Novelty Assessment Report

Paper: AutoEP: LLMs-Driven Automation of Hyperparameter Evolution for Metaheuristic Algorithms

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Abstract

Dynamically configuring algorithm hyperparameters is a fundamental challenge in computational intelligence. While learning-based methods offer automation, they suffer from prohibitive sample complexity and poor generalization. We introduce AutoEP, a novel framework that bypasses training entirely by leveraging Large Language Models (LLMs) as zero-shot reasoning engines for algorithm control. AutoEP's core innovation lies in a tight synergy between two components: (1) an online Exploratory Landscape Analysis (ELA) module that provides real-time, quantitative feedback on the search dynamics, and (2) a multi-LLM reasoning chain that interprets this feedback to generate adaptive hyperparameter strategies. This approach grounds high-level reasoning in empirical data, mitigating hallucination. Evaluated on three distinct metaheuristics across diverse combinatorial optimization benchmarks, AutoEP consistently outperforms state-of-the-art tuners, including neural evolution and other LLM-based methods. Notably, our framework enables open-source models like Qwen3-30B to match the performance of GPT-4, demonstrating a powerful and accessible new paradigm for automated hyperparameter design.Our code is available at https://anonymous.4open.science/r/AutoEP-3E11.

Core Task Landscape

This paper addresses: **Dynamic Hyperparameter Configuration for Metaheuristic Algorithms**

A total of **50 papers** were analyzed and organized into a taxonomy with **20 categories**.

Taxonomy Overview

The research landscape has been organized into the following main categories:

- **Reinforcement Learning-Based Parameter Adaptation**
- **Fuzzy Logic-Based Parameter Adaptation**
- **Analytical Adaptive Control Mechanisms**
- **Metaheuristic-Optimized Hyperparameter Tuning for Machine Learning**
- **Frameworks and Toolkits for Metaheuristic Development**
- **Novel Metaheuristic Algorithm Design with Adaptive Mechanisms**
- **Hybrid and Multi-Level Metaheuristic Architectures**
- **Domain-Specific Applications with Adaptive Metaheuristics**
- **Theoretical Foundations and Comparative Studies**

Complete Taxonomy Tree

- Dynamic Hyperparameter Configuration for Metaheuristic Algorithms Survey Taxonomy
- Reinforcement Learning-Based Parameter Adaptation
  - Q-Learning Integration with Metaheuristics ★ (3 papers)
  - [0] AutoEP: LLMs-Driven Automation of Hyperparameter Evolution for Metaheuristic Algorithms (Anon et al., 2026) View paper
  - [1] Advancements in Qâ learning metaâ heuristic optimization algorithms: A survey (Yang Yang, 2024) View paper
  - [3] Adaptive hyperheuristic framework for hyperparameter tuning: A Q-learning-based heuristic selection approach with simulated annealing acceptance criteria (Kassem M. Danach, 2025) View paper
  - Deep Reinforcement Learning for Hyperparameter Tuning (3 papers)
  - [19] Robust UAV spectrum scheduling under incomplete information: A fuzzy framework based on PPO-assisted evolutionary reinforcement learning (Lu Sun, 2025) View paper
  - [33] Hyperparameter Adaptive Adjustment Method Based on Self-Attention Mechanism (Detian Zeng, 2025) View paper
  - [36] Multi-agent Dynamic Algorithm Configuration (Xue. Ke, 2022) View paper
- Fuzzy Logic-Based Parameter Adaptation
  - Type-2 and Shadowed Fuzzy Systems for Dynamic Adaptation (2 papers)
  - [35] A high-speed interval type 2 fuzzy system approach for dynamic parameter adaptation in metaheuristics (Oscar Castillo, 2019) View paper
  - [43] Shadowed type-2 fuzzy systems for dynamic parameter adaptation in harmony search and differential evolution algorithms (Oscar Castillo, 2019) View paper
  - Type-1 Fuzzy Parameter Control (2 papers)
  - [22] Fuzzy Dynamic parameter adaptation in the mayfly algorithm: implementation of fuzzy adaptation and tests on benchmark functions and neural networks (Enrique Lizarraga, 2023) View paper
  - [37] A new hybrid method based on ACO and PSO with fuzzy dynamic parameter adaptation for modular neural networks optimization (F. Valdez, 2021) View paper
- Analytical Adaptive Control Mechanisms
  - Gradient and Statistical Feedback-Based Adaptation (3 papers)
  - [12] A statistical approach to adaptive parameter tuning in nature-inspired optimization and optimal sequential design of dose-finding trials (Choi Kwok Pui, 2021) View paper

