Computer vision in the new era of Artificial Intelligence and Deep Learning

Visión por computador en la nueva era de la Inteligencia Artificial y el Deep Learning

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https://github.com/albertofernandezvillan/computer-vision-and-deep-learning-course

TensorFlow and Keras

Introduction to TensorFlow and Keras

- keras_applications_prediction.ipynb
- set_up_kaggle_api_in_colab.ipynb
- keras_applications_feature_extraction_for_classification.ipynb
- keras_applications_feature_extraction_for_clustering.ipynb
- keras_imagedatagenerator_and_dataset_augmentation.ipynb
- keras_applications_transfer_learning.ipynb

Open in Colab

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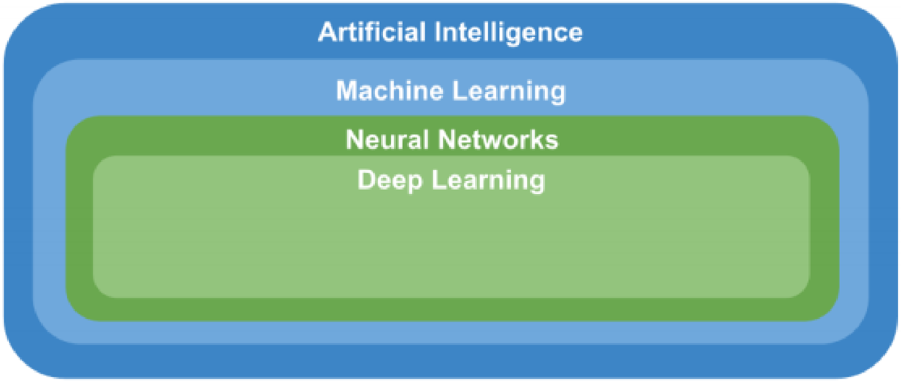
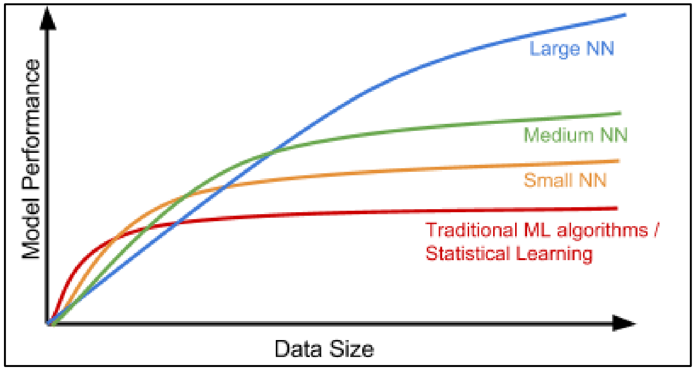
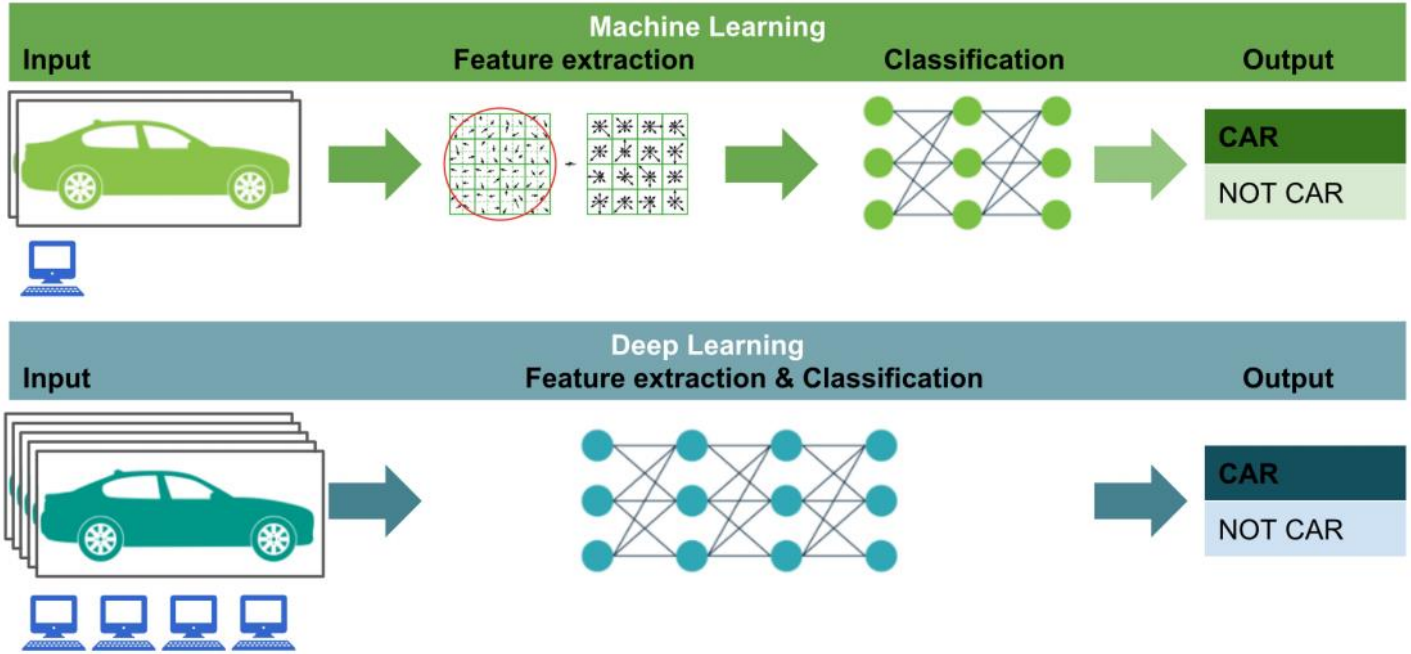
Machine learning vs deep learning







