2． Compression and Coding

Wang Zhongsheng

wzhsh1681@163.com

Xi'an Technological University

Xi’an, China

2018.09

Volume

2.1 Necessity and possibility of data compression

2.2 Compression coding algorithm

2.3 Huffman coding algorithm (omit)

2.4 International standard of data compression coding

2.1 Necessity and possibility of data compression

Digital audio, image, animation, video have a large amount of data, which needs a large amount of storage space and transportation resources. The key technology to solve this problem is data compression. This chapter focuses on some important compression coding methods,

and at the same time introduces the existing international standards for media information data compression. These compression algorithms and international standards can be widely used in media transmission and storage technology, as well as in conventional digital video, mobile TV and interactive TV systems.

1.1.1 Features of New Media Data

Images or videos in new media belong to digital information, which has significant characteristics of digitized information. The image's quality will not be changed due to the operation of storage, transmission or replication, etc., with high resolution, high information quality and good stability.

Digital videos and images have a large amount of data, which makes it difficult to store and transmit. So, in many applications, in order to store and transmit data effectively, the images must be encoded and compressed. Compression is a mechanism to reduce the amount of data through specific algorithms, which can improve the efficiency of image storage and transmission.

Compression ratio refers to the proportion between the size of a image before compression and its size after compression. Without distortion of the image, the larger the compression ratio is, the better it is, however, the smaller the compressed file is, the longer the decompression time is. Compression coding methods can be divided into lossless compression and lossy compression. The lossless compression only removes the redundant information, and can restore the original image accurately when

decoding, which is a reversible process.

The lossy compression coding, on the other hand, makes use of the insensitivity of human to some frequency components in images or videos to allow certain information to be lost in the process of compression. Although the original data cannot be completely restored, the lost part has less impact on the original image to be understood, but the compression ratio is very large.

(1) Lossless compression coding

Lossless compression can be divided into two categories: statistical probability based methods and dictionary based methods. The first is based on information theory's variable-length coding theorem and information entropy knowledge, and USES shorter code to represent the symbol with high probability and longer code to represent the symbol with low probability, so as to realize data compression.

Lossless compression coding cannot achieve a high compression ratio because it is limited by the entropy of the information source itself, so lossless compression coding is also known as entropy coding.

(2) Lossy compression coding

In order to improve the compression ratio of coding, the correlation between pixels in image and the difference of gray sensitivity in human vision are used to encode. The lossy compression coding becomes an important research direction of image compression coding. The common used methods are divided into four categories: transform coding, predictive coding, vector coding and model coding.

Due to a certain degree of distortion, lossy compression coding has much higher compression ratio than lossless compression coding, and has greater compression potential. At present, the study of image compression coding is mainly focused on lossy compression coding. In the actual image compression system, the lossless compression coding and lossy compression coding are used together to improve the coding efficiency.

2.2 Compression coding algorithm

2.2.1 Shannon-Fano Algorithm

Claude Elwood Shannon, an American electrical engineer, he is known as the founder of information theory. The coding is a technique of constructing prefix codes based on a set of symbols and their probabilities. The technology was discovered independently by Claude Shannon (1948) and Robert Fano (1949), hence it was

In Shannon-Fano coding, symbols are sorted from the maximum possible to the minimum possible, and the arranged symbols are divided into two groups, so that the probability of the two groups is nearly the same, and each is assigned a binary code ‘0’ and ‘1’. Repeat these sets in the same process as long as there are symbols remaining to determine the code's continuous number.

Continue until only one source symbol remains in each group. When a group has been lowered to a symbol, it obviously means that the code for the symbol is complete and does not form a code prefix for any other symbol.

The purpose of Shannon-Fano coding is to produce code words with minimal redundancy. The symbols of some code can be represented by shorter code.

The criterion of estimating the length of code word is the probability of symbol occurrence. The greater the probability of the symbol is, the shorter the length of the code word is.

(1) An example

A string of codes is composed of 5 symbols in A~E, which can be encoded with the following number of occurrences. A set of strings has a total of 39 characters, the number of A is 15, the number of B is 7, the number of C is 6, the number of D is 6, and the number of E is 5, as shown in the following table.

符号	A	B	C	D	E
计数	15	7	6	6	5
概率	0.38461538	0.17948718	0.15384615	0.15384615	0.12820513

Shannon-Fano's coding algorithm can be described by binary tree, which is based on a valid code table specification. The setup is as follows.

(1) For a given symbol list, a corresponding list or frequency count is formulated, so that the relative frequency of each symbol is known.

