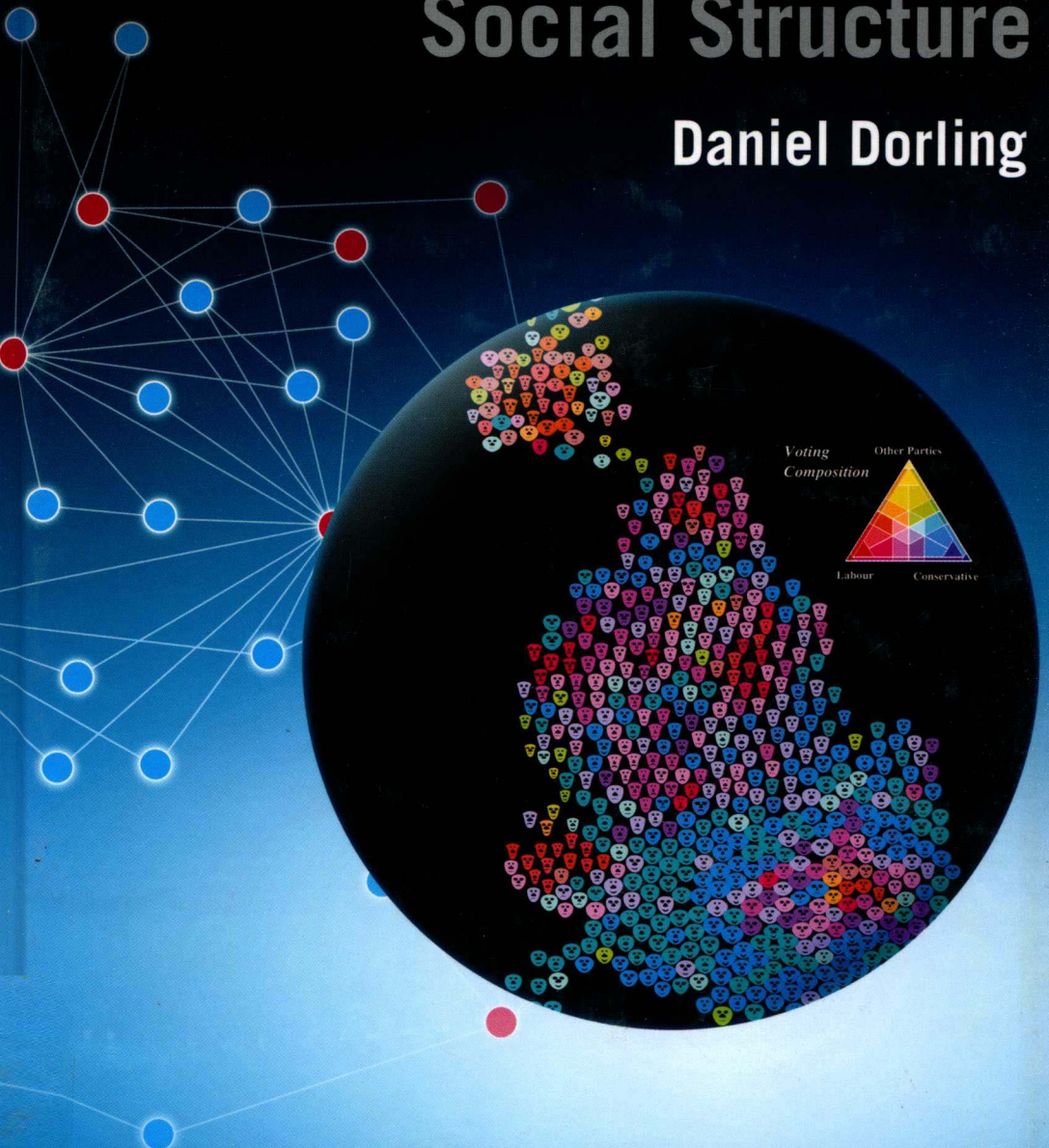


 WILEY

# The Visualization of Spatial Social Structure

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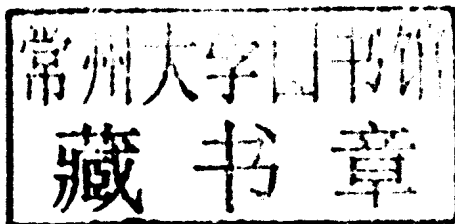


WILEY SERIES IN COMPUTATIONAL  
AND QUANTITATIVE SOCIAL SCIENCE

# The Visualization of Spatial Social Structure

**Daniel Dorling**

*Department of Geography, University of Sheffield, UK*



 **WILEY**

A John Wiley & Sons, Ltd., Publication

This edition first published 2012  
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John Wiley & Sons Ltd, The Atrium, Southern Gate, Chichester, West Sussex, PO19 8SQ, United Kingdom

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*Library of Congress Cataloging-in-Publication Data*

Dorling, Daniel.

The visualization of spatial social structure / Daniel Dorling.

p. cm.

Includes bibliographical references and index.

ISBN 978-1-119-96293-9 (cloth)

1. Human geography--Great Britain. 2. Cartography--Methodology. 3. Cartography--Philosophy. I. Title.

GF551.D674 2005

304.2072'8--dc23

2012009924

A catalogue record for this book is available from the British Library.

ISBN: 978-1-119-96293-9

Typeset in 10/12pt Times by Laserwords Private Limited, Chennai, India  
Printed and bound in Singapore by Markono Print Media Pte Ltd

# Preface

This book tells a story about seeing things differently. The story is a way of introducing the reader to new ways of thinking about how to look at social statistics, particularly those about people in places.

