1. **解：**

设第k月的需求量为Nk(k=1,2,3,4)

状态变量Xk：第k月初的库存量，X1=X5=0，0≤Xk≤Nk+…+N4

决策变量Uk：第k月的生产量，max{0，Nk-Xk}≤Uk≤min{6，Nk+…+N4 - Xk}

状态转移方程：Xk+1 = Uk + Xk – Nk

第k月的成本Vk = 0.5\*(Xk - Nk) Uk=0

3 + Uk + 0.5\*(Uk + Xk - Nk) Uk≠0

设Fk(Xk)是由第k月初的库存量Xk开始到第4月份结束这段时间的最优成本

则Fk(Xk) = min{Vk + Fk+1(X k+1)} 1≤k≤4

= min{ 3 + Uk + 0.5\*(Uk + Xk - Nk) + Fk+1(Uk + Xk - Nk) } Uk≠0

min{ 0.5\*(Xk - Nk) + Fk+1(Xk - Nk) } Uk=0

F5(X5)=0

四个月内的最优成本为F1(X1)=F1(0)

详细计算步骤如下：

（1）k=4时

0≤X4≤4，max{0，4 - X4}≤U4≤min{6，4-X4}

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| X4 | U4 | X5 | V4 | F5(X5) | V4 + F5(X5) |
| 0 | 4 | 0 | 7 | 0 | 7=F4(0) |
| 1 | 3 | 0 | 6 | 0 | 6=F4(1) |
| 2 | 2 | 0 | 5 | 0 | 5=F4(2) |
| 3 | 1 | 0 | 4 | 0 | 4=F4(3) |
| 4 | 0 | 0 | 0 | 0 | 0=F4(4) |

即对于状态X4的每个取值，都有唯一确定的决策变量U4使得F4(X4)最优

（2）k=3时

0≤X3≤6，max{0，2 - X3}≤U3≤min{6，6-X3}

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| X3 | U3 | X4 | V3 | F4(X4) | V3 + F4(X4) |
| 0 | 2 | 0 | 5 | 7 | 12 |
| 3 | 1 | 6.5 | 6 | 12.5 |
| 4 | 2 | 8 | 5 | 13 |
| 5 | 3 | 9.5 | 4 | 13.5 |
| 6 | 4 | 11 | 0 | 11=F3(0) |
| 1 | 1 | 0 | 4 | 7 | 11 |
| 2 | 1 | 5.5 | 6 | 11.5 |
| 3 | 2 | 7 | 5 | 12 |
| 4 | 3 | 8.5 | 4 | 12.5 |
| 5 | 4 | 10 | 0 | 10=F3(1) |
| 2 | 0 | 0 | 0 | 7 | 7=F3(2) |
| 1 | 1 | 4.5 | 6 | 10.5 |
| 2 | 2 | 6 | 5 | 11 |
| 3 | 3 | 7.5 | 4 | 11.5 |
| 4 | 4 | 9 | 0 | 9 |
| 3 | 0 | 1 | 0.5 | 6 | 6.5=F3(3) |
| 1 | 2 | 5 | 5 | 10 |
| 2 | 3 | 6.5 | 4 | 10.5 |
| 3 | 4 | 8 | 0 | 8 |
| 4 | 0 | 2 | 1 | 5 | 6=F3(4) |
| 1 | 3 | 5.5 | 4 | 9.5 |
| 2 | 4 | 7 | 0 | 7 |
| 5 | 0 | 3 | 1.5 | 4 | 5.5=F3(5) |
| 1 | 4 | 6 | 0 | 6 |
| 6 | 0 | 4 | 3 | 0 | 2=F3(6) |

