Assignment 5

DSC 440 Data Mining
Nov. 11, 2019
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10.2

(a)For A2: d(A1A2) = 5, d(B1A2) = 3*sqrt(2), d(C1A2) = sqrt(10)
Because d(C1A2) is the smallest, A2 belongs to the third cluster.
Continue doing this for A3, B2, B3 and C2, we can get the final cluster after the first iteration:
Cluster 1: A1
Cluster 2: B1, A3, B2, B3, C2
Cluster 3: C1, A2

(b)Take mean value of each cluster, calculate the distance for every point, and reassign them to the three clusters, we can get the final cluster result:
Cluster 1: A1, C2, B1
Cluster 2: A3, B2, B3
Cluster 3: A2, C1

10.4

The initialization process of k-means++ guarantees datapoints with higher distances have larger probabilities to be selected as cluster center.
This speed up the convergence of k-means because it prevents the situation that selected cluster centers are too close to separate the dataset so that it needs a lot of iterations to make it right.
This also improves the final quality of clustering. Because in k-means, the choice of initial cluster center greatly influences the clustering result, if the cluster is not diverse enough, the number of datapoints in each cluster center will not be even. K-means++ maintains the diversity of cluster center, so the result improves in datapoints distribution among different clusters.

10.6

(a) Strength: k-means is faster as the calculation of mean value is simpler.
Weakness: mean value is less robust than medoids in terms of noise and outliners.
(b) k-means and k-medoids algorithms are partitioning-based cluster methods.
Strength: By changing cluster centers and repartitioning data points, k-means and k-medoids can roll back to former cluster status. This allows the methods to be more flexible and can adjust previous mistakes. But hierarchical clustering method cannot make this kind of adjustment.
Weakness: Partitioning-based cluster methods need to know the number of the clusters before performing the algorithm, and the cluster number is hard to decide when the dataset is complex. Hierarchical clustering can determine the number of clusters by itself.

11.2

(a)

Ada and Bob, the number of identical purchased items and their probability:

i	3	4	5	6	7	8	9	10
dist	$\sqrt{14}$	$\sqrt{12}$	$\sqrt{10}$	$\sqrt{8}$	$\sqrt{6}$	$\sqrt{4}$	$\sqrt{2}$	$\sqrt{0}$
J	3/17	4/16	5/15	6/14	7/13	8/12	9/11	10/10
P	$\frac{C_{997}^{7} * C_{7}^{i-3} * C_{990}^{10-i}}{(C_{997}^{7})^{2}}$							

Ada and Cathy, the number of identical purchased items and their probability:

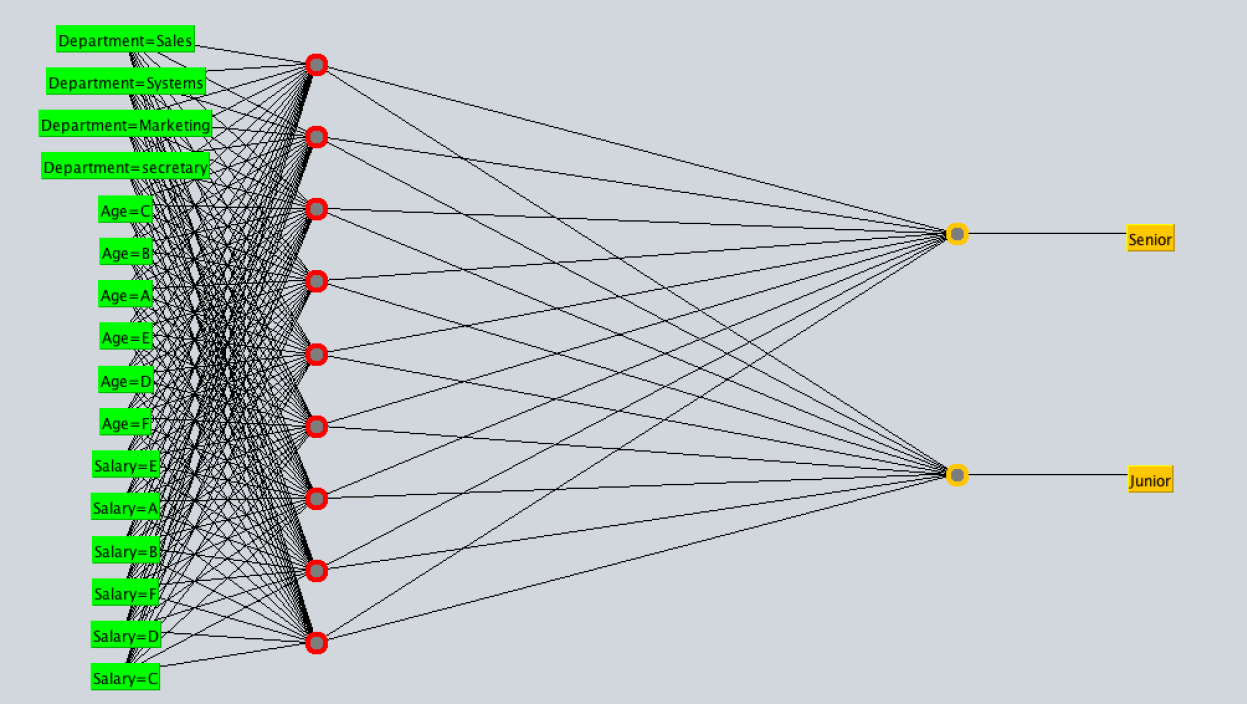
j	0	1	2	3	4	5	6	7	8	9
dist	$\sqrt{20}$	$\sqrt{18}$	$\sqrt{16}$	$\sqrt{14}$	$\sqrt{12}$	$\sqrt{10}$	$\sqrt{8}$	$\sqrt{6}$	$\sqrt{4}$	$\sqrt{2}$
J	0/20	1/19	2/18	3/17	4/16	5/15	6/14	7/13	8/12	9/11
P	$\frac{C_{997}^{7} * C_{10}^{j} * C_{990}^{10-j}}{C_{997}^{7} * C_{1000}^{10}}$									

Using Euclidean distance, the probability that dist(Ada, Bob) > dist(Ada, Cathy) is $9.8474 * 10^{-7}$
Using Jaccard similarity, the probability that J(Ada, Bob) > J(Ada, Cathy) is 0.9999

(b) The Euclidean distance is not bounded while Jaccard similarity is bounded into [0,1], both of them have realistic meaning and easy to explain, but Jaccard similarity is easier to calculate and use.
The probabilities of (Ada, Bob) > (Ada, Cathy) using different distance measure are very small.
The more similar a choice are, the smaller Euclidean distance is, but the larger Jaccard similarity is.

9.1

(a) Multiplayer feed forward neural network design:



(b) Training process:
Learning rate = 0.1, momentum = 0.05, after one iteration:
MSE error = 0.4051
Initial weights: W->random, b-> 0.
Weight values after first back propagation:

Sigmoid Node 0
Inputs Weights
Threshold -0.26850603233689985
Node 2 -0.1536414339165637
Node 3 -0.17286860603738968
Node 4 -0.1364763907158364
Node 5 -0.1417153018851152
Node 6 -0.16754821927106747
Node 7 -0.14391559301750534
Node 8 -0.15019737513177056
Node 9 -0.1858561194454201
Node 10 -0.13526583430423164

Sigmoid Node 1
Inputs Weights
Threshold 0.3250999661508872
Node 2 0.11735720436348823
Node 3 0.09648946838429141
Node 4 0.1325624679326844
Node 5 0.15698257685819983
Node 6 0.12829954102240823
Node 7 0.207029580465071
Node 8 0.18924299523947155
Node 9 0.15837187964839178
Node 10 0.08615410010553524

Sigmoid Node 2
Inputs Weights
Threshold 0.038653348425512636
Attrib Department=Sales 0.05434560124976678
Attrib Department=Systems 0.050109545588148244
Attrib Department=Marketing -0.058778105453982016
Attrib Department=secretary 0.02722769706499169
Attrib Age=C -0.035306422313939545
Attrib Age=B 0.03638901057815278
Attrib Age=A -0.03679265696140824
Attrib Age=E -0.04488552333272854
Attrib Age=D 0.020980767695431522
Attrib Age=F -0.02202247968999582
Attrib Salary=E -0.02692232166122509
Attrib Salary=A 0.052523338128237396
Attrib Salary=B -0.006360847155370609
Attrib Salary=F 0.013645909211310722
Attrib Salary=D 0.006326506159760579
Attrib Salary=C 0.0187459385176509

