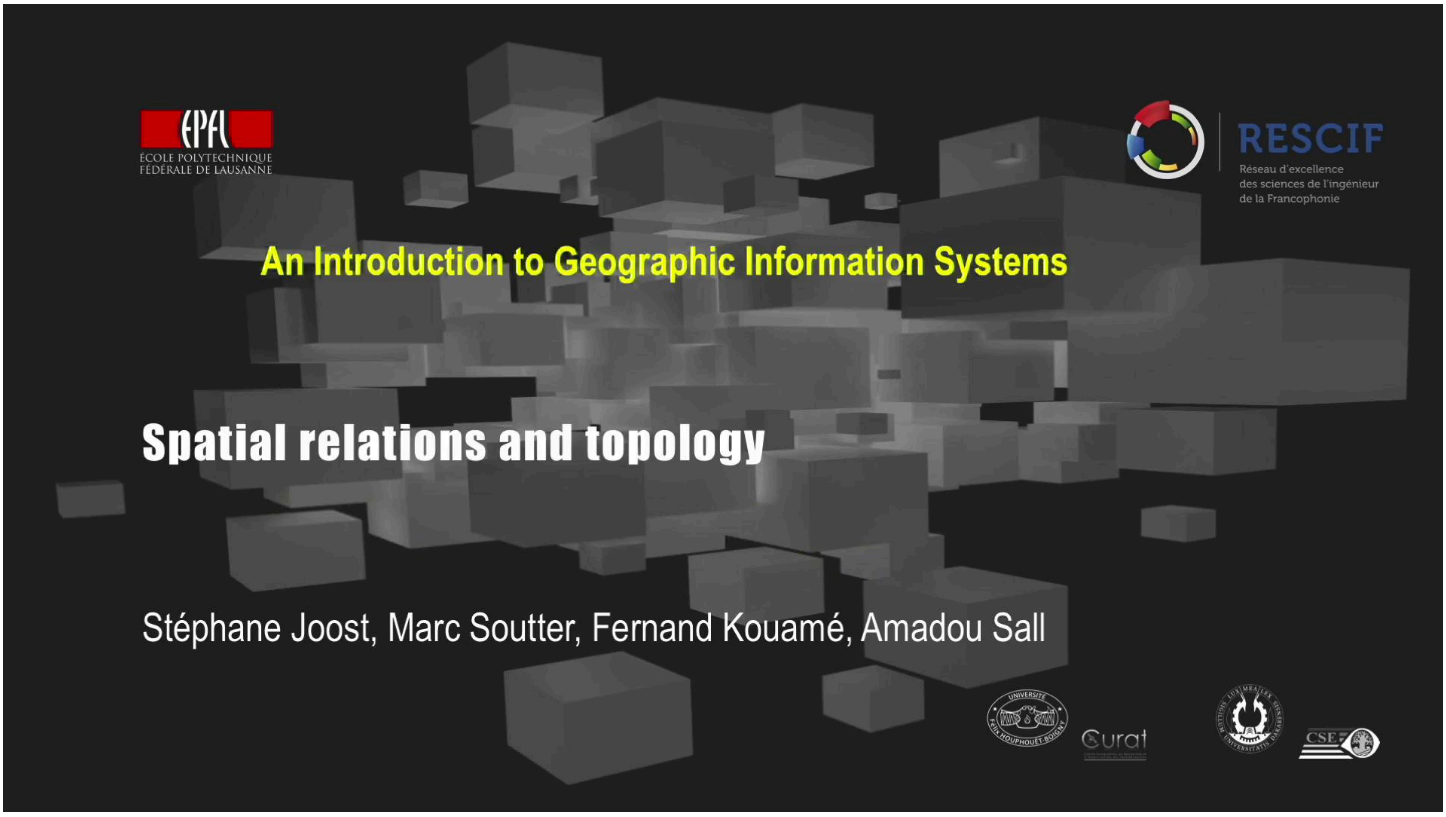

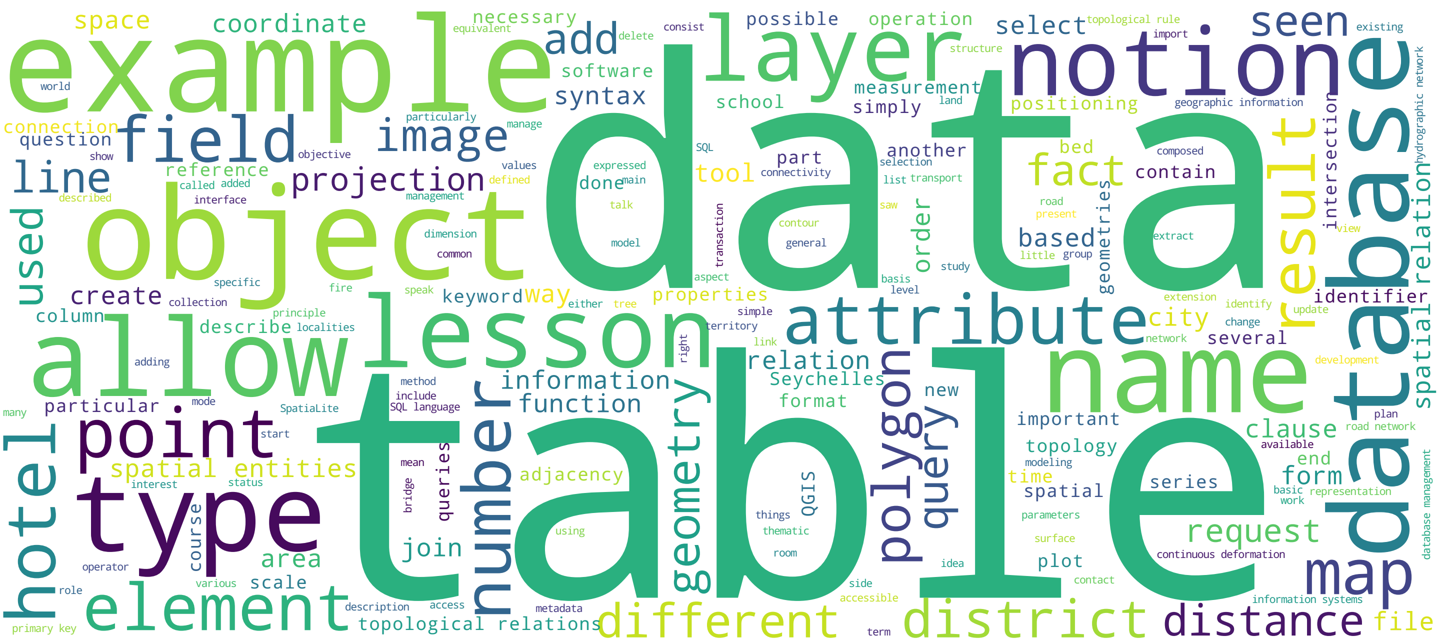

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Video

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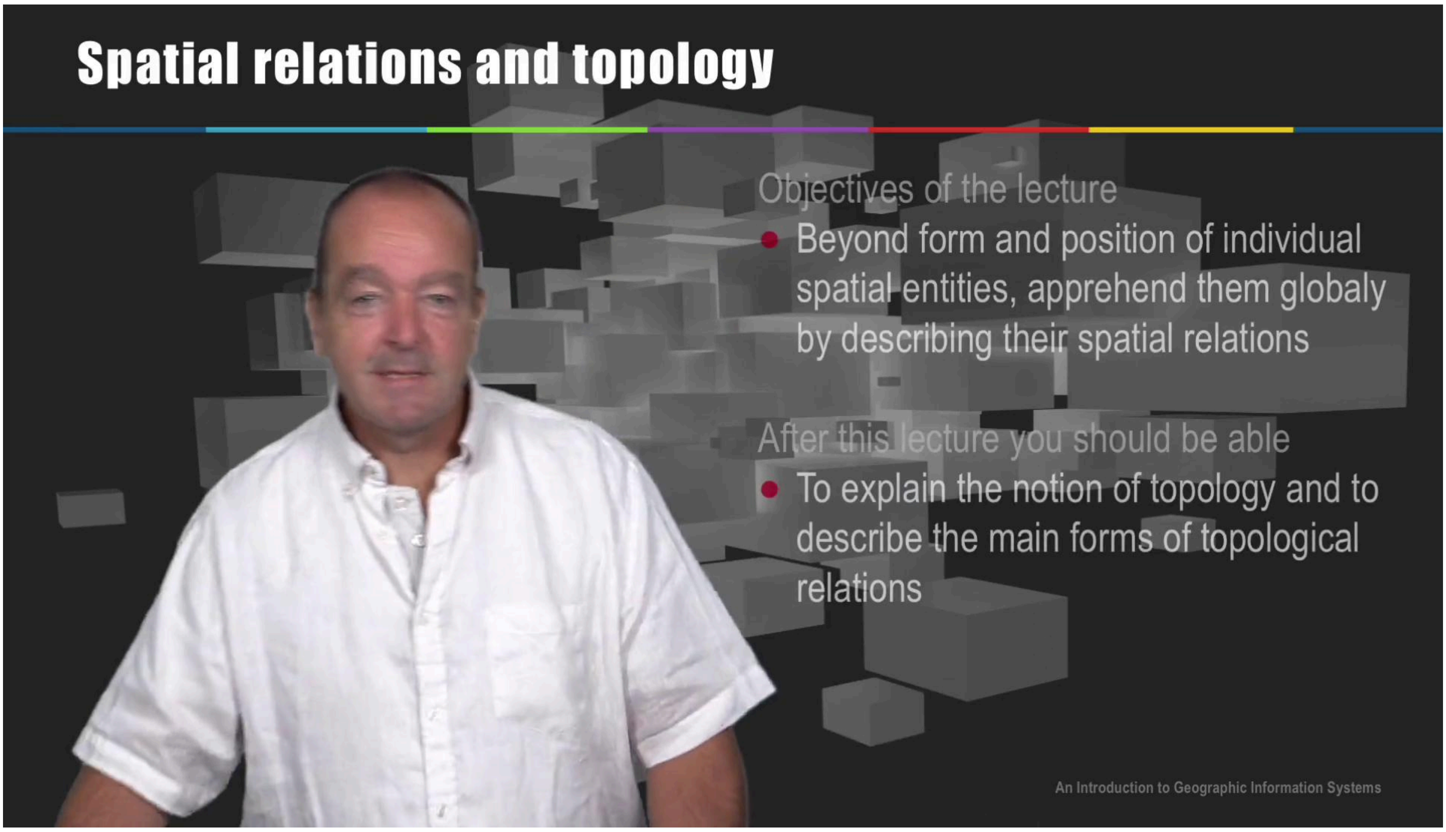


Welcome to this lesson on spatial relations and topology. The positioning of geographical objects compared to each other and their connectivity are very important elements to be taken into account when analyzing networks for example. We have seen in the 2 first lessons that the modeling of the territory involves to be able to identify and discriminate space objects then to be able to characterize their geometries by positioning them in a referential generally composed of a flat coordinate system which derives from a projection system. We have also noted that the description of the geometry of objects is not only about their absolute positioning in space but is also about the positioning of the objects in relation to each other in other words their spatial relations and this particular subset of spatial relations that topological relations are composed of. This thematic is important because the integrity of a spatial database depends on the validity or the verification of these topological rules. This integrity being necessary for the database in question to be exploited by GIS softwares.

Notes

Summary

0m 22s

This lesson aims to describe the relations between spatial entities and the notion of topological rule so that you are able to explain these concepts and to describe the main forms of topological relations. In this lesson we will tackle successively the spatial relations theme then the notion of topology and eventually describe the main topological relations. Working on spatial entities implies the ability to locate and describe them individually but also the ability to comprehend them collectively by describing their relations in space. The question of these relations arises for exemple in the case of two cities linked together independently of their remoteness, for example by air links or, like here, by sea links, of 2 mountain towns located in two neighboring valleys that have a common border and yet are far away in terms of distance to go from one to the other. In the case of road networks in the research of the shortest way to connect 2 points or of the distance from a residence to the school or to the nearest health service. The spatial relations identify all the properties that spatial entities share among themselves. They are inseparable from the notion of neighborhood or link which makes two entities dependent according to a given property.

Notes

Summary

1m 46s

Spatial relations

Spatial entities

- Individual apprehension by localization and description
- Collective apprehension by describing their arrangement or their relations in space

