From Normals to Shape

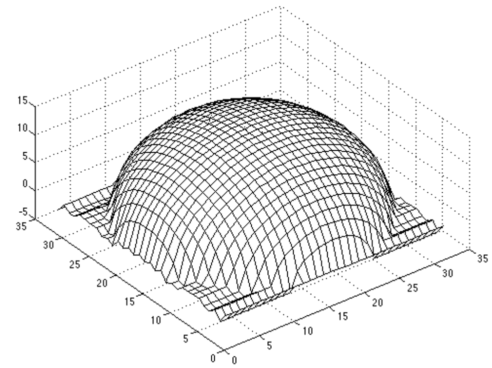
So, if have the normals, we can estimate the derivatives of f(x,y)

Minor point for those who have vector calculus: If we assume that f_x and f_y are the derivatives of a differentiable function, f(x,y) we can further check (or constrain) that $f_{xy}=f_{yx}$.

We can recover the surface height at any point by integration along some path. For example, if we declare the origin to be at height C, and go along the x axis, then parallel to the y axis:

$$f(x,y)=\int_0^x f_x(x',0)dx'+\int_0^y f_y(x,y')dy'+C$$

Surface recovered by integration



Color (very briefly)

Color is a sensation

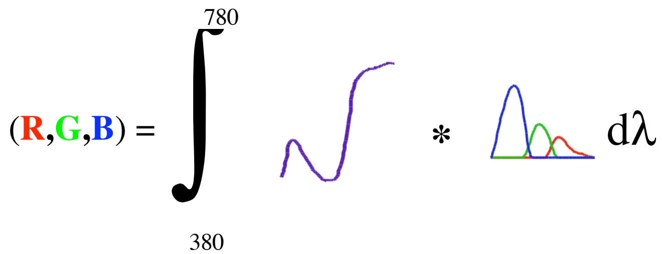
Usually there is light involved, and usually there is a relationship between the world and the colors you see

Your brain has a big effect on the colors you see

We will focus on what colors mean to a camera which is **much simpler**

Color for a camera (R,G,B) is a very limited sampling of spectral light energy (why three values?)

Recall Image Formation (Spectral)



Recall Discrete Version

Represent the light by a vector, **L**

Consider a matrix R whose rows are the discretized version of the response functions.

Let ρ be a vector of camera responses (i.e., $(R,G,B)^T$)

Then

$$\rho = R * \mathbf{L}$$

From previous slide

$$\rho = R * \mathbf{L}$$

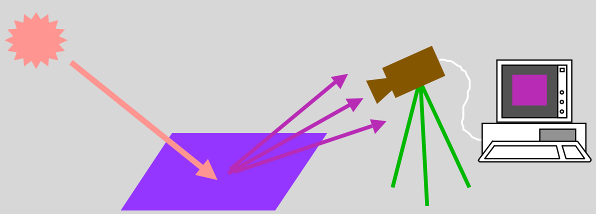
R is **not** full rank (typical values are 3 by 101 or 3 by 31)

First key observation is that you cannot recover **L** from **p** (**L** is spectra**, p** is RGB)

Second observation---many spectra can have the same RGB.

(This is the essence of color reproduction)

(R,G,B) depends on the light, the surface, and the camera

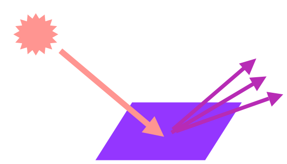


Spectral reflectance

By definition, the spectral reflectance, satisfies

$$S(\lambda)=\frac{L(\lambda)}{E(\lambda)}$$ where is $E(\lambda)$ incoming and $L(\lambda)$ is outgoing

So we get $L(\lambda)$ from before by: $L(\lambda)=E(\lambda)S(\lambda)$

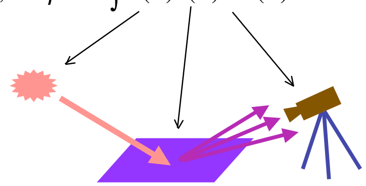


Spectral reflectance

So we get $L(\lambda)$ from before by: $L(\lambda) = E(\lambda)S(\lambda)$

Recall $\rho^{(k)} = \int L(\lambda)R^{(k)}(\lambda)d\lambda$

Now, $\rho^{(k)} = \int E(\lambda)S(\lambda)R^{(k)}(\lambda)d\lambda$



Naive Color Model

Now consider white light (255, 255, 255)

- This is **relative** to the camera!
- By definition, this is the color of perfect diffuse, uniform, reflector

Suppose that a surface has color (R_S, G_S, B_S) under white light

- Naively, this is the "color of the surface"
- (Naïve, because surfaces don't have color until you turn on the light, and it matters what the color of the light is!)
- The albedo in each channel is $\rho_R = \frac{R_S}{255}$ $\rho_G = \frac{G_S}{255}$ $\rho_B = \frac{B_S}{255}$

Naive Color Model (2)

Naive value for the color of the surface under a **different** light, (R_L, G_L, B_L) is given by:

$$(R, G, B) = (\rho_R R_L,\ \rho_G G_L,\ \rho_B B_L)$$

This is naïve because we assume that the part of the light that stimulates one channel, does **not** interact with the albedo of any other channel.

Alternatively, everything about the surface color can be captured in these 3 numbers.

This is the "diagonal model" for illumination change.