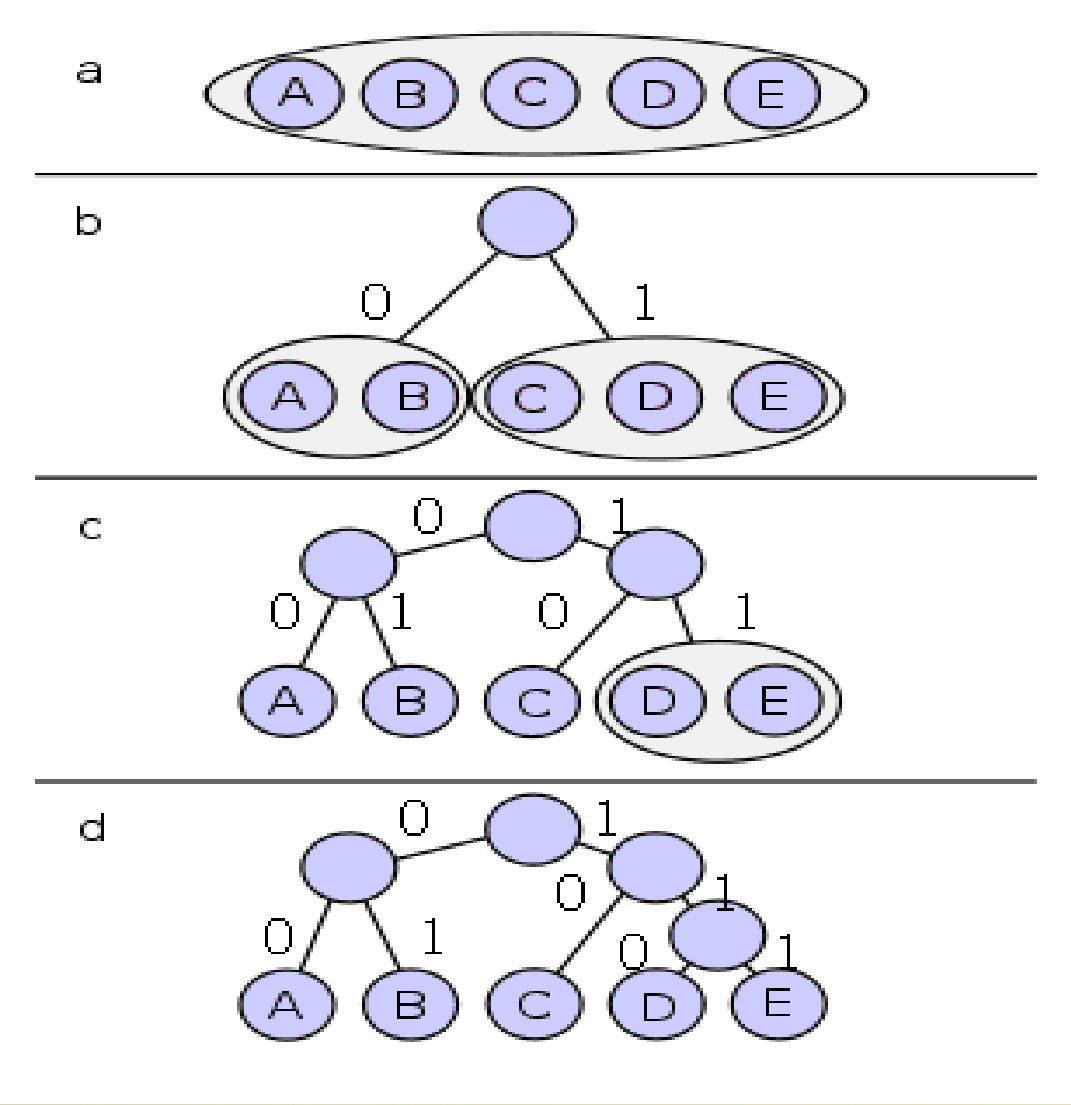
(2) Sort the list of symbols by frequency, with the most common symbols on the left and the least symbols on the right.

(3) Make the total frequency of the left part and as close to the right part as possible.

(4) The left half of the list is allocated with the binary number 0, and the right half is with the number 1. This means that the first half of the symbol code starts at 0, and the second half starts at 1.

(5) recursively apply steps 3 and 4 to the left and right halves, subdivide the population, and add code bits until each symbol has become a leaf of a corresponding code tree.

The algorithm structure tree is shown in the following figure .


a
A B C D E
b
0 1
A B C D E
c
0 1
0 1 0 1
A B C D E
d
0 1
0 1 0 1
0 1 0 1
A B C D E

From left to right, all symbols are divided by the number of times they appear. Dividing line between letter B and C is obtained, and the total number is 22 and 17 respectively. This minimizes the difference between the two groups. Through such segmentation, A and B simultaneously have A code word beginning with 0, while C, D and E have A code word of 1, as shown in the follow table.

符号	A	B	C	D	E
编码	00	01	10	110	111

Figure Coding Table.

the two-digit code length of A, B and C, and the three-digit code length of D and E, the final average code word length is:

$$\frac{2\,\text{Bit}\cdot(15+7+6)+3\,\text{Bit}\cdot(6+5)}{39\,\text{Symbol}}\approx 2.28\,\text{Bits per Symbol.}$$

If the number of bits required to encode each character in ASCII format is 8Bit, it only takes 2.28bit to encode each character in Shannon-Fano, which saves a lot of storage space.

.

