Situated Documents in Personal Information Spaces

- Final Presentation -

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Agenda

- Mymory: Motivation & Goal
- Conceptual and Technical Results
- Evaluations
- Application, Dissemination, Summary
Motivation: In Knowledge-intensive Work, Context Means to Be in a „Specific Mindset“

► In which context are you currently situated?
► How can we determine?
► How do we (re-)contextualize?
► How can we exploit context knowledge?

Goal: Support Personal Knowledge Work

► Represent and elicit the user’s current context
► Exploit current context for
  • More precise information retrieval
  • Pro-active information delivery
► Alleviate costs of context switches
  • Re-contextualization

The user’s attention towards his environment is a key indicator for the relevant context aspects.
Mymory Created a Framework for Document-centered Knowledge Work Support

► Mymory focused on attention towards text documents
  • e.g., considering different modes of reading, annotation, …

► Context model concentrates on a desktop environment.
  • Many physical aspects of context are not regarded.

► Technical approach: Enrich document production and consumption with formal annotations.

An extensive diary study has been conducted at the project’s beginning in order to validate underlying assumptions.

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The Platform Level Facilitates Access to Semantic Desktop Components

- Light-weight basis for a service-oriented organization of Mymory components
  - Supervises the services' life-cycles (deployment, start, stop)
  - Provides communication facilities for synchronous as well as asynchronous information exchange between services
  - Supports distributions among desktops

- Provides endpoints for external applications (e.g., Thunderbird, Firefox) to deliver information

- Management of ontologies is done by services built on top of the platform
  - Ontologies can be added at runtime, including SPARQL and inferencing support
  - High-level operations on the personal information model (PIMO)
The Service Level Realizes the Core Functionalities of a Personal Memory: (1) User Attention

- Attention evidence can be acquired from multiple sources and be uniformly represented.
- From eye movements to document work: A robust algorithm for detecting the reading mode has been developed.

Core Functionalities of a Personal Memory (2): Multi-Context Tracking

- The user's work context can be formally represented:
  - The Personal Information Model (PIMO) provides the basic vocabulary for the context model.
  - Weighting the concepts according to their relevance for the specific context leads to a vector representation.
- Efficient basic operations on contexts are defined:
  - The current context can be identified from user observation.
  - Context switches can be detected.
Core Functionalities of a Context-oriented Personal Memory (3): Document & Information Services

► **Semantic Wiki document backend**
  - Enriching documents with semantic, context- and attention-oriented annotations
  - Manually and automatically generated annotations

► **Exploitation of context and attention data**
  - Attention-oriented information retrieval engine
    - Desktop and web search
  - Faceted search:
    - Page filters
    - Annotation filters
    - Context filters
    - Combination of simple filters with AND, OR

Semantic Document Representation
Attention Evidence
Context Elicitation
Switch Detection

Attention-oriented Information Retrieval
Faceted Browsing

Ontologies and Personal Information Model (PIMO)
Service Framework

Application Level
MyDesk VisualBacktrack
Kaukolu Wiki
DynaQ Desktop Search
Kaukolu Search
Sidebar & Dashboard

Service Level
Context Switching & Browsing
Document Production & Consumption
Information Support

Platform Level
Context Services
Document Work Services
Information Services
Visual Backtracking with the Context-sensitive Dashboard Application

- **Dashboard metaphor a la Mac OS X**
  - *context-sensitive* behavior of widgets
    - E.g., TODO list, information provision, …

- **Assist context transitions**
  - Addresses main problem with context switches: remember + resume old, abandoned goals and tasks
  - Visual Backtrack widget allows looking into the past (of a context)

- **Experiment:**
  - Simulate resuming of *old tasks* by introducing *new clerks*
    - New participants were asked to continue the work of other participants
    - No task description was given: Use Dashboard and the Visual Backtrack!
    - After 96 seconds (avg.), the new user’s had a close description of 50% of the tasks to resume.
    - The max. time needed to resume a task was 7.28 minutes.

