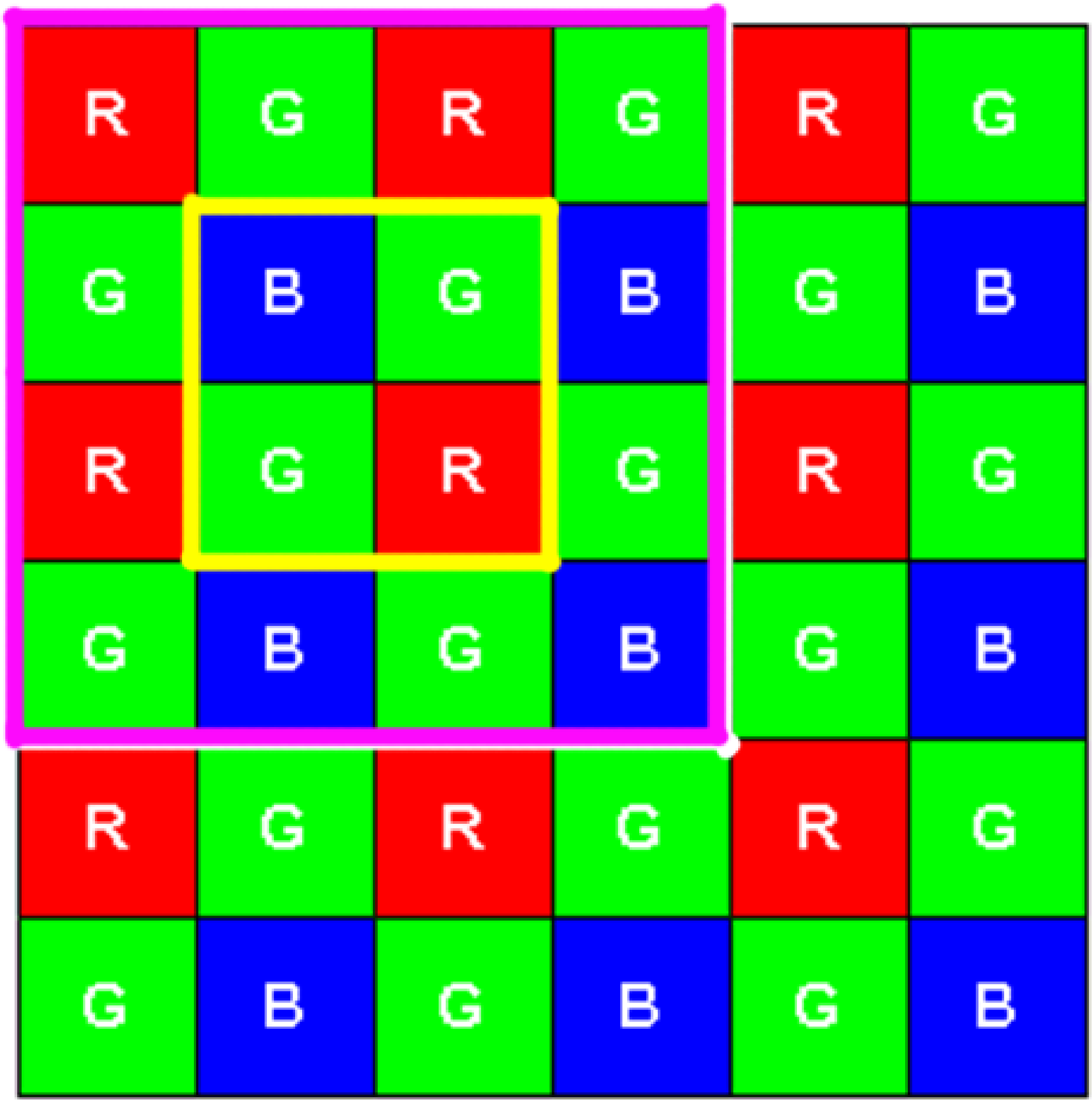
