Homework 3: Clustering Techniques

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Exercise 1: Implement K-Means Manually

(a). What’s the center of the first cluster (red) after one iteration?

$$\mu_1 = \begin{bmatrix} 5.171 & 3.171 \end{bmatrix}$$

(b). What’s the center of the second cluster (green) after two iterations?

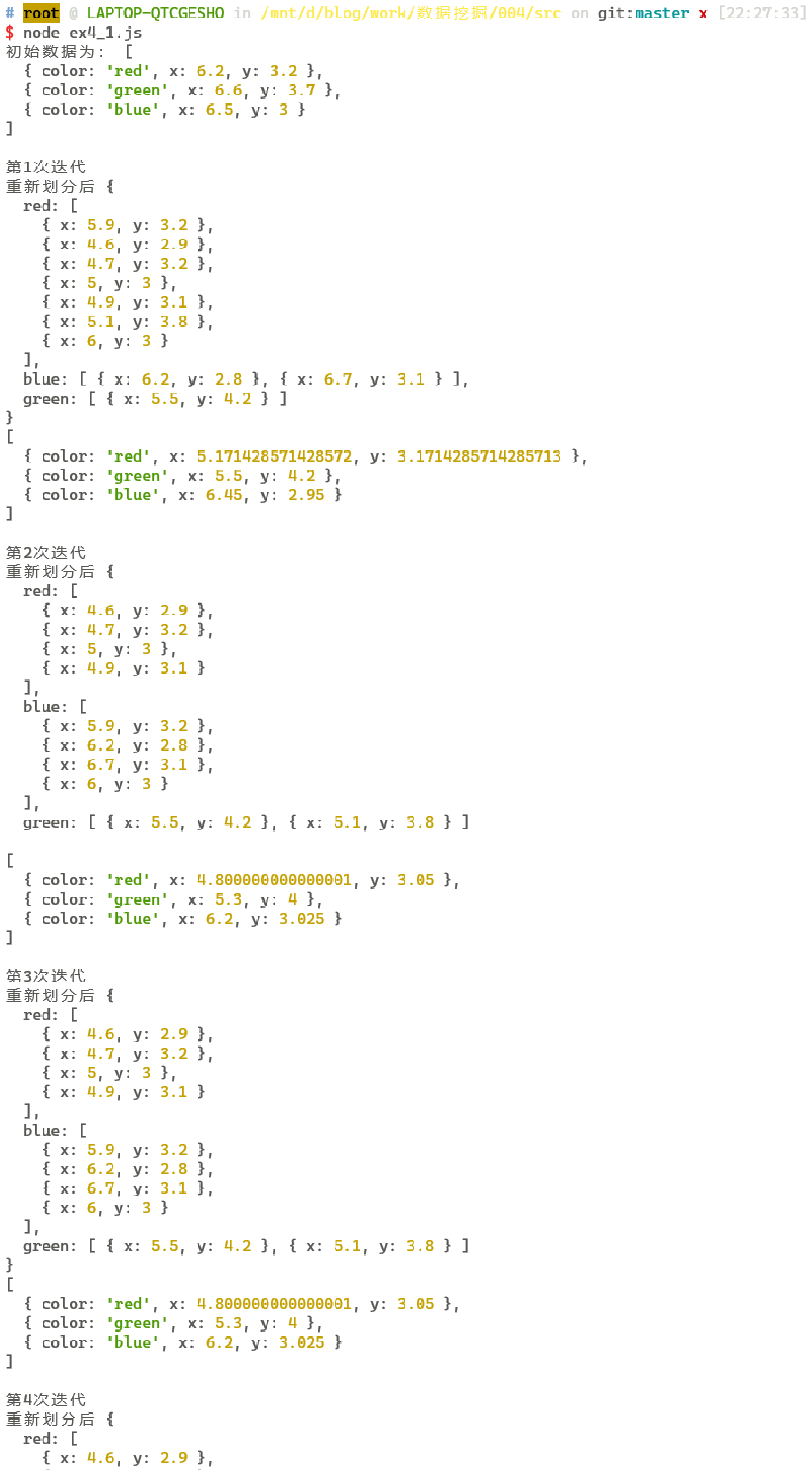
$$\mu_2 = \begin{bmatrix} 5.3 & 4 \end{bmatrix}$$

(c). What’s the center of the third cluster (blue) when the clustering converges?

