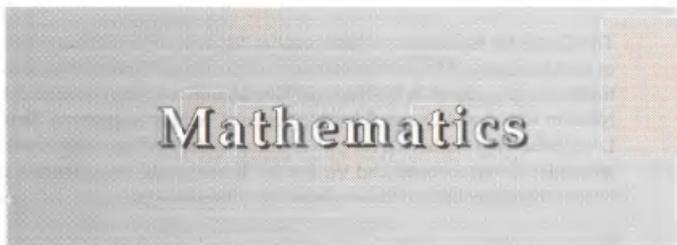


RESOURCE BOOKLET



MATHEMATICS

The BBC Domesday Discs Resource Booklet for



RESOURCE BOOKLET CO-ORDINATOR:

Bruce Wright

AUTHORS:

Bruce Wright

Centre for Innovation in Mathematics Teaching,
School of Education, University of Exeter

Val Snell

SERIES EDITOR:

Phyllis Gove



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PREFACE

The BBC launched the Domesday Discs and the Advanced Interactive Video System in November 1986 to celebrate the 900th anniversary of the original Domesday Book, commissioned by William the Conqueror.

These two videodiscs, the result of a project co-ordinated by the BBC in 1985 and 1986, present a portrait of Britain in the 1980s. Well over a million people in the UK were involved in creating this massive database, an interactive resource for education, industry, government and the information services. Information suppliers have included university and government statistical data banks, photo and print agencies, and nationally recognised experts in specialist subjects. However, the largest number of contributors has been the school children of the United Kingdom who surveyed their local areas in the Summer Term of 1985, supervised and assisted by their teachers and members of the local community.

This booklet, along with the others in the series, carries the Domesday Project one step further by illustrating how the Domesday Discs provide an invaluable educational resource. The BBC once again gratefully acknowledges this project work generously supported by the listed LEAs and institutions, produced by practising teachers, and trialled by young people in schools during the Spring and Summer Terms of 1987. These first steps in exploring the Domesday Discs are offered as a source of ideas to encourage others.

Booklets in this series

Curricular area	LEA/Institution
Projects and Topics	N. Ireland Education and Library Boards Bulmershe College, Reading, Berkshire and Hampshire LEAs
Mathematics	School of Education, University of Exeter
Social Sciences	Gwent LEA and Gwent Institute of Higher Education
Art; Craft, Design and Technology	Gateshead LEA, North Eastern ELB, N. Ireland
Environmental Education	Moray House College of Education, Edinburgh, and Scottish LEAs
Geography	University of Loughborough
In-Service	Christ Church College, Canterbury
	Phyllis Gove Series Editor

INTRODUCTION

This booklet demonstrates some of the uses of Domesday in the mathematics classroom. It is addressed to the teacher, with two distinct sections, one for each disc, the Community and the National.

Community Disc pupils' notes

The Community Disc section is further sub-divided into two parts. The first is a series of pupil worksheets which can be photocopied if required. The first of these, Community Cross-Number, is **not** intended for an individual pupil to work through from beginning to end, but is intended as a class activity for small groups of pupils contributing to its solution over a period of time.

In fact as a general principle, most of the activities in this booklet can be carried out by small groups. The 'on system' activity will initiate a great deal of 'off system' investigation and follow up work. The experience gained in the classroom so far indicates that the use of interactive video can lead to a great deal of discussion between pupils. The teacher, not superfluous in this type of learning situation, acts as a consultant or adviser, with particular emphasis on efficient problem-solving strategies.

Community Disc teachers' notes

The second part of the Community Disc section is a detailed set of teachers' notes for each worksheet with mathematical solutions and precise 'Domesday routes' to those solutions. Also included are details about mathematical content, suitability by age and ability, any relevant definitions, and references to other resources.

National Disc notes

The section relating to the National Disc is organised somewhat differently. Initially there are some notes and references about sampling, followed by a set of questions using the chart data available. These are not intended to be photocopied as there is a mixture of questions covering a large range of age and ability. A guide to the suitability of these questions is included. The detailed solutions to these questions are backed up by relevant notes and a worksheet, followed by some suggestions for further investigation. These questions can be used in a number of ways, depending upon the prior experience of the user. If the user is inexperienced on the National Disc, then carefully working through some of the solutions will be a great help. The questions themselves are supposed to demonstrate the types of questions that could be asked. A great deal of discussion should come out of this and the following section.

The second part of the National Disc section on mappable data follows a similar pattern to the chart data section. There are also some ideas for further investigation.

COMMUNITY DISC PUPILS' NOTES

Guidelines and assumptions

The pupils' worksheets assume that they have been given some instruction by their teacher in the use of the various facilities required and have spent some time playing with the system. It is not anticipated that pupils will start on Domesday by using these sheets.

Help facility

It has been assumed throughout this booklet that teachers are fully conversant with the In-Service resource booklet in this series. If experiencing difficulty in using one of the facilities, then initially select HELP on the menu bar and press ACTION. Then select DEMO and press ACTION. You will be shown a short video sequence. If you are still not sure then select HELP TEXT and press ACTION.

Refer to the 'Domesday Video Disc User Guide' for more detailed help when using the more sophisticated facilities.

Answers

There are a number of activities in this booklet where there will be some degree of disagreement with answers, due to personal differences when using various facilities, in particular, the SCALE and AREA facilities on the Community Disc. The answers are provided as guidelines, with a tendency towards undue accuracy when using the scale and area facilities to approximate.

The very fact that there is not one exact answer could cause problems for some classrooms. That pupils may also be correct in their approach and accurate in their working, yet still obtain

a different solution to the teacher is a stimulus for discussion and analysis. Order of magnitude, estimation and approximation are often skills lacking in many pupils. The Domesday Community Disc provides a rich source of stimuli in these areas.

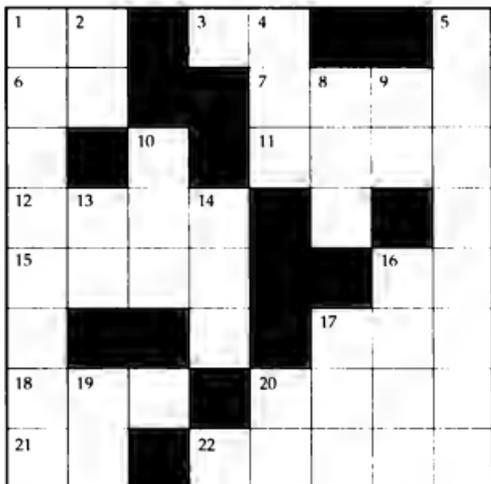
Community cross-number

The first sheet, Community cross-number, is provided as an extensive resource which pupils can use to practice and develop their 'Domesday skills'. It is not intended that an individual or small group of pupils should complete the whole cross number on their own, rather that different pupils will dip into the clues at various times and complete one or two clues. The completion of the cross-number could be a class project over a period of time. The other sheets relating to the Community Disc are provided to demonstrate some possible uses of Domesday in a mathematical context. The mathematics arises from a geographical context in these sheets, thus demonstrating that mathematics does not exist in a vacuum, but has genuine connections with the real world.

Community cross-number

Rules

1. When giving 10 digit grid references ignore the zero at the front of each set of 5 digits (easting, northing).
2. When looking up roads, the letter is included if the name is asked for (e.g. A56), but not if the question refers to the road number.
3. Decimal points go on the lines between the two figures (i.e. they do not occupy a box).



COMMUNITY CROSS NUMBER

Across

1. If twelve of the Newport (I.O.W.) police cars are off the road, what is the maximum number available for a big operation?
3. The number of the main road South out of Dalby (I.O.M.).
6. What percentage of the people of Larne (N. Ireland) who were receiving supplementary benefit in 1985 were not pensioners?
7. In which year was the Bedford (Beds) May photographed for Domesday?
11. If I flew 100 feet above Poinaven (N.W.Scotland), how high would I be above sea-level?
12. The height of Ben Nevis (in feet).

15. What year was it, 40 years before Didsbury College (S. Manchester) became the first Technology College in Britain?
16. What is the number of the road that links Stoke on Trent and Leek?
17. The number of the road north from Selkirk and Clovenford.
18. The distance (to the nearest 10 miles) from Cambridge to Southampton, as the crow flies.
20. The road number from Newbury to Hermitage.
21. What percentage of those places labelled as white-collared lie within the S.E. region? (See articles on Southern Britain.)
22. Area of the boating lake in Leazes Park (Newcastle on Tyne) to the nearest 1000 square yards.

Down

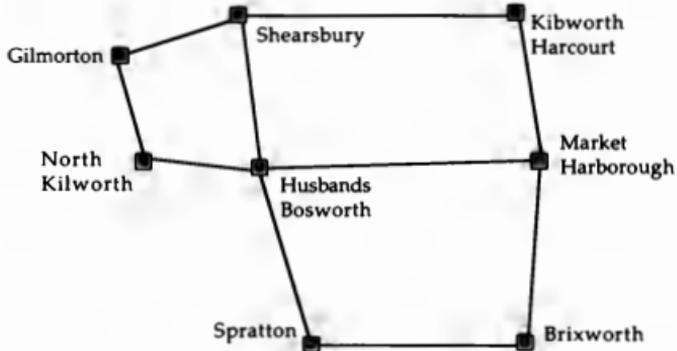
1. Grid reference of Reading (Berks) University library.
2. What percentage of the people interviewed by Combeinteignhead (Devon) survey team would walk under a ladder?
4. How high is Meall an t-Suidhe (near Ben Nevis)?
5. Grid reference of Worksop bus station.
8. How many years ago was Windsor Castle built (to the nearest 100)?
9. Perimeter of Lough Neagh (N. Ireland) to the nearest 10 miles.
10. Perimeter of the lake in 22A (to the nearest 100 metres).
13. In Belfast, what is the number of fatal accidents per 1000 people (to 1 decimal place) in the S.W. belt of twelve Catholic wards?

14. How far would the controller of the BBC regional centre at Spital Tongues (Newcastle on Tyne) have to walk to buy a stamp (nearest 10 metres)?
16. Area (in square miles) of the triangle enclosed by Brighton, Bristol and Birmingham (to the nearest 100 square miles).
17. If a light aircraft flies along the coast from Plymouth to Norwich, stopping at all the towns marked on the map of Southern Britain, how far has it travelled (to the nearest 100 km)?
19. The century that the oldest house in Curridge (Berks) was built.
20. The distance from Plymouth to Exeter, as the crow flies (to the nearest 10 miles).

Snow drifts

Market Harborough Council highways depot has the problem of clearing the snow drifts from the roads joining itself, Kibworth Harcourt, Shearsby, Gilmorton, North Kilworth, Husbands Bosworth, Spratton and Brixworth. (grid reference 0474 0286)

A network representing these towns and roads is shown below.



It is important to clear the roads as quickly as possible.

(a) Can one snowplough clear all of the roads shown without travelling over any of them more than once?

(b) The snowplough starts in Market Harborough and must be locked up there at night. What is the minimum distance that it can do whilst clearing all the roads in one day? (Use the scale facility to find the distances between towns to the nearest kilometre.)

(c) Are there any other towns where the snowplough might be stored, without it having to travel any further in a day?

