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Reasoning Over Spatial Relations for Context-Aware Distributed User Interfaces

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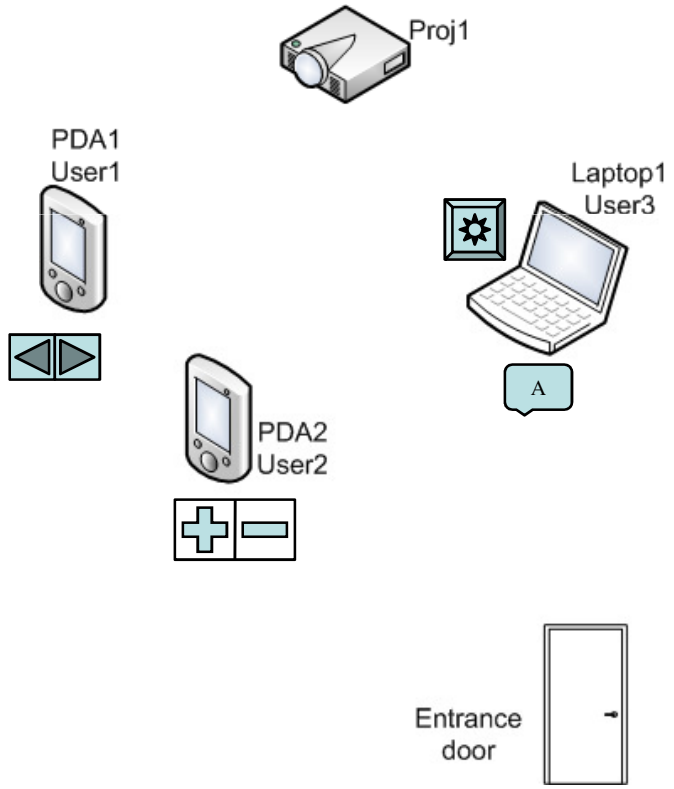
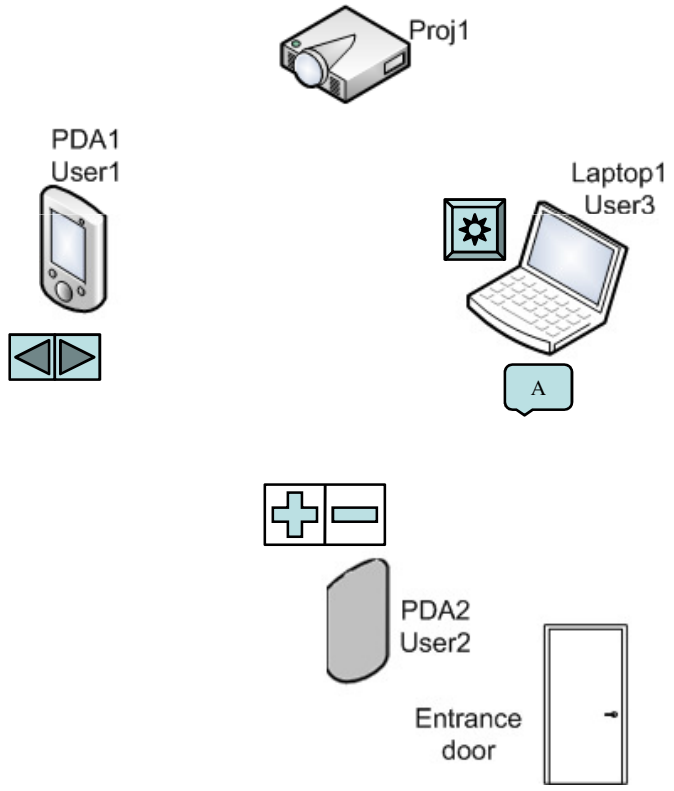
Introduction

