University of Stellenbosch

Graduate School of Business

Business Statistics

Individual Assignment

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written: April 2002

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born on the 24th of March, 1977

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Declaration

Hereby I, Alexander Markowski, declare that this work is my own original work and that all sources have been accurately reported and acknowledged, and that this document has not previously in its entirety or in part been submitted at any university in order to obtain an academic qualification.

Bellville, 2002-04-21

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1 Introduction

1.1 Background

The Company Steier produces more than 100m parts per year. This ist entirely done by maschines. Since every part has to fulfill certain measurements and tolerances, the analysis of the output is more than important.

One of theses parts is the belt-connection shown in figure 1.1 on page 1. This part is produced more than 36,000,000 times per year. The central part is made of glue, covered by paper. It is sold in boxes of 4,000 pieces.

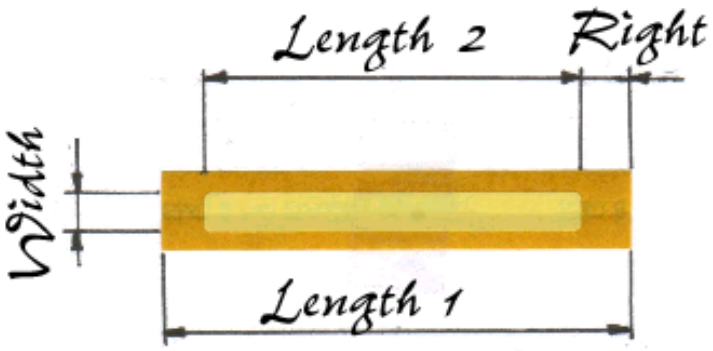

Figure 1.1: Part and measurements

Each part has to fulfill the measurements and tolerances shown in table 1.1 on page 2 in order to pass the quality control.

	Size in mm	**tolerance**
Length 2	48	±0.2
Width	4.9	±0.2
Length 1	60	±1
Right	6	±0.2

Table 1.1: Target Sizes

1.2 Roadmap

In chapter 2 I want to classify the data and show diagrams of these. This gives us a good impression about the distribution of the data. By taking into acount the measurements and the tolerances it gives us a good indication of the maschine's ability.

Later, in chapter 3 I take a quick look at the describing figures of the sample, also comparing them to the prescribed measurements and tolerances.

Beginning with chapter 4 I start making inferences about the whole population, using the t-statistic. This will show us, if the mean of the population is close to the prescribed measurement.

A possibly existing correlation between the four taken measurements is the matter of interest in chapter 5. A high correlation indicates that the deviations deviations are highly correlated, and the errors are due to a big problem with the maschine, while a small correlation indicates a random error.

2 Classified Data

2.1 Classified Data

By building frequency distributions out of our data, we enable ourselves to get a bigger and better picture of the data, the concentration and the distribution. In the following chapter, I start by building frequency distributions out of the four different measurements.

Since the concentration and distribution of each of the four data-rows is different, the classes have to be different, too. In the following tables i refer to the class by using the class-middle. As an example i will use the data in table 2.2. The class-middle's are: $5.85, 5.95, 6.05, ..., 7.15$ Based on these figures, the class-borders are:

Class-Middle	Class-Borders
6.05	6.00-6.10
6.15	6.10-6.20
⋮	⋮
7.15	7.10-7.20

Note that in this assignment – not like in Keller & Warrack (1999) – the upper border *includes* the value, while the lower border does not include the value. In the form of an equation this will be:

$$\text{lower border} < \text{class-middle} \leq \text{upper border} \tag{2.1}$$

2.2 Graphs and frequency distributions

Class	Frequency
6.05	0
6.15	6
6.25	20
6.35	34
6.45	55
6.55	65
6.65	26
6.75	14
6.85	15
6.95	12
7.05	3
7.15	0

Table 2.1: Classified Data for Right

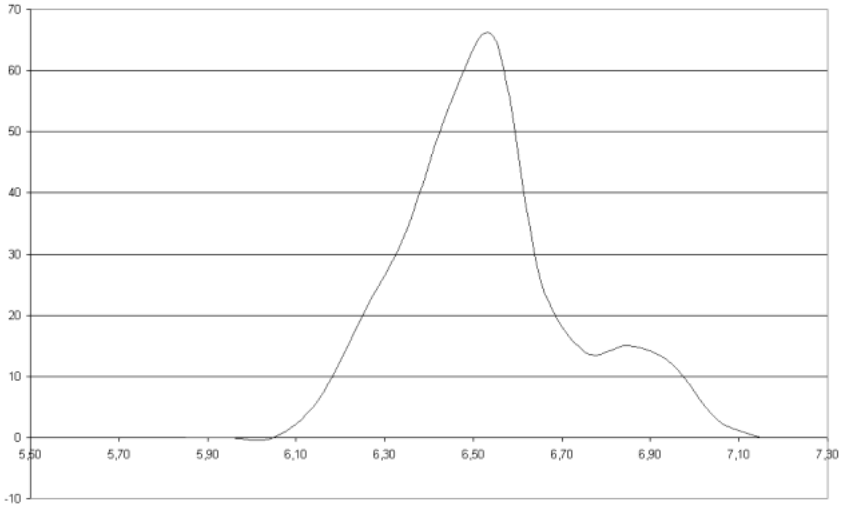

Figure 2.1: Classified Data for Right

Class	Frequency
59.43	0
59.45	1
59.47	1
59.49	2
59.51	2
59.53	7
59.55	17
59.57	25
59.59	8
59.61	23
59.63	20
59.65	22
59.67	30
59.69	36
59.71	25
59.73	14
59.75	11
59.77	5
59.79	1
59.81	0

