Project 3 Writeup: SARSA (λ) with a Fourier Basis

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Overview

The goal of this project was to build a SARSA (λ) Reinforcement learning solution using a Fourier Basis. By using sin and cos waves of varying frequency, a value function for the problem can be learned and approximated. This approximation is then used to guide the actions of the agent. The mountain car problem was used to test the effectiveness of the algorithm's learning and value function reconstruction at varying harmonics.

Part 1

For the first part of this project, I graphed the learning curves for a Fourier Basis with $\alpha_1 = 0.001$ and $\epsilon = 0$. $\gamma = 1$ and $\lambda = 0.9$. The learning curves were as follows:

1. Learning Curve With 3 Fourier Harmonics (Figure 1).
2. Learning Curve With 5 Fourier Harmonics (Figure 2).
3. Learning Curve With 7 Fourier Harmonics (Figure 3).

Part 2

The second portion of this lab was to create surface plots of the negative value functions for the above harmonics. The following graphs were made with 100,000 episodes

1. Value Function With 3 Fourier Harmonics (Figure 4).
2. Value Function With 5 Fourier Harmonics (Figure 5).
3. Value Function With 7 Fourier Harmonics (Figure 6).

Part 3

The third part of this lab is to answer some theoretical questions.

3a

Q: What would happen if γ was < 1 and the solution was many steps long?

A: The back propagation of the learning algorithm would be small, leading to the system learning slower or possibly even stagnating and never learning at all.

3b

Q: What would happen if we had a 0 step cost, and a positive reward for the case where $\gamma = 1$ and for the case where γ is < 1?

A: For the case of $\gamma = 1$, a 0 step cost and positive reward would cause the total reward to blow up out of proportion. The algorithm would fail to learn how to get to the terminal state. Similar results would happen if $\gamma < 1$.

Conclusion

A good lab. Learning how to use function approximation is extremely useful. Getting an understanding of how to use Fourier Bases can expand into other bases in the future, making them easier to work with and understand.

