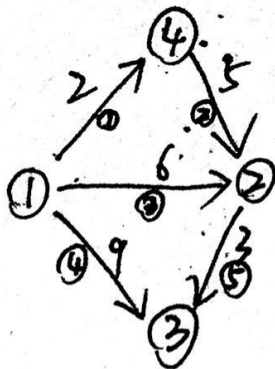


Proj_4-1 :

- 1. 分别用线性规划模型 SPM1 和整数规划模型 SPM2 建模单源单宿最短路问题。
用 Lingo 软件求解这两个模型，比较求解时间和求解的结果。

网络模型：

4个节点, 5个边, 从 1 → 3



Node-Arc incidence matrix

节点: 1 2 3 4

边: ① ② ③ ④ ⑤

权重c: 2 5 6 9 3

$$\begin{bmatrix} 1 & 0 & 1 & 1 & 0 \\ 0 & -1 & -1 & 0 & 1 \\ 0 & 0 & 0 & -1 & -1 \\ -1 & 1 & 0 & 0 & 0 \end{bmatrix}$$

SPM1 建模求解：

过程：

SPM 1:

$$\text{minimize } CX = \sum_{i=1}^5 c_i x_i$$

Subject to:

$$Nx = b \quad x \geq 0$$

$$\begin{aligned} & \text{求 } 2x_1 + 5x_2 + 6x_3 + 9x_4 + 3x_5 \text{ 最小} \\ & \Rightarrow \begin{cases} x_1 + x_3 + x_4 = 1 \\ -x_2 - x_3 + x_5 = 0 \\ -x_4 - x_5 = -1 \\ -x_1 + x_2 = 0 \\ x_1 \geq 0, x_2 \geq 0, x_3 \geq 0, x_4 \geq 0 \end{cases} \end{aligned}$$

输入：

```

LINGO Model - SPM1

model:
min=2*x1+5*x2+6*x3+9*x4+3*x5;
x1+x3+x4=1;
-x2-x3+x5=0;
-x4-x5=-1;
-x1+x2=0;
x1>=0;
x2>=0;
x3>=0;
x4>=0;
x5>=0;
end

```

结果：

LINGO 11.0 Solver Status [SPM1]

Solver Status	
Model	LP
State	Global Opt
Objective:	9
Infeasibility:	0
Iterations:	0

Variables	
total:	5
nonlinear:	0
integers:	0

Constraints	
total:	10
nonlinear:	0

Nonzeros	
total:	20
nonlinear:	0

Generator Memory Used (K)	
	19

Elapsed Runtime (hh:mm:ss)	
	00:00:00

Extended Solver Status	
Solver	. . .
Best	. . .
Obj Bound:	. . .
Steps:	. . .
Active:	. . .

Update

Solution Report - SPM1

Global optimal solution found.

Objective value:	9.000000
Infeasibilities:	0.000000
Total solver iterations:	0

Variable	Value	Reduced Cost
X1	0.000000	0.000000
X2	0.000000	1.000000
X3	0.000000	0.000000
X4	1.000000	0.000000
X5	0.000000	0.000000

Row	Slack or Surplus	Dual Price
1	9.000000	-1.000000
2	0.000000	0.000000
3	0.000000	6.000000
4	0.000000	9.000000
5	0.000000	2.000000
6	0.000000	0.000000
7	0.000000	0.000000
8	0.000000	0.000000
9	1.000000	0.000000
10	0.000000	0.000000

SPM2 :

再 SPM1 的基础上增加整数约束 : (@gin(xi);)
输入 :

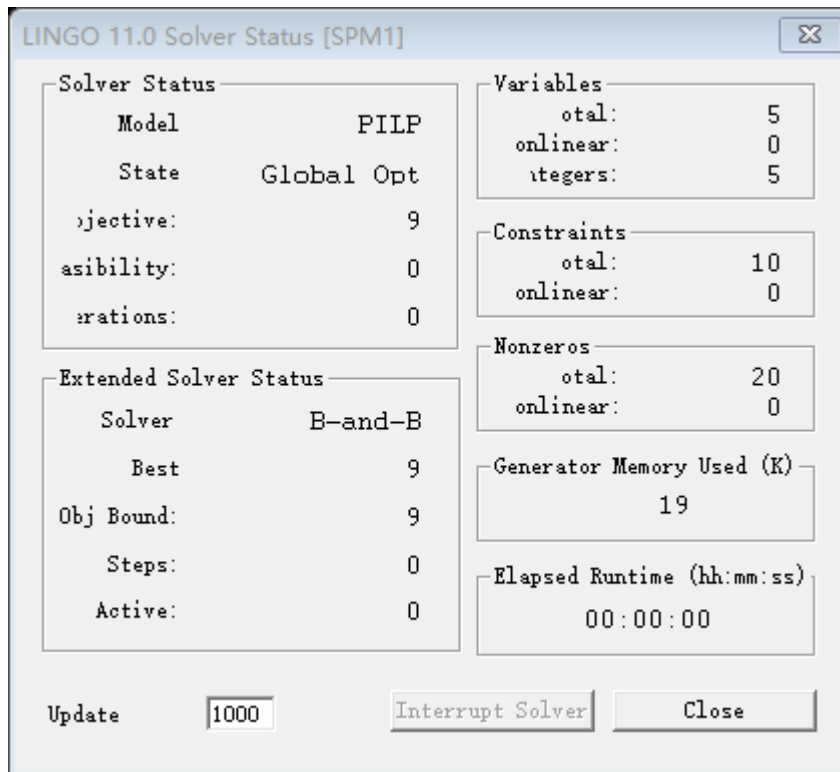
```
model:
min=2*x1+5*x2+6*x3+9*x4+3*x5;
x1+x3+x4=1;
-x2-x3+x5=0;
-x4-x5=-1;
-x1+x2=0;
x1>=0;
x2>=0;
x3>=0;
x4>=0;
x5>=0;
@gin(x1);
@gin(x2);
@gin(x3);
@gin(x4);
@gin(x5);
end
```

结果 :

Global optimal solution found.	
Objective value:	9.000000
Objective bound:	9.000000
Infeasibilities:	0.000000
Extended solver steps:	0
Total solver iterations:	0

Variable	Value	Reduced Cost
X1	0.000000	2.000000
X2	0.000000	5.000000
X3	1.000000	6.000000
X4	0.000000	9.000000
X5	1.000000	3.000000

Row	Slack or Surplus	Dual Price
1	9.000000	-1.000000
2	0.000000	0.000000
3	0.000000	0.000000
4	0.000000	0.000000
5	0.000000	0.000000
6	0.000000	0.000000
7	0.000000	0.000000
8	1.000000	0.000000
9	0.000000	0.000000
10	1.000000	0.000000



结果状态说明与比较：

两个结果虽然都不一样，但是根据网络图我们发现结果都是正确的。Lingo 默认只给出一个最优解。

其次 SPM1 与 SPM2 求解在消耗上可能因为模型相对简单，runtime 太短无法进行时间比较。