 - loss: 0.1133 - val_accuracy: 0.9202 - val_loss:
    0.3079 - learning_rate: 5.0000e-04 - lr: 5.0000e-04
Epoch 14/100
98/98 ━━━━━━━━━━━━━━━━━━━━ 57s 582ms/step - accuracy: 0.9548 - loss: 0.1204 - val_accuracy: 0.9231 - val_loss:
    0.2902 - learning_rate: 5.0000e-04 - lr: 5.0000e-04
Epoch 15/100
98/98 ━━━━━━━━━━━━━━━━━━━━ 59s 595ms/step - accuracy: 0.9453 - loss: 0.1547 - val_accuracy: 0.9088 - val_loss:
    0.3538 - learning_rate: 5.0000e-04 - lr: 5.0000e-04
Epoch 16/100
98/98 ━━━━━━━━━━━━━━━━━━━━ 57s 586ms/step - accuracy: 0.9480 - loss: 0.1494 - val_accuracy: 0.9003 - val_loss:
    0.4038 - learning_rate: 5.0000e-04 - lr: 5.0000e-04
Epoch 17/100
98/98 ━━━━━━━━━━━━━━━━━━━━ 57s 583ms/step - accuracy: 0.9627 - loss: 0.1132 - val_accuracy: 0.9373 - val_loss:
    0.2918 - learning_rate: 5.0000e-04 - lr: 2.5000e-04
Epoch 18/100
98/98 ━━━━━━━━━━━━━━━━━━━━ 57s 577ms/step - accuracy: 0.9687 - loss: 0.0982 - val_accuracy: 0.9658 - val_loss:
    0.1981 - learning_rate: 2.5000e-04 - lr: 2.5000e-04
Epoch 19/100
98/98 ━━━━━━━━━━━━━━━━━━━━ 57s 582ms/step - accuracy: 0.9761 - loss: 0.0703 - val_accuracy: 0.9658 - val_loss:
    0.1861 - learning_rate: 2.5000e-04 - lr: 2.5000e-04
Epoch 20/100
98/98 ━━━━━━━━━━━━━━━━━━━━ 59s 597ms/step - accuracy: 0.9774 - loss: 0.0581 - val_accuracy: 0.9715 - val_loss:
    0.1612 - learning_rate: 2.5000e-04 - lr: 2.5000e-04
Epoch 21/100
98/98 ━━━━━━━━━━━━━━━━━━━━ 58s 595ms/step - accuracy: 0.9805 - loss: 0.0568 - val_accuracy: 0.9687 - val_loss:
    0.1839 - learning_rate: 2.5000e-04 - lr: 2.5000e-04
Epoch 22/100
98/98 ━━━━━━━━━━━━━━━━━━━━ 57s 582ms/step - accuracy: 0.9806 - loss: 0.0503 - val_accuracy: 0.9801 - val_loss:
```

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227 0.1645 - learning_rate: 2.5000e-04 - lr: 2.5000e-04
228 Epoch 23/100
229 98/98 ━━━━━━━━━━━━━━━━━━━━ 57s 583ms/step - accuracy: 0.9783 - loss: 0.0505 - val_accuracy: 0.9744 - val_loss:
    0.1552 - learning_rate: 2.5000e-04 - lr: 2.5000e-04
230 Epoch 24/100
231 98/98 ━━━━━━━━━━━━━━━━━━━━ 57s 576ms/step - accuracy: 0.9786 - loss: 0.0660 - val_accuracy: 0.9487 - val_loss:
    0.2574 - learning_rate: 2.5000e-04 - lr: 2.5000e-04
232 Epoch 25/100
233 98/98 ━━━━━━━━━━━━━━━━━━━━ 57s 587ms/step - accuracy: 0.9779 - loss: 0.0583 - val_accuracy: 0.9658 - val_loss:
    0.1803 - learning_rate: 2.5000e-04 - lr: 2.5000e-04
234 Epoch 26/100
235 98/98 ━━━━━━━━━━━━━━━━━━━━ 57s 578ms/step - accuracy: 0.9809 - loss: 0.0560 - val_accuracy: 0.9687 - val_loss:
    0.1605 - learning_rate: 2.5000e-04 - lr: 1.2500e-04
236 Epoch 27/100
237 98/98 ━━━━━━━━━━━━━━━━━━━━ 57s 579ms/step - accuracy: 0.9833 - loss: 0.0410 - val_accuracy: 0.9658 - val_loss:
