Multimedia Systems

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Today Lecture

Introduction to Information compression

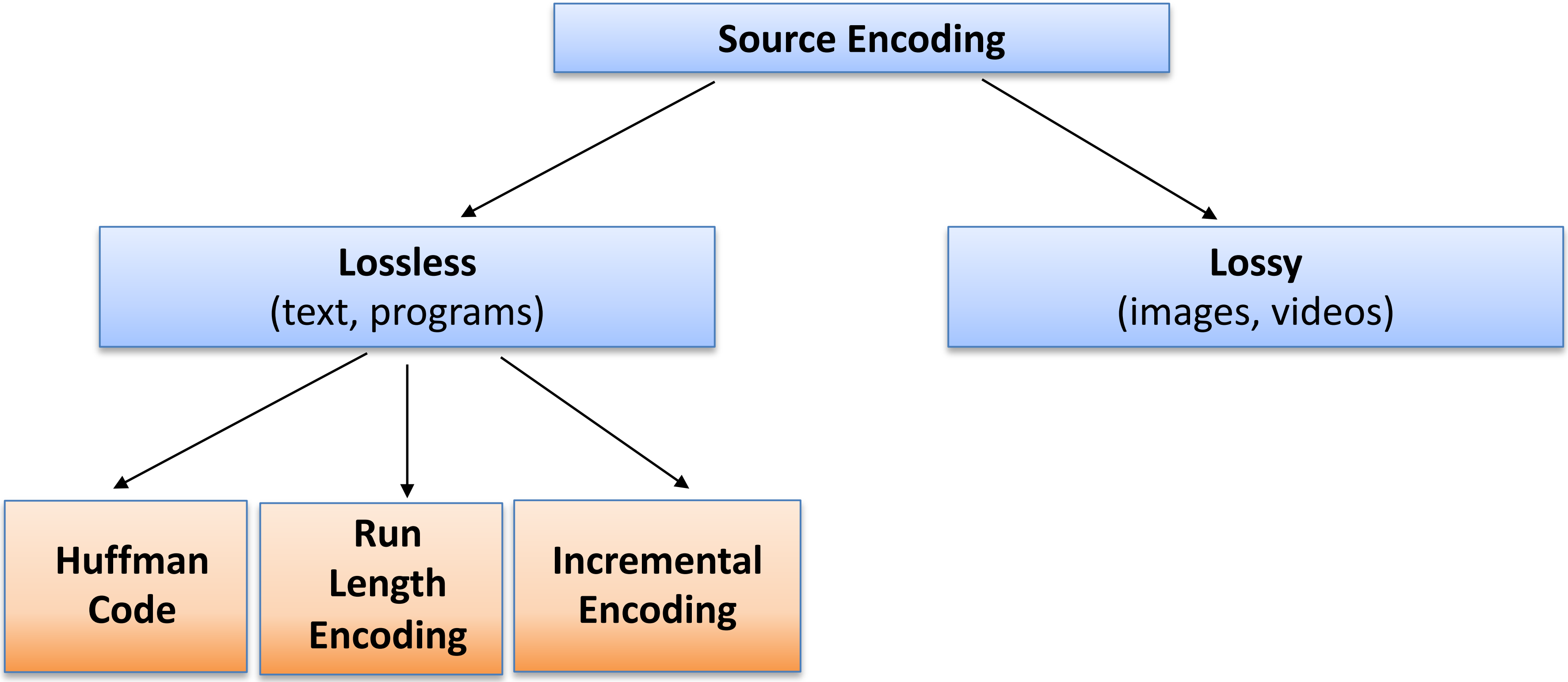
- Source Coding
- Information and Entropy
- Variable length coding
- Quantization

Multimedia Systems

- Image and Lossy Compression
  - Transforms
  - JPEG Quantization
  - JPEG Lossless Compression

- Video Compression
  - Motion Compensation

Source Coding



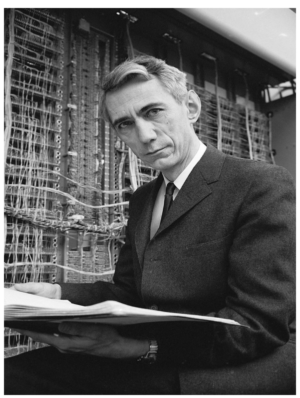
Source Coding

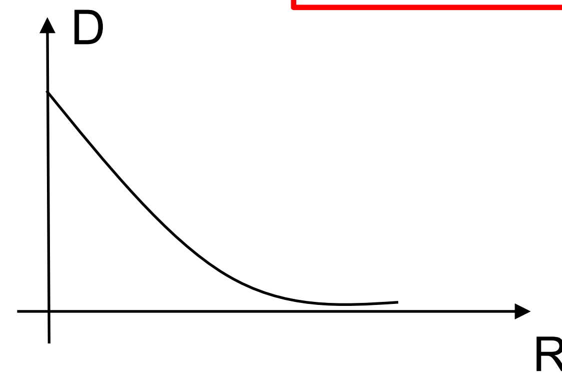
Source Encoding

Lossless

Lossy

Speech and Video coding





Shannon's first theorem (1948)