Table 2.2: Classified Data for Length 1

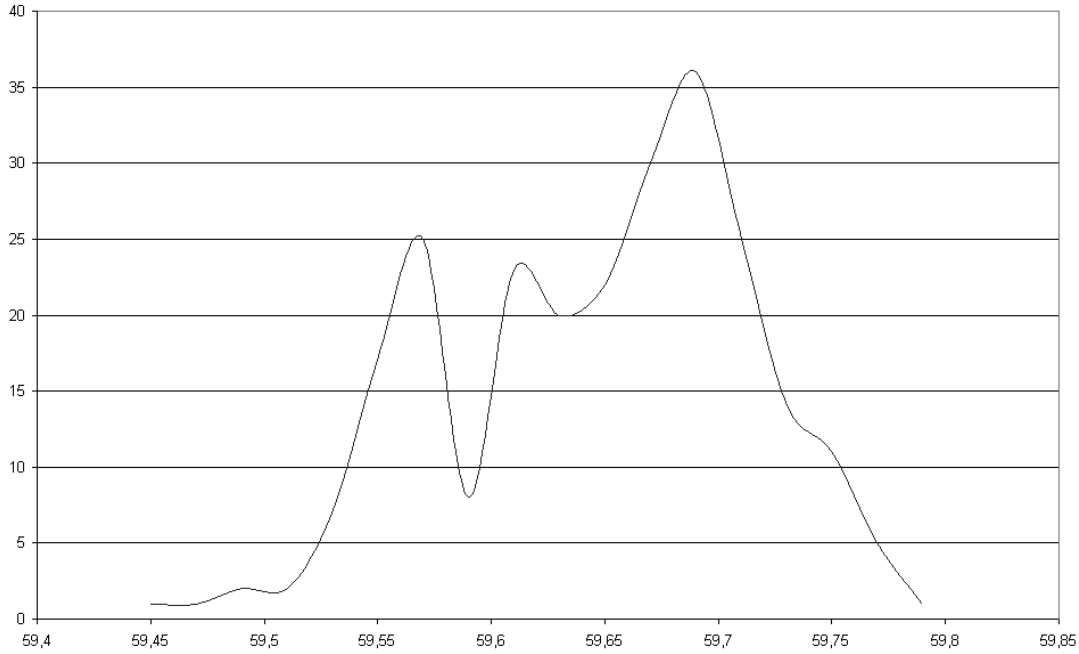

Figure 2.2: Classified Data for Length 1

Class	Frequency
47.925	0
47.935	1
47.945	0
47.955	1
47.965	1
47.975	11
47.985	19
47.995	25
48.005	38
48.015	39
48.025	45
48.035	34
48.045	20
48.055	10
48.065	5
48.075	1
48.085	0

Table 2.3: Classified Data for Length 2

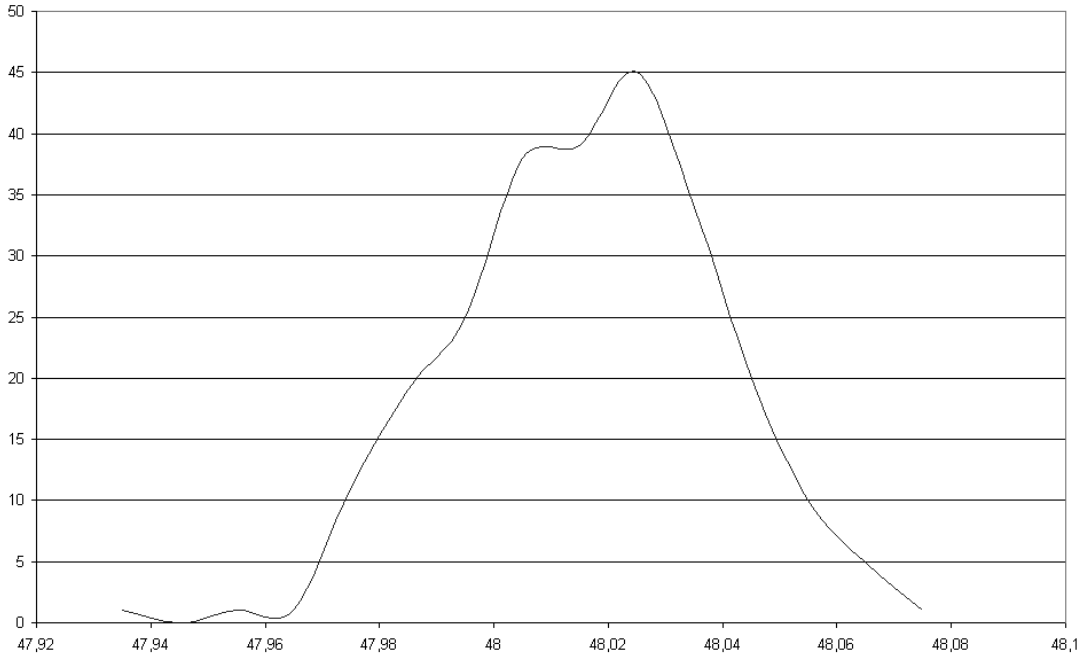

Figure 2.3: Classified Data for Length 2

Class	Frequency
4.45	0
4.55	8
4.65	7
4.65	0
4.85	28
4.95	11
5.05	56
5.15	57
5.25	42
5.35	32
5.45	9
5.55	0

