==================================================

Running Genetic Algorithm...

==================================================

==================================================

=== GENETIC ALGORITHM OPTIMIZATION ===

==================================================

[Initialization]

- Population size: 60

- Generations: 40

- Crossover rate: 80%

- Mutation rate: 20%

- Search space: 14 features

- Target: Minimize MSE using XGBoost

[Evolution Progress]

Gen 01/40 | Best MSE: 0.497159 | Avg MSE: 0.501093

Gen 06/40 | Best MSE: 0.494339 | Avg MSE: 0.494458

Gen 11/40 | Best MSE: 0.494339 | Avg MSE: 0.494339

Gen 16/40 | Best MSE: 0.494339 | Avg MSE: 0.494339

Gen 21/40 | Best MSE: 0.494339 | Avg MSE: 0.494339

Gen 26/40 | Best MSE: 0.494339 | Avg MSE: 0.494339

Gen 31/40 | Best MSE: 0.494339 | Avg MSE: 0.494339

Gen 36/40 | Best MSE: 0.494339 | Avg MSE: 0.494339

Gen 40/40 | Best MSE: 0.494339 | Avg MSE: 0.494339

==================================================

=== OPTIMIZATION RESULTS ===

==================================================

▶ Best MSE achieved: 0.494339

▶ Time elapsed: 1110.28 seconds

▶ Features selected: 14/14 (0.0% reduction)

▶ Selected features:

1. 0

2. 1

3. 2

4. 3

5. 4

6. 5

7. 6

8. 7

9. 8

10. 9

11. 10

12. 11

13. 12

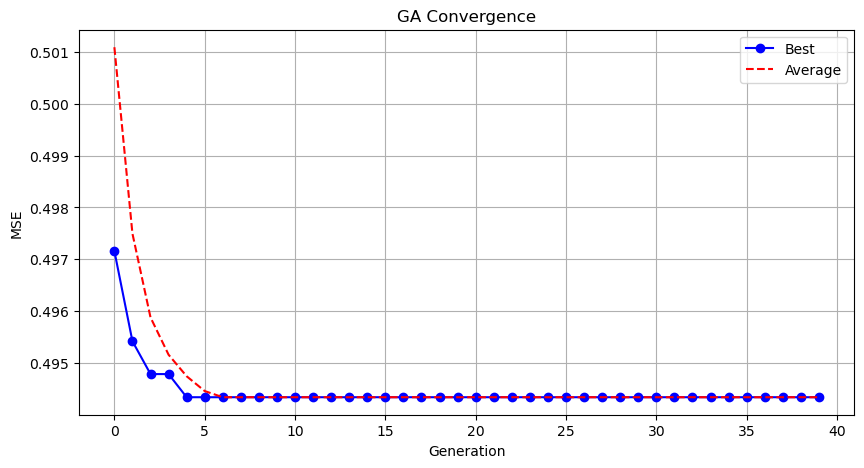
14. 13

▶ Convergence progress:

- Initial MSE: 0.4972

- Final MSE: 0.4943

- Improvement: 0.6%



Genetic Algorithm completed successfully with MSE: 0.4943

==================================================

Running Particle Swarm Optimization...

==================================================

==================================================

=== PARTICLE SWARM OPTIMIZATION ===

==================================================

[Initialization]

- Swarm size: 60 particles

- Iterations: 40

- Cognitive weight: 0.5

- Social weight: 0.5

- Inertia weight: 0.5

- Search space: 14 features

- Target: Minimize MSE using XGBoost

[Optimization Progress]

No constraints given.

Iteration 1: Best MSE = 0.502251

New best for swarm at iteration 1: [1. 0.10047949 0.80345972 0.50782911 0.83267326 0.66023438

0.50459836 0.48464727 0.00855099 0.67342872 0.65113751 1.

0.80725706 1. ] 0.497700035572052

Best after iteration 1: [1. 0.10047949 0.80345972 0.50782911 0.83267326 0.66023438

0.50459836 0.48464727 0.00855099 0.67342872 0.65113751 1.