Notions of

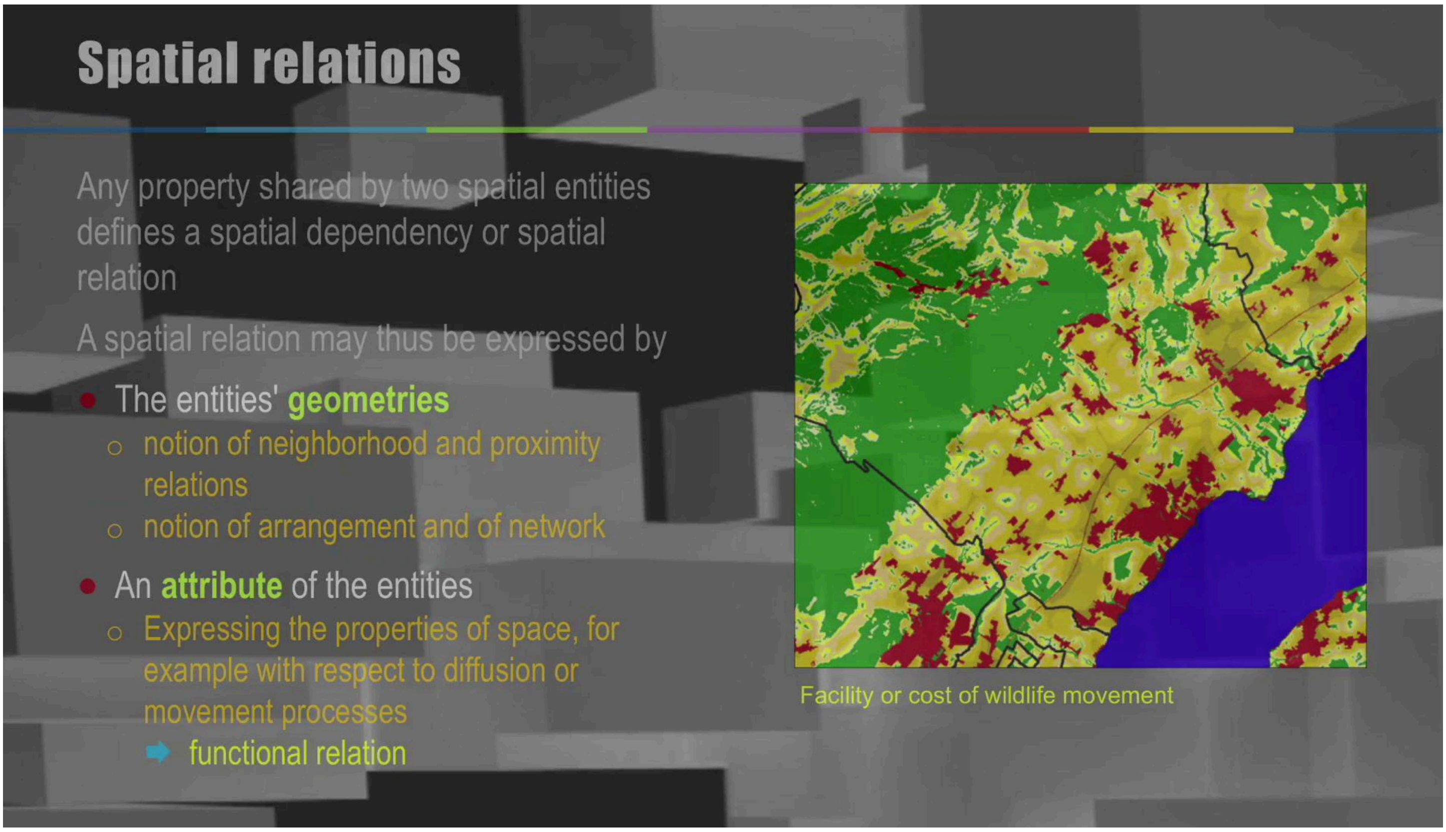
- Contact
- Connection
- Proximity / Distance
- Attenuation

Spatial relationships are therefore based on notions of contact: In the case of a plot X, is the plot A in contact? What about the plot B or C? On the notion of connection: is the way to school in connection with Pérosset road ? The notions of proximity and distance : what is the distance between the different houses and the way to school? Or finally the notions of attenuation for exemple the noise propagation of traffic on the way to school.

Notes

Summary

3m 22s

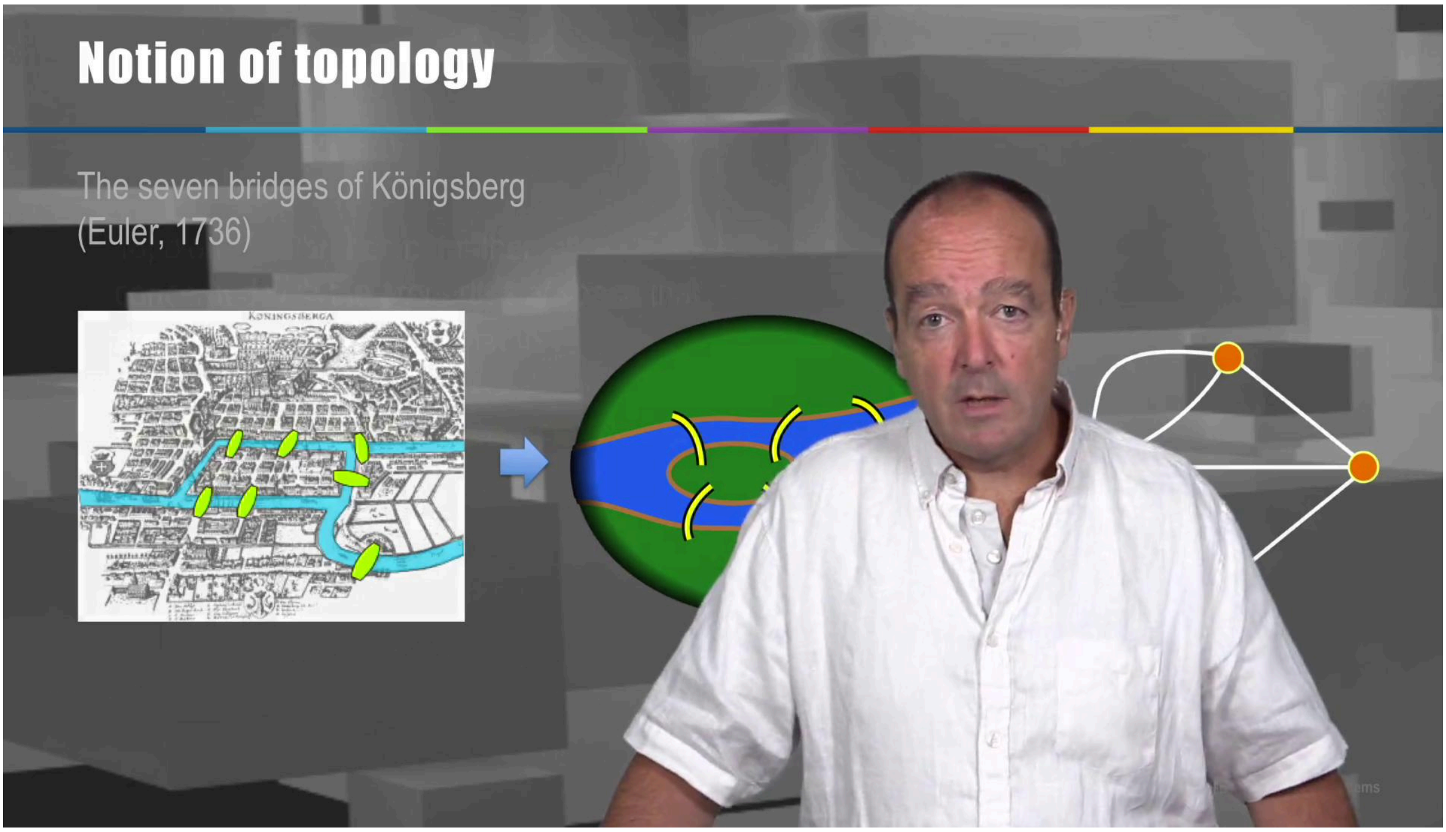


As a property shared by two spatial entities, the spatial relations can be expressed by the geometry of these entities with neighborhood concepts and the proximity relations as we have just seen or by the arrangement and network concepts as illustrated in this figure which shows the most classical forms of arrangement of objects in a star, a mesh, a loop, a tree etc. Spatial relations can also be expressed by an attribute linked to entities translating the properties of space in relation to diffusion or movement processes for example. And it is called functional relations in this case. In this figure, the red areas represent urban areas, the most inaccessible areas for wildlife, and the green areas represent natural reservoirs, especially the Jura forests and corridors that follow the streams and that allow communication between the Jura mountains and the lake. We can also note the motorway which represents a difficult obstacle for wildlife.

