题目讲解

- Leetcode 207. Course Schedule

图搜索初探

先导课

- 递归 = 递 + 归
- 递归奥义——复制自己
    - 如何造纳米机器人

先导课

- 递归框架
- int robot(int x, int y)　　// 机器人的输入

```
    if（边界条件）                    // 什么时候不用造了（自己就能干完）
        return 0;
    int a = robot(x1, y1);            // 造一个小的自己帮忙干活
    int b =  robot(x2, y2);           // 再造一个小的自己帮忙干活
    return a + b;                     // 自己要做的就是把别人的成果组装起来
```

Leetcode 78

Outline

- 何谓图？
  - 图是描述世间万物关系的一种方式
  - 节点+边
- 隐式图
  - 状态（结点）不确定（明显）
  - 关系（边）不确定（明显）
  - 如何确定状态和关系（重点）

Outline

- 图搜索
  - 深度优先遍历（DFS）
  - 广度优先遍历（BFS）
- 隐式图搜索
  - N皇后问题、骑士游历问题、八数码

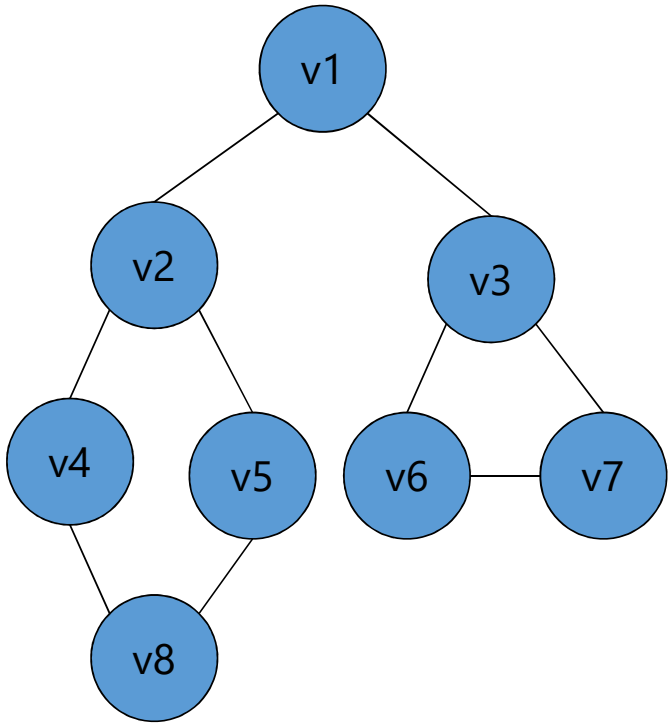
遍历：定义

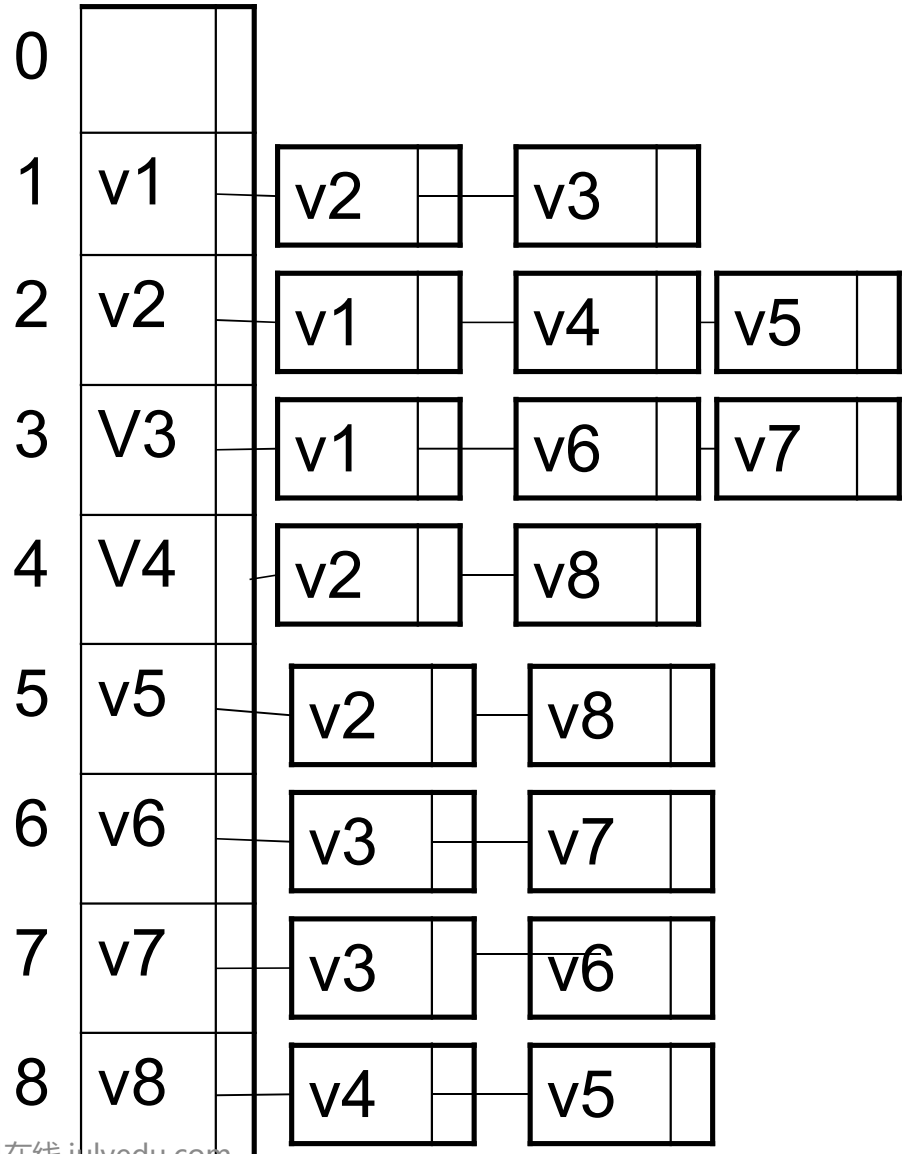
- 按某种顺序访问“图”中所有的节点
- 顺序
  - 深度优先（优先往深处走）
  - 广度优先（优先走最近的）
- 时间复杂度 O(n + m)
- 空间复杂度？

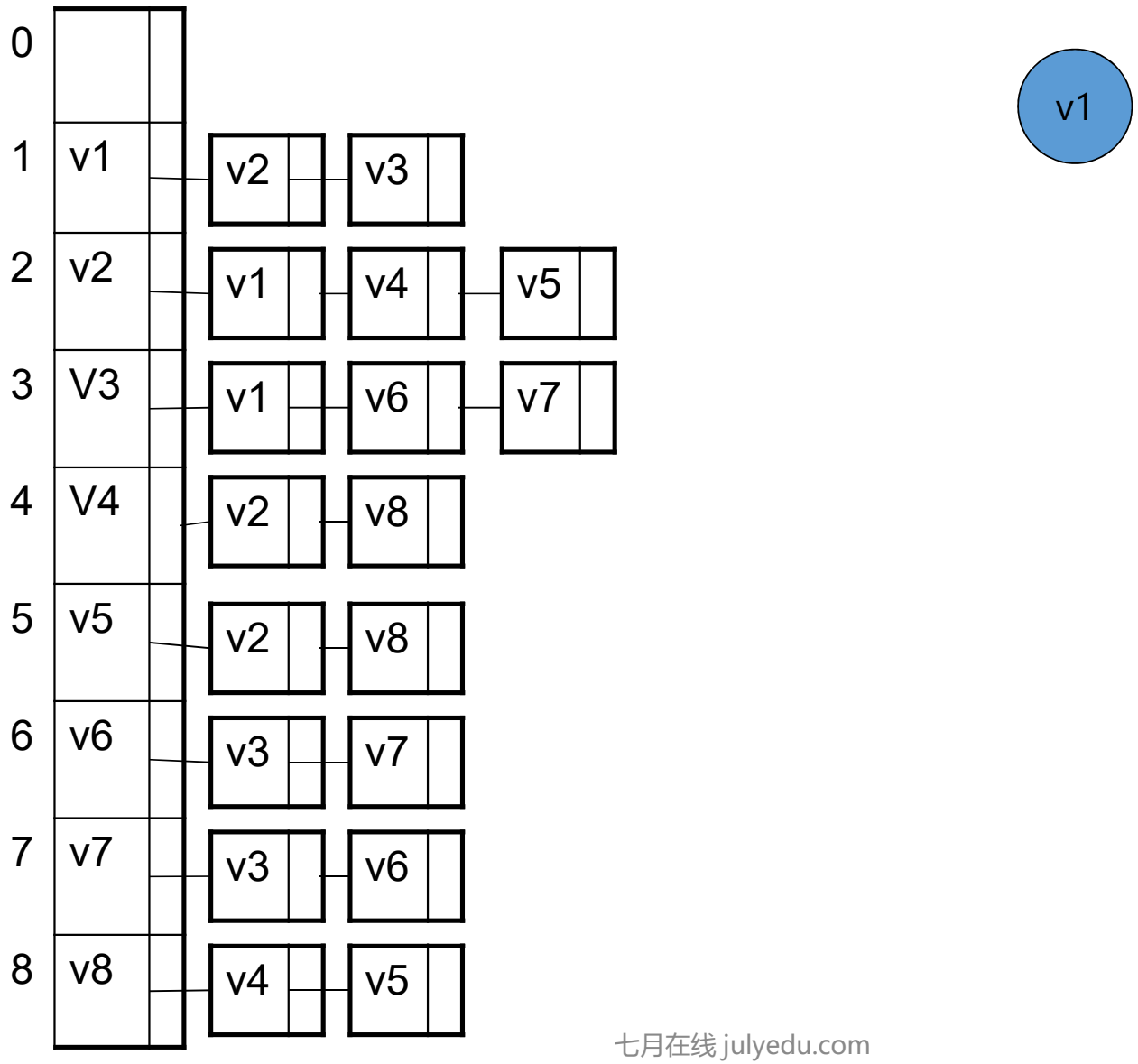
遍历

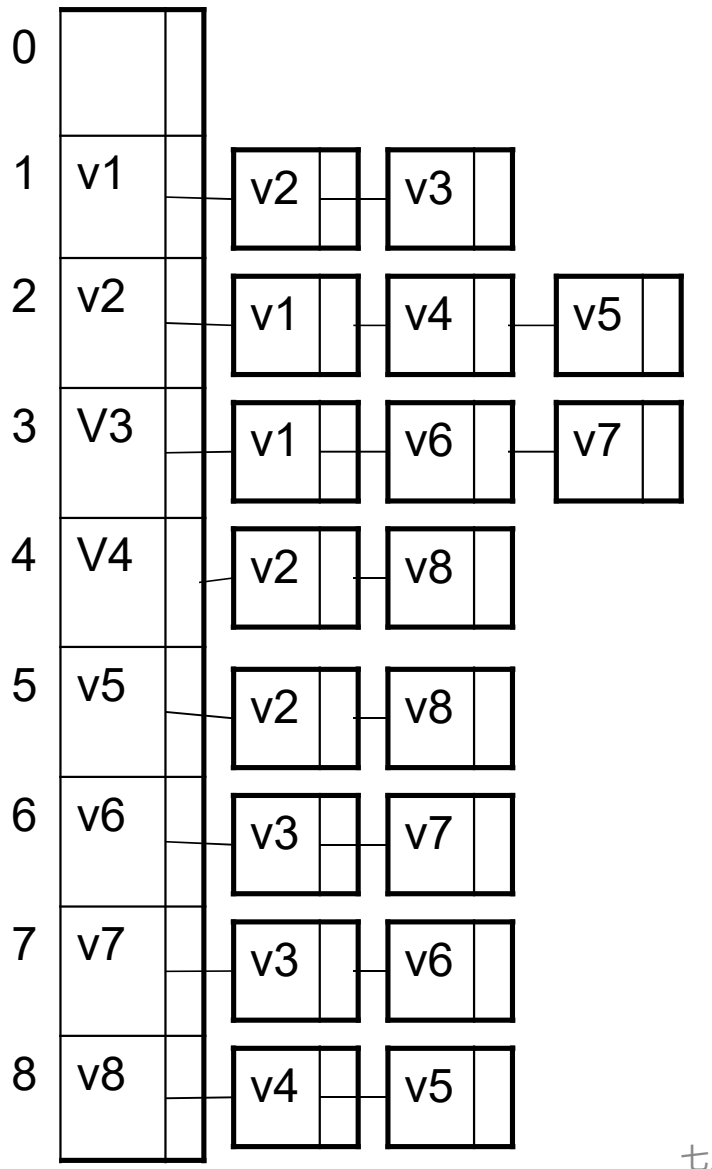
- 给出图G，要求求从入口v1访问到每一个点
- 两种遍历方式的数据结构
  - 栈（递归，深度优先）
  - 队列（广度优先）
- 广度优先找出的路径，经过节点数最少

