CSc 461/561
Multimedia Systems
Image compression

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Image compression

- Lossless (often computer-generated images)
  - PCX: run-length encoding (RLE), color palette
  - GIF: dictionary-based (LZW), animation, etc
  - PNG (PNG's Not GIF): palette, DEFLATE
- Lossy (e.g., for photos)
  - JPEG (DCT)
  - JPEG2000 (DWT)
- Or other ways to represent: vector images

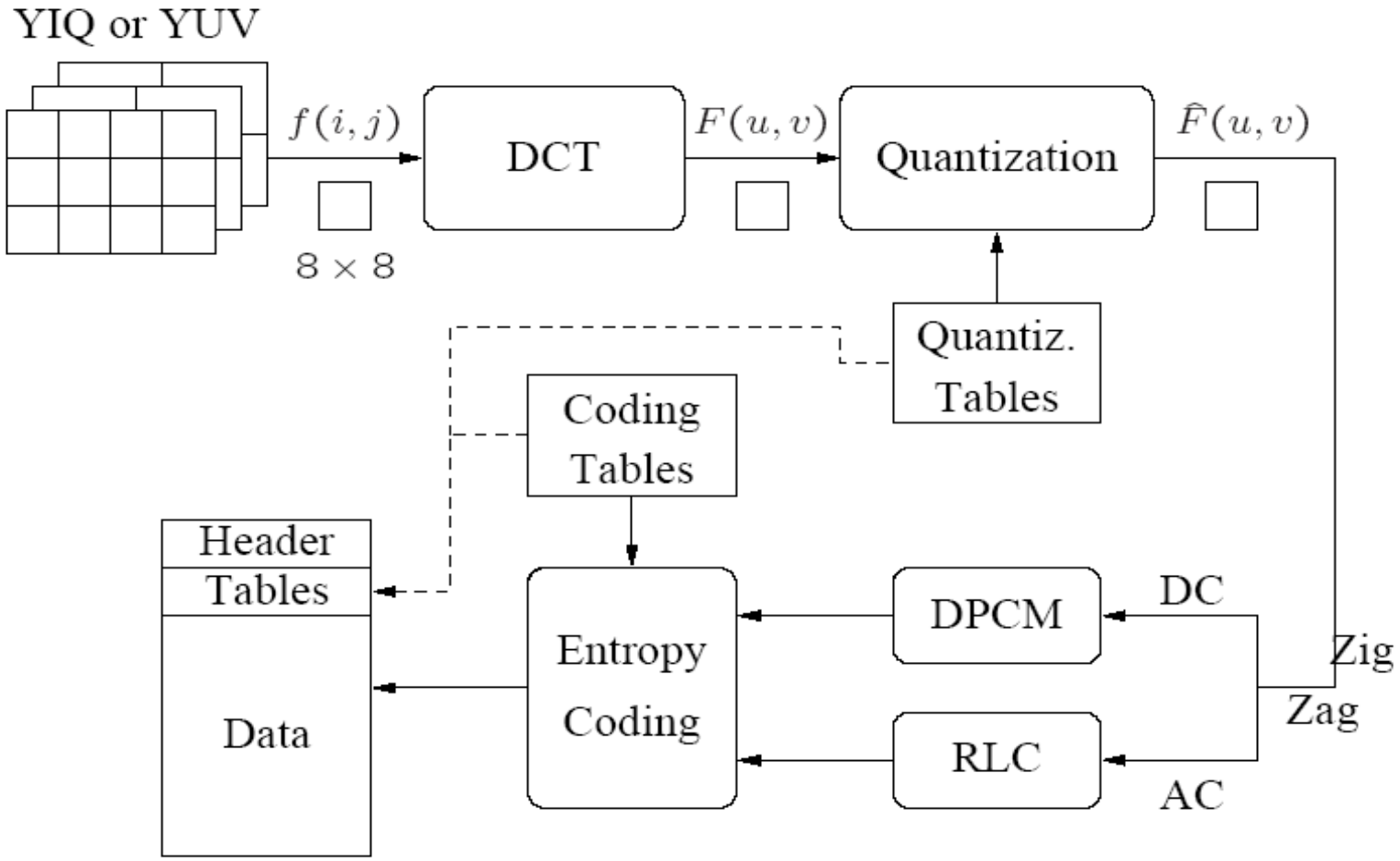
JPEG

- Joint Photographic Experts Group (JPEG)
  - ISO standard (1992)
  - widely used (.jpeg, .jpe, .jpg; C/R: 10~20)
