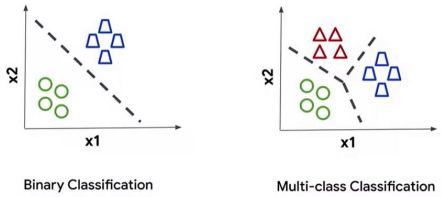
Image Classification

Image Classification

- Multi-class Classification
  - Binary Classification (Subset of the problem)
- Multi-label Classification

Multi-label Classification

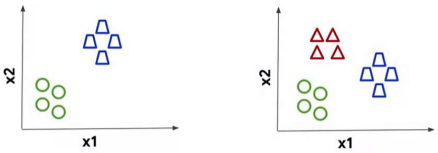
Binary vs. Multi Class Classification



Binary Classification

Multi-class Classification

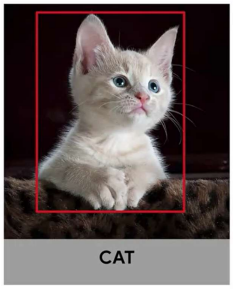
Binary vs. Multi Class Classification



Binary Classification

Multi-class Classification

Object Localization



Object Detection

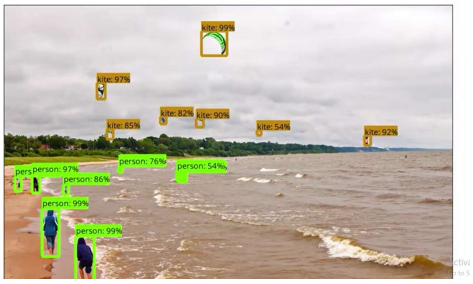


Image Segmentation

Object Detection

- For each object:
  - confidence scores
  - bounding boxes.
- Popular algorithms
  - R-CNN
  - Faster-RCNN
  - YOLO
  - SSD

Semantic vs. Instance Segmentation

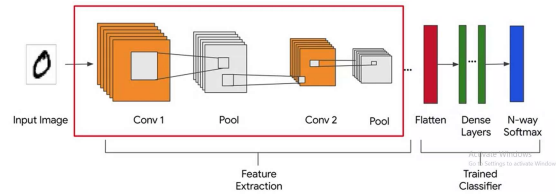
Semantic Segmentation

Instance Segmentation

Semantic Segmentation

- Same class → one segment.
- Each pixel is associated with one class.
  - All person(s) in an image are treated as one segment
- Popular models are Fully Convolutional Neural Networks, U-Net, DeepLab

Convolutional Neural Networks Architecture

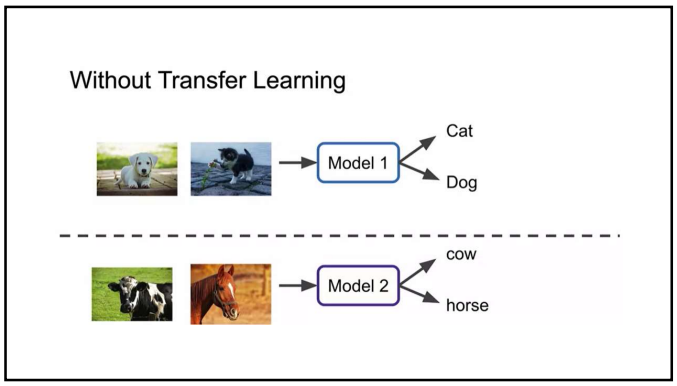


Instance Segmentation

- Multiple "instances" of same class are separate segments.