Repeat these questions for the following networks:

1. Duns, Greenlaw, Berwick upon Tweed and Coldstream (grid reference 0384 0639) using only A roads.

2. Chelford, Holmes Chapel, Monks Heath, Alderley Edge, Prestbury, Macclesfield and Congleton (grid reference 0382 0374) using only A roads and not including the road from Alderley Edge to Chelford, since there is a power cable down across it.

If the road between Alderley Edge and Chelford was included in the network, would it be possible to clear all the roads without travelling over any of them more than once?

3. Alcester, Norton (junction of A435 and A439), Wooton Waven, Stratford upon Avon, Evesham, Broadway (junction of A44 and A46), and Weston sub Edge (junction of A46 and B4035) using A roads and the B4035 and B4089 (grid reference 0420 0254).

Investigate some more networks from the Community Disc.

Make up some networks of your own. Which ones are traversable? (Ask your teacher what this word means.)

Can you find the rule which tells you if a network is traversable or not?

Town shapes

Are all towns and cities circular in shape?

Do they all cover approximately the same area?

Are their population densities all similar? (Ask your teacher about density.)

Use the area facility (select OPTION, then SCALE, then AREA) to find the areas of various towns and cities. Make a drawing of the outline shape. Find the populations of these places from the library or your geography teacher.

Calculate their population densities. Are there any differences between large cities and small towns? Which place would give you the most space? Are there any patterns or differences between various regions of the country?

Can you find any towns or cities that are a similar shape? Do they have similar population densities?

Design your own method of classifying towns and cities by their shape. Can you think of any reasons why these various shapes may have evolved?

Might there be some variation in population density within cities and towns? Why?

Compactness

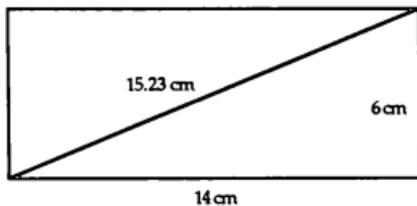
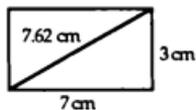
Some geographers are interested in the shape and spread of towns and cities. A man called Horton was the first to investigate this topic. He used to measure the area of a town, A , and the length of the line, L , joining the two most distant points of the town.

An example is given overleaf.



So $\frac{A}{L} \times \frac{22.5}{7.5} = 3$

This approach has a major problem. Consider the two similar shapes below.



Although the lengths are doubled the areas are quadrupled.

So for rectangle 1

$$\frac{A}{L} = \frac{21}{7.62} = 2.76 \text{ (2 d.p.)}$$

and for rectangle 2

$$\frac{A}{L} = \frac{84}{15.23} = 5.52 \text{ (2 d.p.)}$$

So with this calculation, A/L depends upon size not shape. (Both rectangles are as compact as each other.) The problem can be overcome by squaring the length, L , which is what Horton did.

So for rectangle 1

$$\text{Horton's ratio} = \frac{A}{L^2} = \frac{21}{58} = 0.36$$

and for rectangle 2

$$\text{Horton's ratio} = \frac{A}{L^2} = \frac{84}{.232} = 0.36$$

Calculate Horton's ratio for the towns used in Town shapes.

What is the minimum value of Horton's ratio?

What is the most compact shape of all?

Can you calculate the Horton's ratio for this shape?

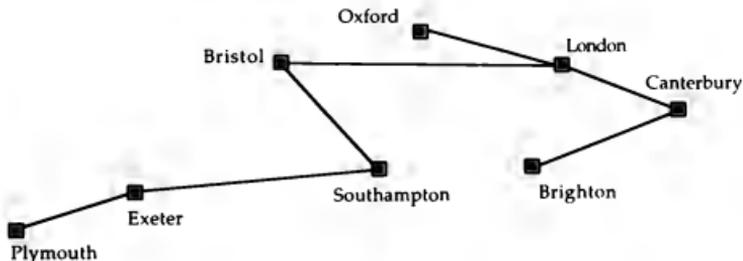
How could you convert Horton's ratio so that the minimum value was 0 and the maximum 1? (This figure is then called the form ratio.)

Convert the Horton's ratios for the towns used above into form ratios. Are there any patterns or categories? Do they fall into the broad bands that you expected?

Calculate the form ratios for the twelve pentominoes. Are there any patterns?

Computer connections

A computer company wishes to connect all its offices into one network linked with its main office in London. They are already linked as shown below:



The computer firm would like to reduce the amount of cable used in order to cut down communication times, maintenance and breakdowns.

1. How much cable (in km) has the company used?
2. Can you suggest a network which uses less cable?

Note that Oxford is linked to Bristol even though there is no cable directly between them. They are connected via London.

3. How much cable has your solution saved?
4. If the computer firm rents a new office block in Cambridge which town would you suggest connecting it to? Why?

The correct answer to question 4 should provide a good clue as to how to attempt the next question.

The computer company is making large profits and decides to expand. It takes over another computer firm in the North of England. This new company has a large number of offices



spread throughout the region. They are already networked together, but the newly formed company decides to link all of its offices together on one network. The 25 offices are in the towns and cities marked on the map of Southern Britain above.

5. Can you link them all together using the minimum amount of cable? (The cable can cross areas of sea.)
6. How much cable was used? (2 s.f.)
7. Have you got a system or strategy which will always work? Describe it in words.

COMMUNITY DISC TEACHERS' NOTES

Command conventions for solutions

All command sequences start with the map of the United Kingdom and stop when the frame containing the solution appears.

Single key presses will be expressed in CAPITAL LETTERS
e.g. ACTION.

Selections from the menu bar will be in CAPITAL LETTERS
e.g. FIND.

Typing from the keyboard will be inside inverted commas,
e.g. 'Norwich', but it is not necessary to type in the inverted
commas when using the system.

A semicolon is used to indicate a pause by the user, whilst the
system operates.

FIND is by place name unless otherwise indicated.

Selections from text or a map using the arrow will be indicated
by ^, e.g. ^10 ACTION ; means select item 10 from the text
index and press action. Alternatively ^Bedford ACTION means
place the arrow on Bedford and press action.

Obviously there are alternative methods of searching for the
solutions.

Community cross-number teachers' notes

1	2		3	4		5			
4	5		2	7		4			
6	7	5		7	1	8	9	8	5
3			10		11				
			5		1	0	0		8
12	13		14						
4	4	0	6			0			4
15								16	
1	8	0	2					5	3
7						17			
			0			7	0		7
18	19			20					
1	1	0		4	0	0			9
21				22					
7	7			2	0	0	0		0

SOLUTION

Command solutions

These will all assume that you have started with the Southern side of the Community Disc.

Across

1. FIND ACTION; 'Newport' RETURN; ^18 ACTION; TEXT ACTION; ^10 ACTION; A=45

3. FIND ACTION; 'Dalby' RETURN; ^13 ACTION; A=27
6. ^N.Ireland ACTION; ^Larne ACTION; TEXT ACTION; [f8] (repeatedly until page 19 appears); A=75
7. FIND ACTION; 'Bedford' ACTION; ^12 ACTION; PHOTO ACTION; [f8]; A=1985
11. ^Scotland ACTION; ^extreme N.W. Scotland (mainland) ACTION; ^Balchrick CHANGE; A=1008
12. TEXT ACTION; [f8]; [f8]; [f8]; A=4406
15. ^Southern Britain ACTION; ^Manchester ACTION; South Manchester ACTION; map walk search for Didsbury CHANGE; TEXT ACTION; ^17 ACTION; A=1802
16. FIND ACTION; 'Leek' RETURN; ^4 ACTION; OUT ACTION; A=53
17. FIND 'Selkirk' RETURN; ^3 ACTION; ^Yarrow CHANGE; A=77
18. ^Southern Britain ACTION; OPTIONS ACTION; SCALE ACTION; ^Southampton ACTION; ^Cambridge ACTION; UNITS ACTION; A=110
20. FIND ACTION; 'Hermitage' RETURN; [f8]; ^11 ACTION; OUT ACTION; A=4009
21. ^Southern Britain ACTION; TEXT ACTION; ^28 ACTION; [f8]; A=77
22. FIND ACTION; 'Newcastle' RETURN; ^8 ACTION; ^ central Newcastle ACTION; 'Y'; (insert Northern side); map walk search for Spital Tongues; ^ Spital Tongues ACTION; S.W. corner CHANGE; OPTIONS ACTION; SCALE ACTION; AREA ACTION; use ^ to step round the lake; A=20000

Down

1. FIND ACTION; 'Reading' RETURN; 6 ACTION; ^East CHANGE; ^University ACTION; OPTIONS ACTION; GRID REF ACTION; ^Library ACTION; A=4734 1717
2. FIND ACTION; 'Combeinteignhead' RETURN; TEXT ACTION; ^18 ACTION; A=55
4. FIND ACTION; 'Meall an t-Suidhe' RETURN; ^Ben Nevis ACTION; 'Y'; (insert Northern side); FIND ACTION; 'Meall an t-Suidhe' RETURN
5. FIND ACTION; 'Worksop' RETURN; ^4 ACTION; ^Worksop ACTION; OPTIONS ACTION; KEY ACTION; [f8] 5 times to discover the symbol for a bus station; MAIN ACTION; OPTIONS ACTION; GRID REF ACTION; ^bus station symbol ACTION; A=4584 3790
8. FIND ACTION; 'Windsor' RETURN; ^3 ACTION; ^inset rectangle ACTION; ^castle ACTION; TEXT ACTION; ^2 ACTION; A=900
9. ^ N.Ireland ACTION; ^ Lough Neagh ACTION; OPTIONS ACTION; SCALE ACTION; ^ Lurgan ACTION; (use scale facility to measure the perimeter); UNITS ACTION; A=80
10. FIND ACTION; 'Newcastle' RETURN; ^8 ACTION; ^central Newcastle ACTION; 'Y'; insert Northern side; map walk search for Spital Tongues; ^Spital Tongues ACTION; ^S.E. corner CHANGE; OPTIONS ACTION; SCALE ACTION; use ^ to step round lake; UNITS ACTION; A=500
13. FIND ACTION; 'Belfast' RETURN; ^2 ACTION; OUT ACTION; TEXT ACTION; ^22 ACTION; A=4.8
14. ^Northern Britain ACTION; ^Newcastle ACTION; ^central Newcastle ACTION; map walk search to find

- Spital Tongues; ^Spital Tongues ACTION; OPTIONS ACTION; SCALE ACTION; ^B.B.C. regional centre ACTION; use ^ scale facility ; A=620
16. ^ Southern Britain ACTION; OPTIONS ACTION; SCALE ACTION; AREA ACTION; use ^ area facility; UNITS ACTION; A=5000
17. ^ Southern Britain ACTION; OPTIONS ACTION; SCALE ACTION; use ^ scale facility; UNITS ACTION; A=700
19. FIND ACTION; 'Curridge' RETURN; TEXT ACTION; ^7 ACTION; A=17
20. ^ Southern Britain ACTION; OPTIONS ACTION; SCALE ACTION; ^ Plymouth ACTION; ^Exeter ACTION; UNITS ACTION; A=40

Snow drifts teachers' notes

Mathematical content: networks, nodes and traversability

A network is traversable if it can be drawn without taking the pencil off the paper and no line is traced over more than once.

