Analysis and Modeling of the Charging Stations in Shanghai

2018 ICM Problem D

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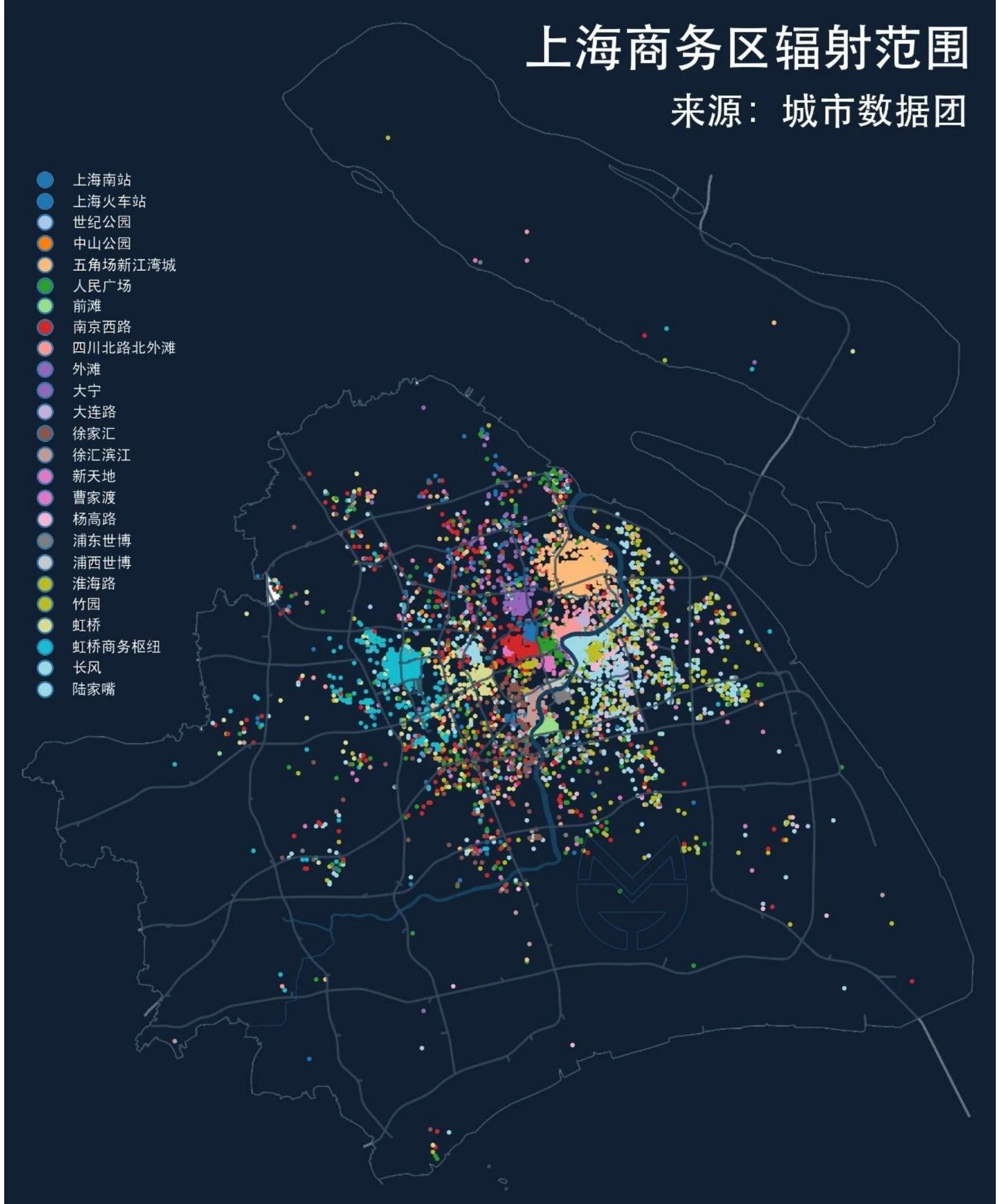
Problem Introduction

- For the purpose of environment protection, new energy automobiles are replacing traditional cars gradually in many countries. Some countries are even planning to ban gasoline motor cars and diesel cars completely. We will focus on electric cars in this problem.
- In this case, we need to establish enough charging stations in proper locations, so that the process of replacing traditional cars with new energy can be promoted rather than impeded.
- However, this process cannot be accomplished in an action. For example, we need to consider the charging station’s distribution when there are 10%, 30%, 50%...... electric cars.