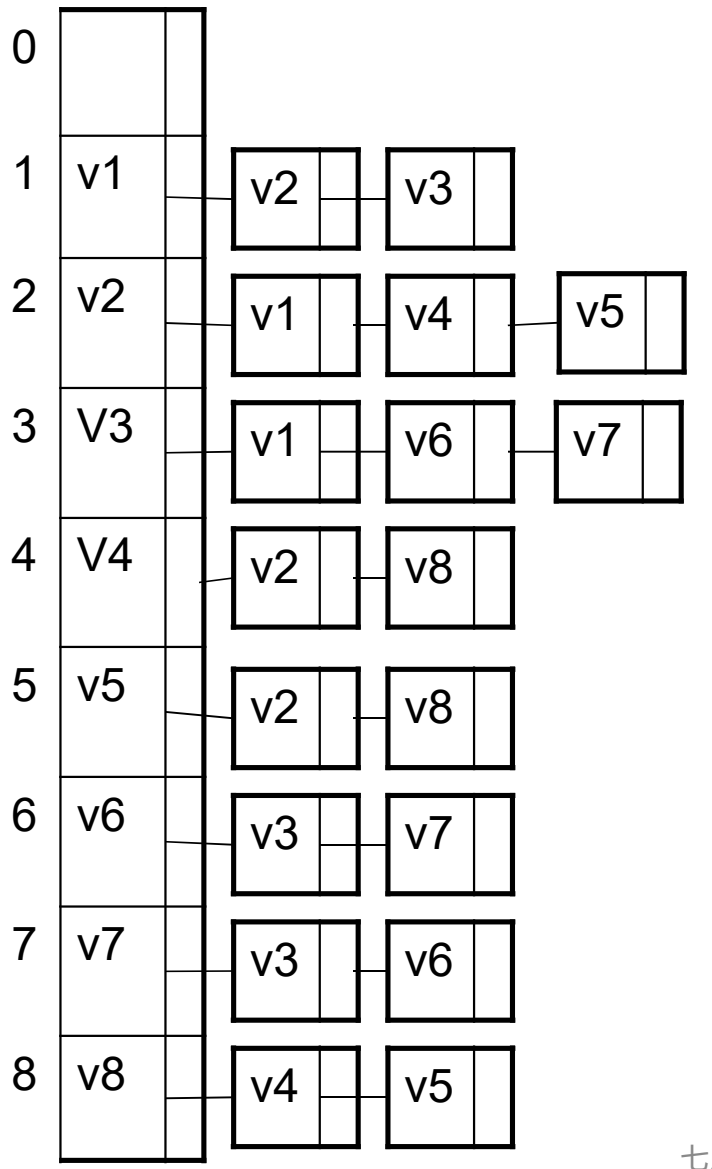
深度优先

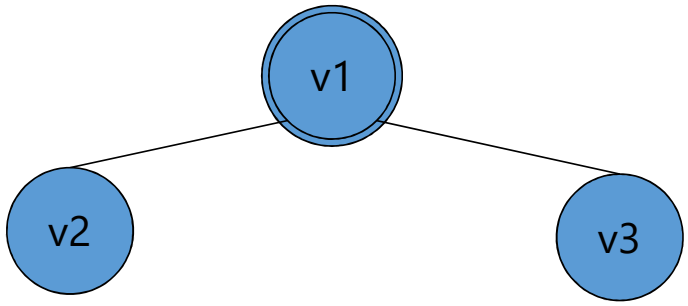


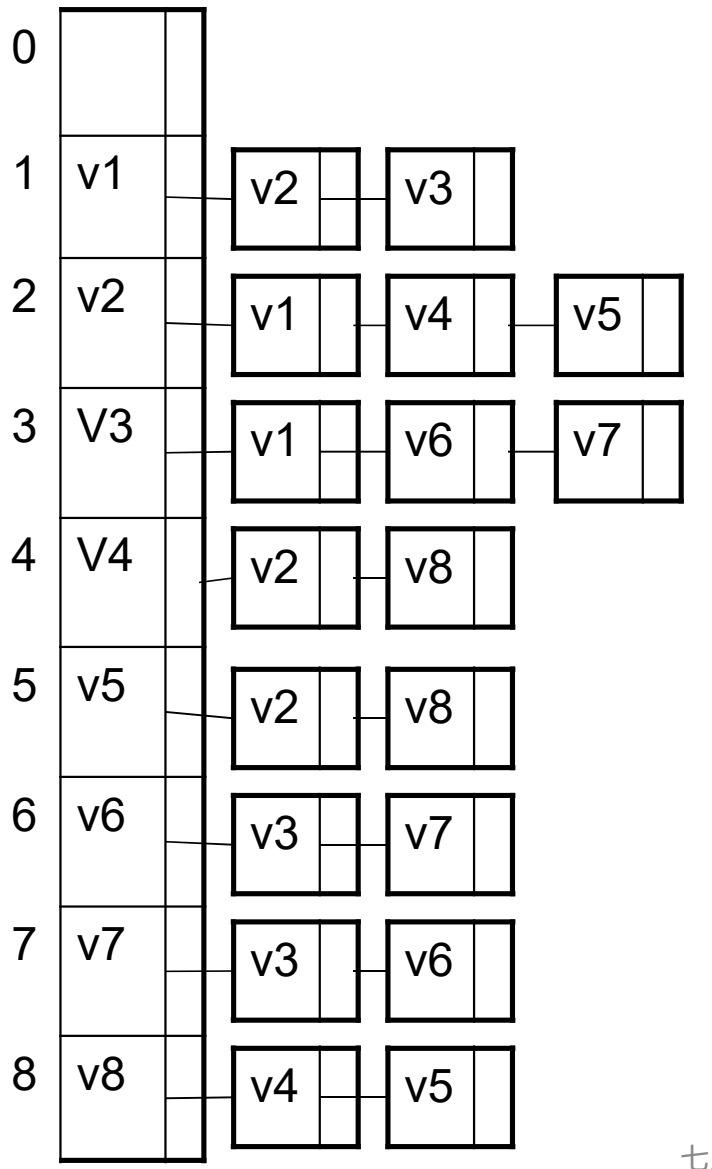


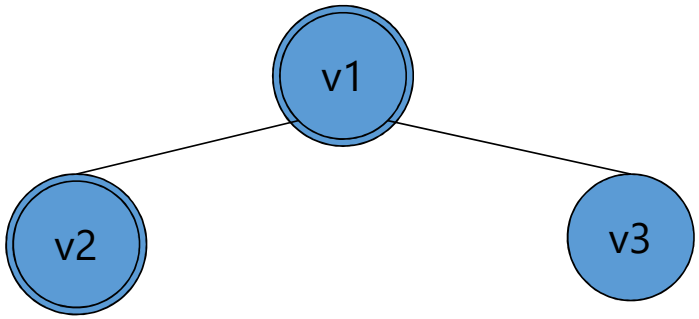


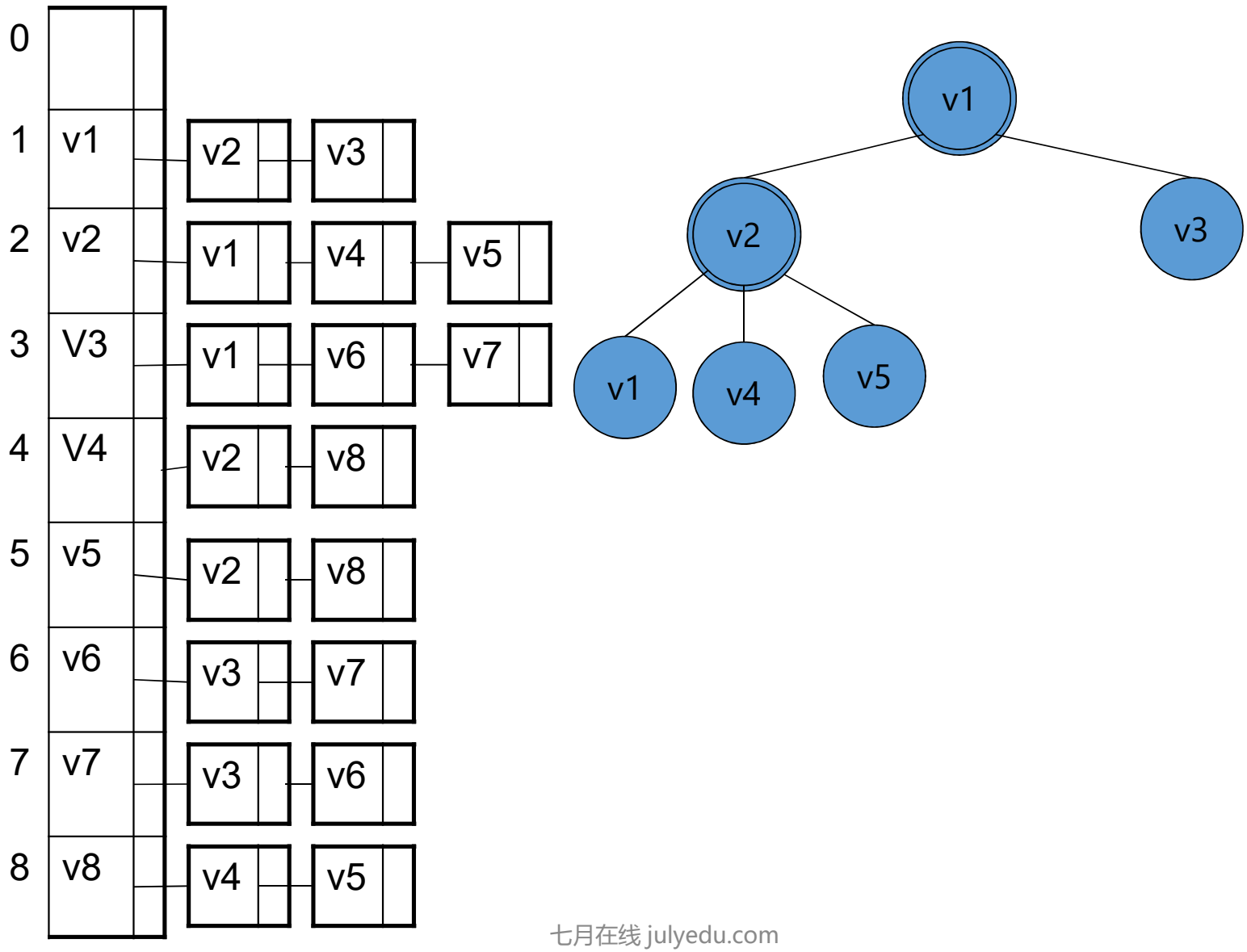


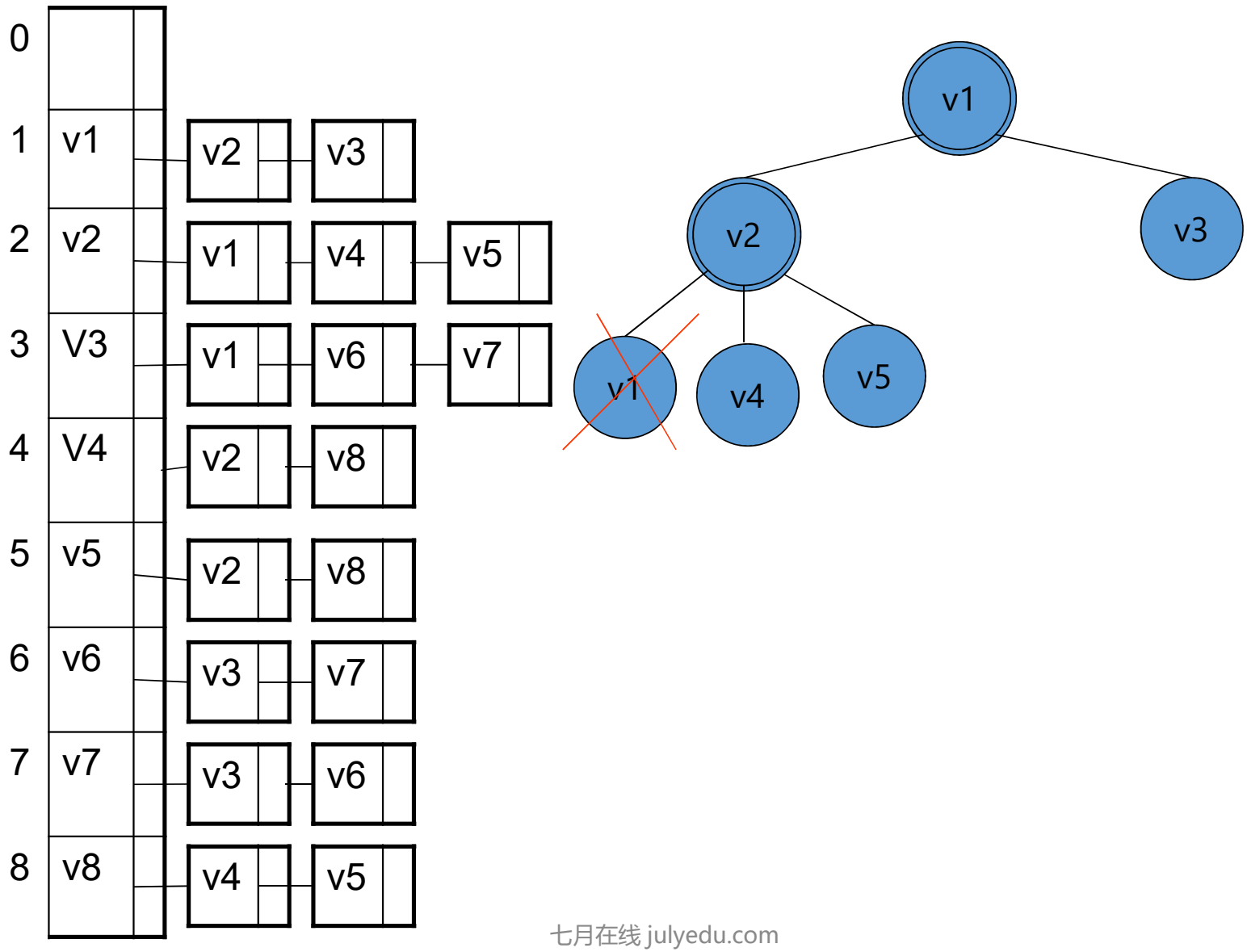


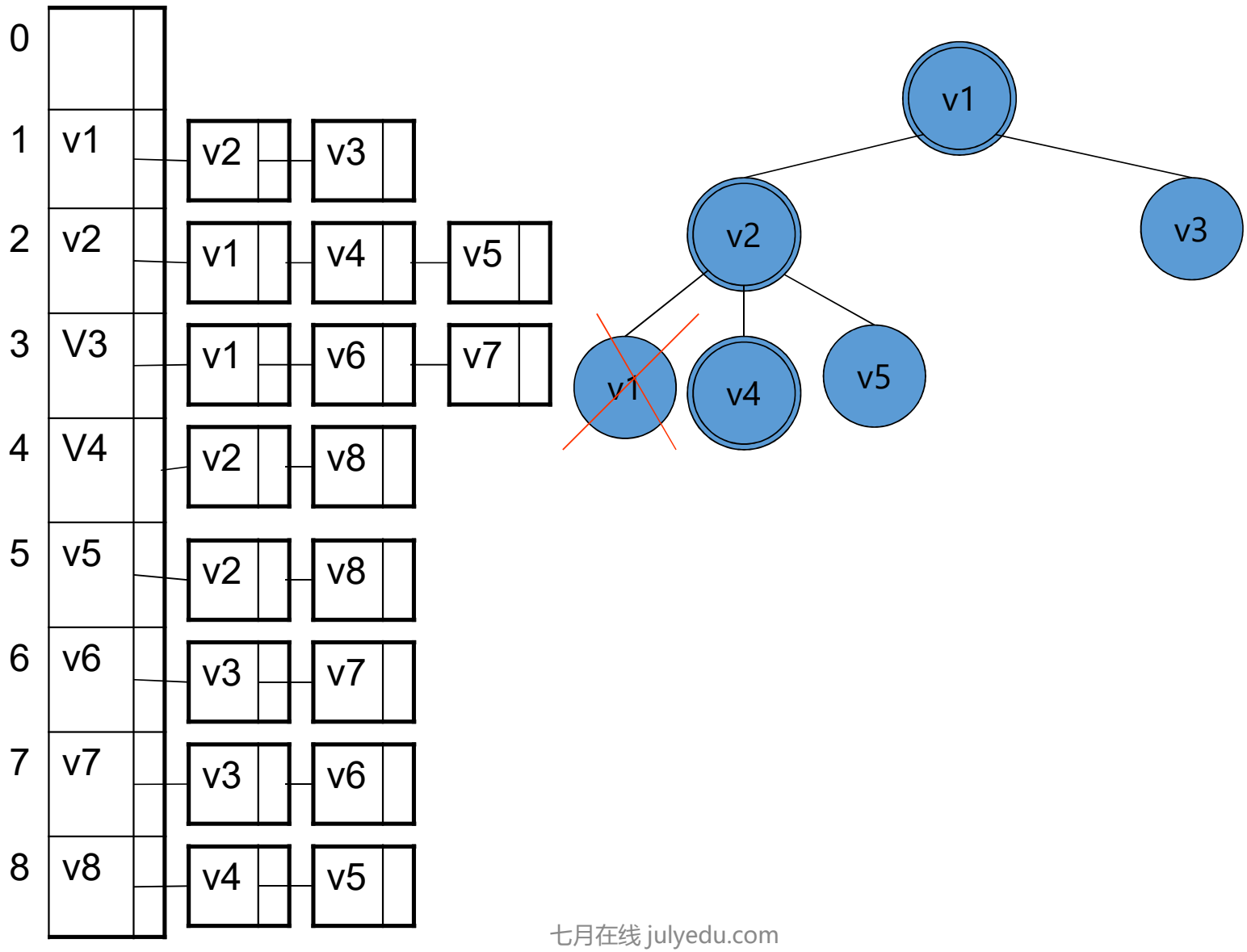


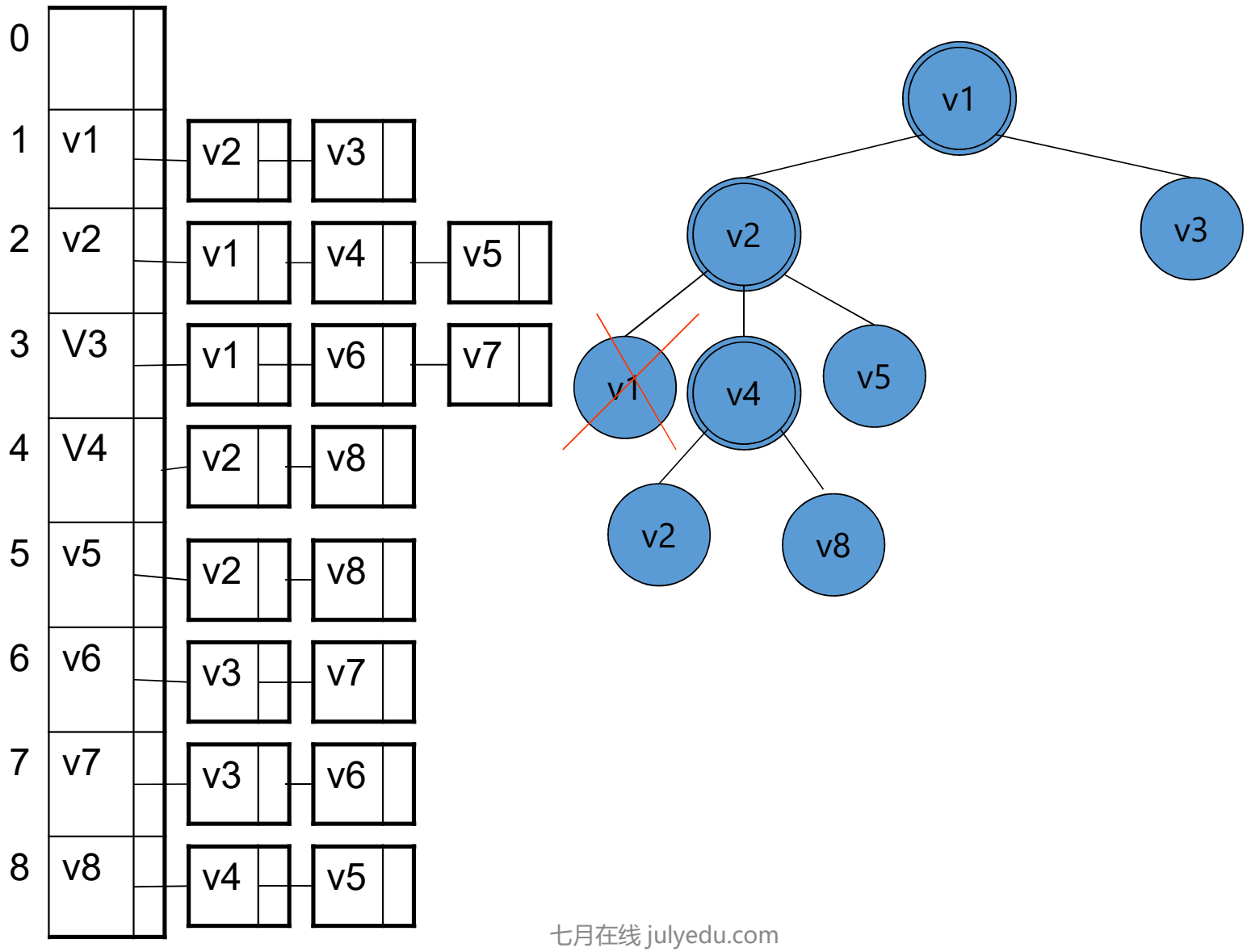


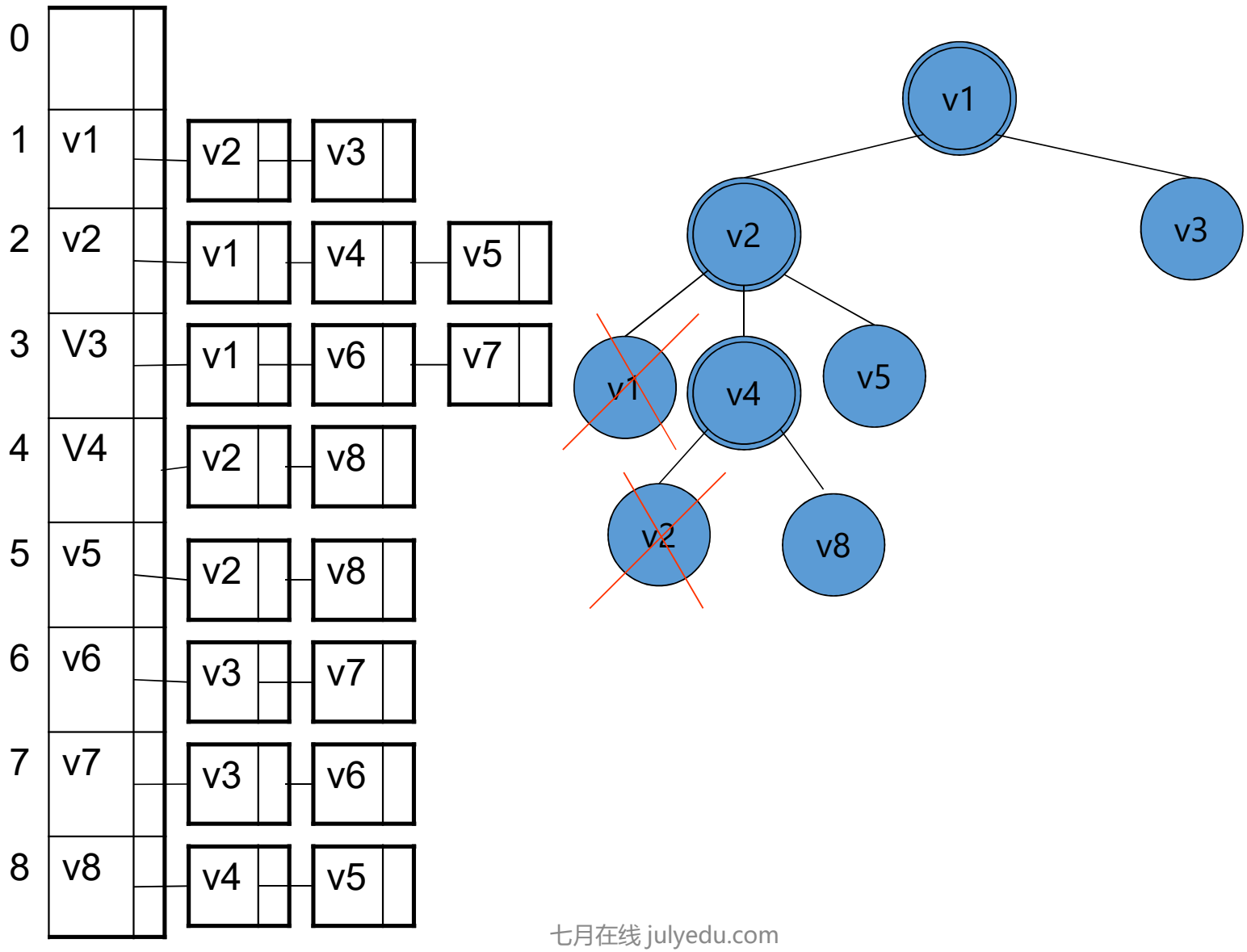


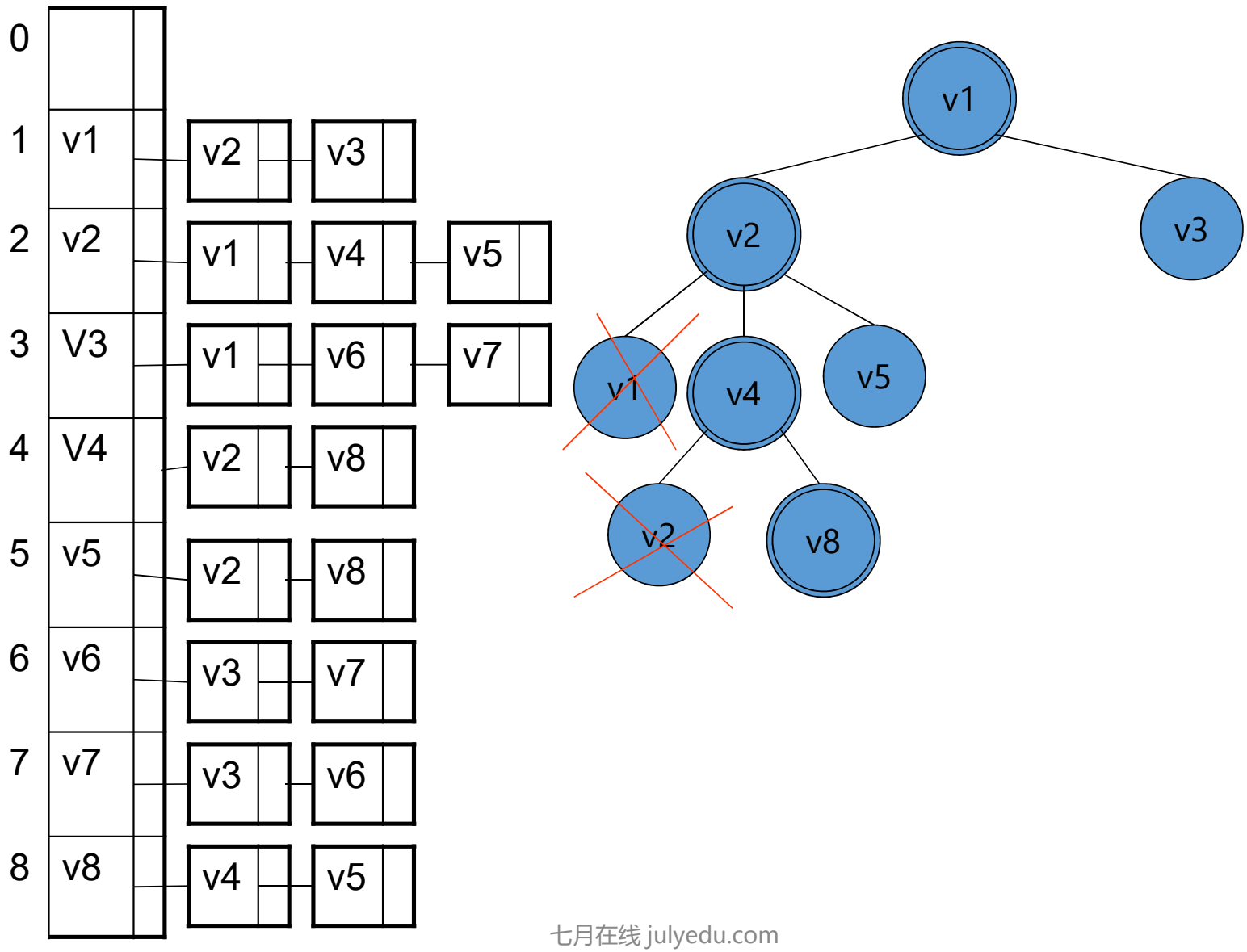


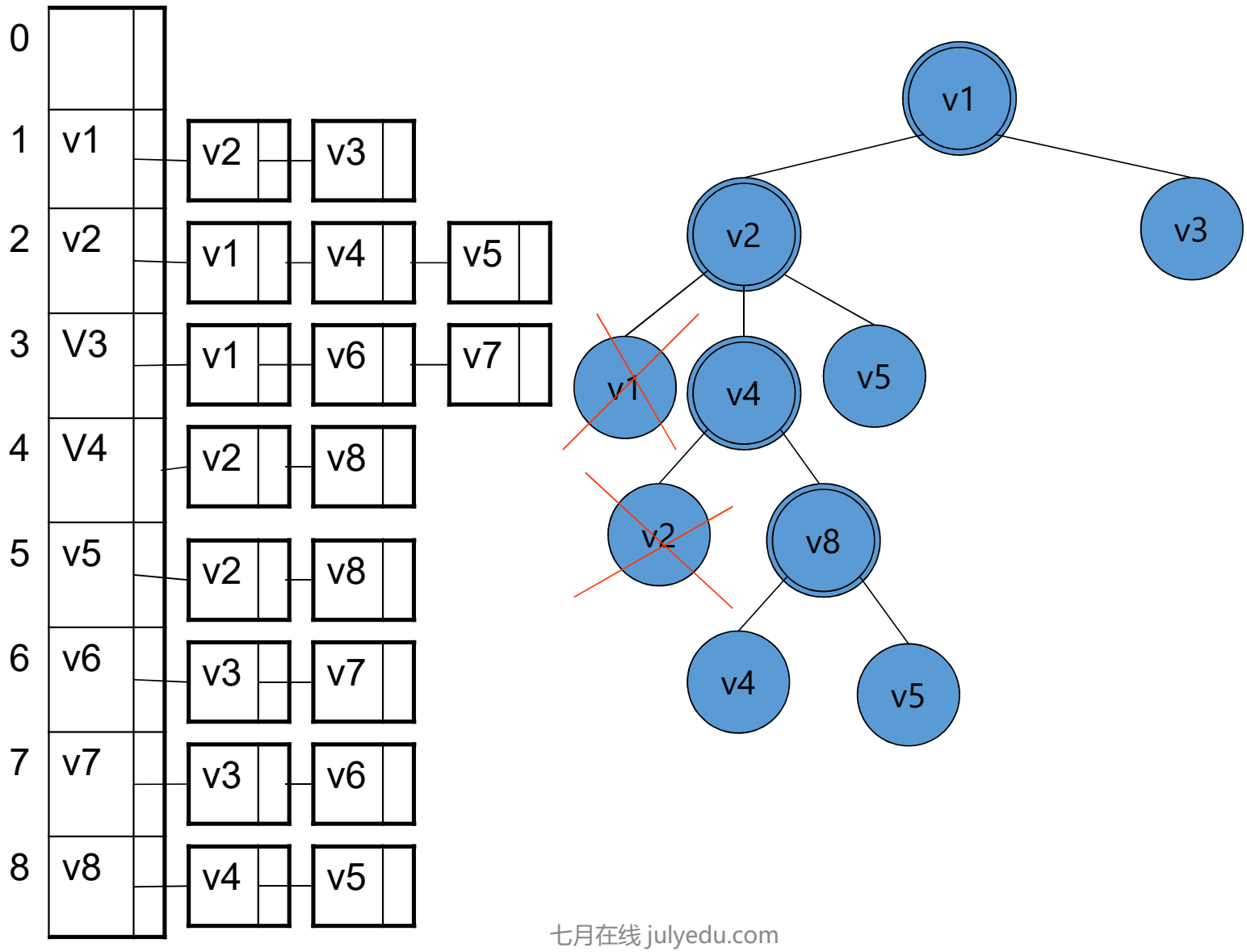


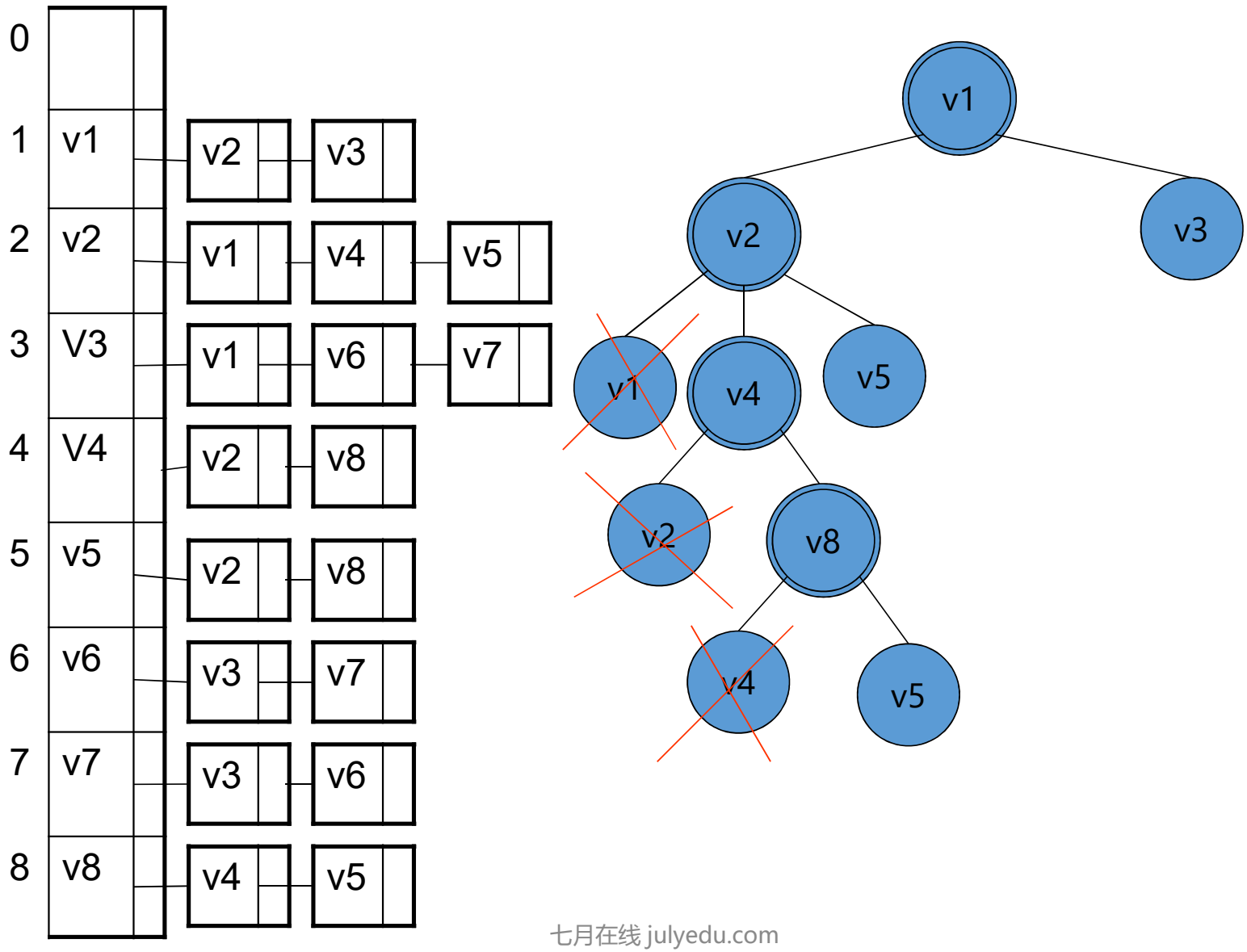


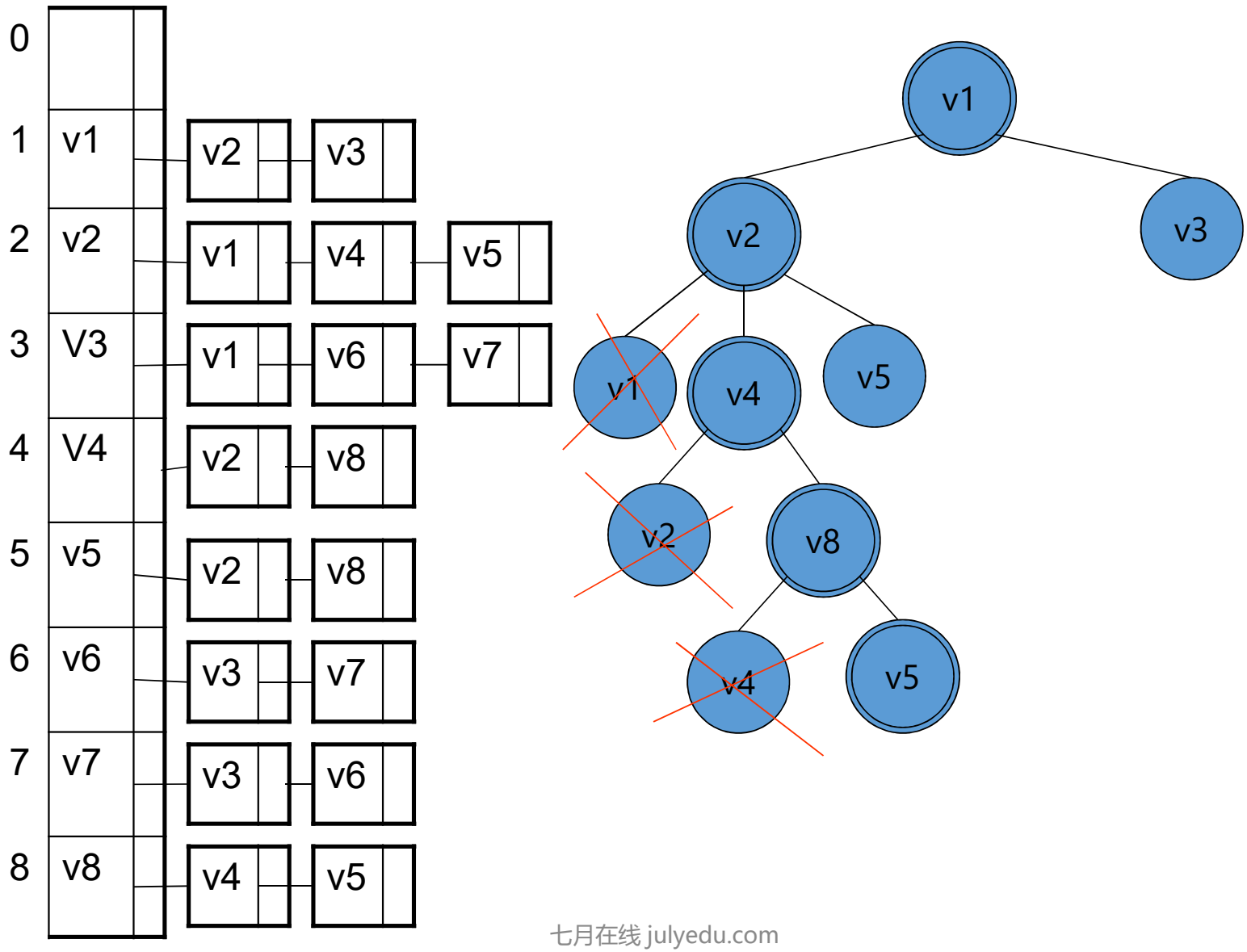


