Mikuš Filip

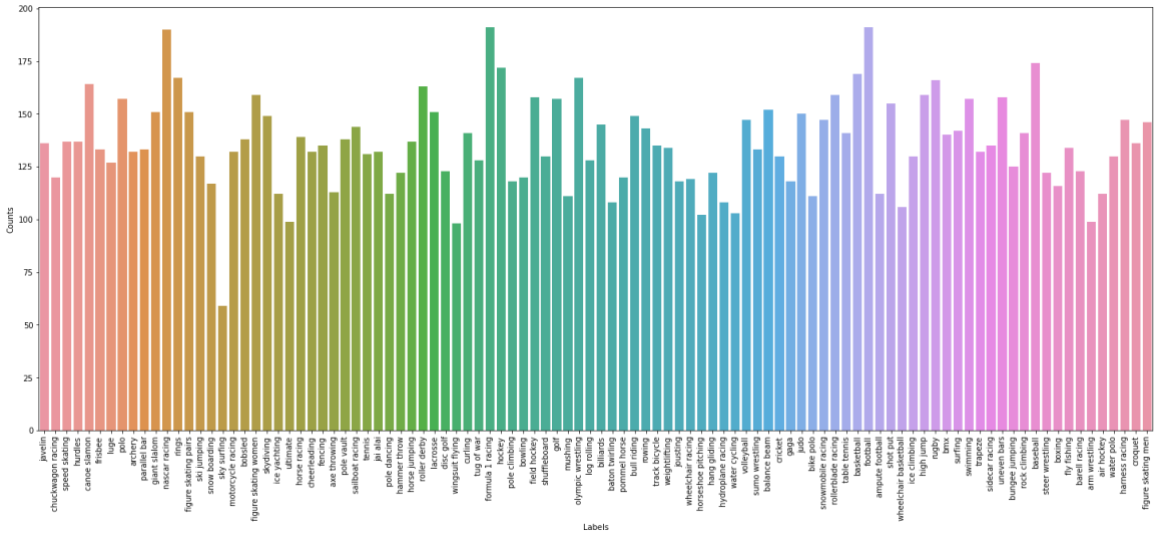
I-SUNS – Zadanie č. 3

Import datasetu

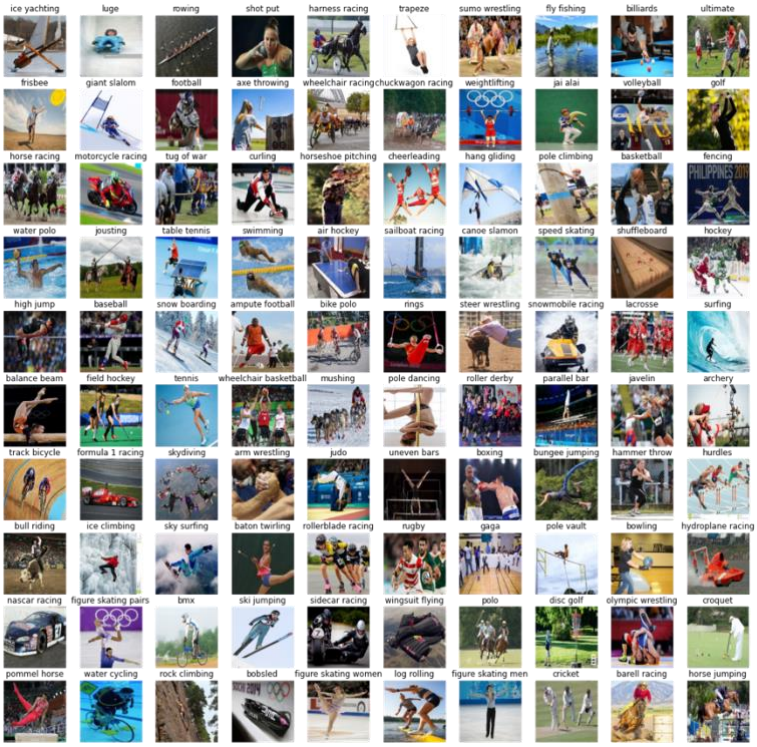
- import do ***tf.data.Dataset*** pomocou metódy ***tf.keras.utils.image_dataset_from_directory***
- dáta normalizované ***(tf.keras.layers.Rescaling(1./255))***
- aktivovaný ***shuffle***

EDA

Graf početnosti v triedach



Graf zobrazenia reprezentantov tried



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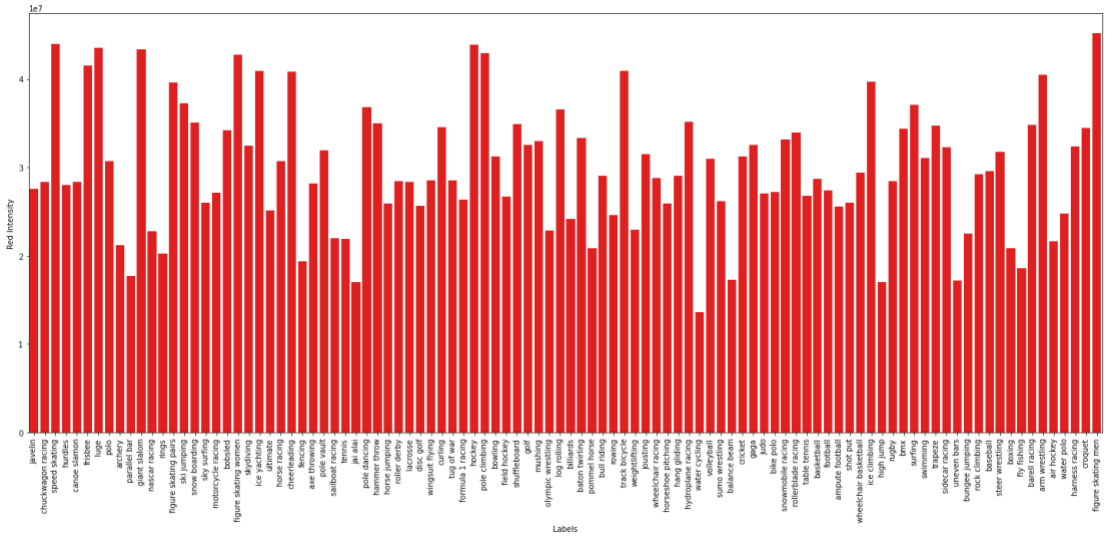
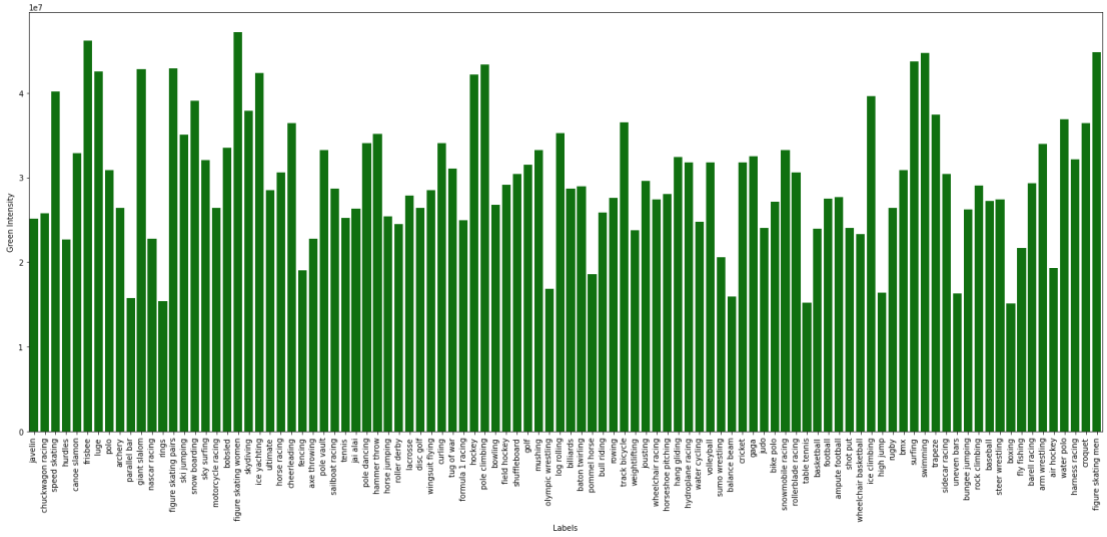
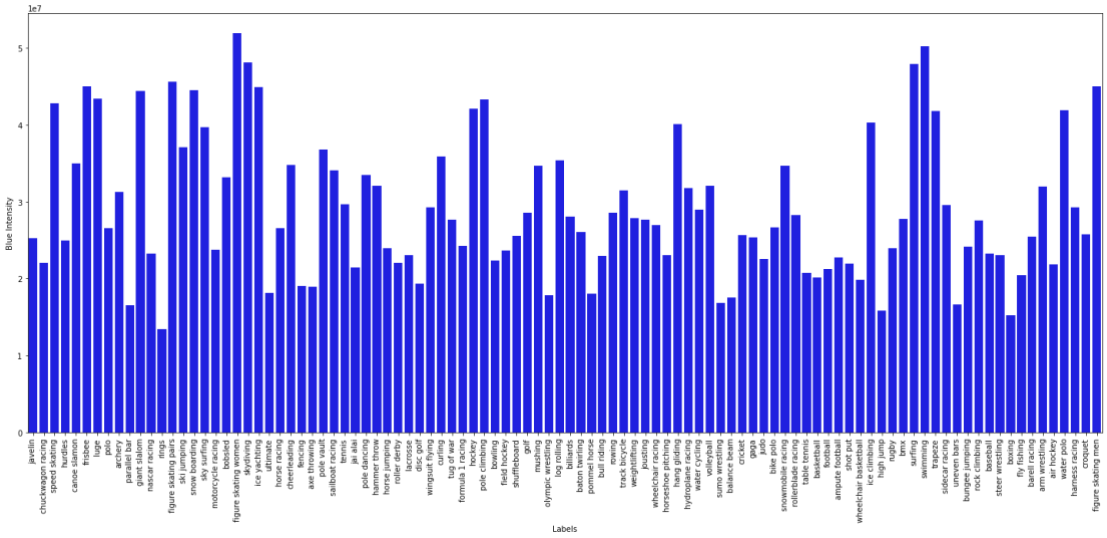
Graf hodnôt intenzity červených pixelov v triedach