Outline of our work

- We focus on Tesla's electric cars and their charging stations in Shanghai.
- We firstly collected the data about the transportation in Shanghai, and used MATLAB to process the data to get the approximate traffic density distribution in Shanghai.
- Then, we used the k-means clustering algorithm to plan the ideal super charging station's distribution in Shanghai.
- Finally, we will consider other factors, like the current cars, current economy and policy to give some advice on the promotion of electric cars in China.


上海商务区辐射范围
来源：城市数据团
上海南站
上海火车站
世纪公园
中山公园
五角场新江湾城
人民广场
前滩
南京西路
四川北路北外滩
外滩
大宁
大连路
徐家汇
徐汇滨江
新天地
曹家渡
杨高路
浦东世博
浦西世博
淮海路
竹园
虹桥
虹桥商务枢纽
长风
陆家嘴

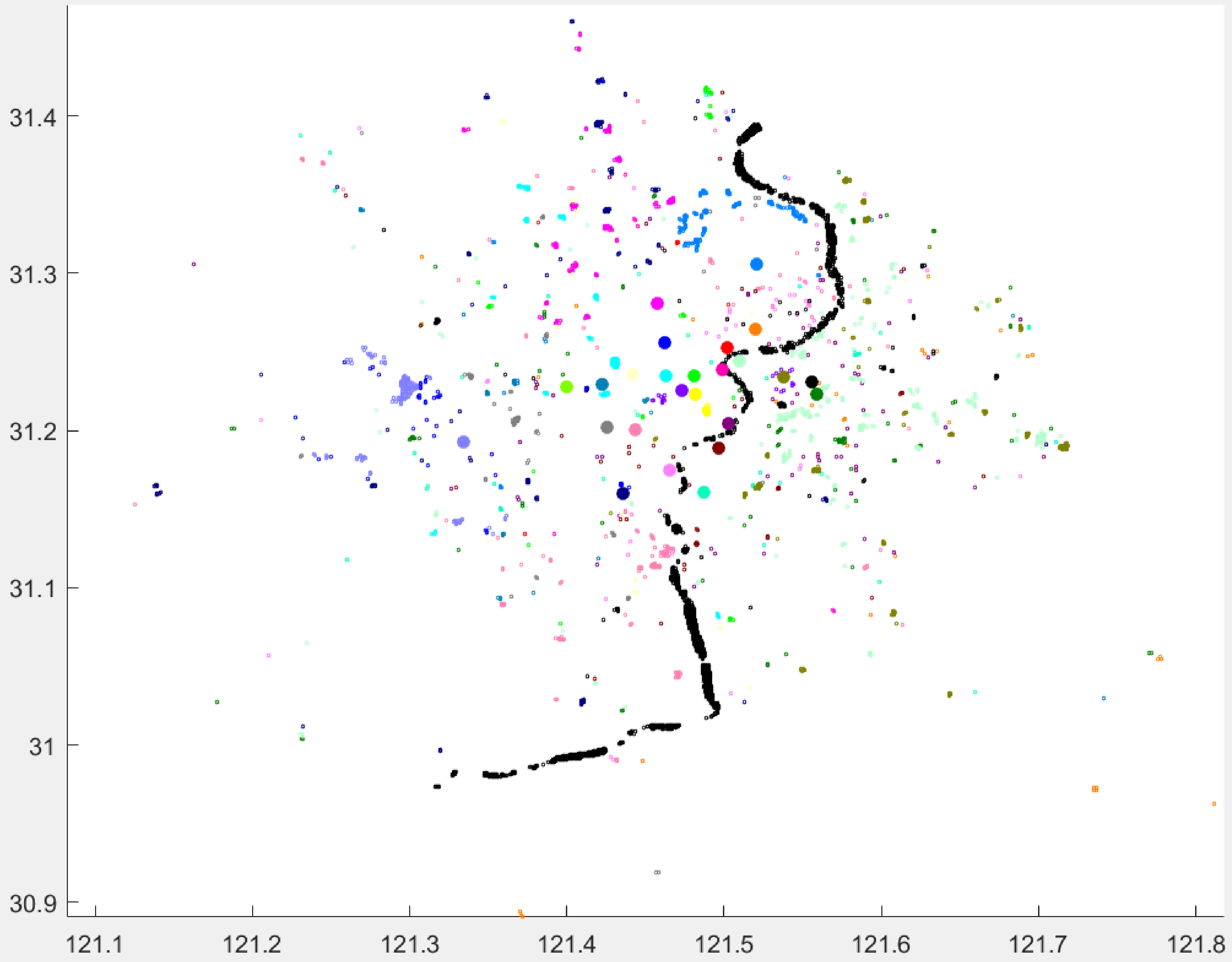
a	上海南站	[37,112,157]	31.1596	121.4355
b	上海火车站	[18,125,181]	31.2561	121.4621
c	世纪公园	[172,199,230]	31.2228	121.5593