- The family of JPEGs
  - lossless JPEG: prediction-based compression
  - lossy JPEG: DCT-based compression
  - M-JPEG: motion JPEG
  - JPEG2000: discrete wavelet transform; new!

JPEG compression guidelines

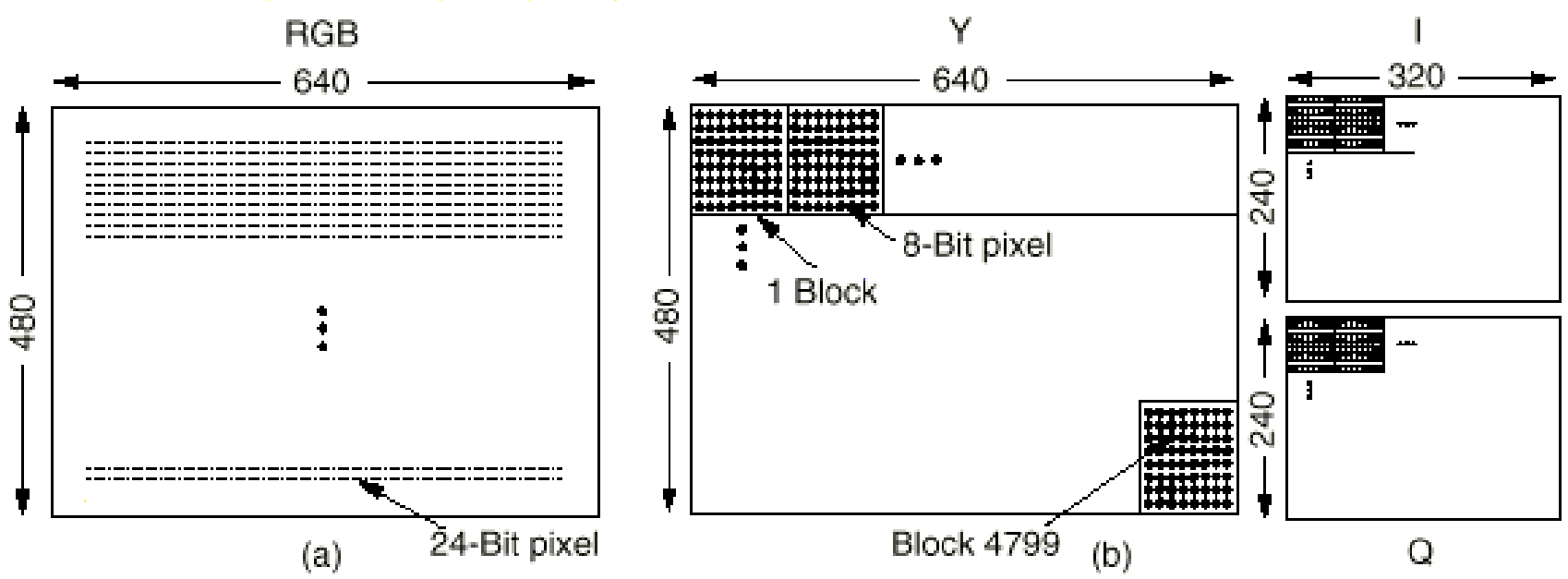
- Brightness vs color sensitivity
  - RGB => YUV/YIQ
  - chroma subsampling (4:2:0)
- Spatial correlation among nearby pixels
  - slice an image into 8x8 blocks (bad for text)
- Remove redundancy in frequency domain
  - discrete cosine transform (DCT)
  - coarse quantization for high freq coefficients

