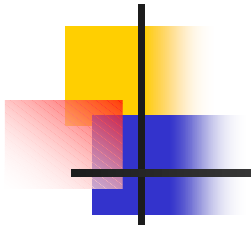


# MPEG-1 Video Coding Standard

Jianping Fan

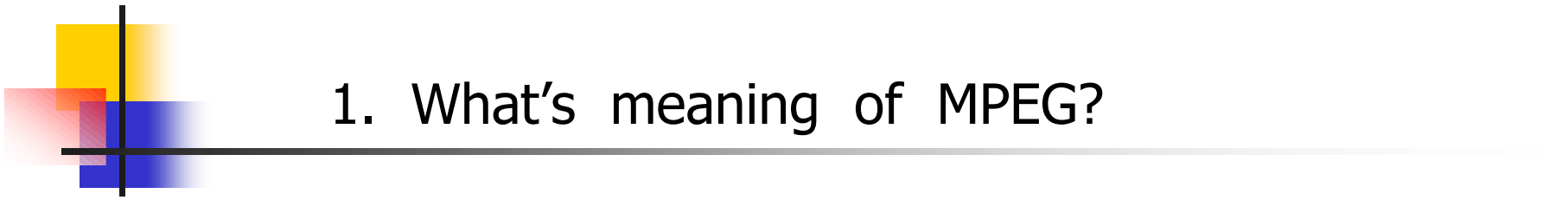
Department of Computer Science

University of North Carolina at Charlotte

Charlotte, NC 28223

jfan@uncc.edu

http://www.cs.uncc.edu/~jfan



# 1. What's meaning of MPEG?

MPEG: Moving Picture Experts Group

## 2. Why we do not use MJPEG?

12

13

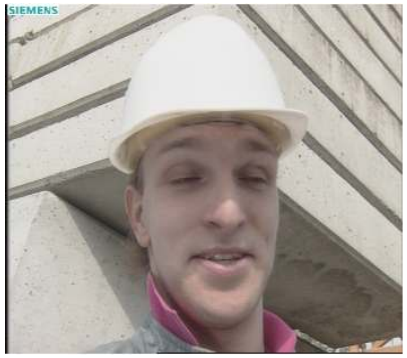
14

# 3. Why we need MPEG?

Exploit temporal relationship among frames for coding!

save our money for: a. Storage space;

