International Meeting on

Visualization in Complex Environments

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POLITECNICO DI MILANO

Urban Modeling and Visualisation: Improving the Semantic Link with Ontologies

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A preliminary notation: models in planning (in a cognitive perspective)

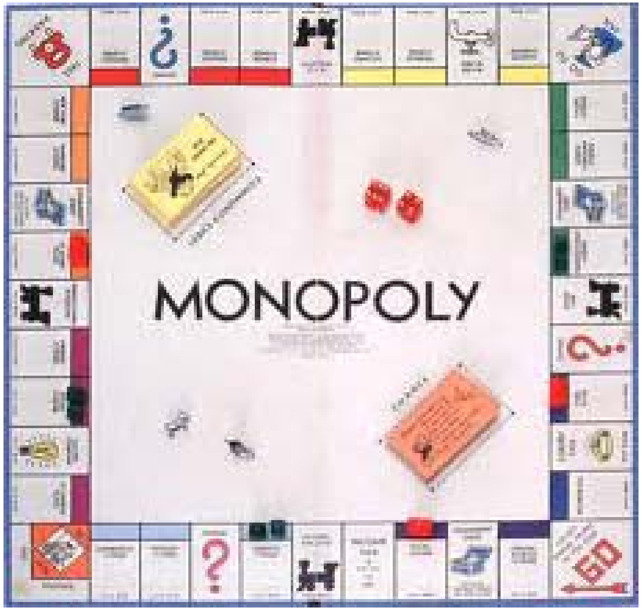
Models as ALC agents, i.e. tools for:

- **performing a certain course of Action**, thus enabling the realization of a certain project of investigation of spatial phenomena.
- **enabling users with a certain Learning ability**, thus generating stimuli in critical revising both the external and internal loops of the modelling activity (substantive and formal construction of the model) likely to trigger new quest of investigation
- **Communicate with other kinds of agents** (people or other models), thereby affecting them and/or modifying itself in the process.

Contents

1. The power of digital visualizations

2. Visualizing models: benefits and costs



3. Ontologies as a mean for reducing costs

4. Examples
   (from EU Cost Actions:
   TU C-21 and TU0801)

DOING SCIENCE IN INFORMATION/KNOWLEDGE SOCIETY:

The 4 dimensions of changement:

1. ***"Extreme data" handling***

2. ***Computer-aided "reasoning" and artificial reasoning***

3. ***"At distance" distributed and integrated knowledge***

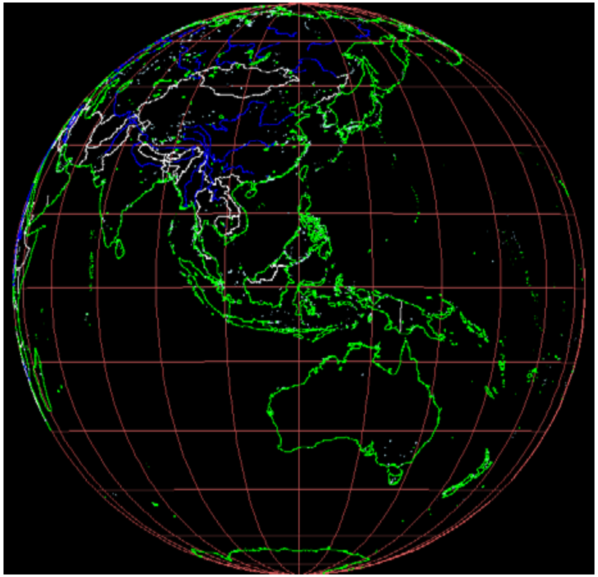
4. ***"Visualization" of knowledge***

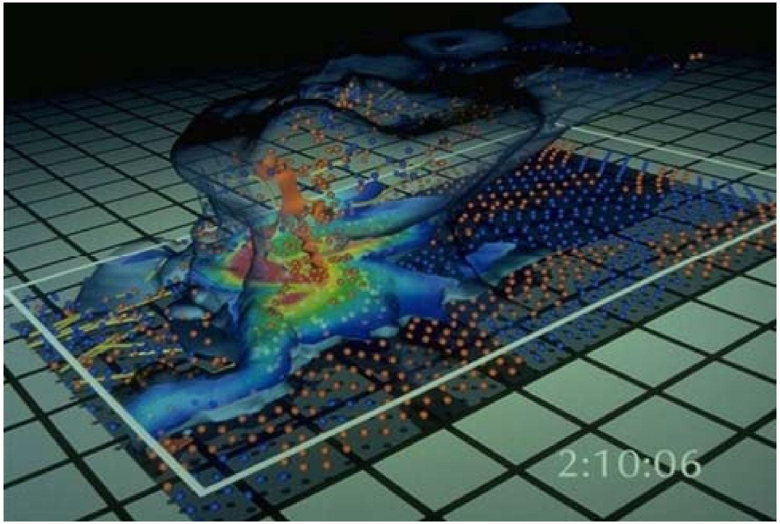
(source: IBM "Science 2020")

The power of digital visualization (1)

The extension of the domain

- Space-dimensionality (1d, 2d,3d …and more)
- Time dynamics
- More than physical objects (virtual world, abstract concepts …)
- Man-machine interaction
- …

