Spatial Information Science / GIS Fundamentals

GEOM1033 / GEOM1159

Week 3 – Spatial Data Models

RMIT UNIVERSITY

Spatial Data Models

- Defining the data model
- Raster data model
- Raster spatial elements
- Creating a raster
- Vector data model
- Vector data components
- Raster vs Vector
- Main issues of spatial data models

RMIT UNIVERSITY

Spatial Data Models

- model
  - representation of reality in either material form (tangible) or symbolic form (abstract)
  - simplifies the “real world” which is infinitely complex

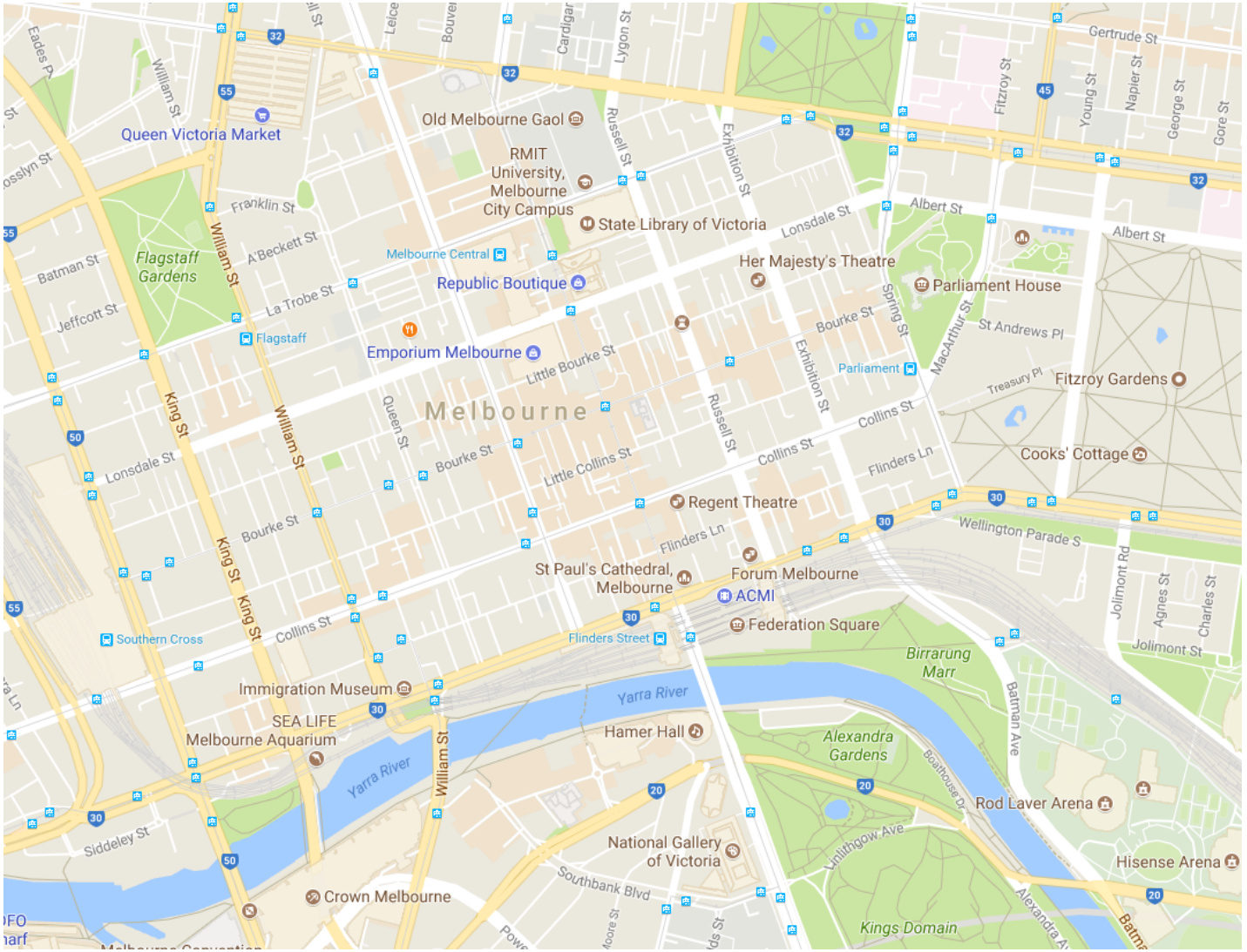
- data model
  - set of rules used to convert the infinitely complex real world into simple objects in a GIS