Notes

Summary

4m 00s

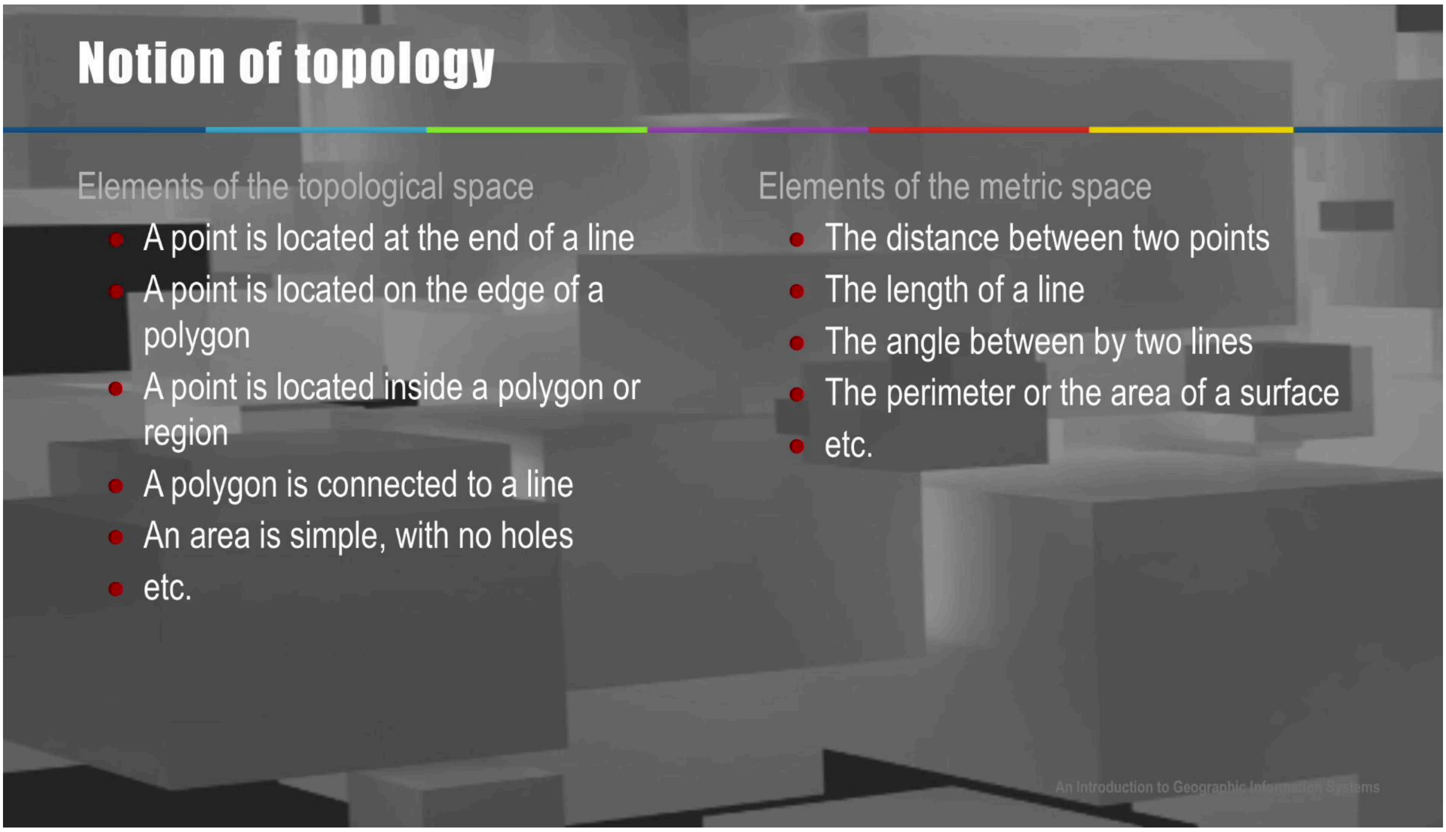


The notion of topology has developed from the problem of the 7 bridges of Königsberg, now Kaliningrad, addressed by Euler in the 18th century. In this city, crossed by a river and having 2 large islands connected to each other and to both banks by 7 bridges, the problem was to find a path through the city that would cross each bridge only once and admitting that the islands are accessible only via bridges and that once the crossing of the bridge had started, it should be pursued to its other end. Euler noted that the path taken in various parts of the city does not matter and only the bridge crossing sequence was important. This has allowed him to schematize the problem and to reformulate it in abstract terms, thus establishing the basis of the graphs theory which is based on a knotted schematization linked by connections.