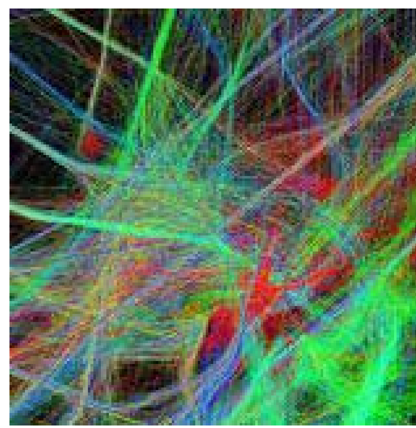


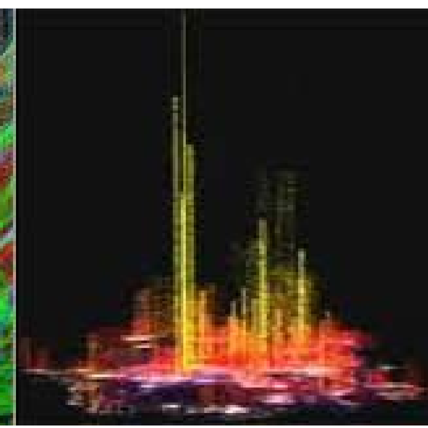


The power of digital visualization (2)

The coverage of the domain

- **Extremely large systems (networks, patterns …)**
- **Alternative display**
- **Interconnection; inter--operability**
- **…**





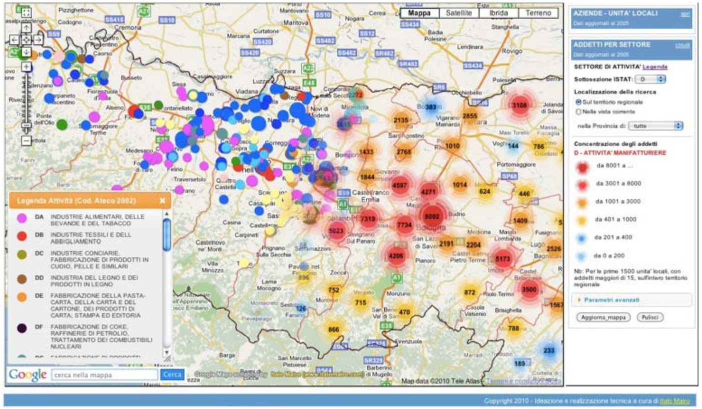
The power of digital visualization (3)

The details of the domain

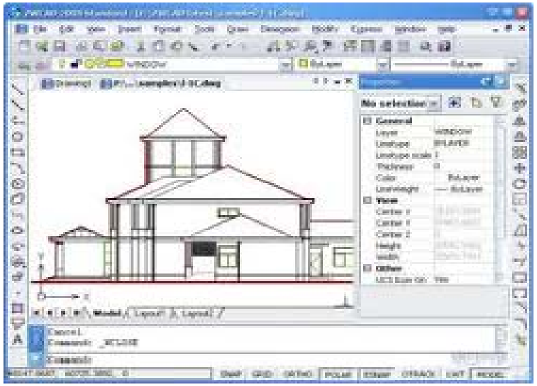
- Multi-scale display (dynamic zoom)
- Video-realism
- Flexibility (Reuse,…)
- Stereo-vision
- …

Setting the problem …

With the exception of the *mapping* domain …

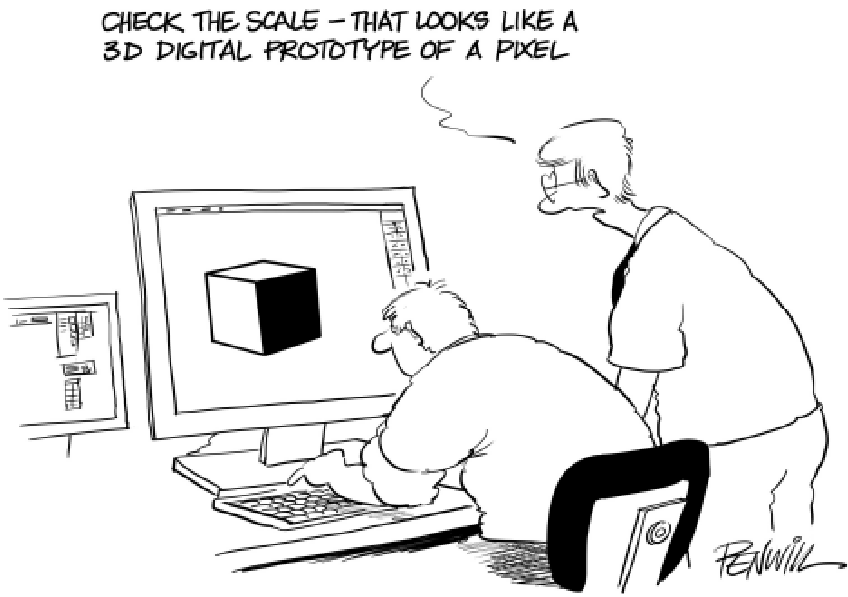


GIS



CAD

… scales, keys are going to disappear in digital visualiz



Furthermore …

Visualization is not neutral
(embedded values and judgments)

