Microsoft

MarS : A Financial Market Simulation Engine Powered by Generative Foundation Model

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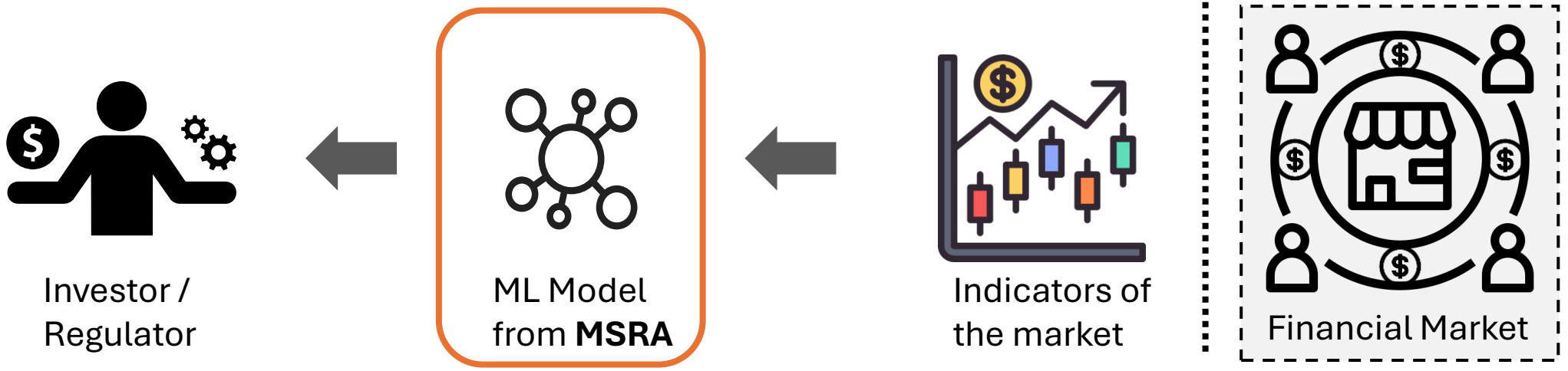
Microsoft Research Asia

