# Wavelets as a Representation for Creative Design


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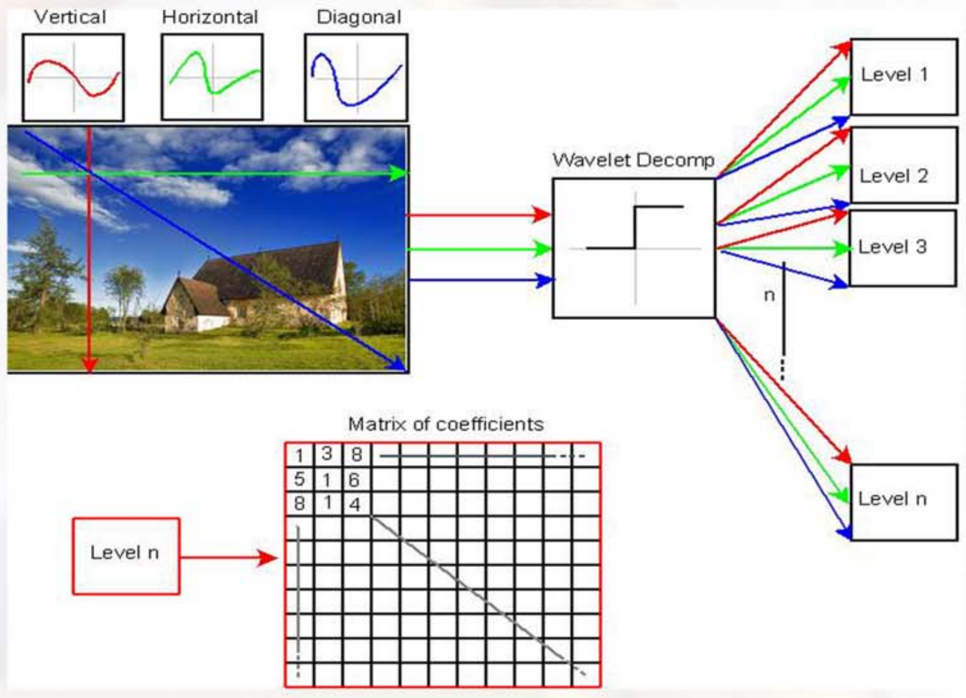

Figure 1: Breaking down an image using the wavelet transform

## Stage 1: Wavelet Decomposition

The wavelet transform is used to break down the input images (see figure 1). The wavelet transform uses small non-linear wavelets to approximate a signal (see figure 2).

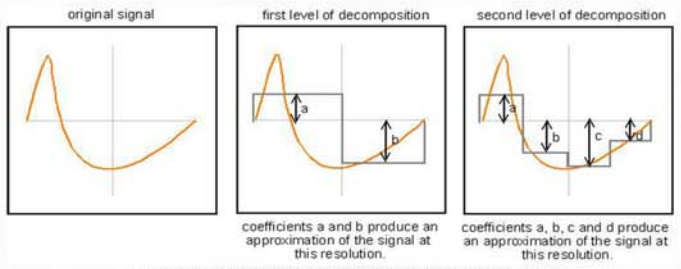

Figure 2: A simple Haar wavelet decomposion

The result of this approximation is a set of coefficient matrices. The size of the coefficient represents how much 'importance' that part of the image plays in the image. A hard threshold can then be applied to each matrix in order to remove the lower coefficients (see figure 3).

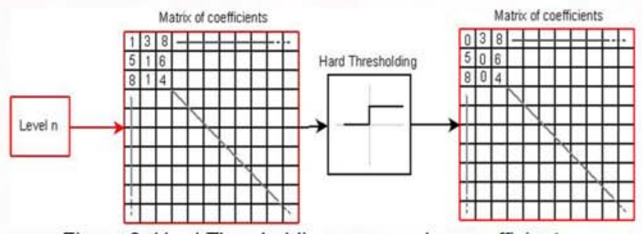

Figure 3: Hard Thresholding removes low coefficients

When used on images the wavelet transform is performed in a horizontal, vertical and diagonal direction. This is important to make sure that all the features in the image are recorded. Recent research has shown that a wavelet type transform is likely to be used by the human vision system. The reason for this is because of the image compression that is possible, by removing the lower coefficients the amount of data is greatly reduced. This non-salient reduction in data is essential in order for the brain to be able to process all of the data received from each of the senes.