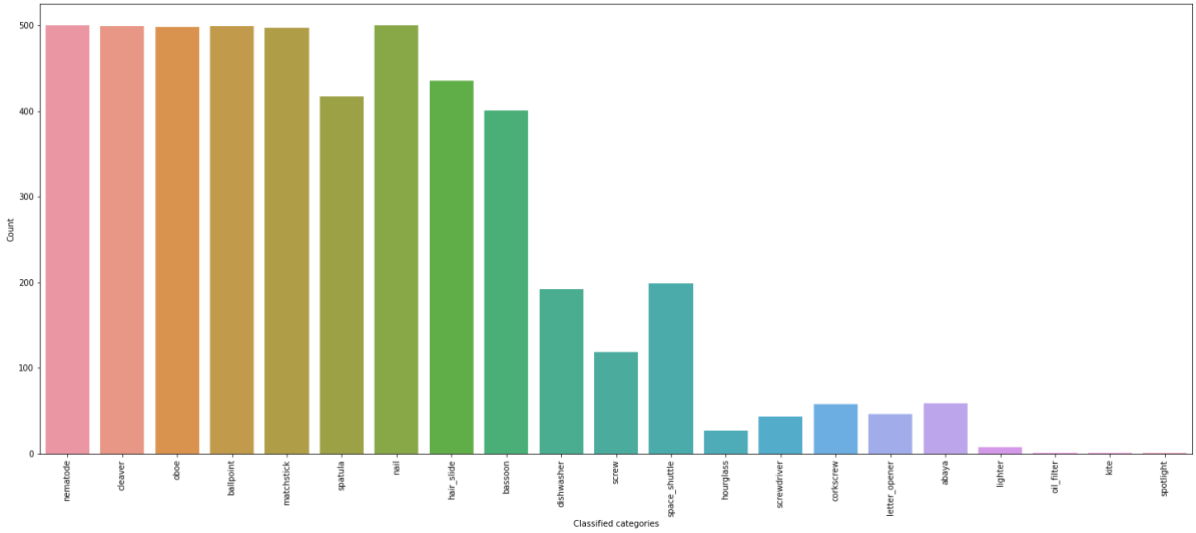
Graf hodnôt intenzity zelených pixelov v triedach



Graf hodnôt intenzity modrých pixelov v triedach



Graf predpovedaných tried pred-trénovaným modelom ResNet50



CNN

Experiment č. 1

```
[ ] cnn_model = models.Sequential()
    cnn_model.add(layers.Conv2D(32, (3, 3), activation='relu', input_shape=(28, 28, 3)))
    cnn_model.add(layers.MaxPooling2D((2, 2)))
    cnn_model.add(layers.Conv2D(64, (3, 3), activation='relu'))
    cnn_model.add(layers.MaxPooling2D((2, 2)))
    cnn_model.add(layers.Conv2D(64, (3, 3), activation='relu'))
    cnn_model.add(layers.Flatten())
    cnn_model.add(layers.Dense(64, activation="relu"))
    cnn_model.add(layers.Dense(100, activation="softmax"))
```

```
    cnn_model.compile(
          optimizer="adam",
          loss="sparse_categorical_crossentropy",
          metrics=["accuracy"]
    )
    cnn_model.summary()
```

```
Model: "sequential"
_________________________________________________________________
 Layer (type)                Output Shape              Param #
=================================================================
 conv2d (Conv2D)             (None, 26, 26, 32)        896

 max_pooling2d (MaxPooling2D  (None, 13, 13, 32)       0
 )

 conv2d_1 (Conv2D)           (None, 11, 11, 64)        18496

 max_pooling2d_1 (MaxPooling  (None, 5, 5, 64)         0
 2D)

 conv2d_2 (Conv2D)           (None, 3, 3, 64)          36928

 flatten (Flatten)           (None, 576)               0

 dense (Dense)               (None, 64)                36928

 dense_1 (Dense)             (None, 100)               6500

=================================================================
Total params: 99,748
Trainable params: 99,748
Non-trainable params: 0
_________________________________________________________________
```

```
[ ] cnn_model_history = cnn_model.fit(
          train_ds,
          validation_data=val_ds,
          epochs=50
    )
    print(cnn_model_history.history)
```