（3）k=2时

0≤X2≤9，max{0，3 - X2}≤U2≤min{6，9-X2}

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| X2 | U2 | X3 | V2 | F3(X3) | V2 + F3(X3) |
| 0 | 3 | 0 | 6 | 11 | 17 |
| 4 | 1 | 7.5 | 10 | 17.5 |
| 5 | 2 | 9 | 7 | 16=F2(0) |
| 6 | 3 | 10.5 | 6.5 | 17 |
| 1 | 2 | 0 | 5 | 11 | 16 |
| 3 | 1 | 6.5 | 10 | 16.5 |
| 4 | 2 | 8 | 7 | 15=F2(1) |
| 5 | 3 | 9.5 | 6.5 | 16 |
| 6 | 4 | 11 | 6 | 17 |
| 2 | 1 | 0 | 4 | 11 | 15 |
| 2 | 1 | 5.5 | 10 | 15.5 |
| 3 | 2 | 7 | 7 | 14=F2(2) |
| 4 | 3 | 8.5 | 6.5 | 15 |
| 5 | 4 | 10 | 6 | 16 |
| 6 | 5 | 11.5 | 5.5 | 17 |
| 3 | 0 | 0 | 0 | 11 | 11=F2(3) |
| 1 | 1 | 4.5 | 10 | 14.5 |
| 2 | 2 | 6 | 7 | 13 |
| 3 | 3 | 7.5 | 6.5 | 14 |
| 4 | 4 | 9 | 6 | 15 |
| 5 | 5 | 10.5 | 5.5 | 16 |
| 6 | 6 | 12 | 2 | 14 |
| 4 | 0 | 1 | 0.5 | 10 | 10.5=F2(4) |
| 1 | 2 | 5 | 7 | 13 |
| 2 | 3 | 6.5 | 6.5 | 13 |
| 3 | 4 | 8 | 6 | 14 |
| 4 | 5 | 9.5 | 5.5 | 15 |
| 5 | 6 | 11 | 2 | 13 |
| 5 | 0 | 2 | 1 | 7 | 8=F2(5) |
| 1 | 3 | 5.5 | 6.5 | 12 |
| 2 | 4 | 7 | 6 | 13 |
| 3 | 5 | 8.5 | 5.5 | 14 |
| 4 | 6 | 10 | 2 | 12 |
| 6 | 0 | 3 | 1.5 | 6.5 | 8=F2(6) |
| 1 | 4 | 6 | 6 | 12 |
| 2 | 5 | 7.5 | 5.5 | 13 |
| 3 | 6 | 9 | 2 | 11 |
| 7 | 0 | 4 | 2 | 6 | 8=F2(7) |
| 1 | 5 | 6.5 | 5.5 | 12 |
| 2 | 6 | 8 | 2 | 10 |
| 8 | 0 | 5 | 2.5 | 5.5 | 8=F2(8) |
| 1 | 6 | 7 | 2 | 9 |
| 9 | 0 | 6 | 3 | 2 | 5=F2(9) |

（4）k=1时

X1=0，max{0，2}≤U1≤min{6，11}

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| X1 | U1 | X2 | V1 | F2(X2) | V1 + F2(X2) |
| 0 | 2 | 0 | 5 | 16 | 21 |
| 3 | 1 | 6.5 | 15 | 21.5 |
| 4 | 2 | 8 | 14 | 22 |
| 5 | 3 | 9.5 | 11 | 20.5=F1(0) |
| 6 | 4 | 11 | 10.5 | 21.5 |

由以上计算可得，4个月的总最优成本为F1(0) = 20.5(千元)

从k=1回溯，可得最优结果中各阶段的状态变量Xk和决策变量Uk如下表：

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| 月份k | 产量Uk | 月初库存量Xk | 需求量Nk | 每月成本Vk |
| 1 | 5 | 0 | 2 | 9.5 |
| 2 | 0 | 3 | 3 | 0 |
| 3 | 6 | 0 | 2 | 11 |
| 4 | 0 | 4 | 4 | 0 |

1. **解：**

**1、变量设定**

阶段k：已遍历过k个结点，k=1,2…6,7。

K=1表示刚从V1出发，k=7表示已回到起点V1

状态变量Xk=(i，Sk)：已遍历k个结点，当前位于i结点，还未遍历的结点集合为Sk。则X1=(1，{2,3,4,5,6})，X6=(i，Φ)，X7=(1，Φ)

决策变量Uk=(i，j)：已遍历k个结点，当前位于i结点，下一个结点选择j。

状态转移方程：Xk+1 = T(Xk，Uk) = (j，Sk-{j})

