实验3：回溯法（地图填色问题）

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Outline

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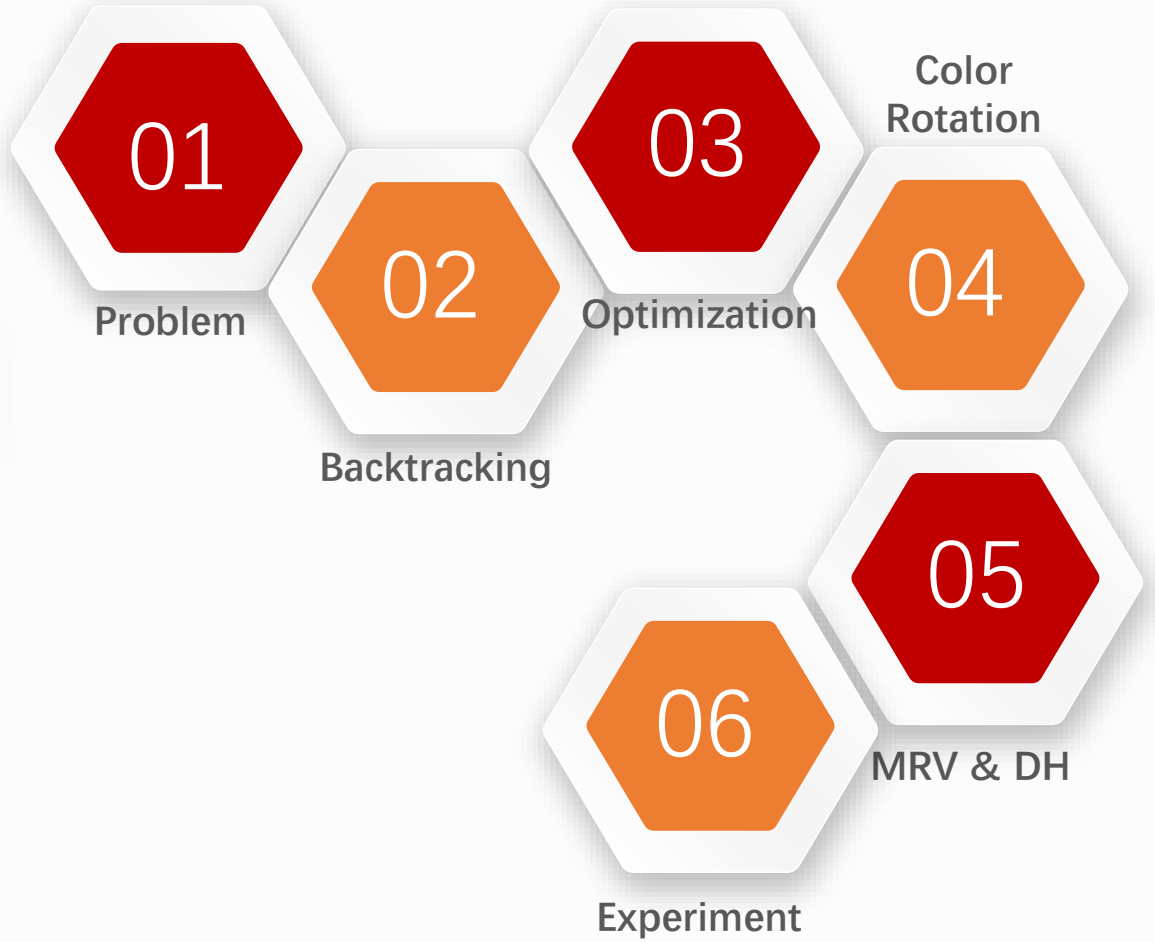
CATALOG