Figures

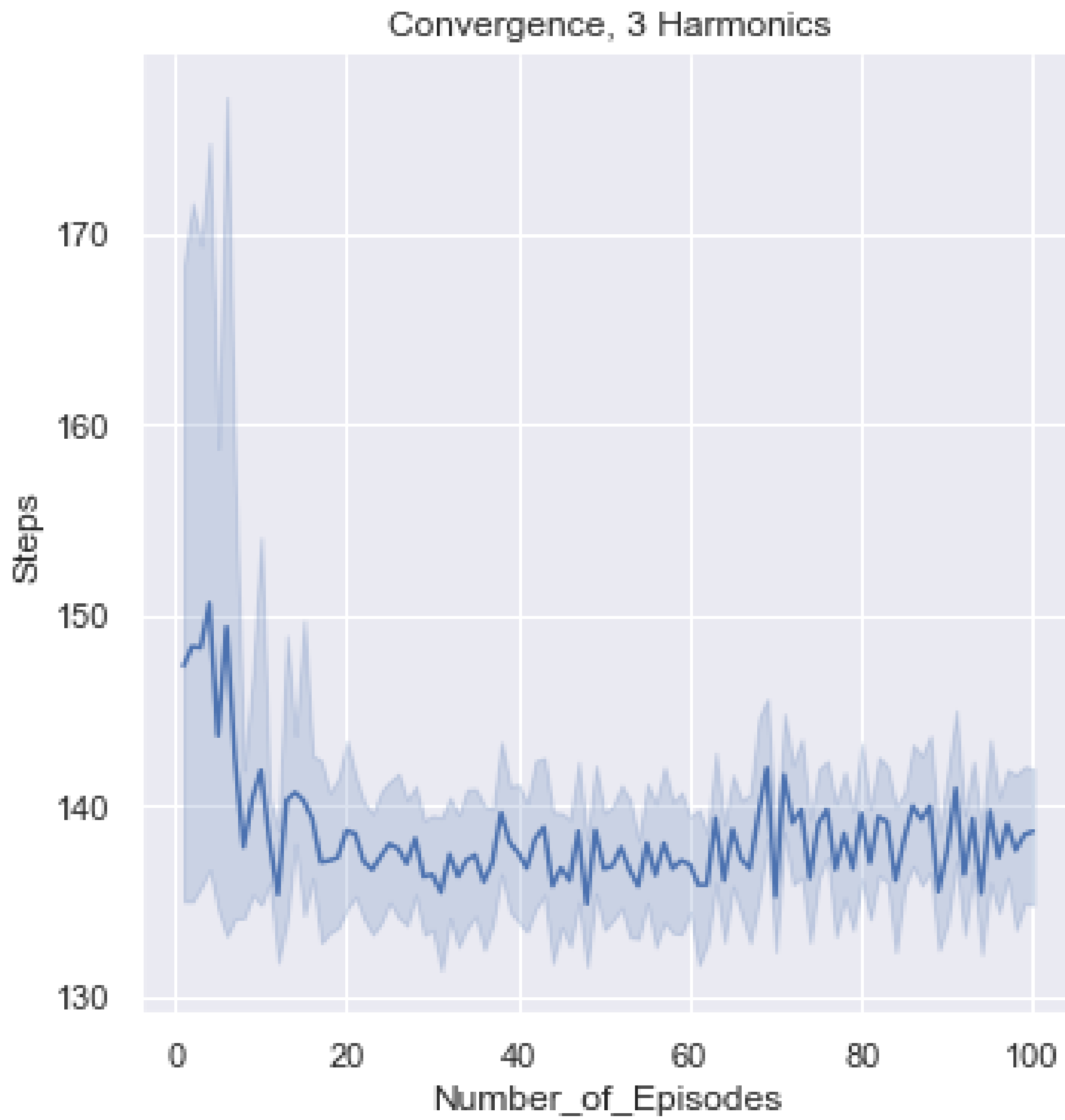

Figure 1: Convergence of algorithm with 3 Fourier Harmonics.