A network is traversable if it has either none or two odd nodes (i.e. all even nodes or all even except for two).

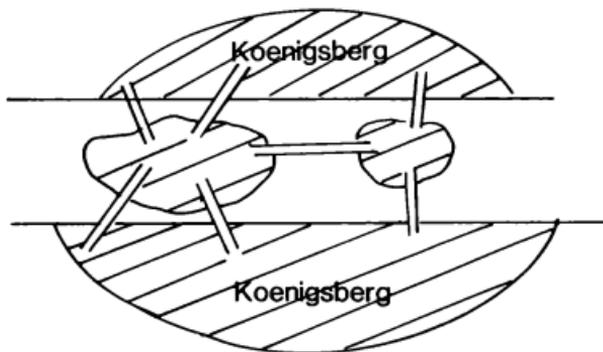
If a network has only two odd nodes they must be the starting and finishing points.

Suitability: 11 - 13 upper and middle ability pupils; 13 - 15 lower ability pupils.

History

Euler studied traversability in the 18th century. The most famous traversability problem was the Koenigsberg bridges. Koenigsberg was a river town in Germany. Two islands in the

middle of the river were connected by bridges to the main part of the town situated on both banks of the river. The townspeople had for years tried to find a way of crossing every bridge once and once only, also finishing where they had started. Euler proved that the problem was incapable of solution.



References

For a more detailed review of Euler's proof see Brian Bolt's 'Mathematical Activities' (Cambridge University Press), solution to activity 48.

Factor (number 8), a magazine for pupils, produced by Smile (ILEA), also has an account of the Königsberg problem.

There is also a 5 minute VHS tape, 'Seven Bridges of Königsberg', available from some LEA film libraries.

The Spode Groups Decision Maths Pack (Edward Arnold) contains a module called Network Inspection which links the ideas explored in Snow Drifts with those covered in Oil Delivery.

Solutions

If the pupil decides to find the appropriate map by using the grid references given, then on one occasion he/she will be asked 'Do you mean GB or N Ireland (G/N)?' This is due to Northern Ireland having a different grid system with some of the same numbers as Great Britain.

It may be necessary to use the OUT option after using 'Find by Grid Reference'.

On the introductory problem Shearsby is under the A50 symbol. It will in fact be necessary to use the zoom facility and to map walk in order to read some of the place names and to measure all the distances involved. The question says to find distances to the nearest kilometre. The solutions below are given to 1 decimal place; this should help you to judge which distances could be reasonably accurate, even though they may differ by 1 kilometre from those given here. There is obviously a hand - eye coordination factor to be taken into account.

Main problem

(a) Yes, it is possible to traverse the network.

(b) Distances:

M.H.	-	H.B.	=	10.2 km	H.B.	-	Sh	=	7.6
M.H.	-	B.	=	16.9	H.B.	-	N.K.	=	2.7
M.H.	-	K.H.	=	9.2	H.B.	-	Sp.	=	16.4
N.K.	-	G.	=	4.3	Sp.	-	B.	=	3.6
G.	-	Sh.	=	6.6	Sh.	-	K.H.	=	7.2

For Sp. - B. zoom to 4 by 3 km blocks is necessary since the road is on the boundary of two 40 by 30 km blocks. The 3.6km is made up of two parts, as it is necessary to map walk (0.49 + 3.11).

H.B. - Sp. = 16.4 since it is 15.9 to the bottom edge of the 40 by 30 km grid, the remaining part of the road was estimated.

Minimum distance travelled = $10+17+9+4+4+7+8+3+16+4+7+7+9$
 = 101

The last two figures are necessary to return the snowplough to Market Harborough from Sharsby via the shortest route.

(c) Yes, the snowplough could be stored at Sharsby.

Supplementary questions

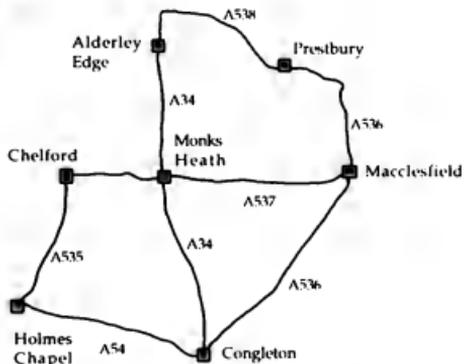
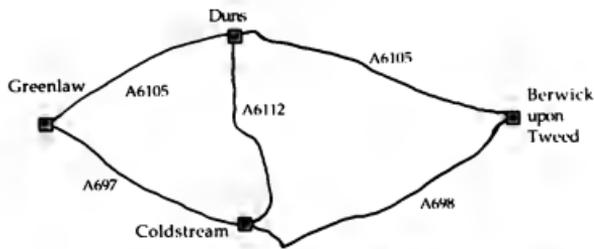
1. (a) Yes.

(b) $D - B = 22.9$ $G - C = 15.3$ $C - B = 22.8$

$D - C = 18.8$ $D - G = 11.1$

Minimum distance = $23+19+11+15+23+19=110$

(c) Yes, at Duns or Coldstream.



2. Monks Heath is at the junction of the A34 and A537 (use the zoom facility).

(a) Yes.

(b) Ch- H.C. = 10.0 M.H.- M. = 7.3 Ch- M.H. = 2.7
 P.- M. = 4.9 H.C.- Co. = 13.3 P.- A. = 10.0
 Co- M. = 14.3 A.- M.H. = 4.4 Co- M.H. = 11.8

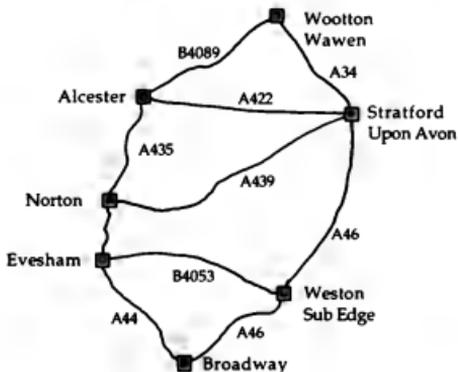
Minimum distance = $10+3+13+14+12+7+5+10+4+14 = 92$

(c) Yes, at Congleton or Macclesfield.

(d) No, not traversable as there would be 4 odd nodes.

3. No, this network is not traversable as there are 4 odd nodes.

Note: When converting real life situations into network problems, it is important to focus on whether it is the arcs or nodes that you are concerned with. In snow drifts we need to cover all the roads: it is therefore a traversability problem. In the case of visiting every town in a network traversability is not involved since it is not necessary to use all of the roads. The fuel problem (activity 29) in 'More Mathematical Activities' is a good example of this.



Town shapes teachers' notes

Mathematical content: population density, estimation of area, classification skills and approximation (rounding off).

Suitability: 12-13 upper ability, 14-15 middle ability.

References: this activity is related to Compactness in this booklet. See also '101 Mathematics Projects: A Resource Book' by David Hobbs and Brian Bolt.

Solutions: Area is calculated in square metres. All statistics in the table below are to 2 significant figures.

Shape	Area	Population	Pop. Density (square metres per person)
Star			
Yeovil	8,600,000	27,000	320
Dunstable	6,600,000	31,000	210
Carlisle	22,000,000	72,000	310
Durham	16,000,000	26,000	620
Norwich	36,000,000	122,000	300
Circular			
Bridgwater	8,500,000	26,000	330
Taunton	14,400,000	35,000	410
Andover	7,400,000	31,000	240
Crawley	17,000,000	73,000	230
Semi-Circular			
Llanelli	7,000,000	24,000	290
Swansea	18,000,000	168,000	110
Penarth	4,500,000	23,000	200
Weymouth	10,000,000	46,000	220
Edinburgh	92,000,000	419,000	220
Ribbon			
Barry	8,500,000	44,000	190
Bognor	11,000,000	40,000	280
Yarmouth	12,000,000	49,000	240
Margate	12,000,000	53,000	230

Stars are often found at crossroads. New Towns may well be circular. Coastal towns are usually semi-circular or ribbon-like. Valley towns might also be ribbon-like.

Obviously there may well be some disagreement between pupils about the classification of certain towns. This could prove to be a fruitful discussion point which leads to greater consistency by individual pupils (or small groups preferably) when applying their criteria.

Context

The decisions influencing how to organise public services and amenities can be affected by the shape of a town, e.g. bus services, snowploughs, schools, etc.

Compactness teachers' notes

Mathematical content: algebraic formula in use, pentominoes and Pythagoras.

Suitability: 14-16 upper ability

References

There is extensive coverage of this topic in 'Pattern and Place' by Keith Selkirk, Cambridge University Press (1982). Also see '101 Mathematics Projects: A Resource Book' by David Hobbs and Brian Bolt.

Context

Geographers have found it difficult to quantify shape. The dominant concept used is 'Compactness'. This concept has a use in political, economic and physical geography. The first investigation into shape by a geographer was carried out by Horton in 1932, when he examined drainage basin characteristics.

	Area	L(km)	L ²	Horton's ratio	Form ratio
Star					
Yeovil	8.6	4.7	22.1	0.39	0.50
Dunstable	6.6	4.1	16.8	0.39	0.50
Carlisle	22.0	7.2	51.8	0.42	0.53
Durham	16.0	7.4	54.8	0.29	0.37
Norwich	36.0	11.0	121.0	0.30	0.38
Circular					
Bridgwater	8.5	3.5	12.2	0.69	0.88
Taunton	14.0	5.1	26.0	0.54	0.69
Andover	7.4	3.6	13.0	0.57	0.73
Crawley, Sussex	15.6	5.6	31.4	0.50	0.64
Semi-Circular					
Llanelli	7.0	3.8	14.4	0.48	0.61
Swansea	18.0	6.9	47.6	0.38	0.48
Penarth	4.5	3.0	9.0	0.50	0.64
Weymouth	10.0	5.2	27.0	0.37	0.47
Edinburgh	92.0	14.0	196.0	0.47	0.60
Ribbon-Like					
Barry	8.5	5.6	31.4	0.27	0.34
Bognor Regis	11.0	9.3	86.5	0.13	0.17
Gt Yarmouth	12.0	8.2	67.2	0.18	0.23
Margate	12.0	7.4	54.8	0.22	0.28

table 1

The minimum value of Horton's ratio is very small, but not zero. If a town exists then A must have some value, but a very long, thin town would have a large value for L and a small value for A.

A circle is the most compact shape of all. Horton's ratio for a circle is approximately 0.788, which is the maximum value for this ratio.