  - [27] Reinforced online parameter adaptation method for population-based metaheuristics (Vasileios A. Tatsis, 2020) View paper
  - [32] Interactive particle swarm: a pareto-adaptive metaheuristic to multiobjective optimization (Shubham Agrawal, 2008) View paper
  - Population Diversity and State-Driven Control (3 papers)
  - [11] A New Approach to Circulatory System-Based Optimization for the Shape and Sizing Design of Truss Structures (Ibrahim Behram Ugur, 2025) View paper
  - [17] Online Cluster-Based Parameter Control for Metaheuristic (Vasileios A. Tatsis, 2025) View paper
  - [25] A Parameter Control Strategy for Parallel Islandâ Based Metaheuristics (Roberto Prado-Rodriguez, 2025) View paper
- Metaheuristic-Optimized Hyperparameter Tuning for Machine Learning
  - Swarm Intelligence for ML Hyperparameter Optimization (3 papers)
  - [6] Heart disease prediction optimization using metaheuristic algorithms (Zaid Nouna, 2025) View paper
  - [14] Adaptive hyperparameter fine-tuning for boosting the robustness and quality of the particle swarm optimization algorithm for non-linear RBF neural network â¦ (Z Ahmad, 2023) View paper
  - [16] Particle Swarm-Optimized U-Net Framework for Precise Multimodal Brain Tumor Segmentation (Shoffan Saifullah, 2025) View paper
  - Evolutionary and Hybrid Metaheuristic Tuning (3 papers)
  - [5] Phishing Website Detection with XGBoost and Adaptive Hyperparameter Optimization using the Bat Algorithm (Santosh Kumar Birthriya, 2025) View paper
  - [26] Feature Importance Guided Random Forest Learning with Simulated Annealing Based Hyperparameter Tuning (Kowshik Balasubramanian, 2025) View paper
  - [31] A Metaheuristic Approach of predicting the Dynamic Modulus in Asphalt Concrete (Ilham Yahya Amir, 2024) View paper
  - Metaheuristic Tuning for Deep Learning Architectures (3 papers)
  - [44] Reforming disease prognosis and treatment prediction for palliative care with hybrid metaheuristic deep neural architectures in IoT healthcare ecosystems (M S Kavitha, 2025) View paper
  - [47] An attention based hybrid deep learning with metaheuristic algorithm for enhanced gesture recognition to aid visually challenged people (HA Mengash, 2025) View paper
  - [50] Integrative Hybrid Metaheuristic Algorithm for Hyperparameter Optimisation in Pre-Trained Convolutional Neural Network Models (I-HAHO) (Nazleeni Samiha Haron, 2025) View paper
- Frameworks and Toolkits for Metaheuristic Development (2 papers)
  - [2] MetaGen: A framework for metaheuristic development and hyperparameter optimization in machine and deep learning (David GutiÃ©rrezâ AvilÃ©s, 2025) View paper
  - [13] Adaptive parameter tuning for agent-based modeling and simulation (R. Tan, 2019) View paper
- Novel Metaheuristic Algorithm Design with Adaptive Mechanisms
  - Bio-Inspired Metaheuristics with Adaptive Components (3 papers)
  - [15] â¦ Identification of Solar Photovoltaic Cell Model Based on an Enhanced Swarm Intelligence Optimization with Adaptive Parameter Tuning and Alternating Strategies (K Hu, 2025) View paper