Expected code length relates to the source entropy

Source recovered with a distortion D (function of the coding rate)

Why do we compress?

These are related to the 3 types of redundancy in images/videos:

- Interpixel redundancy
- Psychovisual redundancy
- Coding redundancy

Coding Redundancy

- Some colors are more common than others
- For example, black, brown, and red hardly appear in this picture
- This is sometimes called *coding redundancy*

Interpixel Redundancy

- Blue pixels tend to occur next to other blue pixels; yellow pixels are near other yellow pixels
- This spatial correlation is sometimes called *interpixel redundancy*
- There are also interspectral and interframe redundancy

Psychovisual Redundancy

- Some parts of the scene are very homogeneous (sky)
- Other parts are very busy (flowers) and could hide noise
- This is sometimes called *psychovisual redundancy*

Why Lossy?

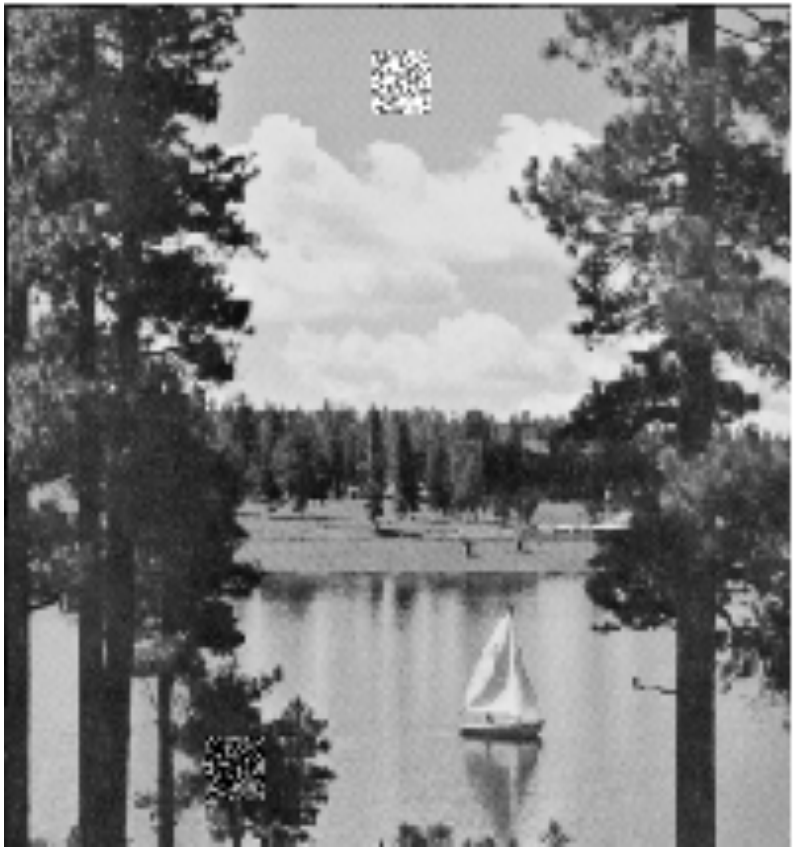
Human Visual System Issues

- We can get away with lossy compression because *your eye doesn't see everything anyway*
  - Contrast sensitivity function
  - Mach bands
  - Spatial masking
  - Oblique effect

Spatial Masking

- A stimulus is harder to see in the presence of large visible spatial and temporal changes in luminance
- Line presented near a luminance edge is harder to see as it gets closer

Spatial Masking



Implication: Can allow more error in busy parts of the picture

How well is the compression doing?

- We would like to have a low bit rate and yet a high image/video quality

  (there are also other factors – not covered today- such as complexity, error resilience, delay etc.)