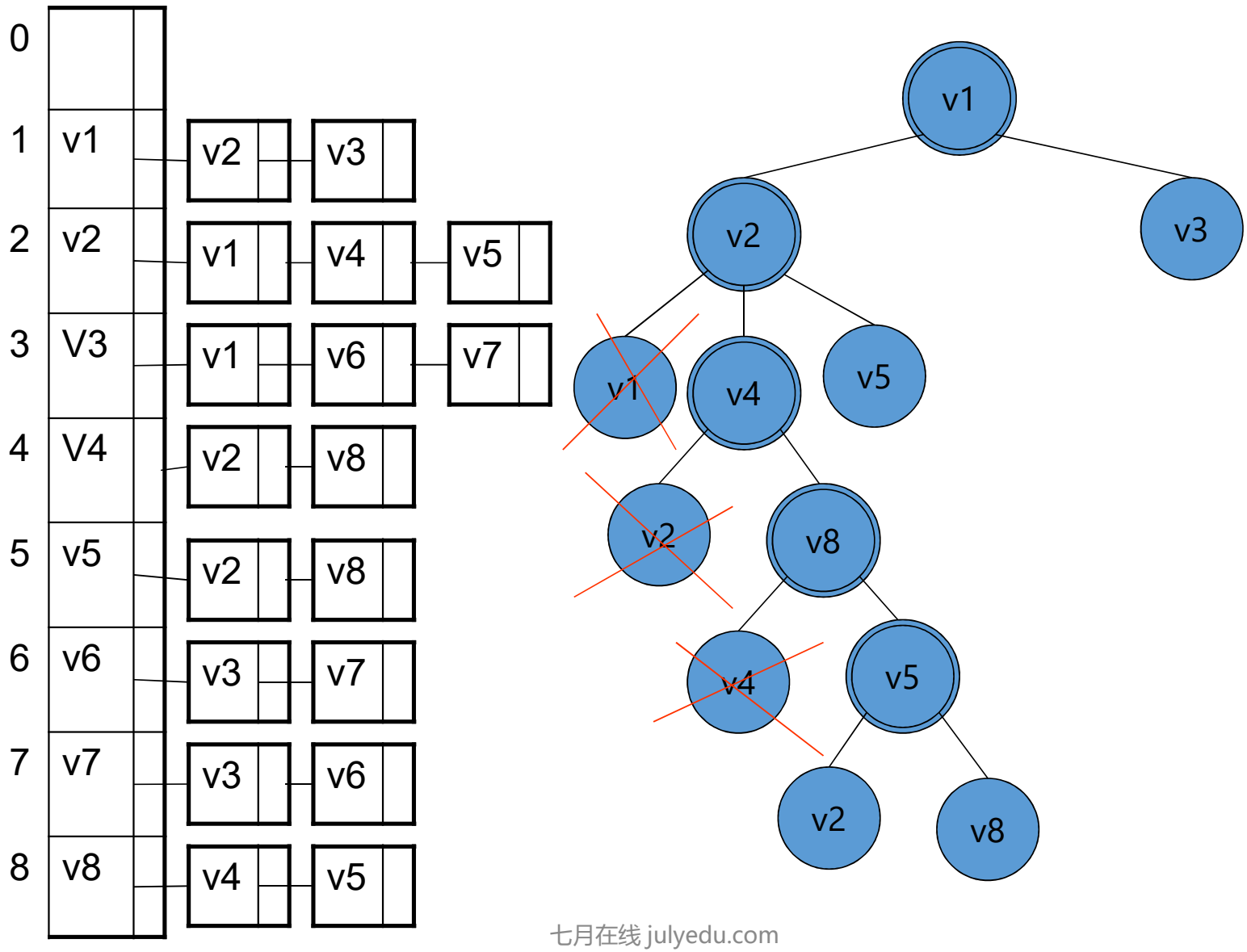


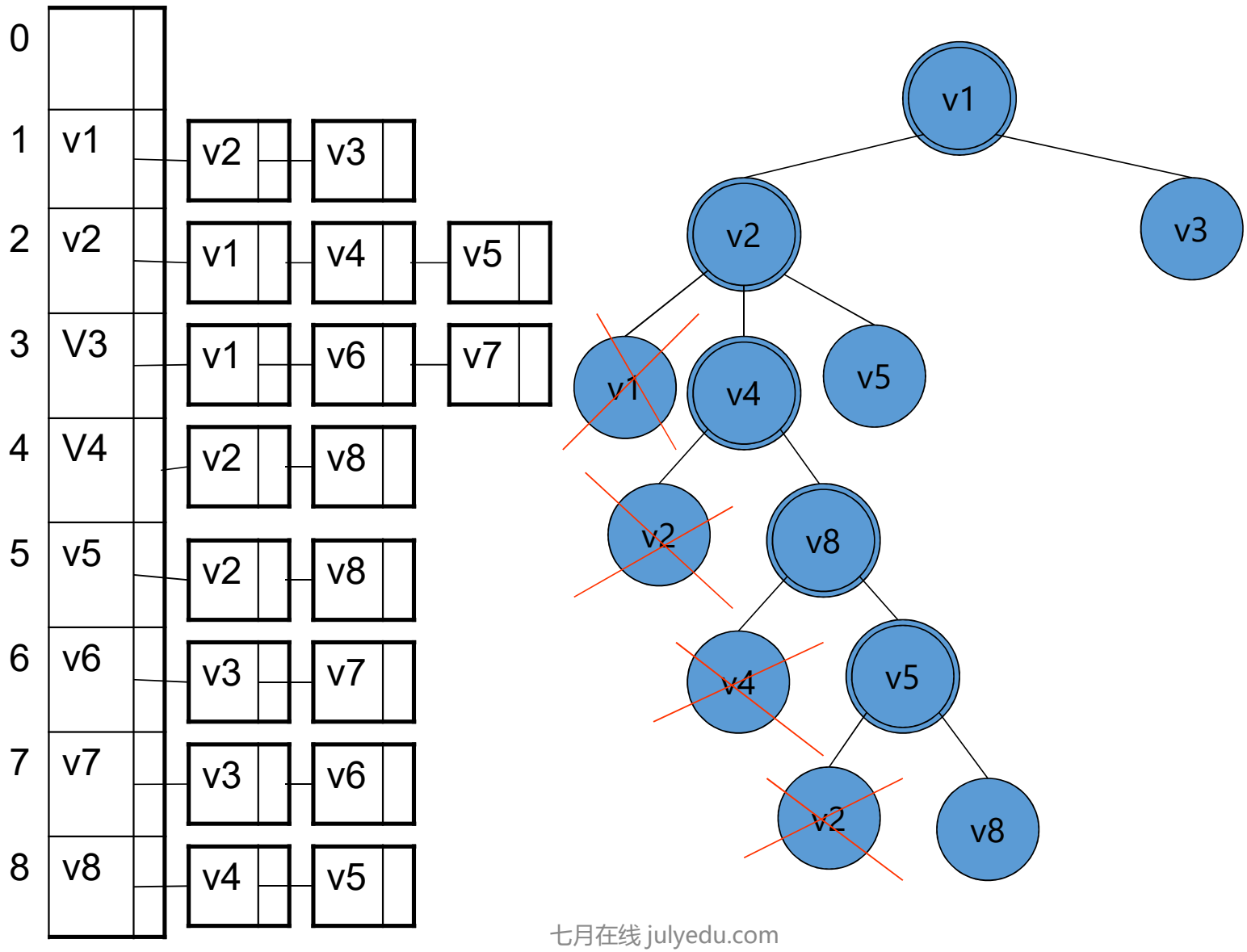


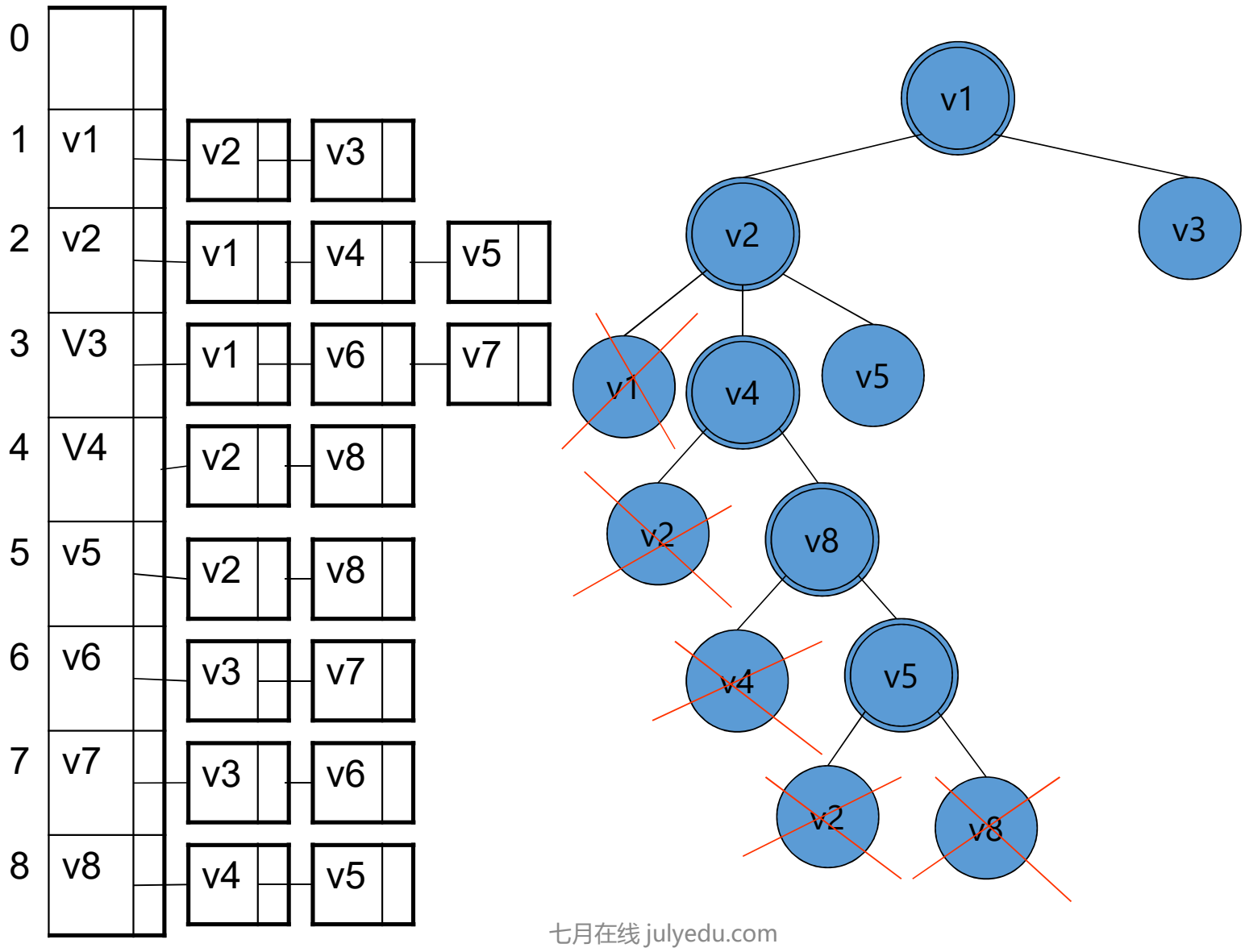


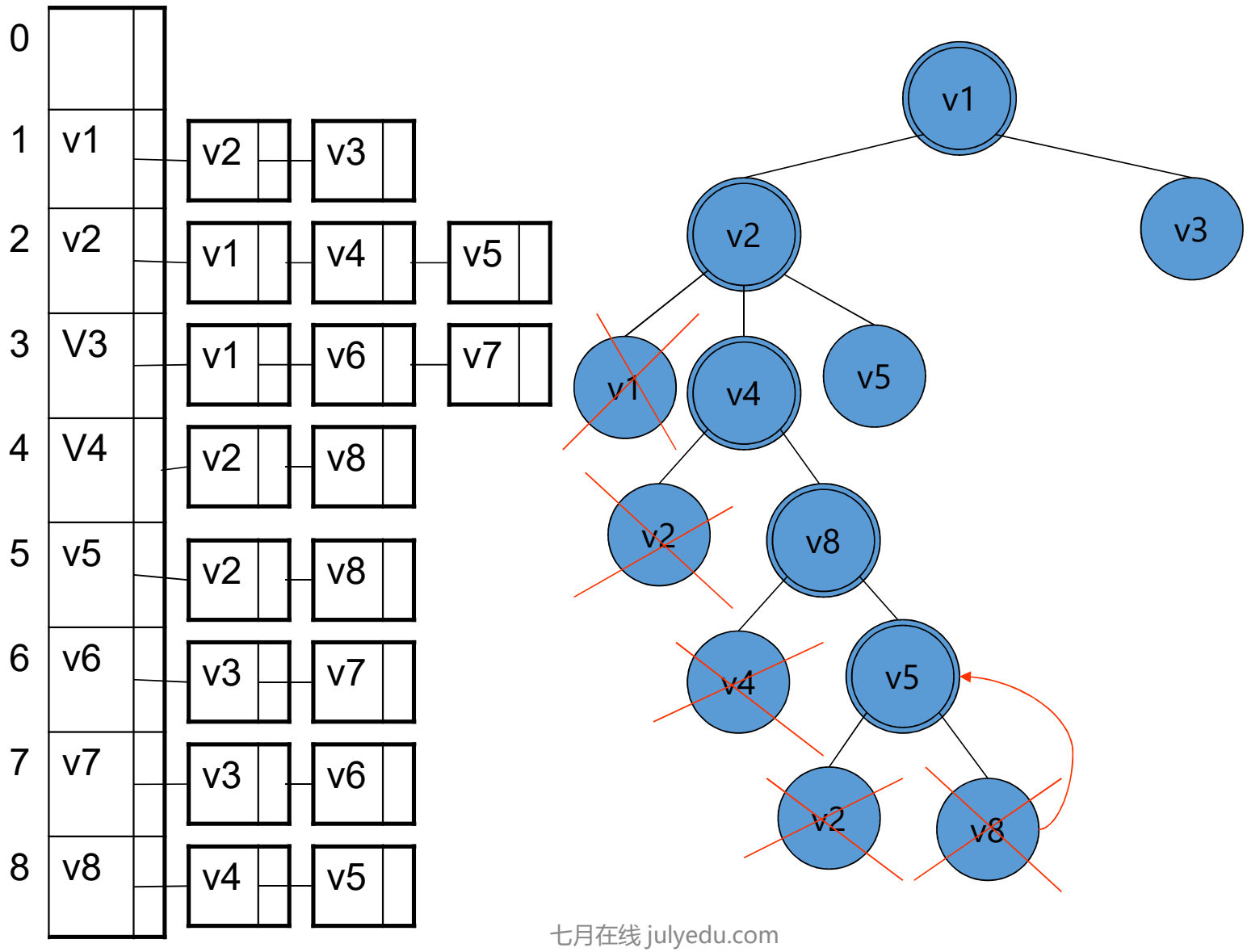


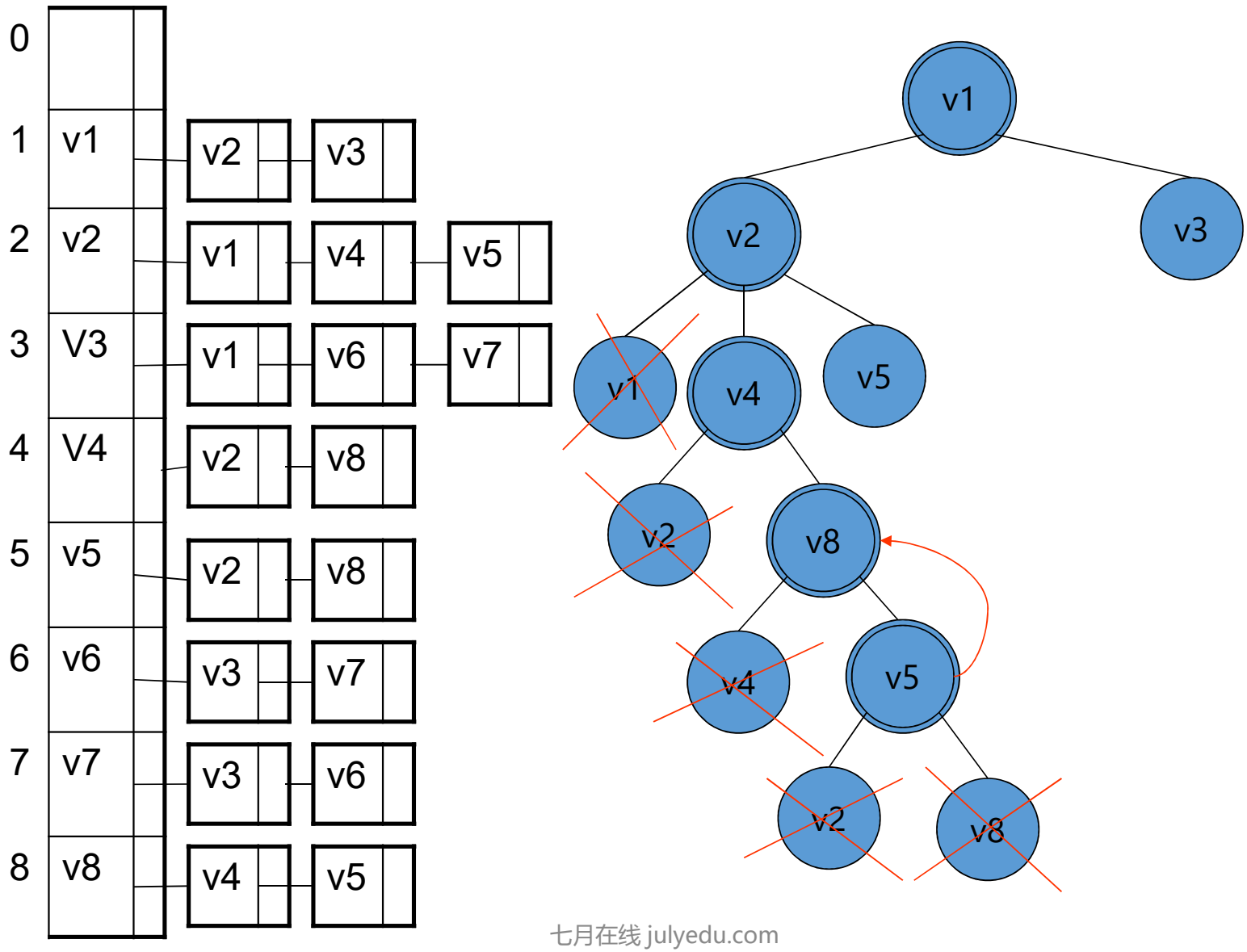


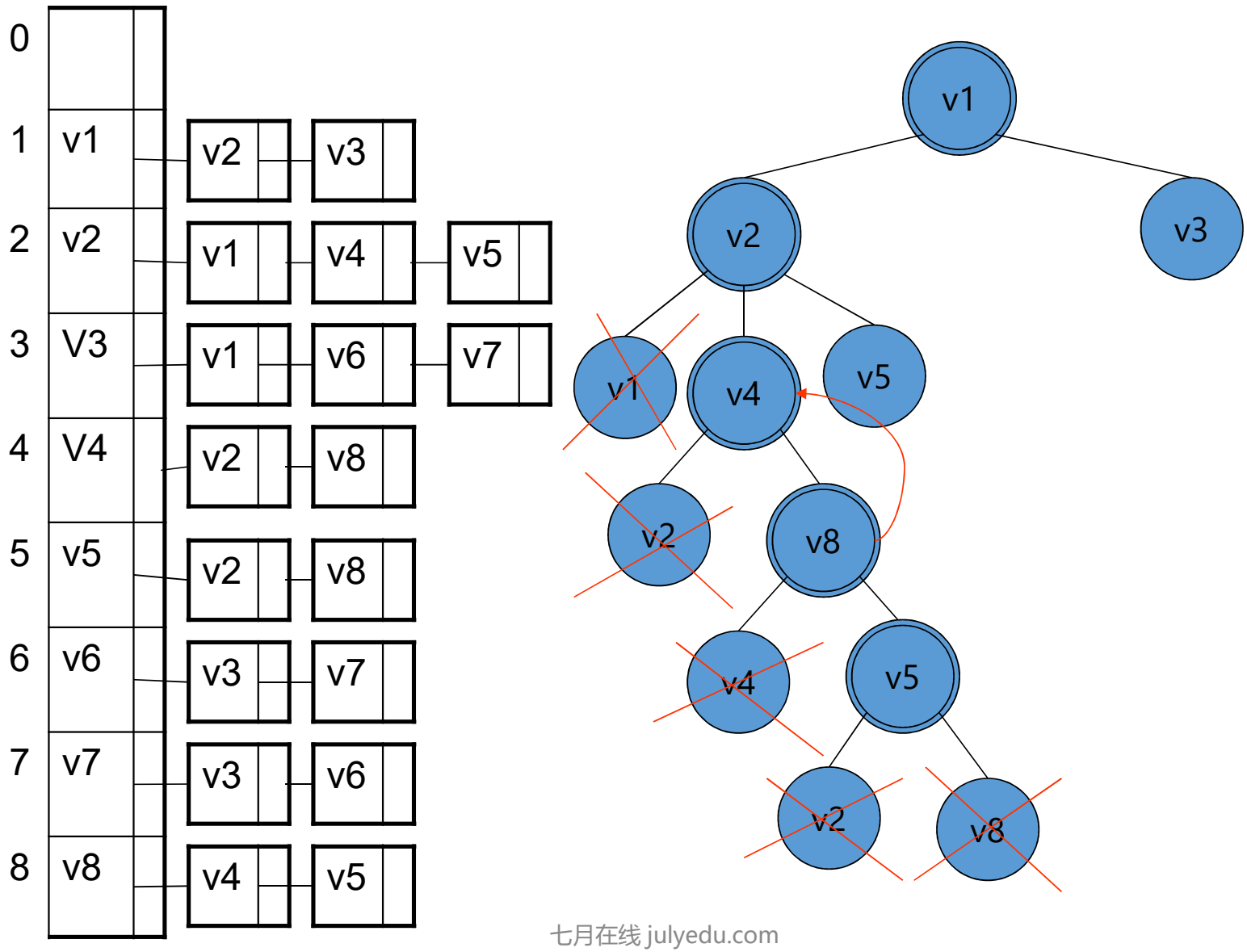


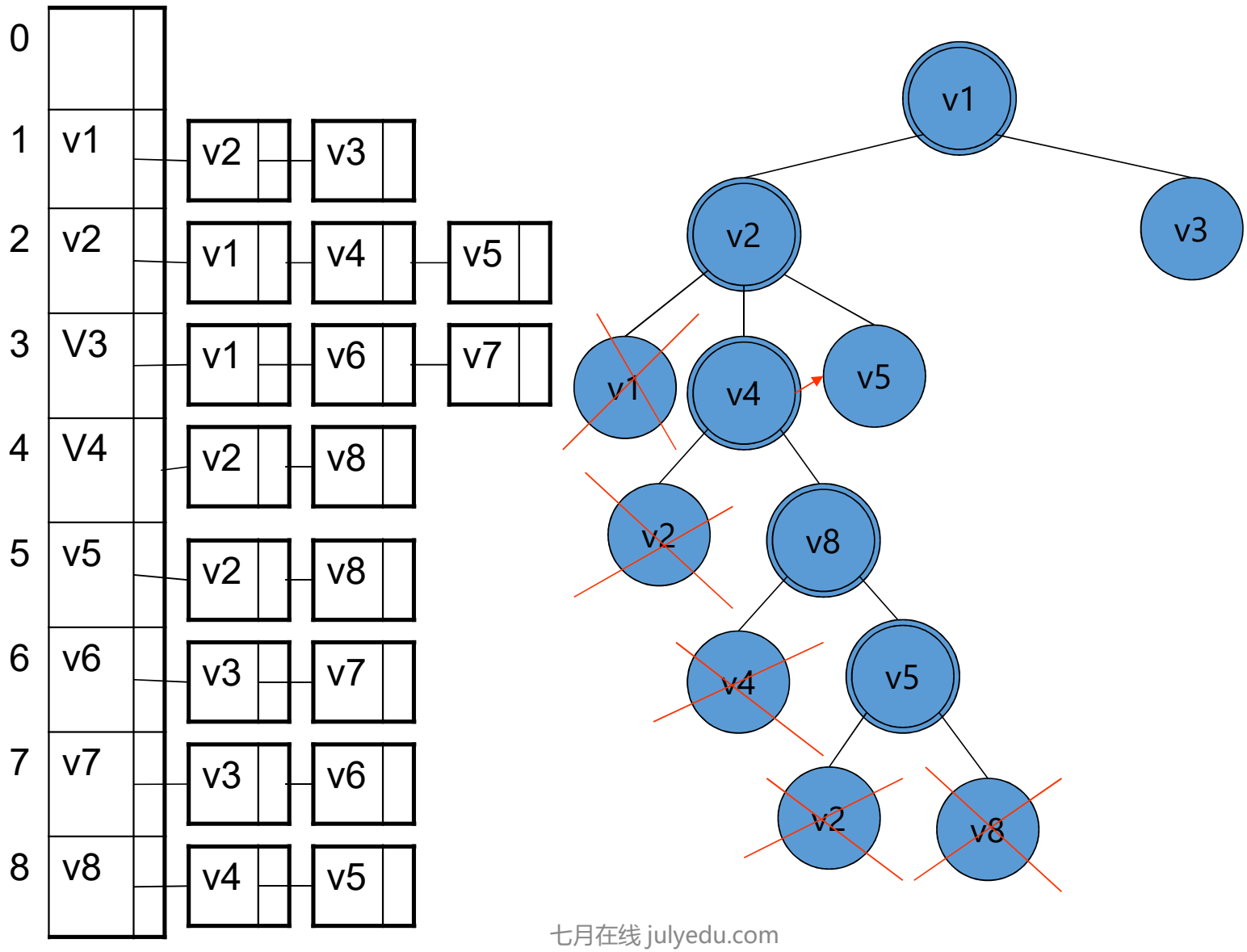


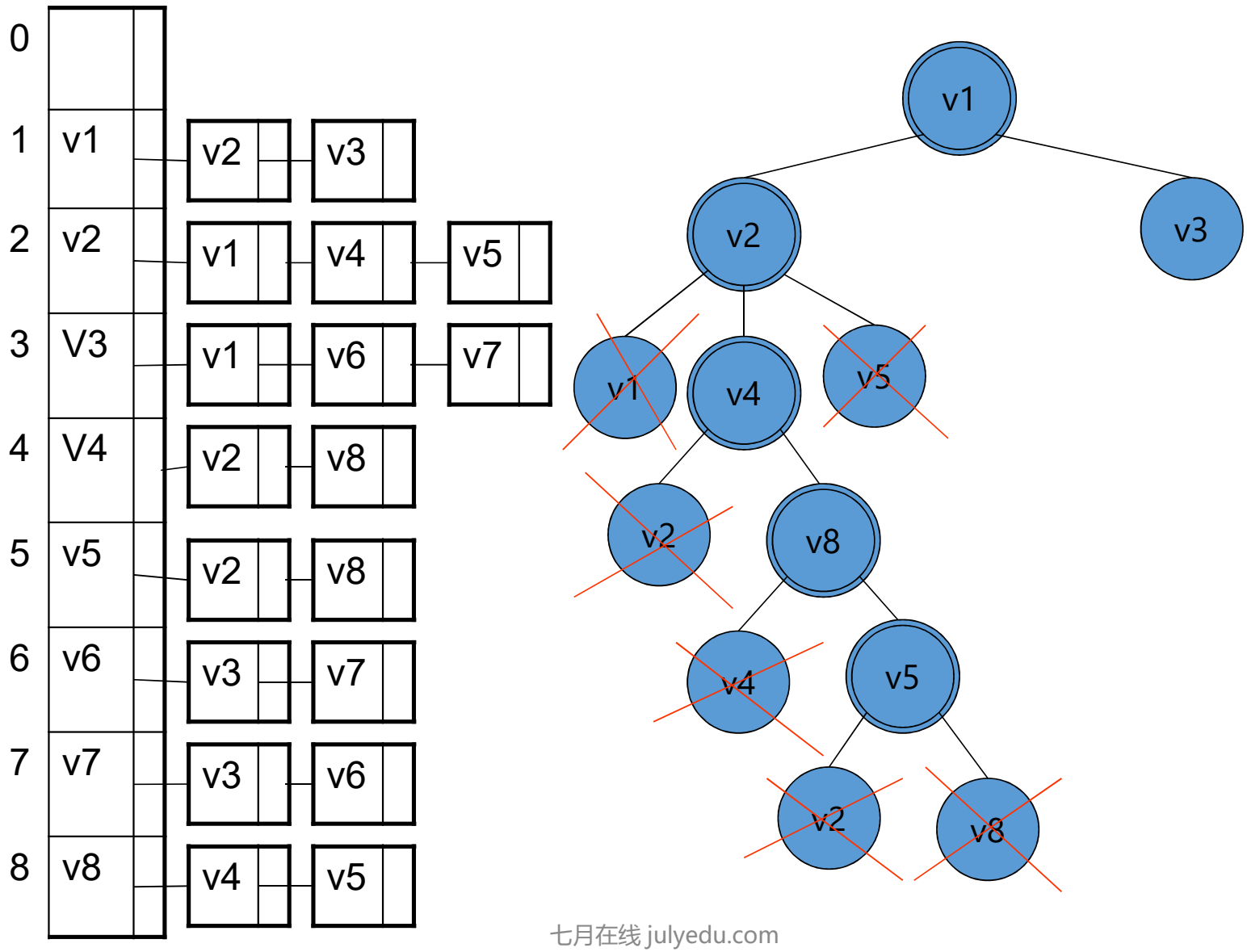


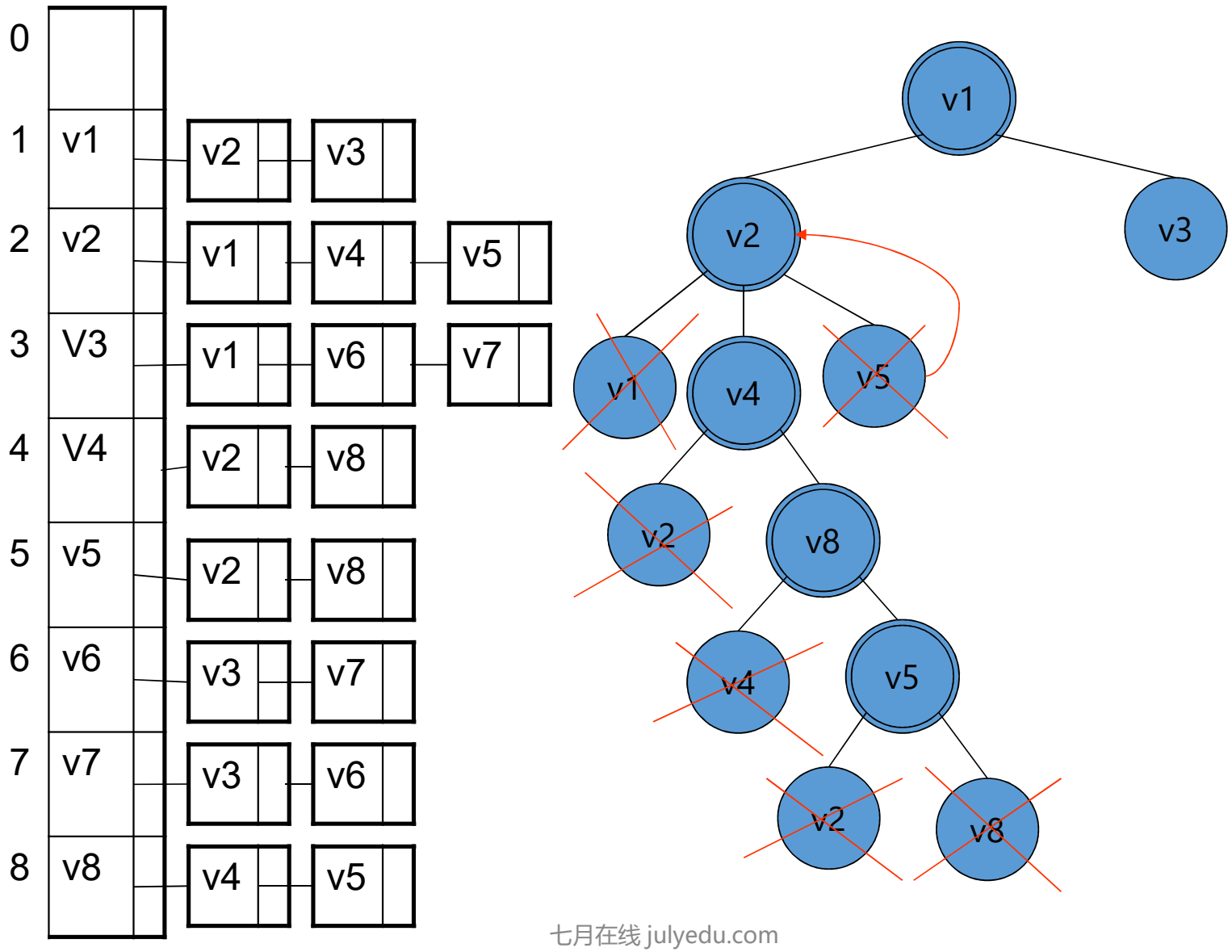


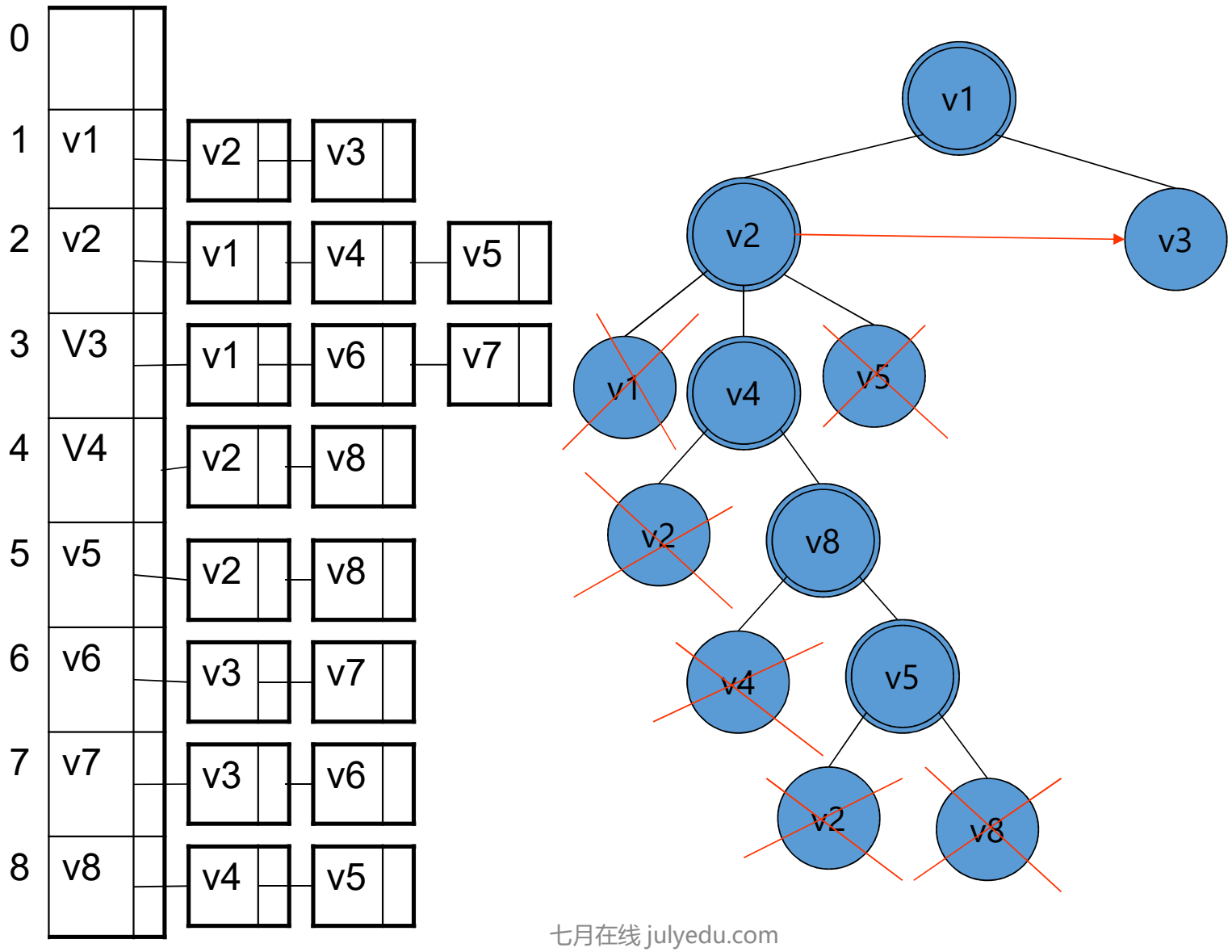


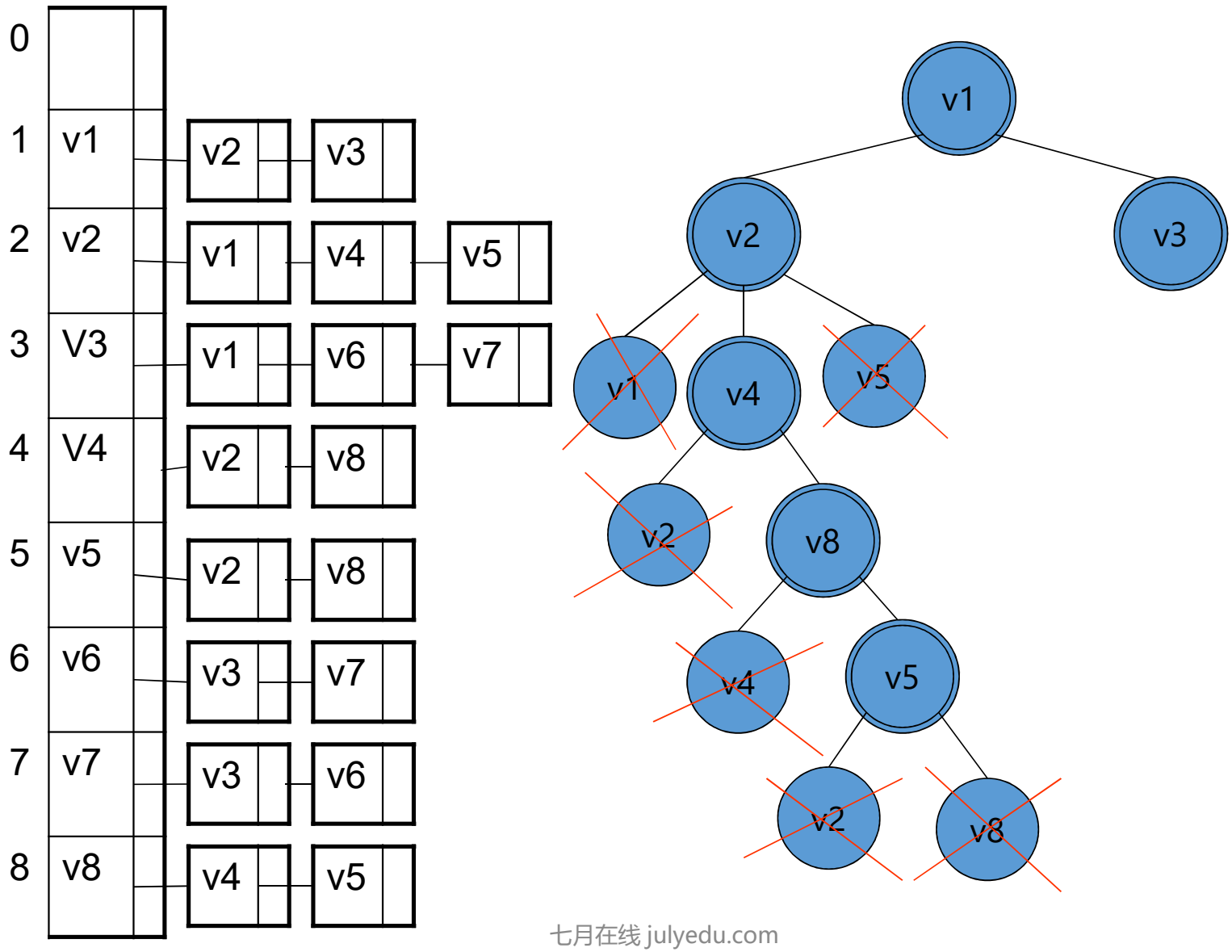


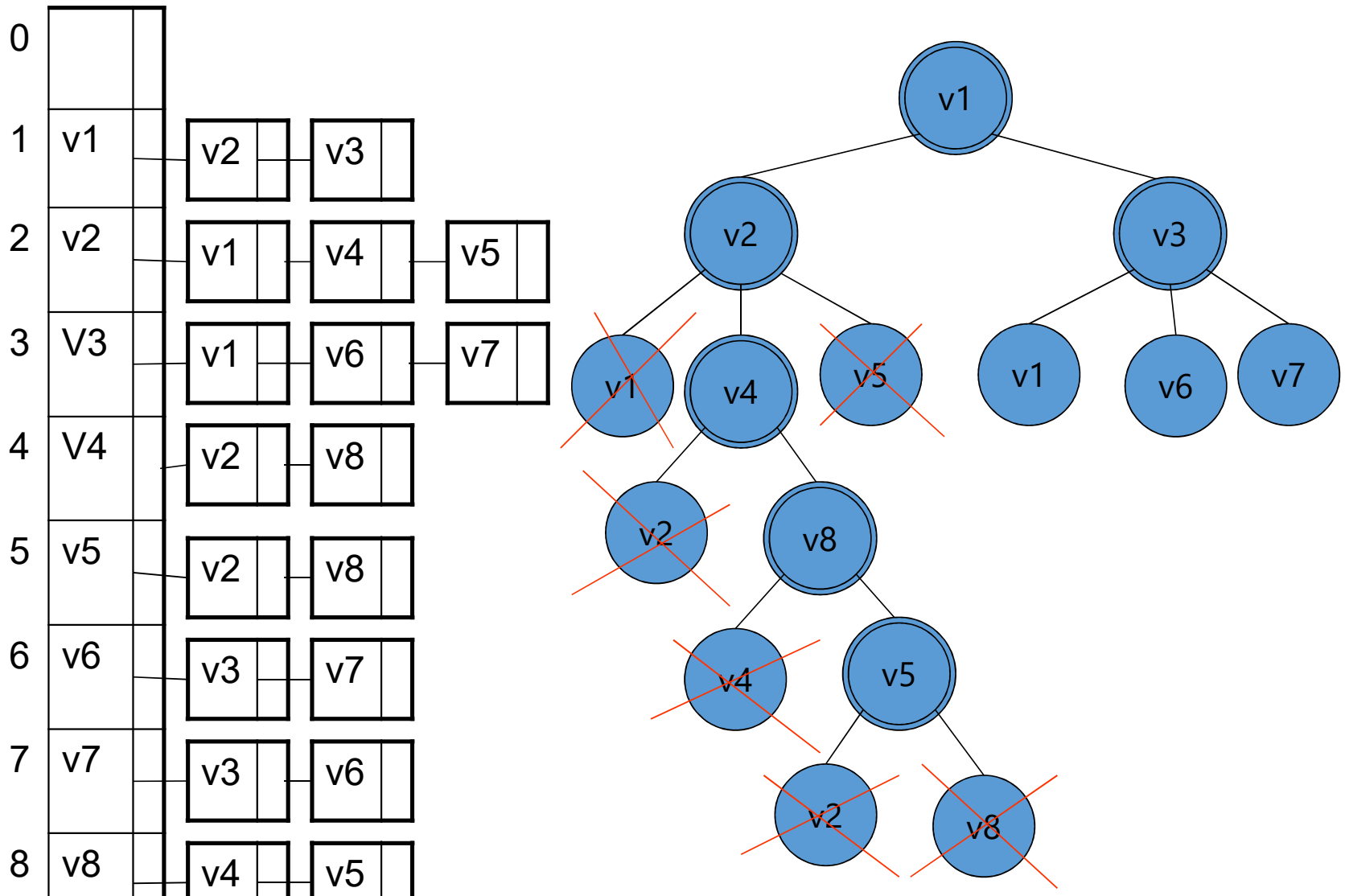


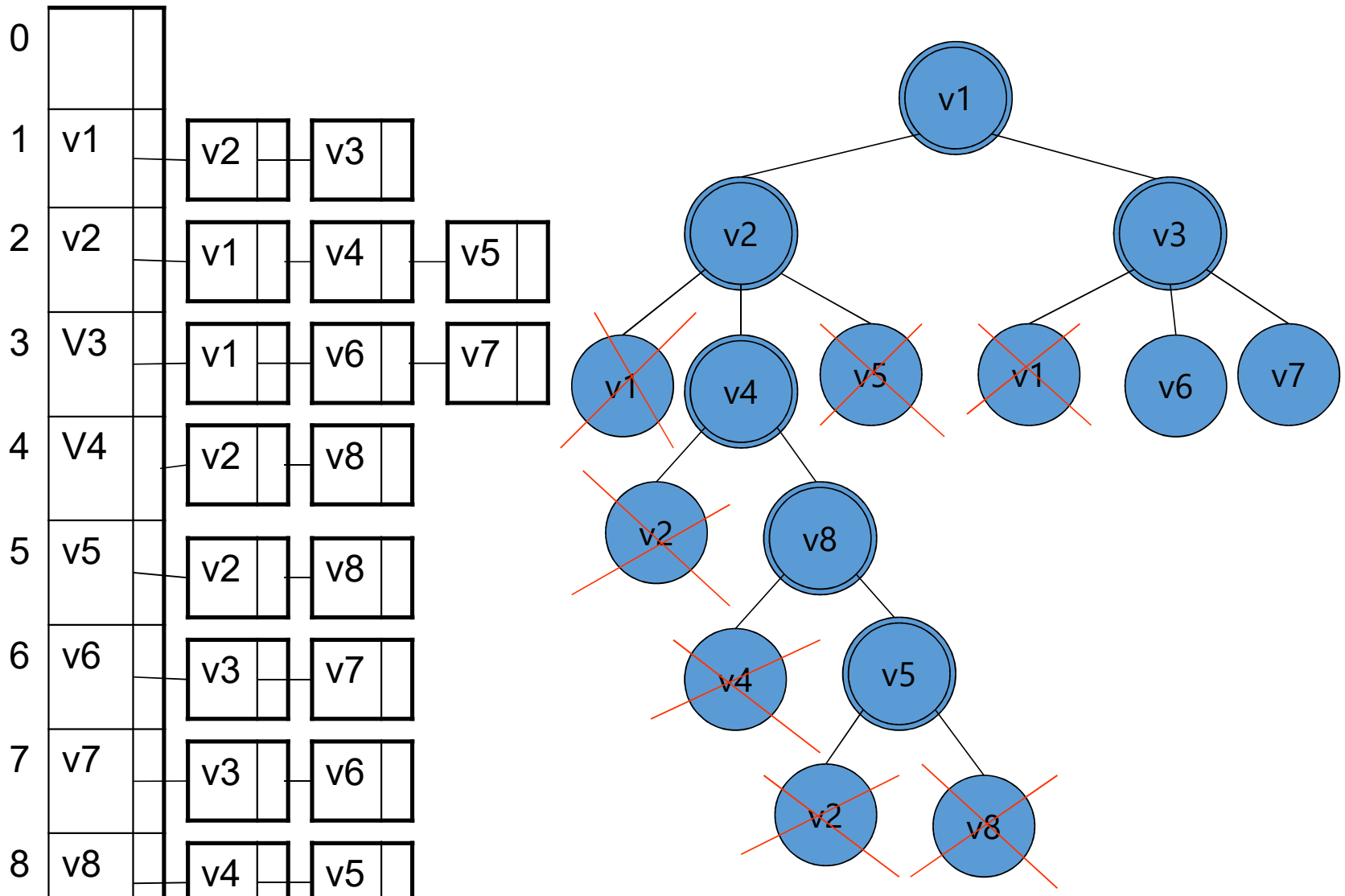


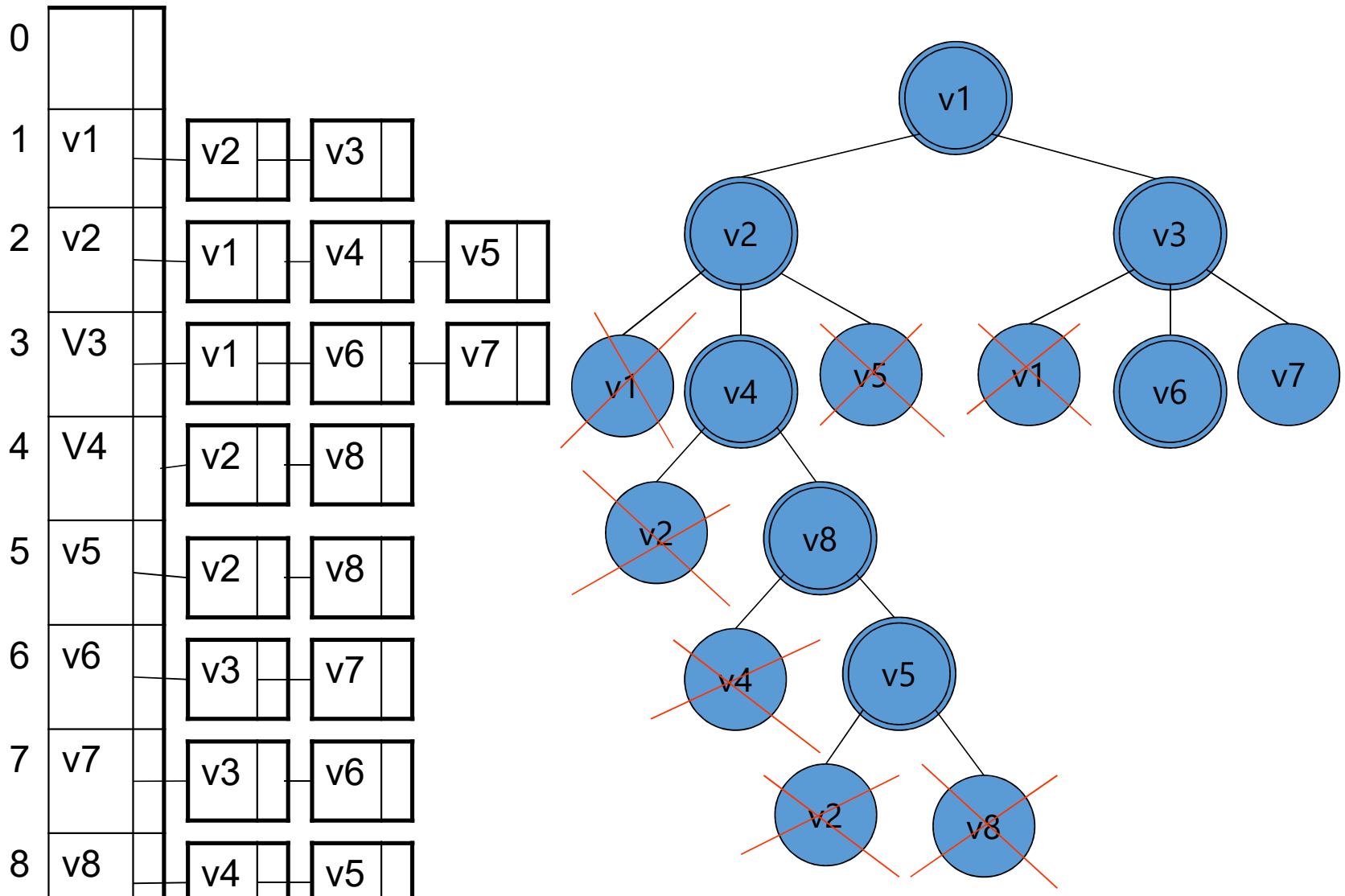


