



**CSN08704**

# **Telecommunications**

Images (JPEG)

**Data, Audio, Video and Images**

<http://asecuritysite.com/comms>

Prof Bill Buchanan



**CSN08704**

# **Telecommunications**

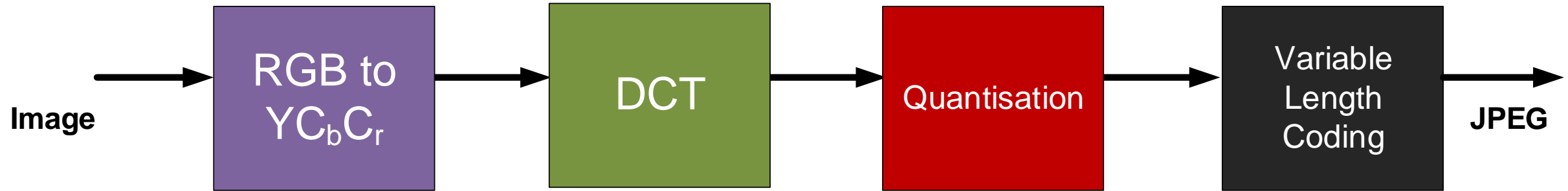
**Images (JPEG) – JPEG Processing**

**Data, Audio, Video and Images**

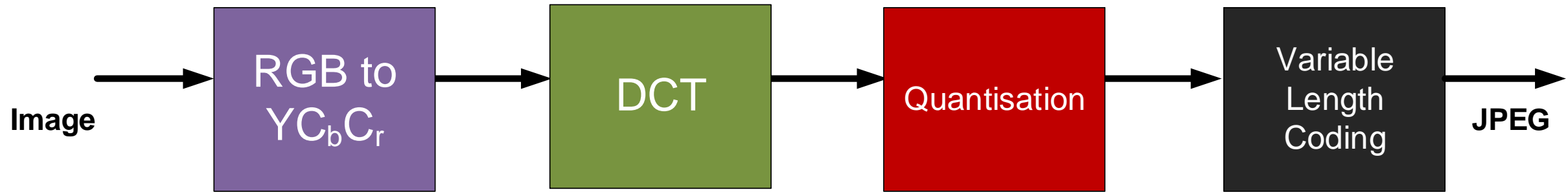
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# JPEG Process



