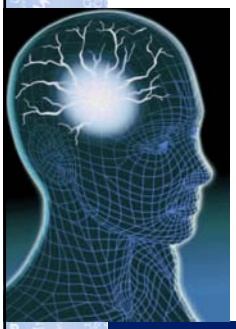

Situated Documents in Personal Information Spaces

– Project Report, 2nd Year –

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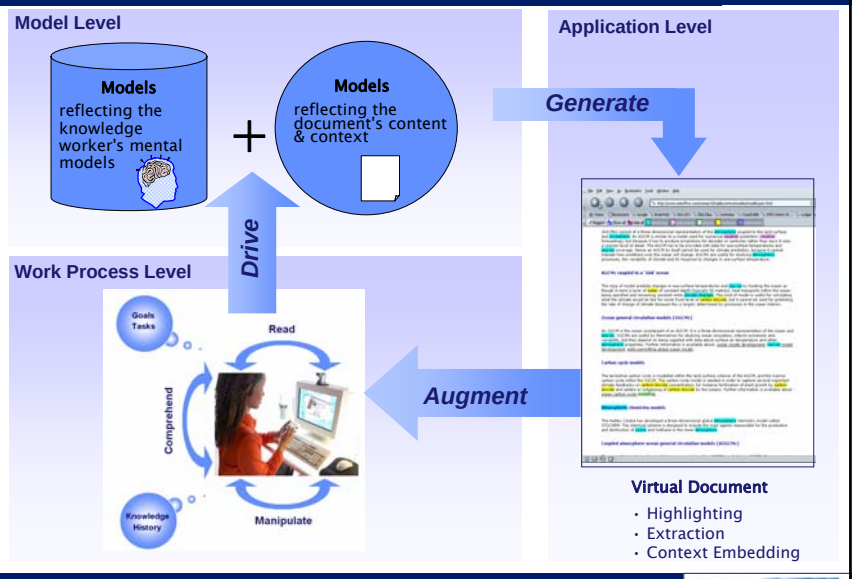
L. van Elst, M. Kiesel, S. Schwarz

SAB February 18–19th 2008

Getting "in tune" with our documents can be an amplifier for the quality knowledge work

- Business documents contain information which is related to our tasks, our experience, our attitude, or expectations addressing persons, things, events, topics, etc.
- Exploitation of these relations in personal information webs is still restricted as they are
  - rarely explicated during document generation,
  - hardly ever captured during document consumption,
  - to a large extend context-dependant.
- Information about a user's attention and interaction with documents may be a good guideline to find out which relations are worth being established and how they can be utilized for improved information handling.

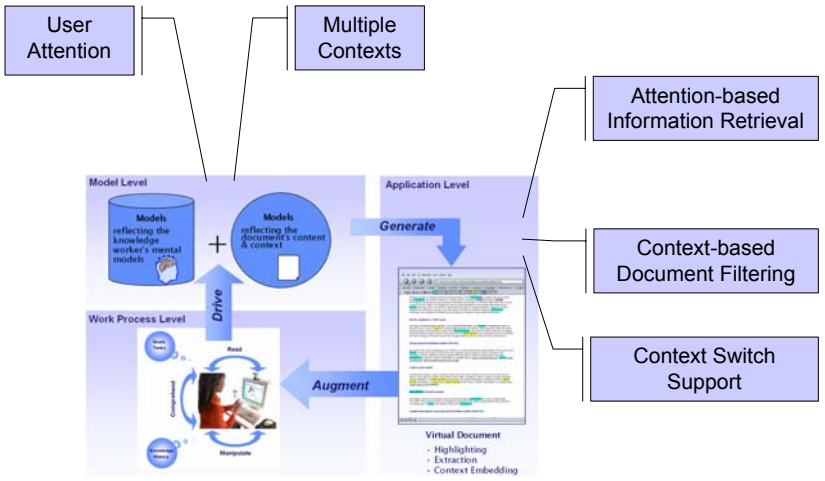
In *My*mory, the user's attention is complemented by „attentive“ documents



