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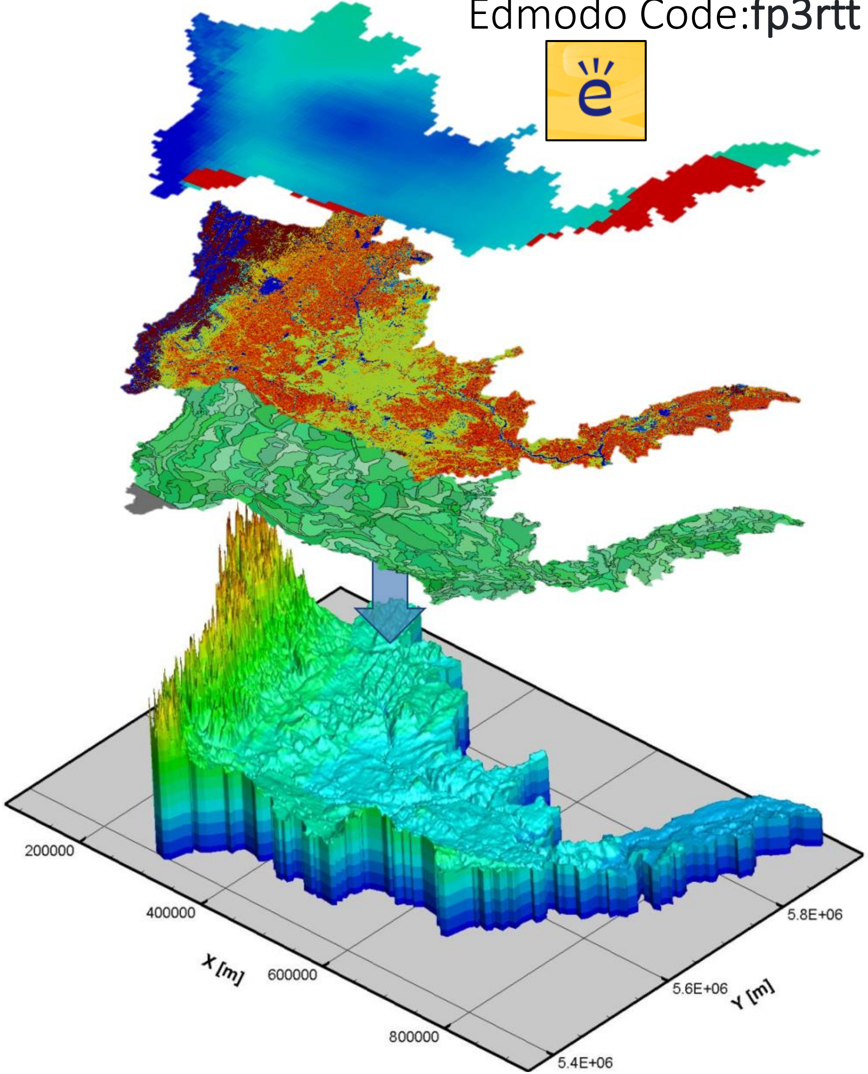
Salahaddin University-Erbil
College of Engineering
Water Resources Eng. Dept.
Second Year Students
1st Semester
2020-2021

Introduction to GIS
Vector Data Model

8th Lec.

Sarkawt H. Muhammad
sarkawt.muhammad@su.edu.krd



What we Learned in the Previouse class

Fundamentals of Remote Sensing

Electromagnetic Wave (EM)

Electromagnetic Spectrum

EM spectral region for RS

Outline

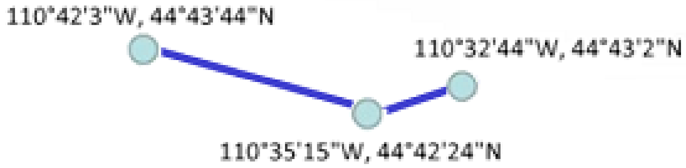
- Types of Vector Data
- Point, Line, Polygon
- Topology
- Adjacency and Incidence

