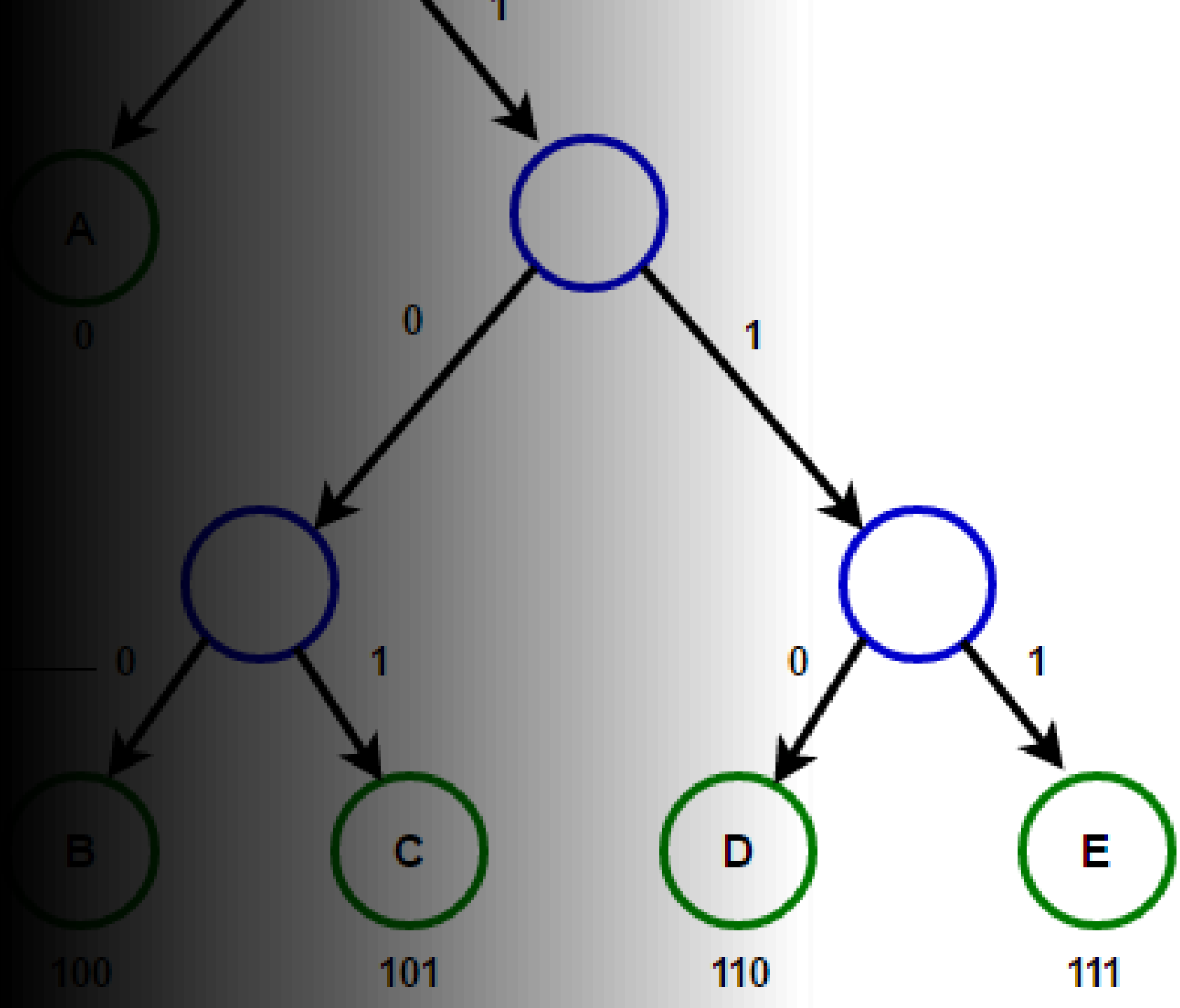
Lecture 20

Image Compression Methods

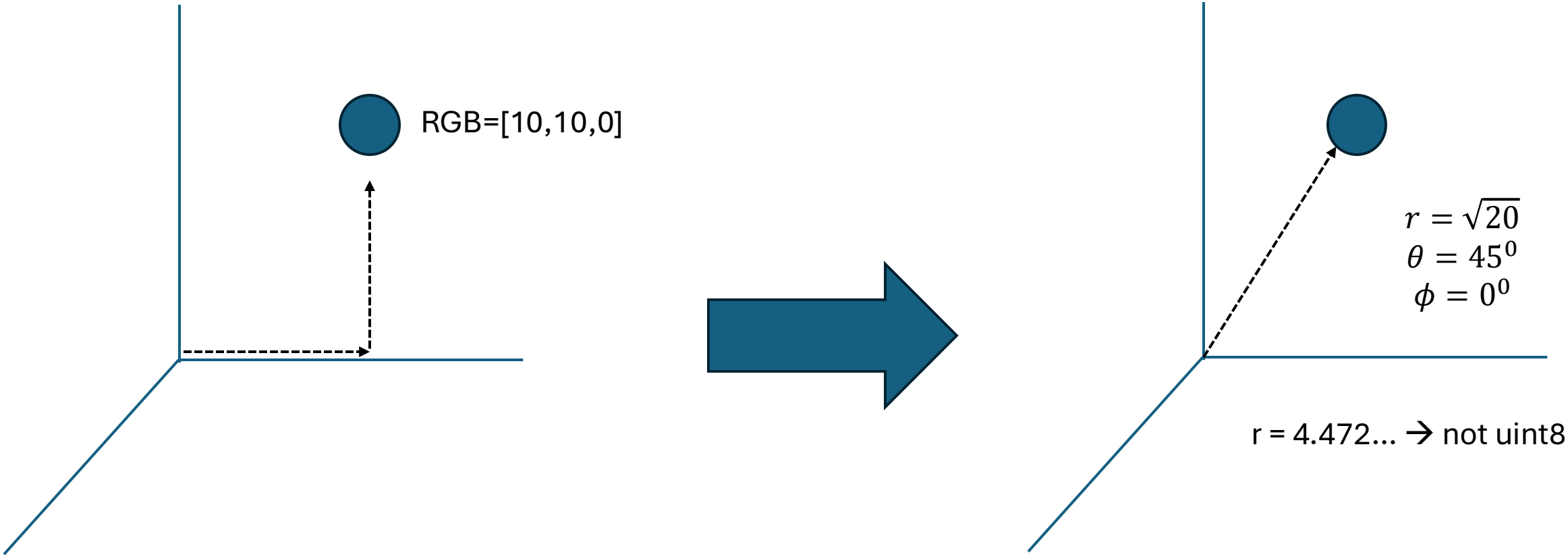
ECE 1390/2390



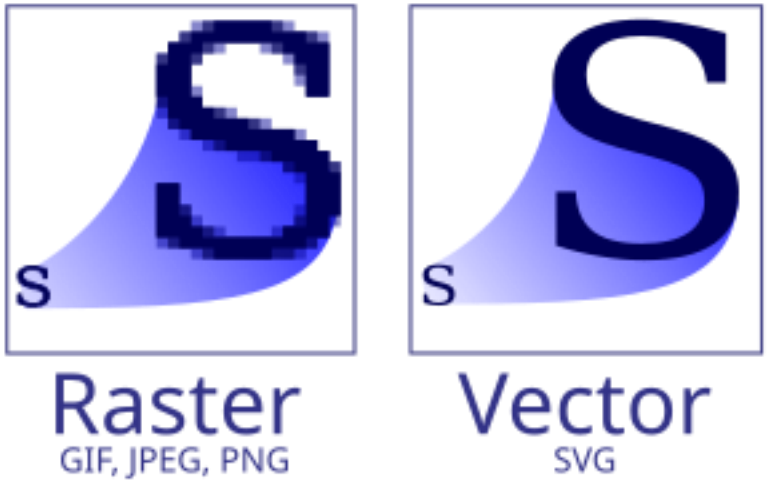
- Lossy (non-lossless). (Lecture 4)
  - DCT
  - Wavelet
  - Haramord-Walsh
