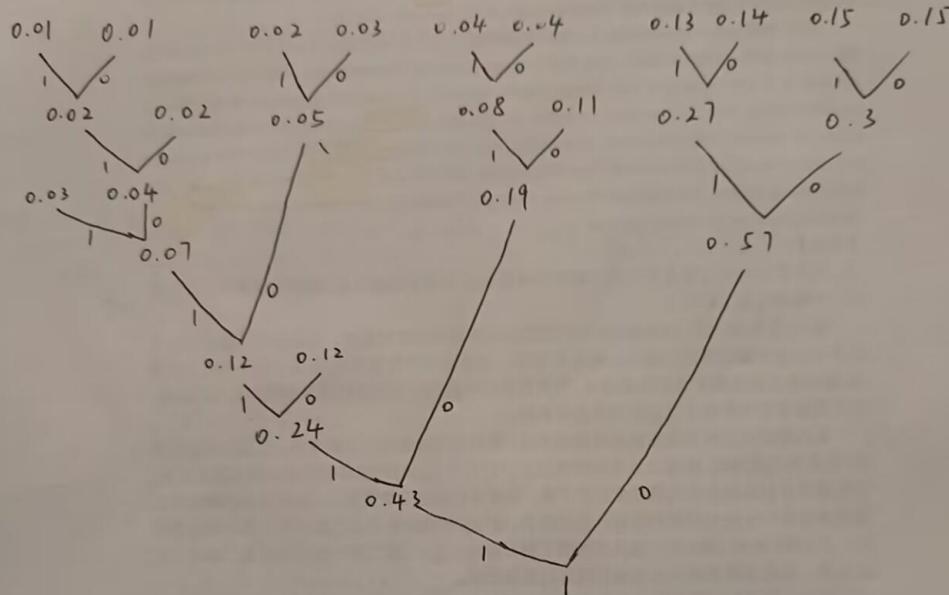


1. 把14条指令全编号为1-14

则指令操作码的进长编码为：

1: 0000 2: 0001 3: 0010 4: 0011 5: 0100 6: 0101 7: 0110
8: 0111 9: 1000 10: 1001 11: 1010 12: 1011 13: 1100 14: 1101

Huffman 编码为：



∴ 1: 111011 2: 001 3: 110 4: 1100 5: 11100 6: 1011 7: 11101

8: 1010 9: 111010 10: 011 11: 000 12: 010 13: 100 14: 1111

扩展编码：

排序：1: 0.01 9: 0.01, 5: 0.02 7: 0.02 4: 0.03 14: 0.03 6: 0.04

8: 0.04 13: 0.11 3: 0.12 10: 0.13 12: 0.14 2: 0.15 11: 0.15

采用等长扩展(3-6)7/7 编码

1: 111000 9: 111001 5: 111010 7: 111011 4: 11100 14: 11101 6: 11110

8: 000 13: 001 3: 010 10: 011 12: 100 2: 101 11: 110

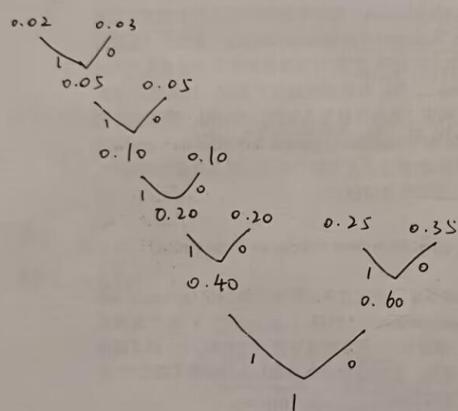
平均码长

定长编码：4

$$\begin{aligned} \text{Huffman 编 2 号: } & 7 \times 0.01 + 0.15 \times 3 + 0.12 \times 3 + 0.03 \times 5 + 0.02 \times 6 + 0.04 \times 4 + \\ & 0.02 \times 5 + 0.04 \times 4 + 0.01 \times 7 + 0.13 \times 3 + 0.15 \times 3 + 0.14 \times 3 + \\ & 0.11 \times 3 + 0.03 \times 5 \\ = & 3.38 \end{aligned}$$

$$\begin{aligned} \text{扩展编码: } & (0.01 + 0.01 + 0.02 + 0.02 + 0.03 + 0.03 + 0.04) \times 6 + \\ & (0.04 + 0.11 + 0.12 + 0.13 + 0.14 + 0.15 + 0.15) \times 3 \\ = & 3.48 \end{aligned}$$

2. (1) 1: 0.35 2: 0.25 3: 0.20 4: 0.10 5: 0.05 6: 0.03 7: 0.02



∴ 编码为: 1: 00 2: 01 3: 10 4: 110 5: 1110 6: 11110 7: 11111

平均长度为: $2 \times 0.35 + 2 \times 0.25 + 2 \times 0.20 + 3 \times 0.10 + 4 \times 0.05 + 5 \times 0.03 + 5 \times 0.02$

$$= 2.35$$

(2) RR型:
01 XXX XXX
10 XXX XXX
11 XXX XXX
OP R₁ R₂

RS型:
0000 - XXX P AAAAAAAA
0001 - XXX P AAAAAAAA
0010 - XXX P AAAAAAAA
0011 - XXX P AAAAAAAA
OP R 变址

3. (1) 双地址：操作码长度： $16 - 2 \times 6 = 4$

单地址：操作码长度： $16 - 6 = 10$

零地址：操作码长度： $16 - 0 = 16$

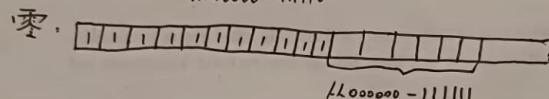
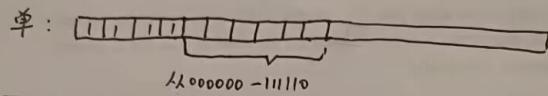
设单地址有x条：

$$\text{零地址的条数为 } y = (2^4 - 15) \times (2^{10-4} - x) \times 2^{16-10}$$

$\because x$ 与 y 大致相等

$$\therefore x = 63 \quad y = 64$$

操作码分配：



(2) 设双地址有a条，单地址有b条，零地址有c条

$$C = (2^4 - a) \times (2^b - b) \times 2^c$$

$$a:b:c = 1:9:9$$

$$\text{解得 } a=14, b=126, c=126$$

