Intelligent Information Processing and Visualisation for Civil Crisis Management and beyond

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Presentation Plan

1. The OASIS project
2. Intelligent decision support in crisis management: goals and research directions
3. How it looks like now *(live demo)*
4. What stands behind
5. Next steps:
   1. Design effective visualisations for analysis and communication
   2. Support data analysis
6. Challenge: extend it beyond OASIS

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The Oasis project

http://www.oasis-fp6.org/

- Oasis is a DG INFSO co-funded project part of the Sixth Framework Programme (FP6) within the priority “Improving Risk Management”
- This is a 4 years Integrated Project which started on the 1st September 2004

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Objectives of Oasis

- To develop a Disaster and Emergency Management system
  - aiming to support the response operations in the case of large scale as well as local emergencies;
  - providing an IT framework which can be used at the different levels of the Civil protection organisations, European, national or local;
  - facilitating the cooperation between the information systems used by the civil protection organisations.

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Our Role and Tasks

- Suggest novel decision support tools for crisis managers
  - as a complement to the regular crisis management tools
- Orient to the end users:
  - *everything must be very simple and easy!*
- Account for specifics of crisis situations:
  - time pressure, stress, information overload

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The General Approach

- Embedded intelligence:

= Knowledge-based information processing and visualisation

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Our Major Goals

- Reduce the workload of users, save their time
  - e.g. by automating routine work
- Reduce the cognitive load of users
  - e.g. by automated selection and effective presentation of relevant information
- Improve the situation awareness
  - e.g. by automatic detection and highlighting of items requiring attention
- Promote effective communication of relevant information between actors involved
  - e.g. by automated presentation design

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Our Research Focus

- Visual Analytics
  - geovisualisation, general information visualisation
  - combined with computations and database operations
  - to support data analysis and decision making
- Visualisation in OASIS:
  - for situation awareness
  - for information communication
  - for response planning

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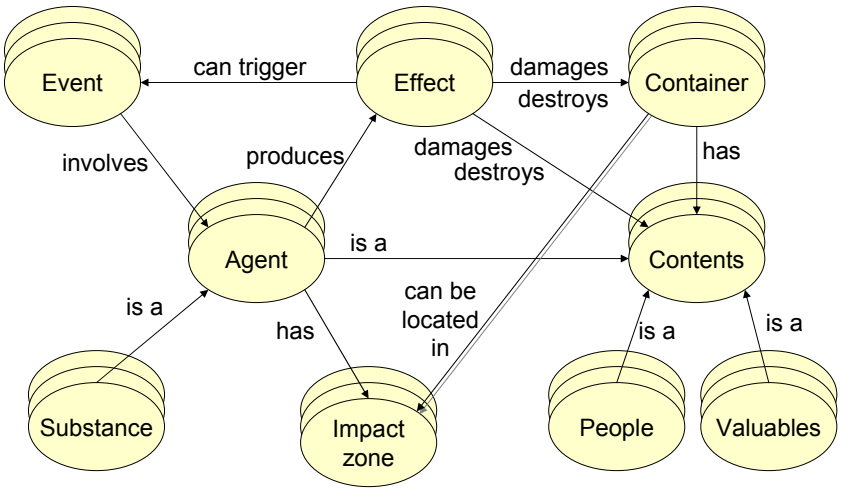
Basic Notions