JPEG procedures



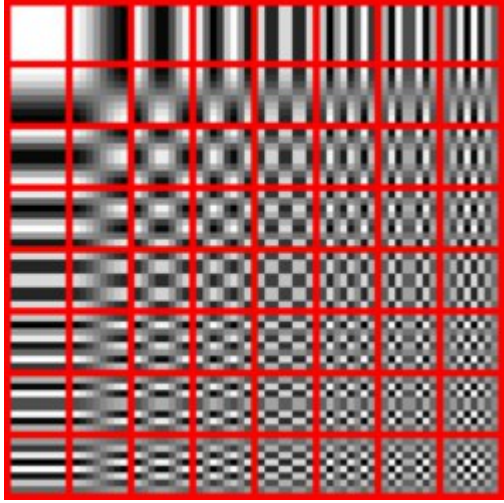
Block preparation

- RGB => YUV/YIQ; 4:2:0 subsampling

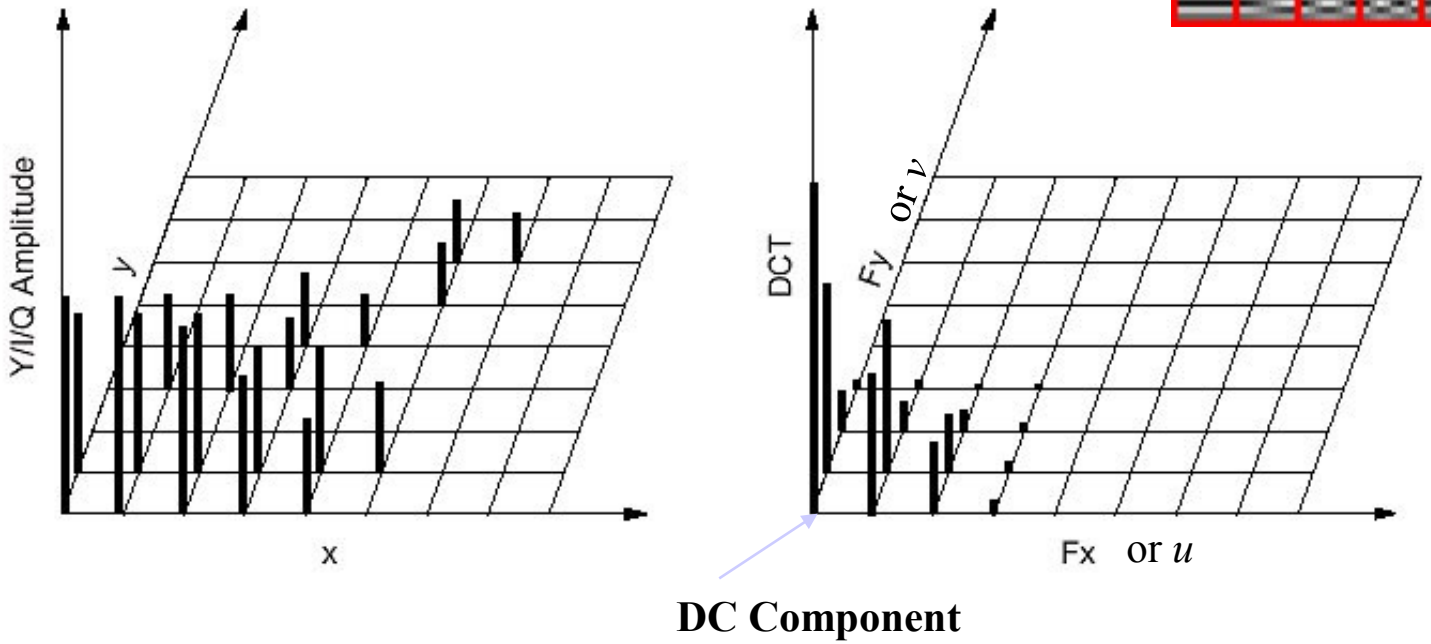


RGB Input Data **After Block Preparation**

DCT on each 8x8 block



basis



DC Component

Original values of an 8x8 block (in spatial domain)

