Filters in Convolution Layers

In the previous activity, you applied filters to an input image using convolution. Convolution layers have weights that are used to filter images.

1.

```
>> net = googlenet;
>> layers = net.Layers;
>> conv = layers(2)

conv =

  Convolution2DLayer with properties:

           Name: 'conv1-7x7_s2'

   Hyperparameters
        FilterSize: [7 7]
       NumChannels: 3
        NumFilters: 64
            Stride: [2 2]
    DilationFactor: [1 1]
       PaddingMode: 'manual'
       PaddingSize: [3 3 3 3]

   Learnable Parameters
           Weights: [7×7×3×64 single]
              Bias: [1×1×64 single]
```

Consider the first convolution layer in GoogLeNet. The hyperparameters are set when the layer is created.

2.

```
>> net = googlenet;
>> layers = net.Layers;
>> conv = layers(2)

conv =

  Convolution2DLayer with properties:

           Name: 'conv1-7x7_s2'

   Hyperparameters
        FilterSize: [7 7]
       NumChannels: 3
        NumFilters: 64
            Stride: [2 2]
    DilationFactor: [1 1]
       PaddingMode: 'manual'
       PaddingSize: [3 3 3 3]

   Learnable Parameters
           Weights: [7×7×3×64 single]
              Bias: [1×1×64 single]
```

Recall that the first two inputs to `convolution2dLayer` is the filter size and the number of filters.

3.

```
>> net = googlenet;
>> layers = net.Layers;
>> conv = layers(2)

conv =

  Convolution2DLayer with properties:

            Name: 'conv1-7x7_s2'

   Hyperparameters
        FilterSize: [7 7]
       NumChannels: 3
        NumFilters: 64
            Stride: [2 2]
    DilationFactor: [1 1]
       PaddingMode: 'manual'
       PaddingSize: [3 3 3 3]

   Learnable Parameters
           Weights: [7×7×3×64 single]
              Bias: [1×1×64 single]
```

When you created a convolution layer earlier in this chapter, the default settings were used for the rest of the hyperparameters.

4.

```
>> net = googlenet;
>> layers = net.Layers;
>> conv = layers(2)

conv =

  Convolution2DLayer with properties:

            Name: 'conv1-7x7_s2'

   Hyperparameters
        FilterSize: [7 7]
       NumChannels: 3
        NumFilters: 64
            Stride: [2 2]
    DilationFactor: [1 1]
       PaddingMode: 'manual'
       PaddingSize: [3 3 3 3]

   Learnable Parameters
           Weights: [7×7×3×64 single]
              Bias: [1×1×64 single]
```

*'NumChannels' is the number of channels of the **input** to this convolution layer. In GoogLeNet, the input is the image sized 224-by-224-by-3, so the number of channels is three.*

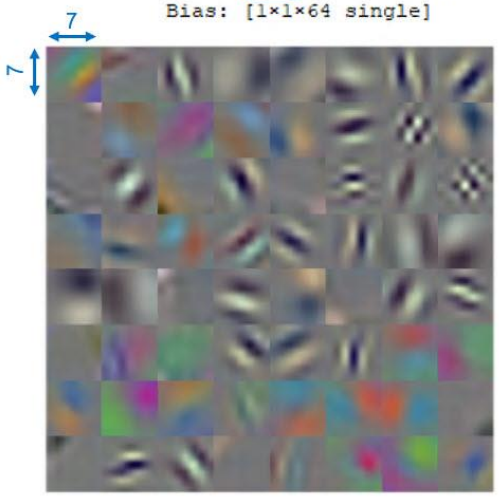
5.

```
>> net = googlenet;
>> layers = net.Layers;
>> conv = layers(2)

conv =

  Convolution2DLayer with properties:

            Name: 'conv1-7x7_s2'

   Hyperparameters
        FilterSize: [7 7]
       NumChannels: 3
        NumFilters: 64
            Stride: [2 2]
    DilationFactor: [1 1]
       PaddingMode: 'manual'
       PaddingSize: [3 3 3 3]

   Learnable Parameters
           Weights: [7×7×3×64 single]
              Bias: [1×1×64 single]
```

The learnable parameters are updated during training, but the size of these arrays is calculated from the filter size, number of input channels, and the number of filters.

6.

```
Learnable Parameters
        Weights: [7×7×3×64 single]
           Bias: [1×1×64 single]
```



The weights in the first convolution layer can be viewed as an RGB image because there are three channels. You will view filters in GoogLeNet in the next interaction.