RMIT UNIVERSITY

Spatial Data Models

RMIT UNIVERSITY

Spatial Data Models



RMIT UNIVERSITY

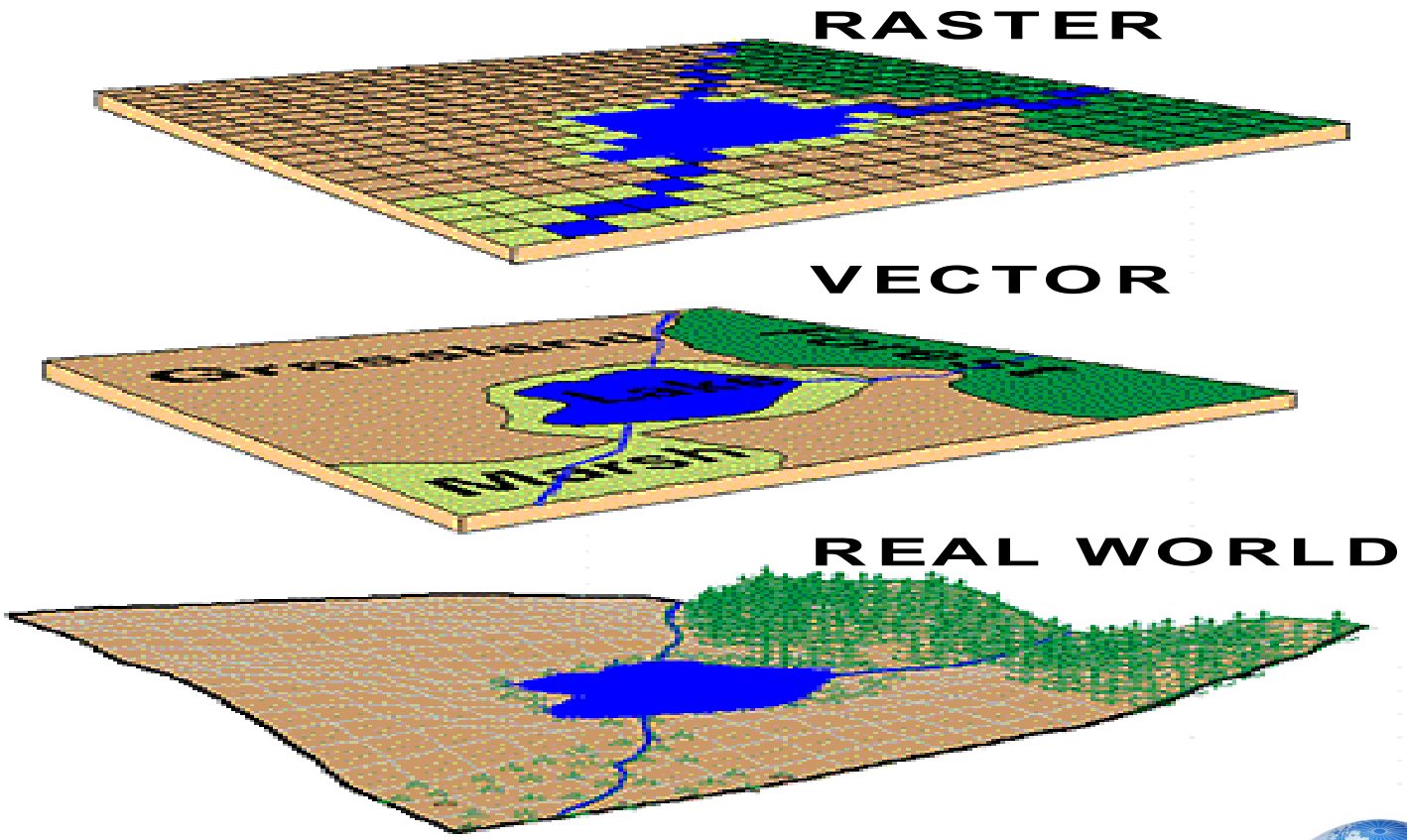
Defining Data Models

- differing GIS data models
  - GIS differ according to the way in which they represent the real world