## Stage 2: Extract genes, create graph and train

Genes can be extracted from the matrices. by laying a grid over the matrices (the size of which is proportional to the level of decomposion). A gene is extracted from a grid square if there are sufficient non zero cells (see figure 4).

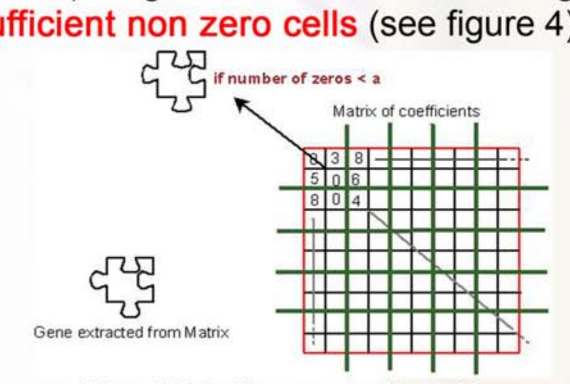

Figure 4: Extracting genes from the matrices

These genes represent the knowledge that can be taken from the image. By creating a genes from a set of images of similar context a knowledge of that domain can be created.

A structure is required that will allow for creative use of the availble data. Modern research suggests that creative thought is possible within the brain because of emotional memory and pre-procesed non-salient memory. The emotional memory links together the pre-processed memory according to its relevance to a certain context.

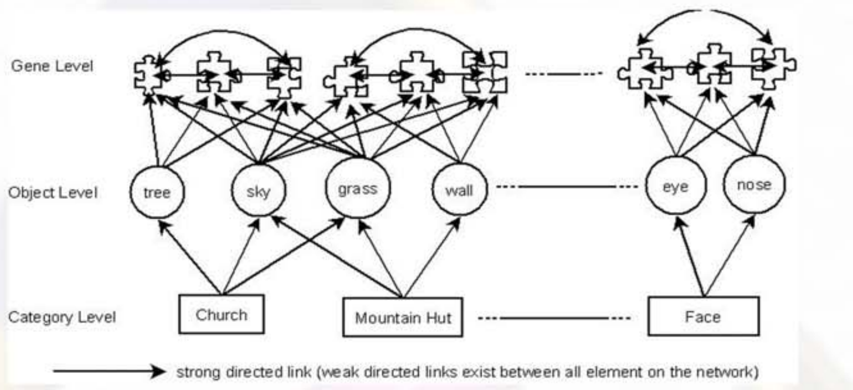

Figure 5: The directed graph representation of image genes, categories and objects.

In the human brain context and objects are represented using language. A directed graph is used to link the genes and linguistic information using weighted arcs (see figure 5).

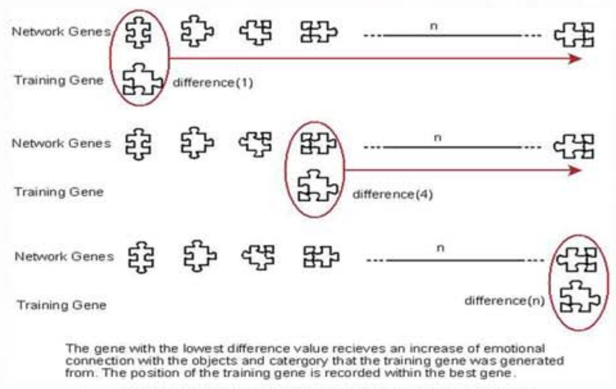

Figure 6: The network gene training regime.

The weights can be trained in order for an aesthetic to evolve (see figures 6 and 7). It is this training process that gives the system its ability to produce creative images.