# RGB to $Y C_b C_r$



$$Y = 0.299R + 0.587G + 0.114B$$

← Y strongly dependent on Green component

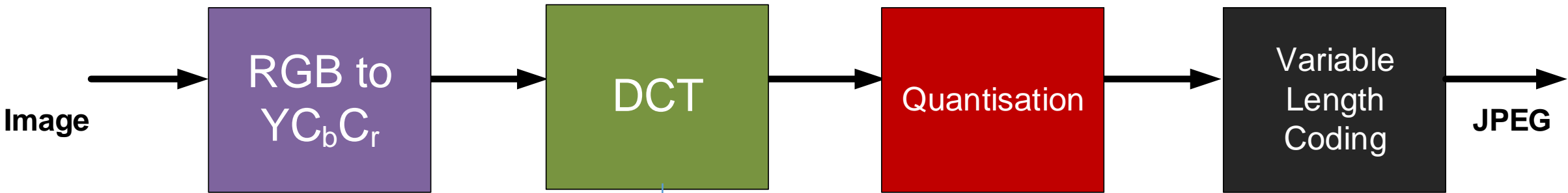
$$C_b = 0.1687R - 0.3313G + 0.5B$$

←  $C_b$  strongly dependent on Blue component

$$C_r = 0.5R - 0.4187G + 0.0813B$$

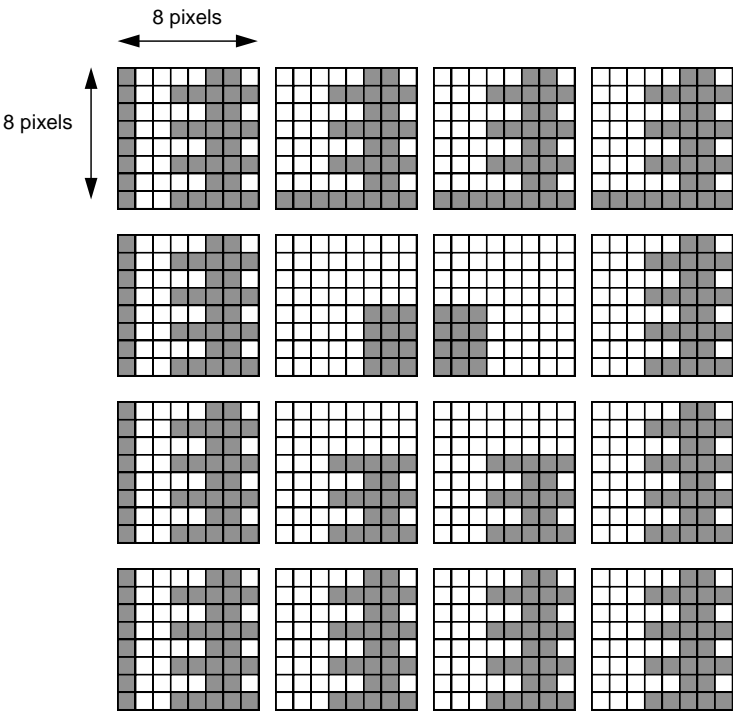
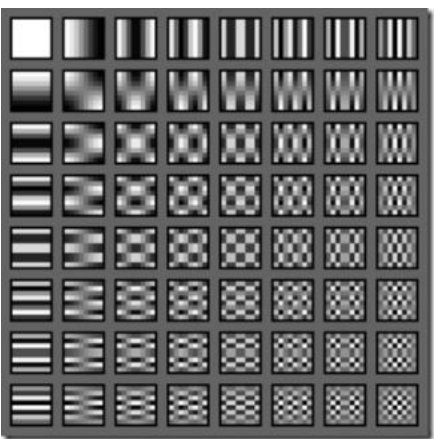
←  $C_r$  strongly dependent on Blue component

# Discrete Cosine Transform (DCT)



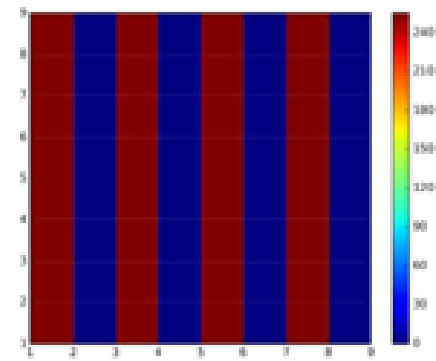
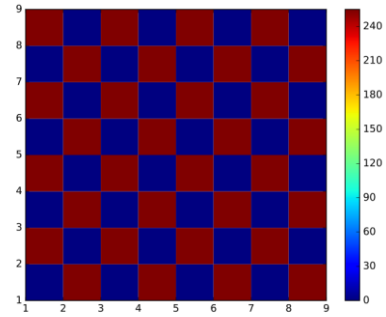
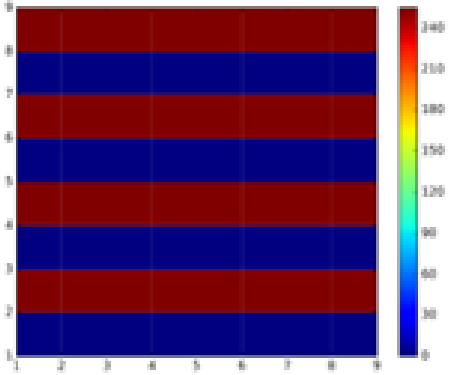
$$F(u, v) = \frac{1}{4} C(u)C(v) \left[ \sum_{x=0}^7 \sum_{y=0}^7 f(x, y) \cos \frac{(2x+1)u\pi}{16} \cos \frac{(2y+1)v\pi}{16} \right]$$

where  $C(z) = \frac{1}{\sqrt{2}}$  if  $z = 0$   
 or  $= 1$  if  $z \neq 0$



[Link](#)

# DCT

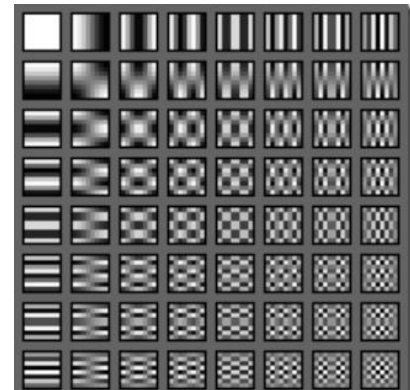


[	[	1020	183	0	216	0	324	0	924]
[	0	0	0	0	0	0	0	0	0]
[	0	0	0	0	0	0	0	0	0]
[	0	0	0	0	0	0	0	0	0]
[	0	0	0	0	0	0	0	0	0]
[	0	0	0	0	0	0	0	0	0]
[	0	0	0	0	0	0	0	0	0]
[	0	0	0	0	0	0	0	0	0]
[	0	0	0	0	0	0	0	0	0]
[	0	0	0	0	0	0	0	0	0]