Notes

Summary

5m 16s

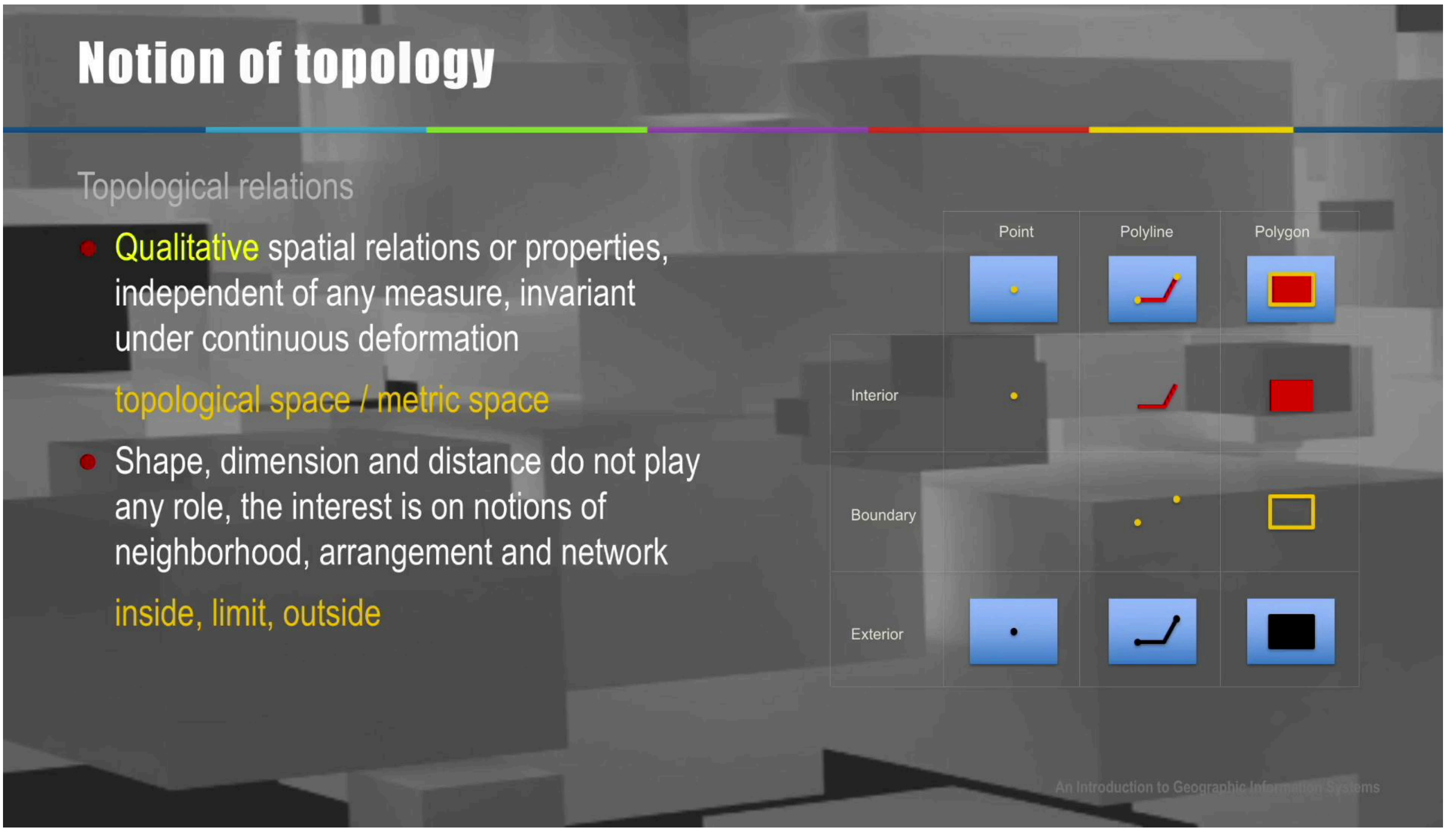


By definition, the topology is the branch of mathematics which focuses on the properties of space that are preserved during continuous deformations, that is to say the stretching, the folding but without the tearing, the holes or the gluing. In this example of continuous deformation by flattening, we see that the quantities like the angle between the 2 straight lines or the rectangles surfaces are not preserved whilst other notions such as the intersection of the 2 straight lines or the fact that the two rectangles are in contact are things which are preserved. Topological relations are therefore relations or qualitative spatial properties independent of any measurement and invariant under continuous deformation. In these examples, we see that the neighborly relations that the pairs of spatial entities have remain the same no matter the geometry of the concerned objects. That is how we speak of topological space as opposed to metric space. In a topological space, the concepts used are of a point at the end of a line, located on the contour of a polygon, inside a polygon or a region, a polygon is connected to a line, an area is simple, non-perforated, etc.

Notes

Summary

6m 08s

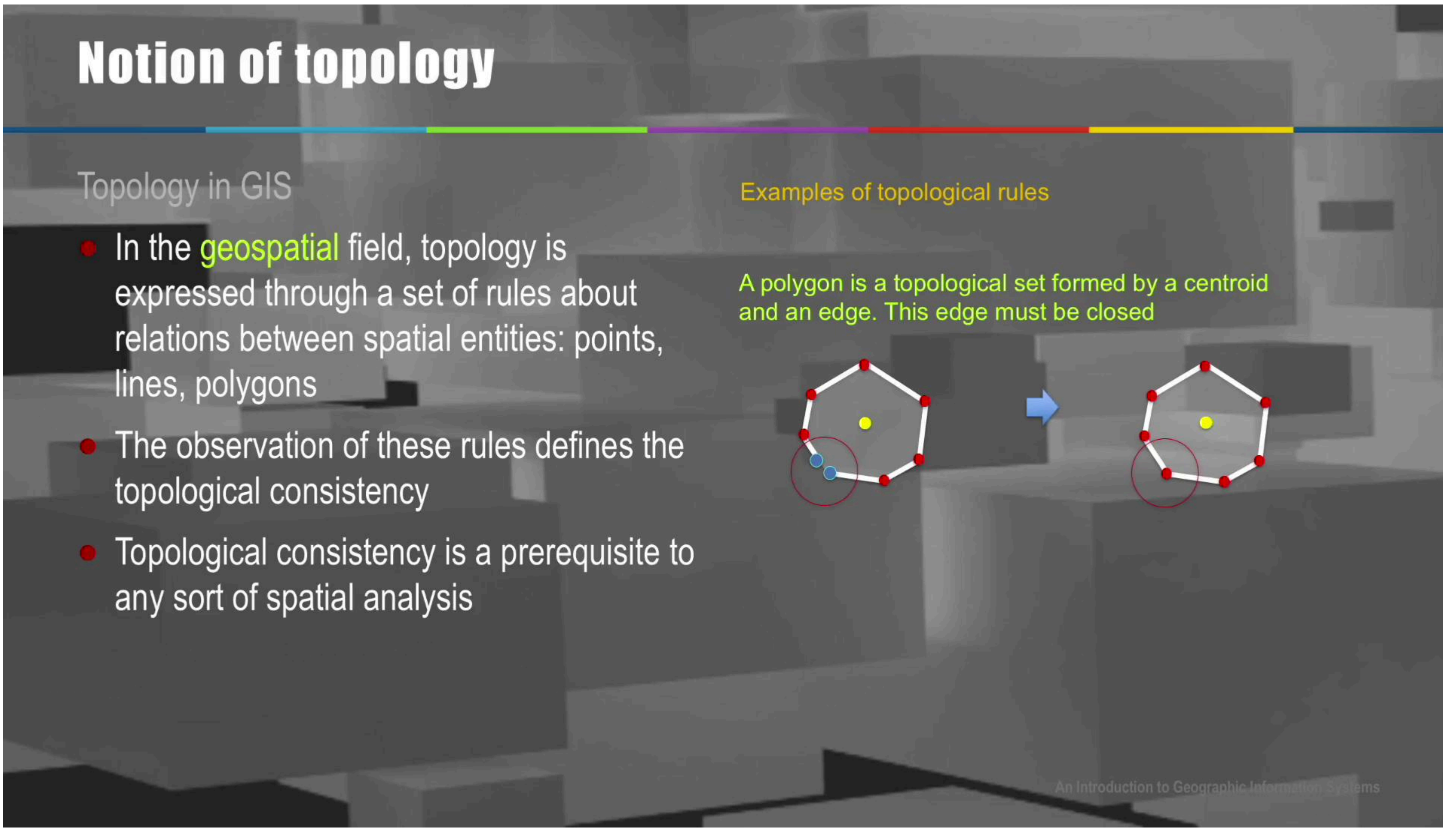


Whilst in the metric space the concepts used are rather those of the distance between 2 points, the length of a line, the angle formed by two lines, the perimeter or surface of a polygon, etc. So we can see that the form, the dimension and the distance have no role, the interest being essentially the notions of neighborhood, arrangement and network with a particular emphasis on the interior, limit and exterior notions.