Distributed UI of an image viewer application



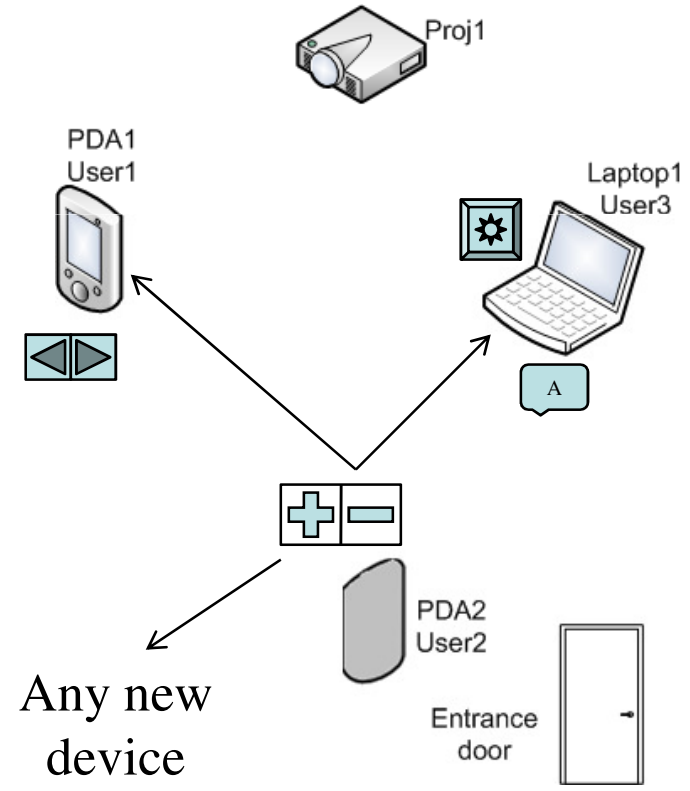
Introduction

Distributed UI of an image viewer application



Introduction

Redistribution of the UI



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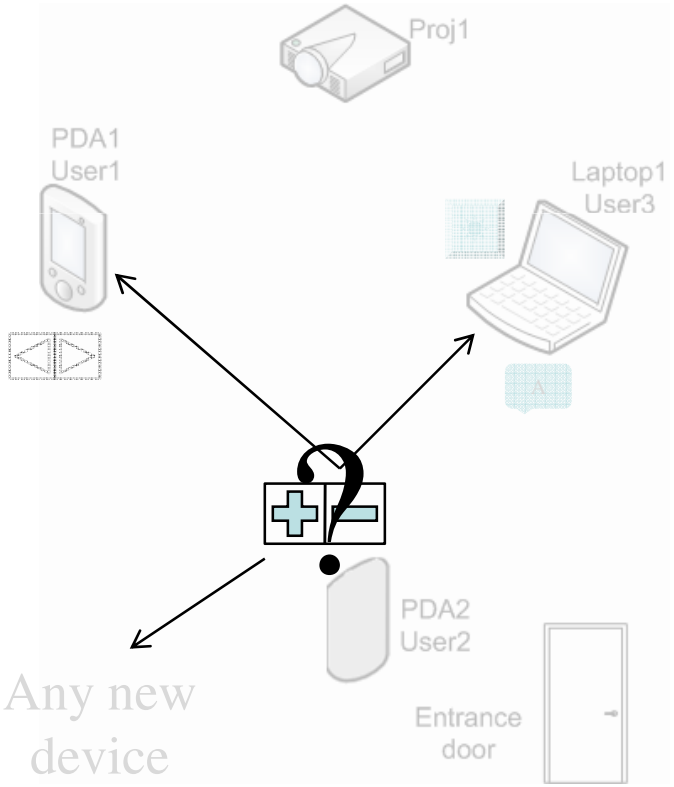
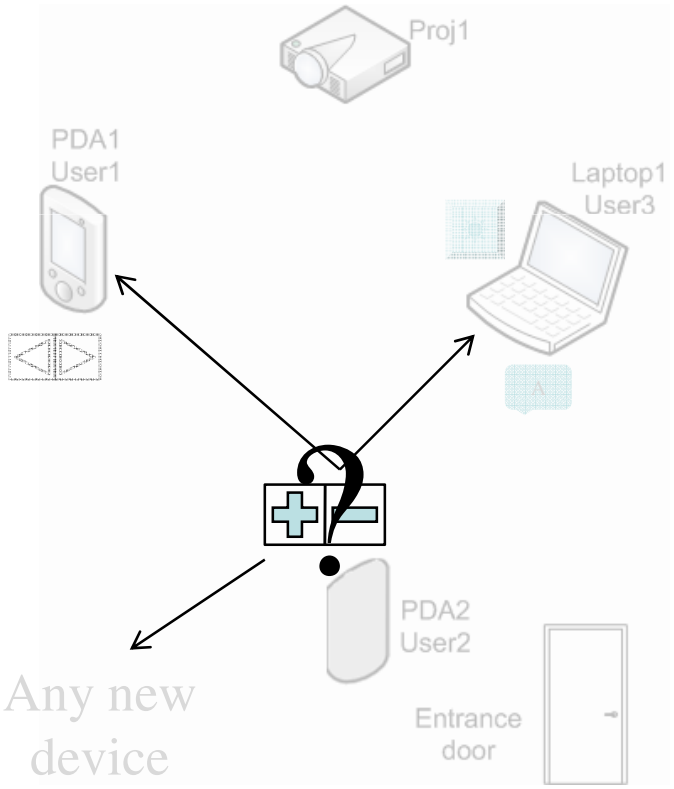


Introduction

Our Approach



- Utilise spatial relations
- Predict system's behaviour
- Device availability
- Device importance
- Description logic
  Fuzzy logic
  Probabilistic logic

Problem domain

Spatial Model

Interactive system:

Devices

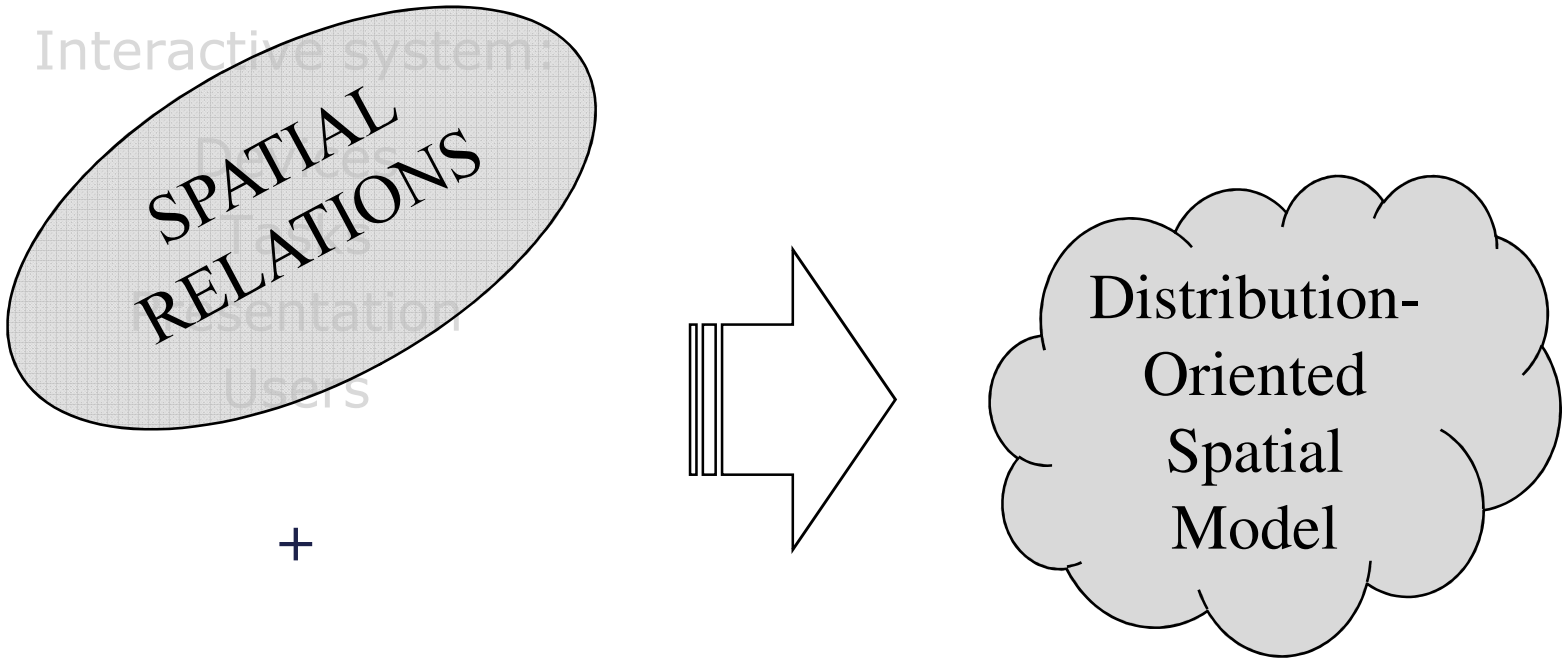
Tasks

Presentation

Users

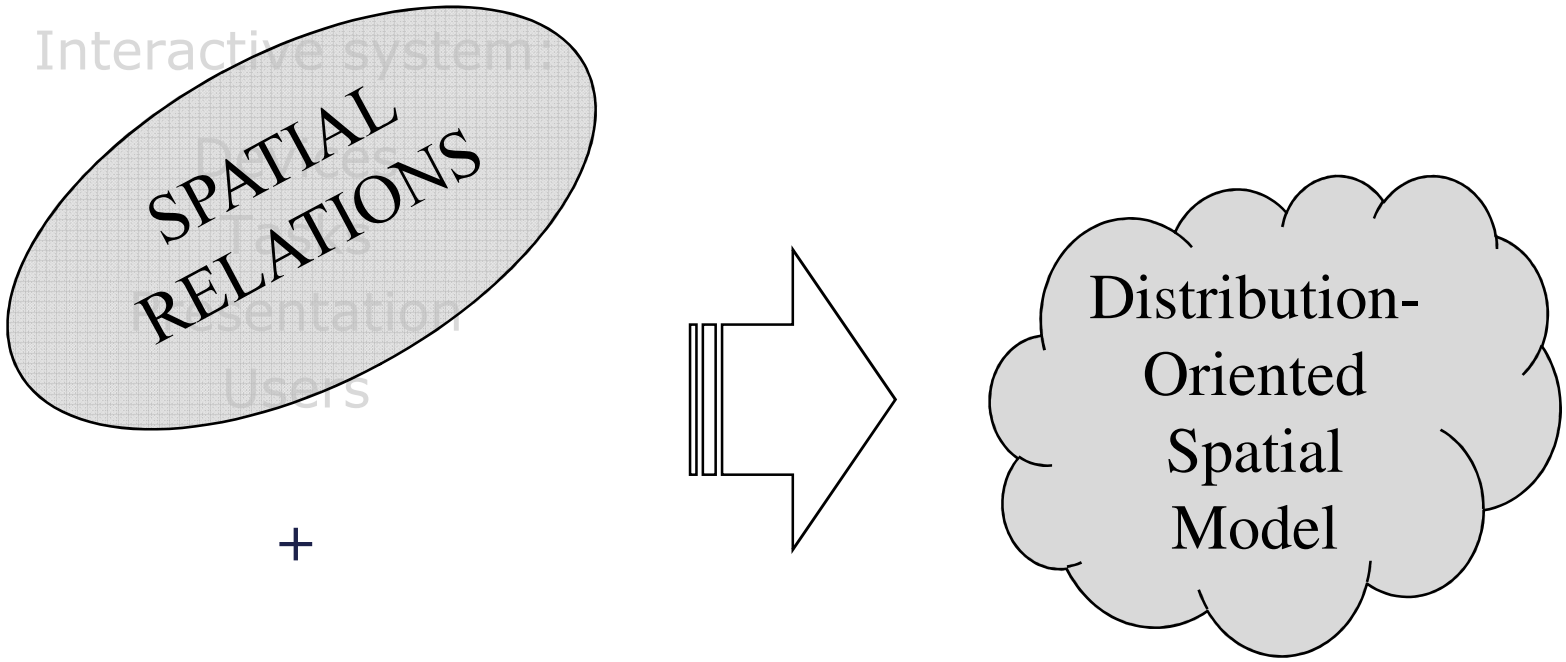
Problem domain

Spatial Model



Problem domain

Spatial Model



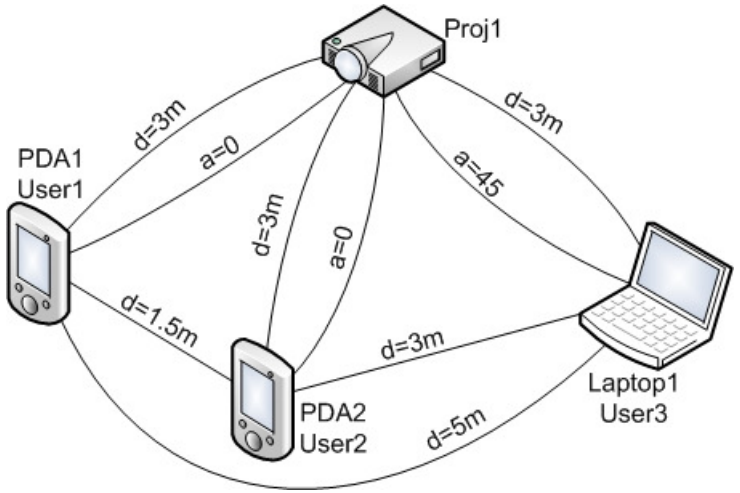
But how to represent this type of information?

Problem domain

Graph of Spatial Relations

