Challenges for Context Management Systems imposed by Context Inference

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- ✓ Introduction
- ✓ Requirements for Future Context Management Systems
- ✓ Creation, Storage and Access of Context Inference Rules
- ✓ Integration of Inference with Context Management Systems





✓ Introduction

- ➤ Requirements for Future Context Management Systems
- ✓ Creation, Storage and Access of Context Inference Rules
- ✓ Integration of Inference with Context Management Systems
- Conclusions and Outlook





Introduction Why Context Inference?

- ➤ Not for everything there are sensors
- ✓ Usage of available information to estimate high-level context



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Introduction Why Context Inference? Use Case



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Introduction Why Context Inference? Use Cases



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- ➤ Introduction
- ✓ Requirements for Future Context Management Systems (CMSs)
- ✓ Creation, Storage and Access of Context Inference Rules
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Requirements for Future Context Management Systems State of the art

7	Efficient Context Modeling and Semantics	\rightarrow	main target
7	Distributed Context Management	\rightarrow	some prototypes
7	Context Source Management	\rightarrow	seldom generic
7	Context Inference	\rightarrow	only on algorithmic level
7	Preference handling	\rightarrow	Concept discussions
7	History of Context	\rightarrow	Available in some projects
7	Context Event Management	\rightarrow	Usually available
7	Group context	\rightarrow	Concept phase
7	Context privacy & security	\rightarrow	Seldom implemented
7	Quality of context	\rightarrow	Conceptually available
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Requirements for Future Context Management Systems Adaptation to New Needs



- Providing concepts and architecture
- ➤ Analysing and optimizing performance in component interactions

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- ➤ Requirements for Future Context Management Systems
- ✓ Creation, Storage and Access of Context Inference Rules (CIRs)
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Creation, Storage & Access of Context Inference Rules Rule Creation





Creation, Storage & Access of Context Inference Rules More Rule Creation

More sources of rules in a CMS:

- → Usage of templates, adapted to a user by incremental personalisation
- → External providers

Triggering of Rule Learning:

	Batch-Process	On-Demand	Incremental
Creation	Х	Х	
Update	Х	Х	Х
Resource usage		+	-
Response time	+		+
Up-to-date information	-	+	+

→ A combination of all aproaches is necessary





Creation, Storage & Access of Context Inference Rules Storage and Access

Storage

- 1) Context providers as external services: registration for input, provision of output info
- 2) Centrally on backend servers inside the CMS
- 3) On mobile user devices managed by the distributed CMS



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Inference in Context Management Systems Reducing inference duration: The Bayeslet concept





Inference in Context Management Systems Inference Scheduling

Options:

7	Continuous Inference	Advantages: Drawbacks:	Always recent inferred information High resource cost, possibly unused information
7	On-Demand Inference	Advantages: Drawbacks:	resource efficient higher response times no subscription possible

Possible solutions:

- ✓ Enable subscription by splitting it to subscriptions for every input node
- ✓ Continuous inference based on the update of the input node





Inference in Context Management Systems Inference Scheduling

Hybrid Solution:

Continuous Inference upon request - On-Demand Inference where possible





Inference in Context Management Systems Update Frequency





High-level Activity Inference Hierarchical Inference

- ➤ Low level algorithms widely used & necessary:
 - ✓ Coordinate based location techniques
 - E.g. Particle Filters for tracking or situation analysis
- Making the result available to and usable in Bayeslets
 - probabilities, soft outcome necessary



- 1. Enhance the precision based on high-frequent absolute location
 - 2. Assign semantics to clusters of related locations
 - 3. Use this information for further inference

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Conclusions and Outlook

- 1. When and how should CIRs be created?
 - → combination of batch and incremental learning + human expertise
- Where should they be stored and how accessed?
 → mobile, but backed up
- 3. How can inference time be reduced?
 → Bayeslet concept, reducing rule size
- 4. How has inference to be scheduled or triggered?
 → on-demand and continuous inference, results stored in CMS
- 5. When has inference to be updated based on its input?
 - \rightarrow upon change of already semantically enriched information, not raw data

Next Steps:

- ✓ Realistic Testing
- ✓ Smart Device User interaction incorporated as expert knowledge.



