HPI Hasso Plattner Institut
IT Systems Engineering | Universität Potsdam

Event Masking Latent Model

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Definitions for the DTMC project

- **Hidden elements**
  - Events: infection, failures, rumor spread, toxic contamination, traffic accident, etc.
  - Entities: components, people, infrastructure, that have **states** and are affected by **events**
- **Observable elements**
  - State (S):
    - operational (no failure/not infected): So
    - degraded (performance): Sd
    - unresponsive (disabled): Su
  - Transition (T): change from one state to another state (self-loops included)
- **State Traces**
  - A sequence of states that happened within a given time horizon:
    - $ST_1 = So_1; So_2; So_3; Sd_3; So_3; So_1; Sd_1; Sd_2; Su_3; So_1; So_2; So_3$
  - Obtained from system logs, contact tracing (GPS), sensors (traffic, water pipes), etc.

Assumptions

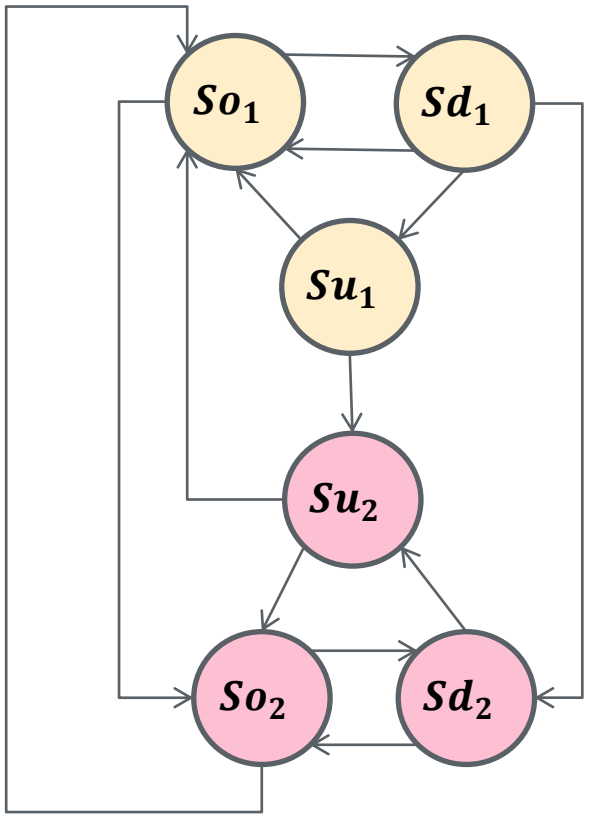
1. Markov property
   - $(S_{t+1} \perp S_{t-1}) | S_t$ or
   - $P(S_{t+1}, S_{t-1}) = P(S_{t+1}|S_t)\, P(S_{t-1})$
   - Memoryless, we do not keep the information from previous states, but the state is rich enough to estimate the transition probabilities.

2. Events might cause other events

3. Root-causes of events are unknown, but should be able to estimate

4. Transitions might have prior probabilities

Example of Markov Chain



Intentionally not showing the self-loops

Markov matrix M

Also called stochastic matrix or transition matrix)

M is a square matrix whose columns are probability vectors $\overrightarrow{x_t}$.

$\overrightarrow{x_t}$

Source states

Target states	So_1	Sd_1	Su_1	So_2	Sd_2	Su_2
So_1	0.15	0.50	0.25	0.80	0.0	0.25
Sd_1	0.05	0.25	0.0	0.0	0.0	0.0
Su_1	0.0	0.10	0.50	0.0	0.0	0.0
So_2	0.80	0.0	0.0	0.15	0.50	0.25
Sd_2	0.0	0.15	0.0	0.05	0.25	0.0
Su_2	0.0	0.0	0.25	0.0	0.25	0.50
$\sum$	**1.0**	**1.0**	**1.0**	**1.0**	**1.0**	**1.0**

