

# CSc 461/561

## Multimedia Systems

### Image compression

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## 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!

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## JPEG compression guidelines

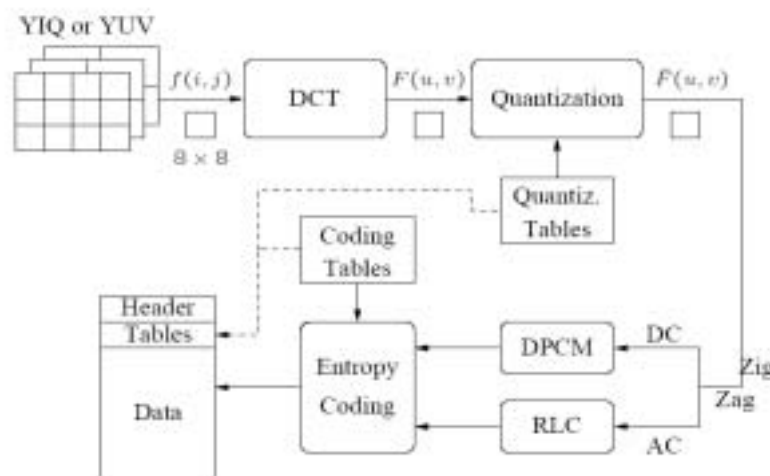
- Brightness vs color sensitivity
  - RGB => YUV/YIQ
  - chroma subsampling (4:2:0)
- Spatial correlation among nearby pixels
  - slice an image into 8x8 blocks (bad for text)
- Remove redundancy in frequency domain
  - discrete cosine transform (DCT)
  - coarse quantization for high freq coefficients

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## JPEG procedures



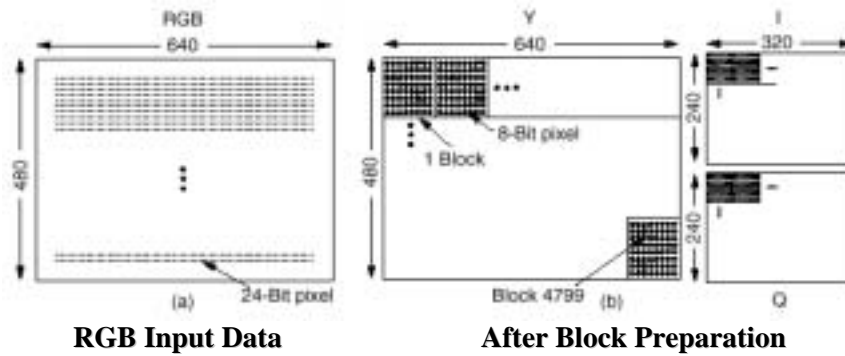
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# Block preparation

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

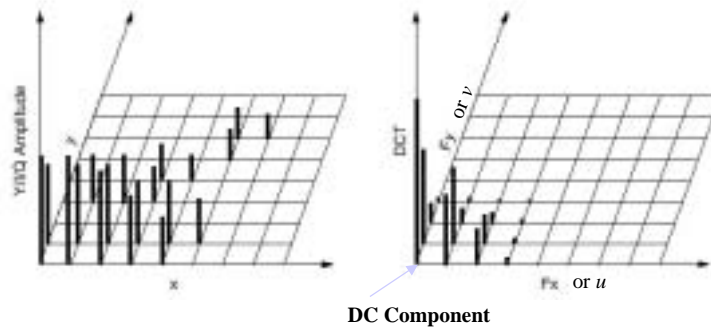


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# DCT on each 8x8 block



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

Corresponding DCT coefficients  
(in frequency domain)

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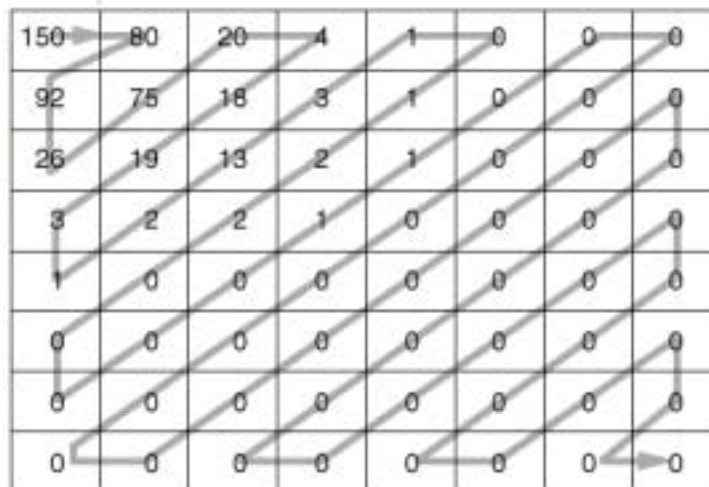
# Quantization