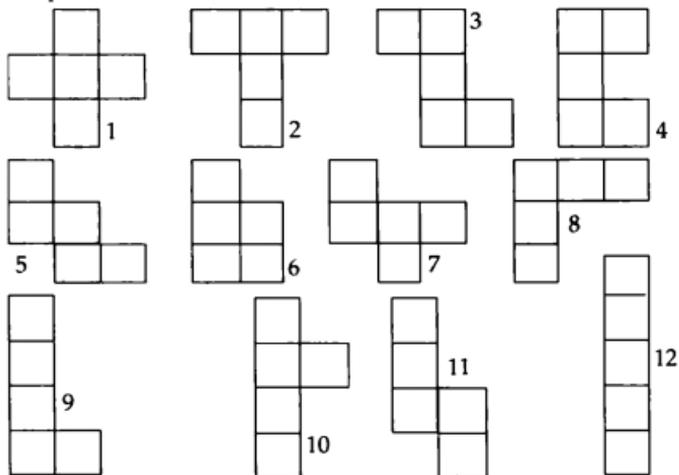
Proof:

$$\begin{aligned}
 A &= \pi r^2 & L &= 2r \\
 \text{so } \frac{A}{L^2} &= \frac{\pi r^2}{(2r)^2} & &= \frac{\pi}{4} \approx 0.788
 \end{aligned}$$

Horton's ratio can be converted to a form ratio by multiplying by $4/\pi$ (Therefore form ratio for a circle is 1.)

The form ratios for the towns used appear in table 1. They seem to fulfill the obvious predictions (i.e. circular > semi-circular > star > ribbon-like).

The twelve pentominoes are shown below. This activity uses the idea of a unit square, gives practice with the Pythagoras theorem and encourages a systematic approach to discovering the pentominoes.



$$1. L = \sqrt{3^2 + 1^2} = \sqrt{10}$$

$$2. L = \sqrt{2^2 + 3^2} = \sqrt{13}$$

$$3. L = \sqrt{3^2 + 3^2} = \sqrt{18}$$

$$4. L = \sqrt{3^2 + 2^2} = \sqrt{13}$$

$$5. L = \sqrt{3^2 + 3^2} = \sqrt{18}$$

$$6. L = \sqrt{3^2 + 2^2} = \sqrt{13}$$

$$7. L = \sqrt{3^2 + 2^2} = \sqrt{13}$$

$$8. L = \sqrt{3^2 + 3^2} = \sqrt{18}$$

$$9. L = \sqrt{4^2 + 2^2} = \sqrt{20}$$

$$10. L = \sqrt{4^2 + 1^2} = \sqrt{17}$$

$$11. L = \sqrt{4^2 + 2^2} = \sqrt{20}$$

$$12. L = \sqrt{1^2 + 5^2} = \sqrt{26}$$

Pentomino number	Area (unit ²)	L (units)	L ²	Horton's ratio A/L^2	Form ratio C
1	5	$\sqrt{10}$	10	0.50	0.64
2	5	$\sqrt{13}$	13	0.38	0.48
3	5	$\sqrt{18}$	18	0.28	0.36
4	5	$\sqrt{13}$	13	0.38	0.48
5	5	$\sqrt{18}$	18	0.28	0.36
6	5	$\sqrt{13}$	13	0.38	0.48
7	5	$\sqrt{13}$	13	0.38	0.48
8	5	$\sqrt{18}$	18	0.28	0.36
9	5	$\sqrt{20}$	20	0.25	0.32
10	5	$\sqrt{17}$	17	0.30	0.38
11	5	$\sqrt{20}$	20	0.25	0.32
12	5	$\sqrt{26}$	26	0.19	0.24

table 2

Extension

There are various other types of ratio that can be calculated, using perimeter instead of L etc. See 'Pattern and Place' by Selkirk.

Computer connections teachers' notes

Mathematical content: developing and application of a problem solving strategy, networks, measurement and calculation.

Suitability: 11-14 most of the ability range.

References: The Spode Group's Problem Solving Pack, Edward Arnold (1986), contains a great deal of applicable mathematics concerned with networks. The Decision Maths Pack by Spode introduces a second method of solving any 'shortest connection' problem, using a tabular matrix and algorithm. This would only be suitable for the upper half of the 14 - 16 age range.

Solutions: The cable lengths are obtained by using the scale facility on the map of Southern Britain.

1. $58+152+101+176+85+87+99 = 758 \text{ km}$



3. $58+107+98+89+85+72+87=596$

So $758-596 = 162\text{km}$ of cable is saved.

4. London, because Cambridge is closer to London than Oxford (the two nearest towns in the existing network).

5.



6. $58+107+43+57+82+91+84+52+73+54+49+38+55+39+37+26+77+89+85+72+87+80+71+63 = 1569 \text{ km} = 1600 \text{ km (2 s. f.)}$
7. In order to obtain the shortest connection, start with any node in the network. Connect it to the nearest node. Identify the node that is nearest to either of the first two nodes and connect it up. Repeat this process until all nodes are joined.

NATIONAL DISC

Introduction

The Domesday Project and the National Disc in particular allow, perhaps for the first time, easy access to data collected from the 1981 Census and national surveys. In the past these data have always been displayed in tabular form in books and journals not easily followed or understood by children or adults. Domesday allows us to look at various data sets either in map or chart form and from these it is possible for people of whatever ability to gain some insight into the meaning of these data sets.

The National Disc can be used to make particular points during a class lesson with the teacher leading the lesson. However, it can be argued that the main use of the disc is to initiate discussion between small groups of perhaps three or four pupils. Since the accessing of information about any subject is very straightforward, much is to be gained from small groups looking at the relevant data of any topic that interests them. In particular, mappable data sets can be broken down into small areas. Pupils can look at these data for the area in which they live, question the apparent data they are looking at and discuss the reasons for the results.

One of the biggest errors made by people looking at statistics for the first time is the reaching of far too many rash conclusions. People are usually prepared to accept information at face value. The National Disc allows us to look more deeply into any data set and question conclusions which may have been arrived at from first impressions. For example, we can break down information displayed as bar charts to show differences in the opinions of males and females or between age

groups, or regions. This may lead us to change completely our minds about what the data set is actually showing us.

In this section of the booklet a selection of questions has been set which can be used to show what the Domesday System can do with various data sets on the National Disc. The questions are of varying degrees of difficulty and some require the user to be able to manipulate some of the more complicated facilities available. The questions can be broken down into three groups:

GROUP A: these questions are straightforward and can be used with pupils of all ability levels.

GROUP B: these questions require the use of slightly more complicated operations and should be used with pupils in the 14-16 year old age group when they have used the system and can easily gain access to particular data sets.

GROUP C: these questions are more difficult and the user will need to be able to use most of the facilities available and should have some knowledge of statistics. These questions are particularly suitable for 'A' level students.

Suitability

The following table divides the questions into three levels of difficulty:

Group A (for pupils at all ability levels)	Question number
Chart Data	1, 2, 3, 4, 5, 6, 7, 12, 13, 14
Mappable Data	1, 2, 3, 5, 6, 14, 21
Group B (pupils 14-16 with experience of accessing data sets)	
Chart Data	6, 8, 9, 10, 11, 15, 17, 18, 19, 20, 23, 25, 27
Mappable Data	4, 7, 9, 11, 12, 13, 15, 17
Group C (‘A’ level students)	
Chart Data	21, 22, 24, 26, 28, 29
Mappable Data	8, 10, 16, 17, 20

Sampling problems and misuses

Much of the data on the National Disc have been collected via various types of sampling. The samples have then been broken down into various categories. For example, if we look at Question 16 from the section 'Chart Data' the data could be broken down in several ways, for example by household or by economic position. The problem with doing this is that the number of people in a sub-sample will be a small sample of the whole population. We cannot be sure that a complete cross-section of the population has been included in these sub-samples.

The problems of obtaining random and unbiased samples which are large enough to reflect accurately the findings that would be obtained from the whole population are probably the biggest problems that statisticians face. We have to rely on the skill of the people who collect the data and hope that the sample fills in any questionnaires accurately and honestly.

We should also be very careful not to be taken in by misleading statistics. By choosing biased unrepresentative samples almost any point could be proved. For further examples of this read 'How to Lie with Statistics' by Darrell Huff (Pelican).

Manipulating data

These first two pieces of work in this section of the book are intended to help you to get used to manipulating and interpreting the different types of data that can be found on the National Disc.

The first step that you should take is to read chapter 17 'An Introduction to Numerical Data on the National Disc' from the Domesday Video Disc User Guide in order to find out the different types of data that are on the disc, especially the difference between mappable and chart data. You will also need to be able to manipulate the different types of data sets, though by working through these pieces of work you will come across a great many different situations that you will learn to deal with as and when necessary.

Many of the questions asked are designed to lead to discussion and the conclusions that you draw may be different to those given. In many situations relating to statistics there are no right or wrong answers.

Chart data

1. What is the most common (modal) number of micros that a secondary school has?
How was this information collected?
2. What is the most common number of children under 16 years of age in a family of a married couple?
3. Display the information relating to the frequency with which people go to the cinema/theatre as a pie chart.
How many people attend once a month?
What percentage of the sample is this?

4. What were the average attendances at Division 1 football matches in the 1983-84 season? (Give your answer to the nearest 1,000.)
5. What four types of road user are most at risk of injury as a result of a road accident? Write down what you expect the answer to be first and then compare with the actual results. Were they as you expected?
6. Look at the destination of 16 year olds after they finish the fifth year at school.
What are the main differences between the years 1975/76, 1982/83 and 1983/84? Why?
Compare the destination of girls and boys in the year 1983/84. Are the differences as you would expect?
Hint: Use back-to-back bar charts to make comparisons.
7. How many new drug addicts were notified to the Home Office in 1984?
8. (i) What was the most popular opinion in 'The Debate on Nuclear Issues 1983' British Nuclear Weapons
- a) Make Britain safer
 - b) Make Britain less safe
 - c) Don't know
 - d) Option not chosen
- (ii) "U.S. missiles make the U.K. safer"
- What percentage of the people surveyed
- a) Agreed with this statement
 - b) Disagreed with this statement
9. What percentage of women have their first child within 2 years of marriage?
10. What were the two most popular destinations of people who holidayed abroad in 1983?
What percentage of those who holidayed abroad did so in Europe?

11. How many of the people surveyed in the 15 and under age group play a musical instrument at least once a week?
12. How many people commute in London by bus?
13. How many paying visitors were there to the Tower of London in 1984?
14. In 1985 which three religions had the highest memberships?
How many members did they each have?
15. Is the percentage of women who avoid going out alone, in Greater London, greater or smaller than the percentage of women who avoid going out alone in the South West?
16. What are the differences in the feelings of households of two adults only and households of large families towards moving away?
Does a pie chart or a bar chart show these differences more clearly?
17. By looking at a pie chart what fraction of the people living in a terraced house in the South West bought their house with a mortgage.
18. Do the British think that the Russians are trustworthy?
Are the views of the men and women questioned the same?
19. Is the number of kilometres travelled by passengers on International Air Flights increasing or decreasing?
20. Do more men or women catch a bus to work?
21. Were there more cadets in the Isle of Man Police Force in 1978 or 1983?
22. How many personnel were there in H.M. Forces in the second quarter of 1981?

Hint: Read the text.

23. Is the number of households owning T.V. sets increasing?
Is this also true of the number of households renting T.V. sets?

24. (i) Do men and women prefer the same T.V. channel?
(look at back-to-back chart).

(ii) Is there any difference in preference of channel between age groups?

(Again look at the back-to-back bar chart. You will have to regroup the age-groups to get four categories. Omit channels other than BBC 1, ITV, BBC2 and Channel 4).