Notes

Summary

7m 23s

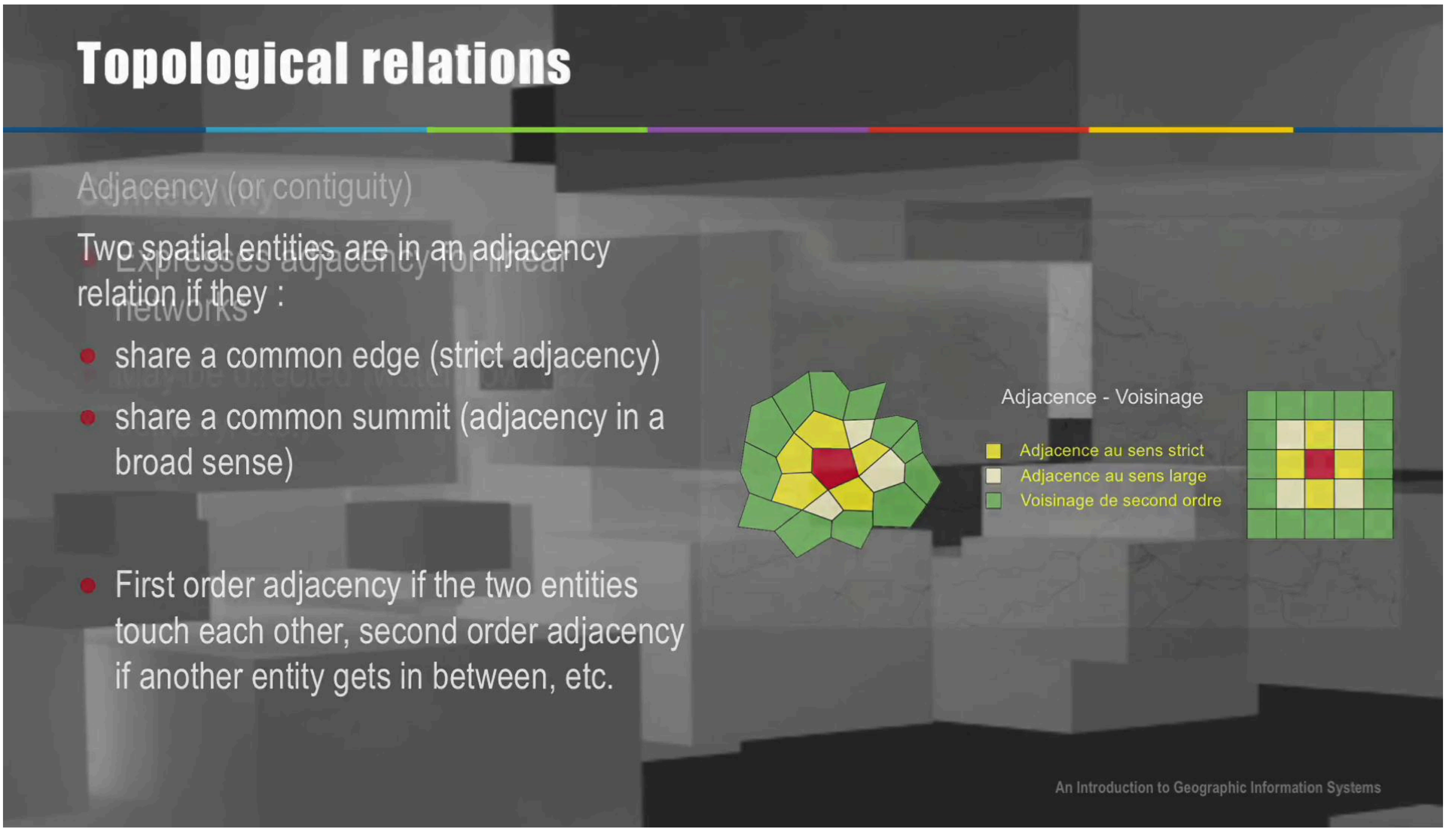


So we have seen the foundations of the topology concept, now we have to see how this notion is important in the geographic information systems world. In the GIS world, the topology is expressed by a set of rules on the relations between spatial entities like point; line or polygon. The compliance of these rules defines the topological coherence and that coherence is essential for any form of spatial analysis. As an example of topological rule, we can cite the fact that jointed lines must have a common knot. This allows for example to ensure that in the case of a hydrographic network rivers flow well into each other; that the limits of jointed polygons are unique, which is necessary if we want to represent for example the land registre with plots juxtaposed one to the other. We can not afford to have polygons overlays or holes between polygons. The fact that a polygon is defined as a topological set composed of a centroid and a contour and that this contour must be closed.

Notes

Summary

7m 51s

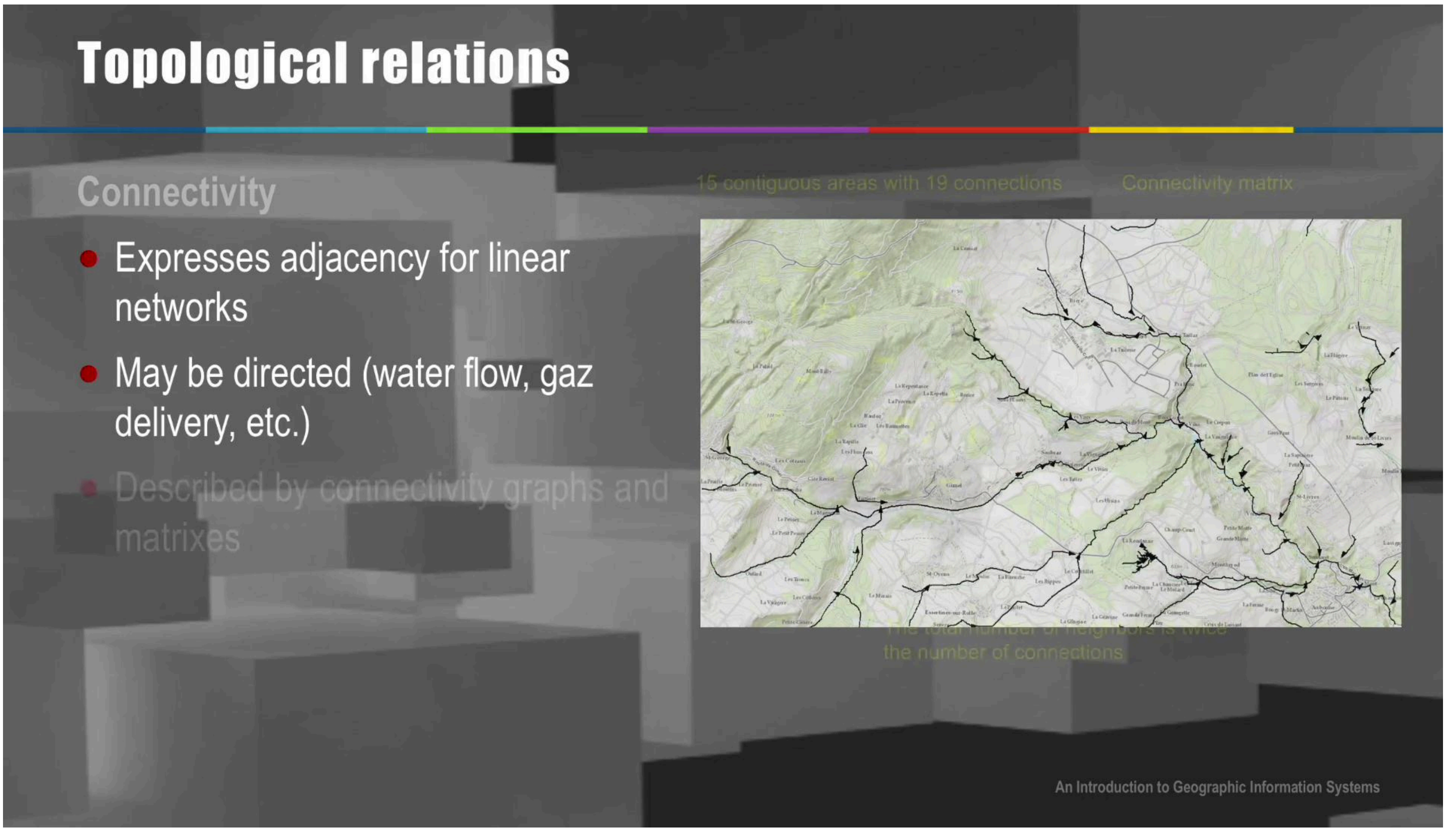


The topological relations are invariant spatial relations under continuous deformation. They are based on neighborhood, proximity, limit, arrangement and network notions. In the next part of the course, we will talk about the 4 main forms of topological relations : the adjacency, the connectivity, the inclusion and the intersection. The notion of adjacency implies that spatial entities have a side or a summit in common. We talk about adjacency in the strict sense when they have a common side and adjacency in the broad sense in the case of a common summit. Moreover, adjacency can be of first order if the two entities are in direct contact, of second order if another entity intercalates etc.