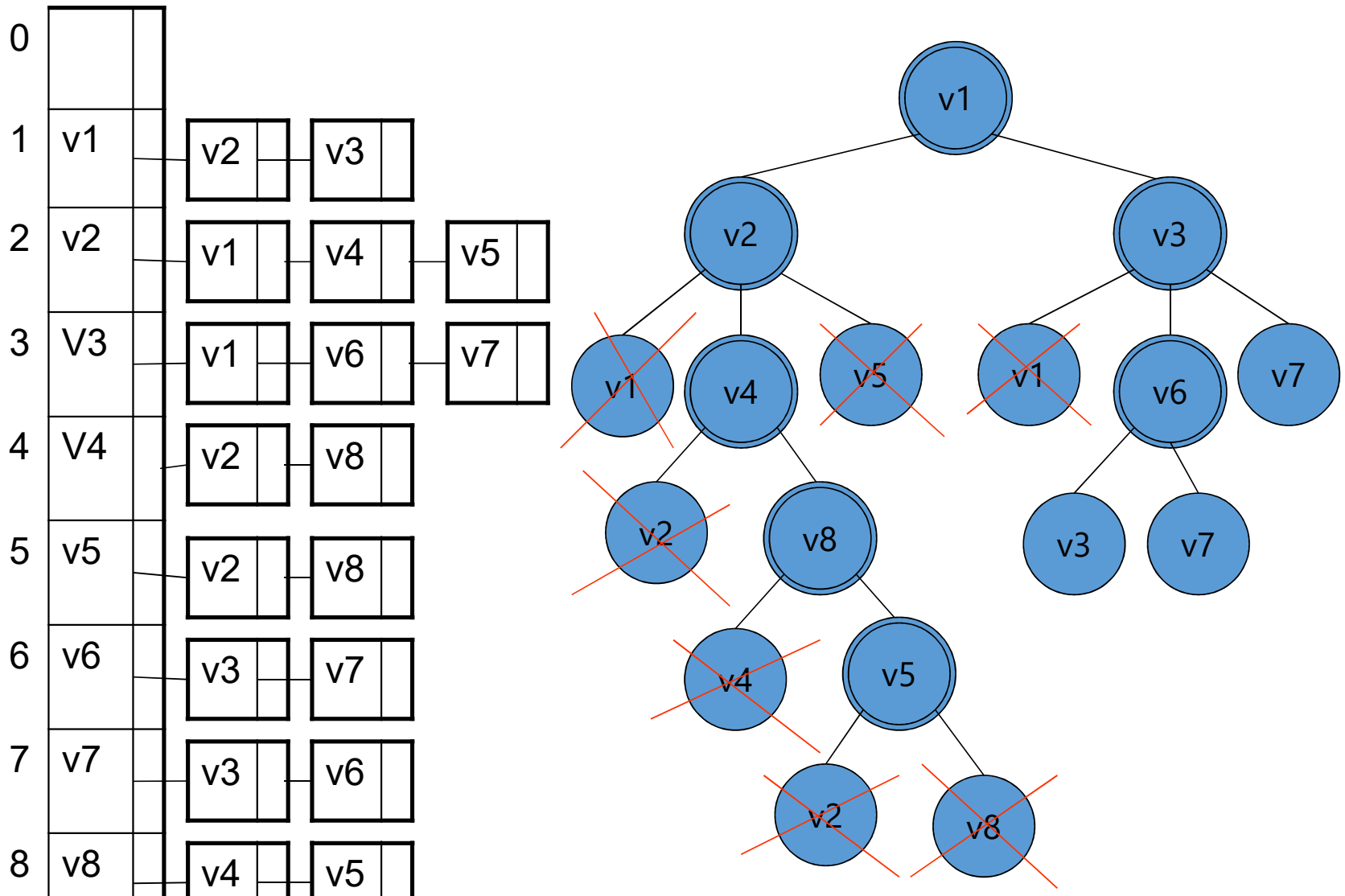


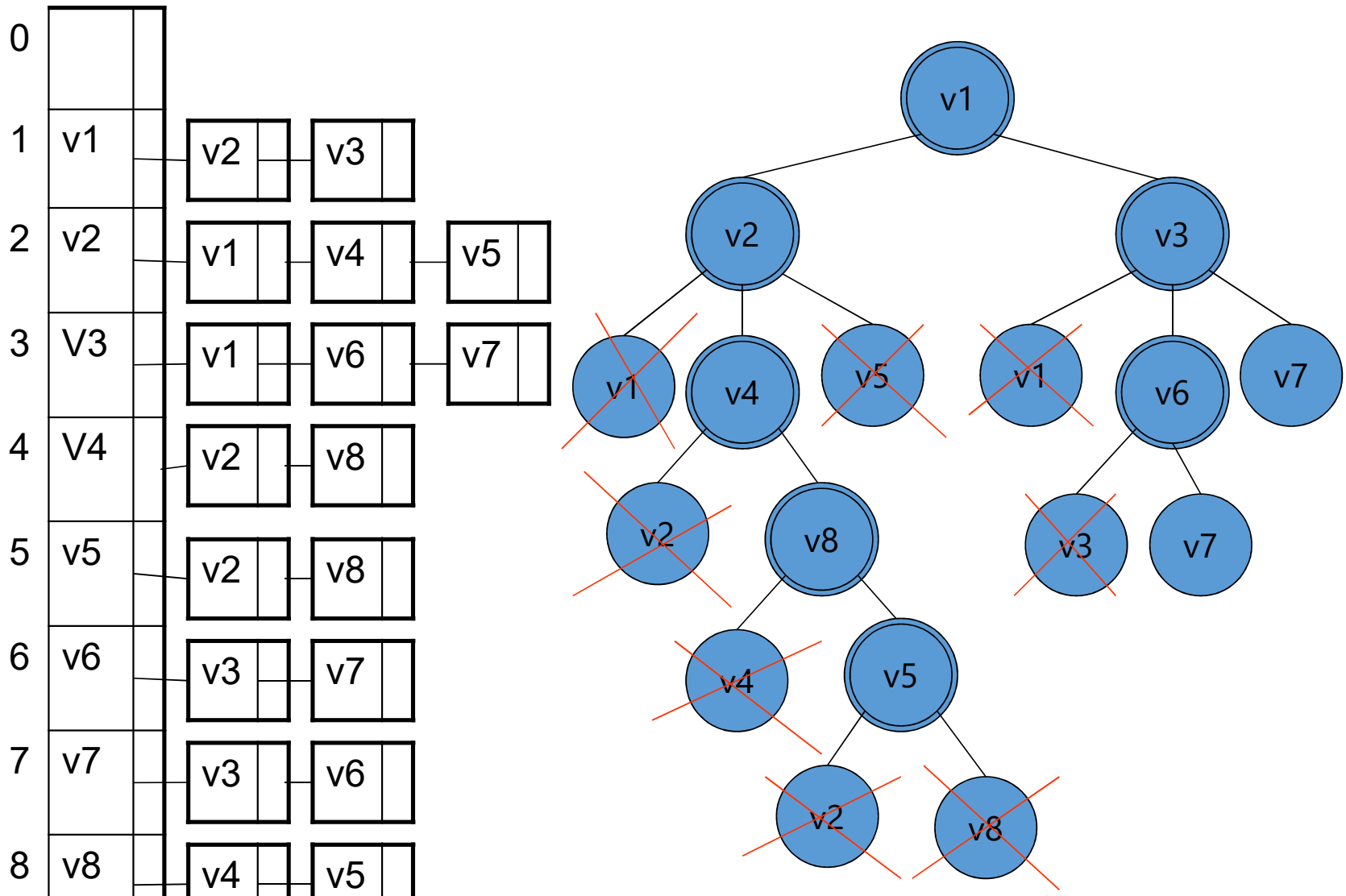


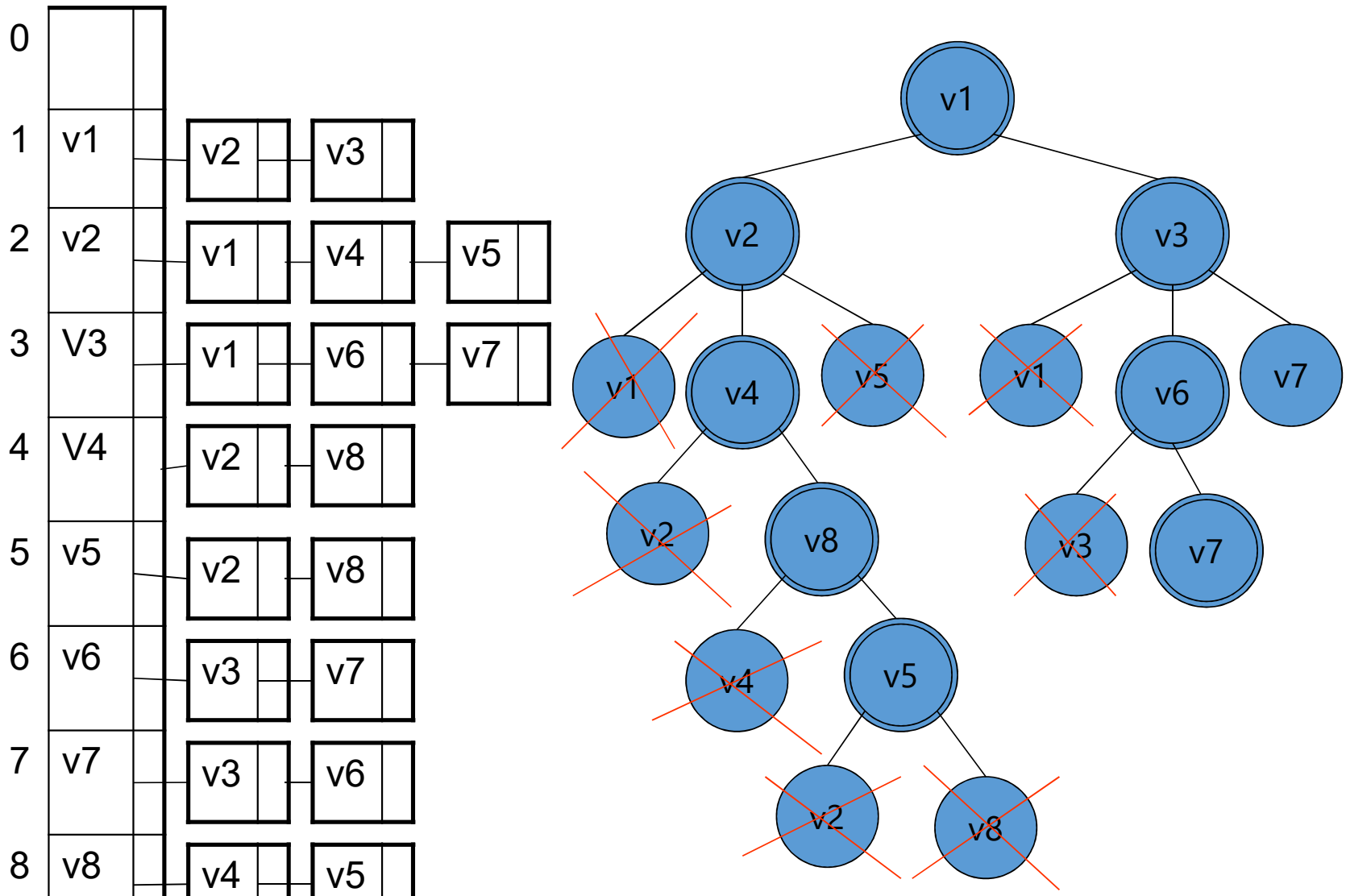


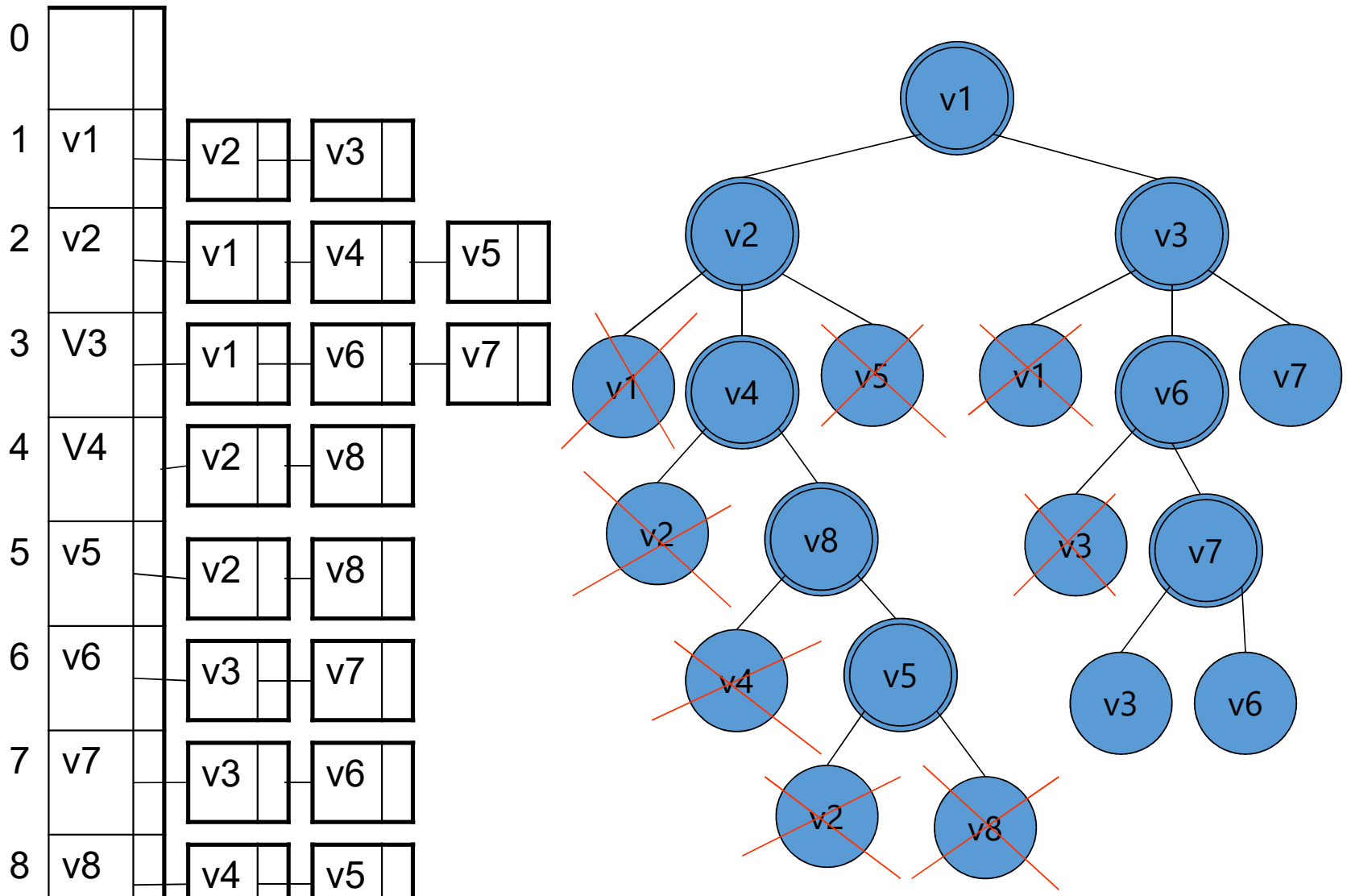


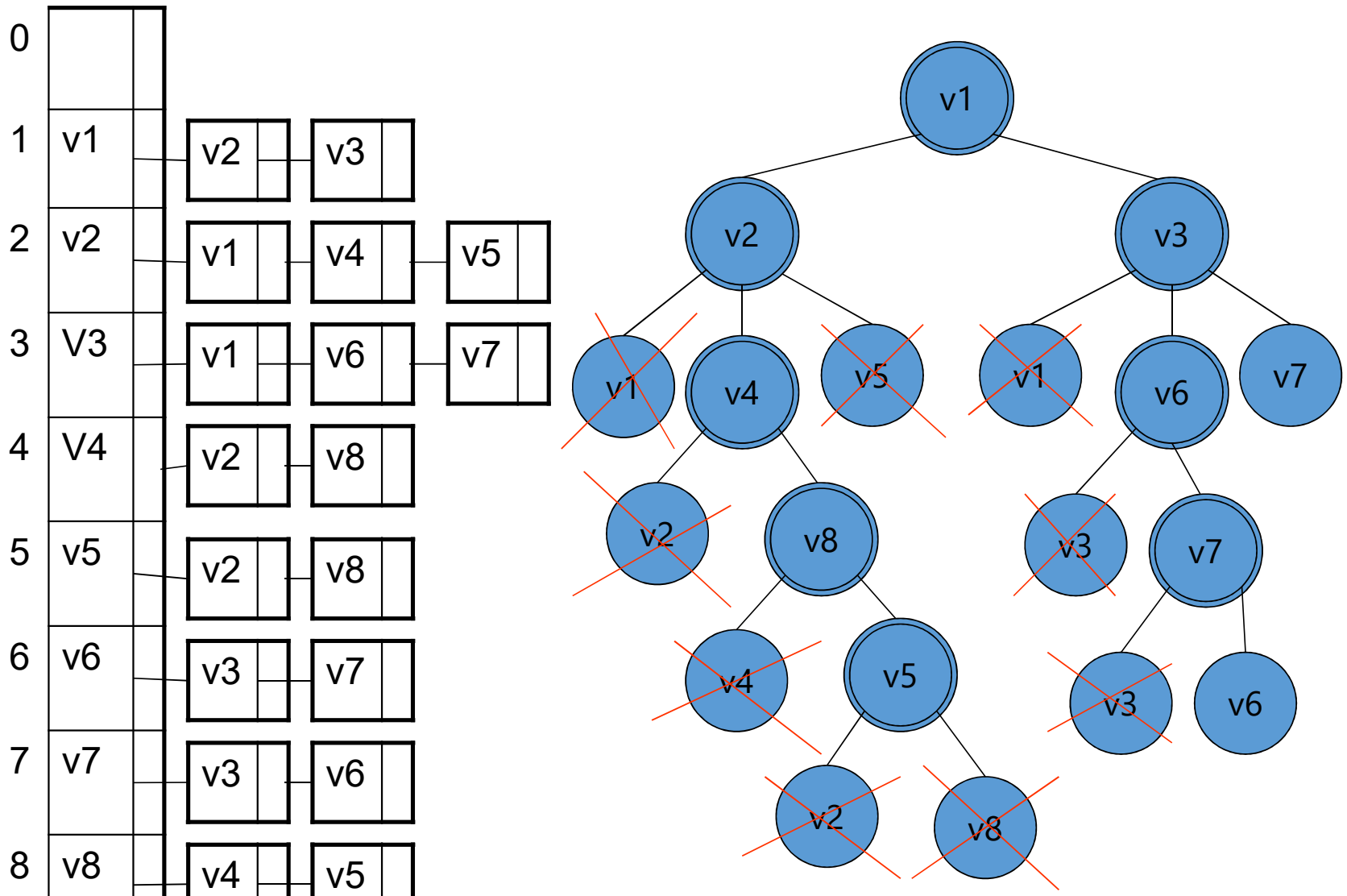


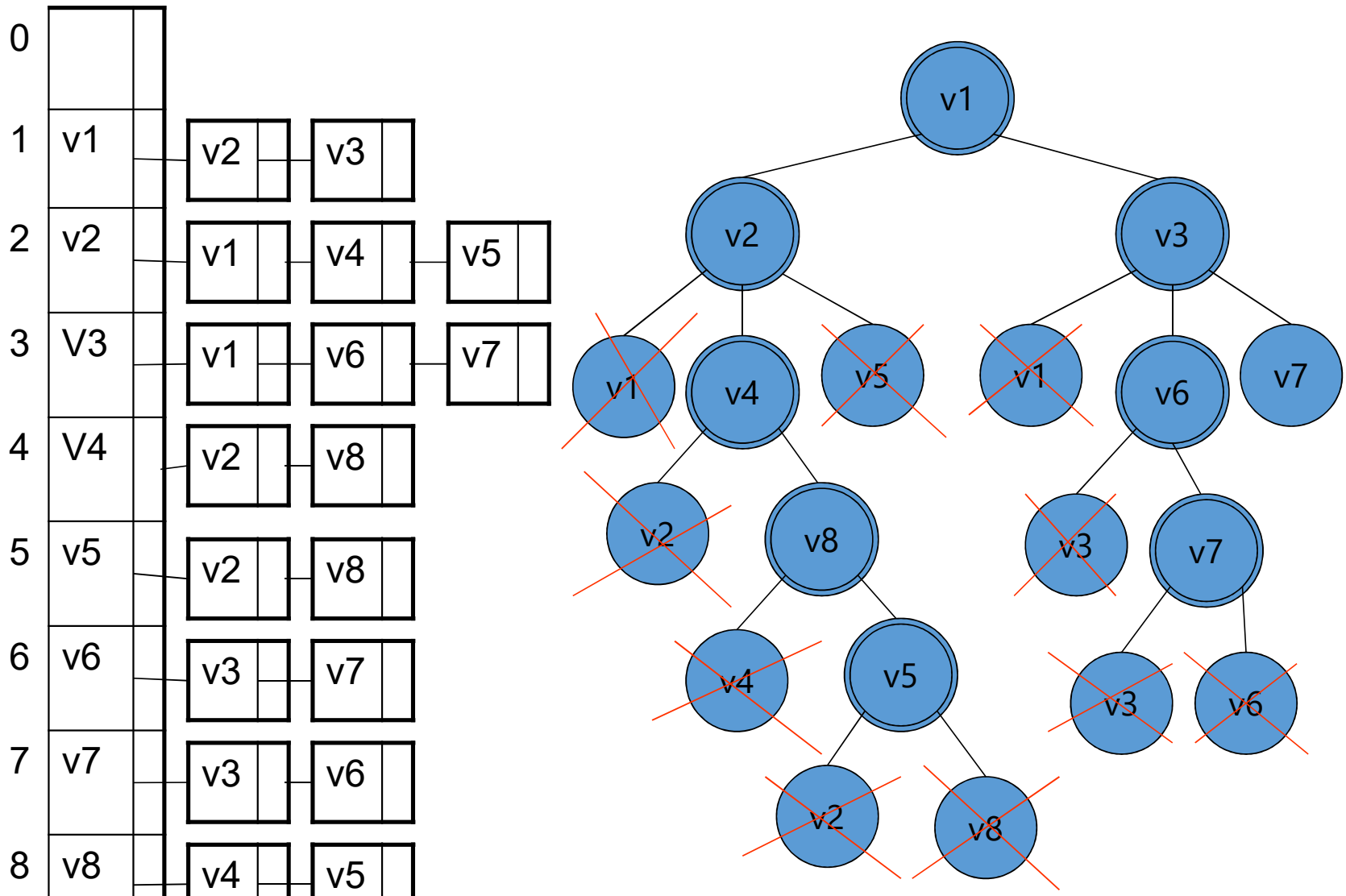


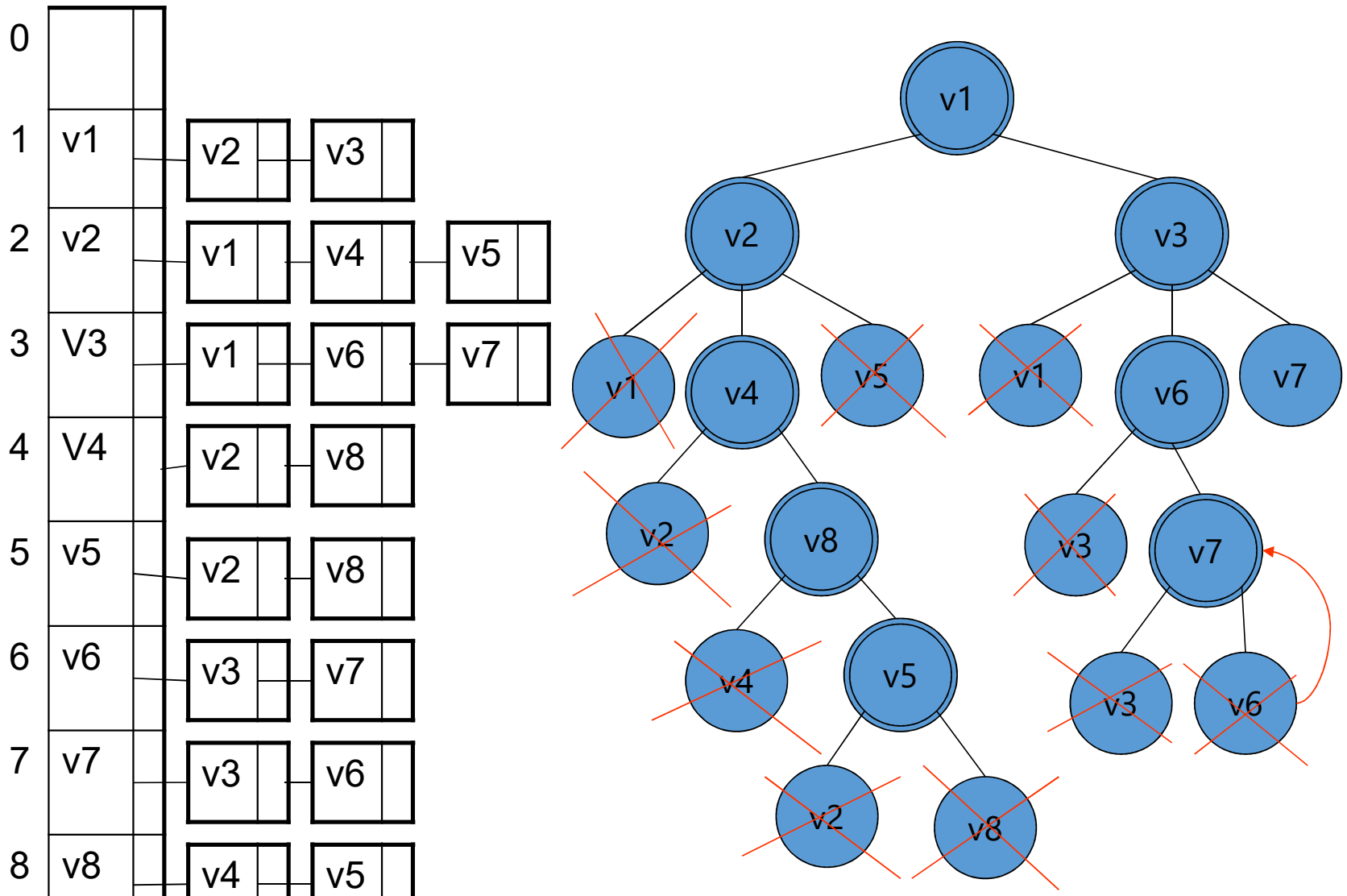


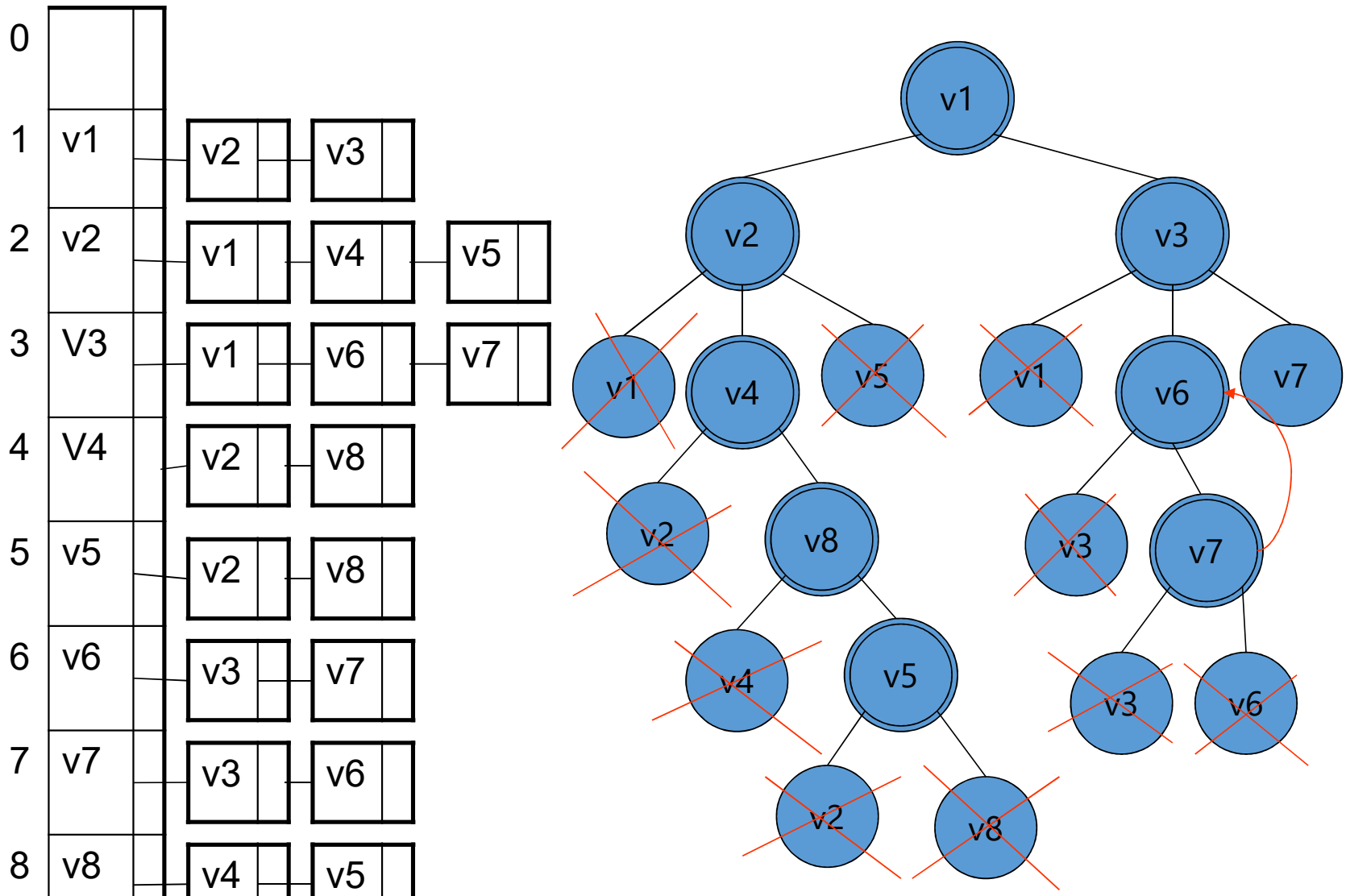


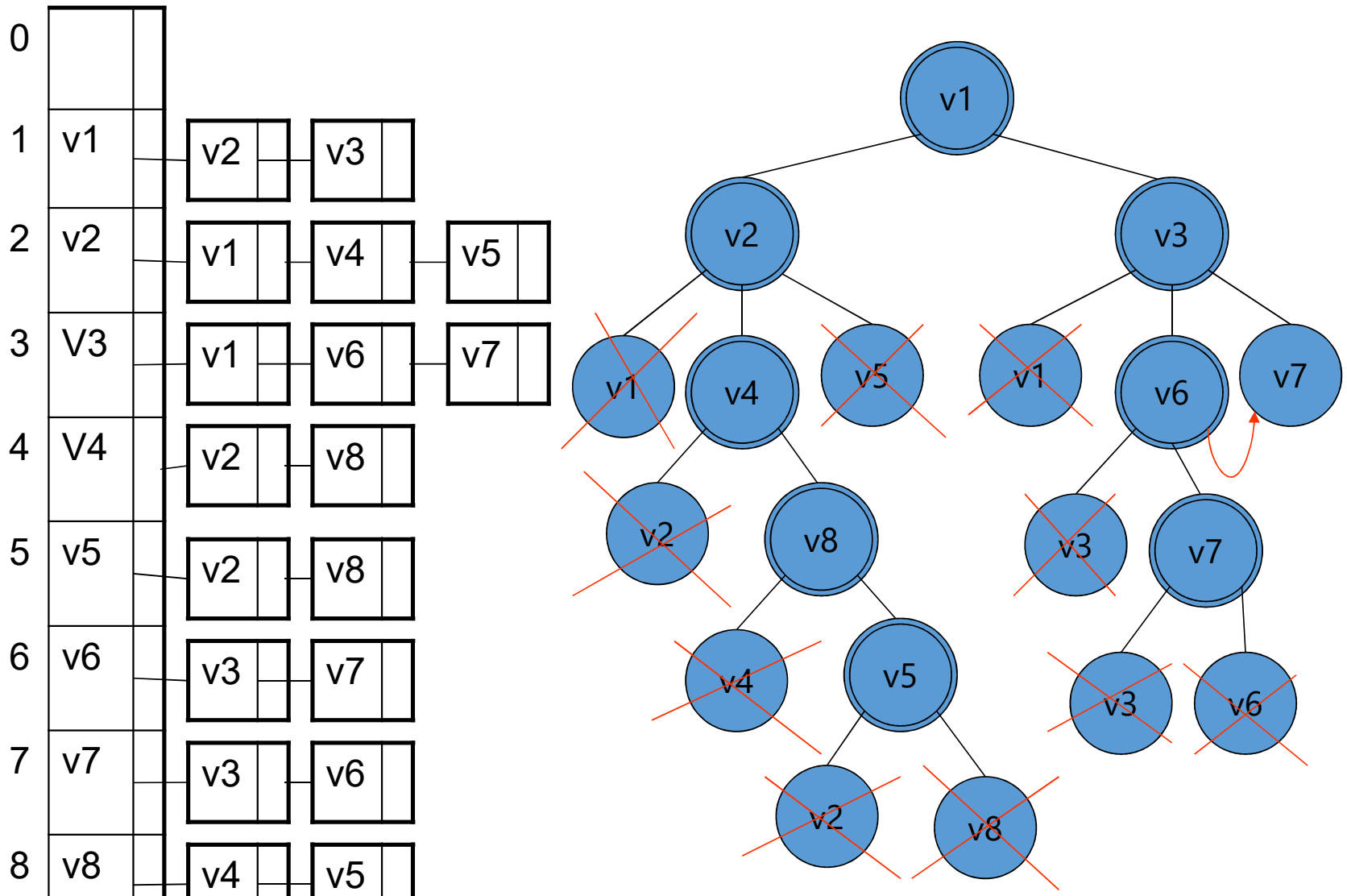


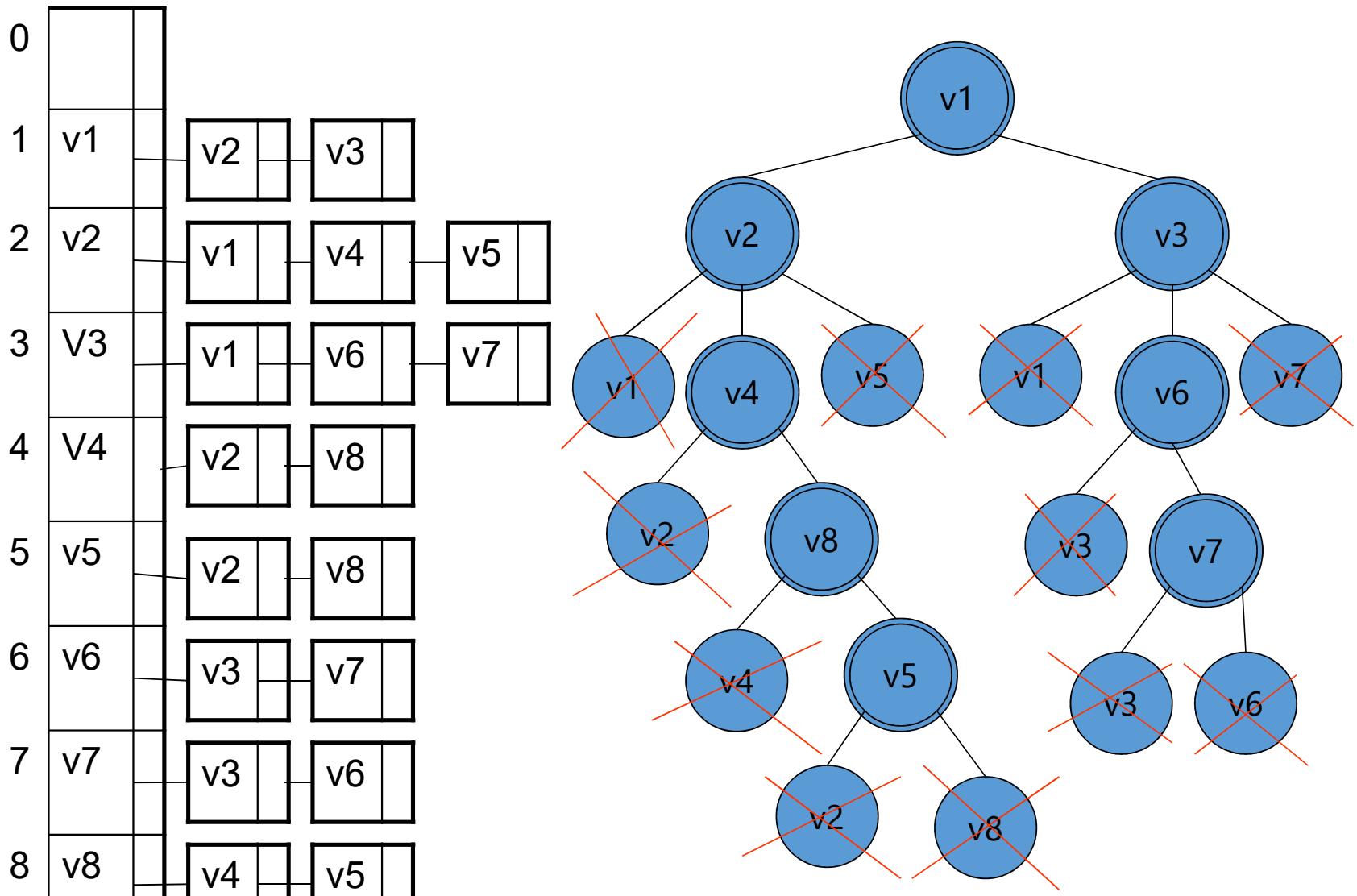


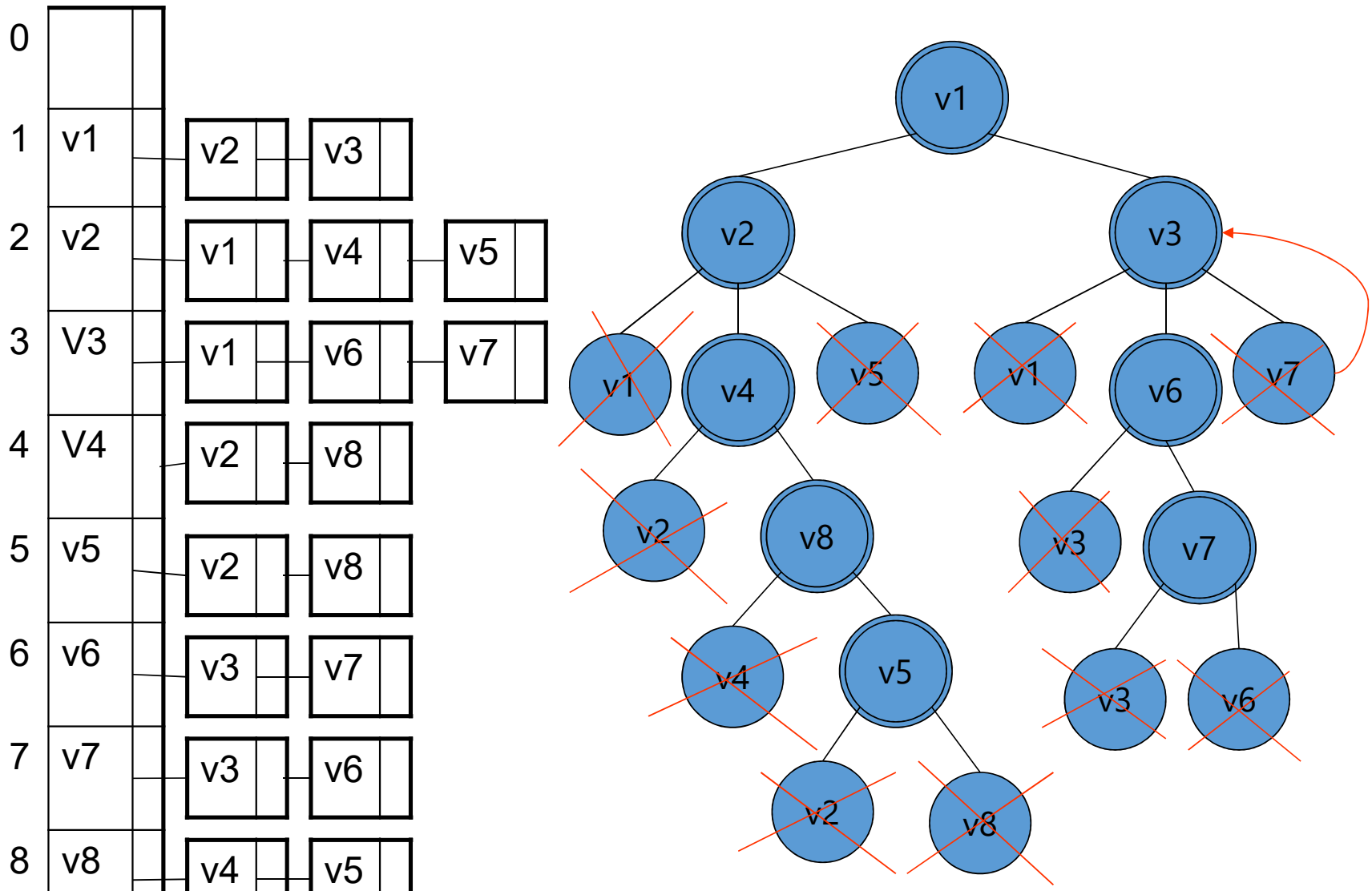


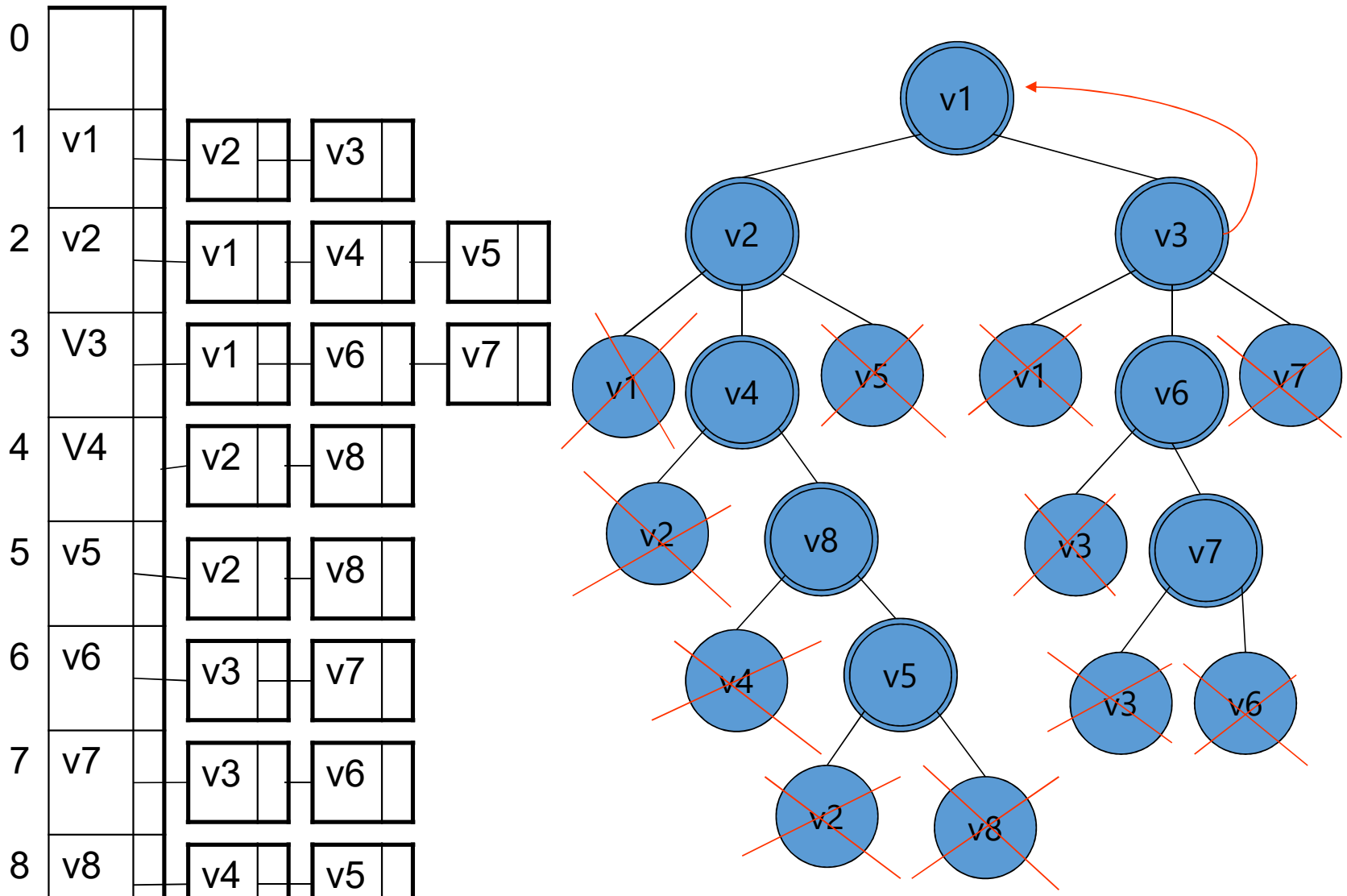




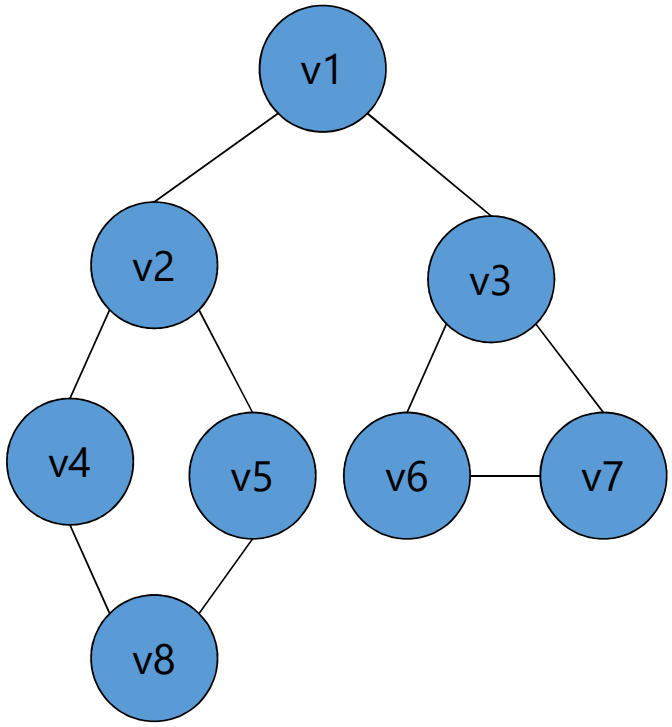


