Nottingham Geospatial Institute

The University of Nottingham

UNITED KINGDOM · CHINA · MALAYSIA

GRACE

world-changing research from The University of Nottingham

Introduction to GIS

Suchith Anand

EMBRACE East Midlands Business and Research satellite Applications Centre of Excellence

ingenuity

HIGHER EDUCATION hefce FUNDING COUNCIL FOR ENGLAND

SABRE

EUROPEAN UNION Investing in Your Future

European Regional Development Fund 2007-13

Introduction & Fundamentals

What is GIS?

Fundamental GIS

- Map generalization

Applied GIS

- Transportation
- Health
- AgriGIS
- Urban Science

Further learning resources

Fundamentals:

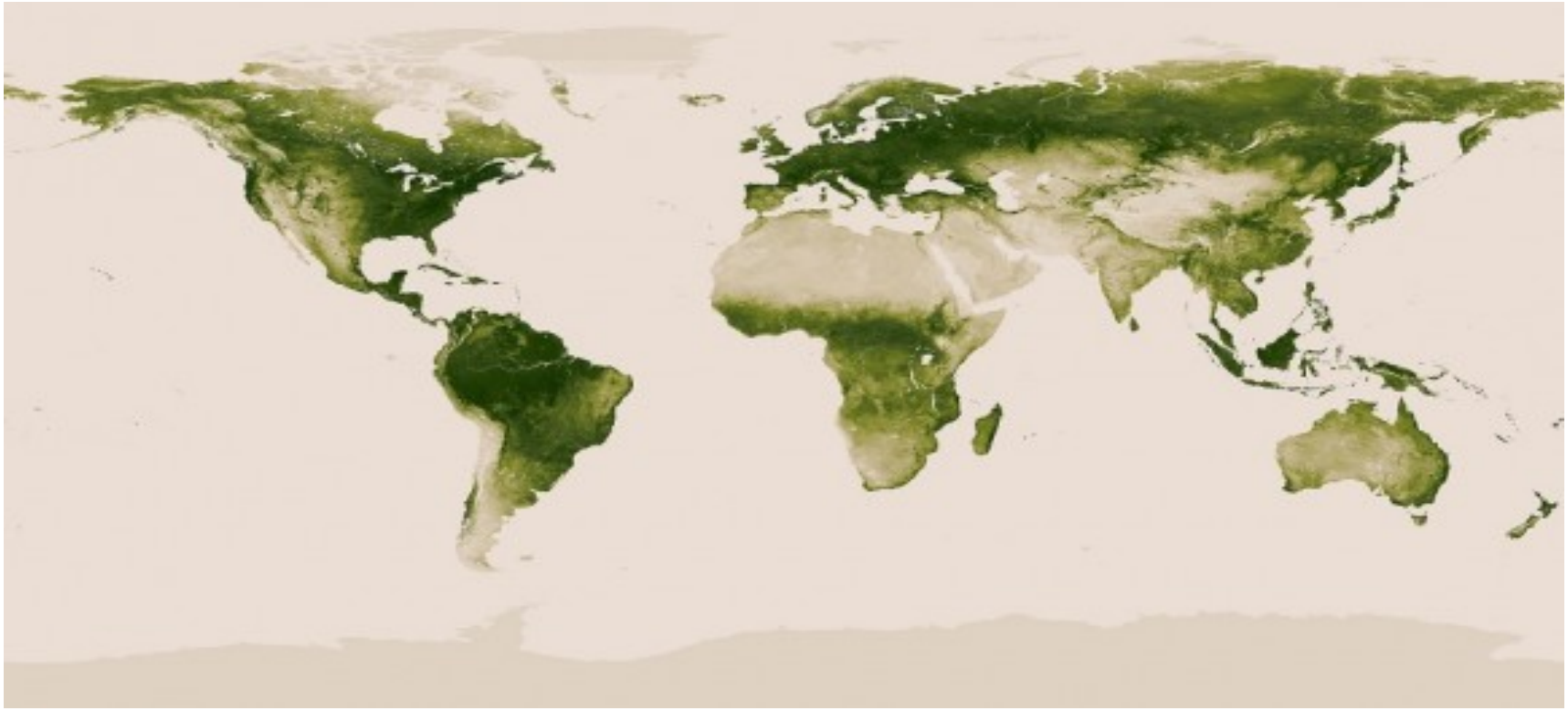
- Different views on the nature of space
- Geo-referencing & Discrete georeferencing
- Locational co-ordinates
- Euclidean space - Cartesian and polar co-ordinate systems
- Latitude and longitude system
- Major types of map projections
- Representing Real world geography in digital *world*
- Vector vs. Raster
- Topology
- Cartography Design Principles

What is a Map?

