Results:

Before explaining our results, we would first introduce the basic models we currently have for both Simultaneous Contrast Illusion (SC-illusion) and Adelson illusion (A-illusion). See the image below for an example of SC-illusion.



Fig 1. SC-illusion

SC-illusion is comparatively easier, as there is no 3D object presenting and human observer do not need to inference anything about whether there are shadows in this area. For simplification, we would refer the two center squares as L-AOI and R-AOI (L/R for left/right, and AOI for area of interest). So our hypothesis is that SC-illusion, which is the difference of perceived color (reflectance in our model) for L/R-AOI with actually same pixel value (luminance in our model), is due to the different backgrounds of those two AOIs with the assumption of human observers thinking the illumination keeps the same for the whole picture.

But for A-illusion, the assumption of human observers thinking the illumination keeps the same for the whole picture no longer holds. Thus, we need to explicitly model the variance of illumination across different areas, i.e. the existence of shadows, besides the influence of different backgrounds. We could simply model the existence of shadows by giving different prior to the illuminations of different areas. But then we would fail to explain how human observers get the information of shadows. Therefore, an alternative model could be that we also model how human observers infer the existence of shadows jointly through the 3D objects and change of pixel values on it, which could provide the cues for the direction of light.

In the next few sections, we would first introduce the theoretic models for SC-illusion, then some experiment results support for that, the theoretic models for A-illusion, and the related experiment results (NOT finished yet).

1. Theoretic models for SC-illusion

The picture in Fig 1 has the size of (with the AOI in the size of ), but for theoretically simplification and as we human observers tend to give inference to a large continuous regions of the same color rather than pixel by pixel, we group the pixels into “superpixels” with each superpixel having size of and indexing them using , where ranges from 0 to 5 and ranges from 0 to 2. So the L-AOI is in the position of and R-AOI is at . As indicated above, the illumination variable () is the same for all the superpixels while each superpixel has its own reflectance () and luminance (). And the pixel value observed is . If we assume that each superpixel is independent from each other except sharing the same illumination, we could have a model as below:

To introduce the influence of backgrounds, we make another assumption of the existence of spatial continuity for the inference of reflectance:

Here, is the set of indexes for nearby superpixels of :

Combining those priors and observations given as pixel values, we could then compute the posterior distribution of and .

1. Experiment results for SC-illusion

We implement the models using webppl, with , , and . And see below for the computed distribution of :



Fig 2. Distribution of , with a mean of -0.52

This result has already explained the illusion observed by human observers. But for further explorations of the model, we use the same mechanism to build a reverse SC-illusion (rSC-illusion) which now have different pixel values for L/R-AOIs but by utilizing the influence of backgrounds, make the human observers believe that they see the same colors.

The implementation to build this rSC-illusion is rather straight-forward. Instead of providing the observations for L/R-AOIs, we make an assumption that their reflectance should be the same:

And then we infer the posterior distribution for the luminance and use the inferred value to draw a new picture, see Fig 3 below:



Fig 3. rSC-illusion, with pixel value of 155 (L-AOI) and 119 (R-AOI)