

# TOUR OF THE BOOK

## PROBABILITY

- 'It is *likely* to rain tomorrow.'
- 'I will *probably* have to have an operation.'
- 'There *might be* a general election next year.'
- 'Demand for new cars *may* decrease if the government imposes an extra 5% tax.'

### Section summary

An overview of each main section

### Can I do this?



There are many more techniques for working with symbols and some will be considered in Chapter EM2. However, if you are in doubt as to whether two expressions are equivalent you can always evaluate both of them for some arbitrarily chosen numbers and see if the results are the same.

For instance, suppose you are unsure whether  $p \times q$  is the same as  $q \times p$ . (We have picked an easy one to start with – we have already said that this is true.) If, for example,  $p = 2$  and  $q = 1$ , then  $p \times q = 2 \times 1 = 2$  and  $q \times p = 1 \times 2 = 2$ , so the expressions are equal for these values. Now try  $p = -5$  and  $q = 2$ , putting a negative number to the test, and we have  $p \times q = -5 \times 2 = -10$  and  $q \times p = 2 \times -5 = -10$  which again are equal.



Be warned, however, that 'trying out' values like this does not constitute proof that the expressions are equal – you may just have been lucky and by chance selected values that worked. If the two expressions are not equal for the values you have chosen, then this does, however, prove that they are not equivalent expressions.

For instance, is it true that

$$\frac{m+n}{n}$$

### Icons

Pointing out tips, warnings and where computers can help

### Contexts

#### What is this chapter about?

This chapter explains how to select a sample of data and use it to make valid inferences about the wider set of data or *population* it came from.

#### Why is it useful?

Businesses and organisations frequently collect just a sample of the data of interest because it is too costly or impractical to obtain all the information, for instance, in surveys, product testing, quality control, auditing and market research.

#### Where does it fit in?

The subject of Statistics broadly divides into two parts: Descriptive Statistics, which we considered in *Describing Data*, is about summarising a set of data, whereas Inferential Statistics,

### Pictures of data: your toolkit

The frequencies of a set of data are the number of values in each class or category

The relative frequencies are the proportion of the values within each class

#### Displays for numerical data

A **histogram** displays the frequencies or relative frequencies in each class

A **stem and leaf diagram** retains information on all the values

A **scatter plot** shows the relationship between pairs of numerical variables

A **time series plot** shows data that occur at regular time intervals

#### Displays for categorical data

A **bar chart** shows the frequencies of categorical data

A **pie chart** shows the proportion of the data in each category

A **contingency table** or **cross-tabulation** shows the frequencies of two categorical variables. It may include row, column or total percentages.

### Contexts

Places each chapter in context and tells what you need to know to get the most from it

### Key facts

Summaries of essential results and equations

### Objectives

After your work on this chapter you should be able to:

- cancel down fractions to their simplest terms;
- cancel down fractions expressed in symbols;
- add and subtract, multiply and divide fractions;
- expand or multiply out brackets in an expression;
- factorise expressions;
- understand positive and negative powers;
- multiply and divide powers of the same number, calculate the power of a power;
- write down powers of products and quotients;
- understand and manipulate fractional powers.

### Objectives

What you should be able to do after completing the chapter

When the number of items sold is the same as the quantity produced (that is, all items are sold) we can draw both the revenue,  $R$ , and total cost,  $C$ , functions on the same graph, as shown in Figure 2.12.

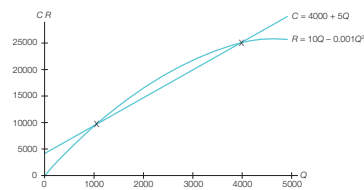


Figure 2.12

### Figures and tables

Clear graphical and tabular presentation of data

**6 Working with symbols: adding, subtracting, multiplying, dividing**

**test box 6** Simplify the following by collecting like terms:  
 $3pq + 2q + 2pq$   
 Write the following expressions more succinctly:  
 $3 \times (-2p) \times 2 \times p$      $2 \cdot 3 \cdot 5$

**Solutions:**  
 $5pq + 2q$   
 $-12p^2$     30

To construct models and solve equations we need to know how to manipulate symbols. This need not be a problem if we remember that the symbols merely stand in for the numbers and so can be treated in exactly the same way. In this section we recall the work of Sections 1-3, but apply it particularly to expressions containing symbols.

**Test boxes**

In *Essential Maths* and *More Maths*, a chance to see whether you already know the material in a section. If you do, you can skip it!

**check this** Continue the simulation for the second customer. (The second *Inter-arrival time* is 1 and the second *Wash time* is 3.)

