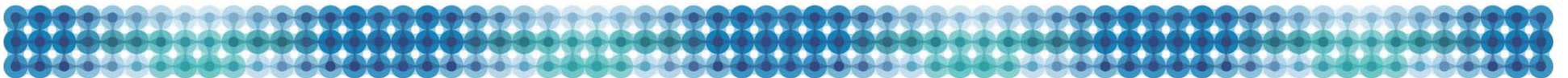


A Career in Trading

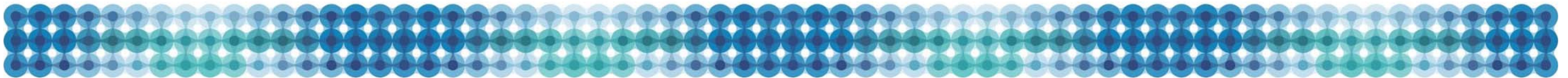
... for students of Physics

Michael Vilim – Michael.Vilim@imc.com



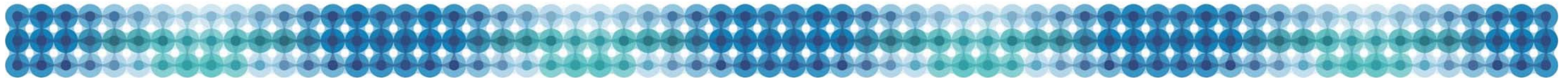
Overview

- **Who am I?**
- **Who is IMC?**
- **Trading & Financial Markets**
- **Technology in Financial Markets**
- **Physics & Trading**
- **Q&A**



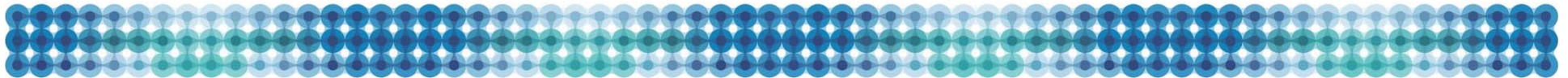
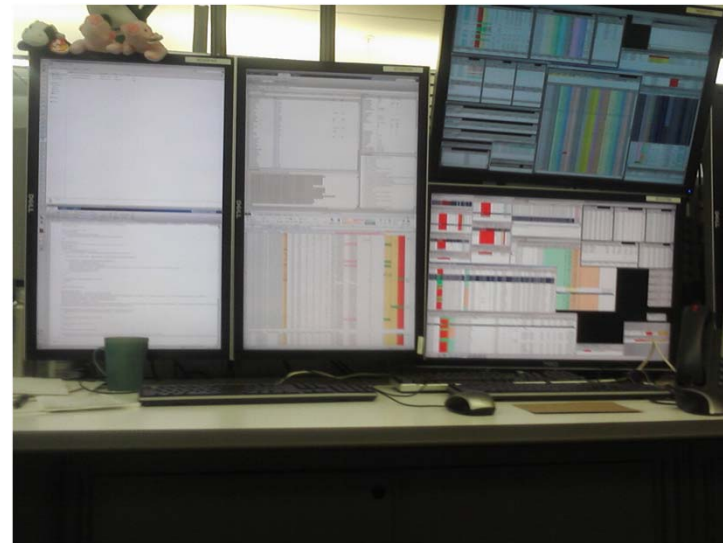
Who am I?

- Grew up in the Chicago suburbs
- Always been interested in trading / mathematical finance
- UIUC class of 2013 – BS in engineering physics, minor in computer science

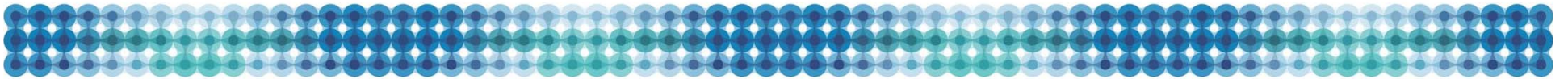


Who am I?

- Started with IMC after graduating in 2013
- Started as an operational trader, now have experience in market making strategy, execution, quant research (options pricing), and software development



Who is IMC?

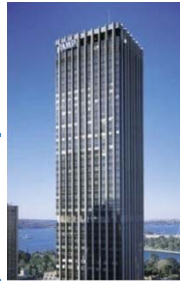


Who is IMC?

1989
IMC started
as floor
traders in
Amsterdam



2002
Opened
Sydney Office



2017

- Around 500 employees worldwide
- Market makers on all major global exchanges
- One of the leading market makers in equities, ETFs, futures and options on over 100 exchanges and platforms worldwide
- IMC is now one of the world's largest electronic market making firms