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Visual Backtrack Widget Supports Reminding Old Context

- **Timeline view**
- **Recorded behavior**
  - Screenshots of desktop
  - Typed text
  - Clipboard actions
  - Accessed resources (e.g., documents, person contacts)
A Set of Exemplary Applications Exploit the Mymory Services

- **MyDesk** supports navigation in large context sets
  - Context ↔ Desktop
- **VisualBacktrack** supports re-contextualization
- **Kaukolu** as main place for document-centric work
  - Wiki for text production and consumption
  - Situated views based on attention and context
- **Kaukolu Search** extends standard wiki search with semantic search.
- **Coupling of DynaQ desktop search with attention services**
- **Sidebar & Dashboard** for (pro-active) information delivery

Appliance level resembles this grouping of applications.
Appliance Level: The Physical Workplace Reflects the Logical Structure

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Context Identification Is a Cornerstone of Multi-Context Knowledge Work Support

► Ground truth: Recorded user’s actions during several work days (1-2 weeks)
  • Done with our user observation framework “UserObservationHub”
  • Parallel to the user working, absolutely no user interference
► Each user action is mapped to one context thread (task)
  • Manual assignment is done offline with specialized GUI
► Context identification has been analyzed on the basis of 10-fold cross validation on ground truth.

Context Identification Using a Cross Validation on Ground Truth Data

► Automatic context identification works well for many contexts
  • Correct identifications (true positives): 69%
  • False identifications (false negatives): 9%
  • Unidentified cases: 13%
► High amount of not observable actions makes some threads hardly identifiable
► False identifications can not be completely eliminated for similar context threads

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<th>Identified contexts (computed)</th>
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Exploitation of Gaze Data Has Been Investigated in Various Retrieval Settings

- Estimation of explicit **relevance feedback**. Prediction whether a document is individually perceived relevant or irrelevant based on eye movement measures:
  - 21% improvement in positive prediction value and
  - 200% improvement in sensitivity over the best test reported in the literature

- **Query expansion and re-ranking** based on gaze feedback on the paragraph level of viewed documents:
  - 32% improvement in Mean Average Precision over relevance feedback on the document level.

- Work published in:

Query Expansion and Re-ranking Based on Display-time-based Feedback on the Paragraph Level

- **Motivation**: Eye tracking is a very expensive technique.
  Approximation by less expensive methods?

- **Idea**:
  - Observation of scrolling behavior
  - Observation of mouse movements
  - Face tracking

- **First study**: common scrolling and mouse movement behaviors
  - Gaze positions during reading are individually different

- **Second study**: How can display time be used to approximate eye-tracking-based feedback in information retrieval scenarios
  - Display-time-based methods can be tuned to work as well as eye-tracking-based methods.

- **→ SIGIR'09 paper submitted**
Mymory Approach Can be Extended to Further Information Services: Attention-Based Document Classification

Before assigning a document to a specific class, the user examines it.

Assumption: Only these document parts can have led to the user’s classification decision that have been paid attention to.

Only these parts are used for training an appropriate document classifier.


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Industrial Case Studies Show Real-World Applicability of the Memory Approach

► Service Center Scenario (…)
  • Partly very long documents (e.g., handbooks)
  • Various types of document consumers with different use profiles
  • Combination of current process, user role, and specific information needs sets context for most useful view

► Engineering Scenario
  • Combination of structured (product) data and textual information
  • Flexible navigation is needed
  • Semantic annotation on the sub-document level

(...): Diagnostics Scenario
Publication and Dissemination Activities

► ~20 Papers published (book chapters, conference & workshops, journals)
► 2 Best paper awards:
► 9 Diploma & project theses
► Several tutorials and lectures (at conferences and universities)
► Scientific exchange
  • Georg Buscher worked at Microsoft Research, Seattle on prediction of visual attention on web pages
► Workshop (co-)organizations in the area of context awareness
► Several program committee memberships
► Co-operations with Semantic Desktop and Semantic Search projects
  • (...)Virtual Office of the Future, (...) iDocument, THESEUS, NEPOMUK, Aloe, DynaQ
Summary: Main results of Mymory

► Concepts and tools for document-centered knowledge work have been developed.
  • Flexible semantic annotations in an integrated document production and consumption environment are the basis for a personal memory system.
  • Context elicitation by unobtrusive attention tracking.
  • Context switches can be technically supported.
  • Attention data can be exploited for Information Retrieval tasks.

► Experiments supported the claimed benefits.

► Perspectives for further exploitation are promising.
  • Attention-based approach will be elaborated in Perspecting (long-term history, utilization for information extraction).
  • EyEducator will transfer eye tracking-based attention and reading technology to learning application.
  • Expert network in iGreen is planned to build on the Semantic Wiki.
  • For Siemens use case, a follow-up project is planned.

Thank you for your attention!

Questions?