Scan of the Past II

New Mexico

Supercomputing Challenge

Final Report

April 2, 2008

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Executive Summary

Can ethnicity be identified on skeletal remains by analyzing the facial structure of individual tribal members? In the project years 2005-06 and 2007-08 the method for determining the ethnicity of Native Americans is made using frontal and side profiles. Along with the computer program Neural Network. Zuni and Navajo facial structures can be differentiated by this process.

Problem Statement

Can ethnicity be identified on skeletal remains by analyzing the facial structure of individual tribal members? This question has held my interest, and anticipation in finding an answer. In a continuation of my 2005-06 project, I intend to come full circle and to find a solution to my problem.

In the 2005-06 challenge, I used the sphere shape in StarLogo 3-D to create a representation of two skulls. Within the program I was able to create a plane where I was able to view both skulls, and I was able to control the X, Y, and Z variables of each skull individually or as a pair. Before starting, I had obtained a letter of recommendation from Lt. Governor Carmelita Sanchez due to taboos of working with skeletal material. Then I conducted research on skeletal structures at the A:Shiwi A:wan Museum and Heritage Center. From there I contacted Christine Landrum with the National Park Service in Colorado in order to obtain a copy of the Native American Graves Protection and Repatriation Act (NAGPRA) rules and regulations.

Method

For this year's project I have returned to the original project and saw that instead of using StarLogo, I could choose a new approach to modeling. At the end of October, I met with Nick Bennett, challenge consultant and mentor, to discuss what would be the best way of approaching the model and what type of computer program would be best to use to create visual representation and to conduct the algorithm in one program.

In finding the points on the skull to use for the project I contacted Dr. Heather Edgar, a human osteologist from the University of New Mexico. When meeting with Edgar she suggested that I use six points on the face and five on the side profile. She also

recommended using the Neural Networks program for analysis, for in Neural Networks it is easy to create a visual and to make changes when necessary.

After contacting Stephen Guerin with the Redfish Group, we decided that using the front and side profile would best for modeling the differences in the facial structures of the different tribes. Some of the tribal members that were included were from full-blooded Zuni, Navajo, Santo Domingo, and San Felipe populations. However instead of using Neural Networks we would use Net Logo; Net Logo provided the ability to set points on the pictures of each student and still be able to move them. When viewing the pictures we noticed that there were more Zuni and Navajo students, so from there we decided to see if we could create a program that could differentiate between Zuni, Navajo, or other. In creating an algorithm that would best fit this, we chose a series of dependents and dependent angles on the front and side profile to test and see if the computer could classify whether the student was a Zuni, Navajo, or Other.

Results

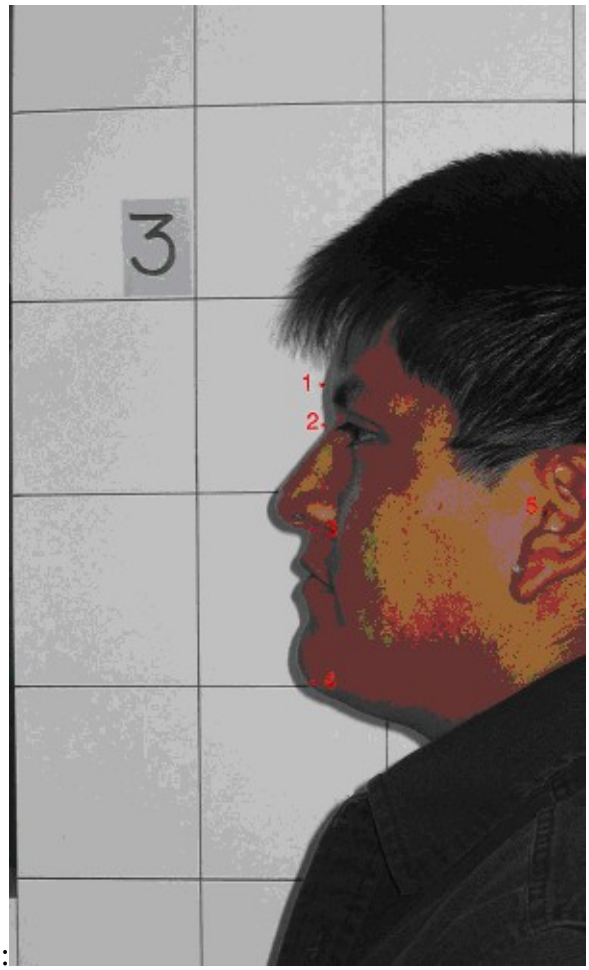
Zuni and Navajo facial structures can be differentiated by this process in differentiating the facial structures of these two ethnic groups and that of an unknown is possible.

