T.C.

YALOVA ÜNİVERSİTESİ

MÜHENDİSLİK FAKÜLTESİ

BİLGİSAYAR MÜHENDİSLİĞİ

BÖLÜMÜ

YAPAY SİNİR AĞLARI PROJE DOKÜMANI

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MELANOM SINIFLANDIRMASI SİNİR AĞI MODELLESİ

1. YAPAY SİNİR AĞLARI NEDİR?

Yapay Sinir Ağları, modern makine öğreniminin merkezinde yer alır. Görüntü ve video tanıma, konuşma tanıma ve üretken rakip ağ sorunları dahil olmak üzere dünyadaki en zorlu makine öğrenimi sorunlarından bazılarını çözmede başarıyla kullanılmıştır. Üstün performanslarına rağmen, sinir ağlarının birkaç dezavantajı vardır:

- Genellikle iyi performans göstermeleri için çok fazla veriye ihtiyaç duyarlar.
- Kara kutu modelleridir ve sonuçlarını açıklamak neredeyse imkansızdır.
- YSA'ların arkasındaki matematik karmaşıktır ve birçok insan için anlaşılması kolay değildir.
- "Yanlış" problem turu için aşırı uyum sağlayabilirler.
- Eğitim sinir ağları bu sözde kaybolan gradyan fenomeni nedeniyle matematiksel olarak zorlayıcı hale gelebilir.
- Sinir ağlarında ince ayar yapılması gereken çok sayıda hiperparametre vardır.
- Yapay sinir ağlarında ince ayar yapmak herkesin bildiği gibi çok zordur.

Öte yandan,

- Çok fazla veriniz varsa,
- Verileriniz, daha geleneksel makine öğrenimi yöntemleriyle tanınması zor olan küçük nüanslar içeriyorsa,
- Birçok sayısal özelliğiniz varsa,
- Hedef özelliğiniz sayısalsa tercih edilen bir araç olabilir.

1.1.Aşırı Öğrenme ve Az Öğrenme

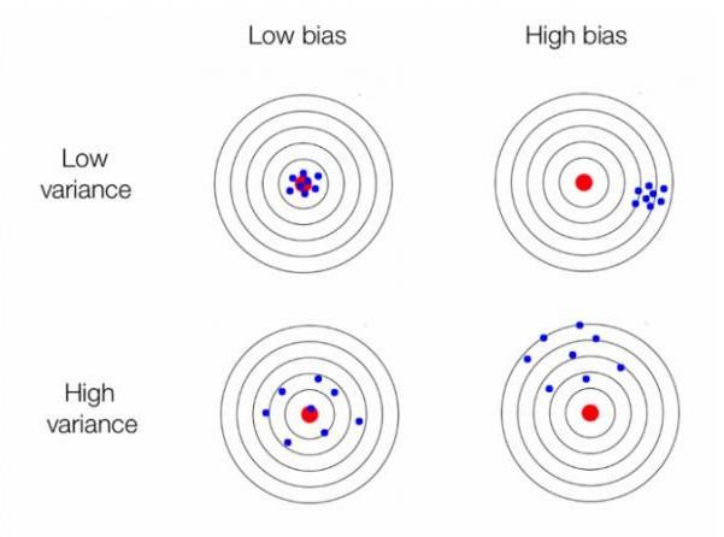
Modellerimizi eğitirken verilerimizi eğitim ve test kümeleri olacak şekilde ikiye ayırıyoruz. Aşırı öğrenme durumunda modelimiz eğitim kümesinde çok iyi bir performans verirken, test kümesinde daha başarısız bir performans gösterir. Eğitim kümesinden elde ettiği bilgileri genelleyemez ve bunun sonucunda test kümesinde daha başarısız bir performans gösterir. Az öğrenme durumunda ise modelimiz hem eğitim hem de test verilerinde başarısız bir performans gösterir.

1.2. Momentum Katsayısı

Çok katmanlı yapılara sahip yapay sinir ağlarında momentum katsayısı vardır. Ağların yerel sonuçlara takılmaması için momentum katsayısı kullanılır. Bu katsayı ile kabul edilebilir hata düzeyi alta çekilebilir fakat bilgisayar gücü bu konuda önemlidir. Çok katmanlı bir yapıda öğrenme oranı ile momentum ciddi işlem suresini uzatabilir. Momentum değeri, yerel çözümlere takılmayı engellerken sayısının küçük ya da büyük seçilmesine dikkat edilmelidir. Ayrıca bir önceki iterasyon değişiminin belirli bir oranının yeni değişim miktarını etkilemesidir.

1.3.Varyans-Bias Çelişkisi

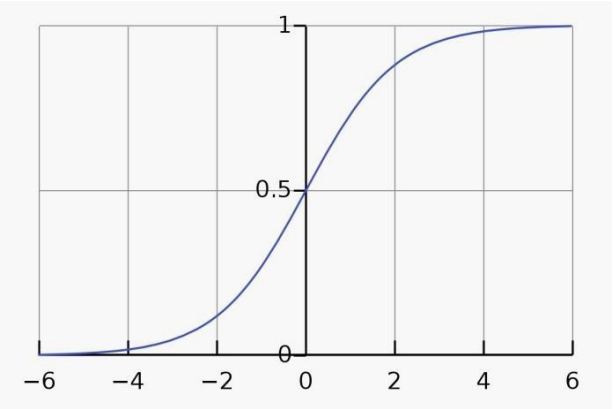
Varyans, gerçek değerden tahmin edilen değerin ne kadar dağınık olduğunu gösterir. Bias ise gerçek değerlerden tahmin edilen değerlerin ne kadar uzak olduğudur. Tahmin edilen değerler gerçek değerlerden uzak ise bias yüksektir. Özetle, varyans ve bias arasındaki dengeyi kurma çabasına varyans-bias çelişkisi denir.



***Resim 1.1**: Düşük/Yüksek Varyansa göre Düşük/Yüksek Bias Dengesi*

1.4. Aktivasyon Fonksiyonu

Eğittiğimiz yapay sinir ağı modeline gerçek dünya verilerini, yani karmaşık verileri öğretebilmek için kullandığımız fonksiyonlardır. Aktivasyon fonksiyonu olmayan bir yapay sinir ağı, verilerdeki kompleks yapıları öğrenip tespit etmekte çok zorlanacak çoğu zaman da yetersiz kalacaktır.



Resim 1.2: *Sigmoid Fonksiyonu*

2. PROJE İÇERİĞİ

2.1.Amaç

Projemde yapay sinir ağını kullanarak modellimizi eğitmeye çalıştım. Bu süreçte "Skin Lesion Images for Melanoma Classification" veri setini kullandım. Çalışmanın amacı ciltte çıkan lezyon görsellerini kullanarak melanom sınıflandırması yaparak hastalık türünü tahmin etmektir.

2.2. Kullandığımız Paketler

Şu anda çok popüler olan Google'ın yazılım kütüphanesi olan Tensorflow'u ve Python kütüphanesi olan Keras arayüzünü tercih ettim. Geliştirme ortamı olarak da Google Colab kullandım.

TensorFlow, derin öğrenme için geliştirilmiş açık kaynaklı bir matematik kütüphanesidir. Geleneksel makine öğrenme algoritmalarını da desteklemektedir ve öncelikle Google Brain ekibi tarafından dahili Google kullanımı için geliştirilmiştir.

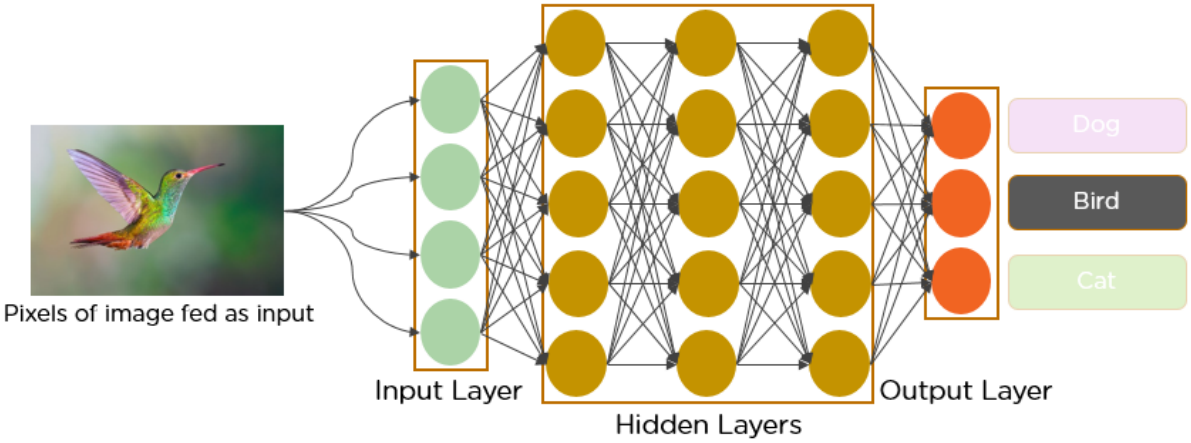
Keras da bir derin öğrenme kütüphanesidir ve TensorFlow üzerinde çalışır. Python aracılığı ile yazılmış ve neredeyse her tür deeplearning modelini tanımlamayan bir kütüphanedir. Yalnızca TensorFlow değil diğer Theano ve CNTK üzerinde çalışabilen bir üst düzey sinir ahları API'sidir.

2.3. Modelleme

ISIC_2019_Training_GroundTruth.csv dosyasını Kaggle kullanarak indirdim, Drive tercih ederek oraya yükledim. Veri setimde 25316 satır bulunmaktadır. Aynı zamanda ISIC_2019_Training_Input dosyamda ise 25.333 görsel bulunmaktadır. Örneklenen verileri %80 eğitim seti ve kalan %20 doğrulama seti olarak böldüm.

2.4. Ağ Parametrelerini Tanımlama

Ödevim için 20 adet gizli katman kullandım. Buna YSA'nın topolojisi denir.



Resim: Convolutional Neural Network (CNN) görseli.

Ödevimde Convolutional Neural Network (CNN) kullandım. CCN genellikle görüntü sınıflandırma görevleri için kullanılır. CNN'ler görüntü sınıflandırma için oldukça efektiftir.

CNN'ler, özellikle görüntü verilerinde, her bir Convolutional Layer'ın filtreleri sayesinde belirli özellikleri çıkarabilir. İlk katmanlar genellikle kenarlar ve renk değişiklikleri gibi düşük seviyeli özellikleri öğrenirken, daha derin katmanlar kompleks özellikleri öğrenir. Bu, modelin veri içerisinde hiyerarşik bir temsil oluşturmasına olanak tanır.

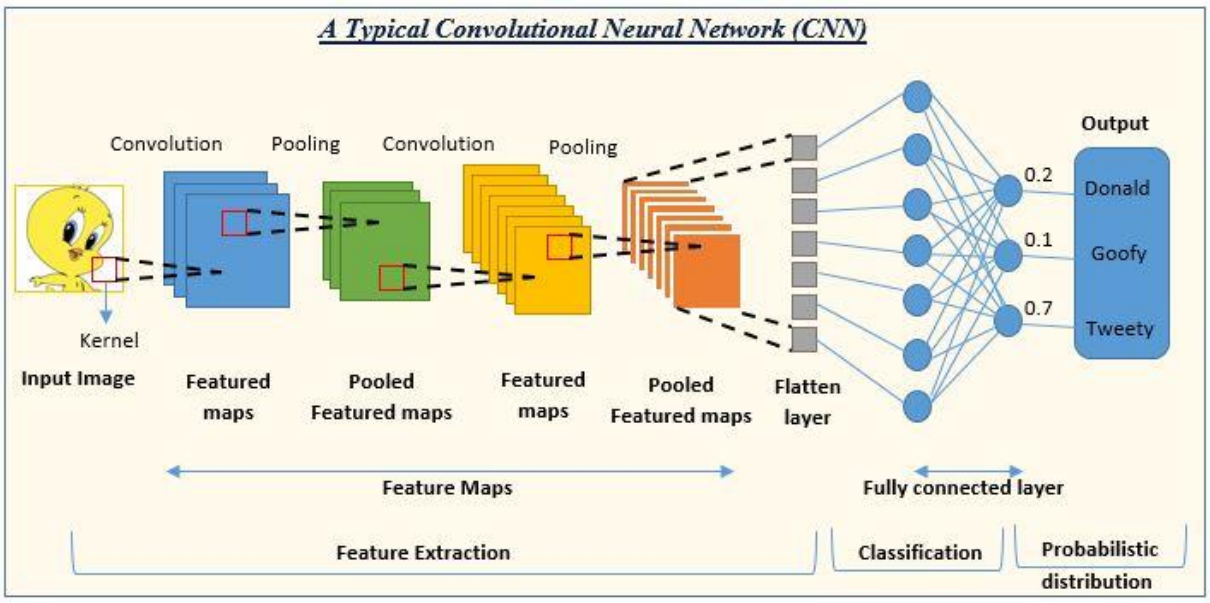
MaxPooling Layer'lar, boyut azaltma işlemi gerçekleştirerek özellik haritalarını küçültür. Bu, modelin daha yüksek seviyeli özellikleri öğrenmesine ve daha etkili bir şekilde genelleme yapmasına yardımcı olur.

Dropout ve BatchNormalization katmanları, aşırı uyumu azaltmaya yardımcı olabilir. Dropout, eğitim sırasında rastgele nöronları devre dışı bırakarak aşırı uyumu azaltır. BatchNormalization, eğitim sürecini daha istikrarlı hale getirir ve aşırı uyumu azaltır.

Flatten katmanı ve ardından gelen tam bağlantılı (dense) çıkış katmanı, CNN tarafından öğrenilen özelliklerden çıkartılan bilgileri kullanarak sınıflandırma yapabilir. Bu örnekte, ikili sınıflandırma yapılıyor, bu nedenle çıkış katmanında bir sigmoid aktivasyon fonksiyonu kullanılmış.

Bu tür bir CNN modeli, özellikle görüntü sınıflandırma, nesne tanıma, yüz tanıma gibi

görevlerde başarılı sonuçlar elde etme potansiyeline sahiptir. Ayrıca, transfer öğrenme kullanılarak önceden eğitilmiş modellerin feyz alınmasıyla performans daha da artırılabilir.



Resim: Convolutional Neural Network (CNN) modellemesi.

Gizli katmanlara ek olarak, bir giriş katmanı ve bir çıktı katmanı olarak iki katmana daha ihtiyacımız var. Gizli katmanlardaki nöronlar doğrusal olmayan fonksiyonlardır. Bu işlevler aracılığıyla, çıktıya, giriş özelliklerinin oldukça doğrusal olmayan bir işlevi olarak yaklaşırız. Nöron sayısı ve/veya gizli katman sayısı ne kadar yüksekse, giriş özellikleri ile hedef özellik arasındaki ilişkinin doğrusal olmama durumu da o kadar yüksek olur.

Gizli katmanlar için **relu** aktivasyon fonksiyonunu kullandım. Her gizli katmandan sonra, bazı durumlarda fazla takma olasılığını azalttığı gösterilen bir çıktı katmanı ekleyebiliriz. Bu çıktı katmanları için, çıktı oranını belirtmemiz gerekmektedir.
Çıkış katmanı için probleminiz ikili sınıflandırmadır ve böylece çıkışı her zaman 0 ile 1 arasında olan bir **sigmoid** aktivasyon fonksiyonu kullanacağız.

