Practical I: An Introduction to GIS and Geographic Information Sources

A: An Introduction to GIS

- What is GIS?
- Why is GIS unique?
- Why use GIS?
- Key Definitions
- The nature of spatial data
- How does a GIS work?
- Layers and vectors
- Relationship of world to GIS
- GIS and mapping applications
- Key stages in using a GIS
- GIS analysis functions

B: Geographic Information Sources

- Spatial data
- Geocoding data
- Attribute data
- Exercise – searching for spatially-referenced attribute data

What is GIS?

- "a system for capturing, storing, checking, integrating, manipulating analysing and displaying data which are spatially referenced to the Earth" *(DoE, 1987)*
- "[GIS are] computerised systems for the ***integrated*** handling of spatially-related data" (Mather, 1991)
- "GIS rests on the assumption that different kinds of spatial data have common structure, and are processed in similar ways, and that there is consequently value in creating common spatial data handling and processing systems" *(Goodchild, 1995)*
- " GIS is a powerful set of tools for collecting, storing, retrieving at will, transforming and displaying spatial data from the real world for a particular set of purposes" (Burrough and McDonnell, 1998)

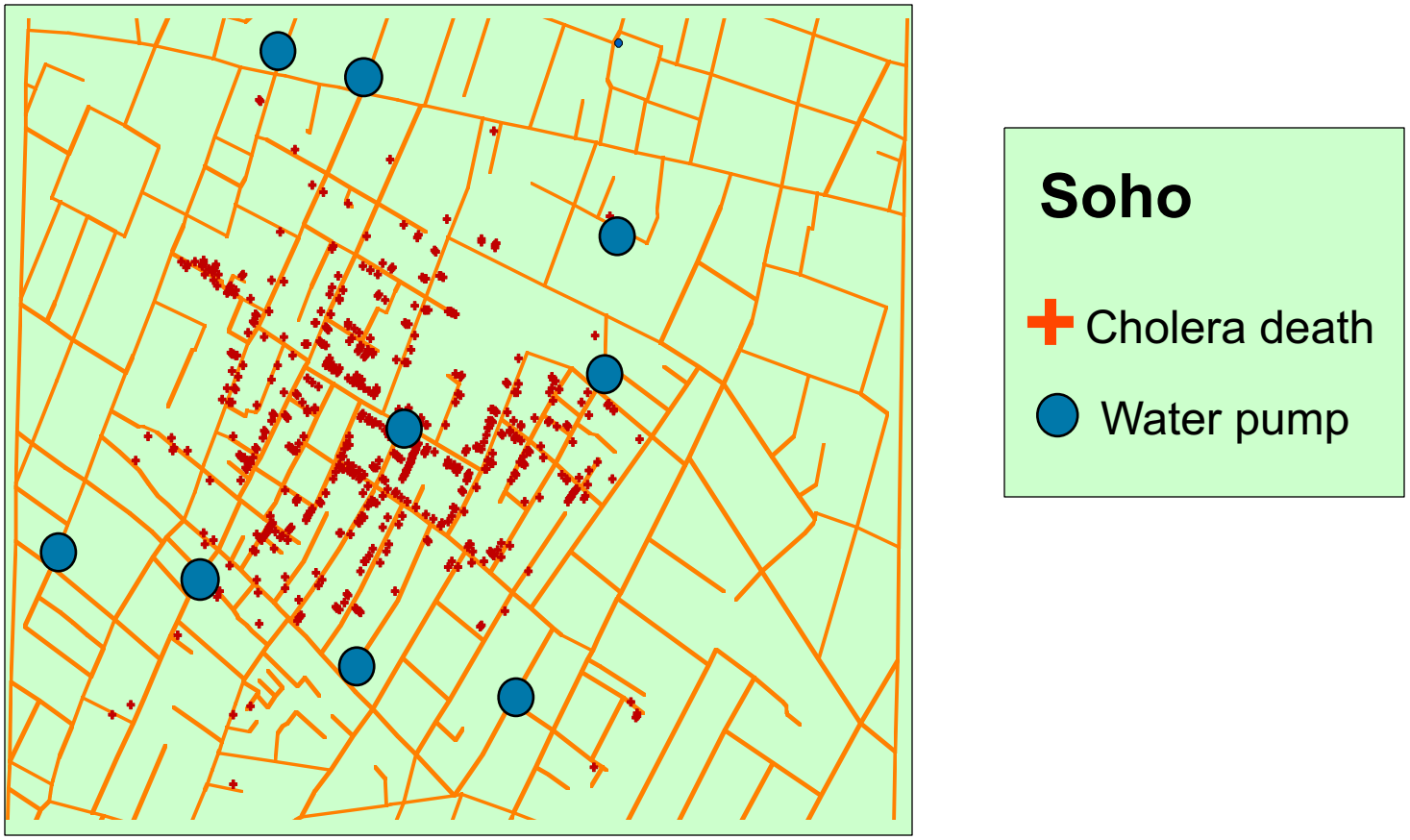
Why is GIS unique?

- GIS handles SPATIAL information
  - Information referenced by its location in space

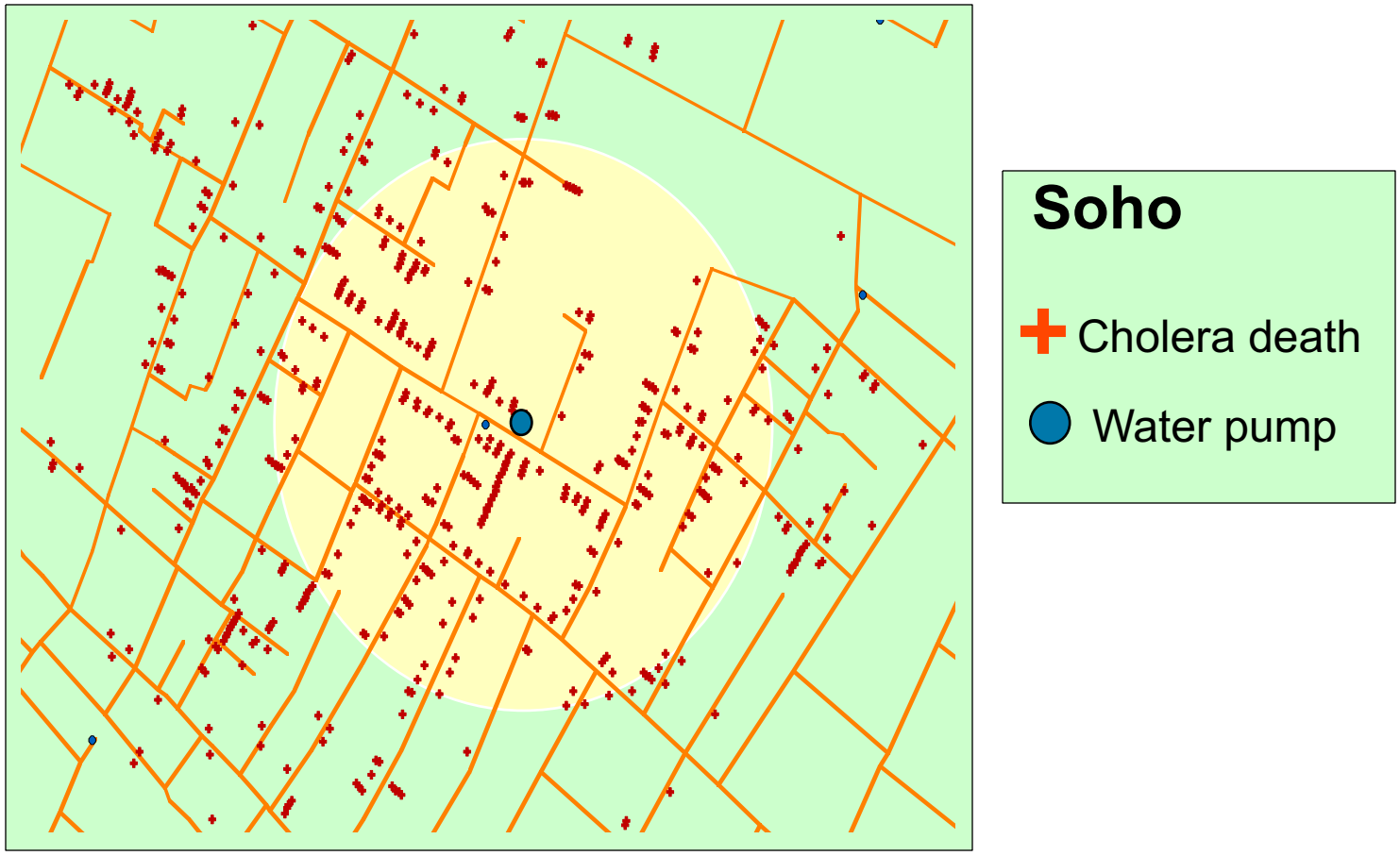
- GIS makes connections between activities based on spatial proximity

GIS concepts are not new!