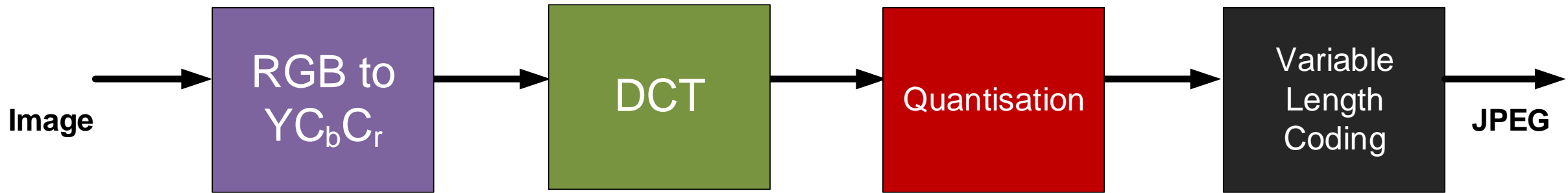
[	[	1020	0	0	0	0	0	0]
[	0	-33	0	-39	0	-58	0	-166]
[	0	0	0	0	0	0	0	0]
[	0	-39	0	-46	0	-69	0	-196]
[	0	0	0	0	0	0	0	0]
[	0	-58	0	-69	0	-103	0	-294]
[	0	0	0	0	0	0	0	0]
[	0	-166	0	-196	0	-294	0	-837]

[	[	1020	0	0	0	0	0	0]
[	-183	0	0	0	0	0	0	0]
[	0	0	0	0	0	0	0	0]
[	-216	0	0	0	0	0	0	0]
[	0	0	0	0	0	0	0	0]
[	-324	0	0	0	0	0	0	0]
[	0	0	0	0	0	0	0	0]
[	-924	0	0	0	0	0	0	0]

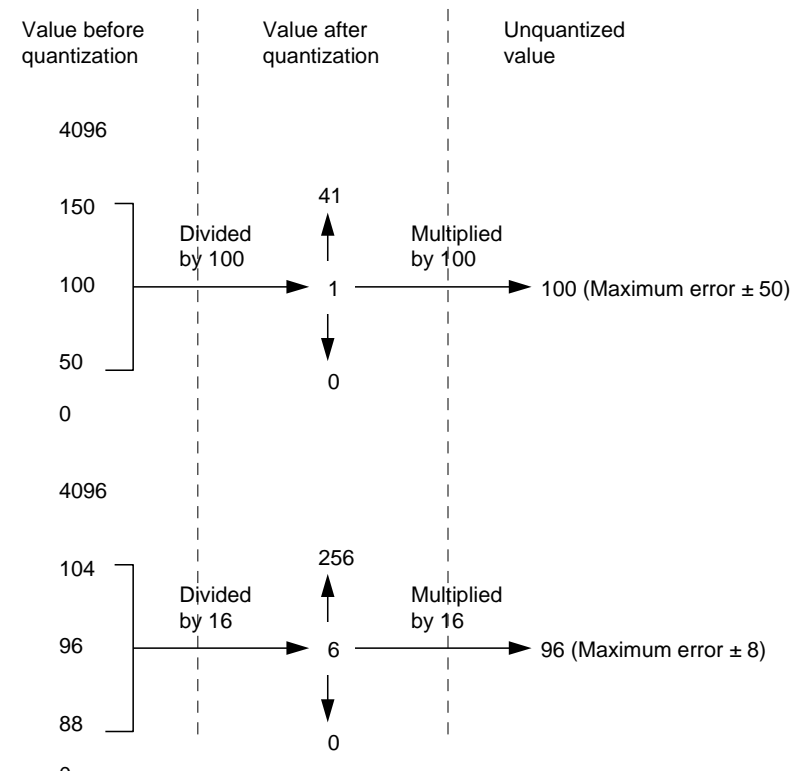
[Link](#)



# Quantisation



- The **quantisation** part aims to suppress less important spectral frequencies to zero, while preserving important ones.