→ Eğitim süreci için şunları belirtmemiz gerekmektedir:

Epoch Sayısı: Model eğitilirken verilerin tamamı aynı anda eğitime katılmaz. Model eğitilirken veri seti, belirli sayıda parçalara bölünür ve bu parçalar sırayla modele sunularak eğitim yapılır. İlk parça eğitilir, modelin başarımı test edilir, başarıma göre geriye yayılım ile ağırlıklar güncellenir. Daha sonra yeni eğitim kümesi ile model tekrar eğitilip ahırlıklar tekrar güncellenir. Bu işlem her bir eğitim adımında tekrarlanarak model için en uygun ağırlık değerleri hesaplanmaya çalışılır. Bu eğitim adımlarının her birine "epoch" denilmektedir.

```
epochs = 10  # Örneğin, 10 epoch boyunca modeli eğit
model.fit(X_train, y_train, epochs=epochs, batch_size=batch_size)
```

Yığın Boyutu (Batch Size): Veri seti, küçük parçalara bölünerek modele sunulur. Yığın boyutu, her bir eğitim iterasyonunda kullanılacak olan örnek sayısını belirtir. Küçük yığınlar kullanmak, bellek verimliliğini artırabilir ve eğitim sürecini hızlandırabilir.

```
batch_size = 32  # Örneğin, her iterasyonda 32 örneklik yığınlar kullan
model.fit(X_train, y_train, epochs=epochs, batch_size=batch_size)
```

Ağı eğitmek için belirtilmesi gereken önemli parametre ve bileşenler şunlardır:

Veri seti
Model mimarisi: modelin katmanları, aktivasyon fonksiyonları, düğüm (nöron) sayıları ve bağlantılarını belirten bir model mimarisi.
Loss function
Optimizasyon algoritması ve metrikleri
Batch size (yığın boyutu)
Epoch sayısı

3. PROJE ADIMLARI

ADIM 1

Kaggle üzerinden Skin Lesion Images for Melanoma Classification için ISIC_2019_Training_GroundTruth.cvs veri setini daha kolay bir erişim için Drive'a yükledim.

Veri seti, '/content/drive/MyDrive/yapaysinir/ISIC_2019_Training_GroundTruth.csv' dosyasından okundu. Veri setimizin %80'lik kısmını modelimizin eğitilmesi için kullandım. Geri kalan %20'luk kısmını ise doğrulama için kullandım.

Kontrol için dosyanın ilk 10 satırı ekrana bastırıldı. 'image' sütunundaki değerlere '.jpg' eklenerek yeni bir 'file' sütunu oluşturulmasını sağladım. Veri seti etiketleme amacıyla 'label' sütunu eklenerek oluşturulan 'filesWithLabels' DataFrame'ine eklendi. Sınıflar belirlendi ve etiketler 'label' sütununa atanarak 'filesWithLabels' güncellendi.

ADIM 2

Yapay sinir ağı modeli için gerekli olan parametreler belirlendi: epochs, input_shape, num_classes. Sonrasında get_model() fonksiyonu tanımladım. Çözeceğimiz problem binary classification problemi olduğundan ötürü loss'a paramatre olarak binary_crossentropy değerini veriyoruz. Epoch, batch size, her bir katman için aktivasyon ve dropout değeri veriyoruz son olarak da optimizer'ı Adam olarak seçip yine aynı şekilde learning rate kısmında değişiklik yapıyoruz.

ADIM 3

Veri seti dosya yolları güncellenerek eksik veriler eklenmiş oldu. 'get_files()' fonksiyonuyla dosya listesi alındı ve 'skin' DataFrame'ine eklendi. 'filesWithLabels' DataFrame'ine 'skin' DataFrame'i eklenerek eksik veriler dolduruldu. Sınıflara göre tablolar oluşturdum ve 'tables' sözlüğüne ekledim. 'conver_models()' fonksiyonuyla modeller TensorFlow Lite formatına çevrildi. 'create_model()' fonksiyonuyla model eğitimi yapıldı ve grafikle görselleştirildi.

ADIM 4

Tanımlanan get_model() fonksiyonunu kullanarak bir model oluşturdum ve bu modelin özetini (summary) görüntüledim. Özet, modelin topolojisini ve parametre sayılarını görsel bir şekilde sunar, bu sayede modelin genel yapısı hakkında bilgi edinilebilir. Bu özet, her katmandaki giriş boyutları, çıkış boyutları, kullanılan parametre sayıları ve toplam parametre sayısı gibi detayları içerir.

4. MODELLERİN KARŞILAŞTIRILMASI

Burada modelimizi eğitirken kullandığımız değişkenleri ve parametreleri birkaç kere deneyip en iyi sonuç veren senaryoyu bulmaya çalıştım. Örnek olması için burada 2 denememizin sonuçlarını görsellerini ekledim.

4.1. Model 1

4.1.1. Parametrelerin değiştirilmesi

```
#learning_rate tanımladığım kısım. (değişkenim) Mevcut optimizerlardan Adam'ı seçtim.
# eğitim boyunce accurarcy mnitorluyoruz

 model.compile(optimizer=tf.keras.optimizers.Adam(learning_rate=0.001),
           loss='binary_crossentropy',
           metrics=['accuracy'])
```

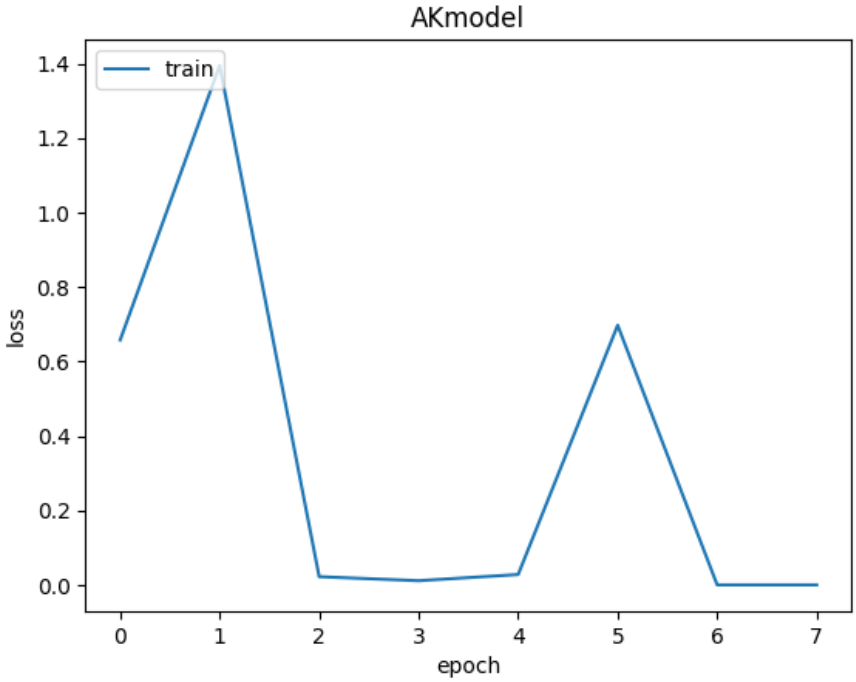
```
# Eğitim döngüsü sayısı, giriş verisinin şekli ve sınıf sayısı

epochs = 8
input_shape = (128, 128, 3)
num_classes = 1
```

```
# Eğitmek için görselleri ekledim.
train_generator = datagen.flow_from_dataframe(
    dataframe=table,
    directory=None,
    x_col='file',
    y_col='label',
    subset="training",
    batch_size=64,
    seed=42,
    shuffle=True,
    class_mode="binary",
    target_size=(128, 128))

# doğrulama (validation) görselleri ekledim.

validation_generator = datagen.flow_from_dataframe(
    dataframe=table,
    directory=None,
    x_col='file',
    y_col='label',
    subset="validation",
    batch_size=64,
    seed=42,
    shuffle=True,
    class_mode="binary",
    target_size=(128, 128))
```

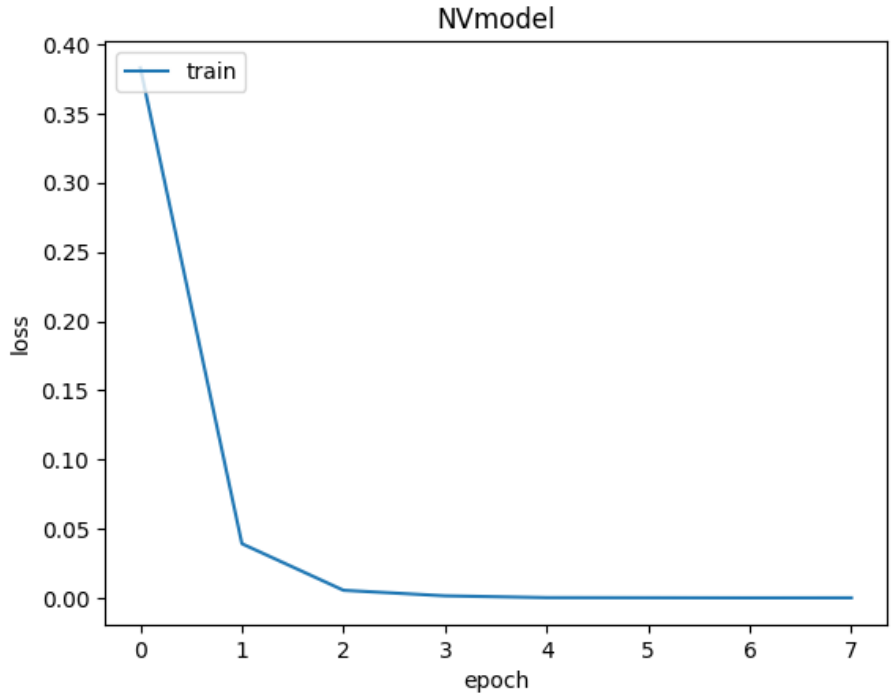
```python
#layerlar arası uyumu indirgemek için dropout değişkenini kullanıldım.

model.add(MaxPooling2D(pool_size=(2, 2)))
model.add(BatchNormalization())
model.add(Dropout(0.2))

model.add(Conv2D(32, kernel_size=(3, 3), activation="relu"))
model.add(MaxPooling2D(pool_size=(2, 2)))
model.add(BatchNormalization())
model.add(Dropout(0.2))

model.add(Conv2D(64, kernel_size=(3, 3), activation="relu"))
model.add(MaxPooling2D(pool_size=(2, 2)))
model.add(BatchNormalization())
model.add(Dropout(0.2))

model.add(Conv2D(128, kernel_size=(3, 3), activation="relu"))
model.add(MaxPooling2D(pool_size=(2, 2)))
model.add(BatchNormalization())
model.add(Dropout(0.2))

model.add(Conv2D(256, kernel_size=(3, 3), activation="relu"))
model.add(MaxPooling2D(pool_size=(2, 2)))
model.add(BatchNormalization())
model.add(Dropout(0.2))
model.add(Flatten())

# İkili sınıflandırma probleminde çıkış katmanı için sigmoid aktivasyon fonksiyonunu kullanıyoruz.

model.add(Dense(1, activation="sigmoid"))
return model
```

4.1.2. Model 1 çıktıları

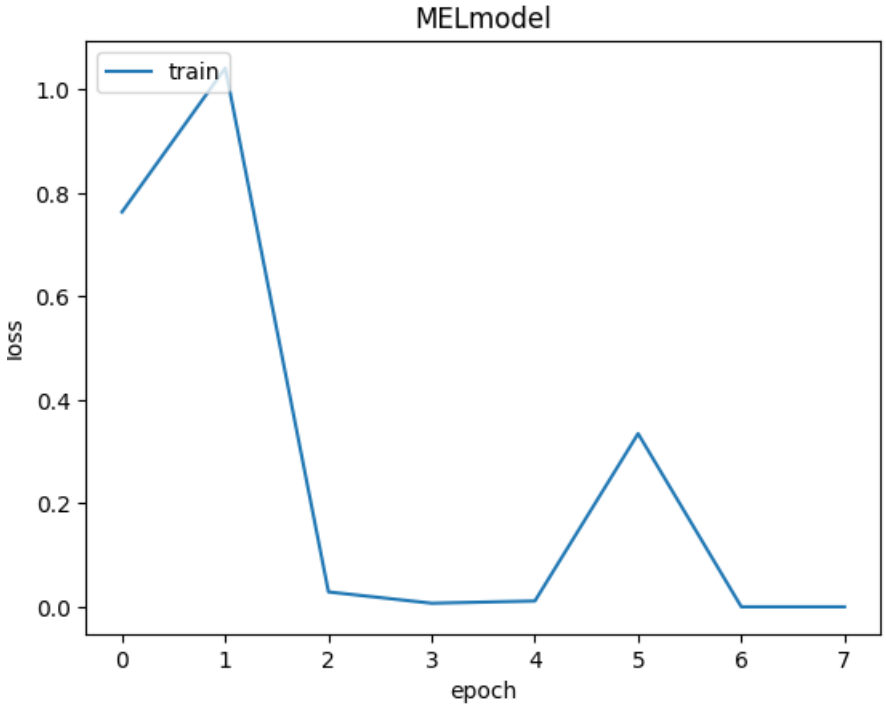
```
Found 1 validated image filenames belonging to 1 classes.
Found 0 validated image filenames belonging to 1 classes.
Epoch 1/8
1/1 [==============================] - ETA: 0s - loss: 0.6576 - accuracy: 1.0000WARNING:tensorflow:Early stopping conditioned on metric `val_loss` which is not available. Available metrics are: loss,accuracy
1/1 [==============================] - 2s 2s/step - loss: 0.6576 - accuracy: 1.0000
Epoch 2/8
1/1 [==============================] - ETA: 0s - loss: 1.3945 - accuracy: 0.0000e+00WARNING:tensorflow:Early stopping conditioned on metric `val_loss` which is not available. Available metrics are: loss,accuracy
1/1 [==============================] - 0s 58ms/step - loss: 1.3945 - accuracy: 0.0000e+00
Epoch 3/8
1/1 [==============================] - ETA: 0s - loss: 0.0220 - accuracy: 1.0000WARNING:tensorflow:Early stopping conditioned on metric `val_loss` which is not available. Available metrics are: loss,accuracy
1/1 [==============================] - 0s 55ms/step - loss: 0.0220 - accuracy: 1.0000
Epoch 4/8
1/1 [==============================] - ETA: 0s - loss: 0.0112 - accuracy: 1.0000WARNING:tensorflow:Early stopping conditioned on metric `val_loss` which is not available. Available metrics are: loss,accuracy
1/1 [==============================] - 0s 55ms/step - loss: 0.0112 - accuracy: 1.0000
Epoch 5/8
1/1 [==============================] - ETA: 0s - loss: 0.0278 - accuracy: 1.0000WARNING:tensorflow:Early stopping conditioned on metric `val_loss` which is not available. Available metrics are: loss,accuracy
1/1 [==============================] - 0s 49ms/step - loss: 0.0278 - accuracy: 1.0000
Epoch 6/8
1/1 [==============================] - ETA: 0s - loss: 0.6972 - accuracy: 0.0000e+00WARNING:tensorflow:Early stopping conditioned on metric `val_loss` which is not available. Available metrics are: loss,accuracy
1/1 [==============================] - 0s 57ms/step - loss: 0.6972 - accuracy: 0.0000e+00
Epoch 7/8
1/1 [==============================] - ETA: 0s - loss: 4.0119e-06 - accuracy: 1.0000WARNING:tensorflow:Early stopping conditioned on metric `val_loss` which is not available. Available metrics are: loss,accuracy
1/1 [==============================] - 0s 54ms/step - loss: 4.0119e-06 - accuracy: 1.0000
Epoch 8/8
1/1 [==============================] - ETA: 0s - loss: 4.1471e-06 - accuracy: 1.0000WARNING:tensorflow:Early stopping conditioned on metric `val_loss` which is not available. Available metrics are: loss,accuracy
1/1 [==============================] - 0s 42ms/step - loss: 4.1471e-06 - accuracy: 1.0000
```