第k阶段的指标函数Vk = D[i,j]。

最优指标函数Fk(Xk) = Fk(i，Sk)：已遍历k个结点，当前从i结点出发，访问Sk中的结点一次且仅一次，最后返回起点V1的最短距离。

则Fk(i，Sk) = min{ D[i,j] + Fk+1(j，Sk-{j}) } 1≤k≤6

F7(X7) = F7(1，Φ) = 0

**2、分析：**

（1）k=6时，F6(i，Φ) = min{D[i,1] + F7(X7)} = D[i,1] i=2,3,4,5,6

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| X6=(i，Φ) | U6=(i，j) | X7=(1，Φ) | V6=D[i,j] | F7(1，Φ) | V6 + F7(X7) |
| (2，Φ) | (2，1) | (1，Φ) | 12 | 0 | 12=F6(2,Φ) |
| (3，Φ) | (3，1) | (1，Φ) | 23 | 0 | 23=F6(3,Φ) |
| (4，Φ) | (4，1) | (1，Φ) | 34 | 0 | 34=F6(4,Φ) |
| (5，Φ) | (5，1) | (1，Φ) | 45 | 0 | 45=F6(5,Φ) |
| (6，Φ) | (6，1) | (1，Φ) | 56 | 0 | 56=F6(6,Φ) |

即k=6时，对于每一种状态X6，都有唯一的决策U6。

（2）k=5时，F5(i，S5) = min{D[i,j] + F6(j，Φ)} i=2,3,4,5,6

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| X5=(i,S5) | U5=(i,j) | X6=(j, Φ) | V5=D[i,j] | F6(j,Φ) | V5 + F6(X6) |
| (2,{6}} | (2,6) | (6，Φ) | 21 | 56 | 77=F5(2,{6}) |
| (2,{5}} | (2,5) | (5，Φ) | 25 | 45 | 70=F5(2,{5}) |
| (2,{4}} | (2,4) | (4，Φ) | 30 | 34 | 64=F5(2,{4}) |
| (2,{3}} | (2,3) | (3，Φ) | 18 | 23 | 41=F5(2,{3}) |
| (3,{6}) | (3,6) | (6，Φ) | 15 | 56 | 71=F5(3,{6}) |
| (3,{5}) | (3,5) | (5，Φ) | 10 | 45 | 55=F5(3,{5}) |
| (3,{4}) | (3,4) | (4，Φ) | 5 | 34 | 39=F5(3,{4}) |
| (3,{2}) | (3,2) | (2，Φ) | 19 | 12 | 31=F5(3,{2}) |
| (4,{6}) | (4,6) | (6，Φ) | 16 | 56 | 72=F5(4,{6}) |
| (4,{5}) | (4,5) | (5，Φ) | 8 | 45 | 53=F5(4,{5}) |
| (4,{3}) | (4,3) | (3，Φ) | 4 | 23 | 27=F5(4,{3}) |
| (4,{2}) | (4,2) | (2，Φ) | 32 | 12 | 44=F5(4,{2}) |
| (5,{6}) | (5,6) | (6，Φ) | 18 | 56 | 74=F5(5,{6}) |
| (5,{4}) | (5,4) | (4，Φ) | 10 | 34 | 44=F5(5,{4}) |
| (5,{3}) | (5,3) | (3，Φ) | 11 | 23 | 34=F5(5,{3}) |
| (5,{2}) | (5,2) | (2，Φ) | 27 | 12 | 39=F5(5,{2}) |
| (6,{5}) | (6,5) | (5，Φ) | 12 | 45 | 57=F5(6,{5}) |
| (6,{4}) | (6,4) | (4，Φ) | 20 | 34 | 54=F5(6,{4}) |
| (6,{3}) | (6,3) | (3，Φ) | 16 | 23 | 39=F5(6,{3}) |
| (6,{2}) | (6,2) | (2，Φ) | 22 | 12 | 34=F5(6,{2}) |