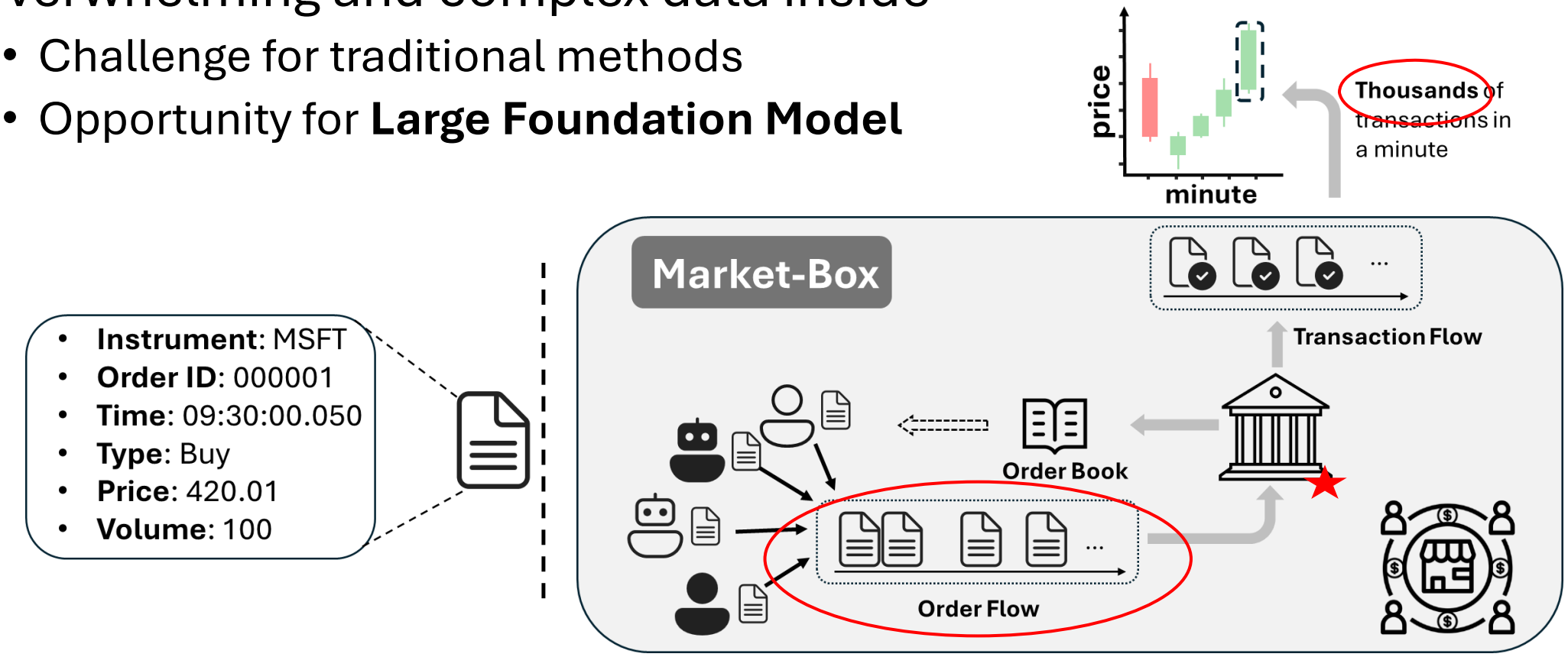
Industry Engagement and Main Job

- 8 years of deep collaboration with financial industry partners.
- Research topics from real tasks
- **Building ML models on market indicators, but rarely go inside.**



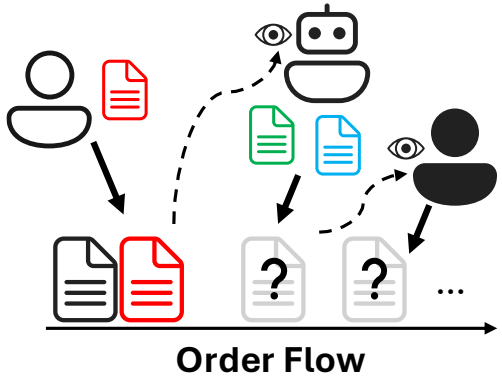
The Challenge & Opportunity of Going Inside

- Overwhelming and complex data inside
  - Challenge for traditional methods
  - Opportunity for **Large Foundation Model**



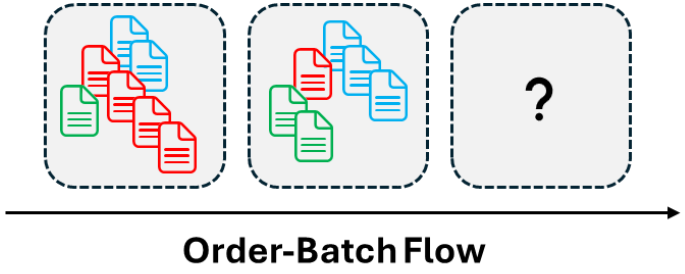
Key Info in Order Flow and Its Tokenization

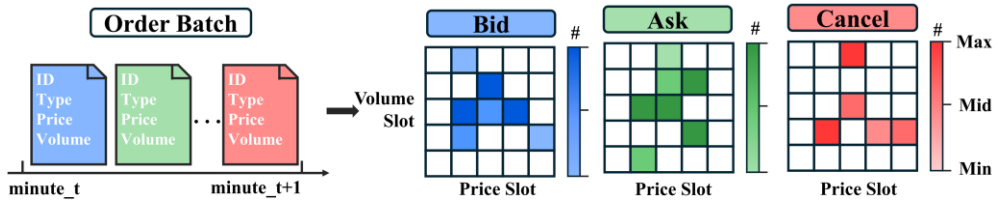
- **Individual Perspective in Microscopic**