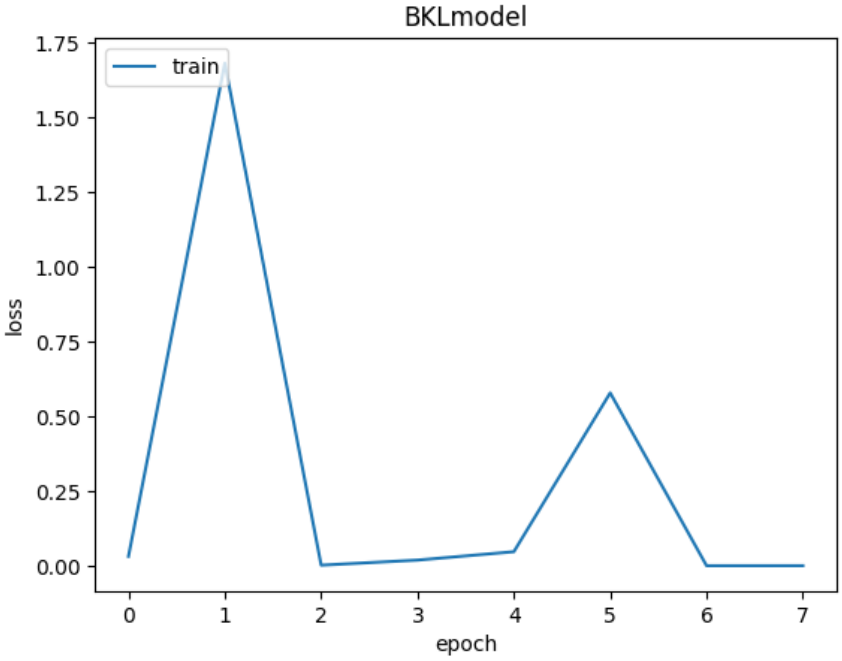

```
Found 851 validated image filenames belonging to 1 classes.
Found 212 validated image filenames belonging to 1 classes.
Epoch 1/8
14/14 [==============================] - 21s 1s/step - loss: 0.3830 - accuracy: 0.8155 - val_loss: 0.0043 - val_accuracy: 1.0000
Epoch 2/8
14/14 [==============================] - 18s 1s/step - loss: 0.0393 - accuracy: 0.9882 - val_loss: 0.0020 - val_accuracy: 1.0000
Epoch 3/8
14/14 [==============================] - 19s 1s/step - loss: 0.0056 - accuracy: 0.9976 - val_loss: 0.0071 - val_accuracy: 1.0000
Epoch 4/8
14/14 [==============================] - 18s 1s/step - loss: 0.0016 - accuracy: 1.0000 - val_loss: 0.0104 - val_accuracy: 1.0000
Epoch 5/8
14/14 [==============================] - 18s 1s/step - loss: 3.2662e-04 - accuracy: 1.0000 - val_loss: 0.0104 - val_accuracy: 1.0000
Epoch 6/8
14/14 [==============================] - 19s 1s/step - loss: 2.5225e-04 - accuracy: 1.0000 - val_loss: 0.0097 - val_accuracy: 1.0000
Epoch 7/8
14/14 [==============================] - 18s 1s/step - loss: 1.6649e-04 - accuracy: 1.0000 - val_loss: 0.0087 - val_accuracy: 1.0000
Epoch 8/8
14/14 [==============================] - 21s 1s/step - loss: 1.9287e-04 - accuracy: 1.0000 - val_loss: 0.0077 - val_accuracy: 1.0000
```



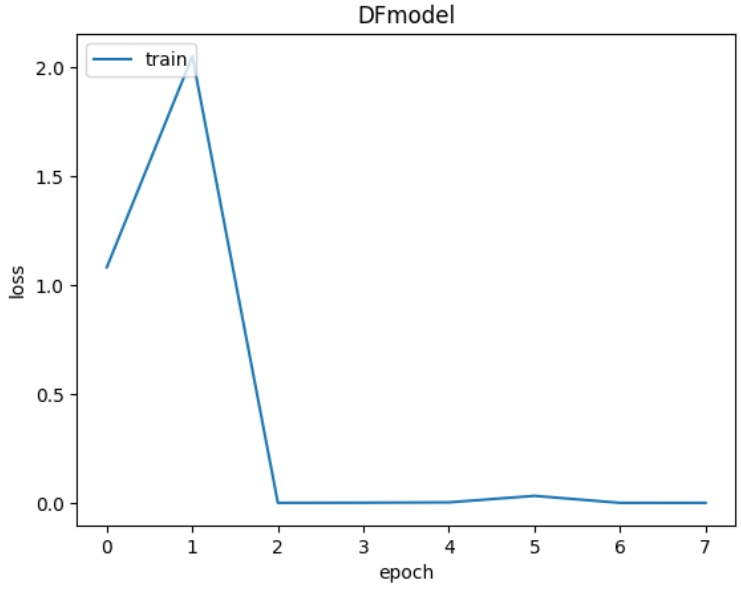
```
Found 1 validated image filenames belonging to 1 classes.
Found 0 validated image filenames belonging to 1 classes.
Epoch 1/8
1/1 [==============================] - ETA: 0s - loss: 0.7633 - accuracy: 0.0000e+00WARNING:tensorflow:Early stopping conditioned on metric `val_loss` which is not available. Available metrics are: loss,accuracy
1/1 [==============================] - 2s 2s/step - loss: 0.7633 - accuracy: 0.0000e+00
Epoch 2/8
1/1 [==============================] - ETA: 0s - loss: 1.0415 - accuracy: 0.0000e+00WARNING:tensorflow:Early stopping conditioned on metric `val_loss` which is not available. Available metrics are: loss,accuracy
1/1 [==============================] - 0s 41ms/step - loss: 1.0415 - accuracy: 0.0000e+00
Epoch 3/8
1/1 [==============================] - ETA: 0s - loss: 0.0289 - accuracy: 1.0000WARNING:tensorflow:Early stopping conditioned on metric `val_loss` which is not available. Available metrics are: loss,accuracy
1/1 [==============================] - 0s 41ms/step - loss: 0.0289 - accuracy: 1.0000
Epoch 4/8
1/1 [==============================] - ETA: 0s - loss: 0.0070 - accuracy: 1.0000WARNING:tensorflow:Early stopping conditioned on metric `val_loss` which is not available. Available metrics are: loss,accuracy
1/1 [==============================] - 0s 45ms/step - loss: 0.0070 - accuracy: 1.0000
Epoch 5/8
1/1 [==============================] - ETA: 0s - loss: 0.0114 - accuracy: 1.0000WARNING:tensorflow:Early stopping conditioned on metric `val_loss` which is not available. Available metrics are: loss,accuracy
1/1 [==============================] - 0s 41ms/step - loss: 0.0114 - accuracy: 1.0000
Epoch 6/8
1/1 [==============================] - ETA: 0s - loss: 0.3348 - accuracy: 1.0000WARNING:tensorflow:Early stopping conditioned on metric `val_loss` which is not available. Available metrics are: loss,accuracy
1/1 [==============================] - 0s 43ms/step - loss: 0.3348 - accuracy: 1.0000
Epoch 7/8
1/1 [==============================] - ETA: 0s - loss: 7.2910e-05 - accuracy: 1.0000WARNING:tensorflow:Early stopping conditioned on metric `val_loss` which is not available. Available metrics are: loss,accuracy
1/1 [==============================] - 0s 44ms/step - loss: 7.2910e-05 - accuracy: 1.0000
Epoch 8/8
1/1 [==============================] - ETA: 0s - loss: 1.0653e-04 - accuracy: 1.0000WARNING:tensorflow:Early stopping conditioned on metric `val_loss` which is not available. Available metrics are: loss,accuracy
1/1 [==============================] - 0s 43ms/step - loss: 1.0653e-04 - accuracy: 1.0000
```



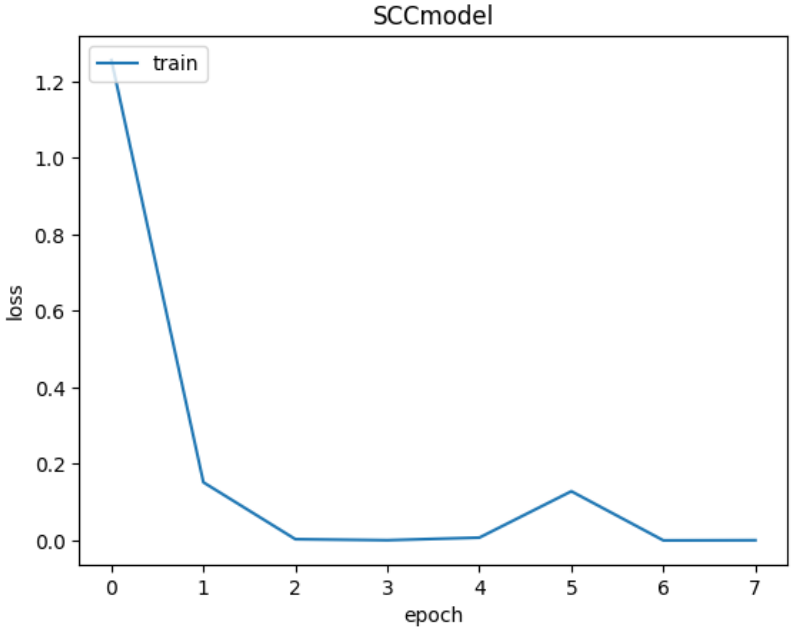

```
Found 1 validated image filenames belonging to 1 classes.
Found 0 validated image filenames belonging to 1 classes.
Epoch 1/8
1/1 [==============================] - ETA: 0s - loss: 0.0312 - accuracy: 1.0000WARNING:tensorflow:Early stopping conditioned on metric `val_loss` which is not available. Available metrics are: loss,accuracy
1/1 [==============================] - 2s 2s/step - loss: 0.0312 - accuracy: 1.0000
Epoch 2/8
1/1 [==============================] - ETA: 0s - loss: 1.6806 - accuracy: 0.0000e+00WARNING:tensorflow:Early stopping conditioned on metric `val_loss` which is not available. Available metrics are: loss,accuracy
1/1 [==============================] - 0s 49ms/step - loss: 1.6806 - accuracy: 0.0000e+00
Epoch 3/8
1/1 [==============================] - ETA: 0s - loss: 0.0017 - accuracy: 1.0000WARNING:tensorflow:Early stopping conditioned on metric `val_loss` which is not available. Available metrics are: loss,accuracy
1/1 [==============================] - 0s 47ms/step - loss: 0.0017 - accuracy: 1.0000
Epoch 4/8
1/1 [==============================] - ETA: 0s - loss: 0.0187 - accuracy: 1.0000WARNING:tensorflow:Early stopping conditioned on metric `val_loss` which is not available. Available metrics are: loss,accuracy
1/1 [==============================] - 0s 42ms/step - loss: 0.0187 - accuracy: 1.0000
Epoch 5/8
1/1 [==============================] - ETA: 0s - loss: 0.0467 - accuracy: 1.0000WARNING:tensorflow:Early stopping conditioned on metric `val_loss` which is not available. Available metrics are: loss,accuracy
1/1 [==============================] - 0s 50ms/step - loss: 0.0467 - accuracy: 1.0000
Epoch 6/8
1/1 [==============================] - ETA: 0s - loss: 0.5780 - accuracy: 1.0000WARNING:tensorflow:Early stopping conditioned on metric `val_loss` which is not available. Available metrics are: loss,accuracy
1/1 [==============================] - 0s 51ms/step - loss: 0.5780 - accuracy: 1.0000
Epoch 7/8
1/1 [==============================] - ETA: 0s - loss: 1.1794e-05 - accuracy: 1.0000WARNING:tensorflow:Early stopping conditioned on metric `val_loss` which is not available. Available metrics are: loss,accuracy
1/1 [==============================] - 0s 44ms/step - loss: 1.1794e-05 - accuracy: 1.0000
Epoch 8/8
1/1 [==============================] - ETA: 0s - loss: 7.0010e-05 - accuracy: 1.0000WARNING:tensorflow:Early stopping conditioned on metric `val_loss` which is not available. Available metrics are: loss,accuracy
1/1 [==============================] - 0s 40ms/step - loss: 7.0010e-05 - accuracy: 1.0000
```



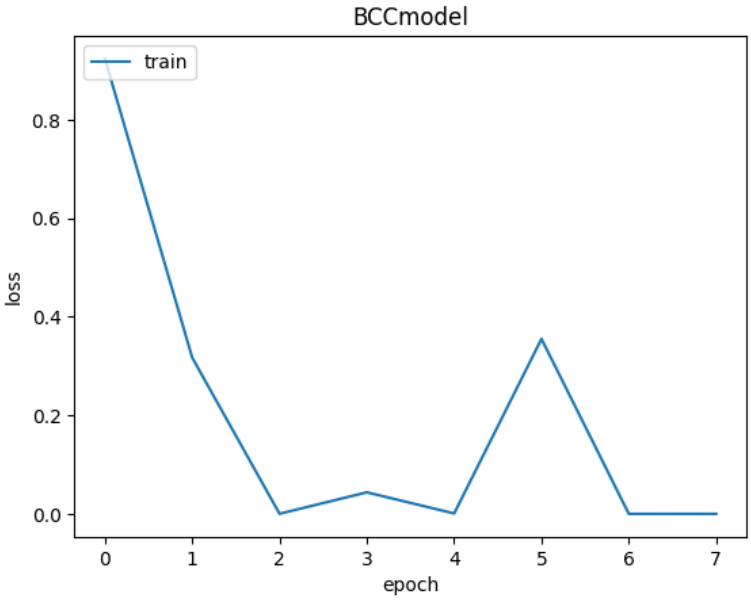

```
Found 1 validated image filenames belonging to 1 classes.
Found 0 validated image filenames belonging to 1 classes.
Epoch 1/8
1/1 [==============================] - ETA: 0s - loss: 1.0823 - accuracy: 0.0000e+00WARNING:tensorflow:Early stopping conditioned on metric `val_loss` which is not available. Available metrics are: loss,accuracy
1/1 [==============================] - 2s 2s/step - loss: 1.0823 - accuracy: 0.0000e+00
Epoch 2/8
1/1 [==============================] - ETA: 0s - loss: 2.0509 - accuracy: 0.0000e+00WARNING:tensorflow:Early stopping conditioned on metric `val_loss` which is not available. Available metrics are: loss,accuracy
1/1 [==============================] - 0s 49ms/step - loss: 2.0509 - accuracy: 0.0000e+00
Epoch 3/8
1/1 [==============================] - ETA: 0s - loss: 2.0380e-04 - accuracy: 1.0000WARNING:tensorflow:Early stopping conditioned on metric `val_loss` which is not available. Available metrics are: loss,accuracy
1/1 [==============================] - 0s 41ms/step - loss: 2.0380e-04 - accuracy: 1.0000
Epoch 4/8
1/1 [==============================] - ETA: 0s - loss: 8.4823e-04 - accuracy: 1.0000WARNING:tensorflow:Early stopping conditioned on metric `val_loss` which is not available. Available metrics are: loss,accuracy
1/1 [==============================] - 0s 42ms/step - loss: 8.4823e-04 - accuracy: 1.0000
Epoch 5/8
1/1 [==============================] - ETA: 0s - loss: 0.0026 - accuracy: 1.0000WARNING:tensorflow:Early stopping conditioned on metric `val_loss` which is not available. Available metrics are: loss,accuracy
1/1 [==============================] - 0s 47ms/step - loss: 0.0026 - accuracy: 1.0000
Epoch 6/8
1/1 [==============================] - ETA: 0s - loss: 0.0324 - accuracy: 1.0000WARNING:tensorflow:Early stopping conditioned on metric `val_loss` which is not available. Available metrics are: loss,accuracy
1/1 [==============================] - 0s 40ms/step - loss: 0.0324 - accuracy: 1.0000
Epoch 7/8
1/1 [==============================] - ETA: 0s - loss: 1.7428e-04 - accuracy: 1.0000WARNING:tensorflow:Early stopping conditioned on metric `val_loss` which is not available. Available metrics are: loss,accuracy
1/1 [==============================] - 0s 61ms/step - loss: 1.7428e-04 - accuracy: 1.0000
Epoch 8/8
1/1 [==============================] - ETA: 0s - loss: 2.7738e-04 - accuracy: 1.0000WARNING:tensorflow:Early stopping conditioned on metric `val_loss` which is not available. Available metrics are: loss,accuracy
1/1 [==============================] - 0s 58ms/step - loss: 2.7738e-04 - accuracy: 1.0000
```