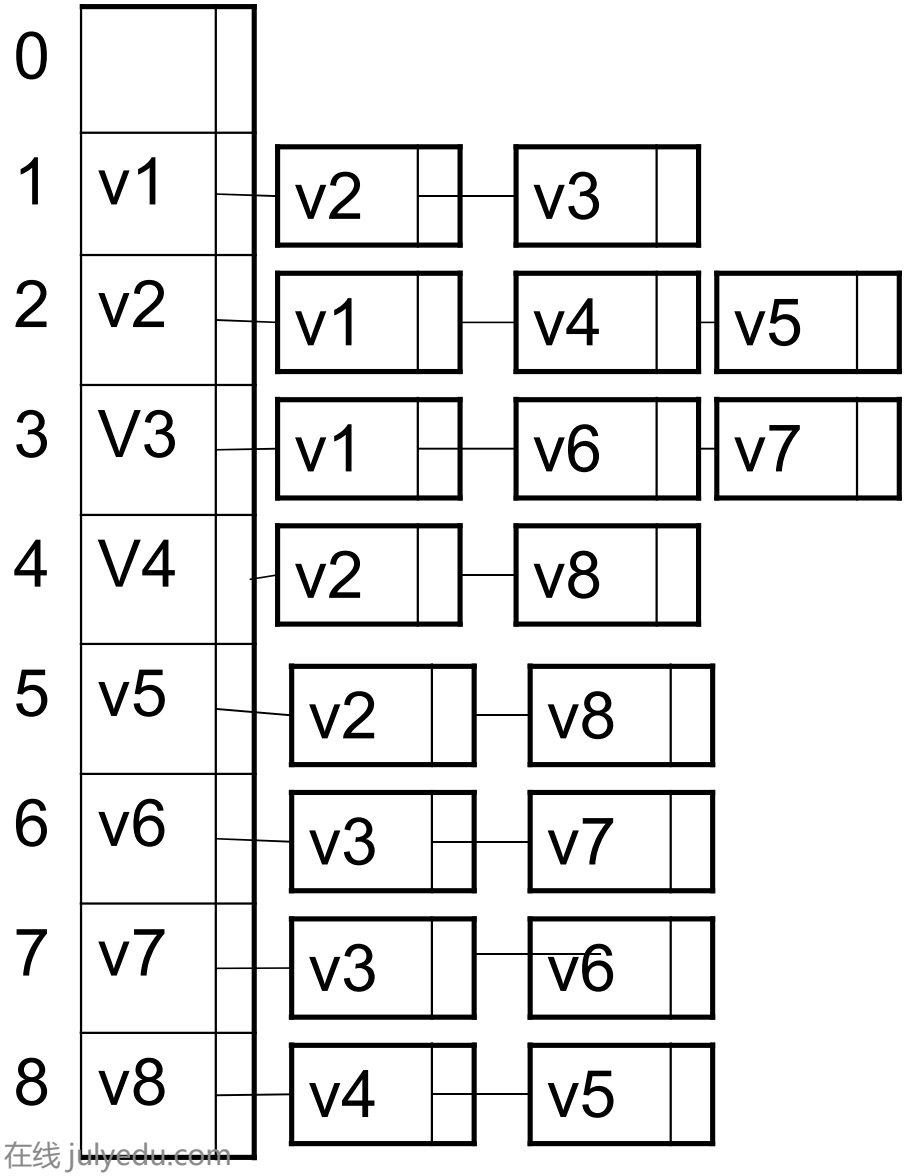


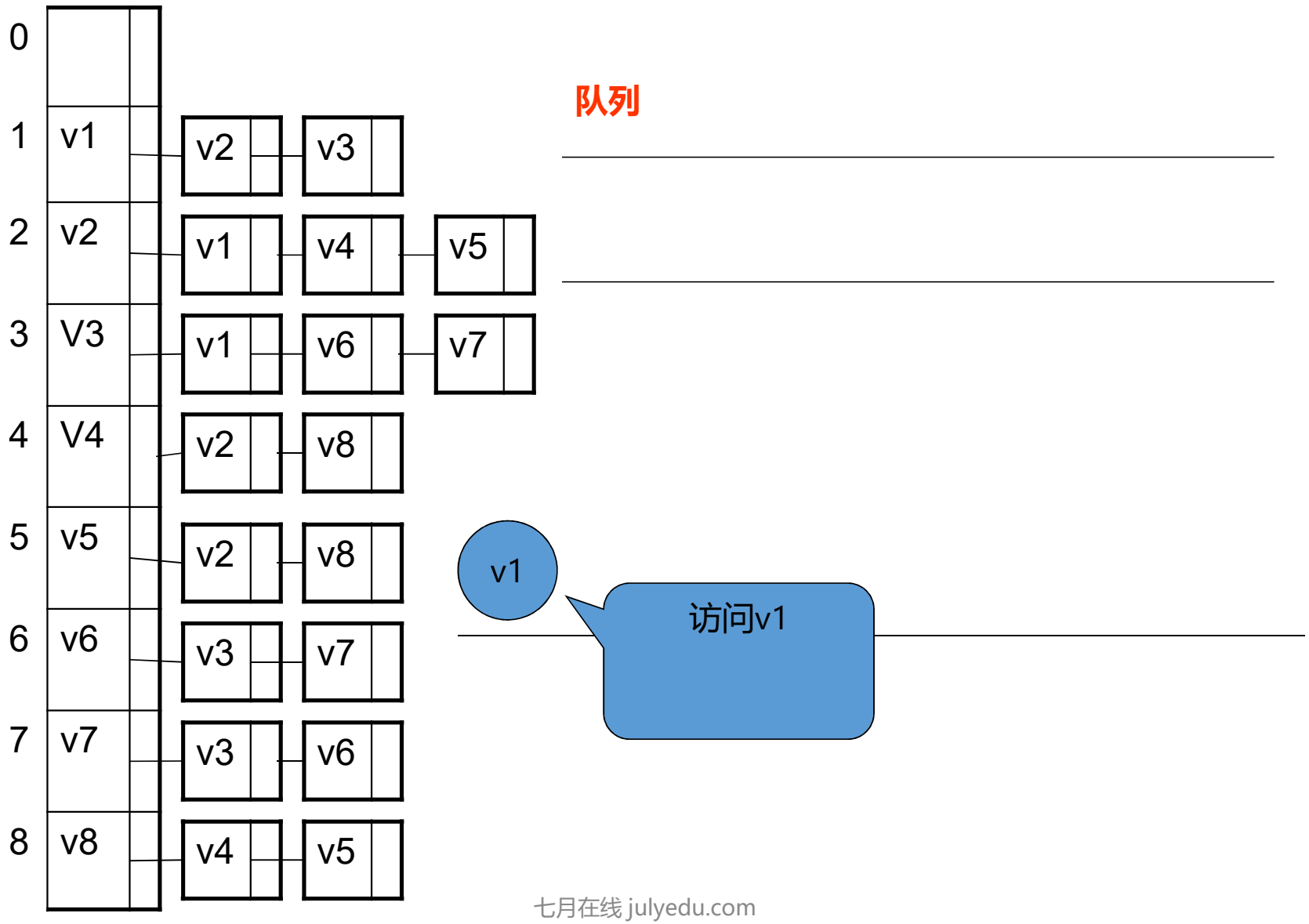


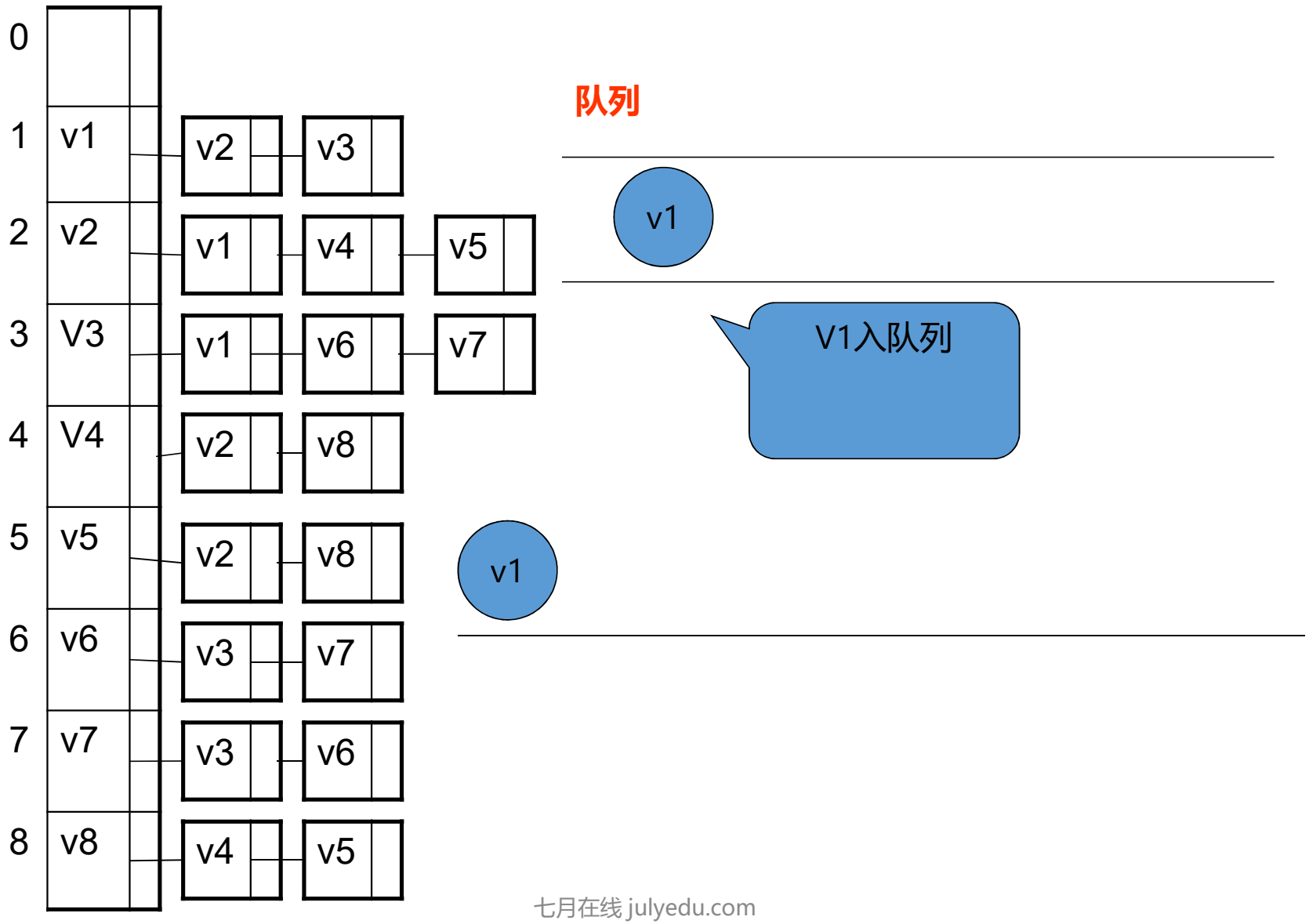


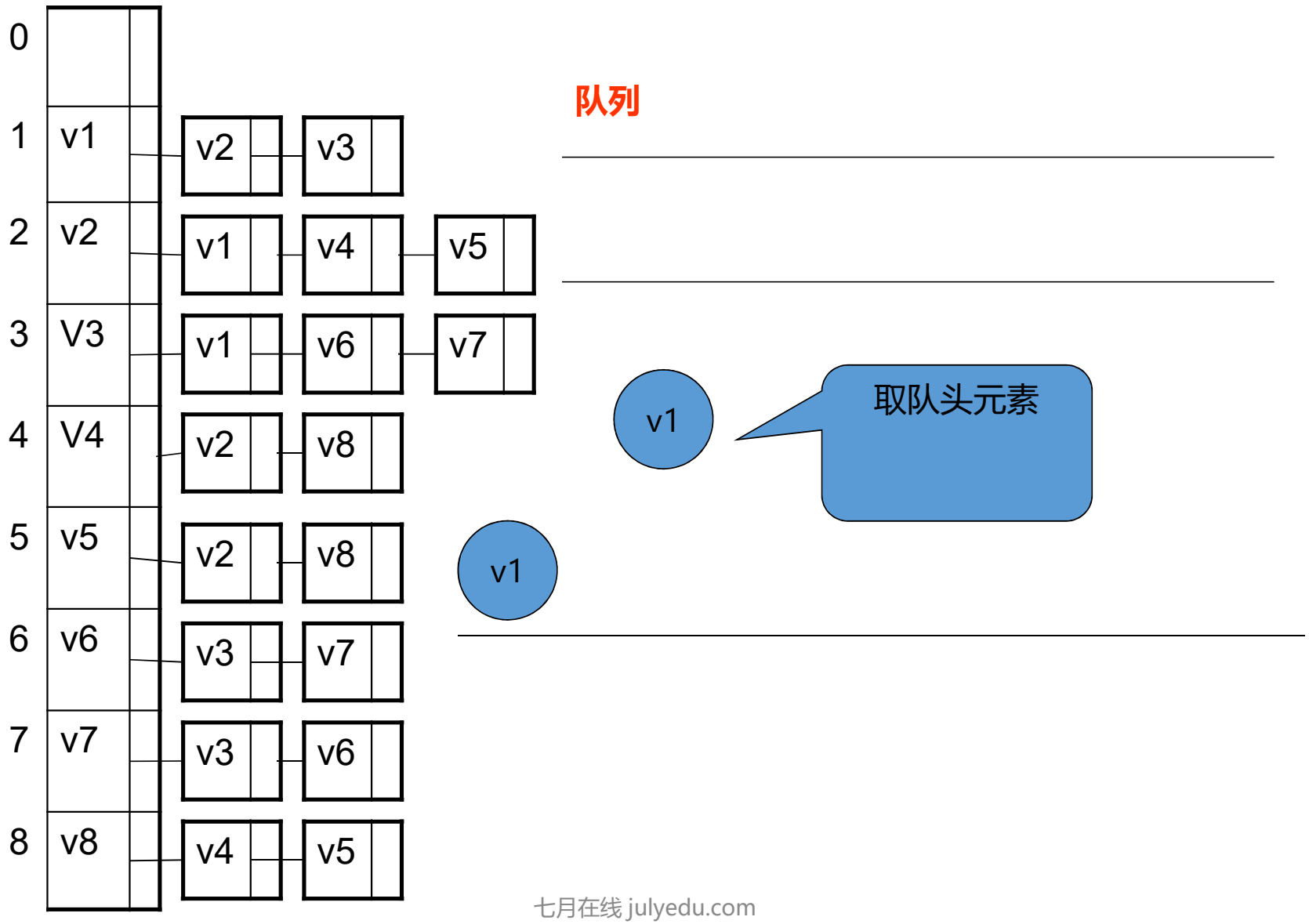
广度优先

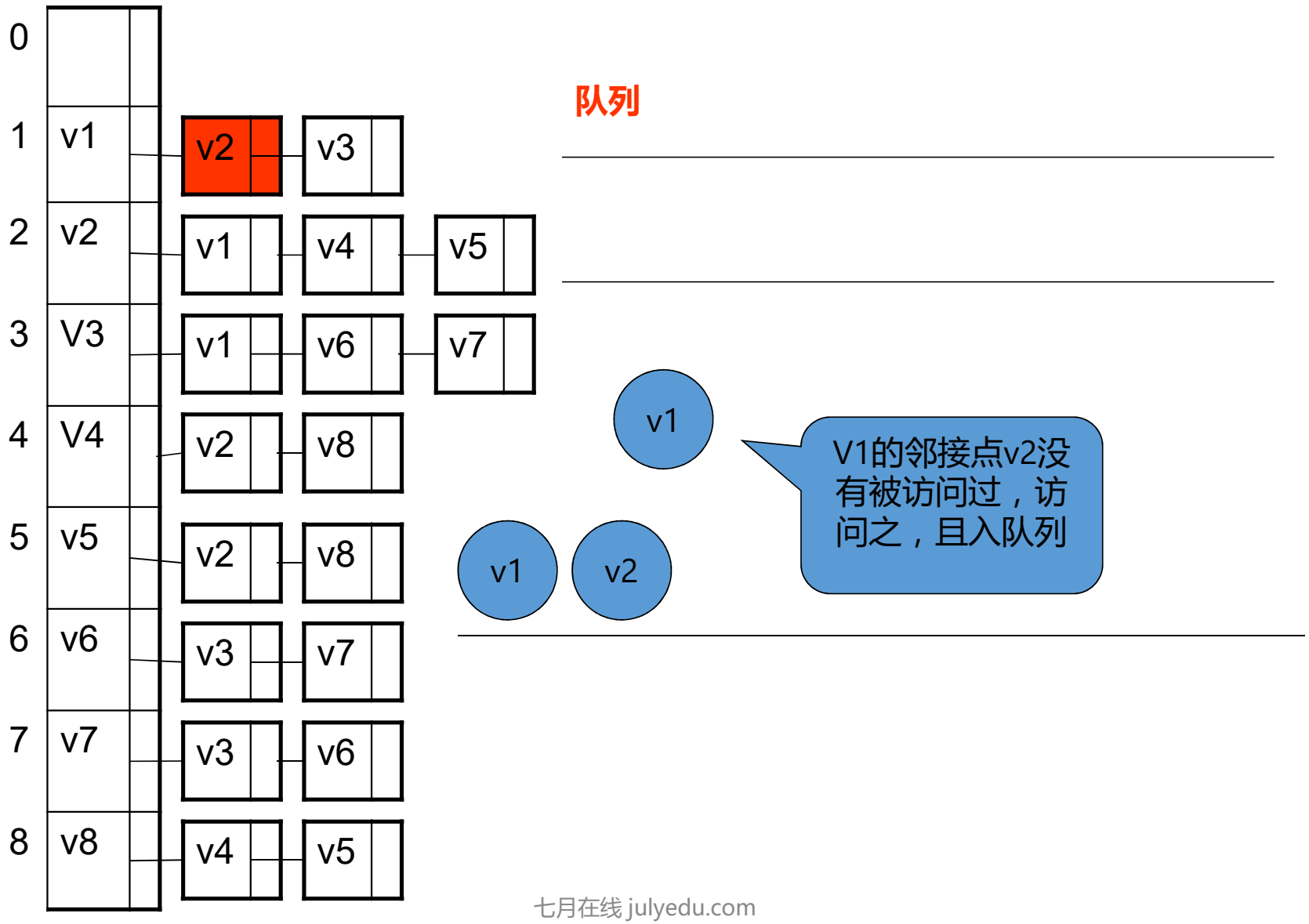


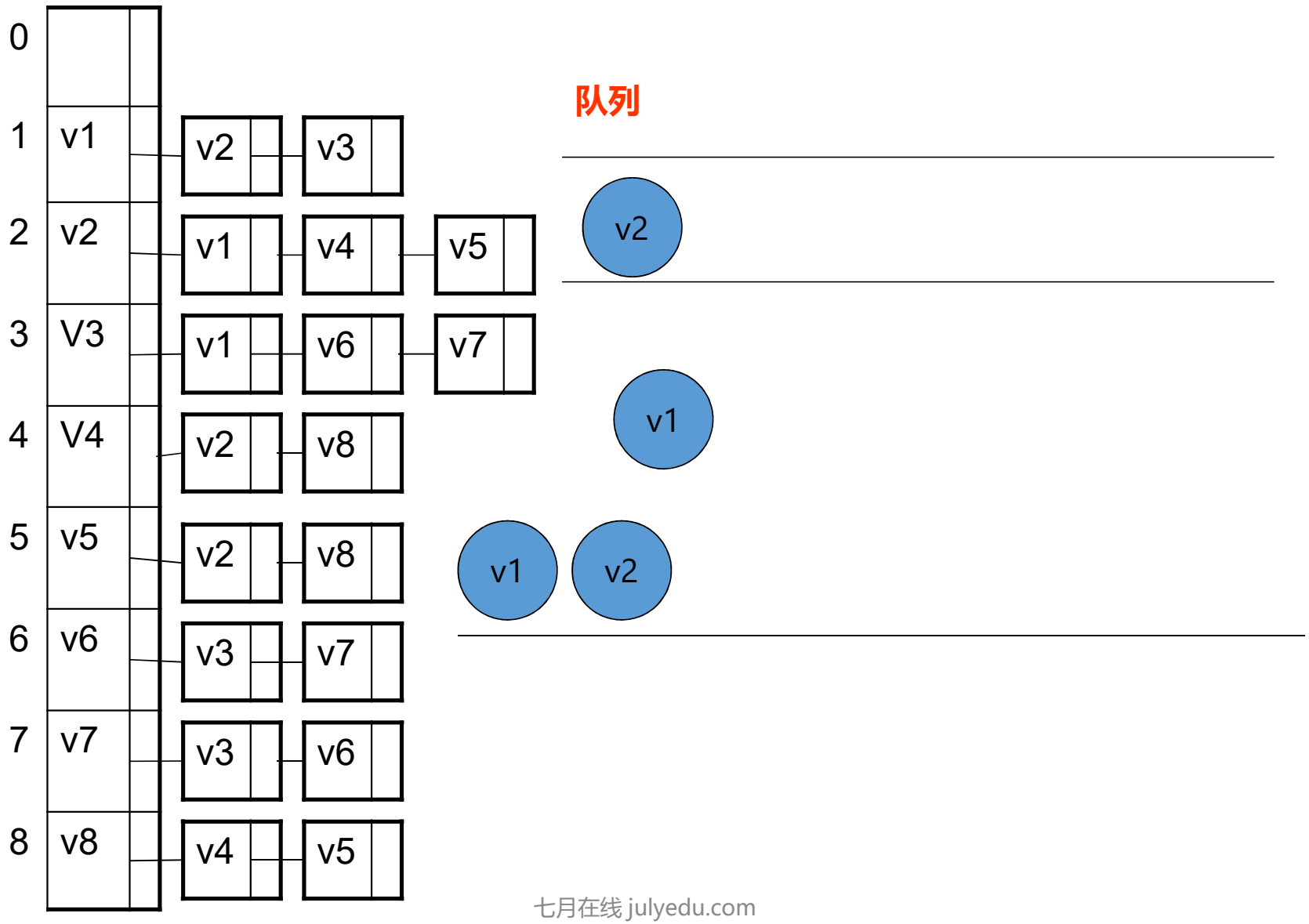


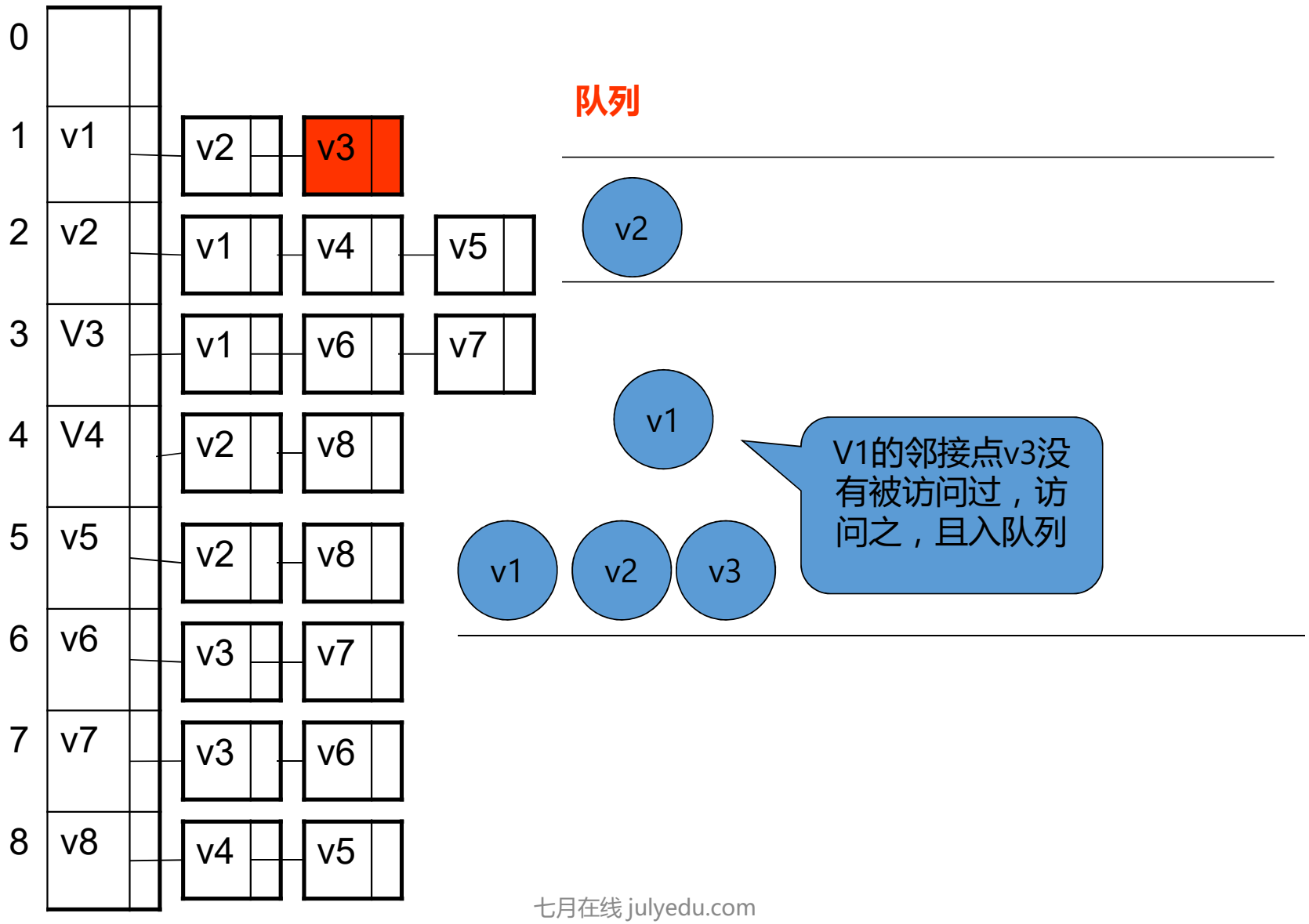


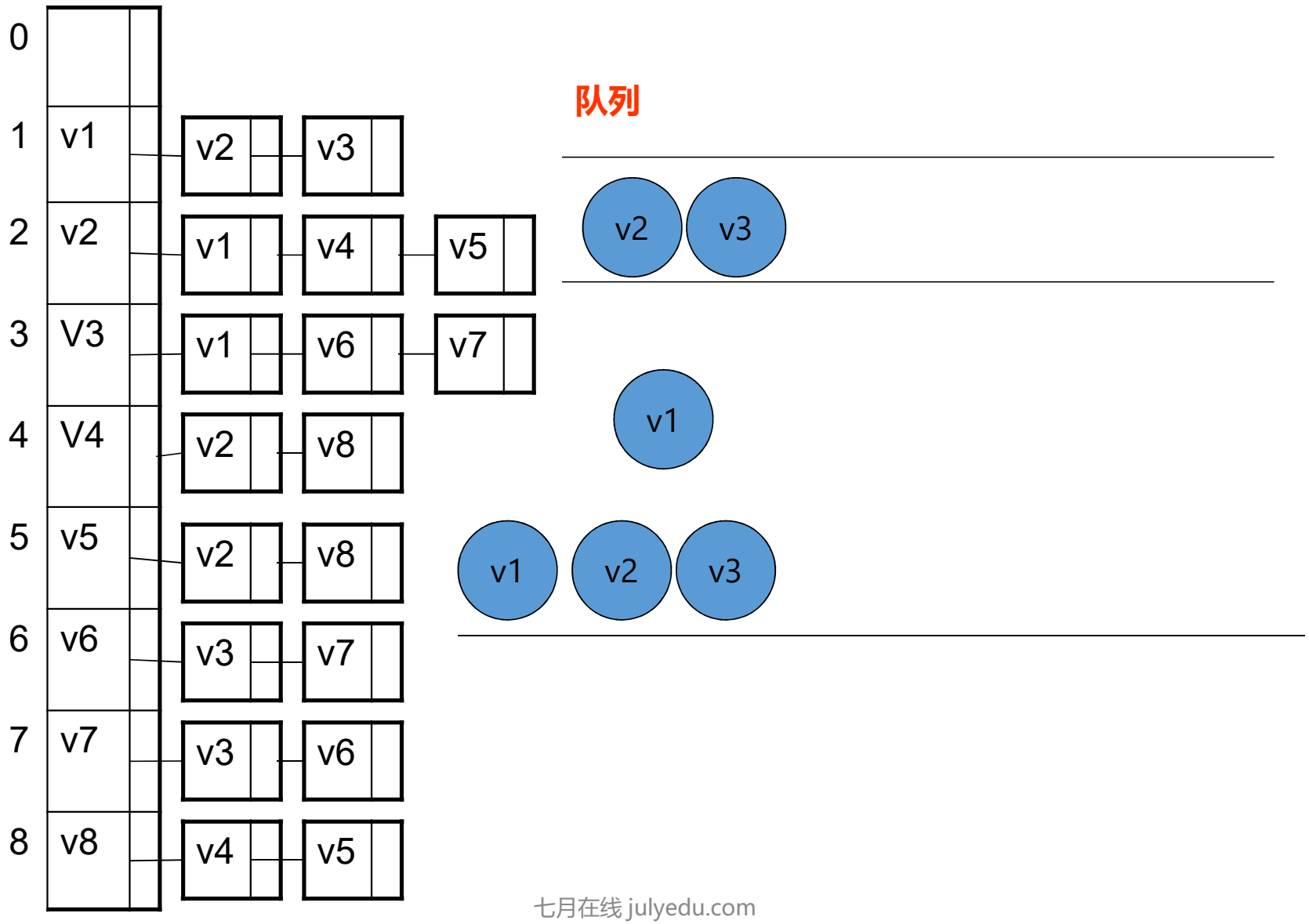


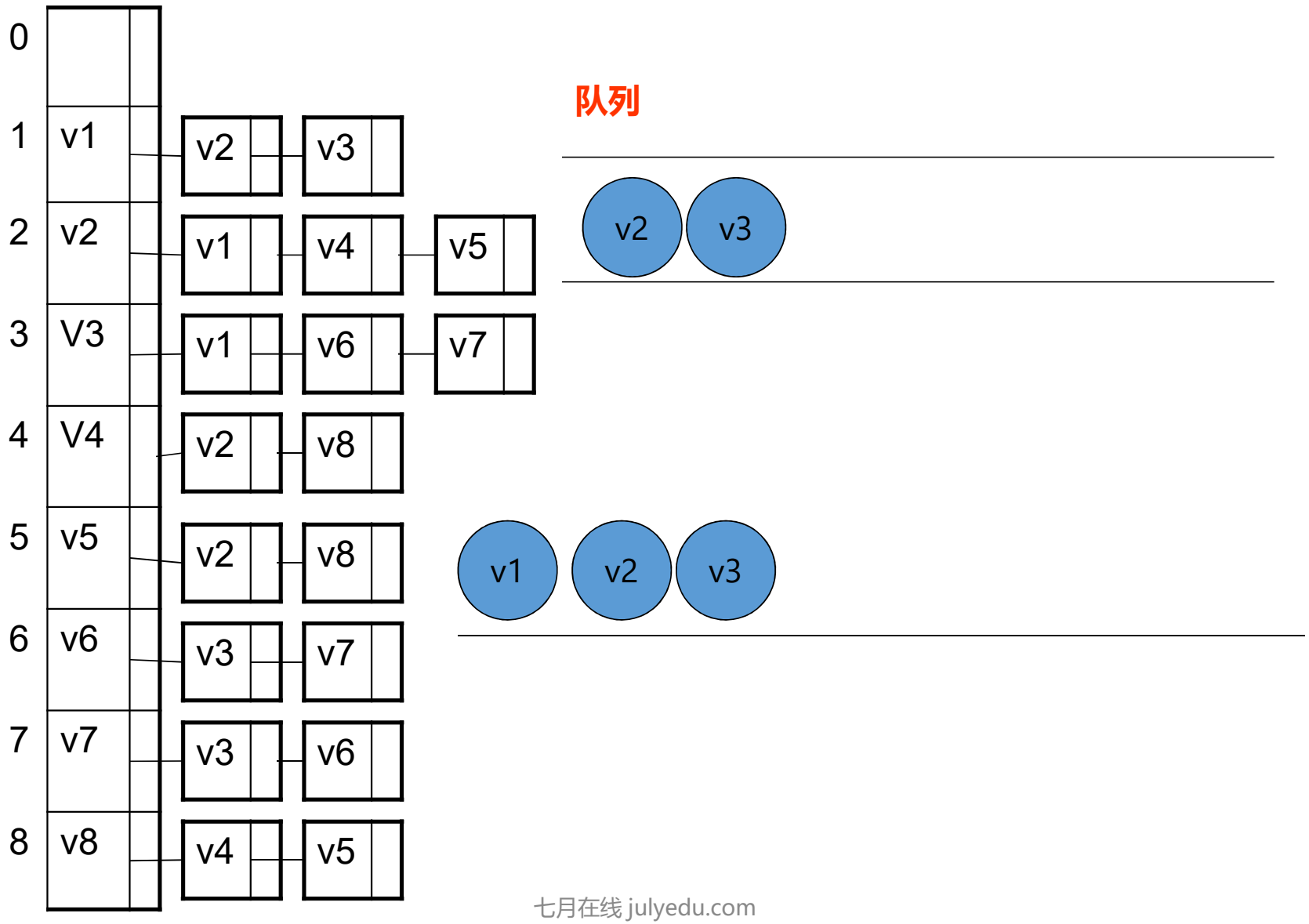


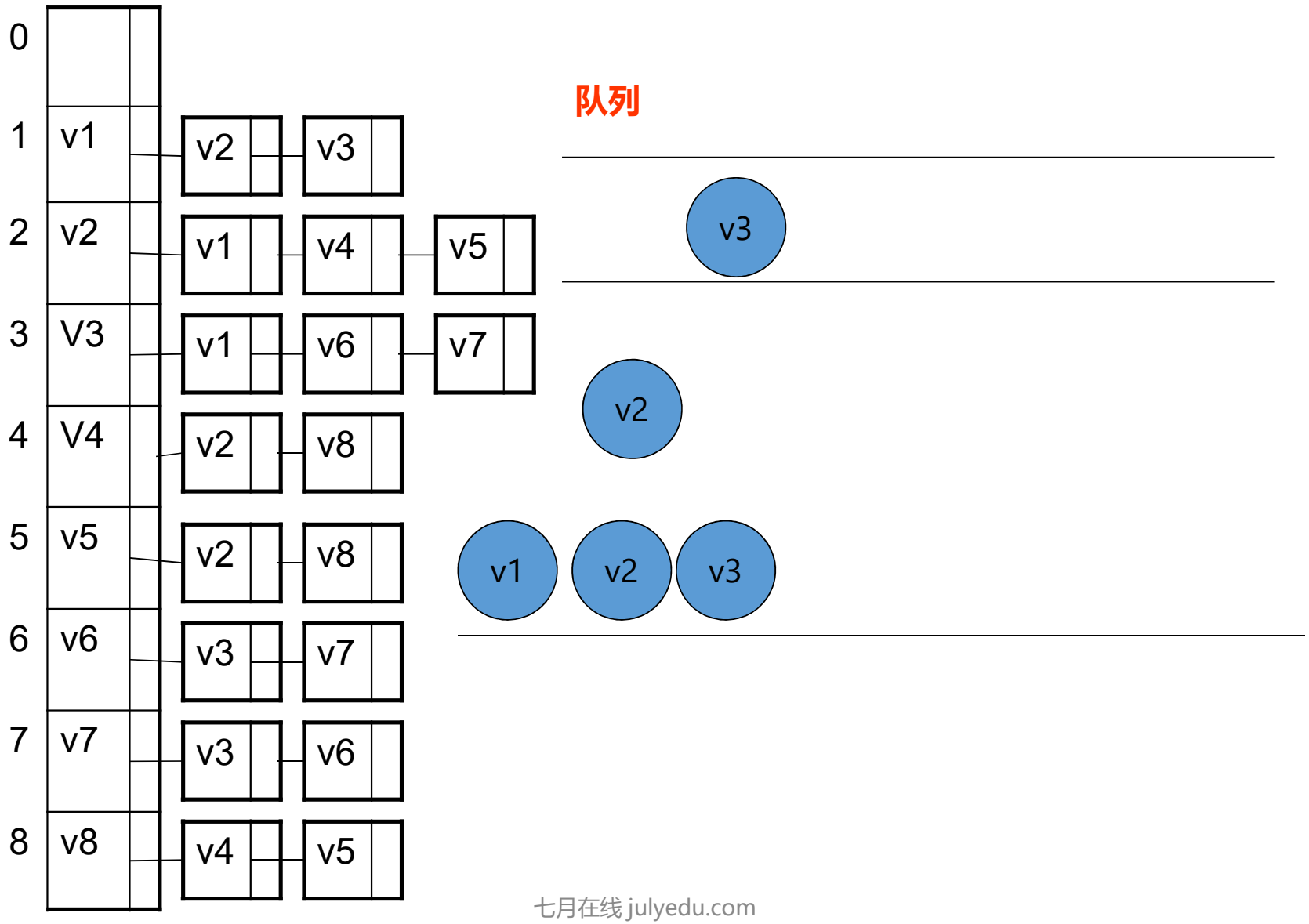

0
1 v1
2 v2
3 V3
4 V4
5 v5
6 v6
7 v7
8 v8
v2
v3
v1
v4
v5
v1
v6
v7
v2
v8
v2
v8
v3
v7
v3
v6
v4
v5
队列
v1
v1
v2
V1的邻接点v2没有被访问过，访问之，且入队列