  - [21] Bio-Inspired Optimization: A hearing-based metaheuristic Algorithm for Global Optimization Problems (Akinsunmade, 2025) View paper
  - [40] Goat Optimization Algorithm: A Novel Bio-Inspired Metaheuristic for Global Optimization (Nozari Hamed, 2025) View paper
  - Physics and Abstract-Inspired Adaptive Metaheuristics (2 papers)
  - [20] Adaptive dimensional search: a new metaheuristic algorithm for discrete truss sizing optimization (OÄuzhan HasanÃ§ebi, 2015) View paper
  - [28] A novel adaptive optimization scheme for advancing metaheuristics and global optimization (Majid Ilchi Ghazaan, 2024) View paper
- Hybrid and Multi-Level Metaheuristic Architectures (3 papers)
  - [38] Adaptive and multilevel metaheuristics (Marc Sevaux, 2008) View paper
  - [39] RAG/LLM Augmented Switching Driven Polymorphic Metaheuristic Framework (Beydoun, 2025) View paper
  - [48] A Hierarchical Method of Parameter Setting for Population-Based Metaheuristic Optimization Algorithms (E. Yu. Seliverstov, 2022) View paper
- Domain-Specific Applications with Adaptive Metaheuristics
  - Energy Systems and Physical Modeling (2 papers)
  - [8] â¦ control-oriented polarization characteristic modeling for proton exchange membrane water electrolyzer with adaptive hunting game based metaheuristic optimization (Y Li, 2024) View paper
  - [9] A novel metaheuristic optimizer based on improved adaptive guided differential evolution algorithm for parameter identification of a PEMFC model (Yida Ge, 2025) View paper
  - Robotics Path Planning and Control (1 papers)
  - [7] Adaptive Particle Swarm and Ant Colony Optimization Path Planning for Autonomous Robot Navigation (A Essaadoui, 2025) View paper
  - Environmental and Geotechnical Prediction (4 papers)
  - [4] Hybrid artificial intelligence models based on adaptive neuro fuzzy inference system and metaheuristic optimization algorithms for prediction of daily rainfall (B. Pháº¡m, 2024) View paper
  - [30] An enhanced adaptive dynamic metaheuristic optimization algorithm for rainfall prediction depends on long short-term memory. (Ahmed M. Elshewey, 2025) View paper
  - [42] Two-Stage Dam Displacement Analysis Framework Based on Improved Isolation Forest and Metaheuristic-Optimized Random Forest (Zhihang Deng, 2025) View paper
  - [46] Research on High-Precision Load Forecasting Model Based on Improved Metaheuristic Algorithms and Multi-Physics Coupling Feature Optimization (Qinglong Ma, 2025) View paper
  - Medical Diagnosis and Healthcare Systems (2 papers)
  - [41] Optimized breast cancer diagnosis using self-adaptive quantum metaheuristic feature selection. (A. Shukla, 2025) View paper
  - [49] Identifying the impact of Metaperceptron in optimizing neural networks: a comparative study of gradient descent and metaheuristic approaches (Darwin Darwin, 2025) View paper
  - Cybersecurity and Intrusion Detection (2 papers)
  - [18] A Convolutional Neural Network with Hyperparameter Tuning for Packet Payload-Based Network Intrusion Detection (Ammar Boulaiche, 2024) View paper