The visualization of spatial social structure means, literally, trying to make visible the geographical patterns to the way our lives have come to be socially organised, seeing the geography in society. To a statistical readership visualization implies using data. More widely defined it implies freeing our imaginations.

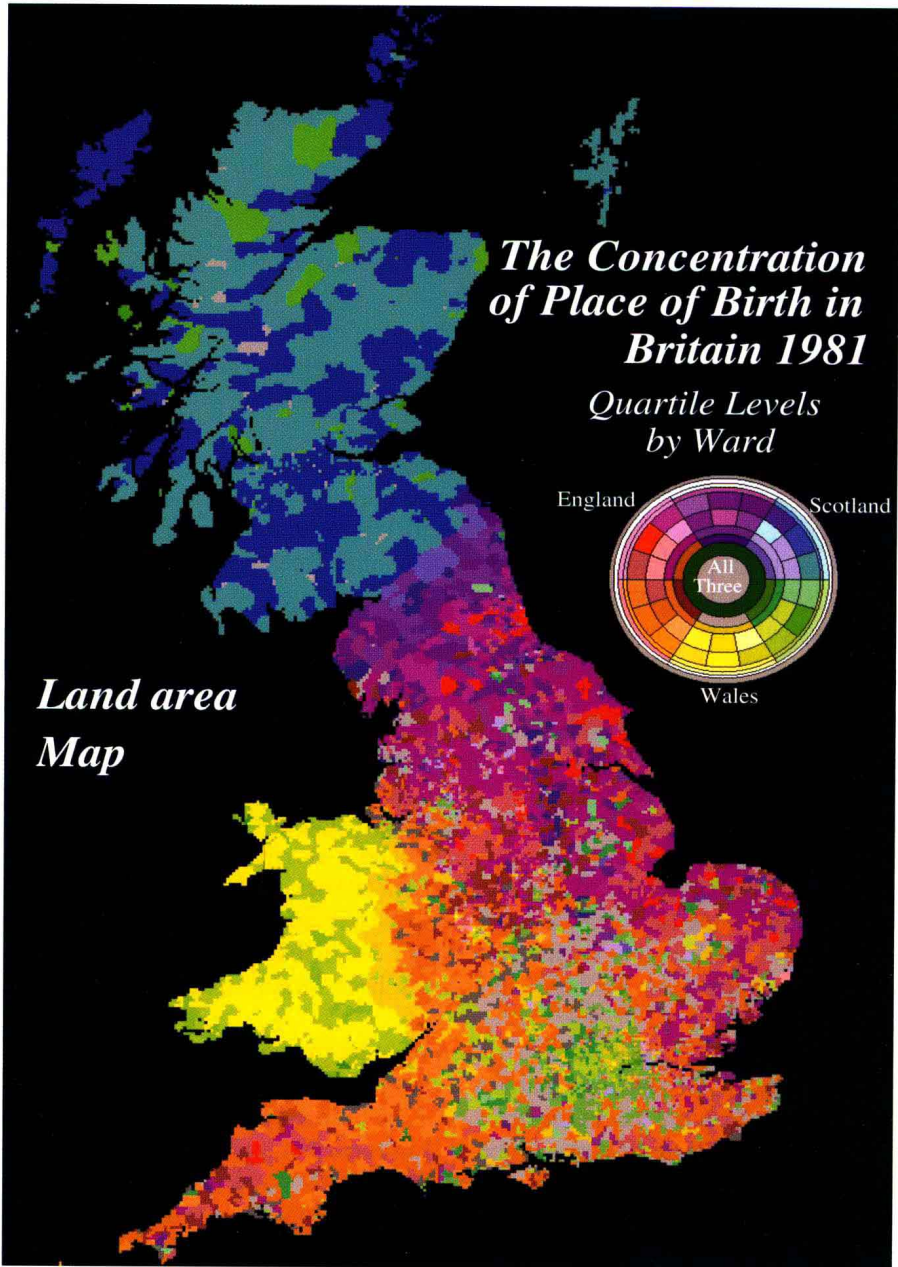
The story of this book centres on a particular place and time, 1980s Britain, and a particular set of records, routine social statistics. A great deal of information about the 1980s social geography of Britain is contained within databases such as the population censuses, surveys and administrative data. During the 1980s computer graphics developed and, to comprehend the information they held, a few social scientists thought it needed to be effectively visualized with computer graphics (Figure P.1).

In the United States a small but significant number of geographers in the 1960s<sup>1</sup> argued that conventional maps contained a massive and unwanted distortion, but a growing number in the social sciences back in the 1970s then thought that anything numerical was in some way suspicious and could de-humanise inquiry. This work builds on listening to the latter, but also on developing the techniques of the former group, which have been largely ignored in the 1990s and the 2000s.

Mapping, by the late 1980s, had been rejected by many social analysts as an unsuitable means of showing spatial social structure. The usual alternative was, and remains, to write in the abstract on social structure and rarely to employ graphics or maps or to rely on numbers. However, that wastes a huge amount of information and the skills of many more numerically minded people who might also be interested in uncovering the social organisation of the world they live in.

A human cartography is proposed here that reveals, through amalgamating and subdividing the events of people's lives, the shape of society (Figure P.2). The aim here is to see the whole, in as much detail as possible, at a glance. While the case study is 1980s Britain, the geography of Thatcherism, the applicability of these techniques is hopefully far wider. The areas studied could be far smaller

<sup>1</sup> The work of one was recently republished (Bunge, 2011).