- If you use lossy compression, need to be able to measure the quality

MSE Metric

- The most common computable measures are the MSE

$$MSE = \frac{1}{N \times M} \sum_{i=1}^{N} \sum_{j=1}^{M} (F(i,j) - G(i,j))^2$$

where F is the input image, G is the output image, and the images are of size N by M

PSNR Metric

- The MSE is often reported in logarithmic form as a signal-to-noise ratio:

$$SNR = 10\log_{10}\frac{D_0}{MSE}\,dB$$

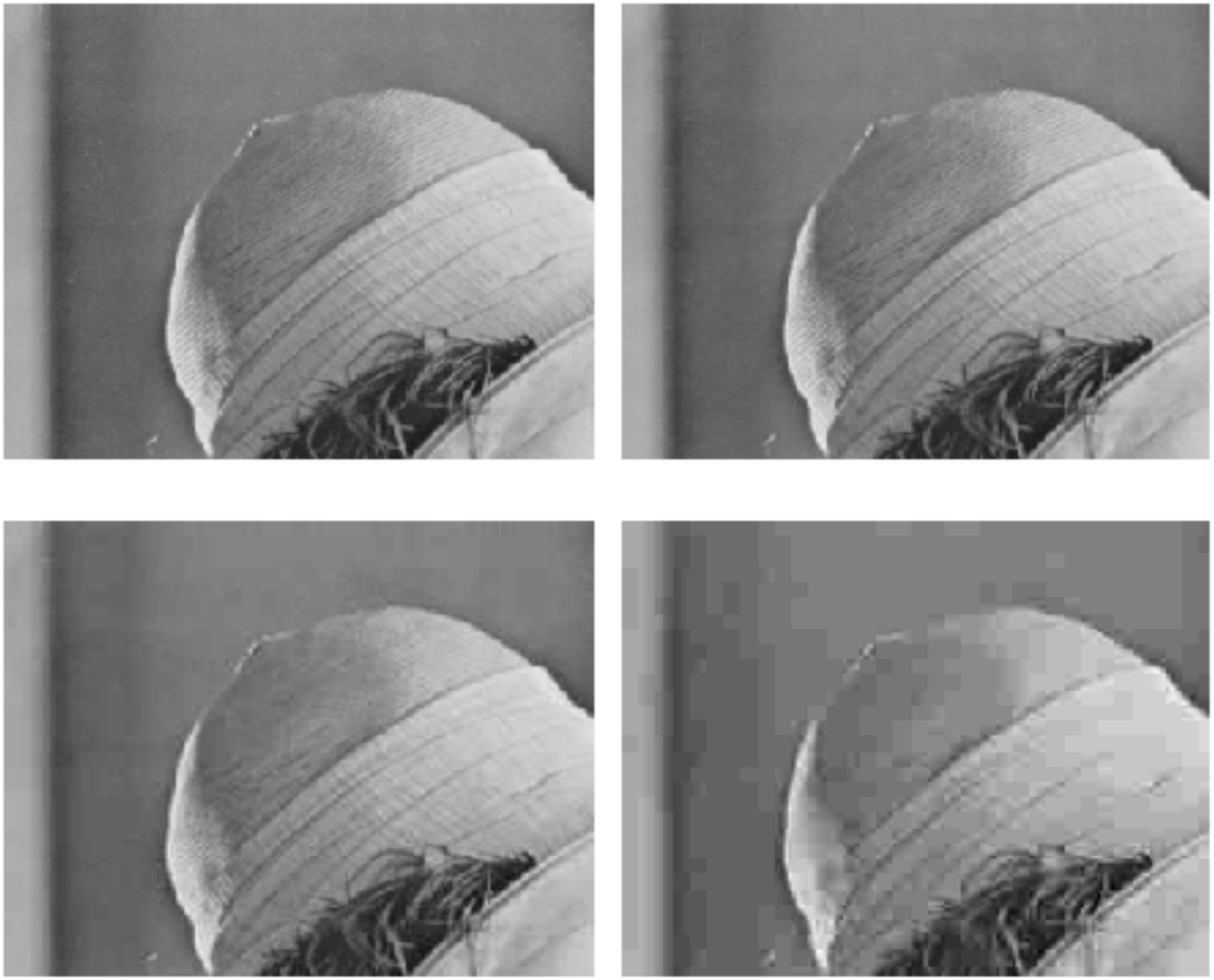
where D_0 is a normalization factor

  - D_o often chosen to be the square of the maximum possible input value (e.g., 255^2)
  - Then it's called a "peak SNR" or PSNR

JPEG Example

Original

1 bpp



0.5 bpp

0.25 bpp

Thank You