2000
Opened Chicago
Office



2004
Opened Zug
Office



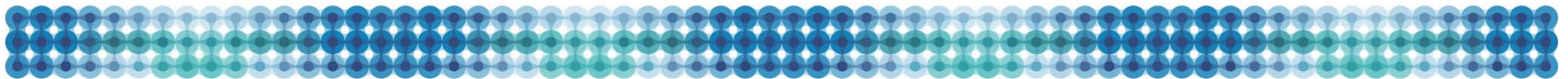
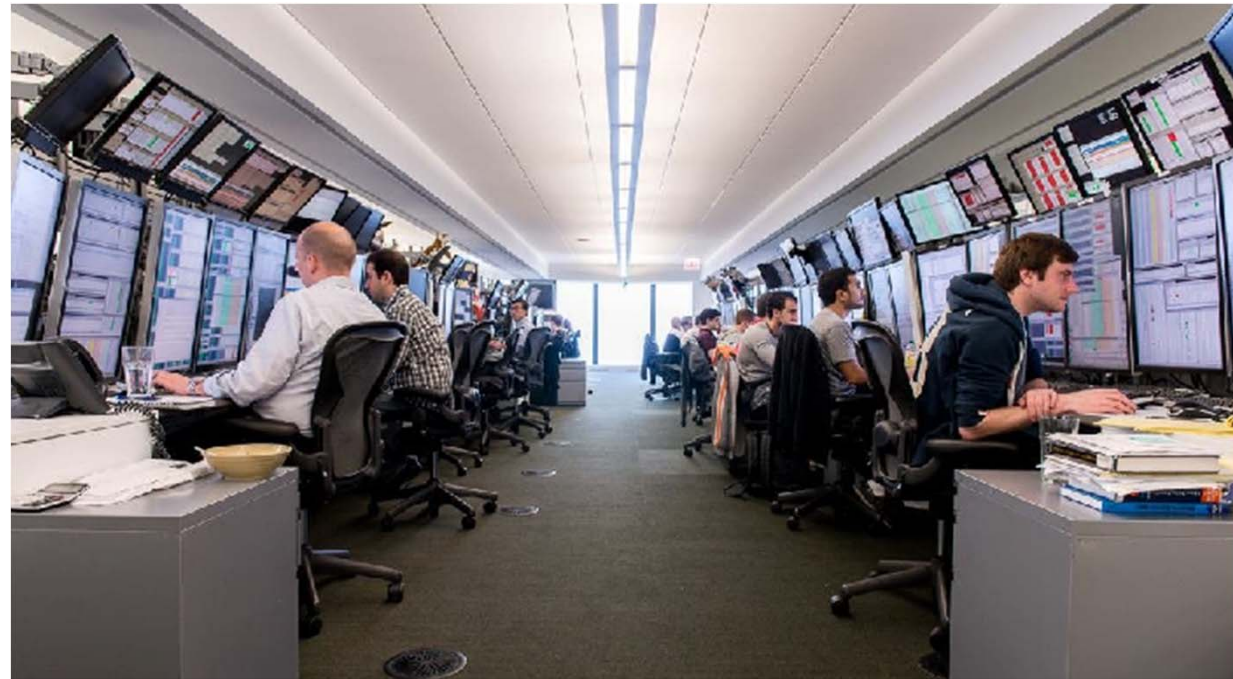
2006
Opened
Hong Kong
Office



2008 - 2017
Growth of the
markets and
products that
we trade

Who is IMC?

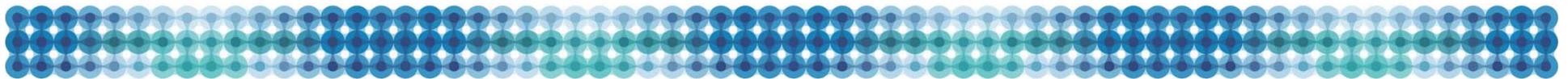
“IMC is a technology-driven trading firm. We develop innovative technology and employ advanced trading strategies to make markets on more than 100 of the world’s best-regulated trading venues.”



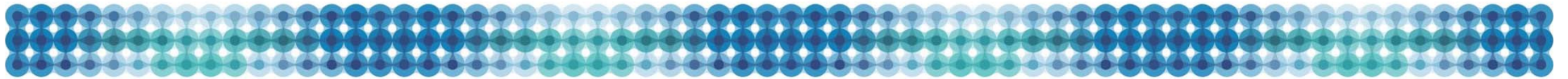
Who is IMC?

We are also a Designated Market Maker on the New York Stock Exchange.

