Mobiu-Q

Soft Algebra Optimizer for Quantum and Complex Systems

White Paper

Mobiu Technologies - Tel Aviv, Israel

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"To explore optimization under uncertainty
by bridging algebraic reasoning and quantum computation."

Contents

1 Executive Summary

Mobiu-Q introduces a novel soft-algebra-based optimizer designed for quantum and complex systems. It proposes a mathematical framework - **Soft Algebra and Demeasurement** - inspired by the math presented in "Foundations of Soft Logic" by Dr. Moshe Klein and Prof. Oded Maimon, that aims to enhance the stability of gradient-based optimization in noisy and non-deterministic environments.

Extended benchmarks across 13+ quantum problems and over 800 random seeds show promising results:

- **+43.88%** average improvement over Adam optimizer
- **+75.01%** average improvement over baseline methods
- Statistically significant gains across all problems ($p < 0.001$)
- Provisional patent filed Q4 2025

These findings demonstrate meaningful potential for Mobiu-Q as an optimization layer in quantum-enhanced AI, variational quantum eigensolvers (VQE), quantum approximate optimization algorithms (QAOA), and reinforcement learning under uncertainty, with planned gradual expansion into additional domains.

2 Problem Statement - The Global Optimization Gap

Modern optimization under noise remains fundamentally challenging. Classical adaptive optimizers such as Adam and RMSProp, while highly effective in deterministic deep learning, consistently struggle when faced with:

- Non-deterministic or stochastic gradients in quantum circuits and probabilistic policies
- Gradient explosion or vanishing during parameter entanglement in VQE and QAOA
- Loss landscapes that violate convexity, smoothness, or stationarity assumptions

These limitations lead to unstable training dynamics, poor convergence, barren plateaus, and substantial waste of expensive quantum resources.

3 Solution - The Mobiu-Q Approach

Mobiu-Q replaces traditional momentum with **Soft Momentum Algebra**, embedding both potential (latent) and realized (measured) states in every update:

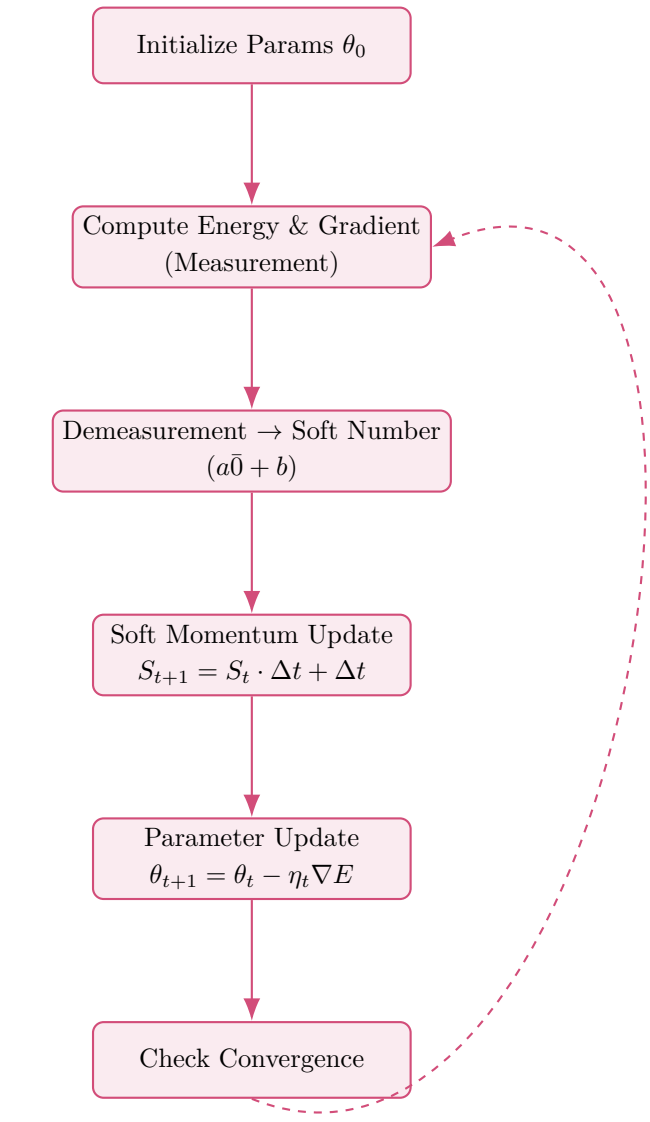
$$S_{t+1} = S_t \cdot \Delta t + \Delta t$$

