Memory Islands: an approach to Cartographic Visualization

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Memory Islands: an approach for cartographic visualization

Outline

- Introduction
- Motivation and Objective
- Ontology and Ontology Visualization
- Memory Islands - Cartographic Visualization
- Evaluation
- Demonstration
- Conclusion and Perspective

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Introduction
Motivation and Objective

- **Motivation**
  - Ontology has been proven as a useful tool
    - *E.g. classification system*
  - Non-experienced users rely on effective ontology visualization tools.

- **Objective**
  - Novel cartographic visualization approach to visualize ontologies
  - Aid knowledge navigation and memorization
  - Help advance the application of documentary and bibliographic classifications in information and knowledge discovery
Memory Islands: an approach for cartographic visualization

Ontology and Ontology Visualization

- Introduction
- Ontology and Ontology Visualization
  - Ontology and its skeleton
  - Information Visualization and Ontology Visualization
  - Information Visualization Mantra
- Memory Islands - Cartographic Visualization
- Evaluation
- Demonstration
- Conclusion and Perspective
Ontology and Ontology Visualization
Ontology and Ontology and its skeleton

- **Ontology**
  - a systematic account of existence (philosophy)
  - a formal and explicit description of concepts (classes) in a domain of discourse (Noy & McGuinness, 2001).
  - it contains the objects, concepts and other entities that are presumed to exist in some area of interest, and the relations that exist between them (Gruber, 1993; Sowa, 2000).
  - an explicit specification of a conceptualization -- triple $O = (C; S; isa)$

- **Ontology’s skeleton**
  - taxonomy
  - useful approximation of the ontology
Ontology and Ontology Visualization

Information Visualization and Ontology Visualization

- **Information Visualization**
  - interdisciplinary study
  - visual representation of large-scale collections of non-numerical information (Friendly & Denis, 2001)
  - the communication of abstract data through the use of interactive visual interfaces. (Keim et al., 2006)

- **Ontologies Visualization**
  - Visualize ontology and its “skeleton”.
  - most of the ontology visualization tools focus on that skeleton. (Katifori, A. et al. 2006 & 2007)
Information visualization mantra (Shneiderman, 1996): **Overview** first, **Zoom** and **filter**, then **details-on-demand** for any kind of visualization.

Seven important tasks for information visualization consisting:

- **Overview**: Gain an overview of the entire collection.
- **Zoom**: Zoom in on items of interest.
- **Filter**: Filter out uninteresting items.
- **Details-on-demand**: Select an item or group and get details when needed.
- **Relate**: View relationships among items.
- **History**: Keep a history of actions to support undo, replay, and progressive refinement.
- **Extract**: Allow extraction of sub-collections and of the query parameters.
Memory Islands—Cartographic Visualization

Idea and approach – Idea

- Inspired by the method of “loci” of “Art of Memory”,
  - people in the antiquity and the Middle Ages used spatialization to increase their memory capacity, consists
    - Creating a virtual map - island
    - Spatialization: associating each entity to designated areas (point) on the map
- Transform structured knowledge into a 2D space (a hierarchical structure represents in a plane).
- Navigating through artificial landscape of our imagination
Memory Islands-Cartographic Visualization

Idea and approach -- approach

- Using the notion of “Memory Islands”
  - Automatically generating artificial cartographies of our memories (Memory Islands).
- A cartographic visualization task consisting:
  1. Information extraction
     - concepts, relations (e.g. taxonomy) etc.
  2. automatically generate the geographic representation
     - automated cartography algorithm corresponding to the given knowledge;
       - Using the notion of “Memory Islands”
     - without loss of information -- label placement algorithms
     - label overlapping
       - Zoom function
       - Automatic decide the max zoom level
  3. a user-interactive interface – similarly to the map services (e.g. Google Maps or Apple Maps).
Memory Islands-Cartographic Visualization
Idea and approach - Prototype algorithms 1

- Prototype algorithms of Memory Islands
  - Output: The Memory Islands

- Step 1: Parse the ontology.
  1. a. Extract automatically the concepts and their relations from the ontology and related web-sources.
  1. b. Construct an ordered weighted tree to manage the information to visualize; Each concept is associated to a node in this tree.
  1. c. Re-ordering the tree structure if needed. (e.g. semantic similarity)
Step 2: Perform automated cartography algorithm to create geographic representation of that tree structure. Associate each node to a specific location in the result map.

Distance between one node and its parent node could have some signification.

E.g. Number of sub-concepts or number of articles in an Encyclopedia, etc.
Memory Islands-Cartographic Visualization

Idea and approach - Prototype algorithms 3

- Step 3: Initialize the map size according to the zoom-level (begin at level-1), and then initialize the labels according to the given configuration (random placement to begin).