Vector Data Model

The vector data model uses the geometric objects of point, line, and polygon to represent spatial features

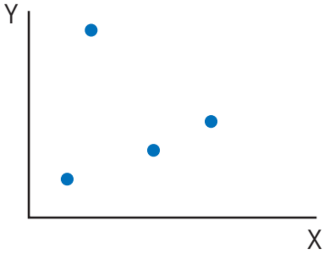
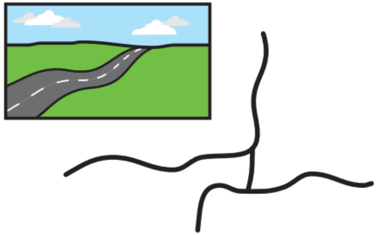
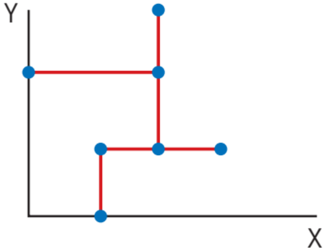
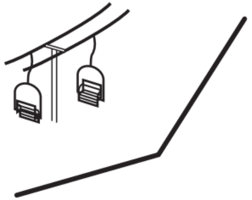
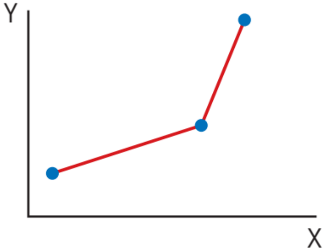
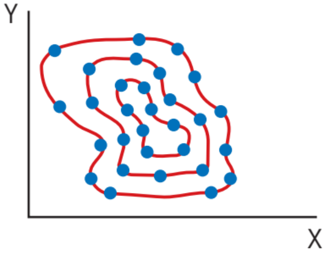
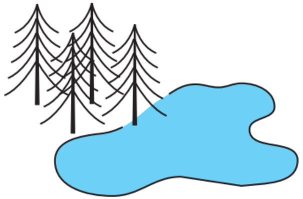
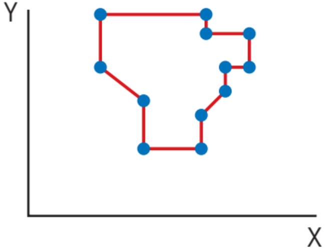
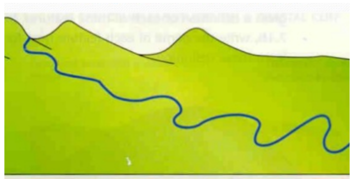
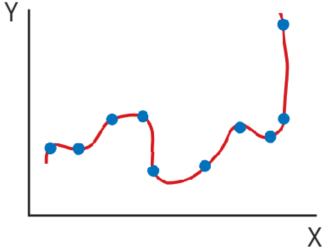
Types of Vector Data

- *<u>Points</u>*: One pair of coordinates defines the location of a point feature
- *<u>Polylines</u>* (*<u>LineStrings</u>*): Two or more pairs of coordinates that are connected define a line feature, and contains a set of series of connected points



- *<u>Polygons</u>*: Multiple pairs of coordinates that are connected and closed define a polygon feature. A series of connected points that loop back to the first point (Multiple "polygons" can exist in one layer, Polygons can have internal polygons or "holes“, The beginning and ending coordinates for a polygon are the same)

Vector Data Model

spatial entities	The vector view of the world	spatial entities	The vector view of the world
 Points: hotels		 Network: roads	
 Lines: ski lifts		 Surface: elevation	
 Areas: forest		 Stream	