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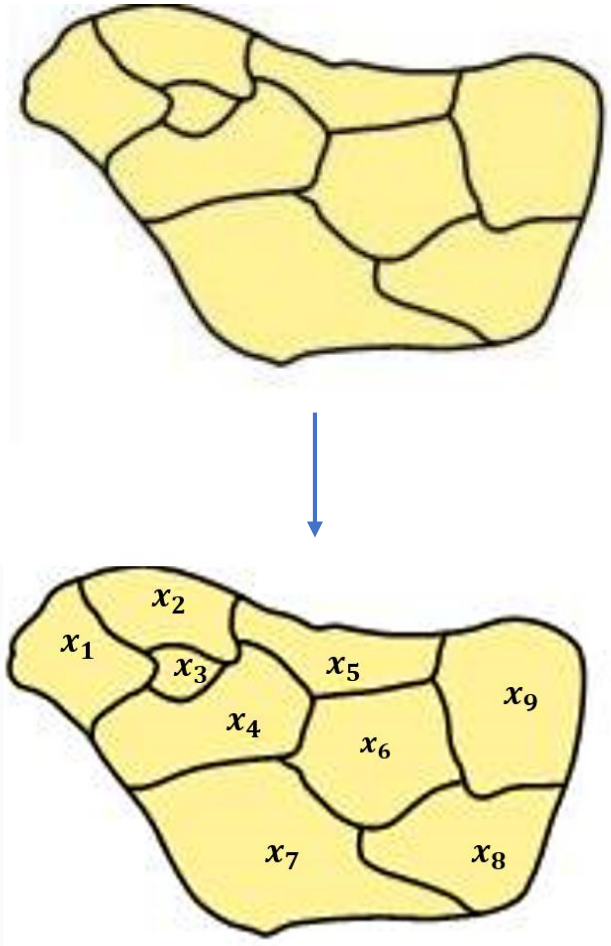
01

PART 01

SECTION 1

Problem

Problem



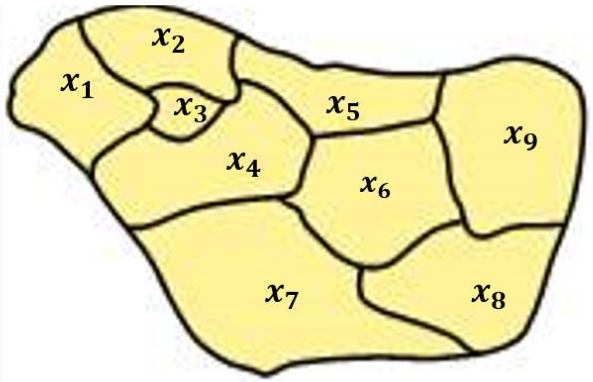
Constraint Satisfaction Problem

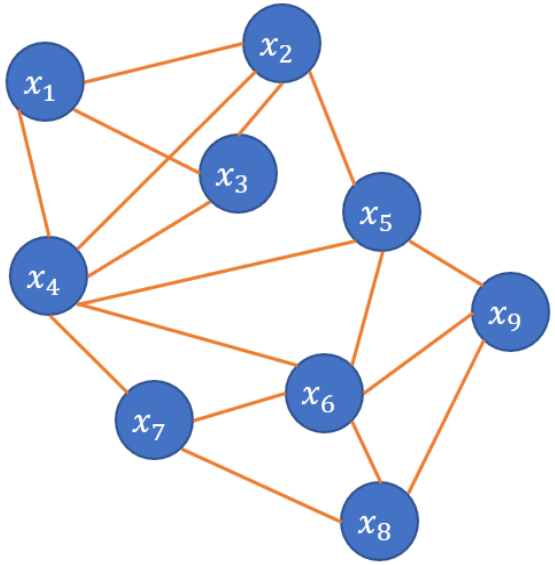
$< X, D, C >$ $\quad X = \{X_1, ..., X_n\}$ $\quad D = \{D_1, ..., D_n\}$

$Y = \{Y_1, ..., Y_n\}$ $\quad Y_i \in D_i$ $\quad$ ***Y Satisfy all constraints in C***

$X = \{X_1, ..., X_9\}$ $\quad D = \{D_1, ..., D_9\}$ $\quad C = \{X_1 \neq X_2, X_1 \neq X_3, \cdots, X_8 \neq X_9\}$

Problem





$$X = \{X_1, ..., X_9\} \quad D = \{D_1, ..., D_9\}$$

$$C = \{X_1 \neq X_2, X_1 \neq X_3, \cdots, X_8 \neq X_9\}$$

02

PART 02

SECTION 2

Backtracking

Backtracking

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- ***Algorithm Process***
- ***Complexity Analysis***
- ***Experiment***
- ***Correctness Test***