Types of Traces

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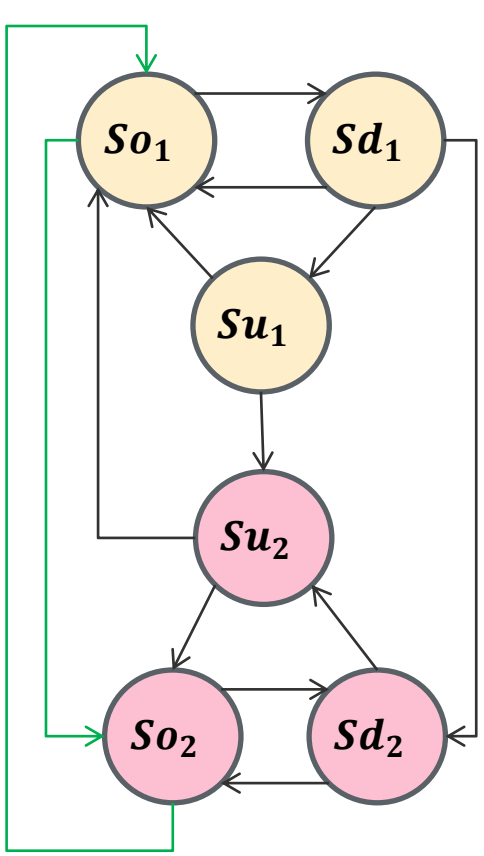
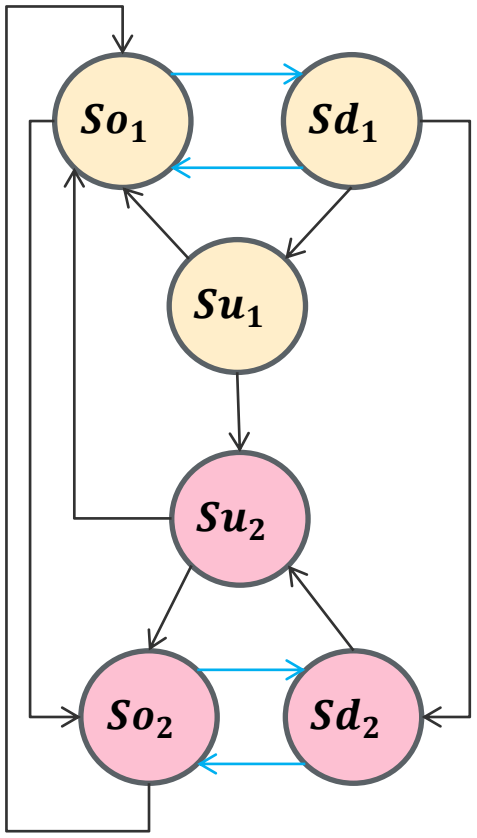