d	中山公园	[216,136,53]	31.2291	121.4226
e	五角场新江湾城	[252,186,122]	31.3062	121.5208
f	人民广场	[42,162,42]	31.2352	121.4813
g	前滩	[150,223,132]	31.1608	121.4872
h	南京西路	[212,40,38]	31.2345	121.4631
i	四川北路北外滩	[255,150,150]	31.2529	121.5020
j	外滩	[149,102,186]	31.2391	121.4988
k	大宁	[148,102,189]	31.2806	121.4576
l	大连路	[199,175,213]	31.2644	121.5198
m	徐家汇	[134,89,80]	31.2002	121.4435
n	徐汇滨江	[201,151,148]	31.1749	121.4657
o	新天地	[227,122,193]	31.2234	121.4817
p	曹家渡	[222,122,196]	31.2359	121.4417
q	杨高路	[249,180,212]	31.2309	121.5555
r	浦东世博	[127,127,127]	31.1888	121.4964
s	浦西世博	[191,202,197]	31.2048	121.5029
t	淮海路	[193,194,52]	31.2258	121.4732
u	竹园	[190,186,38]	31.2344	121.5378
v	虹桥	[218,220,145]	31.2024	121.4252
w	虹桥商务枢纽	[25,189,210]	31.1924	121.3341
x	长风	[160,214,226]	31.2275	121.3996
y	陆家嘴	[157,219,230]	31.2446	121.5099