Deep learning frameworks

Deep learning frameworks introduced in this course

TensorFlow Keras PyTorch

Introduction to Keras

- Models API: Different ways to create Keras models
- Layers API: API for creating layers and also using many built-in layers
- Callbacks API: Performing “actions” at various stages of training (e.g. At start or end of an epoch)
- Data preprocessing: Transfor raw data on disk to a Dataset. Also other functions to work with images (e.g. load an image into PIL format)
- Optimizers: Different available optimizers (e.g. SGD, RMSprop, Adam)
- Metrics: Many available metrics to judge the permormance of your model
- Losses: Many available losses, which compute the quantity that a model should seek to minimize during training
- Built-in datasets: Few toy datasets (already-vectorized, in Numpy format) that can be used for debugging a model or creating simple code examples. See also TensorFlow Datasets
- Keras Applications: Deep learning models that are made available alongside pre-trained weights. These models can be used for prediction, feature extraction, and fine-tuning
- Utilities: Many utilities for: 1) model plotting, 2) serialization, 3) Python NumPy, …

Introduction to Keras Applications

[Keras Applications](): Keras Applications are deep learning models that are made available alongside pre-trained weights. These models can be used for 1) prediction, 2) feature extraction, and 3) fine-tuning.

Example for prediction

```
from tensorflow.keras.applications.resnet50 import ResNet50
```

```
model = ResNet50(weights='imagenet')
```

Instantiates the ResNet50 architecture with the weights pre-trained on ImageNet (note that include_top is True by default

Introduction to Keras Applications

Keras Applications: Keras Applications are deep learning models that are made available alongside pre-trained weights. These models can be used for 1) prediction, 2) feature extraction, and 3) fine-tuning.

Example for prediction

```
from tensorflow.keras.applications.resnet50 import ResNet50
from tensorflow.keras.preprocessing import image
from tensorflow.keras.applications.resnet50 import preprocess_input, decode_predictions
```

```
model = ResNet50(weights='imagenet')
```

Instantiates the ResNet50 architecture with the weights pre-trained on ImageNet (note that include_top is True by default

```
img_loaded = image.load_img(IMG_NAME, target_size=(224, 224))
```

Load the image (PIL format)

```
x = image.img_to_array(img_loaded)
x = np.expand_dims(x, axis=0)
x = preprocess_input(x)
```