- ◦ [23] Cloud-Cyber Physical Systems: Enhanced Metaheuristics with Hierarchical Deep Learning-based Cyberattack Detection (Ahmad Taher Azar, 2024) View paper
- ◦ Financial Forecasting and Market Prediction (1 papers)
- ◦ [45] Comparative Study of Metaheuristic Optimization Algorithms in Stock Market Prediction (KELVIN, 2024) View paper
- Theoretical Foundations and Comparative Studies (4 papers)
  - ◦ [10] Parameter adaptation in ant colony optimization (Manuel LÃ³pez-IbÃ¡Ã±ez, 2012) View paper
  - ◦ [24] Parameter meta-optimization of metaheuristic optimization algorithms (Christoph NeumÃ¼ller, 2011) View paper
  - ◦ [29] Adaptive Search Algorithms: A Comprehensive Overview and Emerging Optimization Trends (Ibrahim Mahmood, 2025) View paper
  - ◦ [34] Metaheuristic techniques (Sunith Bandaru, 2016) View paper

Narrative

Core task: dynamic hyperparameter configuration for metaheuristic algorithms. The field addresses how to automatically adjust the control parameters of metaheuristic optimization methods during search, rather than fixing them in advance. The taxonomy reveals several major branches: Reinforcement Learning-Based Parameter Adaptation leverages Q-learning and related techniques to learn optimal parameter schedules online, as surveyed in Q-learning Metaheuristics Survey[1]; Fuzzy Logic-Based Parameter Adaptation employs fuzzy inference systems to modulate parameters based on search state indicators; Analytical Adaptive Control Mechanisms derive parameter updates from mathematical models of algorithm behavior; Metaheuristic-Optimized Hyperparameter Tuning for Machine Learning applies metaheuristics to tune hyperparameters of neural networks and other ML models; Frameworks and Toolkits provide reusable software infrastructure such as MetaGen[2]; Novel Metaheuristic Algorithm Design introduces entirely new nature-inspired or bio-inspired algorithms with built-in adaptive mechanisms; Hybrid and Multi-Level Metaheuristic Architectures combine multiple metaheuristics or operate at different abstraction levels; Domain-Specific Applications demonstrate adaptive metaheuristics in areas ranging from energy systems to medical diagnosis; and Theoretical Foundations and Comparative Studies offer rigorous analysis and benchmarking across methods.

Within Reinforcement Learning-Based Parameter Adaptation, a dense cluster of works integrates Q-learning with classic metaheuristics to enable agents to select parameter values or operator choices based on accumulated reward signals. AutoEP[0] sits squarely in this Q-Learning Integration with Metaheuristics subgroup, alongside Adaptive Hyperheuristic[3], which also explores learning-driven parameter control. These approaches contrast with the Fuzzy Logic branch, where parameter adjustments rely on expert-defined membership functions rather than trial-and-error learning, and with Analytical Adaptive Control, which uses closed-form update rules. A key trade-off is between the sample efficiency and interpretability of analytical or fuzzy methods versus the flexibility and potential for discovery offered by reinforcement learning. AutoEP[0] emphasizes automated, data-driven tuning through Q-learning, distinguishing it from Adaptive Hyperheuristic[3] by its specific focus on evolutionary parameter schedules, while both share the goal of reducing manual parameter calibration and improving robustness across diverse problem instances.

Related Works in Same Category

The following **2 sibling papers** share the same taxonomy leaf node with the original paper:

1. Advancements in Qâlearning metaâheuristic optimization algorithms: A survey

Authors: Yang Yang, Yuchao Gao, Zhe Ding, Jinran Wu, Shaotong Zhang, et al. (10 authors total) | **Year/Venue**: 2024 | **URL**: View paper

Abstract

This paper reviews the integration of Qâlearning with metaâheuristic algorithms (QLMA) over the last 20âyears, highlighting its success in solving complex optimization problems. We focus on key aspects of QLMA, including parameter adaptation, operator selection, and balancing global exploration with local exploitation. QLMA has become a leading solution in industries like energy, power systems, and engineering, addressing a range of mathematical challenges. Looking forward, we suggest furt...

Relationship Analysis

Both papers belong to the Q-Learning Integration with Metaheuristics category, focusing on using reinforcement learning for dynamic algorithm control. The candidate paper is a comprehensive survey reviewing 20 years of Q-learning integration with metaheuristics, covering parameter adaptation, operator selection, and exploration-exploitation balance across various applications. In contrast, the original paper (AutoEP) proposes a novel LLM-driven framework that uses Large Language Models with Exploratory Landscape Analysis for zero-shot hyperparameter evolution, representing a fundamentally different technical approach that bypasses traditional Q-learning training entirely.

2. Adaptive hyperheuristic framework for hyperparameter tuning: A Q-learning-based heuristic selection approach with simulated annealing acceptance criteria

Authors: Kassem M. Danach, Kassem Danach, Wael Hosny Fouad Aly | **Year/Venue**: 2025 | **URL**: View paper

Abstract

Hyperparameter tuning is a crucial step in optimizing machine learning models, directly impacting their performance and generalization capabilities. Traditional approaches, such as grid search, random search, and Bayesian optimization, often suffer from inefficiencies, especially in high-dimensional hyperparameter spaces. To address these challenges, this paper proposes an adaptive hyperheuristic framework for hyperparameter tuning, integrating Q-learning-based heuristic selection and simulated ...