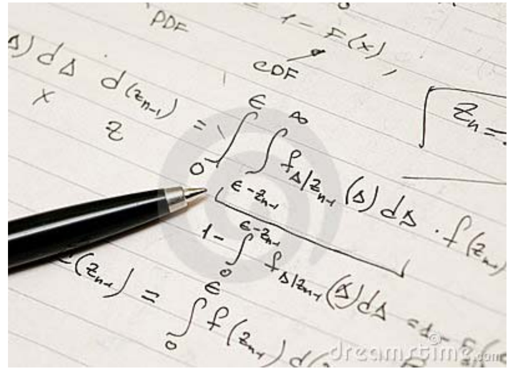
Images convey emotions

Images (as a kind of text)
“materialize” (make real)
social objects

(see M. Ferraris “Documentality”)

… on the otherside: urban modelling

Analytic models
(e.g. OR optimization models)



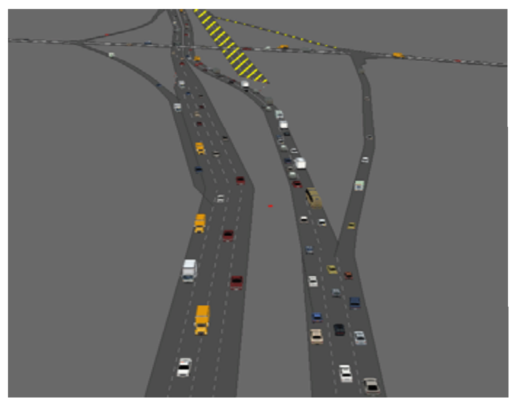
Algorithmic models
(e.g. SIA models)

Table 2
Numerical Results for Alternative Bivariate Change Score Model

	Model 2a: Invariant over groups				Model 2b: Free intercept far and near				Model 2c: Free near→far regression				Model 2d: Relaxed posttest parameters			
	Group C		Group T		Group C		Group T		Group C		Group T		Group C		Group T	
Parameters	MLE	S	MLE	S	MLE	S	MLE	S	MLE	S	MLE	S	MLE	S	MLE	S
(a) Fixed parameters																
1→*Near*[0]	32.5	1.75	= =		32.5	1.75	= =		32.5	1.75	= =		32.5	1.75	= =	
1→D*Near*	6.16	0.51	= =		1.46*	0.13	11.7	1.07	2.14*	0.20	10.9	0.99	2.15*	0.22	10.9	0.91
Near[0]→D*Near*	−0.237	−0.36	= =		−0.241	−0.41	= =		−0.215	−0.37	−0.267	−0.45	−0.215	−0.41	−0.267	−0.41
Far[0]→D*Near*	0.190	0.32	= =		0.186	0.35	= =		0.163	0.31	0.210	0.39	0.163	0.34	0.211	0.36
(b) Fixed parameters																
1→*Far*[0]	65.9	3.21	= =		65.9	3.21	= =		65.9	3.21	= =		65.9	3.21	= =	
1→D*Far*	11.9	1.11	= =		12.2	1.14	11.3	1.06	11.9	1.13	11.6	1.07	11.9	1.16	11.6	1.04
Far[0]→D*Far*	−0.270	−0.48	= =	−0.52	−0.273	−0.52	= =		−0.243	−0.47	−0.304	−0.57	−0.243	−0.49	−0.304	−0.56
Near[0]→D*Far*	0.169	0.29	= =	0.34	0.199	0.35	= =		0.154	0.27	0.244	0.42	0.154	0.28	0.244	.041
DNear→DFar	0.112	0.13	= =		0.129	0.13	= =		0.101	0.10	0.152	0.16	0.101	0.10	0.152	0.16
(c) Random parameters																
Variance change																
Far	98.7	0.86	= =		98.6	0.86	= =		9.83	0.88	= =	0.83	9.25	0.88	104	0.84
Near	134.0	0.92	= =		108.0	0.90	= =		108	0.92	= =	0.88	86.8	0.90	130	0.90
(d) Goodness− of− fit																
χ^2/df	309/14				37/12				31/7				3.3/5			
$d\chi^2/ddf$	0/0				272/2				278/7				305.7/9			
ϵ_a	0.174				0.054				0.069				0.000			
+90% bounds	.157−.191				.035−.075				.045−.095				.000−.042			

Note. Paired equals signs indicate "held equal." MLE = maximum likelihood estimate; S = standardized estimates.
* Nonsignificant estimates.

