

6.1 Compression-Reading

Notebook: How Computers Work [CM1030]

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Tags: Compression, Dictionary, Frequency, GIF, Image, JPEG, Lossless, Lossy, MP3, Pixel, RGB, ...

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| Cornell Notes | Topic: 6.1 Compression | Course: BSc Computer Science |
| | | Class: How Computer Work [CM1030]-Reading |
| | | Date: November 04, 2019 |
| Essential Question: | | |
| What is data compression and the various techniques/file formats used to compress Image and Audio files? | | |
| Questions/Cues: | | |
| <ul style="list-style-type: none">• What is data compression?• What is lossless and lossy data compression?• What is Run-length encoding?• What is Frequency-dependent encoding?• What is Relative encoding?• What is Dictionary encoding?• What is Adaptive Dictionary encoding?• What is a GIF?• What is a JPEG?• What is TIFF?• What is MP3? | | |
| Notes | | |
| <ul style="list-style-type: none">• Data Compression = to reduce size of data involved while retaining underlying info• Lossless = don't lose info in compression process• Lossy = may lead to loss of info in compression process<ul style="list-style-type: none">◦ provide more compression than lossless, popular in case of images and audio where minor errors tolerated• Run-length encoding = process of replacing sequences of identical data elem. with code indicating element that is repeated & # of times it occurs in the sequences<ul style="list-style-type: none">◦ where data being compressed consists of long sequences of same value• Frequency-dependent encoding = a system in which length of bit pattern used to rep data item is inversely related to frequency of item's use• Relative encoding (differential encoding) = record differences between consecutive data units rather than entire units; each unit encoded in terms of relationship to previous unit | | |

- can be implemented in either lossless or lossy depending on whether differences between consecutive data units encoded precisely or approximated.
- Dictionary encoding = term dictionary refers to collection of building blocks from which message being compression is constructed & msg itself encoded as sequence of references to dictionary.
 - Normally thought of as lossless system, but when img compressing, there's times when entires in dictionary are only approximations of correct data elem. resulting in lossy compression
- Adaptive dictionary encoding (dynamic dictionary encoding) = dictionary allowed to change during encoding process
 - Example of this is Lempel-Ziv-Welsh (LZW) encoding. To encode msg using LZW, one starts with dictionary containing basic building blocks from which msg is constructed, but as larger units found in msg they added to dictionary, meaning future occurrences of those units can be encoded as single, rather than multiple dictionary refs.
- GIF (Graphic Interchange Format) = dictionary encoding system, reduces # of colours that can be assigned to pixel to only 256
 - RGB combo for each of these colors encoded using 3 bytes and these 256 encoding stored in table (a dictionary) called palette. Each px in img can then be rep'ed by single byte whose value indicates which of the 256 palette entires reps the px's color.
 - GIF is lossy system when applied to arbitrary imgs because colors in palette may not be identical to colors in original img.
 - GIF can obtain additional compression using LZW techniques. Final dictionary consists of original palette and collection of pixel patterns
 - 1 of colours in GIF palette assigned value "transparent", meaning bg shows through anything assigned this color. This make GIF logical choice in simple animation apps but GIF unsuitable for apps of higher precision
- JPEG (Joint Photographic Experts Group) = for compressing color photos, JPEG baseline standard is standard choice, requires a sequence of steps concerning human eye's limitations, eye more sensitive to brightness changes than changes in color
 - starting from image that is encoded in terms of luminance & chrominance components, 1st step to average chrominance values over 2 by 2 pixel squares. This reduces size of the chrominance info by factor of 4 while preserving all original brightness info. Result is significant degree of compression with noticeable loss of image quality
 - Next step to divide image into 8 by 8 pixel blocks and compress info in each block as unit, applying discrete cosine transform. This transformation converts original 8 by 8 into another block whose entries reflect how pixels in original block relate to each other rather than actual pixel values.
 - Values in new block under predetermined threshold replaced by 0s
 - JPEG baseline standard normally color images by factor of at least 10 and often by as much as 30
- TIFF (Tagged Image File Format) = standard format for storing photographs along with related info such as date, time and camera settings
 - image itself is stored as RGB pixel components with compression
 - TIFF collection of standards includes data compression techniques designed for compressing images of text documents
- MP3 (MPEG Layer 3) = takes advantage of properties of human ear, removing details that human ear cannot precieve
 - Temporal Masking = short period after loud sound, human ear cannot detect softer sounds that would otherwise be audible
 - Frequency Masking = sound at 1 frequency tends to mask softer sounds at nearby frequencies
 - Transfer rates of no more than 64 Kbps

In this week, we learned what data compression is and what is meant by lossless and lossy compression. Also we looked at the different file format used to compress Image and Audio files. Alongside this, we explored in detail how each file format derives compression using dictionary or run-length encoding techniques.