- data models fall into one of two categories
  - raster
  - vector

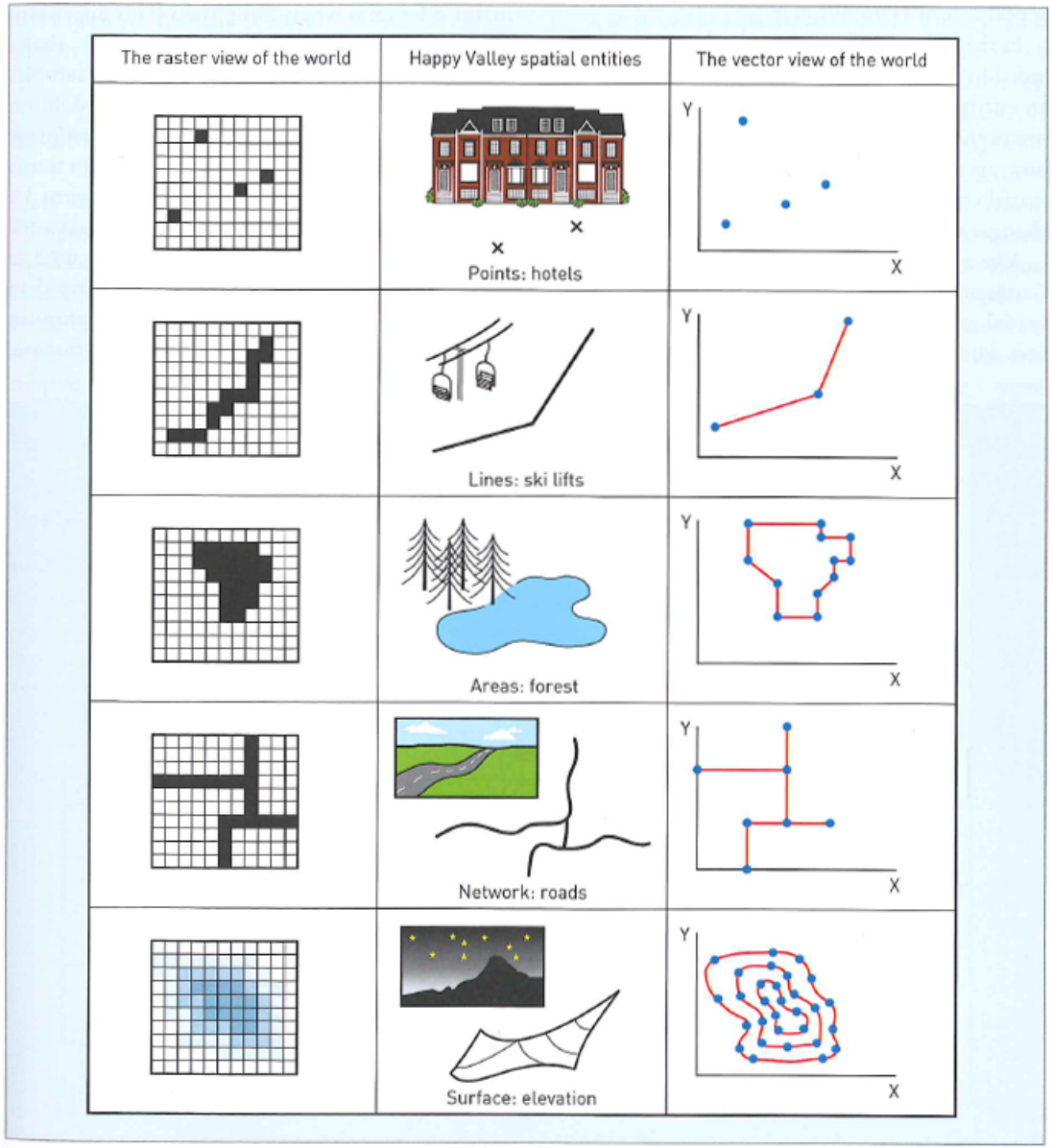
RMIT UNIVERSITY

Defining Data Models



RMIT UNIVERSITY

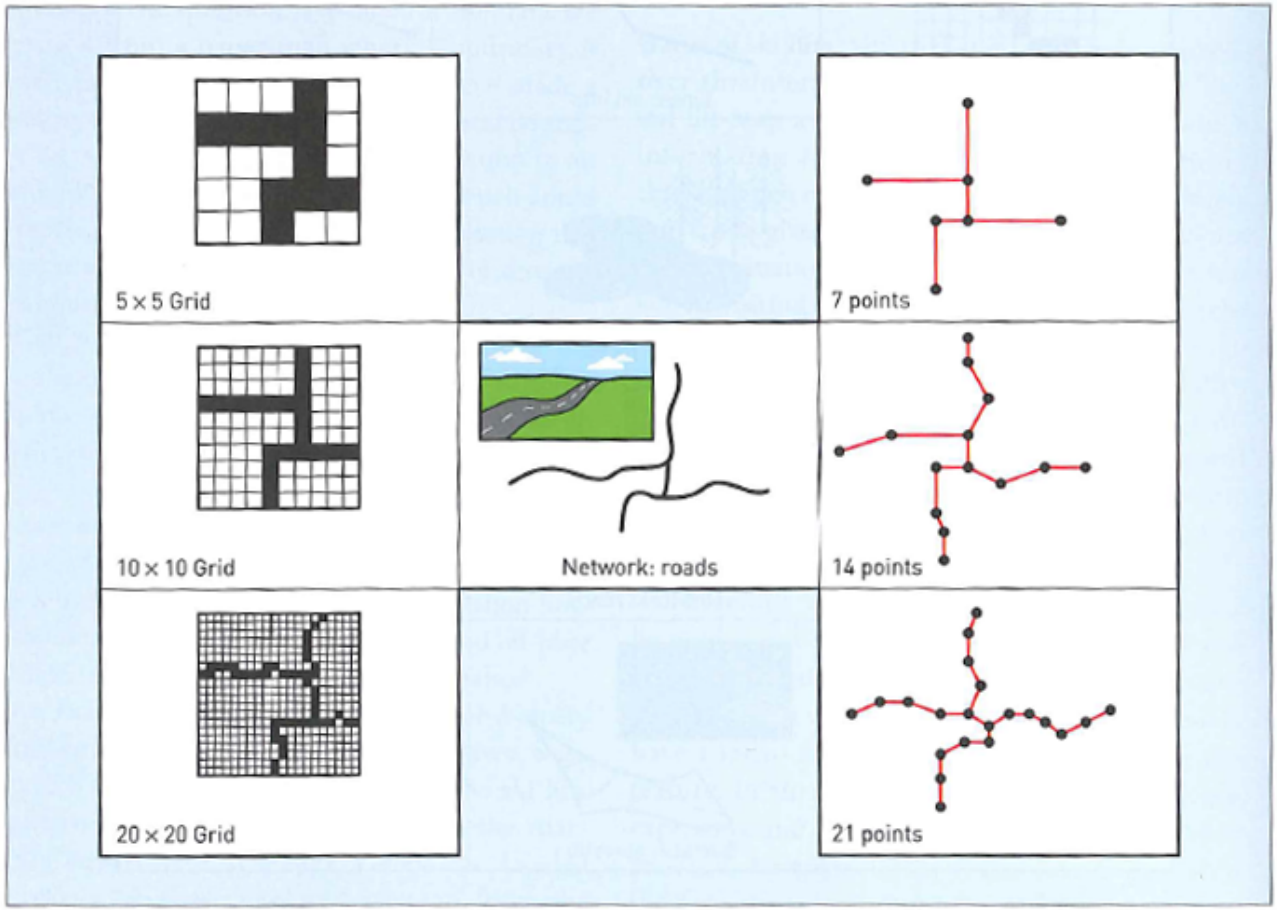
Raster and Vector Data Models



Ref: Heywood, Cornelius, Carver (2011) An Introduction To Geographical Information Systems

