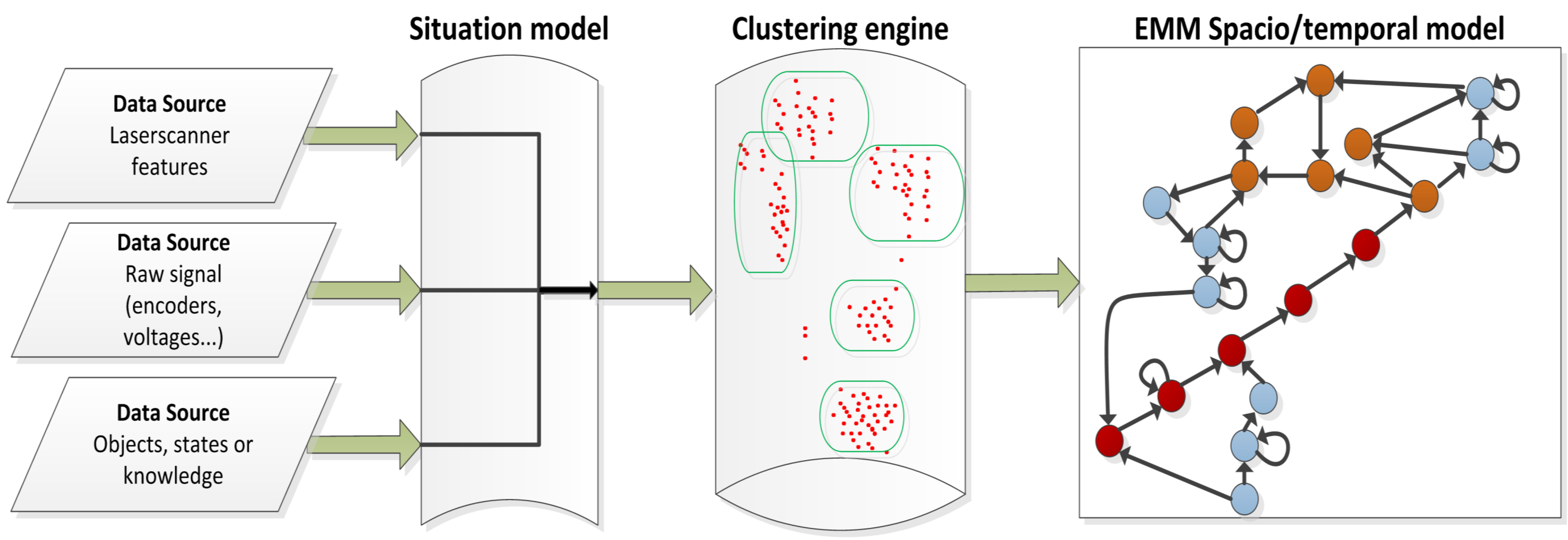
Technical University of Denmark

Spacio / Temporal Situation Assessment for Mobile Robots

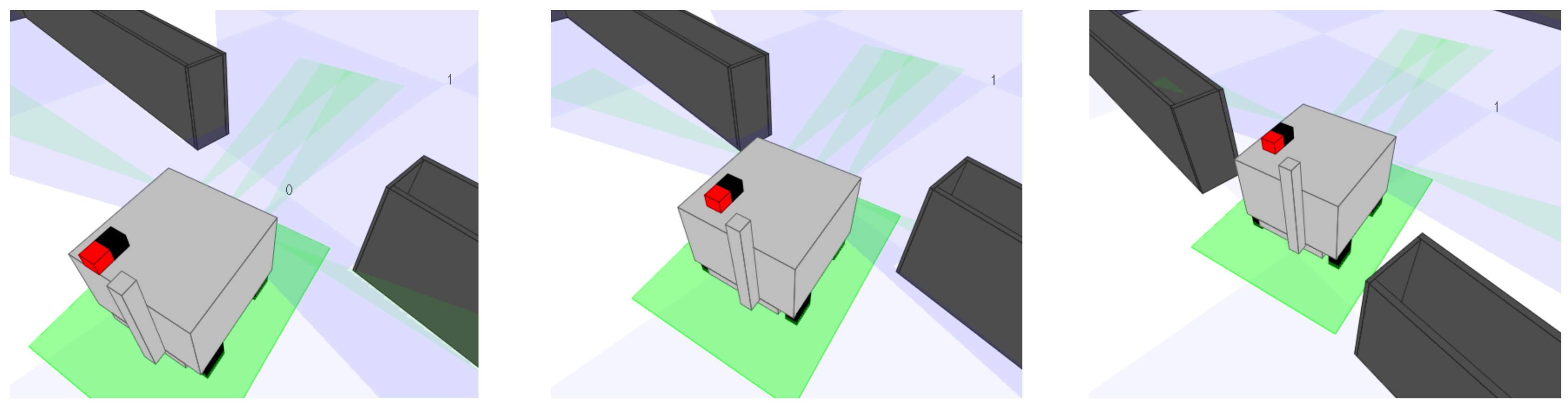
Mobile service robots must be able to work autonomously in long durations of time and be capable of handling the daily changes of human environments. The challenge of the project is to understand the situation a mobile robot is involved in, and evaluate if there is a need to interact with the actions of the robot to avoid potential hazards or solve the challenges of the situation satisfactorily. By reducing the problem domain into a range of situations, the robot will be able to handle a wide range of unexpected events by matching them to situation template models.