  - Color space transform (Lecture 3)

- Lossless
  - Variable Length Coding (Huffman compression)

Color space transforms are lossy

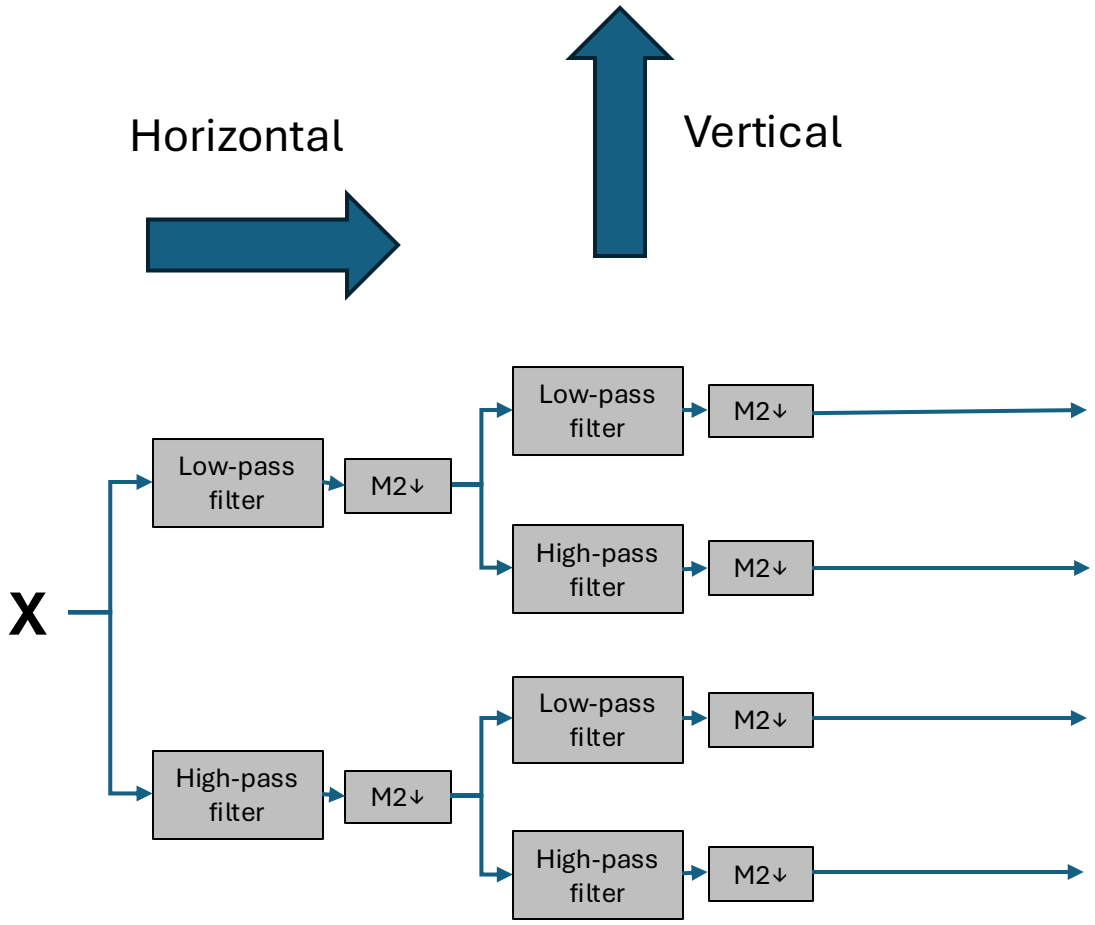


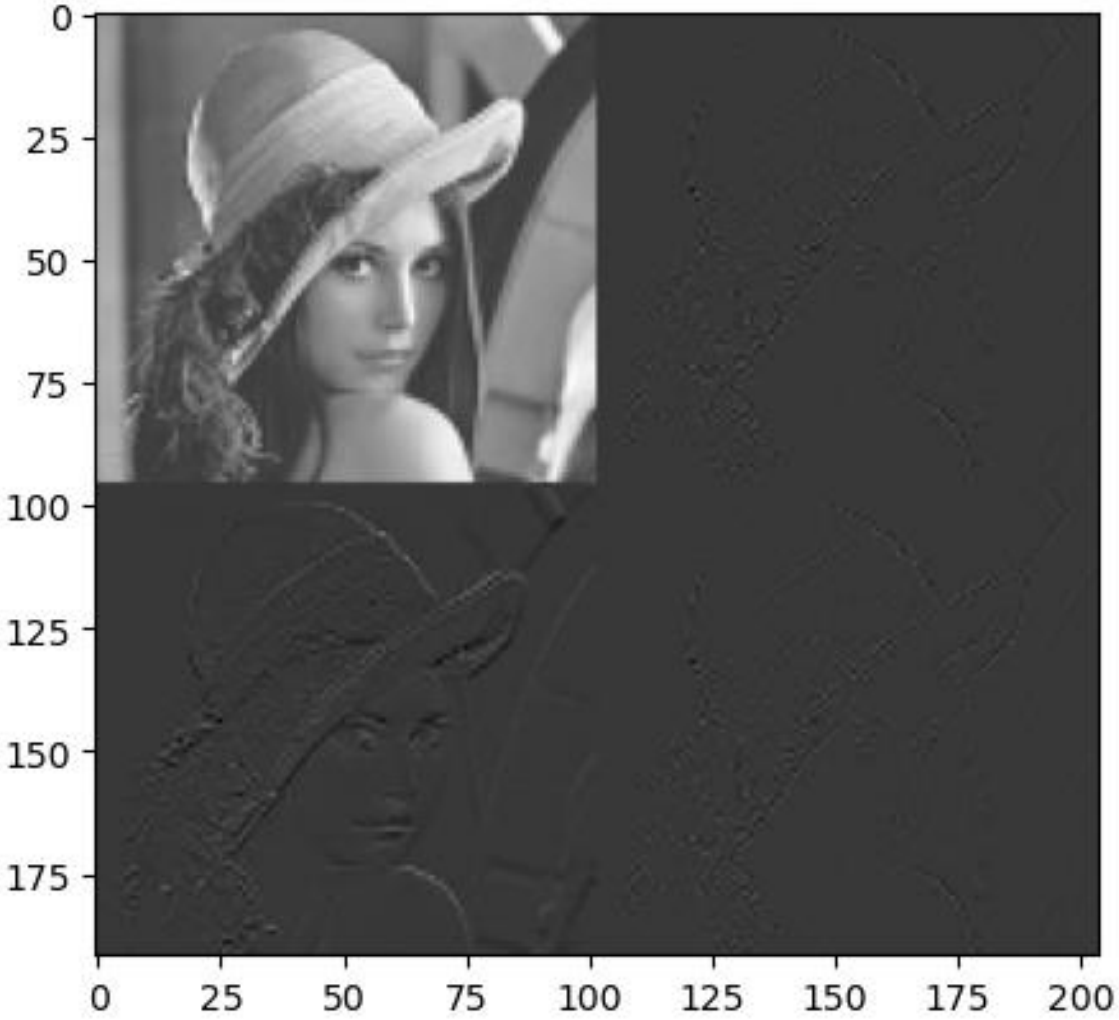
(From Lecture 1)