Conclusion

With this process is used to find the ethnicity of a unknown skull and the classifying it into a category so that it can be used for other comparisons.

Appendix A. Screen shots

Cranial Points

Side: 

1. glabella
2. nasion
3. nasospinale
4. gnathion
5. porion: central point on the upper margin of the external auditory meatus

Cranial Points

Front: 

1) glabella
2) nasion
3) nasospinale
4) zygion

Appendix B: Blood Quantum (percent)

ID	Name	Tribes									
		Acoma	Anglo	African	Alaskan	Apache**	Hopi	Jemez	Kiowa***	Navajo	San Felipe
1	Kerry Bobelu Jr									0.00	
2	Keera Bobleu									0.00	
3	Terence Pedro	0.75								0.00	
4	Erik Dickson						0.25			0.00	
5	Nolan Eskeets		0.50							0.50	
6	Ronald Mescal									1.00	
7	Brittany Pedro	0.25								0.00	
8	Courtney Neito									0.00	
9	Christian Calabaza			0.25							
10	Autumn Vigil					0.5		0.25		0.25	
11	Haley Garica									0.50	0.50
12	Calvin Salas							0.25		0.25	
13	Teresa Cata				0.50					0.00	
14	Alex Rosetta									0.00	
15	Tyler Woods									1.00	
16	Christian Genny									0.00	1.00
17	Davina Calabaza									0.00	
18	Vanessa Keetso									1.00	
19	Racheal Manygoat									1.00	
20	Josetta Tafoya								0.50	0.00	
21	Jamita Rosetta									0.00	

Key

*	Santo Domingo
**	Jicarilla
***	Comanche

Acoma	Anglo	African	Alaskan	Apache**	Hopi	Jemez	Kiowa***	Navajo	San Felipe
-1	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	0.185409	-1

San Juan	Santa Clara	SD*	Zia	Zuni				
				1.00	1	0.898734		
				1.00	1	0.86194		
				0.25	1	0.873188		
				0.75	1	0.875676		
					1	0.912371		
					1	1.020619		
				0.75	1	0.989474		
				1.00	1	0.907895		
		0.75			1	1.068085		
						0.843137		
					1	0.929577		
			0.50		1	1.017621		
0.50					1	0.96		
		1.00			1	0.804878		
					1	0.917647		
					1	0.914634		
		1.00			1	0.949807		
					1	0.917355		
					1	0.884211		
	0.50				1	0.936242	0.50	0.912371
		1.00			1	0.942478	1.00	1.020619
							0.25	1.068085
							0.50	0.843137
							0.25	0.929577
San Juan	Santa Clara	SD*	Zia	Zuni			1.00	0.804878
		-						
#DIV/0!	#DIV/0!	0.78517	#DIV/0!	0.07738			1.00	0.949807
							1.00	0.917355
								-0.23629

Appendix C: X, Y, and Z points

	1		2		3		4		5		6	
1	406	427	407	409	409	331	419	214	535	355	298	340
2	359	514	361	493	362	394	359	283	479	421	211	427
3	423	689	428	664	423	578	423	448	568	595	292	589
4	388	473	389	457	395	386	392	311	478	433	293	433
5	370	509	368	493	368	425	374	332	472	469	278	472
6	395	520	395	505	397	430	392	322	493	454	299	460
7	349	643	359	616	374	499	385	361	508	586	223	535
8	420	629	423	608	422	518	423	422	526	559	298	539
9	395	660	395	639	397	538	394	409	509	561	274	546
10	395	649	395	620	385	524	388	434	515	593	260	617
11	389	545	389	521	395	419	402	281	529	473	245	473
12	388	677	382	650	370	560	361	446	484	571	257	601
13	425	530	428	509	430	431	430	314	524	463	299	457
14	414	602	414	584	420	470	415	338	570	515	242	530
15	459	668	462	644	465	566	462	434	577	566	322	575
16	402	591	408	579	408	477	406	366	532	476	286	473
17	373	644	373	617	379	533	387	398	514	596	255	566
18	348	680	346	665	342	575	337	458	456	605	214	602
19	446	566	441	545	438	446	432	314	586	511	301	514
20	408	572	399	539	394	452	382	293	549	503	251	521
21	381	591	384	567	381	486	379	378	490	543	264	549

Appendix C: X, Y, and Z points (cont.)