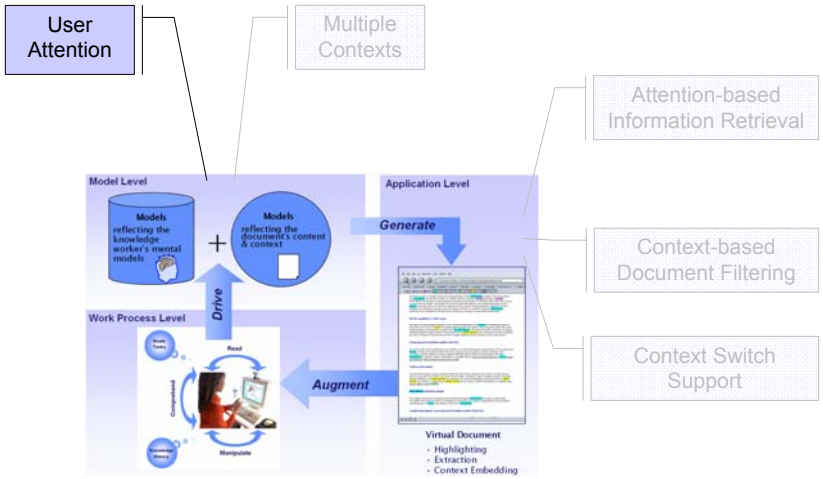
A small recapitulation: Main achievements of *My*mory's first year

- **Foundations**
  - The project's vision has been refined by the definition of more detailed use cases (in co-operation with a commercial partner).
  - The understanding of document use in knowledge work has been further developed by a real world diary study.
- **Core services**
  - A uniform attention representation collects and integrates evidence from multiple sources
  - State-of-the-art eye tracking device serves as high precision source for attention evidence
  - From eye movements to document work: Detecting the reading mode
  - An attention-based Personal Information Model plus context results in a comprehensive memory model
  - An experimental environment for attention-based informational retrieval has been established.
- **Application level**
  - A running prototype for semantically enriched document work is available as open source software. The semantic Wiki system serves as a hub and main GUI for document-centered knowledge work and the C^{3}DW demo application.
  - The "License Wiki" serves as a comprehensive and surveyable test scenario.

Key aspects of Mymory's second year



Explicit and implicit sources of evidence are used to estimate the user's attention



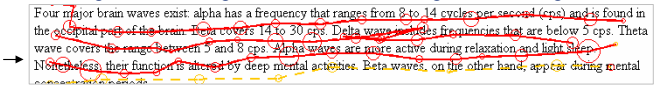
Mymory's attention pipeline is with fed from multiple sources of evidence

- User observation monitors handling of information objects.
  - **`userobservation.opendfki.de`** as open-source platform with shared user action ontology
    - Mozilla plugins observe email + web browsing
    - Filesystem observer
    - PAS logger (L3S): observe window management
    - Camera-based document recognition (from Prof. Kise, Osaka Prefecture University) was integrated as real-time bridge to Gutenberg's world.
- Explicit attention indicators (e.g., highlighting) are captured within the document workbench.
- Eye tracking drives fine grained attention estimation.

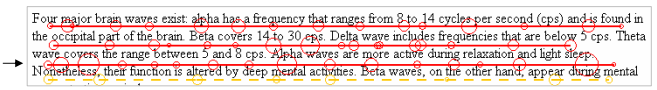
Attention data can be stored with the documents in the semantic wiki Kaukolu.