0.80725706 1. ] 0.497700035572052

New best for swarm at iteration 2: [0.8030648 0.97745777 0.72655569 0.52651901 1. 0.46405102

1. 0.50685367 0.43301782 0.05798867 1. 0.87006673

0.98024505 1. ] 0.4974202513694763

New best for swarm at iteration 2: [0.78393728 0.68948 0.77727631 0.68354734 0.84818771 0.64504268

0.62969688 0.48623592 0. 1. 0.36781583 0.60226026

1. 1. ] 0.4962160885334015

Best after iteration 2: [0.78393728 0.68948 0.77727631 0.68354734 0.84818771 0.64504268

0.62969688 0.48623592 0. 1. 0.36781583 0.60226026

1. 1. ] 0.4962160885334015

New best for swarm at iteration 3: [0.63992037 0.69186796 0.96806012 0.64906674 1. 1.

0.97819196 0.13538786 0.08682126 0.5394234 0.76959232 0.61213159

0.91303487 0.56907179] 0.49541839957237244

New best for swarm at iteration 3: [0.87880605 0.76074647 0.94242379 0.71682843 0.82062215 0.76078494

0.66950016 0.51063995 0.36716558 0.57340543 0.5822522 0.55278175

0.52132903 0.76207179] 0.4947851896286011

Best after iteration 3: [0.87880605 0.76074647 0.94242379 0.71682843 0.82062215 0.76078494

0.66950016 0.51063995 0.36716558 0.57340543 0.5822522 0.55278175

0.52132903 0.76207179] 0.4947851896286011

New best for swarm at iteration 4: [0.70715389 0.6879597 0.91224663 0.57945693 0.86258776 0.86401888

0.81518292 0.55054184 0.53512003 0.6412256 0.58062581 0.68082316

0.857637 0.52790283] 0.4943385124206543

Iteration 5: Best MSE = 0.495880

Best after iteration 4: [0.70715389 0.6879597 0.91224663 0.57945693 0.86258776 0.86401888

0.81518292 0.55054184 0.53512003 0.6412256 0.58062581 0.68082316

0.857637 0.52790283] 0.4943385124206543

Best after iteration 5: [0.70715389 0.6879597 0.91224663 0.57945693 0.86258776 0.86401888

0.81518292 0.55054184 0.53512003 0.6412256 0.58062581 0.68082316

0.857637 0.52790283] 0.4943385124206543

Best after iteration 6: [0.70715389 0.6879597 0.91224663 0.57945693 0.86258776 0.86401888

0.81518292 0.55054184 0.53512003 0.6412256 0.58062581 0.68082316

0.857637 0.52790283] 0.4943385124206543

Best after iteration 7: [0.70715389 0.6879597 0.91224663 0.57945693 0.86258776 0.86401888

0.81518292 0.55054184 0.53512003 0.6412256 0.58062581 0.68082316

0.857637 0.52790283] 0.4943385124206543

Best after iteration 8: [0.70715389 0.6879597 0.91224663 0.57945693 0.86258776 0.86401888

0.81518292 0.55054184 0.53512003 0.6412256 0.58062581 0.68082316

0.857637 0.52790283] 0.4943385124206543

Iteration 10: Best MSE = 0.495880

Best after iteration 9: [0.70715389 0.6879597 0.91224663 0.57945693 0.86258776 0.86401888

0.81518292 0.55054184 0.53512003 0.6412256 0.58062581 0.68082316

0.857637 0.52790283] 0.4943385124206543

Best after iteration 10: [0.70715389 0.6879597 0.91224663 0.57945693 0.86258776 0.86401888

0.81518292 0.55054184 0.53512003 0.6412256 0.58062581 0.68082316

0.857637 0.52790283] 0.4943385124206543

Best after iteration 11: [0.70715389 0.6879597 0.91224663 0.57945693 0.86258776 0.86401888