Converts a PIL Image instance to a NumPy array

Shape: (1, 224, 224, 3)

The images are converted from RGB to BGR, then each color channel is zero-centered

```
preds = model.predict(x)
```

Get the predictions

```
decoded_preds = decode_predictions(preds, top=3)[0]
```

decode the results into a list of tuples (class, description, probability)

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Example for prediction

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Inst   nts pre-
tra   y default

```
img_loaded = image.load_img(IMG_NAME, target_
```

ormat)

```
x = image.img_to_array(img_loaded)
x = np.expand_dims(x, axis=0)
x = preprocess_input(x)
```

y array

GR, then

show_predictions(predictions, img)

```
preds = model.predict(x)
```

Get the predictions

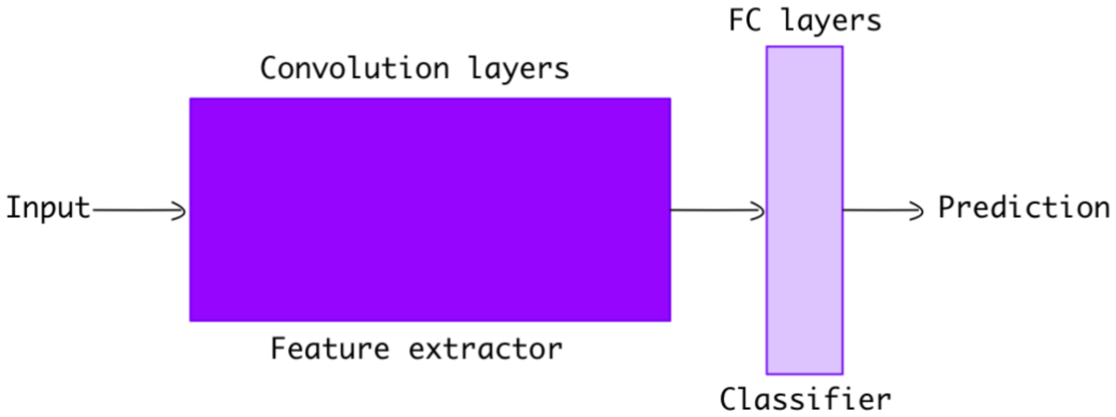
```
decoded_preds = decode_predictions(preds, top=3)[0]
```

decode the results into a list of tuples (class, description, probability)

Introduction to Keras Applications

Example for feature extraction in a classification problem

- Convolution layers extract features from the image
- Fully connected layers classify the image using extracted features.