- Step 4: Apply label placement algorithm to place the labels in the map.
  4. a. If Successful (no overlaps)
     4. a. 1. go to Step 5;
  4. b. Failure (at least one overlap)
     4. b. 1. Increase zoom level. (Map size increase by four times.)
     4. b. 2. Appropriate increase in the label size, make sure that the size increment for labels is less than the map;
     4. b. 3. Save current label placement configuration for next zoom level and go to Step 3.
Step 5: Create images for each zoom-level
Step 6: Automatically create web-scale user interface
Memory Islands-Cartographic Visualization
Design & Implementation

4 subsystem components of our Memory Islands Application

- Memory Islands Application
- Ontology Parsing
- Automated Cartography
- User Interface Generation
- Label Placement and Images Generation

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Memory Islands-Cartographic Visualization
Design & Implementation

- 4 subsystem components
  - **Ontology Parsing**
    - extracts information (given knowledge and/or web-sources)
    - some algorithms for re-ordering the tree structure (Taxonomy)
  - **Automated Cartography**
    - algorithm generates the map (island)
    - also include the function for reshaping (e.g. Bezier Curve)
    - mechanism for the coloration of the map.
  - **Label Placement and Images Generation:**
    - stochastic algorithms (Simulated Annealing)
    - no label can be deleted
  - **User Interface Generation**
    - web-scale user interactive interface based on HTML 5
    - integrated a small Search engine
Memory Islands-Cartographic Visualization
Concrete case: InPhO ontology
Memory Islands: an approach for cartographic visualization

Evaluation

- Introduction
- Ontology and Ontology Visualization
- Memory Islands - Cartographic Visualization
- Evaluation
  - Visualization mantras
  - Psychological experimental protocol
- Demonstration
- Conclusion and Perspective
- References
Visualization mantras tasks

Overview:
- to guess general domain of ontology or to guess by determining which portion of ontology contains the most or the least number of nodes.

Zoom:
- to check zoom task, such as how many descendants of a given node the users can find, etc.

Filter & Extract:
- we will not ask questions for these type of task, as Memory Islands does not currently provide a function to hide parts of the island to gain more sense-making context.

Details-on-demand:
- users have to search for specific node and find either what is the ancestor or descendant node of that node.

Relate:
- to find the relationship among the items.
- to compare two nodes of the same ontology such as counting its children in order to make comparisons.

History:
- what part of ontology they used for previous questions to check how well the users kept their mind when exploring through ontology.
Evaluation
Visualization mantras - experiments

- 20 participants with different levels of expertise, listed as follows:
  - Zero knowledge of ontology: 9 users
  - Have background in the field of ontology: 11 users
- Four ontologies
  - InPhO ontology, “software" ontology ,"material" ontology and “derm“ ontology
- Three tools
  - Indented list
  - Node link diagram
  - Memory Islands
Evaluation
Visualization mantras - results

Time spent for each task by no experience users

Time spent for each task by experienced users

Memory Islands: an approach to cartographic visualization
Evaluation
Psychological experimental protocol

- Based on the paper of Katifori, A et al. (2006 & 2007)
  - Ontology Browsing
    - Navigating through the content of ontology is the main purpose of this task
  - Ontology Understanding
    - This task tested how well participants can understand ontology using the different interfaces.
  - Ontology Remembering
    - The main purpose of the third task is to test how well the different interfaces can help people remember the positions of the classes on a previously visited path.
    - Revisit the previously visited classes after performing the browsing and understanding task.
Evaluation
Psychological experimental protocol - experiments

- 15 participants with different levels of expertise
- Four ontologies
  - InPhO ontology, “software” ontology, “material” ontology and “derm” ontology
- Three tools
  - Indented list
  - Gephi
  - Memory Islands
Evaluation
Psychological experimental protocol - results

![Graph showing overall correct rates for browsing, understanding, and remembering.](image)

Legend:
- Indented List
- Memory Islands
- Gephi
An overview of Memory Islands – an approach for cartographic visualization

Demonstration
Memory Islands: an approach for cartographic visualization

Conclusion and Perspective

- **Conclusion**
  - New approach and new architecture for cartographic visualization
  - Better for retrieving, browsing and remembering ontology
  - Provides advantages for non-experienced users

- **Future Works**
  - Applied to other fields
    - biological ontology, classification, etc.
  - Collaborative visualization
    - trace one researcher’s visiting and he could share it with others researchers
  - Learning through Visualization


Song, H.; Kim, B.; Lee, B.; Seo, J. (2010)."A Comparative Evaluation on Tree Visualization Methods for Hierarchical Structures with Large Fan-outs”. In: Proceedings of the 28th international conference on Human factors in computing systems (CHI ’10), Atlanta, Georgia, USA.


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