Relationship Analysis

Both papers belong to the Q-Learning Integration with Metaheuristics category, focusing on reinforcement learning-based dynamic hyperparameter control. The candidate paper proposes a hyperheuristic framework (AHPQA) that uses Q-learning to select among low-level heuristics (constructive, improvement, perturbation) combined with simulated annealing acceptance criteria for machine learning hyperparameter tuning, while the original paper (AutoEP) leverages LLMs as zero-shot reasoning engines guided by real-time ELA features to dynamically adjust metaheuristic hyperparameters for combinatorial optimization. The key difference is that AutoEP uses LLM-driven semantic reasoning grounded in search trajectory analysis without training, whereas AHPQA employs traditional Q-learning with iterative reward-based learning to select heuristic operators for hyperparameter optimization.

Contributions Analysis

Overall novelty summary. The paper introduces AutoEP, a zero-shot LLM-driven framework for dynamic hyperparameter control in metaheuristic algorithms. It resides in the 'Q-Learning Integration with Metaheuristics' leaf, which contains only three papers total, indicating a relatively sparse research direction within the broader Reinforcement Learning-Based Parameter Adaptation branch. This leaf focuses on Q-learning approaches for operator selection and parameter tuning, contrasting with the six papers in the sibling 'Deep Reinforcement Learning for Hyperparameter Tuning' leaf that employ more complex neural architectures.

The taxonomy reveals that AutoEP's parent branch, Reinforcement Learning-Based Parameter Adaptation, sits alongside Fuzzy Logic-Based Parameter Adaptation (six papers across two leaves) and Analytical Adaptive Control Mechanisms (six papers across two leaves). These neighboring branches represent alternative paradigms: fuzzy systems use expert-defined rules, while analytical methods employ mathematical feedback models. AutoEP diverges by leveraging LLMs as reasoning engines rather than traditional RL training loops, positioning it at the intersection of learning-based adaptation and symbolic reasoning. The taxonomy also shows substantial activity in Metaheuristic-Optimized Hyperparameter Tuning for Machine Learning (nine papers across three leaves), which addresses ML model tuning rather than metaheuristic self-configuration.

Among 30 candidates examined through semantic search, none clearly refute any of AutoEP's three core contributions. The first contribution (zero-shot LLM framework) examined 10 candidates with no refutations; the second (grounding LLM reasoning with real-time Exploratory Landscape Analysis) examined 10 with no refutations; and the third (multi-LLM chain of reasoning) examined 10 with no refutations. This suggests that within the limited search scope, the combination of LLM-driven control, online landscape analysis feedback, and multi-model reasoning chains appears relatively unexplored. However, the search examined only top-30 semantic matches, not the full literature, and the taxonomy shows the Q-learning leaf itself is sparsely populated.

Based on the limited 30-candidate search and the sparse three-paper leaf containing AutoEP, the work appears to occupy a relatively novel position. The taxonomy structure indicates that while RL-based parameter adaptation is an established direction, the specific integration of LLMs for zero-shot reasoning represents a departure from traditional Q-learning or deep RL training paradigms. The analysis cannot assess whether broader literature beyond the top-30 semantic matches contains overlapping work, particularly in emerging LLM-for-optimization research.

This paper presents **3 main contributions**, each analyzed against relevant prior work:

Contribution 1: Zero-shot LLM-driven framework for hyperparameter control

Description: The authors introduce AutoEP, a framework that uses Large Language Models as zero-shot reasoning engines to automatically configure metaheuristic algorithm hyperparameters without requiring any training phase. This approach is designed to be applicable to any metaheuristic algorithm as a plug-and-play module.

This contribution was assessed against **10 related papers** from the literature. Papers with potential prior art are analyzed in detail with textual evidence; others receive brief assessments.

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1. Llamea: Automatically generating metaheuristics with large language models

URL: View paper

Brief Assessment

Llamea[66] focuses on using LLMs to generate entire metaheuristic algorithms from scratch through iterative refinement, not on zero-shot hyperparameter control during algorithm execution. The candidate's approach involves generating and evolving complete algorithm code, which is fundamentally different from AutoEP's runtime hyperparameter adjustment framework.

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2. Large Language Model Agent for Hyper-Parameter Optimization

URL: View paper

Brief Assessment

LLM Agent Optimization[67] focuses on hyperparameter optimization for machine learning models (e.g., neural networks), not metaheuristic algorithms. The candidate does not address dynamic control of metaheuristic algorithm hyperparameters during optimization runs, which is the core novelty of AutoEP.

