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PROPOSITION DE SUJET DE THESE

Intitulé : Offline learning for online shortest path planning in stochastic environment

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Mots clés

Path planning, Markov Decision Process, Machine learning

Profil et compétences recherchées

Stochastic process, Machine learning, Python programming

Présentation du projet doctoral, contexte et objectif

Shortest path planning problems in stochastic environment are common in real-world problems, such as autonomous vehicle navigation under uncertain sensor measurements or uncertain environmental disturbance.

Stochastic shortest path (SSP) problems with dead-ends, such as obstacle collision in the vehicle navigation example, have two conflicting objectives: maximization of the probability to reach the goal – Safety – and minimization of the expected travel cost (time or distance) to reach the goal – Efficiency. They are often treated by imposing a dead-end penalty and finding a path policy with the least total cost including this penalty [1]. The bigger the dead-end penalty is, the more safety we seek. Imposing infinite dead-end penalty implies seeking the safest policy.

For ensuring the safety, a minimum goal-probability requirement can be added to SSP problems. Solving such safety-Constrained SSP (C-SSP) problems is challenging, especially with the limited planning time [2,3]. This Ph.D. thesis project addresses online resolution of the safety-Constrained SSP problems by introducing an offline learning process to guide the online policy search.

Inspired by the CAMP (Context-specific Abstract Markov decision Process) method [4], we have proposed an offline learning-guided online path planning approach for a UAV urban navigation problem under uncertain GPS availability [5], which is modeled as SSP. It learns to select a navigation corridor for a given mission from the planning experiences on the training tasks, and imposes it during the online planning for reducing the search space while conserving the solution optimality.

This Ph.D. thesis aims first to generalize this constraint-selector learning approach for the C-SSP problems. It requires modifying the input/output of the offline learning process so that they become applicable to any C-SSP task. The generality of the approach will be investigated to see if the planning experiences on the training SSP tasks from other problem domains/instances could aid the online planning of a test task. Then we will explore other relevant approaches, such as learning model abstraction, to improve the online planning performance.

The work consists of: 1) Literature review on C-SSP problems and their resolution algorithms, 2) Development of online planning methods for C-SSP problems based on offline learning, 3) Evaluation of the proposed methods on benchmark problems available in literature and 4) Publications and thesis writing. Although the evaluation will be done mainly through numerical simulations on benchmark problems, there is a possibility to apply the proposed approaches to a UAV navigation problem and to perform experiments on a real platform.

References:

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[4] J.A.Delamer, Y.Watanabe and C.Chanel, Safe path planning for UAV urban operation under GNSS singal occlusion risk, Robotics and Autonomous Systems 2021.

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Collaborations envisagées

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