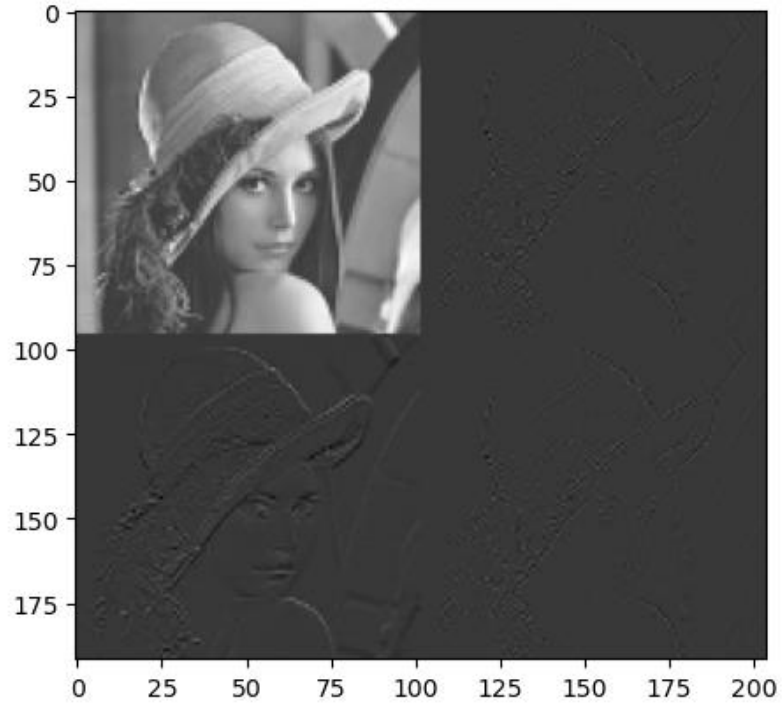


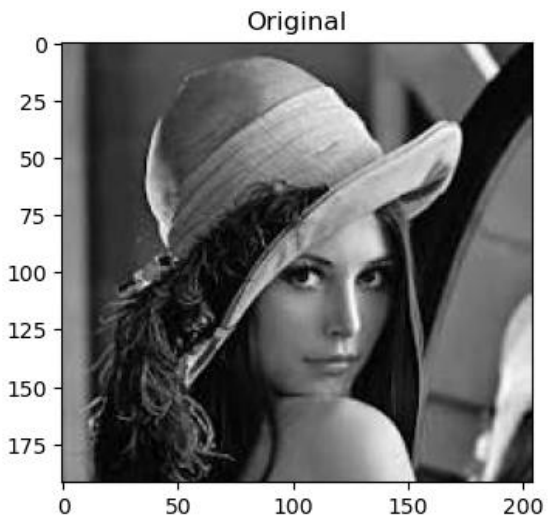
- **Raster data formats**
  - GIF (Lossy in color)
    - Uses specific color maps
  - JPEG (Lossy in value)
    - Uses DCT → spasticity (followed by VLC compression)
  - PNG (mostly lossless)
    - 24-bit color
    - Can be compressed with VLC (or similar)
    - Adds alpha channel
  - TIFF (Lossless)
    - Versatile bit depth and color-depth
    - Can be compressed with VLC (or similar)
- **Vector data formats (lossless/scale invariant)**
  - EPS
  - SVG

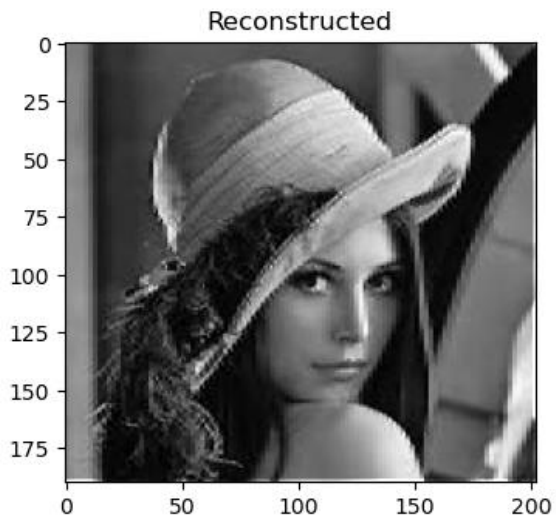
From Lecture 4

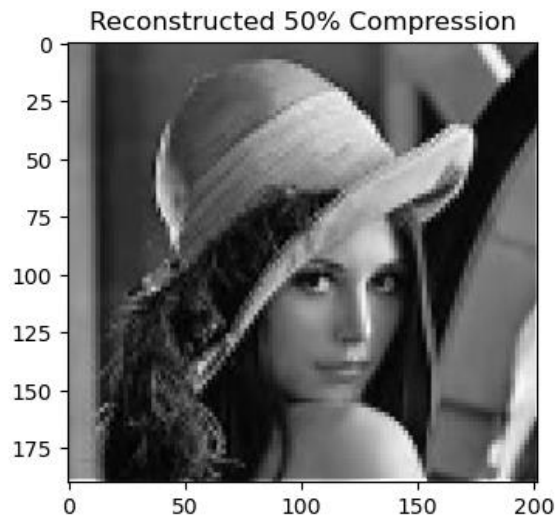


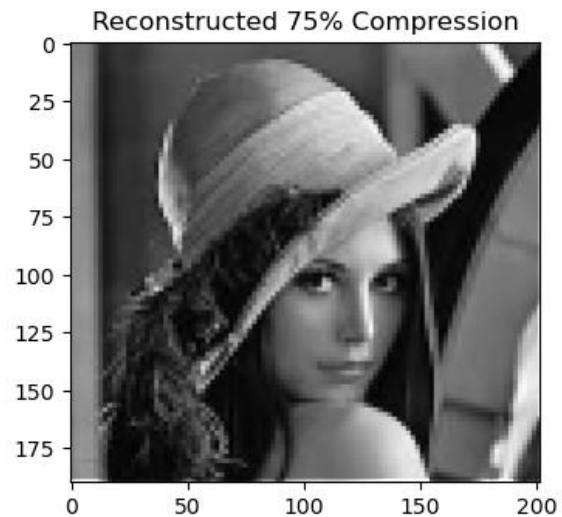





Original


Reconstructed


Reconstructed 50% Compression


Reconstructed 75% Compression

Original: 9 x uint8 values = 72 bits

As sparse:

Dimensions [3,3] → 2 x unit8 values
3 non-zeros →3 x 3 x uint8 values = 72 bits

= 88 bits total

$$\begin{bmatrix} a & 0 & 0 \\ b & 0 & 0 \\ 0 & c & 0 \end{bmatrix}$$

As sparse

3,3
0,0, a
0,1,b
1,2,c

Huffman Compression
Variable Length Coding (VLC)

Store as 8-bit

Store as 1-bit

3 x 8bit + 6 x 1bit = 30 bits

$$\begin{bmatrix} a & 0 & 0 \\ b & 0 & 0 \\ 0 & c & 0 \end{bmatrix}$$

As VLC

9 x 8bit = 72 bits

$$\begin{bmatrix} a & 0 & 0 \\ b & 0 & 0 \\ 0 & c & 0 \end{bmatrix}$$

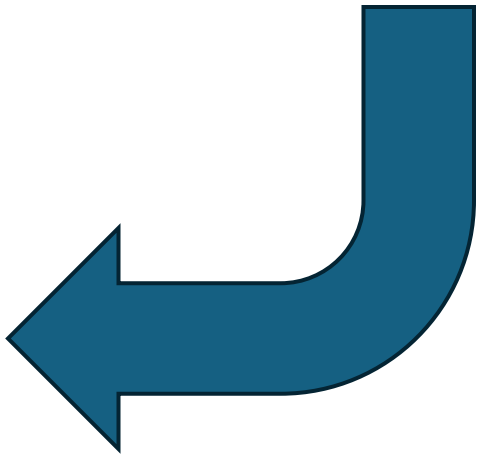
As sparse

11 x 8bit = 88 bits

3,3
0,0, a
0,1,b
1,2,c

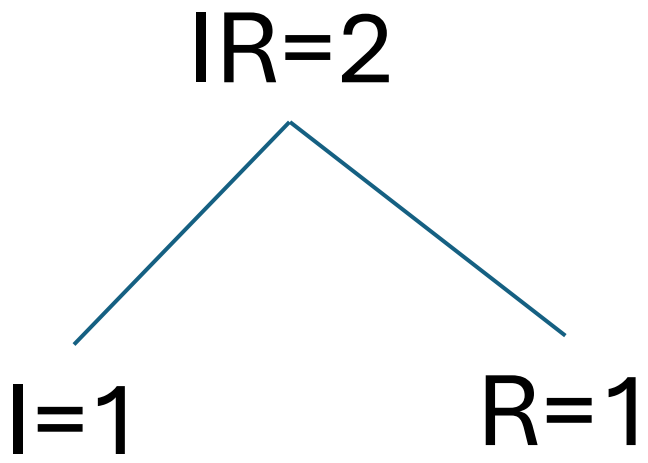
SWANSON_SCHOOL_OF_ENGINEERING

O: 4
N: 4
S: 3
_: 3
E: 3
G: 2
W: 1
A: 1
C: 1
H: 1
L: 1
F: 1
I: 1
R: 1



O: 4
N: 4
S: 3
_: 3
E: 3
G: 2
W: 1
A: 1
C: 1
H: 1
L: 1
F: 1
I: 1
R: 1

O: 4
N: 4
S: 3
_: 3
E: 3
G: 2
IR: 2
W: 1
A: 1
C: 1
H: 1
L: 1
F: 1



O: 4
N: 4
S: 3
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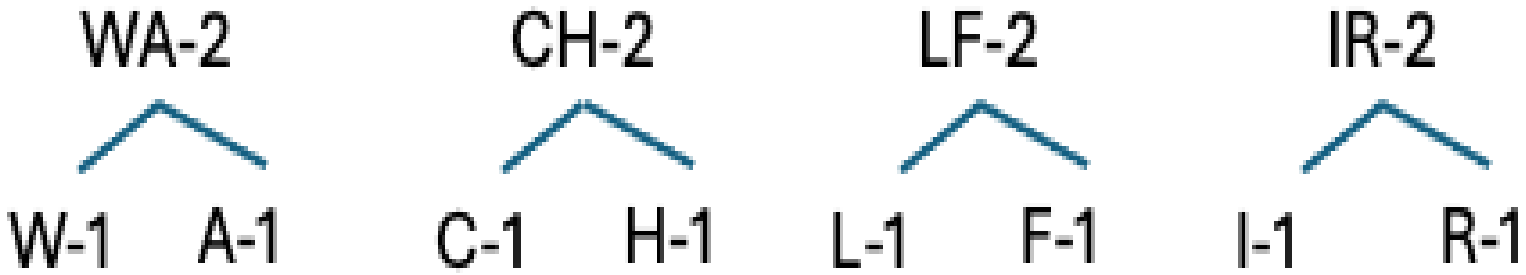
E: 3
G: 2
W: 1
A: 1
C: 1
H: 1
L: 1
F: 1
I: 1
R: 1

O: 4
N: 4
S: 3
_: 3
E: 3
G: 2
IR: 2
W: 1
A: 1
C: 1
H: 1
L: 1
F: 1

O: 4
N: 4
S: 3
_: 3
E: 3
G: 2
IR: 2
LF: 2
CH: 2
WA: 2



O: 4
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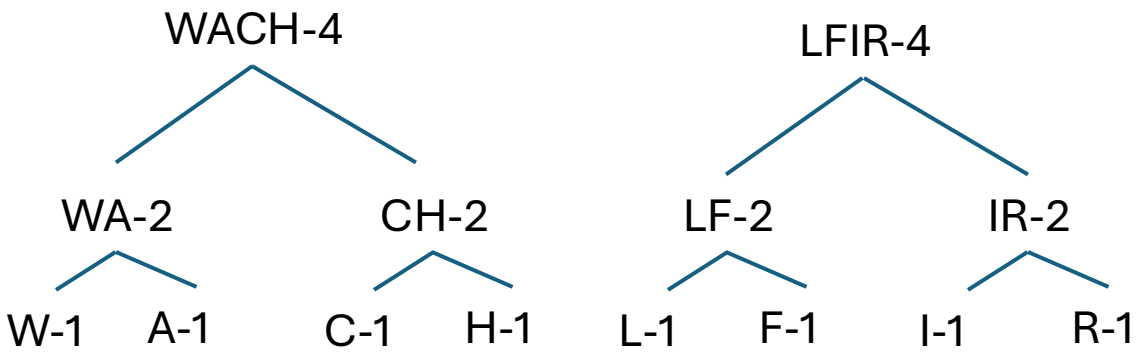
E: 3
G: 2
W: 1
A: 1
C: 1
H: 1
L: 1
F: 1
I: 1
R: 1