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3. Open and Closed Source Models for LLM-Generated Metaheuristics Solving Engineering Optimization Problem

URL: View paper

Brief Assessment

LLM-Generated Metaheuristics[68] focuses on using LLMs to generate metaheuristic algorithms themselves, not on zero-shot hyperparameter control frameworks. The candidate's limited context mentions hyperparameter optimization in prompts but does not demonstrate a comparable zero-shot framework architecture.

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4. In-the-loop hyper-parameter optimization for llm-based automated design of heuristics

URL: View paper

Brief Assessment

In-the-loop Optimization[64] focuses on integrating HPO procedures with LLM-based heuristic generation (LLaMEA framework), where the LLM generates algorithmic structures while HPO handles parameter tuning. This differs from the original paper's zero-shot reasoning approach where LLMs directly control hyperparameters without training, using ELA features and multi-LLM chains for real-time adaptation.

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5. A Critical Examination of Large Language Model Capabilities in Iteratively Refining Differential Evolution Algorithm

URL: View paper

Brief Assessment

LLMs Differential Evolution[70] focuses on iterative prompting to enhance Differential Evolution algorithm performance, not on zero-shot hyperparameter control frameworks. The candidate requires repetitive prompting and does not claim a training-free, plug-and-play approach applicable to any metaheuristic.

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6. LLM Agent for Hyper-Parameter Optimization

URL: View paper

Brief Assessment

LLM Hyper-Parameter Agent[63] focuses on hyper-parameter tuning for WS-PSO-CM algorithm in UAV trajectory optimization, not a general zero-shot framework for metaheuristic algorithms. The candidate requires iterative exploration with algorithm execution feedback, whereas AutoEP emphasizes training-free, plug-and-play applicability across diverse metaheuristics.

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7. LLM-Assisted Non-Dominated Sorting Genetic Algorithm for Solving Distributed Heterogeneous No-Wait Permutation Flowshop Scheduling

URL: View paper

Brief Assessment

LLM-Assisted NSGA[65] uses LLMs to orchestrate genetic algorithm operators (selection, crossover, mutation) for a specific scheduling problem, not for general hyperparameter control across metaheuristic algorithms. The candidate focuses on operator selection rather than hyperparameter tuning.

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8. Metaheuristics and large language models join forces: Towards an integrated optimization approach

URL: View paper

Brief Assessment

Metaheuristics LLMs Integration[69] discusses incorporating LLM outputs into metaheuristics but does not present a complete zero-shot framework with real-time feedback mechanisms like ELA features and multi-LLM reasoning chains for dynamic hyperparameter control.

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9. Large language models as evolutionary optimizers

URL: View paper

Brief Assessment

LLMs Evolutionary Optimizers[61] focuses on using LLMs to directly generate solutions and perform crossover/mutation operations for combinatorial optimization (TSPs), not on hyperparameter control for metaheuristic algorithms. The candidate addresses solution generation while the original addresses algorithm configuration.

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10. An investigation on the use of Large Language Models for hyperparameter tuning in Evolutionary Algorithms

URL: View paper

Brief Assessment

LLMs Hyperparameter Tuning[62] focuses on online hyperparameter recommendations for (1+1)-ES step-size adaptation using LLMs to analyze optimization logs, but does not present a zero-shot framework with the architectural components (ELA features, multi-LLM chain of reasoning, experience pool) that characterize AutoEP's approach.

Contribution 2: Grounding LLM reasoning with real-time Exploratory Landscape Analysis

Description: The framework incorporates an online Exploratory Landscape Analysis module that continuously provides quantitative metrics about the optimization state to the LLM. This grounding mechanism anchors the model's abstract reasoning in observable search dynamics, reducing hallucination and enabling data-driven hyperparameter decisions.

This contribution was assessed against **10 related papers** from the literature. Papers with potential prior art are analyzed in detail with textual evidence; others receive brief assessments.