RMIT UNIVERSITY

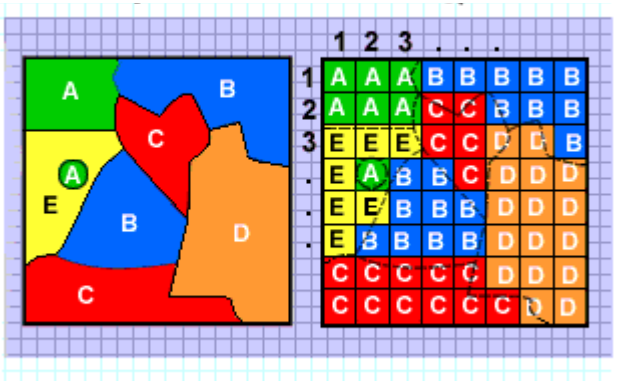
Changing Resolution



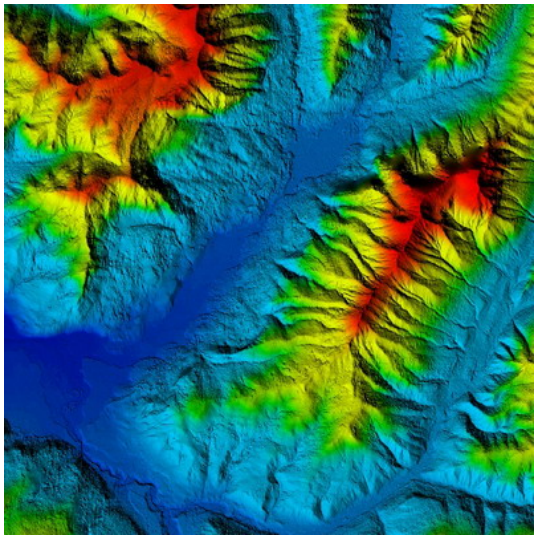
Ref: Heywood, Cornelius, Carver (2011) An Introduction To Geographical Information Systems

Spatial Data Models – RASTER

- data representation
  - divides study area into a rectangular grid of cells
- data storage
  - uses a conventional sequence of row by row from the top left hand corner
  - the raster data model assigns a value for every location or cell in the study area
- layers of information
  - one set of cells and associated values constitutes a layer
  - simple data storage and data analyses



