Intelligent Visualisation and Information Presentation for Civil Crisis Management

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Presentation Plan

1. The OASIS project
2. Intelligent decision support: goals and research directions
3. Knowledge-based approach to data analysis and visualisation
4. Prototype
5. Ongoing work

The Oasis project

European Commission

Information Society Technologies

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

EADS THALES BAE SYSTEMS DATAMAT SINTEF EDISOFT AIS ERICSSON EDIUM SOFT Russian Academy of Sciences Institut Autonome Intelligente Systeme

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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Intelligent Decision Support in OASIS

- Conduct applied research on decision support in emergency situations; develop advanced techniques and tools for emergency management personnel
  - as a complement to the regular crisis management tools
- Major goals of intelligent decision support:
  - Reduce the workload of users (e.g. by automating routine work)
  - Reduce the cognitive load of users (e.g. by automated selection and efficient presentation of relevant information)
  - Improve the situation awareness (e.g. by automatic detection and highlighting of items requiring attention)
  - Improve the quality of decision making (e.g. by optimisation and what-if modelling)

Russian Academy of Sciences

A dedicated subproject is coordinated by Fraunhofer Institute AIS

Institut Autonome Intelligente Systeme

Our main focus

- Goal: give everybody the right information at the right time and in the right way:
  - an actor should be able to get the information that is necessary for the adequate behaviour in the current situation or fulfilling his tasks;
  - the information should be presented in a way promoting its rapid perception, proper understanding, and effective use
    => visualisation is essential

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Actors and their information needs

*give **everybody** the **right information** at the right time and in the right way*

- Analyst
  - situational data (real-time) + reference data (long-term)
- Decision maker
  - a compact informative summary
- Planner
  - information relevant to a particular problem
- Performer
  - information relevant to a task to be performed
- Sufferer
  - explanation what happens & instructions what to do
- Observer
  - general information about the accident

Domain Knowledge Base

*give everybody the **right information** at the **right time** and in the right way*

- Types of events (e.g. fire, flood), their agents (e.g. flame, heat, water), and the effects that may be produced (e.g. destruction, contamination);
- Types of objects entailing latent dangers and the agents that may activate those dangers;
- Groups of population that may require help;
- General tasks in emergency management (e.g. evacuation);
- Types of resources and their properties.

Knowledge extracted from books and descriptions of past events

Example knowledge fragments

```
- <PeopleClass id="invalids">
  - <Name>
      <Default>invalids</Default>
      <Synonym lang="German">Kranke</Synonym>
      <Keyword>invalid</Keyword>
      <Keyword>sick</Keyword>
      <Keyword>disabled</Keyword>
      <Keyword>handicapped</Keyword>
    </Name>
    <Attribute id="health_state" value="sick disabled" />
    <SpecialNeed>help to move</SpecialNeed>
    <SpecialNeed>special transport</SpecialNeed>
    <SpecialNeed>medical equipment</SpecialNeed>
    <SpecialNeed>attendance</SpecialNeed>
  </PeopleClass>
- <PeopleClass id="prisoners">
  - <Name>
      <Default>prisoners</Default>
      <Synonym lang="German">Haeftlinge</Synonym>
      <Keyword>prison</Keyword>
      <Keyword>convict</Keyword>
      <Keyword lang="German">Haeftling</Keyword>
      <Keyword lang="German">Gefangener</Keyword>
    </Name>
    <Attribute id="legal_constraint" value="confined" />
    <SpecialNeed>special transport</SpecialNeed>
    <SpecialNeed>surveillance</SpecialNeed>
  </PeopleClass>
```

```
<!-- Objects requiring special protection, e.g.
containing people  -->
- <Object id="people_container" isA="root" riskSource="false">
  - <Name>
      <Default>building containing people</Default>
    </Name>
  - <Contains what="slot" category="People">
    - <Slot fillerType="People">
      - <Yields>
          <Property name="SpecialNeeds" />
        </Yields>
      </Slot>
    </Contains>
  </Object>
- <Object id="school" isA="people_container">
  - <Name>
      <Default>school</Default>
      <Keyword lang="German">Schule</Keyword>
    </Name>
    <Contains what="children" category="People"
      presenceTime="recurrent" />
  - <TimeLimits>
      <WeekDay from="Monday" to="Friday" />
      <DayTime from="7" to="15" />
      <Excluded>holidays vacations</Excluded>
    </TimeLimits>
  </Object>
```