*Figure P.1 In the 1980s ward data might be put on a grid of small squares as shown here. Each ward is coloured by the proportions of people born in each of the three main countries of Britain, but who are now living in that ward. The mixing of colours suggests the outcome of lifetime migration patterns. However, the map is misleading, overemphasising mixing in remoter rural areas.*

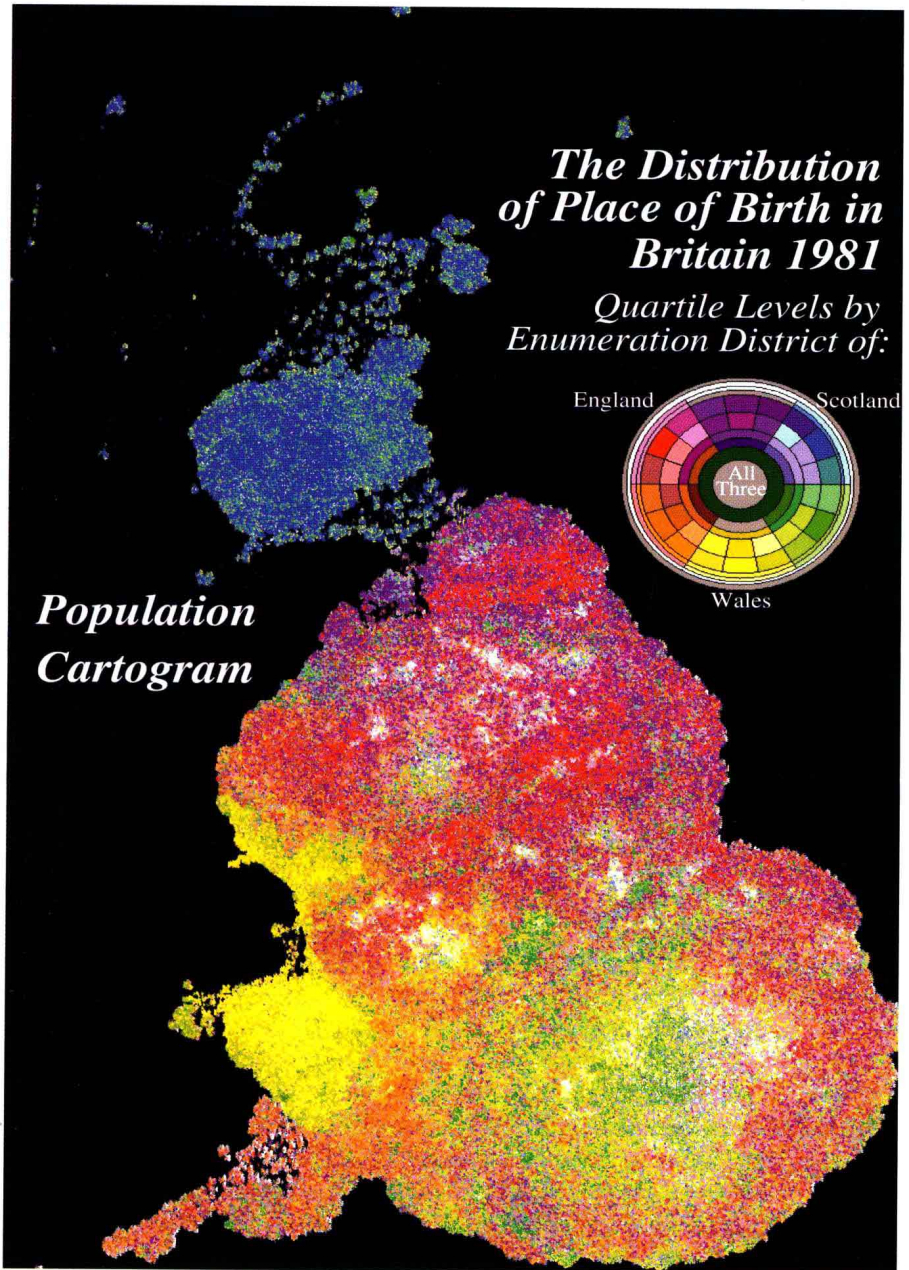


Figure P.2 This population cartogram shows the mix of people by birthplace in 129 211 small areas of similar population size. All are visible. On the previous map even most wards are invisible. Here it is clear that neighbourhoods were not mixed in much of urban Scotland and Wales. Areas coloured white – where more people are born overseas – can now be seen.

than an island like Britain, or larger. Revealed here is the society inherited by Margaret Thatcher's government in 1979 and how that society had been changed by 1990, the year of her forced resignation.

These same techniques could be applied to visualize a state like California from when it was dreaming in 1965 to when it was potentially bankrupt in 2012. The more human focused forms of cartography proposed here include new ways of looking at the geography and social statistics of places as large as India, as remote as Anchorage or even as tiny as number 29 Acacia Avenue.

The illustrations included here are what is core to this work. They include pictures of the distribution of age, sex, birthplace and occupation across Britain in 1981, changes in these from 1971, unemployment and house price dynamics throughout the 1980s boom and 1989 bust, general election results from 1955 to 1987 (followed by all local election voting from 1987 to 1990), visual summaries of migration flows from one part of the country to another and drawings of thousands of daily commuting streams (Figure P.3).

The creation of simple computer generated cartograms is explained, where each spatial unit (up to one hundred thousand to a page) is drawn with its area proportional to the number of people who live there. Colour and complex symbols are used to study several factors simultaneously upon these cartogram bases, to let the analyst compare different datasets at the same time, for what they show about the same places.

Novel visually effective means of showing millions of flows and other changes over time are also developed (Figure P.4). Further advances are imagined and travel time surfaces are described, through which tunnels are cut and over which other information can be draped. A case study of the distribution of childhood leukaemia in space and time is undertaken, showing a pattern of no pattern<sup>2</sup> (Figure P.5). The detailed results of the ten general elections up to Margaret Thatcher's last victory, of 1987, are compared. Revealing images of the beginnings of how Britain came to be set on the path to growing polarisation is a theme that runs throughout.

