Towards Knowledge-driven Urban Planning

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Can be downloaded from www.laurini.net/ftp/isprs.pdf

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Scopes

- Ultimate Scope
  - Is knowledge-driven urban planning possible?
- Scopes of this paper
  - Identify knowledge bundles used or generated by urban planning
  - Propose models

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Definition of Urban Intelligence

Urban Intelligence = City + Collective Human Intelligence + Artificial Intelligence → Sustainable development of cities

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Definition of Geographic Knowledge

- Geographic knowledge corresponds to information potentially useful
  - to explain,
  - to manage,
  - to monitor,
  - to innovate
  - and to plan a territory.

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Knowledge of Urban Planning Must Include

- Knowledge about the area, such as its morphology, local history, and lessons coming from past projects (including abandoned ones),
- Laws and byelaws regulating planning, which may vary by country,
- International norms or recommendations linked to environmental issues, and especially sustainable development,
- Engineering expertise and skills,
- Knowledge regarding daily life of the inhabitants,
- Knowledge coming from sociological studies,
- Knowledge about people and goods security,
- Knowledge extracted from data mining,
- Strategic means to reach planning objectives,
- Interesting experiences in other cities observed by technological and sociological watch.
- Knowledge regarding the surrounding areas of the city, that may impact its development (external knowledge),
- Suggestions from citizens or neighboring committees given during participatory meetings or from other circumstances,
- Etc.

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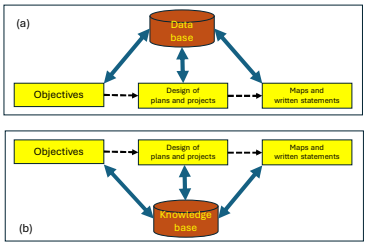
Evolution of Urban Planning

Now

Future



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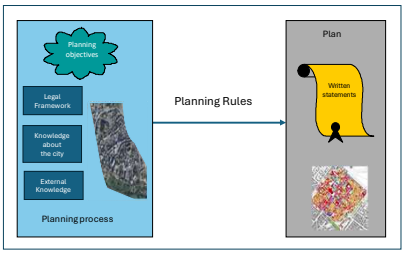
Schema of Urban Intelligence



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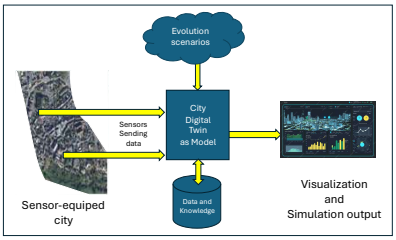
Principle of Digital Twin Systems



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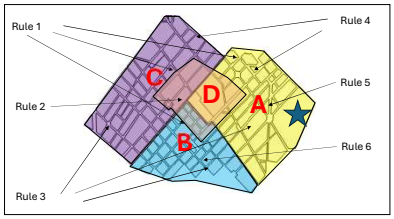
Located Rules



IF Object Z Belongs to ZoneA
Then Apply Rules 1, 3 and 5

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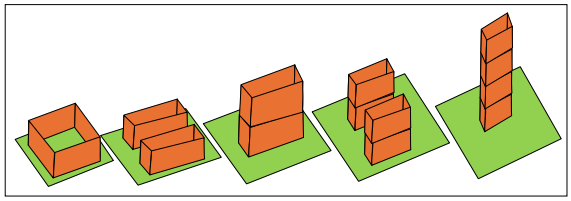
Example of a Rules in Urban Planning: « *Floorspace ratio = 50%* »



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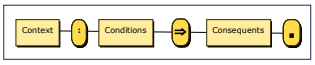
Rules in Urban Planning

- In business applications: IF-THEN-Fact and IF-THEN-Action
- In spatial planning
  - **co-location rules** the meaning of which is "IF something here, THEN something else here"; or its variant "if something here, then something else nearby";
  - **bi-location rules** such as "IF something here, THEN something else elsewhere"; in other domains, this rule can model to the well-known butterfly effect.
  - **creation of a new zone**, such as IF-THEN-Zone, but for the creation of a zone from scratch, for instance the administrative creation of a recreational park;
  - **geospatial metarules** such as "IF some conditions hold here, THEN apply RuleB"; a specific example is rule like "IF something is in place A, THEN apply RuleB", indicating that RuleB applies when in place A.



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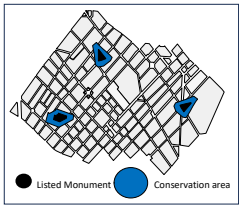
Example of Rules around Historical Monuments



$\forall\ T \in Earth, \forall\ B \in PROJECT, \exists\ M \in Geo\text{-}Objects,$

$\text{Type}\ (B) = \text{“Building”},$

$\text{Type}\ (M) = \text{“Listed\_Monument”},$

$\vDash Inside\ (Geom\ (B), T), Inside\ (Geom\ (M), T)$

:

$Disjoint\ (\text{Geom}(B), Union\ (Buffer\ (Geom\ (M), 100)))$

$\Rightarrow$

$State\ (B) = \text{“LM\_Approved”}$

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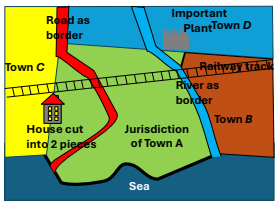
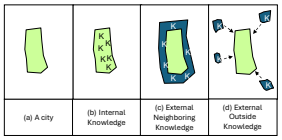
External Knowledge

- Knowledge located outside the jurisdiction which can influence the development of the city





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Feedforward Rules

- Consider two rules:

1 - If it rains, I get wet

- ***Cause-effect chain***

2 - If it rains, I take my umbrella

- ***Result of an anticipation to buy an umbrella***
- This is a Feedforward rule

Planning is a Feedforward activity

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General Model of Feedforward Rules

- General framework in two steps

Pre-rule	Since it frequently rains, Consequently I will buy an umbrella
Post-rule	Whenever it rains, Then I take my umbrella.