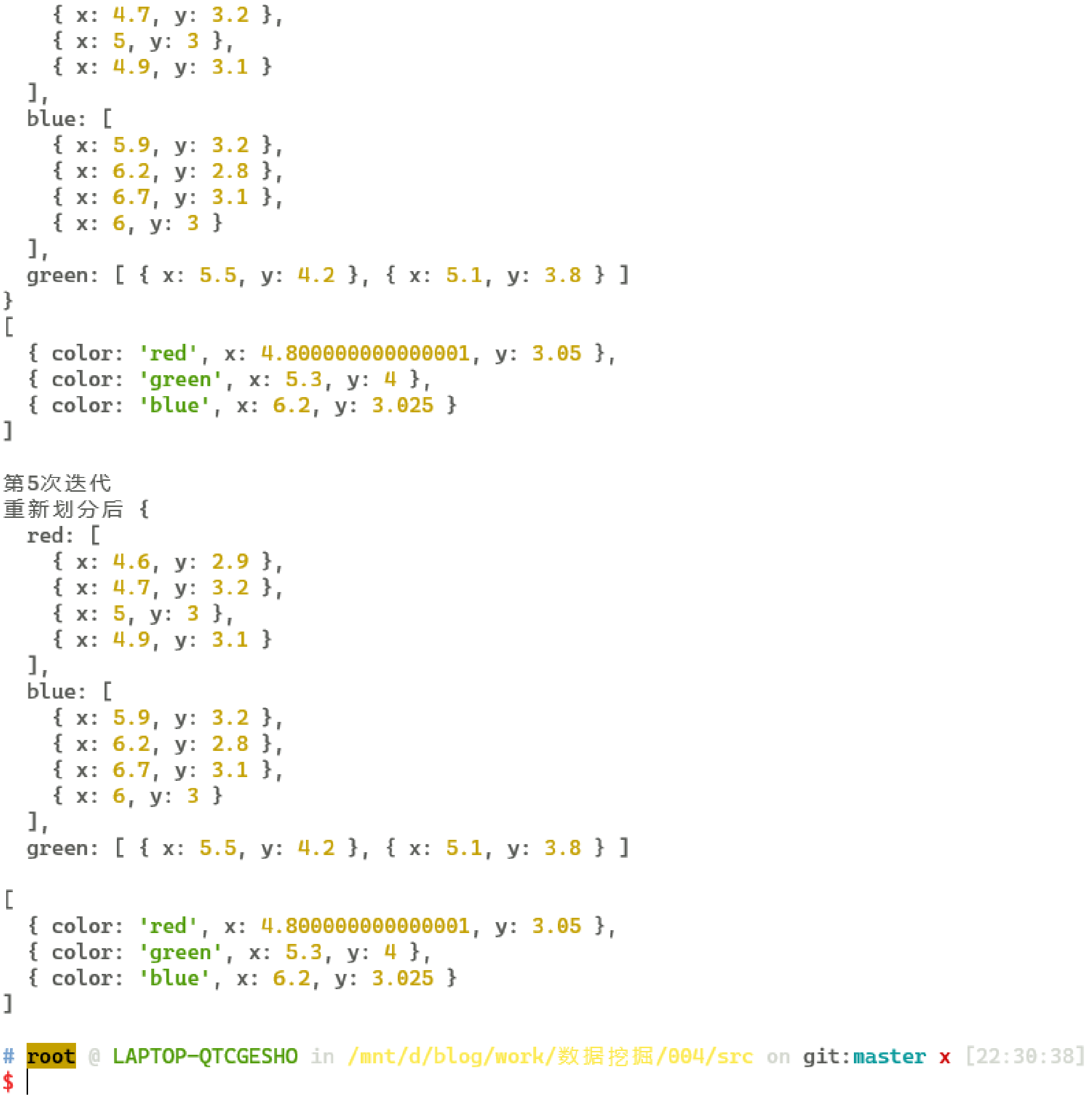
$$\mu_3 = \begin{bmatrix} 6.2 & 3.025 \end{bmatrix}$$

(d). How many iterations are required for the clusters to converge?

