

Department of Computer Science California State University, Channel Islands

COMP-546: Pattern Recognition Lab Report

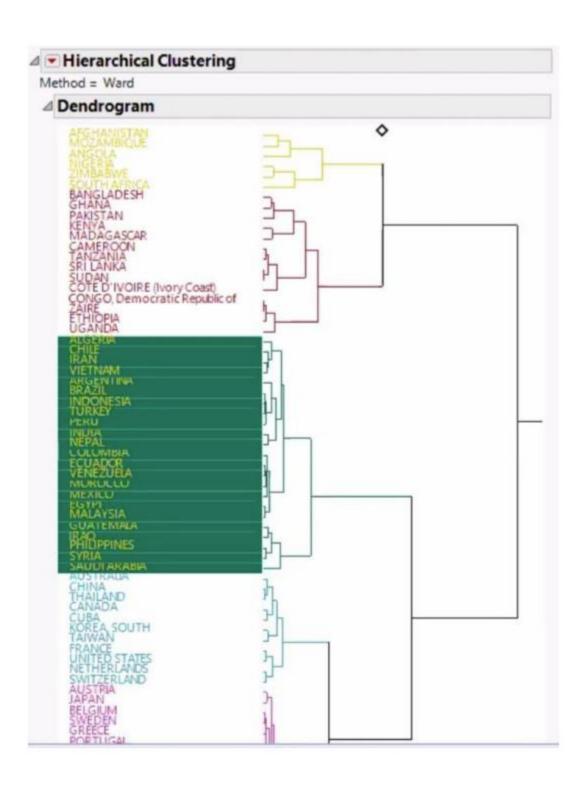
Lesson 8 phys546 Clustering HW 8A

Student Name: Sandipta Subir Khare Student Major: Masters in Computer Science Q1. The data set Birth Death.jmp contains mortality (i.e., birth and death) rates for several countries. Use cluster analysis to determine which countries share similar mortality characteristics. What do you notice that is similar among the countries that cluster together?

Ans.

	country	birth	death	Region
1	AFGHANISTAN	45	19	Asia
2	ALGERIA	17	5	Africa
3	ANGOLA	44	24	Africa
4	ARGENTINA	18	7	S America
5	AUSTRALIA	12	7	Pacific
6	AUSTRIA	9	10	Europe
7	BANGLADESH	25	9	Asia
8	BELGIUM	10	10	Europe
9	BRAZIL	18	6	S America
10	BULGARIA	10	14	Europe
11	BURMA	17	9	Asia
12	CAMEROON	34	12	Africa
13	CANADA	10	8	N America
14	CHILE	15	6	S America
15	CHINA	14	7	Asia
16	COLOMBIA	20	6	S America
17	CONGO, Democratic Republic of	43	12	Africa
18	COTE D'IVOIRE (Ivory Coast)	32	11	Africa
19	CUBA	11	7	N America
20	CZECH REPUBLIC	9	11	Europe
21	ECUADOR	21	5	S America
22	EGYPT	22	5	Africa
23	ETHIOPIA	44	12	Africa
24	FRANCE	13	9	Europe
25	GERMANY	8	11	Europe
26	GHANA	29	9	Africa
27	GREECE	9	11	Europe
28	GUATEMALA	28	5	S America
29	HUNGARY	10	13	Europe
30	INDIA	22	6	Asia
31	INDONESIA	19	6	Pacific
32	IRAN	17	6	Asia
33	IRAQ	30	5	Asia
34	ITALY	8	11	Europe
35	JAPAN	8	10	Asia
36	KAZAKHSTAN	17	9	Europe
37	KENYA	37	10	Africa
38	KOREA, NORTH	15	11	Asia
39	KOREA, SOUTH	9	6	Asia
40	MADAGASCAR	38	8	Africa
41	MALAYSIA	22	5	Asia
42	MEXICO	20	5	N America
43	MOROCCO	21	5	Africa
44	MOZAMBIQUE	38	20	Africa
45	NEPAL	23	7	Africa