Backtracking

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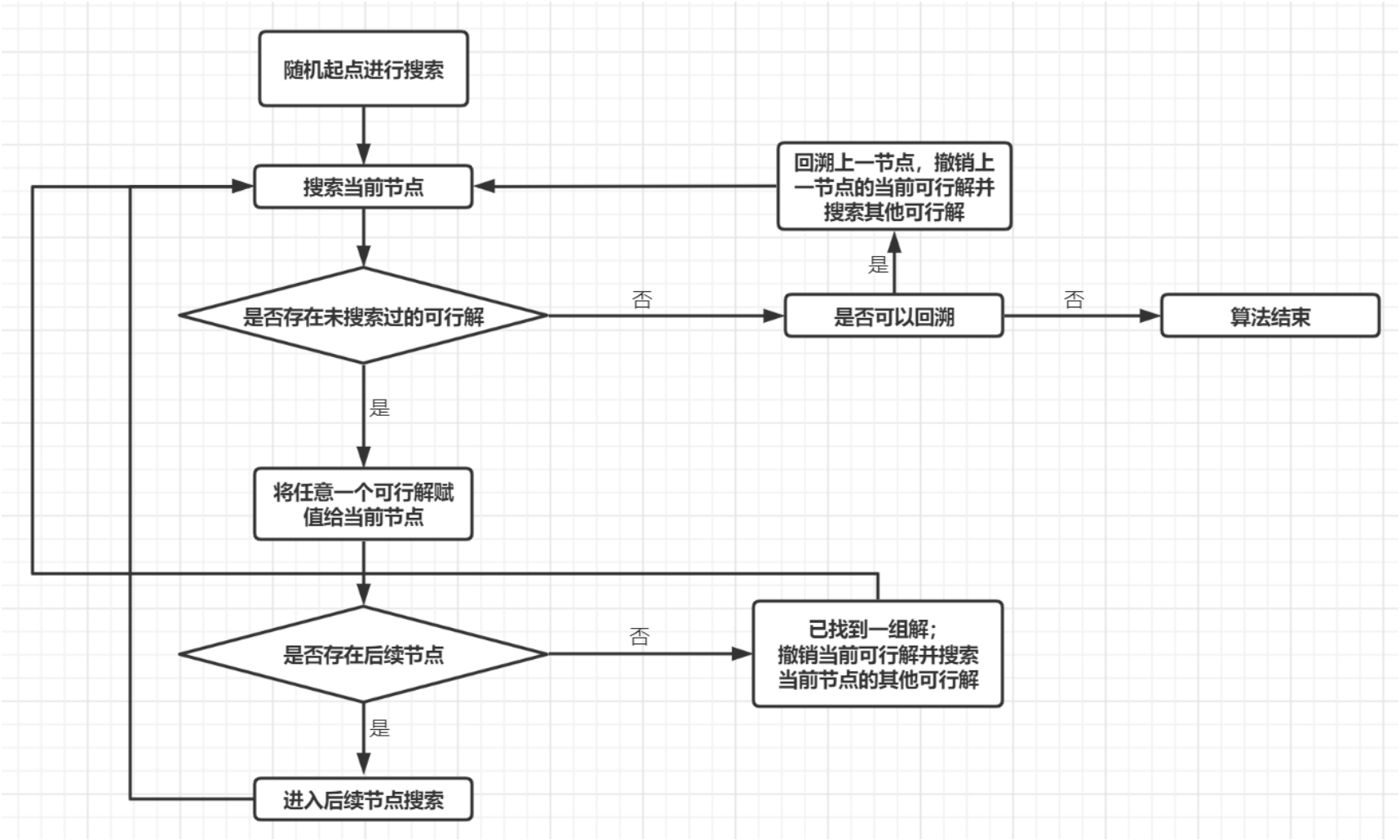
- ***Algorithm Process***



Backtracking

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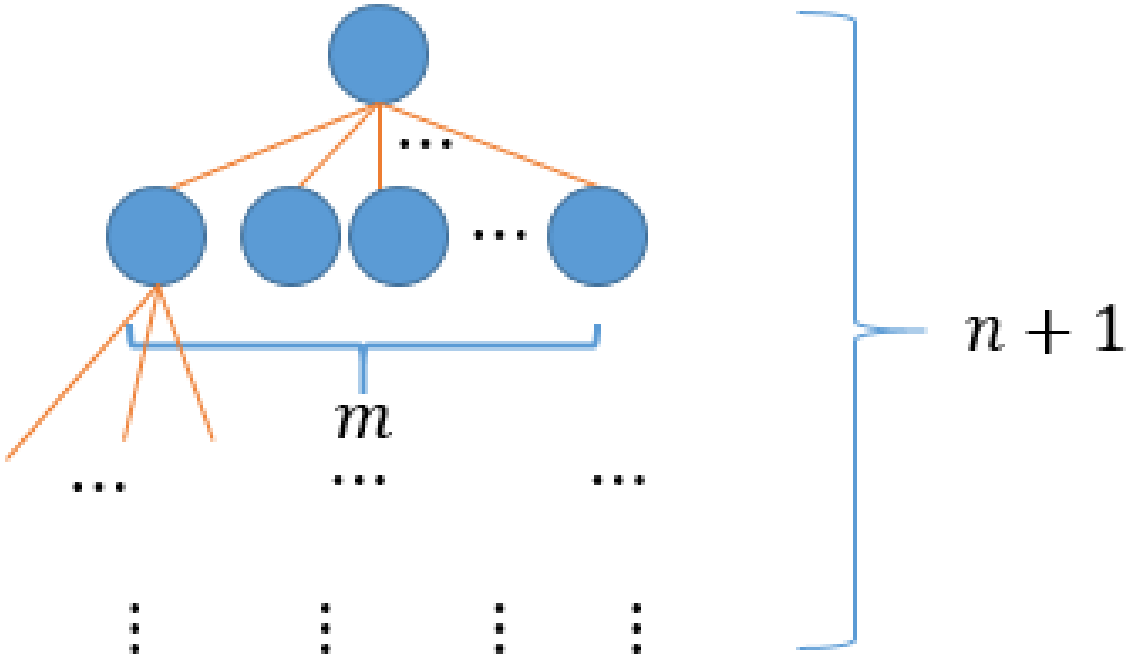
- ***Complexity Analysis*** $O(m^n)$