- London cholera epidemic 1854



Spatial information handling 1854



Why use GIS?

- "A GIS links **spatial data** with geographic information about a particular **feature** on a map. The information is stored as **attributes** of the graphically represented **feature**."

ESRI 1992

- "With GIS it is possible to map, model, query, and analyse large quantities of data all held together within a single database."

The Geographer's Craft, 1992

Key definitions

- spatial data
  - data that can be linked in geographic space to some feature on a map
  - has both a spatial (*where*) and an attribute (*what*) component
- feature
  - a single entity that comprises part of a landscape which can be represented as a point, line or polygon
- attribute
  - a characteristic of a feature that contains a measurement or value for the feature - a column in a data file

Spatial data: Are these spatial data?

Recent World Earthquake Report

Date (UTC)	Lat.	Long.	Depth (km)	Mag.	Description
99/10/05 17:58:39	39.12	71.70	33.0	**5.0**	TAJIKISTAN
99/10/05 00:53:30	36.79	28.03	33.0	**5.3**	DODECANESE ISLANDS
99/10/03 13:19:14	38.58	48.93	33.0	**4.5**	ARMENIA-AZERBAIJAN-IRAN BORD
99/09/29 15:57:00	26.52	53.56	33.0	**4.5**	SOUTHERN IRAN
99/09/29 00:13:06	40.59	29.31	10.0	**5.0**	TURKEY
99/09/27 02:31:24	28.58	51.33	33.0	**4.7**	SOUTHERN IRAN
99/09/25 20:46:30	37.96	23.69	10.0	**4.1**	SOUTHERN GREECE
99/09/25 19:19:30	28.70	51.21	33.0	**5.2**	SOUTHERN IRAN
99/09/25 09:56:24	29.37	51.77	33.0	**4.5**	SOUTHERN IRAN
99/09/24 19:17:14	28.58	51.43	33.0	**5.1**	SOUTHERN IRAN
99/09/24 01:29:00	37.08	71.44	109.3	**4.5**	AFGHAN-TAJIKISTAN BORD REG.
99/09/23 16:36:42	38.15	23.47	10.0	**4.3**	GREECE
99/09/23 12:45:16	42.32	84.49	33.0	**4.9**	NORTHERN XINJIANG, CHINA
99/09/20 21:27:59	40.59	28.00	10.0	**4.5**	TURKEY
99/09/20 21:27:59	40.70	27.62	10.0	**4.5**	TURKEY
99/09/19 16:46:59	43.07	46.82	33.0	**4.8**	EASTERN CAUCASUS
99/09/18 00:48:24	40.67	28.93	10.0	**4.5**	TURKEY
99/09/17 20:14:47	29.03	52.49	33.0	**4.5**	SOUTHERN IRAN
99/09/14 15:47:25	39.84	15.30	298.1	**4.7**	SOUTHERN ITALY
99/09/13 23:32:07	31.94	50.58	33.0	**4.7**	NORTHERN IRAN
99/09/13 11:55:28	40.74	30.03	10.0	**5.8**	TURKEY

Source: www.esri.com

Of course!

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99/09/25 19:19					OUTHER
99/09/25 09:56					OUTHER
99/09/24 19:17					OUTHER
99/09/24 01:29					FGHAN-TAJIKISTAN BORD REG.
99/09/23 16:36					REECE
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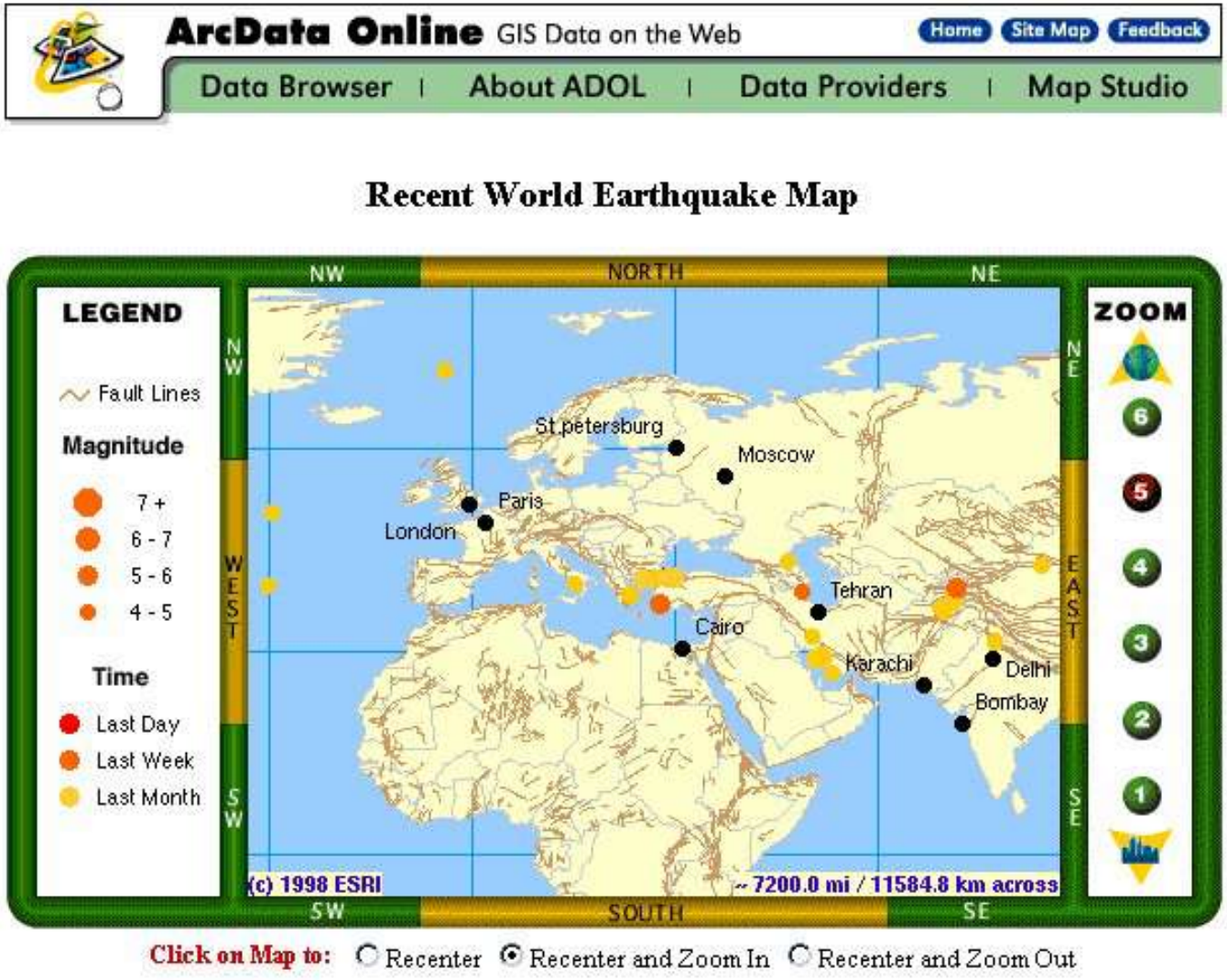
Spatial reference

Attributes

Source: www.esri.com


ArcData Online GIS Data on the Web
Home
Site Map
Feedback
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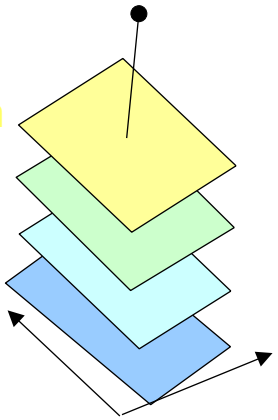
Recent World Earthquake Map
NW
NORTH
NE
LEGEND
Fault Lines
Magnitude
7 +
6 - 7
5 - 6
4 - 5
Time
Last Day
Last Week
Last Month
WEST
EAST
St.petersburg
Moscow
Paris
London
Tehran
Cairo
Karachi
Delhi
Bombay
ZOOM
6
5
4
3
2
1
(c) 1998 ESRI
~ 7200.0 mi / 11584.8 km across
SW
SOUTH
SE
Click on Map to:
Recenter
Recenter and Zoom In
Recenter and Zoom Out