25. What percentage of the people asked in the 16-19 year age group do not intend to have any children?

26. What, in the opinion of the people surveyed, would be the best solution to our energy problems?

27. Of the people questioned who smoke, what is the most common number of cigarettes smoked per week by:

a) men?

b) women?

28. Using a loop bar chart, what percentage of the people responding to the questionnaire on 'Weekly Household Expenditure on Alcohol' spent nothing on alcohol each week in the years 1978, 1980 and 1982.

29. Using a loop bar chart, compare the percentage of people who have oil central heating in the following regions:

a) Wales

b) Scotland

c) Greater London

d) South West

e) Yorkshire

f) East Anglia

Chart data solutions

- FIND ACTION; 'Micros' RETURN; ^7 ACTION;
^A = O CHANGE x 13;
Most common number of micros = 13 to 16
TEXT ACTION;
The data were calculated via a postal survey with
questionnaire distributed to a sample of primary and
secondary schools.
- FIND ACTION; 'Number of children per family'
RETURN; ^31 ACTION; ^A = One child under 16 years
CHANGE
Most common number of children under 16 in a family of a
married couple = 2.
- FIND ACTION; 'Cinema' RETURN; ^9 ACTION; ^chart
type CHANGE x 3; REPLOT ACTION; ^A = 3 or more
times a week CHANGE x 3; ^square D ACTION; Number
of people attending cinema/theatre once a month = 1234

$$\text{Percentage of the sample} = \frac{1234 \times 100}{12576} = 9.8 \%$$
- FIND ACTION; 'Football' RETURN; ^11 ACTION; ^bar
1983. ACTION;
Average attendances at Division 1 football matches in
season 1983/84 = 19,000.
- FIND ACTION; 'Road Accidents' RETURN; ^11 ACTION;
^A = Pedestrians CHANGE; types of road user most at risk
of injury as a result of a road accident:-

 1. Pedestrians
 2. Motor Cyclist
 3. Car Driver
 4. Car Passenger

11. FIND ACTION; 'Music' RETURN; ^57 ACTION; ^All (under AGE) CHANGE; REPLOT ACTION; ^No. responding CHANGE; Number in 15 and under age group playing a musical instrument at least once a week = 369

$$\frac{+372}{741}$$

^bar A ACTION; ^ bar B ACTION;

12. FIND ACTION; 'London' RETURN; ^12 ACTION; ^ A=British rail CHANGE x 2; ^ bar C ACTION; Number of people commuting by bus in London = 1,324,000
13. FIND ACTION; 'London' RETURN; ^62 ACTION; ^ All (under YEAR) CHANGE x 2; REPLOT ACTION; ^ bar A ACTION; Number of paying visitors to the Tower of London in 1984=2,341,000.
14. FIND ACTION; 'Religion' RETURN; ^54 ACTION; ^All (under YEAR) CHANGE x 3; REPLOT ACTION; ^A = Anglican CHANGE; ^bar A ACTION; ^ bar B ACTION; ^B = Presbyterian CHANGE x 4; ^ bar F ACTION. Three religions with highest memberships in 1985 were
- | | | |
|-------------------|-----------|----------------|
| 1. Roman Catholic | 2,265,000 | ^ bar F ACTION |
| 2. Anglican | 2,058,000 | ^ bar A ACTION |
| 3. Presbyterian | 1,483,000 | ^ bar B ACTION |
15. FIND ACTION; 'Attitudes' RETURN; ^17 ACTION; ^ All (under Standard R) CHANGE x 5; REPLOT ACTION; ^ All (under SEX) CHANGE x 2; REPLOT ACTION; ^ bar Y ACTION; ^Greater L CHANGE x 2; REPLOT ACTION; ^ bar Y ACTION; Percentage of women who avoid going out alone
- a) Greater London = $\frac{355 \times 100}{1126} = 31.5 \%$
- b) South West = $\frac{62 \times 100}{437} = 14.2 \%$

Therefore greater in Greater London.

16. FIND ACTION; 'Attitudes' RETURN; ^94 ACTION;
 ^ All (under HOUSEHOLD) CHANGE x 6; REPLOT ACTION;
 ^ bar A ACTION; ^ bar B ACTION; etc.
 ^ 2 adults (under HOUSEHOLD) CHANGE x 7; REPLOT ACTION;
 ^ bar A ACTION; ^ bar B ACTION; etc.

	No.	%age	No.	%age
	Large Families		2 Adults	
A. Very pleased	82	9.8	156	8.7
B. Fairly pleased	61	7.3	93	5.2
C. Mixed feelings	279	33.5	426	23.7
D. A bit sorry	143	17.1	199	11.1
E. Very Sorry	266	31.9	913	50.8
O. Option not chosen				
SAMPLE SIZE	834		1796	

Look at percentages because sample sizes are very different. Pie chart shows very clearly that about half of the people asked in the 2-adult category were very sorry to be moving away, whereas only about a third of the people asked in the large family category felt this way.

17. FIND ACTION; 'Wealth' RETURN; ^19 ACTION;
 ^ All (under Region) CHANGE x 8; REPLOT ACTION;
 ^ No. RESPONDING CHANGE; ^ All (under Dwelling T)
 CHANGE x 2; REPLOT ACTION; ^bar A ACTION; ^
 chart type CHANGE x 3; REPLOT ACTION; square A
 ACTION; Ans. from pie chart about one sixth actual
 figures =

$$\frac{40}{250} = \frac{4}{25}$$

18. FIND ACTION; 'Soviet trustworthiness' RETURN; ^3 ACTION; ^A = very trustworthy CHANGE x 3; British do not think that the Russians are trustworthy. ^Chart type CHANGE x 2; ^sex CHANGE; REPLOT ACTION; Men's and women's views are different.
19. FIND ACTION; 'Travel' RETURN; ^25 ACTION; ^ chart type CHANGE x 2; Year CHANGE; REPLOT ACTION; Number of kilometres travelled on international flights is increasing.
20. FIND ACTION; 'Travel' RETURN; ^61 ACTION; ^ bar chart CHANGE x 2; ^sex CHANGE; REPLOT ACTION; ^A = walked CHANGE x 4; More women than men catch a bus to work.
21. FIND ACTION; 'Armed Forces' RETURN; ^64 ACTION; ^chart type CHANGE x 2; ^ year CHANGE; REPLOT ACTION; ^1978 cadet bar ACTION; ^1983 cadet bar ACTION; Number of cadets in IOM Police Force in 1978 = 14. Number of cadets in IOM Police Force in 1983 = 14. Same number.
22. FIND ACTION; 'Armed Forces' RETURN; ^62 ACTION; ^appropriate point on the single line graph ACTION; TEXT ACTION; scale is in thousands. Number of personnel in HM Forces in 2nd quarter of 1981 = 328,000.
23. FIND ACTION; 'Television' RETURN; ^20 ACTION; ^chart type CHANGE x 2; ^year CHANGE; REPLOT ACTION; Number of people owning T.V. sets is increasing. Number of people renting T.V. sets is not increasing.

24. (i) FIND ACTION; 'Television' RETURN;
 ^94 ACTION; ^chart type CHANGE x 2; ^sex CHANGE;
 REPLOT ACTION;
 Men and women both prefer the same T.V. channel.
 (discussion - this is obvious from the back-to-back bar
 chart. ITV is the most popular channel, but women have
 a greater preference for ITV than men.)
- (ii) MAIN ACTION; ^94 ACTION; ^chart type
 CHANGE x 2; ^ Age CHANGE; REGROUP ACTION;
 ^ Age ACTION; ^2 ACTION; ^1 ACTION; ^3 ACTION;
 ^ 2 ACTION; ^4 ACTION; ^3 ACTION; CONTINUE
 ACTION; ^A 'A' RETURN; ^under 15 'under 15-24'
 RETURN; ^C 'B' RETURN; ^25-34 '25-44' RETURN;
 ^E 'C' RETURN; ^45-54 '45-64' RETURN;
 ^G 'D' RETURN; REPLOT ACTION; REGROUP
 ACTION; ^CHANNEL FA ACTION; CONTINUE
 ACTION x 2; ^5 ACTION; ^6 ACTION; ^7 ACTION;
 REPLOT ACTION: ^Chart type CHANGE x 2;
 ^Age CHANGE; REPLOT ACTION. No overall
 difference in preference for channels by age groups with
 the exception of 45-65 year olds for BBC 2.
25. FIND ACTION; 'Intended parenthood' RETURN;
 ^2 ACTION; ^All (under AGE) CHANGE; REPLOT
 ACTION; ^A = will have any more children CHANGE;
 ^ bar B ACTION Percentage of people asked in the 16-19
 year age group who do not intend to have children =
- $$\frac{31 \times 100}{425} = 7.3 \%$$
26. FIND ACTION; 'Energy in the Environment' ACTION;
 ^81 ACTION; ^A = Foreign supplies CHANGE; Best
 solution to energy problems would be to 'research new
 forms'.

27. FIND ACTION; 'Smoking' ACTION; ^12 ACTION;
 ^chart type CHANGE x 2; ^sex CHANGE; REPLOT
 ACTION; ^A = less than 7 CHANGE x 3;
 ^bar D male ACTION; a) 1584 men smoke 140-209 cigs.
 per week ^D = 140-209 CHANGE x 8;
 ^bar C female ACTION; 1644 women smoke 70-139
 cigs.per week.

28. FIND ACTION; 'Expenditure' ACTION; ^1 ACTION;
 ^chart type CHANGE; ^Year CHANGE; REPLOT
 ACTION; ^ bar A ACTION;
 Percentage of people spending nothing on alcohol:

$$\text{In 1978} \quad \frac{2950 \times 100}{7001} = 42.1\%$$

$$\text{In 1980} \quad \frac{1913 \times 100}{6944} = 27.5\%$$

$$\text{In 1982} \quad \frac{2704 \times 100}{7428} = 36.4\%$$

29. FIND ACTION; 'Expenditure' RETURN; ^26 ACTION;
 ^chart type CHANGE; ^standard R CHANGE; REPLOT
 ACTION; Percentage of people who have oil central
 heating

$$\text{a) Wales} \quad \frac{21 \times 100}{382} = 5.5\%$$

$$\text{b) Scotland} \quad \frac{16 \times 100}{620} = 2.6\%$$

$$\text{c) Greater London} \quad \frac{30 \times 100}{853} = 3.5\%$$

$$\text{d) South West} \quad \frac{48 \times 100}{560} = 8.6\%$$

$$\text{e) Yorkshire} \quad \frac{12 \times 100}{684} = 1.8\%$$

Chart data further investigations

1. Fast Food Sales

Investigate which type of fast-food, burgers or pizzas, was gaining or losing ground as a proportion of total takings on fast-foods between 1983 and 1984.

FIND Eating Habits

ITEM 17 'Fast Food Sales 83/84.'

REGROUP Type of outlet: Burgers v Pizzas v all the rest.

Back-to-Back Chart

1983	B	$\frac{382}{561} \times 100 = 68\%$
	total	
	P	$\frac{71}{561} \times 100 = 13\%$
	total	
1984	B	$\frac{460}{670} \times 100 = 69\%$
	total	
	P	$\frac{82}{670} \times 100 = 12\%$
	total	

Conclusion: very slight movement up for burgers and down for pizzas but probably not significant.