206	473	203	448	184	362	196	256	358	392
143	514	145	493	136	415	148	310	299	418
278	701	283	674	263	584	253	469	454	602
350	530	353	509	338	437	331	365	480	452
275	533	286	515	272	449	290	362	415	476
271	523	274	497	263	421	275	313	425	451
152	628	155	610	127	499	134	373	365	526
151	647	154	619	142	536	160	443	310	569
283	609	286	585	248	486	255	375	443	483
278	650	275	638	269	551	286	461	433	608
292	576	289	558	263	474	266	366	443	480
250	678	254	654	248	564	274	459	406	603
178	509	185	485	176	407	207	299	356	435
288	580	292	560	288	452	292	341	490	484
279	651	277	636	244	555	246	435	445	570
255	617	251	599	216	506	226	377	394	488
315	608	313	590	291	500	300	392	448	532
322	686	320	670	307	572	325	440	490	581
326	655	331	634	322	550	350	418	488	562
202	565	206	546	184	462	191	330	397	441
282	600	279	579	274	498	295	384	412	534

Appendix D: X, Y, and Z points (cont.)

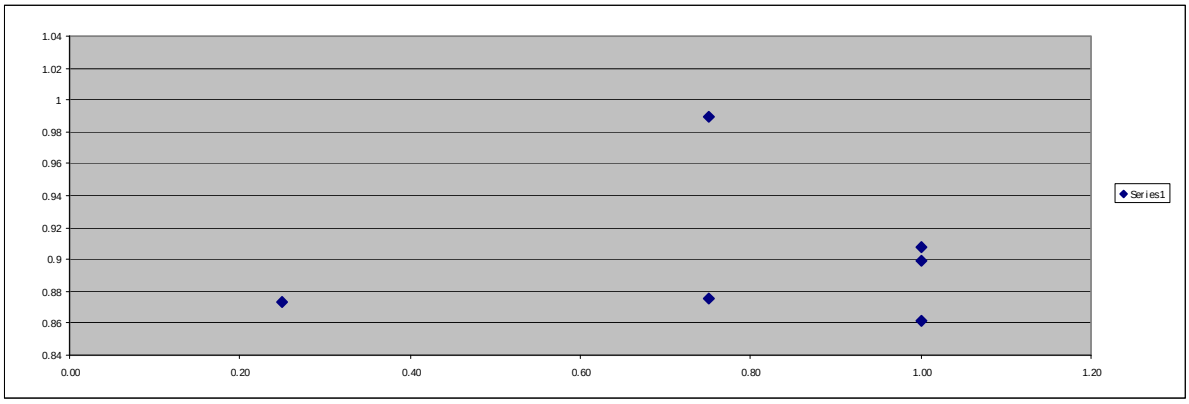


Figure1. Zuni: Face Correlation

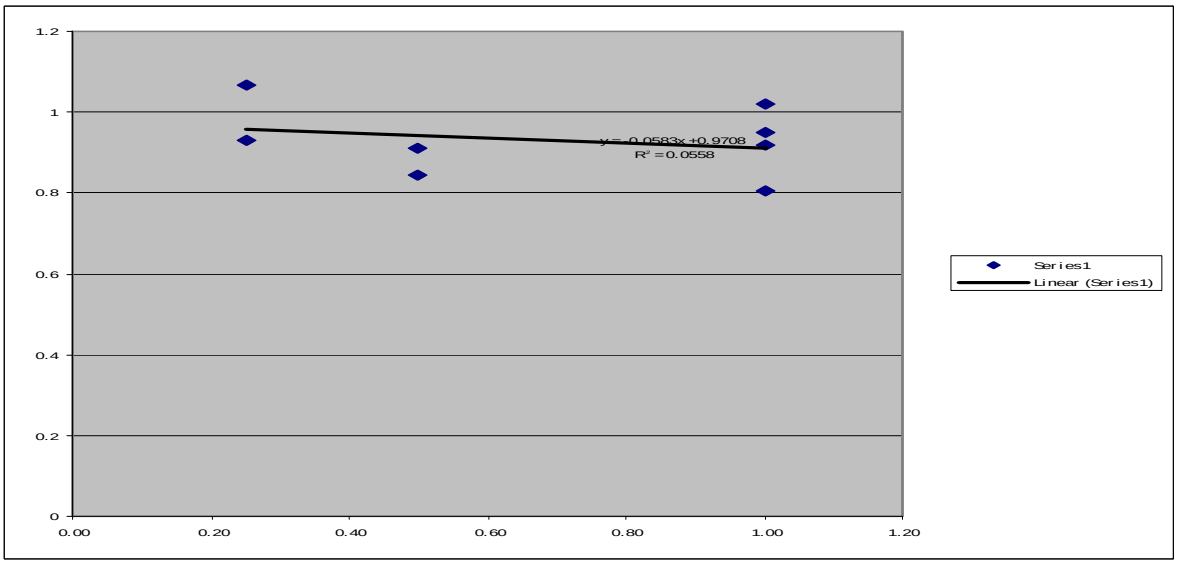


Figure 2.Navajo: Negative Correlation

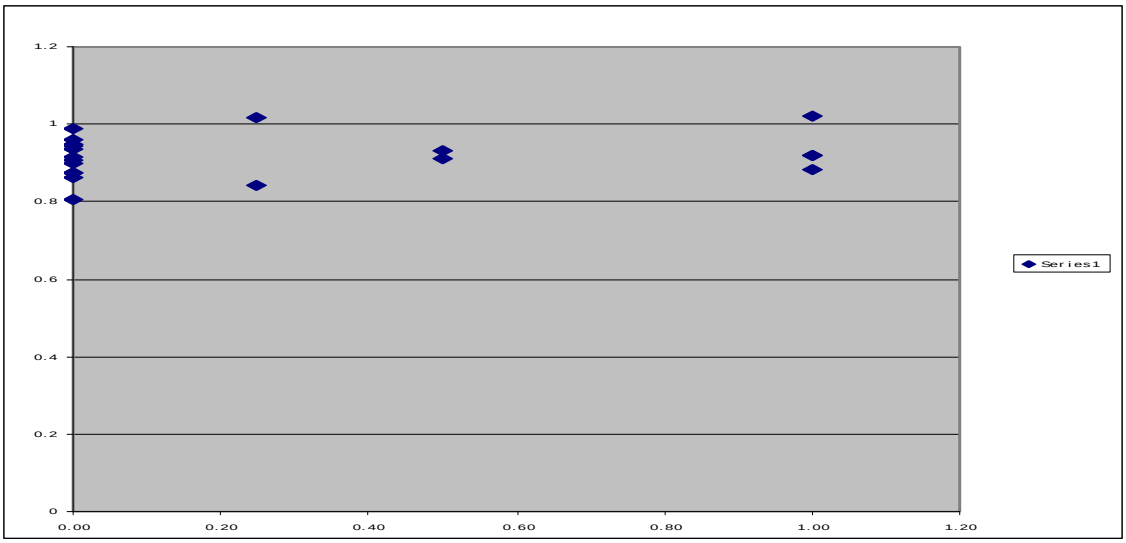


Figure3. Navajo Face Correlation (zero is added)

