

# The role of the mathematical sciences in finance



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## Dirty Harry applies some probability theory

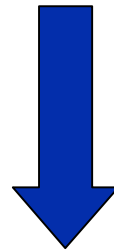
“I know what you're thinking. "Did he fire six shots or only five?" Well, to tell you the truth, in all this excitement I kind of lost track myself. But being as this is a .44 Magnum, the most powerful handgun in the world, and would blow your head clean off, you've got to ask yourself a question: Do I feel lucky? Well, do ya, punk? “

**Clint Eastwood as “Dirty Harry” 1971.**



## Overview

**Banking  
Insurance  
Funds management**



It's all about pricing of risk. This cannot be done without an understanding of probability theory, statistics and economics.



# The world of finance is abstract (until you lose your shirt)

## ■ This is why people have trouble

- Even Nobel Prize winners can over-estimate their abilities to quantify risk

## ■ Risk is systematically misunderstood in the wider community

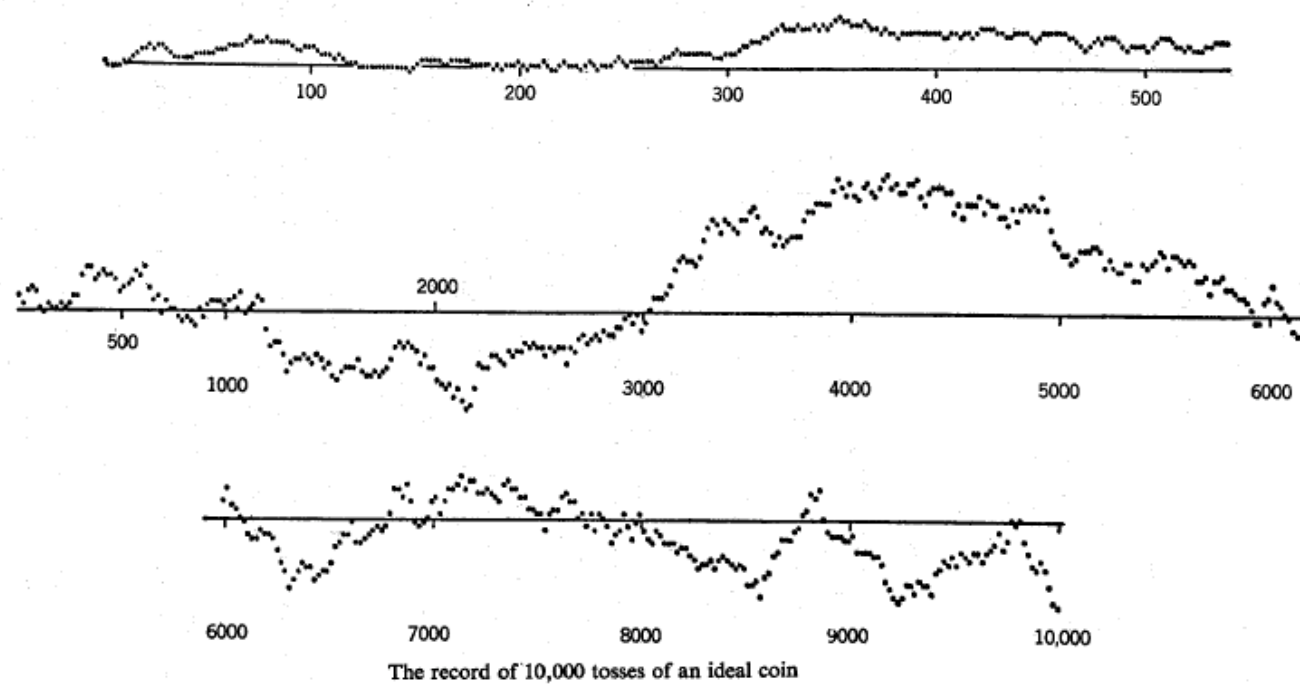
- Virtually every accumulation model used to model superannuation is deterministic
- Investors do not understand stochastic models

## ■ Evolution has not built us to understand probabilities “intuitively”

- Try the test to appreciate why
- We need people with a deep and rigorous training to keep us on track



## Even the experts got this one wrong



## Even the experts got this one wrong

The forward graph shows 78 changes of sign and 64 other returns to the origin. The reversed graph shows only 8 changes of sign and 6 other returns to the origin. Professor Feller sought reactions from experienced statisticians who expected much more than 78 changes of sign in the forward graph and yet *nobody* thought that the reversed graph would show only 8 changes of sign.