即k=时，对于每一种状态X5，都有唯一决策U5。

（3）k=4时，F4(i,S4) = min(D[i,j] + F5(j,S5) ) i=2,3,4,5,6

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| X4=(i,S4) | U4=(i,j) | X5=(j,S5) | V4=D[i,j] | F5(j,S5) | V4 + F5(j,S5) |
| (2,{3,4}) | (2,3) | (3,{4}) | 18 | 39 | 57=F4(2,{3,4}) |
| (2,4) | (4,{3}) | 30 | 27 | 57=F4(2,{3,4}) |
| (2,{4,5}) | (2,4) | (4,{5}) | 30 | 53 | 83 |
| (2,5) | (5,{4}) | 25 | 44 | 69=F4(2,{4,5}) |
| (2,{5,6}) | (2,5) | (5,{6}) | 25 | 74 | 99 |
| (2,6) | (6,{5}) | 21 | 57 | 78=F4(2,{5,6}) |
| (2,{3,5}) | (2,3) | (3,{5}) | 18 | 55 | 73 |
| (2,5) | (5,{3}) | 25 | 34 | 59=F4(2,{3,5}) |
| (2,{3,6}) | (2,3) | (3,{6}) | 18 | 71 | 89 |
| (2,6) | (6,{3}) | 21 | 39 | 60=F4(2,{3,6}) |
| (2,{4,6}) | (2,4) | (4,{6}) | 30 | 72 | 102 |
| (2,6) | (6,{4}) | 21 | 54 | 75=F4(2,{4,6}) |
| (3,{2,4}) | (3,2) | (2,{4}) | 19 | 64 | 83 |
| (3,4) | (4,{2}) | 5 | 44 | 49=F4(3,{2,4}) |
| (3,{2,5}) | (3,2) | (2,{5}) | 19 | 70 | 89 |
| (3,5) | (5,{2}) | 10 | 39 | 49=F4(3,{2,5}) |
| (3,{2,6}) | (3,2) | (2,{6}) | 19 | 77 | 96 |
| (3,6) | (6,{2}) | 15 | 34 | 49=F4(3,{2,6}) |
| (3,{4,5}) | (3,4) | (4,{5}) | 5 | 53 | 58 |
| (3,5) | (5,{4}) | 10 | 44 | 54=F4(3,{4,5}) |
| (3,{4,6}) | (3,4) | (4,{6}) | 5 | 72 | 77 |
| (3,6) | (6,{4}) | 15 | 54 | 69=F4(3,{4,6}) |
| (3,{5,6}) | (3,5) | (5,{6}) | 10 | 74 | 84 |
| (3,6) | (6,{5}) | 15 | 57 | 72=F4(3,{5,6}) |
| (4,{2,3}) | (4,2) | (2,{3}) | 32 | 41 | 73 |
| (4,3) | (3,{2}) | 4 | 31 | 34=F4(4,{2,3}) |
| (4,{2,5}) | (4,2) | (2,{5}) | 32 | 70 | 102 |
| (4,5) | (5,{2}) | 8 | 39 | 47=F4(4,{2,5}) |