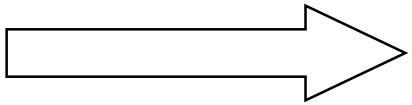
b. Bandwidth




CIF: 352*288
Frame rate: 25f/s

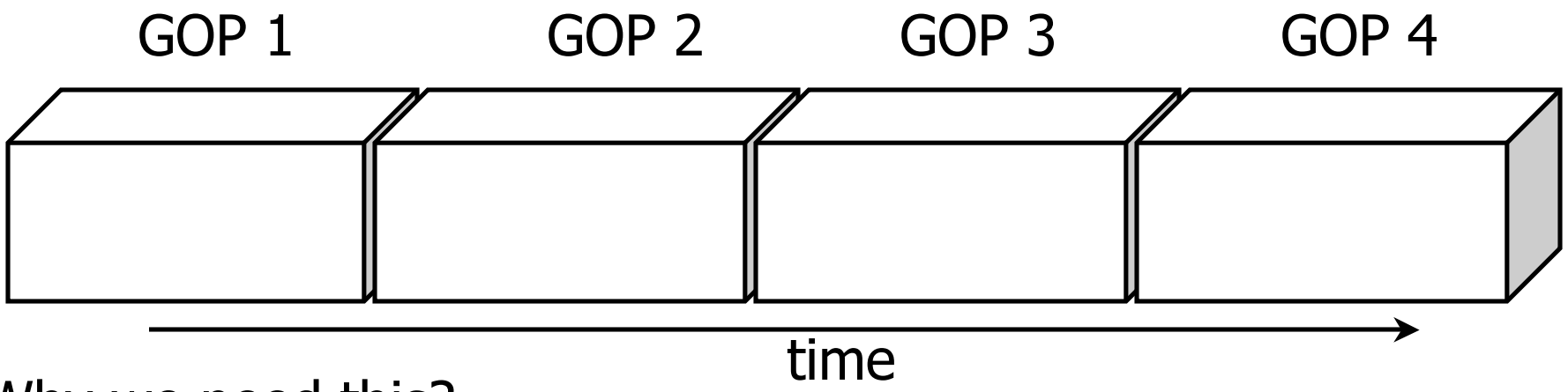
Space: ~21.6Mbits/s

MPEG

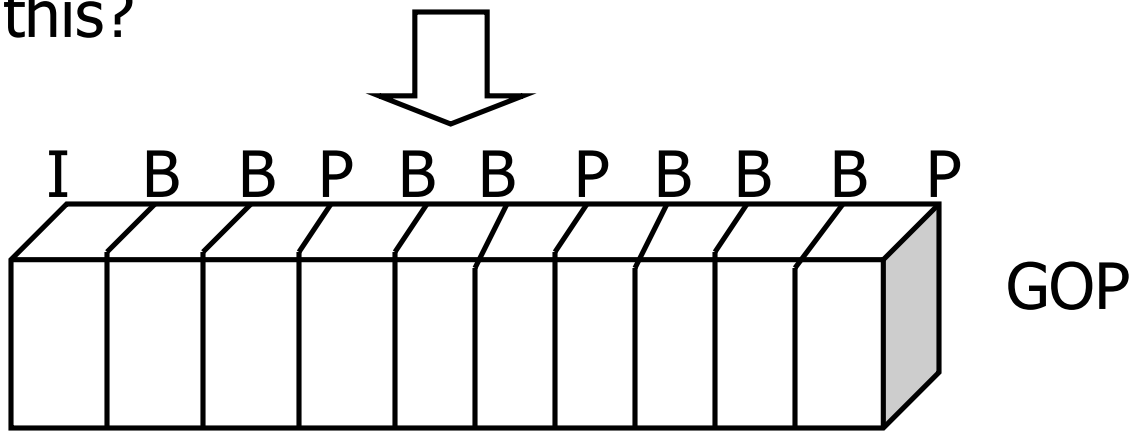


1.5Mbits/s

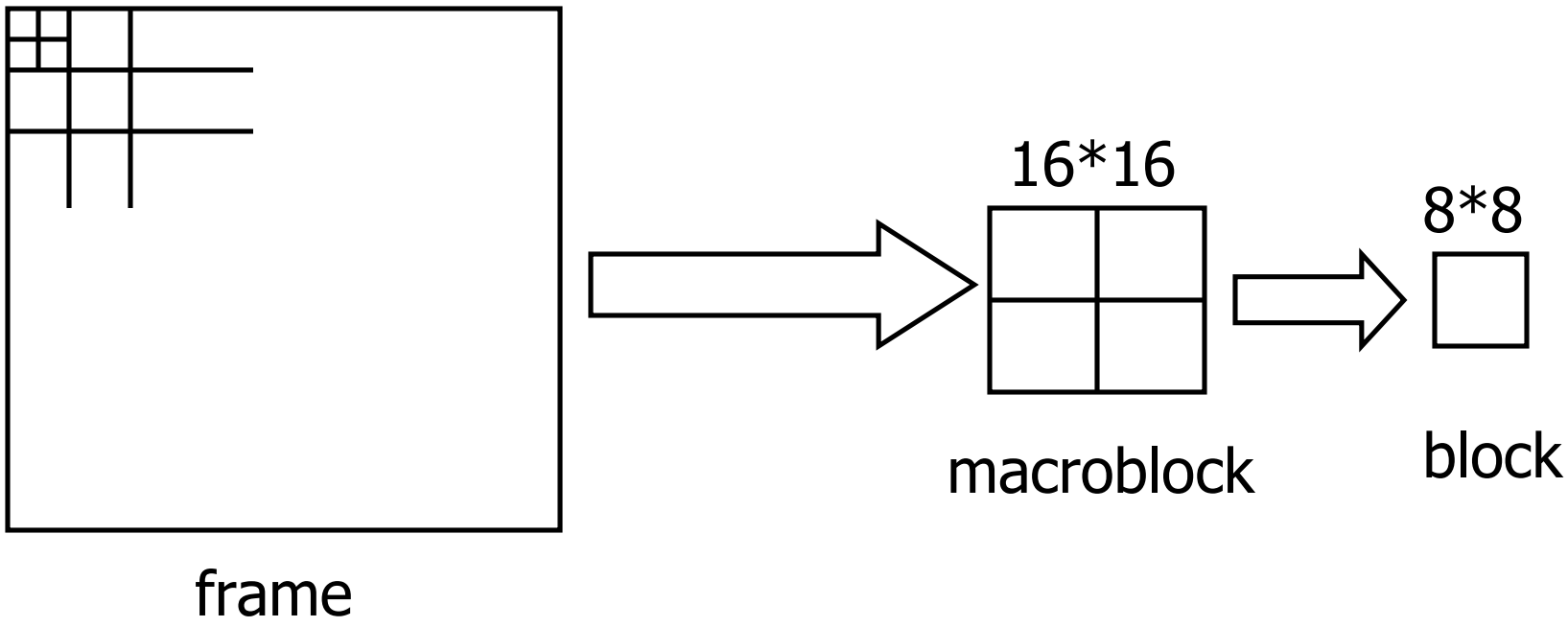
# 4. MPEG Video Structure



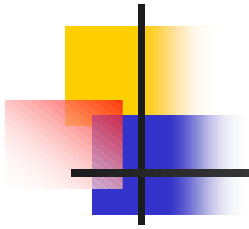

Why we need this?



# 4. MPEG Video Structure




Universal structure is very important for universal decoder!!



# 5. MPEG-1 Encoder

MPEG-1 has defined three frame coding types: **I, P, B**.

I frame: Intra-coding frame

P frame: motion-based predictive coding frame

B frame: motion-based bidirectional predictive coding frame

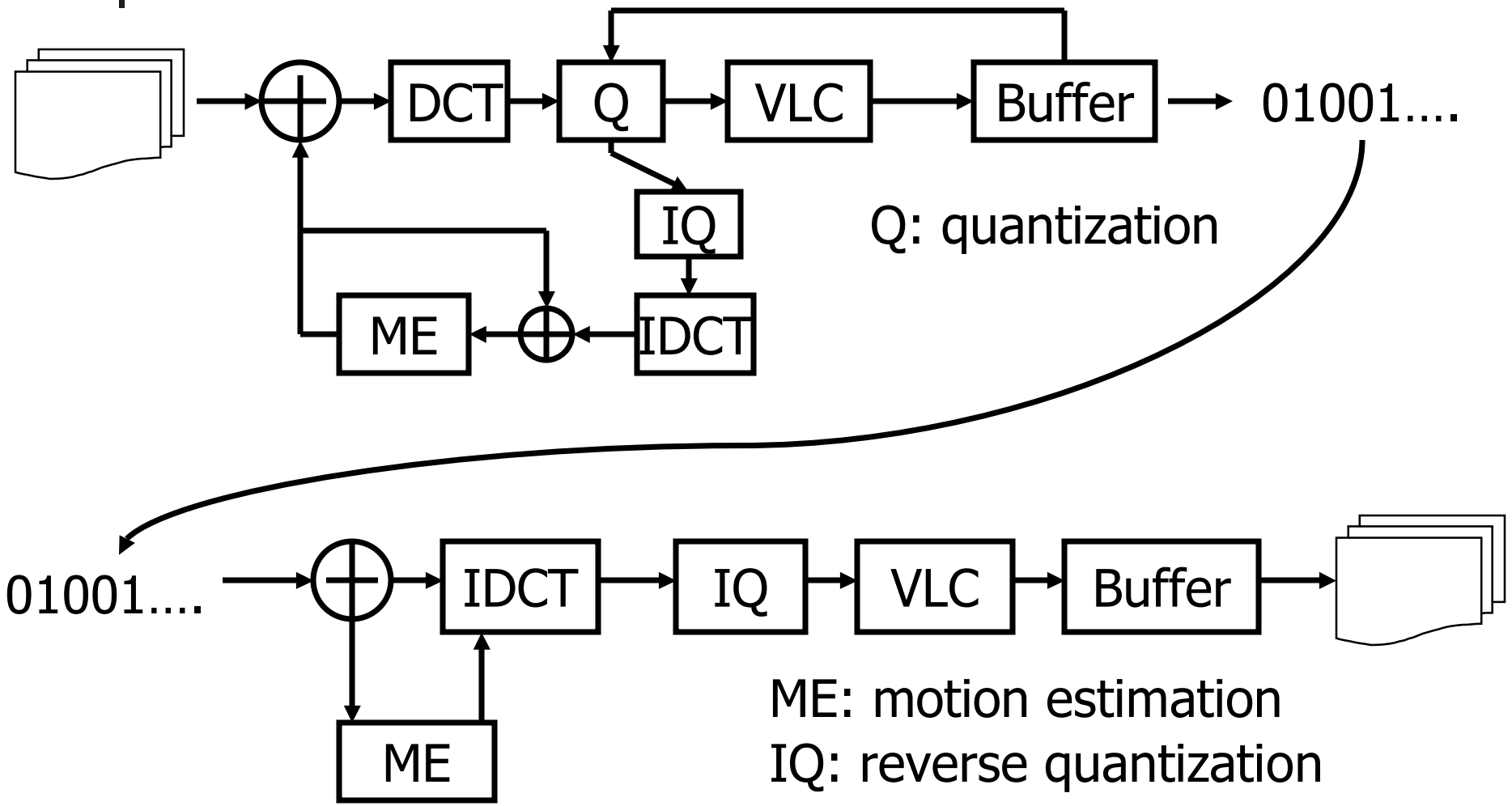
The difference between I and P or B:

I can be encoded/decoded without reference

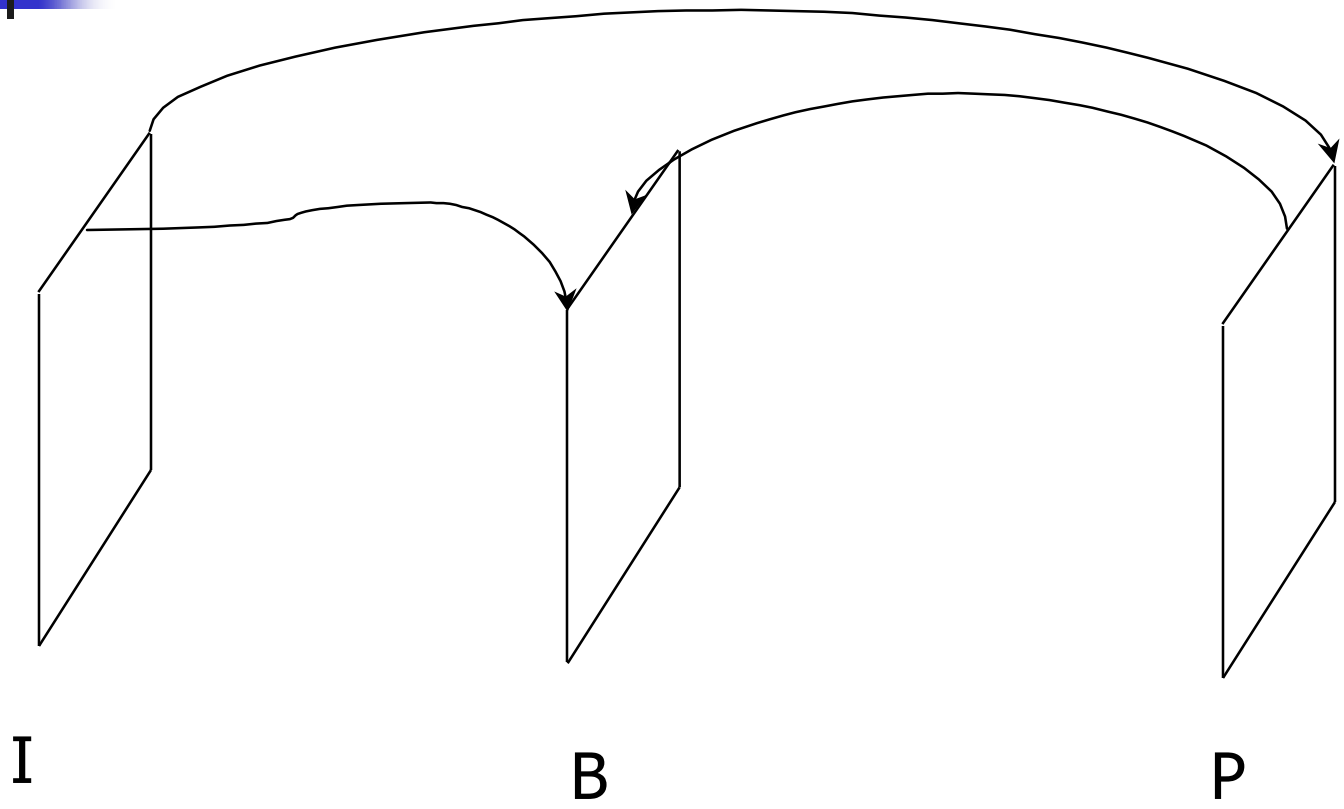
The difference between P and B:

P can be encoded/decoded with one reference

# 5. MPEG-1 Encoder



# 5. MPEG-1 Encoder



# 6. How to Encode I Frame?

slice

Y

U

V

macroblock

block

DCT

Entropy coding

10010100010……

# 6. How to Encode I Frame?

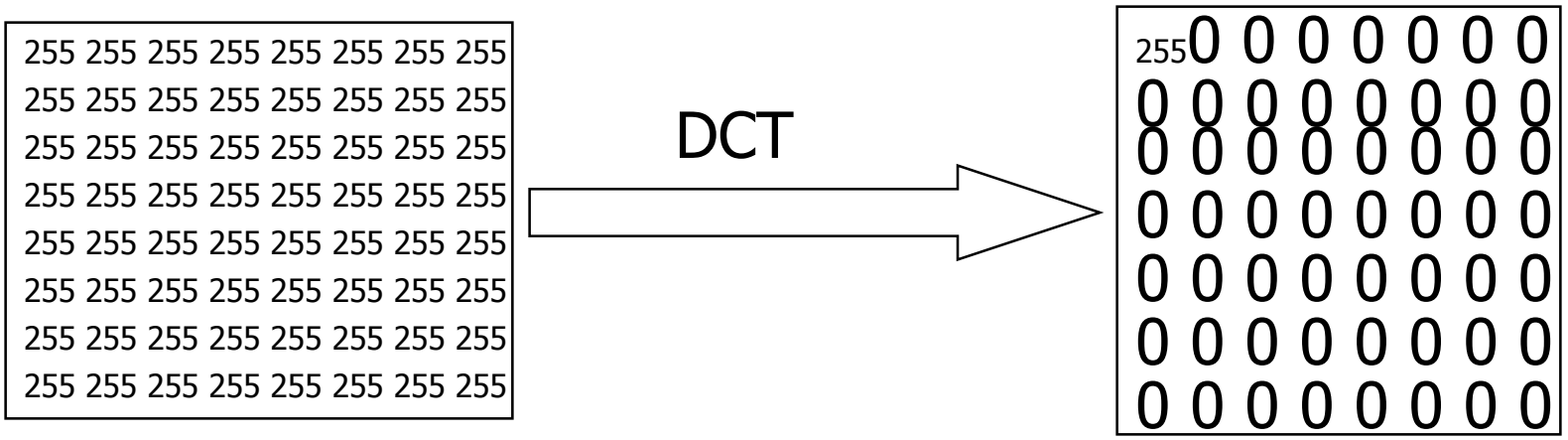
## a. Color Space

(1) RGB: display

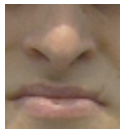
(2) YUV: coding

(3) CIE: more close to human vision

## b. DCT (Discrete Cosine Transformation)



# 6. How to Encode I Frame?



DCT

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 255 | 217 | 120 | 110 | 0 | 0 | 0 | 0 |
| 120 | 110 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 120 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 7 | 2 | 2 | 1 | 0 | 0 | 0 | 0 |
| 5 | 3 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

Zigzag scale

(7,0), (5,0), (2,0), (2,0), (3,4), (1,4), (1,41)