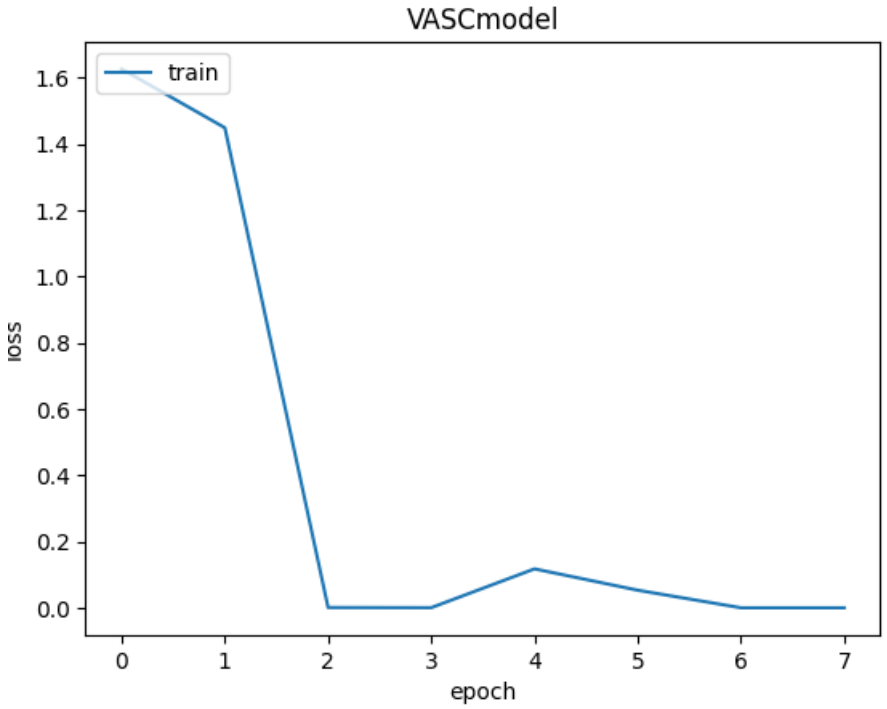
```
Found 1 validated image filenames belonging to 1 classes.
Found 0 validated image filenames belonging to 1 classes.
Epoch 1/8
1/1 [==============================] - ETA: 0s - loss: 1.2560 - accuracy: 0.0000e+00WARNING:tensorflow:Early stopping conditioned on metric `val_loss` which is not available. Available metrics are: loss,accuracy
1/1 [==============================] - 2s 2s/step - loss: 1.2560 - accuracy: 0.0000e+00
Epoch 2/8
1/1 [==============================] - ETA: 0s - loss: 0.1519 - accuracy: 1.0000WARNING:tensorflow:Early stopping conditioned on metric `val_loss` which is not available. Available metrics are: loss,accuracy
1/1 [==============================] - 0s 42ms/step - loss: 0.1519 - accuracy: 1.0000
Epoch 3/8
1/1 [==============================] - ETA: 0s - loss: 0.0031 - accuracy: 1.0000WARNING:tensorflow:Early stopping conditioned on metric `val_loss` which is not available. Available metrics are: loss,accuracy
1/1 [==============================] - 0s 45ms/step - loss: 0.0031 - accuracy: 1.0000
Epoch 4/8
1/1 [==============================] - ETA: 0s - loss: 5.1931e-04 - accuracy: 1.0000WARNING:tensorflow:Early stopping conditioned on metric `val_loss` which is not available. Available metrics are: loss,accuracy
1/1 [==============================] - 0s 44ms/step - loss: 5.1931e-04 - accuracy: 1.0000
Epoch 5/8
1/1 [==============================] - ETA: 0s - loss: 0.0073 - accuracy: 1.0000WARNING:tensorflow:Early stopping conditioned on metric `val_loss` which is not available. Available metrics are: loss,accuracy
1/1 [==============================] - 0s 46ms/step - loss: 0.0073 - accuracy: 1.0000
Epoch 6/8
1/1 [==============================] - ETA: 0s - loss: 0.1284 - accuracy: 1.0000WARNING:tensorflow:Early stopping conditioned on metric `val_loss` which is not available. Available metrics are: loss,accuracy
1/1 [==============================] - 0s 43ms/step - loss: 0.1284 - accuracy: 1.0000
Epoch 7/8
1/1 [==============================] - ETA: 0s - loss: 1.5756e-05 - accuracy: 1.0000WARNING:tensorflow:Early stopping conditioned on metric `val_loss` which is not available. Available metrics are: loss,accuracy
1/1 [==============================] - 0s 43ms/step - loss: 1.5756e-05 - accuracy: 1.0000
Epoch 8/8
1/1 [==============================] - ETA: 0s - loss: 4.1788e-04 - accuracy: 1.0000WARNING:tensorflow:Early stopping conditioned on metric `val_loss` which is not available. Available metrics are: loss,accuracy
1/1 [==============================] - 0s 44ms/step - loss: 4.1788e-04 - accuracy: 1.0000
```




```
Found 1 validated image filenames belonging to 1 classes.
Found 0 validated image filenames belonging to 1 classes.
Epoch 1/8
1/1 [==============================] - ETA: 0s - loss: 0.9241 - accuracy: 0.0000e+00WARNING:tensorflow:Early stopping conditioned on metric `val_loss` which is not available. Available metrics are: loss,accuracy
1/1 [==============================] - 2s 2s/step - loss: 0.9241 - accuracy: 0.0000e+00
Epoch 2/8
1/1 [==============================] - ETA: 0s - loss: 0.3173 - accuracy: 1.0000WARNING:tensorflow:Early stopping conditioned on metric `val_loss` which is not available. Available metrics are: loss,accuracy
1/1 [==============================] - 0s 62ms/step - loss: 0.3173 - accuracy: 1.0000
Epoch 3/8
1/1 [==============================] - ETA: 0s - loss: 1.6459e-04 - accuracy: 1.0000WARNING:tensorflow:Early stopping conditioned on metric `val_loss` which is not available. Available metrics are: loss,accuracy
1/1 [==============================] - 0s 59ms/step - loss: 1.6459e-04 - accuracy: 1.0000
Epoch 4/8
1/1 [==============================] - ETA: 0s - loss: 0.0437 - accuracy: 1.0000WARNING:tensorflow:Early stopping conditioned on metric `val_loss` which is not available. Available metrics are: loss,accuracy
1/1 [==============================] - 0s 64ms/step - loss: 0.0437 - accuracy: 1.0000
Epoch 5/8
1/1 [==============================] - ETA: 0s - loss: 7.9438e-04 - accuracy: 1.0000WARNING:tensorflow:Early stopping conditioned on metric `val_loss` which is not available. Available metrics are: loss,accuracy
1/1 [==============================] - 0s 58ms/step - loss: 7.9438e-04 - accuracy: 1.0000
Epoch 6/8
1/1 [==============================] - ETA: 0s - loss: 0.3553 - accuracy: 1.0000WARNING:tensorflow:Early stopping conditioned on metric `val_loss` which is not available. Available metrics are: loss,accuracy
1/1 [==============================] - 0s 68ms/step - loss: 0.3553 - accuracy: 1.0000
Epoch 7/8
1/1 [==============================] - ETA: 0s - loss: 4.7760e-05 - accuracy: 1.0000WARNING:tensorflow:Early stopping conditioned on metric `val_loss` which is not available. Available metrics are: loss,accuracy
1/1 [==============================] - 0s 63ms/step - loss: 4.7760e-05 - accuracy: 1.0000
Epoch 8/8
1/1 [==============================] - ETA: 0s - loss: 5.8322e-06 - accuracy: 1.0000WARNING:tensorflow:Early stopping conditioned on metric `val_loss` which is not available. Available metrics are: loss,accuracy
1/1 [==============================] - 0s 63ms/step - loss: 5.8322e-06 - accuracy: 1.0000
```



```
Found 1 validated image filenames belonging to 1 classes.
Found 0 validated image filenames belonging to 1 classes.
Epoch 1/8
1/1 [==============================] - ETA: 0s - loss: 1.6269 - accuracy: 0.0000e+00WARNING:tensorflow:Early stopping conditioned on metric `val_loss` which is not available. Available metrics are: loss,accuracy
1/1 [==============================] - 2s 2s/step - loss: 1.6269 - accuracy: 0.0000e+00
Epoch 2/8
1/1 [==============================] - ETA: 0s - loss: 1.4495 - accuracy: 0.0000e+00WARNING:tensorflow:Early stopping conditioned on metric `val_loss` which is not available. Available metrics are: loss,accuracy
1/1 [==============================] - 0s 50ms/step - loss: 1.4495 - accuracy: 0.0000e+00
Epoch 3/8
1/1 [==============================] - ETA: 0s - loss: 7.9411e-04 - accuracy: 1.0000WARNING:tensorflow:Early stopping conditioned on metric `val_loss` which is not available. Available metrics are: loss,accuracy
1/1 [==============================] - 0s 45ms/step - loss: 7.9411e-04 - accuracy: 1.0000
Epoch 4/8
1/1 [==============================] - ETA: 0s - loss: 3.3265e-04 - accuracy: 1.0000WARNING:tensorflow:Early stopping conditioned on metric `val_loss` which is not available. Available metrics are: loss,accuracy
1/1 [==============================] - 0s 44ms/step - loss: 3.3265e-04 - accuracy: 1.0000
Epoch 5/8
1/1 [==============================] - ETA: 0s - loss: 0.1175 - accuracy: 1.0000WARNING:tensorflow:Early stopping conditioned on metric `val_loss` which is not available. Available metrics are: loss,accuracy
1/1 [==============================] - 0s 47ms/step - loss: 0.1175 - accuracy: 1.0000
Epoch 6/8
1/1 [==============================] - ETA: 0s - loss: 0.0530 - accuracy: 1.0000WARNING:tensorflow:Early stopping conditioned on metric `val_loss` which is not available. Available metrics are: loss,accuracy
1/1 [==============================] - 0s 48ms/step - loss: 0.0530 - accuracy: 1.0000
Epoch 7/8
1/1 [==============================] - ETA: 0s - loss: 7.0814e-06 - accuracy: 1.0000WARNING:tensorflow:Early stopping conditioned on metric `val_loss` which is not available. Available metrics are: loss,accuracy
1/1 [==============================] - 0s 49ms/step - loss: 7.0814e-06 - accuracy: 1.0000
Epoch 8/8
1/1 [==============================] - ETA: 0s - loss: 2.3660e-06 - accuracy: 1.0000WARNING:tensorflow:Early stopping conditioned on metric `val_loss` which is not available. Available metrics are: loss,accuracy
1/1 [==============================] - 0s 51ms/step - loss: 2.3660e-06 - accuracy: 1.0000
```



Model: "sequential_34"

Layer (type)	Output Shape	Param #
conv2d_170 (Conv2D)	(None, 128, 128, 16)	448
max_pooling2d_170 (MaxPooling2D)	(None, 64, 64, 16)	0
batch_normalization_170 (BatchNormalization)	(None, 64, 64, 16)	64
dropout_170 (Dropout)	(None, 64, 64, 16)	0
conv2d_171 (Conv2D)	(None, 62, 62, 32)	4640
max_pooling2d_171 (MaxPooling2D)	(None, 31, 31, 32)	0
batch_normalization_171 (BatchNormalization)	(None, 31, 31, 32)	128
dropout_171 (Dropout)	(None, 31, 31, 32)	0
conv2d_172 (Conv2D)	(None, 29, 29, 64)	18496
max_pooling2d_172 (MaxPooling2D)	(None, 14, 14, 64)	0
batch_normalization_172 (BatchNormalization)	(None, 14, 14, 64)	256
dropout_172 (Dropout)	(None, 14, 14, 64)	0
conv2d_173 (Conv2D)	(None, 12, 12, 128)	73856
max_pooling2d_173 (MaxPooling2D)	(None, 6, 6, 128)	0
batch_normalization_173 (BatchNormalization)	(None, 6, 6, 128)	512
dropout_173 (Dropout)	(None, 6, 6, 128)	0
conv2d_174 (Conv2D)	(None, 4, 4, 256)	295168
max_pooling2d_174 (MaxPooling2D)	(None, 2, 2, 256)	0
batch_normalization_174 (BatchNormalization)	(None, 2, 2, 256)	1024
dropout_174 (Dropout)	(None, 2, 2, 256)	0
flatten_34 (Flatten)	(None, 1024)	0
dense_34 (Dense)	(None, 1)	1025

Total params: 395617 (1.51 MB)
Trainable params: 394625 (1.51 MB)
Non-trainable params: 992 (3.88 KB)

4.2. Model 2

4.2.1. Parametrelerin değiştirilmesi

```
#learning_rate tanımladığım kısım. (değişkenim) Mevcut optimizerlardan Adam'ı seçtim.
# eğitim boyunce accurarcy mnitorluyoruz

 model.compile(optimizer=tf.keras.optimizers.Adam(learning_rate=0.010),
           loss='binary_crossentropy',
           metrics=['accuracy'])
```

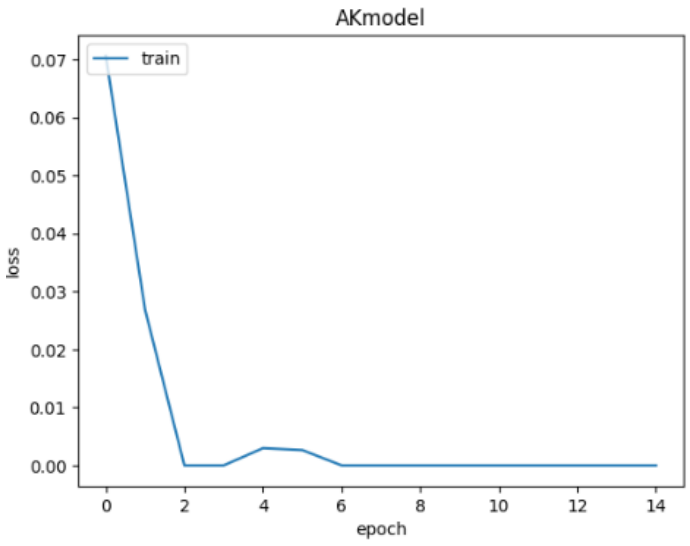
```
# Eğitim döngüsü sayısı, giriş verisinin şekli ve sınıf sayısı

epochs = 15
input_shape = (128, 128, 3)
num_classes = 1
```

```
# Eğitmek için görselleri ekledim.
train_generator = datagen.flow_from_dataframe(
    dataframe=table,
    directory=None,
    x_col='file',
    y_col='label',
    subset="training",
    batch_size=128,
    seed=42,
    shuffle=True,
    class_mode="binary",
    target_size=(128, 128))

# doğrulama (validation) görselleri ekledim.

validation_generator = datagen.flow_from_dataframe(
    dataframe=table,
    directory=None,
    x_col='file',
    y_col='label',
    subset="validation",
    batch_size=128,
    seed=42,
    shuffle=True,
    class_mode="binary",
    target_size=(128, 128))
```

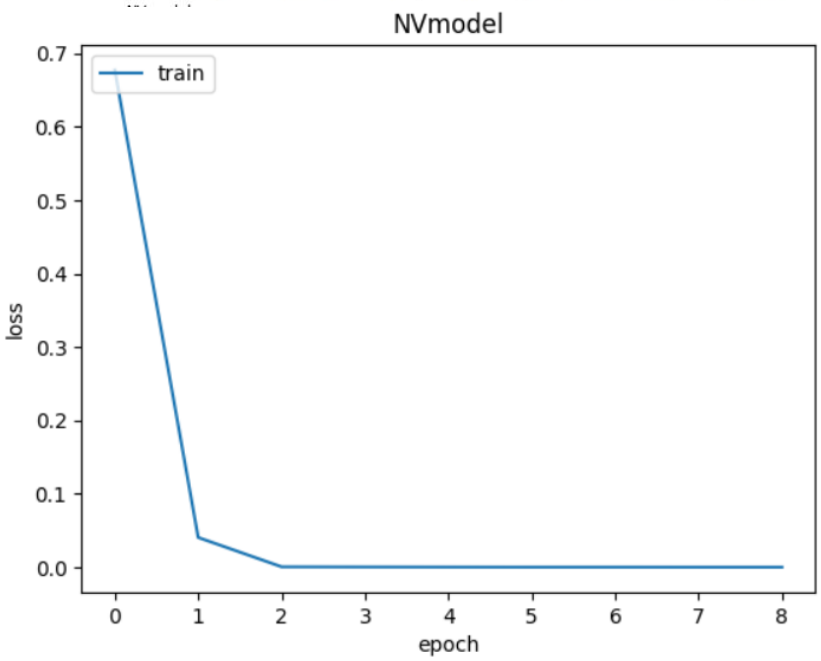
```python
#layerlar arası uyumu indirgemek için dropout değişkenini kullanıldım.

model.add(MaxPooling2D(pool_size=(2, 2)))
model.add(BatchNormalization())
model.add(Dropout(0.3))

model.add(Conv2D(32, kernel_size=(3, 3), activation="relu"))
model.add(MaxPooling2D(pool_size=(2, 2)))
model.add(BatchNormalization())
model.add(Dropout(0.3))

model.add(Conv2D(64, kernel_size=(3, 3), activation="relu"))
model.add(MaxPooling2D(pool_size=(2, 2)))
model.add(BatchNormalization())
model.add(Dropout(0.3))

model.add(Conv2D(128, kernel_size=(3, 3), activation="relu"))
model.add(MaxPooling2D(pool_size=(2, 2)))
model.add(BatchNormalization())
model.add(Dropout(0.3))

model.add(Conv2D(256, kernel_size=(3, 3), activation="relu"))
model.add(MaxPooling2D(pool_size=(2, 2)))
model.add(BatchNormalization())
model.add(Dropout(0.3))
model.add(Flatten())
```