0.81518292 0.55054184 0.53512003 0.6412256 0.58062581 0.68082316

0.857637 0.52790283] 0.4943385124206543

Best after iteration 12: [0.70715389 0.6879597 0.91224663 0.57945693 0.86258776 0.86401888

0.81518292 0.55054184 0.53512003 0.6412256 0.58062581 0.68082316

0.857637 0.52790283] 0.4943385124206543

Best after iteration 13: [0.70715389 0.6879597 0.91224663 0.57945693 0.86258776 0.86401888

0.81518292 0.55054184 0.53512003 0.6412256 0.58062581 0.68082316

0.857637 0.52790283] 0.4943385124206543

Iteration 15: Best MSE = 0.495880

Best after iteration 14: [0.70715389 0.6879597 0.91224663 0.57945693 0.86258776 0.86401888

0.81518292 0.55054184 0.53512003 0.6412256 0.58062581 0.68082316

0.857637 0.52790283] 0.4943385124206543

Best after iteration 15: [0.70715389 0.6879597 0.91224663 0.57945693 0.86258776 0.86401888

0.81518292 0.55054184 0.53512003 0.6412256 0.58062581 0.68082316

0.857637 0.52790283] 0.4943385124206543

Best after iteration 16: [0.70715389 0.6879597 0.91224663 0.57945693 0.86258776 0.86401888

0.81518292 0.55054184 0.53512003 0.6412256 0.58062581 0.68082316

0.857637 0.52790283] 0.4943385124206543

Best after iteration 17: [0.70715389 0.6879597 0.91224663 0.57945693 0.86258776 0.86401888

0.81518292 0.55054184 0.53512003 0.6412256 0.58062581 0.68082316

0.857637 0.52790283] 0.4943385124206543

Best after iteration 18: [0.70715389 0.6879597 0.91224663 0.57945693 0.86258776 0.86401888

0.81518292 0.55054184 0.53512003 0.6412256 0.58062581 0.68082316

0.857637 0.52790283] 0.4943385124206543

Iteration 20: Best MSE = 0.495880

Best after iteration 19: [0.70715389 0.6879597 0.91224663 0.57945693 0.86258776 0.86401888

0.81518292 0.55054184 0.53512003 0.6412256 0.58062581 0.68082316

0.857637 0.52790283] 0.4943385124206543

Best after iteration 20: [0.70715389 0.6879597 0.91224663 0.57945693 0.86258776 0.86401888

0.81518292 0.55054184 0.53512003 0.6412256 0.58062581 0.68082316

0.857637 0.52790283] 0.4943385124206543

Best after iteration 21: [0.70715389 0.6879597 0.91224663 0.57945693 0.86258776 0.86401888

0.81518292 0.55054184 0.53512003 0.6412256 0.58062581 0.68082316

0.857637 0.52790283] 0.4943385124206543

Best after iteration 22: [0.70715389 0.6879597 0.91224663 0.57945693 0.86258776 0.86401888

0.81518292 0.55054184 0.53512003 0.6412256 0.58062581 0.68082316

0.857637 0.52790283] 0.4943385124206543

Best after iteration 23: [0.70715389 0.6879597 0.91224663 0.57945693 0.86258776 0.86401888

0.81518292 0.55054184 0.53512003 0.6412256 0.58062581 0.68082316

0.857637 0.52790283] 0.4943385124206543

Iteration 25: Best MSE = 0.495880

Best after iteration 24: [0.70715389 0.6879597 0.91224663 0.57945693 0.86258776 0.86401888

0.81518292 0.55054184 0.53512003 0.6412256 0.58062581 0.68082316

0.857637 0.52790283] 0.4943385124206543

Best after iteration 25: [0.70715389 0.6879597 0.91224663 0.57945693 0.86258776 0.86401888

0.81518292 0.55054184 0.53512003 0.6412256 0.58062581 0.68082316

0.857637 0.52790283] 0.4943385124206543

Best after iteration 26: [0.70715389 0.6879597 0.91224663 0.57945693 0.86258776 0.86401888

