4. (a) Briefly describe the purpose of chroma subsampling in the MPEG-1 video compression.

4. (a) 简要描述了在MPEG-1视频压缩中色度子采样的目的。 (4 Marks)

(b) Draw a flowchart of the P-frame encoding in the MPEG-1 standard. Clearly label all the key steps in the flowchart. Briefly explain the role of entropy encoding in the process.

(b) 绘制MPEG-1标准中p帧编码的流程图。清楚地标注流程图中的所有关键步骤。 (9 Marks)
简要解释熵编码在这一过程中的作用。

(c) Rank from the best to the worst the following 3 motion estimation methods in terms of: (i) computational speed and (ii) accuracy:

- Three-step search
- Full search
- 2D logarithm search.

(c) 对以下3种运动估计方法从优到劣进行排序： (6 Marks)
(i) 计算速度和（ii）精度：三步搜索全搜索二维对数搜索。

(d) Briefly discuss how MPEG-2 scalability can be used in networks with variable bitrate channels.

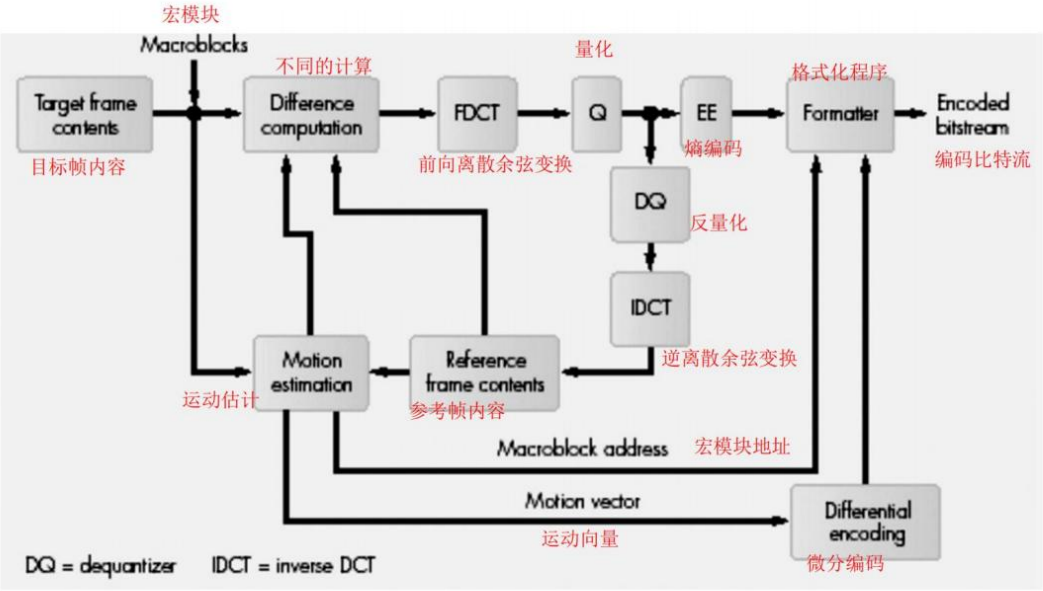
(d) 简要讨论如何在具有可变比特率信道的网络中使用MPEG-2可伸缩性。 (6 Marks)

(a) The purpose of chroma subsampling:

- Human visual system is less sensitive to chrominance (color) component than luminance (brightness) component.
- Hence, chroma subsampling samples the chrominance pixels to reduce the number of pixels that need to be stored, thereby improving the compression efficiency.

色度子采样的目的:人类视觉系统对色度(颜色)分量的敏感度低于亮度(亮度)分量。

(b) 因此，色度子采样对色度像素进行采样，以减少需要存储的像素数，从而提高压缩效率。




熵编码的作用是使用可变长度编码，如更可能的符号被分配更短的码字，而更不可能的符号被分配更长的码字。这将确保每个符号的平均位数更小。对直流系数和交流系数采用熵编码。

The role of entropy encoding is to use variable length coding such as more probable symbols are assigned shorter codewords, and less probable symbols are assigned longer codewords. This will ensure the average number of bits per symbols will be smaller. Entropy encoding is used in coding the DC and AC coefficients.

## Entropy encoding comprises 4 steps:

熵编码包括4个步骤:

- Vectoring (zig-zag scanning)

矢量化(锯齿形扫描)

- Differential encoding / Differential Pulse Code Modulation (DPCM)

差分编码/差分脉冲码调制(DPCM)

- Run-length encoding (RLE)

码长编码(RLE)

- Huffman encoding

霍夫曼编码

# 2D Logarithmic Search

二维对数搜索

- Step 1: Search 5 points for minimum prediction error.

步骤1:搜索最小预测误差5点。

- Step 2: Centered on the found position in previous iteration,

步骤2:以前一次迭代找到的位置为中心,

(i) If the found position is the central position or located at the border, halve the search width; else, retain the search width.

下次步长就减半，直到步长为1

(i)如果找到的位置是中心位置或位于边界，则将搜索宽度减半;

(ii) (a) If the search window is not 3x3 yet, search 5 points for minimum error and repeat Step 2. (ii)(a)如果搜索窗口不是3 × 3，搜索5个点寻找最小误差，重复步骤2;

(b) Else, if the search window is 3x3, search 9 points for minimum error and return best found position.

b)否则，如果搜索窗口是3 × 3，搜索9个点寻找最小误差，返回最佳找到位置。

- Speed: Between full search and 3 step search. 速度:在完整搜索和3步搜索之间。
- Accuracy: Between full search and 3 step search. 准确性:介于全搜索和3步搜索之间。

The MPEG-2 scalable coding uses:

- Layered coding: A base layer and one or more enhancement layers.
- The base layer can be independently encoded, transmitted and decoded to obtain basic video quality.
- Bitstreams of base layer are sent first, to give users a fast and basic view of the video, followed by enhancement layer to improve quality.
- The encoding and decoding of the enhancement layer, however, are dependent on the base layer or the previous enhancement layer.

For a network with variable bitrate channels:

- When the bandwidth is high, MPEG-2 transmit both the base layer and enhancement layer.
- When the bandwidth is low, MPEG-2 transmit only the base layer.

MPEG-2可扩展编码使用:

- 分层编码:一个基础层和一个或多个增强层。
- 基础层可以独立进行编码、传输和解码，以获得基本的视频质量。
- 首先发送基础层的比特流，给用户一个快速和基本的视频视图，然后是增强层，以提高质量。
- 然而，增强层的编码和解码依赖于基础层或先前的增强层。

对于具有可变比特率通道的网络:

- 当带宽较高时，MPEG-2同时传输基础层和增强层。
- 当带宽较低时，MPEG-2只传输基础层。