How does GIS work? - creating a digital world

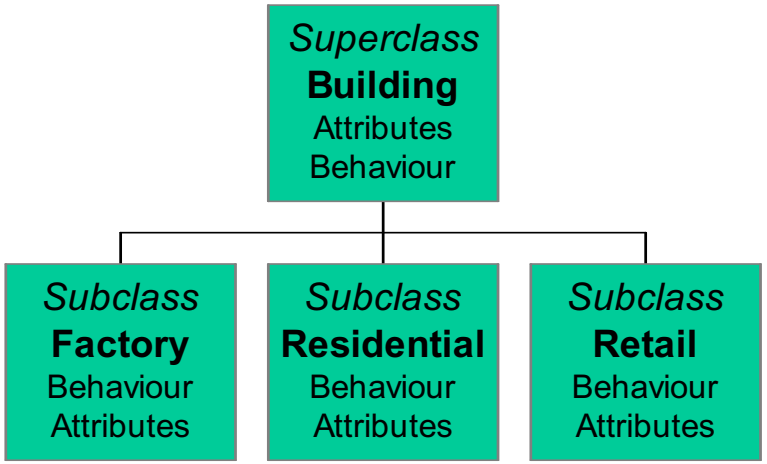
- The layer approach

Communication
Landuse
Conservation
Historic sites

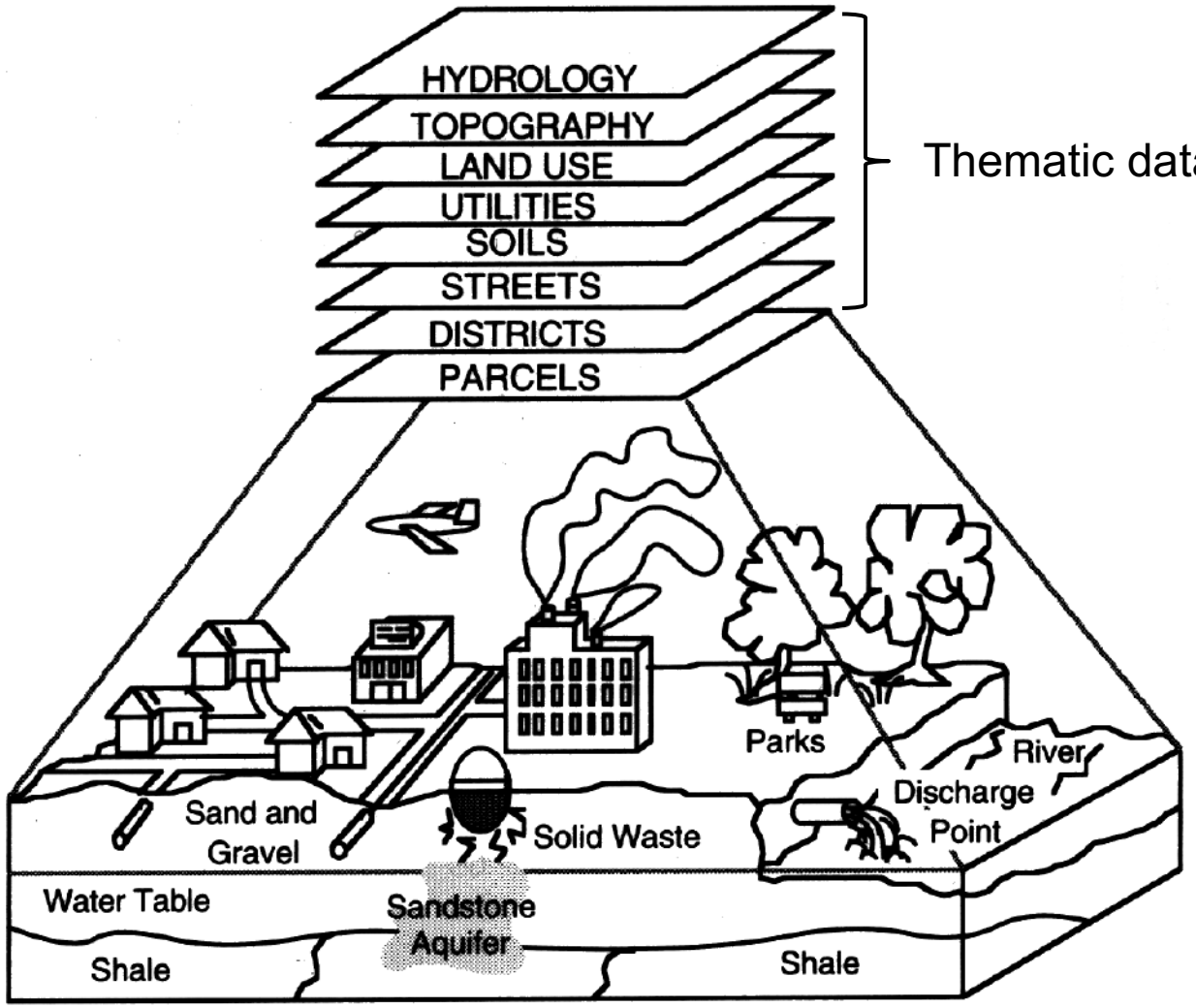


Common referencing framework

- The object approach

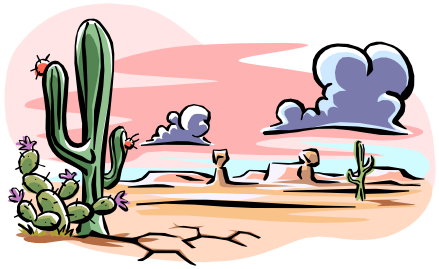


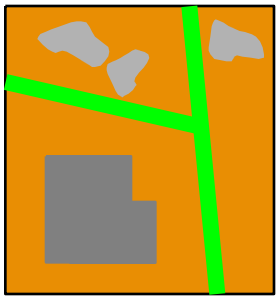
The Layer Approach



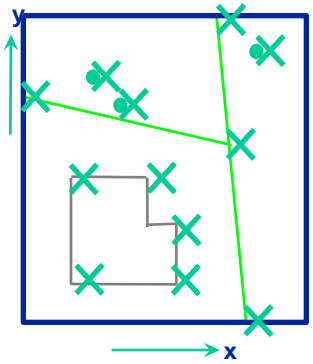
ESRI 1994

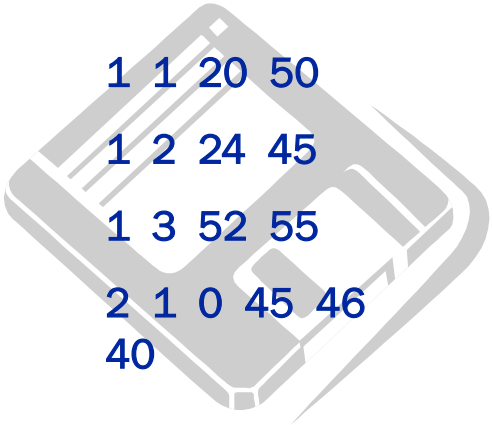
Modelling the real world



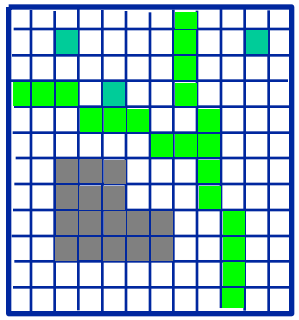


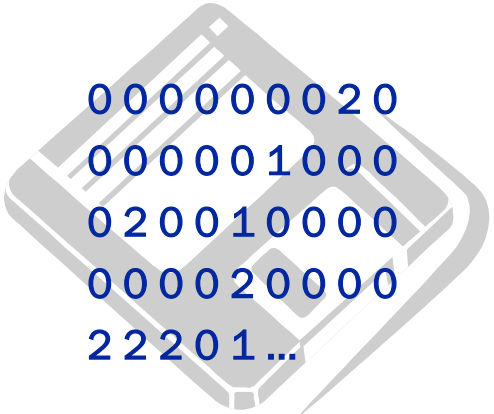
Vector model





Raster model





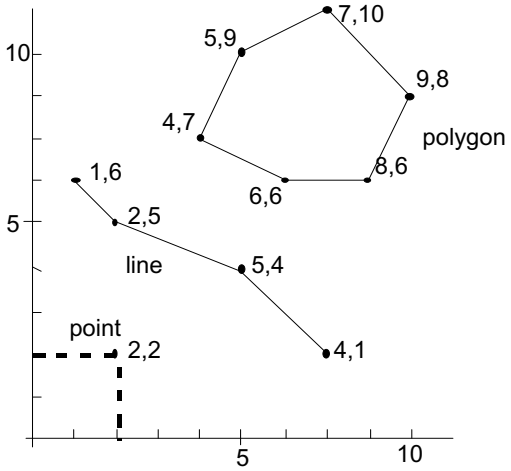
Rasters and Vectors

- Vector data