Normal operation

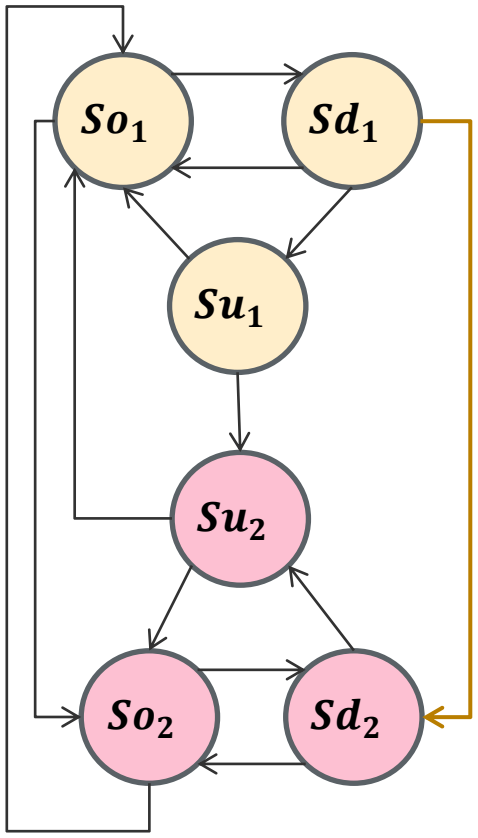
$(So_1; So_2; So_1)$



Intermittent failure

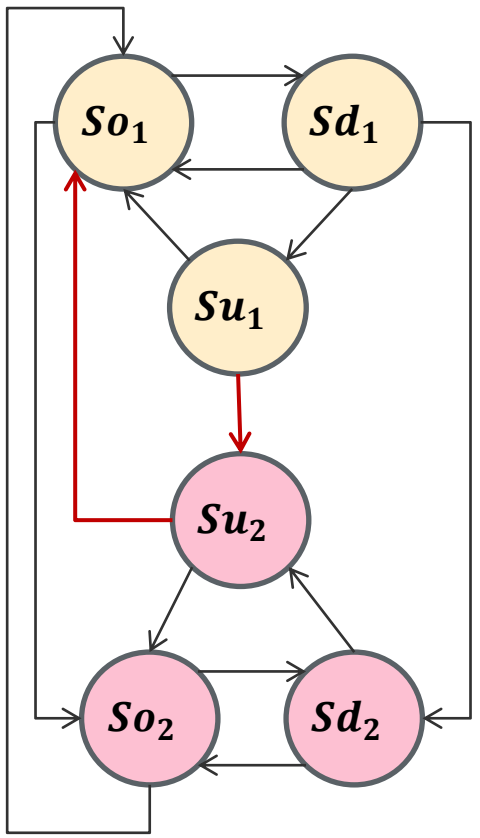
$(So_1 \rightarrow Sd_1 \rightarrow So_1)$

