CE-317 GIS/RS Application to Civil Engineering
Spring 2011

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- Lecture 04: Georeferencing and Geocoding

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World Geographic Reference System - GEOREF

- The World Geographic Reference System is used for aircraft navigation.
- GEOREF is based on latitude and longitude.
- The globe is divided into twelve bands of latitude
- and twenty-four zones of longitude, each 15° in extent.
- These 15° areas are further divided into one degree units identified by 15 characters.

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World Geographic Reference System - GEOREF

Table 3.7: UTM zones and their extents

Zone no.	Central meridian	Bounding meridians	Zone no.	Central meridian	Bounding meridians	Zone no.	Central meridian	Bounding meridians
1	177°W	180° - 174°W	21	57°W	60° - 54°W	41	63°E	60° - 66°E
2	171°W	174° - 16°W	22	51°W	54° - 48°W	42	69°E	66° - 72°E
3	165°W	168° - 162°W	23	45°W	48° - 42°W	43	75°E	72° - 78°E
4	159°W	162° - 156°W	24	39°W	42° - 36°W	44	81°E	78° - 84°E
5	153°W	156° - 150°W	25	33°W	36° - 30°W	45	87°E	84° - 90°E
6	147°W	150° - 144°W	26	27°W	30° - 24°W	46	93°E	90° - 96°E
7	141°W	144° - 138°W	27	21°W	24° - 18°W	47	99°E	96° - 102°E
8	135°W	138° - 132°W	28	15°W	18° - 12°W	48	105°E	102° - 108°E
9	129°W	132° - 126°W	29	09°W	12° - 06°W	49	111°E	108° - 114°E
10	123°W	126° - 120°W	30	03°W	06° - 00°W	50	117°E	114° - 120°E
11	117°W	120° - 114°W	31	03°E	00° - 06°E	51	123°E	120° - 126°E
12	111°W	114° - 108°W	32	09°E	06° - 12°E	52	129°E	126° - 132°E
13	105°W	108° - 102°W	33	15°E	12° - 18°E	53	135°E	132° - 138°E
14	99°W	102° - 96°W	34	21°E	18° - 24°E	54	141°E	138° - 144°E
15	93°W	96° - 90°W	35	27°E	24° - 30°E	55	147°E	144° - 150°E
16	87°W	90° - 84°W	36	33°E	30° - 36°E	56	153°E	150° - 156°E
17	81°W	84° - 78°W	37	39°E	36° - 42°E	57	159°E	156° - 162°E
18	75°W	78° - 72°W	38	45°E	42° - 48°E	58	165°E	162° - 166°E
19	69°W	72° - 66°W	39	51°E	48° - 54°E	59	171°E	166° - 172°E
20	63°W	66° - 60°W	40	57°E	54° - 60°E	60	177°E	172° - 180°E

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Regional Systems

- Regional Systems: Several different systems are used regionally to identify geographic location.
- Some of these are true coordinate systems, such as those based on UTM and UPS systems.
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The British National Grid (BNG)

- The British National Grid (BNG) is based on the National Grid System of England
- Administered by the British Ordnance Survey
- Based on the Ordnance Survey of Great Britain Datum 1936
- The BNG has been based on a **Transverse Mercator projection** since the 1920s

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Indian Grid System

- The Indian system follows almost the same as British system.
- The Indian system has eight grid zones named as 00, 0I, IIA, IIB, IIIA, IIIB, IVA, IVB based on Lamberts conical orthomorphic projection with two standard parallels covering India, Pakistan, Myanmar, Afghanistan, parts of Iran, China, Tibet and Thailand.
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State Plane Coordinates (SPC)

- SPCs are individual coordinate systems adopted by U.S. state agencies.
- State plane systems were developed in order to provide local reference systems that were tied to a national datum.
- In the United States, the State Plane System 1927 was developed in the 1930s and was based on the North American Datum 1927 (NAD-27).
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State Plane Coordinates (SPC)

- The State Plane System 1983 is based on the North American Datum 1983 (NAD-83).
- NAD-83 coordinates are metric.
- While the NAD-27 State Plane System has been superceded by the NAD-83 System, maps in NAD-27 coordinates are still in use.

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Georeferencing

- Geographic location is the element that distinguishes spatial data with non spatial data.
- Methods for specifying location on the earth's surface for geographical data in a map is called as georeferencing.

or …..

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Georeferencing

- All the elements in a map layer have a specific geographic location and extent that enables them to be located on or near the earth's surface.
- The ability to accurately describe geographic locations is critical in both mapping and GIS.
- This process is called georeferencing.