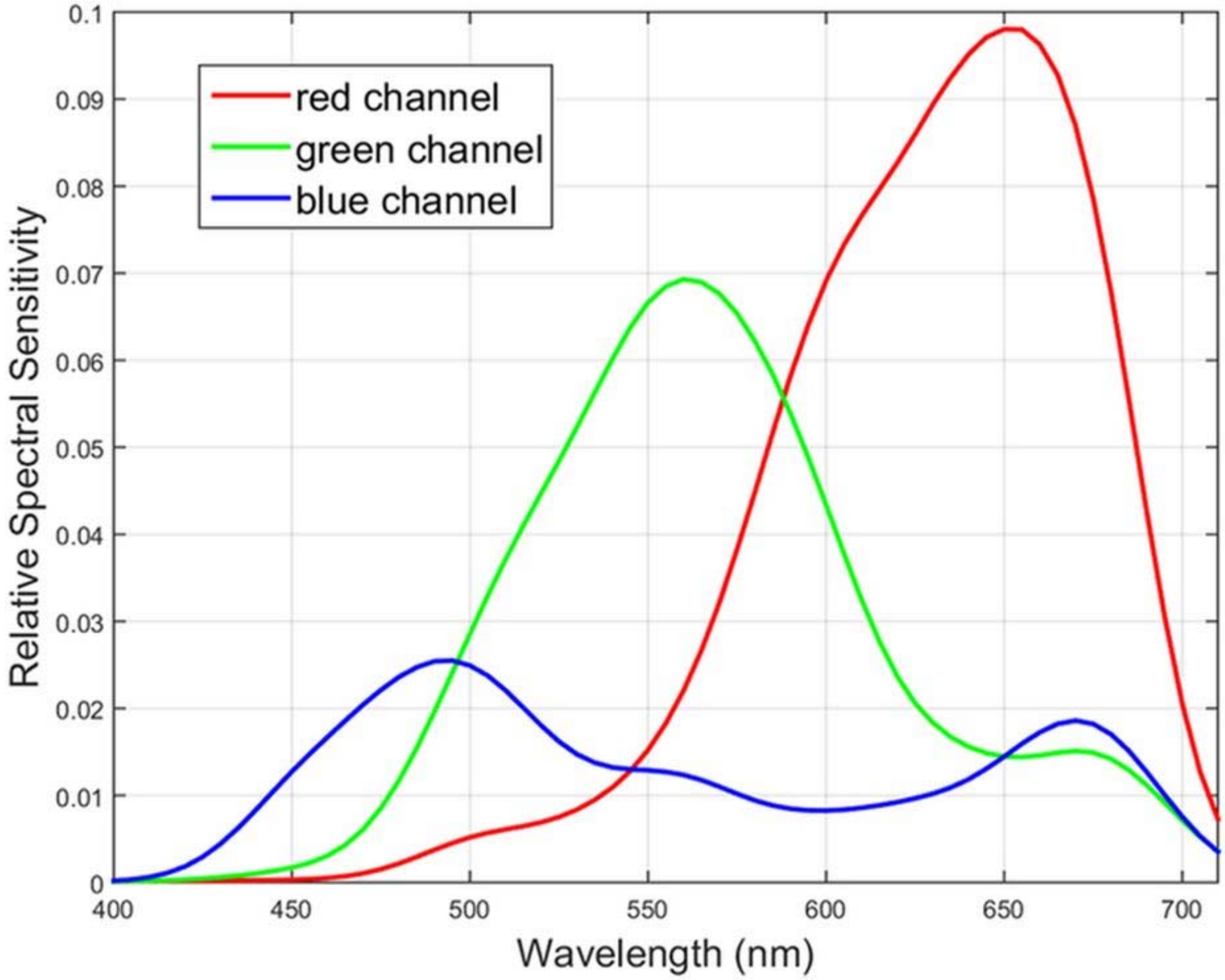
Better CFA Interpolation 3

