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An Artificial Intelligence-Based Framework for Autonomous Big Data Analytics: A Reinforcement Learning Approach

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Big Data Analytics (BDA) have been shown to provide usable insights in support of value-added decision-making. However, the complexities associated with developing and configuring BDA models and the challenges associated with employing them as part of the decision-making lifecycle need to be managed. Collectively we refer to managing such activities as "***Strategy discovery problem (SDP).***" SDP seeks to optimize all activities within the lifecycle of employing BDA to support real-world decision-making that yields the maximum amount of insights from expansive and disparate datasets.

In this study, we aim to develop an Artificial Intelligence (AI)-based BDA framework to solve the SDP. The framework relies on Reinforcement Learning (RL), a family of AI/machine learning algorithms that identify the optimal sequence of actions for an agent towards a given goal in the space of actions and states of the agent by trial and error. RL is chosen instead of traditional optimization methods such as Simulated Annealing and Genetic Search due to its ability to manage the substantial solution spaces resulting from big data. The latest RL methods, such as model-based/deep learning-based RL algorithms, can discover target solutions by learning a limited sample of the entire space, which best suits big data scenarios. As a proof of concept, we formulate the SDP into a Markov Decision Process (MDP) to meet the prerequisite of conducting any RL algorithms:

MDP Components		
	Set of states of the agent or environment	S = {(v, g)|v ∈ all subsets of variables, g ∈ all subgroups of records}
	Set of actions of the agent	A = {(add or remove a variable, add or remove an atomic subgroup, m) | m ∈ all interested analytic methods, e.g., correlation, linear regression, neural network, etc.}
	Matrix of reward	R = {$r_{s \in S,\ a \in A}$ = amount of insight produced by applying a at s}
	User-specified goal of the process	G = producing α amount of total insights from the whole BDA process, where α is a real number specified by the user.

With the formulation above, many RL algorithms can compute the policy p for the MDP, which is a lookup table or predictive model that tells the agent the optimal action to perform at each state to achieve a goal G. We will apply the framework to enhance the autonomy, insightfulness, and efficiency of the BDA process on recurrence of child maltreatment based on real-world big data sets (Han, Modaresnezhad, & Nemati, 2021).

References

Han, Y., Modaresnezhad, M., & Nemati, H. (2021). An Adaptive Machine Learning System for predicting recurrence of child maltreatment: A routine activity theory perspective. *Knowledge-Based Systems*, *227*, 107164.