$$\sum_{i=0}^{n-1} m^i = \frac{1-m^n}{1-m} = \frac{m^n-1}{m-1}$$

Backtracking

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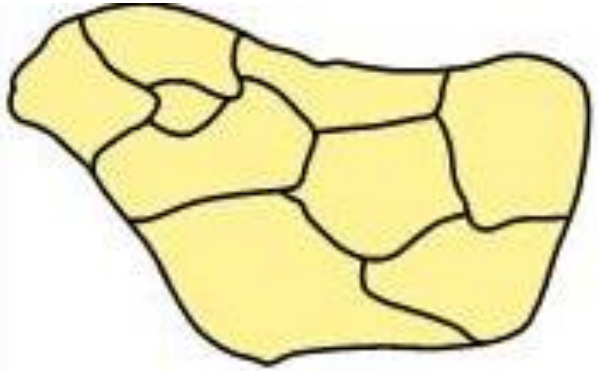
- *Experiment*



地图	平均运行时间(ms)
小规模地图	0.082

- *Correctness Test*

```
for (int i = 1; i <= n; i ++ )
    for (int j = 0; j < edge[i].size(); j ++ )
    {
        int v = edge[i][j];
        if (col[i] == col[v])
        {
            right_test = false;
            break;
        }
    }
```

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03

PART 03

SECTION 3

Optimization

Optimization

- ***DataStructure***
- ***Feasibility***

Optimization

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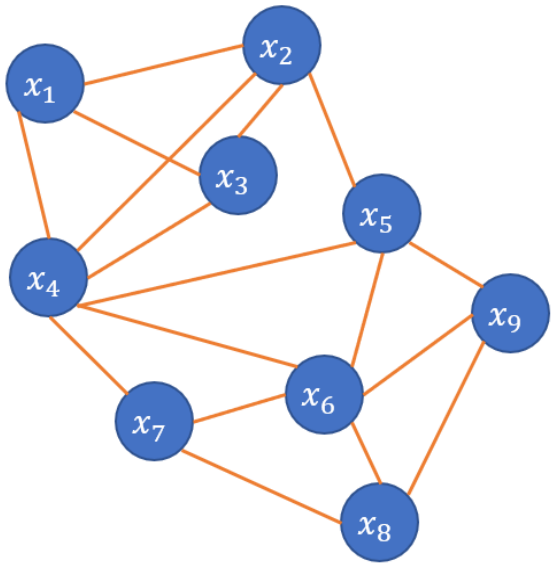
- ***DataStructure***



	0	1	2	3	4	5	6	7	8	9
1	0	1	1	1	0	0	0	0	0	
2	1	0	1	1	1	0	0	0	0	
3	1	1	0	1	0	0	0	0	0	
4	1	1	1	0	1	1	1	0	0	
5	0	1	0	1	0	1	0	0	1	
6	0	0	0	1	1	0	1	1	1	
7	0	0	0	1	0	1	0	1	0	
8	0	0	0	0	0	1	1	0	1	
9	0	0	0	0	1	1	0	1	0	

adjacency matrix

1: 2 3 4
2: 1 3 4 5
3: 1 2 4
4: 1 2 3 5 6 7
5: 2 4 6 9
6: 4 5 7 8 9
7: 4 6 8
8: 6 7 9
9: 5 6 8

