Learning robots to rescue

The RoboCup Rescue as training ground

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RoboCup Rescue

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The RoboCup Rescue as training ground

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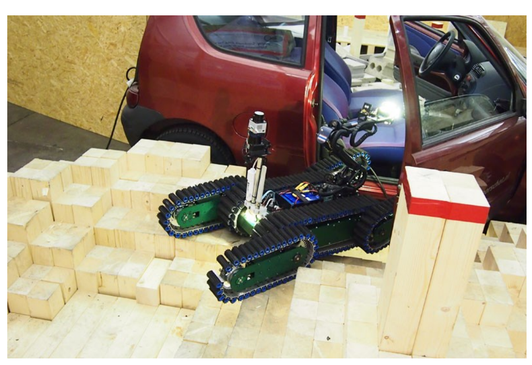
Challenge

- After a disaster a team of robots, must explore the devastated city. Ambulances have to find as many victims as possible, dig them out and bring them to a hospital. Fire fighters have extinguish fires before the situation goes out of hand. Police can help to patrol and explore, but can also clear the road for the other agents.

Fire fighters cooperating to extinguish a fire in the city

Context

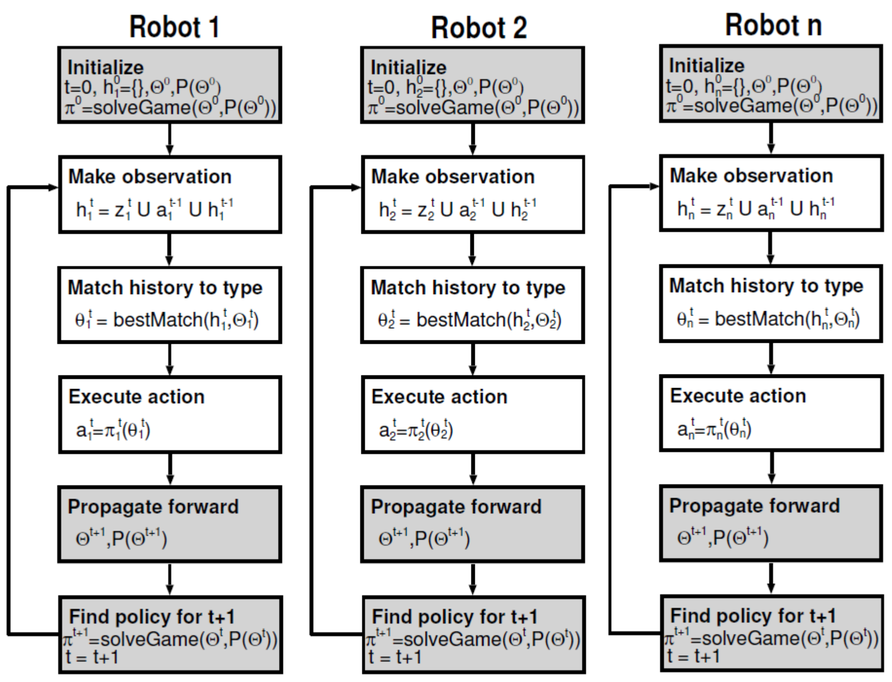
- After the Great Hanshin Earthquake of 1995 in Kobe, the Japanese government decided to promote research related to the problems encountered during large-scale urban disasters.
- A major outcome of this initiative was the RoboCup Rescue competitions. This lead to both versatile robots as control software for large teams of rescue agents.



A RoboCup Rescue robot searching for victims

Learning Coordination Policies

The coordination problem is described as a dec-POMDP, which is interpreted as a series of Bayesian games. In this Bayesian game each robot has some private information (not communicated with the team). This private information is clustered into a type of observation histories. This Bayesian game is used to find a joint policy is designed to maximize the average result achieved on all joint action-observation histories.

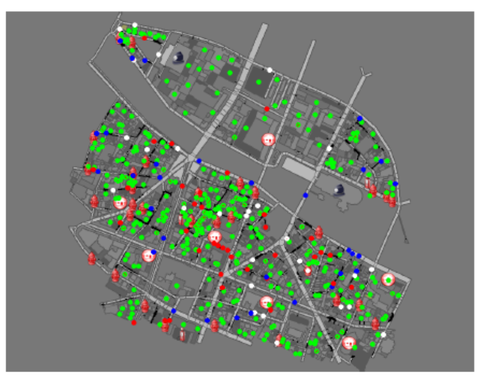


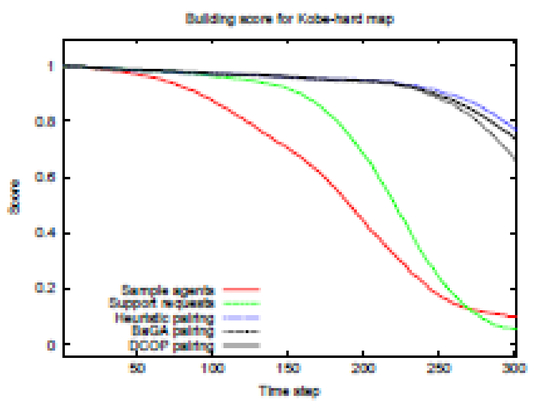
Bayesian Game – independent decisions based on a joint policy found for a type of histories. Courtesy Emery-Montemerlo

Based on the individual action a_i observation z_i the actions of all the other agents are inferred, relying on a common knowledge assumption, by finding match to the type Θ.

Results

To apply Bayesian games to realistic RoboCup Rescue scenario's, the decision making is decomposed into a high-level Bayesian game and low-level MDP:





Results for different coordination approaches on Rescue Simulation maps. Courtesy Trăichioiu

Conclusion

Bayesian Game approximations make it possible to bridge the gap to coordination problems encountered in benchmarks as the RoboCup Rescue. Modeling that each robot has a certain amount of private information, next to a certain amount of common knowledge, is a natural assumption. Also online planning is natural in such dynamic situations.

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