Corresponding DCT coefficients (in frequency domain)

http://en.wikipedia.org/wiki/File:Idct-animation.gif

Quantization

- Fine quantization for low freq coefficients
- Coarse quantization for high freq coefficients
  - example: round-up/bit-shift

Quantization table

1	1	2	4	8	16	32	64
1	1	2	4	8	16	32	64
2	2	2	4	8	16	32	64
4	4	4	4	8	16	32	64
8	8	8	8	8	16	32	64
16	16	16	16	16	16	32	64
32	32	32	32	32	32	32	64
64	64	64	64	64	64	64	64

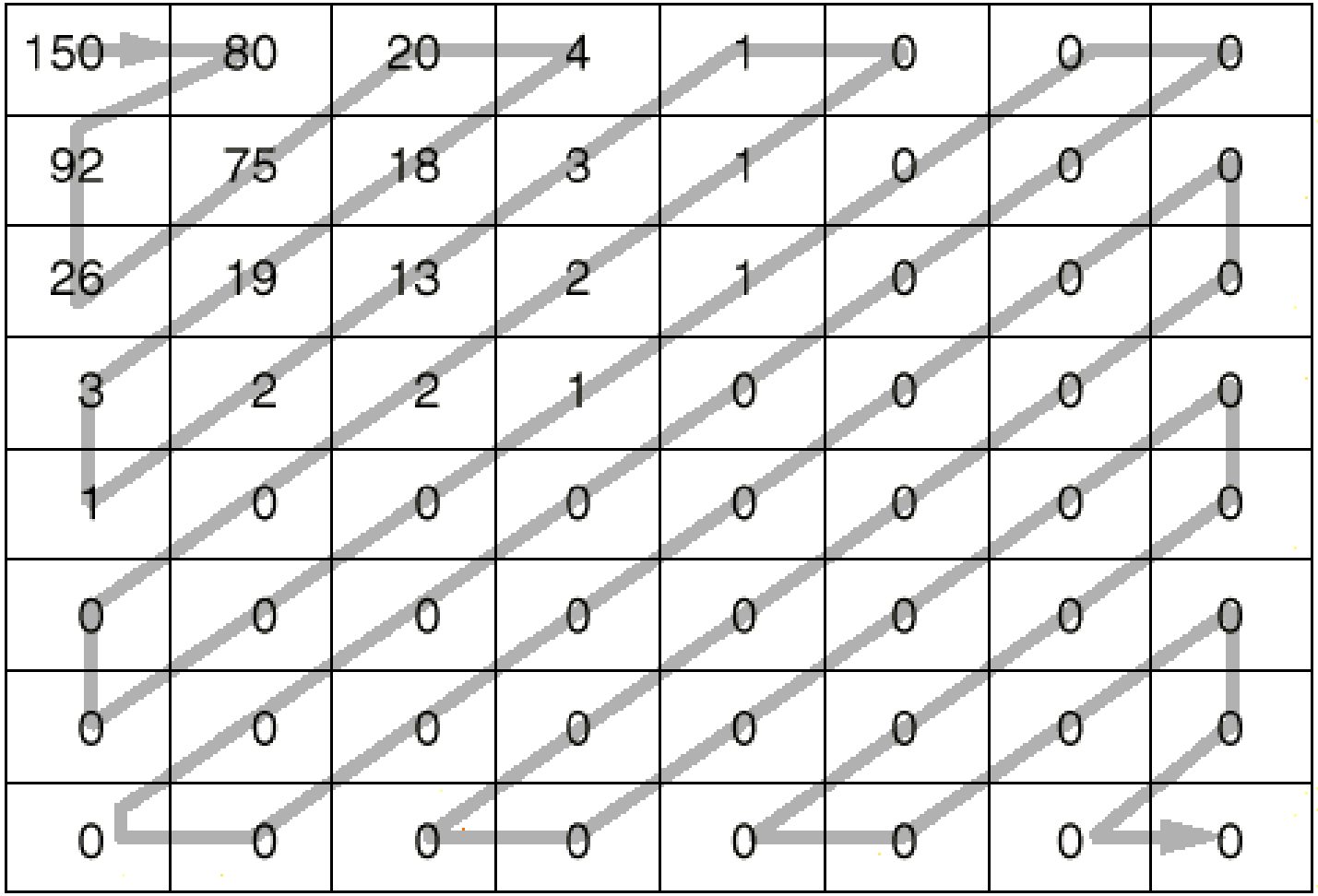
DCT Coefficients

150	80	40	14	4	2	1	0
92	75	36	10	6	1	0	0
52	38	26	8	7	4	0	0
12	8	6	4	2	1	0	0
