# How "i" got into pricing

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AIMS IMAGINARY
Mathematics Communication in Africa
Workshop-Exhibition

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# How I got into pricing and risk analysis

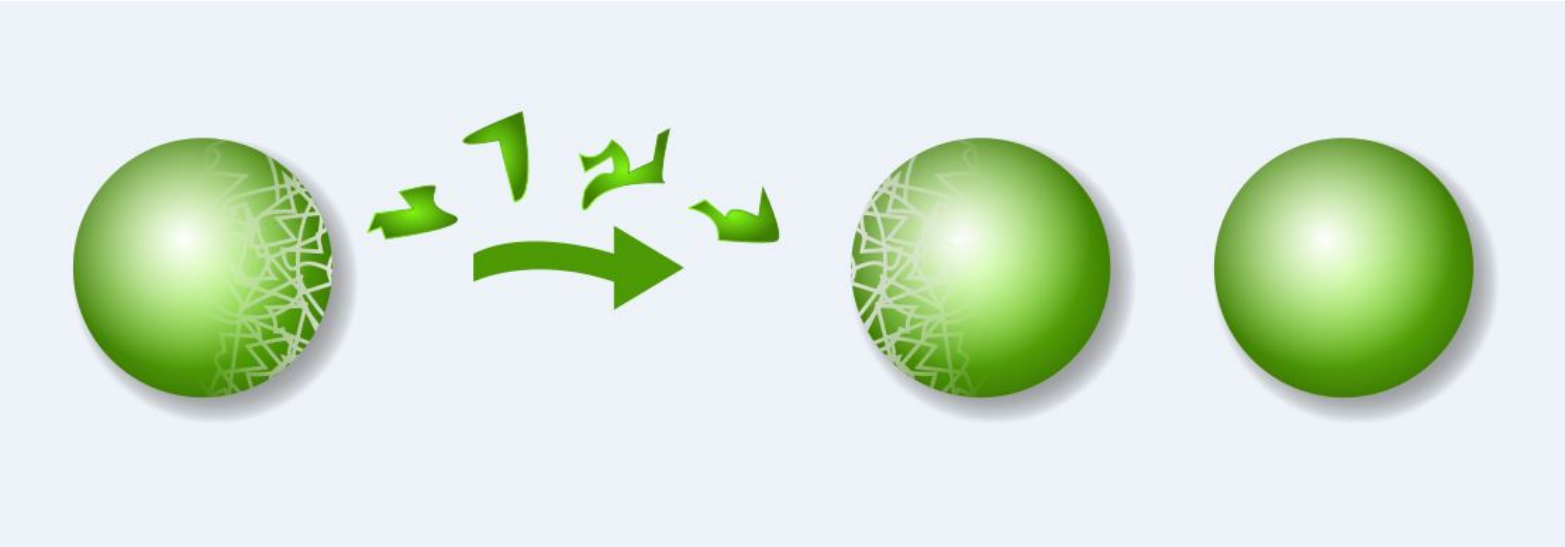


Figure: Banach-Tarski paradox analogy? [image source: Wikipedia]

# Setting a research question

Financial markets include traded shares which can be clustered according to similar characteristics ... The understanding of such properties is important for understanding the overall dynamics of a financial market and is applied to estimation of risk associated with investment instruments...

**Is it possible to identify sectors, groups of stocks which display similar behaviour with respect to returns, and states, time periods for which the market behaves similarly, in SA financial data, by purely quantitative methods under the constraint that noise and temporal stability are understood?**

[D.L.Wilcox, NRF Thuthuka application, 2004]