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Linear Referencing

- Linear referencing is the method of storing geographic locations by using relative positions along a measured linear feature.

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Georeferencing

- The primary requirements of a georeference are that it should be unique,
- so that there is only one location associated with a given georeference (e.g., Hyderabad – one in India another in Pakistan).

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Georeferencing

- It should stay constant through time, because it could create confusion if it changes (e.g., Madras – Chennai).
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Georeferencing

Box 5 : Commonly used systems of georeferencing

System	Domain of uniqueness	Metric / Non-metric	Example	Spatial resolution
Place name	Varies	Non metric	Hyderabad – India or Pakistan?	Varies
Postal address	Country	Non metric	11, Rose Apartments, Marris Road, Aligarh	Size of one mailbox
Postal code	Country	Non metric	202002(Aligarh, India) or WC1H OPF (London, U.K.)	Area occupied by a defined number of mailbox
Telephone code	Country	Non metric	011 (New Delhi, India)	Varies
Latitude/Longitude	Global	Metric	27°53′ North Latitude and 78°35′ East Longitude.	Infinitely fine
UTM	Zones of six degrees of longitude wide	Metric	1393267 & 3117373	Infinitely fine
State plane coordinates	USA only	Metric	55046.37 E & 75246.64 N	Infinitely fine

Data in a GIS must contain a geographic reference to a map, such as latitude and longitude. The GIS cross-references the attribute data with the map data.

Discrete Georeferencing

- The georeferencing methods covered so far latitude–longitude, Cartesian, projections from latitude/longitude to the plane
- Georeferencing is continuous this means that there is no effective limit to precision, as coordinates are measured on continuous scales.

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Discrete Georeferencing

- The discrete methods systems of georeferencing for discrete units on the earth's surface are indirect
- This means that the method provides a key or index
- Which can then be used with a table to determine latitude/longitude or coordinates.

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Discrete Georeferencing

- For example, a Zip code is an indirect georeference, where instead assigning latitude/longitude for a place directly
- It provides a unique number which can be looked up on a map if coordinates are needed.
- Precision is related directly to the size of the discrete unit which forms the basis of the georeferencing system
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Discrete Georeferencing

- **Street Address:** This is a common discrete method of georeferencing
  - here the precision of street addresses as georeferences varies greatly.
  - It is better for cities but poor for rural areas.

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Discrete Georeferencing

- **Postal Code System:** Postal code systems have been set up in many countries
  - these often provide a high level of spatial precision.
  - The 6 digit ZIP potentially provides a much higher level of spatial resolution
  - But problems exist with overlapping and fragmented boundaries.

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Discrete Georeferencing

- **US Public Land Survey System:** PLSS is the basis for land surveys and legal land description over much of the US.
  - Unlike the previous systems, it is designed to reference land parcels,

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Affine And Curvilinear Transformations

- Coordinate transformations are required when we need to register different sets of coordinates for objects in the same area that may have come from maps of different (and sometimes unknown) projections.

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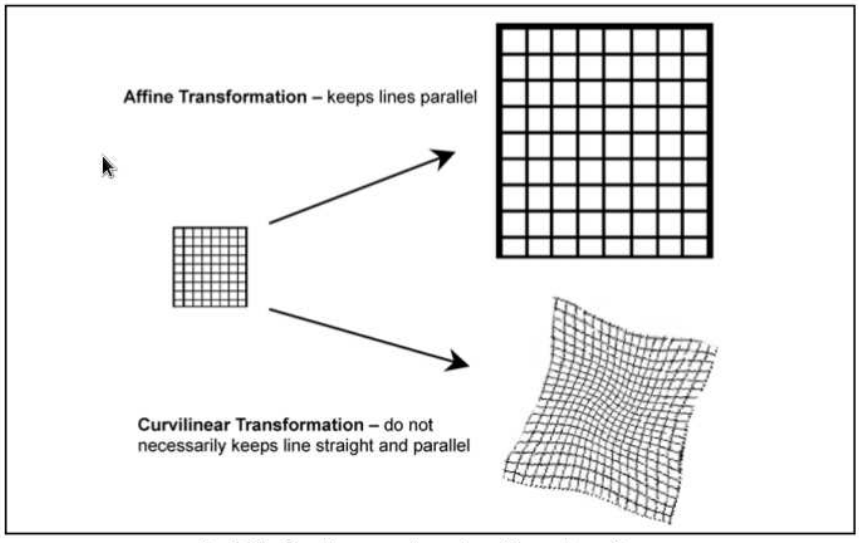
Affine And Curvilinear Transformations



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2 Ways of Transformation

1. Move objects on a fixed coordinate system so that the coordinates change
2. Hold the objects fixed and move the coordinate system, this is the more useful way to consider transformations for GIS purposes.