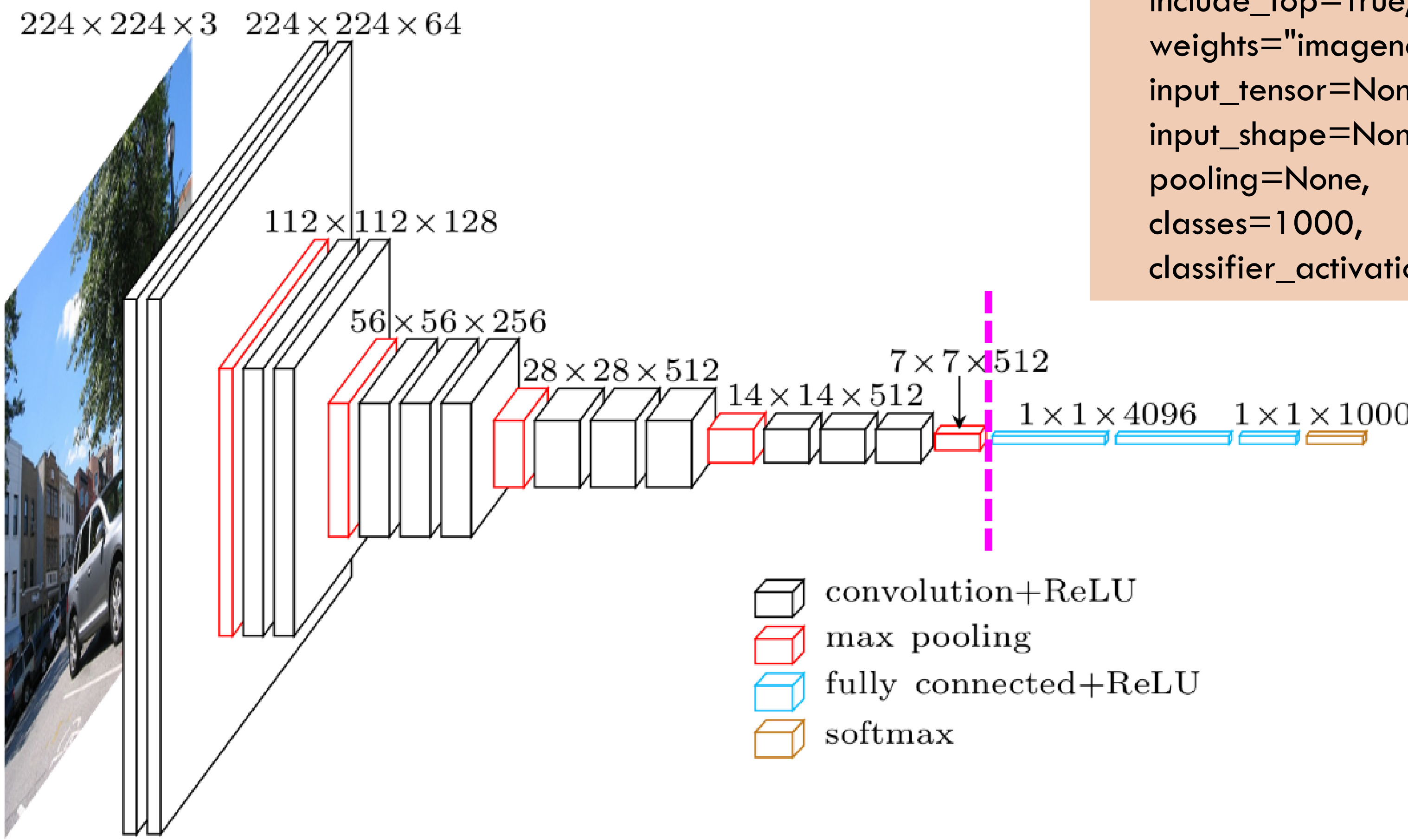
`include_top` parameter when instanciating the model indicates if including (`True`) or not including (`False`) the fully connected layers at the top of the network

Introduction to Keras Applications

Example for feature extraction in a classification problem

VGG16

```
tf.keras.applications.VGG16(
    include_top=True,
    weights="imagenet",
    input_tensor=None,
    input_shape=None,
    pooling=None,
    classes=1000,
    classifier_activation="softmax")
```



Introduction to Keras Applications

Example for feature extraction in a classification problem

VGG16

We will be using the first one. See the notebook for more information

```
model = VGG16(weights="imagenet", include_top=False, input_shape=(224, 224, 3))
•  Output from block5_pool (MaxPooling2D): (None, 7, 7, 512)
```

```
model_2 = VGG16(weights="imagenet", include_top=False, input_shape=(112, 112, 3))
•  Output from block5_pool (MaxPooling2D)   (None, 3, 3, 512)
```

```
model_pooling = VGG16(weights="imagenet", include_top=False, input_shape=(224, 224, 3),
pooling='max')
•  Output from global_max_pooling2d (GlobalMaxPooling2D) (None, 512)
```

```
model_2_pooling = VGG16(weights="imagenet", include_top=False, input_shape=(112, 112, 3),
pooling='max')
•  Output from global_max_pooling2d_1 (GlobalMaxPooling2D) (None, 512)
```

```
model_flatten = tf.keras.models.Sequential()
model_flatten.add(VGG16(weights="imagenet", include_top=False),input_shape=(224, 224, 3))
model_flatten.add(tf.keras.layers.Flatten())
•  Output from flatten: (None, 25088)
```