A **map** is a visual representation of an area (can be for any space not just geographical)

More importantly, Maps helps us make sense of the world

World Map of Vegetation on Earth



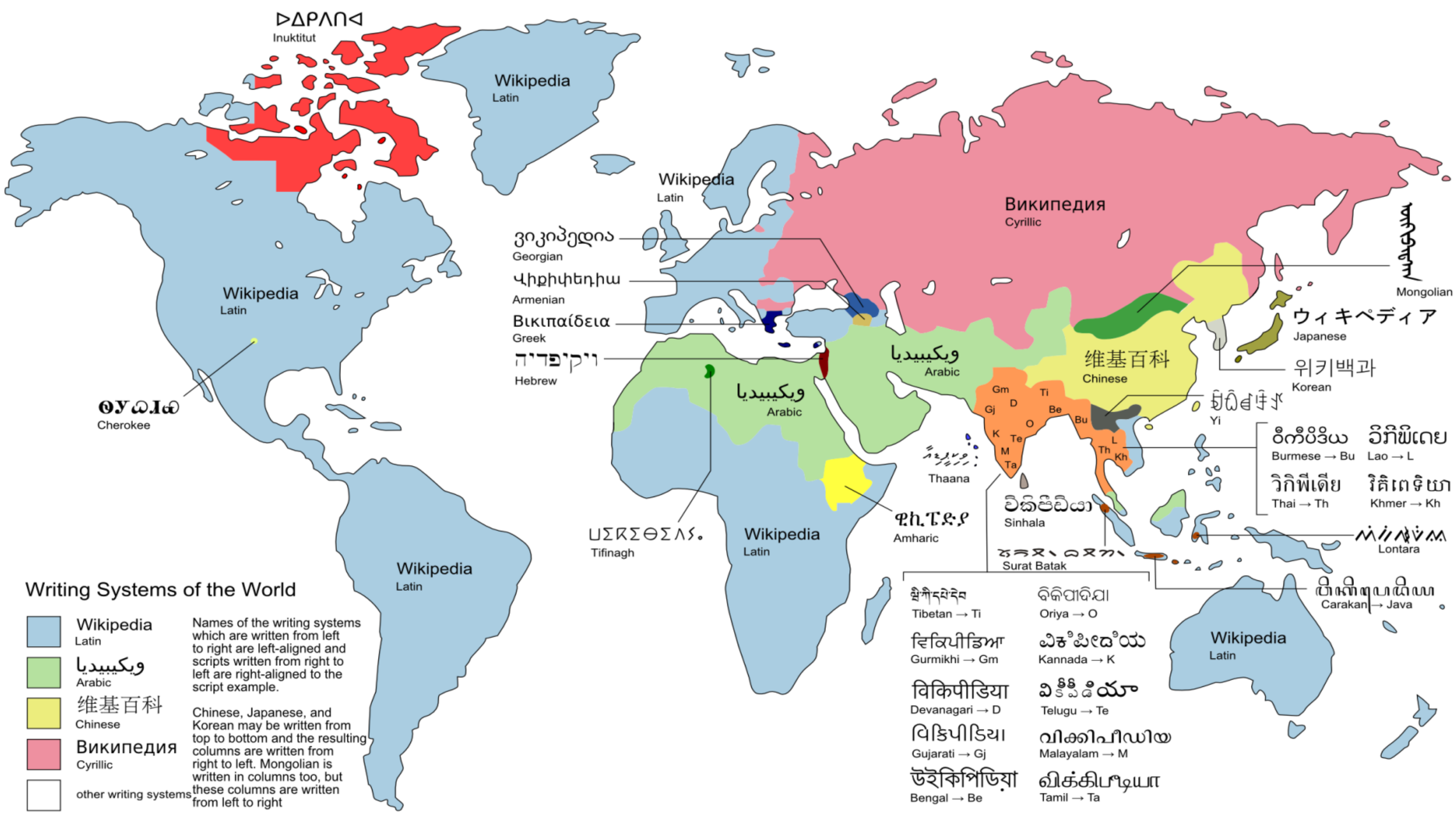
World map of vegetation data collected by the Suomi NPP satellite (National Polar-orbiting Partnership) in a partnership between NASA and the National Oceanic and Atmospheric Administration (NOAA). Image Credit: NASA/ NOAA
Herbal Earth: Spectacular Vegetation Views of Our Home Planet and the Natural World of Living Green Life by Ken Kremer

Nottingham Geospatial Institute

The University of Nottingham

UNITED KINGDOM · CHINA · MALAYSIA

World Map of the Different Writing Systems



Map by Maximilian Dörrbecker (Chumwa) on Wikimedia Commons

What is space? Different perspectives

Medical imagery pespective (eg MRI scans)
Mathematics perspective (eg fractals)
Physics perspective
Astronomy perspective

Geography perspective
Human views (mental maps)

GEOREFERENCING

The key requirements:

Unique

Understandable

Unchanging

Discrete Georeferencing

Practically, it means, Many options to do your search:

- Street name
- Postcode
- Place name
- OS grid reference
- Lat/Long etc

Co-ordinate Systems for recording spatial location

Plane Systems: Cartesian Co-ordinates

Plane Systems: Polar Co-ordinates

Global Co-ordinates: Latitude And Longitude

Projection-based Co-ordinate Systems and Map Projections

Different types of projections

Conformal or Orthomorphic projections

Equal Area or Equivalent projections

Equidistant projections

VECTOR VIEW

Follows an object view of the world in which space is seen to be occupied by different sorts of object

- Records exact locational co-ordinates of the points, lines and areas that make up a map.
- List the features present on the map and represent each as a point, line or area *object*

RASTER VIEW

Originated mostly in the world of image processing using data from remote sensing platforms

Make use of a grid of small units of the earth's surface (called *pixels*) and for each record the value, or presence or absence, of something of interest

In a raster the map is divided into a sequence of identical, discrete elements and contents listed for each

TOPOLOGY

Is the study of properties that are unchanged under transformations such as a stretching or folding