Notes

Summary

9m 20s

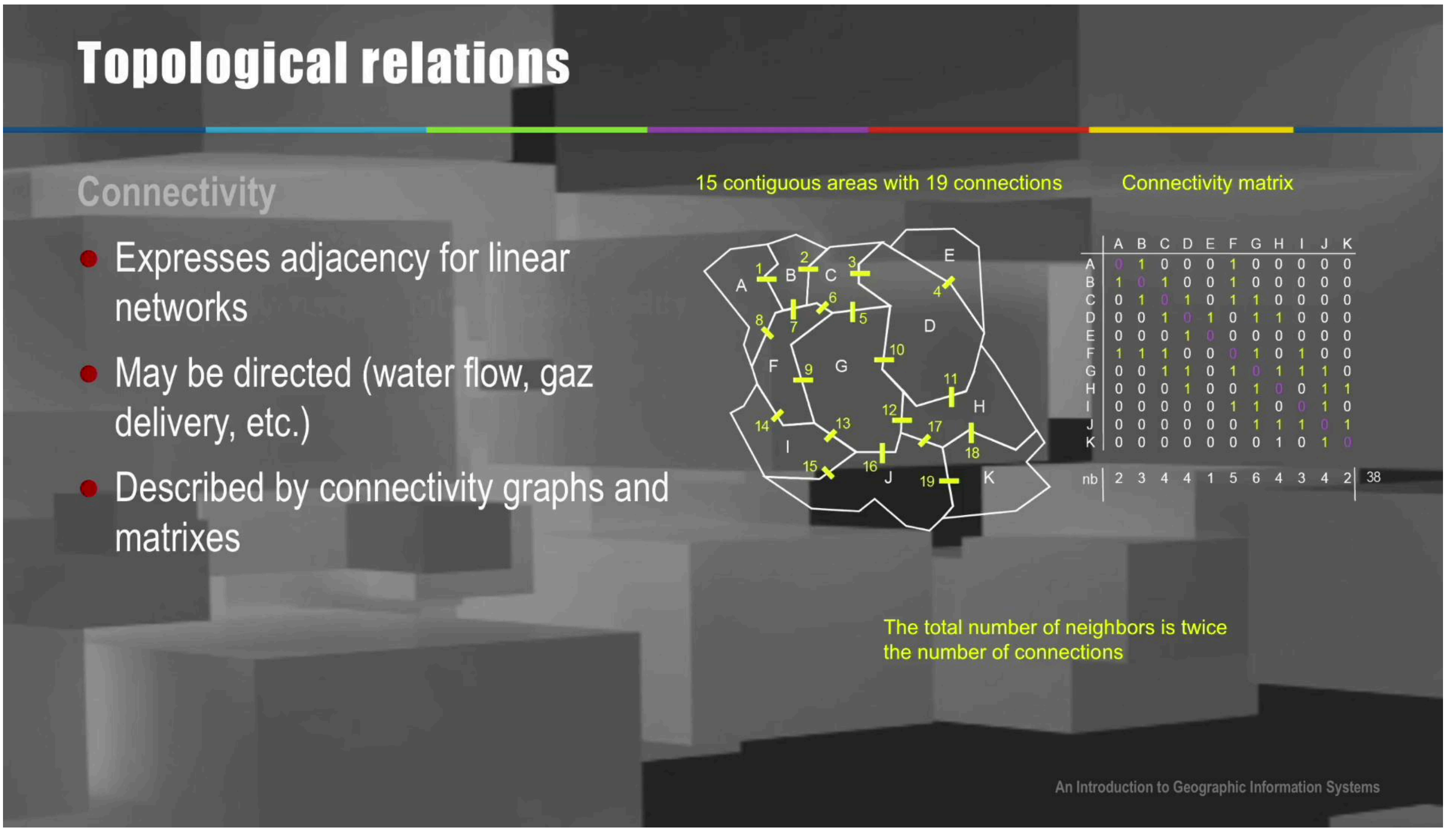


The connectivity expresses the adjacency for the linear networks; it can be oriented as is the case in this example for a hydrographic network.