Introduction to Keras Applications

Example for feature extraction in a classification problem

VGG16

```
model = VGG16(weights="imagenet", include_top=False, input_shape=(224, 224, 3))
•   Output from block5_pool (MaxPooling2D): (None, 7, 7, 512)
```

```
import numpy as np

def get_features(path_image):
  img = load_img(path_image, target_size=(224, 224))
  img = img_to_array(img)
  img = np.expand_dims(img, axis=0)
  img = preprocess_input(img)

  vgg16_feats= model.predict(img)
  vgg16_feats_flat = vgg16_feats.flatten()

  return vgg16_feats_flat
```

For each image, this function returns a flatten array with a shape of (25088,)

Introduction to Keras Applications

Example for feature extraction in a classification problem

N_DOGS = 100

N_CATS = 100

```
vgg16_feature_list = []
labels = []

for each image:
 features = get_features(path_image)
 vgg16_feature_list.append(features)
 labels.append(class_name)
```

```
vgg16_feature_list_np = np.array(vgg16_feature_list) #(200,25088)
labels_np = np.array(labels) #(200,)
```

```
from sklearn.linear_model import LogisticRegression

log_reg_model = LogisticRegression()
log_reg_model.fit(vgg16_feature_list_np, labels_np)
```

```
label =
log_reg_model.predict(get_features(path_image).reshape(1,-1))[0]
```

Introduction to Keras Applications

Example for feature extraction in a clustering problem

N_DOGS = 100

N_CATS = 100

```
vgg16_feature_list = []
labels = []

for each image:
 features = get_features(path_image)
 vgg16_feature_list.append(features)
 labels.append(class_name)
```

```
vgg16_feature_list_np = np.array(vgg16_feature_list) #(200,25088)
labels_np = np.array(labels) #(200,)
```

```
from sklearn.cluster import KMeans

kmeans = KMeans(n_clusters=2, random_state=0)
Kmeans. fit(vgg16_feature_list_np)
```

```
label =
log_reg_model.predict(get_features(path_image).reshape(1,-1))[0]
```

Introduction to Keras Applications

Example for feature extraction in a clustering problem

N_DOGS = 100

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vgg16_feature_list = []
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for each image:
 features = get_features(path_image)
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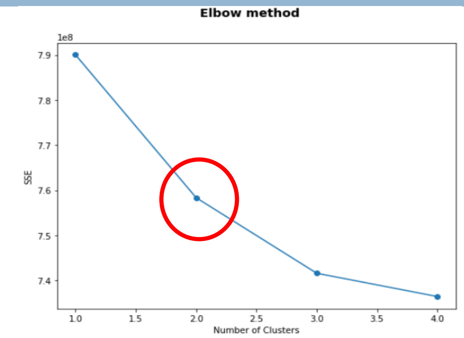


elbow method (see notebook)

```
vgg16_feature_list_np = np.array(vgg16_feature_list) #(200,25088)
labels_np = np.array(labels) #(200,)
```

```
from sklearn.cluster import KMeans

kmeans = KMeans(n_clusters=2, random_state=0)
Kmeans. fit(vgg16_feature_list_np)
```

```
label =
log_reg_model.predict(get_features(path_image).reshape(1,-1))[0]
```

Data augmentation

https://www.tensorflow.org/api_docs/python/tf/keras/preprocessing/image/ImageDataGenerator

```
import tensorflow as tf

data_generator =
tf.keras.preprocessing.image.ImageDataGenerator(rotation_range=30)
image_iterator = data_generator.flow(images)
show_augs(image_iterator)
```

Data augmentation

https://www.tensorflow.org/api_docs/python/tf/keras/preprocessing/image/ImageDataGenerator

```
import tensorflow as tf

data_generator = tf.keras.preprocessing.image.ImageDataGenerator(zoom_range=0.25)
image_iterator = data_generator.flow(images)
show_augs(image_iterator)
```

Data augmentation

https://www.tensorflow.org/api_docs/python/tf/keras/preprocessing/image/ImageDataGenerator

```
import tensorflow as tf

data_generator = tf.keras.preprocessing.image.ImageDataGenerator(width_shift_range=0.3)
image_iterator = data_generator.flow(images)
show_augs(image_iterator)
```