0.81518292 0.55054184 0.53512003 0.6412256 0.58062581 0.68082316

0.857637 0.52790283] 0.4943385124206543

Best after iteration 27: [0.70715389 0.6879597 0.91224663 0.57945693 0.86258776 0.86401888

0.81518292 0.55054184 0.53512003 0.6412256 0.58062581 0.68082316

0.857637 0.52790283] 0.4943385124206543

Best after iteration 28: [0.70715389 0.6879597 0.91224663 0.57945693 0.86258776 0.86401888

0.81518292 0.55054184 0.53512003 0.6412256 0.58062581 0.68082316

0.857637 0.52790283] 0.4943385124206543

Iteration 30: Best MSE = 0.495880

Best after iteration 29: [0.70715389 0.6879597 0.91224663 0.57945693 0.86258776 0.86401888

0.81518292 0.55054184 0.53512003 0.6412256 0.58062581 0.68082316

0.857637 0.52790283] 0.4943385124206543

Best after iteration 30: [0.70715389 0.6879597 0.91224663 0.57945693 0.86258776 0.86401888

0.81518292 0.55054184 0.53512003 0.6412256 0.58062581 0.68082316

0.857637 0.52790283] 0.4943385124206543

Best after iteration 31: [0.70715389 0.6879597 0.91224663 0.57945693 0.86258776 0.86401888

0.81518292 0.55054184 0.53512003 0.6412256 0.58062581 0.68082316

0.857637 0.52790283] 0.4943385124206543

Best after iteration 32: [0.70715389 0.6879597 0.91224663 0.57945693 0.86258776 0.86401888

0.81518292 0.55054184 0.53512003 0.6412256 0.58062581 0.68082316

0.857637 0.52790283] 0.4943385124206543

Best after iteration 33: [0.70715389 0.6879597 0.91224663 0.57945693 0.86258776 0.86401888

0.81518292 0.55054184 0.53512003 0.6412256 0.58062581 0.68082316

0.857637 0.52790283] 0.4943385124206543

Iteration 35: Best MSE = 0.495880

Best after iteration 34: [0.70715389 0.6879597 0.91224663 0.57945693 0.86258776 0.86401888

0.81518292 0.55054184 0.53512003 0.6412256 0.58062581 0.68082316

0.857637 0.52790283] 0.4943385124206543

Best after iteration 35: [0.70715389 0.6879597 0.91224663 0.57945693 0.86258776 0.86401888

0.81518292 0.55054184 0.53512003 0.6412256 0.58062581 0.68082316

0.857637 0.52790283] 0.4943385124206543

Best after iteration 36: [0.70715389 0.6879597 0.91224663 0.57945693 0.86258776 0.86401888

0.81518292 0.55054184 0.53512003 0.6412256 0.58062581 0.68082316

0.857637 0.52790283] 0.4943385124206543

Best after iteration 37: [0.70715389 0.6879597 0.91224663 0.57945693 0.86258776 0.86401888

0.81518292 0.55054184 0.53512003 0.6412256 0.58062581 0.68082316

0.857637 0.52790283] 0.4943385124206543

Best after iteration 38: [0.70715389 0.6879597 0.91224663 0.57945693 0.86258776 0.86401888

0.81518292 0.55054184 0.53512003 0.6412256 0.58062581 0.68082316

0.857637 0.52790283] 0.4943385124206543

Iteration 40: Best MSE = 0.495880

Best after iteration 39: [0.70715389 0.6879597 0.91224663 0.57945693 0.86258776 0.86401888

0.81518292 0.55054184 0.53512003 0.6412256 0.58062581 0.68082316

0.857637 0.52790283] 0.4943385124206543

Best after iteration 40: [0.70715389 0.6879597 0.91224663 0.57945693 0.86258776 0.86401888