Emergent computation
(e.g. MAS models)



Decreasing control on input-output connection

Increasing amount of information in outputs

Cost-benefits of the trend in model-visualization relationship

Benefits:

- amount of information
- easy understanding
- appealing presentation
- source of inspiration
- …

BUT

Costs:

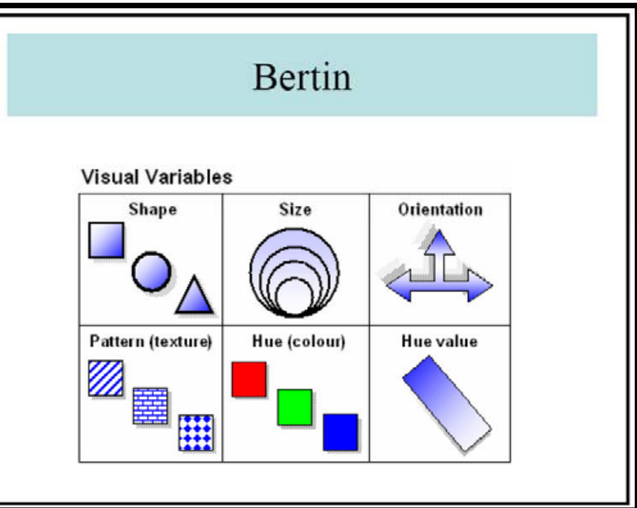
- dis-information (**hidden errors; arbitrariness; …**)
- mis-understanding **(vagueness; incommunicability; …)**
- escape from "scientific testing" **(reproducibility of the model)**
- …

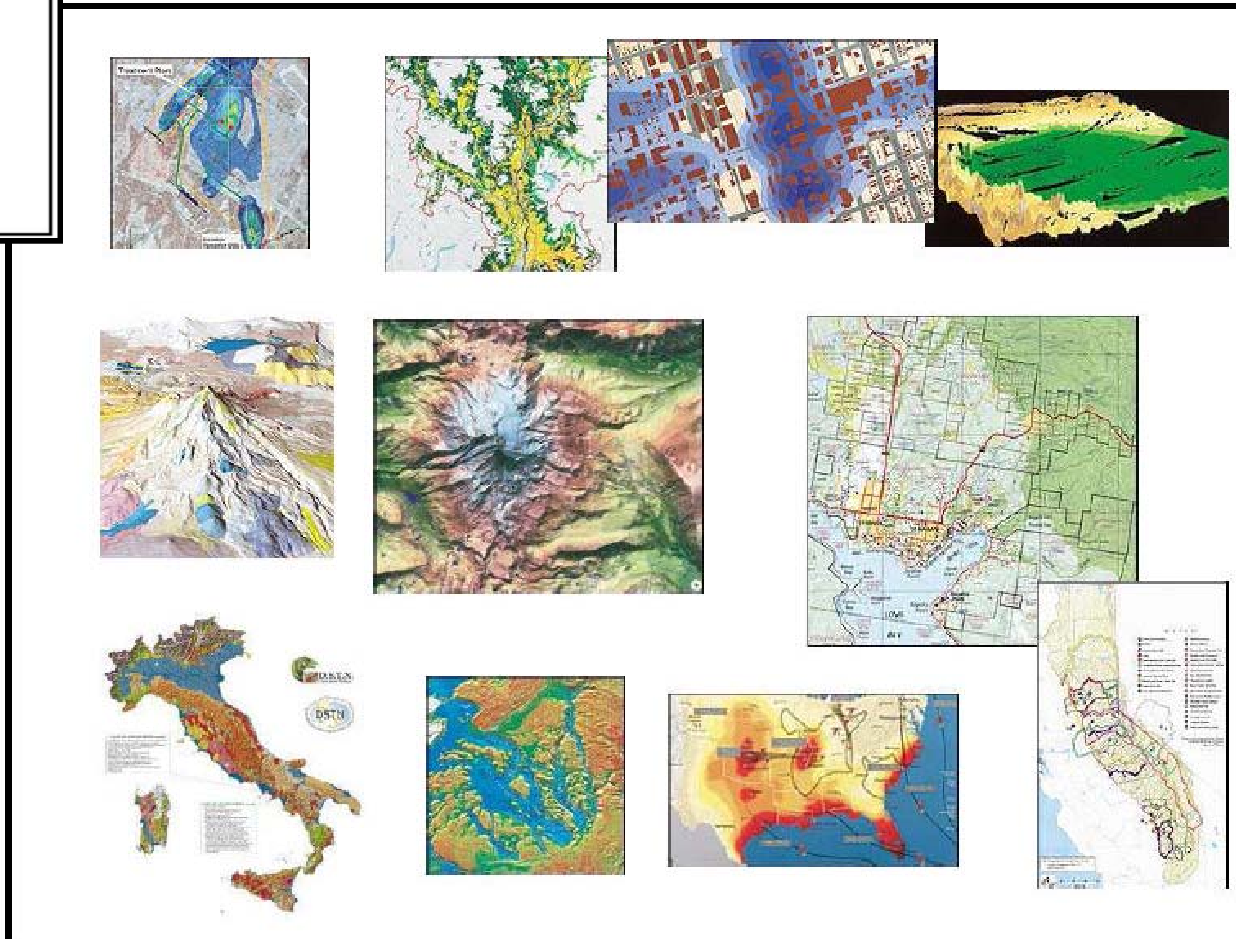
Then the need is: (1) rediscovering "Graphic Semiology" ***(J. Bertin, 1967)***

- elements, grammar, syntax of visual communication -

(2) define the semantic of model output and ALIGN it with the semantic of the associated visualization, using ONTOLOGIES

(A very short note on Graphic Semiology)





What are formal ontologies?