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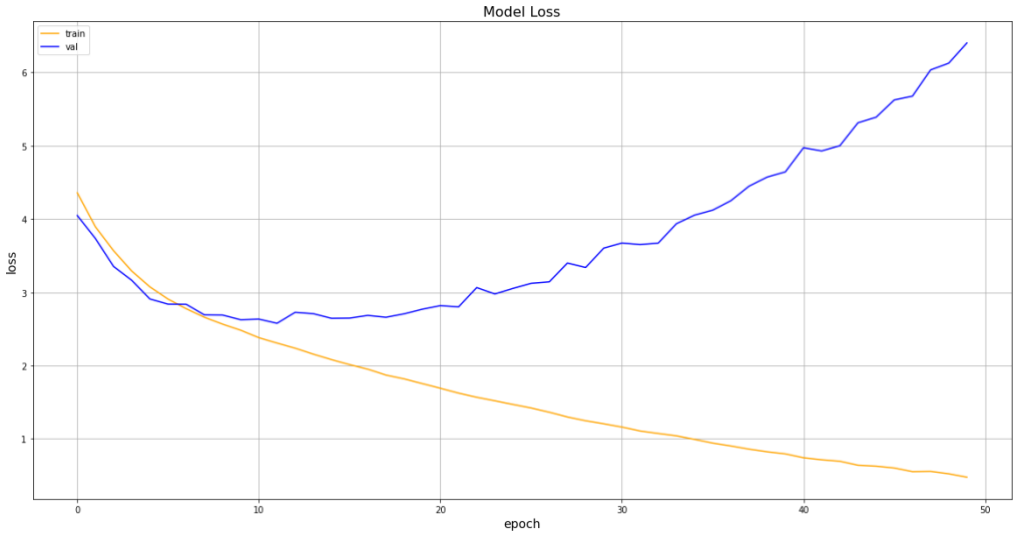
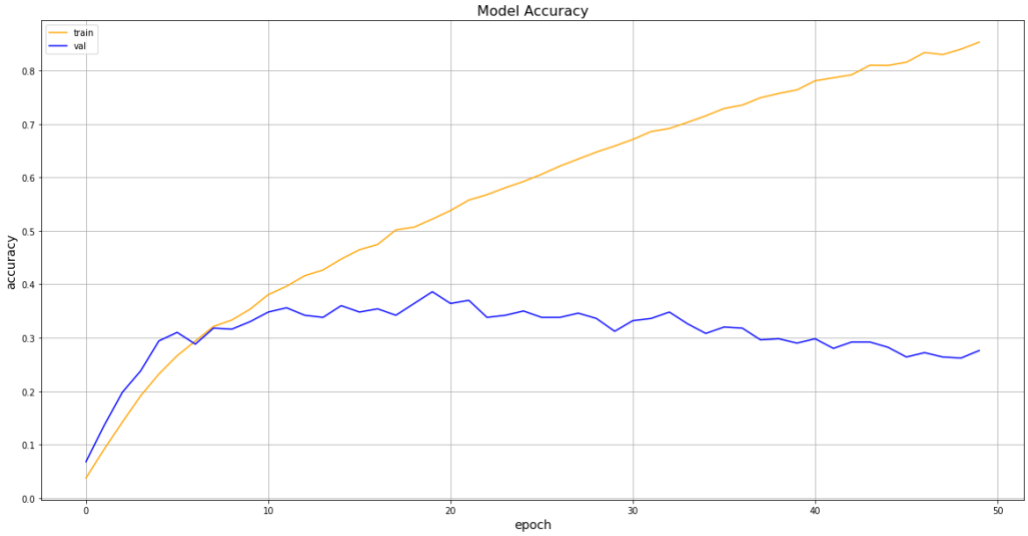
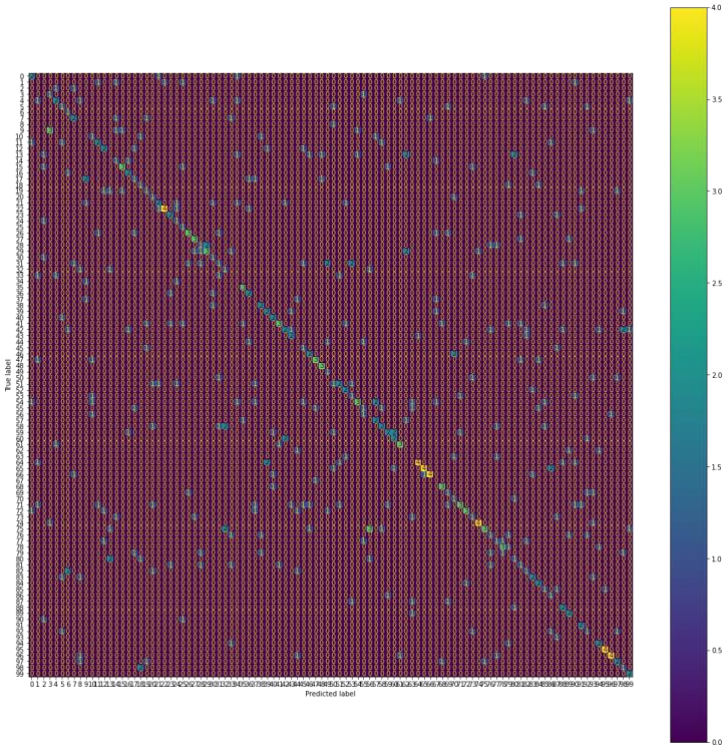
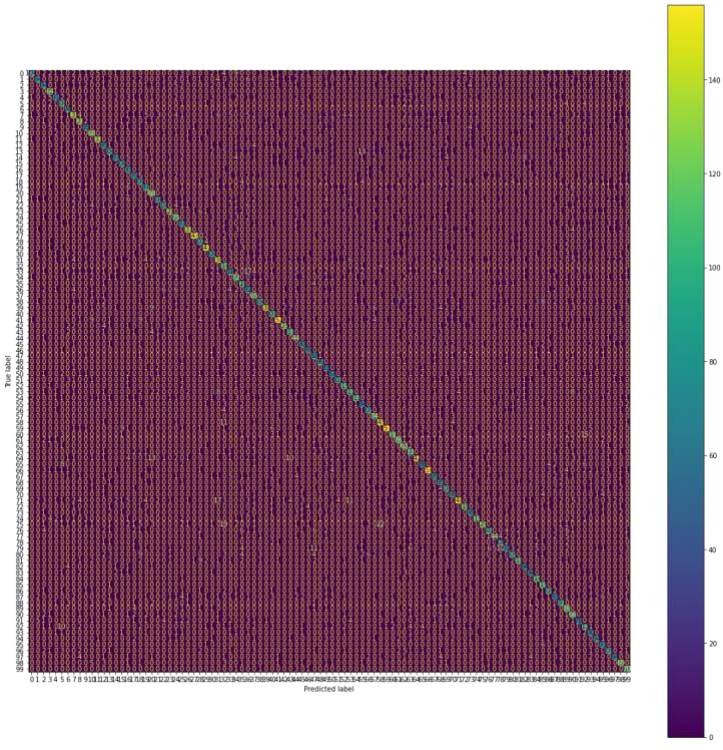
Train Loss	Train Acc,	Test Loss	Test Acc.
0.474	0.852	5.821	0.324









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CNN
Experiment č. 2

```
[ ] cnn_model = models.Sequential()
    cnn_model.add(layers.Conv2D(32, (3, 3), activation='relu', input_shape=(28, 28, 3)))
    cnn_model.add(layers.MaxPooling2D((2, 2)))
    cnn_model.add(layers.Conv2D(64, (3, 3), activation='relu'))
    cnn_model.add(layers.MaxPooling2D((2, 2)))
    cnn_model.add(layers.Conv2D(64, (3, 3), activation='relu'))
    cnn_model.add(layers.Flatten())
    cnn_model.add(layers.Dense(64, activation="relu"))
    cnn_model.add(layers.Dropout(0.2))
    cnn_model.add(layers.Dense(100, activation="softmax"))
```

```
[ ] cnn_model.compile(
          optimizer=tf.keras.optimizers.Adam(learning_rate=0.0001),
          loss="sparse_categorical_crossentropy",
          metrics=["accuracy"]
    )
    cnn_model.summary()
```

```
Model: "sequential_1"
_________________________________________________________________
 Layer (type)                Output Shape              Param #
=================================================================
 conv2d_3 (Conv2D)           (None, 26, 26, 32)        896

 max_pooling2d_2 (MaxPooling  (None, 13, 13, 32)       0
 2D)

 conv2d_4 (Conv2D)           (None, 11, 11, 64)        18496

 max_pooling2d_3 (MaxPooling  (None, 5, 5, 64)         0
 2D)

 conv2d_5 (Conv2D)           (None, 3, 3, 64)          36928

 flatten_1 (Flatten)         (None, 576)               0

 dense_2 (Dense)             (None, 64)                36928

 dropout (Dropout)           (None, 64)                0

 dense_3 (Dense)             (None, 100)               6500

=================================================================
Total params: 99,748
Trainable params: 99,748
Non-trainable params: 0
_________________________________________________________________
```

```
[ ] cnn_model_history = cnn_model.fit(
          train_ds,
          validation_data=val_ds,
          epochs=50
    )
    print(cnn_model_history.history)
```