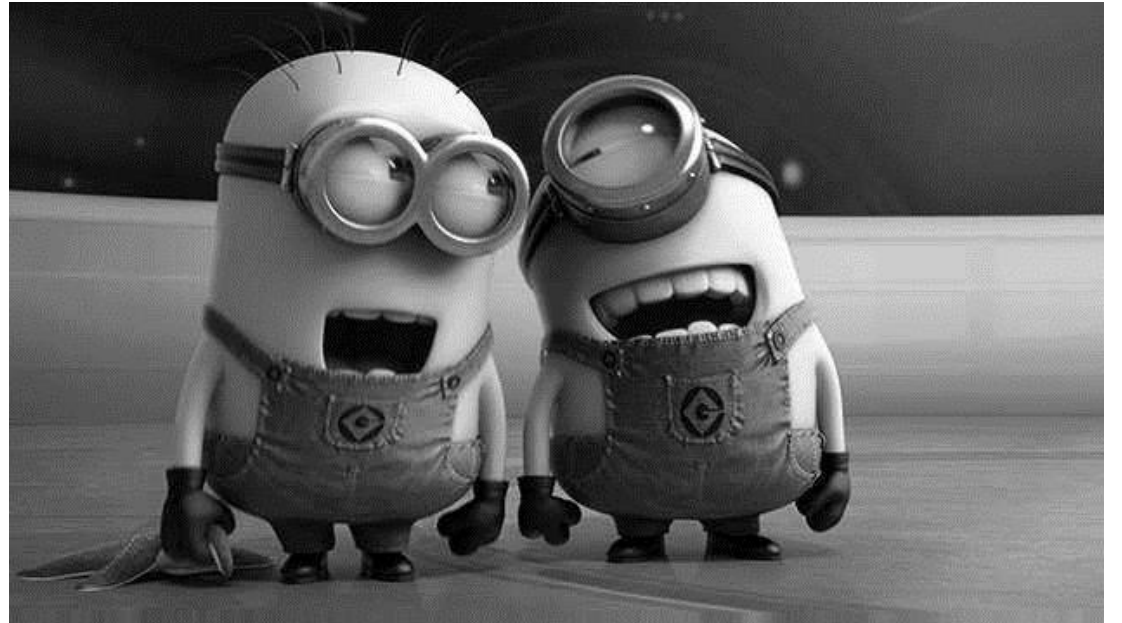


# Quantisation

- [Link](#)

- Quantisation of 16.

- Quantisation of 256.