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1. Mathematical programming through the lens of LLMs: systematic evidence and empirical gaps

URL: View paper

Brief Assessment

Mathematical Programming LLMs[57] focuses on LLMs for mathematical programming formulation and symbolic optimization model generation, not on grounding LLM reasoning with real-time exploratory landscape analysis for dynamic hyperparameter control in metaheuristic algorithms.

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2. LLaMA-Berry: Pairwise Optimization for O1-like Olympiad-Level Mathematical Reasoning

URL: View paper

Brief Assessment

LLaMA-Berry[56] focuses on mathematical problem-solving using MCTS and pairwise reward models, not on grounding LLM reasoning with real-time exploratory landscape analysis for optimization algorithms.

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3. OPT-BENCH: Evaluating LLM Agent on Large-Scale Search Spaces Optimization Problems

URL: View paper

Brief Assessment

OPT-BENCH[51] focuses on evaluating LLM agents on optimization problems through iterative solution refinement with historical feedback, but does not incorporate real-time Exploratory Landscape Analysis (ELA) features to ground LLM reasoning in observable search dynamics as the original paper does.

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4. Combinatorial reasoning: selecting reasons in generative AI pipelines via combinatorial optimization

URL: View paper

Brief Assessment

Combinatorial Reasoning[53] focuses on selecting reasons via combinatorial optimization for NLP reasoning tasks, not on grounding LLM reasoning with real-time exploratory landscape analysis for metaheuristic algorithm control in optimization problems.

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5. Towards AI Search Paradigm

URL: View paper

Brief Assessment

AI Search Paradigm[54] focuses on web search systems with multi-agent architectures for query processing and information retrieval, not on grounding LLM reasoning with real-time exploratory landscape analysis for optimization problems.

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6. RRO: LLM Agent Optimization Through Rising Reward Trajectories

URL: View paper

Brief Assessment

RRO[59] focuses on process reward models for multi-step agent tasks in web navigation and SQL generation, not on grounding LLM reasoning with real-time exploratory landscape analysis for optimization problems.

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7. LLM-First Search: Self-Guided Exploration of the Solution Space

URL: View paper

Brief Assessment

LLM-First Search[52] focuses on self-guided exploration in search algorithms for reasoning tasks (Countdown, Sudoku), not on grounding LLM reasoning with real-time exploratory landscape analysis for metaheuristic optimization. The candidate addresses search tree navigation, while the original addresses hyperparameter tuning via quantitative optimization metrics.

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8. From trial-and-error to improvement: A systematic analysis of llm exploration mechanisms in rlvr

URL: View paper

Brief Assessment

RLVR Exploration[60] focuses on exploration mechanisms in reinforcement learning with verifiable rewards for reasoning tasks, not on hyperparameter optimization for metaheuristic algorithms. The candidate does not address ELA-based grounding for algorithm control.

9. A survey on mathematical reasoning and optimization with large language models

URL: View paper

Brief Assessment

Mathematical Reasoning Survey[55] is a broad survey covering mathematical reasoning and optimization with LLMs across diverse domains (theorem proving, arithmetic, control systems). It does not specifically address real-time ELA integration for metaheuristic hyperparameter control, which is the original paper's core contribution.

10. Iterative self-incentivization empowers large language models as agentic searchers

URL: View paper

Brief Assessment

Agentic Searchers[58] focuses on information retrieval and question answering tasks, where the LLM interacts with document retrievers. The original paper addresses metaheuristic optimization with quantitative ELA features (skewness, kurtosis, R^2, diversity metrics) for hyperparameter control. These are fundamentally different application domains and technical approaches.

Contribution 3: Multi-LLM Chain of Reasoning for complex control tasks

Description: The authors develop a Chain of Reasoning architecture that decomposes the hyperparameter control task into specialized reasoning steps handled by multiple collaborating LLMs. This design enables open-source models to achieve performance comparable to large proprietary models while maintaining lower inference latency.

This contribution was assessed against **10 related papers** from the literature. Papers with potential prior art are analyzed in detail with textual evidence; others receive brief assessments.

1. ReSo: A Reward-driven Self-organizing LLM-based Multi-Agent System for Reasoning Tasks

URL: View paper

Brief Assessment

ReSo[79] focuses on multi-agent systems for mathematical reasoning and scientific problem-solving tasks, not on hyperparameter control or optimization algorithms. The candidate addresses collaborative reasoning among agents for solving math/science problems, while the original paper addresses dynamic algorithm control through a chain of reasoning for metaheuristic optimization.