Table 2.4: Classified Data for Width

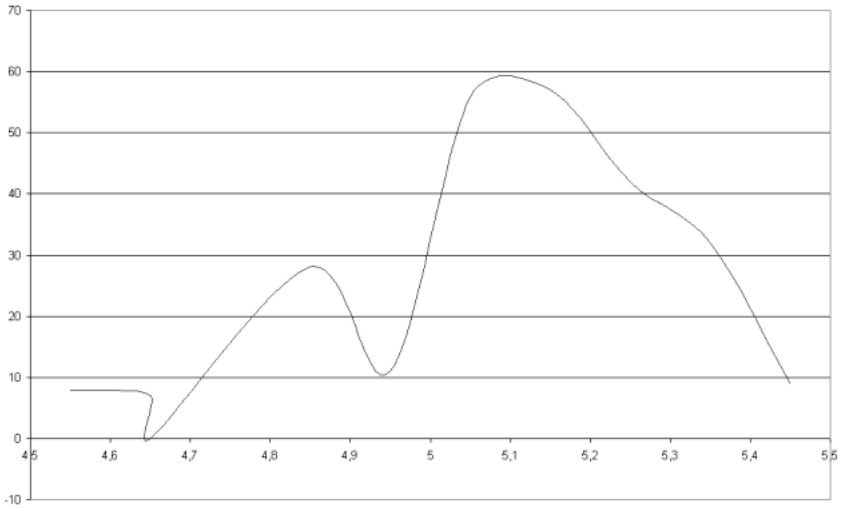

Figure 2.4: Classified Data for Width

2.3 Comments

The frequency distributions are – exept the data in table 2.2 – not distributed around the value like they should be. They are mostly left or right of the prescribed measurement. In the next two chapters I will try to find a proof as well as explanations for this.

3 Important figures

3.1 Calculated Values

The calculated values are based on the original data shown in appendix A. Figures shown are calculated as prescribed in Keller & Warrack (1999).

	Right	**Length 1**	**Length 2**	**Width**
n	250	250	250	250
$\bar{x}$	6.532	59.647	48.017	5.098
μ	6	60	48	4.9
Median	6.513	59.658	48.019	5.126
Q_1	6.4063	59.5993	48.0020	5.0168
Q_3	6.6305	59.6975	48.032	5.24
Range	0.905	0.331	0.139	0.920
s	0.1917	0.0670	0.0224	0.2073
Mode	6.384	59.698	48.030	5.250

Table 3.1: Measures of Locality and Dispersion

3.2 Right

The values for the right measurement are far away from the prescribed 6.0. In fact, even the smallest value (6.146) is bigger. That shouls make us pretty shure that the population is also not distributed around the value 6.0. In chapter 4 i will proof this theory by using the t-statistic.

What else can we conclude from the calculated values? Q_1 and Q_3 surround the Median as well as the $\bar{x}$ very symmerically, but we have a slight difference between $\bar{x}$

and the Median, telling us that the distribution is skewed to the right (positively). A smaller Mode seems to proof this theory.

3.3 Length 1

The values for the measurement of length 1 are completely smaller than the prescribed 60.0. Even the largest value (59.787) is smaller. In this case, the population seems to be smaller than prescriben. Again, I want to proof this in chapter 4.

This time, the Median is larger than $\bar{x}$, showing us a population that ist skewed to the left (negatively). A even larger Mode gives us more evidence in this.

3.4 Length 2

In the values for Length 2 we seem to be very close to the prescribed 48.0. The smalles value is 47.933, and the prescribed value lies between it and the Q_1. Unlike in Right and Length 1, the expected μ lies within the range of the sample. The standard deviation is the smalles we have in our values.

Median and $\bar{x}$ are very close together, so we can predict the distribution to be very symmetric. The only thing that seems to a bit of funny, is the larger Mode, but looking at figure 2.3, we see the reason more clearly. Since Length 2 is the most crucial in this production process, we are glad to have a very good sample here. The largest value is smaller than the prescribed size plus tolerance.

3.5 Width

The values for the Width of the glue is somewhat funny. With a smallest value of 4.538, it seems that the prescribed measurement is within the distribution, being more accurate between the smallest value and Q_1. The t-statistic of this sample must be better than the one of Right and Length 1.

Looking at the location, and shape, we find that the Median is larger than $\bar{x}$, assuming that the destribution is skewed to the left side (negatively skewed). The even larger value for the Mode supports this assumption.

4 Inferences about the population

4.1 t-statistic

Since we don't know anything about the population (σ and μ are unknown), we have to utilise the Student t distribution and use the test statistic for μ when σ is unknown described in Keller & Warrack (1999, p. 349 ff). The value for t is computed as follows:

$$t = \frac{\bar{x} - \mu}{\frac{s}{\sqrt{n}}} \tag{4.1}$$

4.2 Computed values

The null hypothesis in this case is set as follows:

$$H_0 = \mu = \text{prescribed value}$$
$$H_1 = \mu <> \text{prescribed value}$$

To start the test on this hypothesis, we compute the t-values by taking the figures from table 3.1 and inserting them into equation 4.1. The result of this calculation is shown in table 4.2. I run this two-sided test with a 1% significance level ($\frac{\alpha}{2} = 0.005$).