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

Quantization table	DCT Coefficients	Quantized coefficients
1 1 2 4 8 16 32 64	150 80 40 14 4 2 1 0	150 80 20 4 1 0 0 0
1 1 2 4 8 16 32 64	92 75 36 10 6 1 0 0	92 75 18 3 1 0 0 0
2 2 2 4 8 16 32 64	52 38 26 8 7 4 0 0	26 19 13 2 1 0 0 0
4 4 4 4 8 16 32 64	12 8 6 4 2 1 0 0	3 2 2 1 0 0 0 0
8 8 8 8 8 16 32 64	4 3 2 0 0 0 0 0	1 0 0 0 0 0 0 0
16 16 16 16 16 16 32 64	2 2 1 1 0 0 0 0	0 0 0 0 0 0 0 0
32 32 32 32 32 32 32 64	1 1 0 0 0 0 0 0	0 0 0 0 0 0 0 0
64 64 64 64 64 64 64 64	0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0

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## Zig-Zag: 8x8 => 1x64



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## 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 (# of zero, non-zero)
- Entropy encoding
  - Huffman or arithmetic

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## JPEG modes

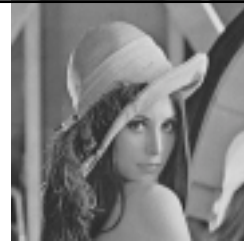
- Sequential mode
- Progressive mode
  - low quality first, then differential data added
    - DC first, then AC; or MSB first, then LSB
- Hierarchical mode
  - lowest resolution first and then higher resolutions
- Lossless mode
  - prediction and entropy encoding

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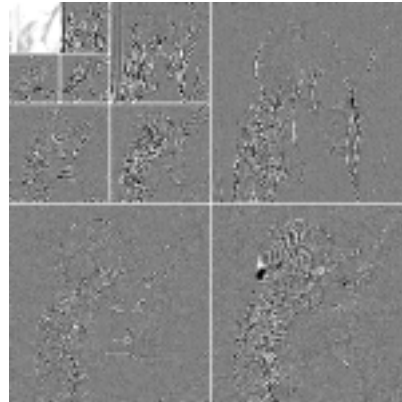
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# JPEG2000



- Discrete wavelet transform
  - improve compressibility
  - improve scalability etc
  - not widely used yet (.jp2)
- JPEG2000 procedures
  - RGB => YUV/YIQ
  - DWT
  - encoding

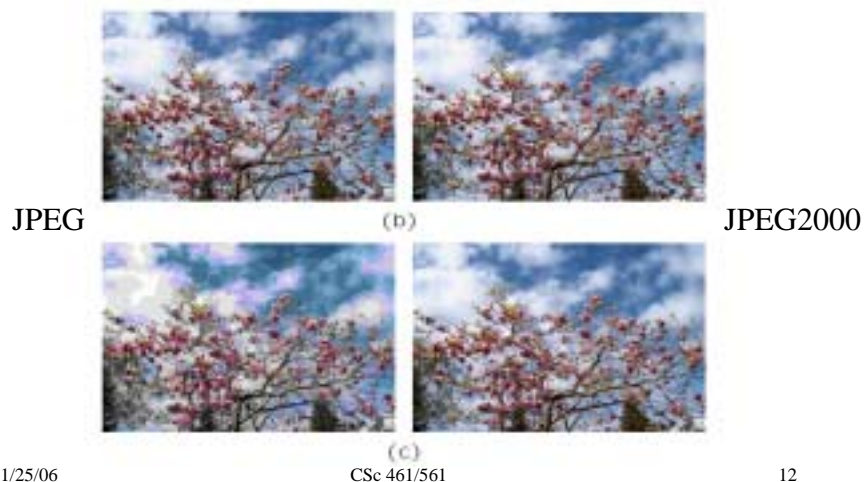


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# JPEG2000 vs JPEG



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## This lecture

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

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## Next lecture

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

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