Sigmoid Node 3
Inputs Weights
Threshold 0.030568650535688614
Attrib Department=Sales -0.010038075173673144
Attrib Department=Systems 0.029978347463971825
Attrib Department=Marketing 0.00851851742731286
Attrib Department=secretary -0.05763385303412723
Attrib Age=C 0.029922043977196826
Attrib Age=B 0.031451196499638075
Attrib Age=A 0.021062087074958543
Attrib Age=E 0.010894327729157069
Attrib Age=D 0.02397239995015439
Attrib Age=F 0.013304227604520234
Attrib Salary=E -0.037865927939002446
Attrib Salary=A 0.006361281116523003
Attrib Salary=B 0.014165063402946654
Attrib Salary=F -0.03393531269405591
Attrib Salary=D 0.04319757907148311
Attrib Salary=C -0.03192214927665161

Sigmoid Node 4
Inputs Weights
Threshold 0.025621421346336264
Attrib Department=Sales -0.022959579565800626
Attrib Department=Systems 0.028400297712035633
Attrib Department=Marketing -0.04148496296283999
Attrib Department=secretary -0.051597923726552586
Attrib Age=C -0.03238239430861803
Attrib Age=B -0.028159869376346614

Attrib Age=A 0.01043362167324314
Attrib Age=E 0.02480877631710337
Attrib Age=D -0.0643114556440574
Attrib Age=F 0.006107221343135527
Attrib Salary=E -0.06727112856062
Attrib Salary=A 0.013939539144729205
Attrib Salary=B -0.014690923558922342
Attrib Salary=F -0.03520433205299514
Attrib Salary=D -0.03742476273913456
Attrib Salary=C 0.021423337091295274

Sigmoid Node 5

Inputs Weights
Threshold -0.012979180996231918
Attrib Department=Sales 0.006976214507463208
Attrib Department=Systems 0.002681257165634325
Attrib Department=Marketing -0.030283947269863613
Attrib Department=secretary 0.006422783618505513
Attrib Age=C -0.02701986265433854
Attrib Age=B 0.027574556564154973
Attrib Age=A -0.02083584892503353
Attrib Age=E 0.010618497515612745
Attrib Age=D -0.06568762581176323
Attrib Age=F 0.032336785062663825
Attrib Salary=E -0.064217316156824
Attrib Salary=A 0.04516784911933486
Attrib Salary=B -0.008079318926876352
Attrib Salary=F -0.019756702283727445
Attrib Salary=D 0.04194935075287159
Attrib Salary=C -0.0337420068460443

Sigmoid Node 6

Inputs Weights
Threshold -0.011048713758458596
Attrib Department=Sales -0.021268362340937073
Attrib Department=Systems 0.011079090837327313
Attrib Department=Marketing -0.03094612448761499
Attrib Department=secretary 0.002085398469667209
Attrib Age=C 0.00979248174951219
Attrib Age=B 0.005523703460711975
Attrib Age=A -0.008390752868117322
Attrib Age=E 0.03279743984142937
Attrib Age=D -0.012389197175083987
Attrib Age=F 0.0245612549141821
Attrib Salary=E -0.06403706988049863
Attrib Salary=A 0.028996296095587258
Attrib Salary=B 0.0491891127007853
Attrib Salary=F -0.04563734132428389
Attrib Salary=D 0.025404940560991587
Attrib Salary=C -0.026936341502251156

Sigmoid Node 7

Inputs Weights
Threshold 0.05243809928953863
Attrib Department=Sales -0.0028839958256765205
Attrib Department=Systems -0.03487698037616963
Attrib Department=Marketing -0.00344964845987625
Attrib Department=secretary -0.058424064979996304
Attrib Age=C -0.06990004383692128
Attrib Age=B 0.058126765896145516
Attrib Age=A -0.015401500591844355
Attrib Age=E 0.011006841707771194
Attrib Age=D -0.050474252502331875
Attrib Age=F -0.029382902594712653
Attrib Salary=E -0.09105728947155484
Attrib Salary=A 0.07112061752691698
Attrib Salary=B -0.012549373930123535
Attrib Salary=F -0.006694426796025129
Attrib Salary=D 0.0302636156561919
Attrib Salary=C 0.03289645185702459