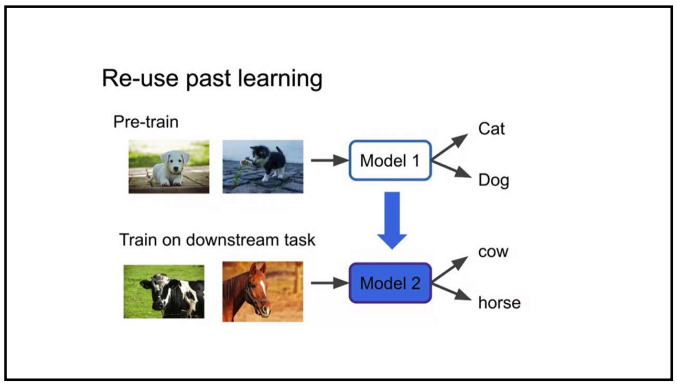
- Popular algorithms are Mask R-CNN.

Without Transfer Learning

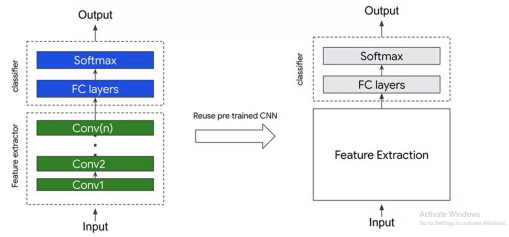


What is Transfer Learning?

- Pre trained model reused for solving downstream task.
- Reuse weights and layers.
- Example: pre-trained MobileNetV2 → cats vs dog classifier.



What is Transfer Learning?



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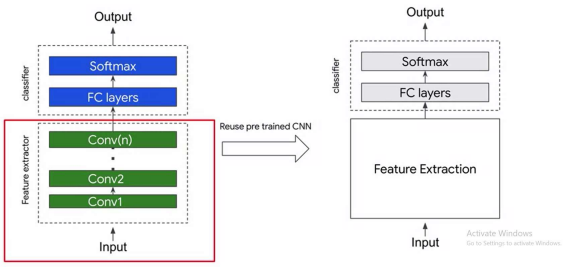

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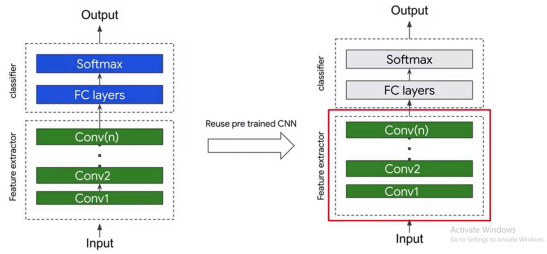

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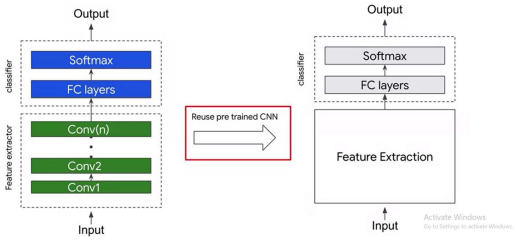
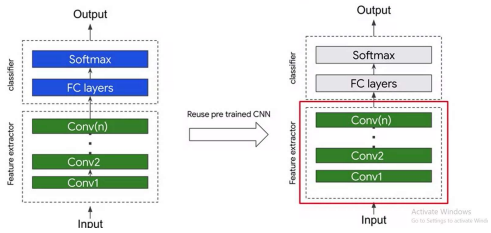
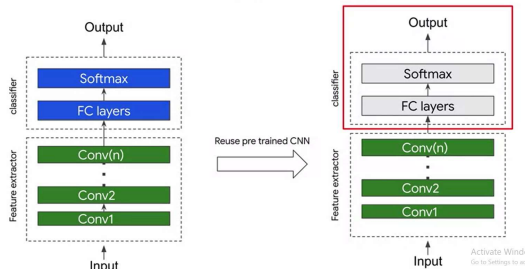