0.81518292 0.55054184 0.53512003 0.6412256 0.58062581 0.68082316

0.857637 0.52790283] 0.4943385124206543

Stopping search: maximum iterations reached --> 40

==================================================

=== OPTIMIZATION RESULTS ===

==================================================

▶ Best MSE achieved: 0.494339

▶ Time elapsed: 1141.90 seconds

▶ Features selected: 14/14 (0.0% reduction)

▶ Selected features (with weights):

1. 0 (weight: 0.707)

2. 1 (weight: 0.688)

3. 2 (weight: 0.912)

4. 3 (weight: 0.579)

5. 4 (weight: 0.863)

6. 5 (weight: 0.864)

7. 6 (weight: 0.815)

8. 7 (weight: 0.551)

9. 8 (weight: 0.535)

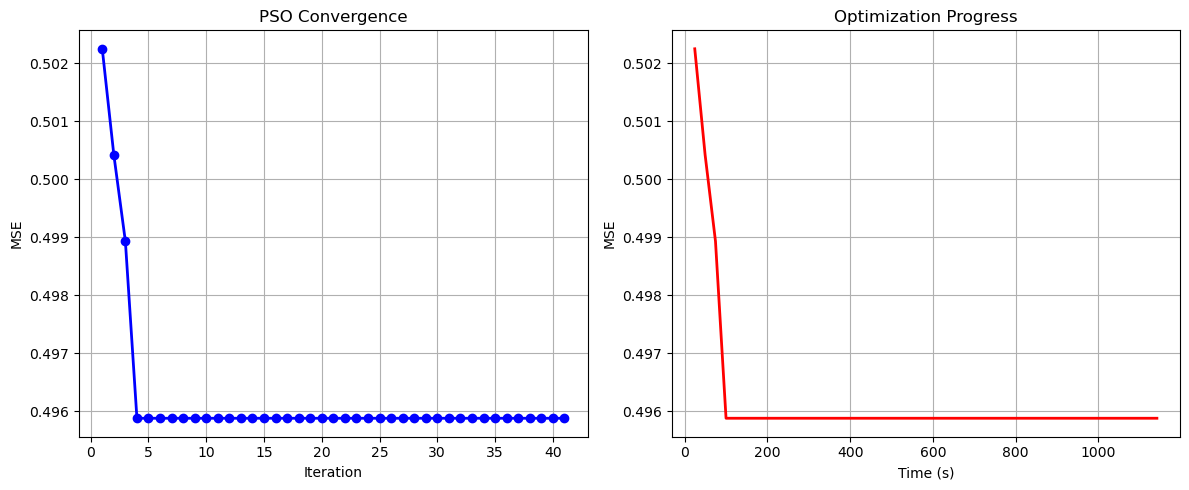
10. 9 (weight: 0.641)

11. 10 (weight: 0.581)

12. 11 (weight: 0.681)

13. 12 (weight: 0.858)

14. 13 (weight: 0.528)



Particle Swarm Optimization completed successfully with MSE: 0.4943

==================================================

Running Whale Optimization...

==================================================

==================================================

=== WHALE OPTIMIZATION ALGORITHM ===

==================================================

[Initialization]

- Population: 60 whales

- Max iterations: 40

- Spiral coefficient (b): 1.0

- Search space: 14 features

- Target: Minimize MSE using XGBoost

[Optimization Progress]

Iter 40/40 | Best MSE: 0.494339

==================================================

=== OPTIMIZATION RESULTS ===

==================================================

▶ Best MSE achieved: 0.494339

▶ Time elapsed: 1085.60 seconds

▶ Features selected: 14/14 (0.0% reduction)

▶ Selected features:

1. 0

2. 1

3. 2

4. 3

5. 4

6. 5

7. 6

8. 7

9. 8

10. 9

11. 10

12. 11

13. 12

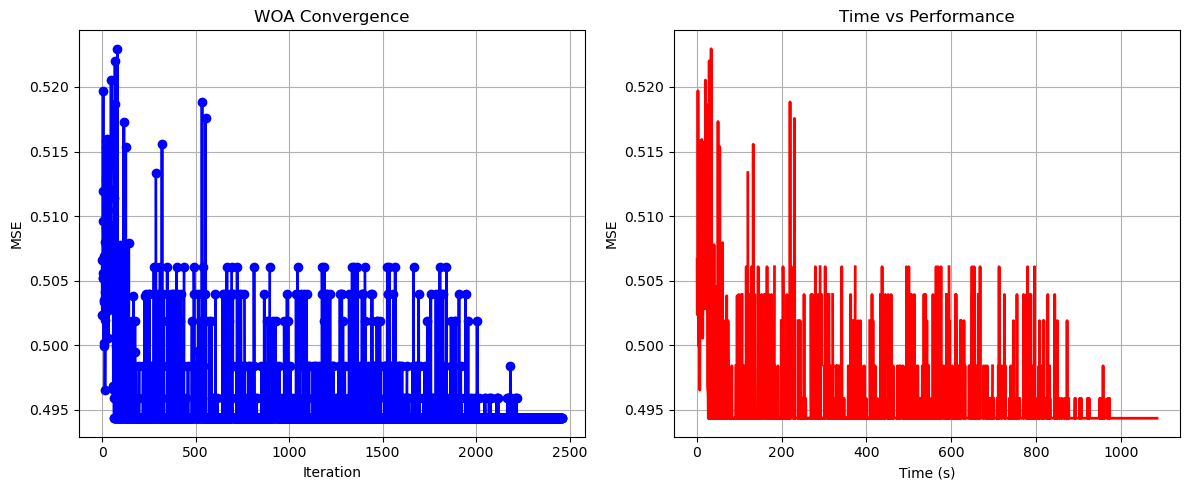
14. 13

▶ Convergence progress:

- Initial MSE: 0.5066

- Final MSE: 0.4943

- Improvement: 2.4%



Whale Optimization completed successfully with MSE: 0.4943

==================================================

Running Squid Game Optimizer...

==================================================

==================================================

=== SQUID GAME OPTIMIZER (SGO) ===

==================================================

[Initialization]

- Players: 60 (30 offensive, 30 defensive)

- Max games: 40

- Search space: 14 features

- Target: Minimize MSE using XGBoost

==================================================

=== OPTIMIZATION RESULTS ===

==================================================

▶ Best MSE achieved: 0.494339

▶ Time elapsed: 1063.02 seconds

▶ Features selected: 14/14 (0.0% reduction)

▶ Selected features:

1. 0

2. 1

3. 2

4. 3

5. 4

6. 5

7. 6

8. 7

9. 8

10. 9

11. 10

12. 11

13. 12

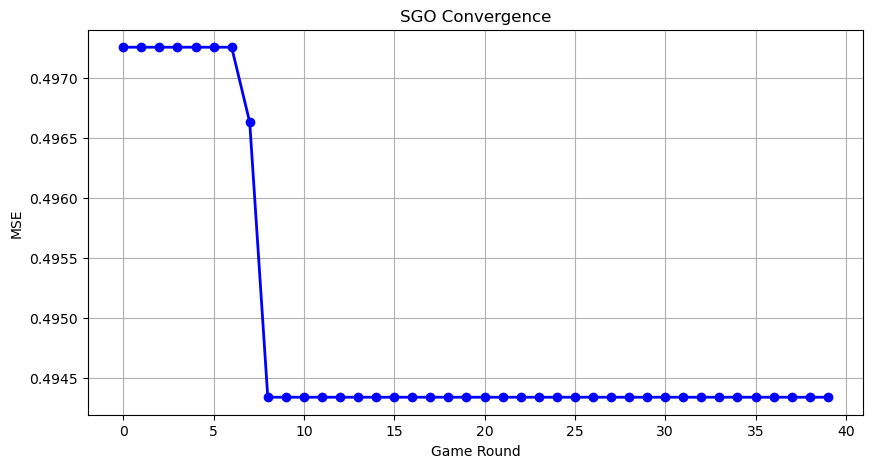
14. 13

▶ Convergence progress:

- Initial MSE: 0.4973

- Final MSE: 0.4943

- Improvement: 0.6%



Squid Game Optimizer completed successfully with MSE: 0.4943

==================================================

Running PSH-Hyptrite...

