

GIS APPLICATIONS

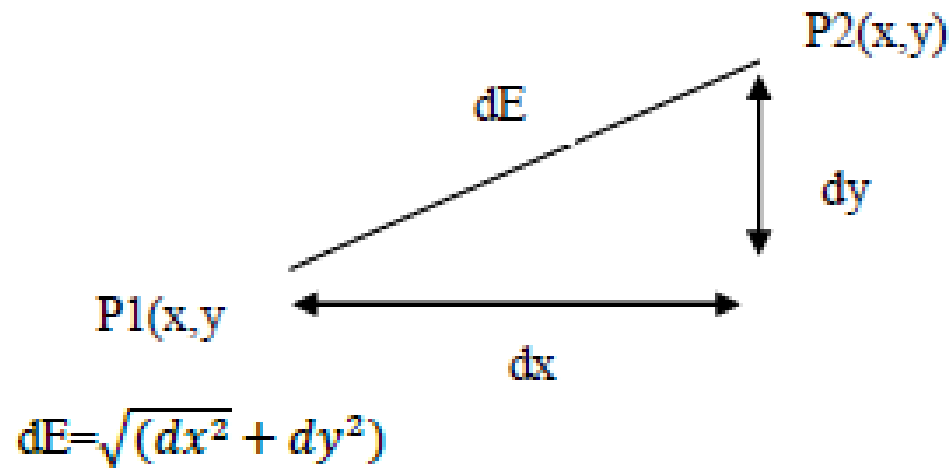
LECTURE 3

CONCEPTS OF DISTANCE

- In mathematics, the Euclidean distance or Euclidean metric is the "ordinary" distance between two points that one would measure with a ruler, and is given by the Pythagorean formula.



CONCEPTS OF DISTANCE



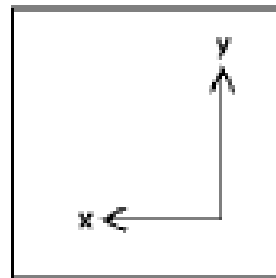
CONCEPTS OF DISTANCE -MANHATTAN DISTANCE

- The Manhattan distance function computes the distance that would be traveled to get from one data point to the other if a grid-like path is followed.
- The formula for this distance between a point $X=(X_1, X_2, \text{etc.})$ and a point $Y= (Y_1, Y_2, \text{etc.})$ is:

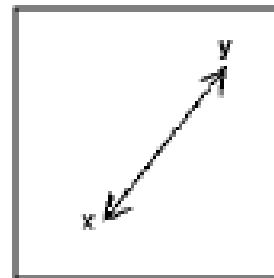


CONCEPTS OF DISTANCE –EUCLIDEAN DISTANCE/MANHATTAN DISTANCE

The following figure illustrates the difference between Manhattan distance and Euclidean distance:



Manhattan



Euclidean



CONCEPTS OF DISTANCE – SPHERICAL DISTANCE

- **Distance on a curved surface**
- Because spherical geometry is rather different from ordinary Euclidean geometry, the equations for distance take on a different form.



CONCEPTS OF DISTANCE – SPHERICAL DISTANCE

Let ϕ_s, λ_s ; ϕ_f, λ_f be the geographical latitude and longitude of two points (a base "standpoint" and the destination "forepoint"), respectively, and $\Delta\phi, \Delta\lambda$ their differences; then $\Delta\hat{\sigma}$, the central angle between them, is given by the spherical law of cosines:

$$\Delta\hat{\sigma} = \arccos(\sin \phi_s \sin \phi_f + \cos \phi_s \cos \phi_f \cos \Delta\lambda).$$

The distance d , i.e. the arc length, for a sphere of radius r and $\Delta\hat{\sigma}$ given in radians, is then:

$$d = r \Delta\hat{\sigma}.$$



CONCEPT OF SPACE

- Note that:
- The way People conceptualise space is important consideration for the design of GIS.
- Better match peoples thinking is expected to lead to easier to use Systems
- Spaces can be categorised-
- Look at this from a thematic mapping point of view!