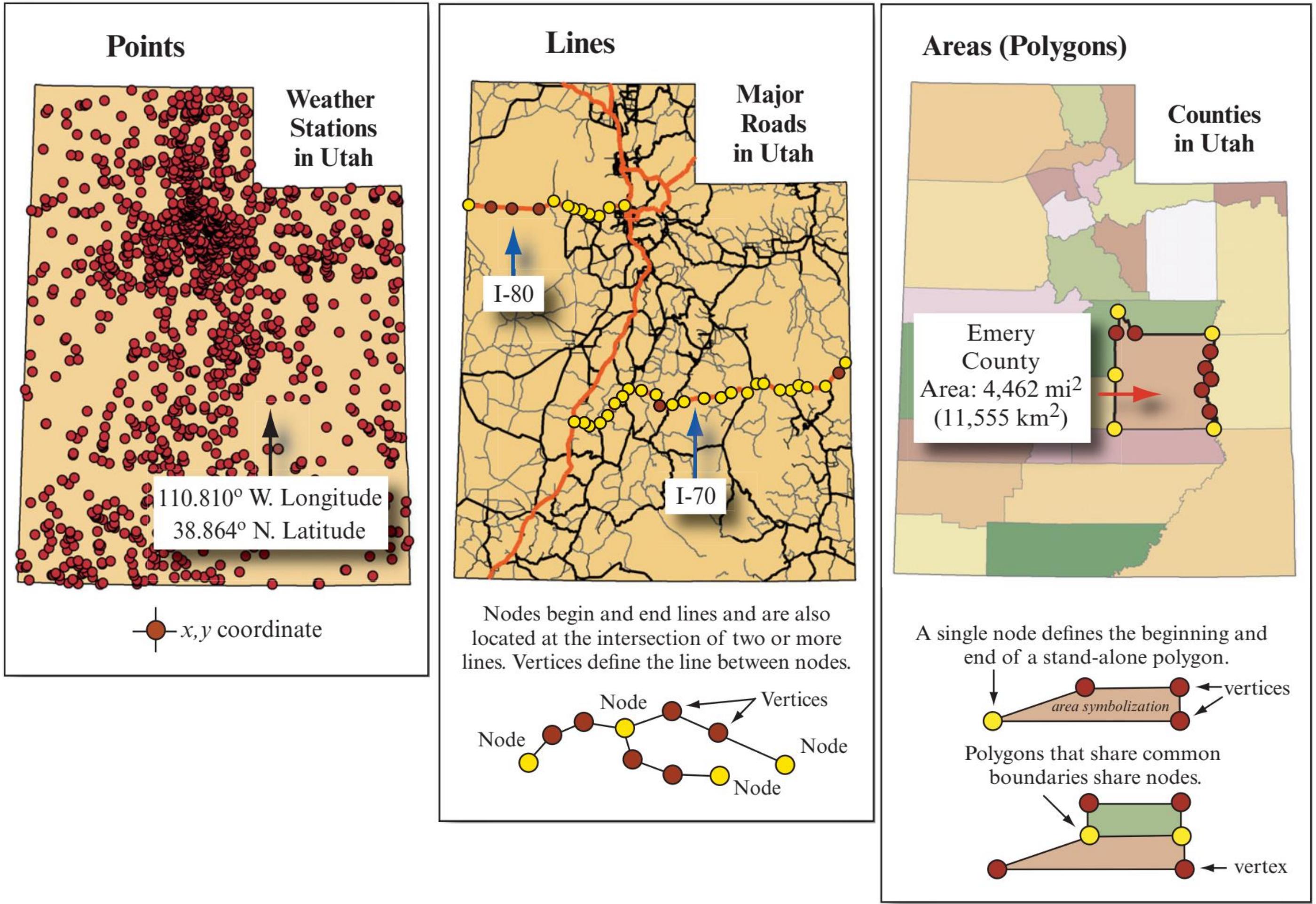
Vector Data Model (Cont.)

A **point** has zero dimension and has only the property of location; point feature is made of a point or a set of points. *Wells*, *Hotels*, *hospitals*, *dams*, *benchmarks*, and *gravel pits on a topographic map* are examples of point features.