	Right	**Length 1**	**Length 2**	**Width**
t-statistic	43.869	-83.265	12.056	15.135
$t_{\alpha,n-1}$	2.576	2.576	2.576	2.576

Table 4.1: Computed t-statistic

4.3 Evaluation

From the results in table 4.2 we can reject every null hypothesis. None of the pupulation means seems to be close to the prescribed value.

5 Correlation analysis

5.1 Data

The correlation analysis is based on the data provided in appendix B.

	Right	**Length 1**	**Length 2**	**Width**
Right	1			
Length 1	-0,1131594	1		
Length 2	-0,20644194	-0,03495772	1	
Width	-0,93894212	0,43159688	0,0714187	1

Table 5.1: Correlation Analysis

5.2 Evaluation

The results are a bit surprising. There seems to be strong negative correlation between the Width and Right measurement. The seem to be dependent, but this can also result from the production methode of the maschine.

We also have a bit of a correlation between Width and Length 1. But this correlation is not as strong as the former one.

All other correlations are not as significant and can be surpressed.

6 Summary

From the calculations done in this assignment we can conclude the following:

- The population means are not very close to the prescribed value, probably due to an error in the maschine.
- Since the Length 2 is the most crucial value, it is good to see that the whole sample lies with in the tolerance (48 ± 0.2).
- Most frequency distributions are not showing a nice and perfect bell-shape, but the seem to be very normal distributed.
- Due to the production methode of the maschine, we have a high negative correlation between Width and Right.

From the sample data we can conclude that the maschine is producing valid products, but all values exept Length 2 are out of specification or tolerance. Since the Length 2 has only a small correlation with the Width, an adjustment will not heavily affect the values for Length 2.

A Raw Data

Table A.1: Sample Data

Data No	Right	Length 1	Length 2	Width
1	6.384	59.683	48.004	5.295
2	6.420	59.698	48.028	5.250
3	6.445	59.698	48.028	5.225
4	6.462	59.696	48.009	5.225
5	6.475	59.694	48.020	5.199
6	6.497	59.693	48.030	5.166
7	6.523	59.709	48.005	5.181
8	6.561	59.716	48.017	5.138
9	6.486	59.707	48.047	5.174
10	6.459	59.702	48.048	5.195
11	6.457	59.698	48.034	5.207
12	6.412	59.690	48.038	5.240
13	6.421	59.693	48.033	5.239
14	6.377	59.687	48.020	5.290
15	6.360	59.680	48.030	5.290
16	6.848	59.537	48.044	4.645
17	6.859	59.541	48.015	4.667
18	6.821	59.535	48.021	4.693
19	6.782	59.529	48.027	4.720
20	6.802	59.556	48.014	4.740
21	6.775	59.547	48.012	4.760
22	6.717	59.512	47.997	4.798
23	6.730	59.563	47.993	4.840
24	6.728	59.584	48.023	4.833
25	6.783	59.650	48.021	4.846
26	6.827	59.667	48.044	4.796
27	6.843	59.628	48.013	4.772

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Data No	Right	Length 1	Length 2	Width
28	6.904	59.713	47.980	4.829
29	6.850	59.649	47.954	4.845
30	6.869	59.670	47.972	4.829
31	6.805	59.673	47.989	4.879
32	6.443	59.688	47.993	5.252
33	6.477	59.716	48.006	5.233
34	6.488	59.707	48.005	5.214
35	6.394	59.611	47.978	5.239
36	6.390	59.615	47.985	5.240
37	6.427	59.638	48.016	5.195
38	6.434	59.627	48.011	5.182
39	6.445	59.603	48.017	5.141
40	6.473	59.609	48.021	5.115
41	6.502	59.691	48.023	5.166
42	6.485	59.588	48.046	5.057
43	6.637	59.673	48.006	5.030
44	6.663	59.688	48.019	5.006
45	6.655	59.675	48.017	5.003
46	6.706	59.702	48.008	4.988
47	6.748	59.689	48.002	4.939
48	6.712	59.677	48.022	4.943
49	6.450	59.617	48.040	5.127
50	6.485	59.621	48.018	5.118
51	6.528	59.617	48.018	5.071
52	6.552	59.634	48.002	5.080
53	6.515	59.609	48.051	5.043
54	6.533	59.596	48.032	5.031
55	6.208	59.616	48.010	5.398
56	6.258	59.650	48.035	5.357
57	6.248	59.614	48.052	5.314
58	6.251	59.628	48.036	5.341
59	6.483	59.621	48.016	5.122
60	6.494	59.575	48.055	5.026
61	6.504	59.548	48.003	5.041
62	6.540	59.567	48.022	5.005
63	6.554	59.570	48.038	4.978
64	6.576	59.576	48.037	4.963
65	6.613	59.568	48.037	4.918
66	6.620	59.565	48.037	4.908
67	6.662	59.718	48.031	5.025

