



INTRODUCTION TO COMPUTER MUSIC
AUDIO DATA COMPRESSION

Roger B. Dannenberg
Professor of Computer Science, Art, and Music



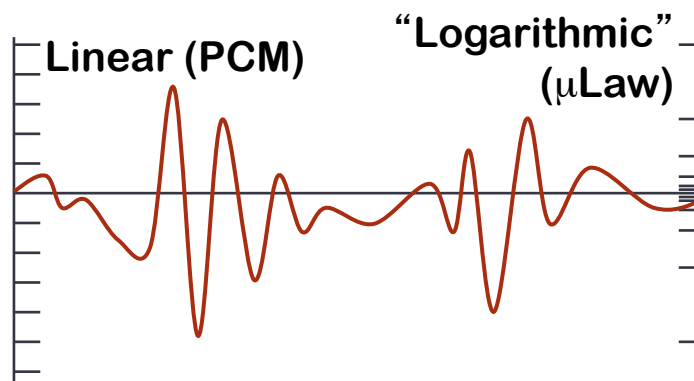
General Compression Techniques

- **Coding Redundancy**
 - optimize the coding of symbols or samples
 - quantize in lossy coding
 - e.g. variable length coding
- **Intersample Redundancy**
 - represent runs of pixels, silence in audio
 - frequency domain representations
 - object descriptions
- **Psycho-Perceptual Redundancy**
 - masking effects
 - noise and distortion thresholds

Coding Redundancy

- PCM – Pulse Code Modulation
 - linear encoding of sampled audio
 - this is the reference “uncompressed” representation
- U-law – logarithmic encoding to 8 bits:
 - sign bit, 3 exponent bits, 4 mantissa bits
 - scaled to span 13 bit dynamic range
- A-law
 - similar, but 12 bit dynamic range

μ Law vs PCM

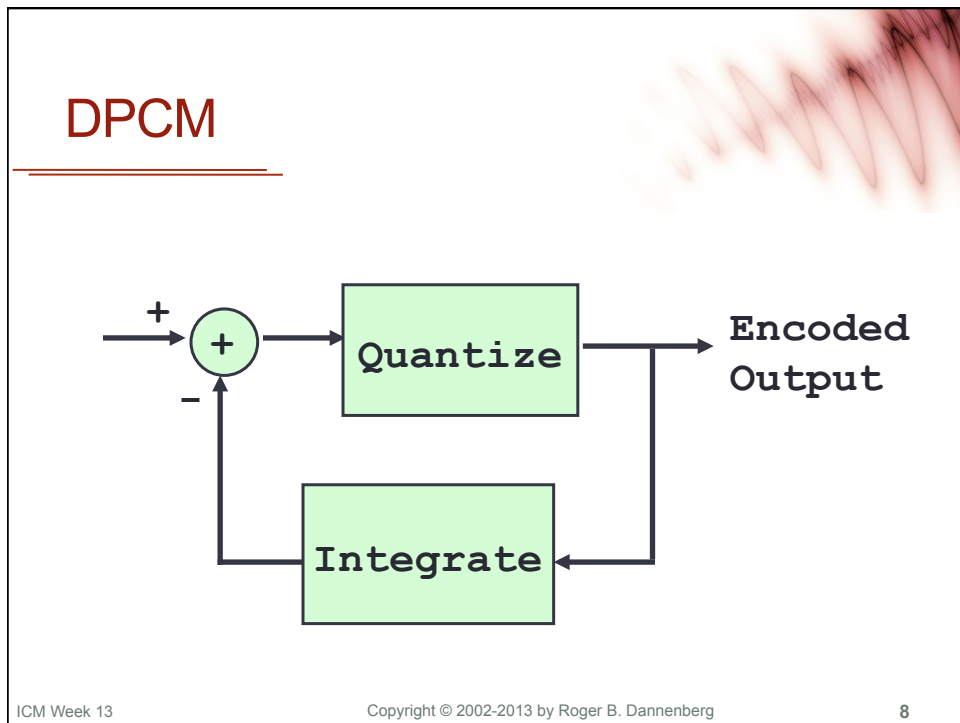
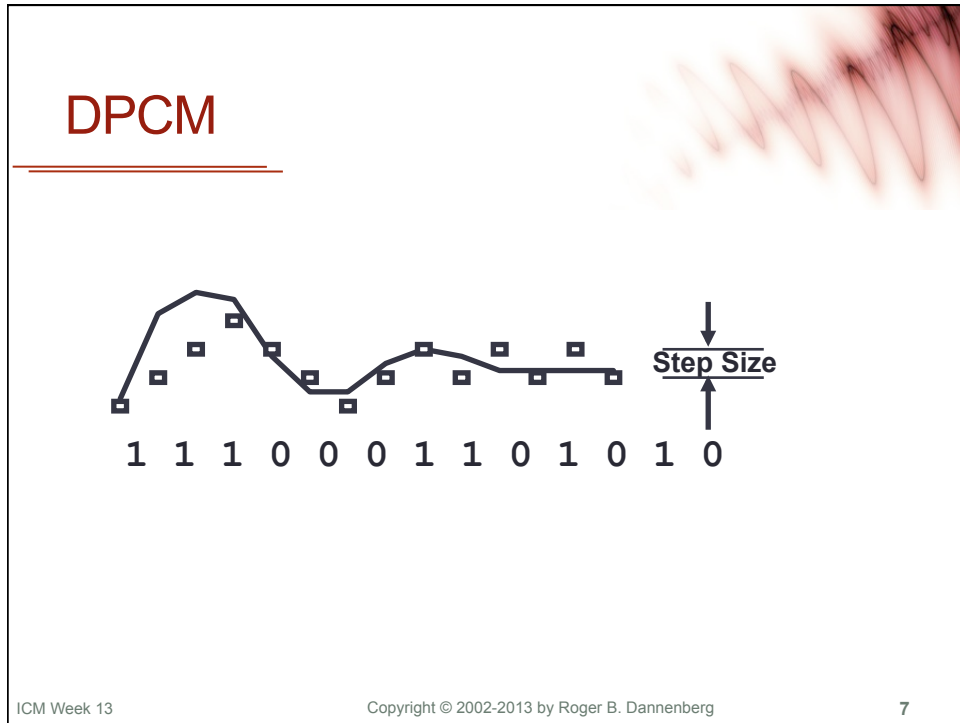