In this work, we present a framework for situation modeling and assessment for mobile robot applications. We consider situations as data patterns that characterize unique circumstances for the robot, and represented not only by the data but also its temporal and spacial sequence. Dynamic Markov chains are used to model the situation states and sequence, where stream clustering is used for state matching and dealing with noise. In experiments using simulated and real data, we show that we are able to learn a situation sequence for a mobile robot passing through a narrow passage. After learning the situation models we are able to robustly recognize and predict the situation.

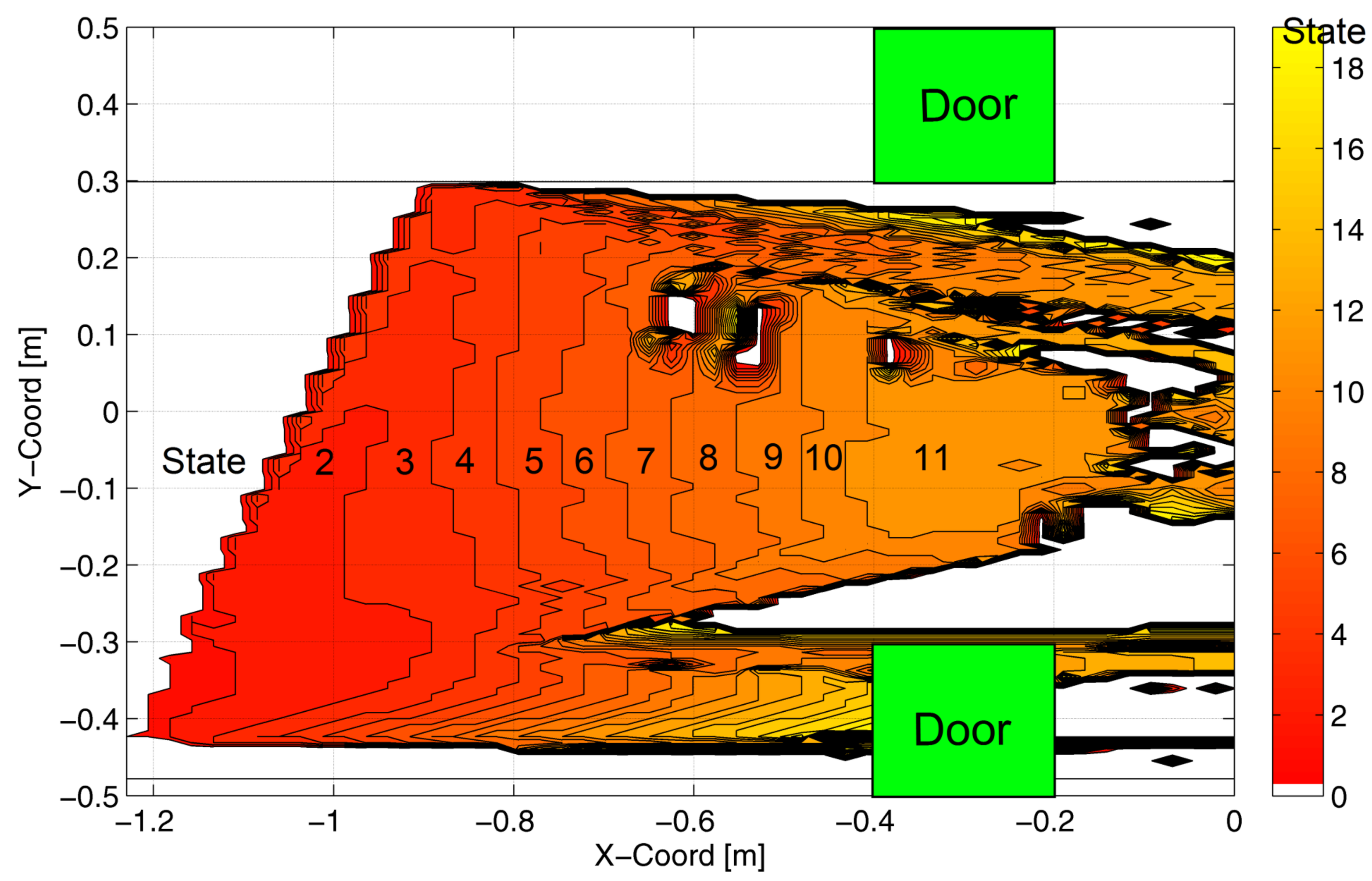
The figure below illustrate the architecture components for assessment of one situation model. Situation (level 1) models are defines the set of data variables that are processed. Possible noisy sensor data or discrete information are then clustered to reduce the state-space and to generalize the observations. Finally the clusters are organized in the EMM structure, where sequences can be classified and transition likelihoods estimated.