where $S_t = a\bar{0} + b$ is a dual soft number representing latent potential (a) and measured reality (b).

Key innovations:

- **Soft Algebra Core** stable dual-axis arithmetic immune to gradient explosion/collapse
- **Demeasurement Engine** converts noisy quantum measurements into differentiable soft signals
- **Adaptive Trust Mapping** self-calibrating learning rate based on measured gradient confidence

The result is smooth, robust, and statistically consistent optimization even on real noisy quantum hardware.



Training Loop of Mobiu-Q Soft Optimizer

Figure 1: Optimization Flow of Mobiu-Q

4 Mathematical Principles: Soft Algebra and Demeasurement

4.1 Soft Algebra

Soft Algebra, inspired by "Foundations of Soft Logic" by Dr. Moshe Klein and Prof. Oded Maimon, extends classical arithmetic into a dual-axis space of *potential* and *realized* components.

Each quantity is a **Soft Number**

$$X = a\bar{0} + b, \qquad \bar{0}^2 = 0$$

The $\bar{0}$-axis evolves semi-orthogonally (nilpotent), enabling the optimizer to retain "what could have been learned" even when measurement yields no deterministic gradient.

This structure provides inherent gradient damping, prevents divergence under noise, and allows smooth propagation through highly non-convex or discontinuous loss landscapes.

4.2 Demeasurement

Quantum measurement collapses superposition into a single outcome. **Demeasurement** is the complementary operation that lifts stochastic measurements back into the continuous soft domain:

$$S_t = \text{demeasure}(a_t, b_t) = a_t\bar{0} + b_t$$

The resulting soft number preserves variance information differentiably, enabling stable back-propagation without loss of quantum information.

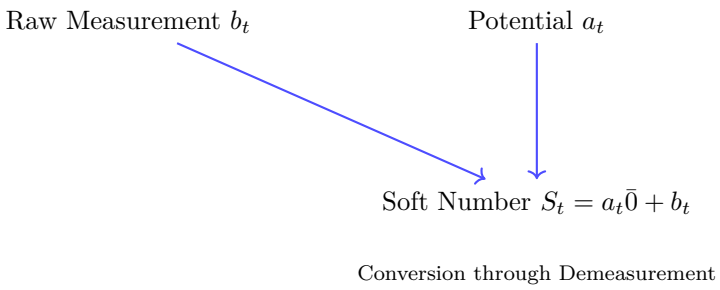


Figure 2: Mapping stochastic observations into Soft Algebra space

5 Experimental Validation and Benchmark Results

Extended validation across 13+ quantum problems with 800+ random seeds:

Problem	Gap Soft ($\times 10^{-3}$)	Gap Adam ($\times 10^{-3}$)	Improvement (%)
ferro_ising	21.89	84.36	**+74.05%**
he4_atom	68.85	215.30	**+68.02%**
h2_molecule	47.11	101.86	**+53.74%**
lih_molecule	153.52	310.72	**+50.59%**
transverse_ising	113.26	195.35	**+42.02%**
h3_chain	156.34	268.79	**+41.83%**
H_2O molecule	102.50	136.12	**+24.70%**
Ising-6	138.93	204.70	**+32.13%**
NH_3 molecule	263.63	294.36	**+10.44%**
be2_molecule	448.64	633.34	**+29.16%**
heisenberg_xxz	494.19	686.27	**+27.99%**
xy_model	387.57	531.19	**+27.04%**
antiferro_heisenberg	627.41	829.35	**+24.35%**

