Efficient Exploration of Unknown Environments

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Assume that an agent has to learn an unknown, bi-directed, strongly connected graph. Empirical analysis shows that algorithms with optimal worst-case complexities tend to perform poorly in average in this exploration problem. The best practical approach - the on-line nearest neighbor - loses significantly in special cases. We therefore develop the Variable Edge Weight Algorithm (VEWA), an algorithmic framework that can accommodate almost any exploration or search strategy (including the on-line nearest neighbor algorithm). We use mathematical models with exponentially growing precision to build a simple exploration framework achieving, for example, the optimal complexity of exploring bi-directed (Eulerian) static environments with finite number of states and actions. While "impractical" models appear to be useful in deriving the desirable complexity, practical implementations solve the precision problem by considering priority lists instead of growing weights. Unlike other exploration strategies VEWA has optimal performance guarantees on sparse Eulerian graphs and even better performance guarantees on dense bi-directed unit edge length graphs, has a competitive empirical performance, and is robust in dynamically changing environments.