| (4,{2,6}) | (4,2) | (2,{6}) | 32 | 77 | 109 |
| (4,6) | (6,{2}) | 16 | 34 | 50=F4(4,{2,6}) |
| (4,{3,5}) | (4,3) | (3,{5}) | 4 | 55 | 59 |
| (4,5) | (5,{3}) | 8 | 34 | 42=F4(4,{3,5}) |
| (4,{3,6}) | (4,3) | (3,{6}) | 4 | 71 | 75 |
| (4,6) | (6,{3}) | 16 | 39 | 55=F4(4,{3,6}) |
| (4,{5,6}) | (4,5) | (5,{6}) | 8 | 74 | 82 |
| (4,6) | (6,{5}) | 16 | 57 | 73=F4(4,{5,6}) |
| (5,{2,3}) | (5,2) | (2,{3}) | 27 | 41 | 68 |
| (5,3) | (3,{2}) | 11 | 31 | 42=F4(5,{2,3}) |
| (5,{2,4}) | (5,2) | (2,{4}) | 27 | 64 | 91 |
| (5,4) | (4,{2}) | 10 | 44 | 54=F4(5,{2,4}) |
| (5,{2,6}) | (5,2) | (2,{6}) | 27 | 77 | 104 |
| (5,6) | (6,{2}) | 18 | 34 | 52=F4(5,{2,6}) |
| (5,{3,4}) | (5,3) | (3,{4}) | 11 | 39 | 50 |
| (5,4) | (4,{3}) | 10 | 27 | 37=F4(5,{3,4}) |
| (5,{3,6}) | (5,3) | (3,{6}) | 11 | 71 | 82 |
| (5,6) | (6,{3}) | 18 | 39 | 57=F4(5,{3,6}) |
| (5,{4,6}) | (5,4) | (4,{6}) | 10 | 72 | 82 |
| (5,6) | (6,{4}) | 18 | 54 | 72=F4(5,{4,6}) |
| (6,{2,3}) | (6,2) | (2,{3}) | 22 | 41 | 63 |
| (6,3) | (3,{2}) | 16 | 31 | 47=F4(6,{2,3}) |
| (6,{2,4}) | (6,2) | (2,{4}) | 22 | 64 | 86 |
| (6,4) | (4,{2}) | 20 | 44 | 64=F4(6,{2,4}) |
| (6,{2,5}) | (6,2) | (2,{5}) | 22 | 70 | 92 |
| (6,5) | (5,{2}) | 12 | 39 | 51=F4(6,{2,5}) |
| (6,{3,4}) | (6,3) | (3,{4}) | 16 | 39 | 55 |
| (6,4) | (4,{3}) | 20 | 27 | 47=F4(6,{3,4}) |
| (6,{3,5}) | (6,3) | (3,{5}) | 16 | 55 | 71 |
| (6,5) | (5,{3}) | 12 | 34 | 46=F4(6,{3,5}) |
| (6,{4,5}) | (6,4) | (4,{5}) | 20 | 53 | 73 |
| (6,5) | (5,{4}) | 12 | 44 | 56=F4(6,{4,5}) |