Such properties include

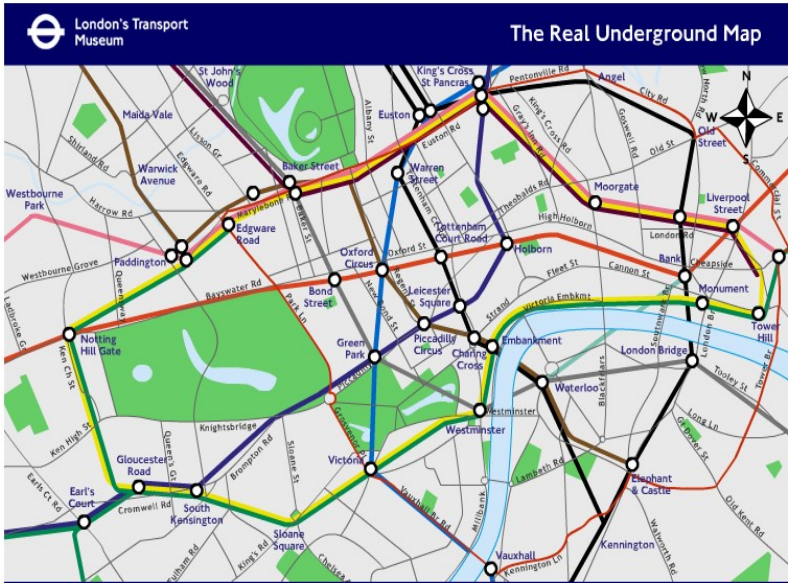
connection

adjacency

containment

London Tube Map

Preserves topology but disregards geometry!



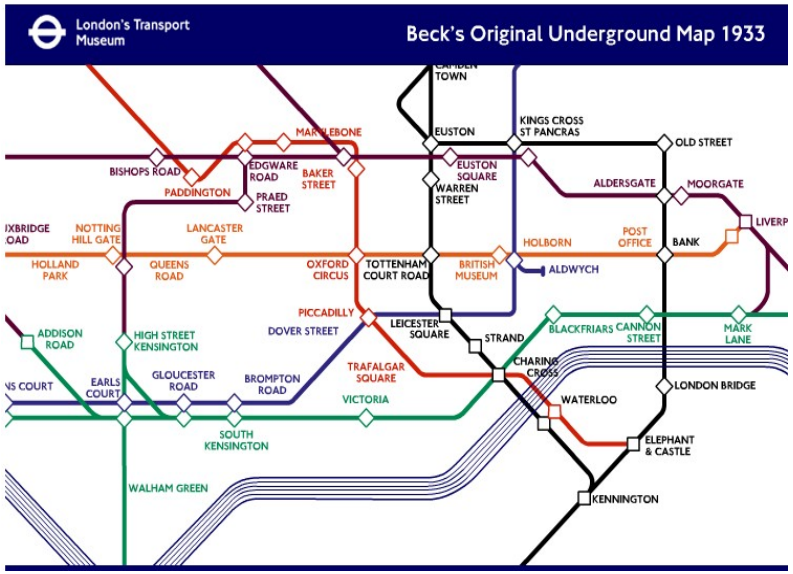
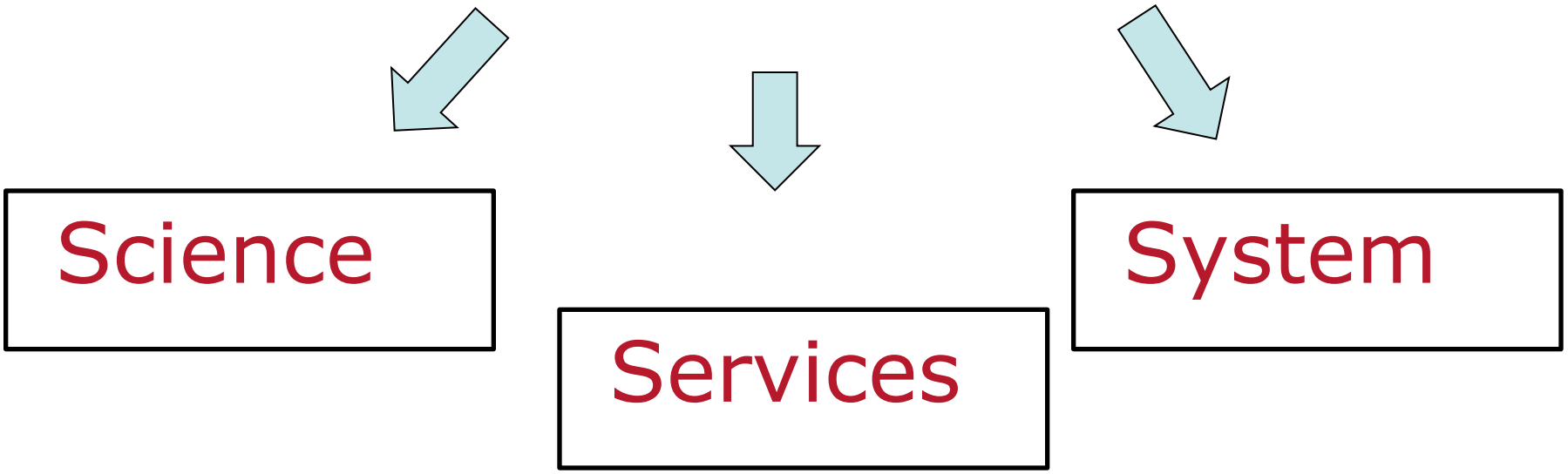


Image Source: LTM Website

What is GIS



GIS is multidisciplinary (Engineering, Computer Science, Statistics, Mathematics, Geography, Psychology, Philosophy…)

Geographic Information Science

Multidisciplinary research that addresses the nature of geographic information and the application of geospatial technologies to basic scientific questions (Goodchild, 1992).