Train Loss	Train Acc,	Test Loss	Test Acc.
2.758	0.298	2.576	0.334

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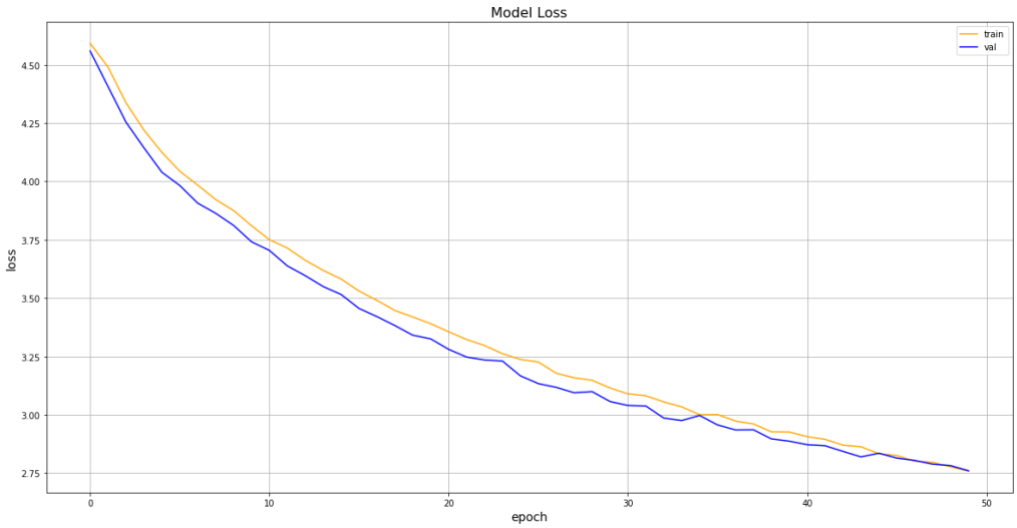
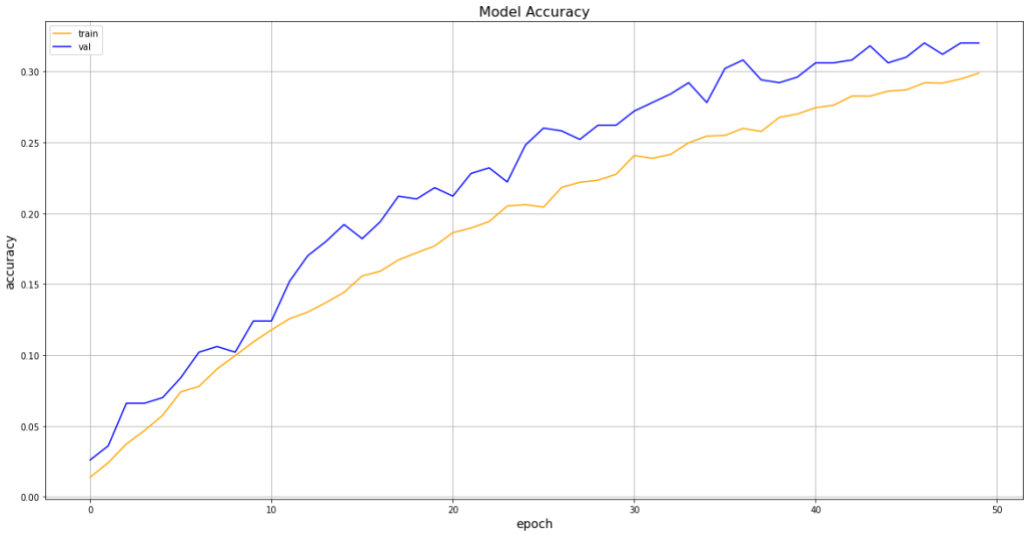
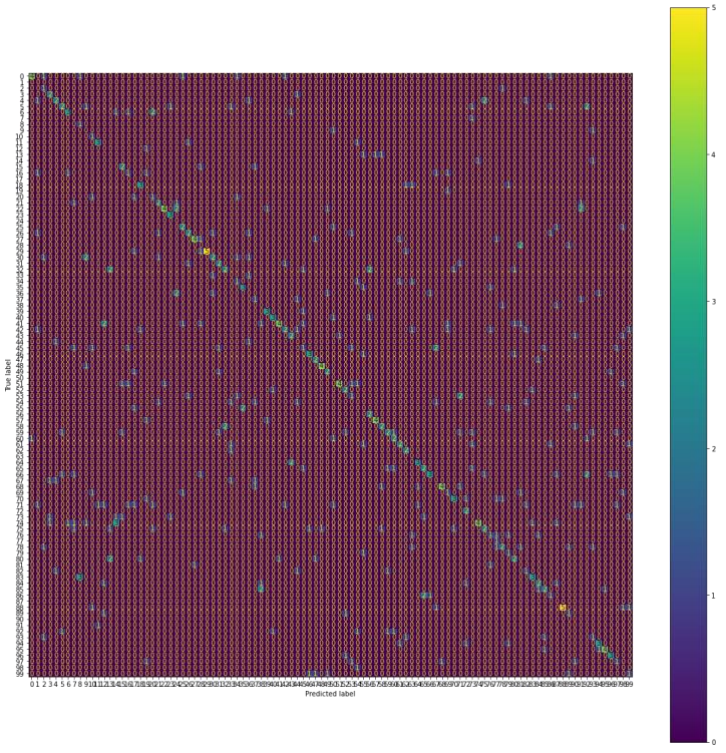
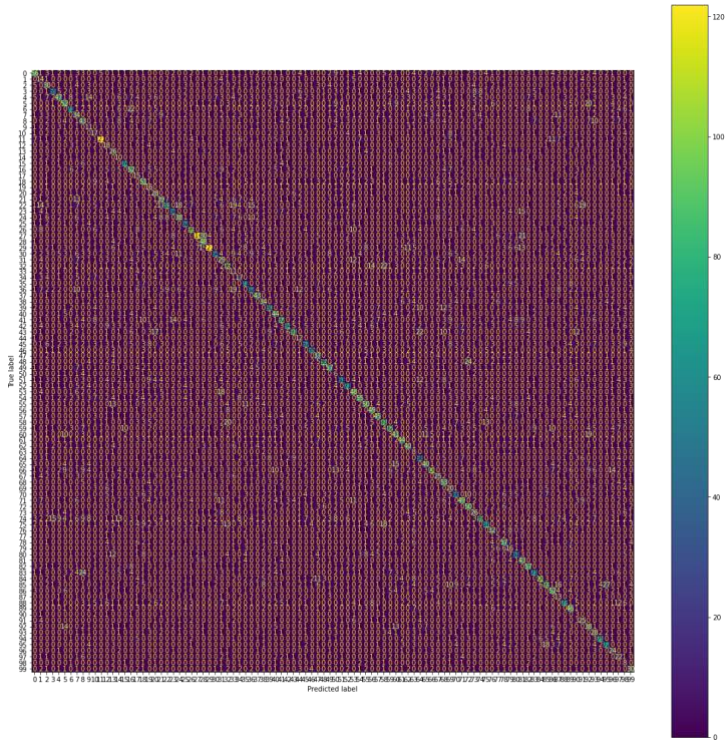

Model Loss
train
val
loss
epoch
4.50
4.25
4.00
3.75
3.50
3.25
3.00
2.75
0
10
20
30
40
50


Model Accuracy
train
val
accuracy
epoch
0.30
0.25
0.20
0.15
0.10
0.05
0.00
0
10
20
30
40
50


True label
Predicted label


True label
Predicted label

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CNN
Experiment č. 3

```
[ ] cnn_model = models.Sequential()
    cnn_model.add(layers.Conv2D(32, (3, 3), activation='relu', input_shape=(28, 28, 3)))
    cnn_model.add(layers.MaxPooling2D((2, 2)))
    cnn_model.add(layers.Conv2D(64, (3, 3), activation='relu'))
    cnn_model.add(layers.MaxPooling2D((2, 2)))
    cnn_model.add(layers.Conv2D(64, (3, 3), activation='relu'))
    cnn_model.add(layers.Flatten())
    cnn_model.add(layers.Dense(128, activation="relu"))
    cnn_model.add(layers.Dropout(0.5))
    cnn_model.add(layers.Dense(100, activation="softmax"))
```

```
[ ] cnn_model.compile(
          optimizer=tf.keras.optimizers.Adam(learning_rate=0.0001),
          loss="sparse_categorical_crossentropy",
          metrics=["accuracy"]
    )
    cnn_model.summary()
```

```
Model: "sequential_2"
_________________________________________________________________
 Layer (type)                Output Shape              Param #
=================================================================
 conv2d_6 (Conv2D)           (None, 26, 26, 32)        896

 max_pooling2d_4 (MaxPooling  (None, 13, 13, 32)       0
 2D)

 conv2d_7 (Conv2D)           (None, 11, 11, 64)        18496

 max_pooling2d_5 (MaxPooling  (None, 5, 5, 64)         0
 2D)

 conv2d_8 (Conv2D)           (None, 3, 3, 64)          36928

 flatten_2 (Flatten)         (None, 576)               0

 dense_4 (Dense)             (None, 128)               73856

 dropout_1 (Dropout)         (None, 128)               0

 dense_5 (Dense)             (None, 100)               12900

=================================================================
Total params: 143,076
Trainable params: 143,076
Non-trainable params: 0
_________________________________________________________________
```

```
[ ] cnn_model_history = cnn_model.fit(
          train_ds,
          validation_data=val_ds,
          epochs=150
    )
    print(cnn_model_history.history)
```