From saccades to gaze-based document annotations

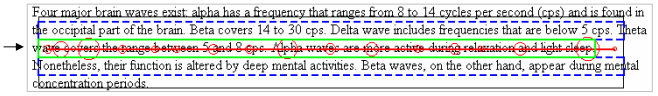
1. Reading detection algorithm detects reading or skimming behavior



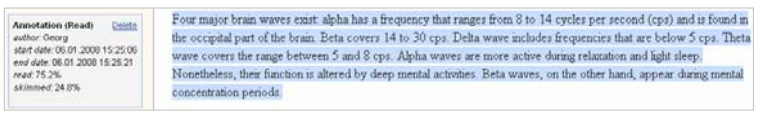
2. Due to eye tracker inaccuracies the lines detected as read or skimmed often differ from the actual text rows



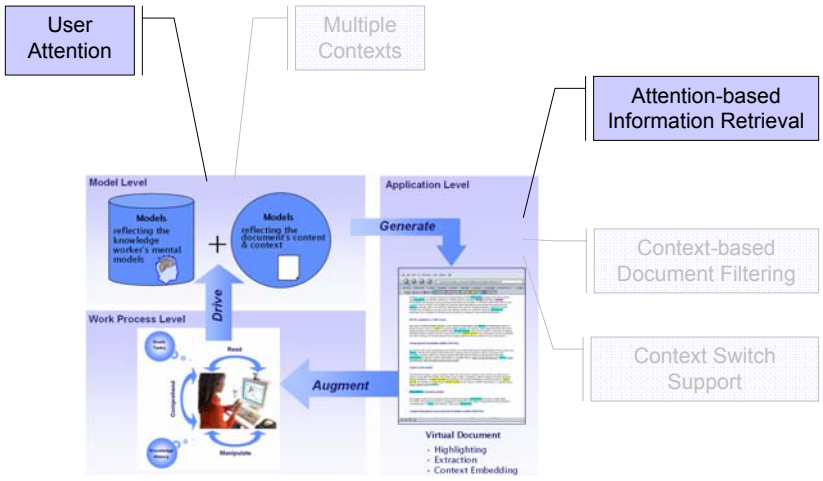
3. Application of OCRopus for online recalibration and line matching



4. Gaze-annotation generation and storage in Kaukolu



Eye tracking data can be exploited to enhance Information Retrieval

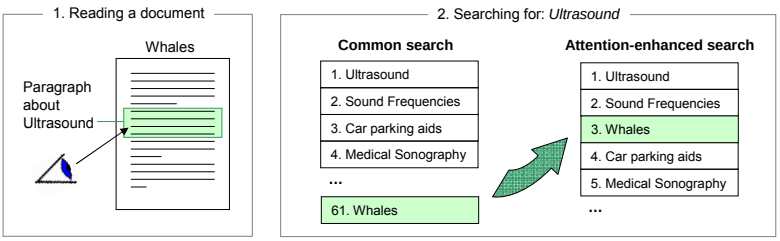


Attention-based document index

- Attention-enhanced documents consider
  - Gaze-based annotations
  - Manual annotations (like highlightings etc.)
  - Combinations of those by applying Dempster-Shafer theory of evidence

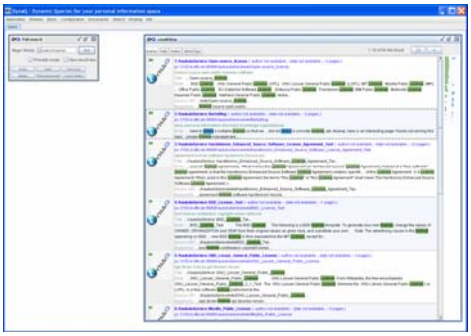
read { The demo workplace will take the user's different situations into account and provide different visualizations and interfaces according to the respective situation.

- Attention-based desktop index to search for attention-enhanced documents
  - Improves re-finding of known material
  - Even if main topic of a document and topic of interest are different