Essentially, however, this is a book about graphical techniques, not about social history, epidemiological analysis or political study. Twenty years ago almost no visualization software existed. To draw a map required writing a computer program. This meant you could draw a map in many different ways. Today software has become sufficiently versatile that, without needing to program, it might *again* be possible to produce the kind of images you might want to produce, rather than those you might get from the default options.

This book is about a spatial way of thinking of the structure of society – of social structure – and how you might draw what it is you are thinking of, if you think of it in a particular way. Although it uses examples from the past, the focus

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<sup>2</sup> This is a lack of clustering later confirmed in numerous studies with access to many more years of data. In May 2011 '... there is no evidence to support the view that there is an increased risk of childhood leukaemia and other cancers in the vicinity of NPPs (Nuclear Power Plants) in Great Britain' (Elliott, 2011, p. 102).

here is on technique, not subject. However, the particular past is of great interest to some (including this author who cannot resist making asides as a result). Prior to 2011, the 1980s were the last time Britain faced mass unemployment, rapidly growing social divisions or widespread rioting.

This text describes the rationale for, and development of, a new way of visualizing information in geographical research (Figure P.6). Through the pictures the methods are illustrated and mistakes, techniques and discoveries shown. From the footnotes, which are largely quotations from a disparate literature, the origins of many of the ideas can be found. Time and again it was the suggestions of others to move in these directions.

Through technical asides some of the practical realities of the work are described. Through the illustrations and their captions, a picture of what had been happening to Britain in those recession years unfolds. Many of the pictures could justify an extended discussion, but the commentary is kept brief. Little detail is included about the computer software written and used here because much of that is dependent on the novel (but inexpensive) Acorn hardware configuration and progress is so rapid that such knowledge is of only transient value.<sup>3</sup>

The images in this book reveal how in aggregate people get to work and the structure of the towns and cities in which they live is examined. Migration (moving home) is studied here in several ways. The changing patterns of migration from birthplaces are shown and the streams of movement that cut across the country are drawn in unprecedented, and as yet not superseded, detail.

House price change is visualized across several years and thousands of places. This detail reveals that the origins of the 1989 crash lay years earlier in the heart of the London housing market. Other new techniques are developed to show the structure of local housing markets. Through different methods again, the changes in this country's industrial structure are seen as they have affected people in actual communities.

Figure P.7 shows a simplified version of a more complex chart of industrial change in which just eight industrial groups are shown, but also how those groups of employment altered for men and women, and for full- and part-time workers separately in 1981, 1984, 1987 and between each consequent pair of survey years.

This single small collection of five glyphs suggests that male full-time manufacturing job losses in the early 1980s were not quite replaced by female full- and part-time work, mostly in service industries, mostly later on in the 1980s. A lot can be shown in just a few simple images.

The spatial and social manoeuvring of political allegiances is viewed from several angles over the same period and the relationships discussed. Finally, a smaller scale of analysis is considered, looking at what many images can tell us about the distribution of a disease, viewed from many different directions in space and time.

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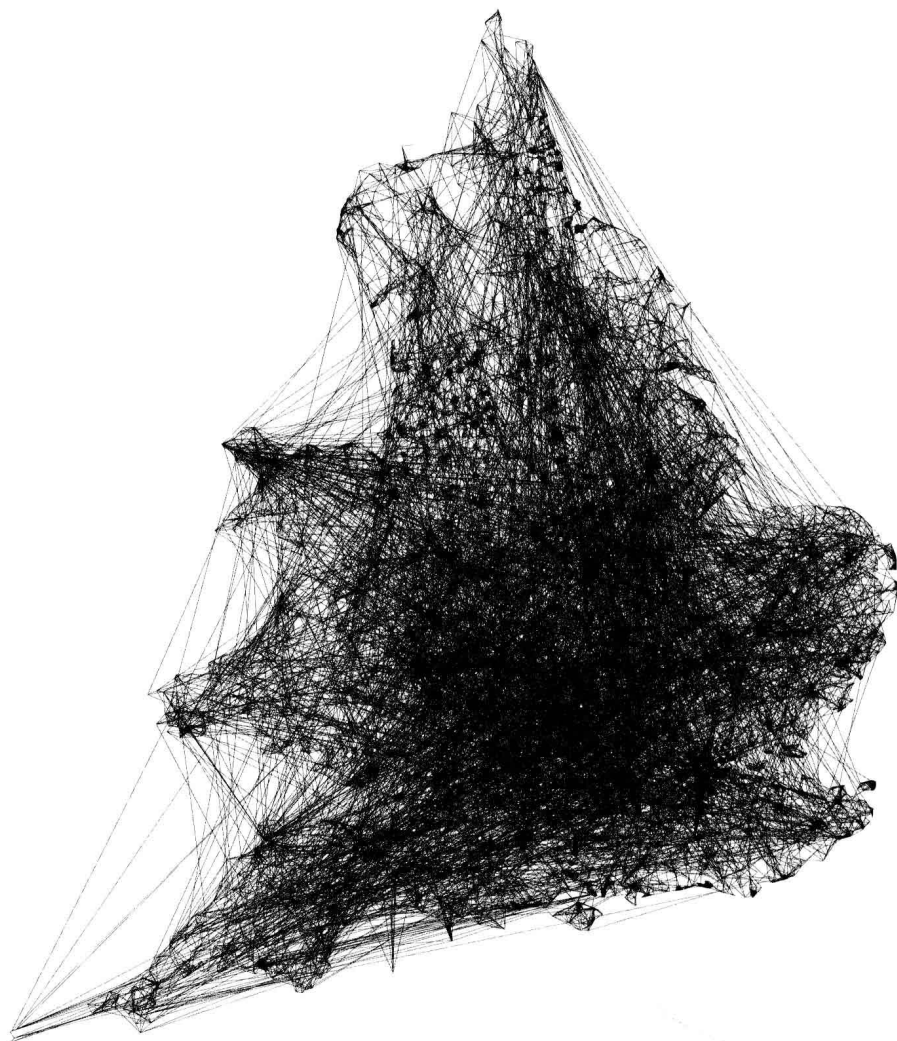
<sup>3</sup> An Acorn Archimedes computer was used, produced by the company known as the 'British Apple', which existed for twenty years from 1978 to 1998. See the endnote to this book for more details.