Graph-like representation of the environment and spatial relations

- **nodes** – interacting resources
- **edges** – spatial relationships



Problem domain

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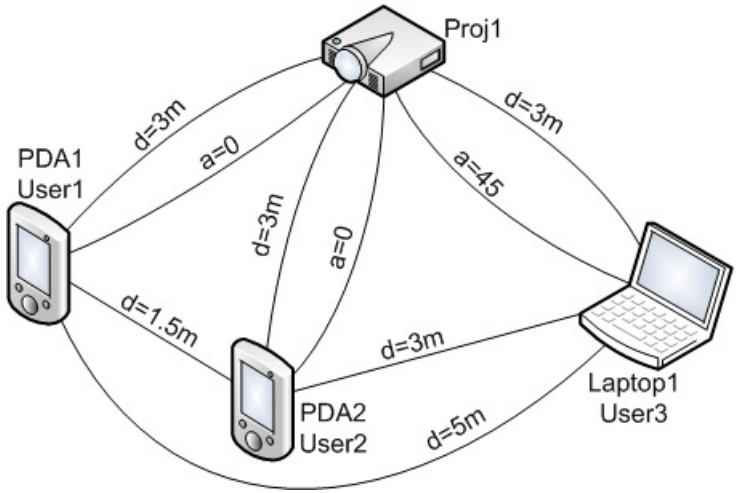
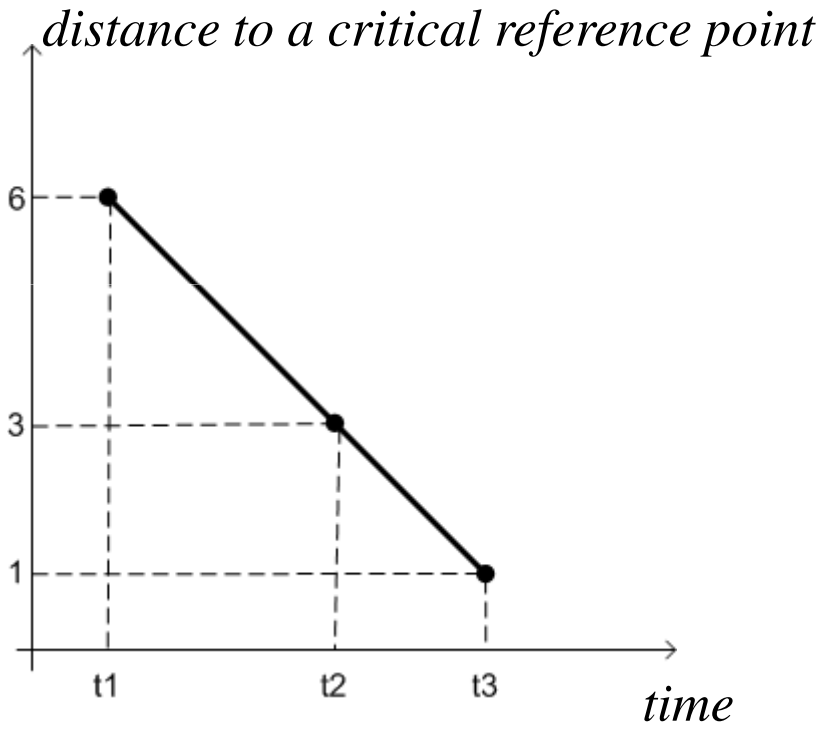


How can we see "spatial" differences between interacting resources?