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Data No	Right	Length 1	Length 2	Width
68	6.641	59.755	48.023	5.091
69	6.636	59.750	48.016	5.098
70	6.192	59.568	48.001	5.375
71	6.156	59.575	48.008	5.411
72	6.146	59.574	48.001	5.427
73	6.690	59.787	48.039	5.058
74	6.654	59.763	48.013	5.096
75	6.651	59.773	48.028	5.094
76	6.442	59.714	48.028	5.244
77	6.451	59.699	48.025	5.223
78	6.407	59.714	48.005	5.302
79	6.562	59.698	48.011	5.125
80	6.580	59.674	47.995	5.099
81	6.828	59.613	48.032	4.753
82	6.822	59.627	48.023	4.782
83	6.852	59.610	48.021	4.737
84	6.861	59.598	48.057	4.680
85	6.629	59.707	48.042	5.036
86	6.934	59.675	47.982	4.759
87	6.964	59.713	47.999	4.750
88	6.177	59.614	47.994	5.443
89	6.195	59.626	47.985	5.446
90	6.165	59.646	48.023	5.458
91	6.661	59.770	48.021	5.088
92	6.612	59.486	48.030	4.844
93	6.600	59.486	48.029	4.857
94	6.582	59.456	48.022	4.852
95	6.591	59.471	48.003	4.877
96	6.251	59.562	48.030	5.281
97	6.248	59.549	48.010	5.291
98	6.932	59.543	48.008	4.603
99	6.880	59.534	47.999	4.655
100	6.255	59.613	47.997	5.361
101	6.616	59.670	47.985	5.069
102	6.577	59.672	47.990	5.105
103	6.573	59.722	48.007	5.142
104	6.592	59.749	48.000	5.157
105	6.559	59.699	48.013	5.127
106	6.551	59.726	48.031	5.144
107	6.527	59.718	47.997	5.194

Continued on next page ...

Data No	Right	Length 1	Length 2	Width
108	6.506	59.748	47.994	5.248
109	7.001	59.566	48.017	4.548
110	6.996	59.546	48.006	4.544
111	6.942	59.558	48.009	4.607
112	6.303	59.564	48.036	5.225
113	6.285	59.656	47.984	5.387
114	6.935	59.674	48.008	4.731
115	6.548	59.625	48.065	5.012
116	6.541	59.658	48.048	5.069
117	6.528	59.664	48.035	5.101
118	6.242	59.681	47.995	5.444
119	6.213	59.658	48.032	5.413
120	6.486	59.674	47.989	5.199
121	6.512	59.652	47.985	5.155
122	6.515	59.666	47.968	5.183
123	6.564	59.650	48.028	5.058
124	6.590	59.670	48.038	5.042
125	6.592	59.667	48.066	5.009
126	6.554	59.699	48.019	5.126
127	6.522	59.674	48.045	5.107
128	6.398	59.521	48.007	5.116
129	6.523	59.655	48.000	5.132
130	6.534	59.680	48.031	5.115
131	6.631	59.673	47.985	5.057
132	6.647	59.668	47.998	5.023
133	6.550	59.742	48.036	5.156
134	6.552	59.701	48.034	5.115
135	6.969	59.553	47.999	4.585
136	6.938	59.520	47.987	4.595
137	6.973	59.559	48.016	4.570
138	6.993	59.544	48.013	4.538
139	7.021	59.566	47.976	4.569
140	6.934	59.706	48.036	4.736
141	7.051	59.529	47.933	4.545
142	6.598	59.751	48.024	5.129
143	6.606	59.703	48.042	5.055
144	6.643	59.703	48.030	5.030
145	6.363	59.721	48.048	5.310
146	6.485	59.654	48.015	5.154
147	6.522	59.662	48.010	5.130

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Data No	Right	Length 1	Length 2	Width
148	6.513	59.611	48.010	5.088
149	6.579	59.662	47.993	5.090
150	6.288	59.655	48.007	5.360
151	6.279	59.688	48.004	5.405
152	6.275	59.653	48.002	5.376
153	6.237	59.616	48.016	5.363
154	6.573	59.607	48.039	4.995
155	6.574	59.609	48.031	5.004
156	6.574	59.631	48.028	5.029
157	6.550	59.606	48.040	5.016
158	6.560	59.656	48.026	5.070
159	6.506	59.620	48.039	5.075
160	6.351	59.731	47.979	5.401
161	6.384	59.757	48.005	5.368
162	6.366	59.724	47.992	5.366
163	6.400	59.754	47.997	5.357
164	6.326	59.613	48.048	5.239
165	6.300	59.569	48.061	5.208
166	6.301	59.588	48.032	5.255
167	6.488	59.696	48.001	5.207
168	6.451	59.672	47.986	5.235
169	6.406	59.649	47.977	5.266
170	6.467	59.622	48.042	5.113
171	6.517	59.685	48.030	5.138
172	6.725	59.544	48.000	4.819
173	6.765	59.578	47.990	4.823
174	6.722	59.538	48.008	4.808
175	6.808	59.569	47.974	4.787
176	6.475	59.737	48.012	5.250
177	6.421	59.717	48.031	5.265
178	6.421	59.745	48.021	5.303
179	6.413	59.758	48.014	5.331
180	6.262	59.590	48.023	5.305
181	6.208	59.578	48.044	5.326
182	6.659	59.702	48.019	5.024
183	6.685	59.766	47.981	5.100
184	6.684	59.620	47.978	4.958
185	6.676	59.690	47.979	5.035
186	6.340	59.649	47.986	5.323
187	6.382	59.658	48.057	5.219