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Affine Transformations

- Affine transformations are those which keep parallel lines parallel
- They are a class of transformations which have 6 coefficients.

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Curvilinear Transformations

- Curvilinear transformations are higher order transformations that do not necessarily keep lines straight and parallel and these transformations may require more than 6 coefficients.

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Affine Transformation Primitives

- Affine Transformation Primitives: affine transformations keep parallel lines parallel and there are four different types (primitives):

a. Translation-origin is moved, axes do not rotate

$u = x - a$
$v = y - b$

- here, origin is moved a units parallel to x and b units parallel to y

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Affine Transformation Primitives

- b. Scaling-both origin and axes are fixed, scale changes
  - u = cx v = dy
  - here, scaling of x and y may be different, if the scaling is different, the shape of the object will change

c. Rotation-origin fixed, axes move (rotate about origin)

- u = x cos(a) + y sin(a) v = – x sin(a) + y cos(a)
- (here a is measured counterclockwise)

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Affine Transformation Primitives

d. Reflection-coordinate system is reversed, objects appear in mirror image to reverse y, but not x:

- u = x v = c – y
- here, this transformation is important for displaying images on video monitors

- Complex Affine Transformations: Usually a combination of these transformations

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Affine Transformation Primitives

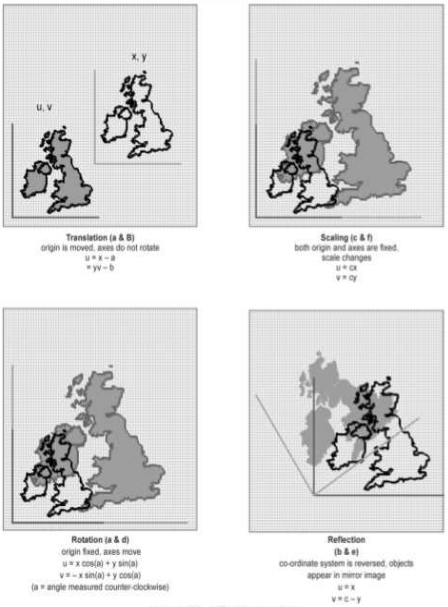

Figure 3.22: Affine transformations.

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Curvilinear Transformations

- Simple linear affine transformation equations can be extended to higher powers:
- u = a + bx + cy + gxy or u = a + bx + cy + gx2

or

- u = a + bx + cy + gx2 + hy2 + ixy
- equations of this form create curved surfaces,

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Geocoding

- Geocoding is the process of assigning a location, usually in the form of coordinate values (points), to an address.
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Address

- An address is simply a method used to describe a location.
- Unlike a coordinate value, an address describes how to reference a location based on existing features in your geographic information system (GIS) database

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Geocoding Work Flow

Building or obtaining reference data
Obtain and make any needed modifications to the reference data to coincide with address locator style requirements.

Determining address locator style
Select an address locator style that accommodates the type of address you want to geocode and the address attributes available in the reference data.

Building an address locator
Based on a specific address locator style, create an address locator, incorporating the style-specific guidelines and specifying the geocoding options.

Locating addresses
Using your address locator, search for an individual address or perform a batch search, locating a group of addresses.

Publishing, maintaining, or customizing your address locator
A wide range of functions are possible including the distribution, updating, and customization of your address locator.

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Process of Geocoding

Original address	127 West Birmingham Drive, 92373
Address parsed	127 | West | Birmingham | Drive | 92373
Abbreviations standardized	127 | W | Birmingham | Dr | 92373
Elements assigned to match keys	[HN]: 127 [ST]: Dr [SD]: W [ZP]: 92373 [SN]: Birmingham
Index values calculated	[HN]: 127 [ST]: Dr [SD]: W [ZP]: 92373 (index #92373) [SN]: Birmingham (Soundex index #B655)

Search address locator and identify candidates.

Score of each potential match established

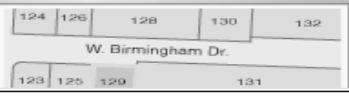
Street	Number	Direction	MatchScore
Birmingham	129	W	90
Birmingham	125	W	85
Burnington	1100	W	60
Brunton	129	N	70
Broomstick	145	S	30

List of candidates filtered

Street	Number	Direction	MatchScore
Birmingham	129	W	90
Birmingham	125	W	85

Best candidate matched: 129 W Birmingham Dr. , 92373

Matched feature indicated



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