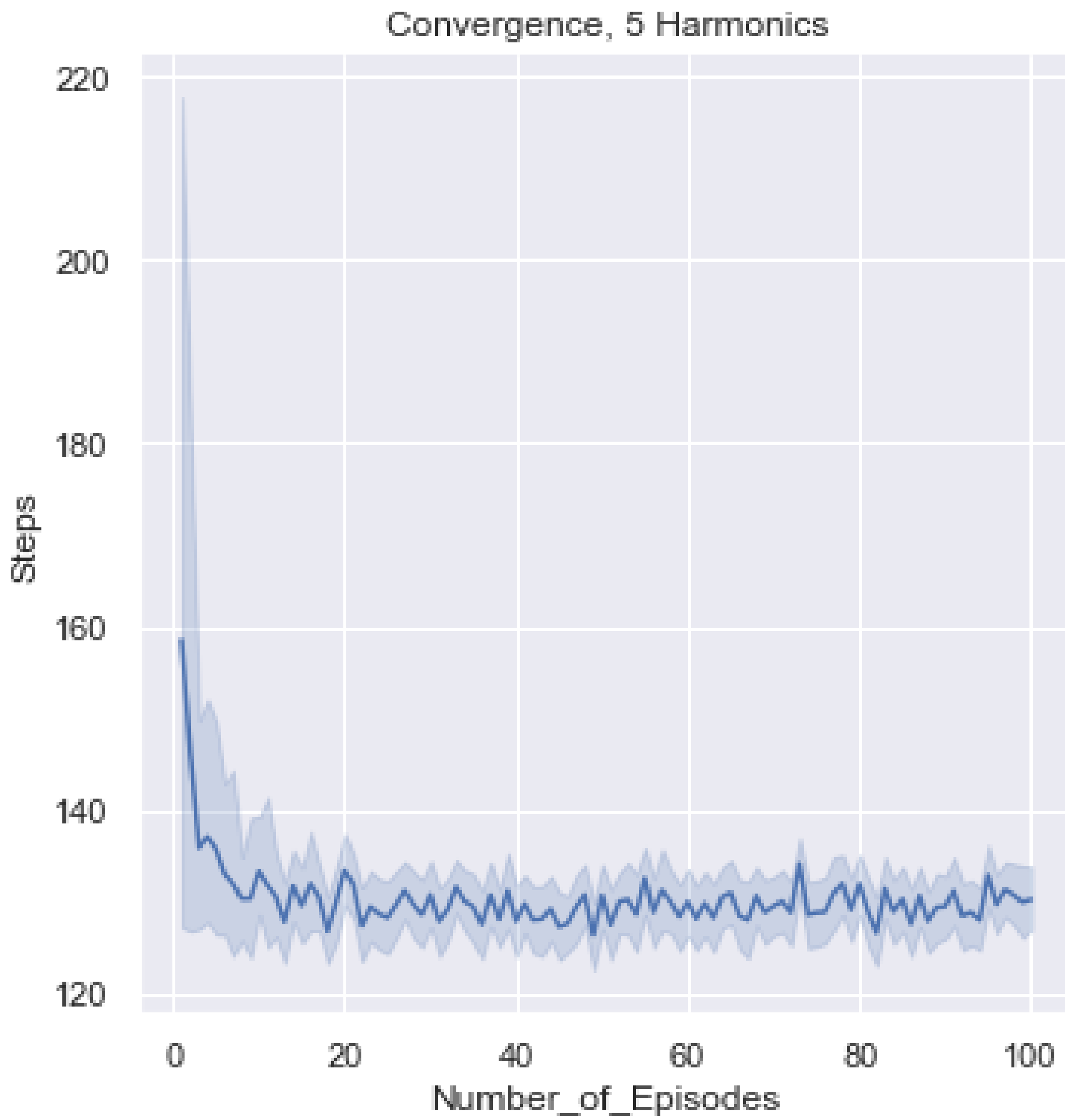

Figure 2: Convergence of algorithm with 5 Fourier Harmonics.