Tokenization of a **Single Order**

- **Market Perspective in Macroscopic**





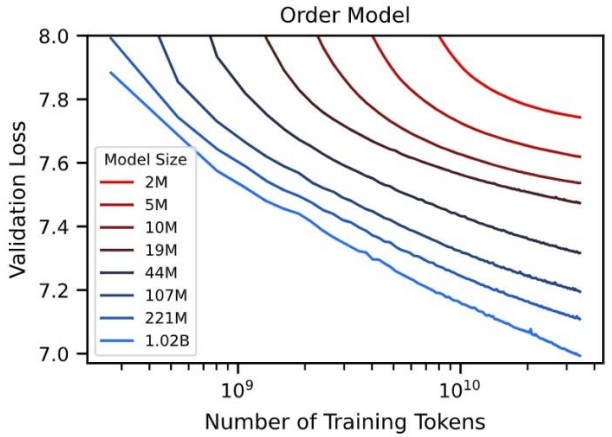
Tokenization of an **Order-Batch**

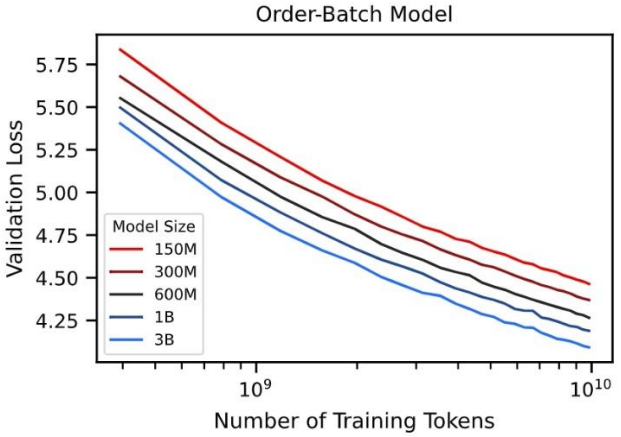
Large Market Model (LMM) and the Scaling Law

- **Transformer-based Auto-regressive Training on Two-Kinds of Token Series**

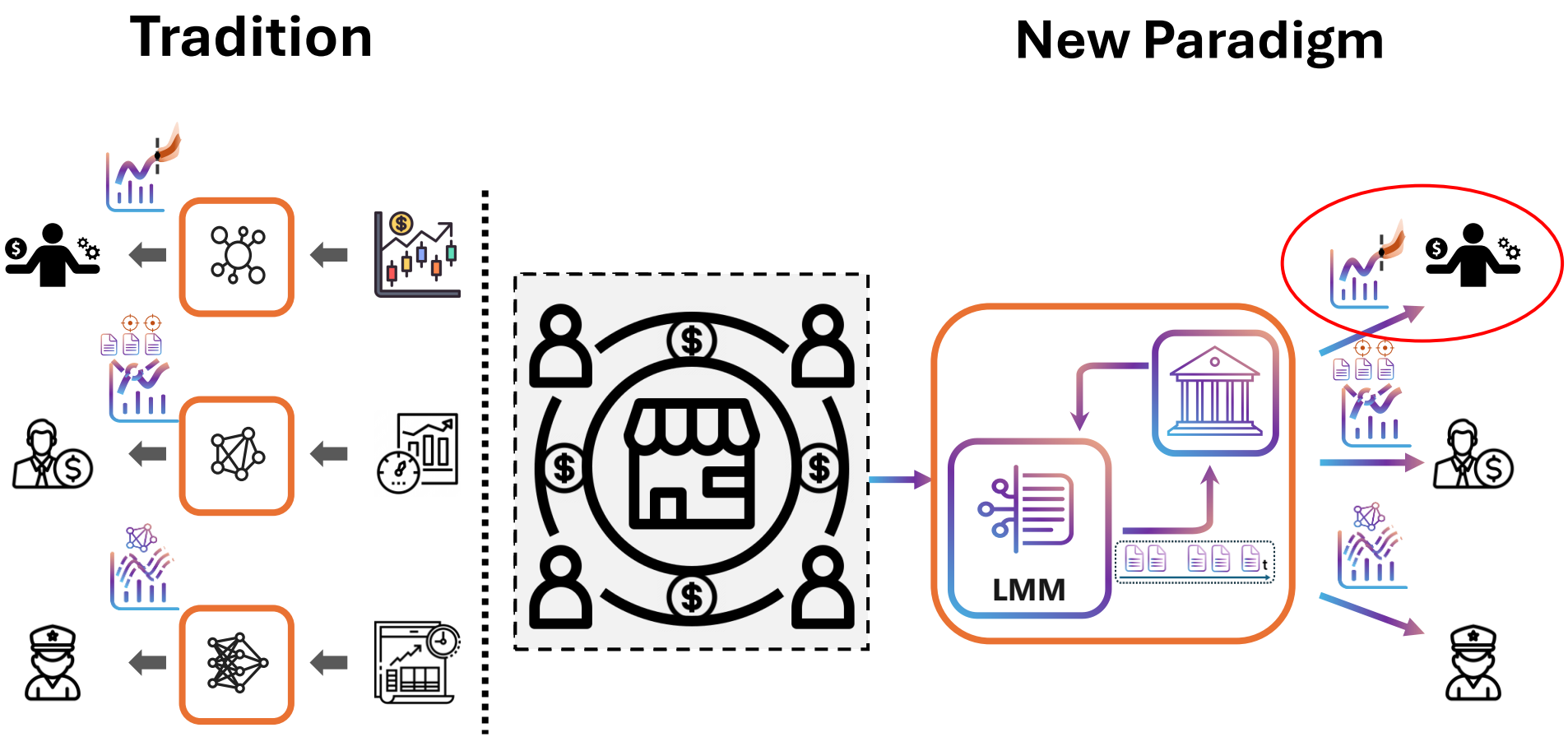
Order Model
Individual Perspective in Microscopic

