## **Visualising filters**

What does a filter capture?

1. We have dealt with filters in all our CNN models so far. Now the question is, what exactly does a filter capture?
2. Let’s look at the working of a 2x2 filter on a 4x4 input image
   1. Here, the input image is 4x4 while the fiter is 2x2
   2. The red input pixel vector
   3. The weight vector
   4. By convolving the input pixels with the filter, we get the output
   5. Output
   6. (This is the same as the dot product between the two vectors)
   8. Now for certain inputs, we want the filter to fire (give a high value).
   9. Now, will be high when is high (cos(θ) = 1), i.e. when θ is 0. This implies the two vectors w and x are in the same direction.
   10. So, we can say that an input vector which aligns with a filter vector yields maximum output.
   11. The neuron will fire maximally when (x is a unit vector in the direction of w)
   12. Thus, when we **slide the** **2x2 filter w** across the 4x4 input region, whenever we **reach a 2x2 region x** that looks exactly like the filter, we get a high output. For all other regions which do not align with the filter, the output is low.
3. Now, let us visualize the filters in AlexNet
   1. The above image shows us how different patterns are identified by different filters.