O: 4
N: 4
S: 3
_: 3
E: 3
G: 2
IR: 2
W: 1
A: 1
C: 1
H: 1
L: 1
F: 1

O: 4
N: 4
S: 3
_: 3
E: 3
G: 2
IR: 2
LF: 2
CH: 2
WA: 2

O: 4
N: 4
S: 3
_: 3
E: 3
G: 2
WACH:4
LFIR: 4



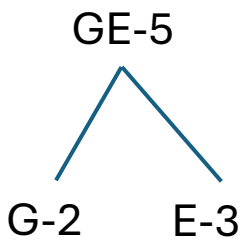
O: 4
N: 4
S: 3
_: 3
E: 3
G: 2
W: 1
A: 1
C: 1
H: 1
L: 1
F: 1
I: 1
R: 1

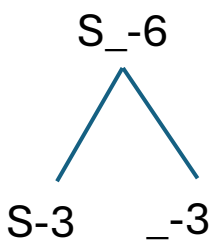
O: 4
N: 4
S: 3
_: 3
E: 3
G: 2
IR: 2
W: 1
A: 1
C: 1
H: 1
L: 1
F: 1

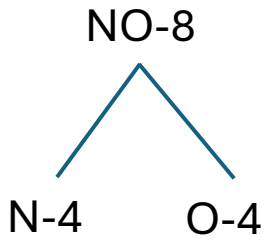
O: 4
N: 4
S: 3
_: 3
E: 3
G: 2
IR: 2
LF: 2
CH: 2
WA: 2

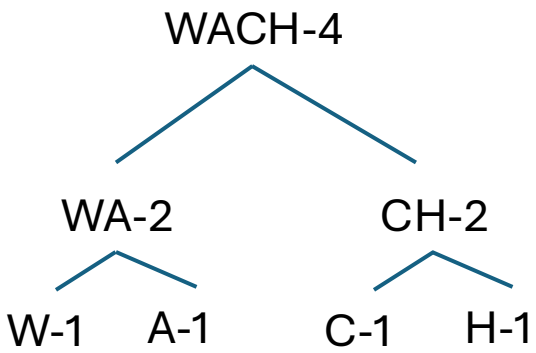
O: 4
N: 4
S: 3
_: 3
E: 3
G: 2
WACH:4
LFIR: 4

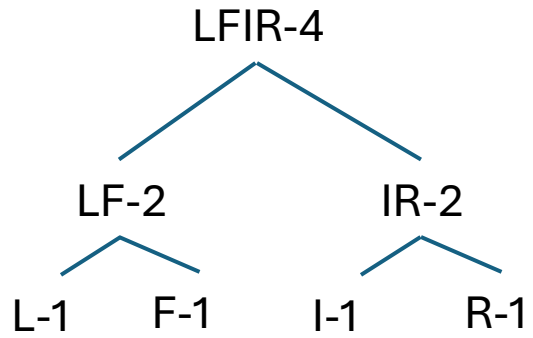
NO: 8
S_: 6
GE:5
WACH:4
LFIR: 4











O: 4
N: 4
S: 3
_: 3
E: 3
G: 2
W: 1
A: 1
C: 1
H: 1
L: 1
F: 1
I: 1
R: 1

O: 4
N: 4
S: 3
_: 3
E: 3
G: 2
IR: 2
W: 1
A: 1
C: 1
H: 1
L: 1
F: 1

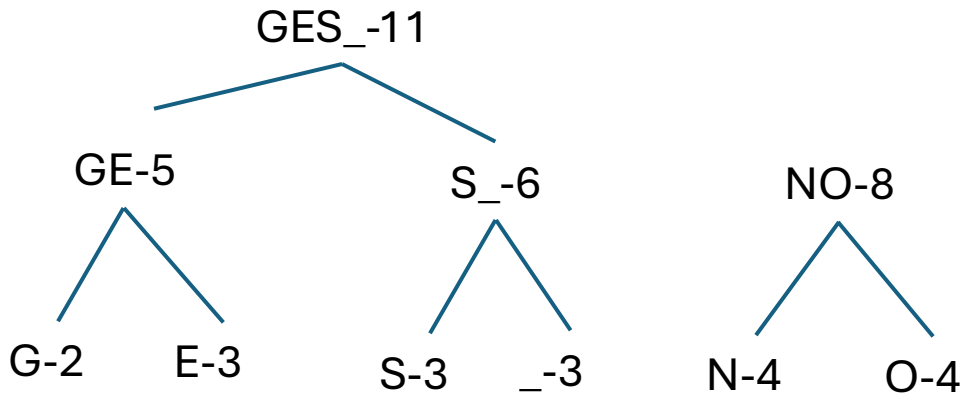
O: 4
N: 4
S: 3
_: 3
E: 3
G: 2
IR: 2
LF: 2
CH: 2
WA: 2

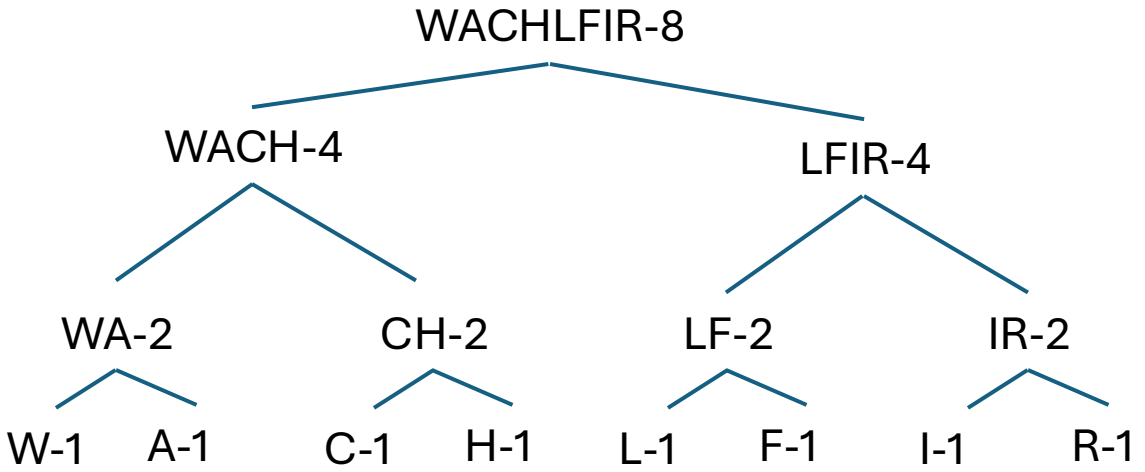
O: 4
N: 4
S: 3
_: 3
E: 3
G: 2
WACH:4
LFIR: 4

