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Resource-Aware On-Line RFID Localization Using Proximity Data

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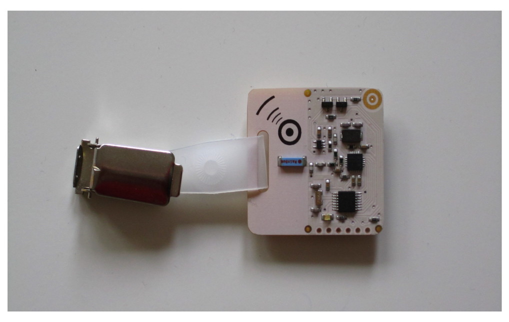
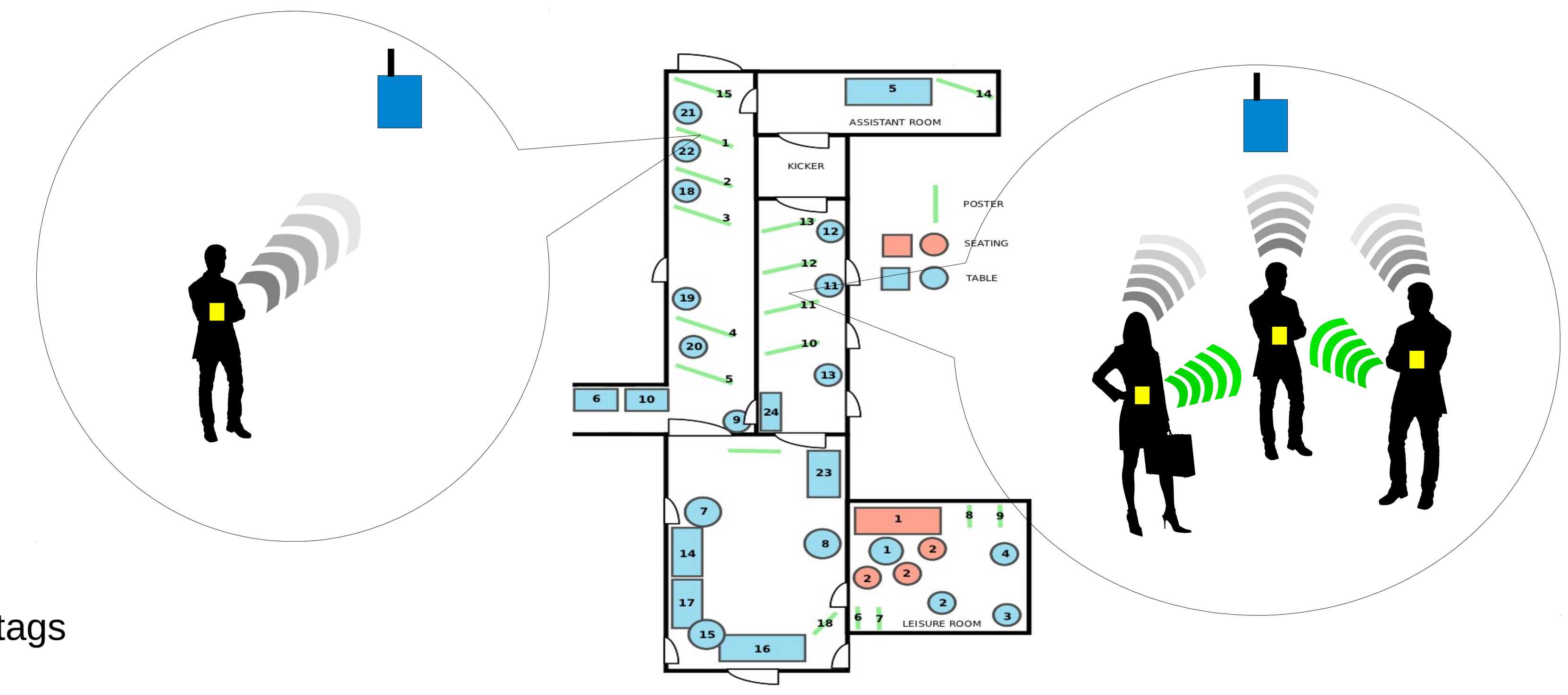
Our work focuses on resource-aware and cost-effective indoor-localization at room-level using RFID (Radio-Frequency Identification) technology. In addition to the tracking information of users wearing active RFID tags, our method *"Social Boost"* also utilizes information about their proximity contacts. We combine state-of-the-art machine learning approaches with strategies utilizing the proximity data in order to improve a core localization technique further. We present an evaluation using real-world data collected during a conference.