2. Spending on Food

Does the hardship of unemployment have an effect on the ability to feed a family?

FIND Eating Habits

ITEM 35 'Poverty and Food Purchase'

REGROUP Employment; Unemployment v Full-time employment; eliminate the rest.

REGROUP Lack of money for family food: Not enough v enough, eliminate the rest.

Back-to-Back Chart

$$\begin{array}{l} \% \text{ Employed who can't feed family} \\ \frac{32}{303} \times 100 = 11\% \end{array}$$

$$\begin{array}{l} \% \text{ Unemployed who can't feed family} \\ \frac{59}{157} \times 100 = 37\% \end{array}$$

Conclusion: big difference between the 2 groups and effect of unemployment on ability to feed family significant.

3. Has cigarette smoking increased or decreased overall since 1974 and by what percentage?

(i) FIND Smoking

ITEM 8 'Cigarette Smoking Habits'

REGROUP Present cigarette smokers: Cigarettes v all the rest.

Back-to-Back

1974	c	<u>9486</u>	x 100	= 42%
	all	22580		
1976	c	<u>10760</u>	x 100	= 40%
	all	27031		
1978	c	<u>9115</u>	x 100	= 38%
	all	24025		
1980	c	<u>8885</u>	x 100	= 37%
	all	23966		

Conclusion: gradual drop in proportions of cigarette smokers over this period (1974-80).

(ii) Investigate North-South differences in smoking habits during this period.

Keep same display, Back-to-Back

REGROUP Region: North v South

(Midlands = North, E.Ang = South, eliminate Scotland and Wales)

1974	N	c	<u>4200</u>	x 100	= 42%
		all	9982		
	S	c	<u>3774</u>	x 100	= 41%
		all	9222		
1980	N	c	<u>3944</u>	x 100	= 38%
		all	10305		
	S	c	<u>3478</u>	x 100	= 35%
		all	9983		

Conclusion: both regions gone down but more rapid drop in South.

(iii) Investigate young-old differences in smoking habits during this period.

Keep same display, Back-to-Back.

REGROUP age: Young v Old

(Young < 35, old > 35)

1974	Y	$\frac{3168}{7494}$	x 100	= 42%
	O	$\frac{6318}{15086}$	x 100	= 42%
1980	Y	$\frac{3269}{8438}$	x 100	= 39%
	O	$\frac{5616}{15530}$	x 100	= 36%

Conclude both groups falling but older people seem to be giving up more rapidly than the younger group.

4. Political Party Membership (1983 election)

In which region of the Country (North/Mid/South) did the Alliance have its best proportion of paid-up party members, in comparison with the other main parties?

FIND Politics

ITEM 178 'Membership of Pol, Parties'.

REGROUP membership of party: L & SDP = Alliance v C/Lab/

Other = Other eliminate none and none of these and retile.

REGROUP Standard Region: N.(incl. Scotland) v Mid (incl.

Wales and EA) v South

Back-to-Back

N	Alliance	$\frac{12}{80}$	x 100	= 15%
	TOTAL			
M	Alliance	$\frac{6}{65}$	x 100	= 9%
	TOTAL			
S	Alliance	$\frac{18}{132}$	x 100	= 14%
	TOTAL			

Conclusion: results not significant; sample much too small.

5. Education as an issue in politics (1983 election)

(i) Which social class attached the greater importance to education as an election issue?

(ii) Which sex attached the greater importance to education as an election issue?

(iii) Which political party attached the greater importance to education as an election issue?

FIND Politics

ITEM 105 'Issue Salience 83 Ed.1'

Back-to-Back

(i) Social Class

REGROUP Social class: Higher and Lower managerial = upper v Skilled and Lower managerial and Skilled and Lower manual = middle v Unskilled = Lower eliminate 'no occupation' and 'none', and retitle.

U	ed:	$\frac{57}{778} \times 100$	=	7%
	all	778		
M	ed:	$\frac{131}{2101} \times 100$	=	6%
	all	2101		
L	ed:	$\frac{32}{740} \times 100$	=	4%
	all	740		

Conclusion: significant correlation Autumn Soc. Class and Ed. as election issue.

(ii) Sex

Use Bar Chart. Select M x F separately.

M	ed:	$\frac{73}{3512} \times 100 = 2\%$
	all	3512
F	ed:	$\frac{147}{1809} \times 100 = 8\%$
	all	1809

Conclusion: very much higher emphasis on Education as election issue by women. Would be interesting to compare M & F on some of the other issues.

(iii) Political party

Back-to-Back

REGROUP party: Con. v Lab. v Alliance eliminate rest.

$$\begin{array}{l} \text{C} \\ \text{all} \end{array} \quad \begin{array}{l} \text{ed: } \frac{74}{1358} \times 100 = 5\% \\ \text{all } 1358 \end{array}$$

$$\begin{array}{l} \text{L} \\ \text{all} \end{array} \quad \begin{array}{l} \text{ed: } \frac{39}{904} \times 100 = 4\% \\ \text{all } 904 \end{array}$$

$$\begin{array}{l} \text{A} \\ \text{all} \end{array} \quad \begin{array}{l} \text{ed: } \frac{64}{805} \times 100 = 8\% \\ \text{all } 805 \end{array}$$

Conclusion: seems to be a significant difference (Alliance most - Labour least) but sample rather small and dangerous to draw conclusions.

Pie charts or bar charts

It is not always clear when it would be best to display chart data as a pie chart or a bar chart. Bar charts are easy to draw and easy to interpret. The scale allows approximate readings to be taken at a glance, and the diagrams draw attention to the relative frequency of each category. They do not conveniently show what proportion of the whole that each category represents.

Comparisons between men and women in age groups, or over a period of time can be readily made using either back-to-back bar charts or looped bar charts. (Look at question 6 from the section on Chart Data.) Several categories can also be included on one bar chart without complicating the chart greatly.

It is also possible to look at the shape of the distribution that the data come from when using a bar chart; for example, consider questions 1 and 2 from the section on Chart Data. It can be seen that there are two differently shaped distributions. From the bar chart displayed for question 1 a 'Normal-type' distribution is displayed with very few schools having either no micros or a very large number of micros, whereas looking at the bar chart for question 2 it can be seen that most married couples have 2 or less children with a longer tail to the right of this point, i.e. very few families have 4 or more children, but the maximum number of children is high.

Pie charts show the proportions of the whole very clearly, particularly when there is a dominance of one category. They do not show the relative proportions as well as bar charts, so the magnitude of each sector needs to be written clearly either on the pie chart itself or on a key. To be most effective, pie charts should not be used to display more than six or seven categories. It is also difficult to compare a series of pie charts as the area or the circle should be proportional to the size of the sample. So the problem of comparing the size of sectors of

differing radii has to be faced, though in practise we very rarely do this. The circles are usually drawn with the same radii in order to make comparisons.

Examples of good use of pie charts

Centrally heated accommodation

FIND ACTION; 'Expenditure' RETURN;26 ACTION; Change chart type to pie chart using arrow CHANGE. REPLOT ACTION

What fraction of the households surveyed have no Central Heating?

It is very clear from the pie chart that over one-third of the households asked have no central heating; this is not nearly so obvious from the bar chart.

Most favoured radio station

FIND ACTION; type in the following file name exactly and include the quotation marks: 'Most Favoured Radio Station 1' RETURN; Regroup stations - only leave in Radios 1, 2, 3 and 4. Regroup age into under 34 and over 34. Replot a pie chart for each age group. What are the differences in the preferences of radio stations between the two age groups?

People under 34

Over three-quarters of those asked prefer Radio 1, with about one-eighth favouring Radio 2.

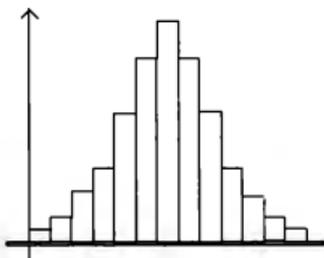
People over 34

Almost half favour Radio 2, with nearly one-third choosing Radio 4 as their favourite Radio station.

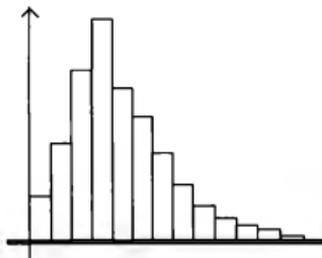
Pie charts/bar charts worksheet

1. Take some of the questions from the section 'Chart data' and compare the use of pie charts and bar charts commenting on the advantages and disadvantages of the type of chart used in each case.
2. Find examples of data which come from different distributions and therefore give rise to bar charts of different shapes, for example -

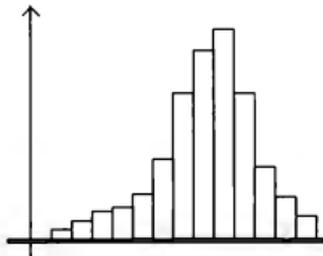
Negatively skewed distribution



Symmetric or 'Normal'
shaped distribution



Positively skewed
distribution



Negatively skewed
distribution

3. Find three examples of your own which show a good use of pie charts.
4. Use a pie chart to answer the question 'Of the people who own pets are more than or less than the total number of people sampled under 45?'

Pie charts/bar charts worksheet solutions

- 1-3: Pupils' own examples and opinions
4. FIND ACTION; 'Pets' RETURN; ^14 ACTION; Change chart type to Back-to Back REGROUP age as secondary variable; Change chart type.

Mappable data

1. What percentage of households in Torbay have 2 cars?
2. What percentage of private households in Cardiff and Bristol have six or more residents?
3. What percentage of school leavers in the following areas leave with one or more 'A' Levels?
 - a) Birmingham
 - b) London
4. What is the actual rateable value of property in the following places?
 - a) Slough
 - b) Orpington(Change the raster size to 1km).
5. How many cinemas are there in Bath?
6. In which regions was the unemployment rate for males in 1984 the highest?

7. What percentage of people living in Central London travel more than 20 km to their workplace?
How does this compare with places on the outskirts of London?
Give some examples.

8. What percentage of householders in Bromsgrove and Birmingham have 2nd homes?
By looking at the same category nationally and by changing the map to incidence data with a suitable upper limit, find the town/area where the percentage of householders with 2nd homes is the highest.

9. In the following places, how many women held jobs in industry in 1981?

- a) Plymouth
- b) London
- c) Inverness

10. In which areas of England and Wales is air pollution the worst?

Compare the map showing most prosecutions with the map showing most complaints. Use an incidence map to find out where more than 250 complaints were made. Can you pinpoint where the most complaints were made and how many there were?

11. What areas of Britain had the lowest rainfall in the July-Sept. period between 1978 and 1981? Where was the driest area in Britain in this period?

12. What percentage of the heads of households in Croydon were born in the New Commonwealth or Pakistan?

13. Where in the Inner London Education Authority region was the percentage of school leavers gaining no 'O' level passes the highest?

14. In which counties in England and Wales is there the greatest concentration of holiday camps?

15. Where in the north of England, would you visit if you were particularly interested in areas of outstanding beauty?

16. By changing the class intervals yourself on the map, name the towns and cities in the south east of England which have more than 20 private schools.