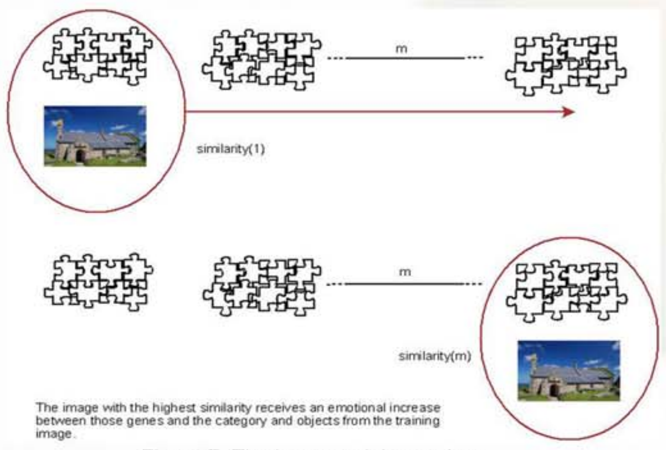

Figure 7: The image training regime.

The gene training regime aims to develop genes that can be used in a scale invarient self similar way.

The image training regime aims to develop emotional links between genes that create successful images.

## Stage 3: Create new images

Once trained, the graph can be used to create new images with a linguistic context and are based on an aesthetic developed in a biologically plausabe way. A path is stochastically created through the graph using the emotional links. A good analogy for this is lightning passing across the graph. (see Figure 8 ).

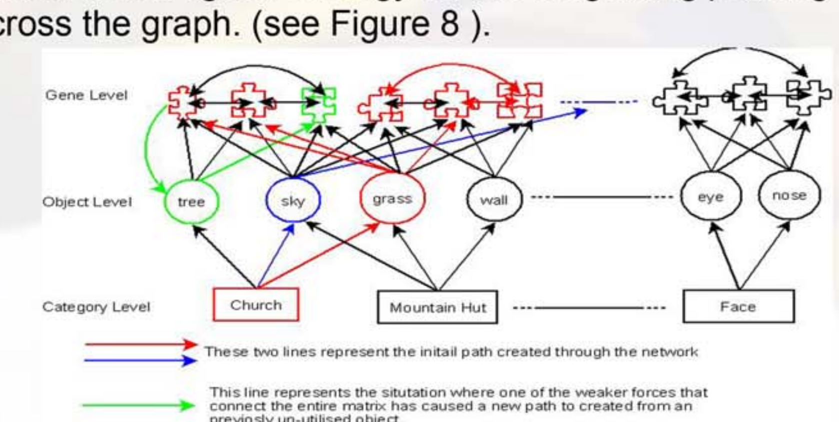

Figure 8: A route created through the graph for the context 'church'

Once a route has been created the genes are placed stochastically and then used to re-compose a new image with context specific stylistic features (see figure 9).

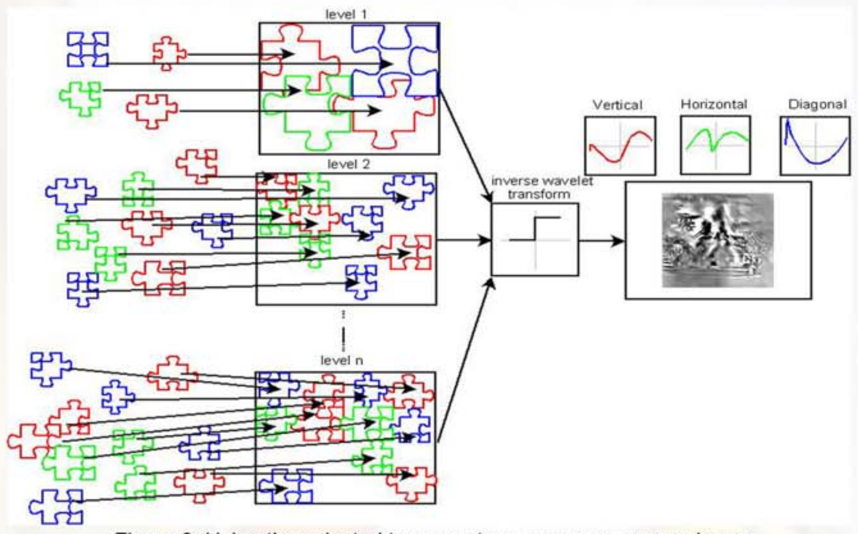

Figure 9: Using the selected to genes to re-compose an new image.