  - - Points, lines and polygons

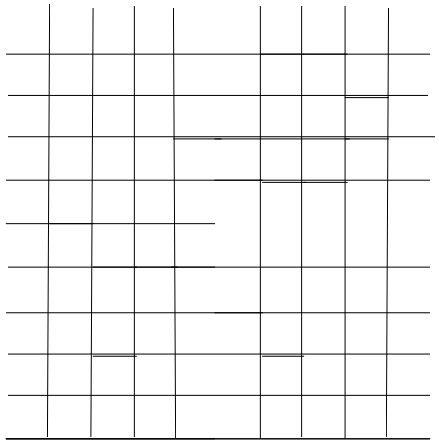
- Raster data
  - - pixels

Spatial data storage

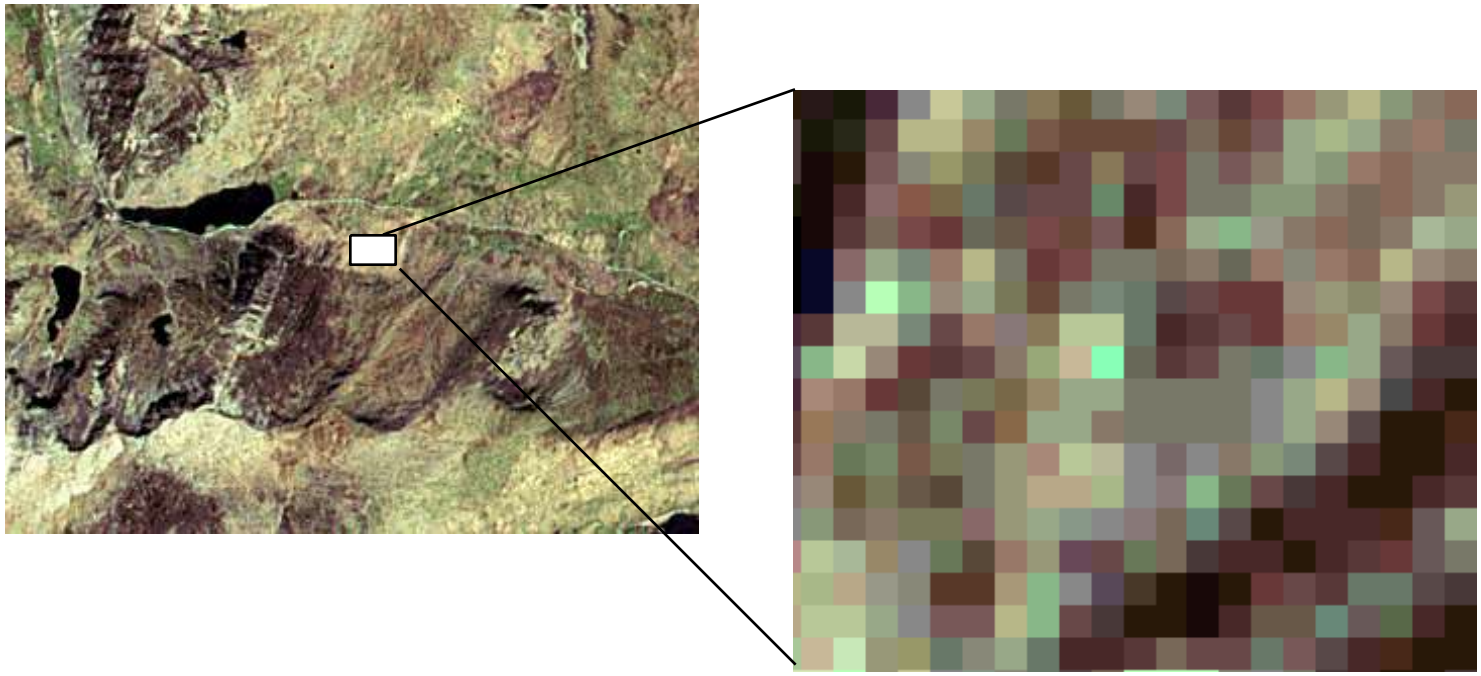
- Vector model



- Raster model



Raster model - Pixels and resolution



10 m grid

Resolution - the size of the smallest recording unit or the smallest feature that can be mapped and measured
(Heywood et al. 1998)

Vector data - points, lines and areas

Points - x,y co-ordinates representing individual points e.g. trees

Lines - sets of points representing linear features e.g. roads, rivers

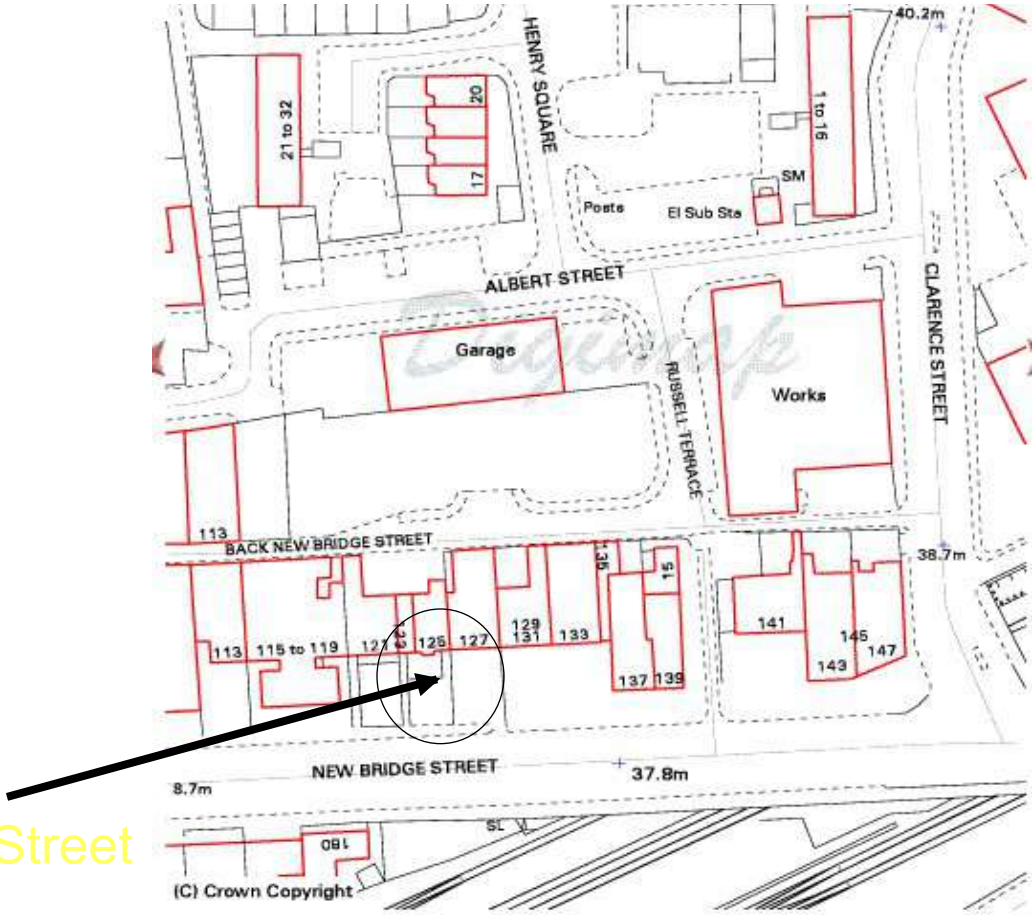
Areas - closed set of lines such as woodlands or a city boundary

