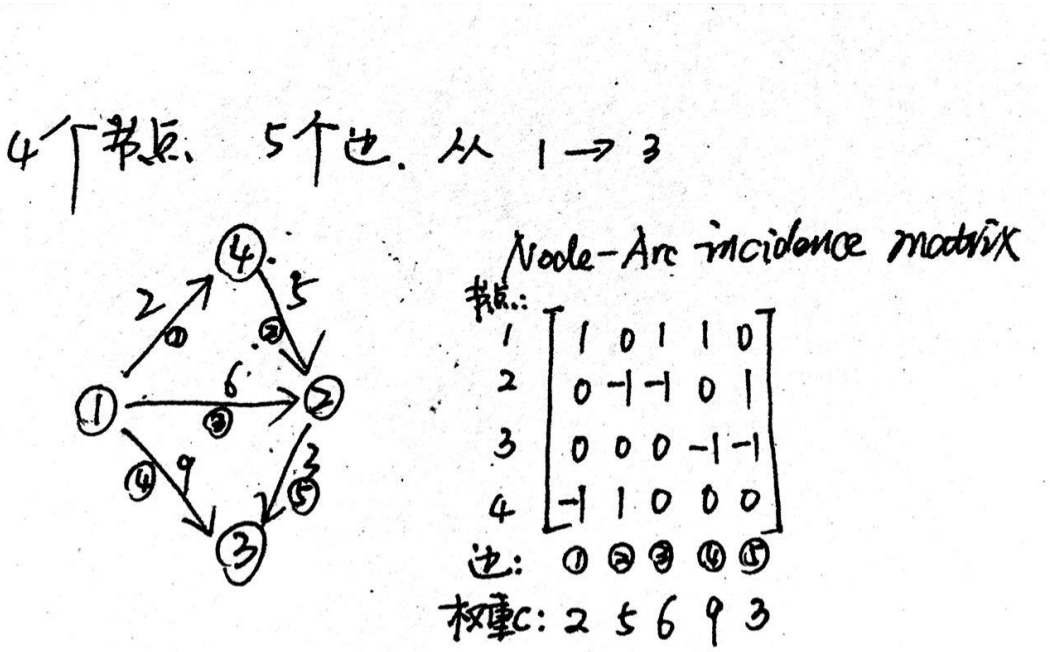
Proj_4-1：

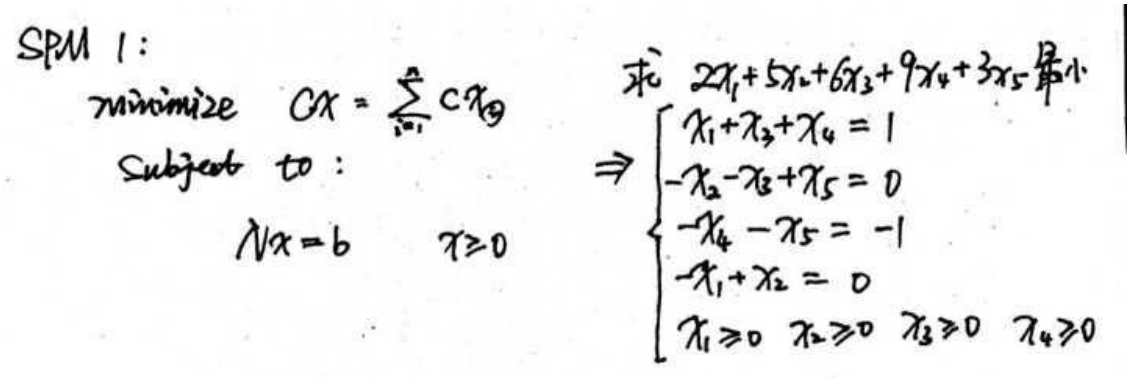
- 1．分别用线性规划模型 SPM1 和整数规划模型 SPM2 建模单源单宿最短路问题。用 Lingo 软件求解这两个模型，比较求解时间和求解的结果。