==================================================

==================================================

=== PSH-HYPTRITE OPTIMIZATION ===

==================================================

[Initialization]

- Search points: 60

- Max iterations: 40

- Initial radius: 0.5 (adaptive)

- Hypersphere samples: 3 per point

- Search space: 14 features

- Target: Minimize MSE using XGBoost

[Optimization Progress]

Iter 40/40 | Best MSE: 0.494339 | Radius: 0.0125

==================================================

=== OPTIMIZATION RESULTS ===

==================================================

▶ Best MSE achieved: 0.494339

▶ Time elapsed: 3319.41 seconds

▶ Features selected: 14/14 (0.0% reduction)

▶ Selected features (with weights):

1. 0 (weight: 0.761)

2. 1 (weight: 0.868)

3. 2 (weight: 0.700)

4. 3 (weight: 0.671)

5. 4 (weight: 1.000)

6. 5 (weight: 0.523)

7. 6 (weight: 0.763)

8. 7 (weight: 0.705)

9. 8 (weight: 0.562)

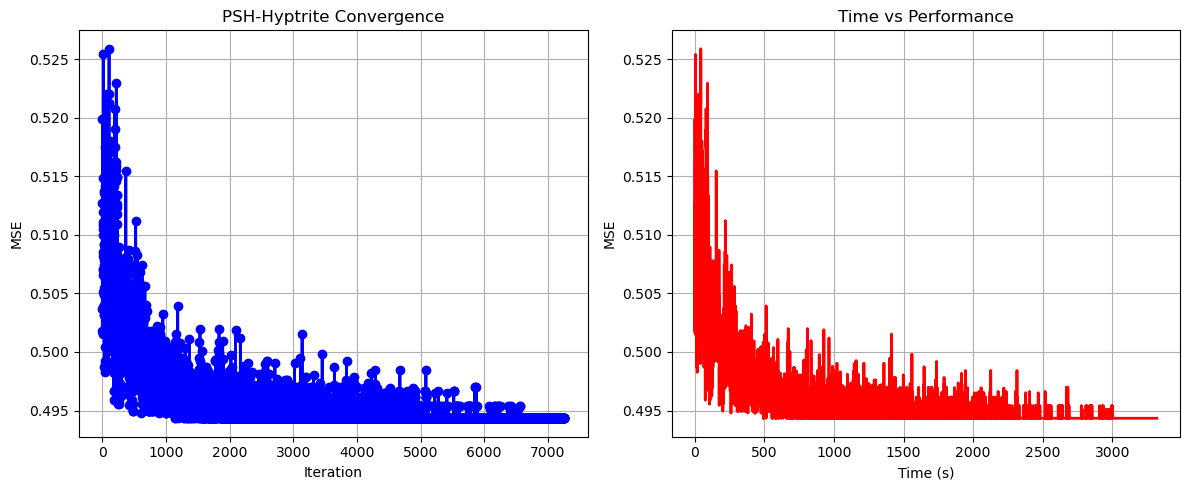
10. 9 (weight: 0.797)

11. 10 (weight: 0.819)

