In order to fine-tune the model, the learning rate of the model was set to 0.001. The model was trained for 10 epochs and the overall accuracy of the model was 77%. This is because since the ResNet50 model was already pre-trained and the weights of the model are good, we want to avoid causing too many changes to the weights of the model when fine-tuning. Instead, we would like to focus on improving the weights of the final linear classifier. Hence, all layers except the new final fully connected linear layer are kept frozen. This is to prevent overfitting while training the model. Since the new dataset is smaller than the original dataset, it is not a good idea to fine-tune all the layers in ConvNet as it may overfit the smaller data. Below shows the performance of fine-tuned model. The higher level features of the new images have some similarity to the one used to train the original ResNet50 but the classes are not the same.

	precision	recall	f1-score	support
Alilaguna	0.48	0.58	0.52	19
Ambulanza	0.38	0.41	0.39	22
Barchino	0.14	0.06	0.08	51
Gondola	0.00	0.00	0.00	3
Lanciafino10m	0.00	0.00	0.00	7
Motobarca	0.20	0.08	0.12	59
Motopontonerettangolare	0.60	1.00	0.75	3
MotoscafoACTV	0.00	0.00	0.00	1
Mototopo	0.69	0.85	0.76	274
Patanella	0.34	0.50	0.40	74
Polizia	0.12	0.07	0.09	15
Raccoltarifiuti	0.43	0.68	0.53	19
Sandoloaremi	0.00	0.00	0.00	3
Topa	0.11	0.07	0.08	29
VaporettoACTV	0.99	0.98	0.99	325
Water	0.97	0.91	0.94	420
accuracy			0.77	1324
macro avg	0.34	0.39	0.35	1324
weighted avg	0.75	0.77	0.75	1324

Feature vectors are extracted from the ResNet50 model Then, a Support Vector Machine (SVM) classifier was trained on the features and corresponding labels. The performance of the SVM classifier is as below.

	precision	recall	f1-score	support
Alilaguna	0.90	1.00	0.95	19
Ambulanza	0.82	0.82	0.82	22
Barchino	0.76	0.25	0.38	51
Gondola	1.00	0.67	0.80	3
Lanciafino10m	0.00	0.00	0.00	7
Motobarca	0.82	0.31	0.44	59
Motopontonerettangolare	1.00	1.00	1.00	3
MotoscafoACTV	0.00	0.00	0.00	1
Mototopo	0.82	0.99	0.89	274
Patanella	0.41	0.84	0.55	74
Polizia	0.67	0.13	0.22	15
Raccoltarifiuti	1.00	0.74	0.85	19
Sandoloaremi	0.00	0.00	0.00	3
Topa	0.00	0.00	0.00	29
VaporettoACTV	0.99	1.00	1.00	325
Water	0.99	0.97	0.98	420
accuracy			0.87	1324
macro avg	0.64	0.54	0.56	1324
weighted avg	0.87	0.87	0.85	1324

When comparing the overall performance, the SVM model has higher overall accuracy (87%) compared to the fine-tuned ResNet50 (77%). The precision and recall for majority of the boat classes are higher when classified using the SVM model compared to the fine-tuned ResNet50. Hence, the SVM worked better when distinguishing between different classes of boats compared to fine-tuned ResNet50. This may be because the amount of data available is small and is not available to train and fine-tune a ResNet50 model. However, in using simple SVM classifier, the features from ResNet50 model can be used and these features already clearly distinguish between features of different boats. The SVM model used on these features hence produces higher accuracy. It was faster to train the SVM classifier than the fine-tuned ResNet50 as the SVM classifier is a simpler classifier model.