Lecture 3 - Compression

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Administrative

- Programming assignment on web site.
  - Due Monday, October 19, 2015
  - Start early
- HW 1 – Due on Wednesday
- QUIZ #1 – Next Wednesday
  - October 14, 2015

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Huffman encoding

Optimal encoding one symbol → one codeword

Huffman codebook required

- optimized for single instance
  - -) have to include in compressed file
- pick generic codebook (eg. English dictionary Huffman table)
  - +) no codebook in file
  - -) not quite as small

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Run Length Encoding

Sequence of data + encode it as

<symbol, run length count>

- applicable to repeating data

1111 1 222 66

300 20 100

<1, 300> <2, 20> <6, 100>

Need to be careful w/ how to encode

- Effective for graphical images
- Limited use in text files
- JPEG uses this as part of its lossless encoding → entropy encoding process

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Compression Fundamental

- CF3 – Escape sequences are necessary for control and disambiguation of data

AAAAA...A B.....B C.....C
9 12 7
A9B12C7

Create special characters or sequences that never occur in regular data
Have a special meaning
Example printf

printf("\"");
"

printf("\\\"");
\"

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Run Length Encoding Variations

Variation 1
AABB CC DD EEEE FFFFF
A2B2C2D2E4F5
- wait for two symbols, then use RLE

AA1BB1CC1DD1EE3FF4

Variation 2
- Use escape sequence to indicate run

AB EEEE DDC BBBBBB *c = escape char
ABE*4D*2CB*6

Variation 3
- Using runs to skip a single common symbol

8 0002 4 005 000003
8([4],2)([1],4)([3],5)([7],3)
skipped places

JPEG uses this form

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Adaptive Compression

- Huffman compression takes one symbol and generates variable length codeword
  - Decompression complicated because of variable bit processing
- Alternative: Learn about common sequences that occur in the input stream and generate one codeword

Common sequences in English, for example
the
and

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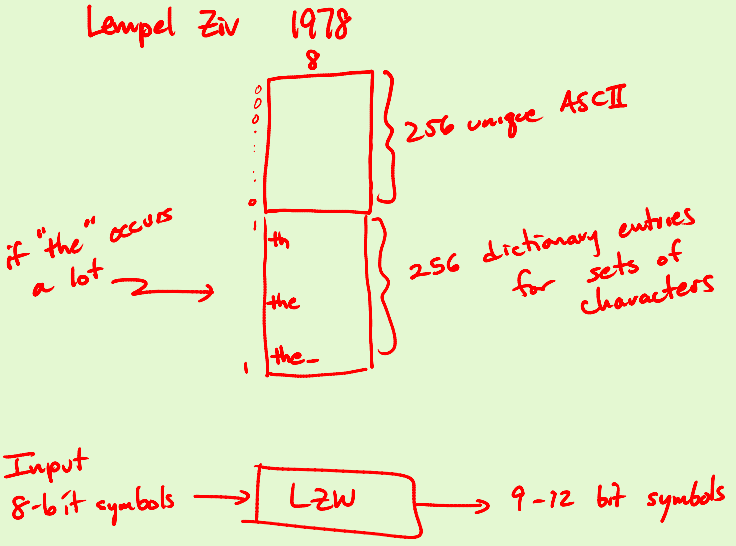
LZW Compression



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LZW Compression – summary
(accidentally skipped but was discussed)

- Lempel-Ziv Compression
  - convert variable length strings into fixed length codes
  - builds "table" during both compression and decompression
    - +) No table
    - -) Needs conditioning
- Lempel-Ziv-Welch (LZW) Compression - is essentially a fast implementation of the LZ compression method
  - Uses:
    - UNIX compress and gzip use LZ and LZW
    - v.42bis network data compression
    - gif and tiff image compression format

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LZW Compression

LZW Compression

```
w = nil
while (read char k)
        if wk exists in dictionary
                w = wk
        else
                add wk to dictionary
                output code for w
                w = k
```

sequences that we have seen

sequences we haven't seen

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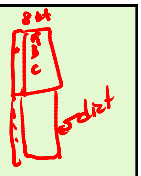
Example: ABCDABCABBABBDABCE



w	k	dict		output
	A			
A	B	AB	<256>	A
B	C	BC	<257>	B
C	D	CD	<258>	C
D	A	DA	<259>	D
A	B			
AB	C	ABC	<260>	<256>
C	A	CA	<261>	C
A	B			
AB	B	ABB	<262>	<256>
B	A	BA	<263>	B
A	B			
AB	B			
ABB	D	ABBD	<264>	<262>

9-bit output symbols

ABC...D padded w/ 0's @ front

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LZW Decompression

LZW Compression

Read *k*
Output *k*
w = *k*
while (read char *k*)
    entry = dictionary entry for *k*
    output *entry*
    add *w* + *entry[0]* to dictionary
    w = *entry*

compressed codeword

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A B C <257> D <258> E <257>

W	k	k-dict	dictionary	output
A	A	B	AB <256>	A
B	B	C	BC <257>	B
C	<257>	BC	CB <258>	C
BC	D	D	BCD <259>	BC
D	<258>	CB	DC <260>	D
CB	E	E	CBE <261>	CB
E	<257>	BC	EB <262>	E

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KwKwK String

K is a single symbol

w is a dictionary entry or single symbol

Kw exists in dictionary before KwKwK appears

w + entry[0] → dictionary

w + w[0] → dictionary

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