	country	birth	death	Region				
46	NETHERLANDS	10	9	Europe				
47	NIGERIA	37	17	Africa				
48	PAKISTAN	28	8	Asia				
49	PERU	19	6	S America				
50	PHILIPPINES	26	5	Pacific				
51	POLAND	10	10	Europe				
52	PORTUGAL	10	11	Europe				
53	ROMANIA	11	12	Europe				
54	RUSSIA	11	16	Europe				
55	SAUDI ARABIA	29	2	Africa				
56	SLOVAKIA	11	10	Europe				
57	SOUTH AFRICA	20	17	Africa				
58	SPAIN	10	10	Europe				
59	SRI LANKA	34	13	Asia				
60	SUDAN	34	13	Africa				
61	SWEDEN	10	10	Europe				
62	SWITZERLAND	10	9	Europe				
63	SYRIA	26	5	Asia				
64	TAIWAN	9	7	Asia				
65	TANZANIA	34	13	Africa				
66	THAILAND	13	7	Asia				
67	TURKEY	19	6	Asia				
68	UGANDA	48	12	Africa				
69	UNITED KINGDOM	11	10	Europe				
70	UNITED STATES	14	8	N America				
71	VENEZUELA	21	5	S America				
72	VIETNAM	16	6	Asia				
73	ZAIRE	43	12	Africa				
74	ZIMBABWE	31	16	Africa				



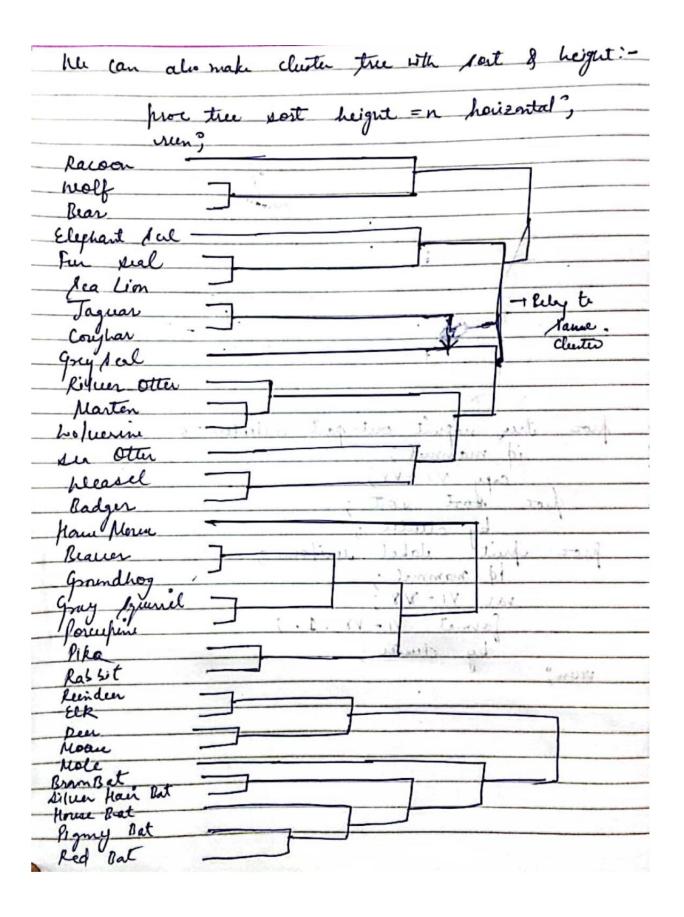
Q2. Consider the data in teeth.jmp, which contains data on the numbers of teeth of different types in a variety of mammals. Do hierarchical clustering to obtain the relevant dendrogram vary the number of clusters? With reference to the scree plot, and your own opinion of which animals should be clustered together, how many clusters do you think is optimal?