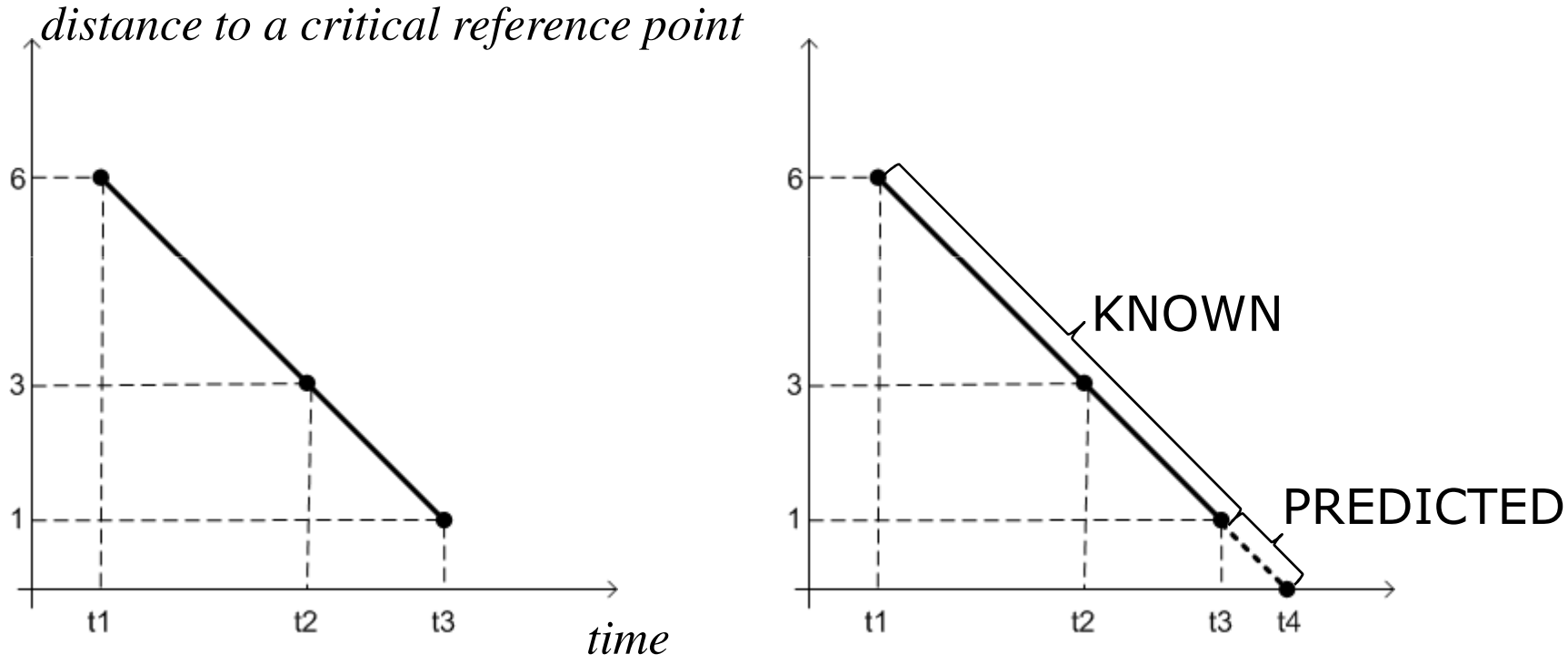
Problem domain

Device Availability Function



Problem domain

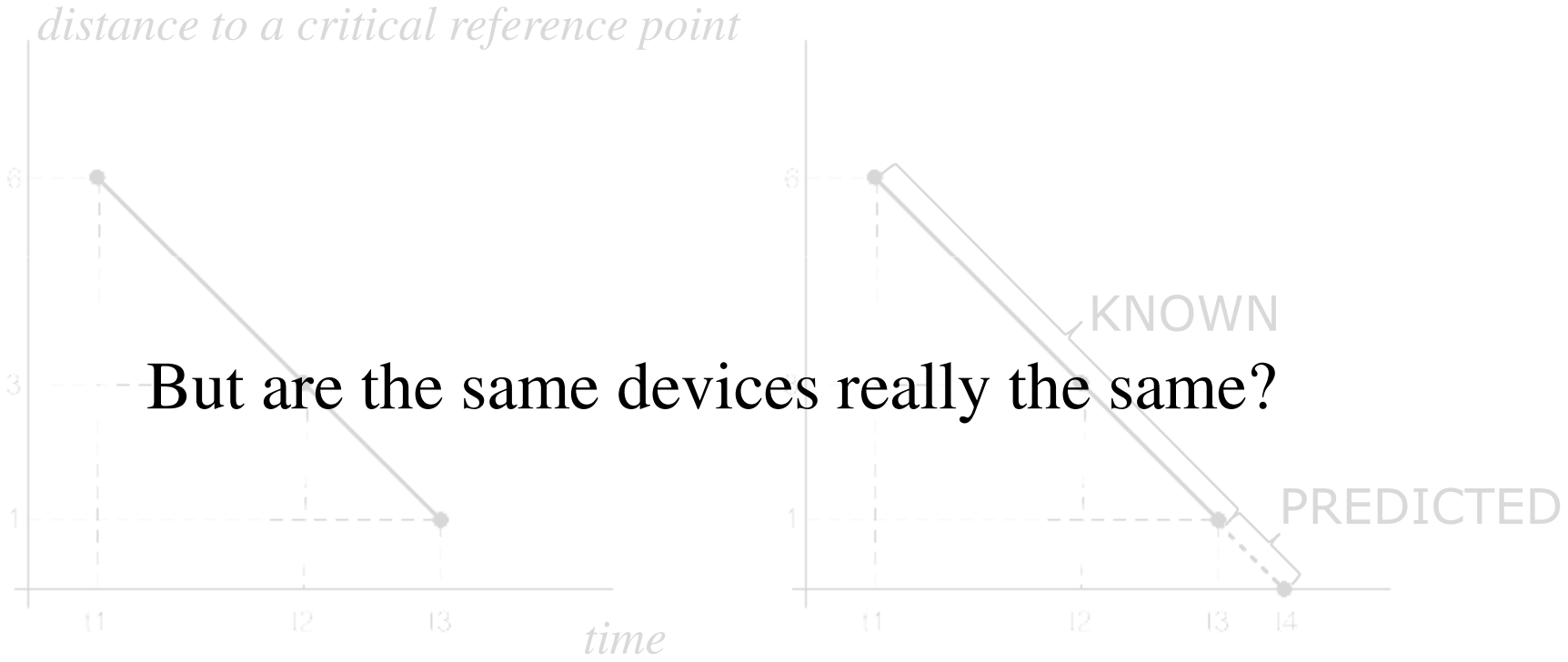
Device Availability Function



t_4 – predicted time when the device is expected to disappear

Problem domain

Device Availability Function



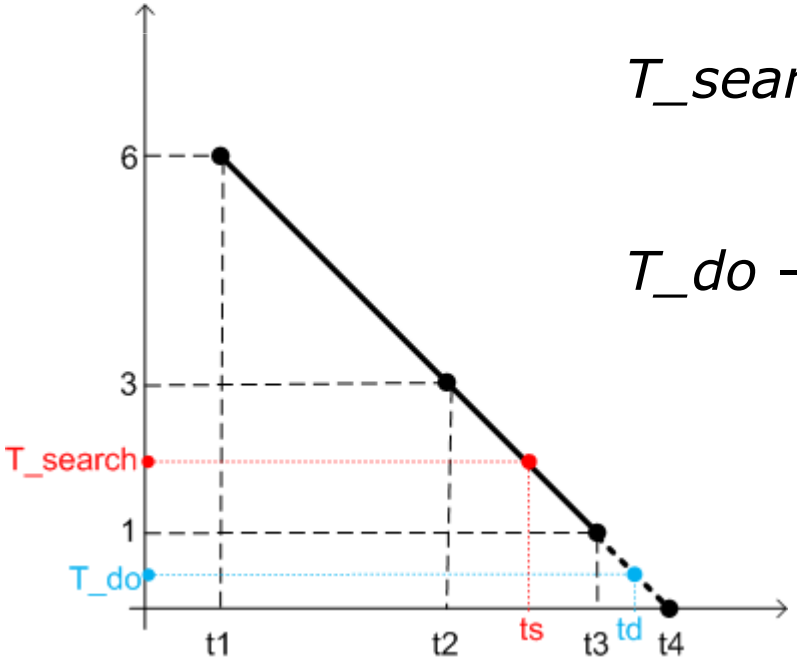
But are the same devices really the same?

t_4 – predicted time when the device is expected to disappear

Problem domain

Device Importance