Train Loss	Train Acc,	Test Loss	Test Acc.
1.950	0.457	2.207	0.412

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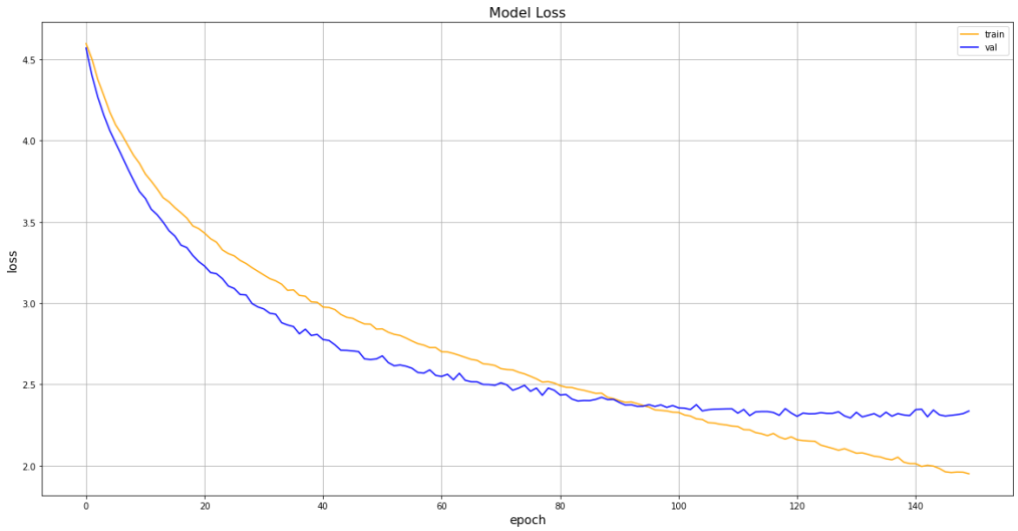
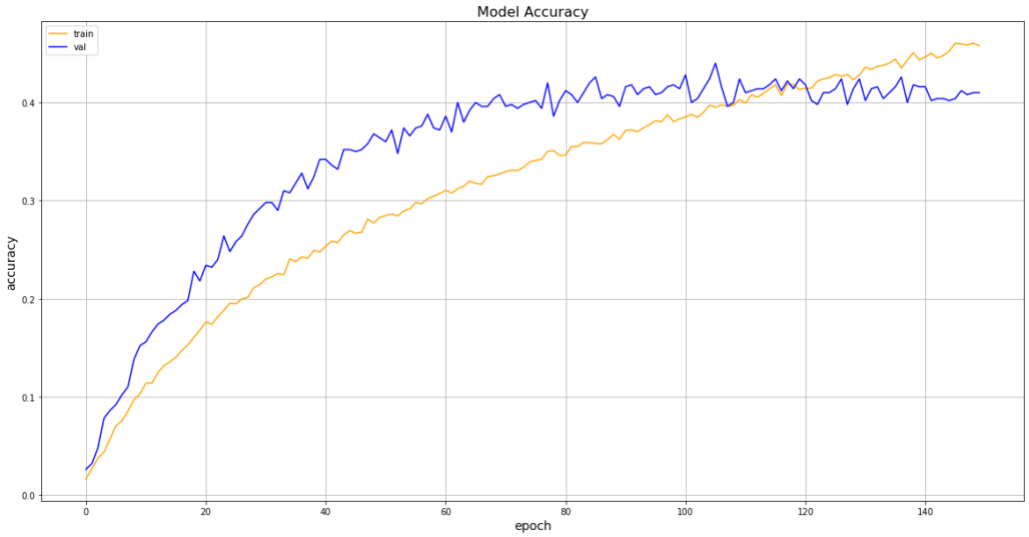
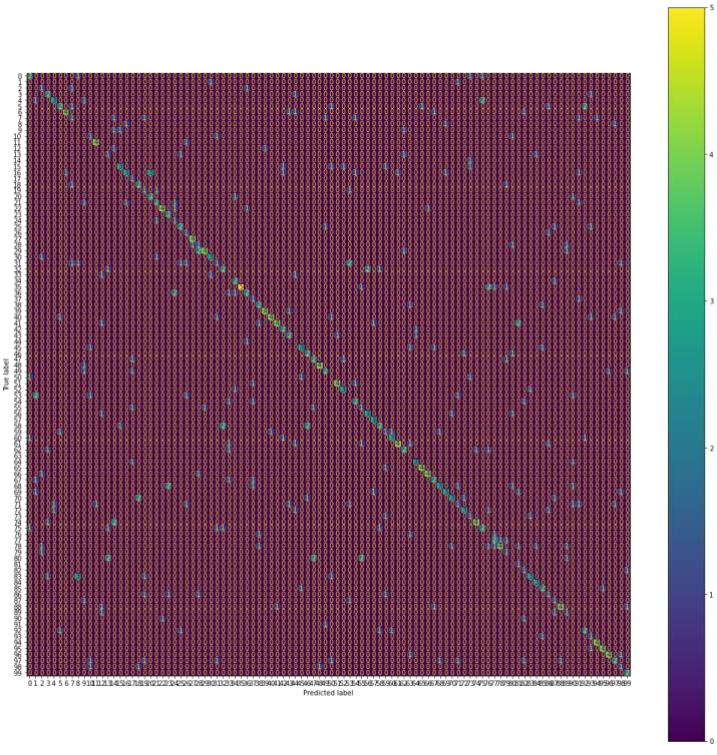
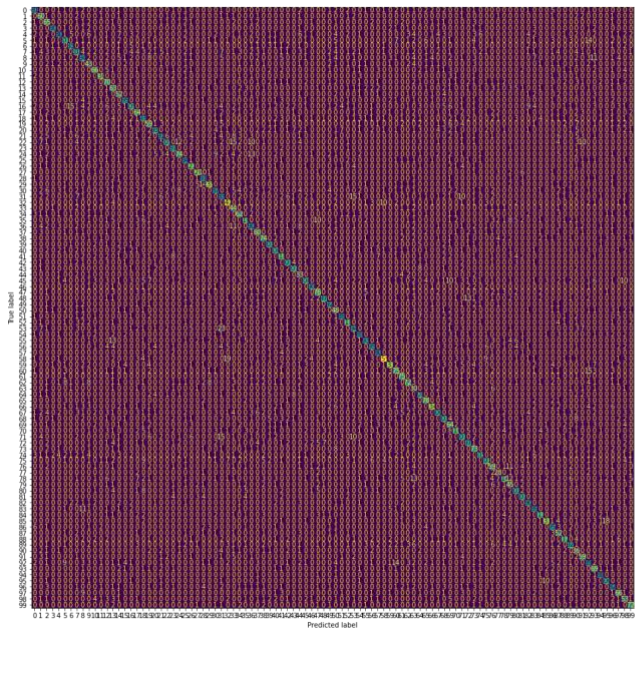