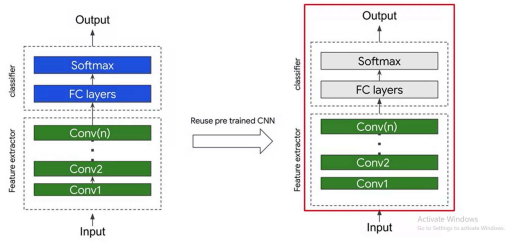
Freeze the Weights



Freeze the Weights



Train with learned values as default



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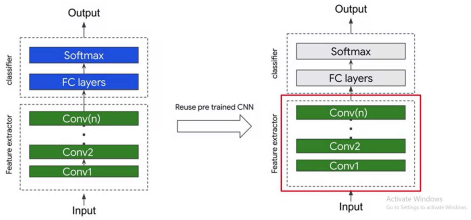
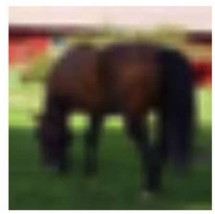


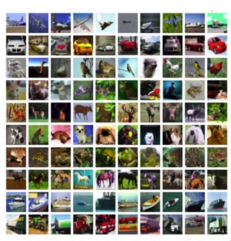
Transfer Learning with ResNet50



CIFAR - 10 Dataset

10

airplane
automobile
bird
cat
deer
dog
frog
horse
ship
truck



https://www.cs.toronto.edu/~kriz/cifar.html

~6,000

...

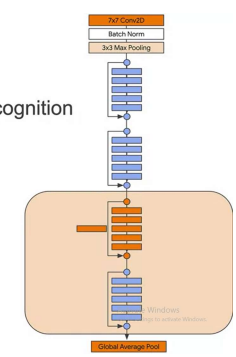
~6,000

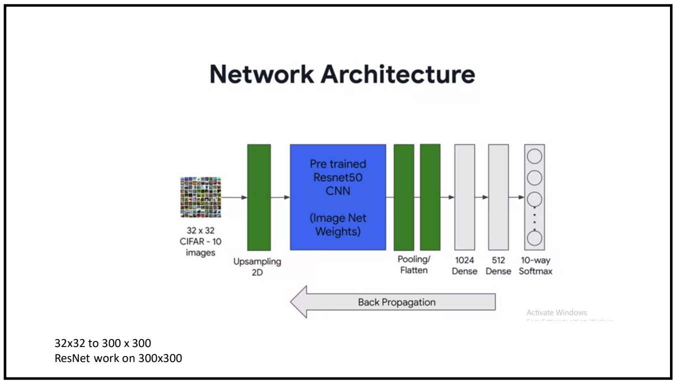
= 60,000

ResNet 50

Deep Residual Learning for Image Recognition

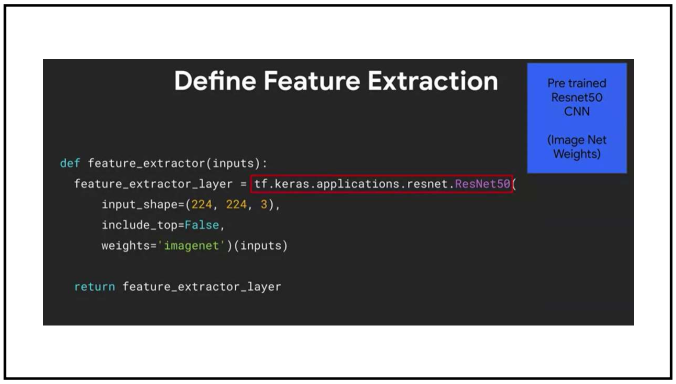
https://arxiv.org/abs/1512.03385





Network Architecture

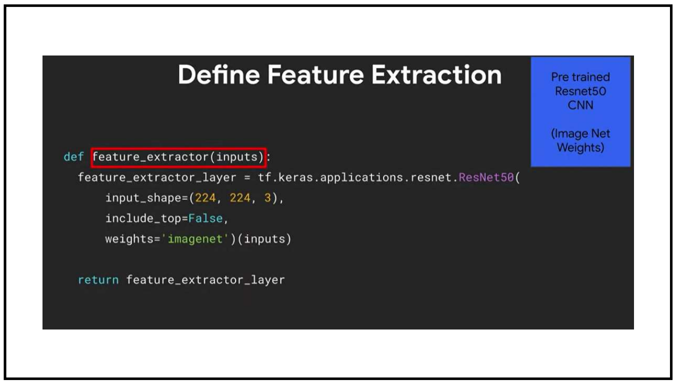
32x32 to 300 x 300
ResNet work on 300x300