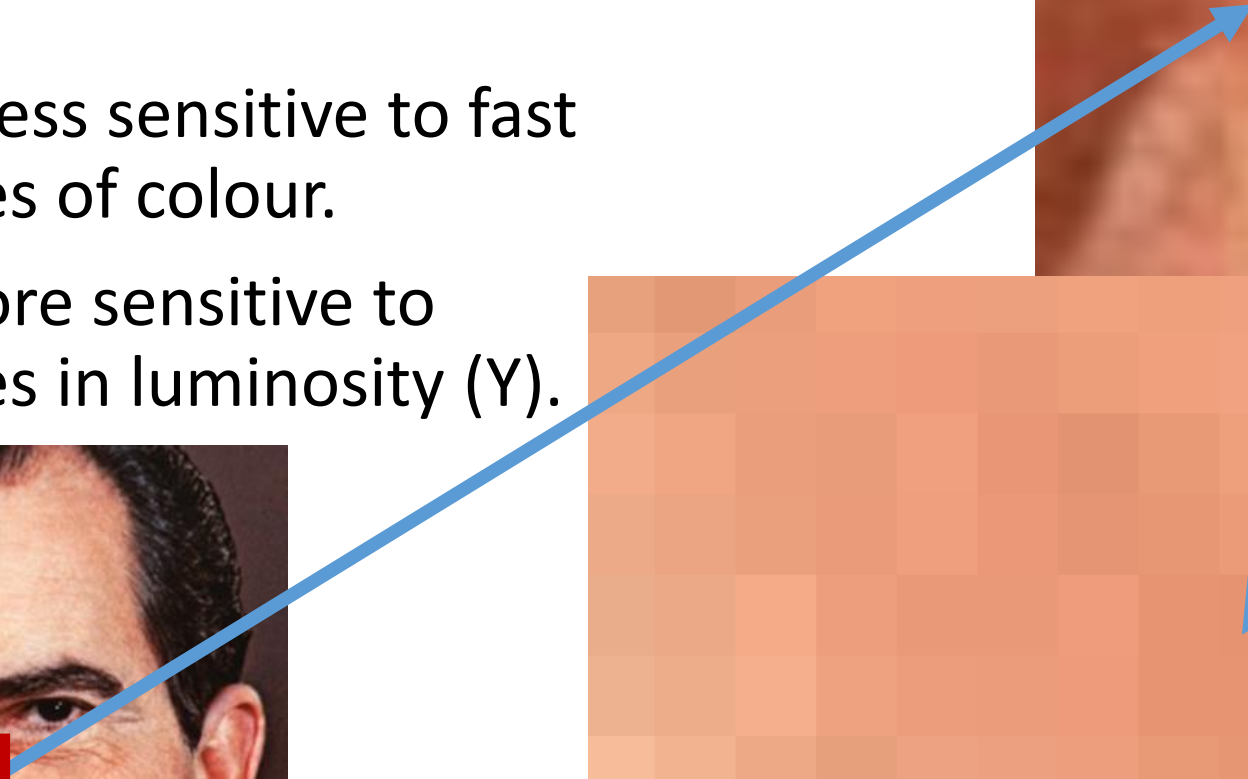
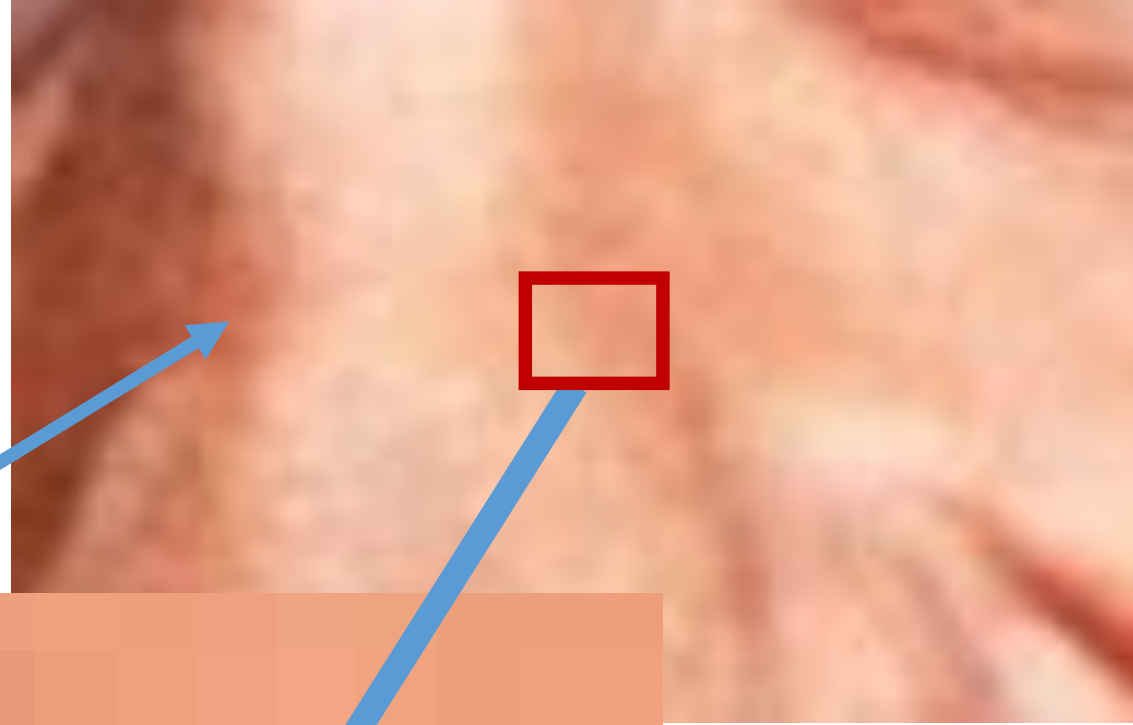