17. Where, in 1981, in the south east of England, was the highest percentage of the population resident in the area, living in institutions?

What percentage of the residents of this area did these people account for? Hint: again change the class intervals manually or convert to an Incidence map with an appropriate upper limit.

Super profiles

18. Which parts of England have the highest percentage of people assigned to the group: 'Large young families; semi-skilled and unskilled in cramped terraces'?

19. Which parts of the country have the smallest percentage of people assigned to the group: 'Pensioner owner occupiers within white collar areas'?

20. What areas have more than two per cent of the two percent of its population made up of people in the group: 'Military bases, younger families'?

21. What percentage of people living in Plymouth are categorised as falling into the super profile group, 'Small, older families in council flats'?

Mappable data solutions

1. AREA 'County' RETURN; 'Devon' RETURN; MAIN ACTION; FIND ACTION; 'Car Ownership' RETURN; ^18 ACTION; ANALYSE ACTION RETRIEVE ACTION VALUES ACTION ^Torbay ACTION % of households in Torbay with 2 cars = 13.27%
2. AREA 'Country' RETURN; 'Wales' RETURN; FIND ACTION; 'Family Size' RETURN; ^64 ACTION; ANALYSE ACTION RETRIEVE ACTION VALUES ACTION ^Cardiff ACTION; ^Bristol ACTION; % householders in Cardiff with 6 or more residents = 4.1% ; householders in Bristol with 6 or more residents = 2.97%
3. AREA 'Country' RETURN 'England' RETURN; FIND 'Education' RETURN; ^2 ACTION; ANALYSE ACTION = RETRIEVE ACTION VALUES ACTION ^Birmingham ACTION ^London ACTION; % of school leavers with 1+ 'A' Levels - Birmingham 12%, London 10%
4. AREA 'County' RETURN 'Greater London' RETURN; FIND 'Rates' RETURN; ^41 ACTION; ANALYSE ACTION DETAIL ACTION RESOLUTION ACTION ^1 REPLOT ACTION; MAIN ACTION RETRIEVE ACTION VALUES ACTION ^Slough ACTION Actual Rateable value in Slough = £245.00 ^Orpington ACTION Actual Rateable value in Orpington = £168.00
5. AREA ACTION; 'County' RETURN 'Avon' RETURN; FIND ACTION; 'Entertainment' RETURN; ^16 ACTION; ANALYSE ACTION RETRIEVE ACTION VALUES ACTION ^Bath ACTION Number of Cinemas in Bath = 4.
6. AREA ACTION; 'Country' RETURN 'England' RETURN FIND ACTION; 'Unemployment' RETURN; ^73 ACTION; ANALYSE ACTION VALUES ACTION, then RETRIEVE ACTION UNIT ACTION ^areas of highest unemployment

rate ACTION Unemployment rate in 1984 highest in Cornwall, N. Wales, North, Strathclyde. Use WINDOW ACTION to get areas for England only.

7. AREA ACTION; 'Country' RETURN 'England' RETURN; FIND ACTION; 'Travel' RETURN; ^11 ACTION; ANALYSE ACTION RETRIEVE ACTION VALUES ACTION ^Central London ACTION. Use UNIT and VALUES to find examples outside of London % of people living in Central London travelling more than 20km to their workplace = 4.68% Examples: Kent coast - 12.4% Areas in North of London > 17%.
8. AREA ACTION 'County' RETURN 'West Midlands' RETURN; FIND ACTION; 'Holidays' RETURN; ^46 ACTION ANALYSE ACTION; DETAIL ACTION; RESOLUTION ACTION; ^2 ACTION; REPLOT ACTION MAIN ACTION RETRIEVE ACTION VALUES ACTION ^Bromsgrove ACTION ^Birmingham ACTION % householders living in Bromsgrove with 2nd homes = 0.13%. % householders living in Birmingham with 2nd homes = 0.03%. AREA ACTION; 'Country' RETURN 'England' RETURN; FIND ACTION 'Holidays' RETURN; ^46 ACTION ^ANALYSE ACTION CLASS ACTION MANUAL ACTION ^ 1st interval on key CHANGE until all colours are the same colour except for the highest interval. ^upper limit ACTION '1.7' RETURN REPLOT ACTION; MAIN ACTION MAIN ACTION RETRIEVE ACTION UNIT ACTION ^area required ACTION Highest % of householders with 2nd homes - Isle of Wight 1.96%.
9. AREA ACTION; 'Country' RETURN 'England' RETURN; FIND ACTION; 'Women' RETURN; ^87 ACTION ANALYSE RETURN RETRIEVE RETURN VALUES RETURN ^Plymouth/London/Inverness ACTION Women holding jobs in Industry
 - a) Plymouth 50,500
 - b) London 1,491,400
 - c) Inverness 29,000

10. AREA ACTION; 'Country' RETURN 'England' RETURN;
FIND ACTION; 'Pollution' RETURN; ^7 (Most
prosecutions) ACTION ANALYSE ACTION RETRIEVE
ACTION UNIT ACTION ^area required ACTION
VALUES ACTION ^Manchester ACTION ^Birmingham
ACTION Most prosecutions

Manchester 13

Birmingham 13

Do exactly as above but look at category 6 (Most
complaints). Change to Incidence map as follows. CLASS
ACTION MANUAL ACTION. Move arrow to each part of
key and change colours to one colour except for highest
interval. Arrow to highest number on key ACTION '250'
ACTION REPLOT ACTION; Use UNIT and VALUES.
More than 250 complaints - Swindon, Birmingham,
Manchester, London. Most complaints made Cardiff area -
1089 complaints.

11. AREA ACTION; 'Country' RETURN; 'England' RETURN;
FIND ACTION; 'Weather' RETURN; ^18 ACTION
ANALYSE ACTION; RETRIEVE ACTION; VALUES
ACTION; UNIT ACTION; ^area required ACTION;

East Anglia 133mm

East of London 114mm

12. AREA ACTION; 'Local Education Authority' RETURN;
'Inner London Education Authority' RETURN; (or
'District' RETURN; 'Brent' RETURN;) FIND ACTION
'Ethnic Groups' RETURN; ^28 ACTION; ANALYSE
ACTION; RETRIEVE ACTION; VALUES ACTION;
^Croydon.ACTION; % of head of households born in the
New Commonwealth or Pakistan in Croydon is 8.33%.
(We have plotted local data and looked at Quantities in
order to get a better picture of the area in question.)
13. AREA ACTION; 'Local Education Authority' RETURN;
'Inner London Education Authority' RETURN; FIND
ACTION; 'Education' RETURN; ^1 ACTION; ANALYSE

ACTION; CLASS ACTION; MAIN ACTION; RETRIEVE ACTION; VALUES ACTION; ^various areas in the top interval ACTION % school leavers gaining no 'O' levels

Central London	21%
East London	25%

14. AREA ACTION; 'Country' RETURN; 'England' RETURN; FIND ACTION; 'Tourism' RETURN; ^20 ACTION; ANALYSE ACTION; CLASS ACTION; MAIN ACTION; RETRIEVE ACTION; VALUES ACTION; ^ around the map highest concentration of holiday camps is in North Wales and East Anglia.
15. AREA ACTION; 'Standard Region' RETURN; 'North' RETURN; FIND ACTION; 'Conservation' RETURN; ^16 ACTION; ANALYSE ACTION; RETRIEVE ACTION; UNIT ACTION; ^areas of outstanding beauty ACTION Areas of outstanding beauty in the North of England - South Kendal, North of Carlisle, North of Ashington.
16. AREA ACTION; 'Standard Region' RETURN; 'South East' RETURN; FIND ACTION; 'Private Schools' RETURN; ^16 ACTION; ANALYSE ACTION; CLASS ACTION; MANUAL ACTION; ^ each interval CHANGE; until all colours are the same except highest interval. ^number in highest interval ACTION; '20' RETURN; REPLOT ACTION; MAIN ACTION; MAIN ACTION; ^Red squares ACTION; RETRIEVE ACTION; towns with more than 20 private schools in the South East - S.W. of Worcester, West London, South London.
17. AREA ACTION; 'Standard Region' RETURN; 'South East' RETURN; FIND ACTION; 'Prisons' RETURN; ^18 ACTION; ANALYSE ACTION; CLASS ACTION; LOCAL ACTION; ^REPLOT ACTION; MAIN ACTION; RETRIEVE ACTION; UNIT ACTION; ^area required ACTION; VALUES ACTION; ^area required. Area with highest % of residents in Institutions = Mid Surrey 4.69%.

Super Profiles

For each of the next four questions AREA ACTION;
'Country' RETURN; 'England' RETURN; FIND ACTION;
'Super Profile' RETURN;

18. Group H ACTION; TEXT ACTION; MAIN ACTION;
ANALYSE ACTION; CLASS ACTION; MAIN ACTION;
RETRIEVE ACTION; VALUE ACTION; ^areas required
from map, highest % of people assigned to this group in
areas- South Coast, Midlands, North Wales.
19. ^Group E ACTION; TEXT ACTION; MAIN ACTION;
ANALYSE ACTION; CLASS ACTION; MAIN ACTION;
RETRIEVE ACTION; VALUES ACTION; ^areas required
from map smallest % of people assigned to this group in
areas: Manchester/Birmingham and East of England.
20. ^Group Y ACTION; ANALYSE ACTION; CLASS
ACTION; MANUAL ACTION; ^number in top interval
ACTION; '2' RETURN; REPLOT ACTION; More than 2%
population assigned to Group Y in Liverpool, Chester, East
Bourne, Brighton, Tameside, and Glossop.
21. ^Group P ACTION; ANALYSE ACTION; RETRIEVE
ACTION; VALUES ACTION; ^Plymouth ACTION; % of
people living in Plymouth who are assigned to this group =
3.64%

Mappable data further investigations

1. Is there a correlation between the % of school leavers with
5+ O-levels, and
 - (i) % social class 1 (professional)
 - (ii) % social class 5 (unskilled)in the Greater London area?

- (i) FIND Education
ITEM 4 'School Leavers - 5+ 0-levels'
AREA County, Greater London, 6km grid.
Bookmark.
FIND Social Class
ITEM 1 'Sc 1 Prof. Occs. by Wkplce.'
Correlate + 0.462 27 data points.
- (ii) Keep bookmark.
FIND Social Class
ITEM 6 'Sc. 5 Unskilled occs by Wkplce'
Correlate -0.543

Conclusions

- (i) only modest correlation, perhaps surprising, but refers to school leavers, i.e. those not staying on to do A levels.
- (ii) significant correlation against this group.

2. Repeat question 1. but change 5+ O-levels to University entrants

- (i) Find Education
ITEM 180 ' Number going to University'
AREA County, Greater London, 6km grid
Bookmark
FIND Social Class
ITEM 1 'Sc.1 Prof. Occs. by Wkplce.'
Correlate +0.548 27 Data points.
- (ii) Keep Bookmark
FIND Social Class
ITEM 6 'Sc 5 Unskilled occs. by Wkplce.'
Correlate not significant.

Conclusions

- (i) slightly higher figure than in Question1 (i).
- (ii) no conclusion can be drawn, possibly sample too small.