Point

Line

Area

Vector model – Attributes



Address: 125 New Bridge Street
Use: Residential

Vector model - topology

Connectivity - e.g. street or pipe networks

Adjacency - adjacent buildings sharing common walls

Containment - one area within another e.g. building inside land parcel

GIS components

GIS and mapping applications

- mapping application
  - primary goal is the production of screen or hard-copy maps
  - enables map data to be transferred into a GIS
  - does not generally support topological data structures
- GIS
  - spatial data with spatial indexing and topology
  - analyse the interaction between different spatial entities
  - query data which has a spatial component or by spatial criteria
  - create new objects based on these interactions

Key stages in using a GIS

- Data acquisition
  - of both spatial and attribute data (see web page)
- *[Data management]*
- Data analysis
- Data output
  - produce a map or report (next week)

Data analysis

- analysis of data is the "turning data into information" part of the GIS (distinguishes GIS proper from mapping)
- whole books have been devoted to spatial analysis
- GIS analysis can be divided into three types:
  - general functions
  - single object analysis
  - multiple object analysis
  - analysis resulting in the creation of a new object

GIS analysis functions

- general functions

  e.g. co-ordinate transformation, modify geometry / attributes of objects, information retrieval

- analysis - single objects

  e.g. generalise or smooth lines, measure area etc.

- analysis - multiple objects

  e.g. measure distance, network analysis, compute statistics for a set of objects, establish intervisibility (terrain analysis)

- analysis - create new objects

  overlay, dissolve, merge and reclassify area objects

Generalisation - exaggeration

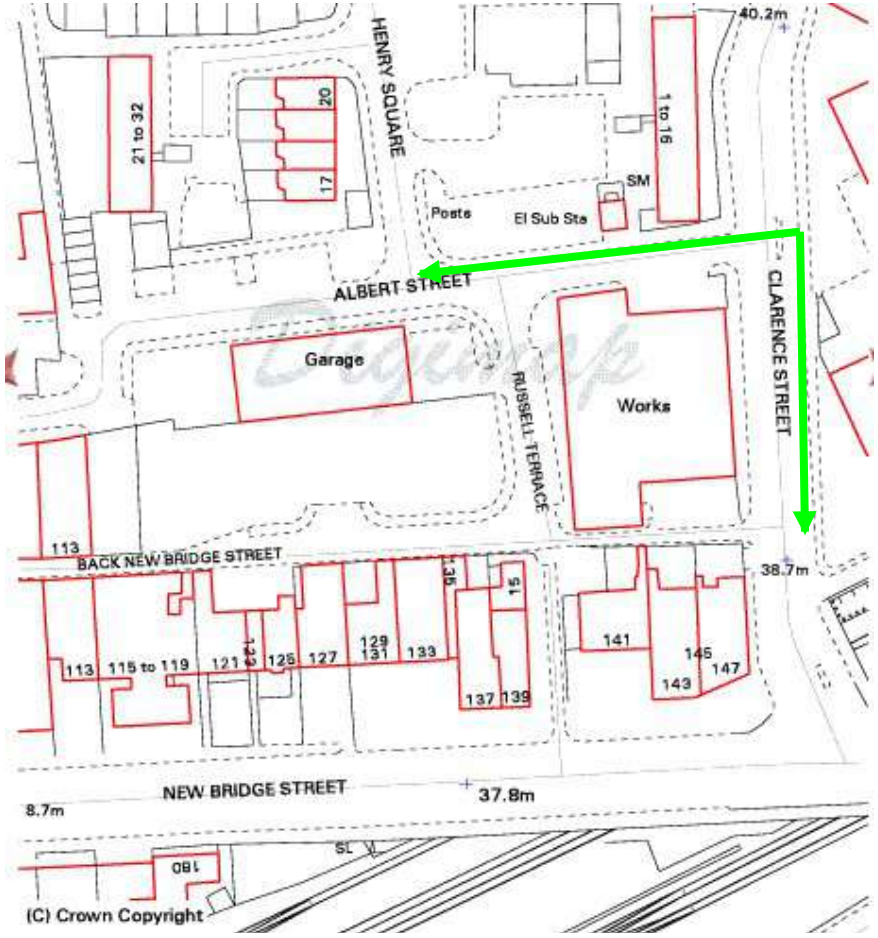
The features on map A have been simplified and exaggerated to produce map B whilst retaining all its main features.