Ans.	
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Mole 72 10 32	
Silver Hair Pat 23/12	
Pigny Bat 27 1122	
Moun Rat 23111	
_ Red Bat 13112	
Pika 21002	2 3 3
Lablit 2100	
_ Beauer 110	
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29 Natton bolueren 2 — — — — — — — — — — — — — — — — — —	
29 Marten bushueren 2 — — — — — — — — — — — — — — — — — —	
28 Martin boluerne 2 27 Necoul Badger 2 26 Jaguar Coryar 2 25 fur Scal Sea Lim 2 29 Seer Moore 2 21 Peer Moore 2 21 Cc 28 River Otter 3 139 20 Cc 21 Cc 30, 4 872 19 lim Bat Silver Pat 2 76.7 19 lim Bat Silver Pat 2 76.7 18 Sika Sablit 2 76.7 19 lim Bat Silver Bat 3 67.4 16 Cc 22 Sear Bat 3 62.9 15 Cc 21 Cc 17 16 Cc 22 Sephant Seal 3 45.0 17 Cc 19 19 Cc 15 Sephant Seal 3 45.0 10 Cc 19 11 Cc 15 Sephant Seal 3 45.0 12 Cc 19 13 Cc 19 14 Cc 15 Sephant Seal 3 45.0 15 Cc 19 16 Cc 19 17 Cc 19 18 Cc 19 19 Cc 19 19 Cc 19 10 Cc 19 11 Cc 19 12 Cc 19 14 Cc 15 15 Cc 19 16 Cc 19 17 Cc 19 18 Cc 19 19 Cc 19 19 Cc 19 19 Cc 19 19 Cc 19 10 Cc 19 11 Cc 19 12 Cc 19 13 Cc 19 14 Cc 15 15 Cc 19 16 Cc 19 17 Cc 19 18 Cc 19 19 Cc 19 10 Cc 19 1	
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Q3. Consider the problem of clustering nine major cities in the United States. The distance between them (in miles) is given below:

BOS	NYC	DC	MIA	CHI	SEA	SF	LA	DEN
0	206	429	1,504	963	2,976	3,095	2,979	1,949
206	0	233	1,308	802	2,815	2,934	2,786	1,771
429	233	0	1,075	671	2,684	2,799	2,631	1,616
1,504	1,308	1,075	0	1,329	3,273	3,053	2,687	2,037
963	802	671	1,329	0	2,013	2,142	2,054	996
	0 206 429 1,504	0 206 206 0 429 233 1,504 1,308	0 206 429 206 0 233 429 233 0 1,504 1,308 1,075	0 206 429 1,504 206 0 233 1,308 429 233 0 1,075 1,504 1,308 1,075 0	0 206 429 1,504 963 206 0 233 1,308 802 429 233 0 1,075 671 1,504 1,308 1,075 0 1,329	0 206 429 1,504 963 2,976 206 0 233 1,308 802 2,815 429 233 0 1,075 671 2,684 1,504 1,308 1,075 0 1,329 3,273	0 206 429 1,504 963 2,976 3,095 206 0 233 1,308 802 2,815 2,934 429 233 0 1,075 671 2,684 2,799 1,504 1,308 1,075 0 1,329 3,273 3,053	0 206 429 1,504 963 2,976 3,095 2,979 206 0 233 1,308 802 2,815 2,934 2,786 429 233 0 1,075 671 2,684 2,799 2,631 1,504 1,308 1,075 0 1,329 3,273 3,053 2,687

(continued)

(continued)

	BOS	NYC	DC	MIA	CHI	SEA	SF	LA	DEN
SEA	2,976	2,815	2,684	3,273	2,013	0	808	1,131	1,307
SF	3,095	2,934	2,799	3,053	2,142	808	0	379	1,235
LA	2,979	2,786	2,631	2,687	2,054	1,131	379	0	1,059
DEN	1,949	1,771	1,616	2,037	996	1,307	1,235	1,059	0

(i) Use single-linkage and (ii) complete-linkage.

Ans.

i single linkage:

step(u) - find the minelement

206 -> (NYC; BOS)

NYC BOS

	RYC	1	- 21	-			LA	DEN
1	NYC, BOS	DC	MIA	CHI	SEA	SF	214	EIV
NYC, BOS	0				. 21		-	
DC.	233	0 .		*.	*			
MIA	1308	1075	0.					_
CHI	802	6.71	1329	0				
SEA	2815	2684	3273	2013	0			
SF.	2934	2799	3053	2142	808	0		
LA	2786	263	2687		-	379	-	
DEN	177/	16.16	2037	1996	1307	1235	1059.	0

To opdate matrix.

