

# Statistical Methods in Practice: for Scientists and Technologists

**Richard Boddy**

**Gordon Smith**

2009, John Wiley & Sons

Chichester.

978-0-470-74664-6

<b>Preface</b>	<b>xi</b>
<b>1 Samples and populations</b>	<b>i</b>
Introduction	1
What a lottery!	2
No can do	2
Nobody is listening to me	3
How clean is my river?	3
Discussion	4
<b>2 What is the true mean?</b>	<b>5</b>
Introduction	5
Presenting data	5
Averages	7
Measures of variability	8
Relative standard deviation	10
Degrees of freedom	11
Confidence interval for the population mean	12
Sample sizes	13
How much moisture is in the raw material?	14
Problems	16
<b>3 Exploratory data analysis</b>	<b>19</b>
Introduction	19
Histograms: is the process capable of meeting specifications?	19
Box plots: how long before the lights go out?	23
The box plot in practice	26
Problems	27
<b>4 Significance testing</b>	<b>29</b>
Introduction	29
The one-sample t-test	29

	The significance testing procedure	31
	Confidence intervals as an alternative to significance testing	32
	Confidence interval for the population standard deviation	35
	F-test for ratio of standard deviations	36
	Problems	38
<b>5</b>	<b>The normal distribution</b>	<b>41</b>
	Introduction	41
	Properties of the normal distribution	42
	Example	43
	Setting the process mean	45
	Checking for normality	46
	Uses of the normal distribution	51
	Problems	51
<b>6</b>	<b>Tolerance intervals</b>	<b>53</b>
	Introduction	53
	Example	53
	Confidence intervals and tolerance intervals	54
<b>7</b>	<b>Outliers</b>	<b>55</b>
	Introduction	55
	Grubbs' test	56
	Warning	58
<b>8</b>	<b>Significance tests for comparing two means</b>	<b>59</b>
	Introduction	59
	Example: watching paint lose its gloss	59
	The two-sample t-test for independent samples	60
	An alternative approach: a confidence intervals for the difference between population means	62
	Sample size to estimate the difference between two means	63
	A production example	64
	Confidence intervals for the difference between the two suppliers	66
	Sample size to estimate the difference between two means	66
	Conclusions	67
	Problems	68
<b>9</b>	<b>Significance tests for comparing paired measurements</b>	<b>71</b>
	Introduction	71
	Comparing two fabrics	71
	The wrong way	72

The paired sample t-test	74
Presenting the results of significance tests	76
One-sided significance tests	77
Problems	78
<b>10 Regression and correlation</b>	<b>83</b>
Introduction	83
Obtaining the best straight line	83
Confidence intervals for the regression statistics	89
Extrapolation of the regression line	92
Correlation coefficient	92
Is there a significant relationship between the variables?	94
How good a fit is the line to the data?	95
Assumptions	95
Problems	98
<b>11 The binomial distribution</b>	<b>101</b>
Introduction	101
Example	101
An exact binomial test	105
A quality assurance example	106
What is the effect of the batch size?	108
Problems	109
<b>12 The Poisson distribution</b>	<b>111</b>
Introduction	111
Fitting a Poisson distribution	111
Are the defects random? The Poisson distribution	112
Poisson dispersion test	114
Confidence intervals for a Poisson count	115
A significance test for two Poisson counts	116
How many black specks are in the batch?	117
How many pathogens are there in the batch?	118
Problems	118
<b>13 The chi-squared test for contingency tables</b>	<b>121</b>
Introduction	121
Two-sample test for percentages	121
Comparing several percentages	123
Where are the differences?	125
Assumptions	126
Problems	127

<b>14 Non-parametric statistics</b>	<b>129</b>
Introduction	129
Descriptive statistics	129
A test for two independent samples: Wilcoxon-Mann-Whitney test	131
A test for paired data: Wilcoxon matched-pairs sign test	132
What type of data can be used?	134
Example: cracking shoes	134
Problems	138
<b>15 Analysis of variance: Components of variability</b>	<b>139</b>
Introduction	139
Overall variability	139
Analysis of variance	141
A practical example	141
Terminology	142
Calculations	143
Significance test	146
Variation less than chance?	146
When should the above methods <i>not</i> be used?	147
Between- and within-batch variability	147
How many batches and how many prawns should be sampled?	149
Problems	151
<b>16 Cusum analysis for detecting process changes</b>	<b>155</b>
Introduction	155
Analysing past data	155
Intensity	156
Localised standard deviation	159
Significance test	160
Yield	161
Conclusions from the analysis	164
Problem	165
<b>17 Rounding of results</b>	<b>167</b>
Introduction	167
Choosing the rounding scale	168
Reporting purposes: deciding the amount of rounding	169
Reporting purposes: rounding of means and standard deviations	169
Recording the original data and using means and standard deviations in statistical analysis	170
References	171

<b>Solutions to Problems</b>	<b>173</b>
<b>Statistical Tables</b>	<b>215</b>
<b>Index</b>	<b>235</b>