Order-batch Model
Market Perspective in Macroscopic





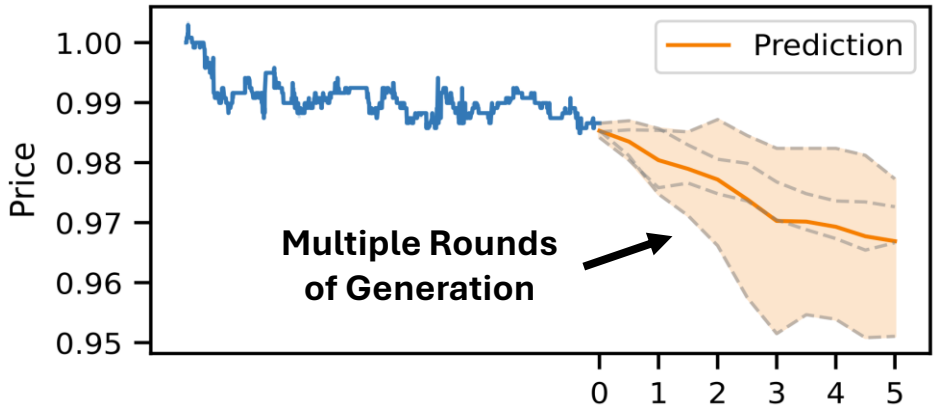
New Paradigm with LMM

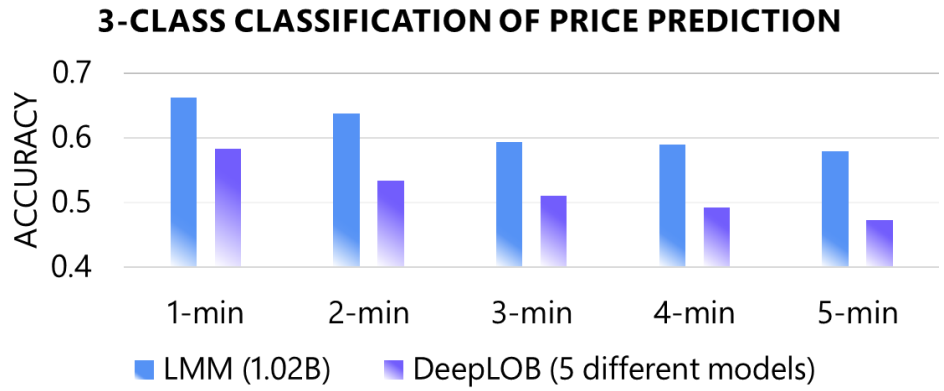


New Paradigm for Financial Market Predictions

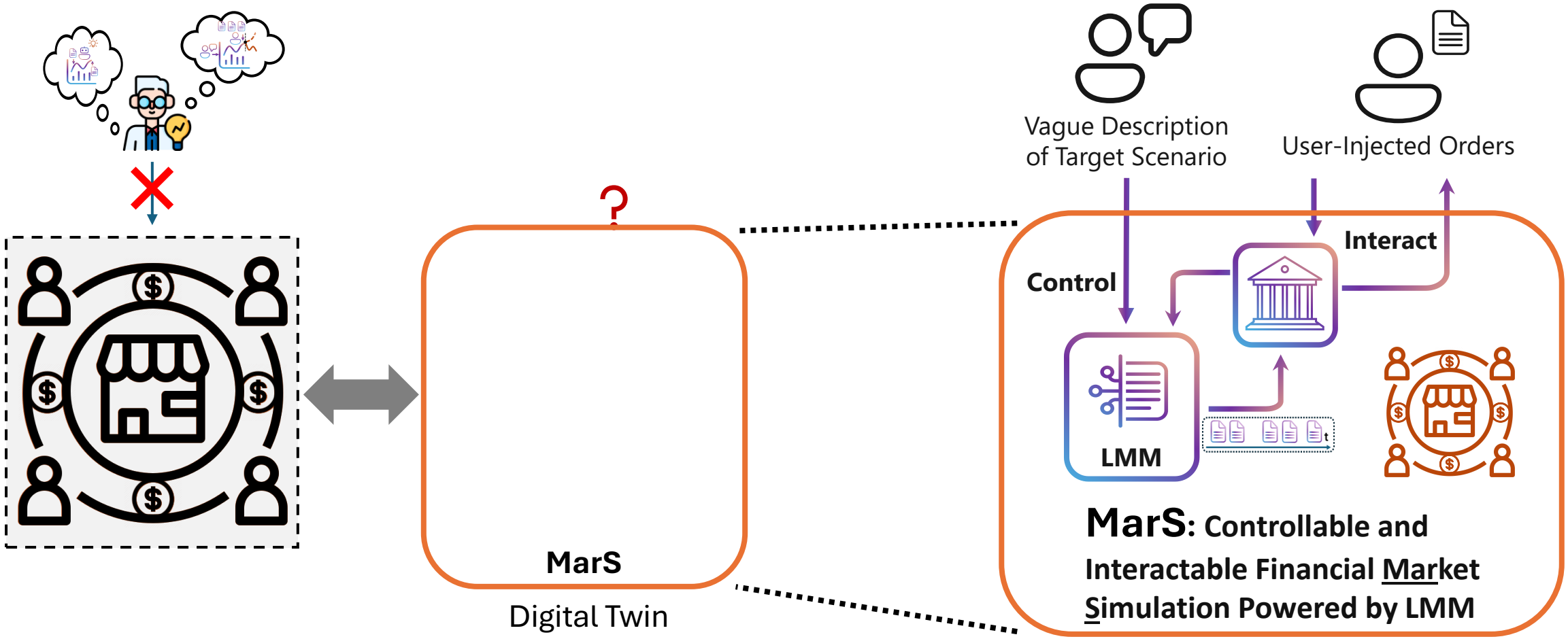
– Estimate future market indicators

- **Traditional Methods**
  - Need redesign for new targets.
- **New Approach**
  - Uses recent real data as input in LMM.
  - Generates future order flows and corresponding market trajectories.
  - Derives **any** indicator's **point / distributional** forecasting across **diverse horizons** from multiple future market trajectories.
- **Enhanced Performance**
  - Outperforms traditional algorithms in predictions.
  - Evidence of LMM's powerful modelling capabilities.