（4）k=3时，F3(i,S3) = min{D[i,j] + F4(j,S4)} i=2,3,4,5,6

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| X3=(i,S3) | U3=(i,j) | X4=(j,S4) | V3=D[i,j] | F4(j,S4) | V3 + F4(j,S4) |
| (2,{3,4,5}) | (2,3) | (3,{4,5}) | 18 | 54 | 72 |
| (2,4) | (4,{3,5}) | 30 | 42 | 72 |
| (2,5) | (5,{3,4}) | 25 | 37 | 62=F3(2,{3,4,5}) |
| (2,{3,4,6}) | (2,3) | (3,{4,6}) | 18 | 69 | 87 |
| (2,4) | (4,{3,6}) | 30 | 55 | 85 |
| (2,6) | (6,{3,4}) | 21 | 47 | 68=F3(2,{3,4,6}) |
| (2,{3,5,6}) | (2,3) | (3,{5,6}) | 18 | 72 | 90 |
| (2,5) | (5,{3,6}) | 25 | 57 | 82 |
| (2,6) | (6,{3,5}) | 21 | 46 | 67=F3(2,{3,5,6}) |
| (2,{4,5,6}) | (2,4) | (4,{5,6}) | 30 | 73 | 103 |
| (2,5) | (5,{4,6}) | 25 | 72 | 97 |
| (2,6) | (6,{4,5}) | 21 | 56 | 77=F3(2,{4,5,6}) |
| (3,{2,4,5}) | (3,2) | (2,{4,5}) | 19 | 69 | 88 |
| (3,4) | (4,{2,5}) | 5 | 47 | 52=F3(3,{2,4,5}) |
| (3,5) | (5,{2,4}) | 10 | 54 | 64 |
| (3,{2,4,6}) | (3,2) | (2,{4,6}) | 19 | 75 | 94 |
| (3,4) | (4,{2,6}) | 5 | 50 | 55=F3(3,{2,4,6}) |
| (3,6) | (6,{2,4}) | 15 | 64 | 79 |
| (3,{2,5,6}) | (3,2) | (2,{5,6}) | 19 | 78 | 97 |
| (3,5) | (5,{2,6}) | 10 | 52 | 62=F3(3,{2,5,6}) |
| (3,6) | (6,{2,5}) | 15 | 51 | 66 |
| (3,{4,5,6}) | (3,4) | (4,{5,6}) | 5 | 73 | 78 |
| (3,5) | (5,{4,6}) | 10 | 72 | 82 |
| (3,6) | (6,{4,5}) | 15 | 56 | 71=F3(3,{4,5,6}) |
| (4,{2,3,5}) | (4,2) | (2,{3,5}) | 32 | 59 | 91 |
| (4,3) | (3,{2,5}) | 4 | 49 | 53 |
| (4,5) | (5,{2,3}) | 8 | 42 | 50=F3(4,{2,3,5}) |
| (4,{2,3,6}) | (4,2) | (2,{3,6}) | 32 | 60 | 92 |
| (4,3) | (3,{2,6}) | 4 | 49 | 53=F3(4,{2,3,6}) |
| (4,6) | (6,{2,3}) | 16 | 47 | 63 |
| (4,{2,5,6}) | (4,2) | (2,{5,6}) | 32 | 78 | 110 |
| (4,5) | (5,{2,6}) | 8 | 52 | 60=F3(4,{2,5,6}) |
| (4,6) | (6,{2,5}) | 16 | 51 | 67 |
| (4,{3,5,6}) | (4,3) | (3,{5,6}) | 4 | 72 | 76 |
| (4,5) | (5,{3,6}) | 8 | 57 | 65 |
| (4,6) | (6,{3,5}) | 16 | 46 | 62=F3(4,{3,5,6}) |
| (5,{2,3,4}) | (5,2) | (2,{3,4}) | 27 | 57 | 84 |
| (5,3) | (3,{2,4}) | 11 | 49 | 60 |
| (5,4) | (4,{2,3}) | 10 | 34 | 44=F3(5,{2,3,4}) |
| (5,{2,3,6}) | (5,2) | (2,{3,6}) | 27 | 60 | 87 |
| (5,3) | (3,{2,6}) | 11 | 49 | 60=F3(5,{2,3,6}) |
| (5,6) | (6,{2,3}) | 18 | 47 | 65 |
| (5,{2,4,6}) | (5,2) | (2,{4,6}) | 27 | 75 | 102 |
| (5,4) | (4,{2,6}) | 10 | 50 | 60=F3(5,{2,4,6}) |
| (5,6) | (6,{2,4}) | 18 | 64 | 82 |
| (5,{3,4,6}) | (5,3) | (3,{4,6}) | 11 | 69 | 80 |
| (5,4) | (4,{3,6}) | 10 | 55 | 65=F3(5,{3,4,6}) |
| (5,6) | (6,{3,4}) | 18 | 47 | 65=F3(5,{3,4,6}) |
| (6,{2,3,4}) | (6,2) | (2,{3,4}) | 22 | 57 | 79 |
| (6,3) | (3,{2,4}) | 16 | 49 | 65 |
| (6,4) | (4,{2,3}) | 20 | 34 | 54=F3(6,{2,3,4}) |
| (6,{2,3,5}) | (6,2) | (2,{3,5}) | 22 | 59 | 81 |
| (6,3) | (3,{2,5}) | 16 | 49 | 65 |
| (6,5) | (5,{2,3}) | 12 | 42 | 54=F3(6,{2,3,5}) |
| (6,{2,4,5}) | (6,2) | (2,{4,5}) | 22 | 69 | 91 |
| (6,4) | (4,{2,5}) | 20 | 47 | 67 |
| (6,5) | (5,{2,4}) | 12 | 54 | 66=F3(6,{2,4,5}) |
| (6,{3,4,5}) | (6,3) | (3,{4,5}) | 16 | 54 | 70 |
| (6,4) | (4,{3,5}) | 20 | 42 | 62 |
| (6,5) | (5,{3,4}) | 12 | 37 | 49=F3(6,{3,4,5}) |