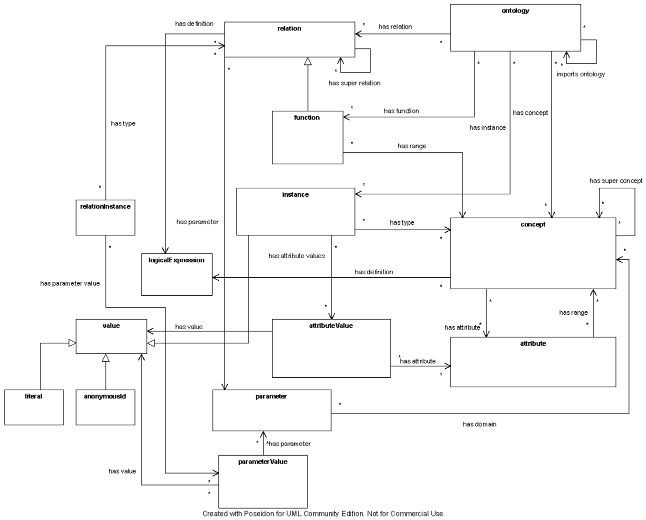
- **Definition:**
  "An ontology is a formal and explicit specification of a shared conceptualization" (Studer, 1998)

- **Explaination:**
  - semantic relationships among concepts, which represent the agreed view of a system structure (a domain of knowledge)
  - (Easy for human) machine-understandable languages (automatic reasoning: e.g.: classification, inference, …)
  - Multi level ontologies (from a top level ontology to generic ontologies); re-usability; interoperability; …

- **Detail:**
  An ontology classification: from hard ontologies to soft ontologies depending on the degree of formalization of semantic relationship

How to deal with formal ontologies?

- **Tools**:
  - Formal dictionaries, Thesauri, etc.
  - Unified Modelling Language
  - Conceptual maps
  - Taxonomies and Folksonomies
  - ...

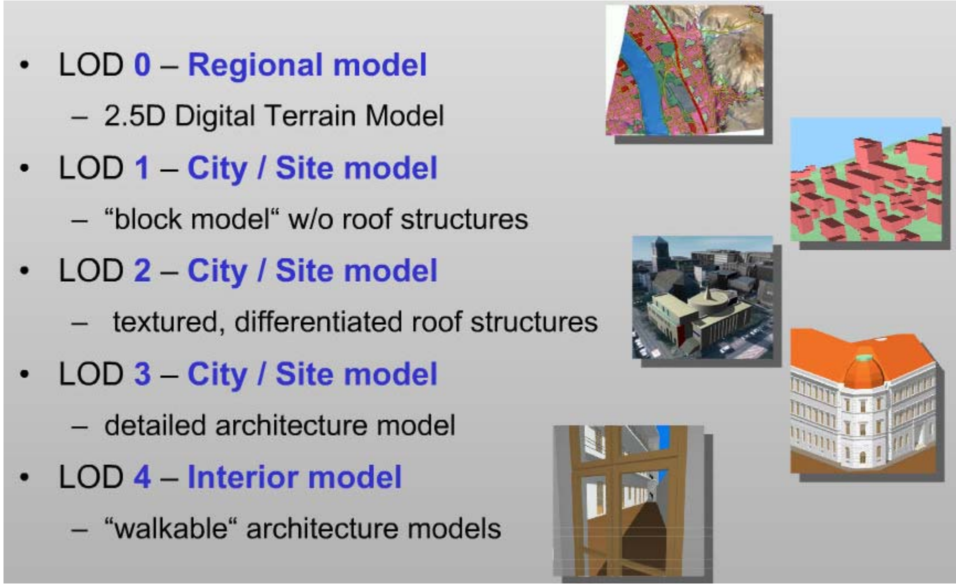


- **Software** (examples):
  - Protégé, Cmap Tools Ontology, ...
  - StarUML, Visual Paradigm, ...
  - Cmap Tools, Decision Explorer, ...
  - Tag-Clouds, WP-Cumulus,..
  - ...

Ontologies for M-V semantic alignement: 1. (V->M) Standardization

Example: Use of CityGML for building 3d urban model

- **XML** => **GML** => **CityGML**
  Extensible Markup Language — **Geography Markup Language** — **GML for urban objects**
- It defines the classes and relations for the most relevant topographic objects in cities with respect to their geometrical, semantical and appearance properties. It includes hierarchies between thematic classes, aggregations, relations between objects, and spatial properties.



Ontologies for M-V semantic alignement: 1. (V->M) Standardization (cont'd)