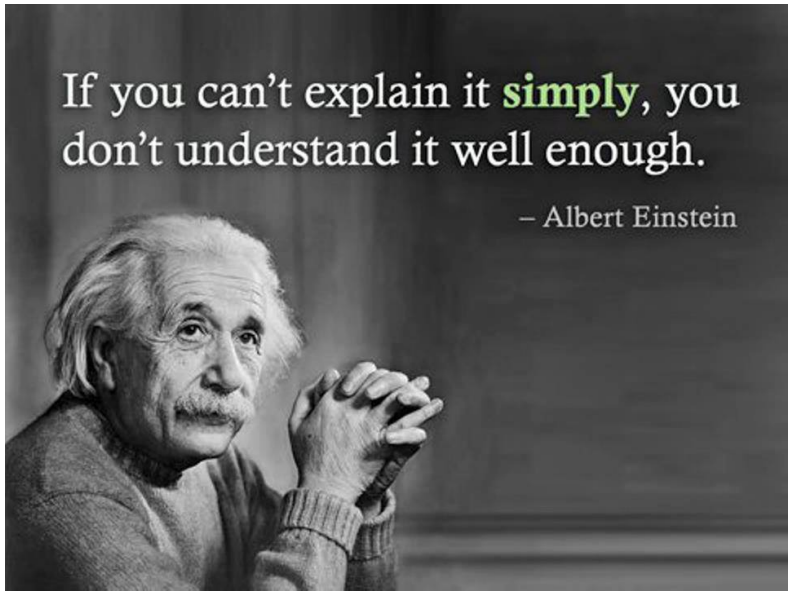
Joseph Fourier:

> *Mathematics compares the most diverse phenomena and discovers the secret analogies that unite them.*

# Inescapable impact of economics and finance


Figure: 72 000 000 000 000 in Rand value! - 31 Dec 2011

# Understanding resource allocation is the hardest science




**Greenspan:** "I guess I should warn you, if I turn out to be particularly clear, you've probably misunderstood what I said." (1988 speech, as quoted in The New York Times, October 28, 2005 - Source: Wikipedia)

Figure: Different aspects through different lamps and lenses [image by Mobiiart]

# Interdisciplinary/Multidisciplinary

- Stochastic analysis and PDEs
- Transform methods for advanced models, volatility and correlation
- Statistical science
- Statistical mechanics models and network analysis
- Big data / data science challenges
- Computing for analysis of data and simulation of future outcomes
- **More needed on science communication and classroom games** to teach concepts such as *convergence, hedging* and *leverage*

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# Diffusion and heat flow

$$\frac{\partial f}{\partial t} = \frac{\partial^2 f}{\partial s^2}$$

Figure: [image source: Thinkstock]