4	3	2	0	0	0	0	0
2	2	1	1	0	0	0	0
1	1	0	0	0	0	0	0
0	0	0	0	0	0	0	0

Quantized coefficients

150	80	20	4	1	0	0	0
92	75	18	3	1	0	0	0
26	19	13	2	1	0	0	0
3	2	2	1	0	0	0	0
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

Zig-Zag: 8x8 => 1x64



DCT coefficient encoding

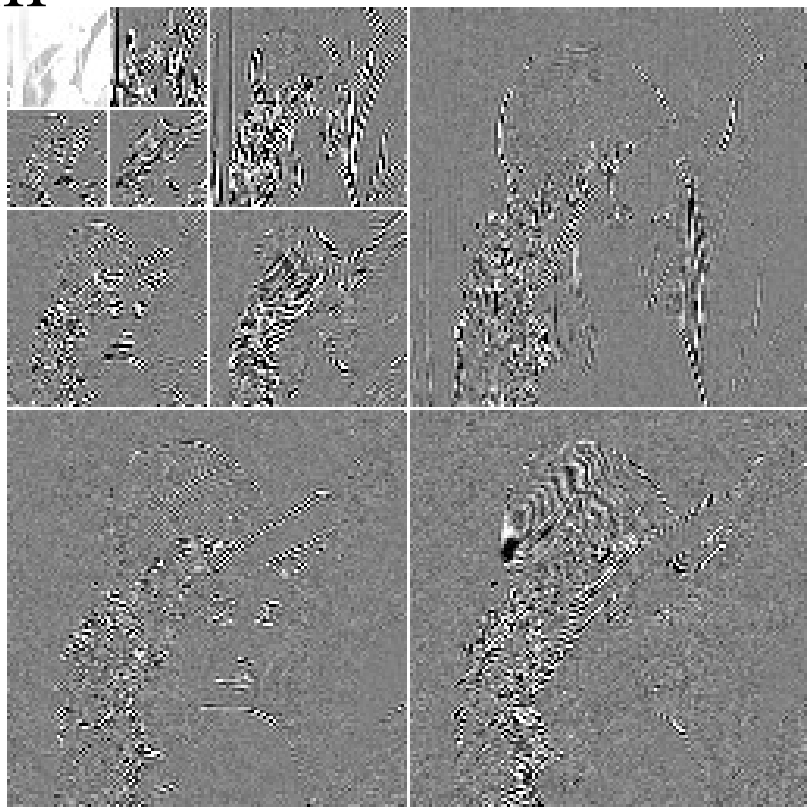
- DC coefficient
  - DPCM: differential pulse code modulation
  - among DC of neighboring blocks
- AC coefficients
  - many consecutive 0s for high freq in a block
  - RLE: run length encoding (non-zero, # of zero)
- Entropy encoding
  - Huffman or arithmetic