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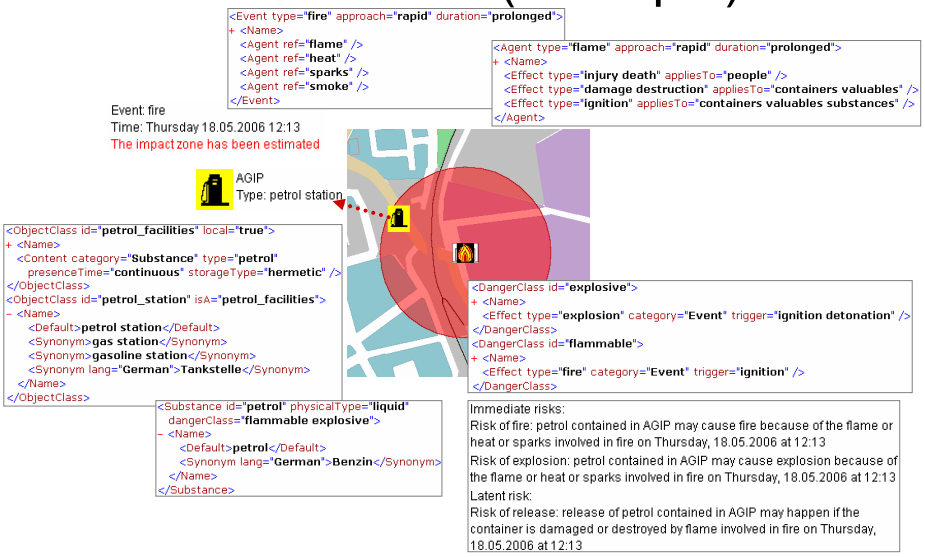
Instantiation (Example)



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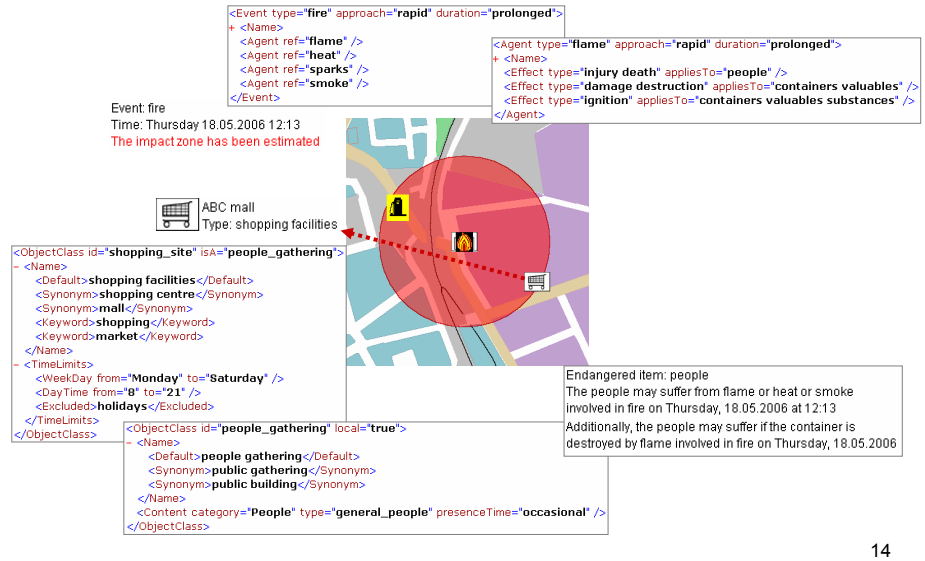
Instantiation (Example) cont.



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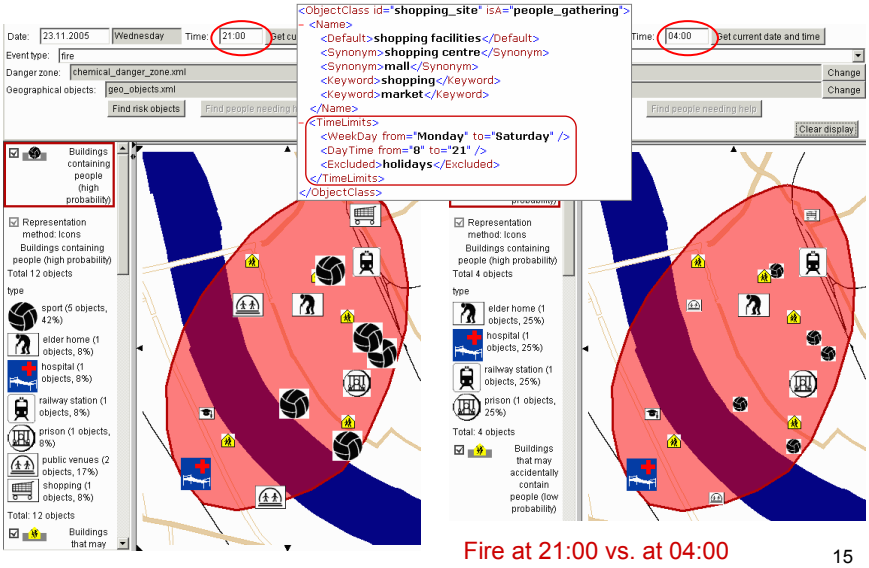
Taking the Time into Account