***Yearly Migration Flows  
Between English and  
Welsh Wards 1980/1981.***

*32% of all migrants included  
1,352,520 people.*

*Flows of more than 0.2% of the geometric  
mean for the resident populations of the  
areas of origin and destination are drawn  
as thin lines, shown on an  
land area map.*

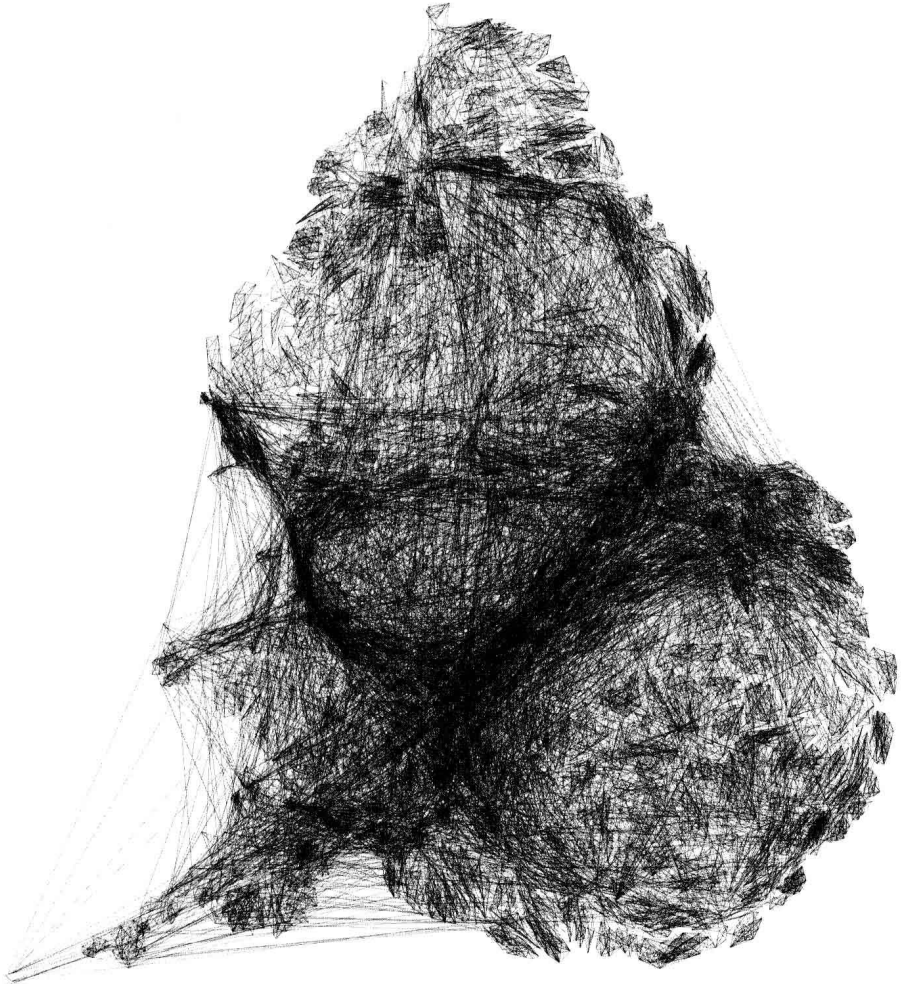


*Figure P.3 Each line represents a minimal number of moves made between wards in England and Wales in one year on a conventional land area map. The interward migration patterns show a complete tangle of lines. The Isle of Wight can be made out, as can the outlines of some towns and cities, but in general areas towards the centre of England simply become mostly criss-crossed.*

***Yearly Migration Flows  
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areas of origin and destination are drawn  
as thin lines, shown on a  
**population cartogram.***



*Figure P.4 On the cartogram the bundles of migratory flows take the shape of London boroughs and other areas from which council house tenants have found it difficult to move in the past. The more prosperous areas of the country are blackened by the density of flows in and through them. The shape of the conurbations is clear, as people who can avoid living there migrate around them.*

# *Selected Frames from an Animation of the Spacetime Distribution of Childhood Leukaemia*

Across the North of England from 1967 to 1987, upon an equal land area projection