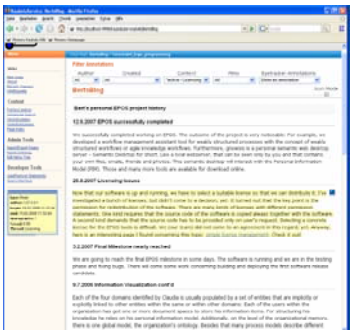


Demo (1):
Previous reading episodes enhance re-finding

- Comparison of standard retrieval engine with/without reading attention data



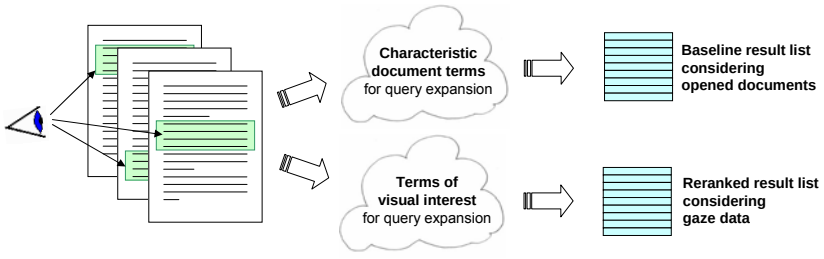
Left Screen
DynaQ Desktop Search Engine



Center Screen
Document Workbench

Attention-based IR evaluation (1):
Gaze-based query expansion and re-ranking

- The user's visual attention is valuable information for estimating the context more precisely.
- Study (21 subjects) for analyzing the effect of gaze-based annotations on web search using query expansion and re-ranking.

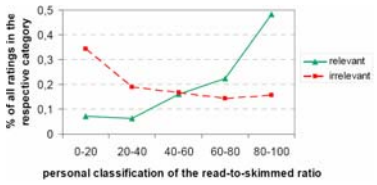


- Result: considering gaze-based annotations for query expansion can **enhance the precision** of the search result ranking by **20%** on average.

Results have been submitted to SIGIR 2008.

Attention-based IR evaluation (2): Predicting relevance from eye movements

- Explicit relevance feedback is an important method for enhancing the ranking of search results. However, rarely used: too much decision effort.
- Eye movements partly reflect cognitive processes
  → study to predict relevance from eye movements (19 participants, 266 relevance ratings)
- Application of our reading detection method to find expressive eye movement measures, e.g.:
  - Simple measures like fixation duration and saccade length
  - Sophisticated measures like the ratio of read lines to skimmed lines

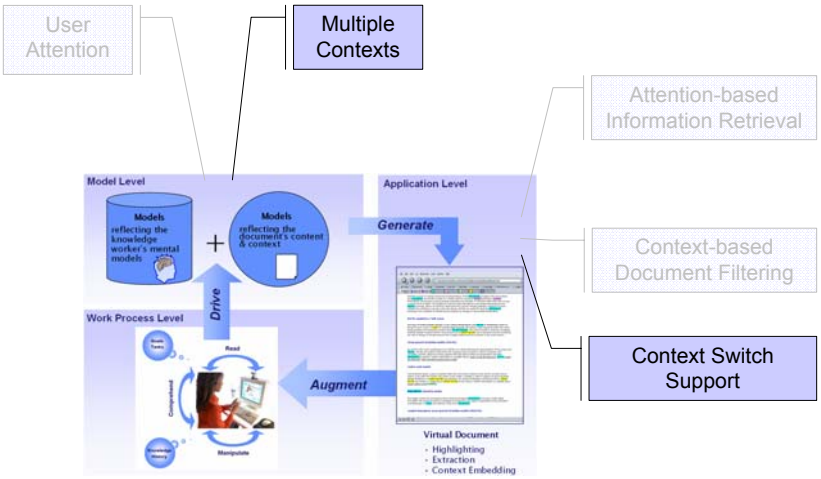


- **Relevance prediction** test based on the eye movement measures:
  - Positive prediction value: **85%**
  - Sensitivity: **75%**
  - Specificity: 73%
  - Significance: high ($< 10^{-13}$)

Previous studies reported values up to:

- Positive prediction value: ca. **70%**
- Sensitivity: ca. **35%**

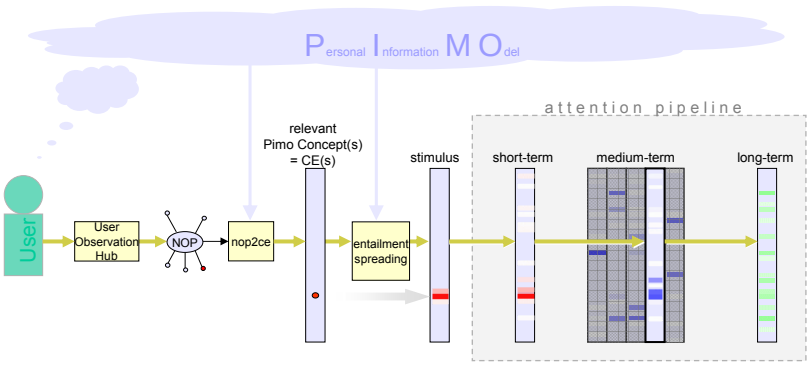
Core question: How do we know which attention values to use?



Multi-modal context models support today's working style

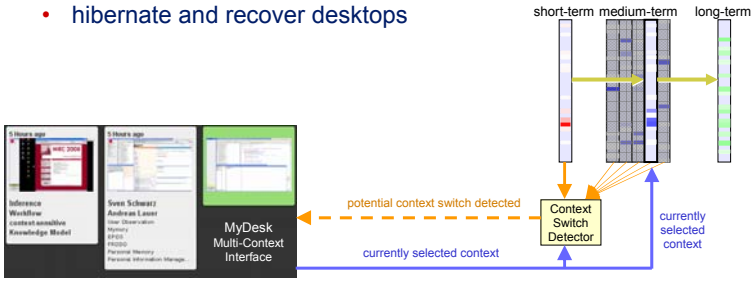
- **Knowledge work requires "multi-tasking capabilities"**
  - The user is embedded in a multitude of processes.
  - Many processes are emerging and changing at a rapid pace.
  - Processes are often intersecting: Tasks run in parallel.
  - The user has to keep track of and switch between processes / tasks.
- **The user observation component monitors the user's activities and feeds a representation of his/her context.**
- **This user context is technically abstracted to the amount of attention the user devotes to individual PIMO concepts (representation of his/her mental models).**
  - A semantically rich RDF/S++ model allows sophisticated reasoning, explanation, and an ontological exchange of contextual (meta-)data.
  - A vector representation allows efficient calculation using standard vector arithmetic.
- **Multiple (different) user contexts are kept in separate models.**
  - Extension of function: `attention( thing, context )` → `[0..1]`
  - As the user can concentrate on only 1 single context at a time, only 1 context is *active* at a given point in time. So, the user has to *switch* between contexts.

A Personal Information Model (PIMO) provides the basic vocabulary for context modeling



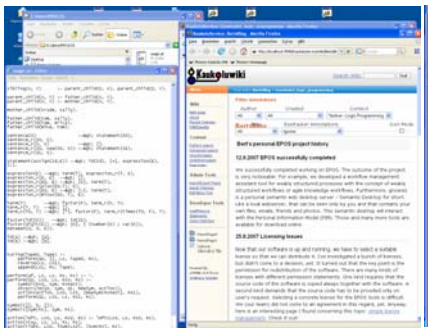
Switch detection is the basic service for multiple context support

- **Multi-desktop paradigm represents context switches by desktop switches**
  - One desktop is identified with one context
  - Visualization of desktop (screenshot, exposé) allows recognition and identification of that desktop/context
  - The set of attended PIMO concepts for a context also classify the corresponding desktop => automatic “tagging” of desktops
  - arbitrarily many desktops
  - hibernate and recover desktops

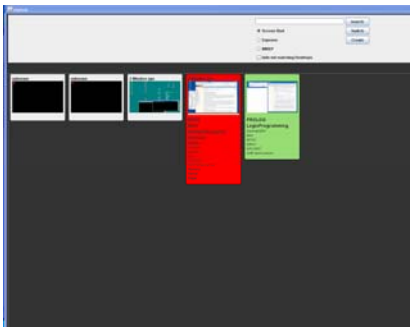


Demo (2): User observation drives context detection

- Dealing with "licenses" after "logic programming" leads to switch proposal.