Define Feature Extraction

```
def feature_extractor(inputs):
  feature_extractor_layer = tf.keras.applications.resnet.ResNet50(
      input_shape=(224, 224, 3),
      include_top=False,
      weights='imagenet')(inputs)

  return feature_extractor_layer
```



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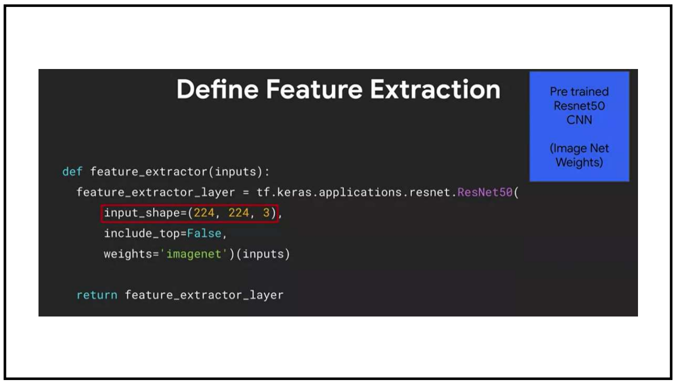

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Define Feature Extraction

Pre trained Resnet50 CNN

(Image Net Weights)

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def feature_extractor(inputs):
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      weights='imagenet')(inputs)

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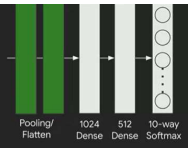
```

Define Classifier




```
def classifier(inputs):
    x = tf.keras.layers.GlobalAveragePooling2D()(inputs)
    x = tf.keras.layers.Flatten()(x)
    x = tf.keras.layers.Dense(1024, activation="relu")(x)
    x = tf.keras.layers.Dense(512, activation="relu")(x)
    x = tf.keras.layers.Dense(10, activation="softmax", name="classification")(x)
    return x
```

Define Feature Extraction

Pre trained Resnet50 CNN

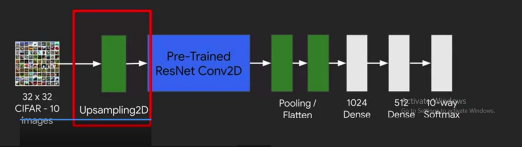
(Image Net Weights)

```
def feature_extractor(inputs):
  feature_extractor_layer = tf.keras.applications.resnet.ResNet50(
      input_shape=(224, 224, 3),
      include_top=False,
      weights='imagenet')(inputs)

  return feature_extractor_layer
```

Define Inputs and Outputs

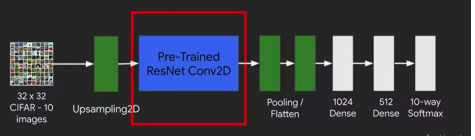
```
def final_model(inputs):
    resize = tf.keras.layers.UpSampling2D(size=(7,7))(inputs)
```



Define Inputs and Outputs

```
def final_model(inputs):
    resize = tf.keras.layers.UpSampling2D(size=(7,7))(inputs)

    resnet_feature_extractor = feature_extractor(resize)
```



Define Inputs and Outputs

```
def final_model(inputs):
    resize = tf.keras.layers.UpSampling2D(size=(7,7))(inputs)

    resnet_feature_extractor = feature_extractor(resize)
    classification_output = classifier(resnet_feature_extractor)

    return classification_output
```