A **line** is one-dimensional and has the property of length, in addition to location. A line has two end points and may have additional points in between to mark the shape of the line. The shape of a line may be a connection of straight-line segments or a smooth curve generated using a mathematical function. A line feature is made of a line or a set of lines. *Roads*, *cable line*, and *small streams* are examples of line features.

A **polygon** is two-dimensional and has the properties of area (size) and perimeter, in addition to location. Made of connected, closed, nonintersecting lines, the perimeter or the boundary defines the area of a polygon. Examples of polygon features include *vegetated areas*, *urban areas*, and *water bodies*.

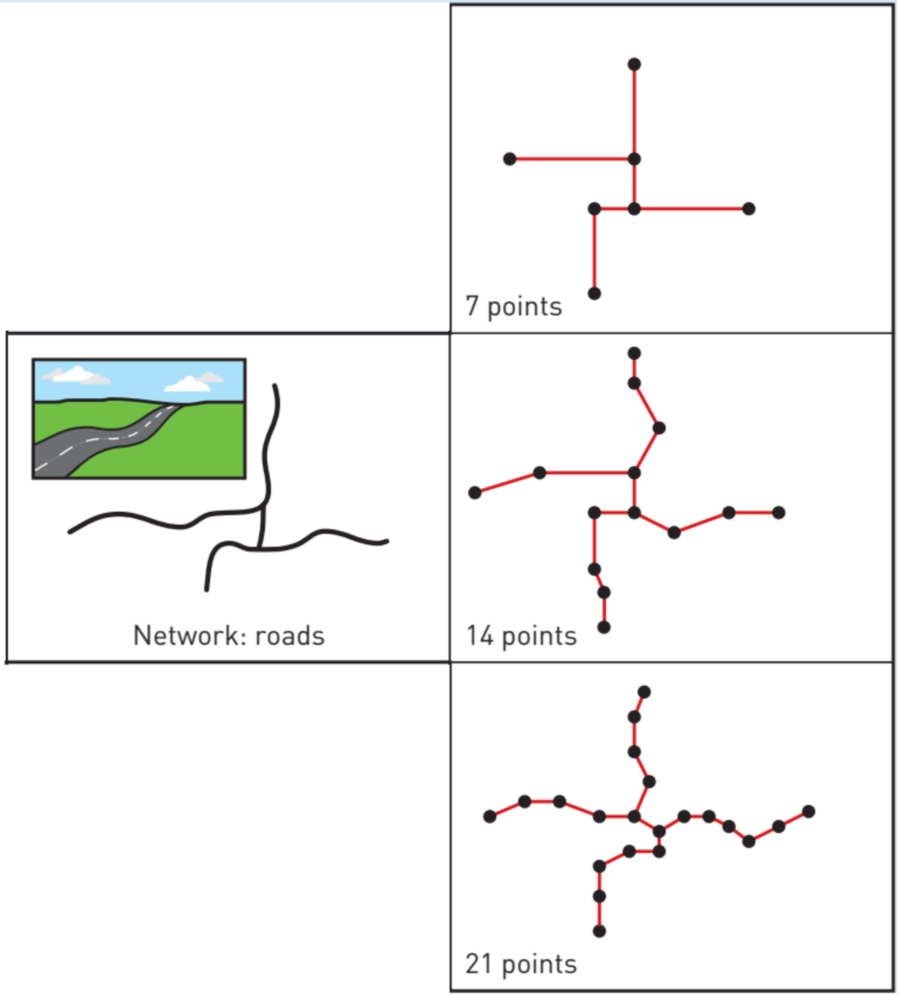
Vector Data Model (Cont.)