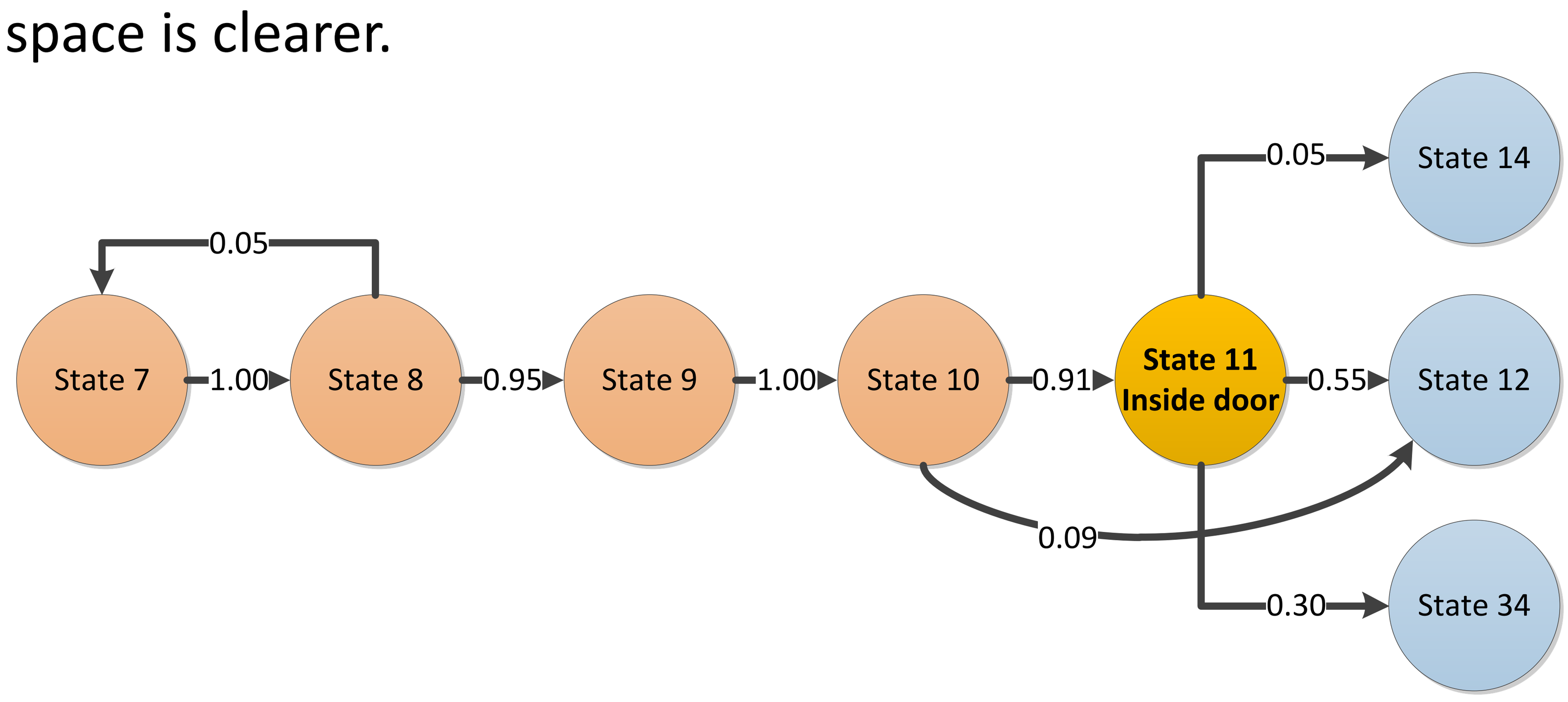
Evaluation of our framework have been done using the DTU Mobotware mobile robot control framework [12]. We have considered a classical problematic scenario for mobile robots: Passage through narrow passages, such as doors or between obstacles.



Already from a significant distance, the state sequence predicts a high the likelihood of a narrow passage. For example, observe in the state figure below how the sequence of states are almost linear from 60 cm before the door and until it has been passed.



The state transitions can also be visualized in a directed graph, where the likelihood of predicting a passage through the narrow space is clearer.



Work presented in the paper:

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Industrial PhD student **Anders B. Beck**, anbb@teknologisk.dk, Tel.: +45 7220 2332, DTU Build. 326 room 014

Assoc. Prof., Head of Section **Ole Ravn**, or@elektro.dtu.dk, Tel.: +45 4525 3560, DTU Build. 326 room 012

Assoc. Prof. **Nils A. Andersen**, naa@elektro.dtu.dk, Tel.: +45 4525 3583, DTU Build. 326 room 016

DTU Electrical Engineering
Department of Electrical Engineering