Based primarily in the discipline of geography, but drawing upon insights and methods from philosophy, psychology, mathematics, statistics, computer science, landscape architecture, and other fields.

Examples:

Map generalization
Ontologies

Geographic Information Systems

Refers to the specialized set of information technologies that handle georeferenced data

Data acquisition

- Aerial imaging
- GNSS
- Remote sensing
- Land surveying

Data analysis

- Statistical analysis
- modeling

Data storage &manipulation

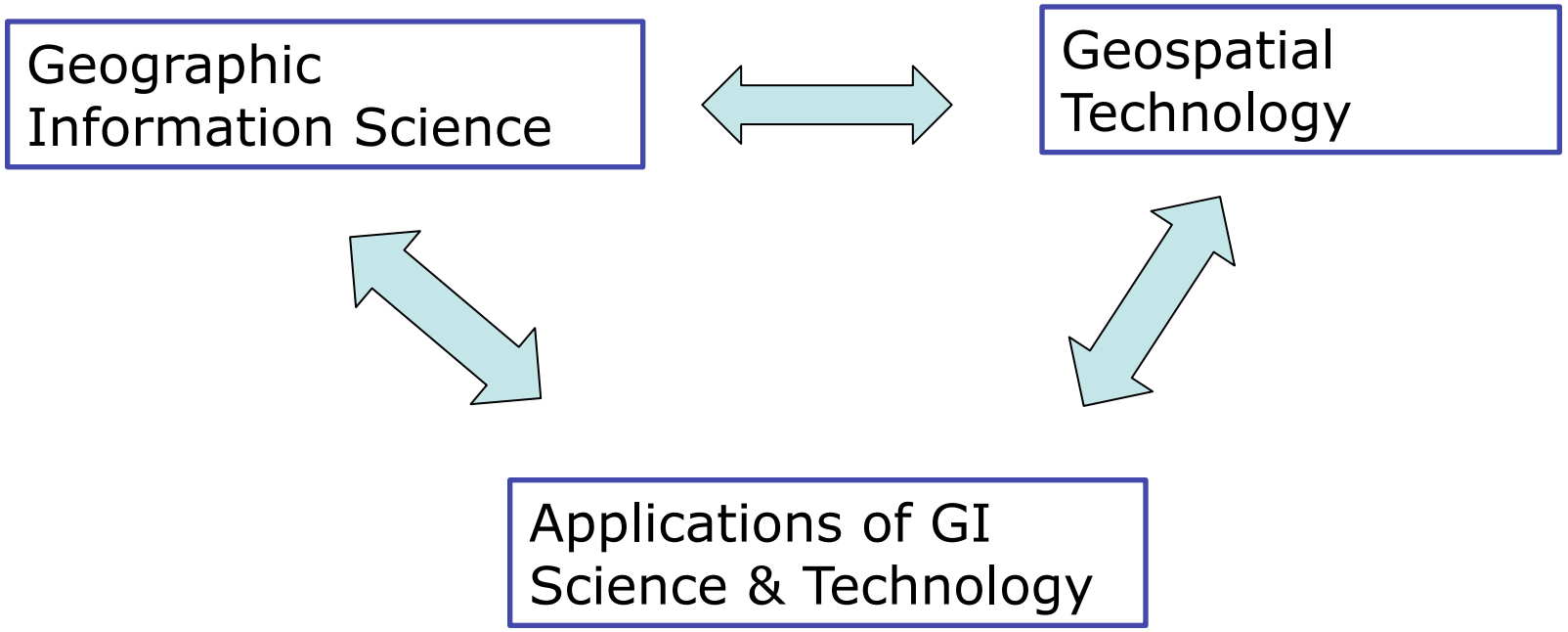
- image processing
- DBMS

Data visualization

- Geovisualization
- imaging

UCGIS GI S&T Body of Knowledge

10 knowledge areas
73 units
329 topics
1,600 formal educational objectives



Applied GIS examples

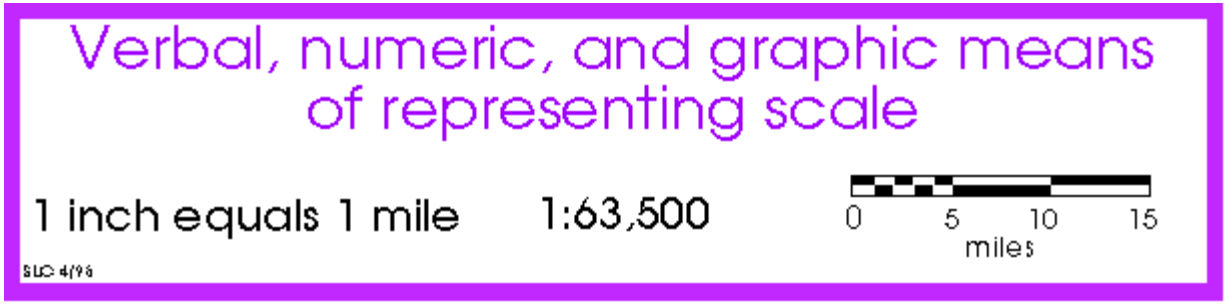
Network of European Regions Using Space Technologies

The NEREUS video "The voice of regions for Space“ regional examples of space based services (EO/GMES, GNSS, Telecommunication etc.) for the benefits of regions and their citizens.

http://www.nereus-regions.eu/NEREUS_videopage

Fundamental GIS example

Map generalization is one of the fundamental research areas of GI Science



Scale

•Maps can be thought of as collections of scaled graphic representations of earth features.