### Results of reversed coin tossing experiment

#### THE PATH STAYS ON THE NEGATIVE SIDE FOR:

the first 7804 steps

next 2 steps

next 30 steps

next 48 steps

next 2046 steps

Total of 9930 steps

**Fraction of time = 99.3%**

#### THE PATH STAYS ON THE POSITIVE SIDE:

next 8 steps

next 54 steps

next 2 steps

next 6 steps

Total of 70 steps

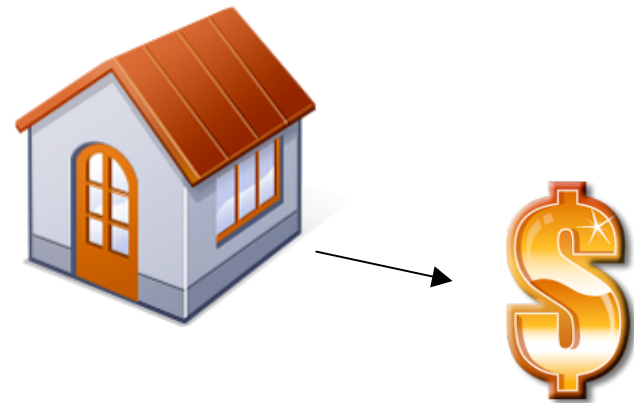
**Fraction of time = 0.7%**



# Product development is getting more complex

- Imagine you want to liberate some of the value in the family home. This has huge social implications (paying for aged care etc)

- Owner gets cash but gives up slice of disposal gains
- How do you rationally model the whole process **AND** make money out of it?
  - Basically option pricing concepts but some difficult technical issues
- BUT people have to understand or they won't invest



Role for the mathematical communicator



## Where did the minus 1 come from?

Does your employee really understand what they are doing?

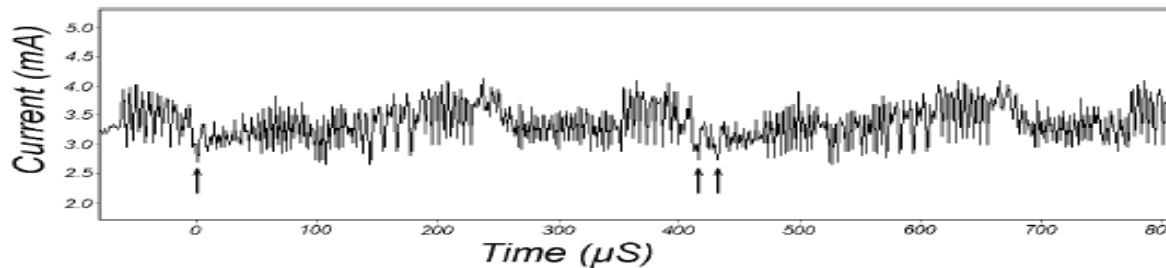
$$\begin{aligned} E[e^{i\xi X}] &= \frac{1}{\sqrt{2\pi}} \int_{-\infty}^{\infty} e^{-x^2/2} \cdot e^{i\xi x} dx \\ &= e^{-\xi^2/2} \end{aligned}$$





# Security is a growth industry

- Security of financial transactions is fundamental to confidence
  - Encryption underpins smart cards, internet transactions etc
  - Sophisticated electrical engineering based statistical attacks can be applied using differential power analysis theory to crack smart cards etc



**Figure 2:** SPA trace showing DES rounds 2 and 3.

Paul Kocher, Joshua Jaffe, and Benjamin Jun



## Mathematics and policy making

- **Capacity for rigorous analysis critical to rational policy development**
  - Australian Bureau of Statistics provided a pool of senior public servants
  - Defence Science and Technology has a pivotal role in the defence world



## The future

- **Multi-dimensional problem requiring multi-dimensional response**
  - Absolutely critical to get more secondary students interested in mathematics and science
  - Communication of the inspiration & job opportunities
- **There is hope....**



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