

The Multi-armed Bandit Problem

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Abstract

This paper analyzes a well known division of reinforcement learning known as the multi-armed bandit problem. The multi-armed bandit problem attempts to determine the best policy when faced with multiple choices. We analyze two different policies for picking machines: upper confidence bound (UCB1) and \mathcal{E}_n -GREEDY. [alg] was a better algorithm due to...

1 Introduction

When faced with multiple options in a situation, naturally one does not know whether to explore more options or stick to the best option that one knows. A multi-armed bandit problem enables us to study the exploration-exploitation trade-off in reinforcement learning. This problem is interesting to Artificial Intelligence researchers due to the number of interesting practical uses that it has been applied to. For example, the multi-armed bandit problem has been used to model clinical trial treatments, ad placement, website optimization, and computer game-playing (Bubeck and Cesa-Bianchi 2012).

The multi-armed bandit problem has been analyzed extensively (Auer, Cesa-Bianchi, and Fischer 2002), and this paper attempts to reproduce a subset of this work. The remainder of this paper includes background information on reinforcement learning and the multi-armed bandit problem, the experiments we performed, the results, and finally our conclusions.

In this section, you should introduce the reader to the problem you are attempting to solve. For example, for the first project: describe the 15-puzzle, and why it's interesting as an A.I. problem. You should also cite and briefly describe other related papers that have tackled this problem in the past — things that came up during the course of your research. In the AAAI style, citations look like (Russell and Norvig 2003) (see the comments in the source file `intro.tex` to see how this citation was produced). Conclude by summarizing how the remainder of the paper is organized.

Overall, the aim in this section is context-setting: what is the big-picture surrounding the problem you are tackling here?

2 Background

Describe any background information that the reader would need to know to understand your work. You do not have to explain algorithms or ideas that we have seen in class. Rather, use this section to describe techniques that you found elsewhere in the course of your research, that you have decided to bring to bear on the problem at hand. Don't go overboard here — if what you're doing is quite detailed, it's often more helpful to give a sketch of the big ideas of the approaches that you will be using. You can then say something like "the reader is referred to X for a more in-depth description of...", and include a citation.

Alternately, you may have designed a novel approach for the problem — your own algorithm or heuristic, say. A description of these would also be placed in this section (use subsections to better organize the content in this case).

3 Experiments

In this section, you should describe your experimental setup. What were the questions you were trying to answer? What was the experimental setup (number of trials, parameter settings, etc.)? What were you measuring? You should justify these choices when necessary. The accepted wisdom is that there should be enough detail in this section that I could reproduce your work *exactly* if I were so motivated.

4 Results

Present the results of your experiments. Simply presenting the data is insufficient! You need to analyze your results. What did you discover? What is interesting about your results? Were the results what you expected? Use appropriate visualizations. Prefer graphs and charts to tables as they are easier to read (though tables are often more compact, and can be a better choice if you're squeezed for space). **Always** include information that conveys the uncertainty in your measurements: mean statistics should be plotted with error bars, or reported in tables with a \pm range. The

95%-confidence interval is a commonly reported statistic.

5 Conclusions

In this section, briefly summarize your paper — what problem did you start out to study, and what did you find? What is the key result / take-away message? It's also traditional to suggest one or two avenues for further work, but this is optional.

References

Auer, P.; Cesa-Bianchi, N.; and Fischer, P. 2002. Finite-time analysis of the multiarmed bandit problem. *Mach. Learn.* 47(2-3):235–256.

Bubeck, S., and Cesa-Bianchi, N. 2012. Regret analysis of stochastic and nonstochastic multi-armed bandit problems. *CoRR* abs/1204.5721.

Russell, S. J., and Norvig, P. 2003. *Artificial Intelligence: A Modern Approach*. Pearson Education.