- -> Min[dis (NYC, BOS), DC]
 - => min[dis (NYC, DX), (BOS, DX)]
 - 7 min = 233, 429 = 233
- -) MIN [dis (NYC, MIA), (BOS, MIA)]
- = 1308, 1504] = 1308
- MIN [dis(NYC, CHI), (BOS, CHI)].
 - =) Min[802, 963] = 802
- > MIN(dis (NYC, SEA), (BOS, SEA))
- => MIN[2815, 2976] = 2815

> min[dis (NYC, LA), (BOS, LA)] => min[2786, 2979] = 2786

-) MIN[dis CNYC, DEN), (BOS, DEN)]

=> Min[1771,1949] = 1771

Step(2):- find minelement

233 -> (DC, (NYC, BOS))

			1		1	-	
	MC)BOS,	MIA	CHI.	SEA	SF	LA.	DEN.
NYC, BOS, DC	0		1				
MIA	1075	0.					· indi
CHI	671	1329	0				
SEA	2684	3273	2013	D	2 12		
SF	2795	3053	2142	808	0	11574	
LA	2631	2687	2054	1131	379	0	
DEN	1616.	2037	1996	1367	1235		0

⁻ MIN [NOTO (DC, CNYCIBOS)), MIA)]

> MIN [dis ((bc, MIA), ((NYC, BOS), MIA)]

> min[1075, 1308] = 1075

- > MIN [dis (DC,CHI) ((NYC, BOS), CHI)] => MIN [671, 802] = 671
-) MIN[dis (DC, SEA), ((NYC, BOS), SEA)]
 - > MIN[2684, 2815] = 2684
- -> Min [dis (DC)SF), ((MYC, BOS), SF)]
 - > MIN[2799, 2934] = 2797
- Min [dis (DC, LA), ((MX, BOS), LA)]
 - => Min[2631, 2786] = 263/
- -) MINIE drs (DC, DEN), ((NYC, BOS), DEN)
 - = MINE [616, 1771] = 1616

MyC. BOS DC

steps) - find min element.

(LA,SF).

	NYC, BOS,	MIA	CHI	SEA	SF,LA	DEN"
MC180S,	0					
MIA	1075	. 6				
CHI	671	1329	0			A 23 - 23
SEA	2684	37.73	2013	0		
SF, LA	263)	2687	2054	808	0	
DEN	1616.	2037	996	1307	1059	0.

- Min[dis (SF,LA), (MYCIBOS,DC)]
 - => MIN[dis (SF, (NYC, BOS, DC)), (LA; (NYC, BOS, DC))
 - > min[2799,2631] = 2631.
- -) Min[dis (SF, LA), MIA]
 - =) Min[dis (SF,MIA), (LA,MIA)]
 - =) Min[3653,2687] = 2687
- -). Min[dis (SF,CHI), (LA,CHI)]
 - => Min[2142,2054] = 2654
- -) MINE dis (SF,SEA), (LA,SEA)]
- => Min[808,1131] = 808
- -) MIN[dis (SE, DEN) , (LA, DEN)]
- -> MIN[1235,1059] = 1059

Step(4) - Nyc BOS DC ST LA Step(4) - find min element

671 -> (CHI, (NYC, BOS, DC))

	DC) CHI	MJA.	SEA	SF,LA	DEN
NYC, BOS,	0	deco	سدو	u	-6-00-
MIA .	1075	0.			
SEA	2013	32-13	0	est of the	
SF, LA	2054	2687	808	0	
DEN	996	2037	1307	1059	0

MIN [dis ((CHI, CNVC, BOSIDG)), MIA)] 3 min [dis ((CHI, MIA), ((NYCIBOSIDC), MIA)] 7 MIN[1329, 1075] = 1075 MIN [dis((CHI, SEA)), ((NYC, BOSIDC), SEA)] => MIN[2015, 2654] = 2013. MINE dis ((CHI, (SF, LA)), (NYC, BOS, DC) (SF, LA) = MIN[2054, 2631] = 2054 - MINE APS (CCHI, DEN), (NYC, BOS, DC), (DEN) =) MIN [996, 1616] = 996 find min element steps) b-808 -) ((SF, LA), SEA) MC, BOS, SEA,ST,LA MIA · DEN DC) CHI MYCIBOS) DC, CHI MIZA 1075 0 2687

