HPC
A Highly Priced Commodity for Financial Institutions

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HPC in Finance

➢ R&D in the banking industry is plagued by two phenomenons

- Massive data feed

- Computationnally challenging models for the derivatives business

HPC in Finance

➤ Orders of magnitude

- More than 800,000 billions € of notional

- A universe of more than 10,000 securities

- Typical books of derivatives : $10^5/10^6$ open positions at the bank level

➤ Questions
- how much information to process ?

- What does it take to process it ?

How much information ?

How much information ?

How much information ?

- Electronic markets – mostly in the equity and the foreign exchange worlds

  - Order-driven markets
  - New data arrive under the form of a new « order »
    - Order to buy/sell at, below or above a given price (limit order)
    - Order to buy/sell at the best available price (market order)

How to process it ?
I. Algorithmic Trading

➢ Based on these data, actions are performed
➢ Two typical computationnally challenging problems are:
  ▪ Constrained-time optimization for high frequency trading
    • strategies based on « recent history » (intraday data)
    • must simulate the whole order book evolution and react faster than $10^{-3}/10^{-4}$ seconds

  ▪ Back-testing and optimization
    • Selection of optimal investment strategies in a large universe (« stock/fund picking » for CPPI-like strategies)
    • Storing the data *via* RAM may prove challenging (5 years of intraday data for 1,000 stocks : 1 To)

How to Process it ?
II The Derivatives Business

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- Example : an equity derivatives trading floor

  - 2,000 cash securities
  - Models require the simulation of the future life of each security

  - Each simulation of the future requires on average

    - 2,000 time steps

    - 100,000 Monte Carlo paths per security

  - The number of simulation per security depends on the sensitivities required (the « greeks » in quant lingo)

  - Cross-security effects (correlation effects) act as a quadratic growth factor for the number of sensitivities

How to Process it ?
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- Based on actual performances in the industry :

  - At Invesment Bank A :
    » 10 PetaFlops would allow for a basic pricing in 1 second

  - At investment bank B
    » 45 Petaflops would allow for a basic pricing in 1 second

- … but the worst is yet to come !

How to Process it ?
II The Derivatives Business

- Scenario-based tasks

  - Most decisions are anticipated using scenario-based simulations (« stress tests ») that run overnight
  - … and should run within minutes/secondes whenever a market move is anticipated (FED annoucements, news,…)

  - Typical stress testing requires a hypercube of deformation for each relevant parameters

  - Example : « volatility scenario »:
    - » deformation of the market data of all equity options
    - » ~200 points/security…
  - Plus all the cross-influences!!!

HPC for the banking industry

➢ From a scientific point of view:

- The production models are still simplistic…

- … and yet, computationnally untractable in the current industrial environment

- What is required
  - More Flops
  - More RAM
  - Better Network…

- … more power and more brains!