Problem 1
For instance

1	High School	Service	Less than 3

P(High School | High) = 1 + 1 / 4 + 2
P(Service | High) = 1 + 1 / 4 + 2
P(Less than 3 | High) = 1 + 1 / 4 + 3
P(High School | Low) = 4 + 1 / 6 + 2
P(Service | Low) = 4 + 1 / 6 + 2
P(Less than 3 | Low) = 2 + 1 / 6 + 3
P(High | X) = 0.0126984126984
P(Low | X) = 0.078125
Because P(High | X) < P(Low | X), this instance should be labeled as Low.

For instance

2	College	Retail	Less than 3

P(College | High) = 3 + 1 / 4 + 2
P(Retail | High) = 0 + 1 / 4 + 3
P(Less than 3 | High) = 1 + 1 / 4 + 3
P(College | Low) = 2 + 1 / 6 + 2
P(Retail | Low) = 0 + 1 / 6 + 3
P(Less than 3 | Low) = 2 + 1 / 6 + 3
P(High | X) = 0.0108843537415
P(Low | X) = 0.00833333333333
Because P(High | X) > P(Low | X), this instance should be labeled as High.

For instance

3	Graduate	Service	3 to 10

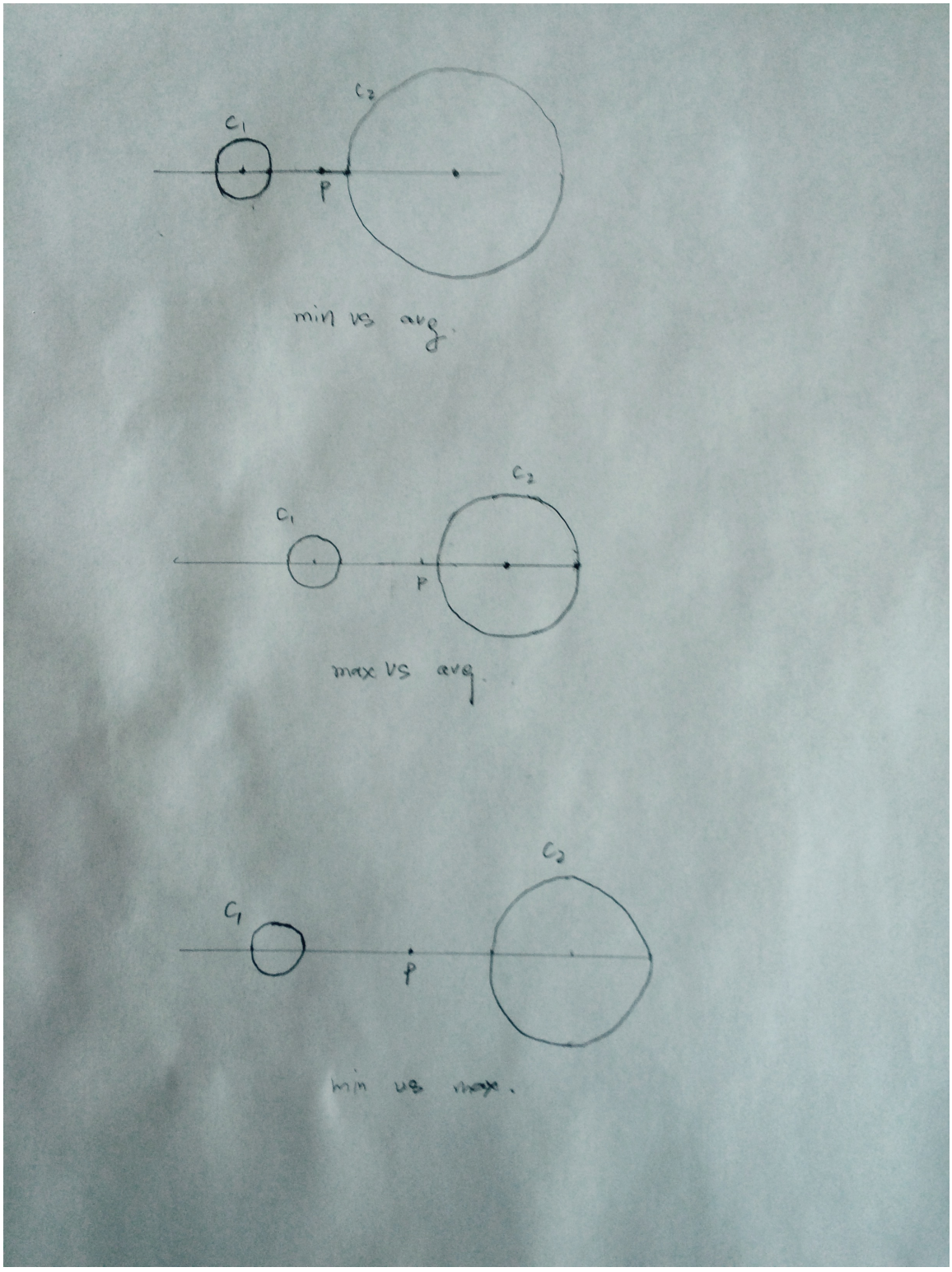
P(Graduate | High) = 0 + 1 / 4 + 3
P(Service | High) = 1 + 1 / 4 + 2
P(3 to 10 | High) = 1 + 1 / 4 + 3
P(Graduate | Low) = 0 + 1 / 6 + 3
P(Service | Low) = 4 + 1 / 6 + 2
P(3 to 10 | Low) = 2 + 1 / 6 + 3
P(High | X) = 0.00544217687075
P(Low | X) = 0.0138888888889