Model Loss
train
val
loss
epoch


Model Accuracy
train
val
accuracy
epoch


True label
Predicted label


True label
Predicted label

Mikuš Filip

Transfer-learning CNN (VGG19)
Experiment č. 4

```
[ ] vgg19_backbone_cnn_model = tf.keras.applications.vgg19.VGG19(
        weights='imagenet',
        include_top=False,
        input_shape = (32, 32, 3)
    )

    for layer in vgg19_backbone_cnn_model.layers:
      layer.trainable = False
```

```
Downloading data from https://storage.googleapis.com/tensorflow/keras
80134624/80134624 [==============================] - 1s 0us/step
```

```
transfer_cnn_model = models.Sequential()
transfer_cnn_model.add(vgg19_backbone_cnn_model)
transfer_cnn_model.add(layers.Flatten())
transfer_cnn_model.add(layers.Dense(128, activation="relu"))
transfer_cnn_model.add(layers.Dropout(0.2))
transfer_cnn_model.add(layers.Dense(100, activation="softmax"))
```

```
[ ] transfer_cnn_model.compile(
        optimizer=tf.keras.optimizers.Adam(learning_rate=0.001),
        loss="sparse_categorical_crossentropy",
        metrics=["accuracy"]
    )
    transfer_cnn_model.summary()
```

```
Model: "sequential_1"
_________________________________________________________________
 Layer (type)                Output Shape              Param #
=================================================================
 vgg19 (Functional)          (None, 1, 1, 512)         20024384

 flatten_1 (Flatten)         (None, 512)               0

 dense_2 (Dense)             (None, 128)               65664

 dropout_1 (Dropout)         (None, 128)               0

 dense_3 (Dense)             (None, 100)               12900

=================================================================
Total params: 20,102,948
Trainable params: 78,564
Non-trainable params: 20,024,384
_________________________________________________________________
```

```
[ ] transfer_cnn_model_history = transfer_cnn_model.fit(
        trans_train_ds,
        validation_data=trans_val_ds,
        epochs=50
    )
    print(transfer_cnn_model_history.history)
```

Train Loss	Train Acc,	Test Loss	Test Acc.
1.560	0.555	2.589	0.396

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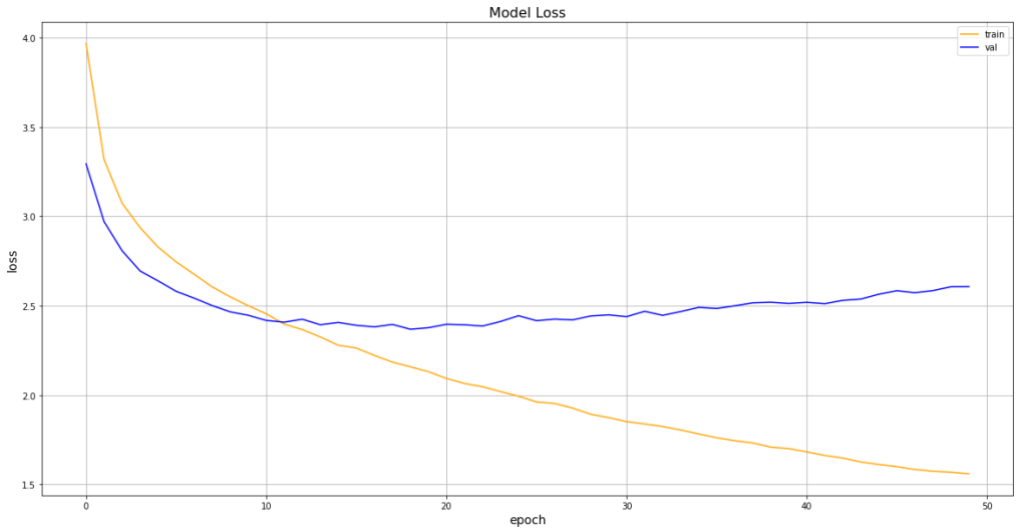
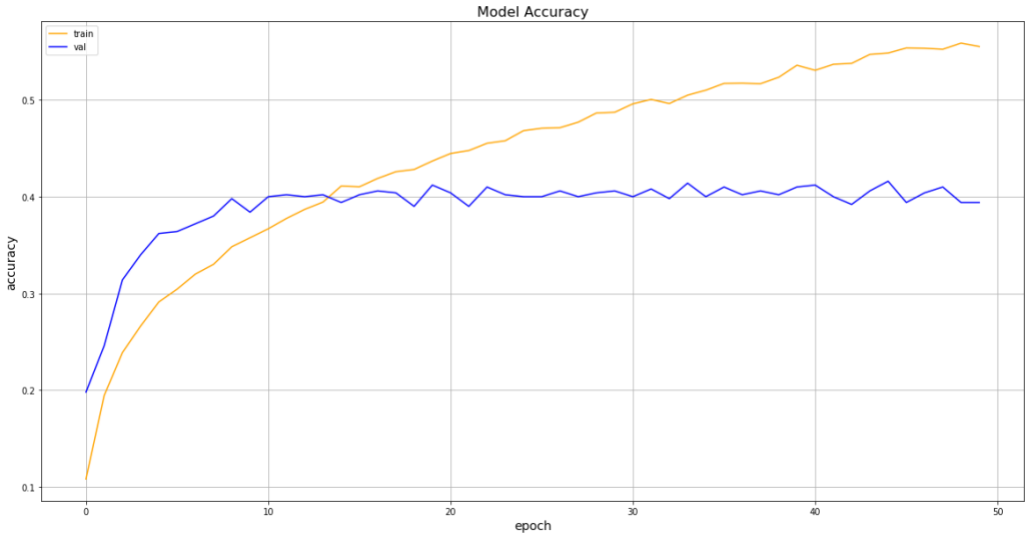
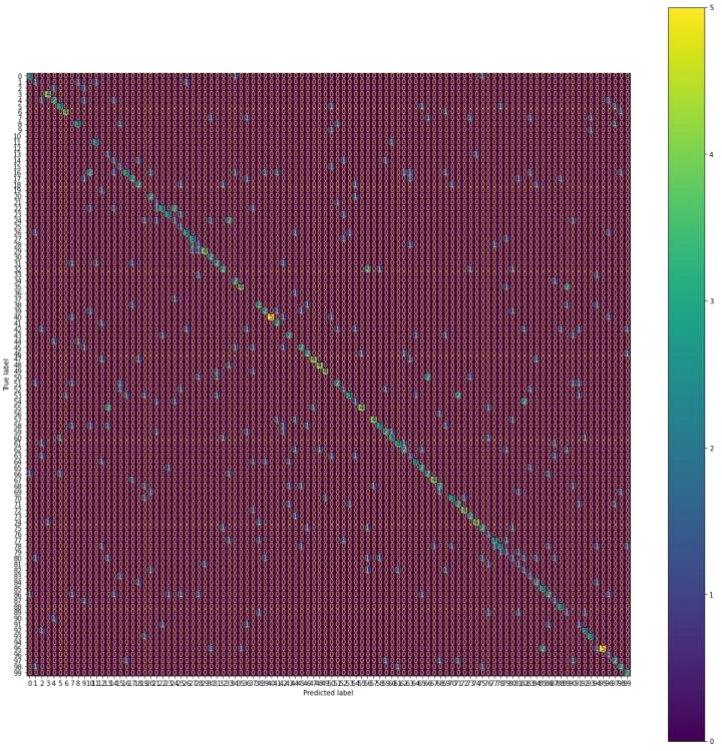
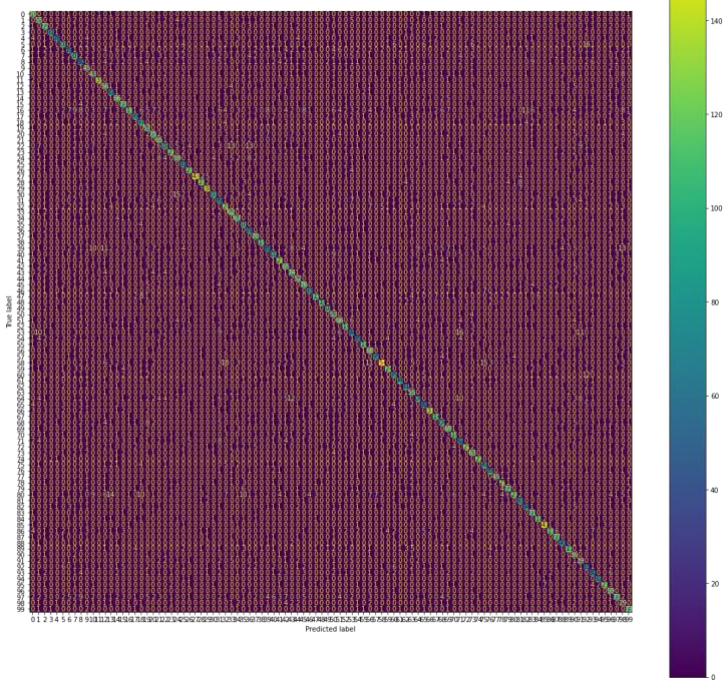