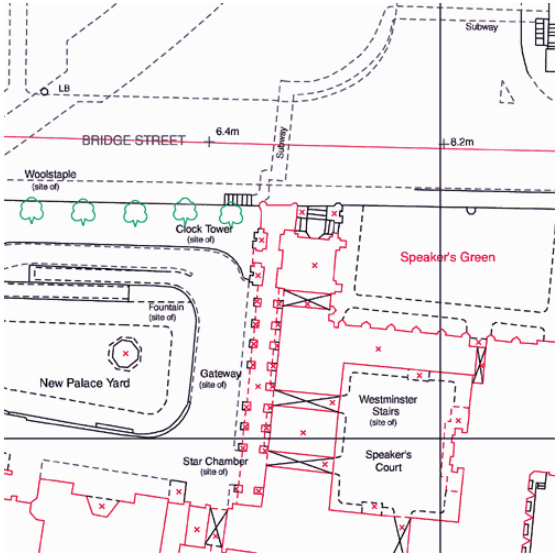
•Dimensions on a map can be related to actual dimensions by a scale value which may be expressed by the ratio between graphic dimension and actual dimension.

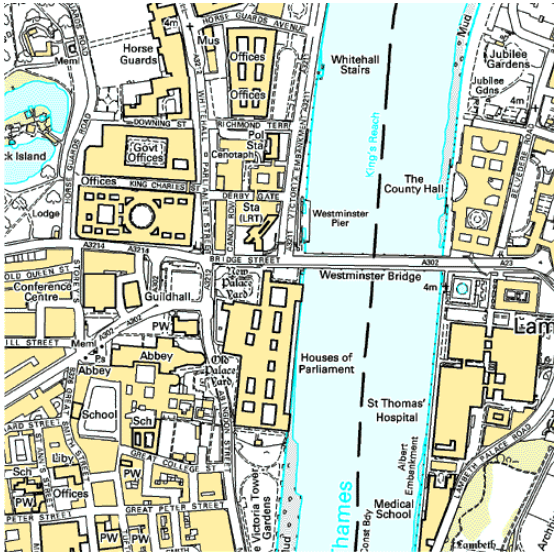
•If a scale value is given as a fraction in which the numerator is 1, it is called the representative fraction (e.g. 1/50000).

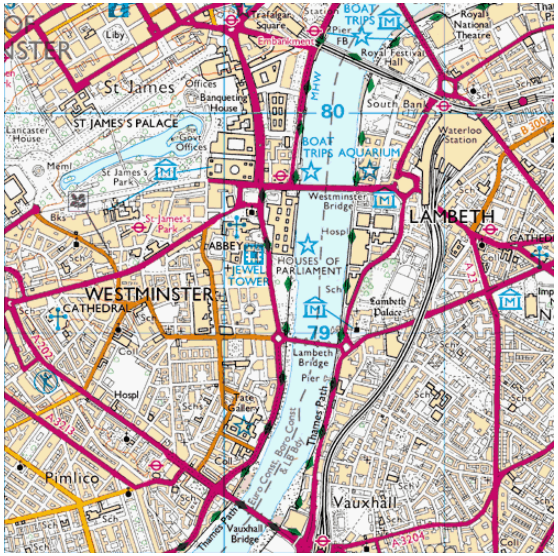
•If the representative fraction is relatively large (e.g. 1/2500), the map is referred to as large scale.

•If the representative fraction is relatively small (e.g. 1/2000000), the map is referred to as small scale.

Scale


BRIDGE STREET
6.4m
8.2m
Subway
Woolstaple
Clock Tower
Speaker's Green
Fountain
New Palace Yard
Gateway
Westminster Stairs
Star Chamber
Speaker's Court