adjacency list

Optimization

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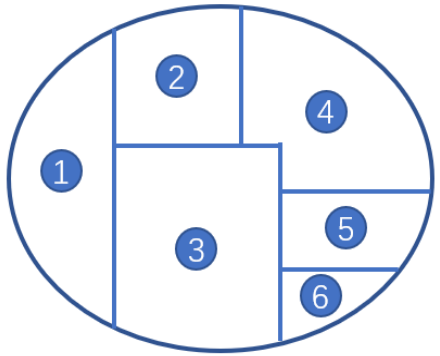
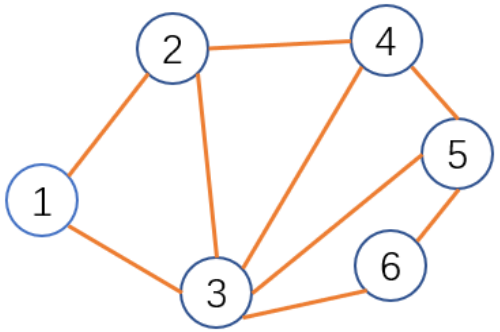
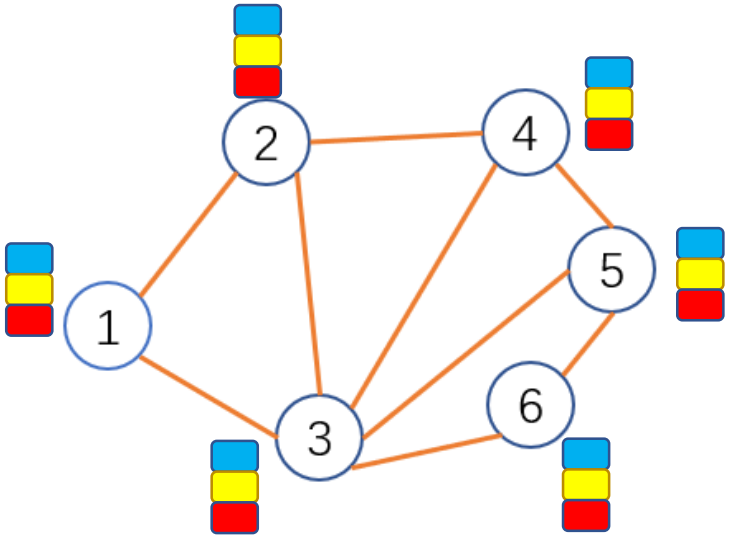
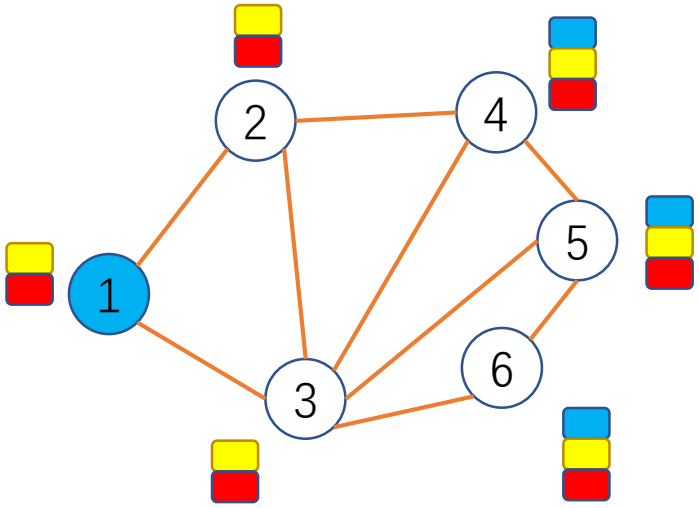
- ***Feasibility***









04

PART 04

SECTION 4

Color Rotation

Color Rotation

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- *Idea*
- *Implement*
- *Experiment*

