Homework 1 – part 1

Psychophysics - 02458 Cognitive Modeling

For a century, Fechner's log law relating stimulus intensity and perceived intensity was considered valid. Now we know that Steven's power law describe the relationship much better. But how could so many people be mistaken for so long? This issue lies at the heart of cognitive modelling, well, of modelling in general. The problem is that for a part of parameter space, the two models offer very similar predictions.

In the case of stimulus and perceived intensity Fechner might have focused on the relationship between luminance and brightness, which Steven's found to be

$$Perceived\ brightness = 10 \times Luminance^{0.33}$$

To see that this relationship might be mistaken for a logarithmic relationship, first calculate the perceived brightness for luminance = 1,2,…,10 using Steven's law. This simulates an observer that rates the brightness. Now, fit Fechner's law to the data:

$$Perceived\ brightness = k \times \log\left(\frac{Luminance}{Luminance\ threshold}\right)$$

The parameters that you have to fit are, *k* and the luminance threshold. Although you can du that using an all-purpose optimization routine like Matlab's fminsearch.m function, it is cooler to realize that the problem is linear and can be solved using the pseudoinverse. This is simple and should take no more than 10 lines of code. When you have done the fit, plot the simulated responses and your fit in the same plot. You should be able to see that Fechner's law provide an excellent fit to the data generated using Steven's law. Hence the two models are hard to distinguish in this area of parameter space.

We can now, as Stevens did, compare the two laws in a different area of parameter space. Stevens found that for electric shock

$$Perceived\ intensity = 0.00015 \times voltage^{3.3}$$

Now, simulate an observer as before and try and fit Fechner's law to that! (It won't work.)

Of course, we could have realized this analytically by using e.g. Taylor expansions but then we wouldn't have practiced fitting a function to "data", which lies at the heart of mathematical modelling.