Because P(High | X) < P(Low | X), this instance should be labeled as Low.

Problem 2

a) mean vector: m1 = $[2,2]^T$, m2 = $[7,2]^T$
b) Total mean: m = $[5{,}125, 2]^T$
c) Scatter matrix : S1 = [[2,2],[2,2]], S2 = [[10,0], [0,0]]
d) Within cluster matrix: Sw = [[12,2],[2,2]]
e) Between cluster matrix: Sb = [[46.875,0],[0,0]]
f) Scatter criterion: 3.348

Problem3



In the first graph, if min distance between was choose, p will be merged into C2 at this time, but if avg distance was choose, p will be merged into C1

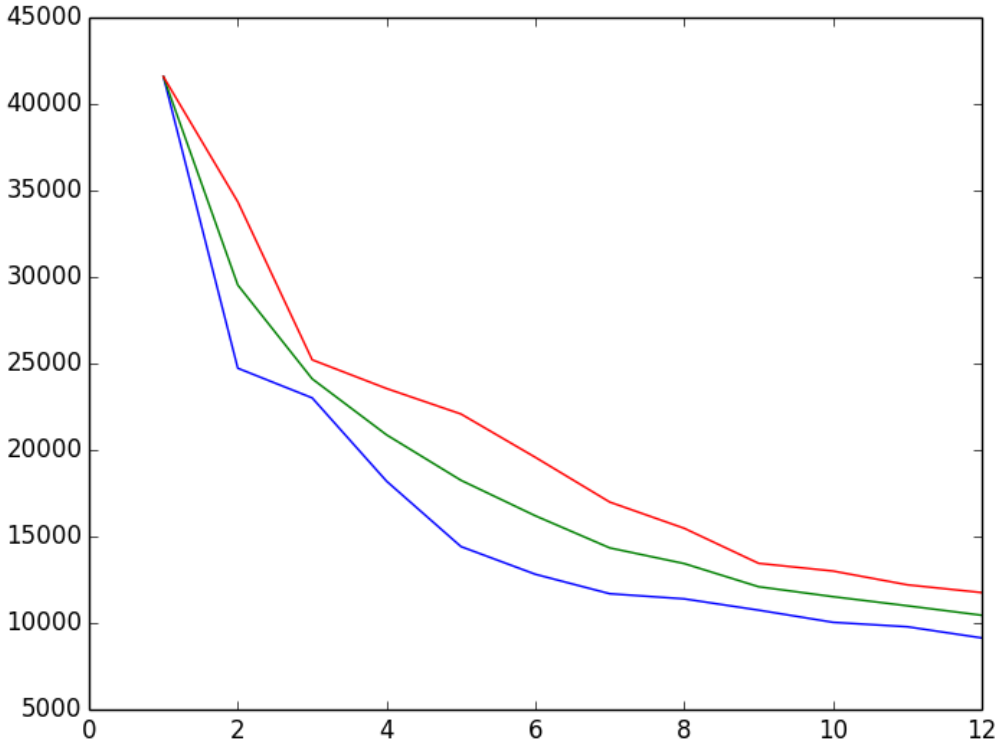
In the second graph, if max distance between cluster was choose, p will be merged into cluster C2 at this time, but it avg distance was choose p will be merged into C1
In the third graph, if min distance between cluster was choose, p will be merged into cluster at C2 at this time, but if max distance was choose p will be merged into C1.

