Iterative vs. Optimized Approach to Expert Systems

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Abstract
Model-based solutions are often seen as the more precise approach as opposed to the iterative process of trial-and-error. In this report, we test the two approaches against each other in the video game Lunar Lander. We conclude that the model-based approach is more effective for this task, but also more difficult to implement.

Introduction
We compare two expert systems for landing a rocket in Lunar Lander, scoring on fuel efficiency. The 'Iterative System' improves through trial and error, while the 'Optimized System' uses physics calculations based on a theoretical model. We hypothesize that the optimized system will outperform the iterative one.

Method
We altered the game source code to remove the framerate cap, automatically restart upon landing the rocket, and record whether each attempt was a success and how much fuel was leftover. We tested each expert system 200 times, and did statistical analysis on the results including mean, standard deviation, and 95% confidence intervals for both.

Results

System	Tests	Success rate	Mean fuel left	Confidence interval for mean (95%)	SD	Confidence interval for SD (95%)
Iterative	200	100%	48.74	[47.71, 49.78]	7.40	[6.74, 8.21]
Optimized	200	100%	83.94	[83.75, 84.13]	1.38	[1.26, 1.53]

Table 1: Relevant parameters for the iterative and optimized systems respectively.

Discussion
Our hypothesis that the optimized system would outperform the iterative system is supported by the data. The optimized system not only had a higher mean fuel efficiency (83.94 vs 48.74), but it also demonstrated significantly lower variability, as evidenced by a smaller standard deviation (1.38 vs 7.40) and tighter 95% confidence intervals for both the mean and SD.

Both approaches did yield 100% success rate, and it is likely possible that the iterative approach could be greatly improved simply by continuing the trial-and-error process of repeatedly changing it slightly, then testing.
In addition, the optimized approach required a lot more time and thinking to implement than the simpler iterative approach. For these reasons, an iterative approach can not decisively be dismissed as inferior to the more mathematical approach for all tasks.

References and credit
Thanks to Leif (s225221) for designing the optimized system.

Learning outcome
During this project, we familiarized ourselves with expert systems as well as the pros and cons of model-based vs trial-and-error iterative approaches to building them. We also got experience coding in Python, specifically using the libraries pygame (which the game is built on) and csv (for data extraction). Finally, we got practice implementing statistical methods and distributions on our data including t and chi-squared distributions.