    0.1564 - learning_rate: 1.2500e-04 - lr: 1.2500e-04
238 Epoch 28/100
239 98/98 ━━━━━━━━━━━━━━━━━━━━ 57s 584ms/step - accuracy: 0.9828 - loss: 0.0438 - val_accuracy: 0.9772 - val_loss:
    0.1386 - learning_rate: 1.2500e-04 - lr: 1.2500e-04
240 Epoch 29/100
241 98/98 ━━━━━━━━━━━━━━━━━━━━ 57s 583ms/step - accuracy: 0.9849 - loss: 0.0409 - val_accuracy: 0.9658 - val_loss:
    0.1644 - learning_rate: 1.2500e-04 - lr: 1.2500e-04
242 Epoch 30/100
243 98/98 ━━━━━━━━━━━━━━━━━━━━ 57s 580ms/step - accuracy: 0.9907 - loss: 0.0289 - val_accuracy: 0.9687 - val_loss:
    0.1465 - learning_rate: 1.2500e-04 - lr: 1.2500e-04
244 Epoch 31/100
245 98/98 ━━━━━━━━━━━━━━━━━━━━ 57s 582ms/step - accuracy: 0.9882 - loss: 0.0298 - val_accuracy: 0.9715 - val_loss:
    0.1471 - learning_rate: 1.2500e-04 - lr: 6.2500e-05
246 Epoch 32/100
247 98/98 ━━━━━━━━━━━━━━━━━━━━ 58s 595ms/step - accuracy: 0.9855 - loss: 0.0321 - val_accuracy: 0.9687 - val_loss:
    0.1337 - learning_rate: 6.2500e-05 - lr: 6.2500e-05
248 Epoch 33/100
249 98/98 ━━━━━━━━━━━━━━━━━━━━ 59s 600ms/step - accuracy: 0.9879 - loss: 0.0287 - val_accuracy: 0.9687 - val_loss:
    0.1354 - learning_rate: 6.2500e-05 - lr: 6.2500e-05
250 Epoch 34/100
251 98/98 ━━━━━━━━━━━━━━━━━━━━ 59s 599ms/step - accuracy: 0.9917 - loss: 0.0259 - val_accuracy: 0.9744 - val_loss:
    0.1252 - learning_rate: 6.2500e-05 - lr: 6.2500e-05
252 Epoch 35/100
253 98/98 ━━━━━━━━━━━━━━━━━━━━ 57s 583ms/step - accuracy: 0.9926 - loss: 0.0211 - val_accuracy: 0.9715 - val_loss:
    0.1225 - learning_rate: 6.2500e-05 - lr: 6.2500e-05
254 Epoch 36/100
255 98/98 ━━━━━━━━━━━━━━━━━━━━ 57s 584ms/step - accuracy: 0.9854 - loss: 0.0334 - val_accuracy: 0.9772 - val_loss:
    0.1157 - learning_rate: 6.2500e-05 - lr: 6.2500e-05
256 Epoch 37/100
257 98/98 ━━━━━━━━━━━━━━━━━━━━ 58s 589ms/step - accuracy: 0.9909 - loss: 0.0267 - val_accuracy: 0.9744 - val_loss:
    0.1155 - learning_rate: 6.2500e-05 - lr: 6.2500e-05
258 Epoch 38/100
259 98/98 ━━━━━━━━━━━━━━━━━━━━ 57s 582ms/step - accuracy: 0.9897 - loss: 0.0245 - val_accuracy: 0.9744 - val_loss:
    0.1150 - learning_rate: 6.2500e-05 - lr: 6.2500e-05
260 Epoch 39/100
261 98/98 ━━━━━━━━━━━━━━━━━━━━ 58s 584ms/step - accuracy: 0.9879 - loss: 0.0264 - val_accuracy: 0.9801 - val_loss:
    0.1133 - learning_rate: 6.2500e-05 - lr: 6.2500e-05
262 Epoch 40/100
263 98/98 ━━━━━━━━━━━━━━━━━━━━ 58s 591ms/step - accuracy: 0.9851 - loss: 0.0261 - val_accuracy: 0.9772 - val_loss:
    0.1164 - learning_rate: 6.2500e-05 - lr: 6.2500e-05
264 Epoch 41/100
265 98/98 ━━━━━━━━━━━━━━━━━━━━ 59s 602ms/step - accuracy: 0.9900 - loss: 0.0264 - val_accuracy: 0.9744 - val_loss:
    0.1143 - learning_rate: 6.2500e-05 - lr: 6.2500e-05
266 Epoch 42/100
267 98/98 ━━━━━━━━━━━━━━━━━━━━ 57s 580ms/step - accuracy: 0.9921 - loss: 0.0192 - val_accuracy: 0.9715 - val_loss:
    0.1124 - learning_rate: 6.2500e-05 - lr: 6.2500e-05
268 Epoch 43/100
269 98/98 ━━━━━━━━━━━━━━━━━━━━ 59s 606ms/step - accuracy: 0.9880 - loss: 0.0244 - val_accuracy: 0.9744 - val_loss:
    0.1126 - learning_rate: 6.2500e-05 - lr: 6.2500e-05
270 Epoch 44/100
271 98/98 ━━━━━━━━━━━━━━━━━━━━ 59s 601ms/step - accuracy: 0.9910 - loss: 0.0218 - val_accuracy: 0.9801 - val_loss:
    0.1000 - learning_rate: 6.2500e-05 - lr: 6.2500e-05
272 Epoch 45/100
273 98/98 ━━━━━━━━━━━━━━━━━━━━ 59s 600ms/step - accuracy: 0.9923 - loss: 0.0184 - val_accuracy: 0.9744 - val_loss:
    0.1040 - learning_rate: 6.2500e-05 - lr: 6.2500e-05
274 Epoch 46/100
275 98/98 ━━━━━━━━━━━━━━━━━━━━ 58s 597ms/step - accuracy: 0.9904 - loss: 0.0243 - val_accuracy: 0.9744 - val_loss:
    0.1138 - learning_rate: 6.2500e-05 - lr: 6.2500e-05
276 Epoch 47/100
277 98/98 ━━━━━━━━━━━━━━━━━━━━ 58s 594ms/step - accuracy: 0.9922 - loss: 0.0195 - val_accuracy: 0.9801 - val_loss:
    0.1056 - learning_rate: 6.2500e-05 - lr: 3.1250e-05
278 Epoch 48/100
279 98/98 ━━━━━━━━━━━━━━━━━━━━ 59s 608ms/step - accuracy: 0.9922 - loss: 0.0215 - val_accuracy: 0.9772 - val_loss:
    0.1104 - learning_rate: 3.1250e-05 - lr: 3.1250e-05
280 Epoch 49/100
281 98/98 ━━━━━━━━━━━━━━━━━━━━ 58s 588ms/step - accuracy: 0.9928 - loss: 0.0173 - val_accuracy: 0.9744 - val_loss:
    0.1090 - learning_rate: 3.1250e-05 - lr: 3.1250e-05
282 Epoch 50/100
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File - main

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283 98/98 ━━━━━━━━━━━━━━━━━━━━ 57s 580ms/step - accuracy: 0.9923 - loss: 0.0198 - val_accuracy: 0.9772 - val_loss:
    0.1089 - learning_rate: 3.1250e-05 - lr: 1.5625e-05
284 Epoch 51/100
285 98/98 ━━━━━━━━━━━━━━━━━━━━ 59s 601ms/step - accuracy: 0.9916 - loss: 0.0223 - val_accuracy: 0.9772 - val_loss:
    0.1072 - learning_rate: 1.5625e-05 - lr: 1.5625e-05
286 Epoch 52/100
287 98/98 ━━━━━━━━━━━━━━━━━━━━ 60s 615ms/step - accuracy: 0.9880 - loss: 0.0257 - val_accuracy: 0.9744 - val_loss:
    0.1088 - learning_rate: 1.5625e-05 - lr: 1.5625e-05
288 Epoch 53/100
289 98/98 ━━━━━━━━━━━━━━━━━━━━ 60s 612ms/step - accuracy: 0.9916 - loss: 0.0206 - val_accuracy: 0.9744 - val_loss:
    0.1078 - learning_rate: 1.5625e-05 - lr: 7.8125e-06
290 Epoch 54/100
291 98/98 ━━━━━━━━━━━━━━━━━━━━ 60s 607ms/step - accuracy: 0.9905 - loss: 0.0219 - val_accuracy: 0.9772 - val_loss:
    0.1075 - learning_rate: 7.8125e-06 - lr: 7.8125e-06
292 12/12 ━━━━━━━━━━━━━━━━━━━━ 7s 506ms/step - accuracy: 0.9807 - loss: 0.0948
293 Test Loss : 0.098
294 Test Accuracy : 0.981
295 11/11 ━━━━━━━━━━━━━━━━━━━━ 6s 546ms/step
296                precision    recall  f1-score   support
297
298         apple       0.90      0.90      0.90        10
299        banana       1.00      0.78      0.88         9
300      beetroot       1.00      1.00      1.00        10
301   bell pepper       0.90      1.00      0.95         9
302       cabbage       1.00      1.00      1.00        10
303      capsicum       1.00      0.90      0.95        10
304        carrot       1.00      1.00      1.00         9
305   cauliflower       1.00      1.00      1.00        10
306 chilli pepper       0.90      1.00      0.95         9
307          corn       0.83      1.00      0.91        10
308      cucumber       1.00      1.00      1.00        10
309      eggplant       1.00      1.00      1.00        10
310        garlic       1.00      1.00      1.00        10
311        ginger       1.00      1.00      1.00        10
312        grapes       1.00      1.00      1.00         9
313      jalepeno       0.90      1.00      0.95         9
314          kiwi       1.00      1.00      1.00        10
315         lemon       1.00      1.00      1.00        10
316       lettuce       1.00      1.00      1.00         9
317         mango       1.00      1.00      1.00        10
318         onion       1.00      1.00      1.00        10
319        orange       1.00      1.00      1.00         9
320       paprika       0.91      1.00      0.95        10
321          pear       1.00      1.00      1.00        10
322          peas       1.00      1.00      1.00        10
323     pineapple       1.00      1.00      1.00        10
324   pomegranate       1.00      1.00      1.00        10
325        potato       1.00      0.90      0.95        10
326       raddish       1.00      1.00      1.00         9
327     soy beans       1.00      1.00      1.00        10
328       spinach       1.00      1.00      1.00        10
329     sweetcorn       1.00      0.80      0.89        10
330   sweetpotato       1.00      1.00      1.00        10
331        tomato       1.00      1.00      1.00        10
332        turnip       1.00      1.00      1.00        10
333    watermelon       1.00      1.00      1.00        10
334
335      accuracy                           0.98       351
336     macro avg       0.98      0.98      0.98       351
337  weighted avg       0.98      0.98      0.98       351
338
339
340
341
342 Process finished with exit code 0
343
```