（5）k=2时，F2(i,S2) = min{D[i,j] + F3(j,S3)} i=2,3,4,5,6

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| X2=(i,S2) | U2=(i,j) | X3=(j,S3) | V2=D[i,j] | F3(j,S3) | V2 + F3(j,S3) |
| (2,{3,4,5,6}) | (2,3) | (3,{4,5,6}) | 18 | 71 | 89 |
| (2,4) | (4,{3,5,6}) | 30 | 62 | 92 |
| (2,5) | (5,{3,4,6}) | 25 | 65 | 90 |
| (2,6) | (6,{3,4,5}) | 21 | 49 | 70=F2(2,{3,4,5,6}) |
| (3,{2,4,5,6}) | (3,2) | (2,{4,5,6}) | 19 | 77 | 96 |
| (3,4) | (4,{2,5,6}) | 5 | 60 | 65=F2(3,{2,4,5,6}) |
| (3,5) | (5,{2,4,6}) | 10 | 60 | 70 |
| (3,6) | (6,{2,4,5}) | 15 | 66 | 81 |
| (4,{2,3,5,6}) | (4,2) | (2,{3,5,6}) | 32 | 67 | 99 |
| (4,3) | (3,{2,5,6}) | 4 | 62 | 66=F2(4,{2,3,5,6}) |
| (4,5) | (5,{2,3,6}) | 8 | 60 | 68 |
| (4,6) | (6,{2,3,5}) | 16 | 54 | 70 |
| (5,{2,3,4,6}) | (5,2) | (2,{3,4,6}) | 27 | 68 | 95 |
| (5,3) | (3,{2,4,6}) | 11 | 55 | 66 |
| (5,4) | (4,{2,3,6}) | 10 | 53 | 63=F2(5,{2,3,4,6}) |
| (5,6) | (6,{2,3,4}) | 18 | 54 | 72 |
| (6,{2,3,4,5}) | (6,2) | (2,{3,4,5}) | 22 | 62 | 84 |
| (6,3) | (3,{2,4,5}) | 16 | 52 | 68 |
| (6,4) | (4,{2,3,5}) | 20 | 50 | 70 |
| (6,5) | (5,{2,3,4}) | 12 | 44 | 56=F2(6,{2,3,4,5}) |

（6）k=1时，F1(1,S1) = min{D[1,j] + F2(j,S2)}

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| X1=(1,S1) | U1=(1,j) | X2=(j,S2) | V1=D[1,j] | F2(j,S2) | V1 + F2(j,S2) |
| (1,{2,3,4,5,6}) | (1,2) | (2,{3,4,5,6}) | 10 | 70 | 80=F1(1,{2,3,4,5,6}) |
| (1,3) | (3,{2,4,5,6}) | 20 | 65 | 85 |
| (1,4) | (4,{2,3,5,6}) | 30 | 66 | 96 |
| (1,5) | (5,{2,3,4,6}) | 40 | 63 | 103 |
| (1,6) | (6,{2,3,4,5}) | 50 | 56 | 106 |

**3、伪代码和时间复杂度**

为方便计算，结点编号改为0到5.

(1)用一张二维表格F[][]表示F(i,Sk)，行数是n，列数是2n-1。

(2)行号表示当前所在的结点i。

列号对应的五位二进制表示表示{V5,V4,V3,V2,V1}的一个子集，1表示在集合中，0表示不在集合中。

例如：00110表示的集合为{V3,V2}，00000表示空集

(3)再用一张n\*2n-1的表格M[][]存储对应每个状态(i，Sk)所做的最优决策，以便回溯找最短路线。

**伪代码：**

TSP(int D[][]，int n)

//输入n个顶点的有向图，矩阵D[][]是有向图的邻接矩阵

//D[][]是原图的邻接矩阵

//F[][]中存储阶段最短路径，M[][]中存储阶段最优策略, 行数是n，列数是2n-1

//找到从V0出发，遍历所有城市一次且仅一次再回到V0的最短路径长度

//并输出最短路径

{

for(i=0; i<n; i++)

F[i][0] = D[i][0]; //初始化第0列，F6(i，Φ)= D[i,0]

for(i=1; i<2n-1-1; i++) //列

for(j=1; j<n; j++) //行

if(j不在i的二进制表示对应的集合中)

对于i对应集合中的每一个点k

{

计算D[j][k]+F[k][i-2k-1]并选择使之取得最小值min的k\*;

F[k][i] = min ; //填表，记录阶段最优值

M[k][i] = k\* ; //记录每个状态的最优决策k\*

}

//i==2n-1-1 时

对于i中的每个节点k

计算D[0][k] + F[k][ [i-2k-1]并选择使之取得最小值min的k\*

F[0][ 2n-1-1] = min; //总最短路径

M[0][ 2n-1-1] = k\*;

//回溯查表M输出最短路径

输出V0

for(2n-1-1,j=0; i>0; )

{

j = M[j][i];//下一步去往哪个结点

i = i –2j-1;//从i表示的集合中删除j

输出Vj

}

}

考虑算法中所做的加法和比较次数:

+ (n-1) = (n-1)(n-2)2n-3 + (n-1) = O(n22n)