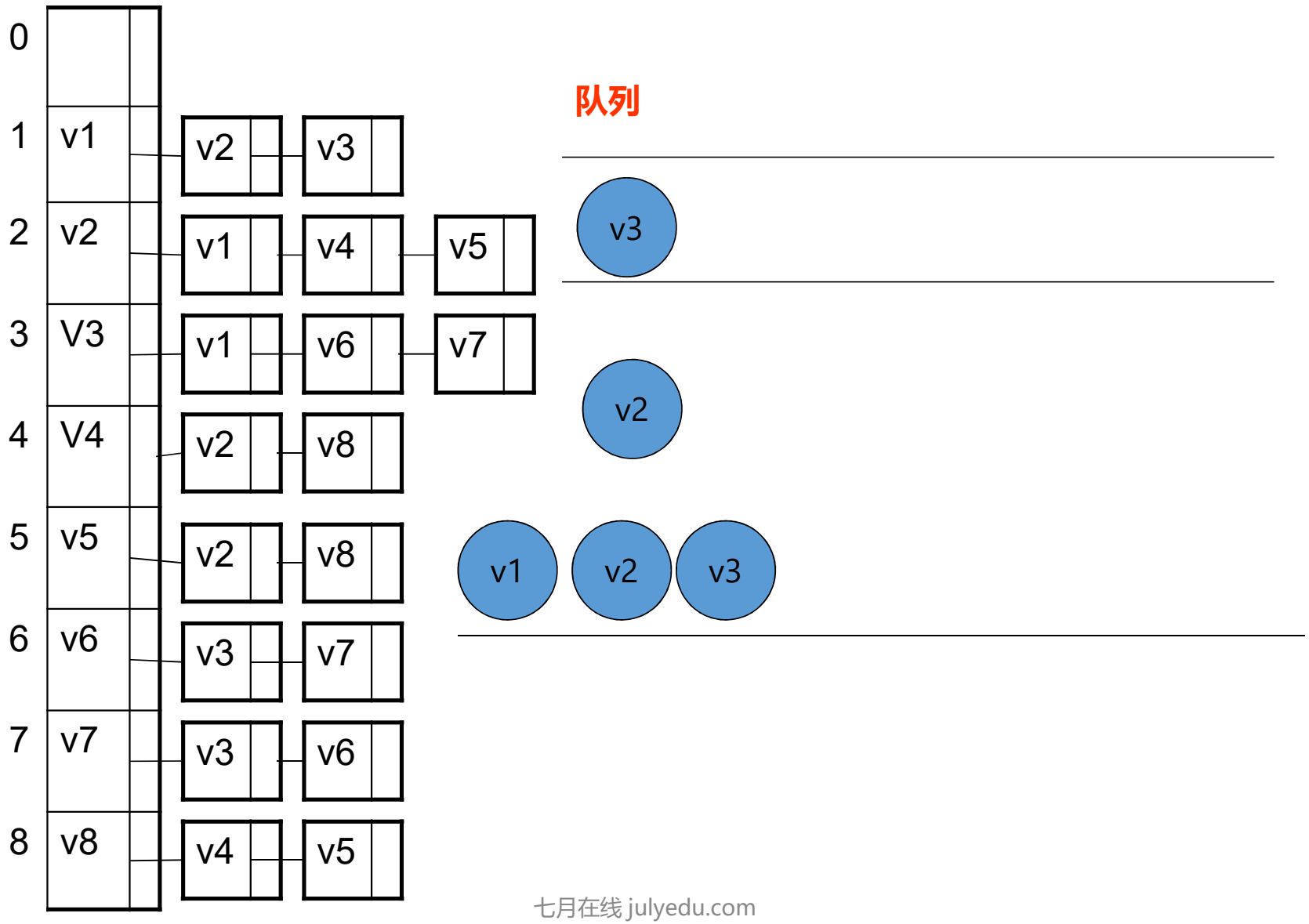


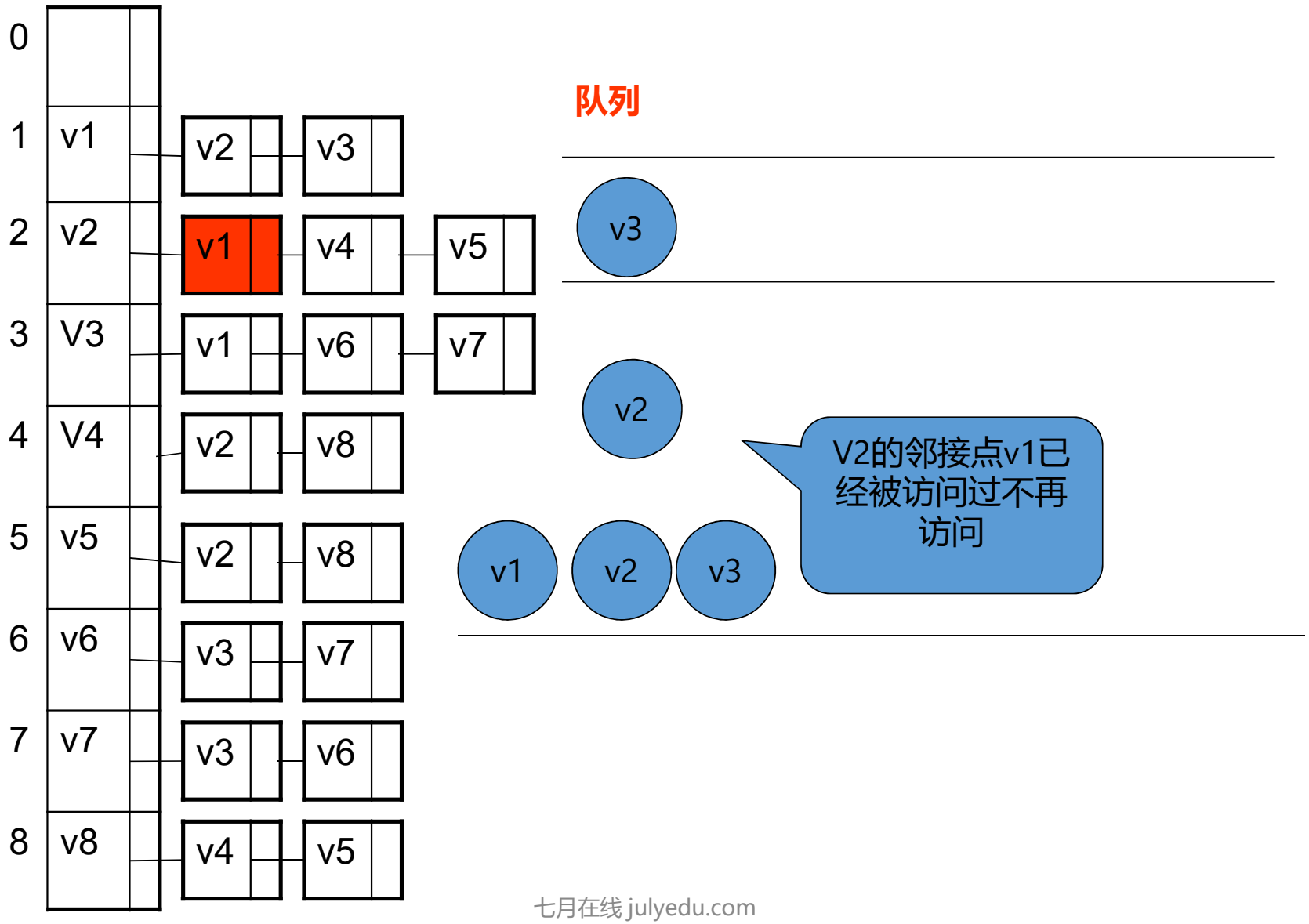


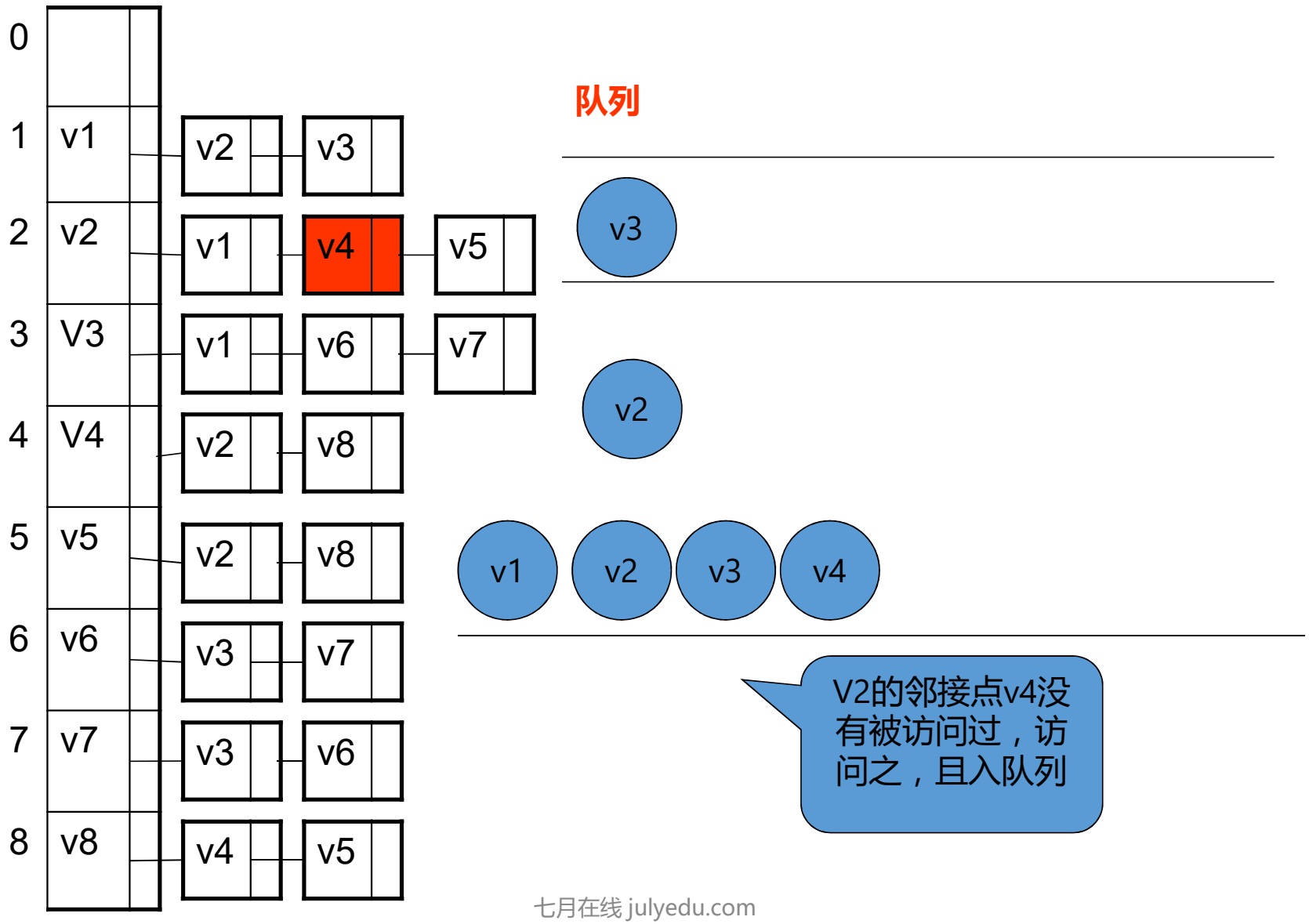


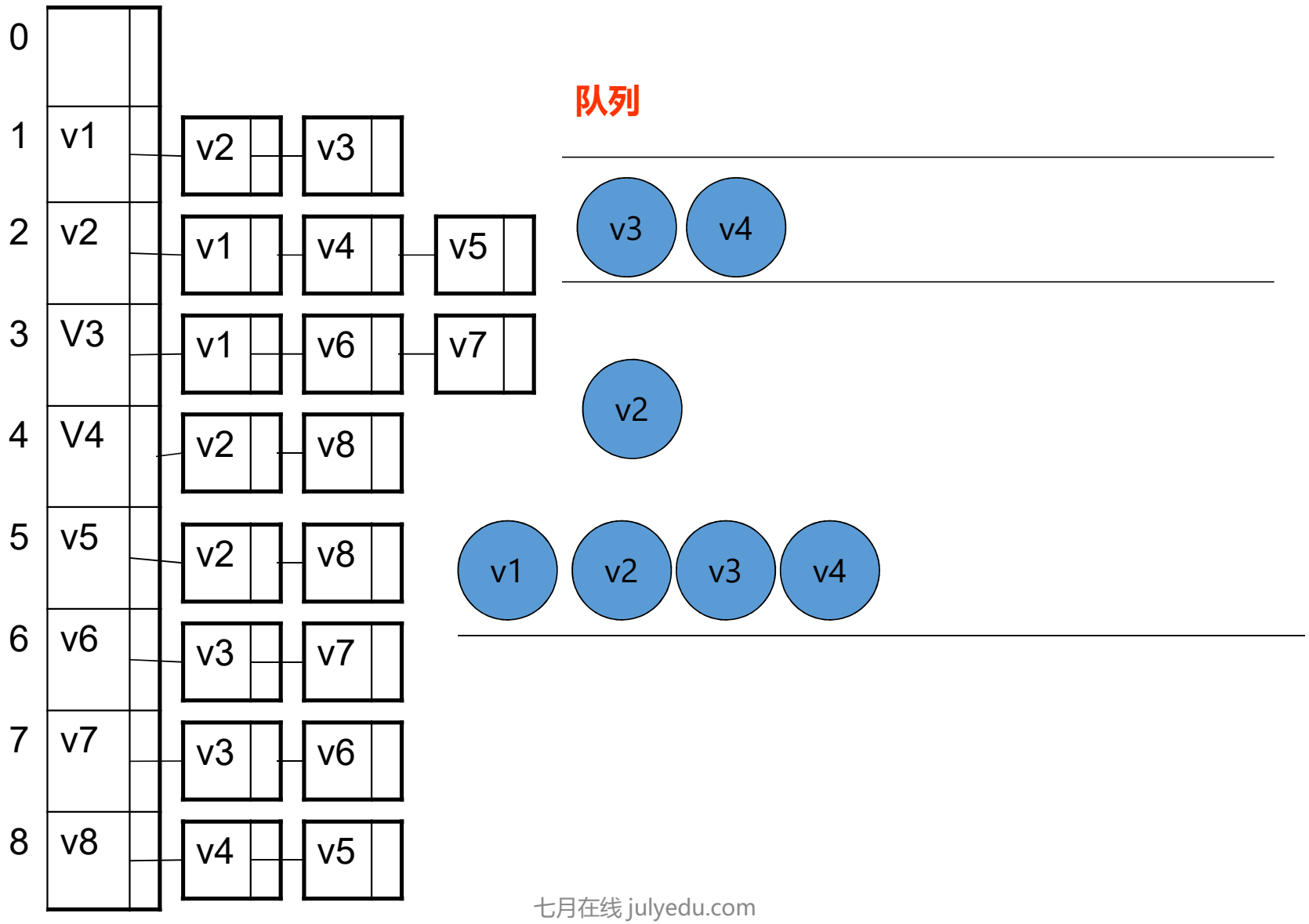


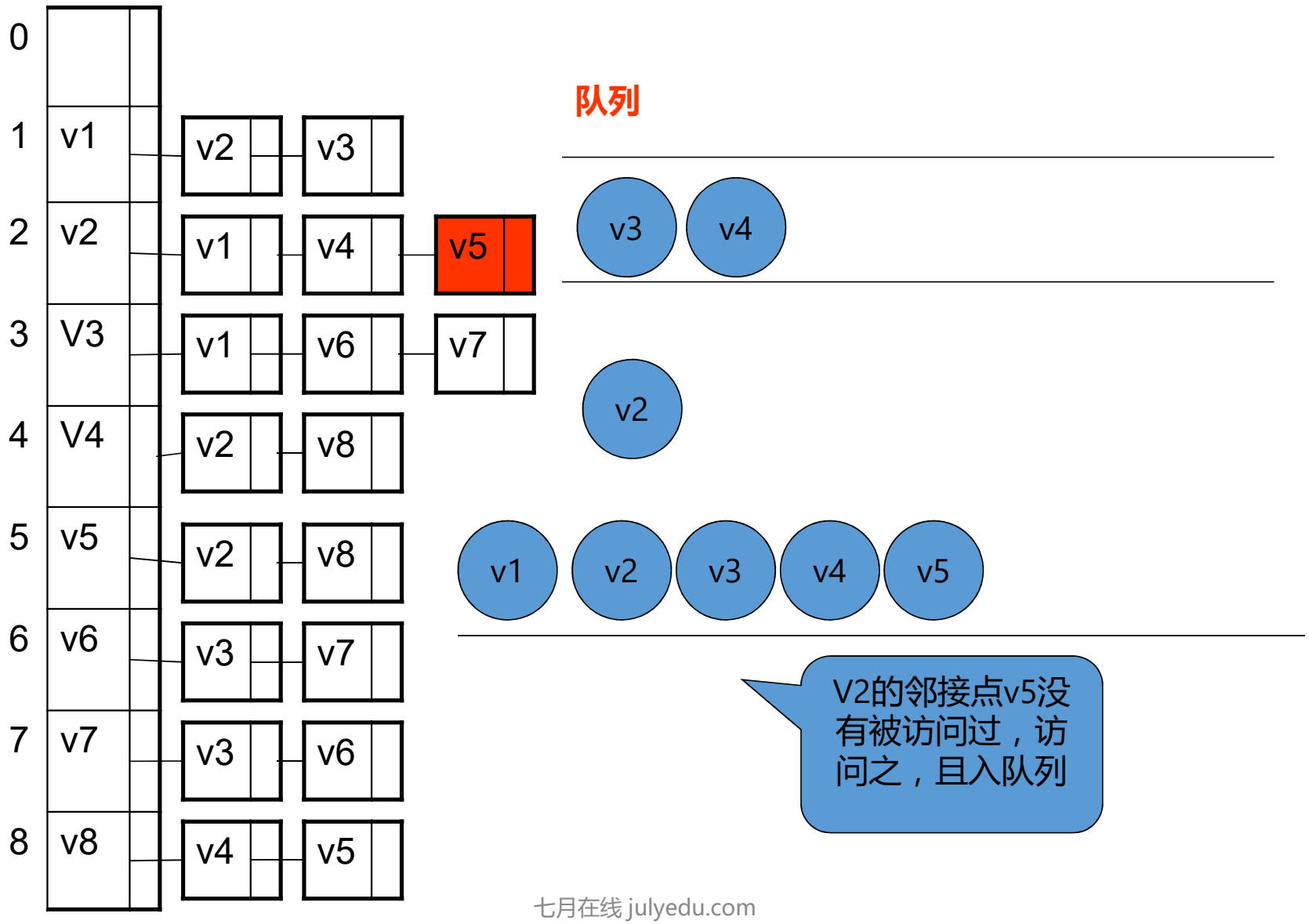


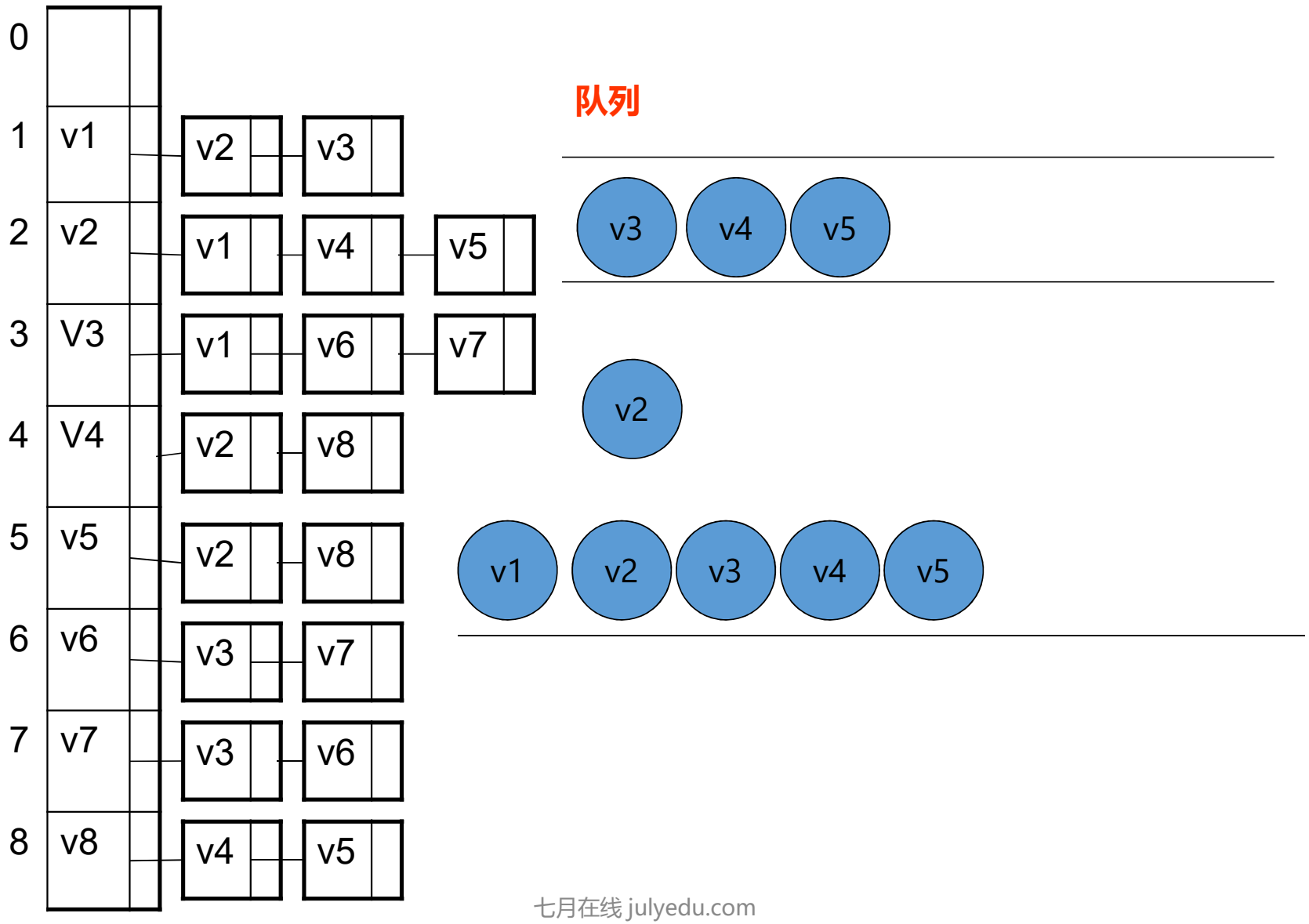


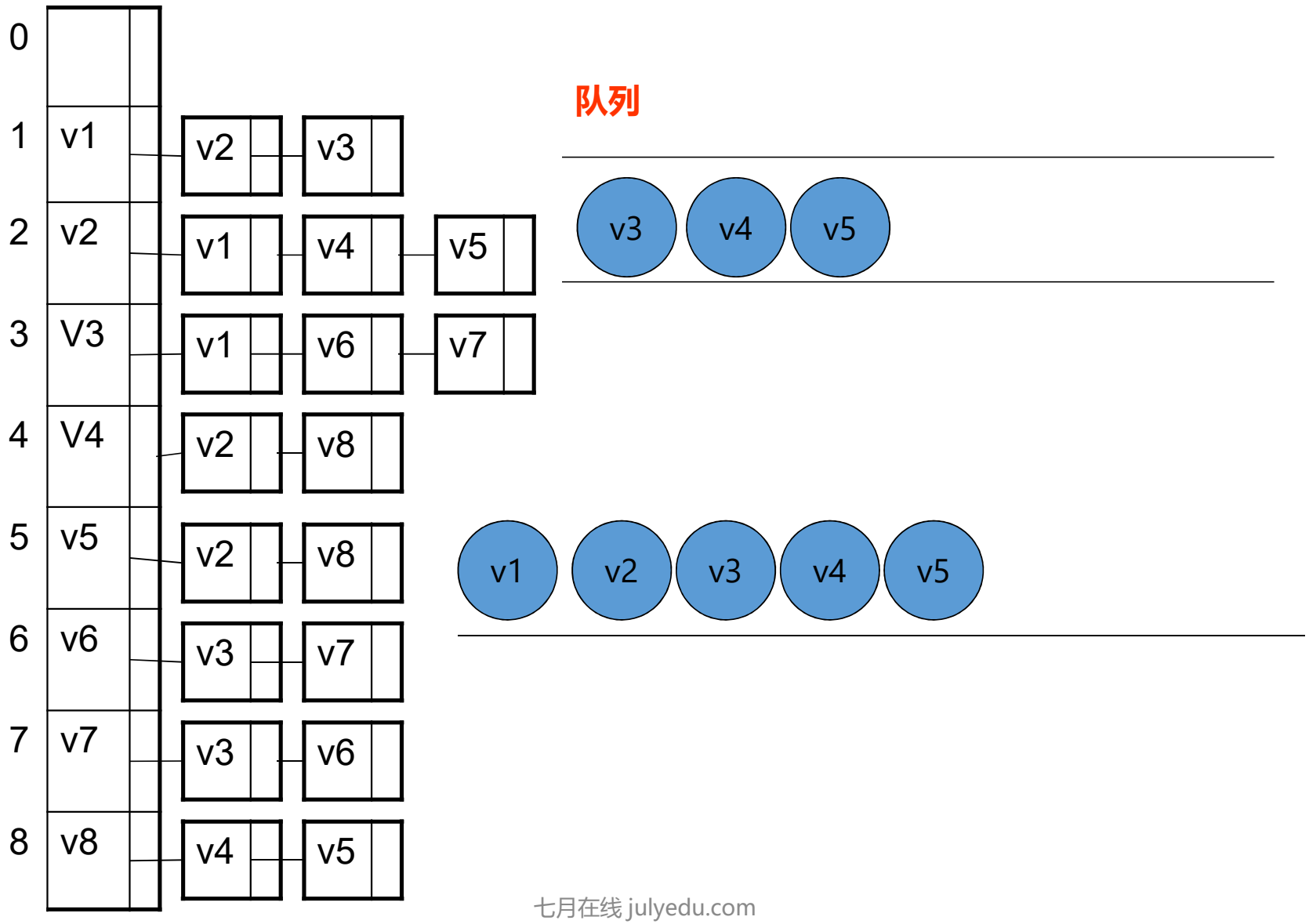


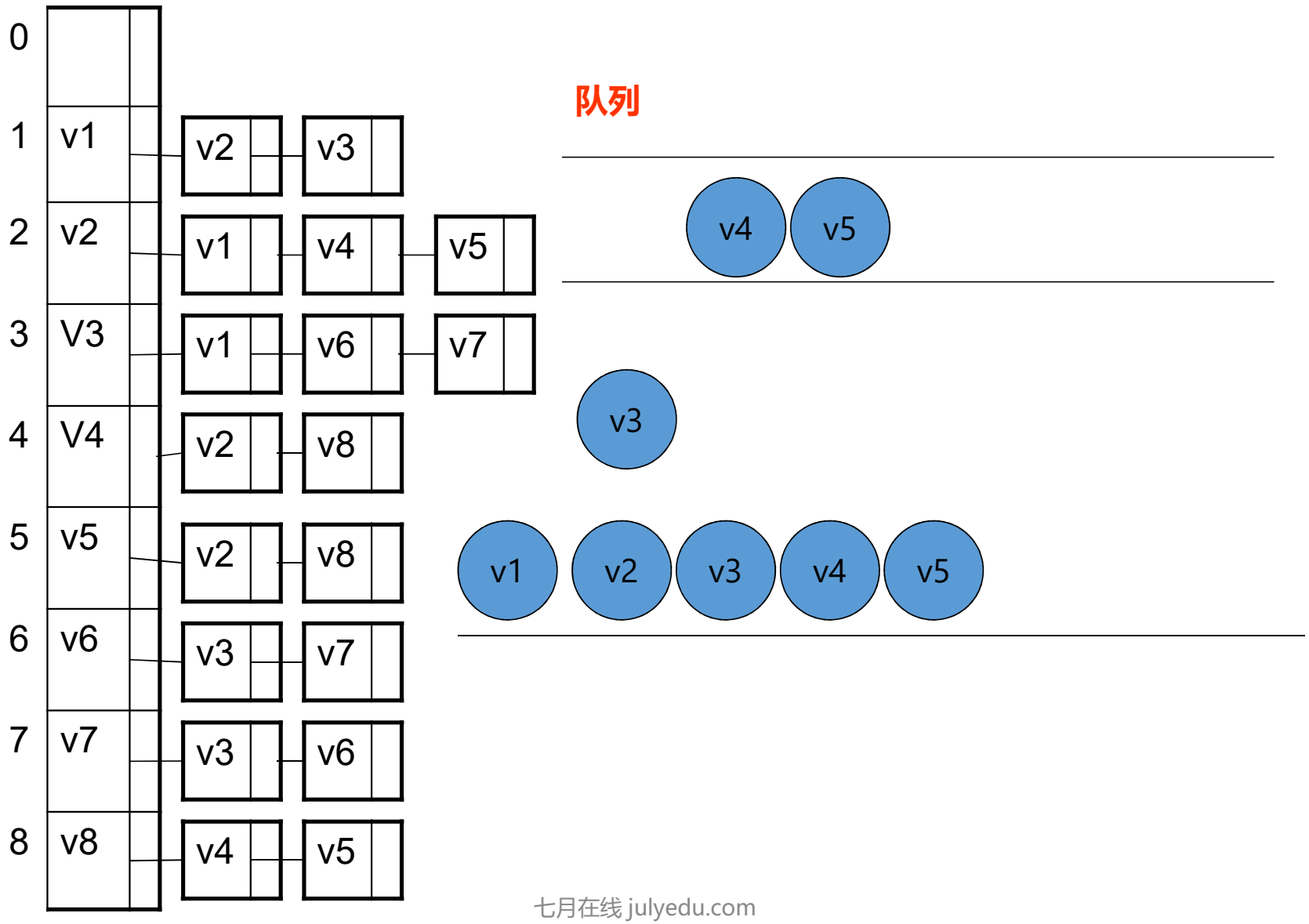


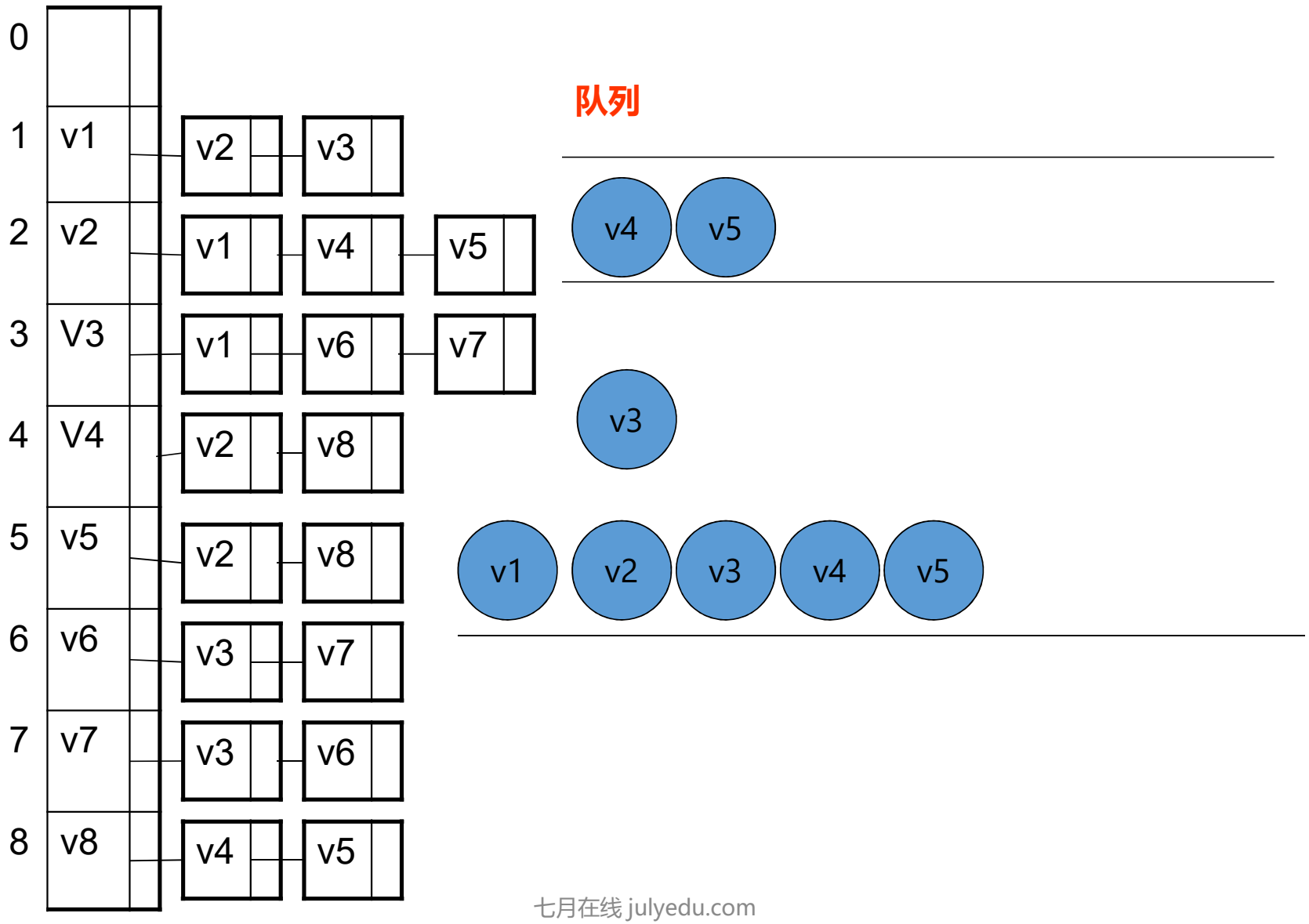


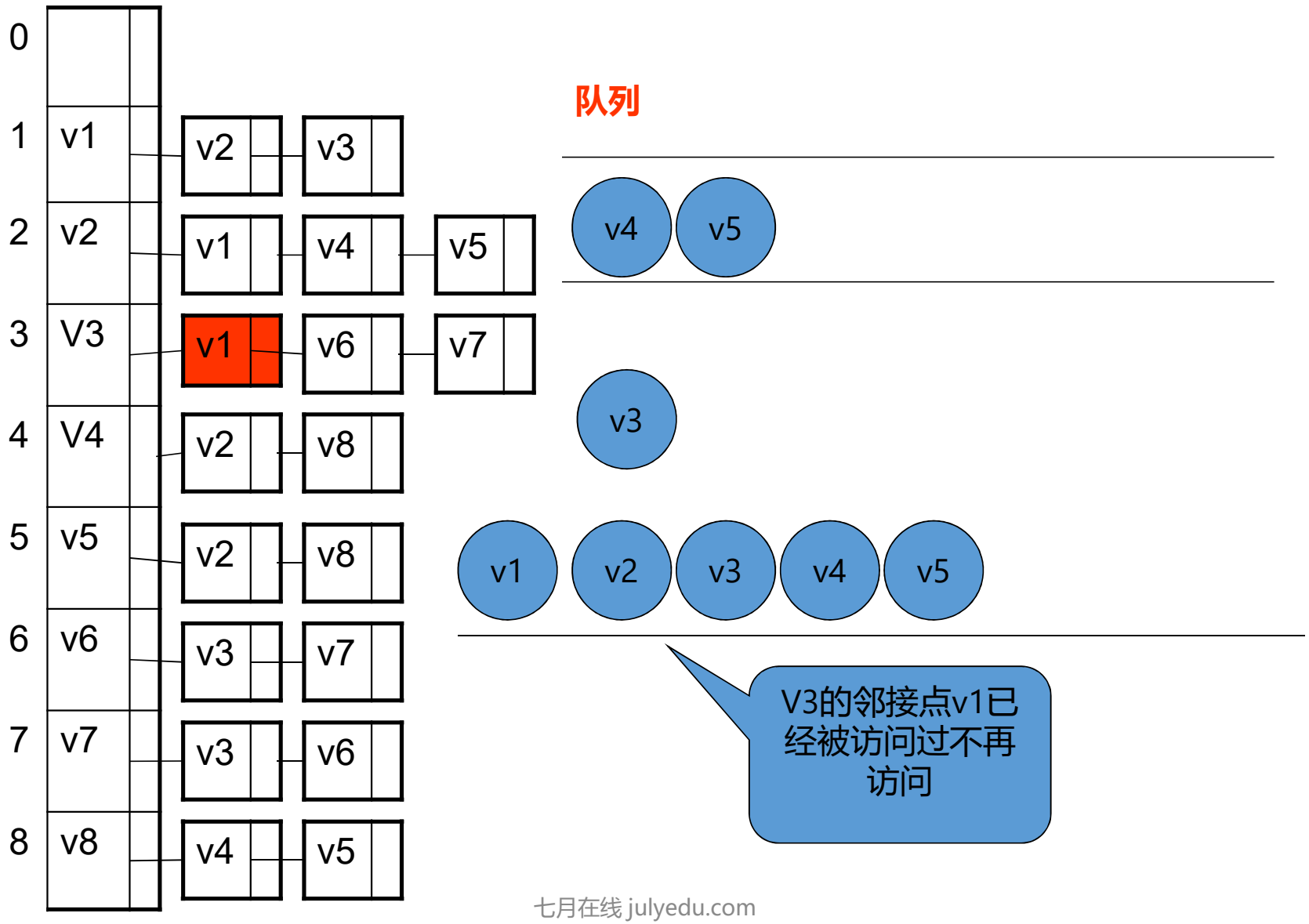


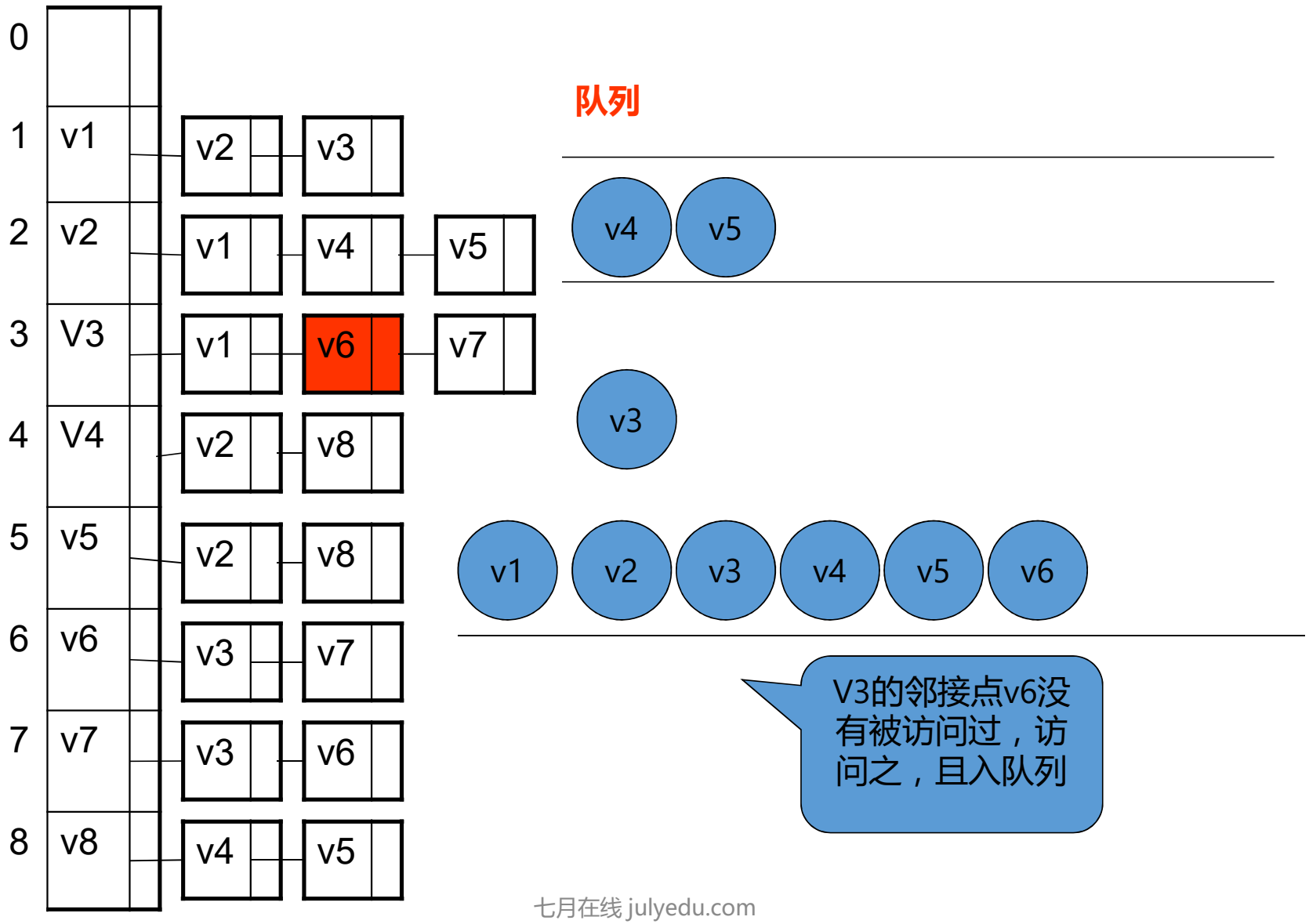


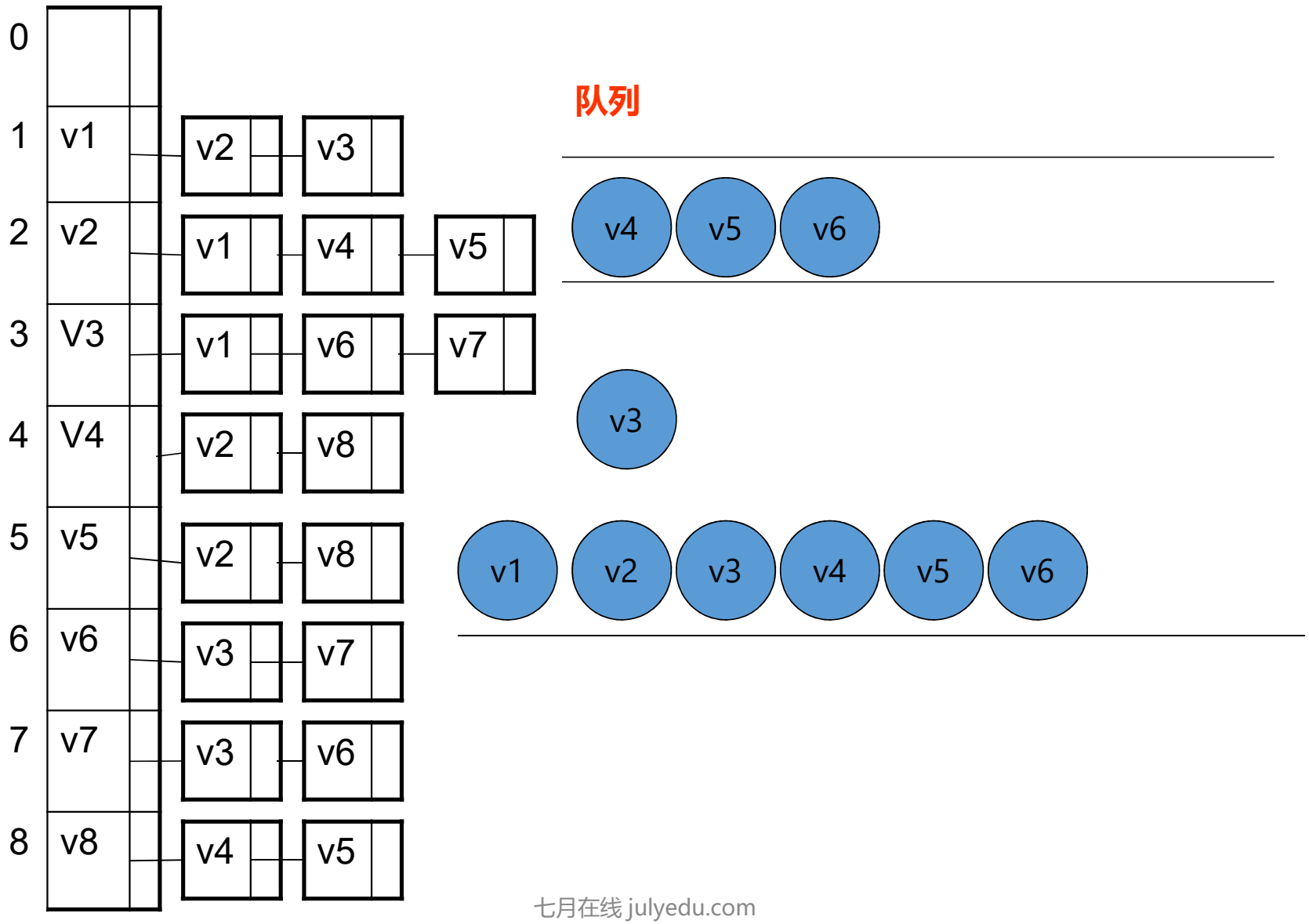


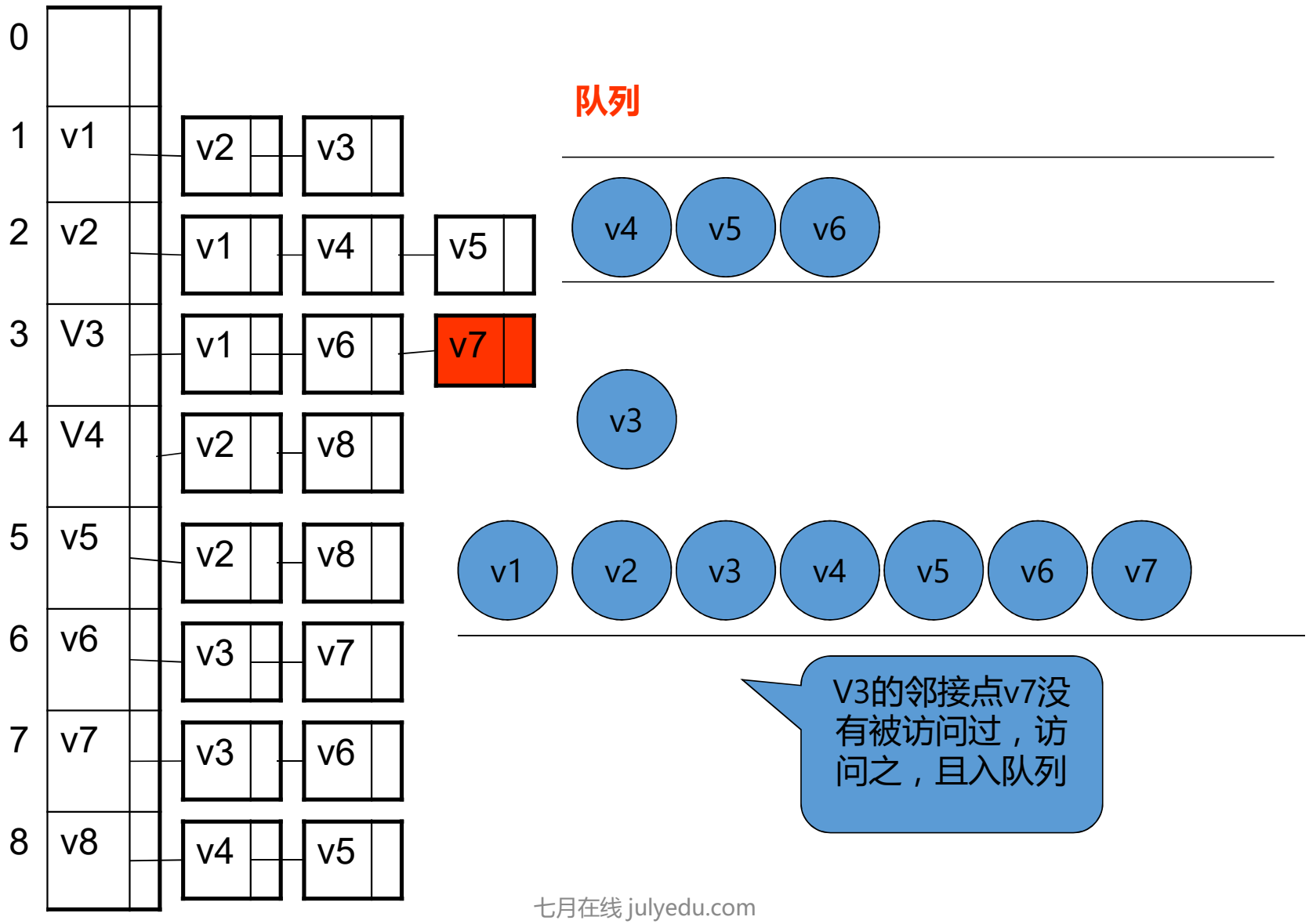


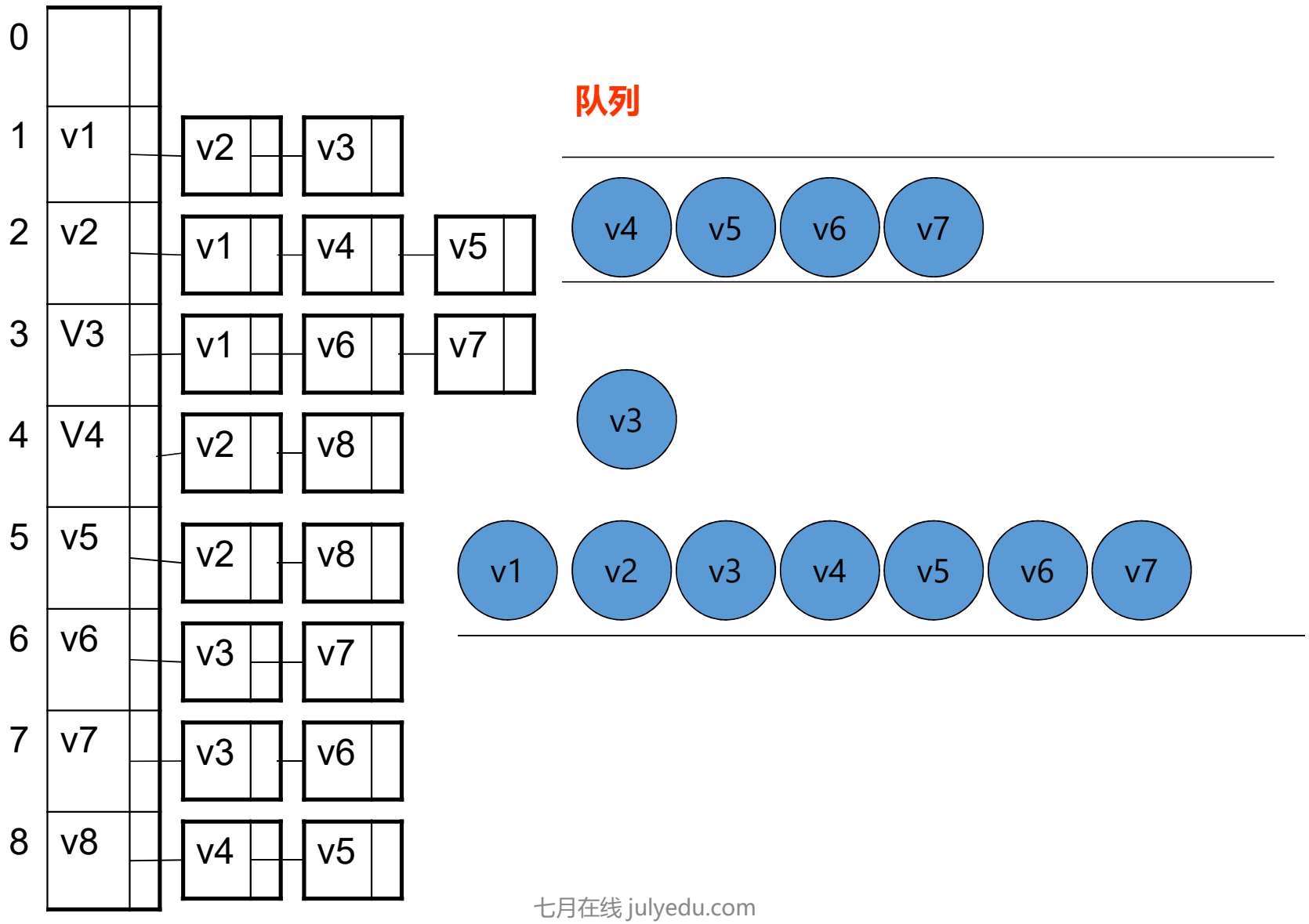


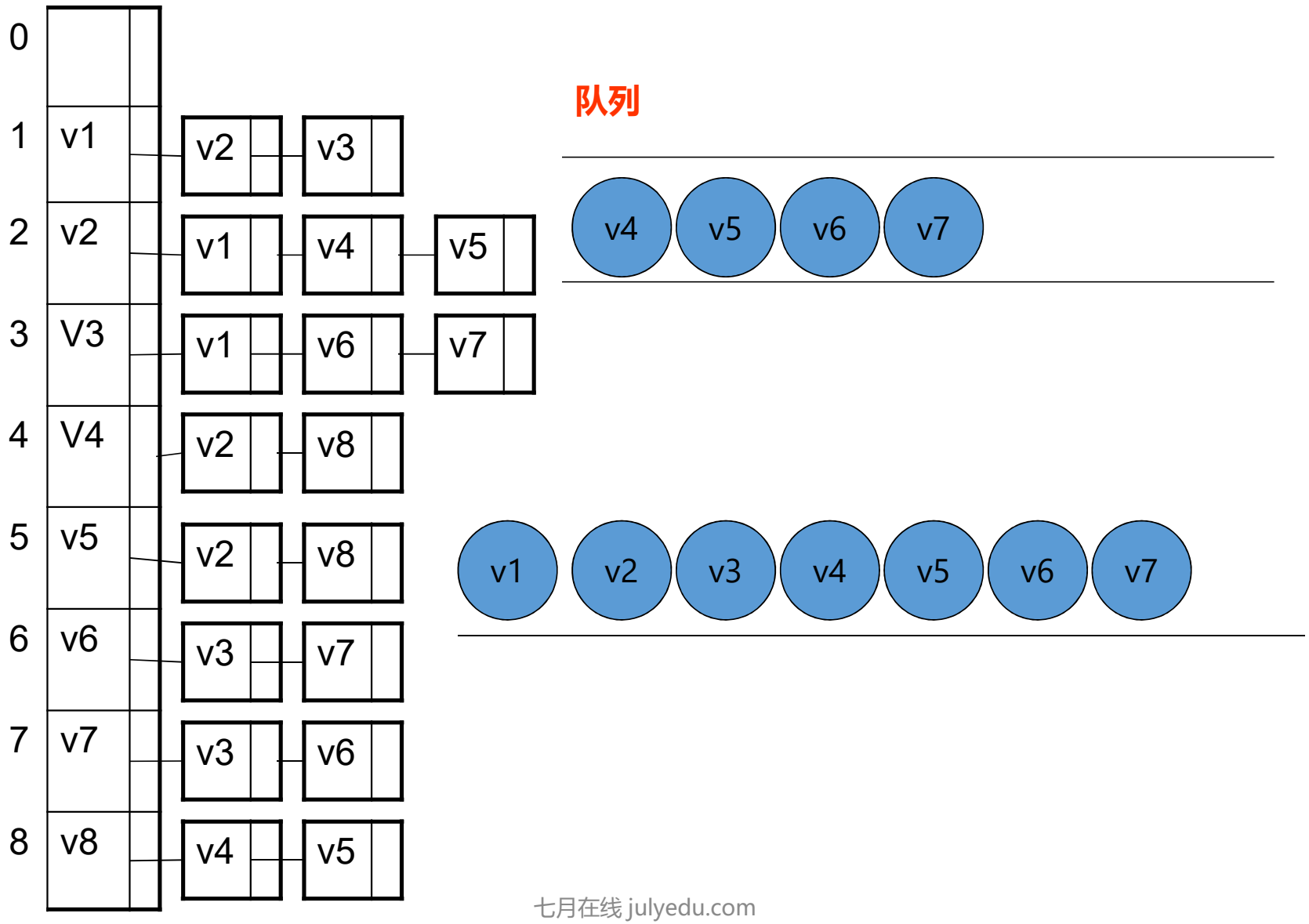


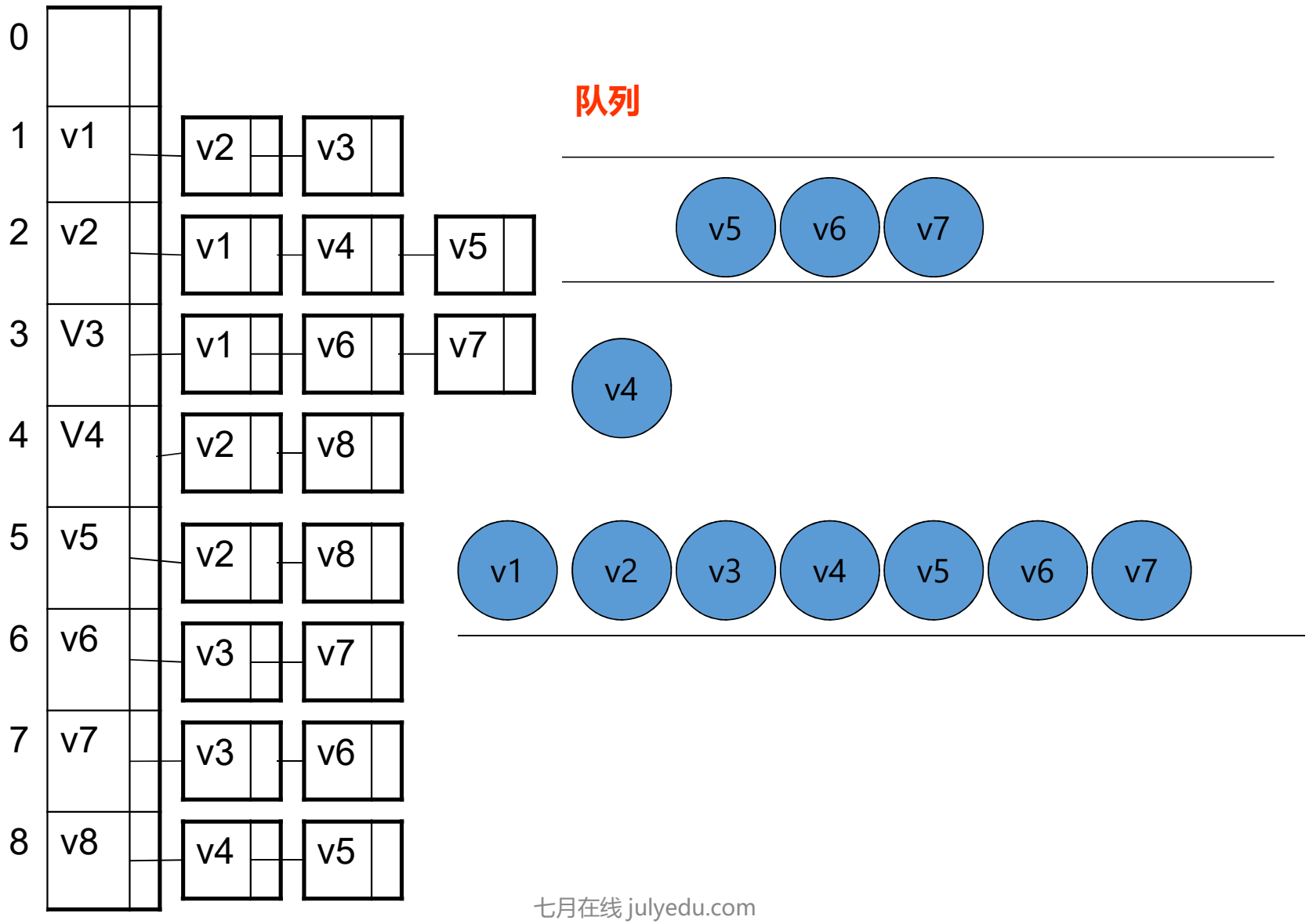


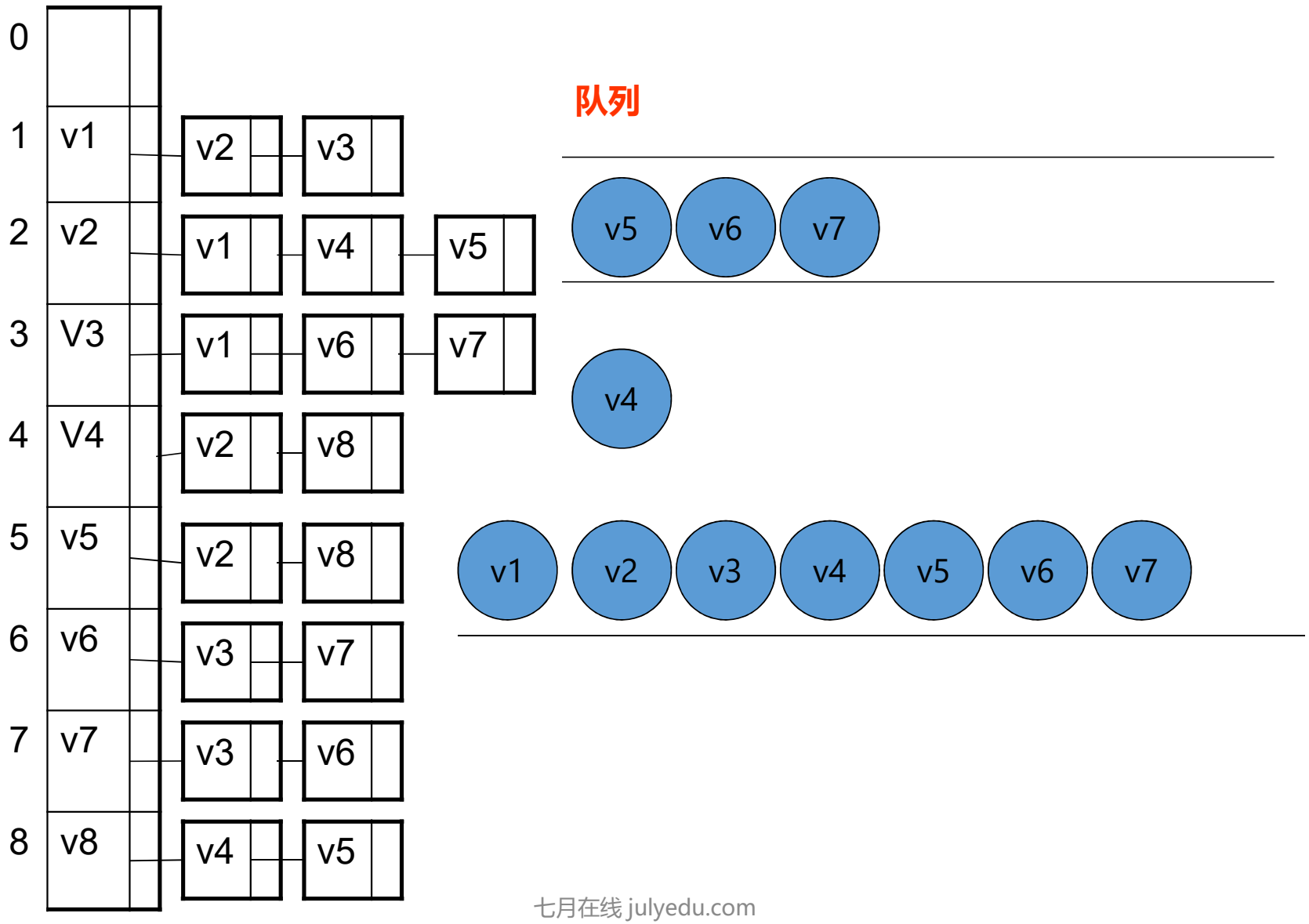


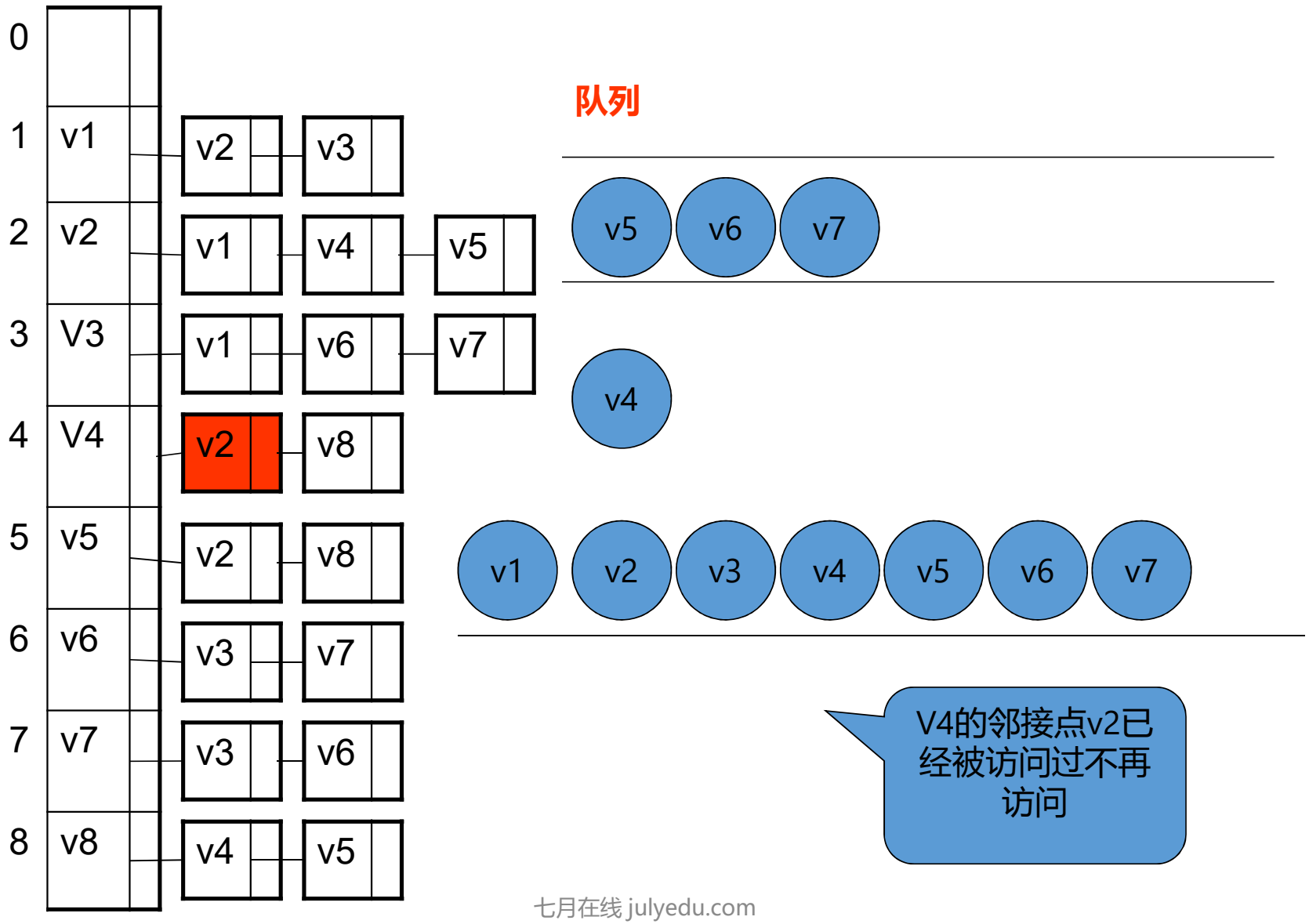


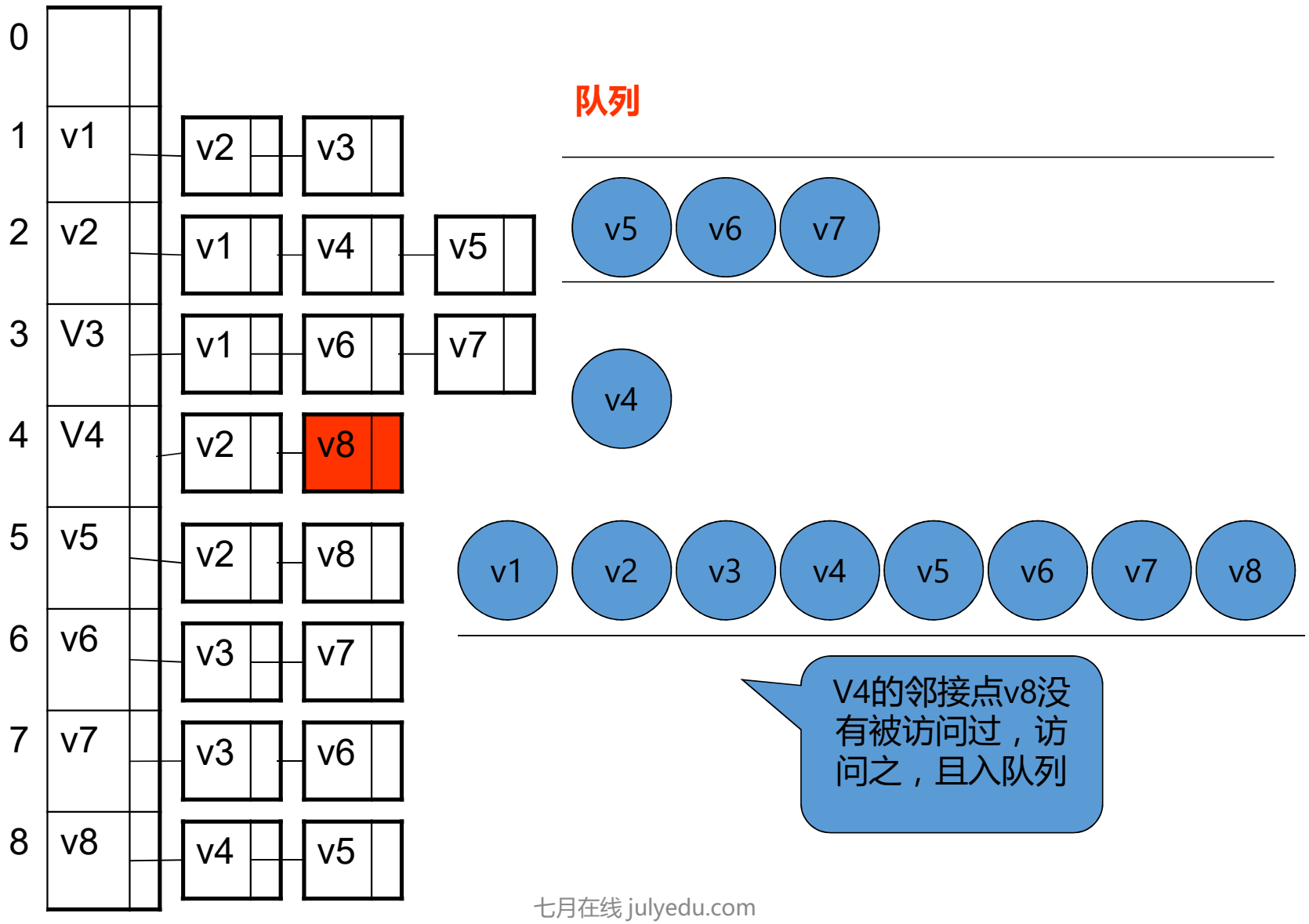


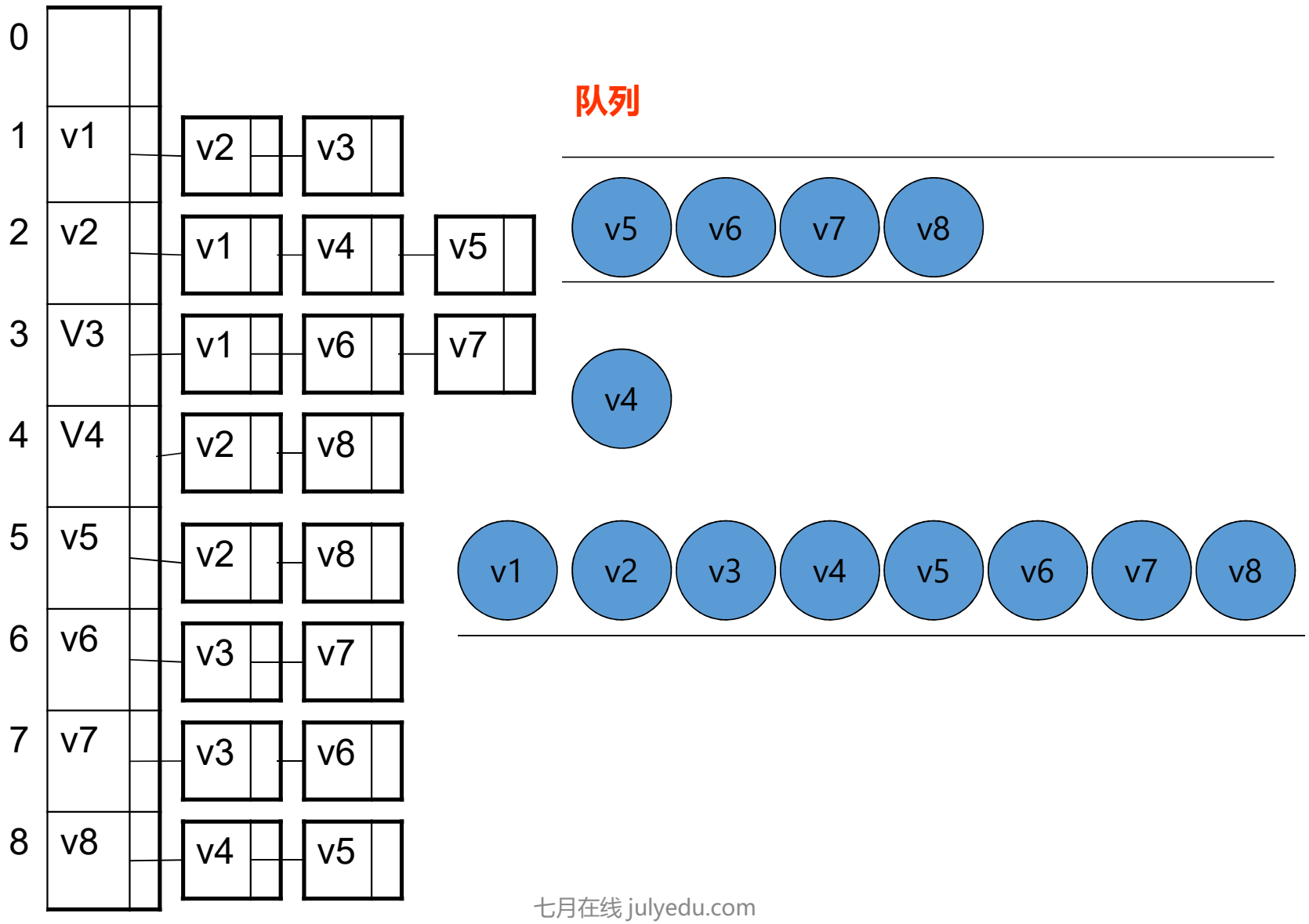