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Data No	Right	Length 1	Length 2	Width
188	6.389	59.691	47.984	5.318
189	6.726	59.724	48.025	4.973
190	6.714	59.719	47.986	5.019
191	6.673	59.738	47.997	5.068
192	6.518	59.569	48.067	4.984
193	6.554	59.626	48.004	5.068
194	6.583	59.613	48.022	5.008
195	6.464	59.646	48.022	5.160
196	6.450	59.622	48.030	5.142
197	6.444	59.582	48.039	5.099
198	6.497	59.718	48.024	5.197
199	6.531	59.727	47.997	5.199
200	6.529	59.694	48.020	5.145
201	6.519	59.675	48.041	5.115
202	6.557	59.704	47.992	5.155
203	6.598	59.685	48.020	5.067
204	6.591	59.689	48.051	5.047
205	6.609	59.717	48.034	5.074
206	6.596	59.684	48.019	5.069
207	6.671	59.730	48.008	5.051
208	6.399	59.572	47.986	5.187
209	6.246	59.553	47.993	5.314
210	6.424	59.550	48.027	5.099
211	6.401	59.554	48.029	5.124
212	6.512	59.578	48.010	5.056
213	6.327	59.702	48.018	5.357
214	6.306	59.683	48.023	5.354
215	6.406	59.692	48.019	5.267
216	6.427	59.750	47.978	5.345
217	6.450	59.729	47.975	5.304
218	6.493	59.735	48.003	5.239
219	6.507	59.734	47.999	5.228
220	6.225	59.562	48.043	5.294
221	6.204	59.566	48.053	5.309
222	6.367	59.616	48.054	5.195
223	6.384	59.641	48.055	5.202
224	6.415	59.623	48.039	5.169
225	6.419	59.630	48.030	5.181
226	6.496	59.566	48.001	5.069
227	6.471	59.541	48.022	5.048

Continued on next page ...

Data No	Right	Length 1	Length 2	Width
228	6.509	59.574	48.019	5.046
229	6.354	59.723	48.028	5.341
230	6.306	59.637	48.047	5.284
231	6.321	59.650	48.020	5.309
232	6.387	59.690	48.043	5.260
233	6.386	59.678	48.056	5.236
234	6.417	59.690	48.072	5.201
235	6.342	59.696	48.008	5.346
236	6.335	59.673	48.036	5.302
237	6.359	59.684	47.999	5.326
238	6.396	59.677	48.014	5.267
239	6.429	59.660	48.042	5.189
240	6.510	59.684	48.047	5.127
241	6.482	59.666	48.020	5.164
242	6.459	59.640	48.061	5.120
243	6.509	59.659	48.026	5.124
244	6.353	59.672	48.025	5.294
245	6.320	59.621	48.034	5.267
246	6.341	59.637	48.018	5.278
247	6.572	59.766	48.016	5.178
248	6.562	59.552	47.985	5.005
249	6.486	59.688	48.049	5.153
250	6.419	59.590	48.003	5.168

B Differences within the data

Table B.1: Differences $(x_i - \mu)$

Data No	Right	Length 1	Length 2	Width
1	0,384	-0,317	0,004	0,395
2	0,420	-0,302	0,028	0,350
3	0,445	-0,302	0,028	0,325
4	0,462	-0,304	0,009	0,325
5	0,475	-0,306	0,020	0,299
6	0,497	-0,307	0,030	0,266
7	0,523	-0,291	0,005	0,281
8	0,561	-0,284	0,017	0,238
9	0,486	-0,293	0,047	0,274
10	0,459	-0,298	0,048	0,295
11	0,457	-0,302	0,034	0,307
12	0,412	-0,310	0,038	0,340
13	0,421	-0,307	0,033	0,339
14	0,377	-0,313	0,020	0,390
15	0,360	-0,320	0,030	0,390
16	0,848	-0,463	0,044	-0,255
17	0,859	-0,459	0,015	-0,233
18	0,821	-0,465	0,021	-0,207
19	0,782	-0,471	0,027	-0,180
20	0,802	-0,444	0,014	-0,160
21	0,775	-0,453	0,012	-0,140
22	0,717	-0,488	-0,003	-0,102
23	0,730	-0,437	-0,007	-0,060
24	0,728	-0,416	0,023	-0,067
25	0,783	-0,350	0,021	-0,054
26	0,827	-0,333	0,044	-0,104
27	0,843	-0,372	0,013	-0,128

Continued on next page ...