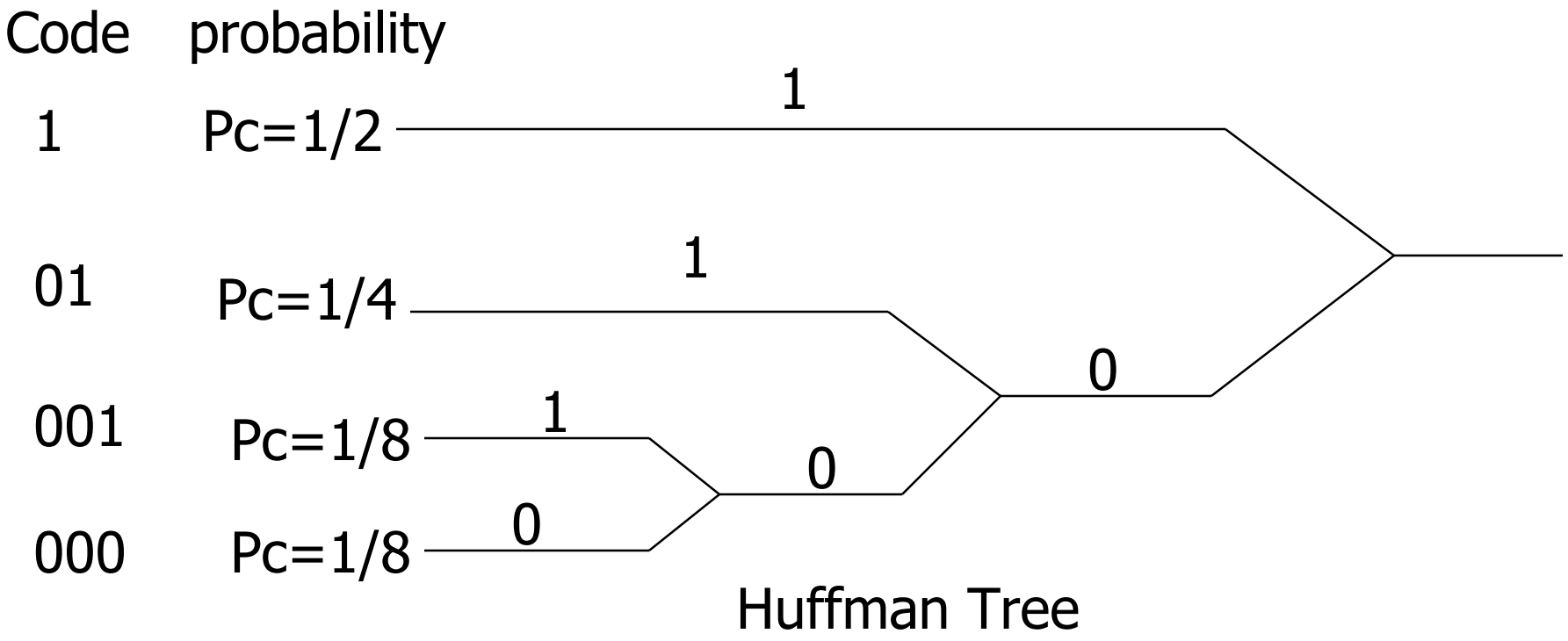
Quantization

Q(u) = *integer round* (u/scale)

Entropy coding

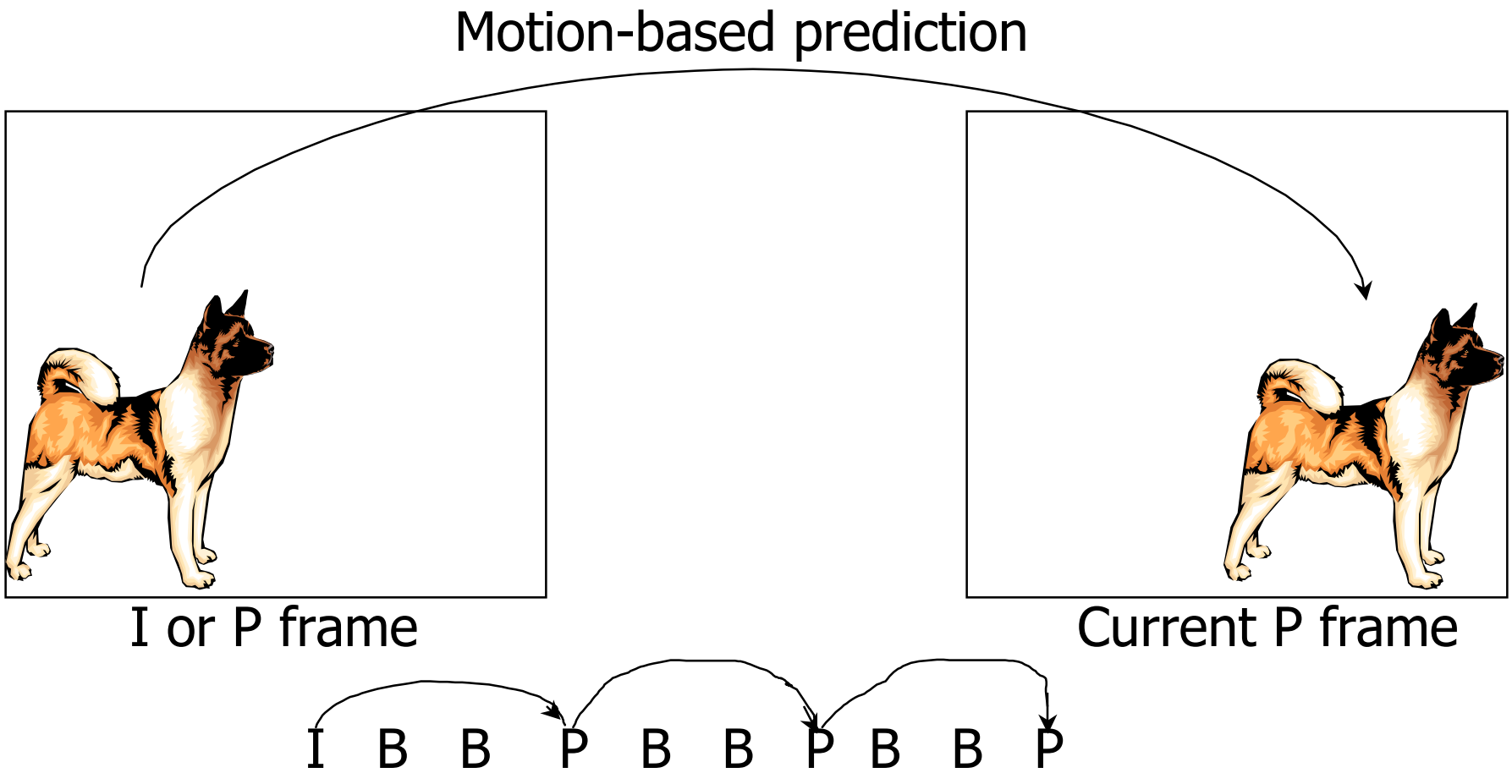
# 6. How to Encode I Frame?

Entrpoy coding:

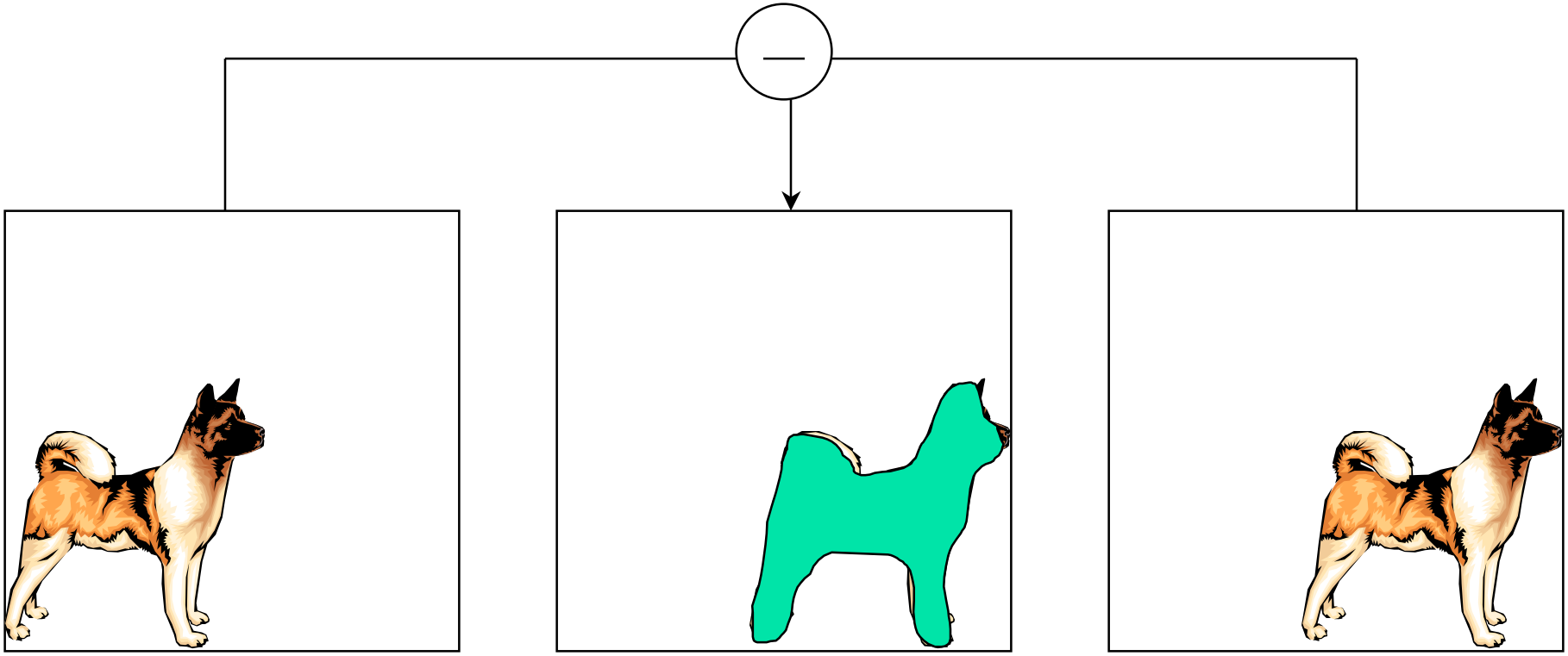



Huffman Tree

# 7. How to Encode P Frame?



# 7. How to Encode P Frame?

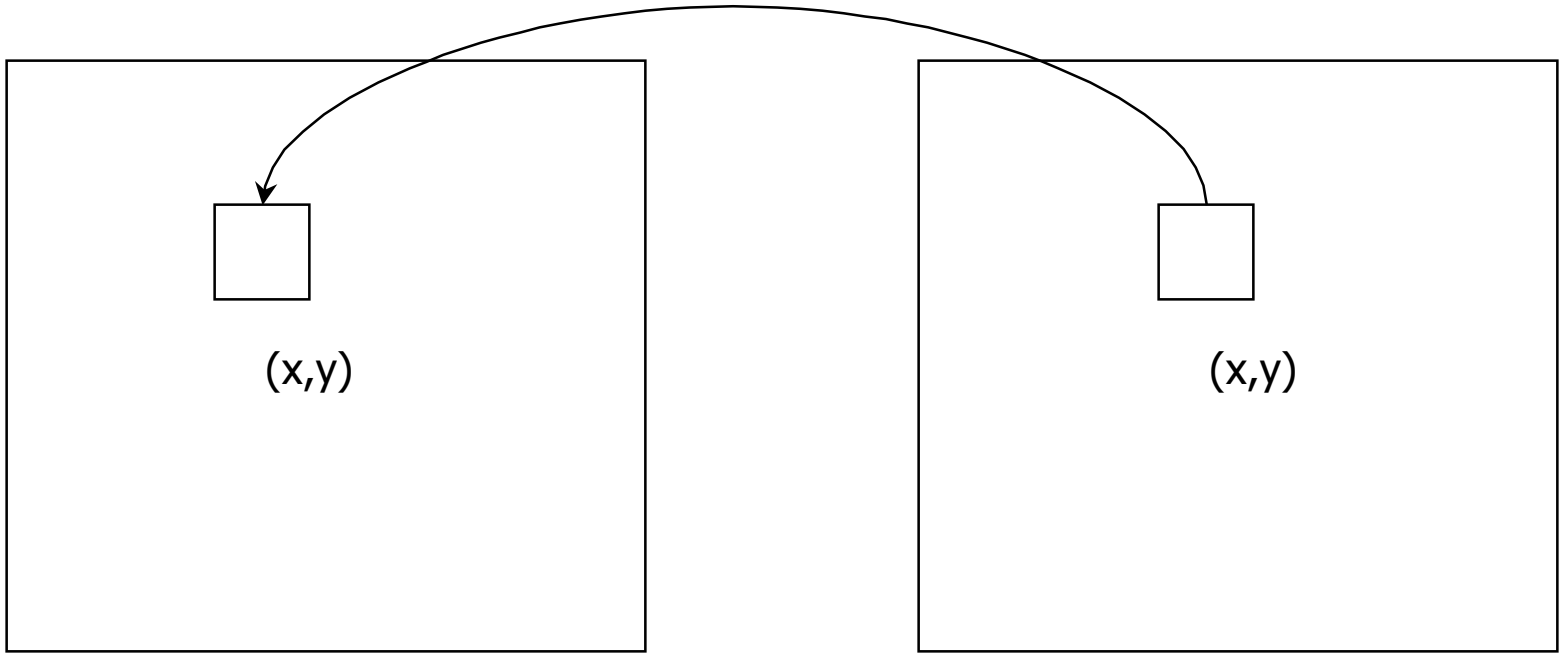


Motion compensation: motion vectors + errors

# 7. How to Encode P Frame?

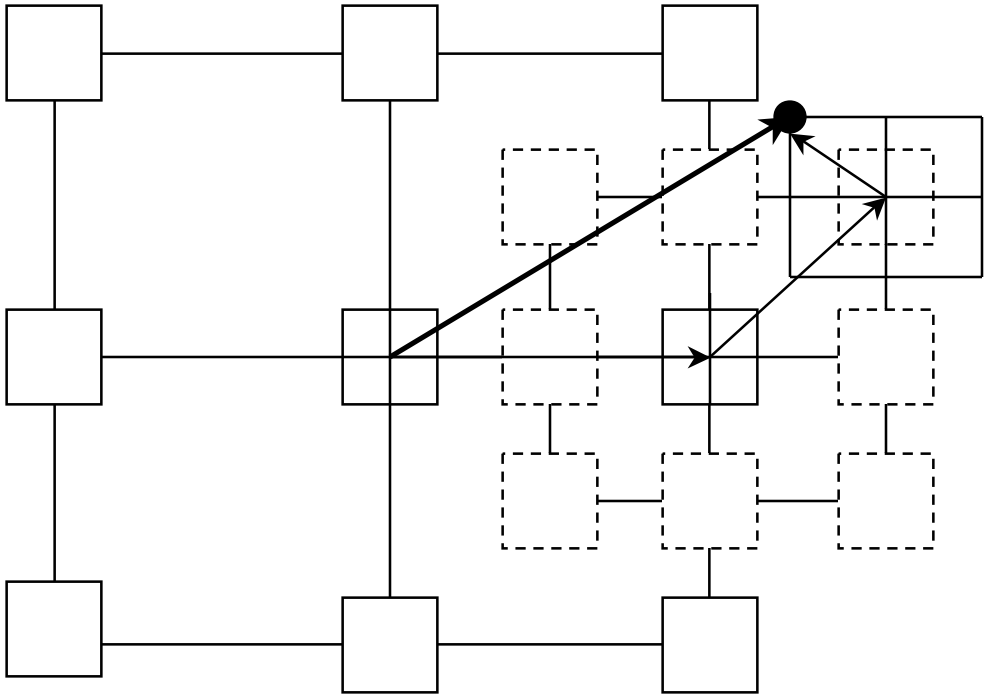
Motion estimation:

a. Find the reference block at the same position

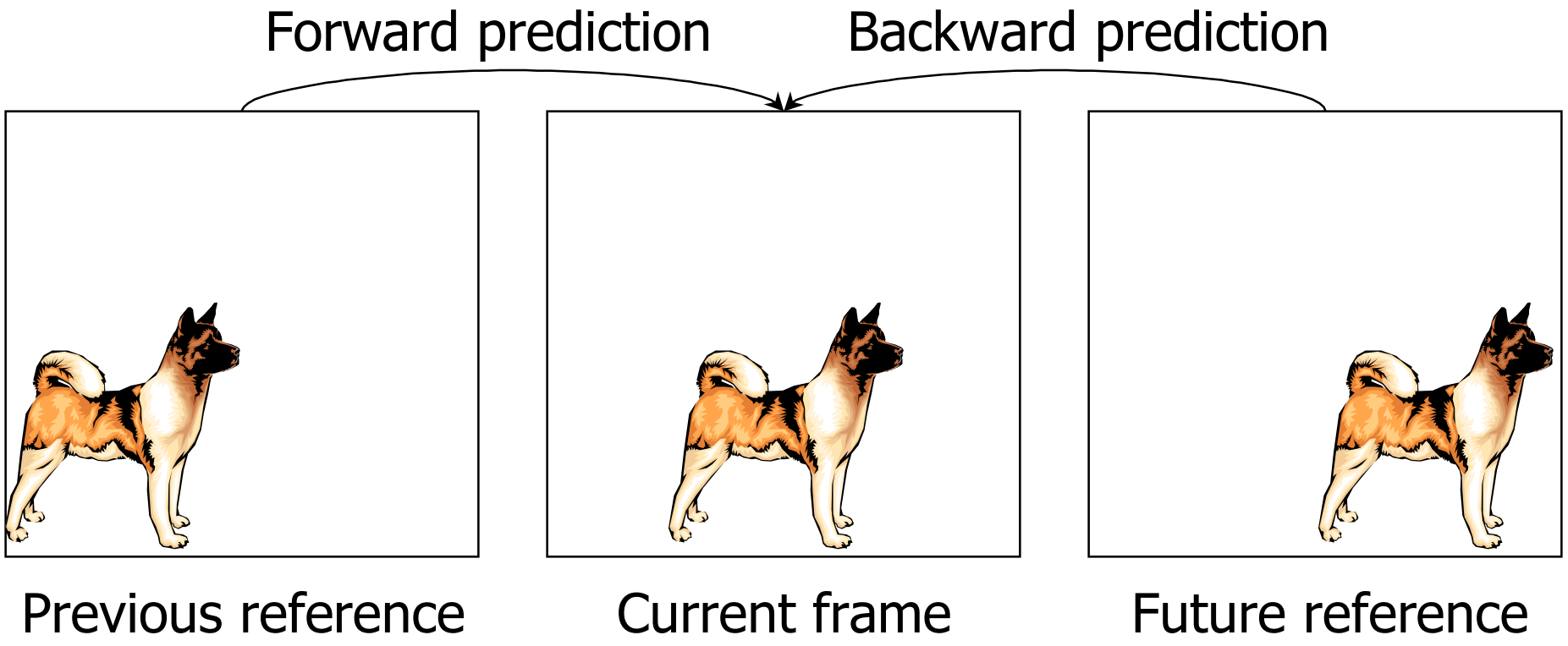


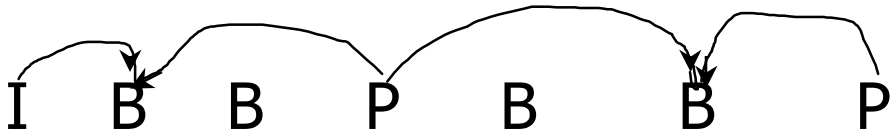
# 7. How to Encode P Frame?

b. Take the reference block as the search center



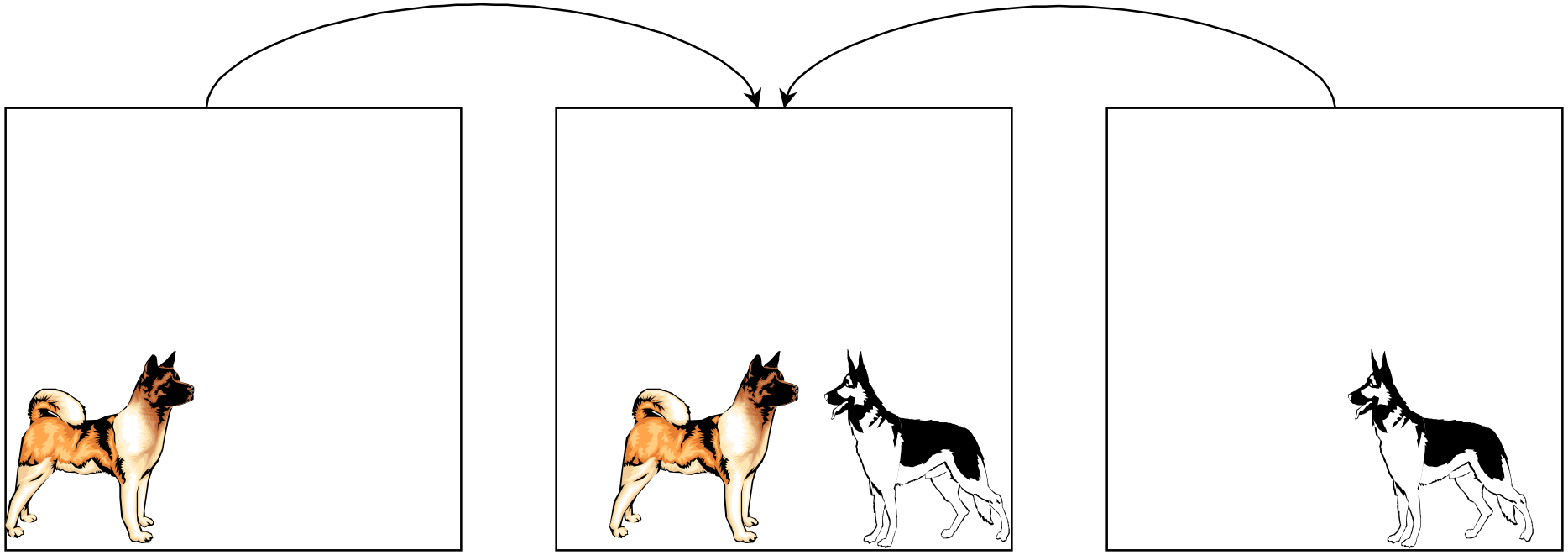
# 8. How to Encode B Frame?