<http://www.imc.com/us/about-us#what-we-do>

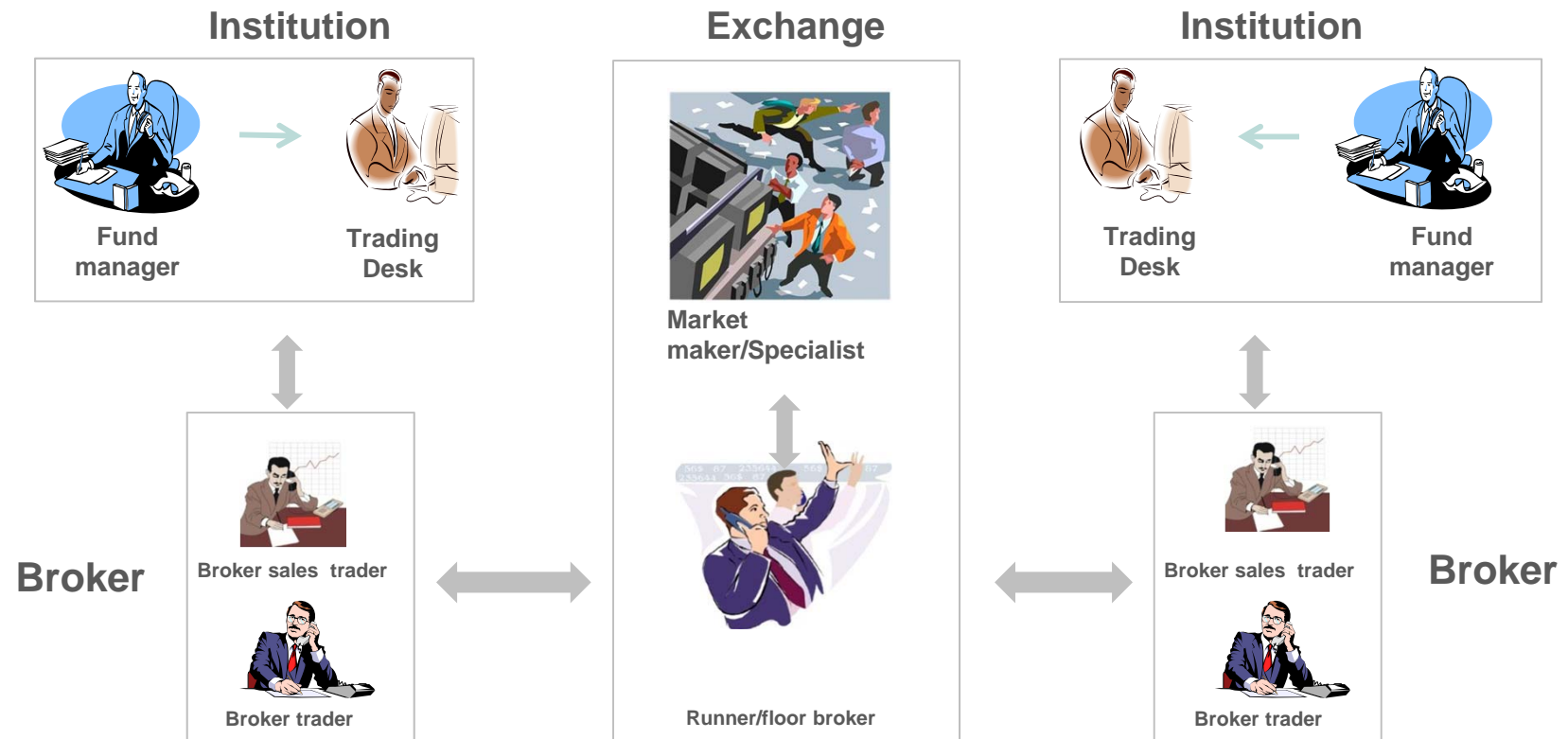


Trading and Financial Markets



Trading and Financial Markets

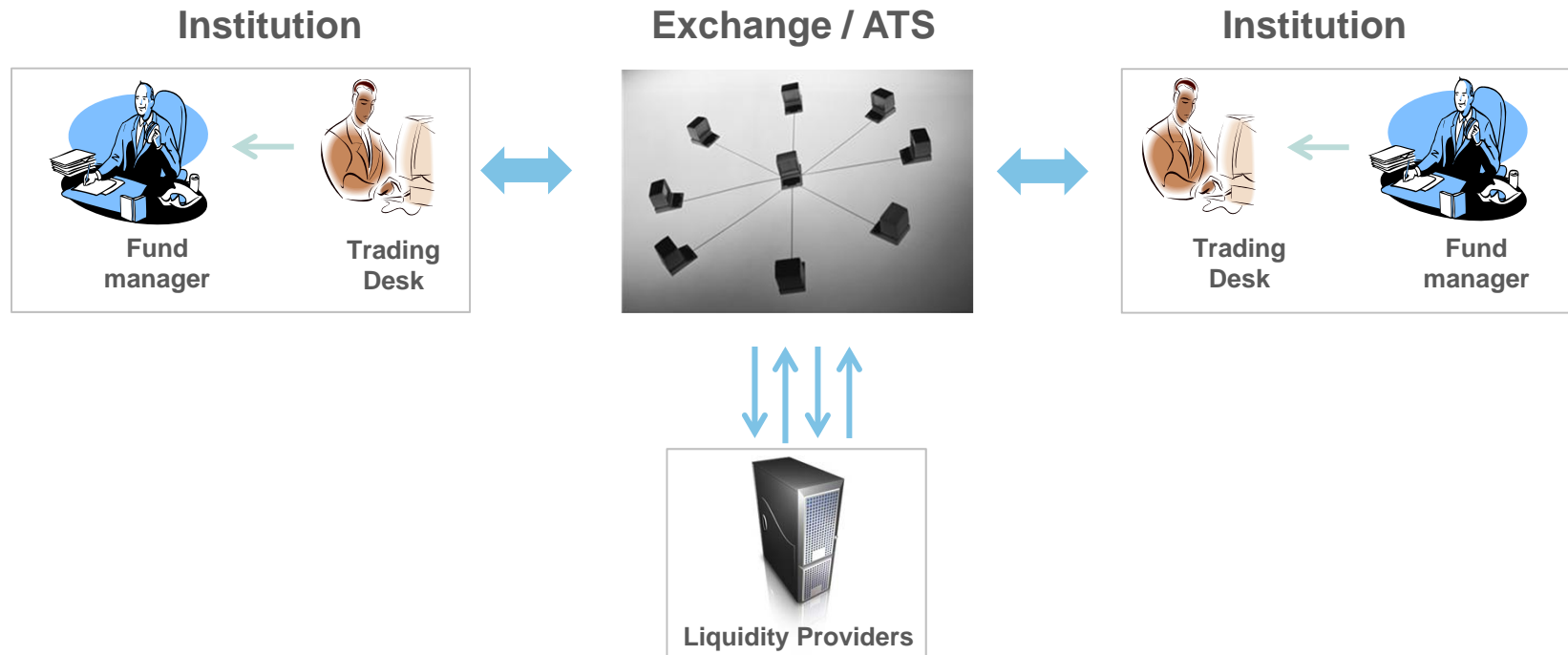
The Old Days



- **Monopoly position of Specialists and privileged position of Market Makers**
- **High spreads and high commissions. High frictional costs**
- **High barriers to entry for new participants, closed shop**

Trading and Financial Markets

Modern times

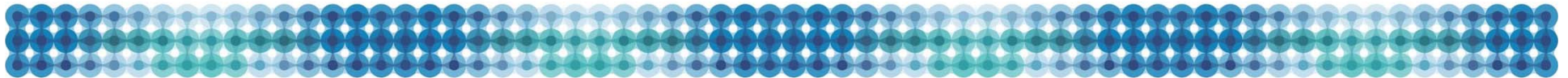


- **Institutions are now self-empowered by the use of Algorithmic Direct Market Access**
- **Fewer intermediaries lead to lower frictional costs**
- **Multiple Liquidity Providers compete with each other**
- **Lower barrier to entry for new participants**

* **Several exchanges still run (limited) floor trading operations: CME, CBOE, NYSE**

Trading and Financial Markets

- **Many exchanges globally**



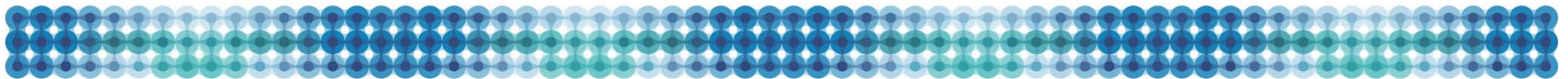
Trading and Financial Markets

- Huge variety of different financial products!



Trading and Financial Markets

- **Matching of orders by exchanges happens at high speeds by big order matching engines**



Trading and Financial Markets

Brokers:

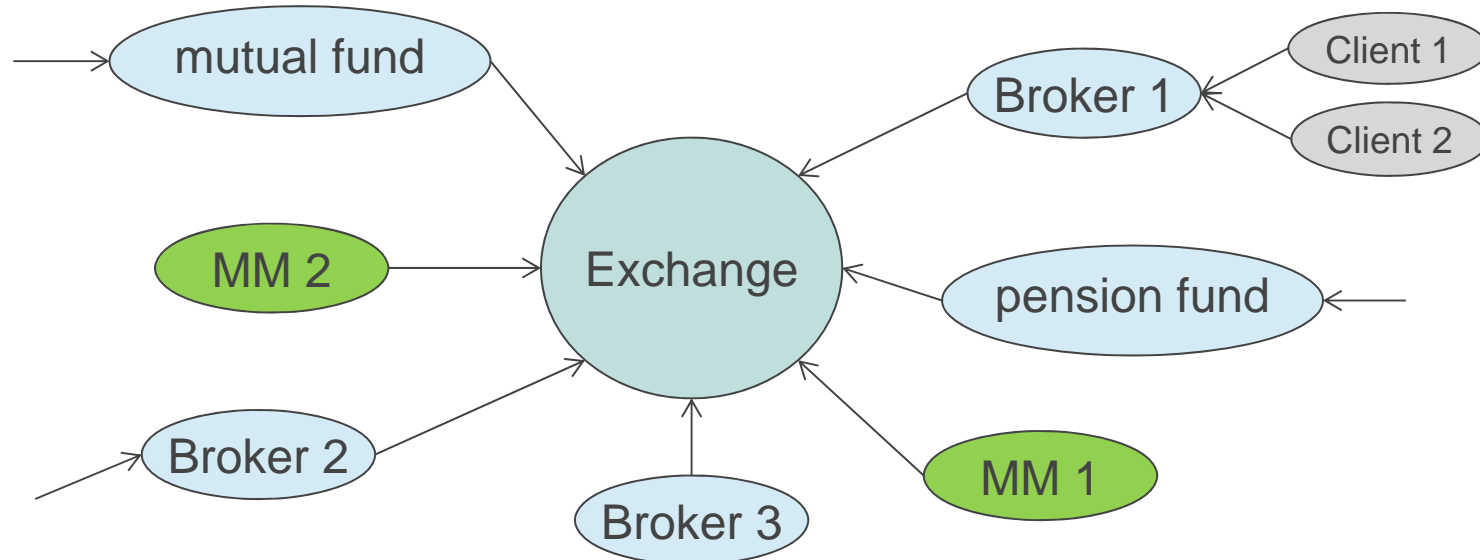
- **Brokers are exchange members that help their clients get access to exchanges**
- **They will have memberships of multiple exchanges to provide you with best prices**
- **They charge additional fees on top of exchange fees for their service**



Trading and Financial Markets

Market makers:

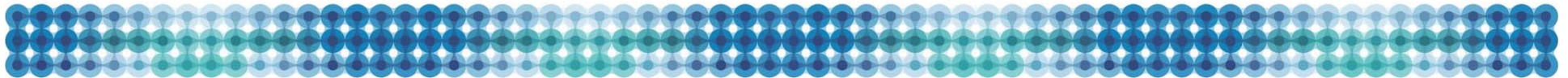
- **Market makers are exchange members that provide liquidity to exchanges**
- **They do not have clients, but trade on their own behalf with own money**
- **They keep prices of related products in-line across multiple exchanges**



Trading and Financial Markets

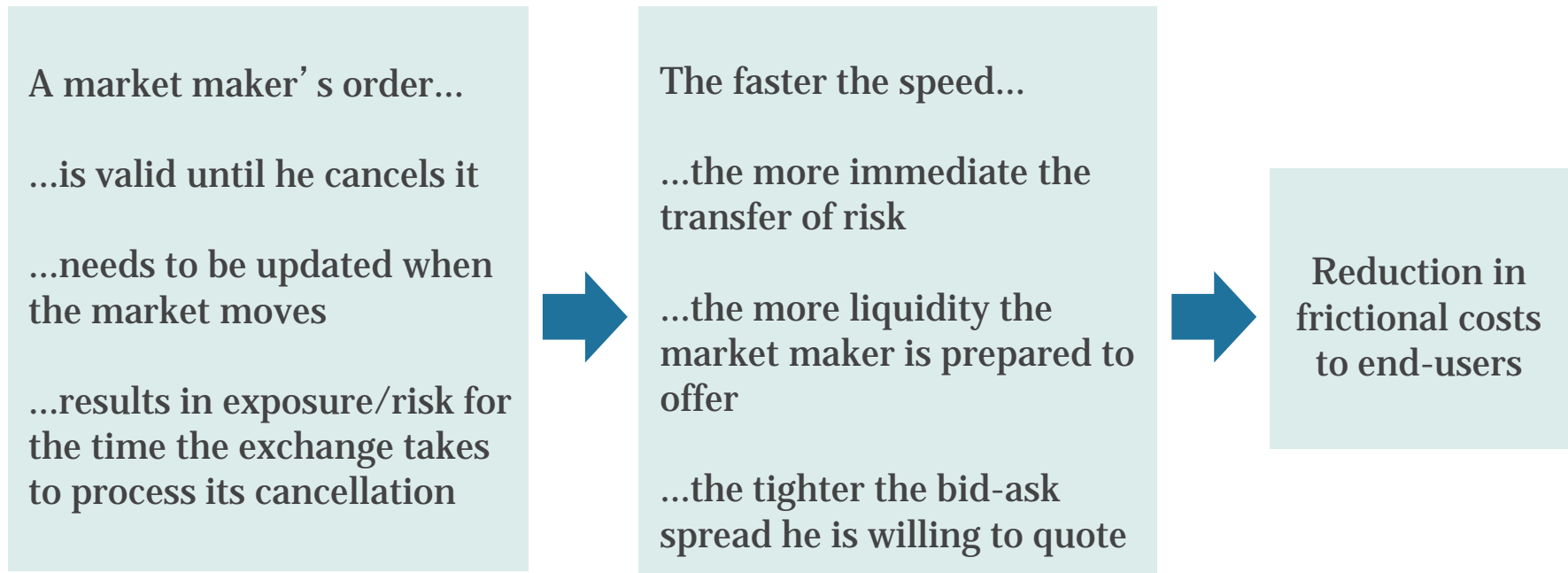
- **Many financial products are equivalent, dependent on each other, related, correlated, co-integrated, etc.**
- **There are many exchanges, and certain products trade on multiple exchanges**
- ***What does that mean for market makers?***

→ Speed is critical!