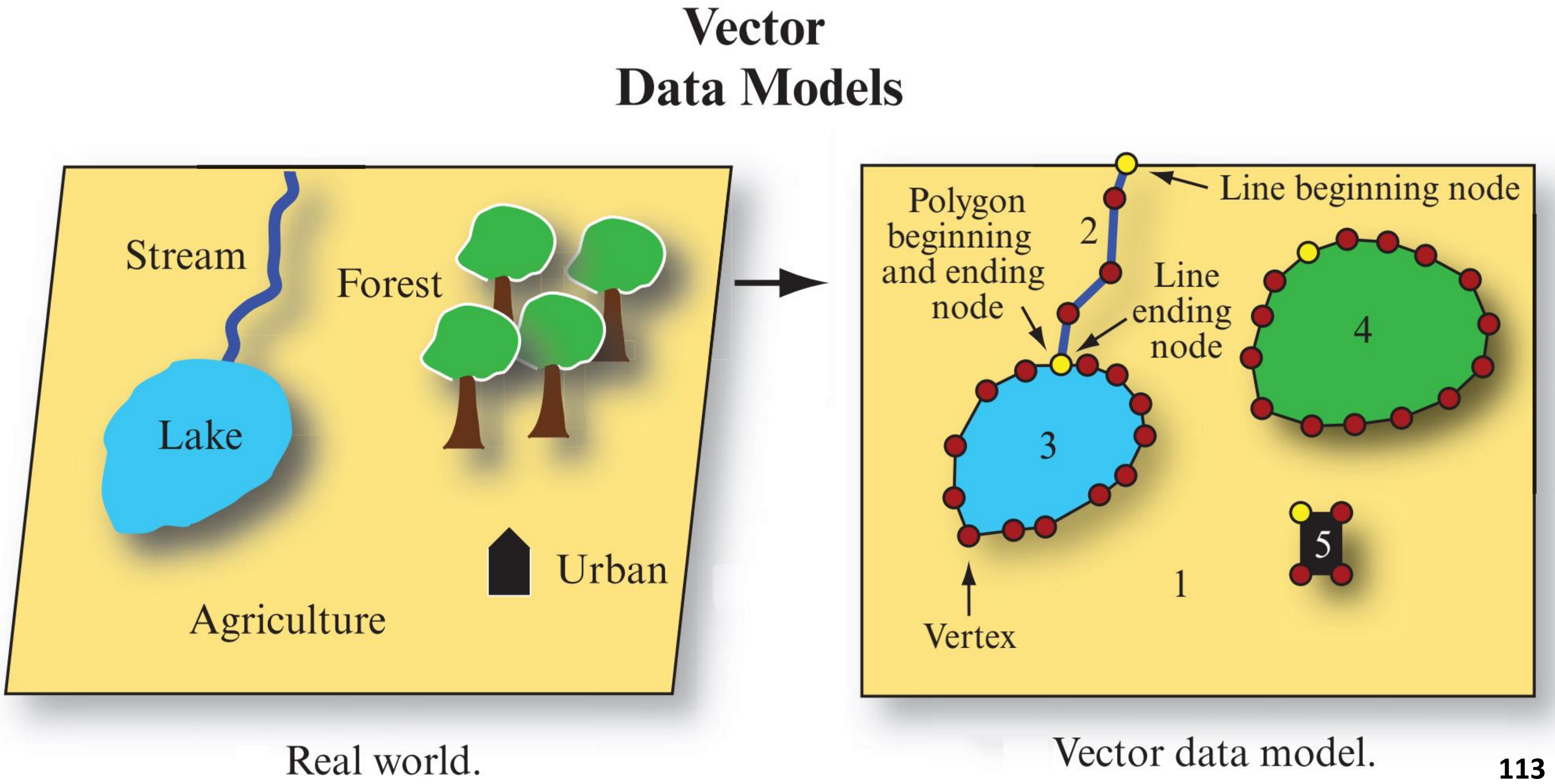
Vector Data Model (Cont.)

The more complex the shape of a line or area feature the greater the number of points required to represent it. Selecting the appropriate number of points to construct an entity is one of the major dilemmas when using the vector approach.

