Lab 6: Clustering and Community Detection

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1 Clustering

1.1 codes

1. mStep of Kmeans:

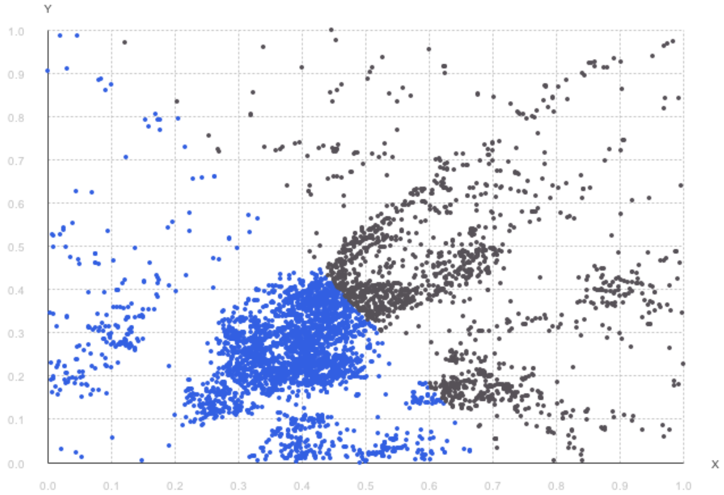
```
public void mStep() {
        // According to the assignment, we update the center of each cluster
        for (int c = 0; c < this.k; ++c) {
                Point2d rnk = new Point2d(0, 0);
                double sum = 0.0;
                for (int p = 0; p < this.data.length; ++p) {
                        if (this.assignments[p] == c) {
                                sum = sum + 1;
                                rnk.set(rnk.getX() + this.data[p].getX(), rnk.getY() + this.data[p].getY());
                        }
                }
                this.centers[c].set(rnk.getX() / sum, rnk.getY() / sum);
        }
    }
```

2. mStep & eStep of Kmeans:

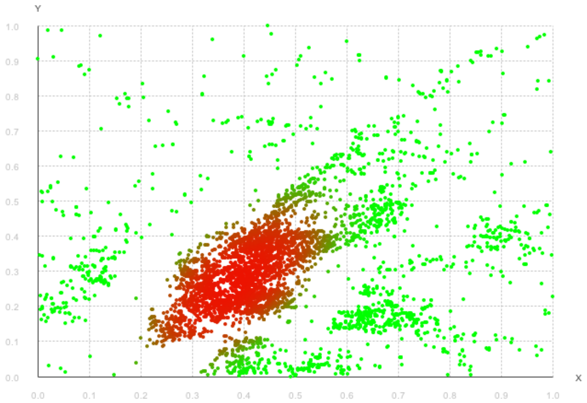
```
public void eStep() {
        // Hint: look at the MultivariateNormalDistribution class used in logLikelihood
        MultivariateNormalDistribution[] pdfs = new MultivariateNormalDistribution[this.k];
        for (int c = 0; c < this.k; c++) {
            pdfs[c] = new MultivariateNormalDistribution(this.mus[c].toArray(),
                    this.sigmas[c].toArray());
        }
        for (int p = 0; p < this.data.length; ++p) {
                double sum = 0.0;
                for (int c = 0; c < this.k; ++c) {
                        sum += pdfs[c].density(this.data[p].toArray()) * this.pi[c];
                }
                for (int c = 0; c < this.k; ++c) {
                        this.gamma[p][c] = this.pi[c] * pdfs[c].density(this.data[p].toArray()) / sum;
                }
        }
    }

public void mStep() {
        for (int c = 0; c < this.k; ++c) {
                double Nsum = 0.0;
                //compute mus
                this.mus[c].set(0.0, 0.0);
                for (int i = 0; i < this.data.length; ++i) {
                        Nsum = Nsum + gamma[i][c];
                        this.mus[c].set(this.mus[c].getX() + gamma[i][c] * this.data[i].getX(),
                                        this.mus[c].getY() + gamma[i][c] * this.data[i].getY());
                }
                this.mus[c].set(this.mus[c].getX() / Nsum, this.mus[c].getY() / Nsum);

                double x = 0.0, y = 0.0, xy = 0.0;
                for (int i = 0; i < this.data.length; ++i) {
                        double a = this.data[i].getX() - this.mus[c].getX();
                        double b = this.data[i].getY() - this.mus[c].getY();
                        x += a * a * this.gamma[i][c];
                        y += b * b * this.gamma[i][c];
                        xy += a * b * this.gamma[i][c];
                }
                this.sigmas[c].set(x / Nsum, y / Nsum, xy / Nsum);
                this.pi[c] = Nsum / this.data.length;
        }
    }
```