This investigation could be exploited further by clear examination of each of the social groups against 0-levels/5+ O-levels/University entrants, and a nation-wide sample. There seems to be enough data to draw out some interesting comparisons in a multi-dimensional way.

3. Is there a correlation between the number of young unemployed and
 - (i) the distribution of the Pakistani population in the E. Midlands.
·
 - (ii) the distribution of all school leavers with 5+ O-levels in E.Midlands.
 - (i) FIND Unemployment
ITEM 3 '% 16-24 Econ. Act. Ltu. April 1985'
AREA Standard Region East Midlands, 6km grid.
Bookmark
FIND Ethnic groups
ITEM 9 'Population New Commonwealth/Pakistan'
Correlate +0.517 157 data points.
 - (ii) Keep Bookmark
FIND Education
ITEM 4 'School Leavers - 5+ 0-levels'
Correlate -0.524 59 data points.

Conclusion

The Pakistani group also includes New Commonwealth, so broader than intended. 'Window' was not used (E. Mid, alone was too restricted) so region actually includes Central Midlands, North, and North East, but gives more representative data.

- (i) significant correlation Pakistanis and young unemployed.
- (ii) by contrast overall population of 5+ 0-levels significant negative correlation with unemployment.

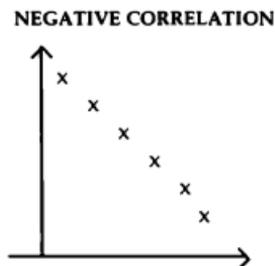
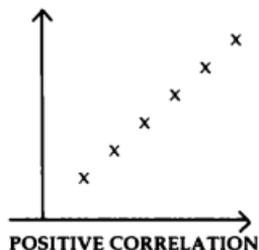
Correlation

The correlation coefficient that is calculated in all cases is Spearman's Rank Correlation Coefficient. As its title implies, the data for the two variables that are being compared are ranked in order and the differences between the ranks are examined using the formula:

$$r_s = 1 - \frac{6\sum d^2}{n(n^2-1)}$$

where d = the difference between the ranks
 n = sample size.

This formula will always give a value between +1 and -1. A value of +1 indicates a perfect positive correlation (i.e. no difference between the ranks) and a value of -1 indicates perfect negative correlation.



In practice, the value of Spearman's rank correlation coefficient will lie somewhere between +1 and -1 and tables (which can be found in most Statistics text books) are used to decide whether the correlation is significant or not, given the sample size.

Examples

1. AREA ACTION; 'Country' RETURN; 'England' RETURN;
FIND ACTION; 'Age' RETURN; ^74 ACTION; COMPARE
ACTION; CORRELATE ACTION; 'Very Old People'
RETURN;

We are going to see if there is any correlation between the % of Babies and Infants and the % of Very Old People living in an area.

The result we are given is -0.681 (64 data points). This indicates a strong negative correlation, i.e. the higher the % of Babies and Infants living in an area, the smaller the % of Very Old People living there.

2. AREA ACTION; 'Country' RETURN; 'England' RETURN;
FIND ACTION; 'Expenditure' RETURN; ^21 ACTION;
COMPARE ACTION; CORRELATE ACTION; 'Children'
RETURN;

In this case we are investigating whether there is any correlation between the Capital Expenditure on Public Transport and the % of the population that are children. We would, perhaps, expect the expenditure on Public Transport to be higher in areas where there are more children. However, this does not seem to be the case since the correlation is not significant.

We could also correlate Capital Expenditure on Public Transport with People with two cars. In this case, the value of $r = -0.429$ (52 data points) again indicating a fairly strong negative correlation. The more people there are with 2 cars, the lower the Capital Expenditure on Public Transport.

3. AREA ACTION; 'Country' RETURN; 'England' RETURN;
FIND ACTION; 'Traffic' RETURN; ^74 ACTION;
COMPARE ACTION; CORRELATE ACTION; 'All
Indust.:Male emp. 81' RETURN;

In this case we are looking at the volume of Heavy Goods Vehicles on the road together with the number of males employed in all industries in 1981 in each area. This gives a very high positive correlation [0.764 (54 data points)] indicating that the two variables are high in the same areas and vice versa.

Important considerations

Correlation does not imply causation. It has, for instance, been shown that there was a high positive correlation between the number of T.V. licenses issued and the number of crimes being committed. However, it is unlikely that greater T.V. viewing leads to more crime. It is more likely that other factors are causing both variables to increase, as is shown also in example 3 above. It is likely that more industry is located in areas of higher employment of males in industry which would perhaps cause higher volumes of heavy goods vehicles in these areas. The best that significant correlation can do is to suggest that there might be a connection between two variables.

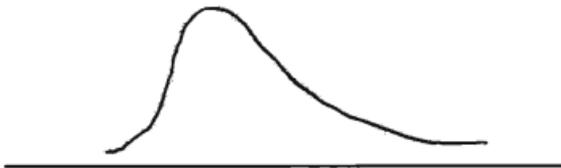
Inference to an untested area: it may be found when looking at a particular region, that there is significant correlation between two variables. We cannot, however, assume that this holds true for the whole country. There may be special factors in the smaller area which affect both variables, leading to the significant correlation.

Skewness of data

Before you look at this section, you should be conversant with the section on different types of class intervals that can be calculated for mappable data. This can be found on pages 195 — 200 of the Domesday Video Disc User Guide.

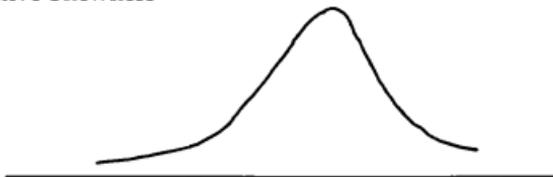
If distribution is precisely symmetrical, the mean and median will coincide. By contrast, when the distribution is asymmetrical and has a relatively long tail to the right (e.g. personal incomes) it is said to be positively skewed.

Positive Skewness



In a similar way a negatively skewed distribution has a relatively long tail to the left.

Negative Skewness



When a distribution is skewed, the median is usually a valuable measure of location. This is because it is unaffected, unlike the

mean, by a small number of particularly large (or small) data values, i.e. outliers which could be judged as not being very important in assessing the general location of the distribution. For example, the median income of employed persons in a town will usually tell more about that town's prosperity than giving the mean income.

This suggests that the use of quantiles is important when looking at skewed data. If much of the data lies to the left of the mean but there is a very long tail to the right (or vice versa), the use of equal intervals will simply take the range of the distribution and split it into 5 equal length intervals; this would lead to most of the data falling into the first interval (or the last if the data is negatively skewed).

Examples

1. AREA ACTION; 'Country' RETURN; 'England' RETURN; FIND ACTION; "Total Income" ACTION; (Total by area of Peoples Income). Replot the map using equal intervals, nested intervals, quantiles.

Looking at the key in each case:

(a) Equal	< 26,495,000	105,980,000 >
(b) Quantiles	< 4,676,000	16,620,000 >
(c) Nested	< 6,361,000	35,125,000 >

When the map is plotted using equal intervals nearly all the map falls into the < 26,495,000 interval. The only real information that the use of Equal intervals has given us is that the range lies between £0 and £132,475,000. However, if we look at the map after it has been replotted using quantiles to calculate the class intervals, it can be seen from the key that the total income in 20% of the areas is less than £4,676,000 etc. We can also get some idea of the 'average' total income in each area by looking at the 40-60% quantile. Nested intervals can also be used to even out the skewness since the presence of a few very

high values will not affect the boundary for the first group and vice versa. It has perhaps one advantage over the use of quantiles in that it gives a better indication of the range of the data.

N.B. Do not assume from this data that the highest incomes are earned by the people living in Birmingham or any of the other areas which lie in the top interval on the Equal interval maps. Since we are looking at Total income by area of people incomes we would need to also look at the population of each area.

2. AREA ACTION; 'Country' RETURN; 'England' RETURN; FIND ACTION; 'Unemployment' RETURN; 33 ACTION; Number of 16-24 year olds registered as unemployed in April 1985.

Looking at the key in each case:

(a) Equal	< 28,910	56,814	84,717	112,621 >
(b) Quantiles	< 6,694	8,580	11,429	22,050 >
(c) Nested	< 8,417	18,228	41,466	>

Again, the data are positively skewed. From the map using equal intervals, all but the London, Birmingham, Manchester and the North West areas lie in the first interval. Indeed from the map drawn using Quantiles we can see that in 80% of the areas < 22,050 16-24 year olds were registered as unemployed.

3. AREA ACTION; 'County' RETURN; 'Greater London' RETURN; FIND ACTION; 'Actual Rateable Value' RETURN; Change the RESOLUTION to 1km squares. Use LOCAL data.

Looking at the map plotted using EQUAL intervals, we can see the areas of very high actual rateable values. Using RETRIEVE UNIT and VALUE the areas of highest rateable value can be picked out, i.e. City of London £44,070 and City of Westminster £17,33. Using LOCAL and QUANTILES it can be seen that 80%

of the areas within Greater London have rateable values $< \pounds 230$.

In this case the use of nested intervals shows very clearly the way in which rateable value falls as we move out from Inner London in an almost uniform way, i.e. there are circular belts.

After each use of LOCAL and EQUAL, LOCAL and QUANTILES, and LOCAL and EQUAL, select WINDOW to remove the areas surrounding Greater London.

This example shows how all three types of interval calculation can be used to gain information about actual rateable value in a particular area. The data in this case was extremely skewed with very high outlying values.

Skewed data worksheet

1. Look at the number of 'Residents aged 0-4 years per 100 Residents' and use EQUAL Intervals and QUANTILES to discuss the data shown.
2. Look at the number of economically active married females per 100 married female residents and use the different maps plotted using EQUAL and NESTED intervals and QUANTILES to discuss the regional differences and the range of the data values.
3. Find some more data examples of skewed data, negatively skewed in particular if you can.
4. Find some data which come from a symmetrical distribution, i.e. the class intervals calculated using EQUAL intervals and QUANTILES will be very similar.

Index numbers worksheet

Find three examples of the use of Index Numbers. State the base period used in each case and comment on the changes that have taken place over time.

Index numbers teachers' notes

The use of index numbers in statistical work has become extremely important. It is a convenient method of showing comparisons of a variable or variables over a period of time. An index number measures the relative changes so that the figures in each period are expressed as a percentage of the figure for one particular period, termed the base period. In this way we can clearly see whether there has been an increase or a decrease. If the figures have risen compared with the base period the percentage will be greater than 100; if they have fallen with time, this will be shown by a percentage value of less than 100.

If we change the base period we would obtain a different series of index numbers, so it is absolutely essential to state what the base period is whenever an index number is quoted. When calculating a set of index numbers we have to choose a suitable base period. A base period should be one during which the conditions are as 'normal' as possible since all future comparisons are going to be made relative to that period. A time of instability in the general economic situation would not be suitable. With most official U.K. index numbers such as the Retail Price Index and the Index of Industrial Production, the base period is brought up-to-date at fairly frequent intervals.

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BBC ENTERPRISES LIMITED
WOODLANDS 80 WOOD LANE
LONDON W12 ENGLAND

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