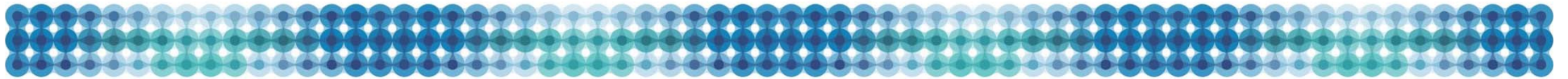


Trading and Financial Markets

Speed helps to create efficient markets:



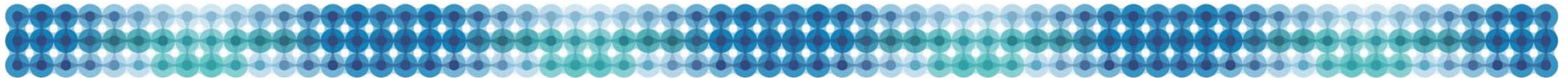
Technology in Financial Markets



Technology in Financial Markets

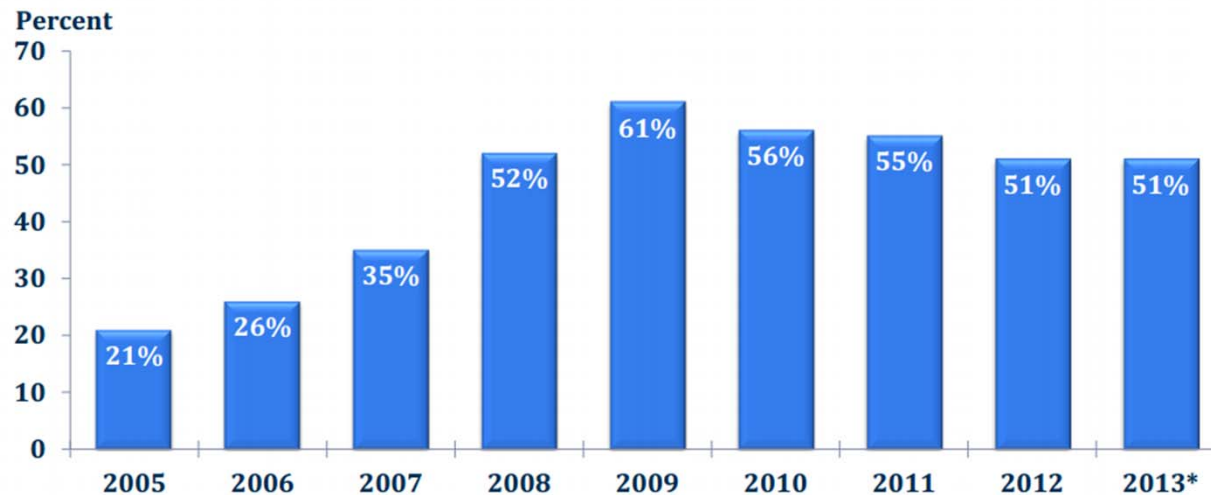
Algorithms for automation of trading

- **Exchange feed is understood by computer algorithms that can immediately react upon it**
- **An algorithm could take a multitude of different inputs, such as the bid- and ask-price with corresponding volumes, trades, data from multiple products on multiple exchanges, etc.**
- **Machine learning algorithms are used to read important news messages such as scheduled unemployment figures and can automatically react upon the information in the news message by buying or selling certain products**
- **Trading strategies can be designed by data-mining and back-testing strategies over tons of data**



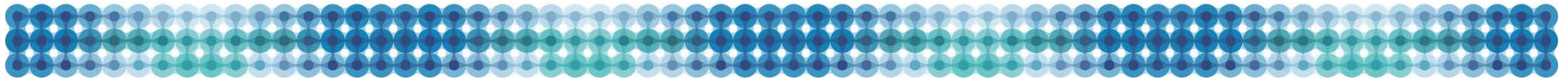
Technology in Financial Markets

- **Computerized automation: so-called “automated high-frequency” trading accounts for an estimated ~50% of all stock trades in the US.**



*Estimated.
Sources: TABB Group, Wall Street Journal, World Federation of Exchanges.

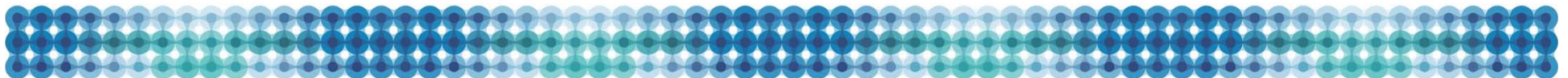
 #2014GC



Technology in Financial Markets

Fast reaction times on a single exchange

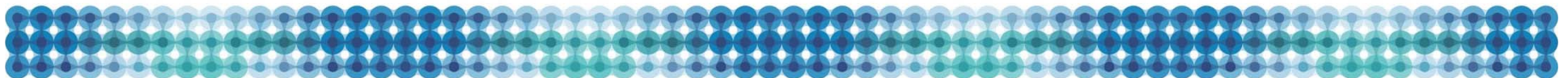
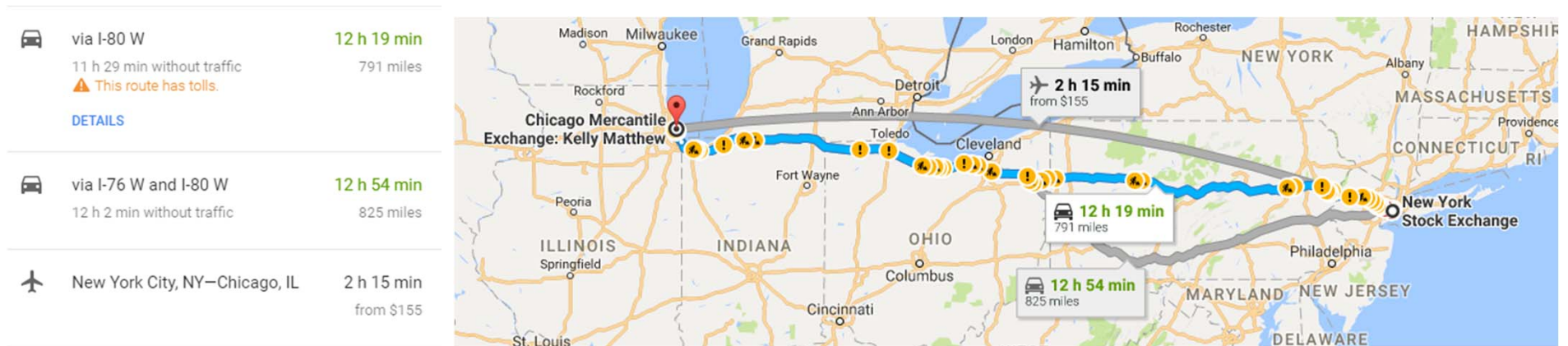
- **Colocation services are provided by exchanges such that a computer can be placed in physically close to an exchange for faster reaction times**
- **Algorithms are written in fast computer languages (C or C++) and are simplified to enhance speed (or layered in different loops/cycles)**
- **Fast CPU's are selected and overclocked, and other computer tweaks are made to ensure the computer is performing optimally**
- **FPGA's (programmable hardware) are used for even faster reaction times**
- **Second -> millisecond -> microsecond scale**