Appendix E: Source Code

```
globals [pointsDB numSubjects numFrontPoints numSidePoints]

breed [people person]
breed [points point]

to setup
  ; hard coding how many images we have. Need to fix later
  set numSubjects 21
  set numFrontPoints 5
  set numSidePoints 5
  file-open "pointsDatabase.txt"
  show file-read-line
  file-close
end

to set-points
  if mouse-down? and not any? [points-here] of patch mouse-xcor mouse-ycor
    [ create-points 1 [setxy mouse-xcor mouse-ycor  set color yellow set
size 5 set label who + 1  set shape "circle"]]

end

to edit-points
  if mouse-down?
    [ let closest-point min-one-of points [distancexy mouse-xcor mouse-
ycor]
    ask closest-point [setxy mouse-xcor mouse-ycor]
    ]

end

to load-next
  set image-id min (list (image-id + 1) numSubjects)
  load-image
end

to load-previous
  set image-id max (list (image-id - 1) 1)
  show image-id
  load-image
end

to load-image
  ifelse view = "front-view"
     [import-drawing (word image-id ".jpg")]
     [import-drawing (word image-id " (1).jpg")]
end

to change-view
  set view ifelse-value (view = "front-view") ["side-view"]["front-view"]
  load-image
end


to create-database
  set pointsDB []
  repeat numSubjects [
```

```
    repeat numFrontPoints[]
    repeat numSidePoints[]
  ]
end
@#$#@#$#@
GRAPHICS-WINDOW
205
10
993
1058
-1
-1
1.0
1
10
1
1
1
0
0
0
1
0
777
0
1016
0
0
1
ticks

CC-WINDOW
5
1116
1012
1211
Command Center
0

BUTTON
21
70
108
103
NIL
set-points
T
1
T
OBSERVER
NIL
C
NIL
NIL

BUTTON
21
102
111
135
```

```
NIL
edit-points
T
1
T
OBSERVER
NIL
NIL
NIL
NIL

CHOOSER
870
1057
1003
1102
view
view
"front-view" "side-view"
0

SLIDER
22
264
162
297
image-id
image-id
1
21
14
1
1
NIL
HORIZONTAL

BUTTON
94
228
157
261
>
load-next
NIL
1
T
OBSERVER
NIL
.
NIL
NIL

BUTTON
23
228
91
261
<
load-previous
NIL
```

1
T
OBSERVER
NIL
,
NIL
NIL

BUTTON
71
297
163
330
NIL
load-image
NIL
1
T
OBSERVER
NIL
NIL
NIL
NIL

BUTTON
23
187
125
220
NIL
change-view
NIL
1
T
OBSERVER
NIL
C
NIL
NIL

BUTTON
23
8
87
42
setup
setup
NIL
1
T
OBSERVER
NIL
NIL
NIL
NIL

Appendix F: Information Window

```
WHAT IS IT?
-----------
This section could give a general understanding of what the model is
trying to show or explain.


HOW IT WORKS
------------
This section could explain what rules the agents use to create the
overall behavior of the model.


HOW TO USE IT
-------------
This section could explain how to use the model, including a
description of each of the items in the interface tab.


THINGS TO NOTICE
----------------
This section could give some ideas of things for the user to notice
while running the model.


THINGS TO TRY
-------------
This section could give some ideas of things for the user to try to do
(move sliders, switches, etc.) with the model.


EXTENDING THE MODEL
-------------------
This section could give some ideas of things to add or change in the
procedures tab to make the model more complicated, detailed, accurate,
etc.


NETLOGO FEATURES
----------------
This section could point out any especially interesting or unusual
features of NetLogo that the model makes use of, particularly in the
Procedures tab.  It might also point out places where workarounds were
needed because of missing features.


RELATED MODELS
--------------
This section could give the names of models in the NetLogo Models
Library or elsewhere which are of related interest.


CREDITS AND REFERENCES
----------------------
```

This section could contain a reference to the model's URL on the web if it has one, as well as any other necessary credits or references.
@#$#@#$#@
default
true
0
Polygon -7500403 true true 150 5 40 250 150 205 260 250

airplane
true
0
Polygon -7500403 true true 150 0 135 15 120 60 120 105 15 165 15 195 120 180 135 240 105 270 120 285 150 270 180 285 210 270 165 240 180 180 285 195 285 165 180 105 180 60 165 15

arrow
true
0
Polygon -7500403 true true 150 0 0 150 105 150 105 293 195 293 195 150 300 150

box
false
0
Polygon -7500403 true true 150 285 285 225 285 75 150 135
Polygon -7500403 true true 150 135 15 75 150 15 285 75
Polygon -7500403 true true 15 75 15 225 150 285 150 135
Line -16777216 false 150 285 150 135
Line -16777216 false 150 135 15 75
Line -16777216 false 150 135 285 75

bug
true
0
Circle -7500403 true true 96 182 108
Circle -7500403 true true 110 127 80
Circle -7500403 true true 110 75 80
Line -7500403 true 150 100 80 30
Line -7500403 true 150 100 220 30