- Again consider 4x4 array – 2x2 Bayer set (purple outline)
- Create an interpolation for the inner Bayer CFA (yellow outline)
- 4x4 has 16 pixels, each pixel has 3 colors potentially
- How many data points do we get – depends on the color response

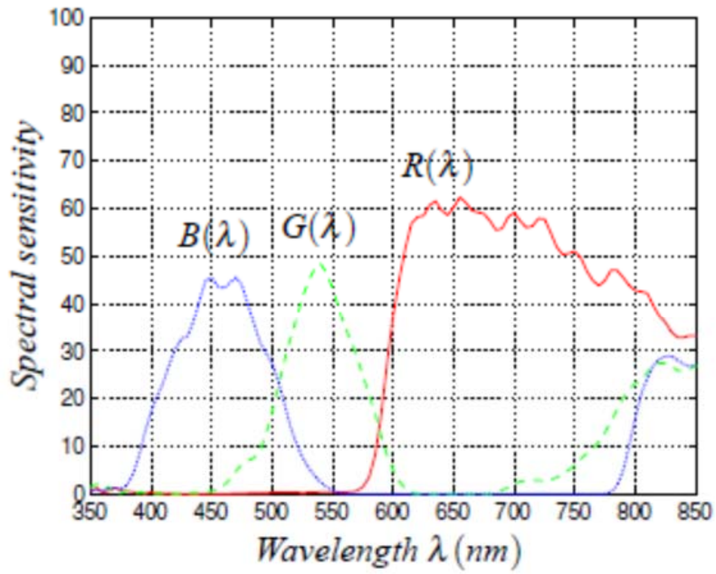


True Camera Response

- Recall the different cameras have different overlaps or R,G,B



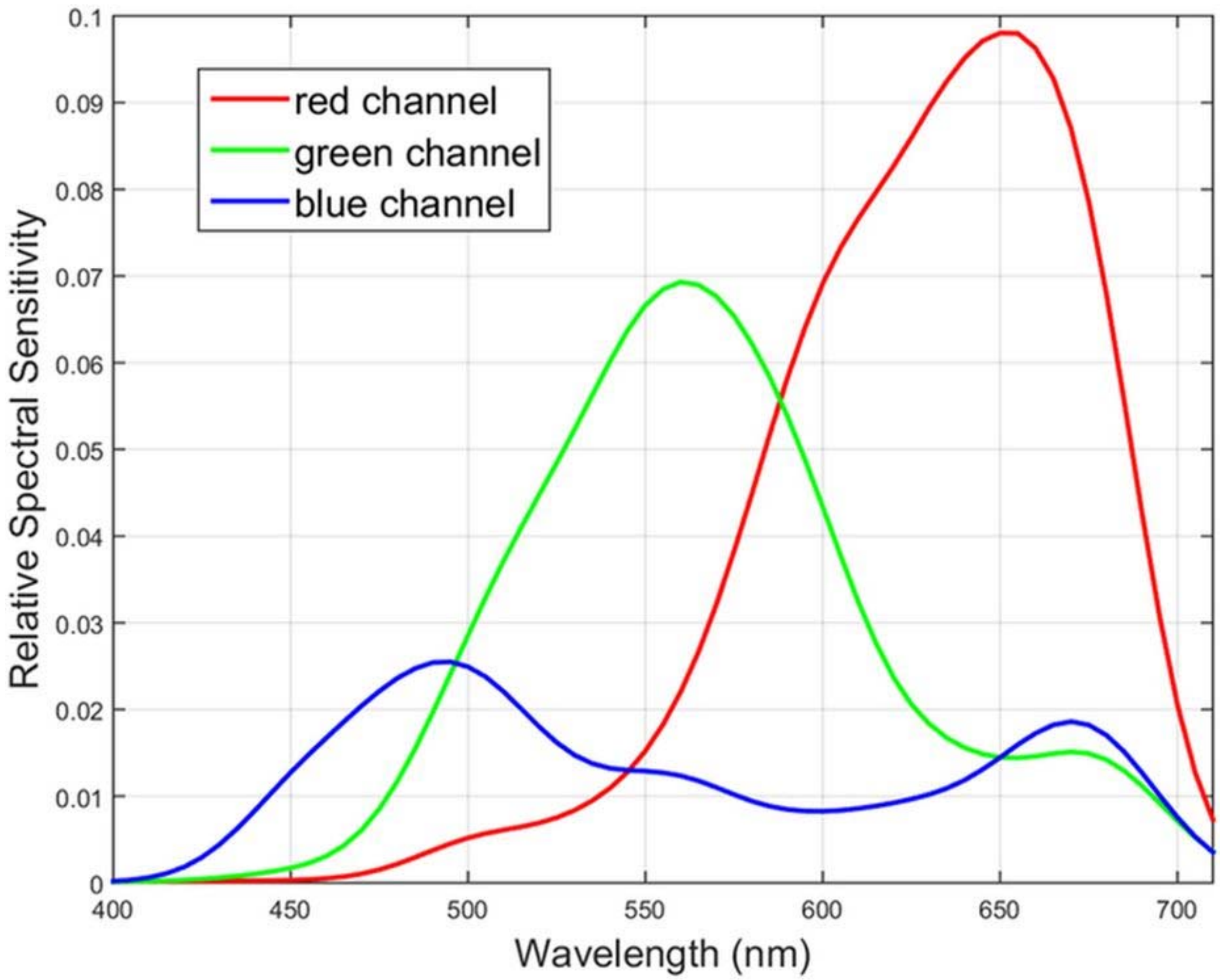
Canon T3i color response



(b) Relative spectral sensitivity of the Kodak KLI-2113 sensor.