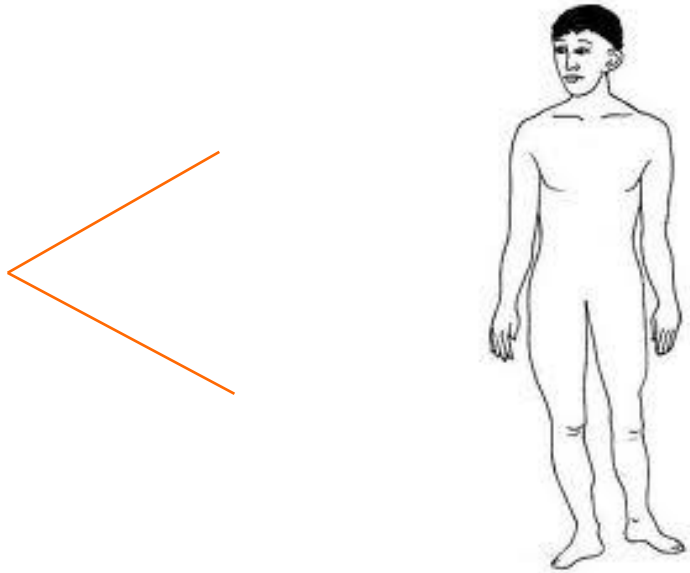
CONCEPT OF SPACE

- Types of spaces can be categorised as follows:
- □ Manipulable object space
- □ Non-manipulable object space
- □ Environmental space
- □ Geographic space
- □ Panoramic space
- □ Map space



CONCEPT OF SPACE

- Manipulable object space is space smaller than the human body

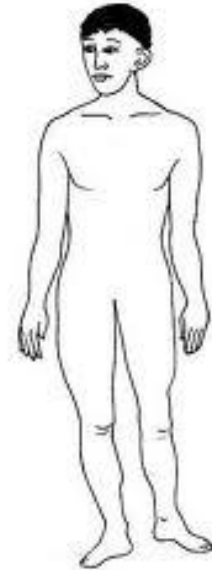


Blank Human Body Diagram to Label



CONCEPT OF SPACE

- Non-manipulable space is space larger than the human body but smaller than a building



Blank Human Body Diagram to Label



CONCEPT OF SPACE

- Environmental space is space that ranges from building sizes to city-size spaces.



CONCEPT OF SPACE

- Geographic space is synonymous with state, country and continent sizes



CONCEPT OF SPACE

- Panoramic spaces are spaces perceived by scanning the landscape.



CONCEPT OF SPACE

- Modelling of physical or environmental space contrary to how people experience spaces.
- Large scale spaces- large space
 - Viewer learns this space piecemeal overtime
 - E.g geographic neighbourhoods and inside of building spaces
- Small scale spaces- small space
 - View whole space from a vantage point
 - E.g. table size, room-size
- People's experience of space is
 - Scale-dependent
 - Experience-based



SPATIAL AGGREGATION/SCALE PROBLEM

- Socio-economic data may be available at a variety of scales,
- For example:
 - municipalities,
 - regional districts,
 - census tracts,
 - enumeration districts,
 - or at the provincial/state level.
- When this data is aggregated at different scales, the **resulting descriptive statistics** may exhibit variations, either in a systematic, predictable way, or in a more uncertain fashion.



SPATIAL AGGREGATION/SCALE PROBLEM

- If we are observing economic data, we may notice a distinct reduction in manufacturing productivity for a country (the USA) over a certain period;
- since this is a general model, individual states may experience these effects differently.
- The result of this aggregation is that the standard deviation of the data in question is increased due to the variability among states.



THE MODIFIABLE AREAL UNIT PROBLEM

- **From Last Week too**
- **The Modifiable Areal Unit Problem**



THE MODIFIABLE AREAL UNIT PROBLEM

- The Modifiable Areal Unit Problem (MAUP) is a potential source of error that can affect spatial studies which utilise aggregate data sources (Unwin, 1996).
- Geographical data is often aggregated in order to present the results of a study –context
- Context-
 - enumeration districts or
 - police beat boundaries
- These zones are often arbitrary in nature!



THE MODIFIABLE AREAL UNIT PROBLEM

- Different areal units can be just as meaningful in displaying the same base level data.
- Large amounts of source data require a careful choice of aggregating zones to display the spatial variation of the data in a comprehensible manner.
- As the study area for crime incident locations has effectively infinite resolution, there exists a potentially infinite number of different options for aggregating the data.



THE MODIFIABLE AREAL UNIT PROBLEM

- Numerous administrative boundaries exist, such as
 - enumeration districts,
 - wards, counties,
 - health authority areas, etc.
- Within modern GIS, it is an elementary task to automatically generate a huge variety of non-overlapping boundaries.
- Regular, often square, grids are common, though polygons have been used in other studies of crime distribution
- what is available/ than what is best!!



THE MODIFIABLE AREAL UNIT PROBLEM

- Openshaw (1984) calculated that if one was to attempt to aggregate 1,000 objects into 20 groups, you would be faced with 101,260 different solution combinations.
- The MAUP consists of both
 - a scale and
 - an aggregation problem, and
 - the concept of the ecological fallacy should also be considered (Bailey and Gatrell, 1995).



MAUP-SPATIAL AGGREGATION/SCALE PROBLEM

- The scale problem is relatively well known.
- It is the variation which can occur when data from one scale of areal units is aggregated into more or less areal units.
 - For example, much of the variation in enumeration districts changes or is lost when the data is aggregated to the ward or county level.
- The aggregation problem is less well known and becomes apparent when faced with the variety of different possible areal units for aggregation.