butterfly
true
0
Polygon -7500403 true true 150 165 209 199 225 225 225 255 195 270 165 255 150 240
Polygon -7500403 true true 150 165 89 198 75 225 75 255 105 270 135 255 150 240
Polygon -7500403 true true 139 148 100 105 55 90 25 90 10 105 10 135 25 180 40 195 85 194 139 163
Polygon -7500403 true true 162 150 200 105 245 90 275 90 290 105 290 135 275 180 260 195 215 195 162 165
Polygon -16777216 true false 150 255 135 225 120 150 135 120 150 105 165 120 180 150 165 225
Circle -16777216 true false 135 90 30
Line -16777216 false 150 105 195 60
Line -16777216 false 150 105 105 60

```
car
false
0
Polygon -7500403 true true 300 180 279 164 261 144 240 135 226 132 213
106 203 84 185 63 159 50 135 50 75 60 0 150 0 165 0 225 300 225 300 180
Circle -16777216 true false 180 180 90
Circle -16777216 true false 30 180 90
Polygon -16777216 true false 162 80 132 78 134 135 209 135 194 105 189
96 180 89
Circle -7500403 true true 47 195 58
Circle -7500403 true true 195 195 58

circle
false
0
Circle -7500403 true true 0 0 300

circle 2
false
0
Circle -7500403 true true 0 0 300
Circle -16777216 true false 30 30 240

cow
false
0
Polygon -7500403 true true 200 193 197 249 179 249 177 196 166 187 140
189 93 191 78 179 72 211 49 209 48 181 37 149 25 120 25 89 45 72 103 84
179 75 198 76 252 64 272 81 293 103 285 121 255 121 242 118 224 167
Polygon -7500403 true true 73 210 86 251 62 249 48 208
Polygon -7500403 true true 25 114 16 195 9 204 23 213 25 200 39 123

cylinder
false
0
Circle -7500403 true true 0 0 300

dot
false
0
Circle -7500403 true true 90 90 120

face happy
false
0
Circle -7500403 true true 8 8 285
Circle -16777216 true false 60 75 60
Circle -16777216 true false 180 75 60
Polygon -16777216 true false 150 255 90 239 62 213 47 191 67 179 90 203
109 218 150 225 192 218 210 203 227 181 251 194 236 217 212 240

face neutral
false
0
Circle -7500403 true true 8 7 285
Circle -16777216 true false 60 75 60
Circle -16777216 true false 180 75 60
```