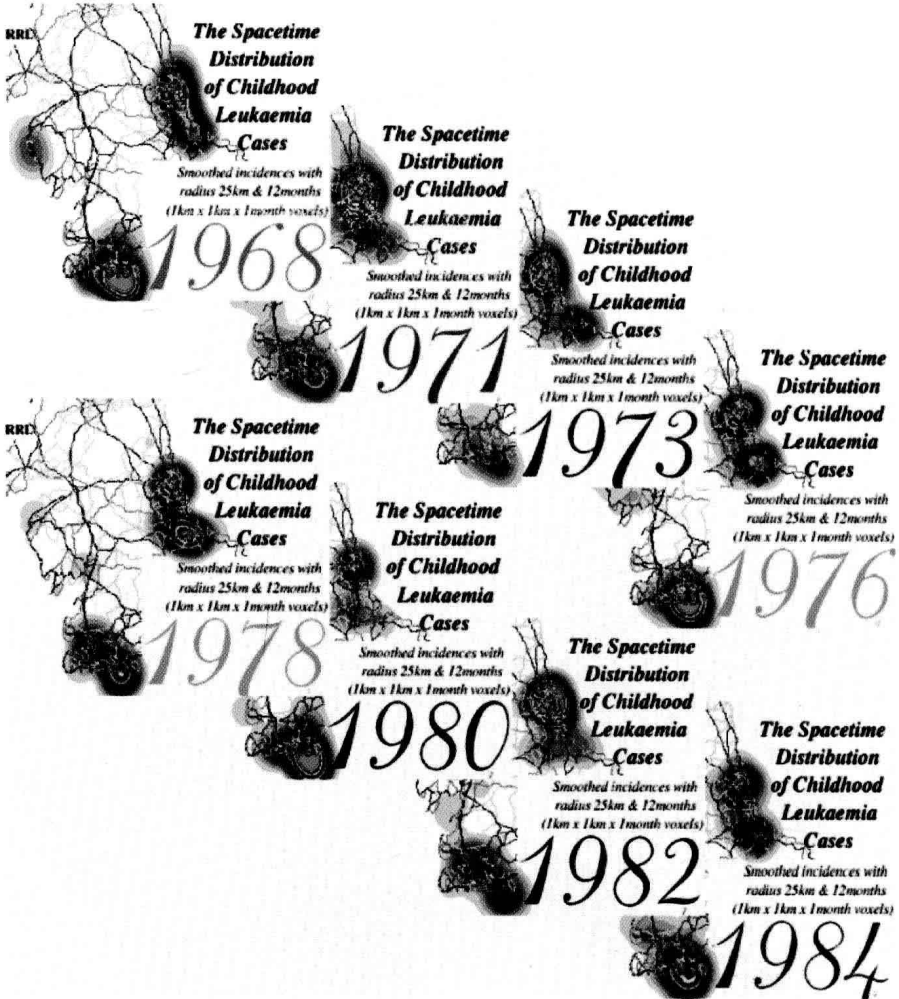


Figure P.5 These eight frames are taken from an animation of the changing concentration of cases of childhood leukaemia (where time is the moving third dimension). They define a volume within which rates are estimated and smoothed. Although it appears there is clustering, the methods used tend to find the areas of highest population density when the base is a land area map. Note: parts of original image were produced as a bit-map of pixels of colour not as a vector graphics file of lines, curves and areas.

*Selected Frames from  
an Animation of the  
Spacetime Distribution  
of Childhood Leukaemia*

Across the North of England  
from 1967 to 1987, using  
population space.