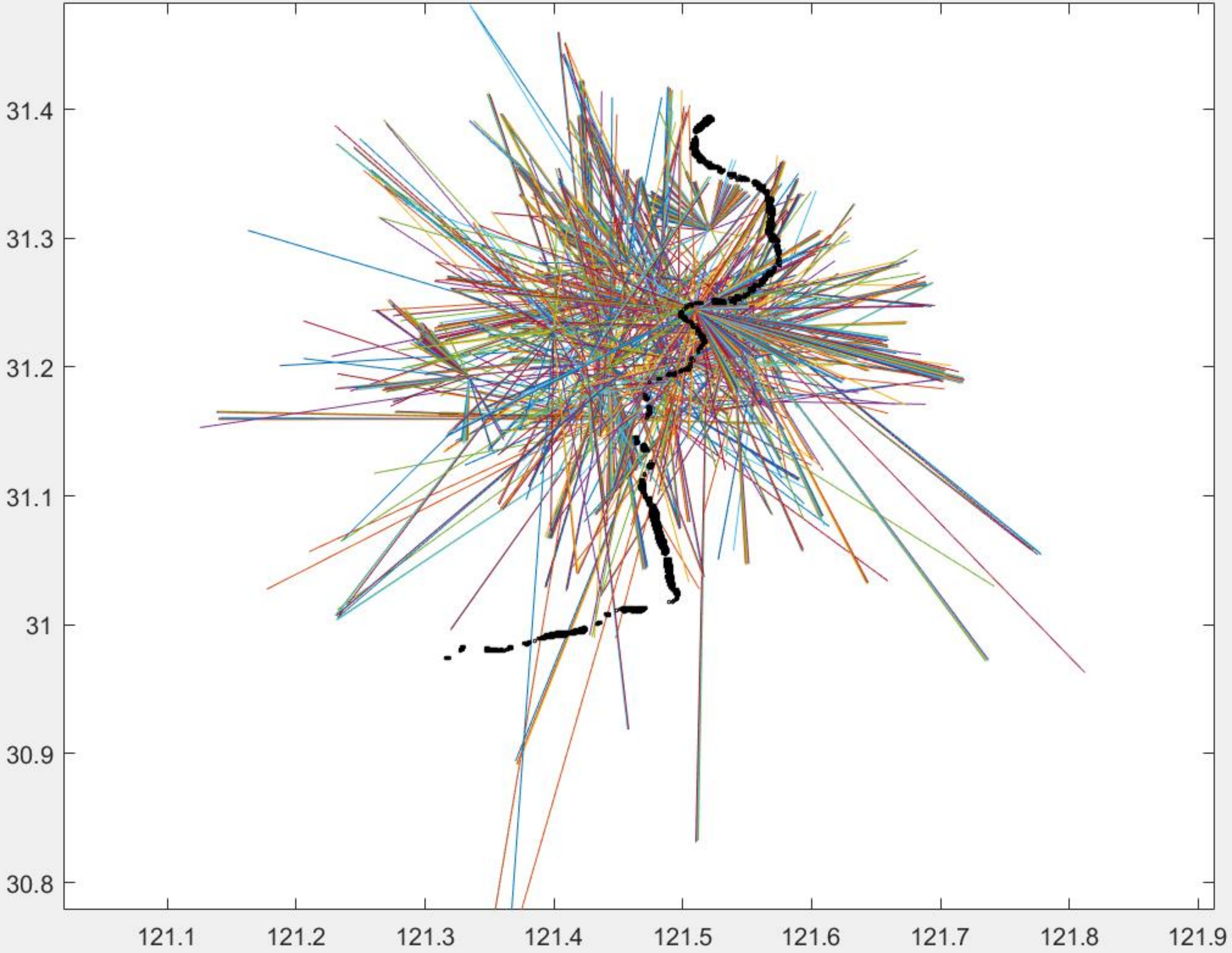
120.867 —— 121.985 E

30.693 —— 31.872 N

1494*1222像素

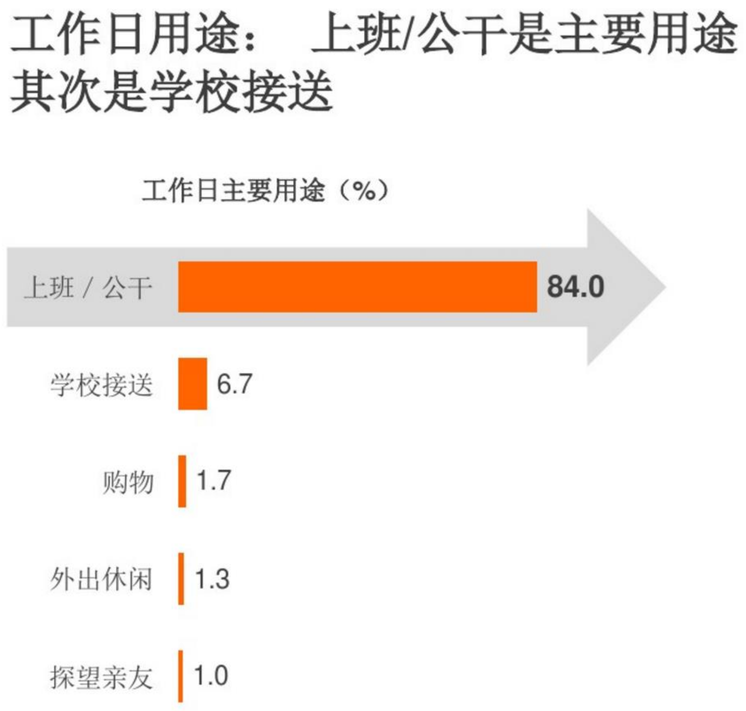
```
function[po]=color(r,g,b,range,cen,rad)
%输入颜色(RGB格式)、颜色误差范围、中心点坐标、消除半径，输出坐标矩阵
load tuu
ut=im2double(tuu);
ut=255.*ut;
%将图片转化为0-255的 x*y*3 整数格式矩阵
po=[];
for x=1:1:1494
    for y=1:1:1222
        if (abs(ut(x,y,1)-r)+abs(ut(x,y,2)-g)+abs(ut(x,y,3)-b))<range
            %判断(x,y)像素点的颜色与输入是否在误差范围内
             po=[po;31.872-x*7.8916e-4,120.867+y*9.14894e-4];
        end
    end
end
for i=1:1:length(po)
    if (po(i,1)-cen(1))^2+(po(i,2)-cen(2))^2<rad
        %判断该坐标与中心点坐标距离是否在消除半径内
        po(i,:)=NaN;
    end
end
po=po(all(~isnan(po),2),:);
scatter(po(:,2),po(:,1))
```


31.4
31.3
31.2
31.1
31
30.9
121.1
121.2
121.3
121.4
121.5
121.6
121.7
121.8


31.4
31.3
31.2
31.1
31
30.9
30.8
121.1
121.2
121.3
121.4
121.5
121.6
121.7
121.8
121.9

Assumptions:

1. 随机样本只考虑上下班通勤的情况。



Assumptions:

1. 随机样本只考虑上下班通勤的情况。
2. 车辆按最短路径通行。
3. EV用户在日常通勤的路径附近寻找充电站。

Assumptions:

1. 随机样本只考虑上下班通勤的情况。
2. 车辆按最短路径通行。
3. EV用户在日常通勤的路径附近寻找充电站。
4. 在路径上随机选择一点来代表这条路径。

Assumptions:

4. 在路径上随机选择一点来代表这条路径。

Assumptions:

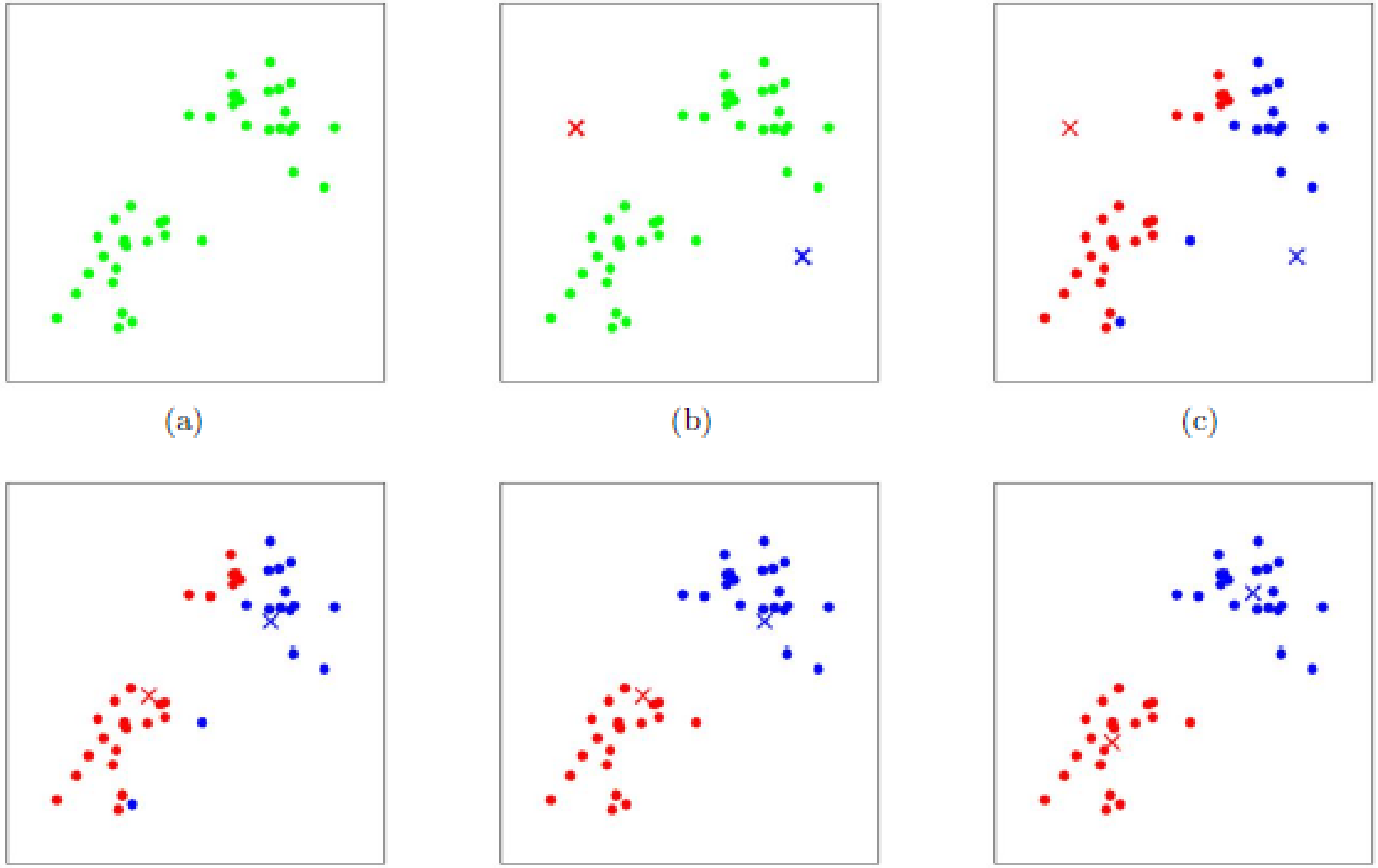
1. 随机样本只考虑上下班通勤的情况。
2. 车辆按最短路径通行。
3. EV用户在日常通勤的路径附近寻找充电站。
4. 在路径上随机选择一点来代表这条路径。
5. 不考虑超级充电站的容量

K-means cluster:

$$\min \sum_{j=1}^{k} \sum_{\overrightarrow{x_i} \in C_j} \left\| \overrightarrow{x_i} - \overrightarrow{\mu_j} \right\|^2$$