Introduced to determine two threshold values on the plot of the device availability function



T_search – when to start looking for a UI redistribution

T_do – when to begin the calculated UI redistribution

Problem domain

The model is set up and relationships and dependencies are defined.

How can we use them?

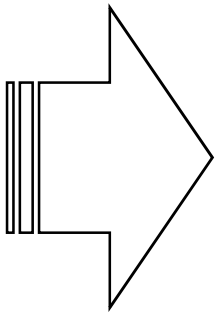
Reasoning

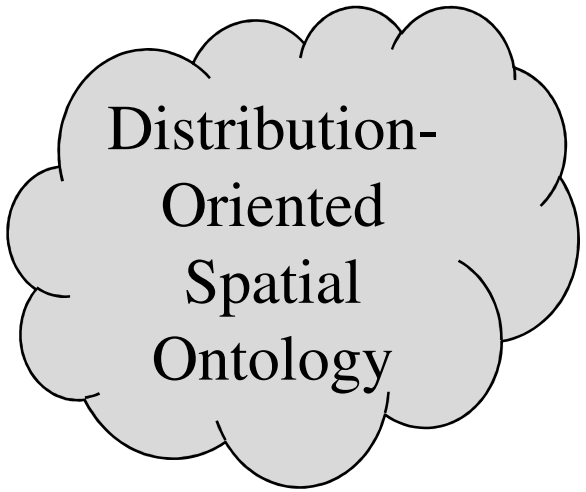
Ontological reasoning

UsefulSpatial(ContextModel_1)
+
UsefulSpatial(ContextModel_2)
+
...
+
UsefulSpatial(ContextModel_N)