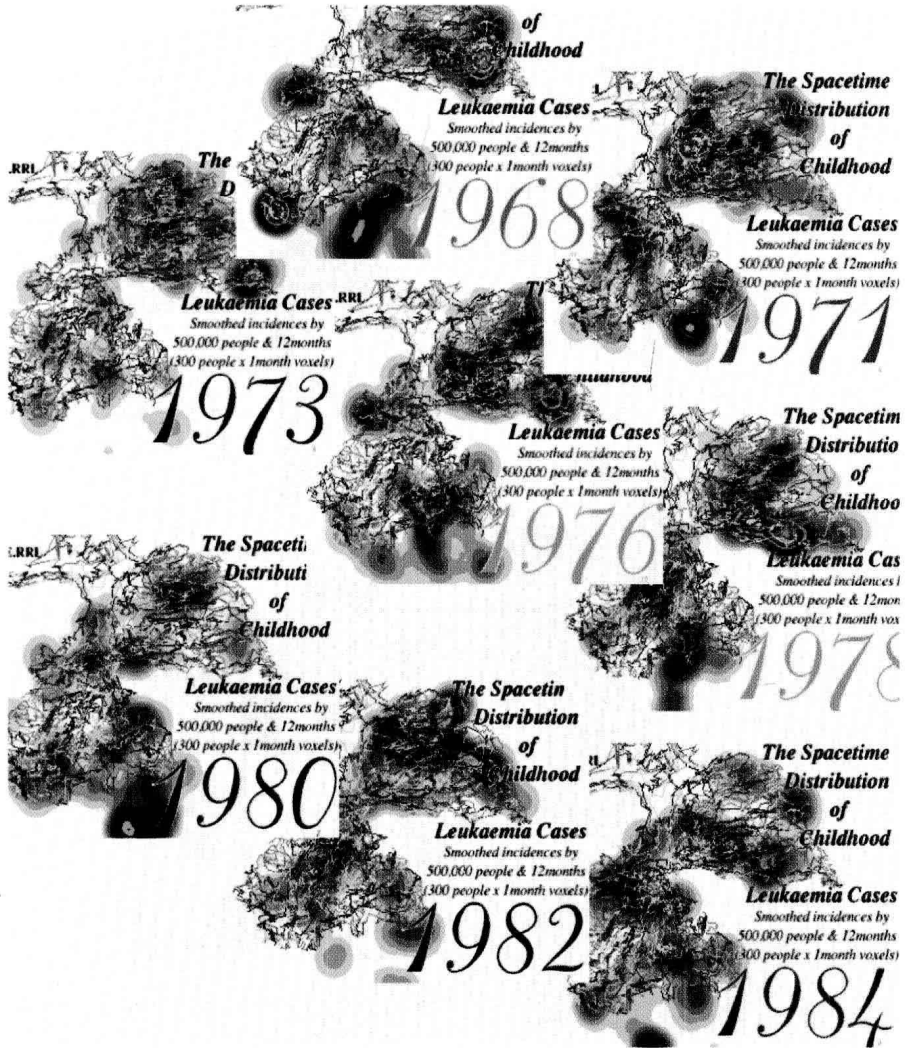
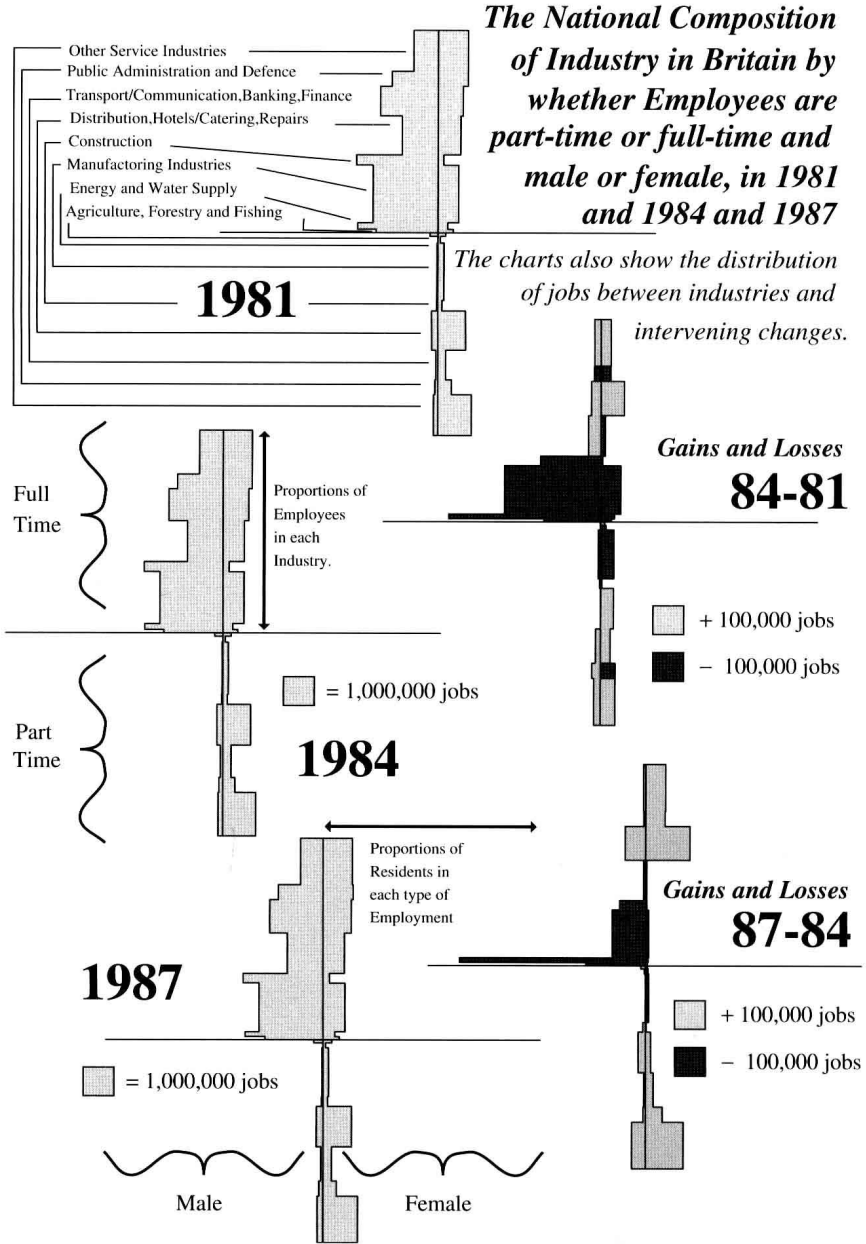
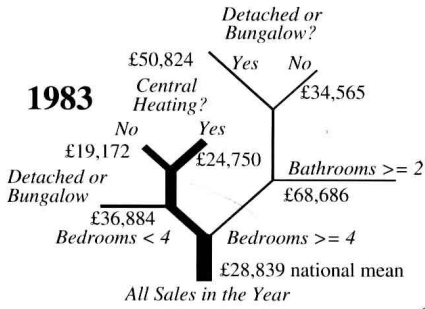


Figure P.6 These eight frames are taken from an animation of the changing concentration of cases of childhood leukaemia over equal population sized areas defining life volumes within which rates are estimated and smoothed. Although it still appears there is clustering the methods used would draw apparent but forever moving concentrations, even from randomly generated data.



*Figure P.7 In the 1980s it was common to aggregate banking and finance with the communication and transport industries as these were all seen as facilitating other work, not as profit-making centres in their own right. Note how so many more jobs were lost in the first period of the 1980s, 1981–1984, as compared to the second period, 1984–1987.*



## The National Composition of Housing Price in Britain by Price, Attributes and Sales, 1983-1989 annually.

Each branch of the housing composition tree represents homes with a particular set of attributes. The width of each branch is in proportion to the number of sales, its length gives the mean price, thus area shows total sales. Dark trees are the inflation between years (magnified by 25). The overall size of each tree illustrates the total size of the housing market (given in millions of pounds).