其中k为聚类数量，C_j为一个聚类，$\overrightarrow{\mu_j}$是聚类中心。

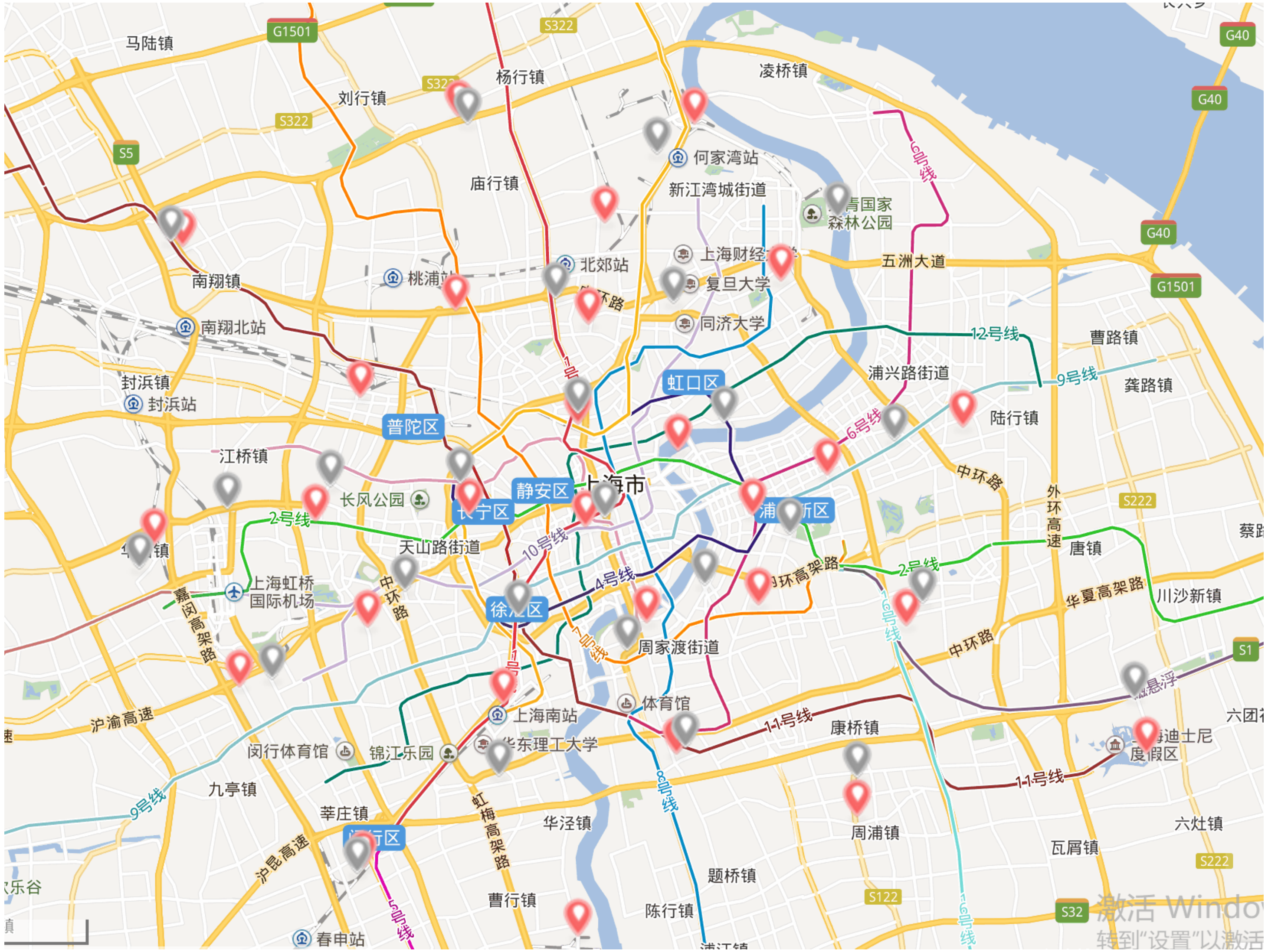
K-means cluster:



(a) (b) (c)

(d) (e) (f)

Results:



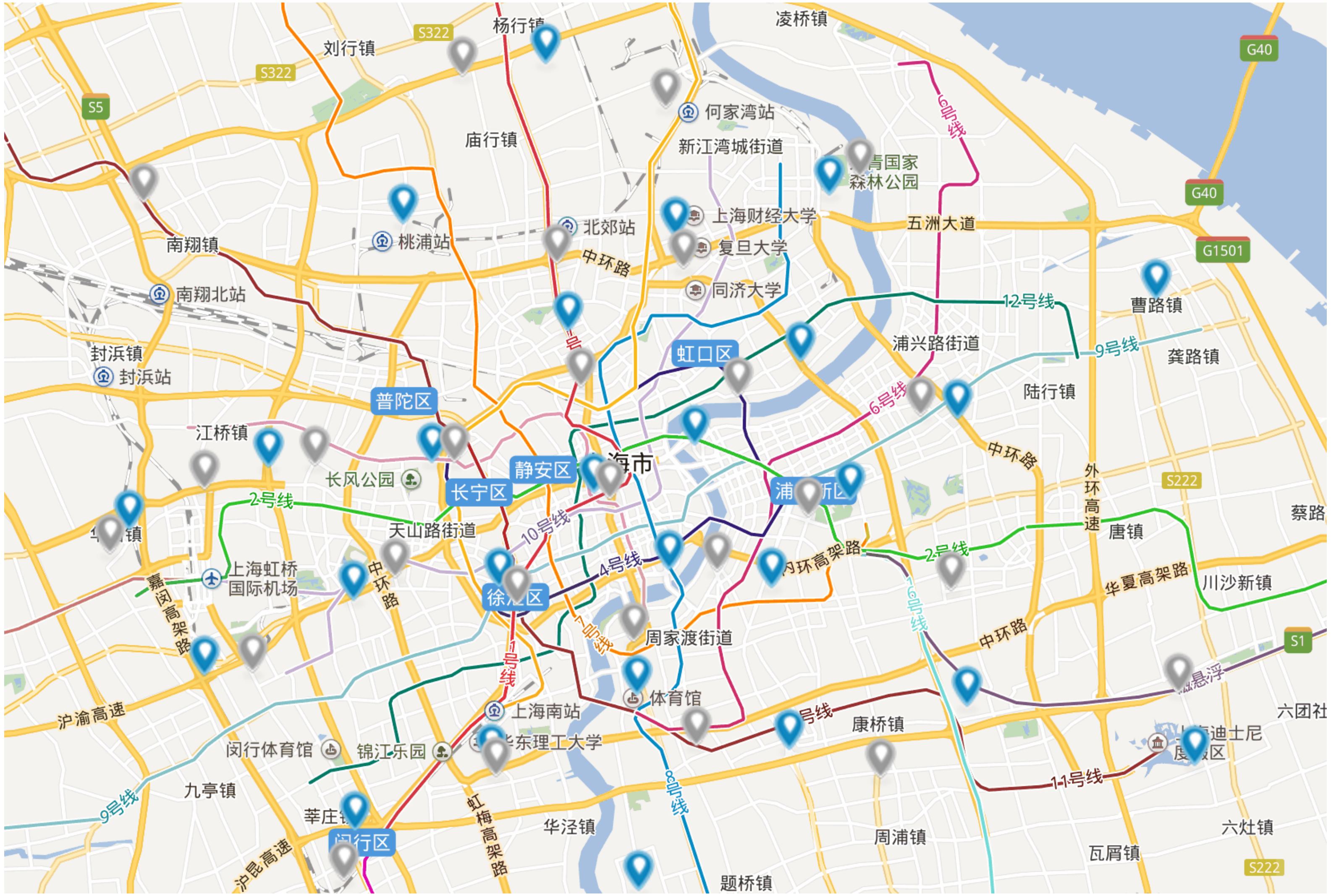
红色：

n≈1200

灰色： n

≈2200

Results:



灰色： n ≈2200

蓝色： n ≈3200

Results:

黄色： 现实位置

蓝色： n

≈3200

改进之处:

1. 样本的生成还可以进一步细化
2. 资料和数据的来源不够可靠
3. 最后,我们将考虑其他因素,比如当前的汽车,目前的经济和政策上给一些建议在中国推广电动汽车。