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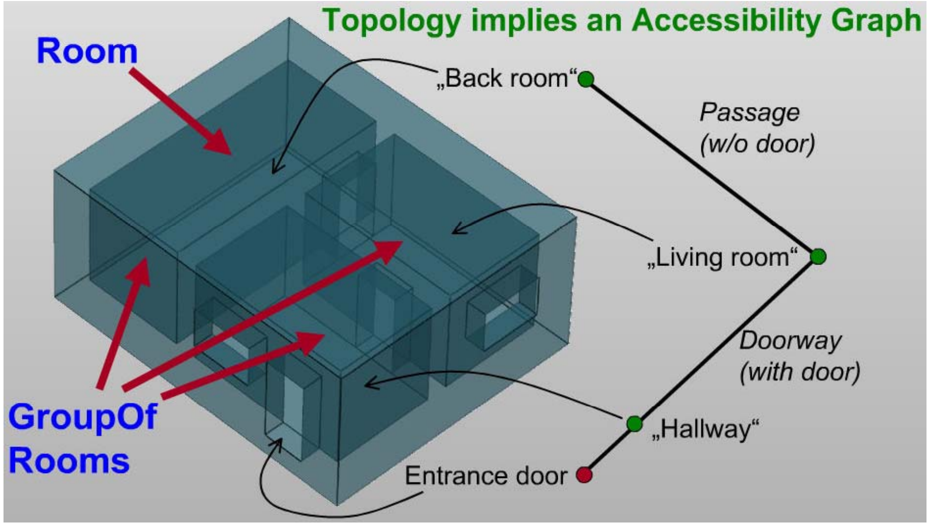
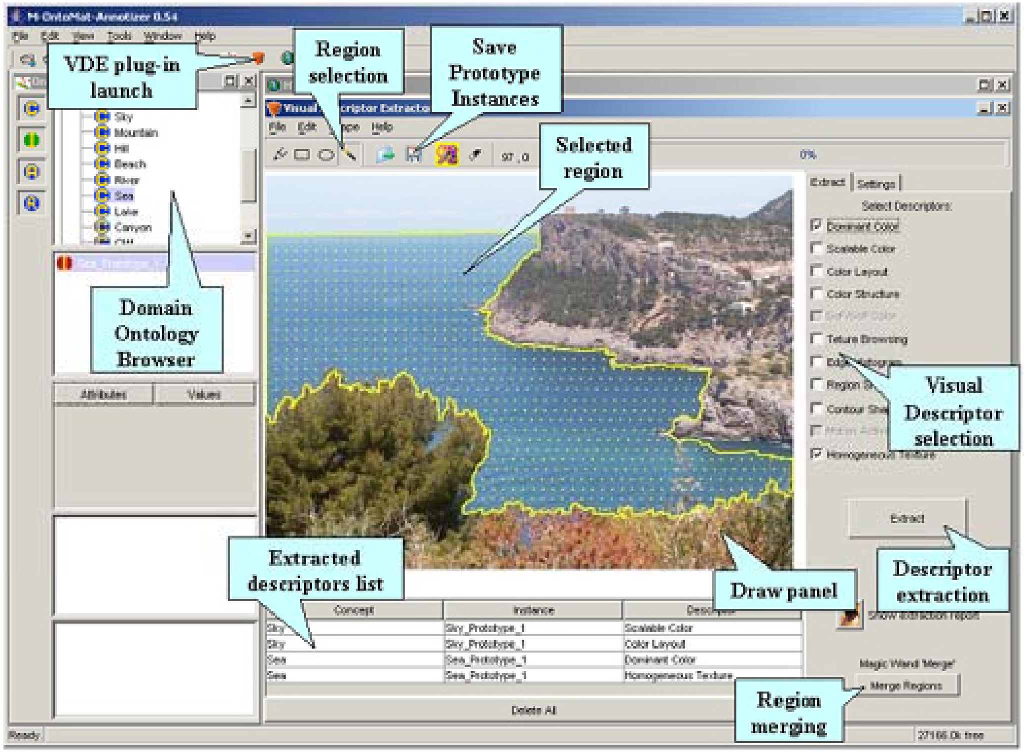


Ontologies for M-V semantic alignement: 2. (V->M) Semantic enhancement of images

Example: Use of “M-OntoMat-Annotizer” on images

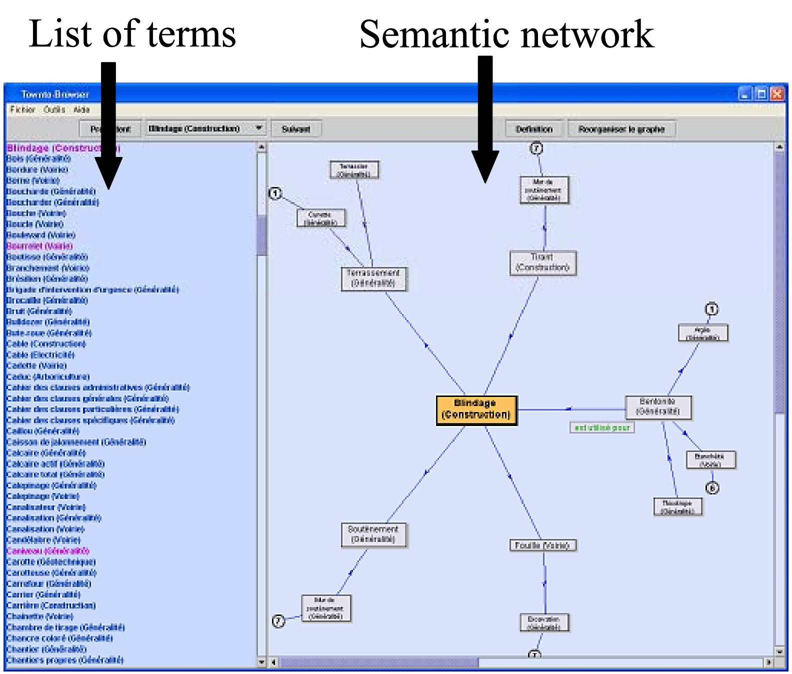
It is a graphical interface for loading and processing of visual content (images and videos), extraction of visual features and association with domain ontology concepts. This extracted knowledge plays a central role in automatic semantic analysis, (content analysis, metadata generation and annotation, etc.) and support intelligent content search and retrieval services.