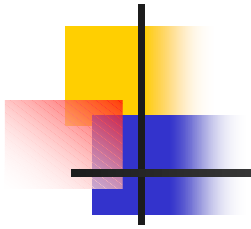


# 8. How to Encode B Frame?

Why we need B frame?  Higher compression ratio





# 8. How to Encode B Frame?

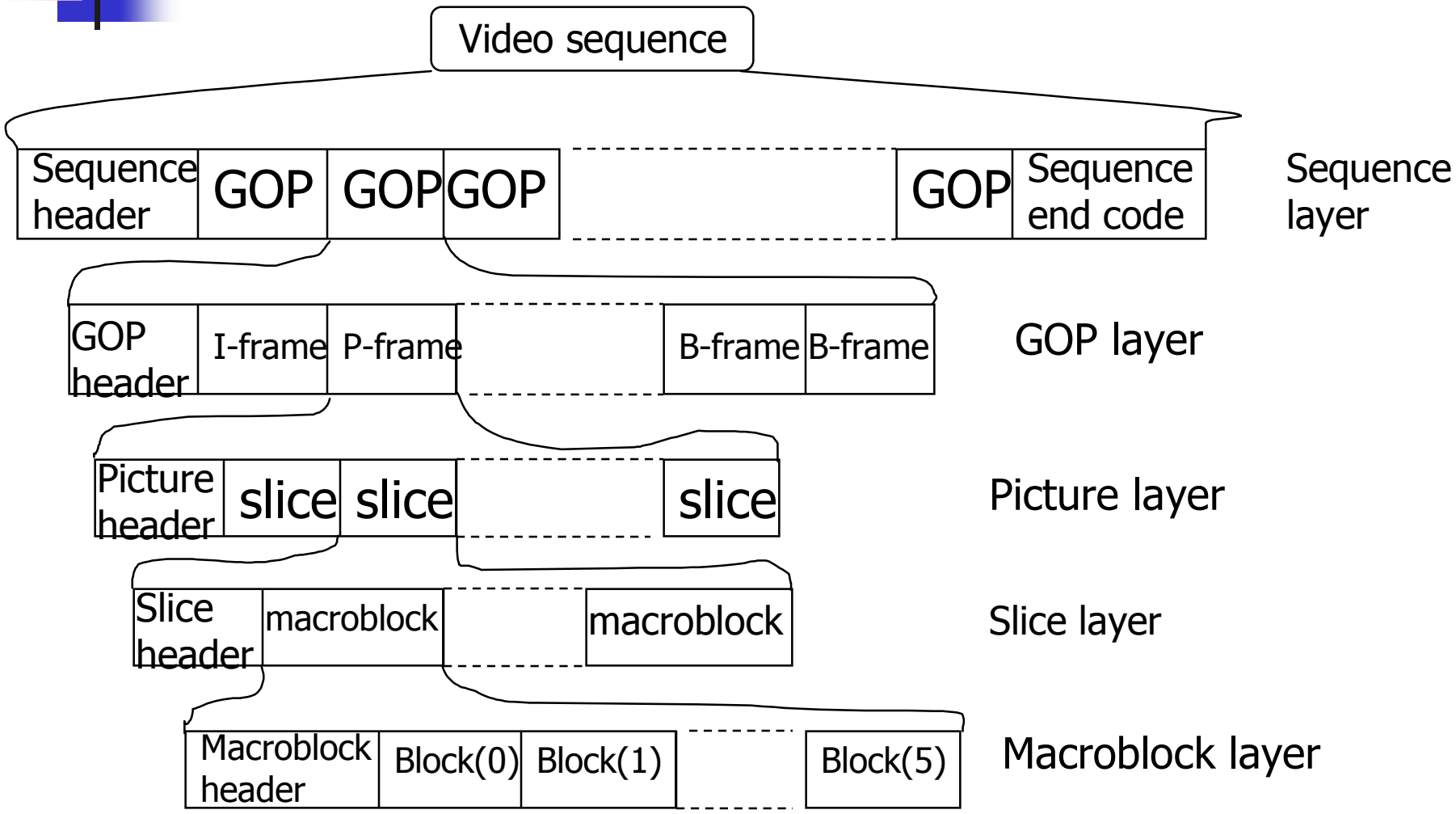
Why we cannot put too much B frames?

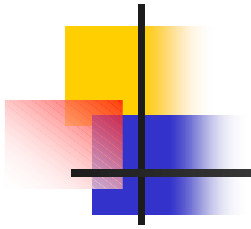
| Display order: | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | I | B | B | P | B | B | P | B | B | P | B | B | P |

| Encoding order: | 1 | 4 | 2 | 3 | 7 | 5 | 6 | 10 | 8 | 9 | 13 | 11 | 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | I | P | B | B | P | B | B | P | B | B | P | B | B |

Buffer Size: 3 frames

# 9. How to Design MPEG Decoder?





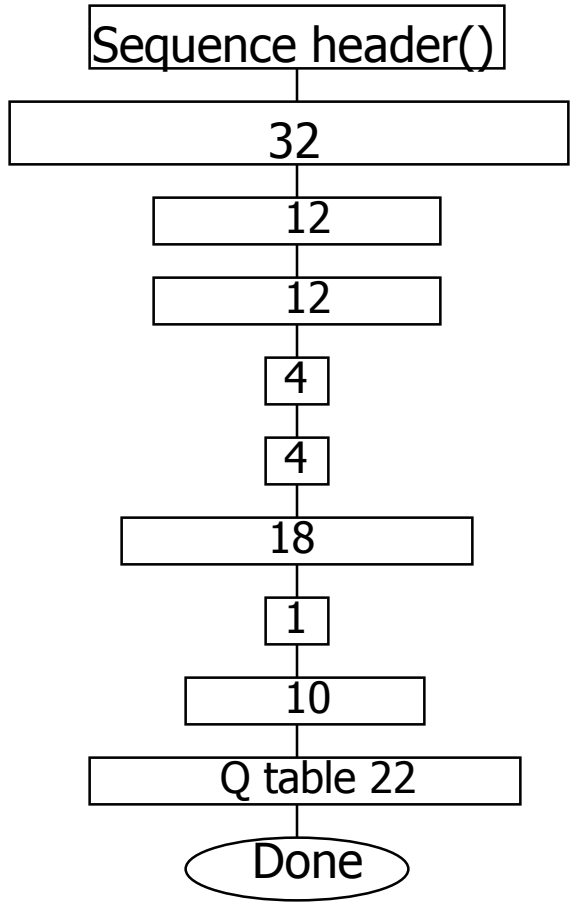
# 9. How to Design MPEG Decoder?

a. Search for the start codes:

| | | |
|---|---|---|
| Sequence header code: | 0x000001B5 | 32bits |
| Sequence end code: | 0x000001B7 | 32bits |
| Group_start_code: | 0x000001B8 | 32bits |
| Picture_start_code: | 0x00000100 | 32bits |
| Slice_start_code: | 0x000001AF | 32bits |

