Machine Learning to the Rescue
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Joint Rescue Forces
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Workshop Goals

• Instruct how to use the MATLAB® Statistics and Machine Learning Toolbox™ through interactive applications to analyze and model disaster scenario data for developing more elaborated rescue decision-making algorithms.
• Demonstrate how to incorporate state-of-the-art machine learning algorithms into RoboCup Rescue competition code using the MATLAB® Engine API for Java.

Supervised Learning

Analysis of the disaster scenario could be used to learn associations between observable variables and hidden variables (part of a causal model of the world).
• Firefighters can optimize their decisions by estimating buildings’ danger of fire ignition (discrete state – classification).
• Ambulances can optimize their rescue operations by predicting more accurately the chance of potential victims to survive (continues state – regression).

Pre-Compute

Before the actual run, an agent of each type can do map reconnaissance. In this phase, agents can precompute the paths and segment the map into sectors.
• Path Planning with MATLAB®:
  o Shortest-path algorithms based on breadth-first, Dijkstra or A* [1].
  o The agents receive the possible path sorted on distance.
  o During the competition each agent can modify the unobstructed distances in its own copy of the graph based on observed or cleared blockades.
• RoboCup teams may divide the work of the agents over different sectors of the map [2].

Results

In Statistics and Machine Learning Toolbox™, data can be preprocessed with dimensionality reduction methods like principal component analysis (PCA) or singular-value decomposition (SVD), followed by classification methods, or linear/non-linear regression methods.

In the regression, when the remaining hit points (HP) at the end of the scenario is estimated with the Gaussian Process Regression [4] the remaining root mean square error (RMSE) is the lowest, i.e., RMSE 1346.

The best classification is estimated with the Ensemble Bagged Trees with PCA enabled and component reduction criterion set to 2 specific components out of 4, achieving accuracy of 75.5%.

Conclusion

By giving a workshop to the RoboCup teams on how to separate machine learning algorithms from the actual code to control the agents / robots, teams can concentrate on the learning aspect.
The algorithms implemented in the workshop are examples of common challenges in this competition, but the approach should extend to any algorithm available/developed in MATLAB®.

References:

Topological and metric graphs based on the TestMap.

Segmentation of the Kobe map into 5 sectors with the k-means method [3].

Several unsupervised methods for recognizing the pattern in the distribution of the buildings are available in MATLAB®, such as e.g. k-means, k-medoids, hierarchical clustering, Gaussian mixture models and hidden Markov models.