网络模型：



SPM1 建模求解：

过程：

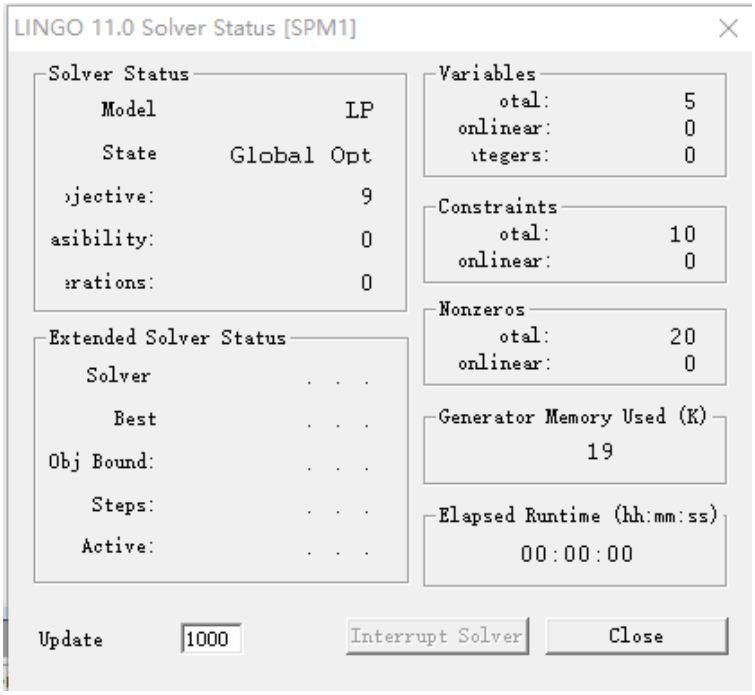


输入：

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：



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：

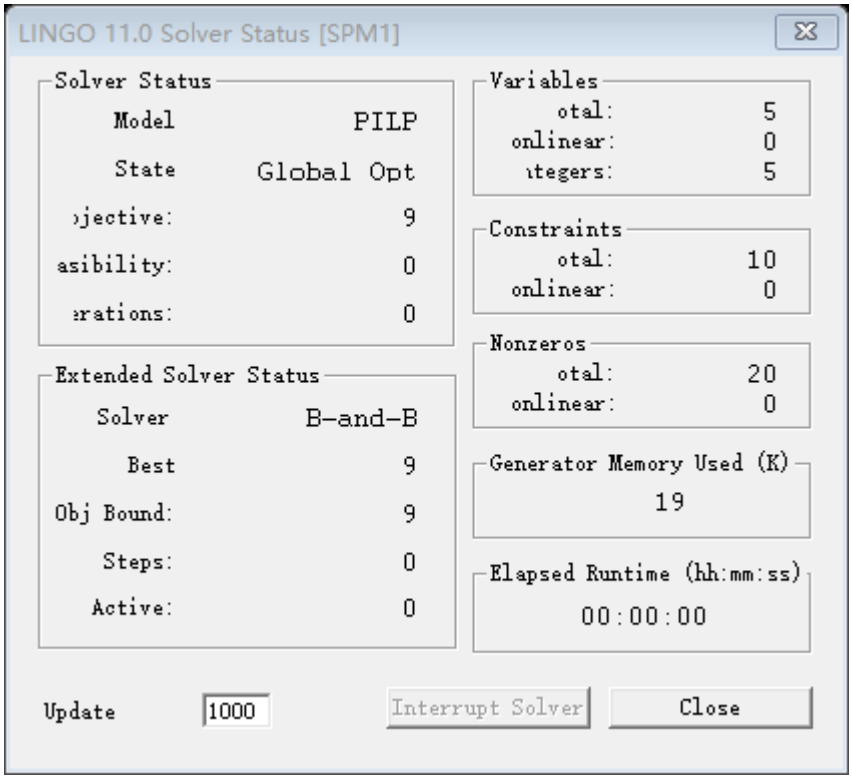
```
model:
min=2*x1+5*x2+6*x3+9*x4+3*x5;
x1+x3+x4=1;
-x2-x3+x5=0;
-x4-x5=-1;
-x1+x2=0;
x1>=0;
x2>=0;
x3>=0;
x4>=0;
x5>=0;
@gin(x1);
@gin(x2);
@gin(x3);
@gin(x4);
@gin(x5);
end
```

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。