+

OwnConcepts

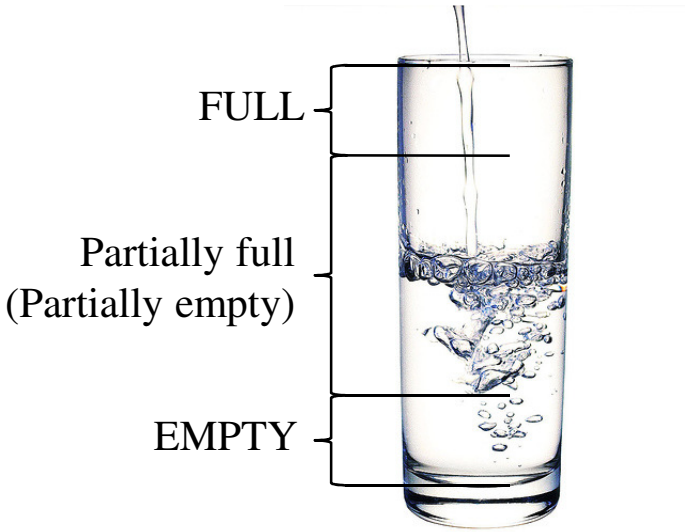




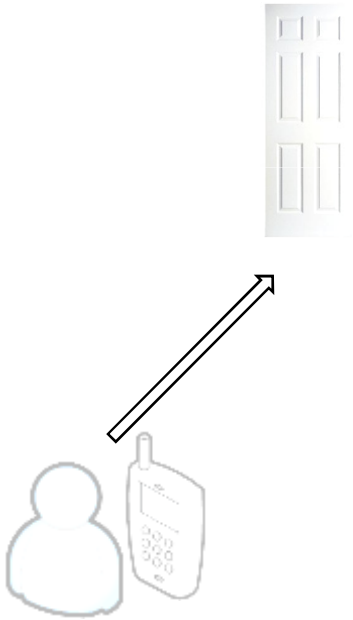
Uncertainty

Dealing with uncertainty

Fuzzy Logic



Probabilistic Reasoning

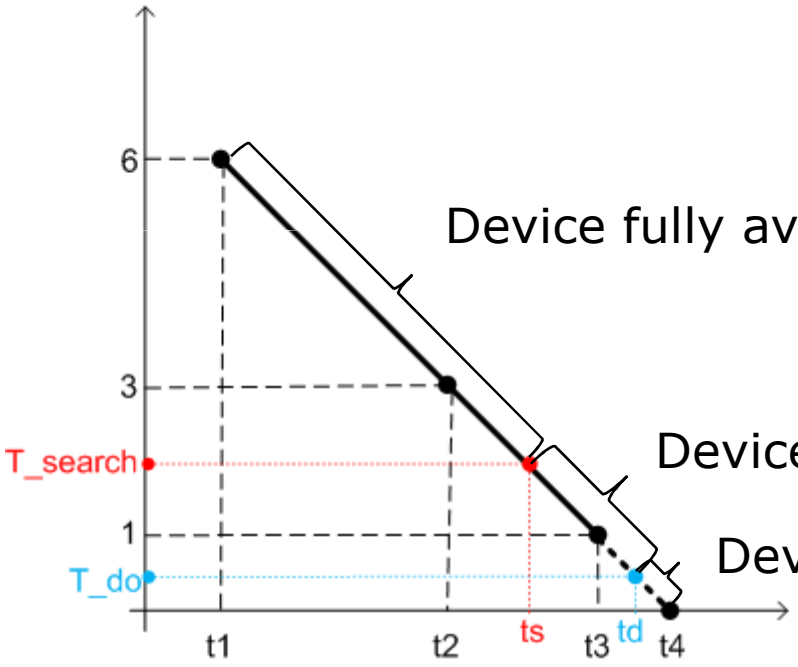


93%

of what the availability function shows

Uncertainty

Fuzzy Logic



Device fully available (do nothing)

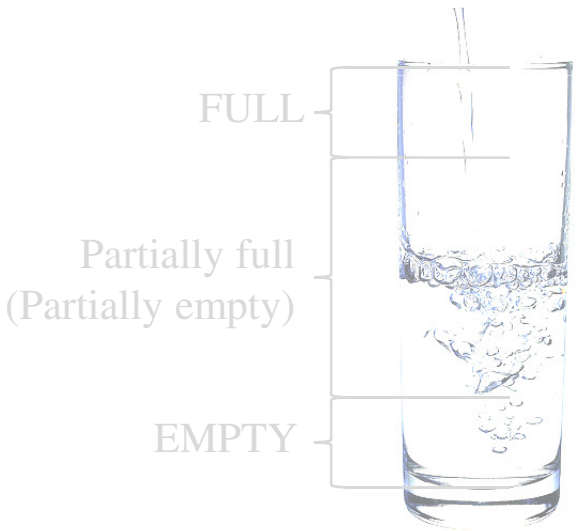
Device partially available (search)

