Universität Rostock

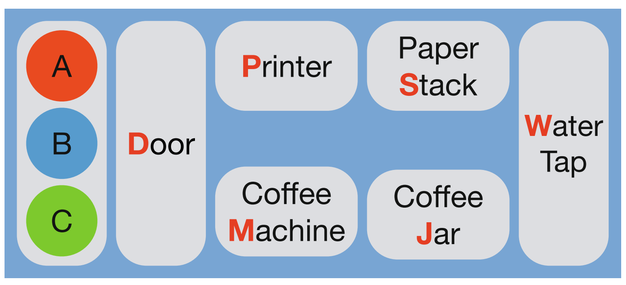
Traditio et Innovatio

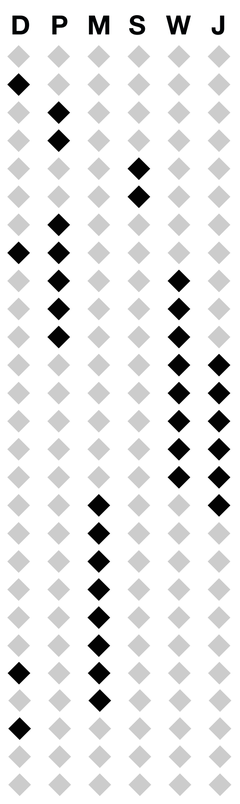
# LiMa: Sequential Lifted Marginal Filtering on Multiset State Descriptions

## Motivation

- Providing **automated assistance** for people suffering from dementia requires the system to **reason** about the **current situation** from **noisy** and **ambiguous sensor data**
- Typical **non-obtrusive sensors** to measure the system state include **accelerometers** or **smart home systems**
- These sensor information are used to **estimate** the current situation in order to answer **application specific questions**, e.g. “Where is Alice?” or “What is Alice holding?”

### Alice, Bob & Charlie scenario




- Alice, Bob & Charlie can **move** between all locations after entering through the door
- **Observations** indicate the presence of at least one of them at a location. A sample sequence is shown on the right (black indicates presence, gray absence).
- They can **print a document** if paper is provided and **get a coffee** if ground coffee and water is provided as well as **replenish** any of these resources
- Their **goal** is to get a coffee and to print a document

## Problem Statement

- For an increasing number of entities, grounded inference leads to a **combinatorial explosion** in the number of hypotheses that need to be considered (i.e. the number of states to be tracked simultaneously)

| No. Agents | No. Locations | No. States |
|---|---|---|
| 1 | 14 | 14 |
| 2 | 14 | 196 |
| 3 | 14 | 2,744 |
| 4 | 14 | 38,416 |
| 5 | 14 | 537,824 |
| 6 | 14 | 7,529,536 |
| 7 | 14 | 105,413,504 |