Model Loss
train
val
loss
epoch
4.0
3.5
3.0
2.5
2.0
1.5
0
10
20
30
40
50


Model Accuracy
train
val
accuracy
epoch
0.5
0.4
0.3
0.2
0.1
0
10
20
30
40
50


True label
Predicted label


True label
Predicted label

Mikuš Filip

Transfer-learning CNN (VGG19)
Experiment č. 5

```
transfer_cnn_model = models.Sequential()
transfer_cnn_model.add(vgg19_backbone_cnn_model)
transfer_cnn_model.add(layers.Flatten())
transfer_cnn_model.add(layers.Dense(128, activation="relu"))
transfer_cnn_model.add(layers.Dropout(0.5))
transfer_cnn_model.add(layers.Dense(100, activation="softmax"))
```

```
transfer_cnn_model.compile(
      optimizer=tf.keras.optimizers.Adam(learning_rate=0.001),
      loss="sparse_categorical_crossentropy",
      metrics=["accuracy"]
)
transfer_cnn_model.summary()
```

```
Model: "sequential"
_________________________________________________________________
 Layer (type)                Output Shape              Param #
=================================================================
 vgg19 (Functional)          (None, 1, 1, 512)         20024384

 flatten (Flatten)           (None, 512)               0

 dense (Dense)               (None, 128)               65664

 dropout (Dropout)           (None, 128)               0

 dense_1 (Dense)             (None, 100)               12900

=================================================================
Total params: 20,102,948
Trainable params: 78,564
Non-trainable params: 20,024,384
_________________________________________________________________
```

```
transfer_cnn_model_history = transfer_cnn_model.fit(
      trans_train_ds,
      validation_data=trans_val_ds,
      epochs=10
)
print(transfer_cnn_model_history.history)
```

Train Loss	Train Acc,	Test Loss	Test Acc.
2.892	0.267	2.556	0.360

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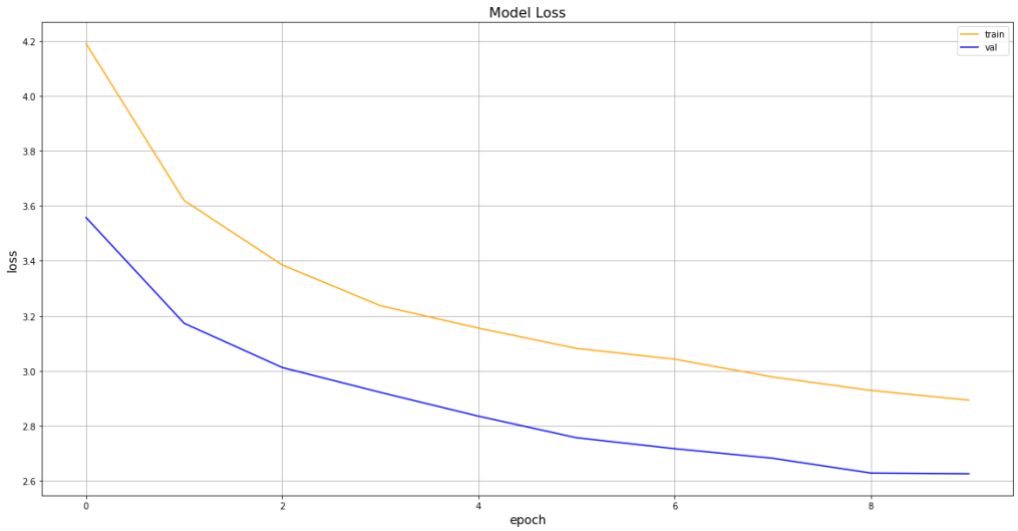
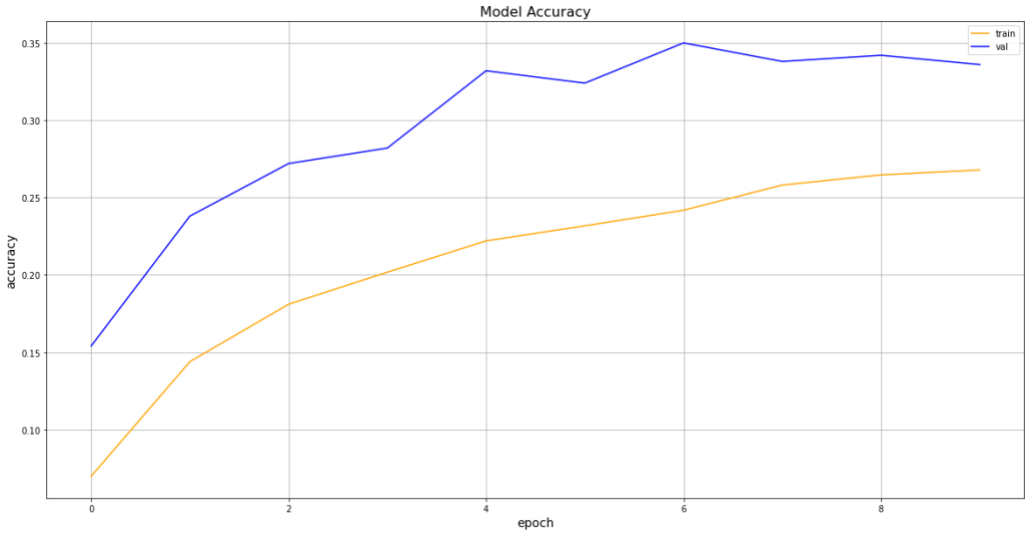
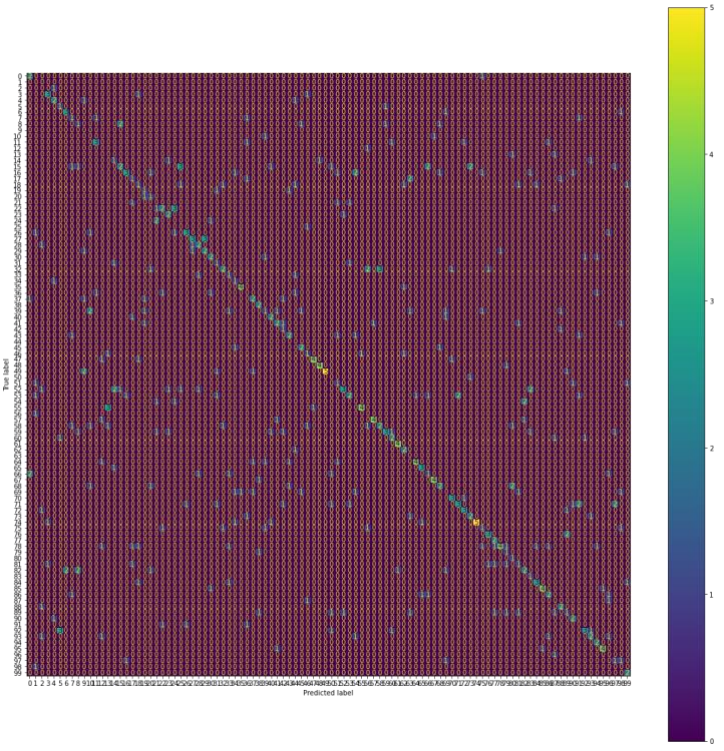
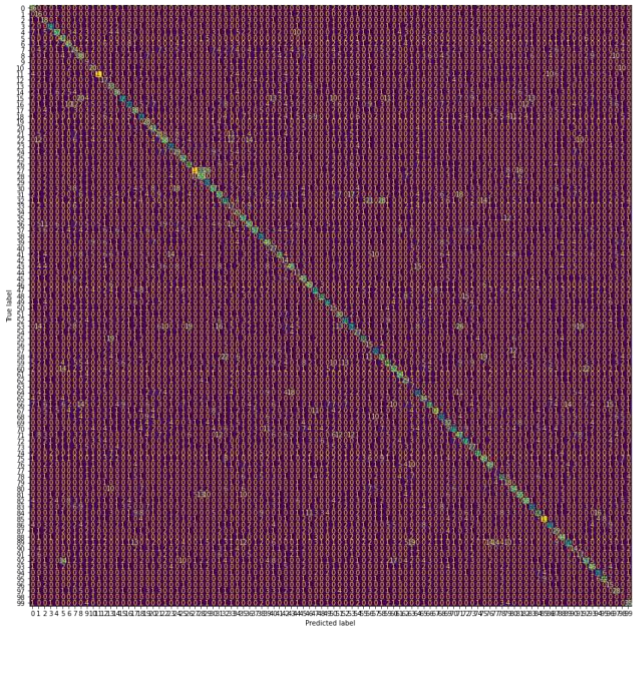