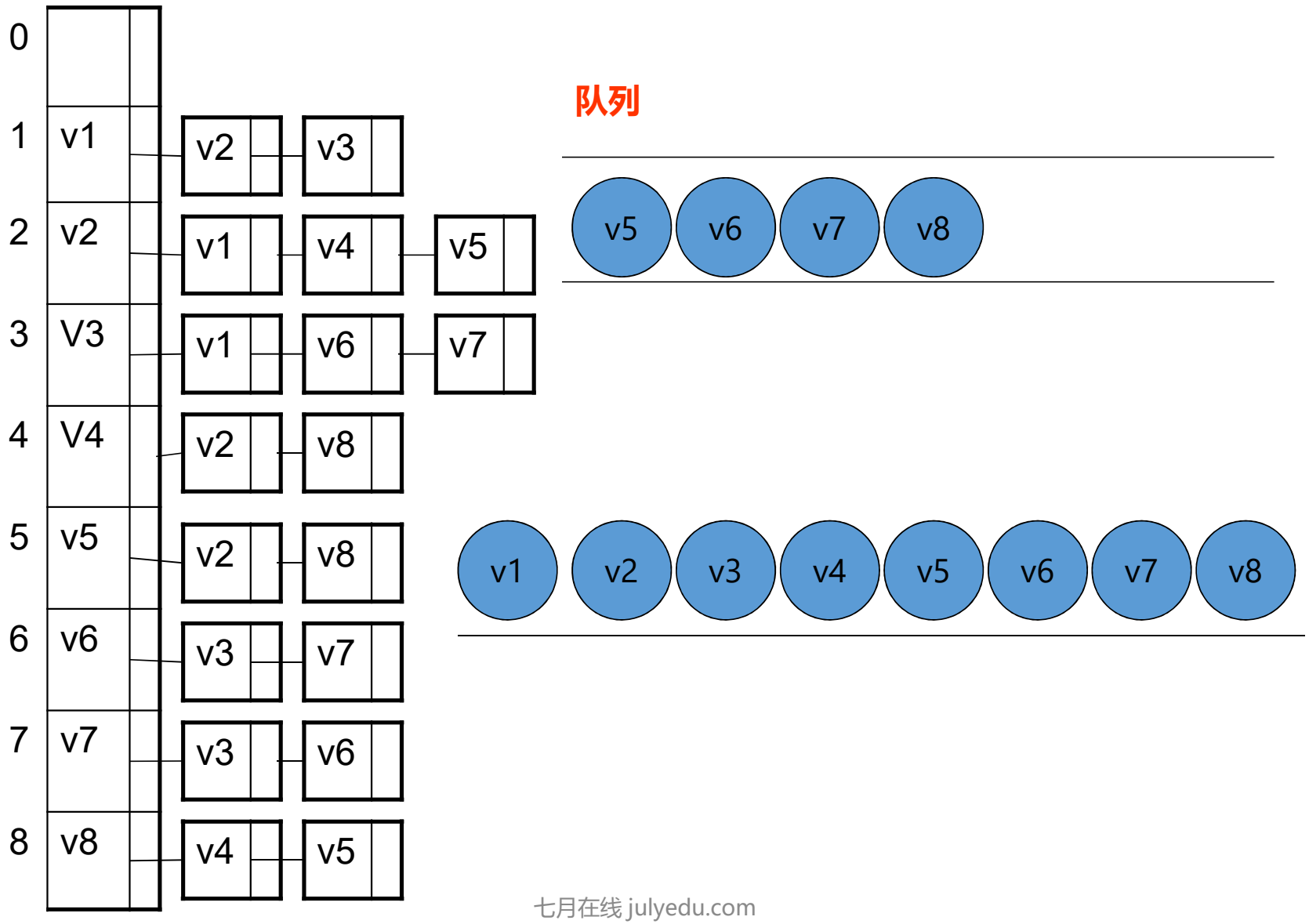


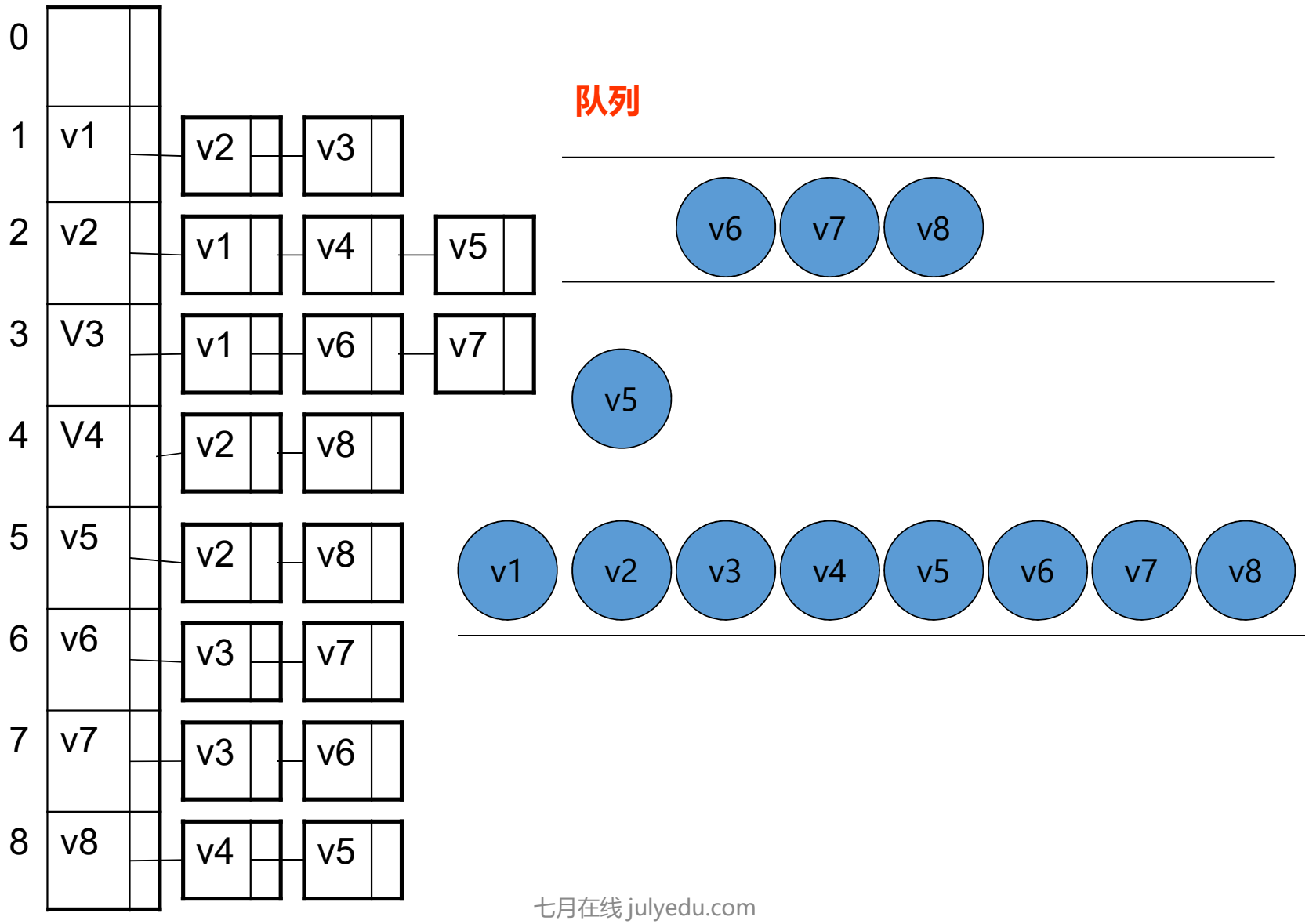


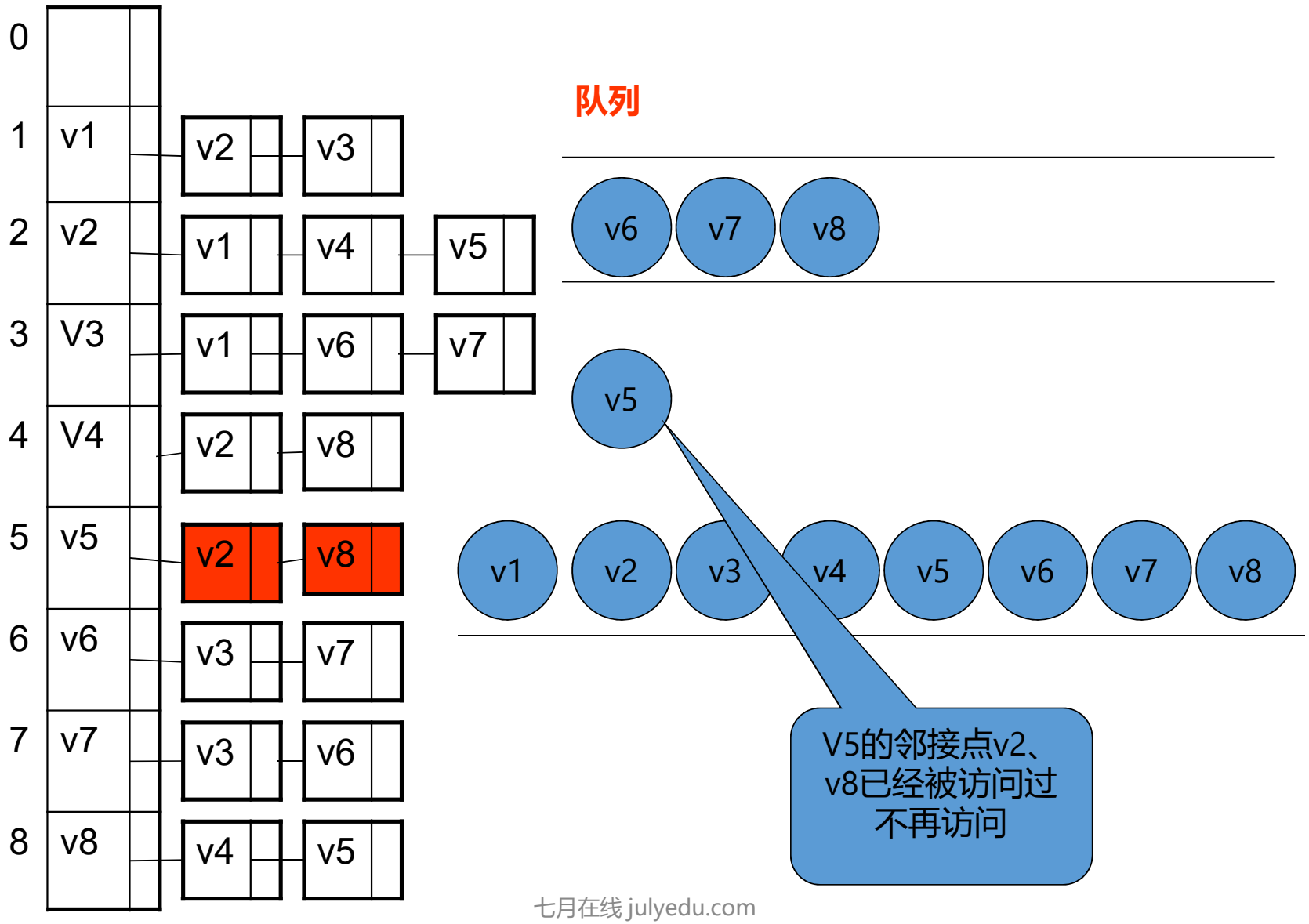


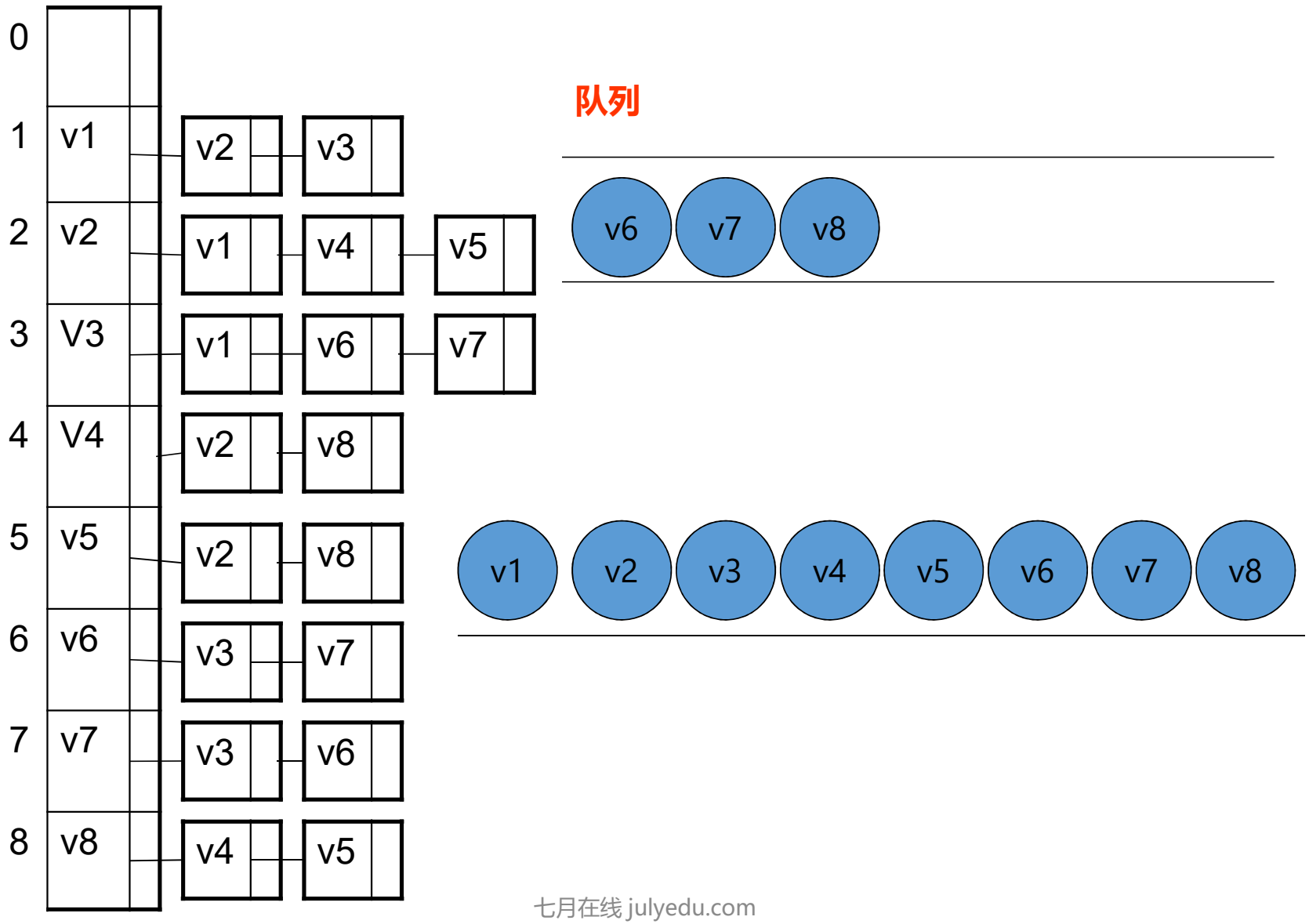


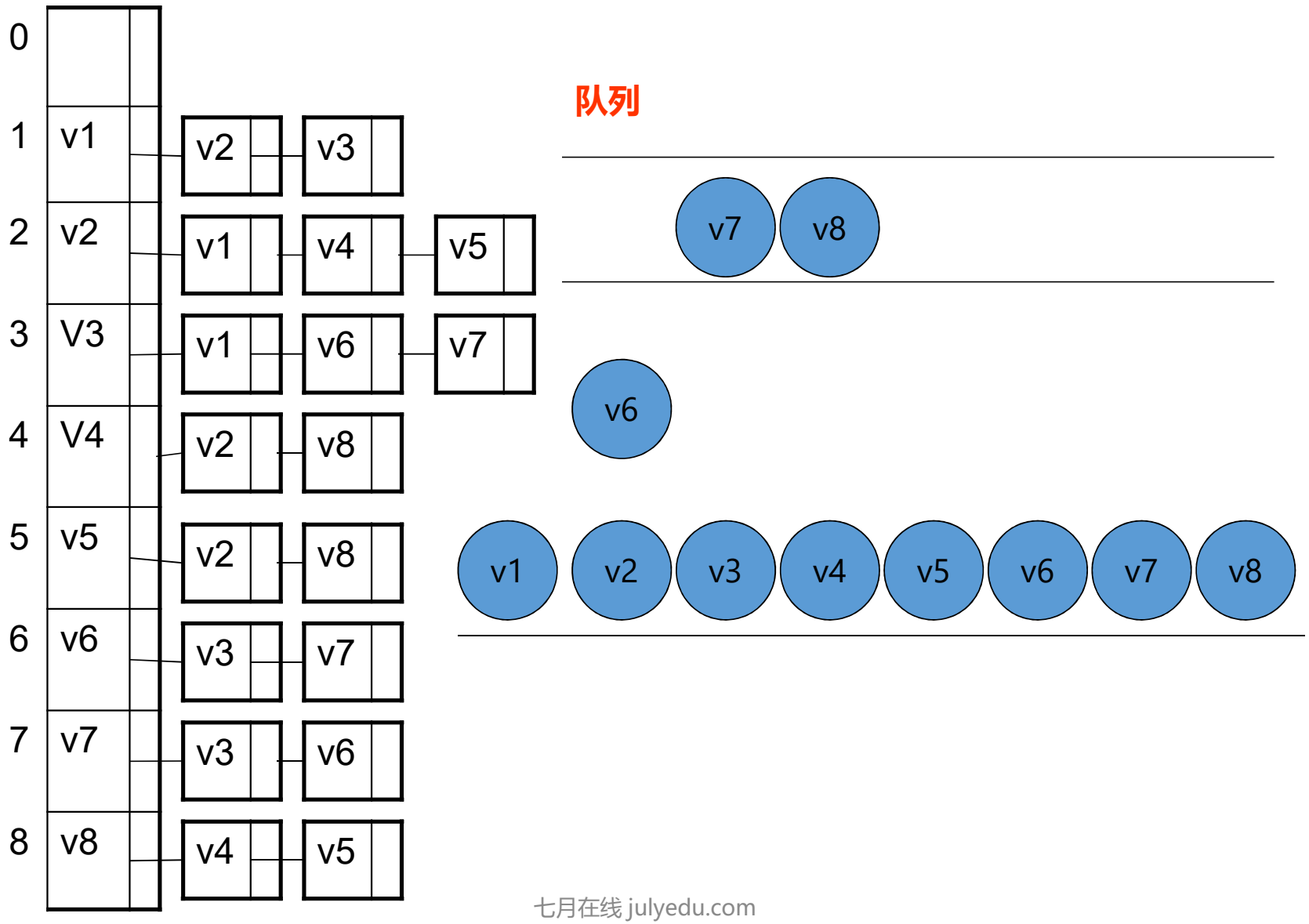


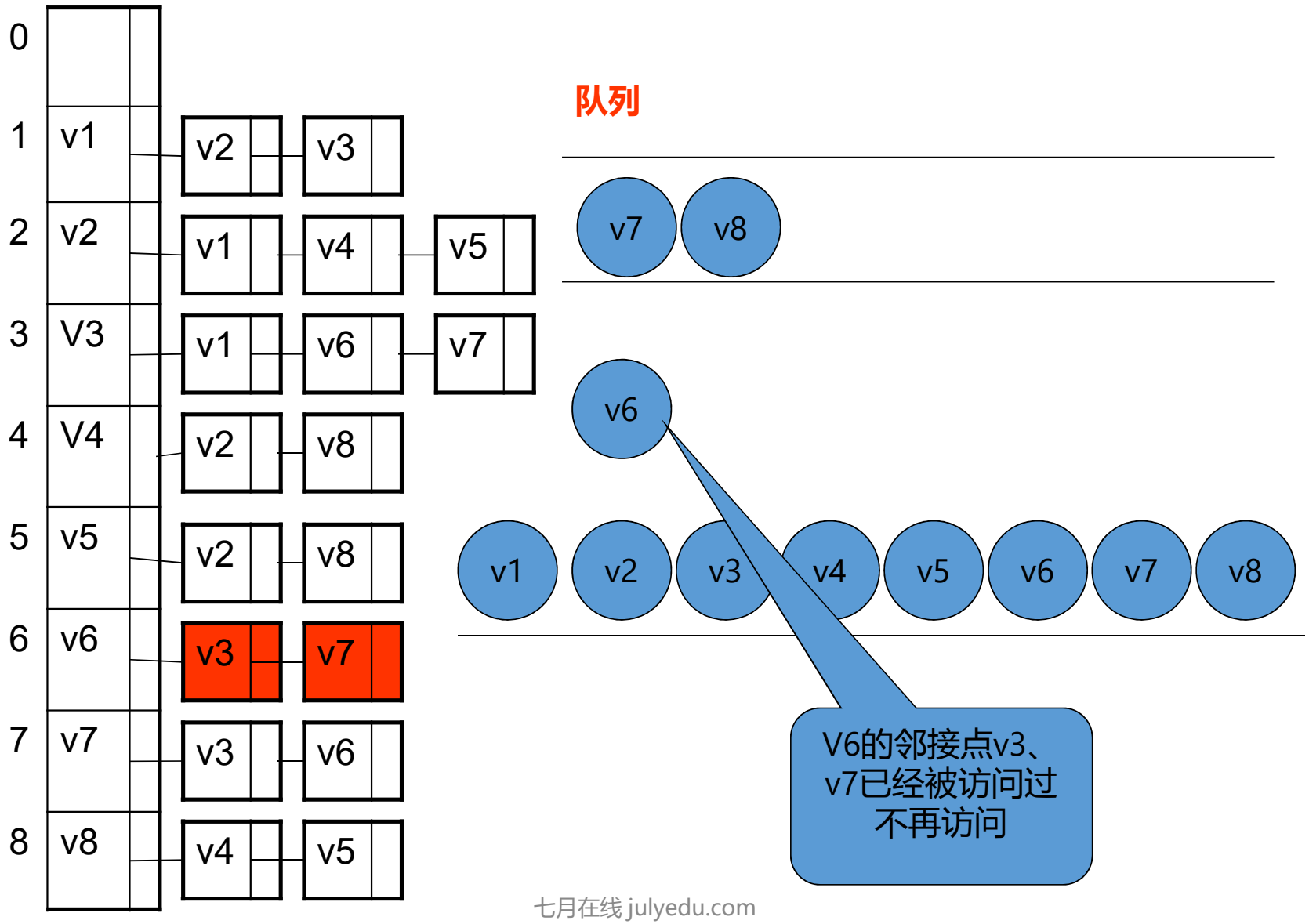


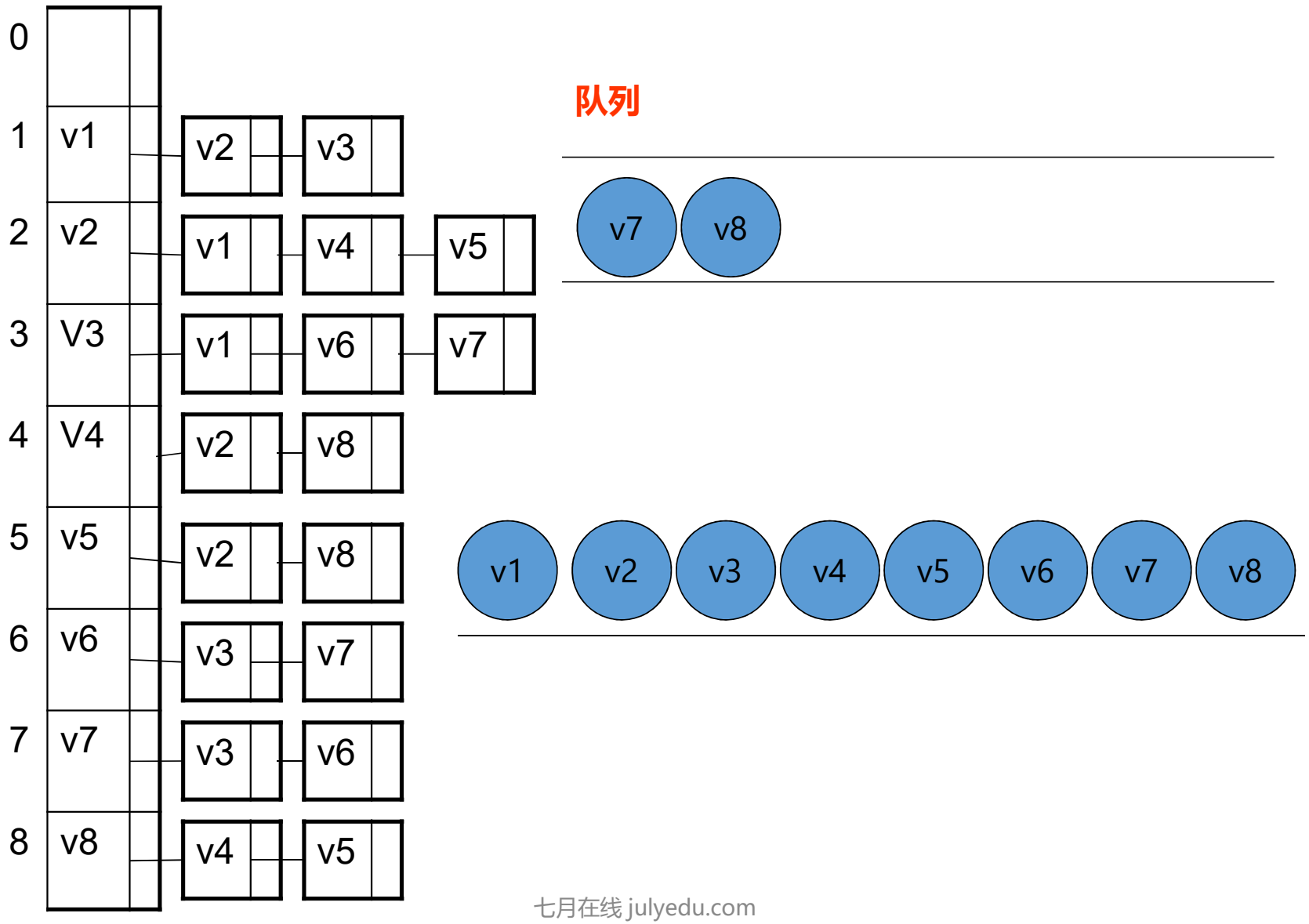


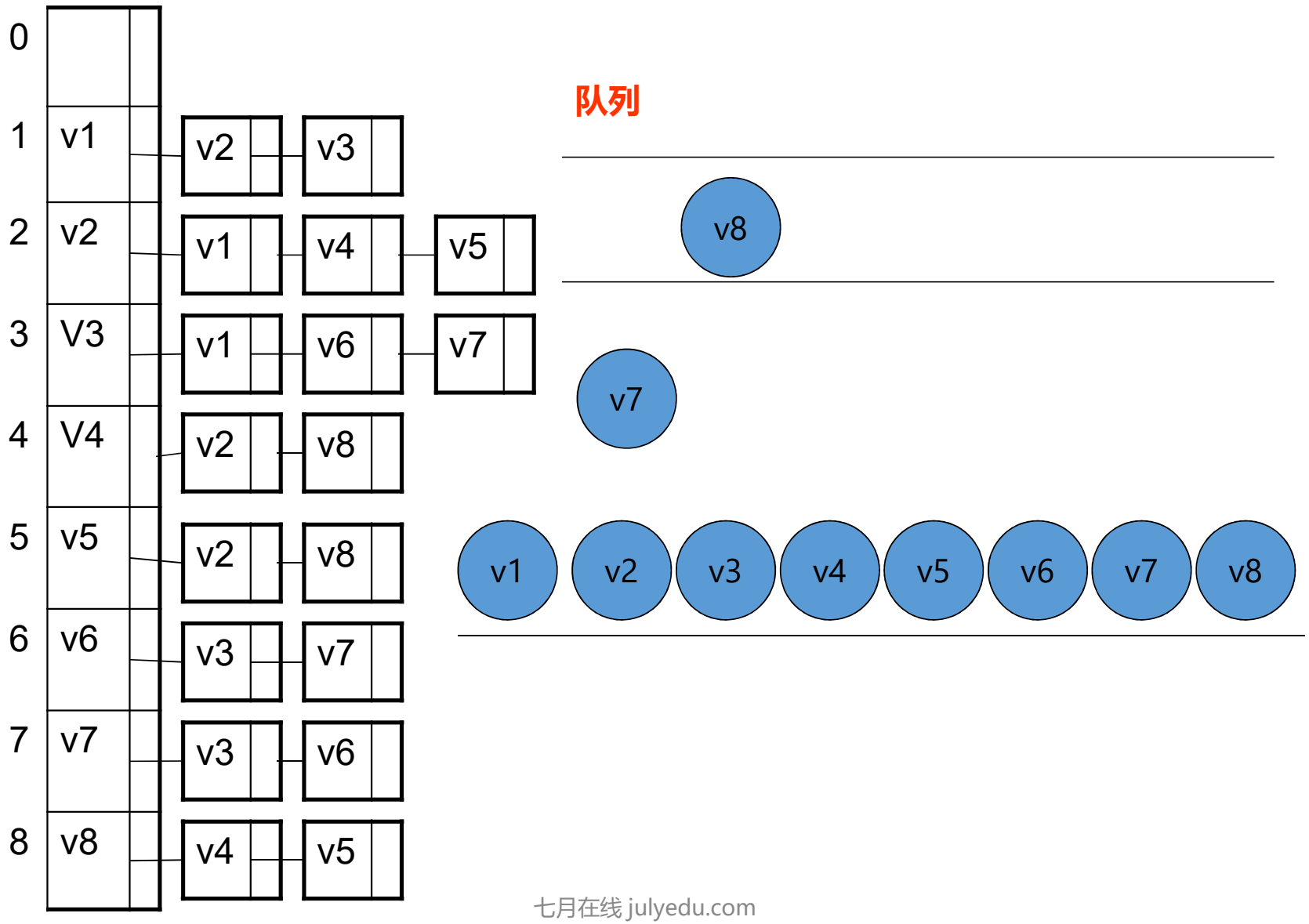


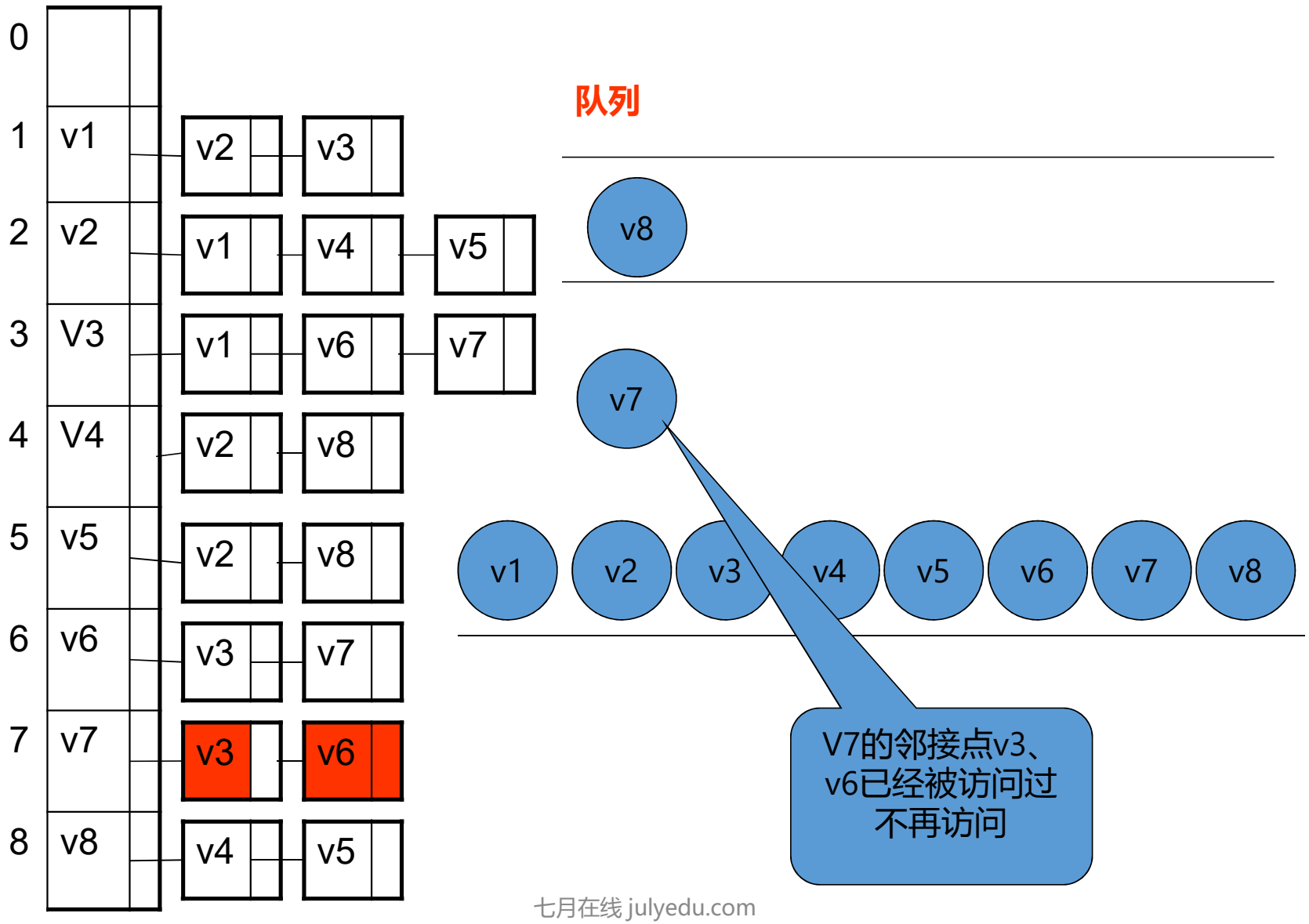


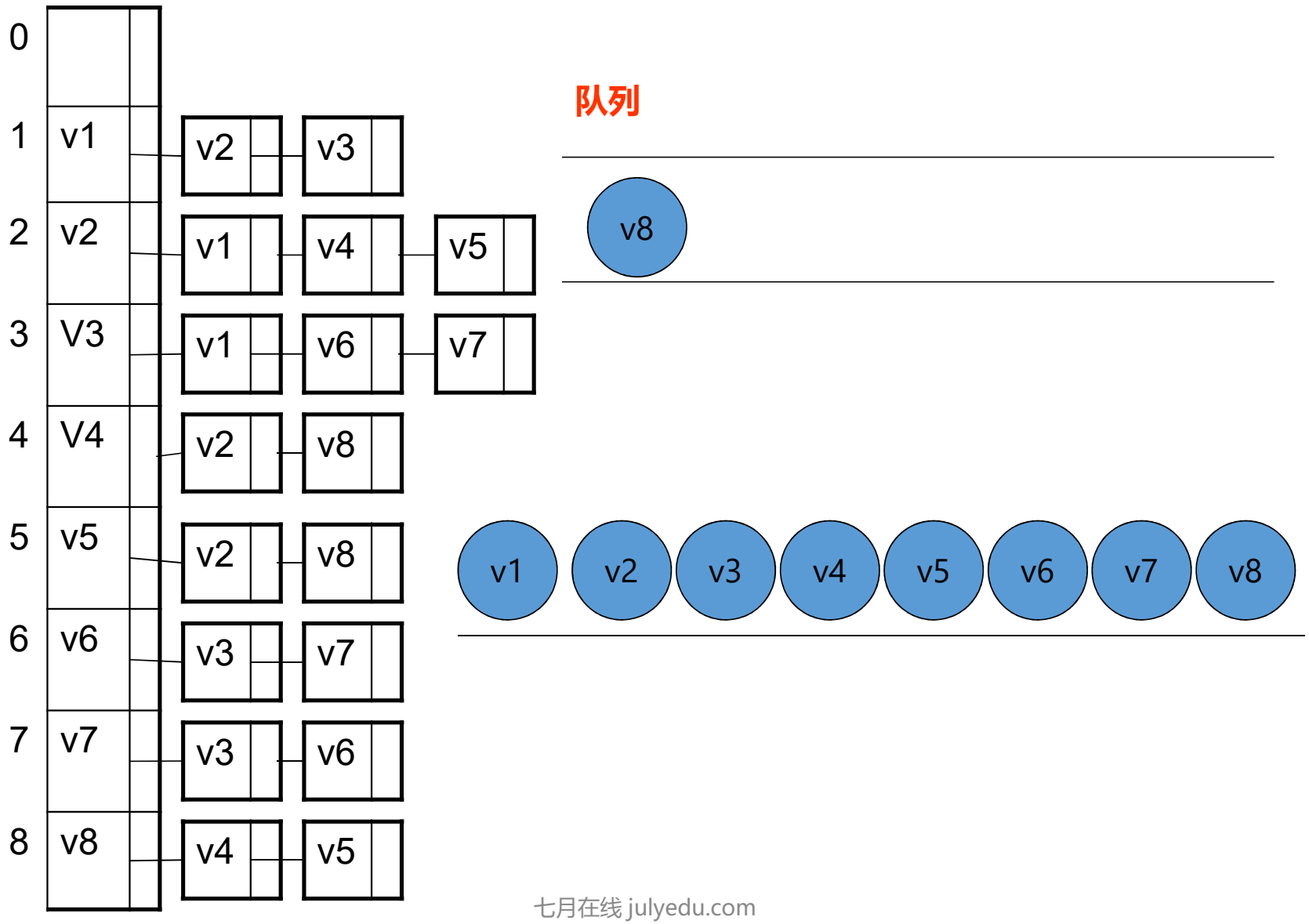


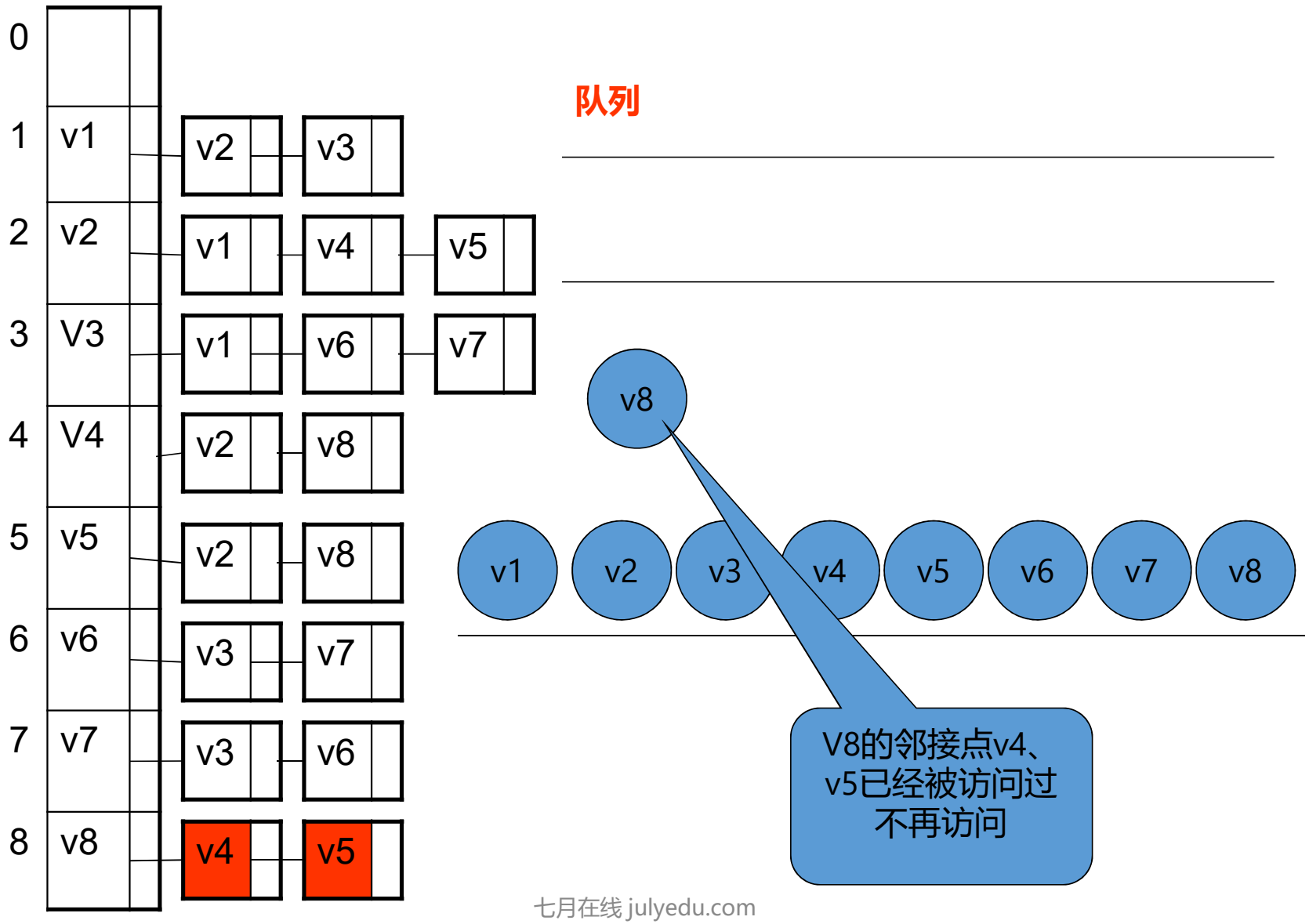


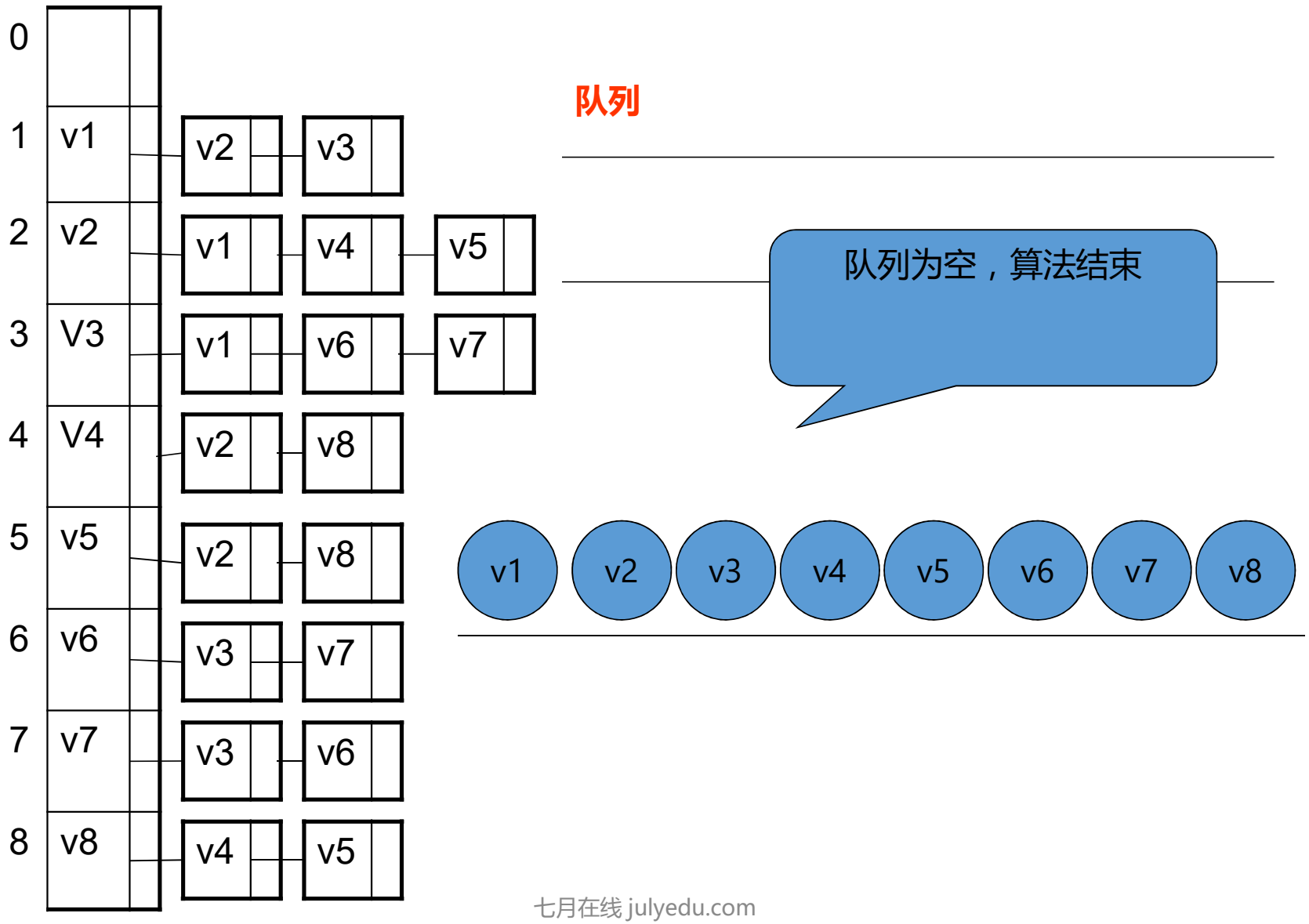












深度优先：伪代码

```
void DFS(int v)
    visited[v] = true
    for (v的每一个邻接点w)
        if (!visited[w])        //如果没有被访问过
            DFS(w)
```

N皇后问题

- 在N*N的棋盘上摆放N个皇后，使得任意两个皇后都不能处于同一行、同一列或同一斜线上
- 回溯法（暴力搜索万金油）
- 本质：深度优先（隐式图搜索）

N皇后问题

- 如何定义状态，关系？
- 时间复杂度 $O(N^N)$（状态空间）
- 剪枝（确定性）
- 作业题：你写的代码能跑多少个皇后？
- Leetcode 51

骑士游历问题