Problem 4

a) C1 = [(1,2), (2,3), (3,4)], C2 = [(5,1),(4,2),(5,3),(6,2)]
b) Each pair of points within the same cluster is density-connected points. For this situation, (1,2) and (2,3), (1,2) and (3,4), (2,3) and (3,4) are density-connected points. (5,1) and (4,2), (5,1) and (5,3), (5,1) and (6,2), (4,2) and (5,3), (4,2) and (6,2), (5,3) and (6,2) are density-connected points.
c) In this situation, point (0,0), (1,6), (7,4) are considered as noisy.

Problem5

a)



b)

k	u – 2 * sigma	u	u+2*sigma
1	41580	41580	41580
2	24727. 14693	29536. 67079	34346. 19465
3	23011. 39774	24112. 01358	25212. 62942
4	18196. 25124	20874. 71562	23553. 17999
5	14416. 56462	18248. 27137	22079. 97812
6	12816. 3799	16195. 78241	19575. 18492
7	11691. 78374	14340. 01024	16988. 23674
8	11395. 47541	13434. 91712	15474. 35884
9	10742. 8972	12096. 09477	13449. 29235
10	10039. 81162	11521. 56762	13003. 32361
11	9781. 918432	10994. 14173	12206. 36502
12	9136. 729933	10447. 31399	11757. 89805

c) By k increases and approaches the total number of N, SSE will decrease and when k=N SSE=0. In general, by increasing k SSE will decrease, so there is not a optimal SSE for k. If we simply think lower SSE means better cluster result, using

SSE selected optimal k will equals to N.

d) We can use scatter criterion. A good partition should have high trace of between cluster matrix(Sb) and low trace of within cluster matrix(Sw), and have high scatter criterion trace(Sb) / trace(Sw).

Homework 2 Problem 1

node 0
Top: 6,4, 0.97
Education Level gain = 0.125
Career gain = 0.125
Years of Experience gain = 0.020
Selected Attribute: Education

node 1
High School 4,1, 0.72
Career gain = 0.171
Years of Experience gain = 0.322
Selected Attribute: Years of Experience

node 3
More than 10
Career gain = 1.0
Selected attribute Career

node 8
Management
Class High

node 9
Service
Class Low

node 4
Less than 3
Class Low

node 5
3 to 10
Class Low

node 2
College 3,2, 0.97
Career gain = 0.420
Years of Experience gain = 0.171
Selected Attribute: Career

node 6
Management
class High

node 7
Service 1,2, 0,91
Years of Experience gain = 0.918
selected attribute: Years of Experience

node 10
More than 10
Class Low

node 11
Less than 3
Class Low

node 12
3 to 10
Class High

Apply the pruning set,

node	prune error	keep error
0	1	2
1	0	0
2	0	2
3	0	0
7	0	1

Node 2 will be pruned. Then the decision will be:

node 0
Top: 6,4, 0.97
Education Level gain = 0.125
Career gain = 0.125
Years of Experience gain = 0.020
Selected Attribute: Education

node 1
High School 4,1, 0.72
Career gain = 0.171

Years of Experience gain = 0.322
Selected Attribute: Years of Experience
node 3
More than 10
Career gain = 1.0
Selected attribute Career

node 8
Management
Class High

node 9
Service
Class Low

node 4
Less than 3
Class Low

node 5
3 to 10
Class Low

node 2
Class Low

Apply pruning set to decision tree:

node	prune error	keep error
0	1	0
1	0	0
3	0	0

No more node should be pruned.