Model Loss
train
val
loss
epoch


Model Accuracy
train
val
accuracy
epoch


True label
Predicted label


True label
Predicted label

Mikuš Filip

Bonus

Zobrazenie filtrov z konvolučných vrstiev

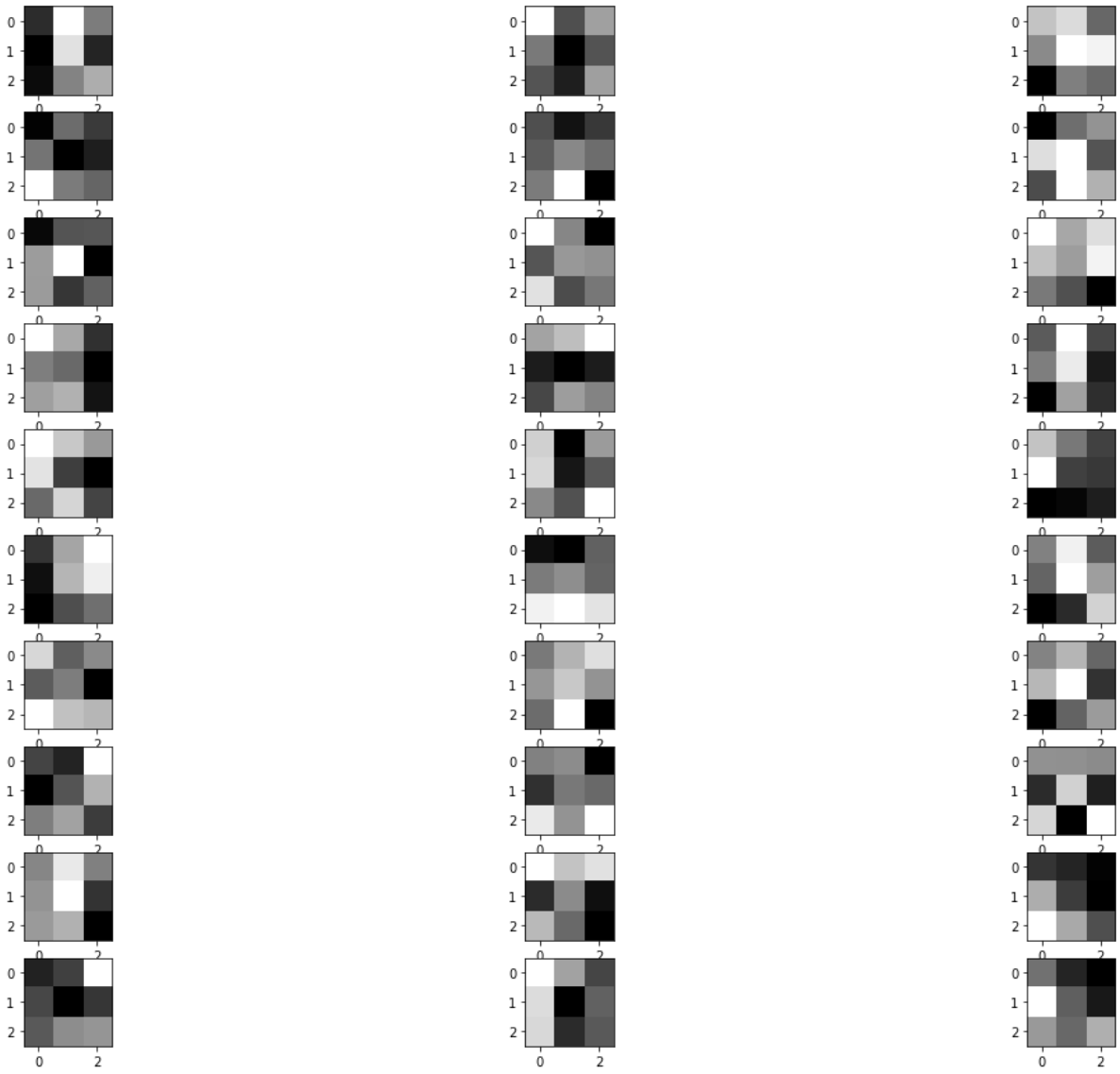
```
cnn_model = models.Sequential()
cnn_model.add(layers.Conv2D(32, (3, 3), activation='relu', input_shape=(28, 28, 3)))
cnn_model.add(layers.MaxPooling2D((2, 2)))
cnn_model.add(layers.Conv2D(64, (3, 3), activation='relu'))
cnn_model.add(layers.MaxPooling2D((2, 2)))
cnn_model.add(layers.Conv2D(64, (3, 3), activation='relu'))
cnn_model.add(layers.Flatten())
cnn_model.add(layers.Dense(256, activation="relu"))
cnn_model.add(layers.Dropout(0.5))
cnn_model.add(layers.Dense(100, activation="softmax"))
```

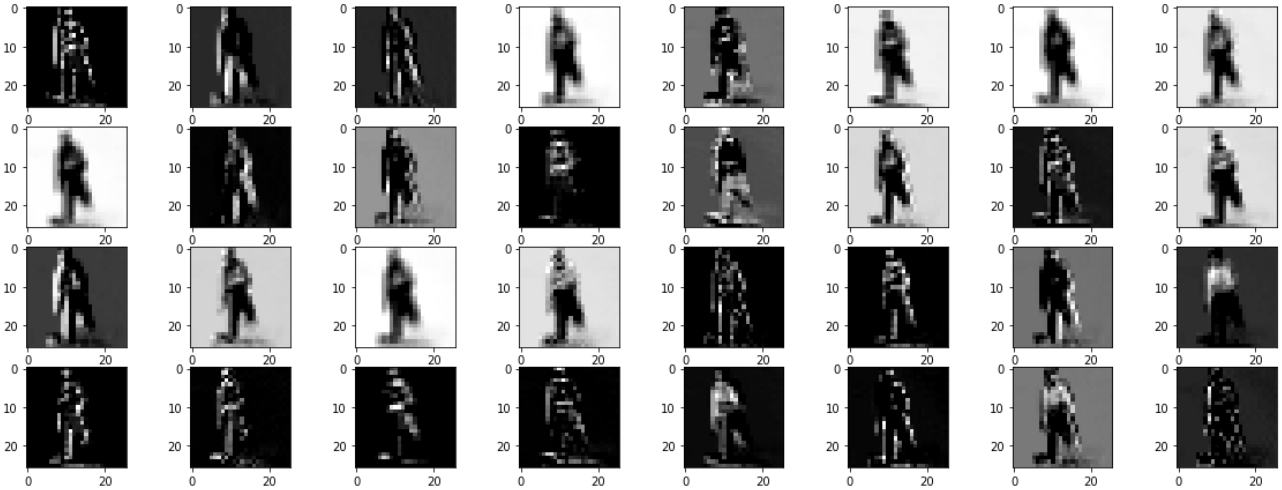
```
cnn_model.compile(
      optimizer=tf.keras.optimizers.Adam(learning_rate=0.0001),
      loss="sparse_categorical_crossentropy",
      metrics=["accuracy"]
)
cnn_model.summary()
```

```
Model: "sequential"
_________________________________________________________________
 Layer (type)                Output Shape              Param #
=================================================================
 conv2d (Conv2D)             (None, 26, 26, 32)        896

 max_pooling2d (MaxPooling2D  (None, 13, 13, 32)       0
 )

 conv2d_1 (Conv2D)           (None, 11, 11, 64)        18496

 max_pooling2d_1 (MaxPooling  (None, 5, 5, 64)         0
 2D)

 conv2d_2 (Conv2D)           (None, 3, 3, 64)          36928

 flatten (Flatten)           (None, 576)               0

 dense (Dense)               (None, 256)               147712

 dropout (Dropout)           (None, 256)               0

 dense_1 (Dense)             (None, 100)               25700

=================================================================
Total params: 229,732
Trainable params: 229,732
Non-trainable params: 0
_________________________________________________________________
```

```
cnn_model_history = cnn_model.fit(
      train_ds,
      validation_data=val_ds,
      epochs=100
)
print(cnn_model_history.history)
```

Mikuš Filip





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