$(So_2 \rightarrow Sd_2 \rightarrow So_2)$



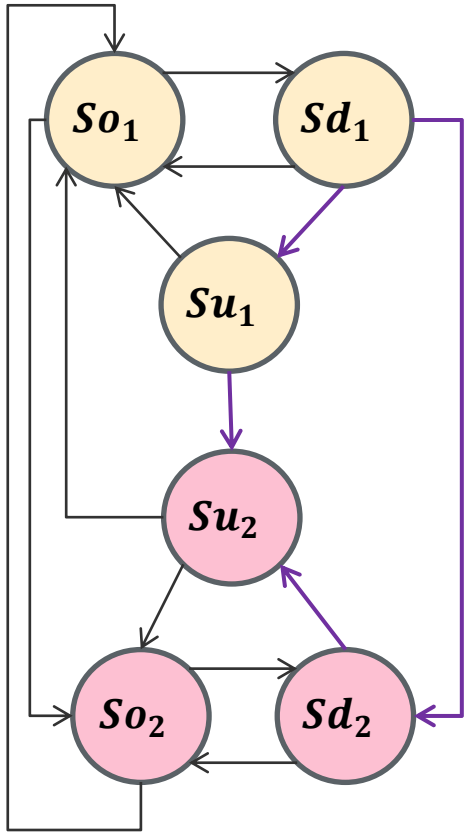
Systemic degradation

$(Sd_1 \rightarrow Sd_2)$



Failure masking

$(Su_1 \rightarrow Su_2 \rightarrow So_1)$

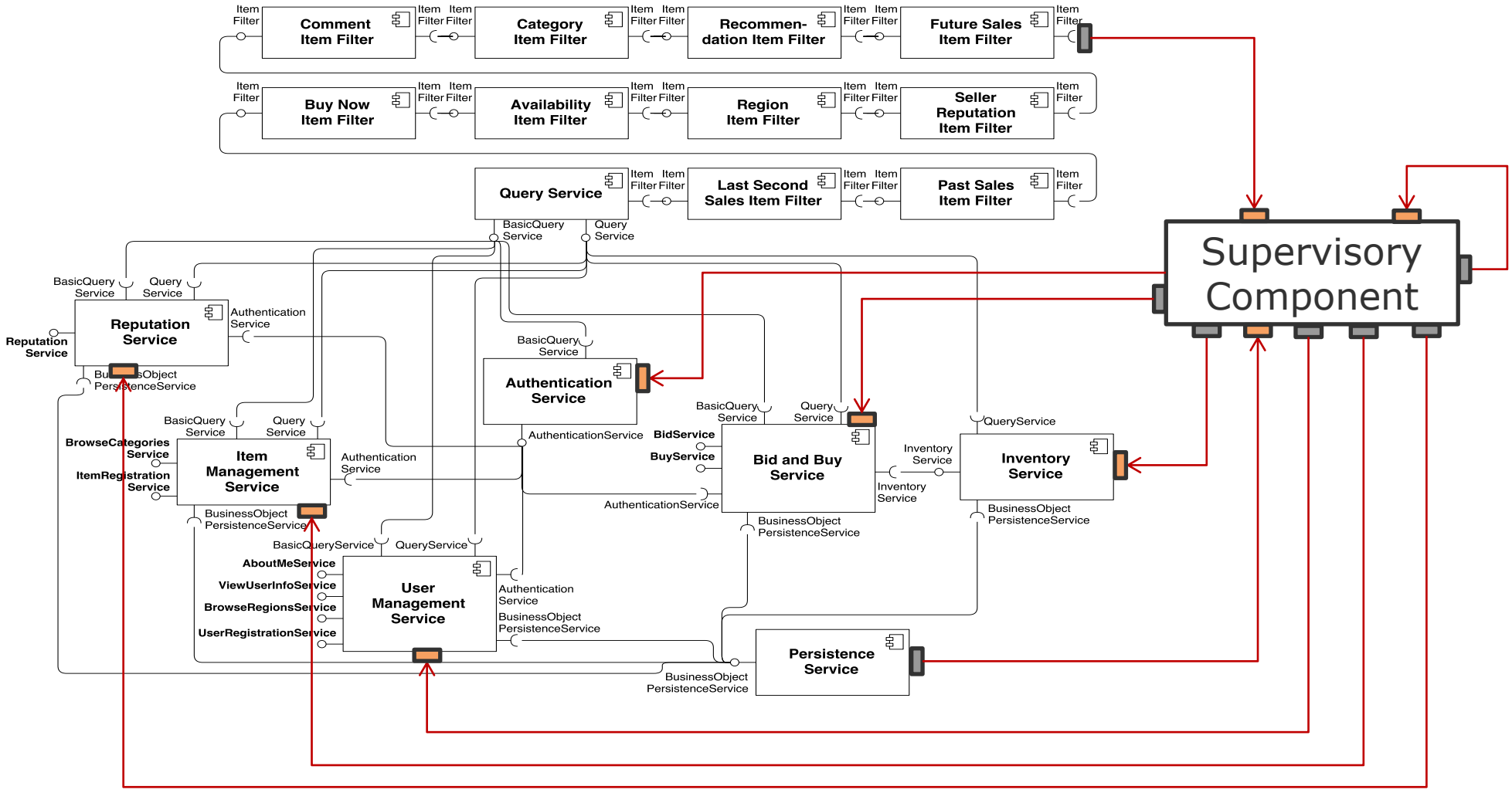


Failure cascade

$(Sd_1 \rightarrow Su_1 \rightarrow So_2)$

$(Sd_1 \rightarrow Sd_2 \rightarrow Su_2)$

End


Comment Item Filter
Category Item Filter
Recommen-dation Item Filter
Future Sales Item Filter
Buy Now Item Filter
Availability Item Filter
Region Item Filter
Seller Reputation Item Filter
Query Service
Last Second Sales Item Filter
Past Sales Item Filter
Item Filter
BasicQuery Service
Query Service
Supervisory Component
Reputation Service
Authentication Service
Item Management Service
BrowseCategories Service
ItemRegistration Service
Bid and Buy Service
BidService
BuyService
Inventory Service
QueryService
User Management Service
AboutMeService
ViewUserInfoService
BrowseRegionsService
UserRegistrationService
Persistence Service
BusinessObject PersistenceService
AuthenticationService