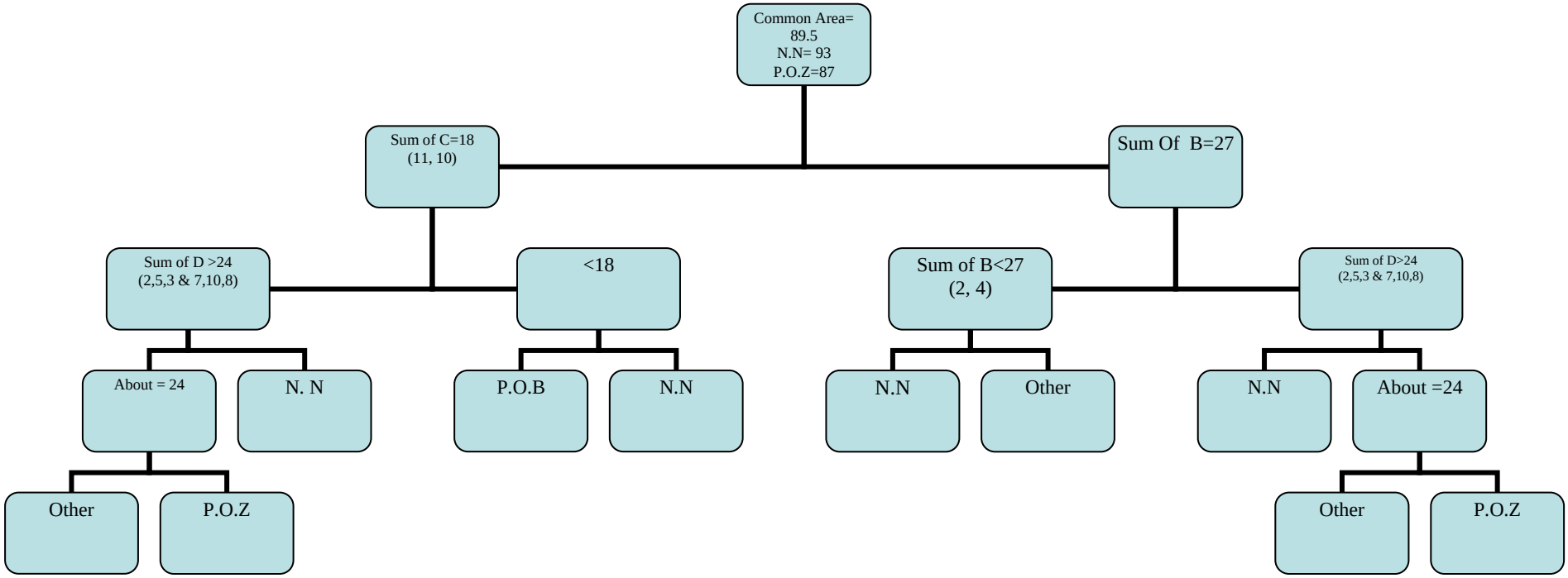
```
Rectangle -16777216 true false 60 195 240 225

face sad
false
0
Circle -7500403 true true 8 8 285
Circle -16777216 true false 60 75 60
Circle -16777216 true false 180 75 60
Polygon -16777216 true false 150 168 90 184 62 210 47 232 67 244 90 220
109 205 150 198 192 205 210 220 227 242 251 229 236 206 212 183

fish
false
0
Polygon -1 true false 44 131 21 87 15 86 0 120 15 150 0 180 13 214 20
212 45 166
Polygon -1 true false 135 195 119 235 95 218 76 210 46 204 60 165
Polygon -1 true false 75 45 83 77 71 103 86 114 166 78 135 60
Polygon -7500403 true true 30 136 151 77 226 81 280 119 292 146 292 160
287 170 270 195 195 210 151 212 30 166
Circle -16777216 true false 215 106 30

flag
false
0
Rectangle -7500403 true true 60 15 75 300
Polygon -7500403 true true 90 150 270 90 90 30
Line -7500403 true 75 135 90 135
Line -7500403 true 75 45 90 45

flower
false
0
Polygon -10899396 true false 135 120 165 165 180 210 180 240 150 300
165 300 195 240 195 195 165 135
Circle -7500403 true true 85 132 38
Circle -7500403 true true 130 147 38
Circle -7500403 true true 192 85 38
Circle -7500403 true true 85 40 38
Circle -7500403 true true 177 40 38
Circle -7500403 true true 177 132 38
Circle -7500403 true true 70 85 38
Circle -7500403 true true 130 25 38
Circle -7500403 true true 96 51 108
Circle -16777216 true false 113 68 74
Polygon -10899396 true false 189 233 219 188 249 173 279 188 234 218
Polygon -10899396 true false 180 255 150 210 105 210 75 240 135 240

house
false
0
Rectangle -7500403 true true 45 120 255 285
Rectangle -16777216 true false 120 210 180 285
Polygon -7500403 true true 15 120 150 15 285 120
Line -16777216 false 30 120 270 120

leaf
```

```
false
0
Polygon -7500403 true true 150 210 135 195 120 210 60 210 30 195 60 180
60 165 15 135 30 120 15 105 40 104 45 90 60 90 90 105 105 120 120 120
105 60 120 60 135 30 150 15 165 30 180 60 195 60 180 120 195 120 210
105 240 90 255 90 263 104 285 105 270 120 285 135 240 165 240 180 270
195 240 210 180 210 165 195
Polygon -7500403 true true 135 195 135 240 120 255 105 255 105 285 135
285 165 240 165 195

line
true
0
Line -7500403 true 150 0 150 300

line half
true
0
Line -7500403 true 150 0 150 150

pentagon
false
0
Polygon -7500403 true true 150 15 15 120 60 285 240 285 285 120

person
false
0
Circle -7500403 true true 110 5 80
Polygon -7500403 true true 105 90 120 195 90 285 105 300 135 300 150
225 165 300 195 300 210 285 180 195 195 90
Rectangle -7500403 true true 127 79 172 94
Polygon -7500403 true true 195 90 240 150 225 180 165 105
Polygon -7500403 true true 105 90 60 150 75 180 135 105

plant
false
0
Rectangle -7500403 true true 135 90 165 300
Polygon -7500403 true true 135 255 90 210 45 195 75 255 135 285
Polygon -7500403 true true 165 255 210 210 255 195 225 255 165 285
Polygon -7500403 true true 135 180 90 135 45 120 75 180 135 210
Polygon -7500403 true true 165 180 165 210 225 180 255 120 210 135
Polygon -7500403 true true 135 105 90 60 45 45 75 105 135 135
Polygon -7500403 true true 165 105 165 135 225 105 255 45 210 60
Polygon -7500403 true true 135 90 120 45 150 15 180 45 165 90

square
false
0
Rectangle -7500403 true true 30 30 270 270

square 2
false
0
Rectangle -7500403 true true 30 30 270 270
Rectangle -16777216 true false 60 60 240 240
```

```
star
false
0
Polygon -7500403 true true 151 1 185 108 298 108 207 175 242 282 151
216 59 282 94 175 3 108 116 108

target
false
0
Circle -7500403 true true 0 0 300