4.2.2. Model 2 çıktıları

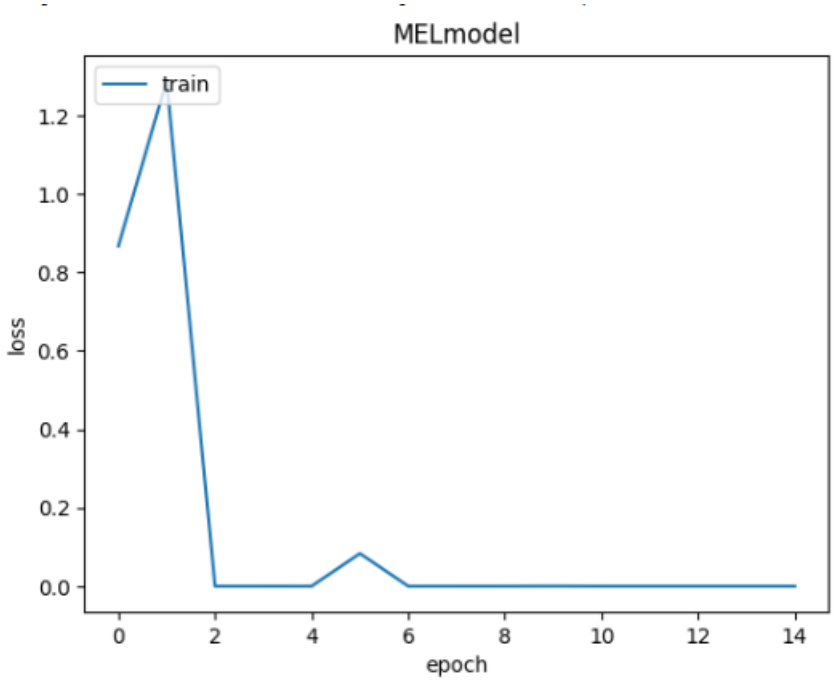
```
Found 1 validated image filenames belonging to 1 classes.
Found 0 validated image filenames belonging to 1 classes.
/usr/local/lib/python3.10/dist-packages/keras/src/preprocessing/image.py:1137: UserWarning: Found 1 invalid image filename(s) in x_col="file". These filename(s) will be ignored.
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/keras/src/preprocessing/image.py:1137: UserWarning: Found 1 invalid image filename(s) in x_col="file". These filename(s) will be ignored.
  warnings.warn(
Epoch 1/15
1/1 [==============================] - ETA: 0s - loss: 0.0707 - accuracy: 1.0000WARNING:tensorflow:Early stopping conditioned on metric `val_loss` which is not available. Available metrics are: loss,accuracy
1/1 [==============================] - 6s 6s/step - loss: 0.0707 - accuracy: 1.0000
Epoch 2/15
1/1 [==============================] - ETA: 0s - loss: 0.0269 - accuracy: 1.0000WARNING:tensorflow:Early stopping conditioned on metric `val_loss` which is not available. Available metrics are: loss,accuracy
1/1 [==============================] - 1s 695ms/step - loss: 0.0269 - accuracy: 1.0000
Epoch 3/15
1/1 [==============================] - ETA: 0s - loss: 7.1557e-07 - accuracy: 1.0000WARNING:tensorflow:Early stopping conditioned on metric `val_loss` which is not available. Available metrics are: loss,accuracy
1/1 [==============================] - 0s 207ms/step - loss: 7.1557e-07 - accuracy: 1.0000
Epoch 4/15
1/1 [==============================] - ETA: 0s - loss: 5.8491e-09 - accuracy: 1.0000WARNING:tensorflow:Early stopping conditioned on metric `val_loss` which is not available. Available metrics are: loss,accuracy
1/1 [==============================] - 0s 183ms/step - loss: 5.8491e-09 - accuracy: 1.0000
Epoch 5/15
1/1 [==============================] - ETA: 0s - loss: 0.0030 - accuracy: 1.0000WARNING:tensorflow:Early stopping conditioned on metric `val_loss` which is not available. Available metrics are: loss,accuracy
1/1 [==============================] - 1s 1s/step - loss: 0.0030 - accuracy: 1.0000
Epoch 6/15
1/1 [==============================] - ETA: 0s - loss: 0.0026 - accuracy: 1.0000WARNING:tensorflow:Early stopping conditioned on metric `val_loss` which is not available. Available metrics are: loss,accuracy
1/1 [==============================] - 0s 223ms/step - loss: 0.0026 - accuracy: 1.0000
Epoch 7/15
1/1 [==============================] - ETA: 0s - loss: 2.2882e-08 - accuracy: 1.0000WARNING:tensorflow:Early stopping conditioned on metric `val_loss` which is not available. Available metrics are: loss,accuracy
1/1 [==============================] - 2s 2s/step - loss: 2.2882e-08 - accuracy: 1.0000
Epoch 8/15
1/1 [==============================] - ETA: 0s - loss: 2.2767e-10 - accuracy: 1.0000WARNING:tensorflow:Early stopping conditioned on metric `val_loss` which is not available. Available metrics are: loss,accuracy
1/1 [==============================] - 1s 859ms/step - loss: 2.2767e-10 - accuracy: 1.0000
Epoch 9/15
1/1 [==============================] - ETA: 0s - loss: 3.6073e-10 - accuracy: 1.0000WARNING:tensorflow:Early stopping conditioned on metric `val_loss` which is not available. Available metrics are: loss,accuracy
1/1 [==============================] - 1s 1s/step - loss: 3.6073e-10 - accuracy: 1.0000
Epoch 10/15
1/1 [==============================] - ETA: 0s - loss: 3.0372e-07 - accuracy: 1.0000WARNING:tensorflow:Early stopping conditioned on metric `val_loss` which is not available. Available metrics are: loss,accuracy
1/1 [==============================] - 0s 165ms/step - loss: 3.0372e-07 - accuracy: 1.0000
Epoch 11/15
1/1 [==============================] - ETA: 0s - loss: 9.8244e-13 - accuracy: 1.0000WARNING:tensorflow:Early stopping conditioned on metric `val_loss` which is not available. Available metrics are: loss,accuracy
1/1 [==============================] - 0s 166ms/step - loss: 9.8244e-13 - accuracy: 1.0000
Epoch 12/15
1/1 [==============================] - ETA: 0s - loss: 4.0967e-09 - accuracy: 1.0000WARNING:tensorflow:Early stopping conditioned on metric `val_loss` which is not available. Available metrics are: loss,accuracy
1/1 [==============================] - 0s 476ms/step - loss: 4.0967e-09 - accuracy: 1.0000
Epoch 13/15
1/1 [==============================] - ETA: 0s - loss: 7.0405e-11 - accuracy: 1.0000WARNING:tensorflow:Early stopping conditioned on metric `val_loss` which is not available. Available metrics are: loss,accuracy
1/1 [==============================] - 0s 93ms/step - loss: 7.0405e-11 - accuracy: 1.0000
Epoch 14/15
1/1 [==============================] - ETA: 0s - loss: 6.3865e-15 - accuracy: 1.0000WARNING:tensorflow:Early stopping conditioned on metric `val_loss` which is not available. Available metrics are: loss,accuracy
1/1 [==============================] - 0s 93ms/step - loss: 6.3865e-15 - accuracy: 1.0000
Epoch 15/15
1/1 [==============================] - ETA: 0s - loss: 3.1544e-13 - accuracy: 1.0000WARNING:tensorflow:Early stopping conditioned on metric `val_loss` which is not available. Available metrics are: loss,accuracy
1/1 [==============================] - 0s 97ms/step - loss: 3.1544e-13 - accuracy: 1.0000
```



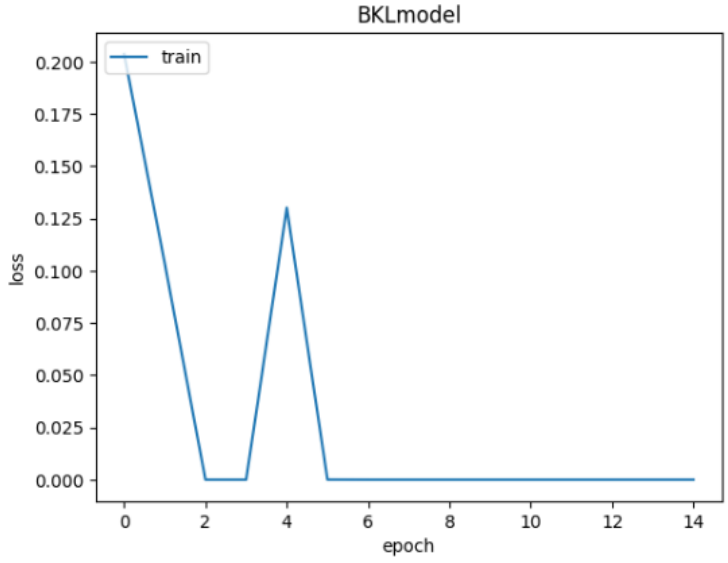
```
Found 851 validated image filenames belonging to 1 classes.
Found 212 validated image filenames belonging to 1 classes.
/usr/local/lib/python3.10/dist-packages/keras/src/preprocessing/image.py:1137: UserWarning: Found 3 invalid image filename(s) in x_col="file". These filename(s) will be ignored.
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/keras/src/preprocessing/image.py:1137: UserWarning: Found 3 invalid image filename(s) in x_col="file". These filename(s) will be ignored.
  warnings.warn(
Epoch 1/15
7/7 [==============================] - 38s 5s/step - loss: 0.6774 - accuracy: 0.7967 - val_loss: 0.0000e+00 - val_accuracy: 1.0000
Epoch 2/15
7/7 [==============================] - 38s 5s/step - loss: 0.0404 - accuracy: 0.9894 - val_loss: 0.0000e+00 - val_accuracy: 1.0000
Epoch 3/15
7/7 [==============================] - 36s 5s/step - loss: 4.7146e-04 - accuracy: 1.0000 - val_loss: 0.0000e+00 - val_accuracy: 1.0000
Epoch 4/15
7/7 [==============================] - 33s 4s/step - loss: 2.9800e-04 - accuracy: 1.0000 - val_loss: 0.0000e+00 - val_accuracy: 1.0000
Epoch 5/15
7/7 [==============================] - 33s 4s/step - loss: 1.6907e-04 - accuracy: 1.0000 - val_loss: 0.0000e+00 - val_accuracy: 1.0000
Epoch 6/15
7/7 [==============================] - 33s 5s/step - loss: 7.5590e-05 - accuracy: 1.0000 - val_loss: 0.0000e+00 - val_accuracy: 1.0000
Epoch 7/15
7/7 [==============================] - 32s 4s/step - loss: 8.5251e-05 - accuracy: 1.0000 - val_loss: 0.0000e+00 - val_accuracy: 1.0000
Epoch 8/15
7/7 [==============================] - 34s 5s/step - loss: 3.9154e-05 - accuracy: 1.0000 - val_loss: 5.2817e-30 - val_accuracy: 1.0000
Epoch 9/15
7/7 [==============================] - 34s 5s/step - loss: 2.2457e-05 - accuracy: 1.0000 - val_loss: 9.4400e-25 - val_accuracy: 1.0000
```



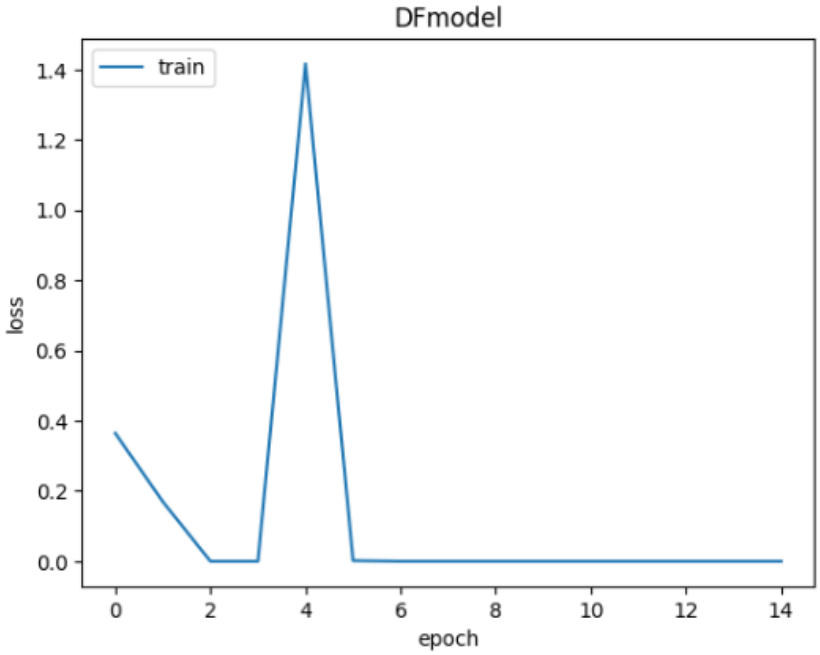

```
  warnings.warn(
Epoch 1/15
1/1 [==============================] - ETA: 0s - loss: 0.8666 - accuracy: 0.0000e+00WARNING:tensorflow:Early stopping conditioned on metric `val_loss` which is not available. Available metrics are: loss,accuracy
1/1 [==============================] - 2s 2s/step - loss: 0.8666 - accuracy: 0.0000e+00
Epoch 2/15
1/1 [==============================] - ETA: 0s - loss: 1.2879 - accuracy: 0.0000e+00WARNING:tensorflow:Early stopping conditioned on metric `val_loss` which is not available. Available metrics are: loss,accuracy
1/1 [==============================] - 0s 57ms/step - loss: 1.2879 - accuracy: 0.0000e+00
Epoch 3/15
1/1 [==============================] - ETA: 0s - loss: 2.9646e-06 - accuracy: 1.0000WARNING:tensorflow:Early stopping conditioned on metric `val_loss` which is not available. Available metrics are: loss,accuracy
1/1 [==============================] - 0s 56ms/step - loss: 2.9646e-06 - accuracy: 1.0000
Epoch 4/15
1/1 [==============================] - ETA: 0s - loss: 2.2660e-07 - accuracy: 1.0000WARNING:tensorflow:Early stopping conditioned on metric `val_loss` which is not available. Available metrics are: loss,accuracy
1/1 [==============================] - 0s 58ms/step - loss: 2.2660e-07 - accuracy: 1.0000
Epoch 5/15
1/1 [==============================] - ETA: 0s - loss: 5.8069e-05 - accuracy: 1.0000WARNING:tensorflow:Early stopping conditioned on metric `val_loss` which is not available. Available metrics are: loss,accuracy
1/1 [==============================] - 1s 1s/step - loss: 5.8069e-05 - accuracy: 1.0000
Epoch 6/15
1/1 [==============================] - ETA: 0s - loss: 0.0833 - accuracy: 1.0000WARNING:tensorflow:Early stopping conditioned on metric `val_loss` which is not available. Available metrics are: loss,accuracy
1/1 [==============================] - 0s 91ms/step - loss: 0.0833 - accuracy: 1.0000
Epoch 7/15
1/1 [==============================] - ETA: 0s - loss: 1.1160e-07 - accuracy: 1.0000WARNING:tensorflow:Early stopping conditioned on metric `val_loss` which is not available. Available metrics are: loss,accuracy
1/1 [==============================] - 0s 79ms/step - loss: 1.1160e-07 - accuracy: 1.0000
Epoch 8/15
1/1 [==============================] - ETA: 0s - loss: 1.0234e-07 - accuracy: 1.0000WARNING:tensorflow:Early stopping conditioned on metric `val_loss` which is not available. Available metrics are: loss,accuracy
1/1 [==============================] - 0s 84ms/step - loss: 1.0234e-07 - accuracy: 1.0000
Epoch 9/15
1/1 [==============================] - ETA: 0s - loss: 3.0108e-05 - accuracy: 1.0000WARNING:tensorflow:Early stopping conditioned on metric `val_loss` which is not available. Available metrics are: loss,accuracy
1/1 [==============================] - 0s 93ms/step - loss: 3.0108e-05 - accuracy: 1.0000
Epoch 10/15
1/1 [==============================] - ETA: 0s - loss: 2.7701e-04 - accuracy: 1.0000WARNING:tensorflow:Early stopping conditioned on metric `val_loss` which is not available. Available metrics are: loss,accuracy
1/1 [==============================] - 0s 84ms/step - loss: 2.7701e-04 - accuracy: 1.0000
Epoch 11/15
1/1 [==============================] - ETA: 0s - loss: 6.7129e-11 - accuracy: 1.0000WARNING:tensorflow:Early stopping conditioned on metric `val_loss` which is not available. Available metrics are: loss,accuracy
1/1 [==============================] - 0s 84ms/step - loss: 6.7129e-11 - accuracy: 1.0000
Epoch 12/15
1/1 [==============================] - ETA: 0s - loss: 7.3955e-08 - accuracy: 1.0000WARNING:tensorflow:Early stopping conditioned on metric `val_loss` which is not available. Available metrics are: loss,accuracy
1/1 [==============================] - 1s 919ms/step - loss: 7.3955e-08 - accuracy: 1.0000
Epoch 13/15
1/1 [==============================] - ETA: 0s - loss: 1.0860e-06 - accuracy: 1.0000WARNING:tensorflow:Early stopping conditioned on metric `val_loss` which is not available. Available metrics are: loss,accuracy
1/1 [==============================] - 1s 735ms/step - loss: 1.0860e-06 - accuracy: 1.0000
Epoch 14/15
1/1 [==============================] - ETA: 0s - loss: 1.5408e-11 - accuracy: 1.0000WARNING:tensorflow:Early stopping conditioned on metric `val_loss` which is not available. Available metrics are: loss,accuracy
1/1 [==============================] - 1s 915ms/step - loss: 1.5408e-11 - accuracy: 1.0000
Epoch 15/15
1/1 [==============================] - ETA: 0s - loss: 3.5447e-11 - accuracy: 1.0000WARNING:tensorflow:Early stopping conditioned on metric `val_loss` which is not available. Available metrics are: loss,accuracy
1/1 [==============================] - 1s 882ms/step - loss: 3.5447e-11 - accuracy: 1.0000
```