Sigmoid Node 8

Inputs Weights
Threshold 0.037168762864944O3
Attrib Department=Sales 0.01597725913632879
Attrib Department=Systems -0.011844421708797868
Attrib Department=Marketing -0.05680055327387138
Attrib Department=secretary -0.02052475728654725
Attrib Age=C -0.03328777267265564
Attrib Age=B 0.06271813282102778
Attrib Age=A 0.006290729630263818
Attrib Age=E 0.007830196826772304
Attrib Age=D -0.04067850730489039
Attrib Age=F 0.02517295161105183
Attrib Salary=E -0.0070622816467351916
Attrib Salary=A -0.019352455913961782
Attrib Salary=B 0.0650263495377443

Attrib Salary=F 0.0179353197268242
Attrib Salary=D 0.0386029201442317
Attrib Salary=C -0.06693488117648713
Sigmoid Node 9
Inputs Weights
Threshold 0.014977177092840358
Attrib Department=Sales -0.01759614326096123
Attrib Department=Systems 0.01277406143287983
Attrib Department=Marketing -0.03940808929201179
Attrib Department=secretary 0.025762441970107283
Attrib Age=C 0.01812765276524513
Attrib Age=B -0.01379520274958834
Attrib Age=A 0.00678781474727209
Attrib Age=E -0.047323849335668314
Attrib Age=D -0.015261474739819016
Attrib Age=F 0.017671623261090202
Attrib Salary=E -0.08825332080678693
Attrib Salary=A 0.04924607547113777
Attrib Salary=B 0.014258696383286595
Attrib Salary=F -0.05663697719158005
Attrib Salary=D -0.0024072310316824936
Attrib Salary=C -0.006127719306334 31
Sigmoid Node 10
Inputs Weights
Threshold -0.030782801677984733
Attrib Department=Sales -0.016139024714893688
Attrib Department=Systems 0.01279216702884576
Attrib Department=Marketing 0.021979004825723868
Attrib Department=secretary 0.012060425628644773
Attrib Age=C -0.039993472220185046
Attrib Age=B -0.0066111599104027455
Attrib Age=A -0.03476569630789775
Attrib Age=E 0.03957296340471577
Attrib Age=D -0.029087761864083 68
Attrib Age=F 0.00910110083915472
Attrib Salary=E -0.018381112562647062
Attrib Salary=A -0.012255679517140343
Attrib Salary=B -0.031230216476898658
Attrib Salary=F 0.010016990812493675
Attrib Salary=D 0.014138839608671998
Attrib Salary=C -0.03779657482166918

After 100 iterations:
MSE reduced to 0.0279
Accuracy = 99.4118 %

(c)* SVM(BinarySMO in WEKA):
Kernel used: Linear Kernel
Classifier for classes: Senior, Junior
Attributes weights:

-0.271 * (normalized) Department=Sales
+ 0.436 * (normalized) Department=Systems
+ 0.1618 * (normalized) Department=Marketing
+ -0.3268 * (normalized) Department=secretary
+ -0.3387 * (normalized) Age=C
+ 0.953 * (normalized) Age=B
+ 0.9544 * (normalized) Age=A
+ -0.3394 * (normalized) Age=E
+ -0.7713 * (normalized) Age=D
+ -0.4579 * (normalized) Age=F
+ -0.6327 * (normalized) Salary=E
+ 0.1311 * (normalized) Salary=A
+ 1.3667 * (normalized) Salary=B
+ -1.3404 * (normalized) Salary=F
+ 0.9332 * (normalized) Salary=D

+ -0.4579 * (normalized) Salary=C
+ 0.243
MAE: 0.0059
Accuracy: 99.4118 %

Other classifier like Logistic Regression:
Logistic Regression with ridge parameter of 1.0E-8
Coefficients...

Variable	Class Senior
Department=Sales	7.8115
Department=Systems	-16.9648
Department=Marketing	4.4046
Department=secretary	12.9138
Age=C	7.1188
Age=B	-10.5308
Age=A	-29.9266
Age=E	42.1782
Age=D	44.0235
Age=F	42.4323
Salary=E	24.2832
Salary=A	-10.098
Salary=B	-21.0905
Salary=F	24.2934
Salary=D	-91.5933
Salary=C	42.4323
Intercept	-13.0612

MAE: 0.0094
Accuracy: 99.4118 %