Fire at 21:00 vs. at 04:00

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Knowledge Types

- ➢ Descriptive (declarative) knowledge
  - ✓ XML; can be easily modified and extended
- ➢ Operational (procedural) knowledge
  - Information processing tasks
    - – Find latent risks
    - – Find endangered people (and other items)
    - – Compute endangered population
    - – Find suitable shelters
  - ☹ Incorporated in program code (Java)
  - 😐 Hope that no major changes to the procedures will be needed

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UI and Visualisation

- *Everything must be very simple and easy!*
  - ☺Friendly user interface
  - Visualisation is essential
    - Simple map
    - Icons with easily recognisable meanings
  - Semantics needed!
    - ☹The user should be bothered as little as possible
    - ☞Try to recognise the meanings of data items automatically
      - e.g. by looking for keywords

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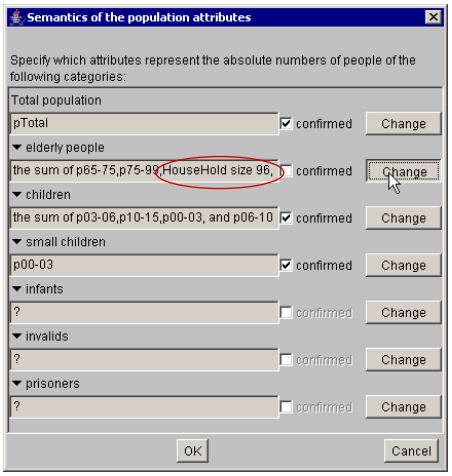
An Example of Semantics Acquisition

Data (population by districts):

```
<Object>
  <id>110</id>
+ <shape closed="true">
  <property name="pTotal" type="numeric">2653</property>
  <property name="pMale" type="numeric">1235</property>
  <property name="pFemale" type="numeric">1418</property>
  <property name="pForeigners" type="numeric">559</property>
  <property name="pChange July96-Dec95" type="numeric">-72</property>
  <property name="p00-03" type="numeric">58</property>
  <property name="p03-06" type="numeric">58</property>
  <property name="p06-10" type="numeric">55</property>
  <property name="p10-15" type="numeric">70</property>
  <property name="p15-18" type="numeric">41</property>
  <property name="p18-25" type="numeric">297</property>
  <property name="p25-30" type="numeric">414</property>
  <property name="p30-45" type="numeric">804</property>
  <property name="p45-60" type="numeric">377</property>
  <property name="p60-65" type="numeric">102</property>
  <property name="p65-75" type="numeric">197</property>
  <property name="p75-99" type="numeric">180</property>
  <property name="HouseHold size 96" type="numeric">1.85</property>
  <property name="HouseHold size 95" type="numeric">1.9</property>
</Object>
<Object>
  <id>496</id>
  ...
```