Color Rotation

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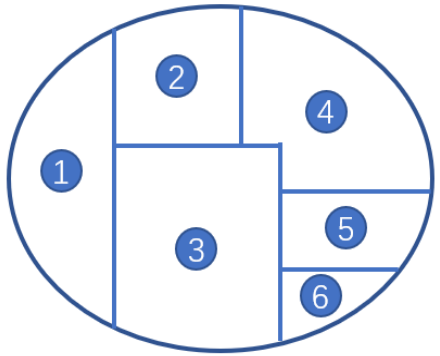
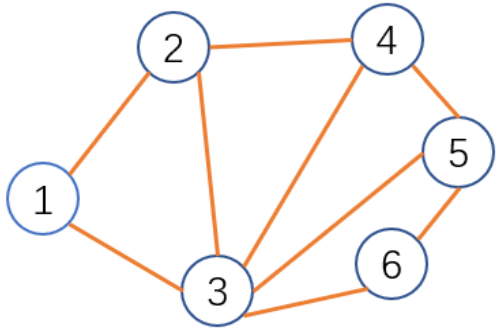
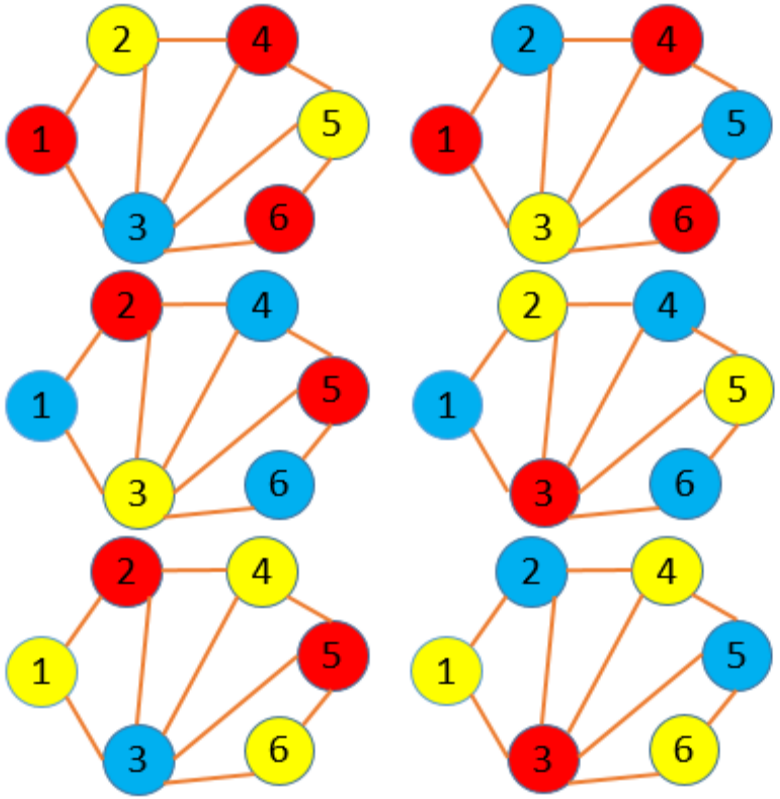
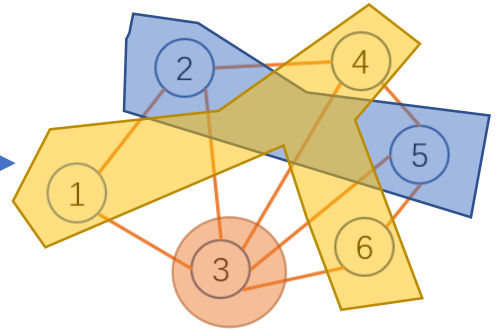
- *Idea*









$1 * 3! = 1 * 6 = 6$

Color Rotation

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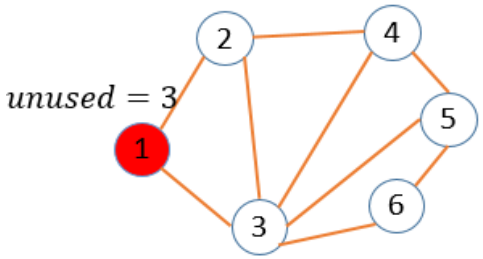
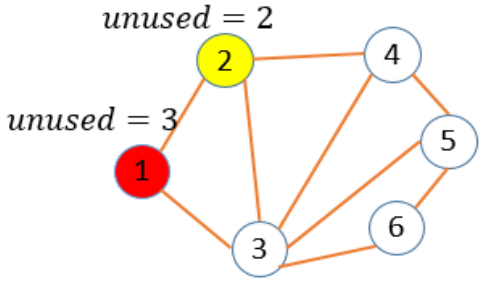
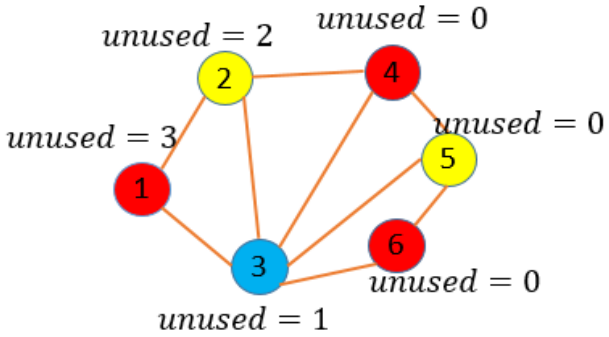
- ***Implement***