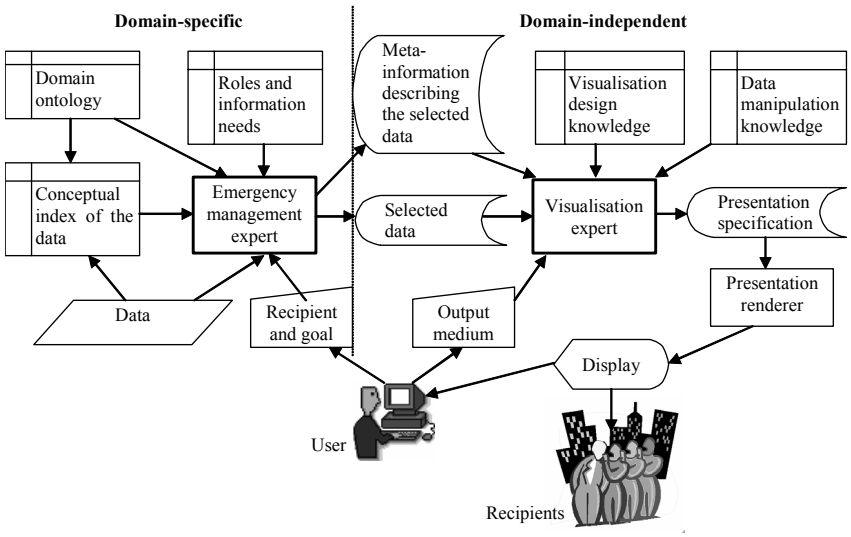
Knowledge Base on Analytics

*give everybody the right information at the right time and in the **right way***

- Methods for data transformation, aggregation, change detection;
- Principles of visualisation design according to data characteristics and analysis tasks;
- Methods for combining complementary visual representations;
- Methods for controlling Level Of Details and visual prominence depending on relevance.

Work in progress

Structure and functioning



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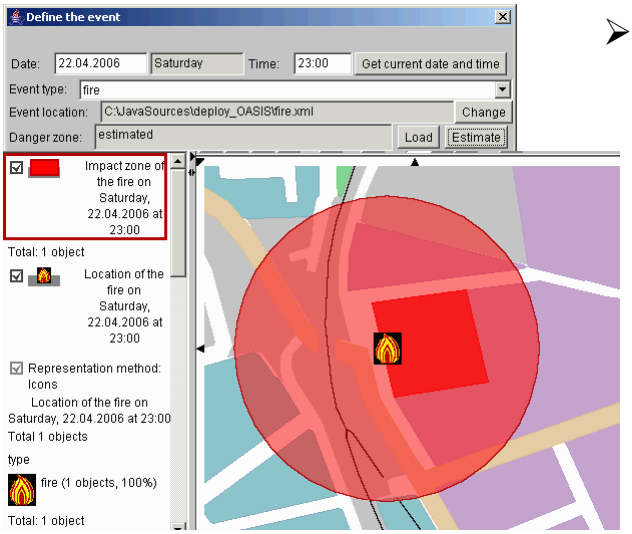
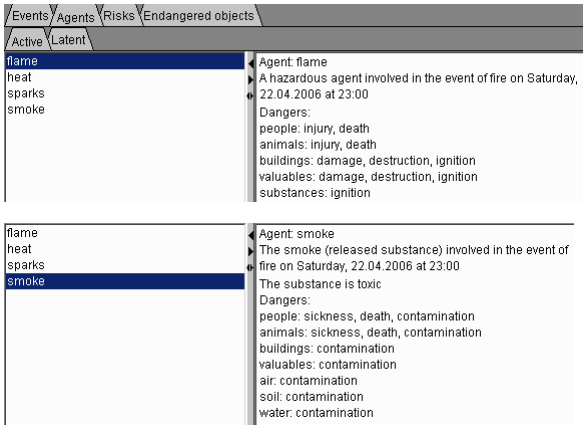
1. Locate and Qualify the Event



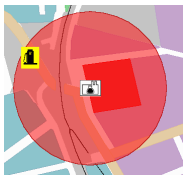
- What happened, when and where (the data are coming from other OASIS modules)