Measurement

Distance

Area

Perimeter

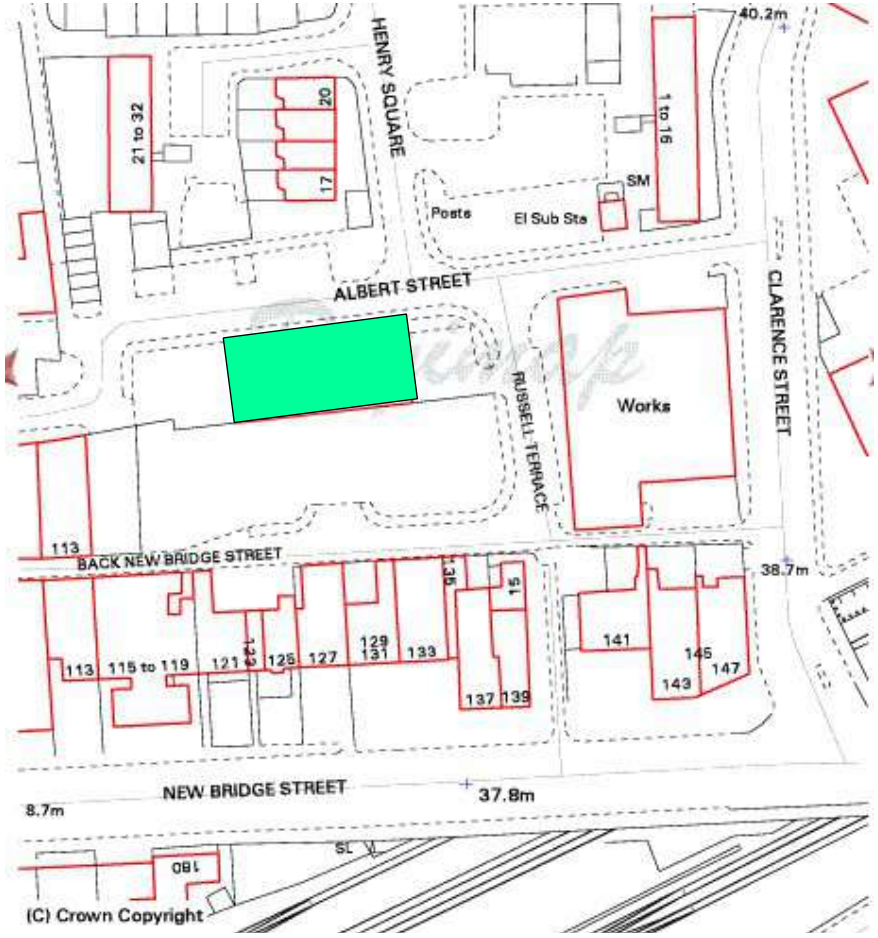


Measurement

Distance

Area

Perimeter

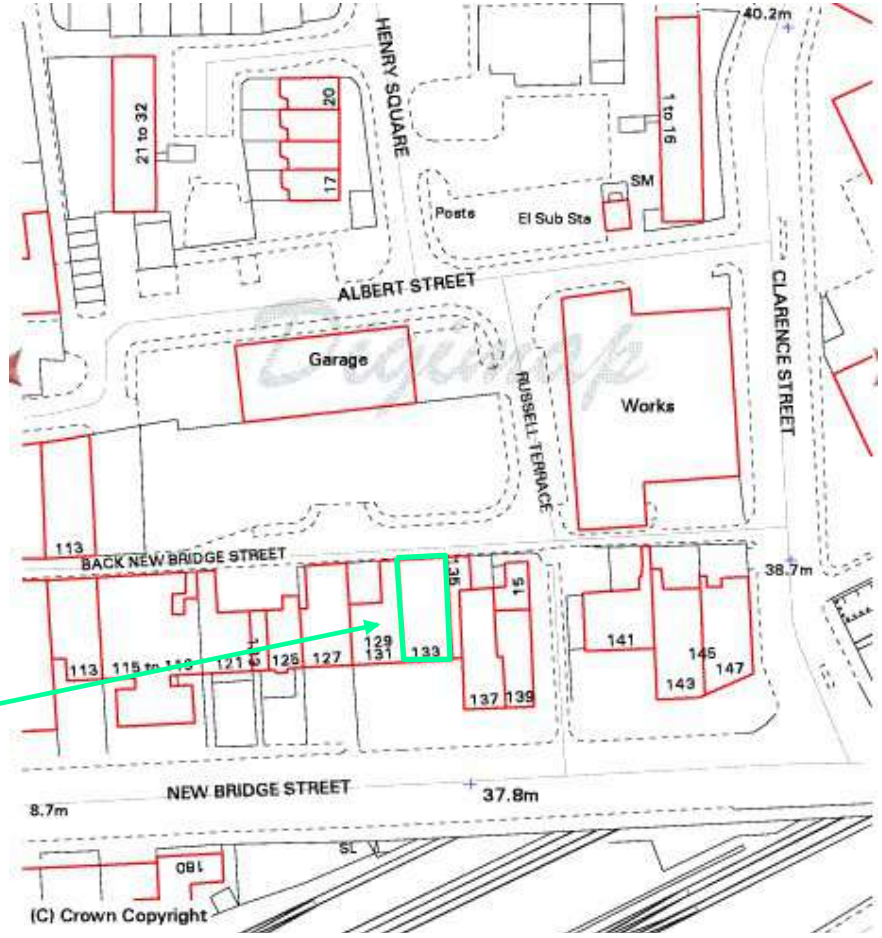


Measurement

Distance

Area

Perimeter



Analysis creating new objects

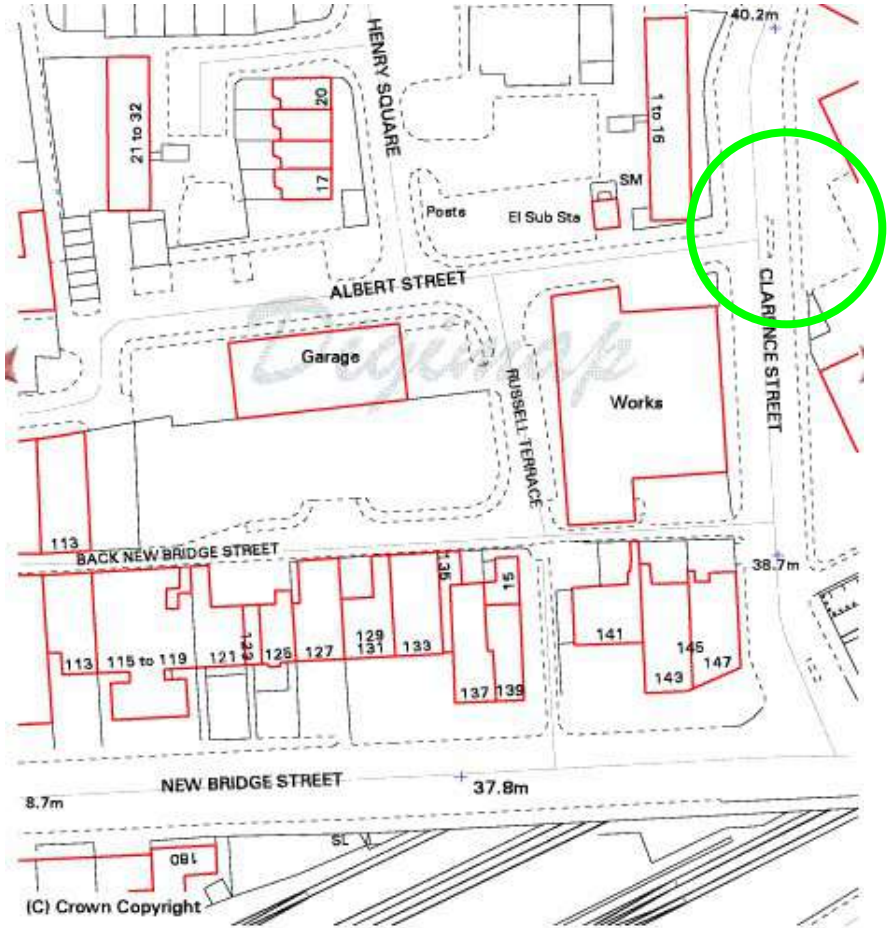
- Polygon overlay
  - Very important procedure of GIS analysis which involves superimposing 2 or more map layers to produce a new map layer
  - Used to answer ‘Where is the best place?’ type of queries
- Buffer analysis
  - Creation of a corridor around a main road thus enables the selection of services within a certain distance of the road
  - Visual analysis - buffer around a river based on flow volume to indicate varying discharge along a river’s course

Buffering

Point
- specified distance from road junction

Area
- specified distance from building

Line
- specified distance from road centreline



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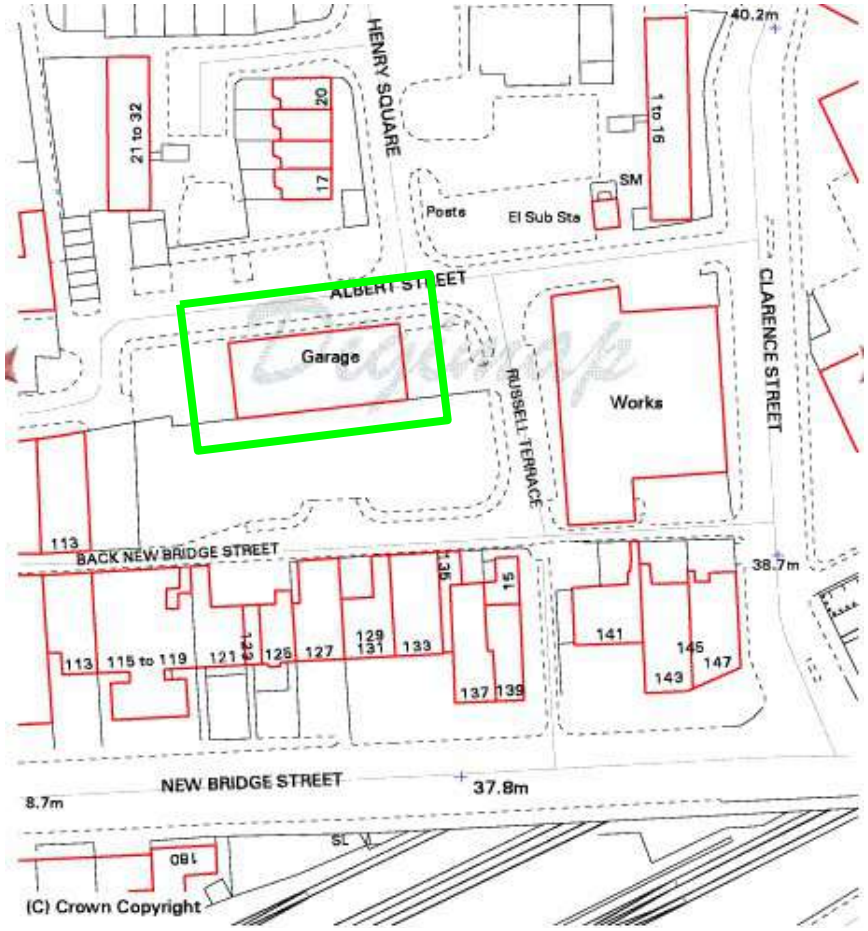


Buffering

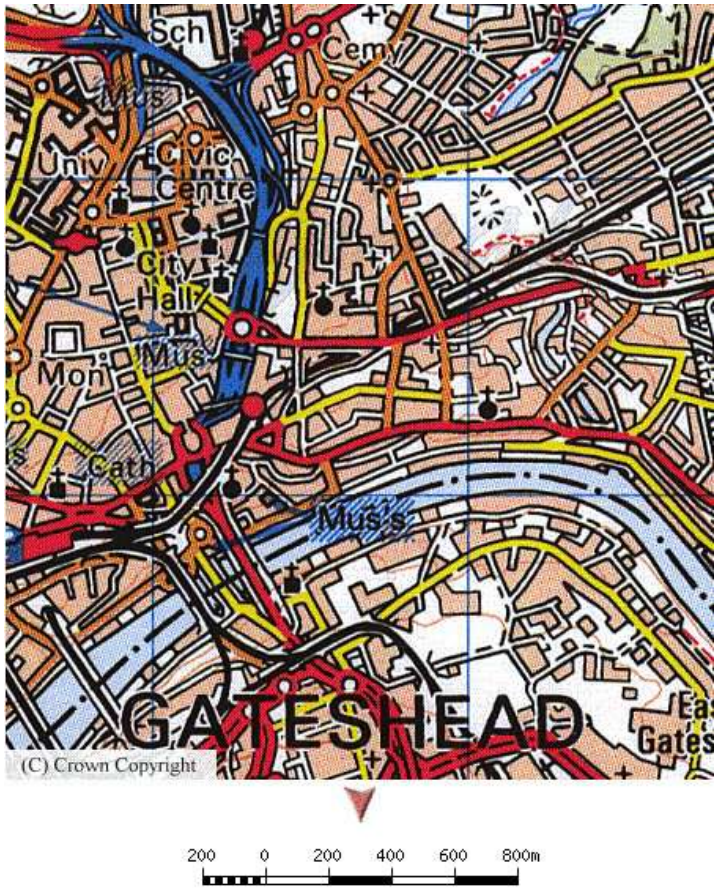
Point
- specified distance from road junction