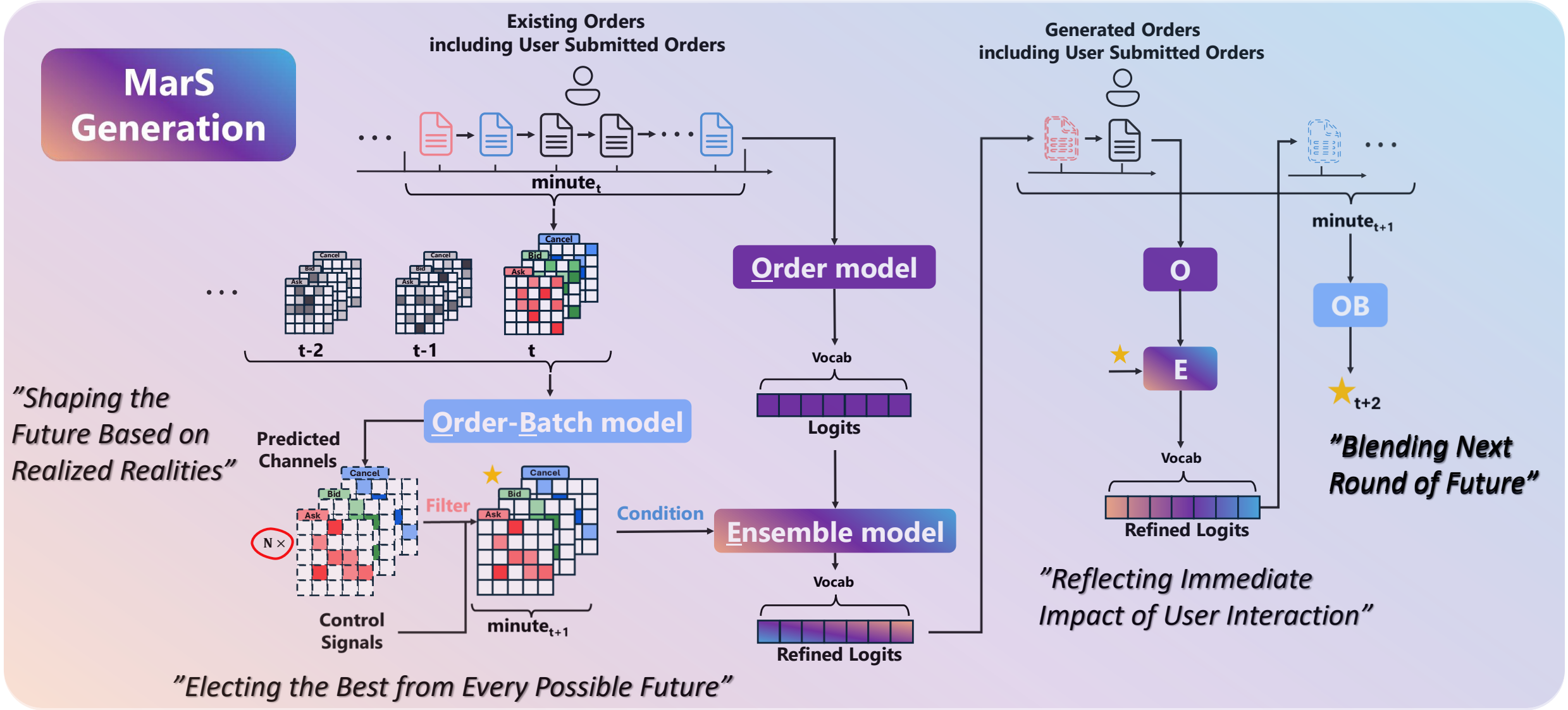




New Ways with MarS



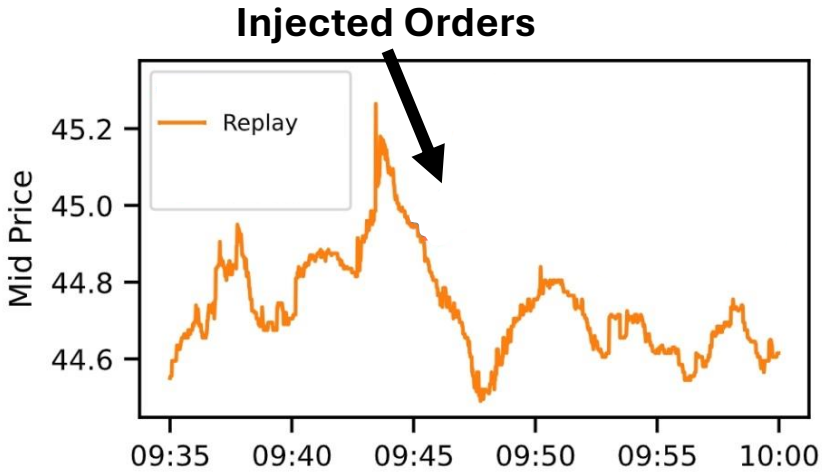
The Process of Order Flow Generation



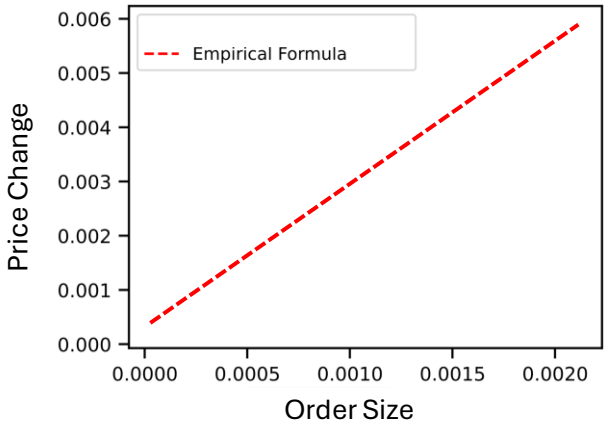
New Way for Market Impact Analysis

– Impact of trading order on markets with different conditions

- **Traditional Methods**
  - Use real transactions for feedback; costly & risky.
- **MarS Benefits**