Technology in Financial Markets

Fast reaction times between multiple exchanges

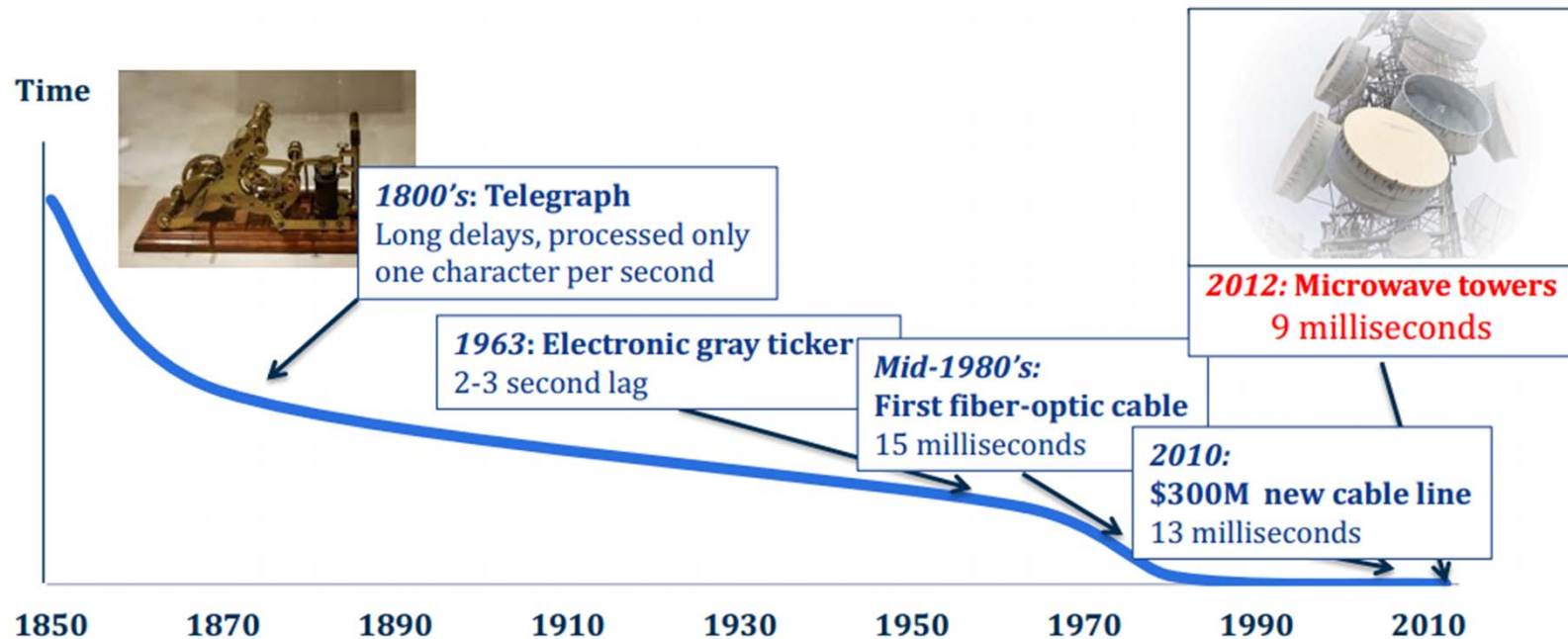
How long does it take for information to travel from the New York Stock Exchange to the Chicago Mercantile Exchange??



Technology in Financial Markets

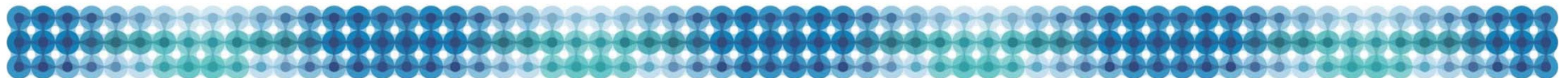
Fast reaction times between multiple exchanges

Round-trip times between Chicago and New York



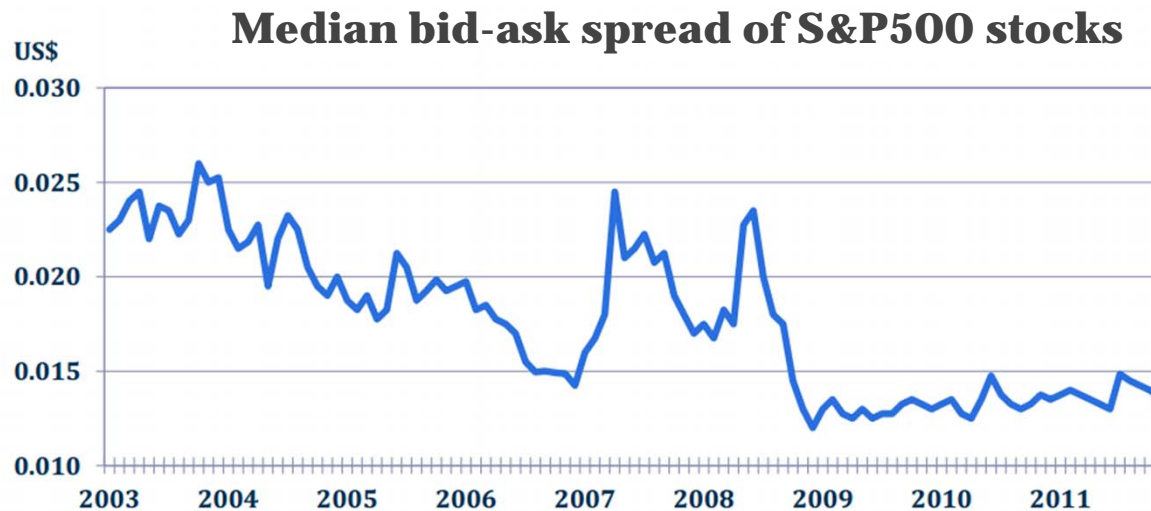
Sources: New York Times, Wired.