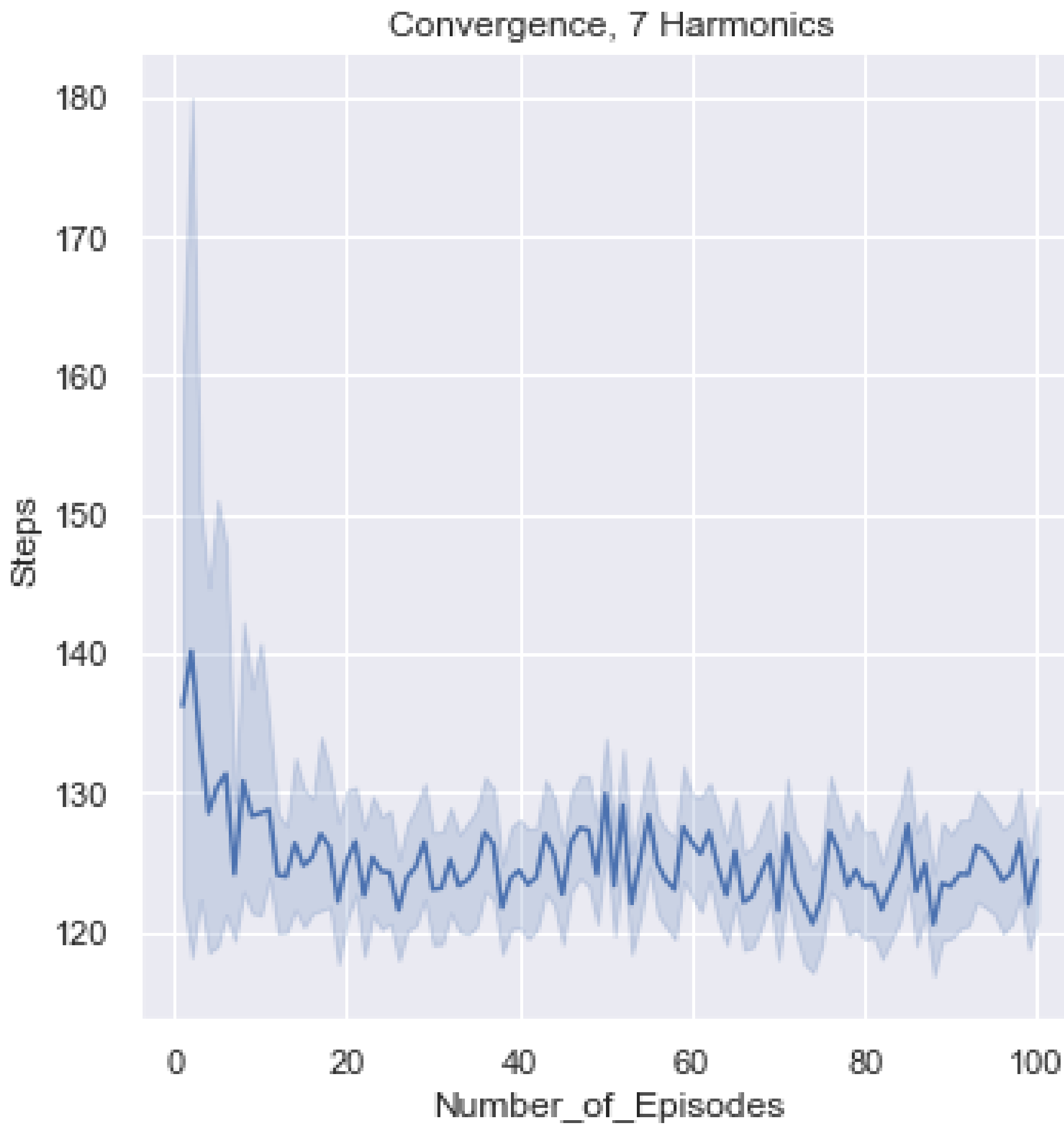

Figure 3: Convergence of algorithm with 7 Fourier Harmonics.