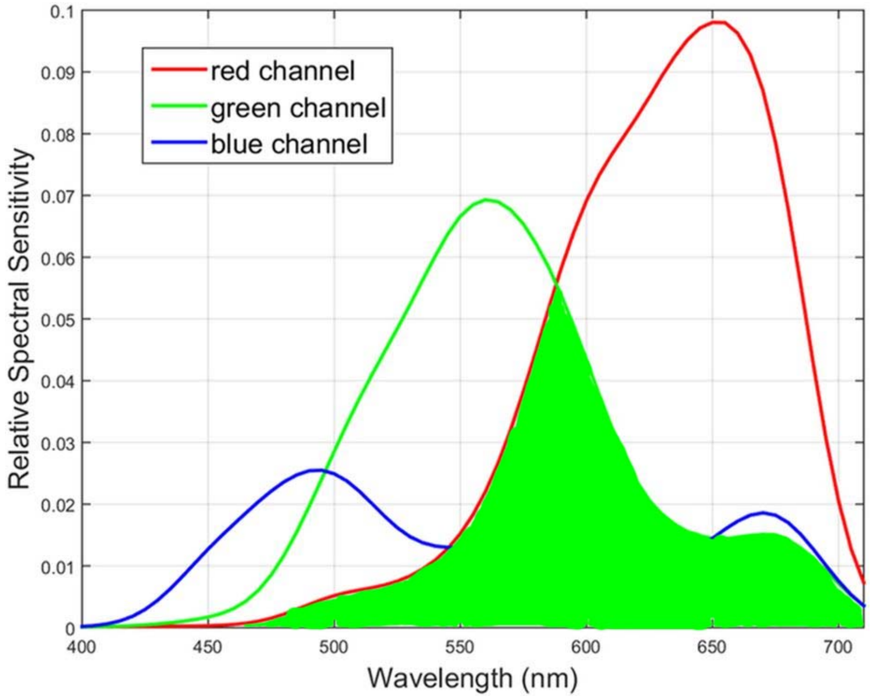
First Calculate overlap response

- Canon T3i has all 3 colors responding to all color
- Kodak did not have same overlap
- Assume a white (gray) light source
- Now calculate each calculate the cross response
- This is the response seen by other colors

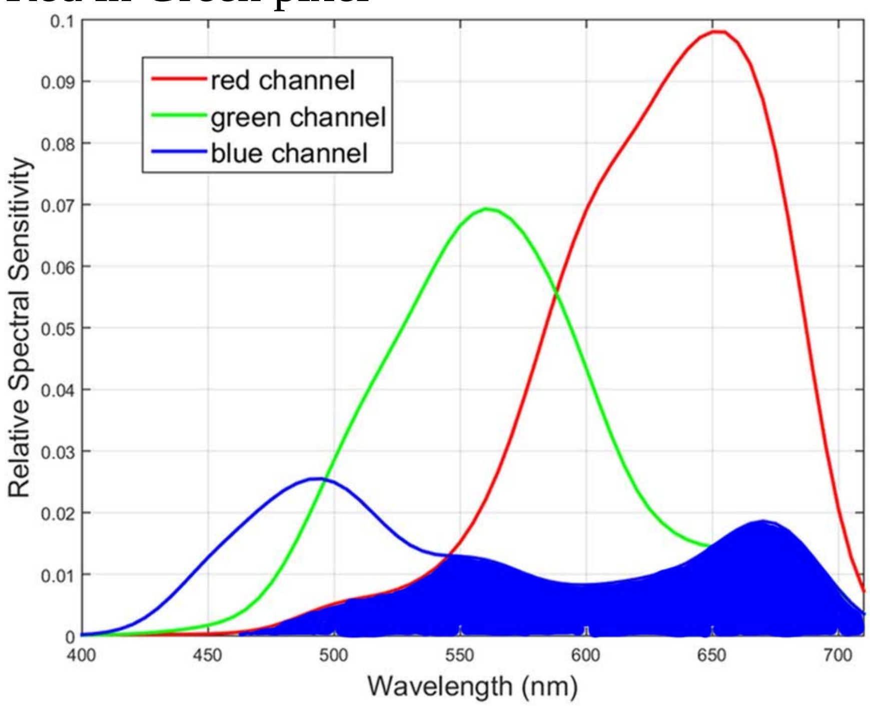


Key point: Overlap RGB Response

- We need the response of each color pix type at different colors
- Eg Green pixel recording of Red
- Blue pixel recording of Red