# 9. How to Design MPEG Decoder?

## b. Functions for decoding the video data:




Sequence_start_code

Horizontal size

Vertical size

Pel_aspect_ratio

Picture_rate

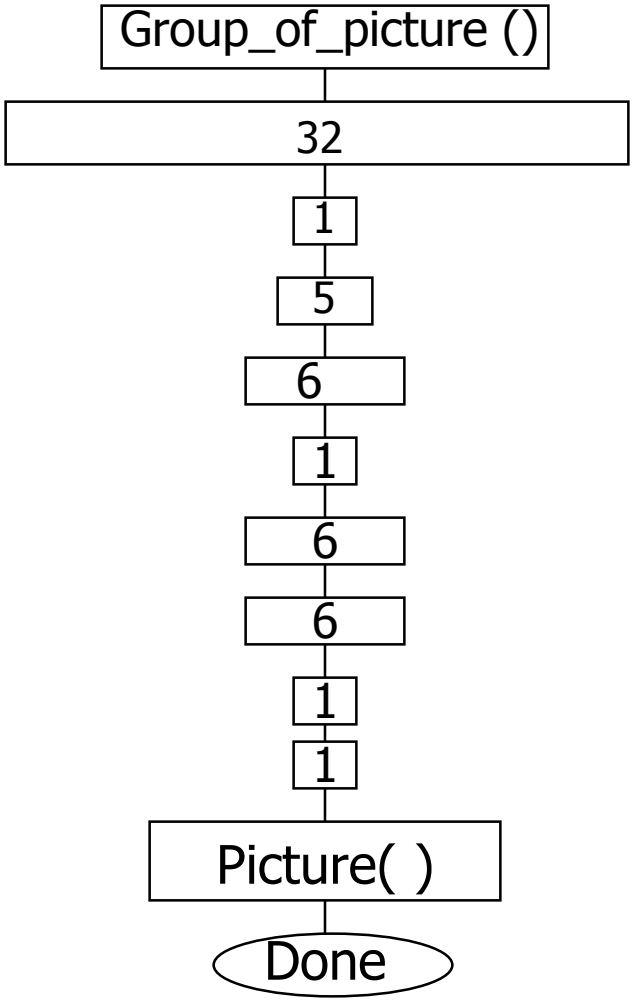
Bit rate

Marker_bit

Buffer_size

Quantization table

# 9. How to Design MPEG Decoder?




Group_start_code

Drop_frame_flag

Time_code_hours

Time_code_minutes

Market_bit

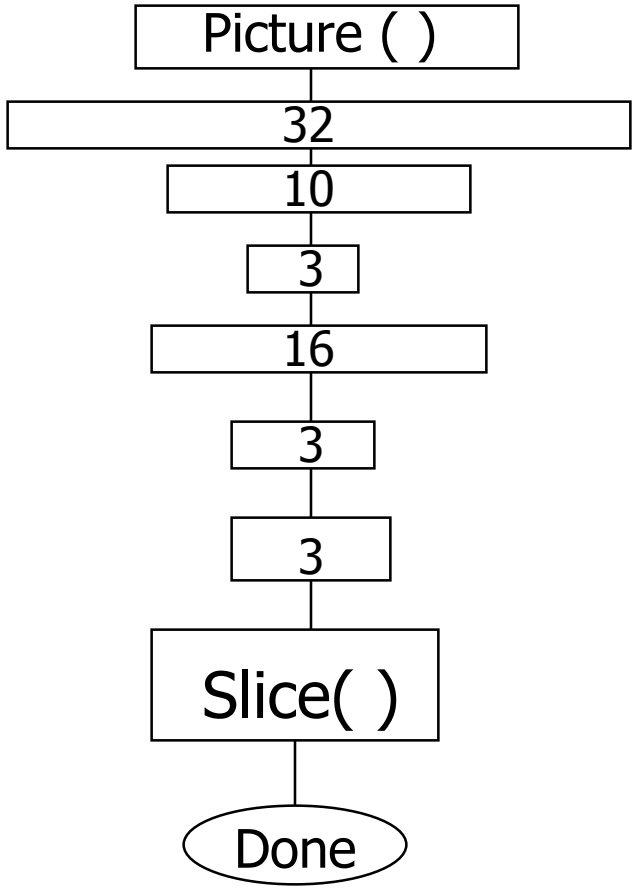
Time_code_seconds

Time_code_pictures

Close_gop

Broken_link

# 9. How to Design MPEG Decoder?




Picture_start_code

Temporal_reference

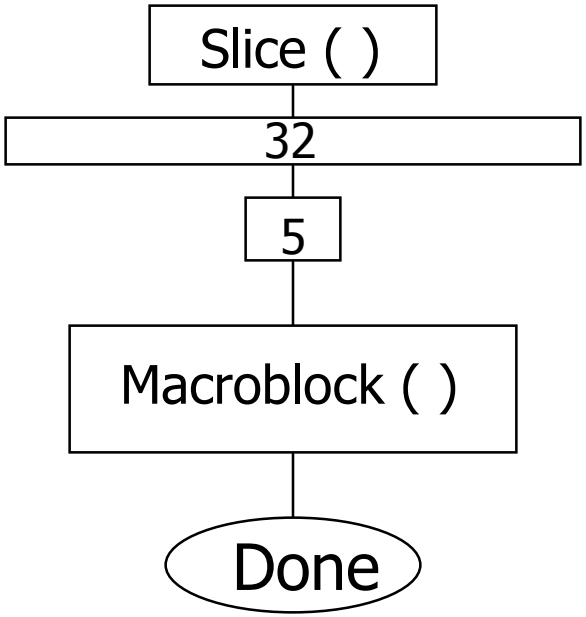
Picture_coding_type

Decoding_delay

Forward_vector_type

Backward_vector_type

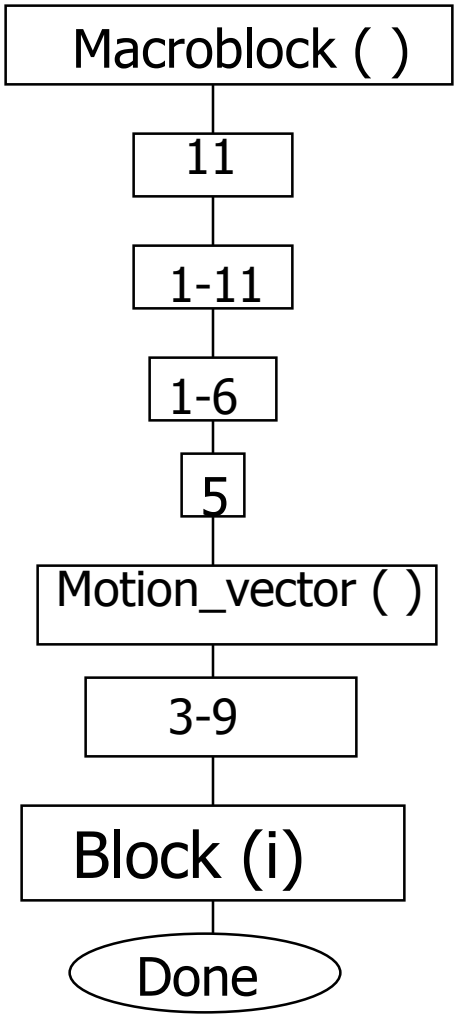
# 9. How to Design MPEG Decoder?




Slice_start_code

Quantization scale

# 9. How to Design MPEG Decoder?



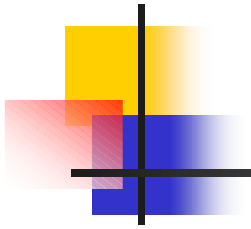

Macroblock_escape

Macroblock_address_increase

Macroblock_type

Quantizer_scale

Coded_block_pattern



# 10. Where you can find MPEG?

a. http://www.mpeg.org

b. http://www.cs.wayne.edu/~dil/research

Question:

If you are offered a job on designing MPEG decoder, how you can do?

***Show me the video frames from 1228 to 1338?***

IBM, Microsoft, Intel, NEC, Cisco, Eastman Kodak, ……, .com