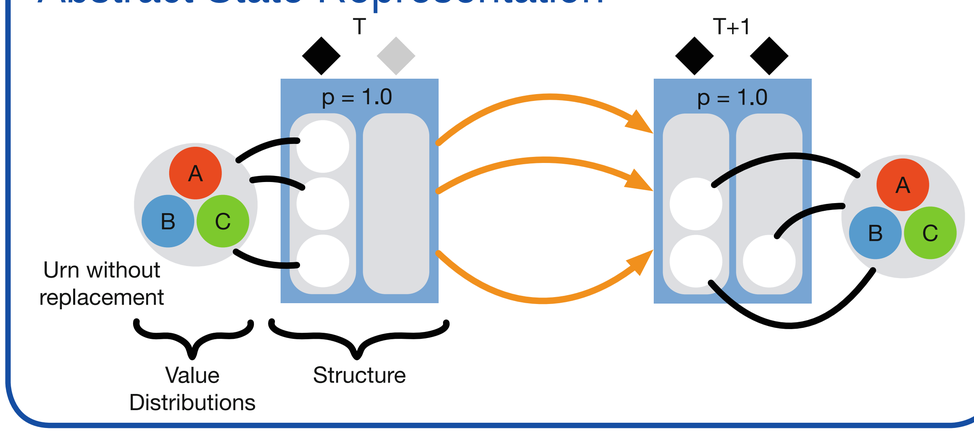
### Grounded Inference




## Idea

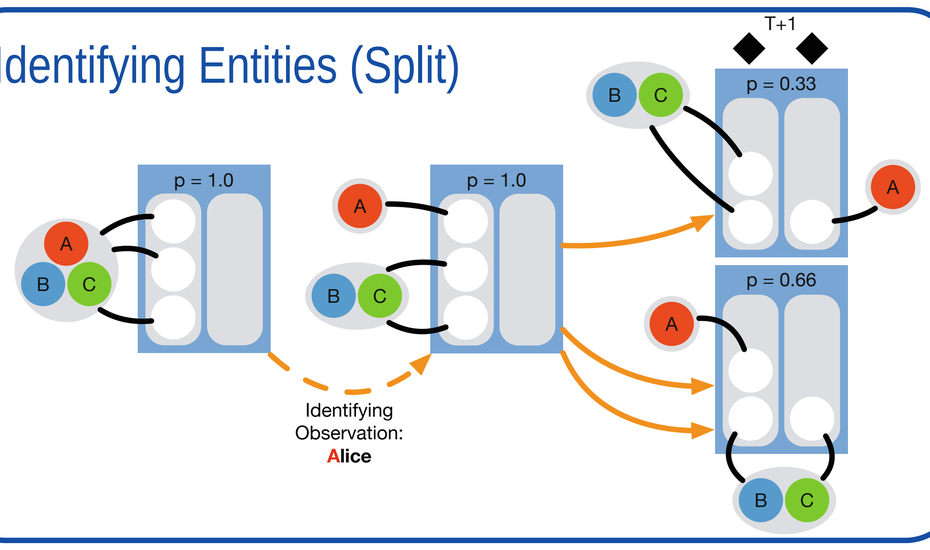
- Abstract from **particular states** that represent instances of the same **group of undistinguishable situations** in order to represent and consider them during inference **together**
- Abstraction is done by separating the **structure of the state** from the **particular value distributions** that may be inserted into that structure
- In order to represent **uncertainty about the situation**, we use a **probability distribution** over this **abstract state representation**

### Abstract State Representation



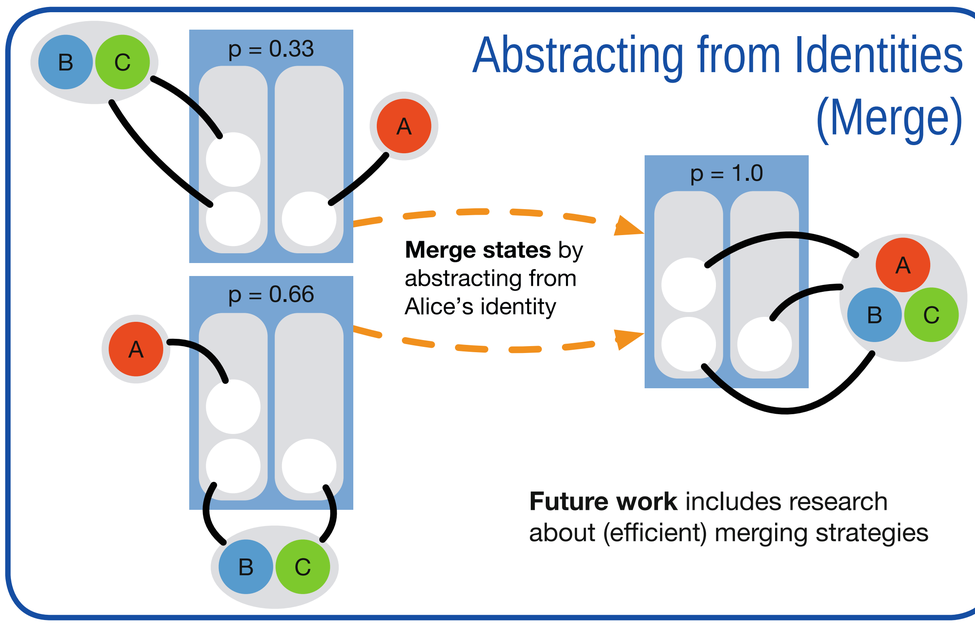

- During the inference, there sometimes are **identifying observations** that enable to introduce **evidence** about some entities
- **Identifying sensors** are e.g. ID-card sensors or personal devices, **Non-identifying sensors** are e.g. presence sensors or light switches

### Identifying Entities (Split)




- Splits **increase the number of hypotheses** that need to be tracked
- From evidence about entities that is **no longer needed** can be abstracted in order to **reduce the computational effort** (merge hypotheses)

### Abstracting from Identities (Merge)





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MOBILE MULTIMEDIA INFORMATION SYSTEMS

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