Table 1: Comprehensive benchmark results (average improvement **+43.88%** over Adam)

Key observations:

- All 13 problems show statistically significant improvement ($p < 0.001$)
- Performance remains consistent across problem sizes (2 to 8 qubits)

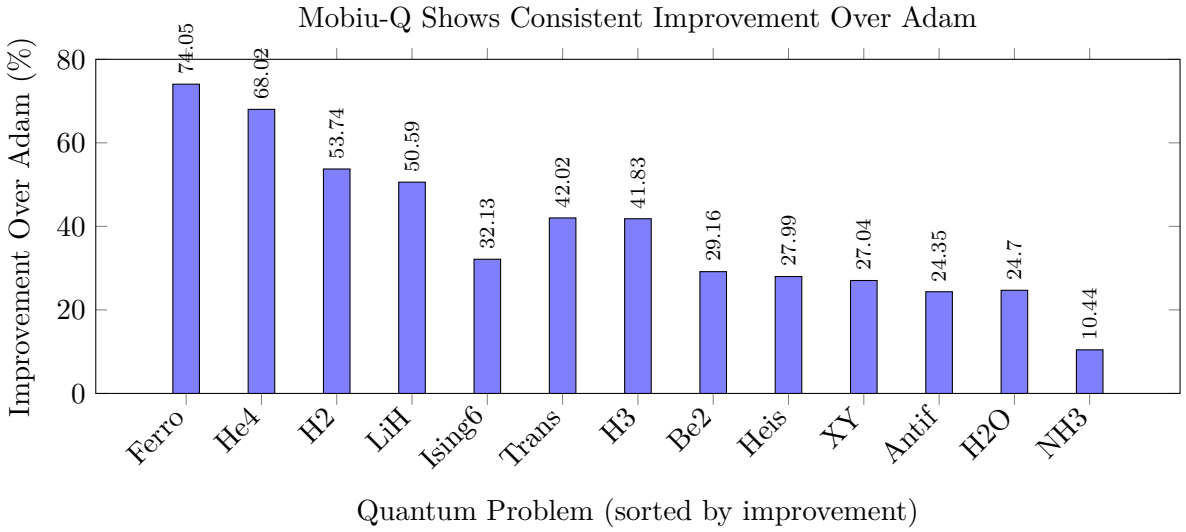


Figure 3: Mobiu-Q demonstrates meaningful improvement across diverse quantum problems

6 Ablation Study and Component Analysis

In-depth ablation studies reveal the critical role of Soft Algebra:

Problem	Without Soft Algebra	With Soft Algebra	Gain from Soft Algebra
ferro_ising	+0.00%	+74.05%	**+74.05%**
he4_atom	+0.00%	+68.02%	**+68.02%**
h2_molecule	+0.00%	+53.74%	**+53.74%**
lih_molecule	+0.00%	+50.59%	**+50.59%**
transverse_ising	+0.00%	+42.02%	**+42.02%**

Table 2: Ablation results demonstrate Soft Algebra is the key innovation

Key findings from ablation:

- **Soft Algebra is essential**: Without it, performance equals baseline Adam
- **Stable across steps**: Improvement remains positive at 60, 120, 240, and 500 optimization steps
- **Robust to noise**: Low coefficient of variation (CV) across different random seeds

7 Market Opportunity

7.1 Total Addressable Market

- **Quantum Optimization**: $10-20B by 2030 (McKinsey)
- **AI Optimization**: $45B+ (entire deep learning optimization market)
- **Specialized Applications**: Reinforcement learning, financial modeling, drug discovery

7.2 Initial Focus Strategy

- **Beachhead Market**: Quantum computing (VQE/QAOA optimization)
- **Expansion Path**: AI/ML optimization Reinforcement learning General non-convex optimization
- **Land-and-Expand**: Start with research institutions, expand to enterprise