 #2014GC



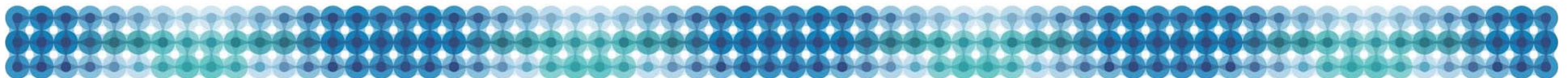
Technology in Financial Markets

- **Improvements in technology and competition amongst market makers has led to a decline in the “bid-ask spread”, i.e. the difference between the active buy and sell price in a product**

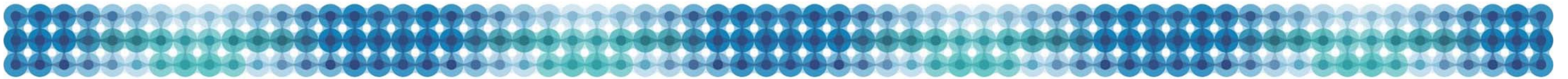


Sources: MarketAxess.

 #2014GC

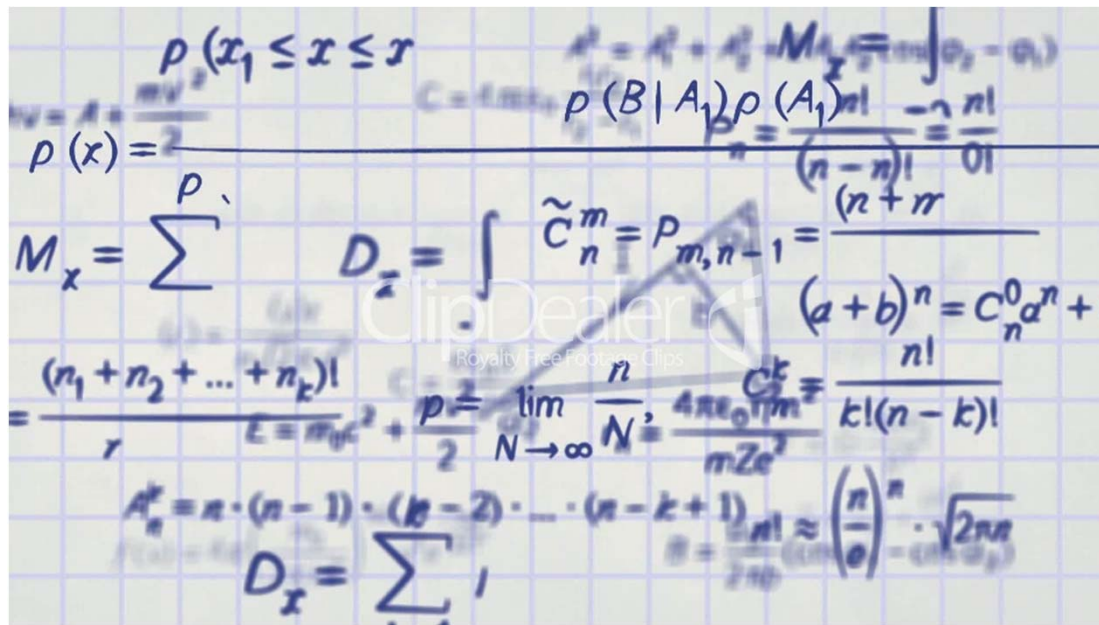


Physics & Trading

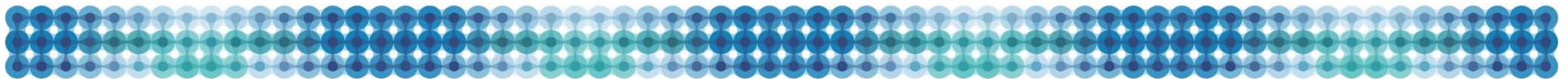


Physics & Trading

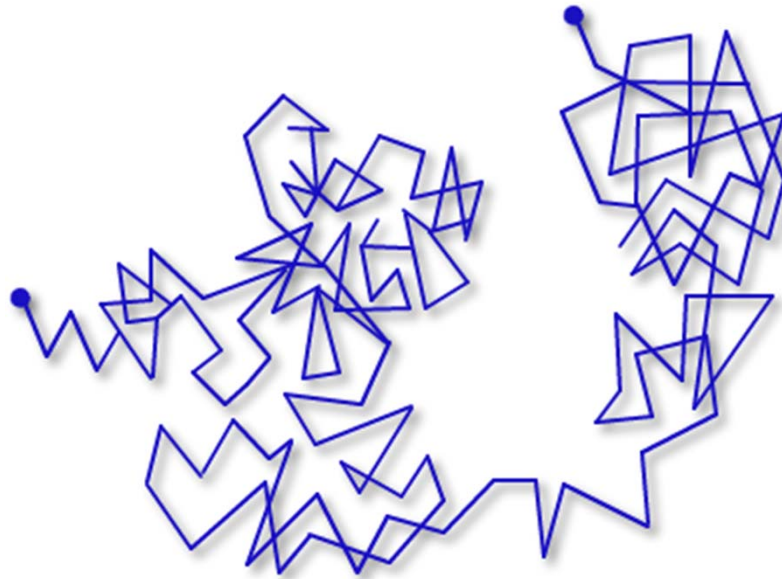
What does trading have to do with physics?



There are actually quite some areas where physics/mathematics is used in trading!