In this lesson, we just introduce a kind of compression coding method, and there are many coding methods, please learn by yourself.

you can also reference to my textbook <New Media Technology and Application>, published by Tsinghua University Press, Beijing, China, 2017, ISBN:9787302480389 .

3. Huffman coding algorithm (omit).

4. International standard of data compression coding

International Standardization Organization(ISO), International Electronics Committee(IEC), International Telecommunication Union(ITU), The three international organizations led the groups to specify the multimedia international standards in the 1990s, such as h. 261, h. 263, JPEG and MPEG.

2.4.1 JPEG coding

JPEG is the first set of international static image compression standards (ISO 10918-1) and was developed by JPEG (Joint exposure Experts Group).Thanks to its superior quality, JPEG has been successful in just a few years and is widely used on the Internet and digital cameras, with 80 percent of images on the site using the JPEG compression standard.

JPEG/JPG is the most commonly used image file format, it was developed by a software development association, It is a lossy compression format that can compress images in a small storage space, where duplicated or insignificant data in the image can be lost, and therefore it is easy to damage image data. In particular, the use of high compression ratio will significantly reduce the image quality restored after final decompression. If high quality images are pursued, excessive compression ratio should not be adopted.

JPEG is a very flexible format with the function of adjusting image quality, which allows the compression of files with different compression ratios and supports multiple compression levels. The compression ratio is usually between 10:1 to 40:1. The larger the compression ratio is, the lower the quality is. On the contrary, the higher the quality is. For example, a 1.37mb BMP bitmap file can be compressed to 20.3kb.You can also find a balance between image quality and file size.

JPEG/JFIF is the most common image transfer format on the Internet.

JPEG compression mainly consists of high-frequency information, which has good retention of color information and is suitable for applications on the Internet. It can reduce the transmission time and can support 24bit true color. It is also widely used in images that need continuous tone.

However, this format is not suitable for drawing lines, text, or icons, as this compression made the images badly damaged.PNG and GIF files are better suited to these types of images. Gifs support 8bits per pixel, which is not suitable for colorful photos, but the PNG format provides JPEG equivalent or even more image details.

2.4.2 MPEG coding

In 1988, Moving Picture Experts Group(MPEG), established video and its audio international coding standard. MPEG illustrates the encoding and decoding process of sound and video, it strictly regulates the syntax of bit data stream of sound and image data, and provides the testing of decoder. The standard solves the problem of how to store audio and video information on the 650MB CD, while preserving sufficient room for development, it allows people to continuously improve the encoding and decoding algorithm to improve the quality.

So far, several MPEG standards have been developed, briefly described below.

(1) MPEG-1

In November 1991, the motion picture expert group proposed "TV image and audio coding for digital storage media with data rates of about 1.5mb /s".

Mpeg-1 is mainly used for digital storage of active images, and has 5 parts including mpeg-1 system, mpeg-1 video, mpeg-1 audio, consistency test and software simulation. It focuses on MPEG video and audio compression techniques.

(2) MPEG-2

Mpeg-2 was formally established as an international standard in November 1994. It is the basic standard of digital audio and image signal digitization, and widely used in digital TV (including HDTV), digital sound broadcasting, digital image and voice signal transmission, multimedia and other fields.

.

(3) MPEG-3

Mpeg-3 is the video and audio compression standard for HDTV (high definition TV), which is prepared to be launched after the formulation of mpeg-2 standard.

It is worth noting that mpeg-3 is not the same as the audio format mp3, which USES the third Layer (Layer 3) of audio compression in mpeg-1 and mpeg-2, with a sampling rate of 16-48khz and a coding rate of 8kb/s~ 1.5mb /s.

(4) MPEG-4

Mpeg-4 began to work in 1994 as an algorithm and tool for coding and interactive playback of audio-visual data, a multimedia communication standard with low data rates. The goal of MPEG-4 is to work in a heterogeneous network environment with high reliability and strong interactivity.

Mpeg-4 is mainly used in public telephone exchange network, videophone, mail and electronic newspaper due to its application in low data transmission rate.

(5) MPEG-7

Mpeg-7 is a new member of the MPEG family. Official name is called multimedia content description interface, it is based on the mpeg-1, mpeg-2, mpeg-4 standard, it will be for the various types of multimedia information provision of a description, this description and the content of the multimedia information itself, to support users interested in various quickly and effectively indexed.

(6) Others

In addition to the standards described above, there are many multimedia international standards, such as H.261, H.263, H.264, Real Video、WMV, Quick Time.

Summarize

This chapter introduces the compression coding technology, classification methods, and foundation of Shannon-Fano algorithm, and talk about the common JPEG and MPEG coding standards used in multimedia images and videos. Information compression coding theory has a relatively complex mathematical foundation and algorithm. In learning, we understanding the basic ideas, which can conduct in-depth study and research on this area.

Prof. Wang Zhongsheng

wzhsh1681@63.com

Contact :

School of Computer Science and Engineering,
Xi'an Technological University,
Xi'an, 710032, China
VK, id506332858
Wechat: diamond-wzs
QQ-mail: 59483672@qq.com