Proximity Tag

- is an active RFID tag
- detects other proximity tags within a range of about 1.5 m
- sends one tracking package in four different signal strengths every 2 sec. to RFID readers
- cannot store information

RFID Reader

- receives RFID packages from proximity tags and forwards them to a central server
- does not depend on costly techniques like Angle of Arrival or Received Signal Strength

The applied RFID technology was kindly provided by SocioPatterns

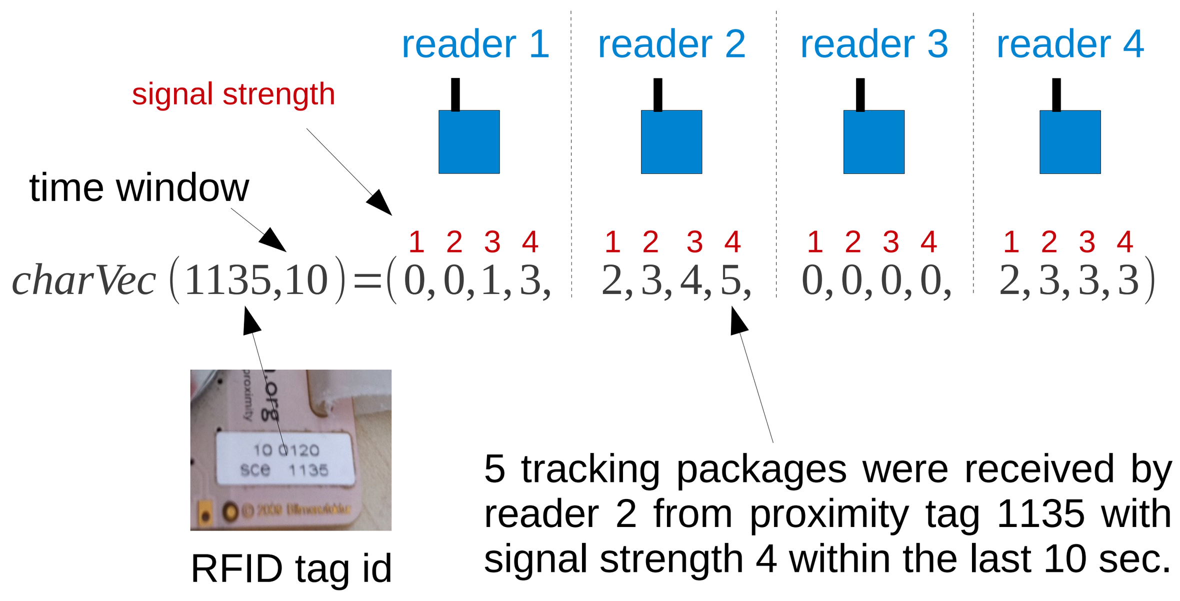
Room-Level Localization

The room-level localization problem can be approached by using machine learning classification methodology.

Training Phase: Collect characteristic vectors in each room from participants wearing proximity tags.
Use RFID tags fixed to immovable objects in the rooms to determine the actual locations.

Prediction Phase: Apply state-of-the-art classification algorithms like k-Nearest Neighbors, Random Forest, Naive Bayes or Support Vector Machines to predict rooms for participants wearing tags.

Characteristic Vectors



The Social Boost

Utilizing information about real-life contacts – gathered using the proximity function of the RFID tags – can boost the accuracy of the room predictions.

Max Approach: Collect the characteristic vectors of the target participant and of all his recent contacts. Use the component-wise *maximum* as input for classification

Mean Approach: Collect the characteristic vectors of the target participant and of all his recent contacts. Use the component-wise *mean* as input for classification.

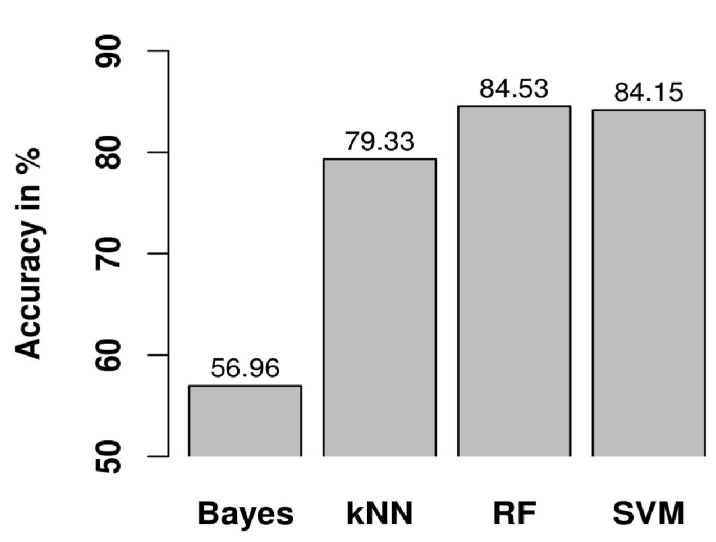
Vote Approach: Apply the classification to the characteristic vector of the target person and to those of all his recent contacts. Determine the result by casting a *majority vote* among the predicted rooms.

Experimental Evaluation

Ground Truth: To assess the accuracy of the algorithms fix RFID tags can be used to determine the participants' true locations.

Benchmark: Application of four state-of-the-art prediction algorithms with different settings for the algorithms' specific parameters as benchmark.

Social Boost: The three approaches are tested on each of the benchmark algorithms with different choices of the parameters *contact window length* and *degree of transitivity*.



Social Boost Parameters

Contact Window Length: The length of the time interval over which the recent contacts of a participant are gathered. When choosing the contact window length the participants' activities need to be considered (frequent change of location vs. stationary activities).

Degree of Transitivity: If a participant A is in contact to a participant B who himself has contact to C one could assume that A and C are in contact too although this "transitive" contact might not be recorded by the RFID tags. The degree of transitivity counts the number of iterations of the procedure of adding such contacts.