

4.3 自适应规划算法

自适应系统需要具备自主进行自适应规划的能力,即:当变化发生后,能够自主地选择一组自适应操作,以使得 S(软件配置)、E(环境状态)、R(用户需求)被持续地满足.自适应规划应当能够响应以下两种变化:(1) 环境的变化;(2) 需求的变化.其中,环境的变化可能是稳态的或非稳态的,稳态的变化是指环境状态的变化,非稳态的变化是指环境状态迁移概率的变化或者环境状态对需求影响的变化;需求的变化是指需求的增加或者减少以及各需求优先级的变化.

表 3 展示了现有的规划算法.这些规划算法可以划分为反射式的算法和主动推理的算法.反射式的规划算法通常依赖于预先规约好的自适应规则,具有规划过程高效、规则易读性强且易修改的优点.但是这类方法采用的自适应规则通常是在离线阶段预先定义的,并且缺乏与高层需求的联系.因此,反射式的规划算法只能响应稳态的环境变化,而无法响应需求的变化和非稳态的环境变化.相反地,采用主动推理算法的自适应系统会根据运行时的环境情况和决策标准推理出最适合的操作.因此,主动推理算法更有可能做出有效的自适应规划.但是在有多个需求、多个控制参数或多个备选方案的情况下,主动推理算法具有较高的复杂性.在备选方案空间庞大的情况下,基于效用函数的最优化、基于目标的推理、概率模型检查、控制模型的合成等规划算法都会面临低效性的问题,有可能无法及时响应运行时的变化.

综上,如何提高现有的动态规划算法、设计出结合反射式与主动推理自适应算法优点的新算法,是一个重要的研究点.理想的规划算法应当具备以下能力:(1) 有效,即,能够自主地选择自适应操作去响应环境和需求的变化,并且操作的执行能够保证需求被持续满足;(2) 高效,即,规划过程应当高效,能够及时地对运行时的变化做出响应.

5 结 论

本文对现有的基于模型的自适应方法的相关研究工作进行了综述.首先,提出了 6 个研究问题,关注相关工作如何进行建模、分析和规划等;然后,对现有的基于模型的自适应方法的相关研究工作进行了分析,对提出的 6 个研究问题进行了回答;最后,基于对现有方法的分析,指出现有研究中存在的问题和不足,提出了解决这些问题的设想,还给出了与基于模型的自适应方法相关的未来的研究方向.

致谢 在此,我们向对本文的工作给予支持和建议的老师和同学表示感谢.

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