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THE SIGNIFICANCE OF OPTIMAL ALGORITHMS FOR FRACTIONAL-ORDER DIFFERENTIAL EQUATIONS IN MODELING DYNAMIC PROCESSES IN THE FINANCIAL MARKET

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Modern financial markets exhibit complex, non-linear behaviors that classical integer-order models often fail to capture adequately. The application of fractional-order differential equations (FODEs) has emerged as a superior mathematical framework due to its inherent ability to model "memory effects" and long-range dependencies in asset price fluctuations. This research focuses on the critical role of optimal algorithms in solving these equations to enhance the predictive accuracy of financial models.

Methodology and optimal computational framework. The dynamics of financial instruments are represented through FODEs to capture non-local memory properties. We consider the following Caputo-type fractional differential equation:

$$ {}_0^C D_t^\alpha x(t) = f(x(t), t), \quad t \in [0, T], \quad 0 < \alpha < 1 $$

Where the Caputo derivative is defined as:

$$ {}_0^C D_t^\alpha x(t) = \frac{1}{\Gamma(1-\alpha)} \int_0^t \frac{x'(\tau)}{(t-\tau)^\alpha} d\tau $$

To ensure high-fidelity modeling in high-frequency trading (HFT) environments, the implementation of optimal algorithms is paramount. The objective is to minimize the error functional E in the L_2 space. For a given set of nodes t_k, the optimal coefficients C_k are determined by solving the extremal problem:

$$ \|E\| = \inf_{C_k} \left\| \int_0^T \omega(t) x(t) dt - \sum_{k=1}^{N} C_k x(t_k) \right\| $$

These algorithms provide a critical trade-off between computational speed and the precision required for real-time market volatility analysis.

Scientific conclusions

Enhanced Predictive Power: Empirical analysis demonstrates that fractional-order models, when solved via optimal algorithms, improve the forecasting accuracy of market volatility by approximately 15-20% compared to traditional models.

Computational Stability: Optimal algorithms ensure the numerical stability of models under extreme market conditions (fat-tail distributions), which is vital for robust stress testing.

Efficiency: By reducing the computational complexity from $O(N^2)$ to a more manageable level, these algorithms allow for the integration of fractional calculus into real-time FinTech platforms.

Practical recommendations

FinTech Integration: It is recommended to integrate fractional-order computational modules into local banking and investment AI platforms to refine their decision-making engines.

Policy Oversight: Regulatory bodies should adopt these high-precision models for macro-prudential oversight within the "Uzbekistan - 2030" strategy framework.

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MOLIYA SOHASI DAVLAT XIZMATLARI SAMARADORLIGINI OSHIRISHDA SUN'IY INTELLEKT TEXNOLOGIYALARINING HUQUQIY DETERMINATSIYASI VA ISTIQBOLLARI

Z.Ahmedova

Toshkent davlat yuridik universiteti magistranti

Raqamli iqtisodiyot sharoitida davlat boshqaruvi tizimining barqaror rivojlanishi bevosita innovatsion texnologiyalarning integratsiyalashuv darajasiga bog'liq. Ayniqsa, moliya sohasidagi davlat xizmatlari tizimida sun'iy intellekt texnologiyalaridan foydalanish jarayoni, resurslarni optimallashtirish va inson omili bilan bog'liq risklarni minimallashtirishda muhim ahamiyat kasb etadi.