$1 \rightarrow n!$

Color Rotation

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- *Experiment*

地图	平均运行时间(ms)
小规模地图	0.016

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05

PART 05

SECTION 5

MRV & DH

MRV & DH

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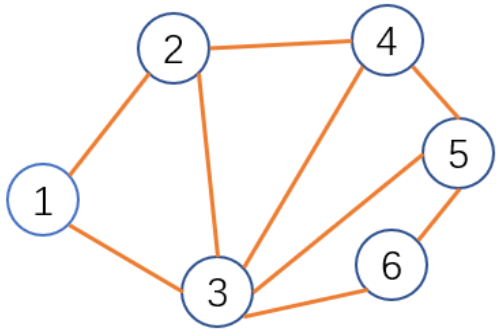
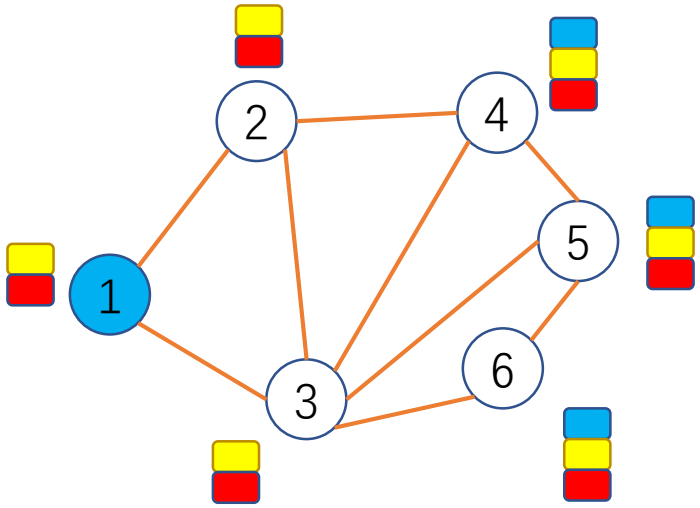
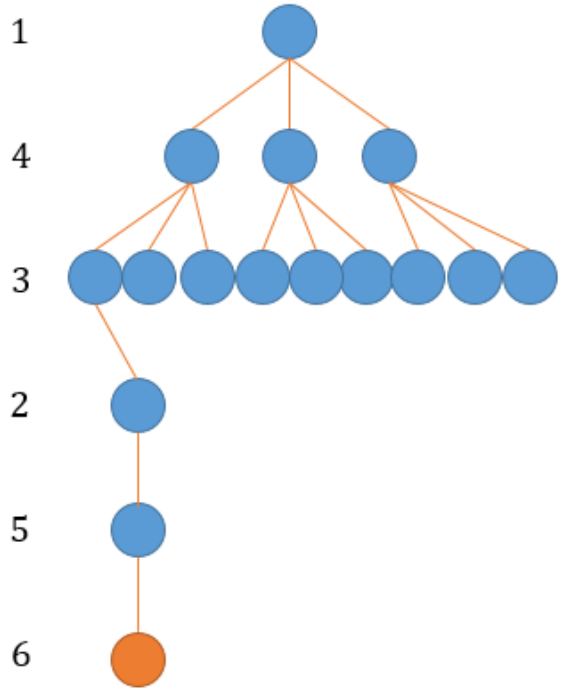
- $MRV - Idea$
- $DH - Idea$
- $Experiment$