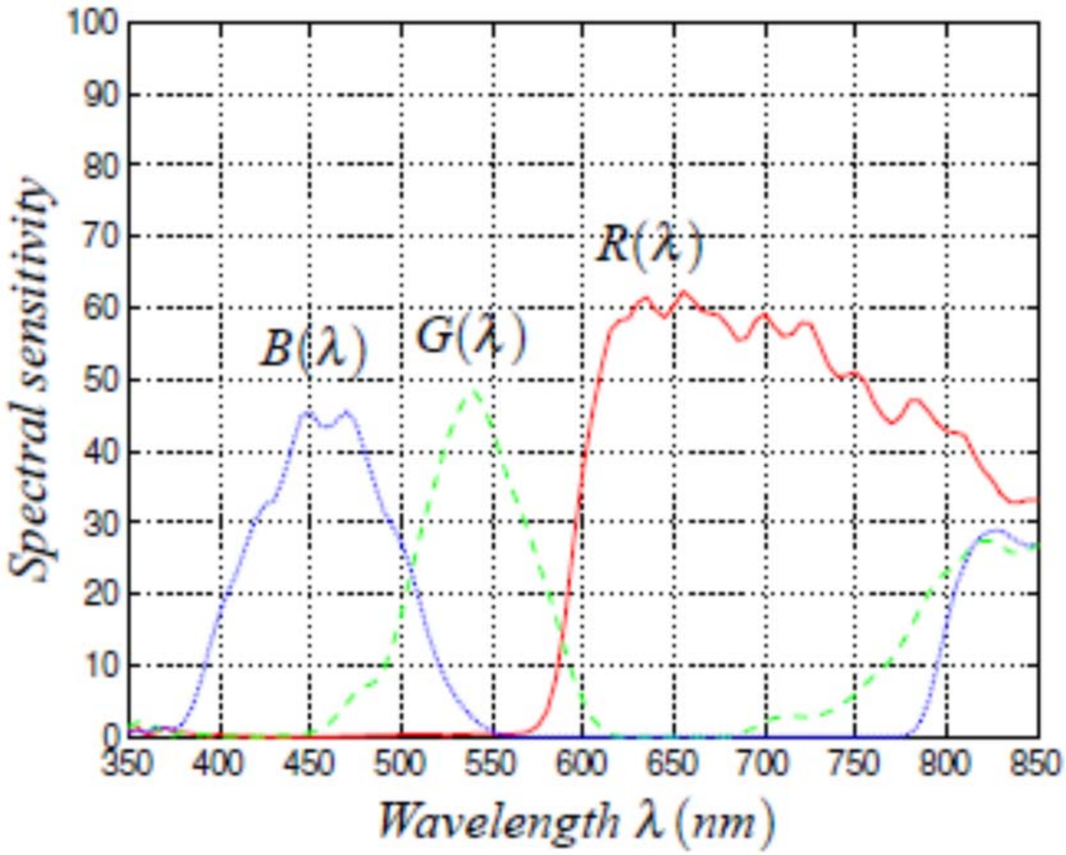
Red in Green pixel



Red in Blue pixel

Simple approximate color types - Triangle

- Simulate the Kodak type
- Use simple Triangle approximation for R G B
- Center wavelengths and widths as per Kodak
-



(b) Relative spectral sensitivity of the Kodak KLI-2113 sensor.

Alternative approximate color types

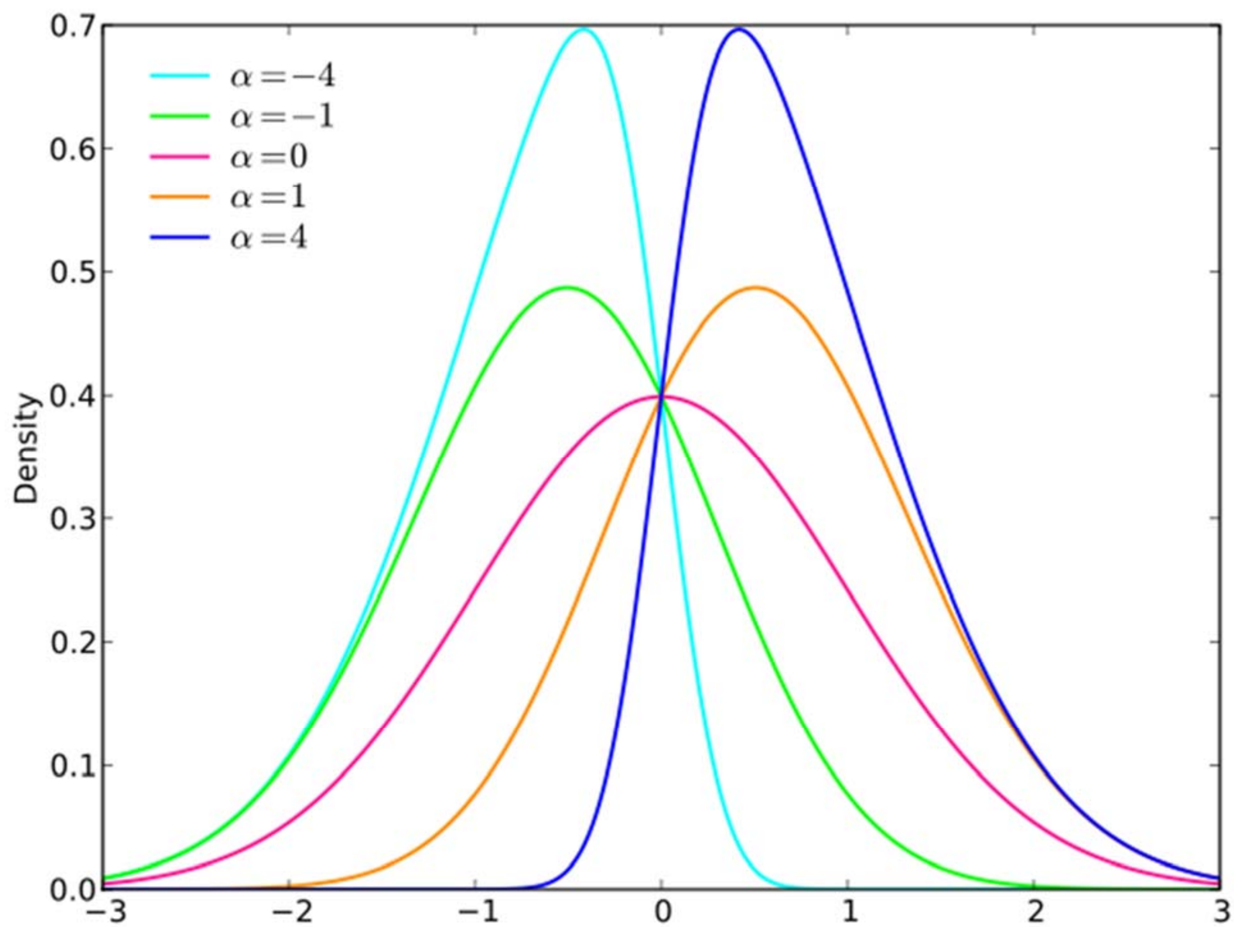
- These curves are too complex for first test
- Make a simple model of the R G B response curves
- Some possibilities – skewed Gaussian