Notes

Summary

10m 13s



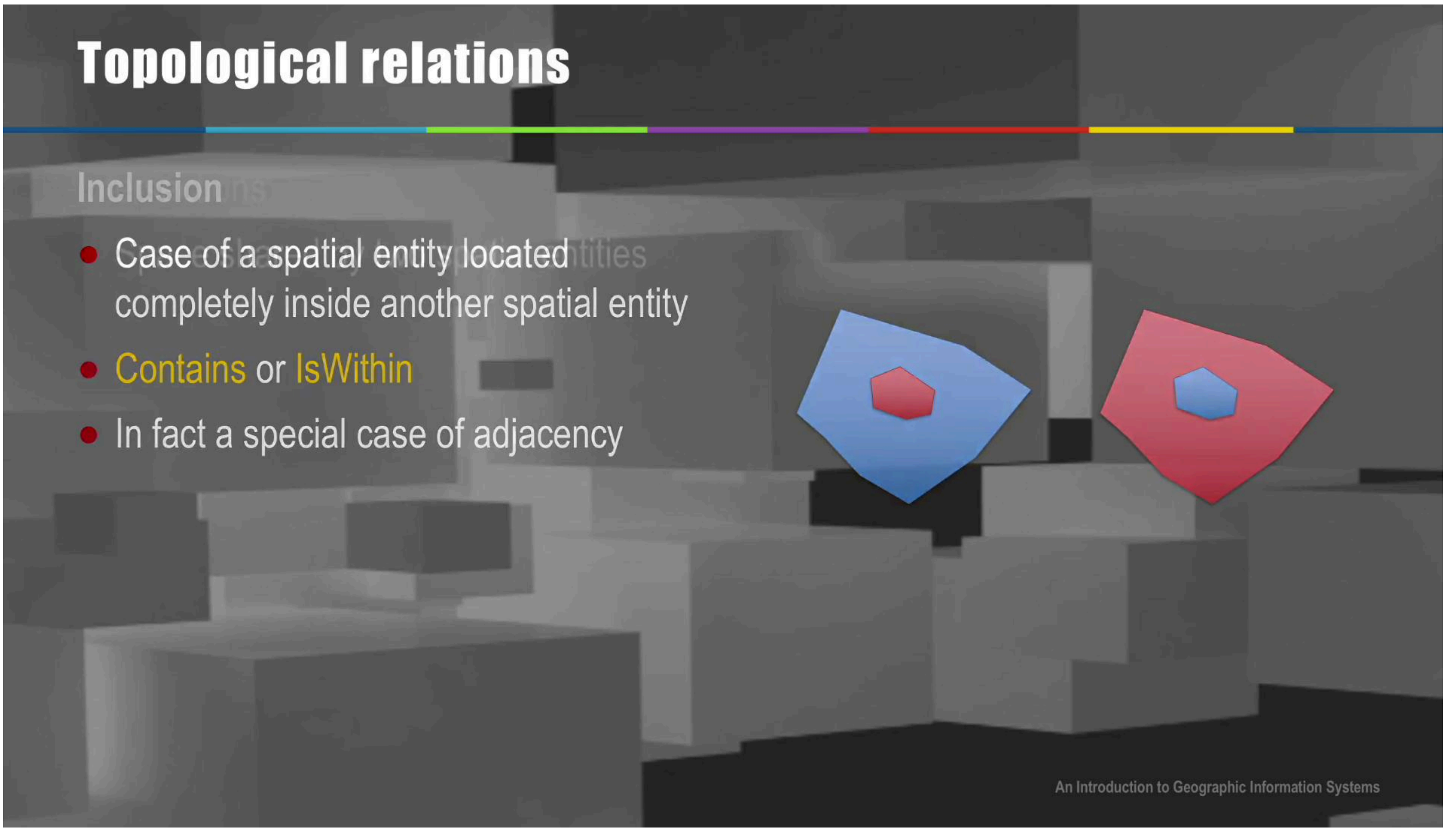
	A	B	C	D	E	F	G	H	I	J	K	
A	0	1	0	0	0	1	0	0	0	0	0	
B	1	0	1	0	0	1	0	0	0	0	0	
C	0	1	0	1	0	1	1	0	0	0	0	
D	0	0	1	0	1	0	1	1	0	0	0	
E	0	0	0	1	0	0	0	0	0	0	0	
F	1	1	1	0	0	0	1	0	1	0	0	
G	0	0	1	1	0	1	0	1	1	1	0	
H	0	0	0	1	0	0	1	0	0	1	1	
I	0	0	0	0	0	1	1	0	0	1	0	
J	0	0	0	0	0	0	1	1	1	0	1	
K	0	0	0	0	0	0	0	1	0	1	0	
nb	2	3	4	4	1	5	6	4	3	4	2	38

The connectivity can be described by graphs and connectivity matrices as shown in this example of 15 contiguous zones which has 19 connections between elements and the connectivity matrice that goes with it. We notice also that the total number of neighbors is equal to twice the number of connections.

Notes

Summary

10m 21s

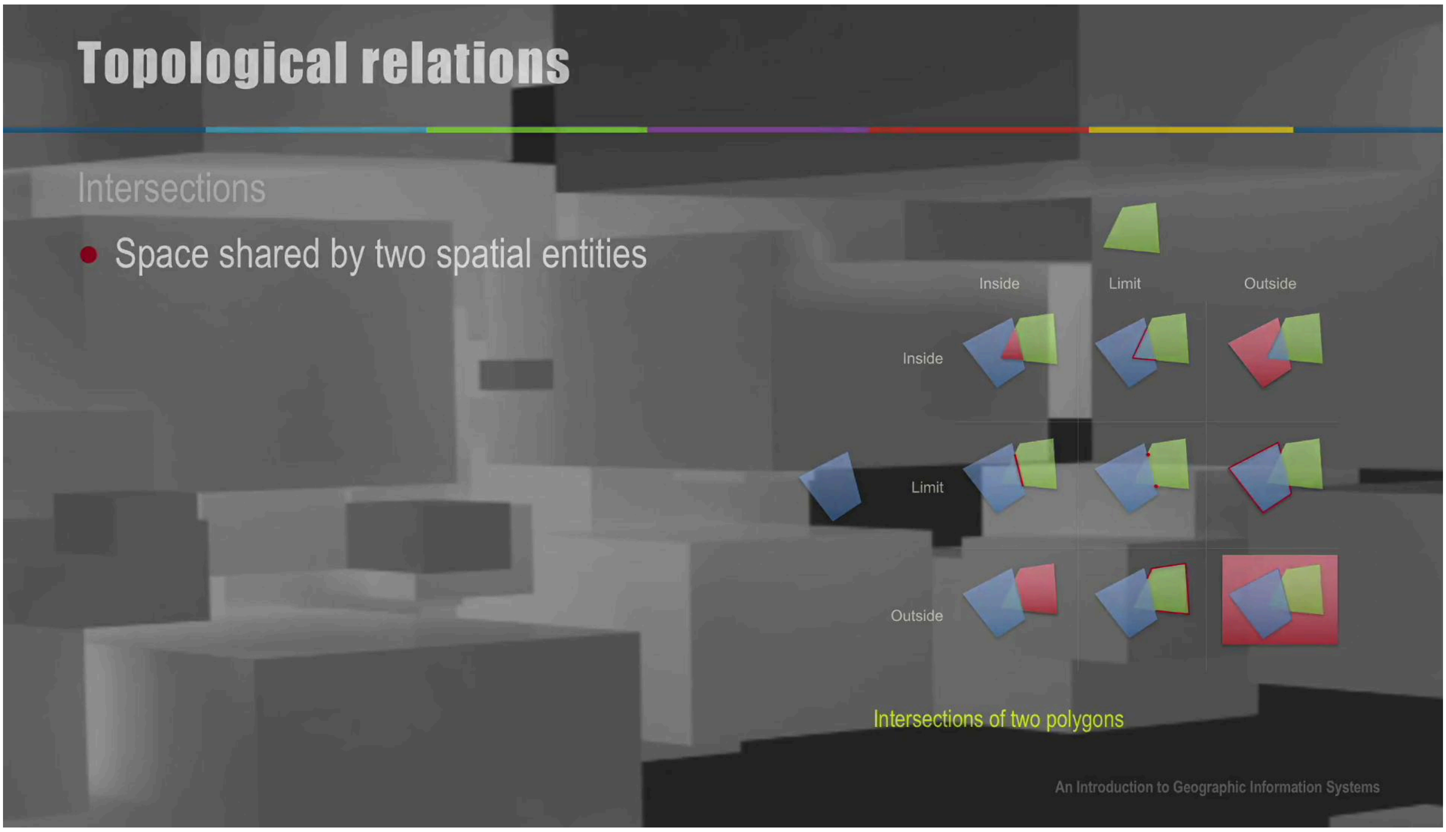


The somewhat trivial case of inclusion which is that of a spatial entity situated completely inside another with relations like "contains" or "is contained", it is in fact a special case of adjacency and finally the intersection which defines the common space to 2 spatial entities.

Notes

Summary

10m 42s



On the basis of interior, limit and exterior notions we have just seen, we see that in the case of two polygons the notion of intersection is made up of 9 different forms.

Notes

Summary

11m 01s