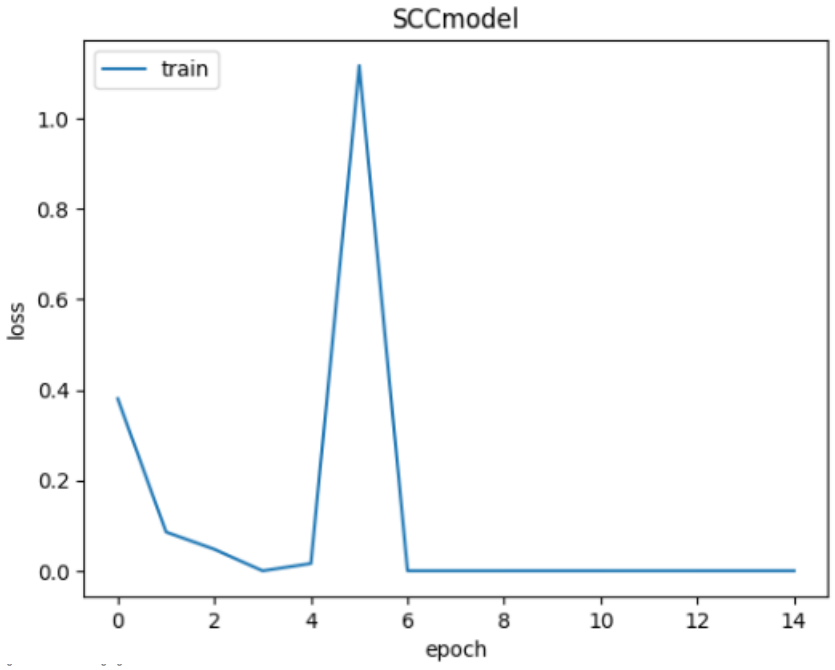

```
Epoch 1/15
1/1 [==============================] - ETA: 0s - loss: 0.2036 - accuracy: 1.0000WARNING:tensorflow:Early stopping conditioned on metric `val_loss` which is not available. Available metrics are: loss,accuracy
1/1 [==============================] - 3s 3s/step - loss: 0.2036 - accuracy: 1.0000
Epoch 2/15
1/1 [==============================] - ETA: 0s - loss: 0.1033 - accuracy: 1.0000WARNING:tensorflow:Early stopping conditioned on metric `val_loss` which is not available. Available metrics are: loss,accuracy
1/1 [==============================] - 0s 87ms/step - loss: 0.1033 - accuracy: 1.0000
Epoch 3/15
1/1 [==============================] - ETA: 0s - loss: 1.0220e-06 - accuracy: 1.0000WARNING:tensorflow:Early stopping conditioned on metric `val_loss` which is not available. Available metrics are: loss,accuracy
1/1 [==============================] - 1s 874ms/step - loss: 1.0220e-06 - accuracy: 1.0000
Epoch 4/15
1/1 [==============================] - ETA: 0s - loss: 4.8604e-08 - accuracy: 1.0000WARNING:tensorflow:Early stopping conditioned on metric `val_loss` which is not available. Available metrics are: loss,accuracy
1/1 [==============================] - 0s 395ms/step - loss: 4.8604e-08 - accuracy: 1.0000
Epoch 5/15
1/1 [==============================] - ETA: 0s - loss: 0.1301 - accuracy: 1.0000WARNING:tensorflow:Early stopping conditioned on metric `val_loss` which is not available. Available metrics are: loss,accuracy
1/1 [==============================] - 0s 83ms/step - loss: 0.1301 - accuracy: 1.0000
Epoch 6/15
1/1 [==============================] - ETA: 0s - loss: 3.7527e-05 - accuracy: 1.0000WARNING:tensorflow:Early stopping conditioned on metric `val_loss` which is not available. Available metrics are: loss,accuracy
1/1 [==============================] - 0s 98ms/step - loss: 3.7527e-05 - accuracy: 1.0000
Epoch 7/15
1/1 [==============================] - ETA: 0s - loss: 9.5783e-10 - accuracy: 1.0000WARNING:tensorflow:Early stopping conditioned on metric `val_loss` which is not available. Available metrics are: loss,accuracy
1/1 [==============================] - 0s 98ms/step - loss: 9.5783e-10 - accuracy: 1.0000
Epoch 8/15
1/1 [==============================] - ETA: 0s - loss: 1.7617e-07 - accuracy: 1.0000WARNING:tensorflow:Early stopping conditioned on metric `val_loss` which is not available. Available metrics are: loss,accuracy
1/1 [==============================] - 0s 81ms/step - loss: 1.7617e-07 - accuracy: 1.0000
Epoch 9/15
1/1 [==============================] - ETA: 0s - loss: 1.1156e-11 - accuracy: 1.0000WARNING:tensorflow:Early stopping conditioned on metric `val_loss` which is not available. Available metrics are: loss,accuracy
1/1 [==============================] - 1s 889ms/step - loss: 1.1156e-11 - accuracy: 1.0000
Epoch 10/15
1/1 [==============================] - ETA: 0s - loss: 1.5062e-11 - accuracy: 1.0000WARNING:tensorflow:Early stopping conditioned on metric `val_loss` which is not available. Available metrics are: loss,accuracy
1/1 [==============================] - 1s 922ms/step - loss: 1.5062e-11 - accuracy: 1.0000
Epoch 11/15
1/1 [==============================] - ETA: 0s - loss: 1.3362e-09 - accuracy: 1.0000WARNING:tensorflow:Early stopping conditioned on metric `val_loss` which is not available. Available metrics are: loss,accuracy
1/1 [==============================] - 1s 578ms/step - loss: 1.3362e-09 - accuracy: 1.0000
Epoch 12/15
1/1 [==============================] - ETA: 0s - loss: 8.3618e-09 - accuracy: 1.0000WARNING:tensorflow:Early stopping conditioned on metric `val_loss` which is not available. Available metrics are: loss,accuracy
1/1 [==============================] - 0s 349ms/step - loss: 8.3618e-09 - accuracy: 1.0000
Epoch 13/15
1/1 [==============================] - ETA: 0s - loss: 3.1740e-09 - accuracy: 1.0000WARNING:tensorflow:Early stopping conditioned on metric `val_loss` which is not available. Available metrics are: loss,accuracy
1/1 [==============================] - 0s 54ms/step - loss: 3.1740e-09 - accuracy: 1.0000
Epoch 14/15
1/1 [==============================] - ETA: 0s - loss: 2.4563e-06 - accuracy: 1.0000WARNING:tensorflow:Early stopping conditioned on metric `val_loss` which is not available. Available metrics are: loss,accuracy
1/1 [==============================] - 0s 56ms/step - loss: 2.4563e-06 - accuracy: 1.0000
Epoch 15/15
1/1 [==============================] - ETA: 0s - loss: 4.7050e-07 - accuracy: 1.0000WARNING:tensorflow:Early stopping conditioned on metric `val_loss` which is not available. Available metrics are: loss,accuracy
1/1 [==============================] - 0s 53ms/step - loss: 4.7050e-07 - accuracy: 1.0000
```



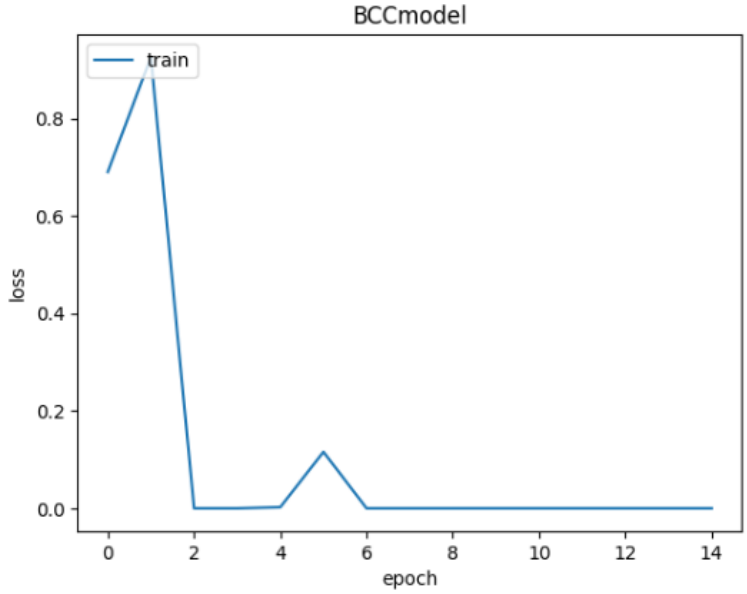
```
Epoch 1/15
1/1 [==============================] - ETA: 0s - loss: 0.3646 - accuracy: 1.0000WARNING:tensorflow:Early stopping conditioned on metric `val_loss` which is not available. Available metrics are: loss,accuracy
1/1 [==============================] - 4s 4s/step - loss: 0.3646 - accuracy: 1.0000
Epoch 2/15
1/1 [==============================] - ETA: 0s - loss: 0.1696 - accuracy: 1.0000WARNING:tensorflow:Early stopping conditioned on metric `val_loss` which is not available. Available metrics are: loss,accuracy
1/1 [==============================] - 1s 942ms/step - loss: 0.1696 - accuracy: 1.0000
Epoch 3/15
1/1 [==============================] - ETA: 0s - loss: 2.2592e-06 - accuracy: 1.0000WARNING:tensorflow:Early stopping conditioned on metric `val_loss` which is not available. Available metrics are: loss,accuracy
1/1 [==============================] - 1s 657ms/step - loss: 2.2592e-06 - accuracy: 1.0000
Epoch 4/15
1/1 [==============================] - ETA: 0s - loss: 5.5447e-08 - accuracy: 1.0000WARNING:tensorflow:Early stopping conditioned on metric `val_loss` which is not available. Available metrics are: loss,accuracy
1/1 [==============================] - 0s 345ms/step - loss: 5.5447e-08 - accuracy: 1.0000
Epoch 5/15
1/1 [==============================] - ETA: 0s - loss: 1.4165 - accuracy: 0.0000e+00WARNING:tensorflow:Early stopping conditioned on metric `val_loss` which is not available. Available metrics are: loss,accuracy
1/1 [==============================] - 0s 57ms/step - loss: 1.4165 - accuracy: 0.0000e+00
Epoch 6/15
1/1 [==============================] - ETA: 0s - loss: 0.0018 - accuracy: 1.0000WARNING:tensorflow:Early stopping conditioned on metric `val_loss` which is not available. Available metrics are: loss,accuracy
1/1 [==============================] - 0s 55ms/step - loss: 0.0018 - accuracy: 1.0000
Epoch 7/15
1/1 [==============================] - ETA: 0s - loss: 2.2877e-10 - accuracy: 1.0000WARNING:tensorflow:Early stopping conditioned on metric `val_loss` which is not available. Available metrics are: loss,accuracy
1/1 [==============================] - 0s 52ms/step - loss: 2.2877e-10 - accuracy: 1.0000
Epoch 8/15
1/1 [==============================] - ETA: 0s - loss: 4.3580e-07 - accuracy: 1.0000WARNING:tensorflow:Early stopping conditioned on metric `val_loss` which is not available. Available metrics are: loss,accuracy
1/1 [==============================] - 0s 58ms/step - loss: 4.3580e-07 - accuracy: 1.0000
Epoch 9/15
1/1 [==============================] - ETA: 0s - loss: 4.9121e-11 - accuracy: 1.0000WARNING:tensorflow:Early stopping conditioned on metric `val_loss` which is not available. Available metrics are: loss,accuracy
1/1 [==============================] - 0s 58ms/step - loss: 4.9121e-11 - accuracy: 1.0000
Epoch 10/15
1/1 [==============================] - ETA: 0s - loss: 4.6763e-10 - accuracy: 1.0000WARNING:tensorflow:Early stopping conditioned on metric `val_loss` which is not available. Available metrics are: loss,accuracy
1/1 [==============================] - 0s 57ms/step - loss: 4.6763e-10 - accuracy: 1.0000
Epoch 11/15
1/1 [==============================] - ETA: 0s - loss: 1.5074e-10 - accuracy: 1.0000WARNING:tensorflow:Early stopping conditioned on metric `val_loss` which is not available. Available metrics are: loss,accuracy
1/1 [==============================] - 0s 58ms/step - loss: 1.5074e-10 - accuracy: 1.0000
Epoch 12/15
1/1 [==============================] - ETA: 0s - loss: 8.9727e-08 - accuracy: 1.0000WARNING:tensorflow:Early stopping conditioned on metric `val_loss` which is not available. Available metrics are: loss,accuracy
1/1 [==============================] - 0s 55ms/step - loss: 8.9727e-08 - accuracy: 1.0000
Epoch 13/15
1/1 [==============================] - ETA: 0s - loss: 6.4953e-12 - accuracy: 1.0000WARNING:tensorflow:Early stopping conditioned on metric `val_loss` which is not available. Available metrics are: loss,accuracy
1/1 [==============================] - 1s 841ms/step - loss: 6.4953e-12 - accuracy: 1.0000
Epoch 14/15
1/1 [==============================] - ETA: 0s - loss: 1.0580e-09 - accuracy: 1.0000WARNING:tensorflow:Early stopping conditioned on metric `val_loss` which is not available. Available metrics are: loss,accuracy
1/1 [==============================] - 1s 870ms/step - loss: 1.0580e-09 - accuracy: 1.0000
Epoch 15/15
1/1 [==============================] - ETA: 0s - loss: 4.8564e-10 - accuracy: 1.0000WARNING:tensorflow:Early stopping conditioned on metric `val_loss` which is not available. Available metrics are: loss,accuracy
1/1 [==============================] - 1s 645ms/step - loss: 4.8564e-10 - accuracy: 1.0000
```