NO: 8
S_: 6
GE:5
WACH:4
LFIR: 4

NO: 8
WACHLFIR: 8
S_: 6
GE:5

GES_: 11
NO: 8
WACHLFIR: 8





O: 4
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S: 3
_: 3
E: 3
G: 2
W: 1
A: 1
C: 1
H: 1
L: 1
F: 1
I: 1
R: 1

O: 4
N: 4
S: 3
_: 3
E: 3
G: 2
IR: 2
W: 1
A: 1
C: 1
H: 1
L: 1
F: 1

O: 4
N: 4
S: 3
_: 3
E: 3
G: 2
IR: 2
LF: 2
CH: 2
WA: 2

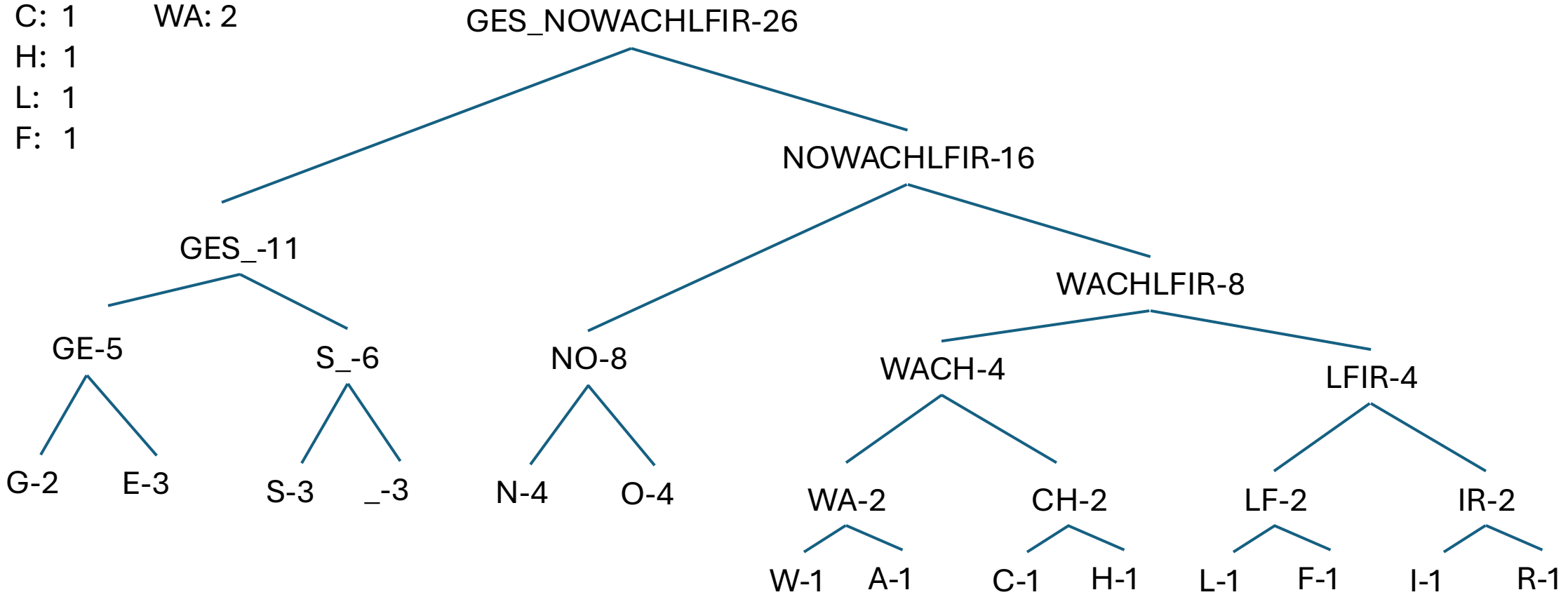
O: 4
N: 4
S: 3
_: 3
E: 3
G: 2
WACH:4
LFIR: 4