https://en.wikipedia.org/wiki/Skew_normal_distribution

$$\phi(x) = \frac{1}{\sqrt{2\pi}} e^{-\frac{x^2}{2}}$$

$$\Phi(x) = \int_{-\infty}^{x} \phi(t)\,dt = \frac{1}{2}\left[1 + \operatorname{erf}\left(\frac{x}{\sqrt{2}}\right)\right],$$

$$f(x) = 2\phi(x)\Phi(\alpha x).$$



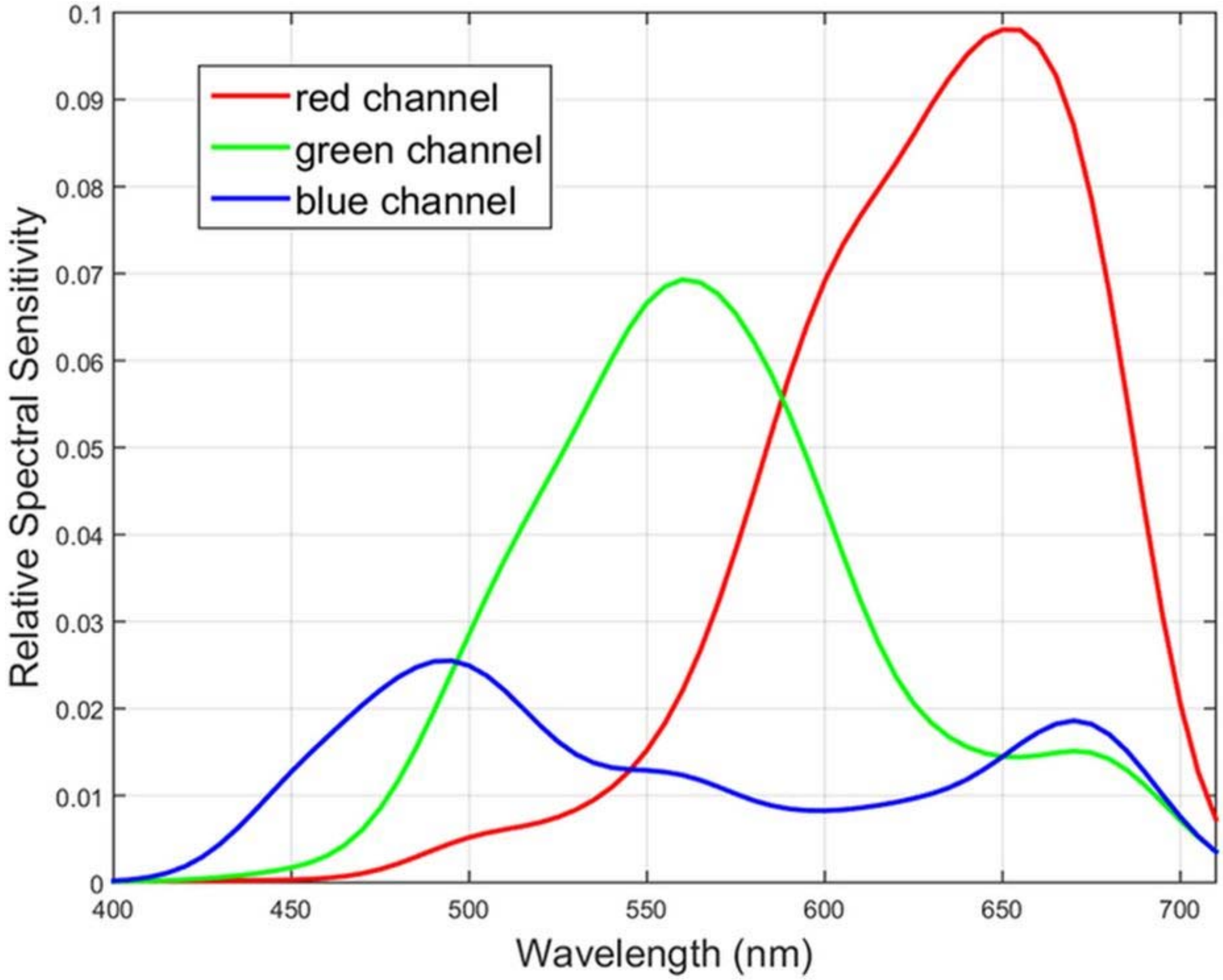
Skew Gaussian

- More detailed equations

Parameters	ξ location (real) ω scale (positive, real) α shape (real)
Support	$x \in (-\infty; +\infty)$
PDF	$\frac{2}{\omega\sqrt{2\pi}} e^{-\frac{(x-\xi)^2}{2\omega^2}} \int_{-\infty}^{\alpha\left(\frac{x-\xi}{\omega}\right)} \frac{1}{\sqrt{2\pi}} e^{-\frac{t^2}{2}}\, dt$