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Ex1: Monitoring Pollution

Dissemination of sensors

Pre-rule	Since pollution must be monitored, Consequently adequate sensors are distributed throughout the city.
Post-rule	Whenever a threshold is exceeded, Then an alert is triggered.

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Ex2: Technology Watch

Pre-rule	Since another city puts in place a clever device, and this one is a success Consequently examine it carefully.
Post-rule	Whenever the context is favorable Then this device can be imported into my city.

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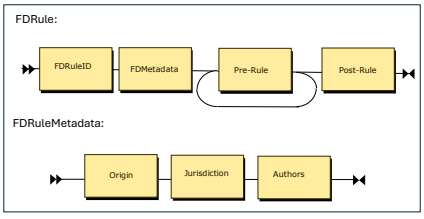
Model for Feedforward rules



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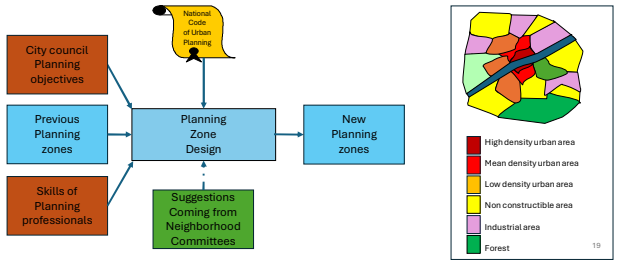
Knowledge Involved in Planning Zone Design



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Suggestion Positioning

- Important phase of public participation
- Citizens can give their opinions relative to the proposed plan
- So, any citizen's suggestion can be positioned

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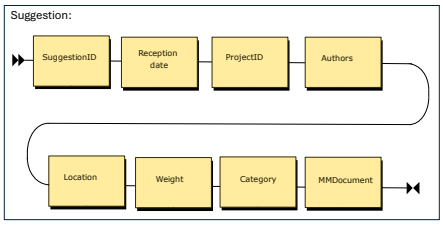
Model of Suggestion



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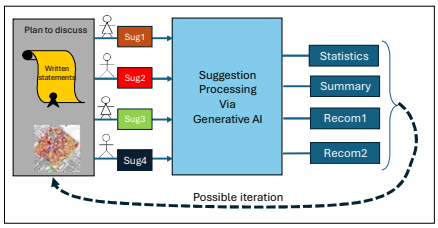
Suggestion Processing to Recommendations

- Suggestions can be summarized.
- Salient propositions are kept as recommendations
- Sometimes possible iterations



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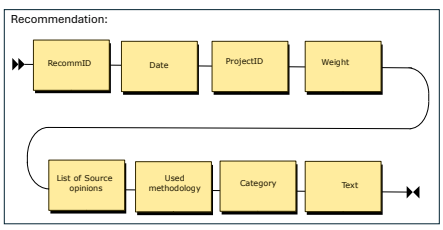
Model of Recommendation



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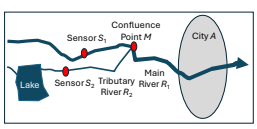
Example of Feedforward Rule Implying an External Chunk of Knowledge

Flood prevention



Pre-Rule	$\forall C \in Cities, \exists R_1, R_2 \in Rivers, \exists S_1, S_2 \in Sensors$ $\vdash Cross(Geom(R), Geom(C));$ $\vdash Tributary(R_2, R_1);$ $\vdash Upstream(S_1, R_1, C);$ $\vdash Upstream(S_2, R_2, C);$ $\vdash Tributary(R_2, R_1);$ $Geom(M) = Confluence(R_2, R_1);$ $\vdash Upstream(M, R_1, C)$ $\Rightarrow$ $\{Activate(S_1); Activate(S_2)\}$
	A while after
Post-Rule	$\exists \theta \in Values$: $Value(S_1) > \theta \; Value(S_2) > \theta$ $\Rightarrow$ $\{Send\ AlarmToPopulation(C);$ $PrepareRescue(C)\}$ ■

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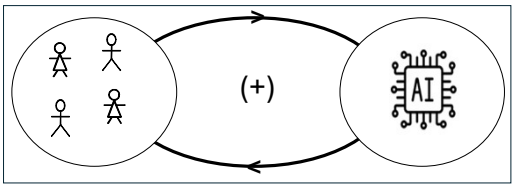
Virtual cycle of Human collective Intelligence and Artificial Intelligence



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Conclusion

- In the past, planning was based on data
- Now, planning based on knowledge
  - Various types of knowledge identified
  - Some models are provided
  - Needs for capturing more semantics
- Combining human collective intelligence and artificial intelligence
- Urban Intelligence

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