If too few points are chosen the character, shape and spatial properties of the entity (for example, area, length, perimeter) will be compromised. If too many points are used, unnecessary duplicate information will be stored and this will be costly in terms of data capture and computer storage



Vector Data Model (Cont.)



Vector Data Model (Cont.)

Although the classification of point, line, and polygon objects is well accepted in GIS, other terms may appear in the literature. For example, a ***multipoint*** refers to a set of points, a ***multiline*** a set of lines, and a ***multi-polygons*** a set of polygons.

Topology

Topology refers to the study of those properties of geometric objects that remain invariant under certain transformations such as bending or stretching. For example, a rubber band can be stretched and bent without losing its intrinsic property of being a closed circuit, as long as the transformation is within its elastic limits. An example of a topological map is a subway map

Topology (Cont.)

In GIS, vector data can be topological or nontopological, depending on whether topology is built into the data or not.

Topology can be explained through directed graphs (digraphs), which show the arrangements of geometric objects and the relationships among objects.

Why topology?

Topology is fundamentally used to ensure data quality of the spatial relationships and to aid in data compilation. Topology is also used for analyzing spatial relationships in many situations such as dissolving the boundaries between adjacent polygons with the same attribute values or traversing along a network of the elements in a topology graph, for example:

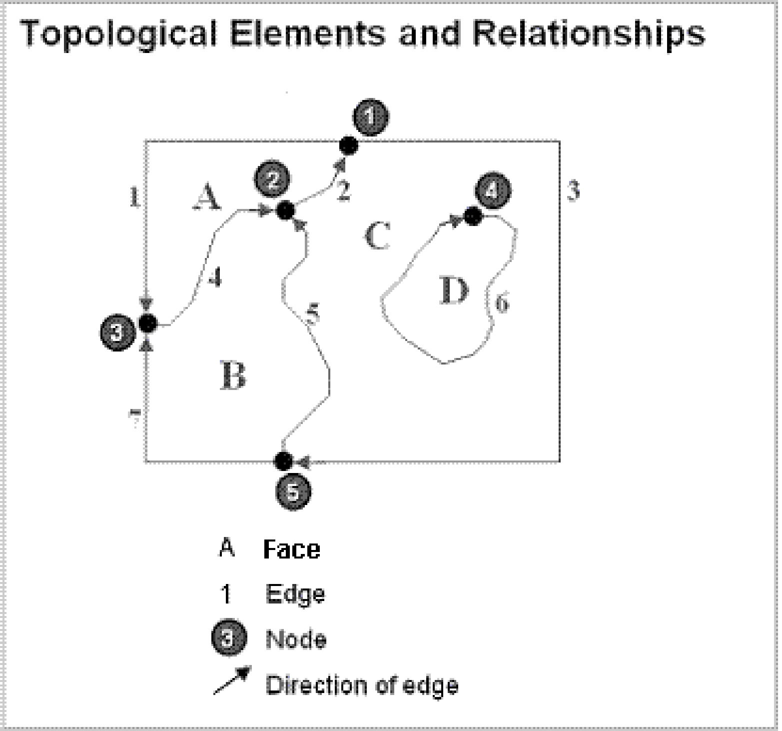
- Adjacent features, such as two counties, will have a common boundary between them. They share this edge.
- The set of county polygons within each state must completely cover the state polygon and share edges with the state boundary.

Topology (Cont.)

An edge or **arc** (used by ArcGIS) is a *directed* line with a *starting point* and an *ending point*. The end points of an arc are **nodes**, and intermediate points, if any, are **vertices**.

A **face** refers to a polygon bounded by arcs**.** If an arc joins two nodes, the nodes are said to be *adjacent* and *incident* with the arc.

Adjacency and *incidence* are two fundamental relationships that can be established between nodes and arcs in digraphs.