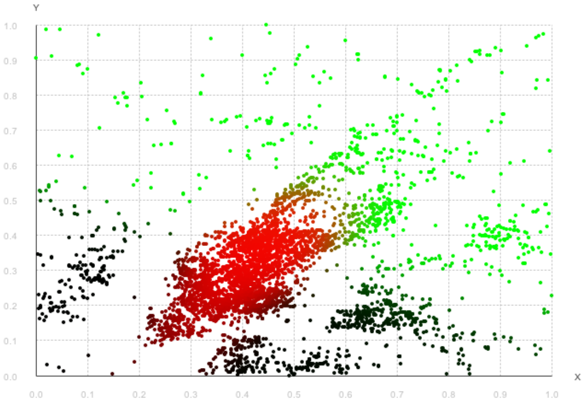
1.2 answers to the questions

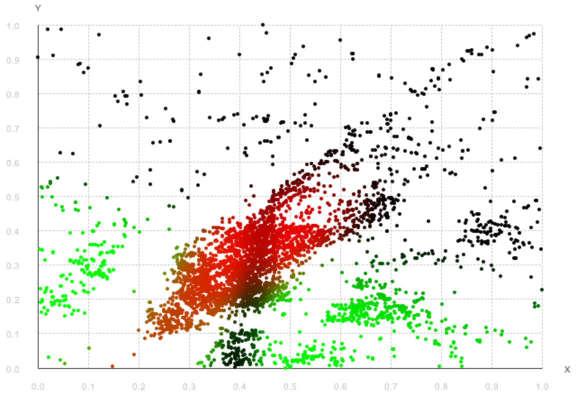
1. The plot of tweet by K-means is below. The geographical distribution of the clusters shows nothing with Manhattan.



2. The measure used in GMM that is the equivalent of the distortion measure in k-means is *LogLikelihood*.
3. GMM plots for tweet are as below:







2 Community Detection

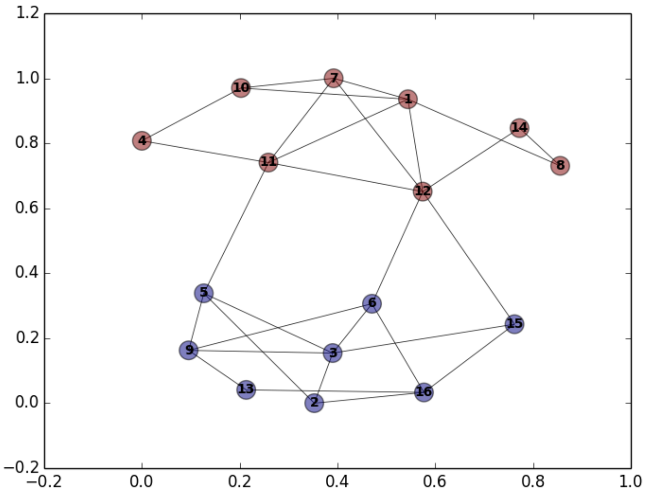
2.1 codes

communityDetection() of Louvain:

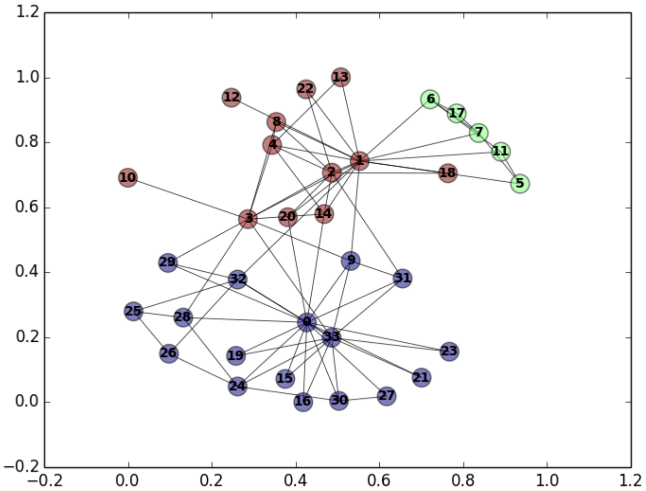
```
public void communityDetection() {
        double delta = 0.0;
        int level = 0;
        do {
                Status s = statusList.get(level ++);
                s.assignCommunities();
                Status s1 = s.getNextLevel();
                statusList.add(s1);
                delta = s1.modularity() − s.modularity();
        } while (delta > CHANGE_MIN);
        System.out.println(statusList.get(level).modularity());
    }
```

2.2 plots

1. Plot of the simple graph and the communities found at the first level of the Louvain method:

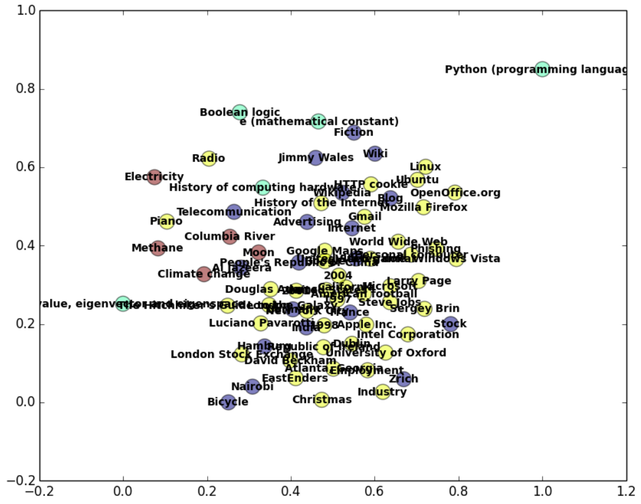


2. Plot of the karate graph and the best communities found by the Louvain method:



3. Highest modularity of the wikipedia graph found by the Louvain method is *0.5236077874099563*.

4. Plot of communities of the node Google and its neighbors from the wikipedia graph: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Boolean logic
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Fiction
Radio
Jimmy Wales
Wiki
Linux
Electricity
Ubuntu
History of computing hardware
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value, eigenvector and eigenspace
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