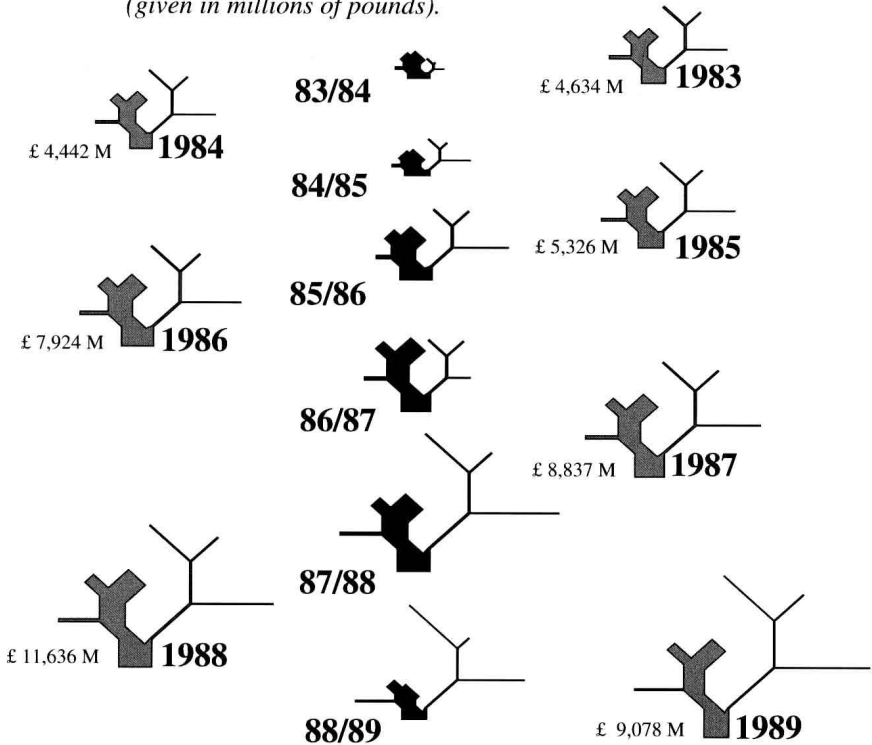


Figure P.8 In these glyphs, the housing market is divided into a number of branches, the branches join to show bigger sectors and the trunk represents the whole housing market. The shape of the resultant trees shows the housing market structure. Here the national shapes are shown. Inflation causes the length of a branch to increase and fewer sales in a sector cause the branch to become thinner.

These social and political subjects are not each arranged in their own, individual chapters, but run through the book, as it is a book about new possible methods of visualization rather than the visualization of subjects. The rationale for using images to study people, places and spaces is discussed as the new images are introduced.

The central part of the book looks at what appears to be a honeycomb structure formed by a particular method of viewing the spatial patterns of society at single points in time and how that image alters through transforming the envisioned mosaic. The cobweb of flows that is responsible for most of the changes and stability is then drawn.

The last part of this book attempts to show more complex aspects on the surface of social landscapes. Sculptured symbols allow us to see the relationships between the wood and the trees of social structure (Figure P.8). Finally, a three-dimensional volume visualization of geographical and historical social structure, of spacetime, is attempted. The book concludes by describing how all these methods and insights can, when brought together, create a new statistical view of human geography and recent history.

Visualization in the social sciences demands that we consider what is happening in many places at the same time. We do not need to study aspects of the world out of context. Here, an attempt is made to cover much ground and show numerous relationships. To do this it is necessary to be brief in detail and to be broad in scope, so the pictures often have to speak for themselves. Only once you have seen what it is you want to talk about can you then better ask questions and make interpretations.<sup>4</sup>

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<sup>4</sup> 'The analytic power to order data has potential equally for control or liberation. It is all a matter of questions asked and interpretations made' (Taylor, 1991, p. 30).

# Introduction: Human cartography

*Images are only images. But if they are numerous, repeated, identical, they cannot all be wrong. They show us that in a varied universe, forms and performances can be similar: there are towns, routes, states, patterns . . . which in spite of everything resemble each other.*

*(Braudel, 1979, p. 133)*

This book presents the thesis that light can be cast on the study of society through the visualization of social structure. The antecedents of the work presented here lie most firmly in human geography and cartography while being influenced by writings in other disciplines. There are contributions from studies in computer and statistical graphics, graphic design and art, mathematical abstraction (Figure I.1) and political science.<sup>1</sup>

Particular views on the study of history, geography and sociology guide much of the writing. Above all, this book is concerned with designing and advocating new ways of seeing the social world we live in. Before doing that, it is necessary to explain why still widely accepted graphical techniques are being discarded by the visual methodology proposed here. Most important of all, in order to show the spatial structure of society the conventional use of maps of physical geography has to be rejected.

Maps were designed to explore new territories and fight over old ones. They show where oceans lie and rivers run. Their projections are calculated to aid navigation by compass or depict the quantity of land under crops (Figure I.2). They are a flat representation of part of the surface of the globe; they show things that often cannot be seen. How then can we see social structure, in the same manner as the map opens up land to the eye?<sup>2</sup> How can we begin to see

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<sup>1</sup> See Muehrcke (1978, 1981), Szegö (1984, 1987), Anderson (1988) and Cuff (1989).

<sup>2</sup> The advantage of maps is simple – they provide context: ‘Maps frown upon the isolation of single items. They preserve the continuity of the real world. They show things in their surroundings and therefore call for more active discernment on the part of the user, who is offered more than he came for; but the user is also being taught how to look at things intelligently. One aspect of looking at things intelligently is to look at them in context’ (Arnheim, 1976, p. 5).





*Figure I.1* Convergence of  $z := z^2 + c$  on the complex plane. The Mandelbrot set exhibits infinite variations on the same visual theme. Every picture is familiar, but all are subtly different. As you magnify the image, the detail and variation is as great at every level. In human geography the same degree of diversity can often be recognised on a local scale, as can be seen nationally.