# Diffusion simulation of prices

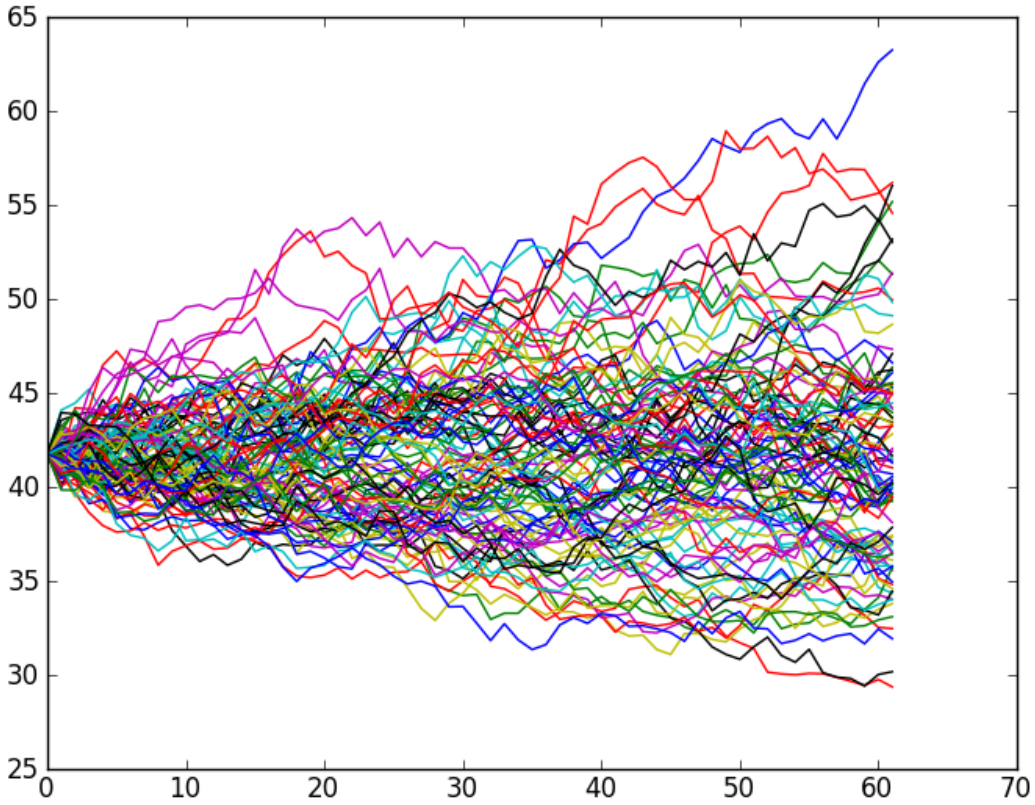


Figure: Possible prices paths for risk analysis

# Fourier series and transforms

$$f(x) = \frac{a_0}{2} + \sum_{n=1}^{\infty}[a_n.\sin(n\pi x) + b_n.\cos(n\pi x)]$$

# Fourier series approximations

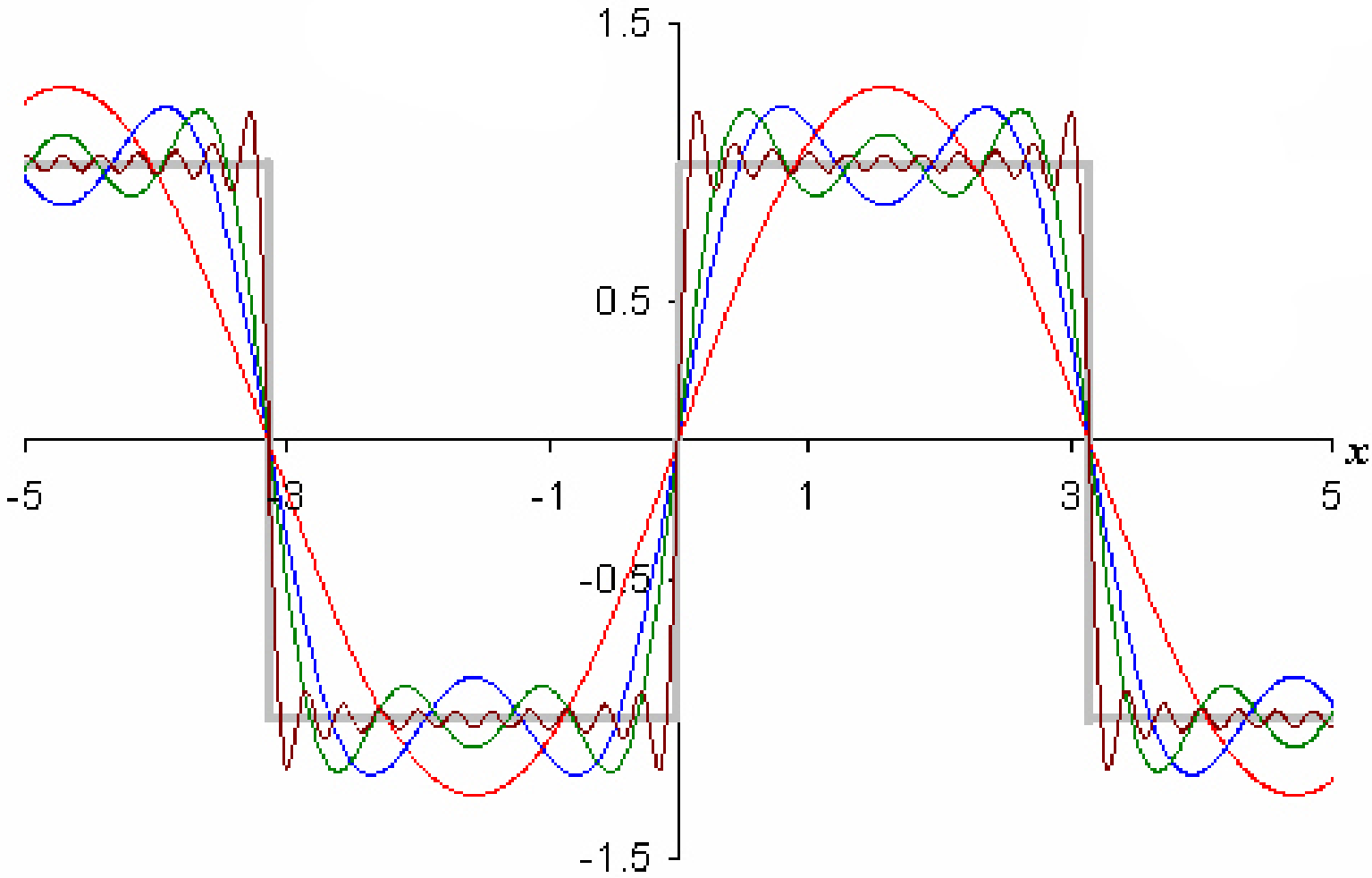


Figure: Illustration of square wave approximated by combinations of basic functions