First attempt Color Balance

- Must take color balance into consideration
- Assume a white/grey
- Then assume B=G=R for that exposure
- Makes more difficult
- This gives the basic ratios of R in B & G etc
- Do same for B in G & R
- Also B in G and R

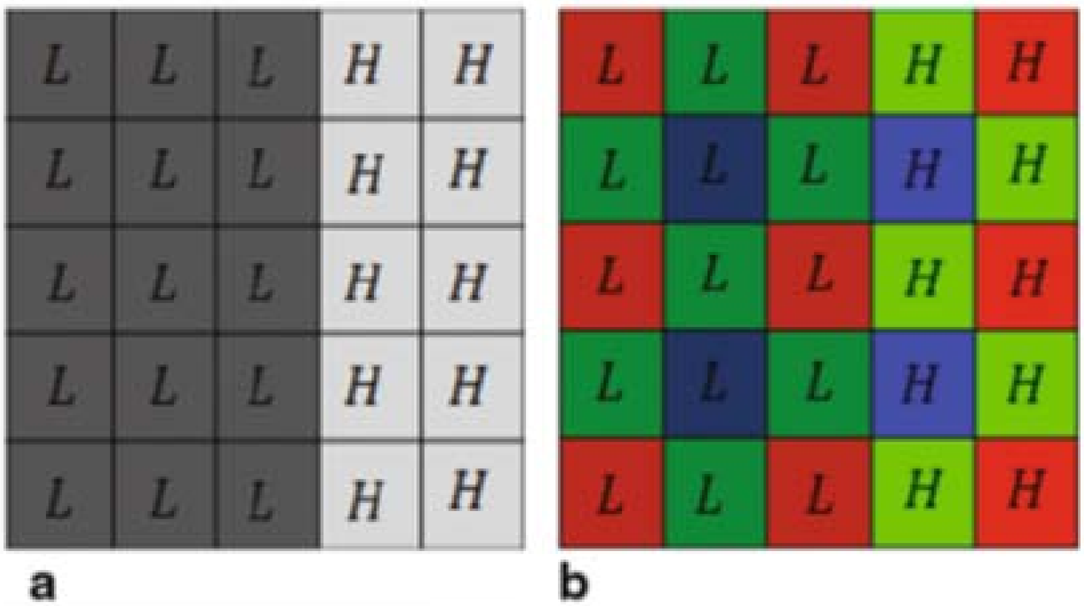


Now applying the grey step

- Now apply the gray step used in bilinear
- Calculate the R,G,B values using the actual response
- Now do the 2D parabolic curve fit

$$F(x,y) = a_{00} + a_{10}x + a_{01}y + a_{20}x^2 + a_{11}xy + a_{02}\,y^2 + a_{21}x^2y + a_{12}xy^2 + a_{22}x^2y^2$$