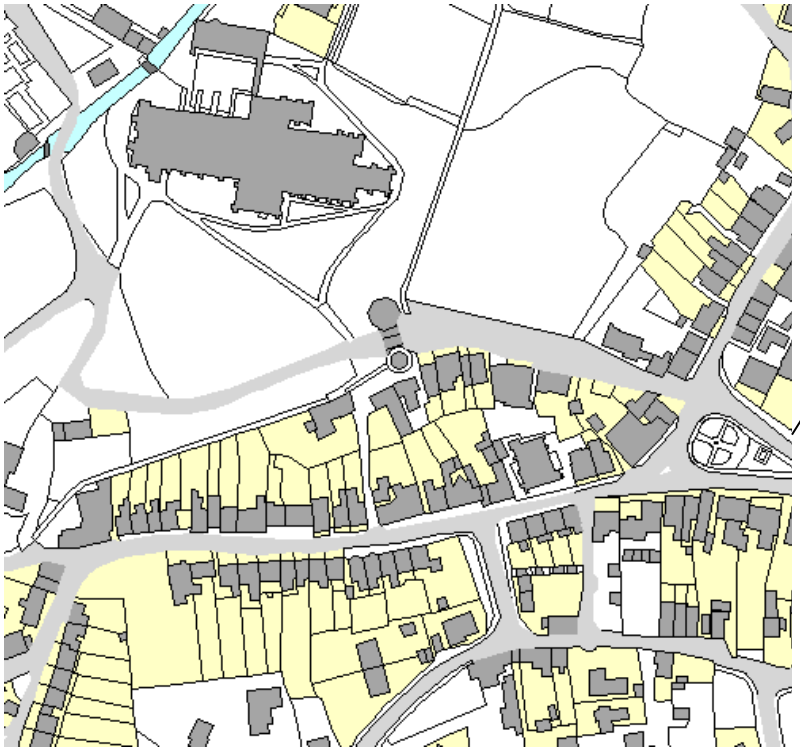

Horse Guards
Whitehall Stairs
Jubilee Gardens
Offices
Govt Offices
The County Hall
Westminster Pier
Lodge
Conference Centre
Guildhall
Westminster Bridge
Houses of Parliament
Abbey
School
St Thomas' Hospital
Medical School
Victoria Tower Gardens
Albert Embankment
Thames


St James
ST JAMES'S PALACE
BOAT TRIPS AQUARIUM
LAMBETH
WESTMINSTER
CATHEDRAL
HOUSES OF PARLIAMENT
JEWEL TOWER
Lambeth Palace
Pimlico
Vauxhall
Thames Path


WESTMINSTER
LAMBETH
Buckingham Palace
St James's Park
Victoria
Pimlico
Vauxhall
Chelsea Bridge
Nine Elms

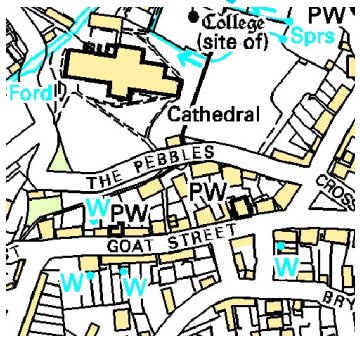

FINCHLEY
WOOD GREEN
TOTTENHAM
WALTHAMSTOW
WOODFORD
HENDON
HORNSEY
STOKE NEWINGTON
LEYTON
WEMBLEY
HAMPSTEAD
HACKNEY
WILLESDEN
CAMDEN TOWN
ISLINGTON
STRATFORD
PADDINGTON
MARYLEBONE
CITY OF LONDON
ACTON
WESTMINSTER
KENSINGTON
CHELSEA
LAMBETH
HAMMERSMITH
BERMONDSEY
POPLAR
GREENWICH
CHISWICK
FULHAM
BARNES
BATTERSEA
CAMBERWELL
DEPTFORD
CLAPHAM
BRIXTON
LEWISHAM
RICHMOND
PUTNEY
WANDSWORTH
CATFORD
STREATHAM
WIMBLEDON
KINGSTON UPON THAMES
MERTON
PENGE
BECKENHAM
MITCHAM
MORDEN
SURBITON


Luton
Stevenage
Bishop's Stortford
Dunstable
Hertford
Hemel Hempstead
St Albans
Hatfield
Harlow
Chelmsford
Amersham
Watford
LONDON
Brentwood
Billericay
Slough
Dagenham
Basildon
Heathrow Airport
Bracknell
Staines
Richmond
Greenwich
Tilbury
Esher
Sutton
Orpington
Gravesend
Woking
Croydon
Surrey Hills
Leatherhead
Maidstone
Sevenoaks
Dorking
Redhill
Guildford
Reigate
Tonbridge
Godalming
Gatwick Airport
Crawley
Royal Tunbridge Wells