Area to Raster

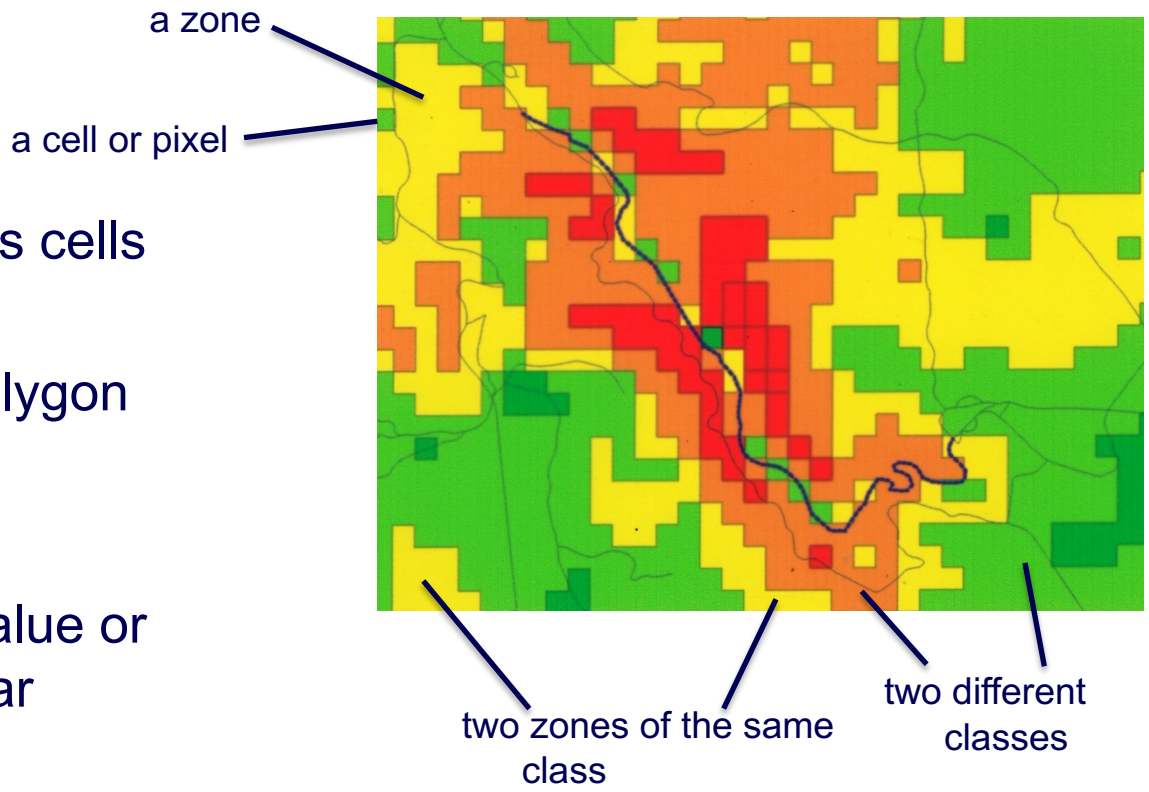


Digital Elevation Model

RMIT UNIVERSITY

Raster Data Model – Elements

- cell (or pixel)
  - smallest unit
- zone
  - a set of contiguous cells of the same value
  - analogous to a polygon
- class
  - a classification (value or type) of a particular phenomena



RMIT UNIVERSITY

Raster Data Model – Components

- resolution
  - the minimum linear dimension of the smallest geographic space for which data is recorded

240 cm resolution

60 cm resolution

- orientation
  - the angular difference between the direction north and the columns of the raster

Raster Layer Creation

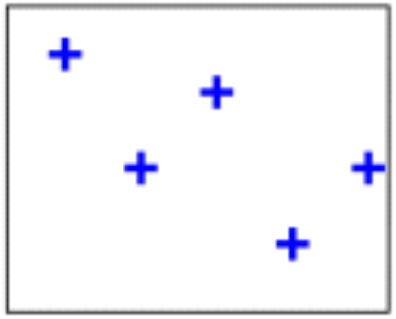
- Raster data components
  - Value
  - Cell location