- Do we do CFA shifting or single pixel shifting
- Do we do 3x3 set or 4x4



Alternative Assume Color

- Assume the central Bayer gives the R G B color
- Use that as the color for each 4x4 square
- Extract the expected R G B from the model
- Now do interpolation on the central 4 colors
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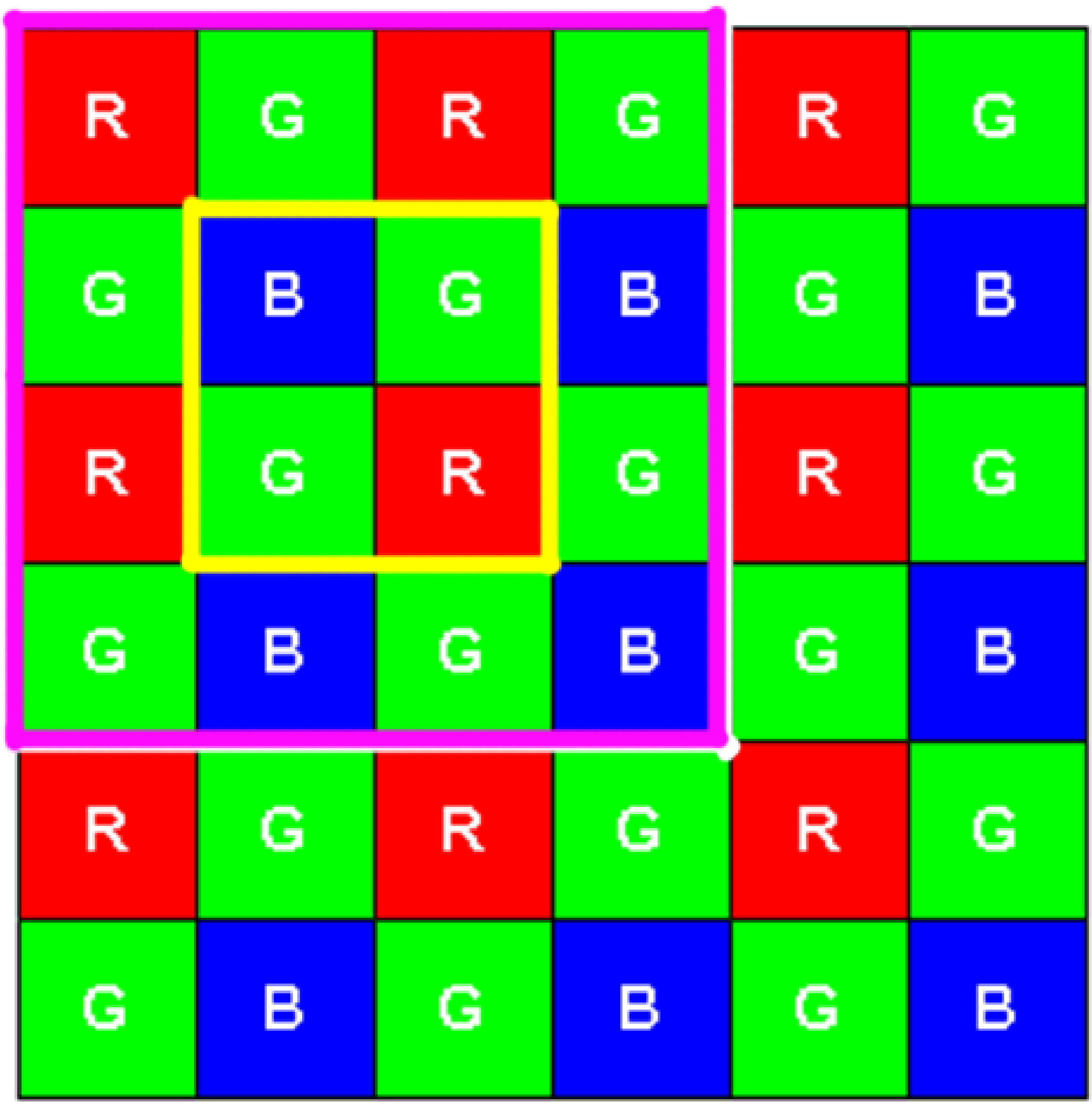

2^{nd} Order – now get color from estimate

- Those first order gives estimate RGB
- Now use this for second order color estimate
- Apply to simple step first
- Do interpolation and see if color develops
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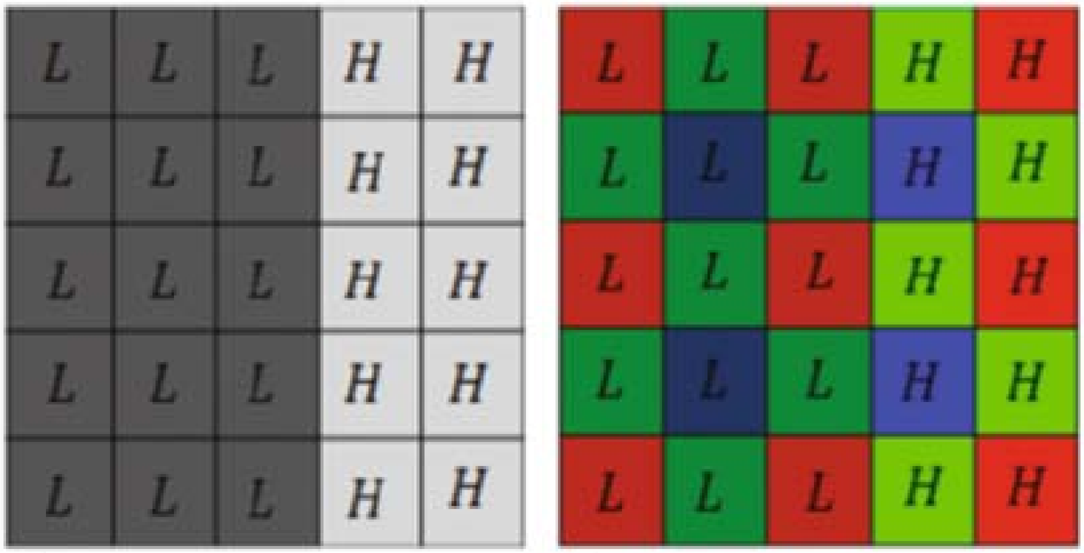

a b