# Fourier series and transforms

$$
\begin{aligned}
f(x) &= \frac{a_0}{2} + \sum_{n=1}^{\infty} [a_n . \sin(n\pi x) + b_n . \cos(n\pi x)] \\
&= \sum_{n=-\infty}^{\infty} c_n e^{in\pi x} \\
&\rightarrow \int_{\mathbb{R}} c(\xi) e^{i\xi x} d\xi
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&\to \int_{\mathbb{R}} c(\xi) e^{i\xi x} d\xi
\end{aligned}
$$

# (R)evolution in market interaction

Trading floors
then...

... and now
( well some anyway,
the rest will follow
eventually )

# Market microstructure, risk and optimisation at the coalface

New frontiers for risk management: need to build the equivalent of simulation wind tunnels.

Challenge: what is the analogue of a bird in the turbine?

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# The Flashcrash of 6 May 2010

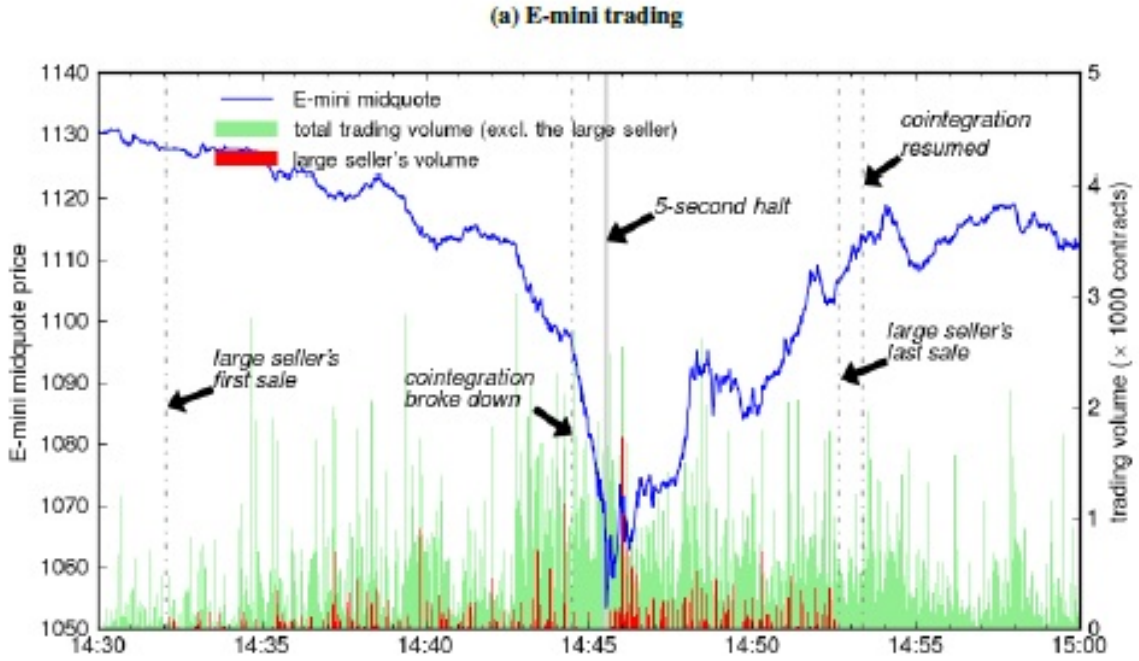


Figure: E-minifutures dropped 9% at 14h45 only to recover within minutes

# Unsupervised learning: parallel genetic algorithm

insert video by D. Hendricks:

- Clusters generated using a CUDA PGA algorithm
- Cluster visualisation using Gephi software

Thank you for your attention!