- Attribute information
  - generally stored in a *lookup* table

RMIT UNIVERSITY

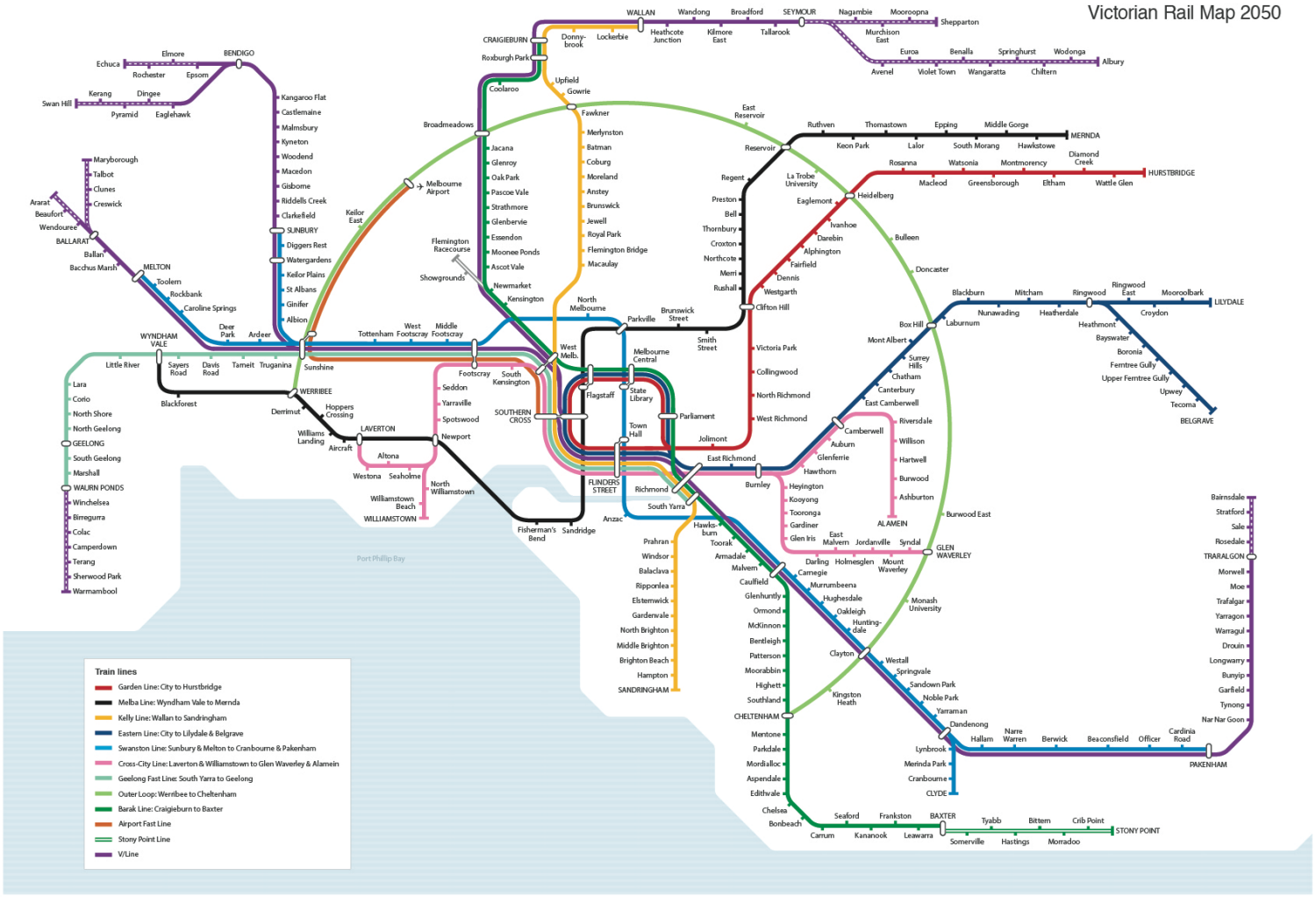
Spatial Data Models – VECTOR

- Data representation
  - uses graphical *primitives* to represent discrete objects
  - primitives:
    - points
    - lines
    - polygons
- Data storage
  - not space filling
  - represented by a series of co-ordinate pairs
- Layers of information
  - composed of one or a number of vector data components
  - more complex data storage and analysis methodology