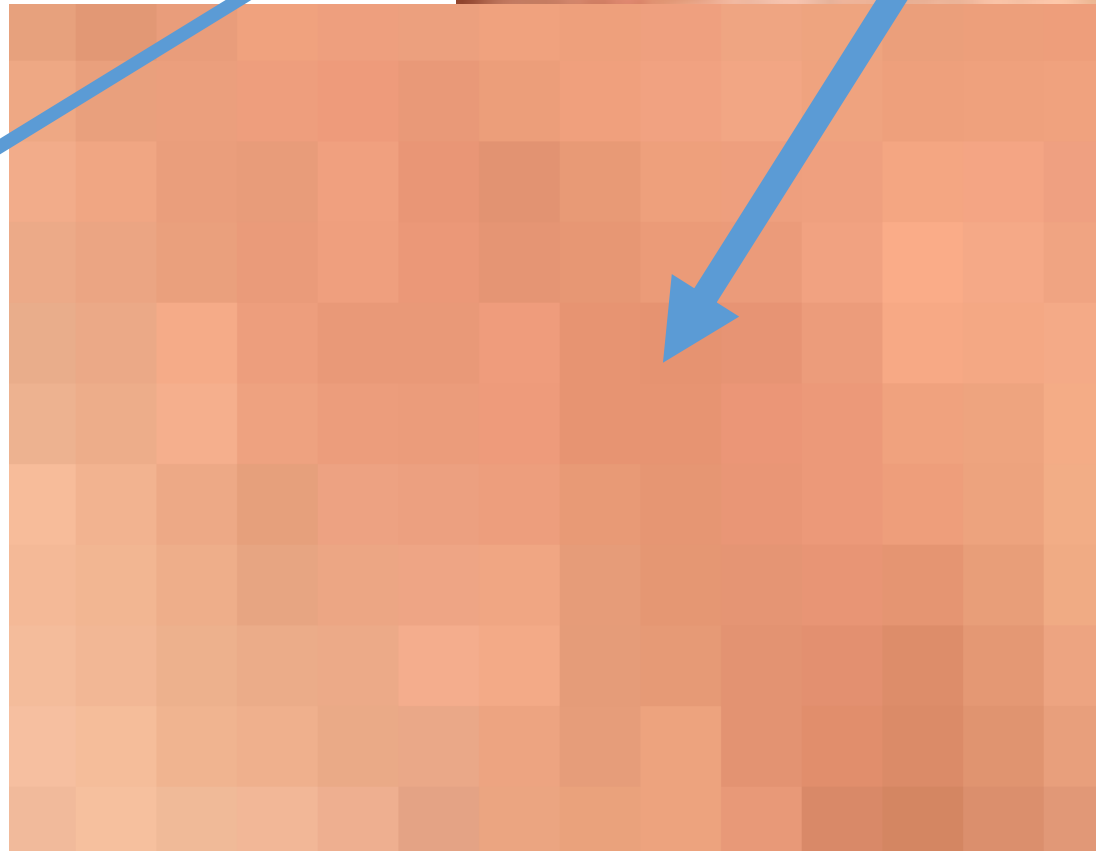
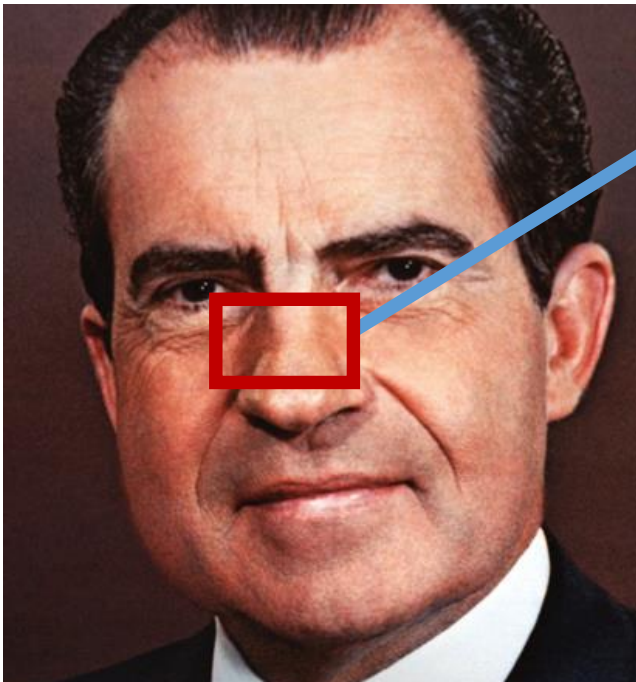