Circle -16777216 true false 30 30 240
Circle -7500403 true true 60 60 180
Circle -16777216 true false 90 90 120
Circle -7500403 true true 120 120 60

tree
false
0
Circle -7500403 true true 118 3 94
Rectangle -6459832 true false 120 195 180 300
Circle -7500403 true true 65 21 108
Circle -7500403 true true 116 41 127
Circle -7500403 true true 45 90 120
Circle -7500403 true true 104 74 152

triangle
false
0
Polygon -7500403 true true 150 30 15 255 285 255

triangle 2
false
0
Polygon -7500403 true true 150 30 15 255 285 255
Polygon -16777216 true false 151 99 225 223 75 224

truck
false
0
Rectangle -7500403 true true 4 45 195 187
Polygon -7500403 true true 296 193 296 150 259 134 244 104 208 104 207
194
Rectangle -1 true false 195 60 195 105
Polygon -16777216 true false 238 112 252 141 219 141 218 112
Circle -16777216 true false 234 174 42
Rectangle -7500403 true true 181 185 214 194
Circle -16777216 true false 144 174 42
Circle -16777216 true false 24 174 42
Circle -7500403 false true 24 174 42
Circle -7500403 false true 144 174 42
Circle -7500403 false true 234 174 42

turtle
true
0
```

```
Polygon -10899396 true false 215 204 240 233 246 254 228 266 215 252
193 210
Polygon -10899396 true false 195 90 225 75 245 75 260 89 269 108 261
124 240 105 225 105 210 105
Polygon -10899396 true false 105 90 75 75 55 75 40 89 31 108 39 124 60
105 75 105 90 105
Polygon -10899396 true false 132 85 134 64 107 51 108 17 150 2 192 18
192 52 169 65 172 87
Polygon -10899396 true false 85 204 60 233 54 254 72 266 85 252 107 210
Polygon -7500403 true true 119 75 179 75 209 101 224 135 220 225 175
261 128 261 81 224 74 135 88 99

wheel
false
0
Circle -7500403 true true 3 3 294
Circle -16777216 true false 30 30 240
Line -7500403 true 150 285 150 15
Line -7500403 true 15 150 285 150
Circle -7500403 true true 120 120 60
Line -7500403 true 216 40 79 269
Line -7500403 true 40 84 269 221
Line -7500403 true 40 216 269 79
Line -7500403 true 84 40 221 269

x
false
0
Polygon -7500403 true true 270 75 225 30 30 225 75 270
Polygon -7500403 true true 30 75 75 30 270 225 225 270

@#$#@#$#@
NetLogo 4.0.2
@#$#@#$#@
@#$#@#$#@
@#$#@#$#@
@#$#@#$#@
@#$#@#$#@
default
0.0
-0.2 0 0.0 1.0
0.0 1 1.0 0.0
0.2 0 0.0 1.0
link direction
true
0
Line -7500403 true 150 150 90 180
Line -7500403 true 150 150 210 180

@#$#@#$#@
```

Appendix G: Algorithm



Appendix H: Acknowledgements

I would like to take the opportunity to thank the people that have helped me reach my goals for this year's Supercomputing Challenge. Stephen Guerin and the Redfish Group of Santa Fe, for helping me in creating the model and spending time in making it possible to come to a full circle. Dr. Heather Edgar of UNM Human Osteology Dept. without your aid in the placement of the points of the front and side profile I wouldn't have had get my project started. Rhonda Ward-Martinez, my sponsor for the challenge, thanks for being patient and for driving me to the various places so that I could work with my mentor. The New Mexico Supercomputing Challenge for three great years that I have throughout my high school career. Last of all thanks to all the people that have helped me when I started in 2005-06 school year and for this year.

Appendix I: References

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Recommendations

In recommendation of this project is that I would need a larger subject group and that when comparing two the skeletal structure of known ethnic groups is that it is possible to conduct this project.