ÉCOLE POLYTECHNIQUE FÉDÉRALE DE LAUSANNE

Color Representation in Deep Neural Networks

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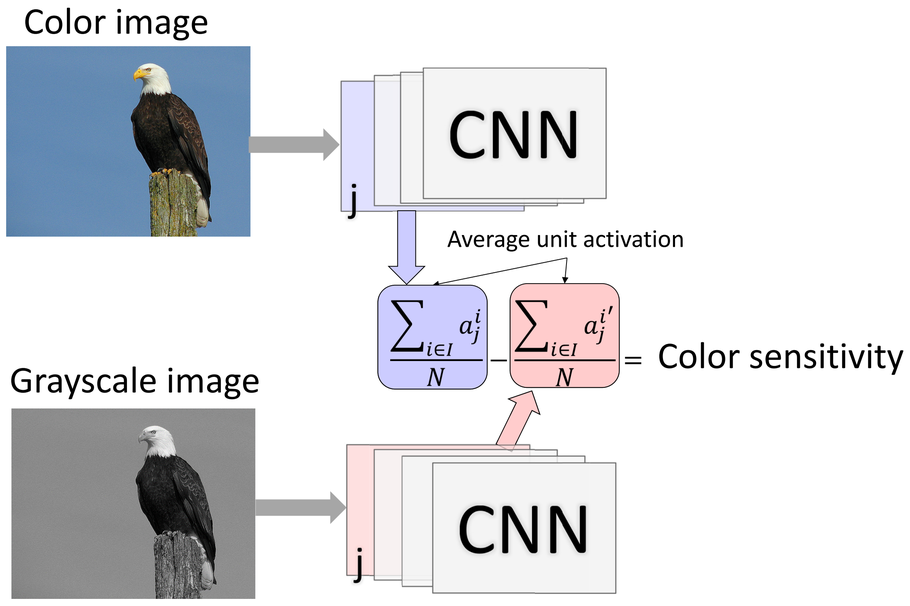
Color Representation in Deep Neural Networks

Deep convolutional neural networks have achieved state-of-art-performance on many vision-related tasks. In this work we investigate how color information is utilized by detecting learned color-sensitive features.

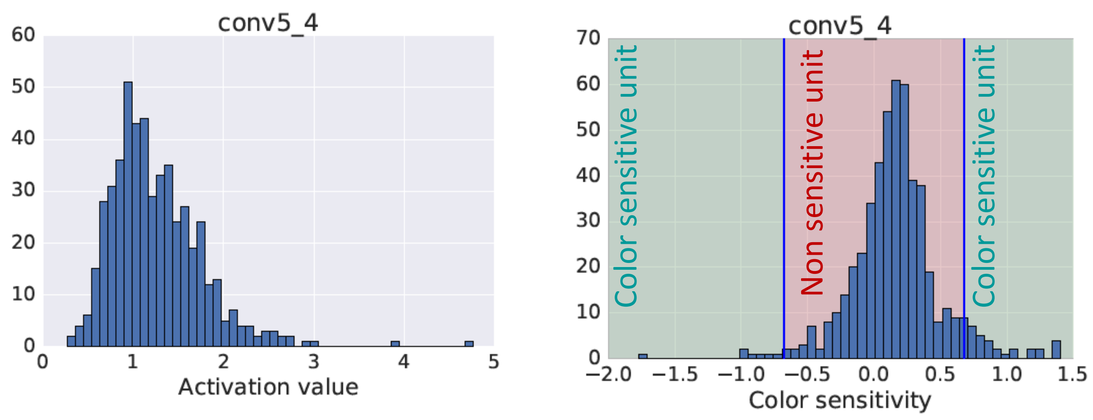
I) Impact of color information

Deep CNNs (such as **VGG**[1] and **Alexnet**[2]) exhibit different performance on classification, depending on whether they are presented with color or grayscale images.



II) Identifying color sensitive unit

Color-sensitive units are defined as units whose average activation changes significantly between color and grayscale versions of the same data. In the figure below, we show color-sensitivity based on images from the PASCAL VOC[3] dataset.