Reduce scale

Generalize



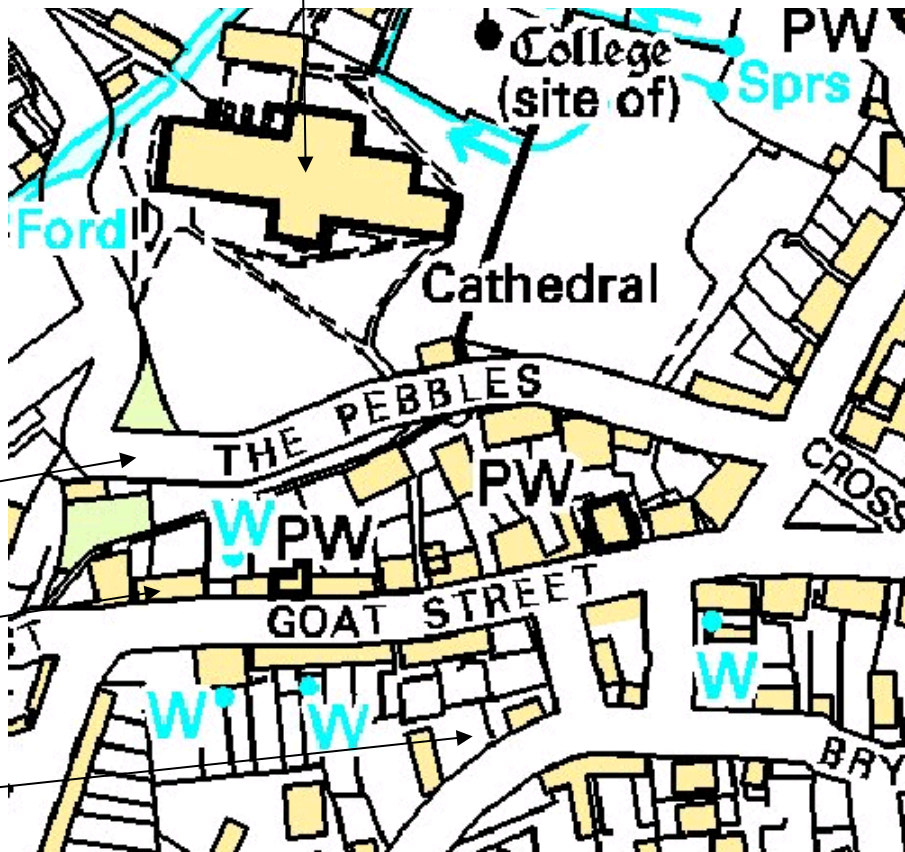
Simplification

Displacement

Exaggeration

Aggregation

Deletion



Cartographic Design Principles

- Understanding of user requirements
- Consideration of display format
- A clear visual hierarchy
- Simplicity
- Legibility
- Consistency
- Assessibility
- Good composition

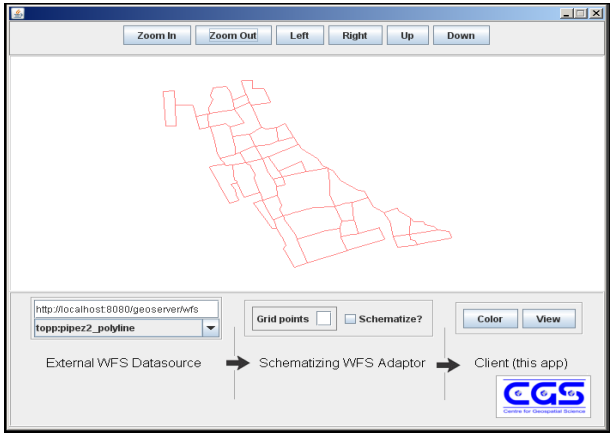
Full details at
http://www.ordnancesurvey.co.uk/resources/carto-design/carto-design-principles.html

Fundamental GIS example

Automated Generalization research-Optimization Framework

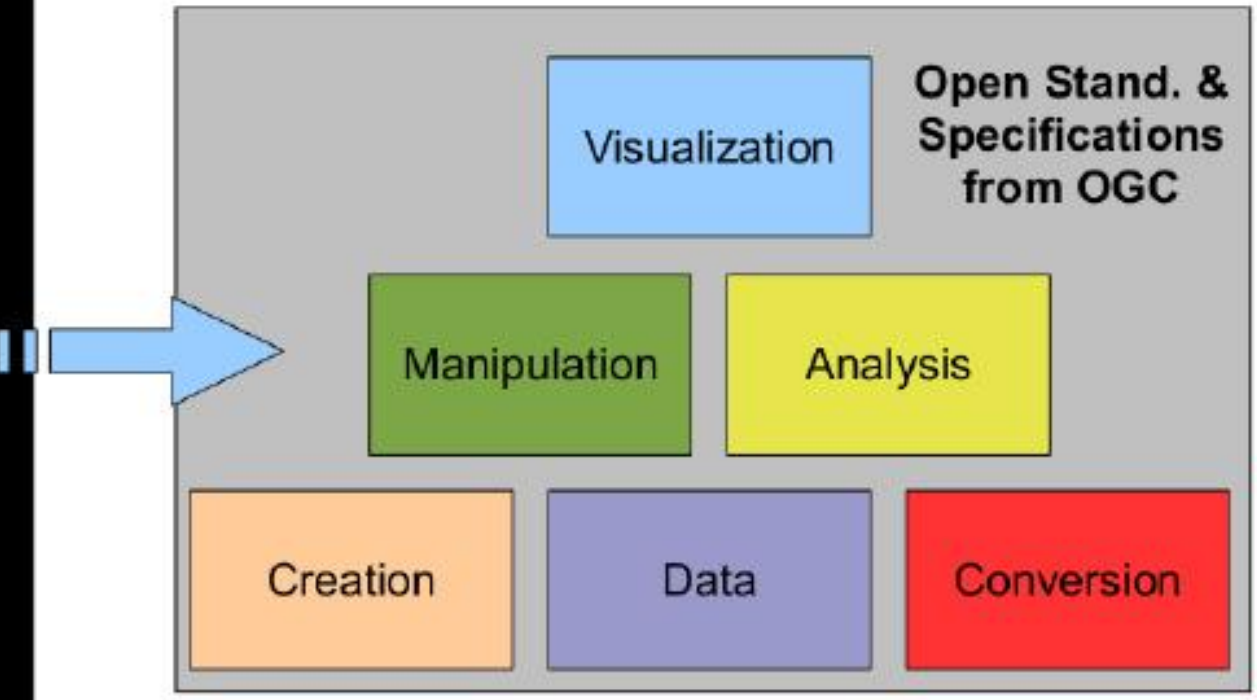
Map generalization is one of the fundamental research areas of GI Science