2. Characterize Event Agents



- The OASIS system uses domain knowledge base to inform about active agents of the event and corresponding dangers

3. Find Risk Objects

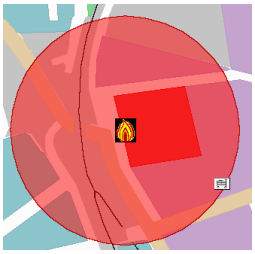


AGIP
Type: petrol station
State: intact Change
Immediate risks:
Risk of fire: petrol contained in AGIP may cause fire because of the flame or heat or sparks involved in fire on Saturday, 22.04.2006 at 23:00
Risk of explosion: petrol contained in AGIP may cause explosion because of the flame or heat or sparks involved in fire on Saturday, 22.04.2006 at 23:00
Latent risk:
Risk of release: release of petrol contained in AGIP may happen if the container is damaged or destroyed by flame involved in fire on Saturday, 22.04.2006 at 23:00

Braun and Co
Type: chemical plant
State: intact Change
Immediate risks:
Risk of fire: hazardous chemical contained in Braun and Co may cause fire because of the flame or heat or sparks involved in fire on Saturday, 22.04.2006 at 23:00
Risk of explosion: hazardous chemical contained in Braun and Co may cause explosion because of the flame or heat or sparks involved in fire on Saturday, 22.04.2006 at 23:00
Latent risk:
Risk of release: release of hazardous chemical contained in Braun and Co may happen if the container is damaged or destroyed by flame involved in fire on Saturday, 22.04.2006 at 23:00

- Using available geo-information, thematic data, and semantic descriptions, the OASIS system finds risk objects, warns about potential dangers, and determines the risk level

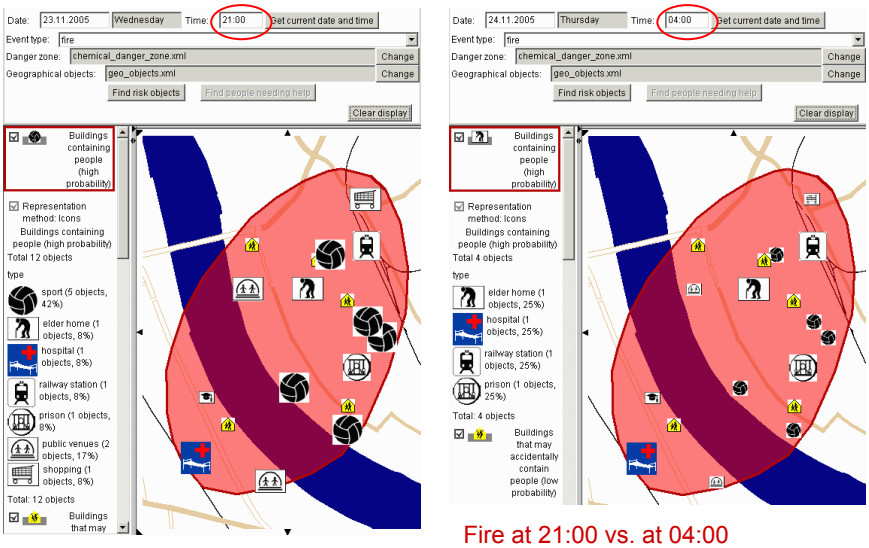
4. Find Endangered Objects



ABC mall
Type: shopping facilities
State: intact Change
Endangered item: people
The people may suffer from flame or heat or smoke involved in fire on Saturday, 22.04.2006 at 23:00
Additionally, the people may suffer if the container is destroyed by flame involved in fire on Saturday, 22.04.2006 at 23:00
The risk is LOW because the people are unlikely to be present at the current time (normally present from Monday to Saturday at times from 8 to 21 except for holidays).

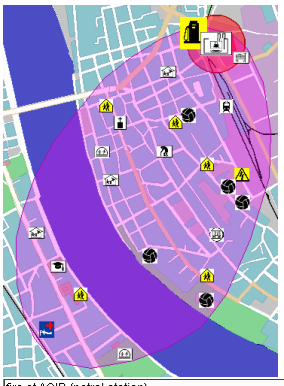
- A similar procedure is used to find endangered objects, estimate the level of danger, and recommend protective measures (e.g. inform and instruct the population, evacuate people etc.)