**Solution:**  
 Customer 2 arrives 1 minute after customer 3, at time 3. Customer 1 does not leave the wash until time 5 so customer 2 has to wait until time 5 to start. He takes 3 minutes so finishes at time 8 having run up 2 minutes of *Waiting time* and kept the car wash busy for 3 minutes.

Customer number	Inputs			Event times			Outputs	
	Inter-arrival time	Wash time	Arrival time	Wash start	Wash end	Waiting time	Busy time	
1	2	3	2	2	5	0	3	
2	1	3	3	5	8	2	3	

We continue in this vein and complete the table for a further five customers.

**Check this**

Worked examples so that you can learn by doing

**work card 3**

- Publishing costs for an accountancy textbook amount to £3000 and in addition it costs £3 per copy to print. The publishers receive £10 a copy from sales but must pay 10% of this to the author. Write down an expression for the publisher's total profit in terms of the number of copies printed. Assume that all copies are sold. Sketch a graph of this expression. How many copies must be sold to break even (make a profit of exactly zero)?
- It costs a college £2000 a year for each Arts student and £3000 for each Science student. The total budget for students is £1,200,000. Write down the budget constraint for the number of Arts and the number of Science students. Sketch the feasible region on a graph.

**Solutions:**

- Costs are  $3000 + 3x$ , receipts are  $9x$ , so profit is  $y = 6x - 3000$ , when  $y = 0$ ,  $x = 500$ , so 500 copies to break even.
- $2x + 3y = 1200$ . The feasible region is the area below the line.

**Work cards**

Exercises with fully worked solutions at the end of each section

**assessment 8** Examples marked \* are more difficult and could be omitted.

- Simplify and evaluate:  
 a.  $\frac{49^3}{7^2 \times 98^2}$     b.  $\frac{85^3}{17^3}$     c.  $\frac{72^2 \times 4}{3^2 \times 2^3 \times 4^2}$     d.  $\frac{105^4 \times 5^{-3}}{49 \times 36 \times 5}$     \*e.  $\frac{(\frac{1}{2})^{-4} \times 128^3 \times 49}{64^3 \times (10^4 - 3 \times 10^0)^3}$
- Express in terms of 2 and 3 to the power of ... only:  
 \*a.  $\frac{132^2 \times (\frac{1}{4})^{-4} \times 8^5}{121 \times 2^7 \times 64^2}$     \*b.  $\frac{384 \times (\frac{1}{6})^3}{(\frac{1}{6})^2 \times 9^{-3}}$
- Simplify:  
 a.  $\frac{(3x)^d}{x^d}$     b.  $(pqr)^m \cdot p^{-n}$     c.  $(\frac{b}{a})^3 \cdot \frac{a}{b^4}$     d.  $\frac{(11^2)^m}{11^m}$     e.  $\frac{(2pq)^n}{(4p)^n}$

**Assessments**

Additional exercises – with solutions only available to lecturers through the companion website

**MOVING ON... to the real world**

In this book we have only had space to describe the basics of project planning using network diagrams. Whilst specialised project planning software offers many extensions and variations, these are based on the same fundamental ideas.

For instance, we have assumed that the duration of each activity is known. Of course, in practice it is just an estimate and so it is useful to consider the effects of any changes to this estimate. One way of doing this is to make three estimates of an activity's duration – a pessimistic one, a real one and an optimistic one – and then use this information (with some probability theory) to calculate the probability of completing the project by a particular date.

Network diagrams can be presented as we have done, with each activity as an arrow and nodes where activities start and finish. However, they can also be presented using nodes for activities and arrows for activities. Software will sometimes do this.

Project planning is part of the discipline of *project management*. To read an interview with a project manager in practice with an experienced project manager, have a look at the companion website.

**Online extension:** Planning projects in real businesses: an interview with a project manager

**Moving on... to the real world**

Discusses the application of quantitative techniques in real-life businesses and organisations, with links to further material on the companion website

**further reading** *Statistics for Business and Economics* by Anderson *et al.* and *Statistics for Management and Economics* by Mendenhall *et al.* both contain more detail but assume more maths of the reader.

*Statistics for Business and Economics* by Newbold *et al.* is excellent but does take a more mathematical approach than most 'business' texts.

See p. xvii.

Now, how about trying the set of multiple choice questions for this chapter on the companion website at [www.palgrave.com/companion/Swift-Quantitative-Methods-4](http://www.palgrave.com/companion/Swift-Quantitative-Methods-4) where you can also find other additional resources.

**Further reading**

Pointers to more sources of information about specific topics in other books, and further resources on the companion website