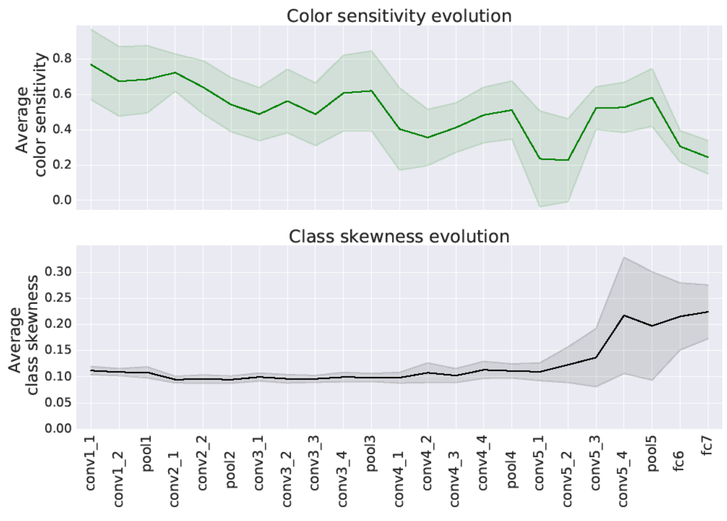
III) Color-sensitive unit analysis

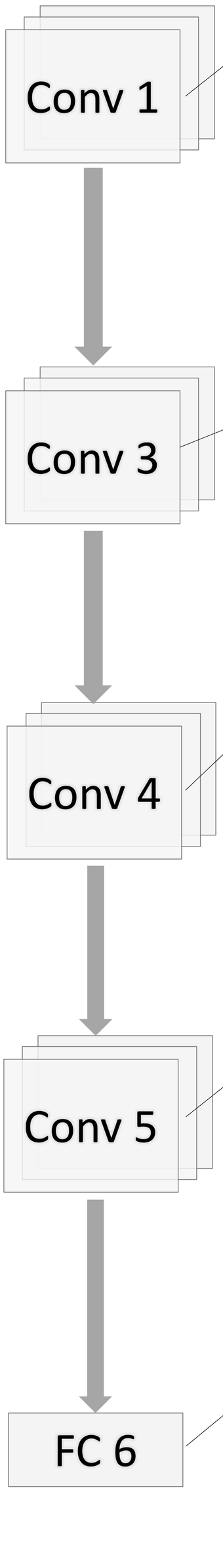
The **hue-specificity** of units is measured by observing the activation value in response to a monochrome image of varying hue.

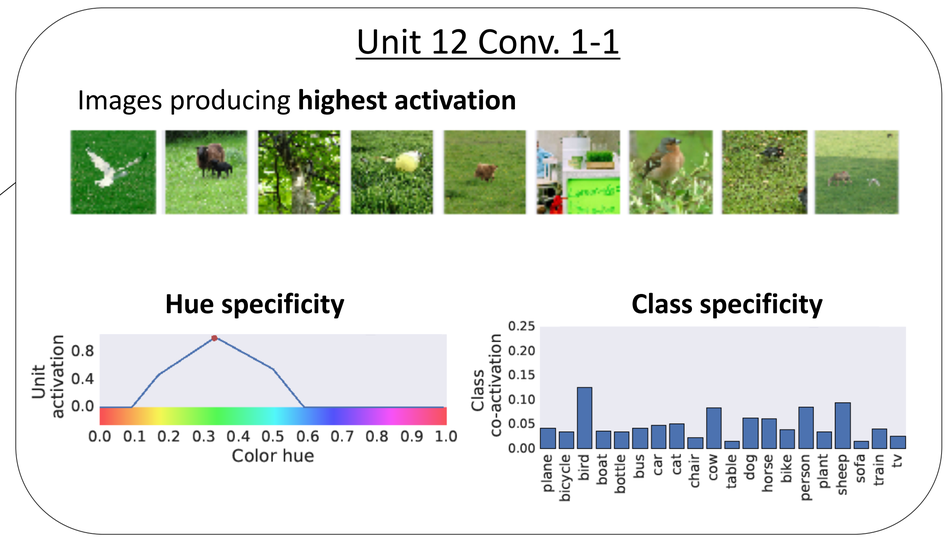
The **co-activation** between units and classes is used to identify units that are **class-invariant**, or **class-specific**.