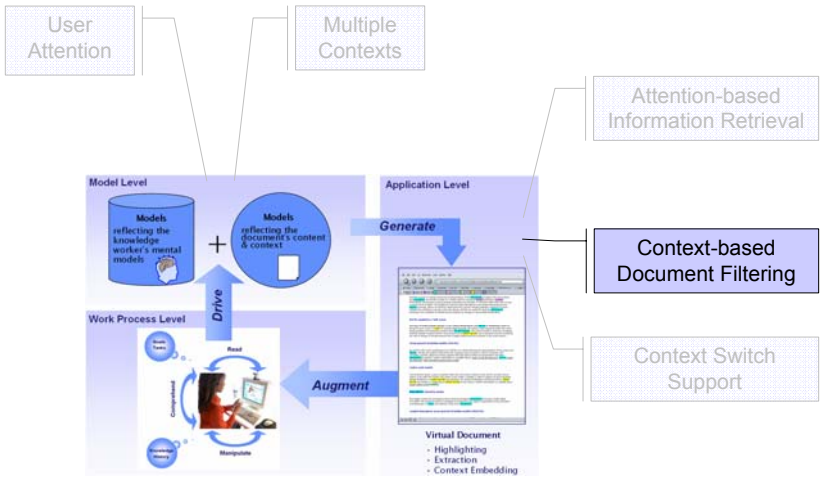


Center Screen
Document Workbench



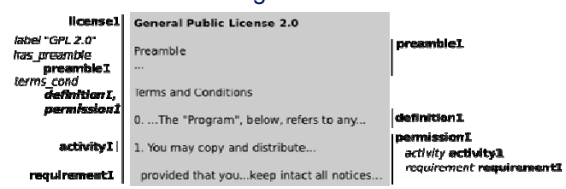
Right Screen
MyDesk Multi-Desktop Handler

Core question: How can we make a large number of annotations usable?



Annotations come from manual and automatic processes

- **Manual annotations**
  - can use concepts from the user's PIMO or arbitrary ontologies and associate them with text passages
  - graphical annotations/freehand drawings are supported (Tablet PC)
  - also meta-data like ratings



- **Automated annotations**
  - eye tracker events
  - context information

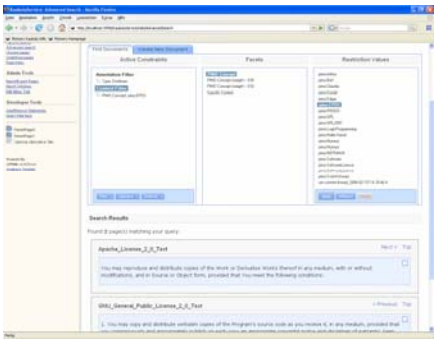
Annotation/Context-based search and filtering leads to situated views on documents

- Kaukolu search can search for annotated paragraphs, e.g.,
  - Passages with text “ultrasonic” read in context of topic “whales”
  - Passages describing rights granted by a software license that have been read in context of project “Mymory”
  - Passages annotated by colleagues yesterday

- Pages/Annotations can be filtered by context/attention information
  - gray out/hide paragraphs not read in the past
  - show only annotations created in a certain context
- Search results can be fused to report documents.
  - Provenance information is being maintained.

Demo (3): Faceted search exploits multitude of annotations

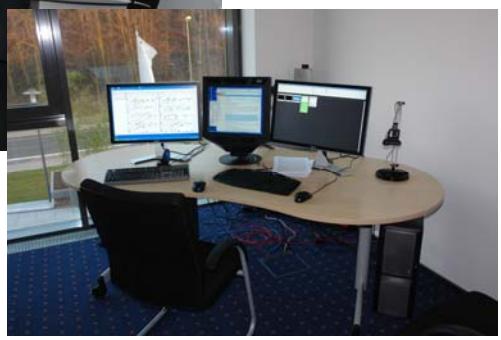
- Context filters narrow down the search space. Results are fused into report document.



Center Screen
Document Workbench

Physical workplace(s)

Living Lab
Virtual Office



Mymory Lab

Thank you for your attention!

Questions and Suggestions