# Quantisation

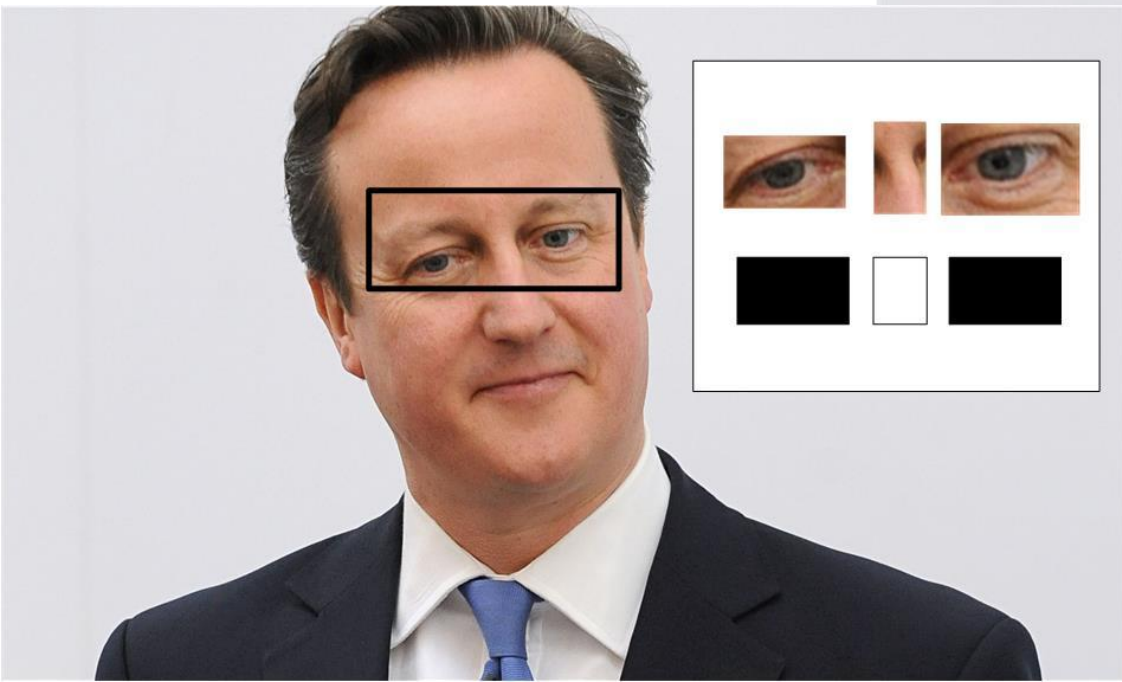
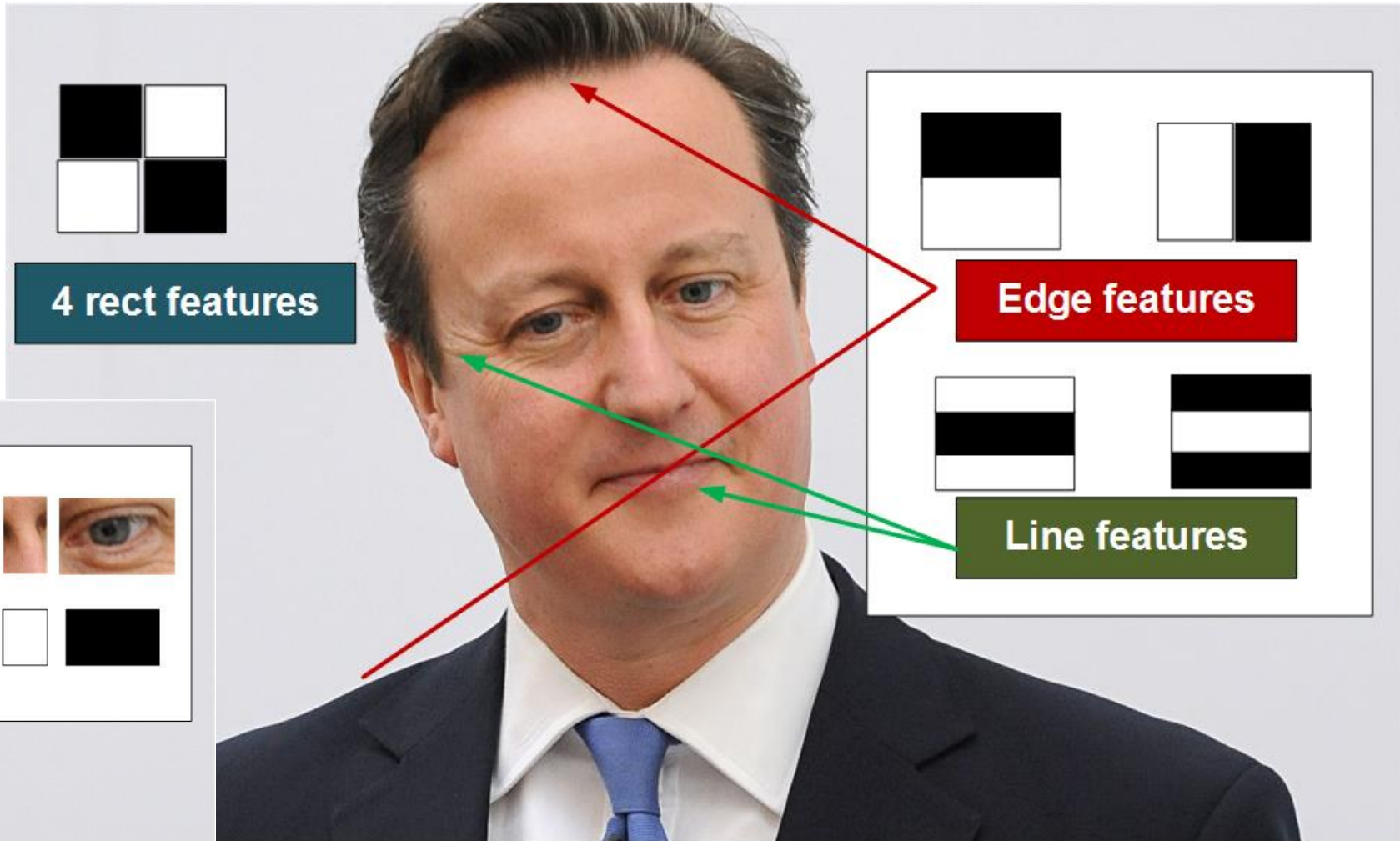
Eye is less sensitive to fast changes of colour.

Eye more sensitive to changes in luminosity (Y).