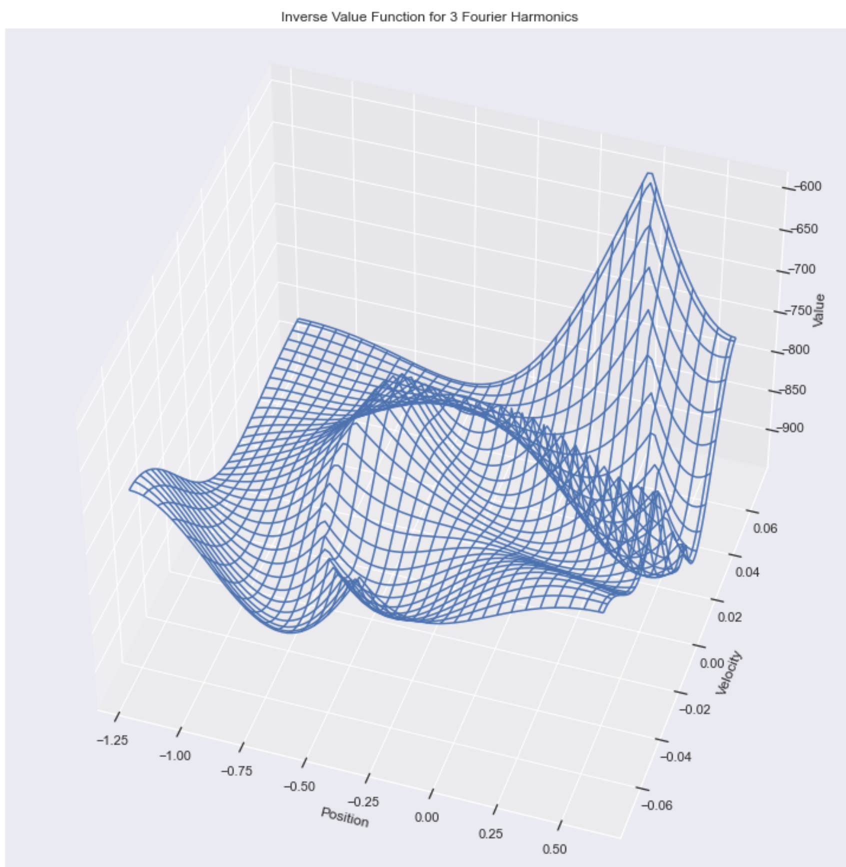

Figure 4: Inverted Value Function with 3 Fourier Harmonics

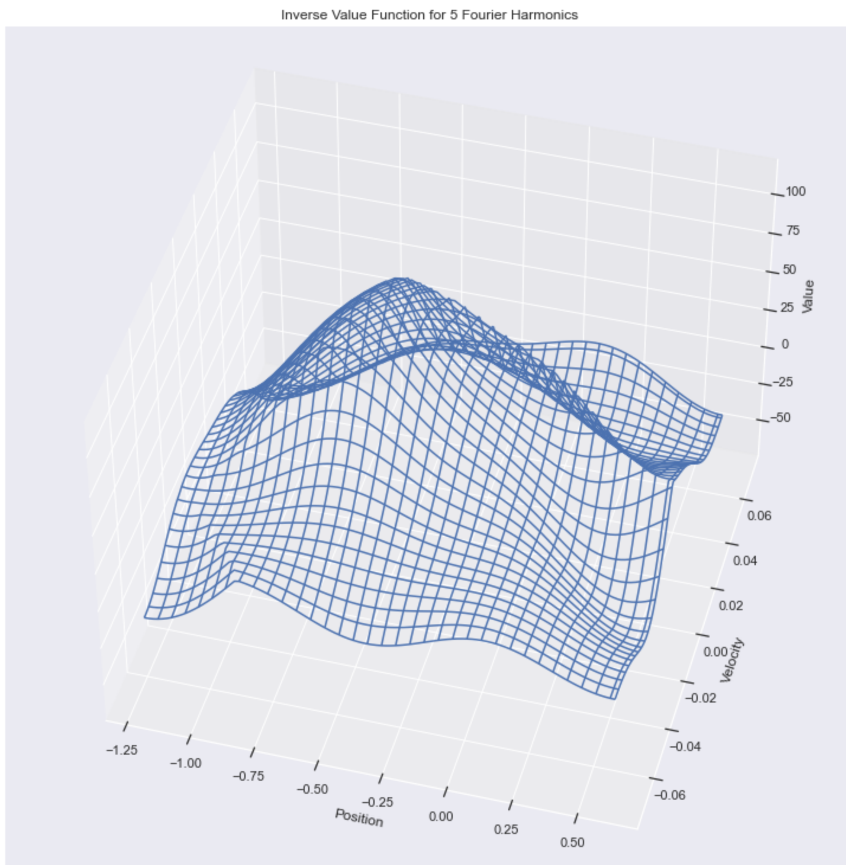

Figure 5: Inverted Value Function with 5 Fourier Harmonics

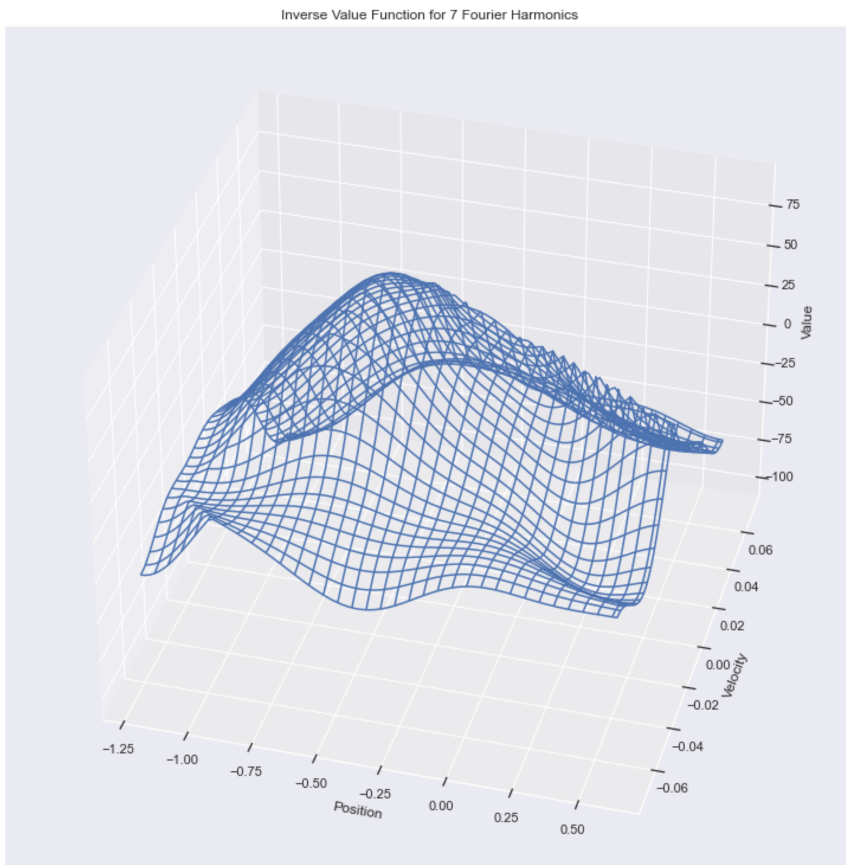

Figure 6: Inverted Value Function with 7 Fourier Harmonics