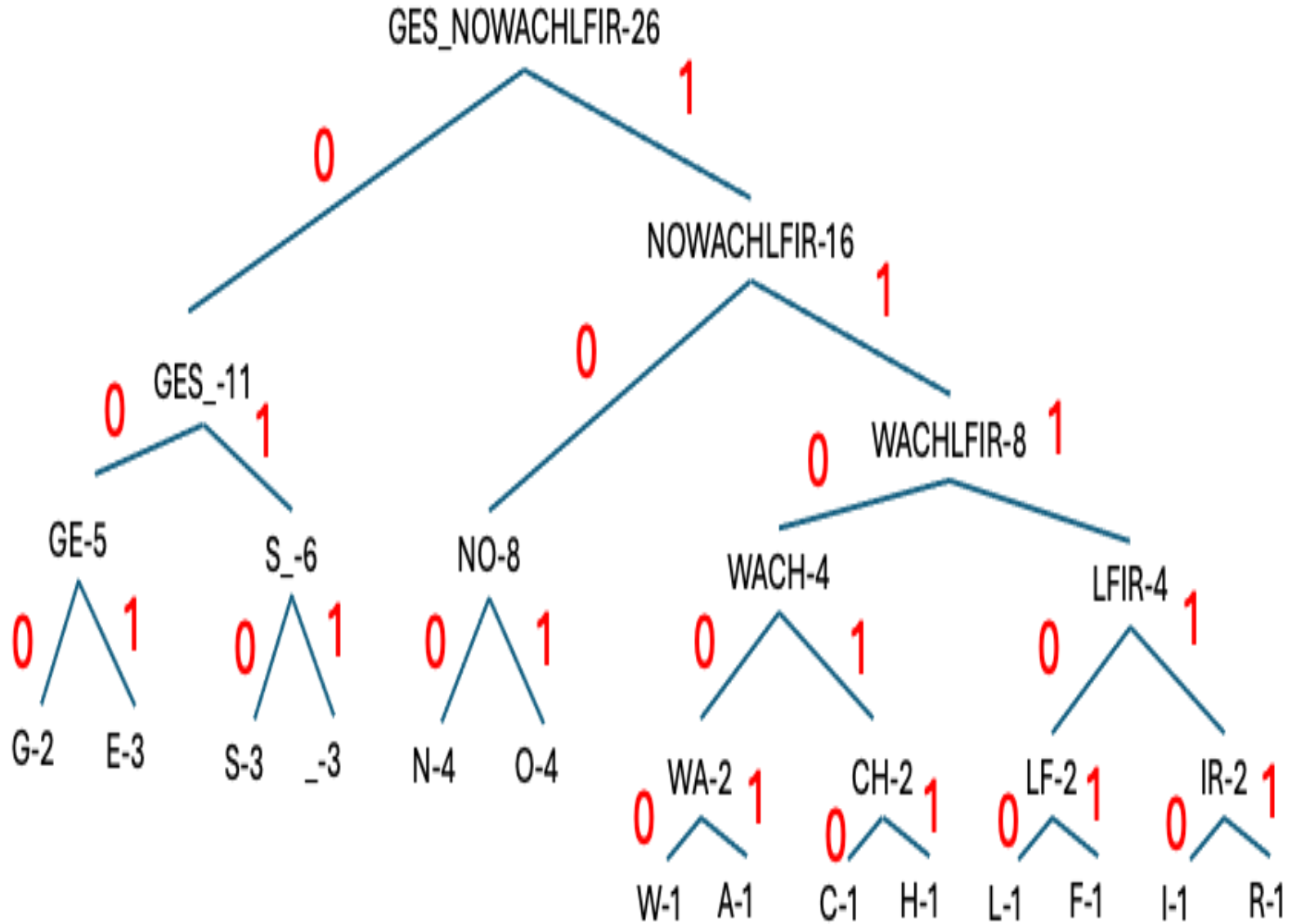
NO: 8
S_: 6
GE:5
WACH:4
LFIR: 4

NO: 8
WACHLFIR: 8
S_: 6
GE:5

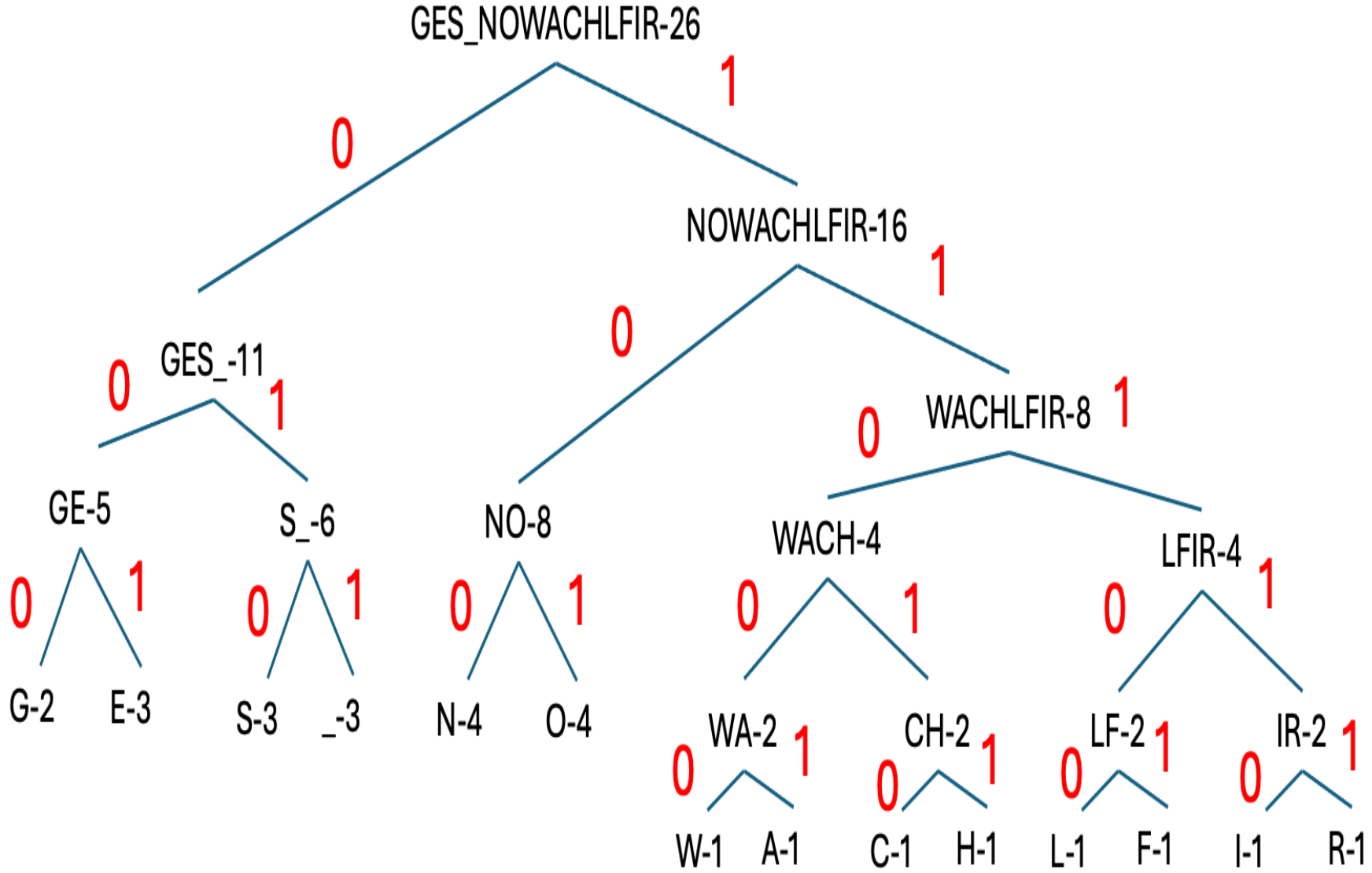
GES_: 11
NO: 8
WACHLFIR: 8

NOWACHLFIR: 16
GES_: 11




GES_NOWACHLFIR-26
0
1
GES_-11
NOWACHLFIR-16
0
1
0
1
GE-5
S_-6
NO-8
WACHLFIR-8
0
1
0
1
0
1
0
1
WACH-4
LFIR-4
G-2
E-3
S-3
_-3
N-4
O-4
0
1
0
1
0
1
0
1
WA-2
CH-2
LF-2
IR-2
W-1
A-1
C-1
H-1
L-1
F-1
I-1
R-1

