CS 640 Introduction to Computer Networks

Lecture21

Today's lecture

- Compression
  - Lossless compression
  - Lossy compression

Why use compression?

- Pros
  - Less data to transfer
  - Application sees better throughput
  - Fewer bytes to store
  - Latency might be better
- Cons
  - Data quality can degrade
  - CPU overhead (harder to compress than to uncompress)
  - Latency might be worse
- Typically done at application or data link layer

Huffman codes

- Core idea: use shorter bit sequences to encode symbols that occur often
  - Symbols can be characters or something else
  - Works for some types of data
- Example: “Ramabhadran”
  - Need 8 symbols in alphabet
  - Equal size encoding
    - 11*3 = 33 bits
  - Huffman encoding
    - 4*2 + 5*3 + 2*4 = 31 bits

Symbol	Code
a	00
R	010
m	011
b	100
h	101
d	110
r	1110
n	1111

Other methods

- Run length encoding
  - Encode AAABBCDDDD as 3A2B1C4D
  - Works well for faxes
- Dictionary based methods
  - Use codes for words occurring in a dictionary
  - Words have variable lengths (may actually be a phrase)
  - Dictionary needs to be known to both sender and receiver
  - Can be static or dynamic (based on the data to compress)
  - Lempel-Ziv uses dynamic dictionaries
  - Works well for many kinds of data

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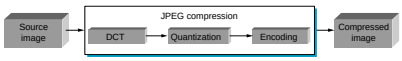
Lossy compression overview

- Data reconstructed by the receiver is similar, but not identical to the data at the sender
- Can achieve higher compression ratios
  - User can control quality loss or compression ratio
- Used for images, audio and video
  - JPEG (images)
  - MPEG-2 video
  - MP3 audio
  - Many other formats exist (some proprietary)

JPEG

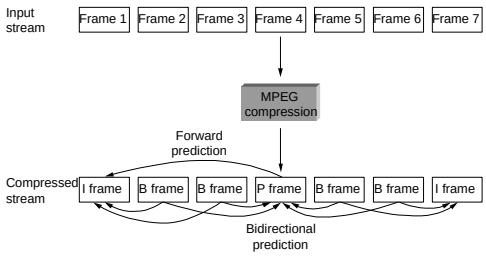


- Operates on blocks of 8*8 pixels at a time
- DCT transforms data w/o loss
  - Like transforming cartesian to polar coordinates
- Quantization drops small coefficients which represent visually unimportant information
- Encoding (Huffman+RLE)
- Compression factor ~ 30

MPEG – video compression

- Typically MPEG encoding too expensive to do online
- Video is a sequence of frames (e.g. 30/second)
  - JPEG exploits spatial locality within images (frames)
  - MPEG also exploits temporal locality – typically the next frame is somewhat similar (compression factor ~ 100)
- MPEG uses 3 types of frames
  - I frames can be decoded independently
  - P frames depend on the previous I frame
  - B frames depend on the previous and next I or P frame

MPEG frame types



Compressing sound

- Represented as periodic samples
  - Phone quality 8 bit samples every 125 μs (64Kbps)
  - CD quality16 bit samples 23 μs (stereo 1.41 Mbps)
- MP3
  - Part of the MPEG standard
  - Divides the sound into frequency bands
  - Works on blocks of 64 to 1024 samples
  - Uses DCT, quantization, and encoding
  - Compression factor up to 12