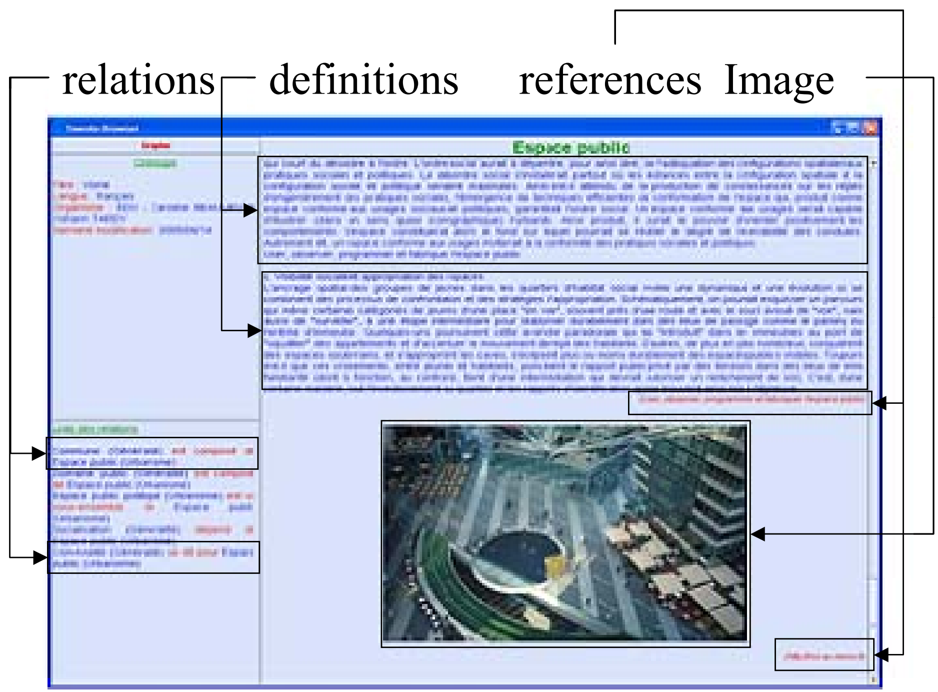


Ontologies for M-V semantic alignement:
3. (M->V) Visualization of semantic content of model output

Example: Use of “Towntology” on urban ontologies

Towntology software allows the construction and the visualisation of a semantic network of concepts. Several pictorial illustrations can be associated to a unique concept in order to express all possible interpretations.