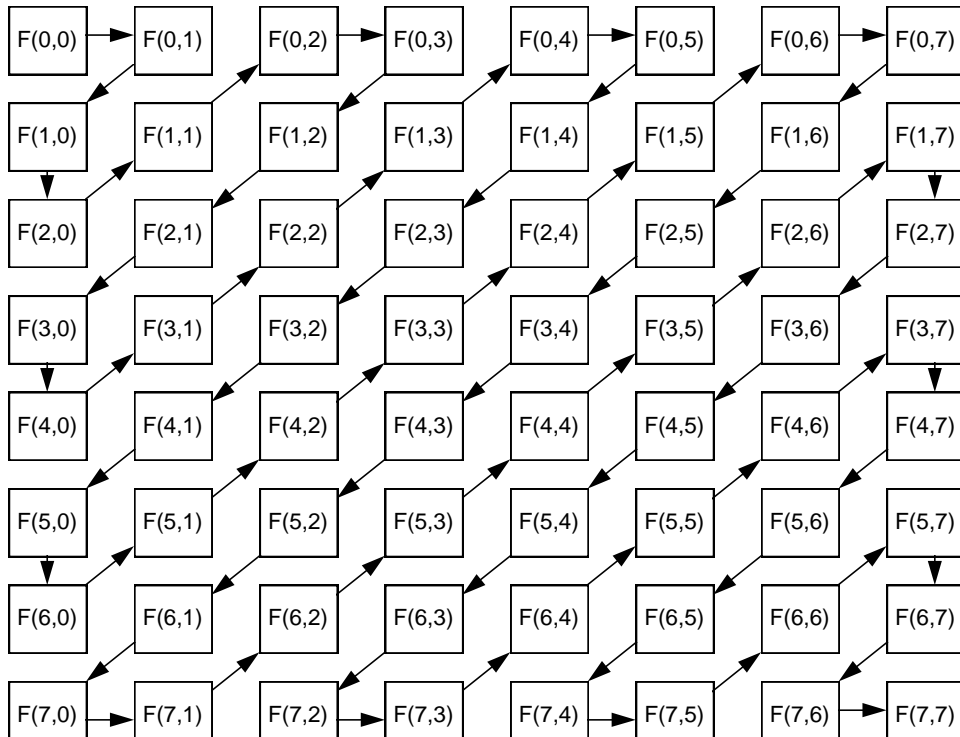
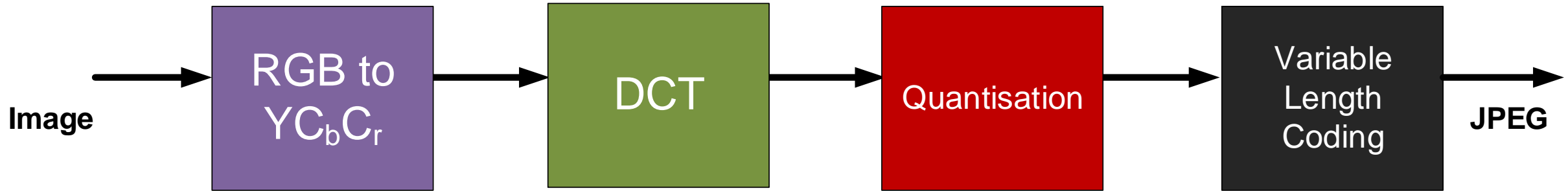


# Face Detection

- [Link](#)



# Zig-zag storage and VLC



251	0	-2	-1	0	0	0	0
-5	-3	0	0	0	0	0	0
-1	-1	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0

251, 0, -5, -1, -3, -2, 0, -1, 0, 0, 0, 0, -1, 0, 0, 0, 0, ..., 0  
 -> 251, 0, -5, -1, -3, -2, 0, -1 ... [51 zeros]



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Images (JPEG) – File Format

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# JPEG Tags



[00000000]	FF	D8	FF	E0	00	10	4A	46	49	46	00	01	00	01	00	C8	.....JFIF.....
[00000016]	00	C8	00	00	FF	FE	00	1F	4C	45	41	44	20	54	65	63	.....LEAD.Tec
[00000032]	68	6E	6F	6C	6F	67	69	65	73	20	49	6E	63	2E	20	56	hnologies.Inc..V
[00000048]	31	2E	30	31	00	FF	DB	00	43	00	19	11	12	16	12	0F	1.01....C.....
[00000064]	19	16	14	16	1C	1A	19	1E	25	3F	29	25	22	22	25	4D	.....%?)%"%"%M
[00000080]	37	3A	2D	3F	5B	50	60	5E	5A	50	58	56	65	71	91	7B	7:-?[P`^ZPXveq.{
[00000096]	65	6B	89	6D	56	58	7E	AC	7F	89	96	9A	A2	A4	A2	61	ek.mVX~.....a

[Link](#)

[Link](#)

- FF F8 tag – Start of file
- FF DB tag (Quantization Table).
- FF C4 tag (Huffman Table).
- FF C0 tag (Start Of Frame (Baseline DCT)).
- FF DA tag (Start Of Scan).
- FF 00 stuffed FF (Likely Huffman Coding).





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