Data No	Right	Length 1	Length 2	Width
28	0,904	-0,287	-0,020	-0,071
29	0,850	-0,351	-0,046	-0,055
30	0,869	-0,330	-0,028	-0,071
31	0,805	-0,327	-0,011	-0,021
32	0,443	-0,312	-0,007	0,352
33	0,477	-0,284	0,006	0,333
34	0,488	-0,293	0,005	0,314
35	0,394	-0,389	-0,022	0,339
36	0,390	-0,385	-0,015	0,340
37	0,427	-0,362	0,016	0,295
38	0,434	-0,373	0,011	0,282
39	0,445	-0,397	0,017	0,241
40	0,473	-0,391	0,021	0,215
41	0,502	-0,309	0,023	0,266
42	0,485	-0,412	0,046	0,157
43	0,637	-0,327	0,006	0,130
44	0,663	-0,312	0,019	0,106
45	0,655	-0,325	0,017	0,103
46	0,706	-0,298	0,008	0,088
47	0,748	-0,311	0,002	0,039
48	0,712	-0,323	0,022	0,043
49	0,450	-0,383	0,040	0,227
50	0,485	-0,379	0,018	0,218
51	0,528	-0,383	0,018	0,171
52	0,552	-0,366	0,002	0,180
53	0,515	-0,391	0,051	0,143
54	0,533	-0,404	0,032	0,131
55	0,208	-0,384	0,010	0,498
56	0,258	-0,350	0,035	0,457
57	0,248	-0,386	0,052	0,414
58	0,251	-0,372	0,036	0,441
59	0,483	-0,379	0,016	0,222
60	0,494	-0,425	0,055	0,126
61	0,504	-0,452	0,003	0,141
62	0,540	-0,433	0,022	0,105
63	0,554	-0,430	0,038	0,078
64	0,576	-0,424	0,037	0,063
65	0,613	-0,432	0,037	0,018
66	0,620	-0,435	0,037	0,008
67	0,662	-0,282	0,031	0,125

Continued on next page ...

Data No	Right	Length 1	Length 2	Width
68	0,641	-0,245	0,023	0,191
69	0,636	-0,250	0,016	0,198
70	0,192	-0,432	0,001	0,475
71	0,156	-0,425	0,008	0,511
72	0,146	-0,426	0,001	0,527
73	0,690	-0,213	0,039	0,158
74	0,654	-0,237	0,013	0,196
75	0,651	-0,227	0,028	0,194
76	0,442	-0,286	0,028	0,344
77	0,451	-0,301	0,025	0,323
78	0,407	-0,286	0,005	0,402
79	0,562	-0,302	0,011	0,225
80	0,580	-0,326	-0,005	0,199
81	0,828	-0,387	0,032	-0,147
82	0,822	-0,373	0,023	-0,118
83	0,852	-0,390	0,021	-0,163
84	0,861	-0,402	0,057	-0,220
85	0,629	-0,293	0,042	0,136
86	0,934	-0,325	-0,018	-0,141
87	0,964	-0,287	-0,001	-0,150
88	0,177	-0,386	-0,006	0,543
89	0,195	-0,374	-0,015	0,546
90	0,165	-0,354	0,023	0,558
91	0,661	-0,230	0,021	0,188
92	0,612	-0,514	0,030	-0,056
93	0,600	-0,514	0,029	-0,043
94	0,582	-0,544	0,022	-0,048
95	0,591	-0,529	0,003	-0,023
96	0,251	-0,438	0,030	0,381
97	0,248	-0,451	0,010	0,391
98	0,932	-0,457	0,008	-0,297
99	0,880	-0,466	-0,001	-0,245
100	0,255	-0,387	-0,003	0,461
101	0,616	-0,330	-0,015	0,169
102	0,577	-0,328	-0,010	0,205
103	0,573	-0,278	0,007	0,242
104	0,592	-0,251	0,000	0,257
105	0,559	-0,301	0,013	0,227
106	0,551	-0,274	0,031	0,244
107	0,527	-0,282	-0,003	0,294

Continued on next page ...

Data No	Right	Length 1	Length 2	Width
108	0,506	-0,252	-0,006	0,348
109	1,001	-0,434	0,017	-0,352
110	0,996	-0,454	0,006	-0,356
111	0,942	-0,442	0,009	-0,293
112	0,303	-0,436	0,036	0,325
113	0,285	-0,344	-0,016	0,487
114	0,935	-0,326	0,008	-0,169
115	0,548	-0,375	0,065	0,112
116	0,541	-0,342	0,048	0,169
117	0,528	-0,336	0,035	0,201
118	0,242	-0,319	-0,005	0,544
119	0,213	-0,342	0,032	0,513
120	0,486	-0,326	-0,011	0,299
121	0,512	-0,348	-0,015	0,255
122	0,515	-0,334	-0,032	0,283
123	0,564	-0,350	0,028	0,158
124	0,590	-0,330	0,038	0,142
125	0,592	-0,333	0,066	0,109
126	0,554	-0,301	0,019	0,226
127	0,522	-0,326	0,045	0,207
128	0,398	-0,479	0,007	0,216
129	0,523	-0,345	0,000	0,232
130	0,534	-0,320	0,031	0,215
131	0,631	-0,327	-0,015	0,157
132	0,647	-0,332	-0,002	0,123
133	0,550	-0,258	0,036	0,256
134	0,552	-0,299	0,034	0,215
135	0,969	-0,447	-0,001	-0,315
136	0,938	-0,480	-0,013	-0,305
137	0,973	-0,441	0,016	-0,330
138	0,993	-0,456	0,013	-0,362
139	1,021	-0,434	-0,024	-0,331
140	0,934	-0,294	0,036	-0,164
141	1,051	-0,471	-0,067	-0,355
142	0,598	-0,249	0,024	0,229
143	0,606	-0,297	0,042	0,155
144	0,643	-0,297	0,030	0,130
145	0,363	-0,279	0,048	0,410
146	0,485	-0,346	0,015	0,254
147	0,522	-0,338	0,010	0,230

Continued on next page ...