在**第2次**迭代后，便能够发现聚簇不再变化，具体如下图：



```
# root @ LAPTOP-QTCGESHO in /mnt/d/blog/work/数据挖掘/004/src on git:master x [22:27:33]
$ node ex4_1.js
初始数据为:  [
  { color: 'red', x: 6.2, y: 3.2 },
  { color: 'green', x: 6.6, y: 3.7 },
  { color: 'blue', x: 6.5, y: 3 }
]

第1次迭代
重新划分后 {
  red: [
    { x: 5.9, y: 3.2 },
    { x: 4.6, y: 2.9 },
    { x: 4.7, y: 3.2 },
    { x: 5, y: 3 },
    { x: 4.9, y: 3.1 },
    { x: 5.1, y: 3.8 },
    { x: 6, y: 3 }
  ],
  blue: [ { x: 6.2, y: 2.8 }, { x: 6.7, y: 3.1 } ],
  green: [ { x: 5.5, y: 4.2 } ]
}
[
  { color: 'red', x: 5.171428571428572, y: 3.1714285714285713 },
  { color: 'green', x: 5.5, y: 4.2 },
  { color: 'blue', x: 6.45, y: 2.95 }
]

第2次迭代
重新划分后 {
  red: [
    { x: 4.6, y: 2.9 },
    { x: 4.7, y: 3.2 },
    { x: 5, y: 3 },
    { x: 4.9, y: 3.1 }
  ],
  blue: [
    { x: 5.9, y: 3.2 },
    { x: 6.2, y: 2.8 },
    { x: 6.7, y: 3.1 },
    { x: 6, y: 3 }
  ],
  green: [ { x: 5.5, y: 4.2 }, { x: 5.1, y: 3.8 } ]

[
  { color: 'red', x: 4.800000000000001, y: 3.05 },
  { color: 'green', x: 5.3, y: 4 },
  { color: 'blue', x: 6.2, y: 3.025 }
]

第3次迭代
重新划分后 {
  red: [
    { x: 4.6, y: 2.9 },
    { x: 4.7, y: 3.2 },
    { x: 5, y: 3 },
    { x: 4.9, y: 3.1 }
  ],
  blue: [
    { x: 5.9, y: 3.2 },
    { x: 6.2, y: 2.8 },
    { x: 6.7, y: 3.1 },
    { x: 6, y: 3 }
  ],
  green: [ { x: 5.5, y: 4.2 }, { x: 5.1, y: 3.8 } ]
}
[
  { color: 'red', x: 4.800000000000001, y: 3.05 },
  { color: 'green', x: 5.3, y: 4 },
  { color: 'blue', x: 6.2, y: 3.025 }
]

第4次迭代
重新划分后 {
  red: [
    { x: 4.6, y: 2.9 },
```



```
    { x: 4.7, y: 3.2 },
    { x: 5, y: 3 },
    { x: 4.9, y: 3.1 }
  ],
  blue: [
    { x: 5.9, y: 3.2 },
    { x: 6.2, y: 2.8 },
    { x: 6.7, y: 3.1 },
    { x: 6, y: 3 }
  ],
  green: [ { x: 5.5, y: 4.2 }, { x: 5.1, y: 3.8 } ]
}
[
  { color: 'red', x: 4.800000000000001, y: 3.05 },
  { color: 'green', x: 5.3, y: 4 },
  { color: 'blue', x: 6.2, y: 3.025 }
]

第5次迭代
重新划分后 {
  red: [
    { x: 4.6, y: 2.9 },
    { x: 4.7, y: 3.2 },
    { x: 5, y: 3 },
    { x: 4.9, y: 3.1 }
  ],
  blue: [
    { x: 5.9, y: 3.2 },
    { x: 6.2, y: 2.8 },
    { x: 6.7, y: 3.1 },
    { x: 6, y: 3 }
  ],
  green: [ { x: 5.5, y: 4.2 }, { x: 5.1, y: 3.8 } ]

[
  { color: 'red', x: 4.800000000000001, y: 3.05 },
  { color: 'green', x: 5.3, y: 4 },
  { color: 'blue', x: 6.2, y: 3.025 }
]

# root @ LAPTOP-QTCGESHO in /mnt/d/blog/work/数据挖掘/004/src on git:master x [22:30:38]
$ 
```

Exercise 2: Application of K-Means

(a). For dataset A, which result is more likely to be generated by K-means method?