G: 000
E: 001
S: 010
_: 011
N: 100
O: 101
W: 11000
A: 11001
C: 11010
H: 11011
L: 11100
F : 11101
I : 11110
R : 11111



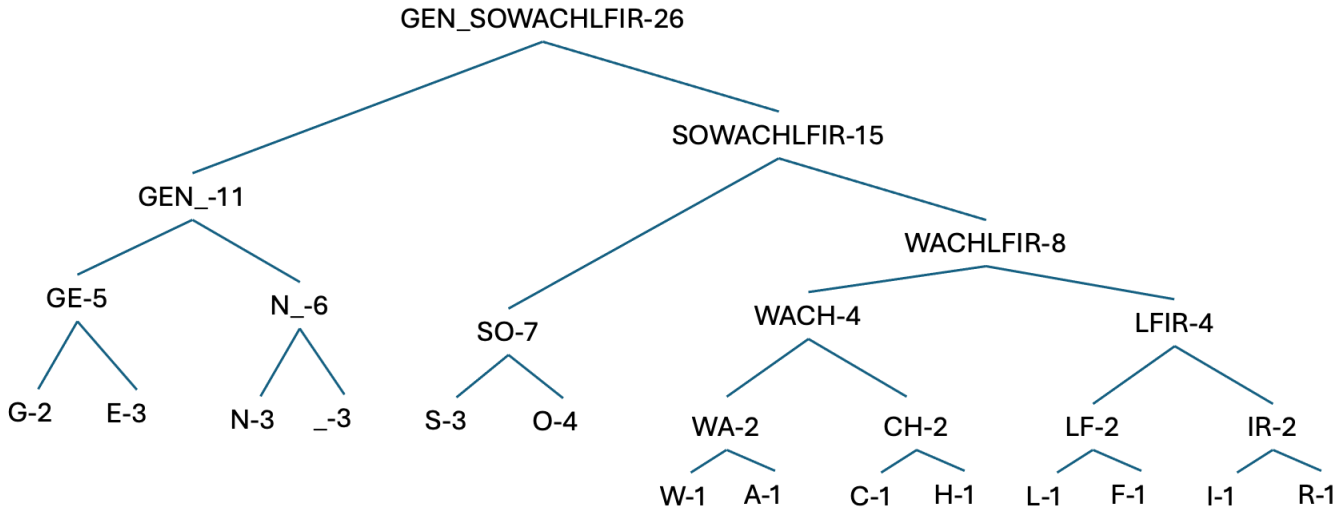
G: 000
E: 001
S: 010
_: 011
N: 100
O: 101
W: 11000
A: 11001
C: 11010
H: 11011
L: 11100
F : 11101
I : 11110
R : 11111

SWANSON_SCHOOL_OF_ENGINEERING

010 11000 11001 100 010 101 100 011 010 11010 11011 101 101 11100 011
101 11101011 001 100 11110 100 001 001 11111 11110 100 000

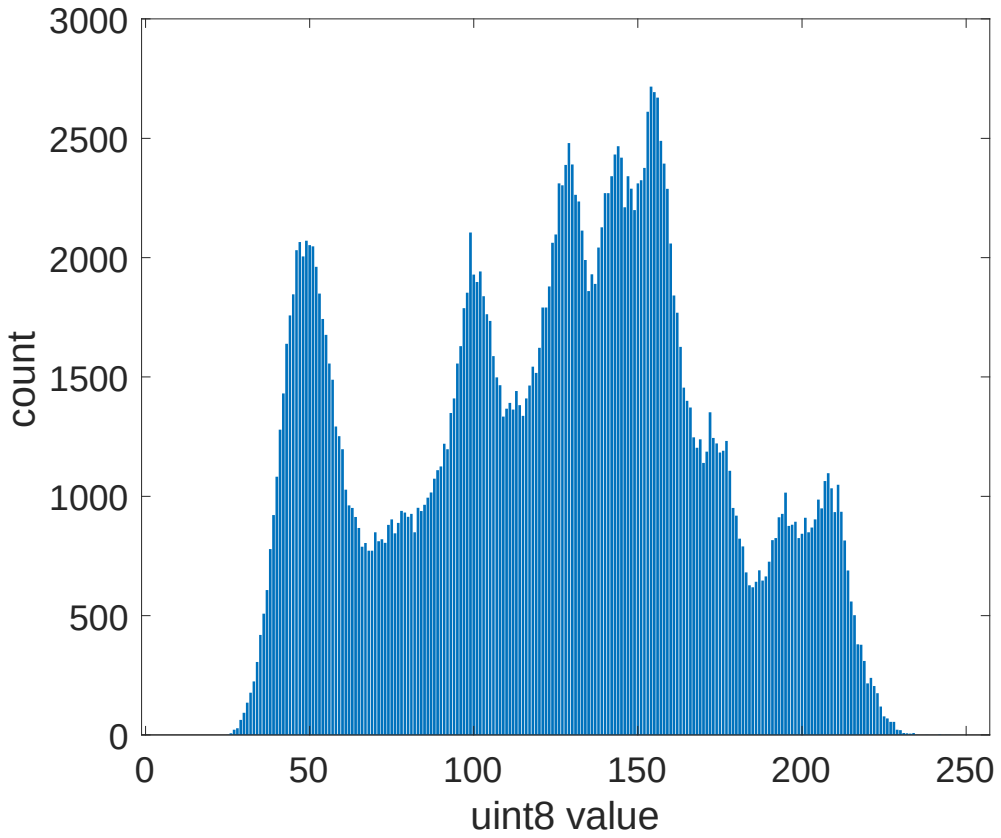
=102 bits

(ASCII) 29char x 8 bits/char =232 bits



G: 000
E: 001
S: 010
_: 011
N: 100
O: 101
W: 11000
A: 11001
C: 11010
H: 11011
L: 11100
F : 11101
I : 11110
R : 11111

010 11000 11001 100 010 101 100 011
010 11010 11011 101 101 11100 011
101 11101011 001 100 11110 100 001
001 11111 11110 100 000


3000
2500
2000
1500
1000
500
0
count
0
50
100
150
200
250
uint8 value

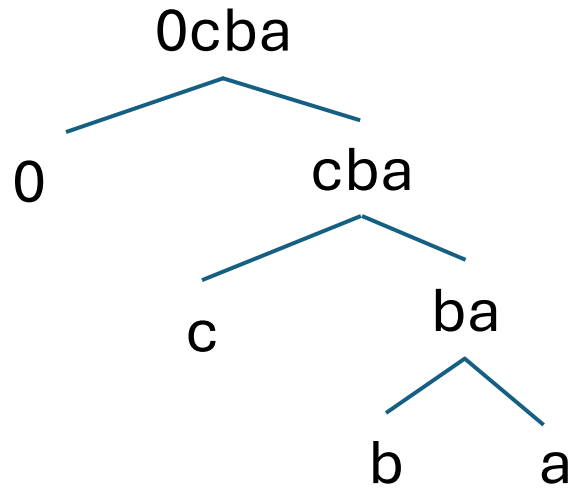
$$\begin{bmatrix} a & 0 & 0 \\ b & 0 & 0 \\ 0 & c & 0 \end{bmatrix}$$

0: 6 → 0

a: 1 → 111

b: 1 → 110

c: 1 → 10



9 x 8bit = 72 bits

$$\begin{bmatrix} a & 0 & 0 \\ b & 0 & 0 \\ 0 & c & 0 \end{bmatrix}$$

As VLC

$$\begin{bmatrix} a & 0 & 0 \\ b & 0 & 0 \\ 0 & c & 0 \end{bmatrix}$$

14 bits

111001100001 00

0: 6 → 0

a: 1 → 111

b: 1 → 110

c: 1 → 10

001001111110000

$$\begin{bmatrix} 0 & 0 & c \\ 0 & a & b \\ 0 & 0 & 0 \end{bmatrix}$$

0: 6 → 0

a: 1 → 111

b: 1 → 110

c: 1 → 10

0010011111110000