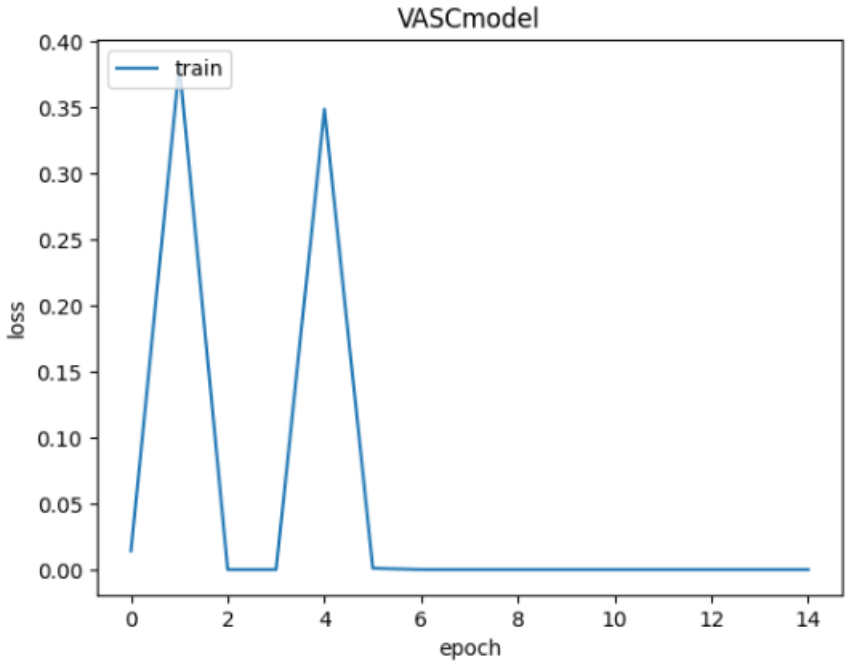

```
Epoch 1/15
1/1 [==============================] - ETA: 0s - loss: 0.3807 - accuracy: 1.0000WARNING:tensorflow:Early stopping conditioned on metric `val_loss` which is not available. Available metrics are: loss,accuracy
1/1 [==============================] - 4s 4s/step - loss: 0.3807 - accuracy: 1.0000
Epoch 2/15
1/1 [==============================] - ETA: 0s - loss: 0.0859 - accuracy: 1.0000WARNING:tensorflow:Early stopping conditioned on metric `val_loss` which is not available. Available metrics are: loss,accuracy
1/1 [==============================] - 1s 958ms/step - loss: 0.0859 - accuracy: 1.0000
Epoch 3/15
1/1 [==============================] - ETA: 0s - loss: 0.0476 - accuracy: 1.0000WARNING:tensorflow:Early stopping conditioned on metric `val_loss` which is not available. Available metrics are: loss,accuracy
1/1 [==============================] - 1s 704ms/step - loss: 0.0476 - accuracy: 1.0000
Epoch 4/15
1/1 [==============================] - ETA: 0s - loss: 7.0862e-08 - accuracy: 1.0000WARNING:tensorflow:Early stopping conditioned on metric `val_loss` which is not available. Available metrics are: loss,accuracy
1/1 [==============================] - 1s 883ms/step - loss: 7.0862e-08 - accuracy: 1.0000
Epoch 5/15
1/1 [==============================] - ETA: 0s - loss: 0.0162 - accuracy: 1.0000WARNING:tensorflow:Early stopping conditioned on metric `val_loss` which is not available. Available metrics are: loss,accuracy
1/1 [==============================] - 0s 333ms/step - loss: 0.0162 - accuracy: 1.0000
Epoch 6/15
1/1 [==============================] - ETA: 0s - loss: 1.1173 - accuracy: 0.0000e+00WARNING:tensorflow:Early stopping conditioned on metric `val_loss` which is not available. Available metrics are: loss,accuracy
1/1 [==============================] - 0s 56ms/step - loss: 1.1173 - accuracy: 0.0000e+00
Epoch 7/15
1/1 [==============================] - ETA: 0s - loss: 6.0604e-11 - accuracy: 1.0000WARNING:tensorflow:Early stopping conditioned on metric `val_loss` which is not available. Available metrics are: loss,accuracy
1/1 [==============================] - 0s 56ms/step - loss: 6.0604e-11 - accuracy: 1.0000
Epoch 8/15
1/1 [==============================] - ETA: 0s - loss: 8.8754e-06 - accuracy: 1.0000WARNING:tensorflow:Early stopping conditioned on metric `val_loss` which is not available. Available metrics are: loss,accuracy
1/1 [==============================] - 0s 63ms/step - loss: 8.8754e-06 - accuracy: 1.0000
Epoch 9/15
1/1 [==============================] - ETA: 0s - loss: 3.6898e-10 - accuracy: 1.0000WARNING:tensorflow:Early stopping conditioned on metric `val_loss` which is not available. Available metrics are: loss,accuracy
1/1 [==============================] - 0s 56ms/step - loss: 3.6898e-10 - accuracy: 1.0000
Epoch 10/15
1/1 [==============================] - ETA: 0s - loss: 1.3007e-07 - accuracy: 1.0000WARNING:tensorflow:Early stopping conditioned on metric `val_loss` which is not available. Available metrics are: loss,accuracy
1/1 [==============================] - 0s 58ms/step - loss: 1.3007e-07 - accuracy: 1.0000
Epoch 11/15
1/1 [==============================] - ETA: 0s - loss: 2.6905e-09 - accuracy: 1.0000WARNING:tensorflow:Early stopping conditioned on metric `val_loss` which is not available. Available metrics are: loss,accuracy
1/1 [==============================] - 0s 64ms/step - loss: 2.6905e-09 - accuracy: 1.0000
Epoch 12/15
1/1 [==============================] - ETA: 0s - loss: 2.6813e-05 - accuracy: 1.0000WARNING:tensorflow:Early stopping conditioned on metric `val_loss` which is not available. Available metrics are: loss,accuracy
1/1 [==============================] - 1s 800ms/step - loss: 2.6813e-05 - accuracy: 1.0000
Epoch 13/15
1/1 [==============================] - ETA: 0s - loss: 2.3694e-10 - accuracy: 1.0000WARNING:tensorflow:Early stopping conditioned on metric `val_loss` which is not available. Available metrics are: loss,accuracy
1/1 [==============================] - 0s 57ms/step - loss: 2.3694e-10 - accuracy: 1.0000
Epoch 14/15
1/1 [==============================] - ETA: 0s - loss: 2.8158e-08 - accuracy: 1.0000WARNING:tensorflow:Early stopping conditioned on metric `val_loss` which is not available. Available metrics are: loss,accuracy
1/1 [==============================] - 1s 832ms/step - loss: 2.8158e-08 - accuracy: 1.0000
Epoch 15/15
1/1 [==============================] - ETA: 0s - loss: 1.7614e-08 - accuracy: 1.0000WARNING:tensorflow:Early stopping conditioned on metric `val_loss` which is not available. Available metrics are: loss,accuracy
1/1 [==============================] - 1s 892ms/step - loss: 1.7614e-08 - accuracy: 1.0000
```




```
Epoch 1/15
1/1 [==============================] - ETA: 0s - loss: 0.6903 - accuracy: 1.0000WARNING:tensorflow:Early stopping conditioned on metric `val_loss` which is not available. Available metrics are: loss,accuracy
1/1 [==============================] - 4s 4s/step - loss: 0.6903 - accuracy: 1.0000
Epoch 2/15
1/1 [==============================] - ETA: 0s - loss: 0.9256 - accuracy: 0.0000e+00WARNING:tensorflow:Early stopping conditioned on metric `val_loss` which is not available. Available metrics are: loss,accuracy
1/1 [==============================] - 0s 351ms/step - loss: 0.9256 - accuracy: 0.0000e+00
Epoch 3/15
1/1 [==============================] - ETA: 0s - loss: 3.8254e-06 - accuracy: 1.0000WARNING:tensorflow:Early stopping conditioned on metric `val_loss` which is not available. Available metrics are: loss,accuracy
1/1 [==============================] - 0s 58ms/step - loss: 3.8254e-06 - accuracy: 1.0000
Epoch 4/15
1/1 [==============================] - ETA: 0s - loss: 2.2004e-08 - accuracy: 1.0000WARNING:tensorflow:Early stopping conditioned on metric `val_loss` which is not available. Available metrics are: loss,accuracy
1/1 [==============================] - 0s 57ms/step - loss: 2.2004e-08 - accuracy: 1.0000
Epoch 5/15
1/1 [==============================] - ETA: 0s - loss: 0.0024 - accuracy: 1.0000WARNING:tensorflow:Early stopping conditioned on metric `val_loss` which is not available. Available metrics are: loss,accuracy
1/1 [==============================] - 0s 61ms/step - loss: 0.0024 - accuracy: 1.0000
Epoch 6/15
1/1 [==============================] - ETA: 0s - loss: 0.1159 - accuracy: 1.0000WARNING:tensorflow:Early stopping conditioned on metric `val_loss` which is not available. Available metrics are: loss,accuracy
1/1 [==============================] - 1s 969ms/step - loss: 0.1159 - accuracy: 1.0000
Epoch 7/15
1/1 [==============================] - ETA: 0s - loss: 4.0953e-06 - accuracy: 1.0000WARNING:tensorflow:Early stopping conditioned on metric `val_loss` which is not available. Available metrics are: loss,accuracy
1/1 [==============================] - 1s 896ms/step - loss: 4.0953e-06 - accuracy: 1.0000
Epoch 8/15
1/1 [==============================] - ETA: 0s - loss: 2.9403e-08 - accuracy: 1.0000WARNING:tensorflow:Early stopping conditioned on metric `val_loss` which is not available. Available metrics are: loss,accuracy
1/1 [==============================] - 0s 318ms/step - loss: 2.9403e-08 - accuracy: 1.0000
Epoch 9/15
1/1 [==============================] - ETA: 0s - loss: 1.6580e-08 - accuracy: 1.0000WARNING:tensorflow:Early stopping conditioned on metric `val_loss` which is not available. Available metrics are: loss,accuracy
1/1 [==============================] - 0s 54ms/step - loss: 1.6580e-08 - accuracy: 1.0000
Epoch 10/15
1/1 [==============================] - ETA: 0s - loss: 1.4809e-05 - accuracy: 1.0000WARNING:tensorflow:Early stopping conditioned on metric `val_loss` which is not available. Available metrics are: loss,accuracy
1/1 [==============================] - 0s 55ms/step - loss: 1.4809e-05 - accuracy: 1.0000
Epoch 11/15
1/1 [==============================] - ETA: 0s - loss: 1.0923e-09 - accuracy: 1.0000WARNING:tensorflow:Early stopping conditioned on metric `val_loss` which is not available. Available metrics are: loss,accuracy
1/1 [==============================] - 0s 59ms/step - loss: 1.0923e-09 - accuracy: 1.0000
Epoch 12/15
1/1 [==============================] - ETA: 0s - loss: 2.2084e-07 - accuracy: 1.0000WARNING:tensorflow:Early stopping conditioned on metric `val_loss` which is not available. Available metrics are: loss,accuracy
1/1 [==============================] - 0s 57ms/step - loss: 2.2084e-07 - accuracy: 1.0000
Epoch 13/15
1/1 [==============================] - ETA: 0s - loss: 3.2267e-09 - accuracy: 1.0000WARNING:tensorflow:Early stopping conditioned on metric `val_loss` which is not available. Available metrics are: loss,accuracy
1/1 [==============================] - 0s 56ms/step - loss: 3.2267e-09 - accuracy: 1.0000
Epoch 14/15
1/1 [==============================] - ETA: 0s - loss: 3.3636e-09 - accuracy: 1.0000WARNING:tensorflow:Early stopping conditioned on metric `val_loss` which is not available. Available metrics are: loss,accuracy
1/1 [==============================] - 0s 57ms/step - loss: 3.3636e-09 - accuracy: 1.0000
Epoch 15/15
1/1 [==============================] - ETA: 0s - loss: 1.2460e-08 - accuracy: 1.0000WARNING:tensorflow:Early stopping conditioned on metric `val_loss` which is not available. Available metrics are: loss,accuracy
1/1 [==============================] - 0s 294ms/step - loss: 1.2460e-08 - accuracy: 1.0000
```



```
Epoch 1/15
1/1 [==============================] - ETA: 0s - loss: 0.0141 - accuracy: 1.0000WARNING:tensorflow:Early stopping conditioned on metric `val_loss` which is not available. Available metrics are: loss,accuracy
1/1 [==============================] - 4s 4s/step - loss: 0.0141 - accuracy: 1.0000
Epoch 2/15
1/1 [==============================] - ETA: 0s - loss: 0.3821 - accuracy: 1.0000WARNING:tensorflow:Early stopping conditioned on metric `val_loss` which is not available. Available metrics are: loss,accuracy
1/1 [==============================] - 0s 61ms/step - loss: 0.3821 - accuracy: 1.0000
Epoch 3/15
1/1 [==============================] - ETA: 0s - loss: 9.9588e-07 - accuracy: 1.0000WARNING:tensorflow:Early stopping conditioned on metric `val_loss` which is not available. Available metrics are: loss,accuracy
1/1 [==============================] - 0s 265ms/step - loss: 9.9588e-07 - accuracy: 1.0000
Epoch 4/15
1/1 [==============================] - ETA: 0s - loss: 2.7808e-07 - accuracy: 1.0000WARNING:tensorflow:Early stopping conditioned on metric `val_loss` which is not available. Available metrics are: loss,accuracy
1/1 [==============================] - 0s 57ms/step - loss: 2.7808e-07 - accuracy: 1.0000
Epoch 5/15
1/1 [==============================] - ETA: 0s - loss: 0.3486 - accuracy: 1.0000WARNING:tensorflow:Early stopping conditioned on metric `val_loss` which is not available. Available metrics are: loss,accuracy
1/1 [==============================] - 0s 59ms/step - loss: 0.3486 - accuracy: 1.0000
Epoch 6/15
1/1 [==============================] - ETA: 0s - loss: 0.0010 - accuracy: 1.0000WARNING:tensorflow:Early stopping conditioned on metric `val_loss` which is not available. Available metrics are: loss,accuracy
1/1 [==============================] - 0s 59ms/step - loss: 0.0010 - accuracy: 1.0000
Epoch 7/15
1/1 [==============================] - ETA: 0s - loss: 4.5681e-07 - accuracy: 1.0000WARNING:tensorflow:Early stopping conditioned on metric `val_loss` which is not available. Available metrics are: loss,accuracy
1/1 [==============================] - 0s 59ms/step - loss: 4.5681e-07 - accuracy: 1.0000
Epoch 8/15
1/1 [==============================] - ETA: 0s - loss: 6.5616e-07 - accuracy: 1.0000WARNING:tensorflow:Early stopping conditioned on metric `val_loss` which is not available. Available metrics are: loss,accuracy
1/1 [==============================] - 0s 60ms/step - loss: 6.5616e-07 - accuracy: 1.0000
Epoch 9/15
1/1 [==============================] - ETA: 0s - loss: 2.6307e-10 - accuracy: 1.0000WARNING:tensorflow:Early stopping conditioned on metric `val_loss` which is not available. Available metrics are: loss,accuracy
1/1 [==============================] - 1s 902ms/step - loss: 2.6307e-10 - accuracy: 1.0000
Epoch 10/15
1/1 [==============================] - ETA: 0s - loss: 3.2462e-10 - accuracy: 1.0000WARNING:tensorflow:Early stopping conditioned on metric `val_loss` which is not available. Available metrics are: loss,accuracy
1/1 [==============================] - 1s 672ms/step - loss: 3.2462e-10 - accuracy: 1.0000
Epoch 11/15
1/1 [==============================] - ETA: 0s - loss: 1.1235e-10 - accuracy: 1.0000WARNING:tensorflow:Early stopping conditioned on metric `val_loss` which is not available. Available metrics are: loss,accuracy
1/1 [==============================] - 1s 867ms/step - loss: 1.1235e-10 - accuracy: 1.0000
Epoch 12/15
1/1 [==============================] - ETA: 0s - loss: 6.5517e-08 - accuracy: 1.0000WARNING:tensorflow:Early stopping conditioned on metric `val_loss` which is not available. Available metrics are: loss,accuracy
1/1 [==============================] - 0s 59ms/step - loss: 6.5517e-08 - accuracy: 1.0000
Epoch 13/15
1/1 [==============================] - ETA: 0s - loss: 1.4304e-10 - accuracy: 1.0000WARNING:tensorflow:Early stopping conditioned on metric `val_loss` which is not available. Available metrics are: loss,accuracy
1/1 [==============================] - 0s 58ms/step - loss: 1.4304e-10 - accuracy: 1.0000
Epoch 14/15
1/1 [==============================] - ETA: 0s - loss: 5.4377e-09 - accuracy: 1.0000WARNING:tensorflow:Early stopping conditioned on metric `val_loss` which is not available. Available metrics are: loss,accuracy
1/1 [==============================] - 0s 55ms/step - loss: 5.4377e-09 - accuracy: 1.0000
Epoch 15/15
1/1 [==============================] - ETA: 0s - loss: 1.2230e-08 - accuracy: 1.0000WARNING:tensorflow:Early stopping conditioned on metric `val_loss` which is not available. Available metrics are: loss,accuracy
1/1 [==============================] - 0s 56ms/step - loss: 1.2230e-08 - accuracy: 1.0000
```



