Analysis Report - Hackman AI Agent

Team Members (AIML Section B):
- PES1UG23AM114
- PES1UG23AM113
- PES1UG23AM117
- PES1UG23AM094

1. Key Observations

The project combined probabilistic reasoning (HMM) and reinforcement learning (Q-learning) to build a high-performing Hangman AI agent.
Challenges included balancing exploration and exploitation, ensuring the HMM generalized across varying word lengths, and tuning the reward structure.
Through experimentation, the agent's performance improved after reward tuning and epsilon decay, achieving over 92% accuracy.

2. Strategies

HMM Design: A unigram letter-based Hidden Markov Model computed probabilistic letter distributions for partially known words.
The HMM provides contextual probabilities guiding the reinforcement learning agent's next move.
Reinforcement Learning Design: Q-learning was chosen for simplicity and interpretability.
The state was represented using the masked word pattern and guessed letters. Actions represented all possible unguessed letters.
The reward function was shaped to encourage correct predictions (+5), discourage wrong guesses (-2), and heavily reward word completions (+30).

3. Exploration vs Exploitation

An epsilon-greedy strategy was used where epsilon decayed from 0.4 to 0.01.
This allowed early exploration of actions and later exploitation of the learned policy.
This balance was key in achieving consistent improvement across 10,000 episodes, as seen in the reward trend graph.

4. Future Improvements

If provided more time, we would improve the model by:

- Implementing a trigram-based HMM for deeper contextual modeling.
- Using a Deep Q-Network (DQN) to handle larger state spaces.
- Adding adaptive difficulty scaling based on agent performance.
- Integrating NLP embeddings for better letter probability prediction.

5. Results Summary

Validation: 2000 Games | Success Rate: 90.00% | Score: 89,042

Test: 2000 Games | Success Rate: 94.60% | Score: 93,787

Overall Score: 182,829 | Average Success Rate: 92.30% | Performance: Excellent (Top-tier)