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How It Works

```
<AttributeDef id="age" type="integer">
- <Name>
    <Default>age</Default>
    <Synonym lang="German">Alter</Synonym>
    <Synonym lang="French">l'âge</Synonym>
    <Keyword>age</Keyword>
    <Keyword>year</Keyword>
    <Keyword>old</Keyword>
    <Keyword lang="German">Jahr</Keyword>
    <Keyword lang="German">alt</Keyword>
    <Keyword lang="French">âge</Keyword>
    <Keyword lang="French">ans</Keyword>
  </Name>
- <ValueDef>
    <Range minValue="0" maxValue="120" />
  </ValueDef>
</AttributeDef>
```

```
<SpecNeedDef id="help_to_move">
- <Name>
    <Default>help to move</Default>
    <Synonym lang="German">Hilfe zum zu bewegen</Synonym>
    <Synonym lang="French">aide à déplacer</Synonym>
  </Name>
</SpecNeedDef>
<SpecNeedDef id="assistance">
- <Name>
    <Default>assistance</Default>
    <Synonym lang="German">Unterstützung</Synonym>
    <Synonym lang="French">assistance</Synonym>
  </Name>
</SpecNeedDef>
```

```
<PeopleClass id="elders">
- <Name>
    <Default>elderly people</Default>
    <Synonym lang="German">ältere Leute</Synonym>
    <Synonym lang="French">personnes ainées</Synonym>
    <Keyword>elder</Keyword>
    <Keyword>old</Keyword>
    <Keyword>aged</Keyword>
    <Keyword>senior</Keyword>
  </Name>
  <Attribute id="age" minValue="65" />
  <SpecialNeed>help_to_move</SpecialNeed>
  <SpecialNeed>assistance</SpecialNeed>
</PeopleClass>
```

```
<Object>
  <id>110</id>
+ <shape closed="true">
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  <property name="HouseHold size 95" type="numeric">1.9</property>
</Object>
<Object>
  <id>496</id>
  ...
```

Not an interval: 96>95!

Good match

False match

This is why this people category is specially dealt with

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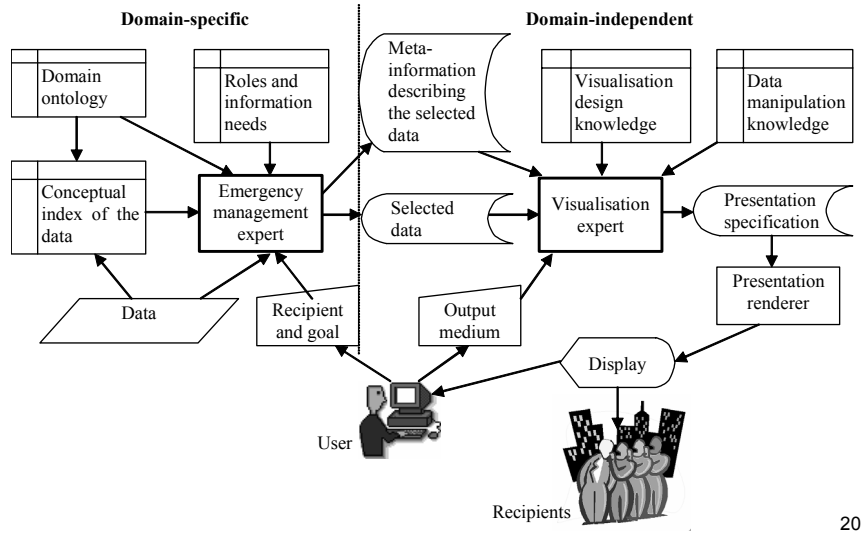
The General Conception



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Visualisation Design for Analysis and Communication

- What factors essentially influence the design?
  - Purpose: analyse, inform, alert, instruct, *???*
  - Recipient's profile: role, task, knowledge and experience, acquaintance with the situation and with the territory, *???*
  - *???*
- What must be known about the information to visualise?
  - The meaning of information components; *what aspects?*
  - Relationships between them; *what relationships?*
- How to specify this meta-information in a domain-independent way?
  - *Ontology of information and data types and relations*
  - *Language to describe information and data*

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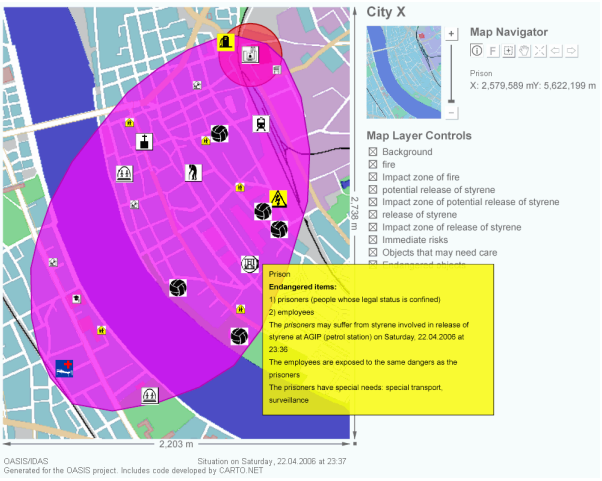
Visual Communication: Current Status