- 国际象棋棋盘上，有一个骑士（马）从左下角出发，是否能不重复的遍历每一个格子
- 没啥好的办法，考虑暴力
- 如何定义状态，关系？
- 除了剪枝，还有什么办法？（求任意解和所有解）
- 启发式(A*)
  - 改变搜索顺序
  - 不确定性

迭代加深

- 求最优 -> 求判定
- 不需要判重
- 搜到即是最优
- 前一个阶段相对下一个阶段仅仅是常数
- 迭代加深 + 启发式（IDA*）

广度优先：伪代码

```
void BFS(int x)
    visited[x] = true
    Queue.push(x)
    While (!Q.empty())
        v = Queue.pop()
        for (v的每个邻接点w)
            if (!visited[w])
                visited[w] = true
                Queue.push(w)
```

种子填充法

- Flood Fill 洪水填充法
- 目标：标记某块封闭的区域，并找出其边界
- 如何定义状态，关系？
- BFS犹如墨汁滴入清水

种子填充法

- Leetcode 200. Number of Islands
- Leetcode 130. Surrounded Regions

八数码

- 3*3的方格内有编号1-8的方块，求最少的步数，恢复这些方块的顺序
- 深度优先 or 广度优先？
- 判重（Hash）

八数码

- 双向搜索
  - 起始点和目标点，轮流扩展
  - Hash表判断相遇
  - 复杂度
- 启发式
  - 价值函数（启发函数）
  - 优先队列（堆）

总结

- DFS vs BFS
  - 都为暴力搜索，但搜索顺序不同
  - 栈 vs 队列
  - 可行解 vs 最优解
  - 递归 vs 非递归
  - 空间占用，BFS需要存储状态，DFS无需
- 事无绝对，仅供参考

Q&A