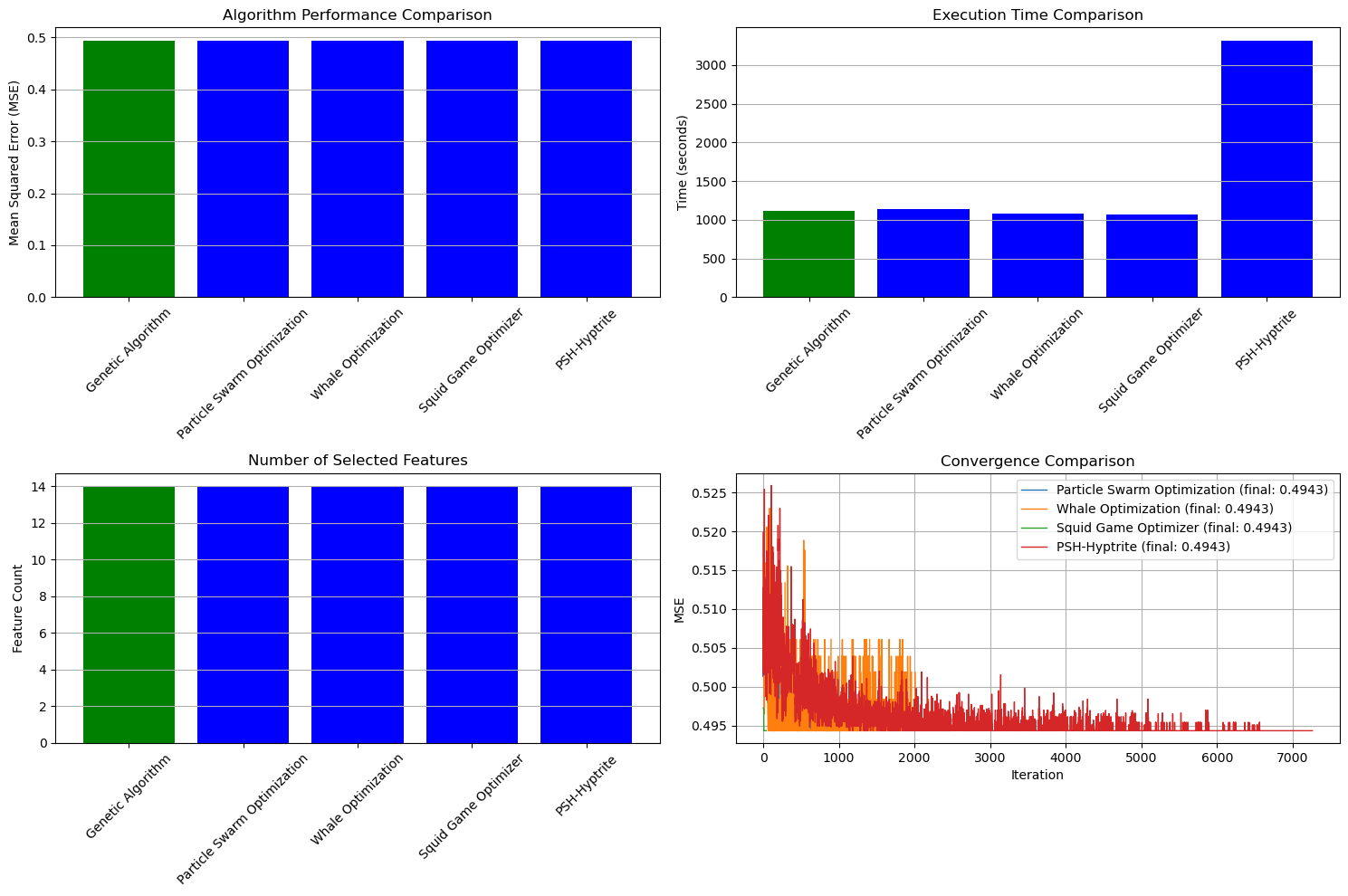
12. 11 (weight: 0.726)

13. 12 (weight: 0.616)

14. 13 (weight: 0.533)



PSH-Hyptrite completed successfully with MSE: 0.4943



==================================================

FINAL RESULTS SUMMARY

==================================================

🏆 Best Algorithm: Genetic Algorithm

📉 Best MSE Achieved: 0.494339

⏱️ Execution Time: 1110.28 seconds

🔢 Features Selected: 14

Selected Features:

1. 0

2. 1

3. 2

4. 3

5. 4

6. 5

7. 6

8. 7

9. 8

10. 9

11. 10

12. 11

13. 12

14. 13