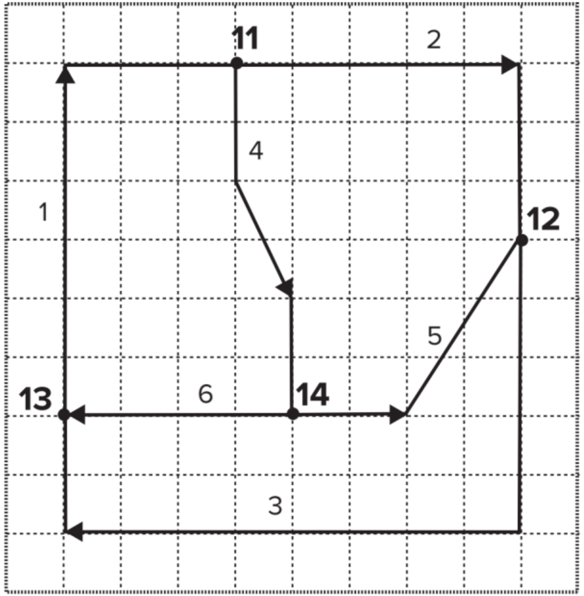


Adjacency and Incidence

If an arc joins two nodes, the nodes are said to be *adjacent* and *incident* with the arc, and the adjacency and incidence relationships can be expressed explicitly in matrices.

The row and column numbers of the ***adjacency*** matrix correspond to the **node numbers**, and the numbers within the matrix refer to the number of arcs joining the corresponding nodes in the digraph.

For example, **1** in (11,12) means one arc joint from node 11 to node 12, and **0** in (12,11) means no arc joint from node 12 to node 11. *The direction of the arc determines whether 1 or 0 should be assigned*

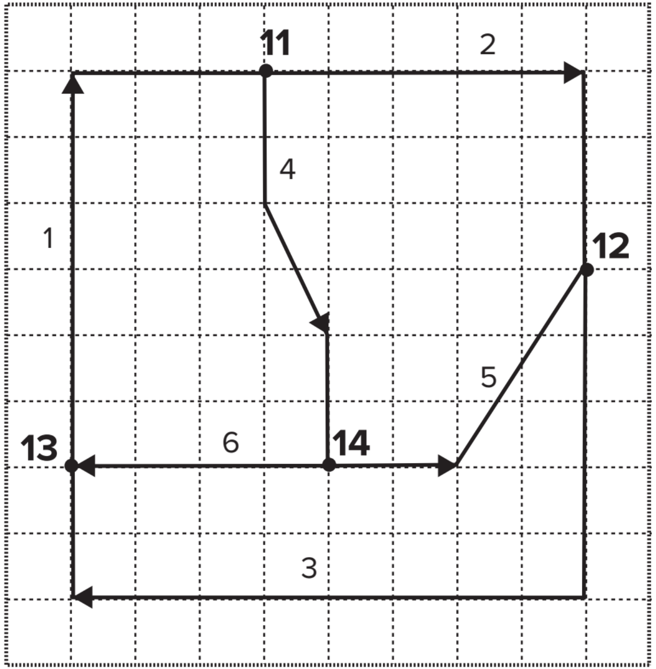


Adjacency matrix

	11	12	13	14
11	0	1	0	1
12	0	0	1	0
13	1	0	0	0
14	0	1	1	0

Adjacency and Incidence (Cont.)

The row numbers of the ***incidence*** matrix correspond to the **node number**, and the column numbers correspond to the **arc numbers**. The number **1** in the matrix means an arc is incident **from** a node, **–1** means an arc is incident **to** a node, and **0** means an arc is not incident from or to a node.



Take the example of arc 1. It is incident **from** node 13, incident **to** node 11, and not incident to all the other nodes.

Thus, the matrices express the adjacency and incidence relationships mathematically

Incidence matrix

	1	2	3	4	5	6
11	–1	1	0	1	0	0
12	0	–1	1	0	–1	0
13	1	0	–1	0	0	–1
14	0	0	0	–1	1	1