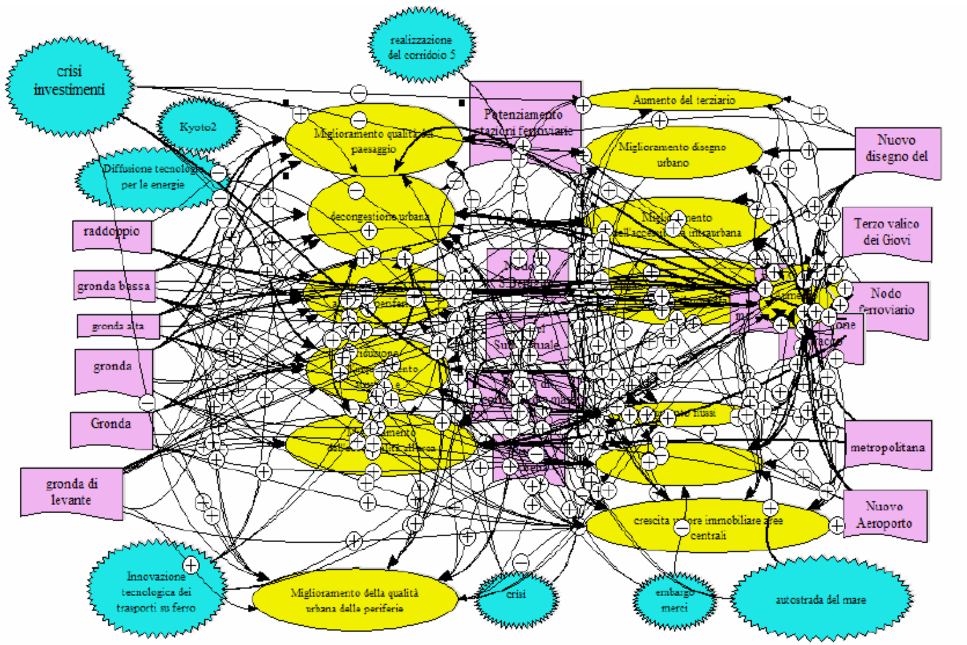


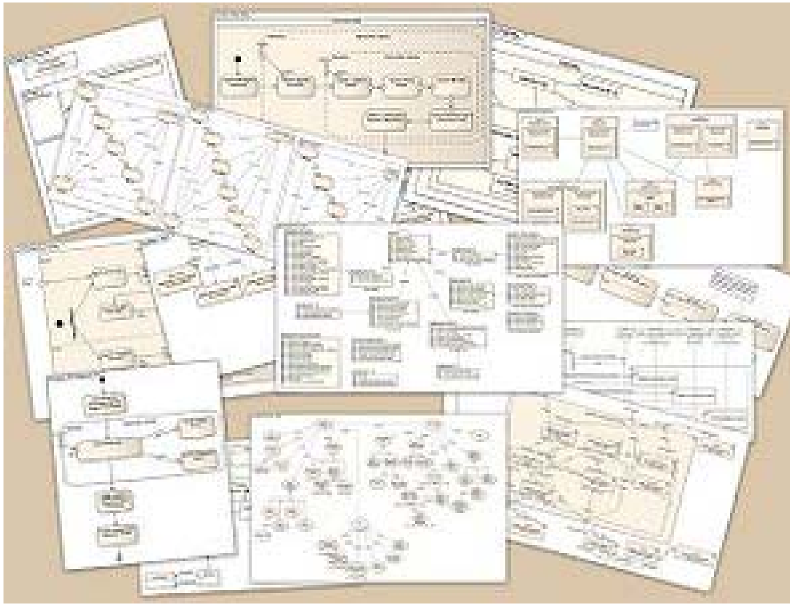


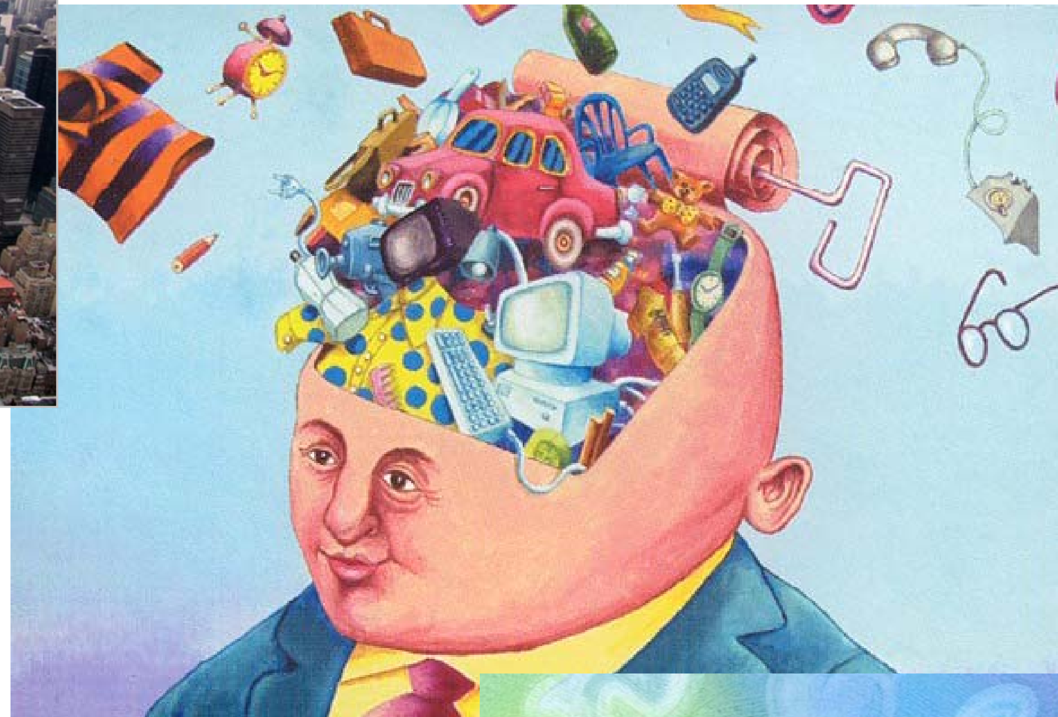
Ontologies for M-V semantic alignement:
4. (M->V) Visualization for (eventually collaborative) building of quali- or quanti-tative models

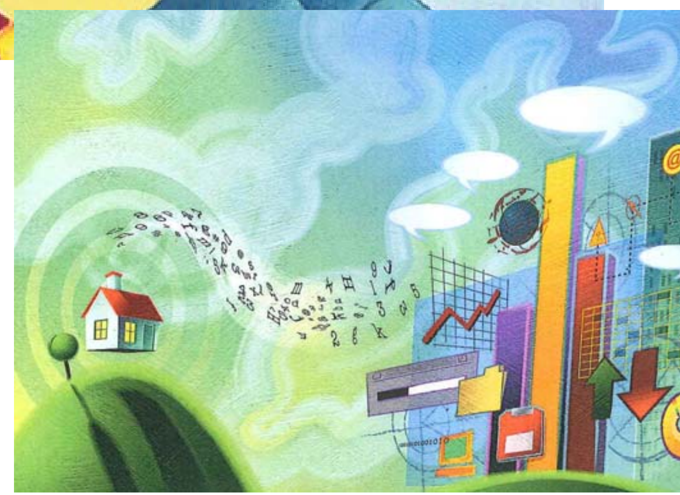
Example: Use of Conceptual maps; use of UML

Conceptual model of a decision situation (with many stackholders, multi actions, multi interacting effects)	UML (Unified Modelling Language) visualizing a model for a shared conceptualization









Many thanks for your kind attention