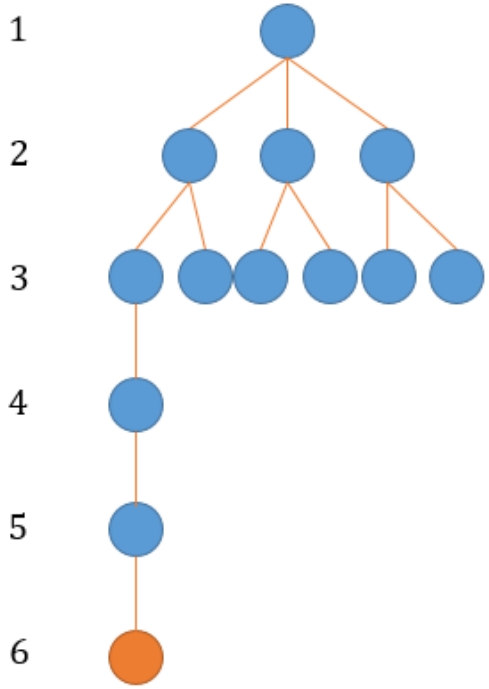
MRV & DH

- ***MRV – Idea***









MRV & DH

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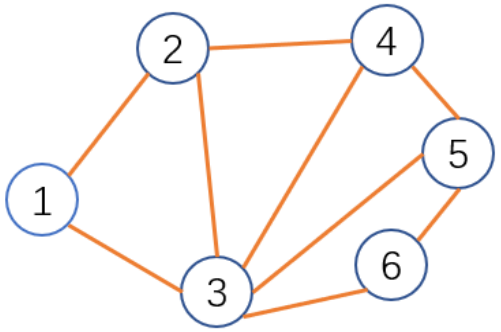
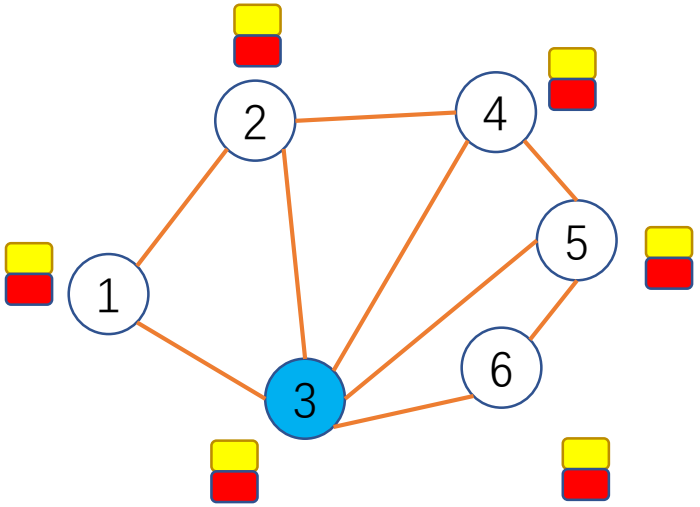
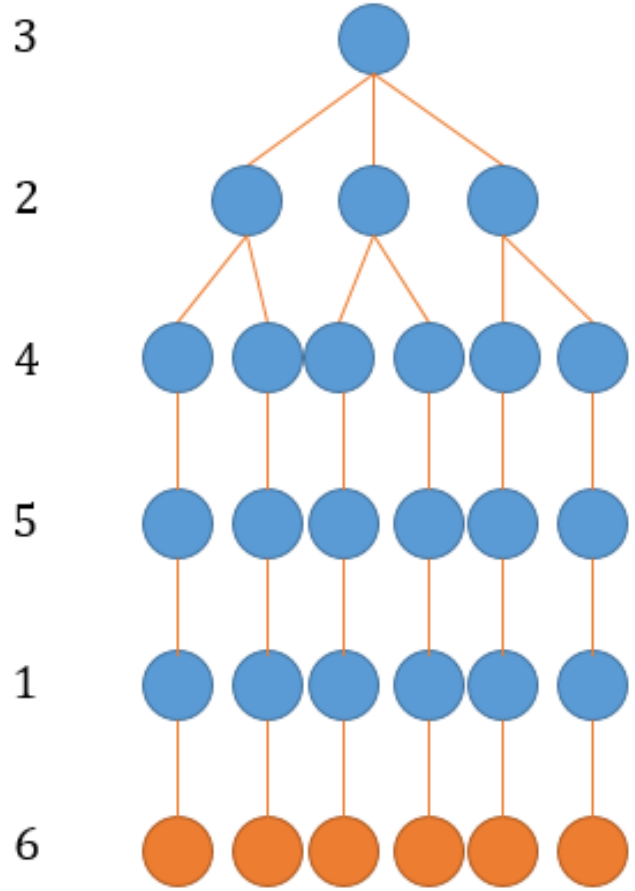
- ***DH – Idea***







MRV & DH

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- *Experiment*

地图	平均运行时间(ms)
小规模地图	0.091
le450_5a	25631.646

地图	1解的平均运行时间(ms)	100w解的平均运行时间(ms)
le450_15b	4.920	590.412
le450_25a	0.665	597.516

06

PART 06

SECTION 6

Experiments

Experiments

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- ***Experiment on given datas***

算法	地图	平均运行时间(ms)	
RV+DH	小规模地图	0.091	
	le450_5a	25631.646	
	le450_15b	4.920	*first solution*
	le450_25a	0.665	
RV+DH+颜色轮询	小规模地图	0.006	
	le450_5a	169.136	
	le450_15b	3.518	*first solution*
	le450_25a	0.523	

Experiments

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- *Experiment on random datas*

数据规模			求解第一个解的平均运行时间（ms）
点数	边数	颜色数	
30	40	4	0.0128
	80	4	0.0143
	120	5	0.025
	160	7	0.0153
	200	7	0.0431
	240	11	0.0172
	280	13	0.0186
	320	15	0.0194
	360	19	0.0198
	400	22	0.0206

Thank You! Questions?

深圳大学计算机与软件学院

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指导老师：李炎然

2022年 5 月 16 日