A2

(b). Dataset B (B1 or B2?)

B2

(c). Dataset C (C1 or C2?)

C1

(d). Dataset D (D1 or D2?)

D1

(e). Dataset E (E1 or E2?)

E2

(f). Dataset F (F1 or F2?)

F2

(g). Provide the reasons/principles that draw your answers to the questions (a) to (f).

对于每个处于当前簇的点，该点距离簇心的距离比距离其他簇心的距离都要近

(h). For dataset F, do you think k-means perform well? Why? Are there other better clustering algorithms to be used to cluster data distributing like the data in the dataset F?

对于数据集 F， k-means 算法效果并不好；因为数据可以比较明显的分成左右两簇；可以使用层次聚类或者密度聚类来进行划分

Exercise 3: Applications of Clustering Techniques in IR and DM

信息检索：

- 搜索结果聚类会对搜索结果进行聚类，以便类似文档一起显示。扫描几个连贯的组通常比许多单个文档更容易。 如果搜索词具有不同的词义，则此功能特别有用。
- 获取更好的用户界面。根据用户选择或聚集的文档组进行聚类，以获取用户所选择文档组。 合并选定的组，并再次对结果集进行聚类。 重复该过程直到找到感兴趣的簇。

数据挖掘：

- 对商场的客户群特征进行了聚类分析，将客户特征与所购商品类别进行了联合聚类,分析顾客特征与购买商品类别之间的联系，从而更好的排布商品

code

> 对于 ex 1

```
let data = [
  { x: 5.9, y: 3.2 },
  { x: 4.6, y: 2.9 },
  { x: 6.2, y: 2.8 },
  { x: 4.7, y: 3.2 },
  { x: 5.5, y: 4.2 },
  { x: 5.0, y: 3.0 },
  { x: 4.9, y: 3.1 },
  { x: 6.7, y: 3.1 },
  { x: 5.1, y: 3.8 },
  { x: 6.0, y: 3.0 },
];

let clusters = [
  { color: "red", x: 6.2, y: 3.2 },
  { color: "green", x: 6.6, y: 3.7 },
  { color: "blue", x: 6.5, y: 3.0 },
];

function distance(point, center) {
  return Math.sqrt(
    Math.pow(point.x - center.x, 2) + Math.pow(point.y - center.y, 2)
  );
}

function updateClusters() {
  let tmp = {
    red: [],
    blue: [],
    green: [],
  };
  for (const point of data) {
    let redDistance = distance(point, clusters[0]);
    let greenDistance = distance(point, clusters[1]);
    let blueDistance = distance(point, clusters[2]);

    if (redDistance < greenDistance && redDistance < blueDistance) {
      tmp.red.push(point);
    } else if (greenDistance < redDistance && greenDistance < blueDistance) {
      tmp.green.push(point);
    } else {
      tmp.blue.push(point);
    }
  }

  console.log(`重新划分后`, tmp);

  for (const cluster of clusters) {
    let newCenter = { x: 0, y: 0 };
    for (const point of tmp[cluster.color]) {
      newCenter.x += point.x;
      newCenter.y += point.y;
    }

    cluster.x = newCenter.x / tmp[cluster.color].length;
    cluster.y = newCenter.y / tmp[cluster.color].length;
  }
}

function iter(times) {
  let n = times;
  console.log(`初始数据为：`, clusters);
  while (n--) {
    console.log(`\n第${times - n}次迭代`);
    updateClusters();
    console.log(clusters);
  }
}

iter(5);
```