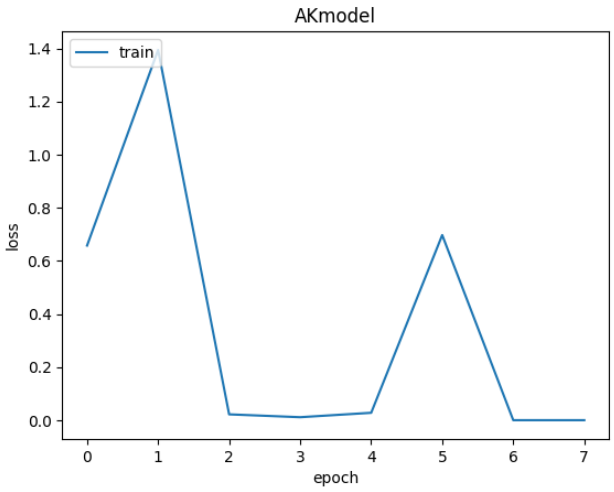
Model: "sequential_8"

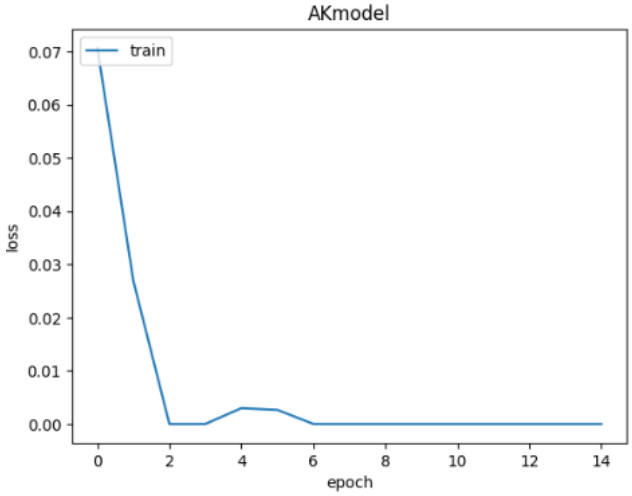
Layer (type)	Output Shape	Param #
conv2d_40 (Conv2D)	(None, 128, 128, 16)	448
max_pooling2d_40 (MaxPooling2D)	(None, 64, 64, 16)	0
batch_normalization_40 (BatchNormalization)	(None, 64, 64, 16)	64
dropout_40 (Dropout)	(None, 64, 64, 16)	0
conv2d_41 (Conv2D)	(None, 62, 62, 32)	4640
max_pooling2d_41 (MaxPooling2D)	(None, 31, 31, 32)	0
batch_normalization_41 (BatchNormalization)	(None, 31, 31, 32)	128
dropout_41 (Dropout)	(None, 31, 31, 32)	0
conv2d_42 (Conv2D)	(None, 29, 29, 64)	18496
max_pooling2d_42 (MaxPooling2D)	(None, 14, 14, 64)	0
batch_normalization_42 (BatchNormalization)	(None, 14, 14, 64)	256
dropout_42 (Dropout)	(None, 14, 14, 64)	0
conv2d_43 (Conv2D)	(None, 12, 12, 128)	73856
max_pooling2d_43 (MaxPooling2D)	(None, 6, 6, 128)	0
batch_normalization_43 (BatchNormalization)	(None, 6, 6, 128)	512
dropout_43 (Dropout)	(None, 6, 6, 128)	0
conv2d_44 (Conv2D)	(None, 4, 4, 256)	295168
max_pooling2d_44 (MaxPooling2D)	(None, 2, 2, 256)	0
batch_normalization_44 (BatchNormalization)	(None, 2, 2, 256)	1024
dropout_44 (Dropout)	(None, 2, 2, 256)	0
flatten_8 (Flatten)	(None, 1024)	0
dense_8 (Dense)	(None, 1)	1025

Total params: 395617 (1.51 MB)
Trainable params: 394625 (1.51 MB)
Non-trainable params: 992 (3.88 KB)

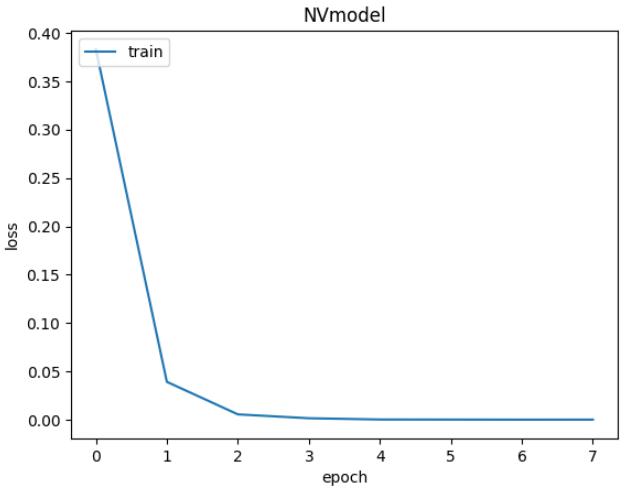
5. MODEL 1 VE MODEL 2 FARKININ GÖZLEMLENEBİLECEĞİ GRAFİKLER

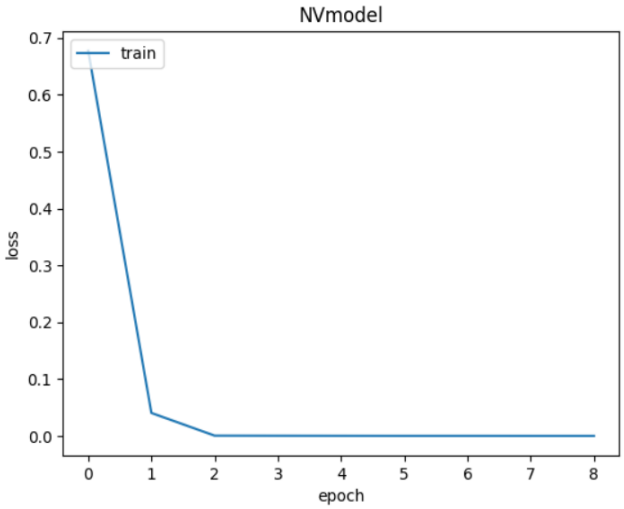
5.1. AKModel



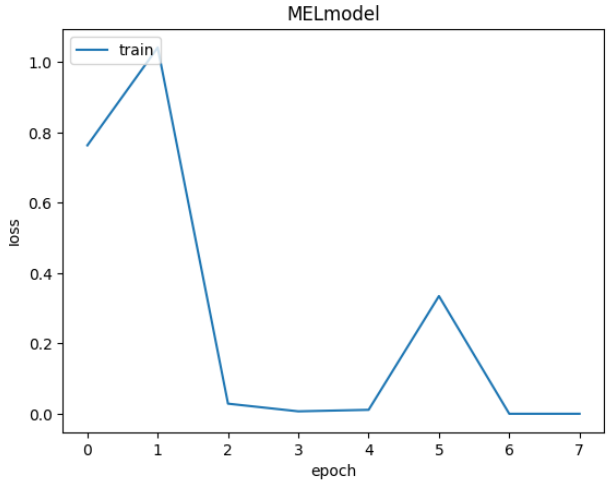


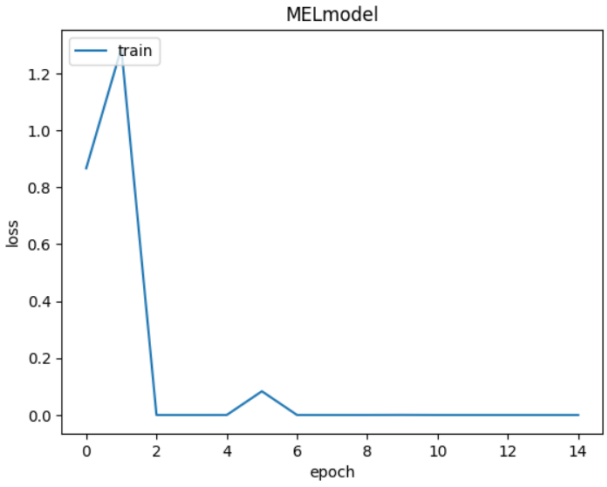
5.2. NVModel



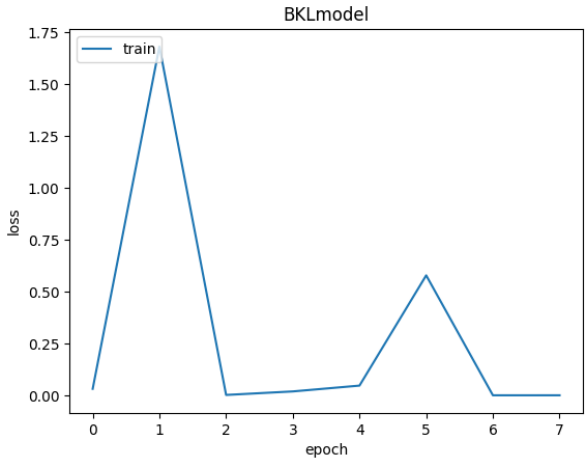


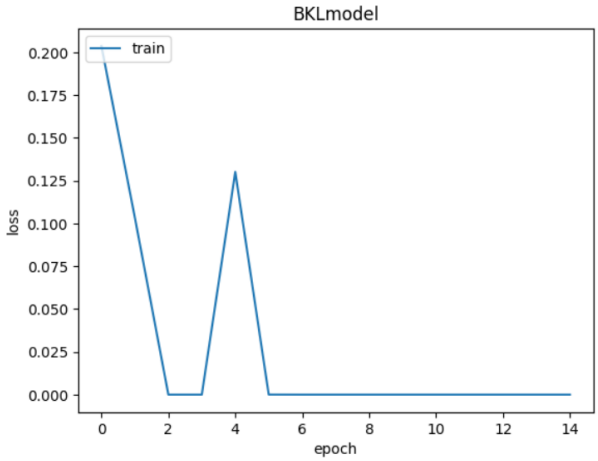
5.3. MELModel



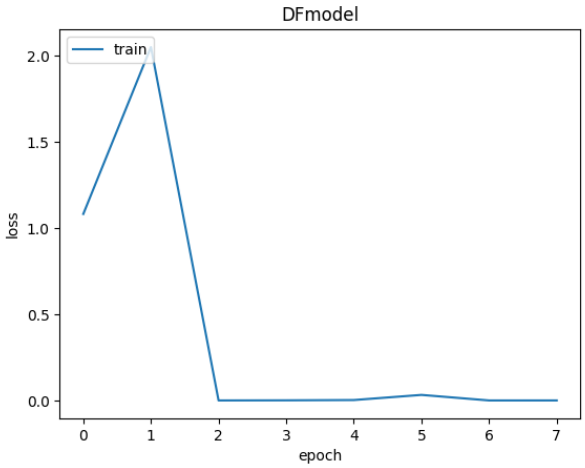


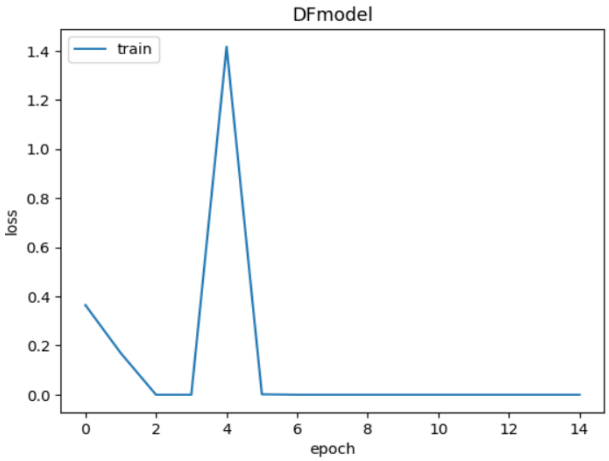
5.4. BKLModel



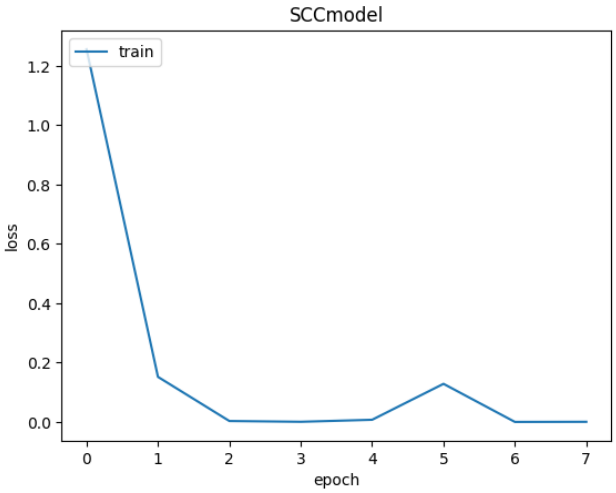


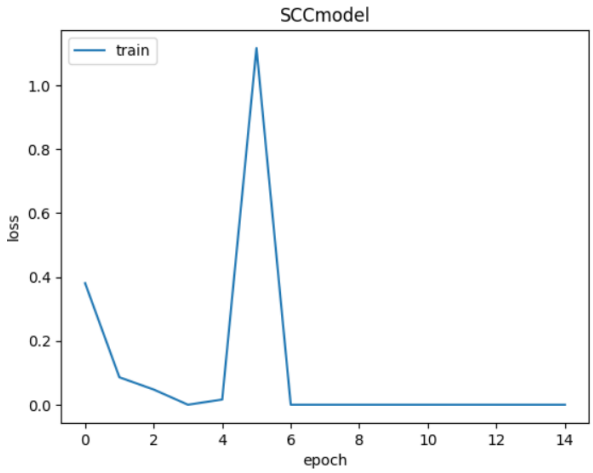
5.5. DFModel



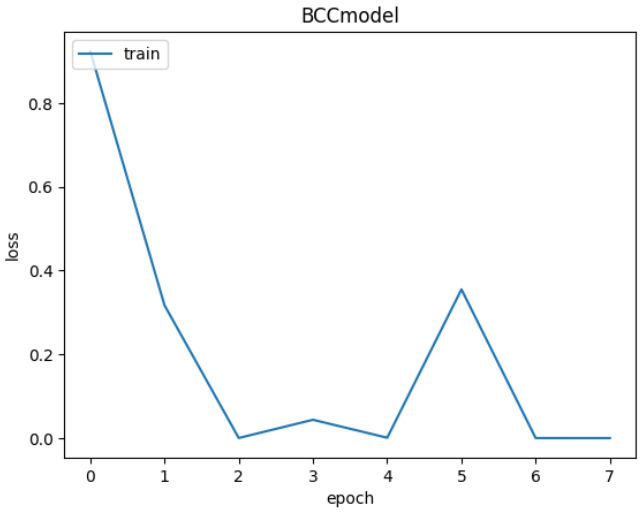


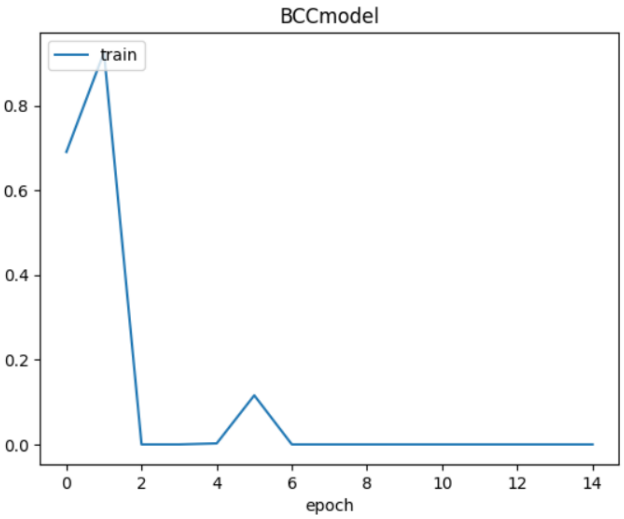
5.6. SCCModel





5.7. BCCModel





5.8. VASCModel