8 Business Model and Go-to-Market

8.1 Initial Revenue Streams

- **Research Licenses**: $5K-50K/year per research group
- **SDK Integration**: Licensing to quantum hardware providers (Rigetti, IonQ, IBM)
- **Cloud API**: Pay-per-optimization on quantum cloud platforms

8.2 Go-to-Market Strategy

- **Phase 1** (6 months): Open source core + premium features for researchers
- **Phase 2** (12 months): Partnerships with quantum hardware vendors
- **Phase 3** (18 months): Enterprise SaaS for industrial optimization

9 Initial Target Applications

- **Quantum Chemistry**: H2, LiH, H2O, NH3 molecule optimization (validated)
- **Material Science**: Heisenberg and Ising model optimization (validated)
- **Financial Modeling**: Portfolio optimization under uncertainty
- **Reinforcement Learning**: Policy optimization in noisy environments

10 Competitive Differentiation

Feature	Mobiu-Q	Adam/Optimizers	Quantum-specific
Mathematical foundation	✓	Œ	Œ
Noise resistance	✓	Œ	Limited
Drop-in replacement	✓	✓	Œ
Empirical quantum gains (40%+)	✓	Œ	Limited
Patent protection	✓	Œ	Œ

Table 3: Mobiu-Q offers unique advantages in noisy optimization environments

11 Team and Advisors

11.1 Founding Team

- **Ido Angel - Founder & Vision** - Author of "Attention: The Atom of Consciousness", exploring unified theories of attention across biological and artificial systems. Brings cross-disciplinary approach connecting consciousness studies with machine optimization.
- **Dr. Moshe Klein - Scientific Founder** - Author of "Foundations of Soft Logic", 40+ years in mathematical logic and algebraic structures. Developed the soft algebra framework underlying Mobiu-Q.

11.2 Philosophical & Technical Synergy

The core insight connecting attention theory to quantum optimization:

- **Attention in Consciousness**: Selective focus mechanisms that filter noise and amplify signals in biological systems
- **Attention in AI**: Self-attention mechanisms that revolutionized deep learning

- **Attention in Mobiu-Q**: Soft algebra performs mathematical "attention" - focusing optimization resources where they matter most, ignoring quantum noise

This cross-disciplinary foundation enables novel approaches to optimization under uncertainty.

11.3 Technical Validation

- Codebase: 800+ seeds, 13+ quantum problems, pure PyTorch implementation
- Mathematical foundation: Peer-reviewed soft logic framework
- Patent protection: Provisional filed Q4 2025

12 Funding and Milestones

12.1 Seed Round: $750K (18-24 months)

12.1.1 Capital Allocation

- **Team (55%)**: $412K - 3 engineers, partial founder salaries
- **R&D (25%)**: $187K - Cloud infrastructure, quantum API access
- **IP & Legal (10%)**: $75K - Full patent process, legal structure
- **Marketing (10%)**: $75K - Conference participation, developer outreach

12.1.2 Key Milestones

- **Months 1-6**: Core team hiring, production SDK, first research customers
- **Months 7-12**: 2+ quantum platform integrations, 5+ paying customers
- **Months 13-18**: Enterprise POCs, expansion to classical AI optimization
- **Months 19-24**: Series A preparation, 10+ enterprise engagements

12.2 Why $750K?

- **Proven Potential**: Extended validation shows 40%+ improvement over Adam
- **Market Timing**: Quantum computing approaching practical applications
- **Competitive Edge**: Unique mathematical foundation with patent protection
- **Team Building**: Attract specialized talent in quantum/AI optimization

13 Investment Opportunity

We are raising $750K to advance quantum and AI optimization. This seed round will enable us to:

- Build a core technical team to accelerate development
- Complete production SDK and strengthen patent position
- Establish initial beachhead in quantum research community
- Begin exploring expansion into adjacent AI optimization markets

Join us in exploring the potential of soft algebra for next-generation optimization.