Data No	Right	Length 1	Length 2	Width
148	0,513	-0,389	0,010	0,188
149	0,579	-0,338	-0,007	0,190
150	0,288	-0,345	0,007	0,460
151	0,279	-0,312	0,004	0,505
152	0,275	-0,347	0,002	0,476
153	0,237	-0,384	0,016	0,463
154	0,573	-0,393	0,039	0,095
155	0,574	-0,391	0,031	0,104
156	0,574	-0,369	0,028	0,129
157	0,550	-0,394	0,040	0,116
158	0,560	-0,344	0,026	0,170
159	0,506	-0,380	0,039	0,175
160	0,351	-0,269	-0,021	0,501
161	0,384	-0,243	0,005	0,468
162	0,366	-0,276	-0,008	0,466
163	0,400	-0,246	-0,003	0,457
164	0,326	-0,387	0,048	0,339
165	0,300	-0,431	0,061	0,308
166	0,301	-0,412	0,032	0,355
167	0,488	-0,304	0,001	0,307
168	0,451	-0,328	-0,014	0,335
169	0,406	-0,351	-0,023	0,366
170	0,467	-0,378	0,042	0,213
171	0,517	-0,315	0,030	0,238
172	0,725	-0,456	0,000	-0,081
173	0,765	-0,422	-0,010	-0,077
174	0,722	-0,462	0,008	-0,092
175	0,808	-0,431	-0,026	-0,113
176	0,475	-0,263	0,012	0,350
177	0,421	-0,283	0,031	0,365
178	0,421	-0,255	0,021	0,403
179	0,413	-0,242	0,014	0,431
180	0,262	-0,410	0,023	0,405
181	0,208	-0,422	0,044	0,426
182	0,659	-0,298	0,019	0,124
183	0,685	-0,234	-0,019	0,200
184	0,684	-0,380	-0,022	0,058
185	0,676	-0,310	-0,021	0,135
186	0,340	-0,351	-0,014	0,423
187	0,382	-0,342	0,057	0,319

Continued on next page ...

Data No	Right	Length 1	Length 2	Width
188	0,389	-0,309	-0,016	0,418
189	0,726	-0,276	0,025	0,073
190	0,714	-0,281	-0,014	0,119
191	0,673	-0,262	-0,003	0,168
192	0,518	-0,431	0,067	0,084
193	0,554	-0,374	0,004	0,168
194	0,583	-0,387	0,022	0,108
195	0,464	-0,354	0,022	0,260
196	0,450	-0,378	0,030	0,242
197	0,444	-0,418	0,039	0,199
198	0,497	-0,282	0,024	0,297
199	0,531	-0,273	-0,003	0,299
200	0,529	-0,306	0,020	0,245
201	0,519	-0,325	0,041	0,215
202	0,557	-0,296	-0,008	0,255
203	0,598	-0,315	0,020	0,167
204	0,591	-0,311	0,051	0,147
205	0,609	-0,283	0,034	0,174
206	0,596	-0,316	0,019	0,169
207	0,671	-0,270	0,008	0,151
208	0,399	-0,428	-0,014	0,287
209	0,246	-0,447	-0,007	0,414
210	0,424	-0,450	0,027	0,199
211	0,401	-0,446	0,029	0,224
212	0,512	-0,422	0,010	0,156
213	0,327	-0,298	0,018	0,457
214	0,306	-0,317	0,023	0,454
215	0,406	-0,308	0,019	0,367
216	0,427	-0,250	-0,022	0,445
217	0,450	-0,271	-0,025	0,404
218	0,493	-0,265	0,003	0,339
219	0,507	-0,266	-0,001	0,328
220	0,225	-0,438	0,043	0,394
221	0,204	-0,434	0,053	0,409
222	0,367	-0,384	0,054	0,295
223	0,384	-0,359	0,055	0,302
224	0,415	-0,377	0,039	0,269
225	0,419	-0,370	0,030	0,281
226	0,496	-0,434	0,001	0,169
227	0,471	-0,459	0,022	0,148

Continued on next page ...

Data No	Right	Length 1	Length 2	Width
228	0,509	-0,426	0,019	0,146
229	0,354	-0,277	0,028	0,441
230	0,306	-0,363	0,047	0,384
231	0,321	-0,350	0,020	0,409
232	0,387	-0,310	0,043	0,360
233	0,386	-0,322	0,056	0,336
234	0,417	-0,310	0,072	0,301
235	0,342	-0,304	0,008	0,446
236	0,335	-0,327	0,036	0,402
237	0,359	-0,316	-0,001	0,426
238	0,396	-0,323	0,014	0,367
239	0,429	-0,340	0,042	0,289
240	0,510	-0,316	0,047	0,227
241	0,482	-0,334	0,020	0,264
242	0,459	-0,360	0,061	0,220
243	0,509	-0,341	0,026	0,224
244	0,353	-0,328	0,025	0,394
245	0,320	-0,379	0,034	0,367
246	0,341	-0,363	0,018	0,378
247	0,572	-0,234	0,016	0,278
248	0,562	-0,448	-0,015	0,105
249	0,486	-0,312	0,049	0,253
250	0,419	-0,410	0,003	0,268

List of Sources

Keller, G. & Warrack, B. (1999), *Statistics for Management and Economics*, 5th edn, Duxbury, Thomson Learning, Pacific Grove, CA.