  - Simulates accurate market impact curves.
  - Cost-effective alternative to data collection.
  - Enables data-driven research on collected data.
- **Overall Advantage**
  - Evidence that MarS effectively represents a digital twin of the real market.
  - Define a new way for financial experts to understand their area.



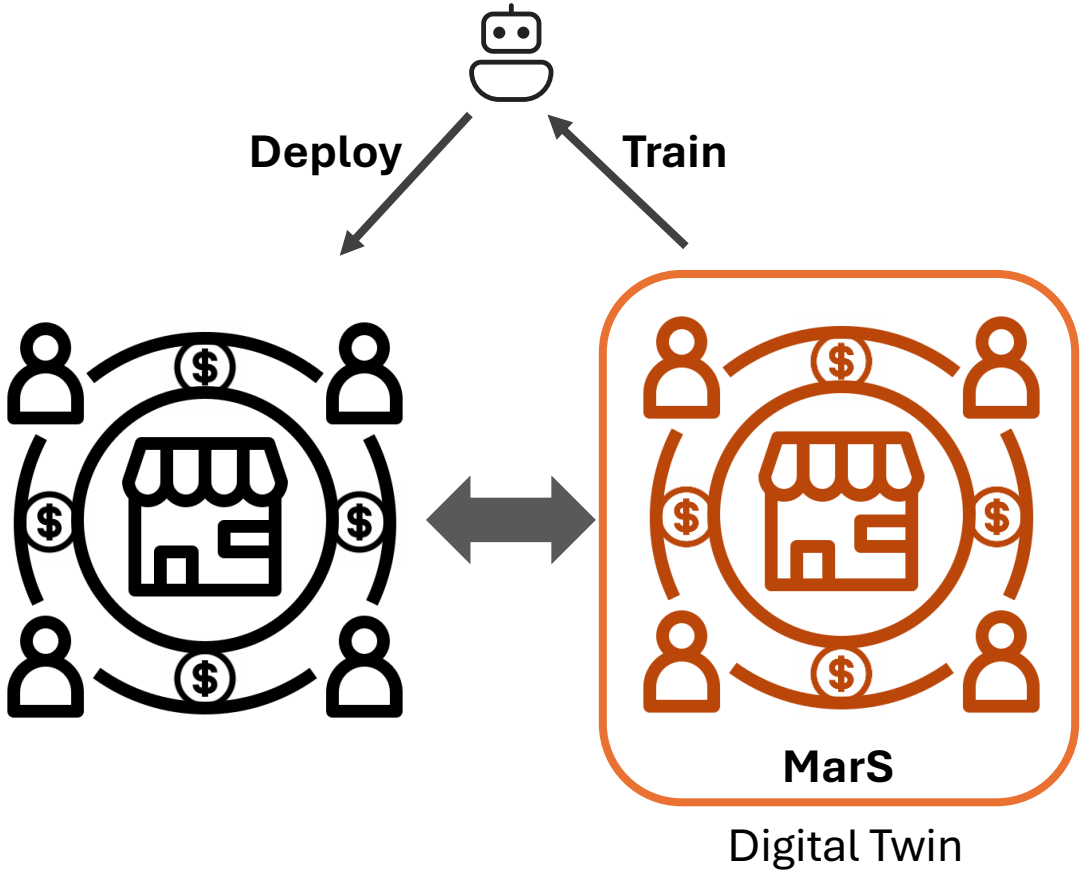
Simulation with Market Impact of Inject Orders

