

Gait Analysis Activity Tutorial

Below is one example of a method used by students to analyze the GSM data:
Students started with this spreadsheet:

	B	C	D	E	F	G	H	I	J	K	L	M	N	O
1		AVG-Step_Time	SD-Step_Time	AVG-A_Gap-V	SD-A_Gap-V	AVG-A_Gap-L	SD-A_Gap-L	AVG-A_Gap-A	SD-A_Gap-A	AVG-AP_SD-V	SD-AP_SD-V	AVG-AP_SD-L	SD-AP_SD-L	AV
2	Adult 1	0.67	0.05	0.40	0.06	0.38	0.06	0.36	0.05	0.14	0.01	0.11	0.01	0.1
3	Adult 2	0.54	0.03	0.43	0.06	0.49	0.08	0.46	0.06	0.18	0.01	0.15	0.02	0.1
4	Adult 3	0.65	0.03	0.45	0.12	0.42	0.11	0.39	0.08	0.15	0.02	0.12	0.02	0.1
5	Adult 4	0.52	0.07	0.54	0.12	0.53	0.17	0.51	0.11	0.19	0.03	0.16	0.04	0.1
6	Child 1	0.55	0.05	0.62	0.21	0.52	0.14	0.53	0.18	0.20	0.05	0.15	0.04	0.1
7	Child 2	0.64	0.09	0.89	0.43	0.52	0.17	0.80	0.29	0.25	0.08	0.16	0.04	0.2
8	Child 3	0.50	0.13	1.28	0.52	1.05	0.23	0.85	0.26	0.36	0.13	0.32	0.06	0.2
9	Child 4	0.61	0.07	0.58	0.12	0.38	0.18	0.44	0.07	0.18	0.03	0.11	0.04	0.1
10														
11	AVG	average for all steps for a subject												
12	SD	standard deviation for all steps for a subject												
13														
14	A_Gap	difference between maximum and minimum values of acceleration within a step												
15														
16	AP_SD	standard deviation of acceleration values within the acceleration phase of a step												
17	DP_SD	standard deviation of acceleration values within the deceleration phase of a step												
18														
19	V	vertical axis												
20	L	lateral axis												
21	A	anterior axis												

They then color-coded the data (that is, adults in red, children in blue):

	B	C	D	E	F	G	H	I	J	K	L	M	N	O
1		AVG-Step_Time	SD-Step_Time	AVG-A_Gap-V	SD-A_Gap-V	AVG-A_Gap-L	SD-A_Gap-L	AVG-A_Gap-A	SD-A_Gap-A	AVG-AP_SD-V	SD-AP_SD-V	AVG-AP_SD-L	SD-AP_SD-L	AV
2	Adult 1	0.67	0.05	0.40	0.06	0.38	0.06	0.36	0.05	0.14	0.01	0.11	0.01	0.1
3	Adult 2	0.54	0.03	0.43	0.06	0.49	0.08	0.46	0.06	0.18	0.01	0.15	0.02	0.1
4	Adult 3	0.65	0.03	0.45	0.12	0.42	0.11	0.39	0.08	0.15	0.02	0.12	0.02	0.1
5	Adult 4	0.52	0.07	0.54	0.12	0.53	0.17	0.51	0.11	0.19	0.03	0.16	0.04	0.1
6	Child 1	0.55	0.05	0.62	0.21	0.52	0.14	0.53	0.18	0.20	0.05	0.15	0.04	0.1
7	Child 2	0.64	0.09	0.89	0.43	0.52	0.17	0.80	0.29	0.25	0.08	0.16	0.04	0.2
8	Child 3	0.50	0.13	1.28	0.52	1.05	0.23	0.85	0.26	0.36	0.13	0.32	0.06	0.2
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21	A	anterior axis												

Then each column was sorted numerically from smallest value to largest:

	B	C	D	E	F	G	H	I	J	K	L	M	N	O
1		AVG-Step_Time	SD-Step_Time	AVG-A_Gap-V	SD-A_Gap-V	AVG-A_Gap-L	SD-A_Gap-L	AVG-A_Gap-A	SD-A_Gap-A	AVG-AP_SD-V	SD-AP_SD-V	AVG-AP_SD-L	SD-AP_SD-L	AV
2		0.50	0.03	0.40	0.06	0.38	0.06	0.36	0.05	0.14	0.01	0.11	0.01	0.1
3		0.52	0.03	0.43	0.06	0.38	0.08	0.39	0.06	0.15	0.01	0.11	0.02	0.1
4		0.54	0.05	0.45	0.12	0.42	0.11	0.44	0.07	0.18	0.02	0.12	0.02	0.1
5		0.55	0.05	0.54	0.12	0.49	0.14	0.46	0.08	0.18	0.03	0.15	0.04	0.1
6		0.61	0.07	0.58	0.12	0.52	0.17	0.51	0.11	0.19	0.03	0.15	0.04	0.1
7		0.64	0.07	0.62	0.21	0.52	0.17	0.53	0.18	0.20	0.05	0.16	0.04	0.1
8		0.65	0.09	0.89	0.43	0.53	0.18	0.80	0.26	0.25	0.08	0.16	0.04	0.2
9		0.67	0.13	1.28	0.52	1.05	0.23	0.85	0.29	0.36	0.13	0.32	0.06	0.2
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11	AVG	average for all steps for a subject												
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Then students looked for columns where the metric showed differences between adults and children. For example, in column E, AVG-A_Gap-V values for all adults are less than the values for all children. Students chose several columns to use in developing a model to predict whether a subject is an adult or a child based on their GSM metrics. Below is one group's model:

	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
1			SD-Step_Time	AVG-A_Gap-V	SD-A_Gap-V	SD-A_Gap-L	SD-AP_SD-V	SD-AP_SD-L	AVG-DP_SD-V	AVG-DP_SD-L						
2			0.03	0.40	0.06	0.06	0.01	0.01	0.28	0.02						
3			0.03	0.43	0.06	0.08	0.01	0.02	0.29	0.03						
4			0.05	0.45	0.12	0.11	0.02	0.02	0.29	0.03						
5			0.05	0.54	0.12	0.14	0.03	0.04	0.29	0.04						
6			0.07	0.58	0.12	0.17	0.03	0.04	0.30	0.04						
7			0.07	0.62	0.21	0.17	0.05	0.04	0.30	0.04						
8			0.09	0.69	0.43	0.18	0.08	0.04	0.31	0.08						
9			0.13	1.28	0.52	0.23	0.13	0.06	0.33	0.15						
10			Statistical min for child	0.04	0.46	0.10	0.14	0.02	0.03	0.29	0.02					
11			Statistical max for adult	0.07	0.53	0.13	0.16	0.03	0.04	0.30	0.04					
12			anterior axis													
13			AVG	average for all steps for a subject												
14			SD	difference between maximum and minimum values of acceleration within a step												
15			A_Gap	standard deviation for all steps for a subject												
16			AP_SD	standard deviation of acceleration values within the acceleration phase of a step												
17			DP_SD	standard deviation of acceleration values within the deceleration phase of a step												
18			V	vertical axis												
19			L													
20			A													
21																
22																
23																
24				If the data value is below statistical min for child, the probability that the person who provided the data is a child is 10%.												
25				If the data value is above statistical max for adult, the probability that the person who provided the data is an adult is 10%.												
26				To figure out if a person is an adult or a child, use these data sets.												
27				If a value is below the statistical min for child, that data set shows that the person is most likely an adult.												
28				If the data value is above the statistical max for adult, the data set shows that the person is most likely a child.												
29				If the data value is between the statistical min for child and max for adult, the data set is ambiguous, so it should be discarded.												
30				Finally, to determine if someone is an adult or a child, add up the number of data entries that show that a person is an adult.												
31				Do the same for the data entries that show that a person is a child.												
32				If there are more entries that show that a person is an adult than that a person is a child, the person is most likely an adult.												
33				If there are more entries that show that a person is a child than that a person is an adult, the person is most likely a child.												

Then students applied their model to three unknown subjects to predict whether each was an adult or a child:

	A	B	C	D	E	F	G	H	I	J	K	L	M	
1			SD-Step_Time	AVG-A_Gap-V	SD-A_Gap-V	SD-A_Gap-L	SD-AP_SD-V	SD-AP_SD-L	AVG-DP_SD-V	AVG-DP_SD-L	Total number of estimated child entries	Total number of estimated adult entries	Adult or Child	
2			Unknown 1	0.13	0.65	0.24	0.23	0.06	0.30	0.11	7	0	Child	
3			Unknown 2	0.06	0.39	0.09	0.10	0.02	0.03	0.28	0.05	1	4	Adult
4			Unknown 3	0.15	0.69	0.19	0.20	0.05	0.04	0.29	0.11	6	0	Child
5			AVG											
6			SD	Key										
7			A_Gap	Purple shows child data entries.										
8			AP_SD	Red shows adult data entries.										
9			DP_SD	Black shows ambiguous data entries.										
10			V											
11			L											
12			A											

Unknown 1 and Unknown 3 were children. Unknown 2 was an adult.