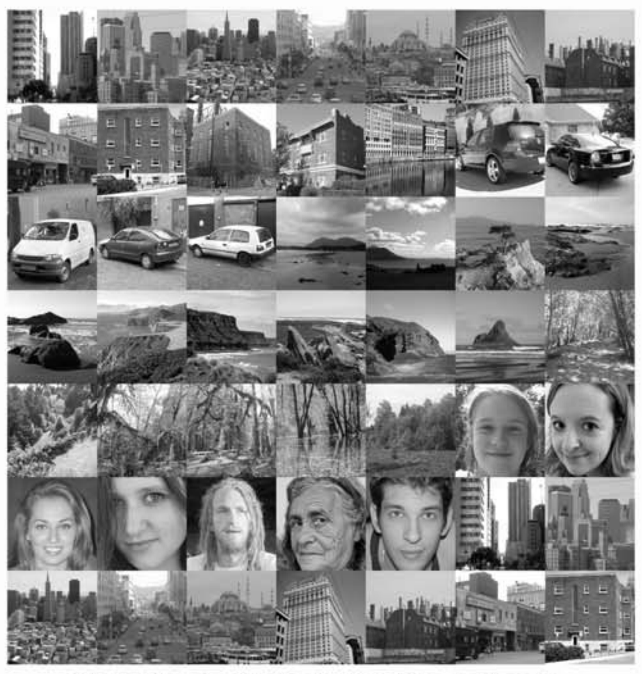
Figure 10: A sample creation/training set of images

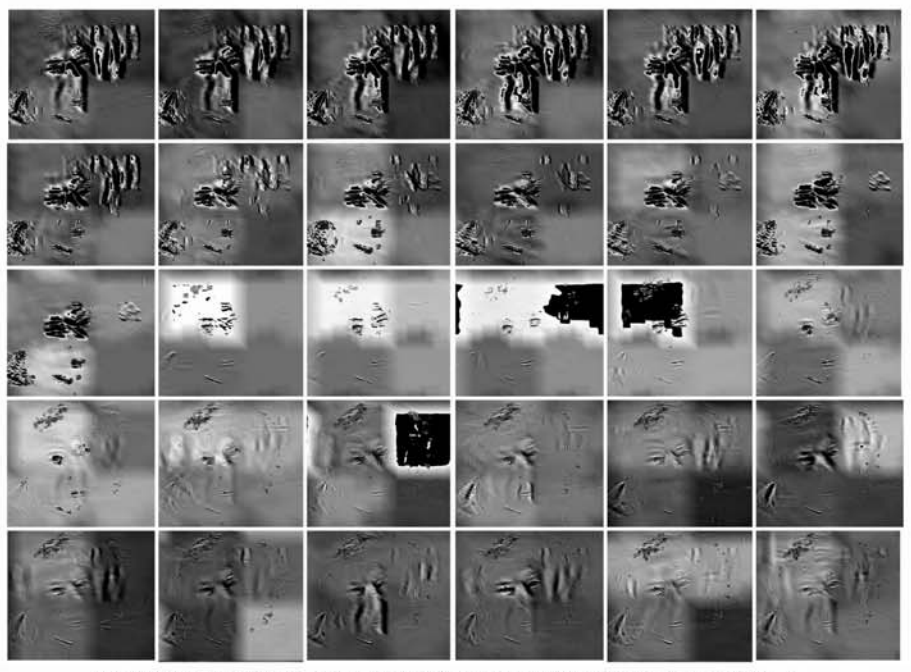
Figure 11: The training process for one image with a context of male face.


Figure 12: An example image produced by the system with a context of church