5. Temporal context

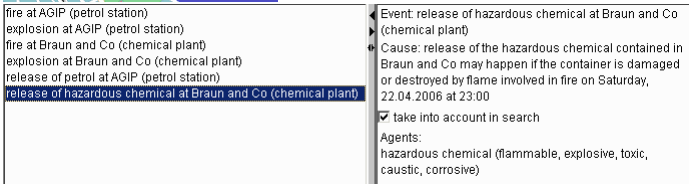


Fire at 21:00 vs. at 04:00

6. What-If Modelling

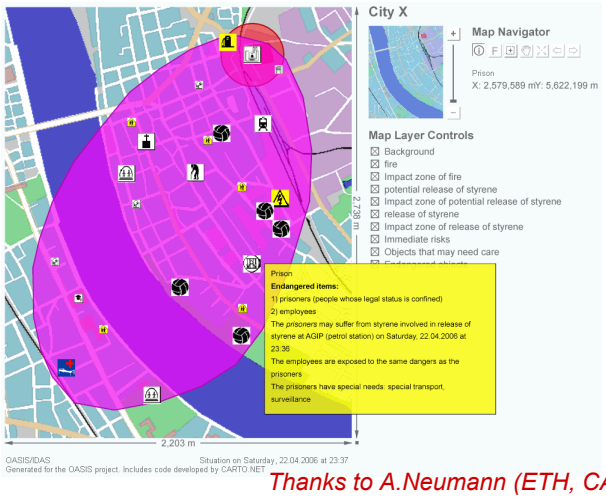


- The analyst is provided tools to model what-if scenarios based on automatically detected potential risks. The map shows which objects will be endangered in a case of release of chemical substance caused by fire.



7. Informing and Instructing

- 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

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Ongoing work

1. Integration with the complete OASIS system (data and control flows)
2. Optimization module for scheduling evacuation and other planning tasks
3. Intelligent support to exploration and analysis of very large spatio-temporal data sets (e.g. environmental monitoring & modelling)
4. Advanced knowledge-based visualisation

Advanced intelligent visualisation - 1

- To design
  - Maps
  - Non-cartographic displays
  - Multiple coordinated displays
  - Compound documents (text + graphics)
    - Static or dynamic (animated, interactive)
- For the purposes of
  - Analysis
  - Communication

To be developed as domain- and software-independent component

Advanced intelligent visualisation - 2

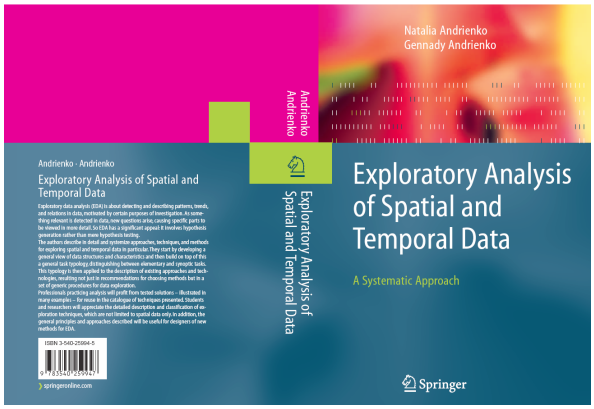
- Addition of a display component (e.g. overview map, summary table)
- Addition of an information item (e.g. new map layers)
- Transformation of information (e.g. generalisation, aggregation, smoothing)
- Re-symbolisation (e.g. of maps)
- Tuning colours scales, symbols etc.
- Selection of appropriate user interaction techniques

We'll use experience accumulated in cartographic and InfoVis communities

Systematic Exploratory Data Analysis

- 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?

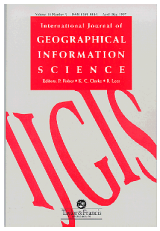
We made an attempt to generalise our experiences in designing and applying EDA tools



Published in December 2005 by Springer-Verlag, ~ 700 pages

Workshop & Special Issue

Workshop on "Visual Analytics and Spatial Decision Support" @ GIScience, Muenster, September 20, 2006, see
http://www.ais.fraunhofer.de/and/



- Special issue on "Visual Analytics & Spatial Decision Support", editors G.Andrienko, N.Andrienko, P.Jankowski, A.MacEachren

Deadline for working papers: May 15, 2006