JPEG modes

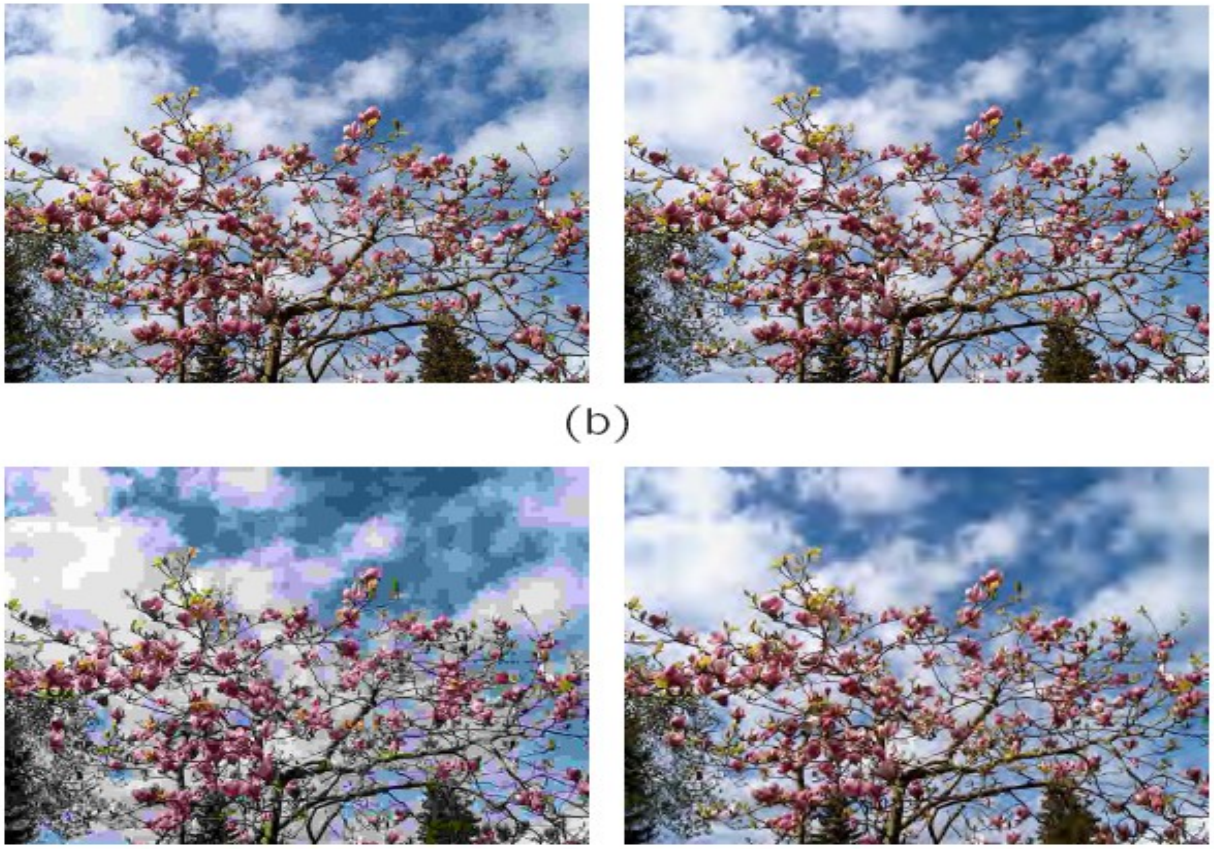
- Sequential mode
- Progressive mode
  - low quality first, then differential data added
    - DC first, then AC; or MSB first, then LSB
- Hierarchical mode
  - lowest resolution first and then higher resolutions
- Lossless mode
  - prediction and entropy encoding

JPEG2000

- Discrete wavelet transform
  - improve compressibility
    - especially at low bitrate
  - improve scalability etc
- JPEG2000 procedures
  - RGB => YUV/YIQ
  - DWT
  - encoding



JPEG2000 vs JPEG



JPEG

(b)

JPEG2000

(c)

This lecture

- image compression
  - JPEG
    - RGB => YUV/YIQ; blocks
    - DCT
    - quantization
    - coefficient coding (DC vs AC); entropy coding
- Explore further
  - JPEG2000 and DWT

Next lecture

- Multimedia manipulation
  - video compression [Ref: Li&Drew Chap 10]
    - motion estimation [10.2-3]
    - H.261/263 [10.4-5]
    - H.264 and H.265?