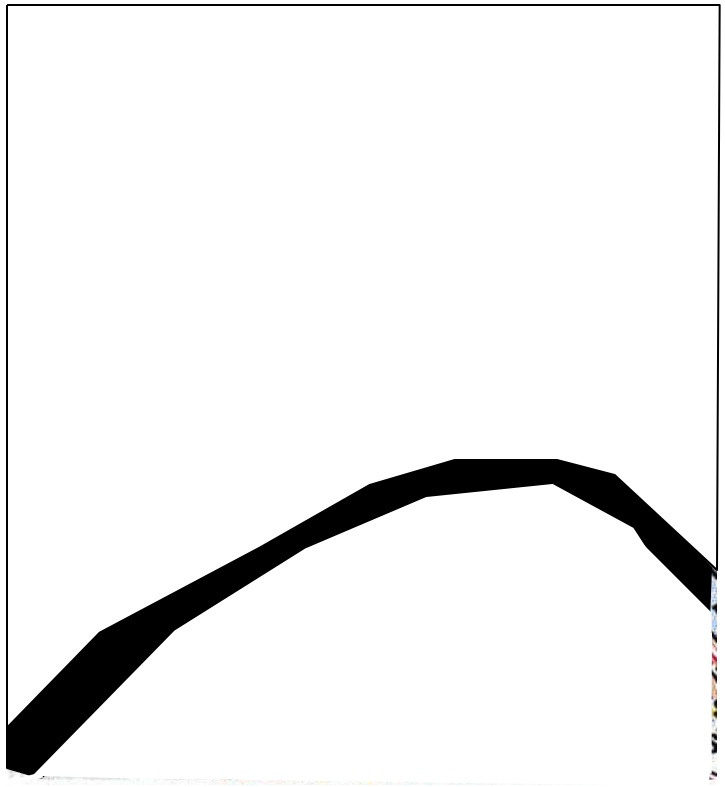
Area
- specified distance from building

Line
- specified distance from road centreline

Merge and reclassify

e.g. reclassify river Tyne to 1, everything else to 0

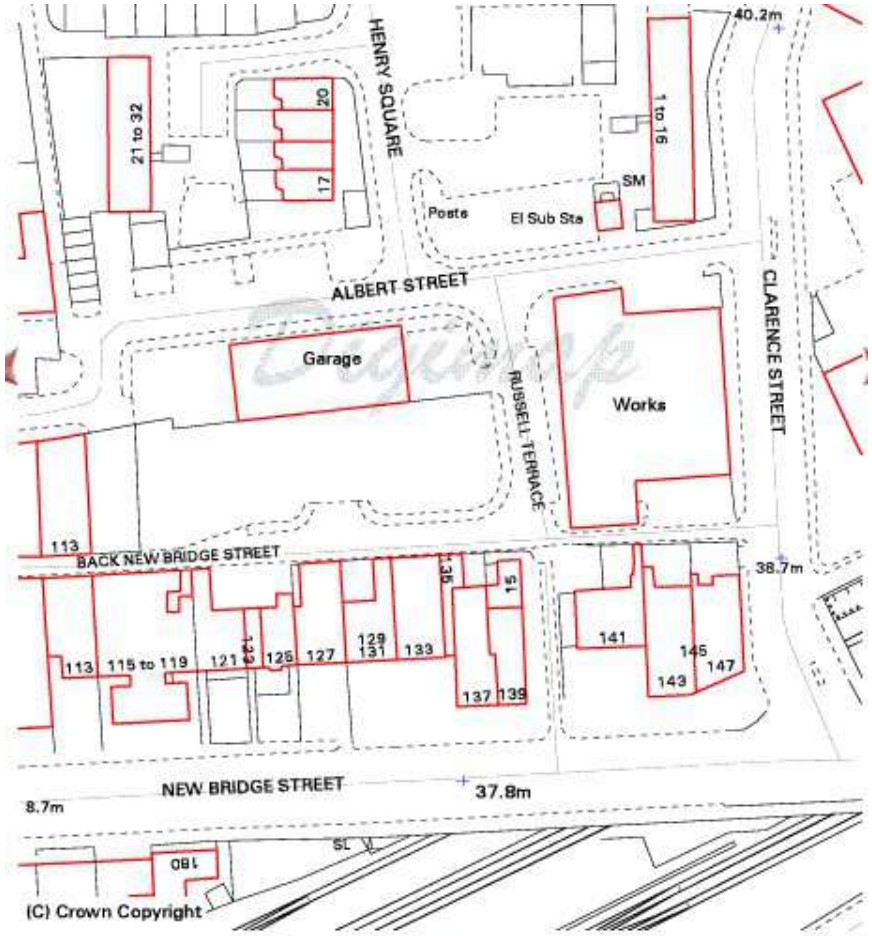




Database applications: i.e. queries

Spatial
- *where* is 17 Henry Square?

Attribute
- *what* is the use of *this* building?



Sources of digital data

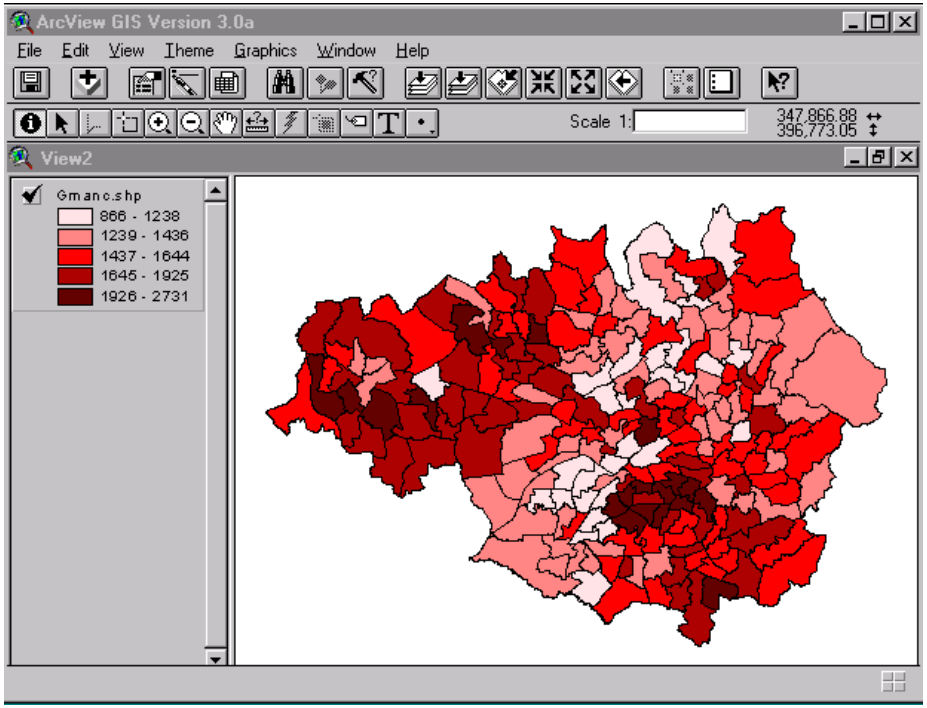
- Spatial (feature and boundary) data
  - Ordnance Survey from EDINA Digimap
  - Bartholomew from MIMAS
  - boundary data from EDINA UKBorders
- *[Geocoding data – addresses & postcodes]*
- Attribute data socio-economic
  - census from MIMAS
  - lifestyle from commercial sources
  - individual researcher sources