2. LLM-Agent-Controller: A Universal Multi-Agent Large Language Model System as a Control Engineer

URL: View paper

Brief Assessment

LLM-Agent-Controller[75] focuses on control engineering tasks (controller design, stability analysis) using a multi-agent architecture with specialized agents (supervisor, planner, controller, critic, etc.). The original paper addresses hyperparameter optimization for metaheuristic algorithms using a Chain of Reasoning with multiple LLMs (strategist, analyst, actuator) grounded in exploratory landscape analysis. These are fundamentally different application domains and technical approaches.

3. Agentic LLMs in the supply chain: towards autonomous multi-agent consensus-seeking

URL: View paper

Brief Assessment

Supply Chain Agents[76] focuses on multi-agent consensus-seeking in supply chain management (inventory levels, delivery coordination), not on hyperparameter control or optimization tasks. The architectural approaches and problem domains are fundamentally different.

4. Toward Evolutionary Intelligence: LLM-based Agentic Systems with Multi-Agent Reinforcement Learning

URL: View paper

Brief Assessment

Evolutionary Intelligence[74] focuses on multi-agent reinforcement learning systems for evolutionary intelligence, not on hyperparameter control through chain-of-reasoning architectures. The available context is too limited to establish any meaningful technical overlap with the original paper's specialized CoR framework for metaheuristic optimization.

5. A Trustworthy Multi-LLM Network: Challenges, Solutions, and A Use Case

URL: View paper

Brief Assessment

Trustworthy Multi-LLM[73] focuses on blockchain-enabled collaboration among multiple LLMs for network optimization (e.g., power allocation in wireless systems), not on hyperparameter control for metaheuristic algorithms. The architectural goals and application domains are fundamentally different.

6. Know the Ropes: A Heuristic Strategy for LLM-based Multi-Agent System Design

URL: View paper

Brief Assessment

Know the Ropes[80] focuses on decomposing optimization problems into specialized agent tasks using algorithmic blueprints (knapsack, task assignment), not on hyperparameter control for metaheuristic algorithms. The candidate's multi-agent design follows classical algorithms (Hungarian, dynamic programming) rather than adaptive reasoning chains for real-time control decisions.

7. Seven Security Challenges That Must be Solved in Cross-domain Multi-agent LLM Systems

URL: View paper

Brief Assessment

Cross-domain Security[78] addresses security challenges in multi-agent LLM systems across organizational boundaries, not optimization control tasks. The candidate focuses on trust, alignment, and containment in collaborative agents, while the original develops a reasoning architecture for hyperparameter tuning in metaheuristic algorithms.

8. Optima: Optimizing effectiveness and efficiency for llm-based multi-agent system

URL: View paper

Brief Assessment

Optima[72] focuses on optimizing multi-agent communication efficiency through iterative training, not on decomposing hyperparameter control tasks into specialized reasoning steps handled by multiple collaborating LLMs as in the original paper.

9. Layered Chain-of-Thought Prompting: Advancing Explainability in Multi-Agent LLM Systems

URL: View paper

Brief Assessment

Layered Chain-of-Thought[77] focuses on explainability in multi-agent LLM systems for general problem-solving, not specifically on hyperparameter control or optimization tasks. The provided context is too limited to establish prior work in the specific domain of multi-LLM reasoning chains for metaheuristic algorithm control.

10. Multi-agent collaboration mechanisms: A survey of llms

URL: View paper

Brief Assessment

Multi-Agent Collaboration Survey[71] is a survey paper that reviews existing multi-agent collaboration mechanisms broadly. It does not present a specific technical framework for hyperparameter control or optimization tasks, and therefore cannot refute the novelty of AutoEP's Chain of Reasoning architecture for metaheuristic algorithm control.

Appendix: Text Similarity Detection

No high-similarity text segments were detected across any compared papers.

References

- [0] AutoEP: LLMs-Driven Automation of Hyperparameter Evolution for Metaheuristic Algorithms View paper
- [1] Advancements in Qâ□□learning metaâ□□heuristic optimization algorithms: A survey View paper
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