- Hillclimbing,
- Simulated Annealing
- (Reactive) Tabu Search
- Simple Genetic Algorithm



Today's Toolkit

Monolithic Black Box



One example

Kibera , Kenya

http://www.flickr.com/photos/8485582@N07/7365580810

Dharavi, Mumbai

http://www.flickr.com/photos/36685562@N00/2340042701

GLOBAL URBAN PROBLEMS: access to water, sanitation, traffic congestions, economic sustainability, citizens' health, impact on environment …

Mapping is a critical component to help understand and develop solutions for urban growth problems

Proprietary software tools are very expensive (hence unavailable) for economically poor countries and communities worldwide

GIS tools play a key role in helping find solutions to global societal challenges

Nottingham Geospatial Institute

The University of Nottingham

UNITED KINGDOM · CHINA · MALAYSIA

International Cartographic Association
Association Cartographique Internationale

ICA ACI

isprs
information from imagery

OSGeo
Your Open Source Compas

"Geo for All"

OpenCitySmart - The Open Platform for Smart Cities

Patrick Hogan , Brandt Melick, Maria Antonia Brovelli, Charles Schweik, Jim Miller, Sven Schade, Chris Pettit, Ant Beck, Doreen Boyd, Darren Robinson, Suchith Anand

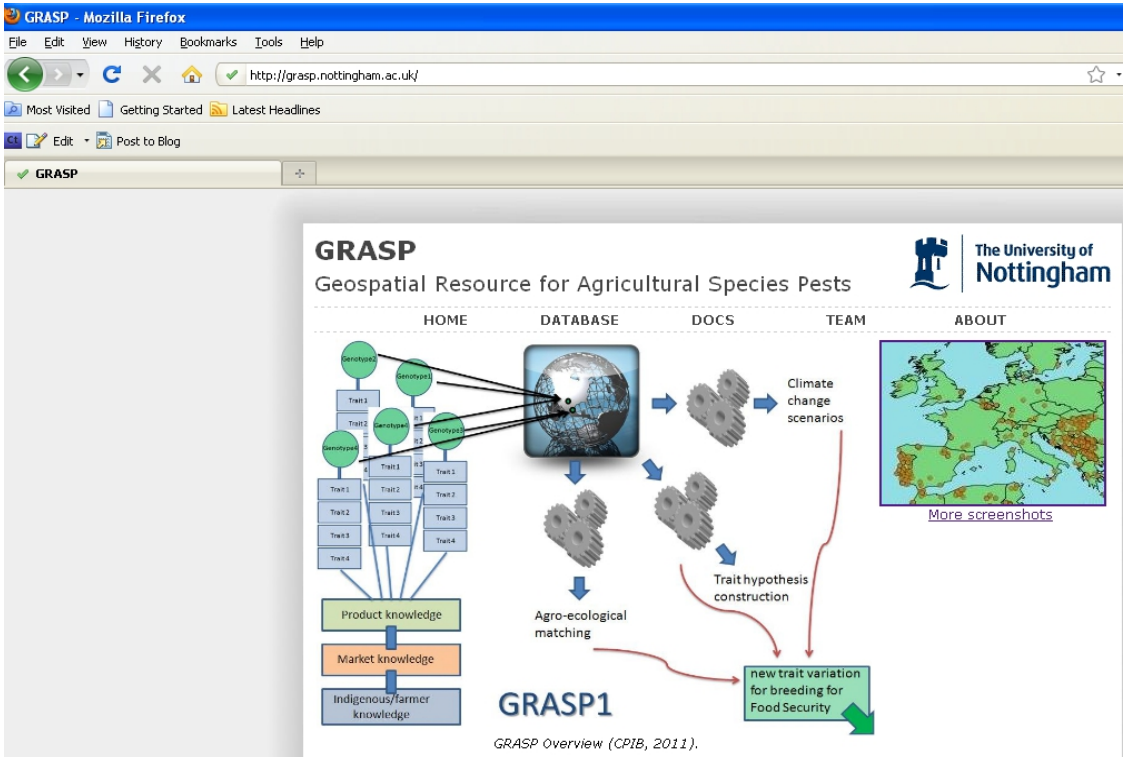
Resources at our disposal to enable OpenCitySmart

- NASA Worldwind Platform
- What if Platform
- Open Source Geospatial Foundation's software tools

More importantly we got an amazing global "Geo for All" team working on our mission

See preview at https://youtu.be/7NaX9b6F05c

Example of attracting research funding/sustainability: AgriGIS Research example



Fully build on Open Source and Open Standards

£10k seed funding internal project helped build up a new research theme at UoN with now BBSRC funding (£150k) and 3 PhD studentships + post doc position at CFFRC to build upon the GRASP framework developed in just 1 year

Further resources:

http://www.qgis.org/en/site/
http://live.osgeo.org/en/index.html

http://spatialquerylab.com/foss4g-academy-curriculum/

GST 101 – Introduction to Geospatial Technology (QGIS)
GST 102 – Spatial Analysis (QGIS)
GST 103 – Data Acquisition and Management (QGIS) –
GST 104 – Cartographic Design (QGIS and Inkscape) –
GST 105 – Introduction to Remote Sensing (QGIS and GRASS)

Acknowledgements

Dr Mark Ware, University of South Wales
Dr. Rafeal Moreno, University of Colarado Denver
SIGTE, University of Girona
GeoAcademy
Geo for All colleagues