2037

1059

SEA, ST, LA

DEN

2013

996

- > Min[dis((SF,LA),SEA), (NYC,BOSIDC,CHI)] 6
- => Min(dis ((SFILA), (NYCIBOSITC, CHIL)), (SEA)
- => Min[2054, 2013] = 2013
- > Min [dis ((SF, LA), MIA), (SFA, MIA)]
 - => Min[2687, 3273] = 2687
- MIN[dis ((SFILA), DEN), (SEA, DEN)]
 - => Min[dese6 1059, 1307] = 1059

Step6) - find min element.

996 -> (DEN, (NYC, BOSIDC, CHI))

	DEN	MIA	SEA, SF, LA
NIBIPC) DEN	0		
MIJA	. 1075	0	
SEA,SF,LA	1059	1059	. , 0

- -> MIN [dis ((DEN, MIA)) ((MC, B, D, CHI), MIA)] => MIN [2037, 107] = 1075
- -) MIN [dis ((DEN, (SEA,SF, LA)), (N, B, D,C), (SE, SAL)
- => MIN [1059, 2013] = 1059

slep@:- find min element 1059 -) ((SEA,SFILA), (NB,D,C,DEN) NIB, DIC, DEN, MITA. SEA, SF, LA NB, DIC, DENISEA SFILA 1059 MITA Min (dis ((SEA,SF, LA), MIA), (N,B,D,C,DEN), MIA) =) min [1059, 1075] = 1059 CHI DEN BOS DC final dendogram is DEN * CHI MC BOS

(i) complete linkage:

same as single linkage but take max element:

SteP(1): - find maxelement

3273 -) (SEA, MIA).

SEA MIA

	BOS	ISOS NYC	DC	SEAIMI	A CHI	- S	F	A	DE)
May Pos	0								
ROD	206	O							
DC	429	233	0.0						
SEA, MIA	2976	2815	2684	0					
CHI	963	802	671	2013	0.				
SF.	3095	2934	2799	3053.	2142	0			
LA	2979	2786	2631	2687	2054	379	0		-y e
DEN	1949	17711	1616	2037	1996	る	1059	D	

- -) MOX [dis (SEA, BOS), (MIA, BOS)]
 - =) x10x[2976, 1504] =2976
- -) Max [dis (SEA, NYC), [MIA, NYC)]
 - 7 Max[2815, 1308] = 2815
-) Max [dis(SFA, DC), (MJA, DC)]
 - 7 Max [2684, 1075] = 2684
- -) MAX [dis (SFA, SF), (MTA, SF)]
 - = 3033 = 3033 = 3033
- -) Max[dis (SEA, CHI), (MIA, CHI)]
 - -) Max [2013, 1829] = 2013

- y Max (dis (SEA, LA), (MIA, LA)
 - => Max[1131, 2687] = 2687
- Max (dis (SEA, DEN), (MIA, DEN)
 - 3 Max[1307, 2037] = 2037.

stered - find max element.

3095 -> (SF,BOS)

SEA MIA SF BOS

	SF, BOS	NYC	DC .	SEAMIA	CHI	LA	DEN'
SFIBOS	0		N 10				11.5
MC	2934	0					•
X	2795	233	0				
SEAIMITA	3013	2815	2684	0			
CHI	2142	802	671	2013.	D		
LA	2979	2786-	2631	2687.	2054	O	
DEN	1949	1771	1616	2037	996	1029	6

- -> Max [disc SF, MC), (BOS, MU]
 - =) Max [2934, 206] = 2934
- -) Max (dis (SF, tx)) (Bos, tx)]
 - => Max (2799, 429) = 2799
- -) Max (dis (SF, (SEA, MIA)), (BOS, (SEA, MIA))
 - 7 Max [3053, 2976] = 3053
- -> Max (dis (SF, CHI), (BOS, CHI)]
- => Max (2142, 963] = 2142.