Feature data: Bartholomew Datasets

- Great Britain
  - Basis for several road atlases and street maps
  - 1:200,000 scale
  - available in single coverage, National Grid tiles (100 x 100km area) or untiled (for 25 x 25km or 50 x 50km)
  - up to 18 separate layers
- British Isles 1:500 000
  - Grey scale raster images
  - Roads, boundaries and towns as vector overlays also available
- London
  - 1:5,000 scale
  - 14 layers including raster layer
  - street level, available for Greater London area
  - basis for several street atlases and sheet maps
- EURO maps
  - 1:1,000,000 scale
  - 20 layers
  - 82,000 towns names Gazetteer
- Europe
  - 1:1,000,000 scale
  - raster images

Boundary data: Digitised 1991 Census Area Boundary Data

- Digitised boundary data
  - available from EDINA's UKBORDERS Web interface or MIMAS using DBD91 (registration required in either case)



Postcode data for geocoding

Ordnance Survey based data sets

CodePoint, ADDRESS-POINT

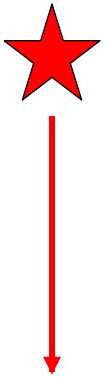
PostPoint®

Post Office based data sets

Address Manager based on PAF (Postal Address File)

Postcode Delivery Points File

Northern Ireland Postcode Delivery Points File



Available via Mimas (registration required)
Postcodes – Census Geography - OSGRs

Attribute Data: Lifestyle data

Commercially available data – see web page

Experian Data

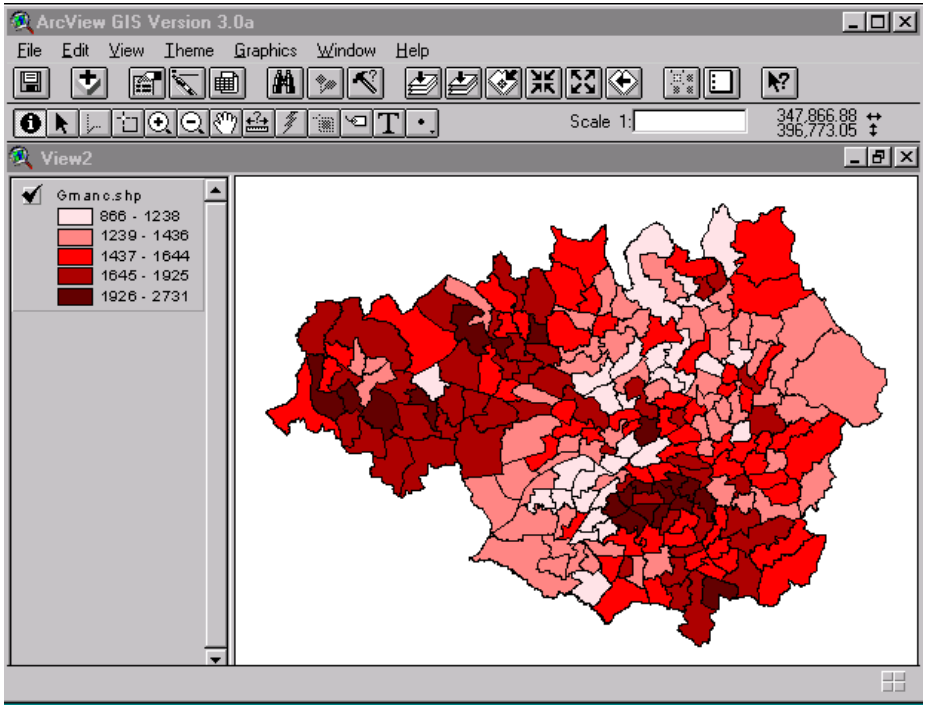
Mail Order
Shopping Pack
Holidays
Leisure
Home
Computers/Internet
Motoring
Finance
Health Insurance Pack
Super Pack - all 480 variables

Claritas Data

Population Demographics
Occupation
Holidays
Leisure Activities
Possessions
Newspapers
Financial Activities
Car Data

Attribute data: 1991 Census Small Area Statistics Data

- Census Area Statistics
  - downloadable from MIMAS using Casweb (registration required)



Data from individual's research or spatially-referenced attribute data extracted from governmental and non-governmental websites

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Guide available via http://www.exeter.ac.uk/~ajgibson

Exercise:

a) 83 students in 20 groups

b) each to select a suitable UK-based dissertation-type topic

c) find appropriate web-based spatially-referenced datasets

d) establish datasets' geography and compare with descriptions provided on http://www.statistics.gov.uk/geography/default.asp

e) establish whether conversion is necessary (and possible) to utilise spatial datasets listed on Spatial Units.xls

f) email short report (as a word document) to me (A.Gibson@exeter.ac.uk) by 5pm this Friday. Remember to include names of group.

Example Exercise: Educational outcomes, schools and social context *(short version)*

Principal sources of data are provided by the Department for Education and Skills (http://www.dfes.gov.uk/statistics), Ofsted (http://www.ofsted.gov.uk/) and individual Local Education Authorities (e.g. Devon http://www.devon.gov.uk/eal/). Information on private schools is available from various sources such as http://www.ukprivateschools.com/, http://www.indschools.co.uk/ and http://www.boarding-schools.com/.

Where individual school data is provided, postcodes can be converted to OSGR grid-refs using http://census.ac.uk/cdu/Datasets/Lookup_tables/Postal/Postcode_Enumeration_District_Directory.htm (registration with Mimas required).

Data on Key Stages 1, 2 and 3 performance at LEA- and GOR-level is available from http://www.dfes.gov.uk/statistics/DB/SFR/s0291/contents.html. GOR-based spatial maps are available (listed on Spatial_Units.xls), whilst LEA-data can be converted to 1998 Local Authorities (as listed on Spatial_Units.xls) using the lookup tables accessible via http://aypc.mcc.ac.uk/afpd/luts.cfm. School-level data on KS1-3 can be obtained via http://www.dfes.gov.uk/performancetables/. This could be mapped using postcode-OSGR linkage as above.

1	2	3	4
BANFIELD, Shaun	BATES, William	BELL, Ewan	BERRY, Natalie
EGERTON-VERNON, Oliver	ELMER, Jonathan	EVANS, Kirsty	EVANS, Verity
IRELAND, Alice	JENNINGS, Alice	JESSON, Sarah	KANE, David
NICHOLLS, Victoria	NOWAK, Edward	OTTEWILL, Sarah	ROBERTS, Gemma
WILLCOX, Jonathan	WILLIAMS, Bethan	WOLLEY, Rebecca	
5	6	7	8
BILES, Nicola	BIRD, Zoe	BRADON, Laura	BROOKER, David
EVERTON-JONES, Aimee	FERGUSON, Edward	FIELDER, Abigail	FIENNES, Eleanor
KELLY, Jonathan	LAWSON, Rebecca	LEWIS, David	MACDONALD, Beverly
ROSS, Samuel	ROWAN, Michael	SEARLE, Natalie	SHAW, David
9	10	11	12
BUCKINGHAM, Laura	BULLOCK, Steven	BURNS, Lucy	CARR, Samuel
FITZJOHN-SYKES, Gemma	FOWLER, Lisa	GOTTS, Naomi	GRANDIS, Emily
MARTIN, Meriel	MASON, James	MAY, Daniel	MILES, Sebastian
SMITH, Alister	SMITH, Stephen	STEPHENS, Gemma	STEVENS, Fjola
13	14	15	16
CONGRAVE, Jennifer	CRITIEN, Iain	CROWE, Philip	DAVIES, Tara
HARMSWORTH, Amy	HAYDON, Victoria	HENRY, Emma	HIGGIN, Louise
MITCHELL, Thomas	MOHERNDL, Karl	MOORE, Sarah	MORETON, Simon
SUMNER, Louise	SURGEONER, Kate	TAYLOR, Matthew	TIPPER, Helen
17	18	19	20
DOWELL, Adam	DUNN, Alexandra	DUNSMORE, Thomas	EARLE, Athlene
HOLLANDS, Christopher	HORNE, Thomas	HULIN, Sarah	INGLE-FINCH, Andrew
MORRIS, Simon	MURPHY, Sarah	NAPIER, Suzi	NEWTON, Amy
TRENT, William	VAUGHAN, Nicola	VENNING, Jessica	VYVYAN-ROBINSON, Joanna