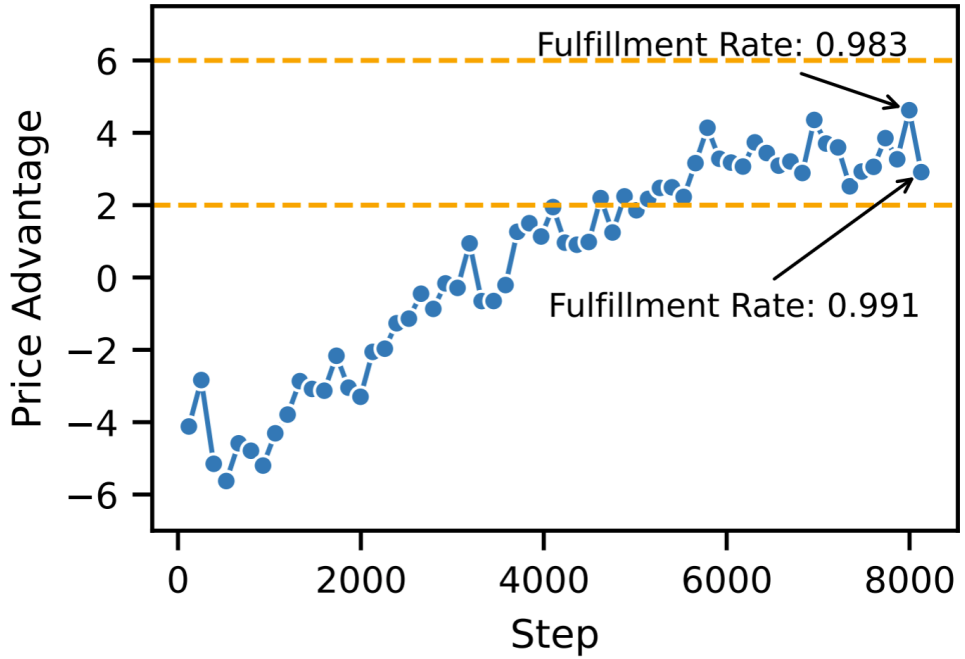


Simulation Results Align Well with Empirical Formula from Real Trans.

≈ Observed $g = 9.8\, m/s^2$ in Sora

New Horizon for Intelligent Agents

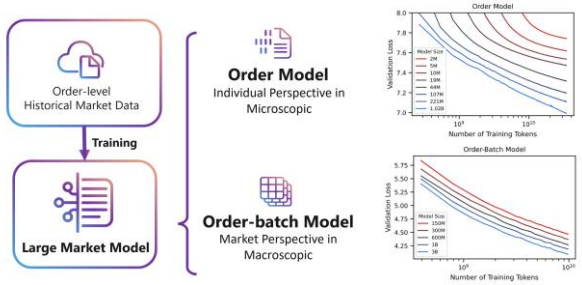


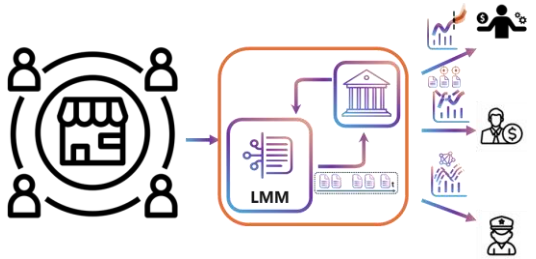


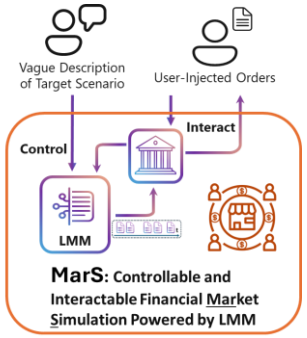
A RL Agent for Order Execution on MarS can reach promising results.

Summery: A Promising Beachhead!

- **LMM: Order Generation as Large Foundation Model of Financial Market**







- **MarS: Digital Twin and New Paradigms, New Ways & New Horizons**

New Paradigm for Mainstream Tasks in Finance Industry

New Way for Financial Experts to Understand Their Area

New Horizon for Applying Intelligent Agent in Finance Industry

THANK YOU!

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