- An interactive SVG presentation can be built automatically for informing people who don't have access to the OASIS system

Thanks to A.Neumann (ETH, CARTO.NET) for support



Still a long way to go…

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Intelligent Support of Data Analysis

- Multitude of possible analysis tasks
- Data complexities: *very large volumes, multidimensionality, space, time*
- Need to use multiple diverse tools: *visualisation and display manipulation, data manipulation, querying, computations*
- Human factors: *low qualification of end users, lack of experience in analysis*
  - ⇒ Everything must be simple and easy!
- Specifics of crisis situations: *time pressure*
  - ⇒ Everything must be fast and efficient!

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Approach in OASIS

- Select a limited set of tasks and data types relevant to disaster management
- Design procedures to accomplish the tasks in automated or semi-automated mode
  - Database operations + data transformations + data mining + visualisation

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Relevant Data Types

- Time series of measurements taken in a number of locations
  - e.g. air or water pollution measured by statically installed sensors
  - May be very long!
- Events occurring in various places at various time moments
  - e.g. disease cases or forest fires
  - e.g. measurements taken in sample locations
  - May be very numerous!

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Relevant Analysis Tasks

- Build a (mental) model of the behaviour of a hazardous phenomenon or process
  - to predict the further development
  - to assess the situation in places with no data
- Detect places with high level of danger or with dangerous trends
- Find relationships between the hazardous phenomenon and other phenomena
  - e.g. weather, land cover, migration of animals,…
  - to explain the reasons or mechanisms of the hazardous phenomenon

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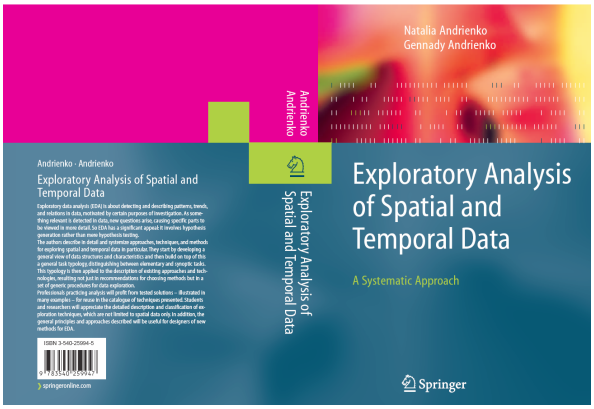
Build on Our Experience

- How can tool designers know what tools are needed?
  - What capabilities should be provided?
  - What kinds of tools can properly do this? What requirements they should meet?
- How several tools providing complementary capabilities can be properly combined?
- How can we teach the users when and how to apply what tools?

An attempt to generalise our experiences in designing and applying EDA tools



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Extend It Beyond OASIS?

- The need exists!
  - People wishing to analyse data often ask us what to begin with, what tools to use, how, …
- ☹Exploratory Data Analysis is complex!
  - 👎about 700 pages in our book… and still no recipes with guaranteed success
- EDA relies on human vision and imagination
  - ⇒It can hardly be done automatically by an intelligent software system

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What an Intelligent System Can Do

- Facilitate the work of a human analyst
  - ✓ Transform the data…
  - ✓ Visualise the data…
  - ✓ Suggest appropriate tools for further analysis…
  - • …depending on the tasks and data characteristics
- Possible approaches
  - • Generic tasks *(👎 too numerous; 👎 may be hard to understand and inconvenient for users)*
  - • Reusable procedures (analysis scenarios)
    - – built by expert analysts for specific tasks
    - – applicable to similar data and tasks

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Fundamental Needs

- Ontology to describe data characteristics and structures
- Ontology of analysis tasks
- Ontology of analysis operations (operation types, inputs, outputs, applicability conditions)
- Language to represent analysis procedures (operation sequence, conditional branching, loops, recursion)

❖ Cooperation?

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