Implementation

- Encoding and decoding by table lookup.
 - Encoding table is lossy, many-to-one mapping.
 - Decoding (256 values) is one-to-one.
- Common in telephony
- What about more bits for music?
 - Studies show that 16-bit PCM is better.
 - Other techniques (perceptual coding) *much* better if you can't afford 16-bit PCM.

Intersample Redundancy Examples

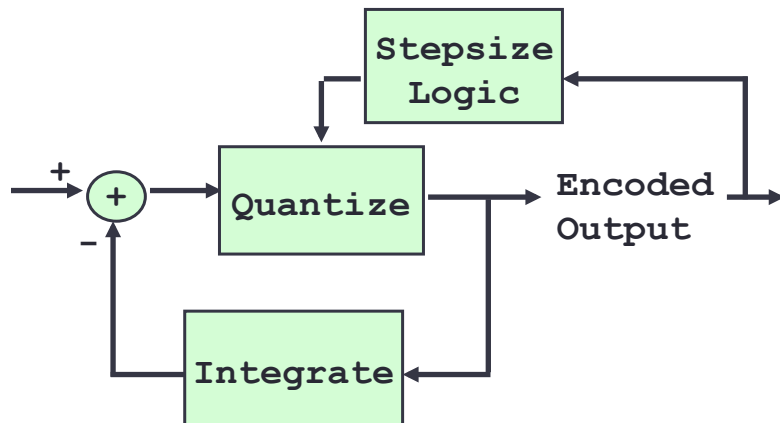
- DPCM – delta PCM
 - encode sample differences
 - about 6dB improvement over PCM for speech
- ADPCM – Adaptive Delta PCM
 - adapt quantization size
 - about 10-11dB improvement over PCM for speech



ADPCM



ADPCM Coder



Adaptive Prediction

- Signals are redundant: future samples are correlated with previous samples
- DPCM uses 1st order predictor, e.g. the previous sample
- Nth order predictor forms weighted sum of past N samples
- Need to adapt the weights → adaptive prediction
- Gain is about 3 or 4 dB, little gain beyond 4th or 5th order

Why not store delta instead of PCM?

- Delta can be big
 - Cannot assume smaller samples
 - Therefore no compression (without loss)
- For music, experiments show PCM is better.

Review

- Uncompressed audio = PCM
 - linear, independent integer samples
- Coding Redundancy
 - U-LAW, A-LAW
- Intersample Redundancy
 - DPCM
 - ADPCM
- Psycho-Perceptual Redundancy