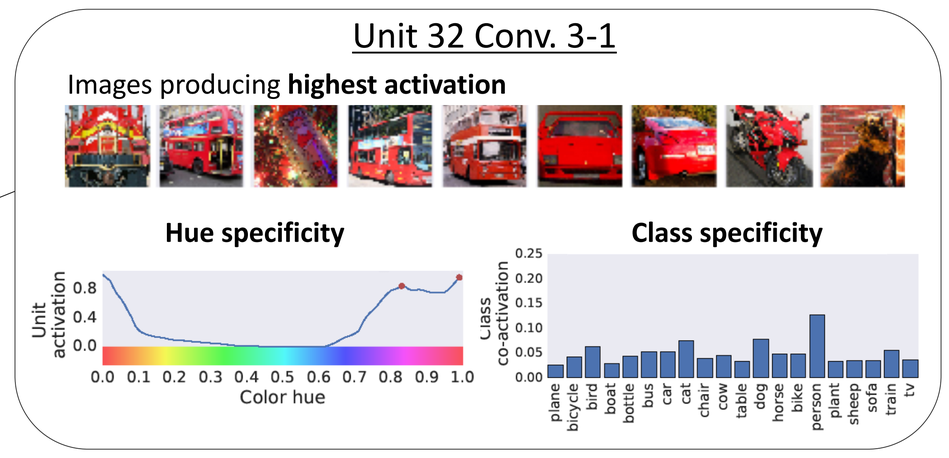
IV) Color-sensitive unit and depth

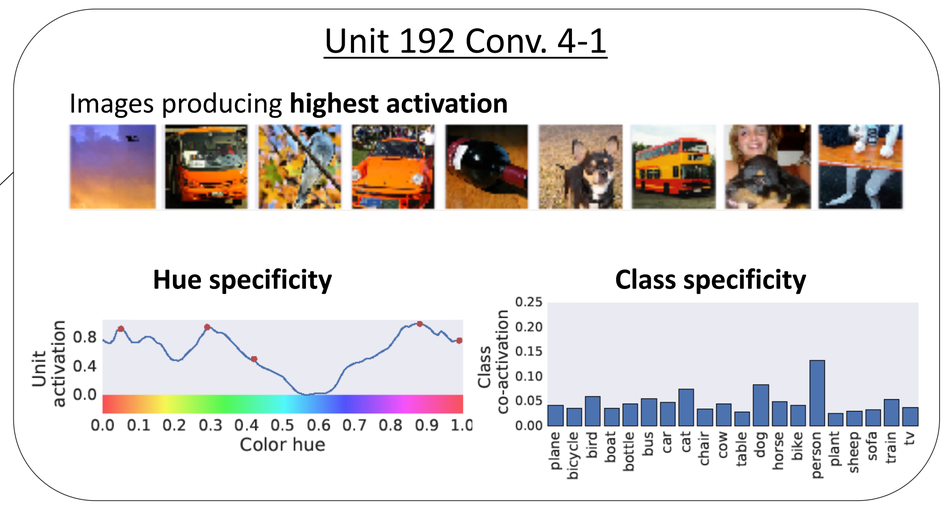
The deeper the layer is in the network, the more units become **class specific** and **less color-sensitive**.

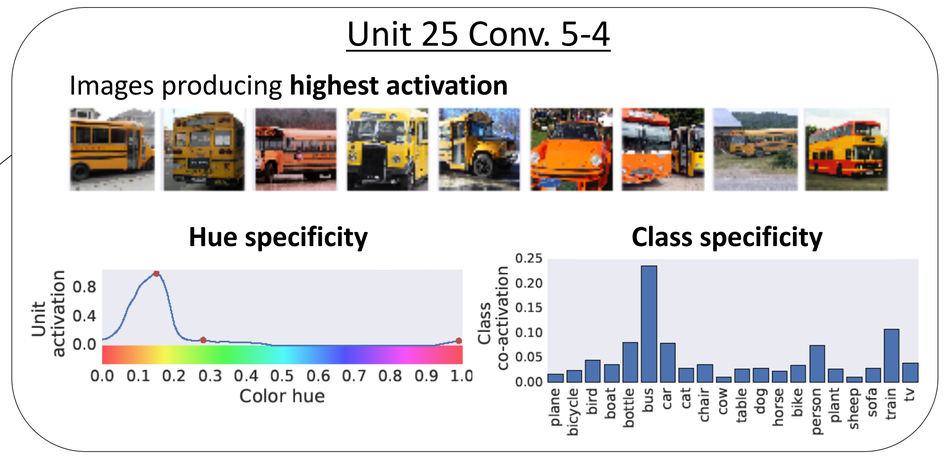


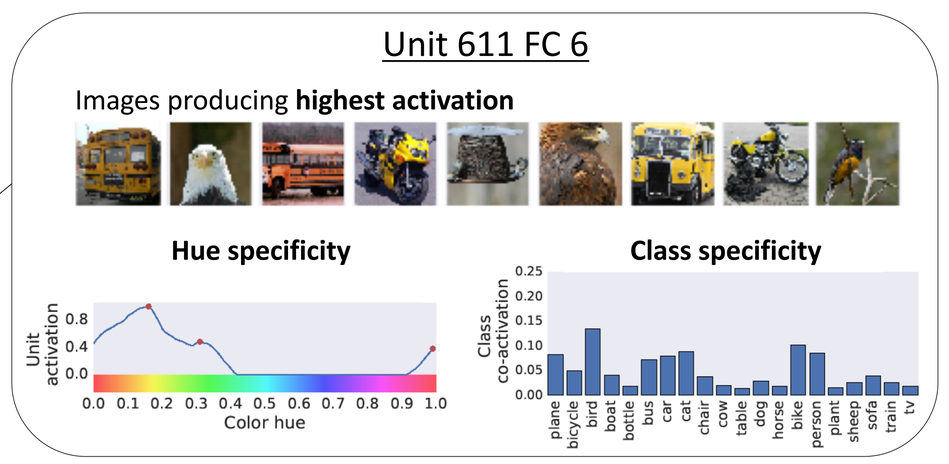












References

[1] K. Simonyan and A. Zisserman, “Very deep convolutional networks for large-scale image recognition,” *CoRR*, vol. abs/1409.1556, 2014.

[2] Alex Krizhevsky, Ilya Sutskever, and Geoffrey E Hinton, “Imagenet classification with deep convolutional neural networks,” in *Advances in Neural Information Processing Systems* 25, F. Pereira, C. J. C. Burges, L. Bottou, and K. Q. Weinberger, Eds., pp. 1097–1105. Curran Associates, Inc., 2012.

[3] Mark Everingham, SM Ali Eslami, Luc Van Gool, Christopher KI Williams, John Winn, and Andrew Zisserman, “The pascal visual object classes challenge: A retrospective,” *International Journal of Computer Vision*, vol. 111, no. 1, pp. 98–136, 2015.