RMIT UNIVERSITY

Vector Data Model – Elements



Vector Data Model – Elements

- points
  - fundamental object in the vector data model
- lines
  - are created by joining points
- polygons
  - sometimes called areas or regions
  - created from a closed set of lines
- identifiers
  - each object is linked to appropriate attribute information via an *identifier*

RMIT UNIVERSITY

Spatial Data Models – Raster vs. Vector

Raster

- **pros**
  - database structures are appealing due to their simplicity (especially with the remote sensing community)
  - spatial operations quick
  - uncertainty automatically reflected by cell size
- **cons**
  - lineal features and outlines can be crude
  - lineal operations more difficult
  - inaccuracies in parcel outlines
  - raster approach can sacrifice too much detail
  - large demand on memory for data storage

RMIT UNIVERSITY

Spatial Data Models – Raster vs. Vector

Vector

- **pros**
  - lineal features displayed elegantly
  - accurate representation for precision graphics
  - detail easily represented
  - minimal data storage requirements
  - links to existing textual databases
- **cons**
  - More intensive calculations required for spatial analysis
  - fine line detail could be misinterpreted for locational precision

RMIT UNIVERSITY

Spatial Data Models – Raster vs. Vector

Issues

- spatial precision
- costs of computing
- mass storage requirements
- characteristics of phenomena

RMIT UNIVERSITY

Spatial Data Models – Precision

Geographic or Spatial Precision

- **raster**
  - unclear whether centre or edge of cell is precise location of co-ordinate
  - locational precision therefore $^1/_2$ cell's width and height
- **vector**
  - can be encoded with any conceivable degree of precision (eg. single or double precision)
  - caution: "know" your source data!
  - real vector data accuracy may be worse than one line width

RMIT UNIVERSITY

Spatial Data Models – Costs of computing

Hardware/software

- **raster**
  - tend to be lower
  - spatial analysis processes tend to be quicker
- **vector**
  - more complex geometrical algorithms required for spatial analysis
  - more expensive software required - development costs higher

RMIT UNIVERSITY

Spatial Data Models – Storage

Mass storage/hard disk requirements

- **raster**
  - simple data structures - one memory location (one or two bytes) per cell
  - not efficient, although file compression techniques employed by most systems
  - memory requirements proportional to spatial variability of data
- **vector**
  - little storage requirements for simple polygons
  - memory requirements proportional to complexity of objects
  - dependent upon precision of co-ordinates stored (single or double)
  - dependent upon how topological data structures are stored
  - generally less storage than raster

RMIT UNIVERSITY

Spatial Data Models – Characteristics of phenomena

- Spatial sampling of phenomena
  - **raster**
    - regularly spaced grid
    - disregards spatial variability
  - **vector**
    - irregular data sample sites can be managed
    - rapid variation at boundaries
    - notion of “fuzzy boundaries”
- Features and objects
  - **raster**
    - cells are independent units not easily linked to complex objects
  - **vector**
    - complex objects can be handled as objects

Spatial Data Models – Raster vs. Vector

	RASTER	VECTOR
Precision in graphics	x	✓
Traditional cartography	x	✓
Data volume	x	✓
Topology	x	✓
Computation	✓	x
Update	✓	x
Continuous space	✓	x
Integration	✓	x
Discrete	x	✓

RMIT UNIVERSITY

Spatial Data Models – Raster vs. Vector

- Certain operations better handled in raster systems

- Need to be able to move seamlessly between the two
  - need for algorithms to convert from raster to vector and vice versa

RMIT UNIVERSITY

End of Week 3 – Spatial Data Models

RMIT UNIVERSITY