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
The Oasis project

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

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

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.
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

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
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
Instantiation (Example)

Event time: Thursday 18.05.2006 12:13
The impact zone has been estimated

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Instantiation (Example) cont.

Event time: Thursday 18.05.2006 12:13
The impact zone has been estimated

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Taking the Time into Account

Fire at 21:00 vs. at 04:00

Knowledge Types

- Descriptive (declarative) knowledge
  - XML; can be easily modified and extended

- Operational (procedural) knowledge
  - Information processing procedural knowledge
    - 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
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

An Example of Semantics Acquisition

Data (population by districts):

- [Diagram of a table or interface showing population data by districts]
**How It Works**

Not an interval: 96>95!

This is why this people category is specially dealt with

**The General Conception**

[Diagram showing the general conception process with various components and their relationships]

- Domain-specific
  - Domain ontology
  - Conceptual index of the data
  - Data
  - Emergency management expert
  - Roles and information needs

- Domain-independent
  - Meta-information describing the selected data
  - Selected data
  - Visualisation design
  - Knowledge
  - Presentation specification
  - Presentation renderer
  - Display
  - Recipients

Good match

False match

Not an interval: 96>95!
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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
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…

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!
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

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!
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

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?
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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, …

 opioids 🍀 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
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

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?