Device unavailable (redistribute the UI)

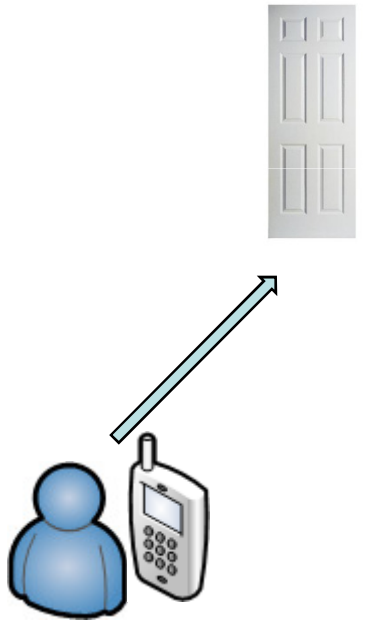
Uncertainty

Dealing with uncertainty

Fuzzy Logic



Probabilistic Reasoning



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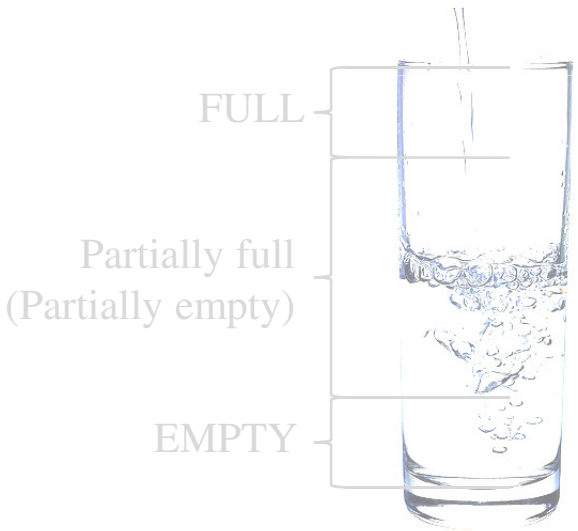
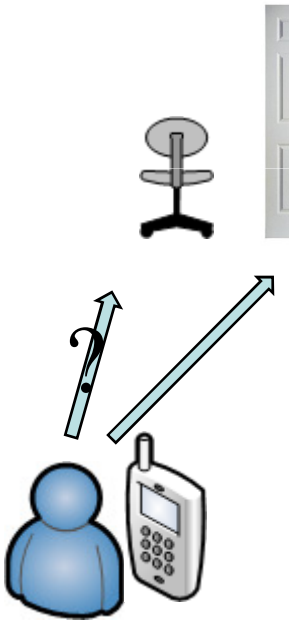


Probabilistic Reasoning



71%

of what the availability function shows

Ongoing activities

Ontology

Modelling aspects

- Existing ontological models analysed
- Valuable bits from each model borrowed
- Supportive ideas and guidelines listed for reference

Practical aspects

- Protégé tool will be used
- RacerPro reasoning engine will be involved

+

- ReWiRe, tool for designing UIs in ambient intelligent environments [Vanderhulst et al., IE2008], to appear

Ongoing activities

UNDO problem

How to perform an UNDO operation when the system eventually remains the same?

(e.g., the user decides not to leave right in the doorway)

- Handling side effects (not known at the time of calculations)
- Handling nested (dependent) transformations
- Recovering affected relations
- Handling UNDO during the continuous process

[Edwards et al., UIST2000]
"A temporal model for Multi-Level Undo and Redo"
[Hernández, COSIT'93]
"Maintaining Qualitative Spatial Knowledge"
Others?

Future Work

Device Importance

DI= F (x_1, x_2, x_3, x_4, ... , x_{n-1}, x_n), where each x_i is a piece of context

$y_1 = g_1(x_1, x_2, \dots, x_j)$

$y_2 = g_2(x_{j+1}, x_{j+2}, \dots, x_p)$

...

$y_k = g_k(x_{q+1}, x_{q+2}, \dots, x_n)$

principal component analysis
clustering algorithms
etc.?

DI= G (y_1, y_2, ... , y_{k-1}, y_k), where k<<n

Future Work

Device Availability Function

Elaborating the most important spatial factors for measuring the availability of a device in the environment

- Relevant distances
- Device orientation

Questions & Discussion

	Some interesting topics
? ! ...	quality of context, uncertainty of context, extrapolation techniques, prediction theory, origin and development of context, physical sizes and measures fuzzy ontology

Ontology development guidelines ⟹

Ontology guidelines

Extract from the shortlist and guidelines for creating ontology

- Core-Extension (Upper-Specific) approach
- Oriented towards distributed environment
- Relative positioning/coordinates and orientation
- Context repository for relatively small areas
- Switching partial ontologies on/off
- Direct/Indirect relations (sensed, defined/aggregated, deduced)
- Static situations/Related to actions
- Comparison of different characteristics (diff. scales)
- Involve time into the system

Comments and/or suggestions are most welcome