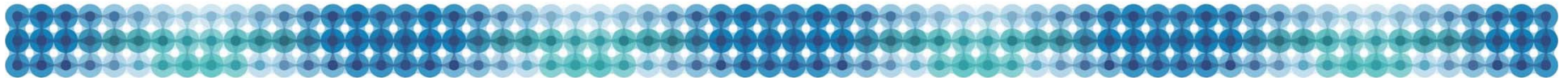
Physics & Trading



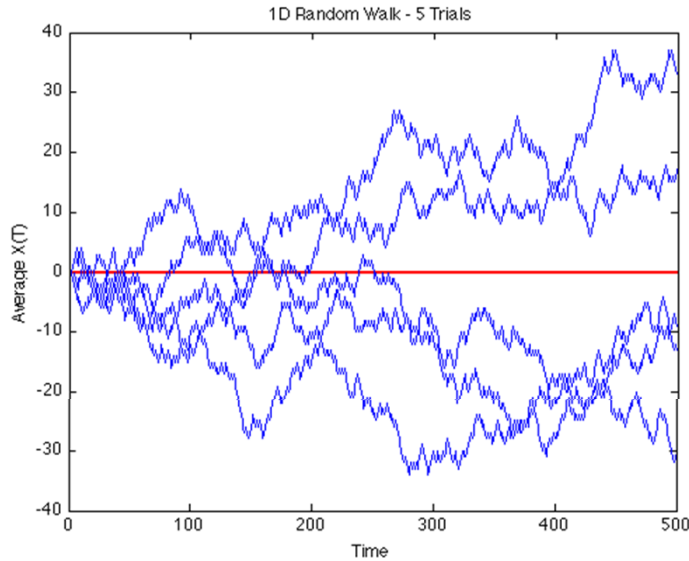
Random walk?

**INVESTIGATIONS ON
THE THEORY OF ,THE
BROWNIAN MOVEMENT**

BY
ALBERT EINSTEIN, PH.D.



Physics & Trading



Finance:
→ Geometric Brownian Motion

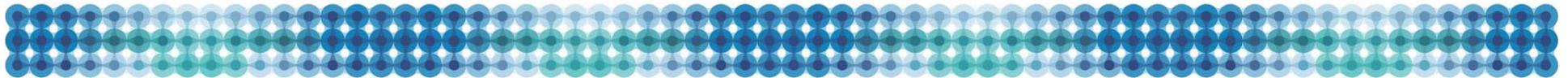
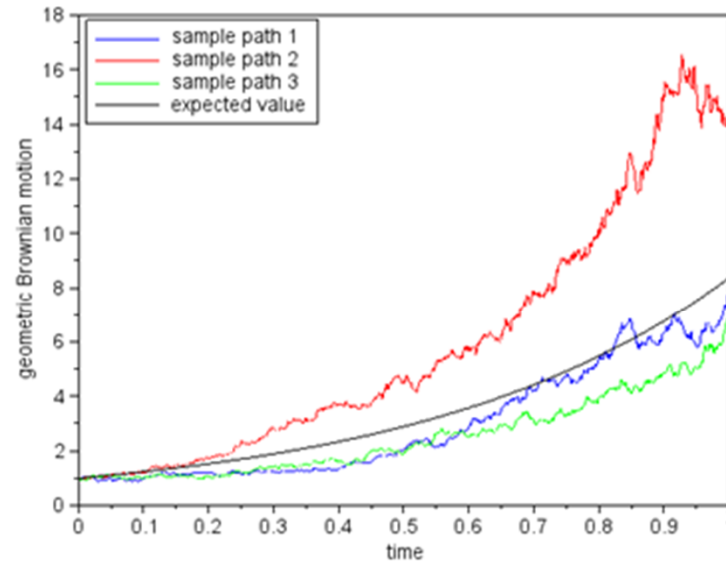
$$dS_t = \mu S_t dt + \sigma S_t dW_t$$

where W_t is a Wiener process or Brownian motion, and μ ('the percentage drift') and σ ('the percentage volatility') are constants.

Kind-of looks like stock prices??

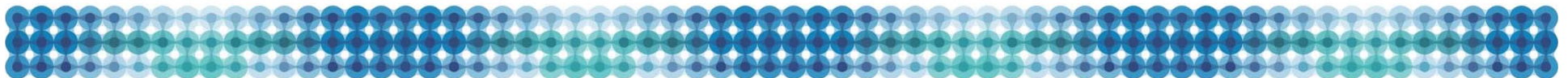
But:

- 1. A stock price cannot become negative**
- 2. Inflation and interest rates typically make stocks go up over time**



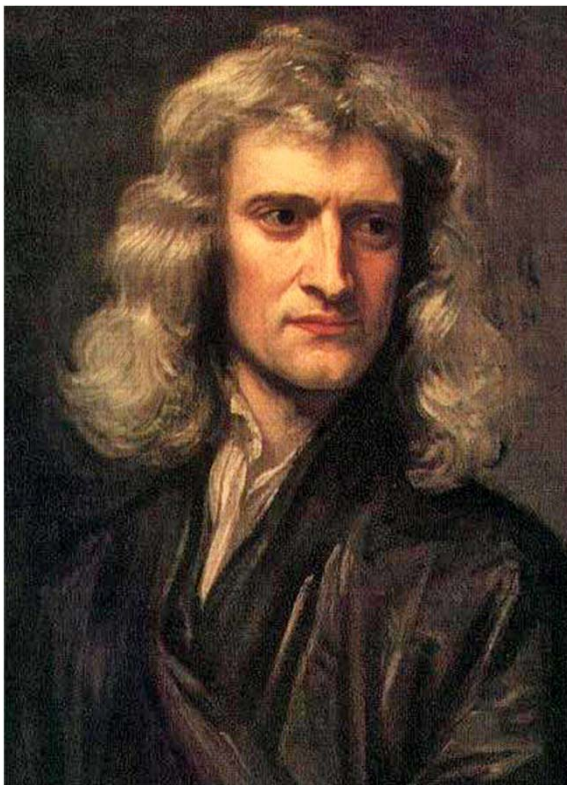
Physics & Trading

- ***Options are financial products that have a nonlinear pricing relation to their underlying, i.e. the derivative to the underlying is non-constant.***
- ***Pricing models for options start with Geometric Brownian Motion, e.g. the widely used Black-Scholes option pricing model.***
- ***Certain types of options allow an analytical-form solution, other require solving a Stochastic Differential Equation using Finite-Difference, Finite-Elements, etc.***
- ***More realistic option pricing models use slightly different diffusion process, e.g. with jump processes included to model sudden market-moving news-events.***



Finishing up

I have a PhD in Physics, surely trading cannot be that difficult?



Sir Isaac Newton lost his fortune buying stocks of the South Sea Company, in what would be classified as one of the earliest large asset bubbles.



Questions?

Want to know more?

Internship possibilities? Full-time opportunities?

<http://www.imc.com/us/>