- -> Max [dis (ST, LA), (BOS, LA)]
- 7 Max [379, 2979] = 2979
- -) MAX [dis(SF, DEN), (BOS, DEN))
- 7 Max [1235, 1949] = 1949

Ster(3) - find max element

3013 -> (SEA, MIA) (ST, BOS))

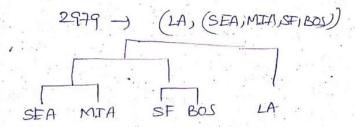
	SFIBOS, SEAIMIA	NYC	DC	CHI	2A	DEN
SF(BOS) SEA,MJA	0					
MC.	2934	0				
DC	2799	233	0.			
CHI	2142,	862	671	0		
LA	29.79	Z 7 86	263/	2054	0	
DEN.	2037	1771	1616	996	1059	0

- -) Max [dis ((SEA, MIA), NYC), (SF, BOS), NYC)]
- -) Max (dis ((SEA, MIA), DC) ((SE, BUD, DC)).
 - 7 Max [2684, 2799] = 2799
- -> MAX[dis ((SEA,MIA), CHI), (SF1BOS), CHI))

 -> MAX[dis ((SEA,MIA), CHI))
- -) Max [dis((SEAMEA), LA), ((ST,BOS), LA)]
 - => Max[2687 , 2979] = 2979

-) MAN [dis ((SEA, META), DEN) (SFIBOS), DEN)
 - =) Max[2037, 1949] = 2037

stepu: find maxelement



	the state of the s				
	SF, BOS, SEA, MIA, LA	MC	DC	CHI	DEN
SFIBOS, SEAIMITALA	0				
NYC	2734	D			
DC:	279)	233	0		
CHI	2142	802	67.1	0	
DEN	2037	1771	1616	996	. δ

⁻⁾ Max [dis ((LA, NYC), (SEA IMTA, SE IBOY), NYC)]

^{=&}gt; Max [2786, 2934] = 2934

⁻⁾ MAN [dis ((LA, DC), ((SEA, MTA, SFIBOS), DC)]

⁻⁾ Max [dis(LA, CHI), (SEA, MIA, SF, 805), CHI)]

-) Max Edis (CLAIDEN), ((SFIBOS, SEAIMTA), DEN) 12

) Max [1059, 2037] = 2037

Steps): - find max element

SEA MIA SF BOS LA' NYC

	SFIBOSISEA, MIAILAINYC	DC.	CHI	DEN
SF, BOS, SEA), MITA, LA, NYC	0			
be	2799	0		
CHI	242	671	0.	
DEN	2037	1616	996	0

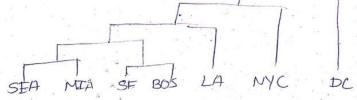
- -) Max [dis (NYC, DC), ((SFIBOS, SEA, MIA, LA), DC)] =) Max[233, 279] = 279)
- -) MOW [dis (MC, CHI), (SE BOS, SEA, MJA, LA), CHI)
- => Max [802) 2/42] 2 2/42
- -) Max [dis (MC, DEN), (SF, BOS, SEA, MTAPA), DEN)
- => Max [1771) 2037] = 2087.

SF, BOS, SEA, MIA, CHI DEN

	SF, BOS, SEA, MIA, LA, NYC, DC	CHI	DEN
ST, BOS, SEA, MTA, LA, MC, DC			
CHI	2142	0	i ix ty ty
DEN .	2037	996	0

- -) MAX [dis (DC, CHII), ((S,B,S,M,L,N), CHII)]
- => MOX (671) 2142] = 2142
- -) Max [dis E DC, DEN), ((S,B)S,M,ZIN), DAN)]
- => Max[1616, 2037] = 2637

Stepa



step=1:- find maxelement

2142 -> (CHI) (S,M,S,B,Z,N,D))

	B, M, SIB, LIN, D, CHII	DEN
S,M,S,B,L,N LHJ,D	0	
DEN	2037	0 /