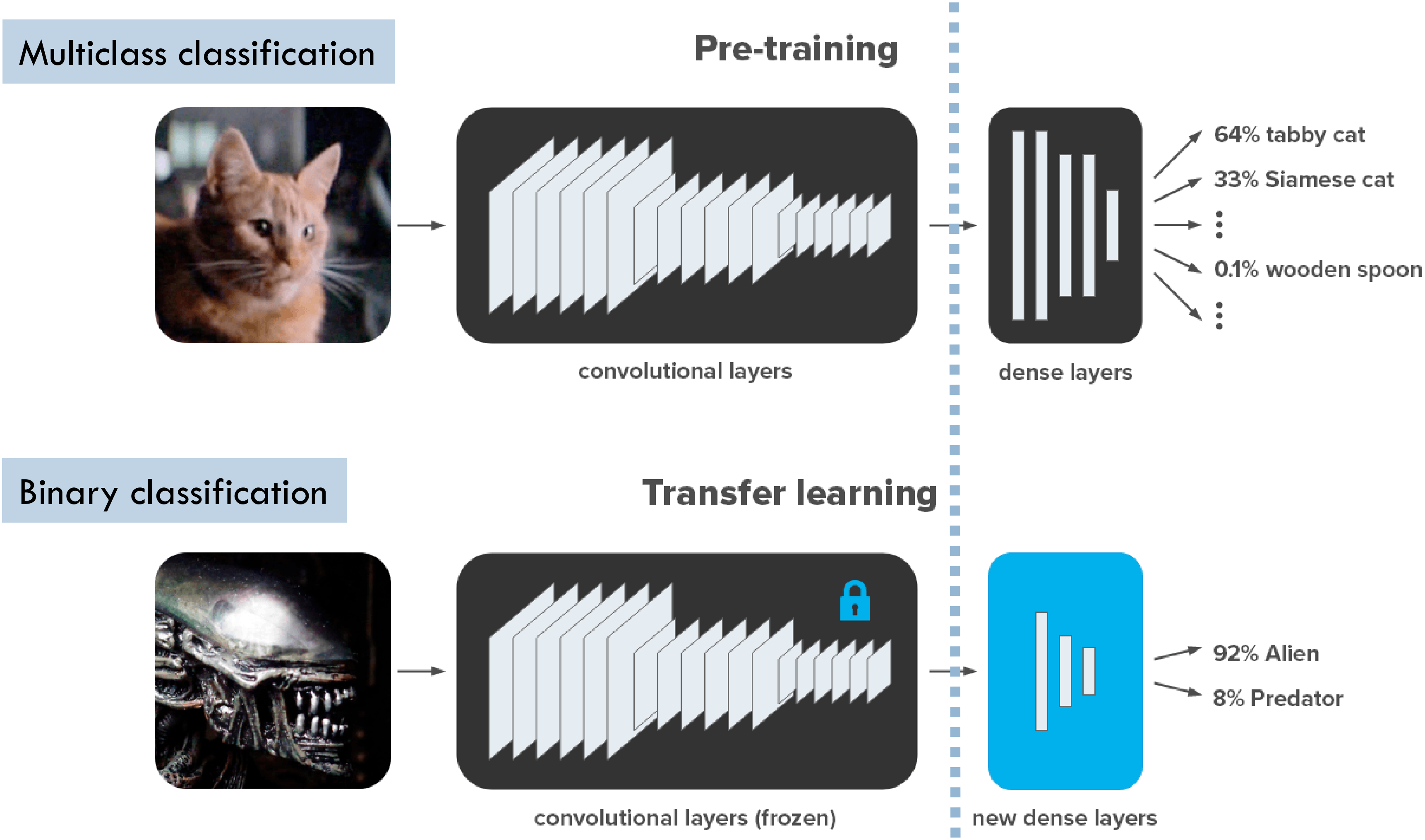
Data augmentation

```
data_generator = tf.keras.preprocessing.image.ImageDataGenerator(
    rescale=1. / 255,
    zoom_range=0.2,
    rotation_range = 5,
    horizontal_flip=True)
```

Introduction to Keras Applications

Example for transfer learning

Image taken from here



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