Wednesday 29 September 1999

THE UNIVERSITY OF
NEW SOUTH WALES

Dynamic Financial Analysis In Insurance and Reinsurance

Title of Presentation
A Clearer Picture from DFA

Presenter
Colin Priest
Classic Solutions

Synopsis

DFA models can be likened to computer imaging techniques such as rendering. They both involve complex calculations that take a considerable amount of CPU time. This paper reviews some techniques to provide higher resolution DFA pictures, such as Latin Hypercube sampling, low discrepancy sequences, parallel processing, using aggregate distributions, avoiding correlations, and avoiding unnecessary recalculations. These techniques can often provide solutions that require less CPU time or less elapsed time. Examples of the effectiveness (or ineffectiveness) of these techniques are provided. The occasional impracticalities of implementing these techniques are also highlighted.

CLASSIC SOLUTIONS

A Clearer Picture From DFA

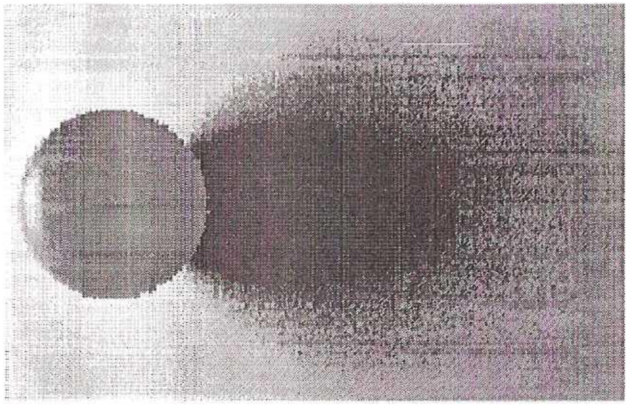
Colin Priest

Classic Solutions

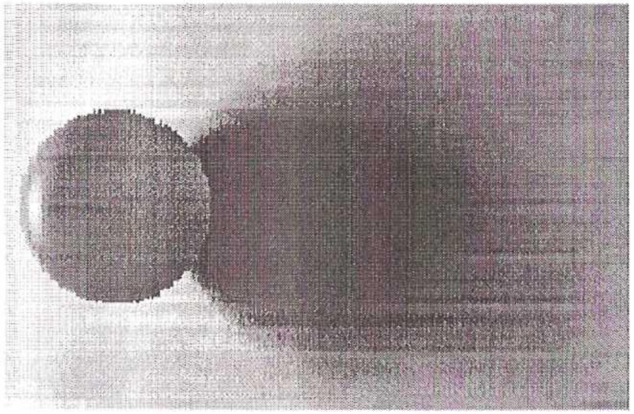
Getting a Better Picture

CLASSIC SOLUTIONS

Using Random Numbers



Using a Halton Sequence



- DFA is like computer animation / graphics
- choosing more representative scenarios provides a better picture

What is the DFA Picture?

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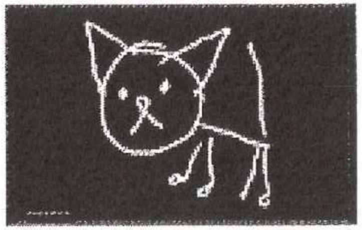
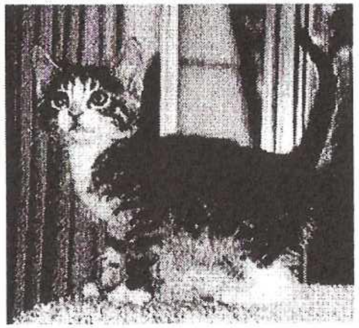
- size = capital requirements

- shape = risk characteristics and capital allocation



- location = risk management & strategy

- reality = complex and chaotic



Random Numbers

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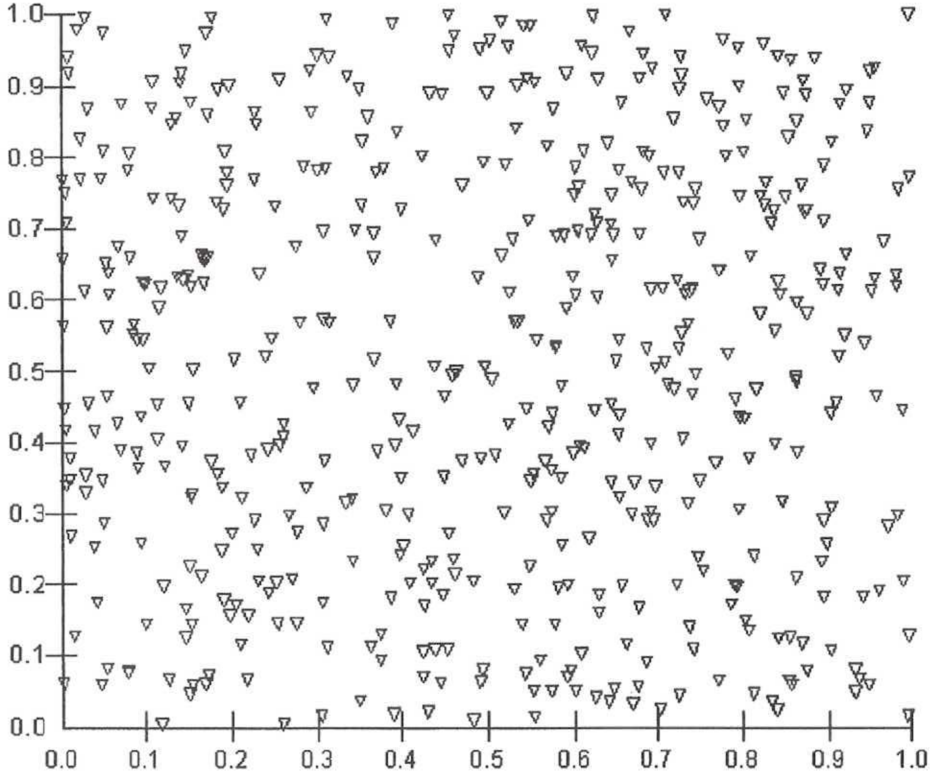

- empty spots
- clumping
- need more sample values to get a good estimate
- no dimensionality

Latin Hypercube Sampling

- What is Latin Hypercube sampling?
  - a form of stratified sampling
  - split each distribution up into sections of equal probability
  - jumble up these sections, then sample a value from each in turn
  - it is not truly "random" as you are extremely unlikely to get two consecutive values close together

Latin Hypercube Sampling

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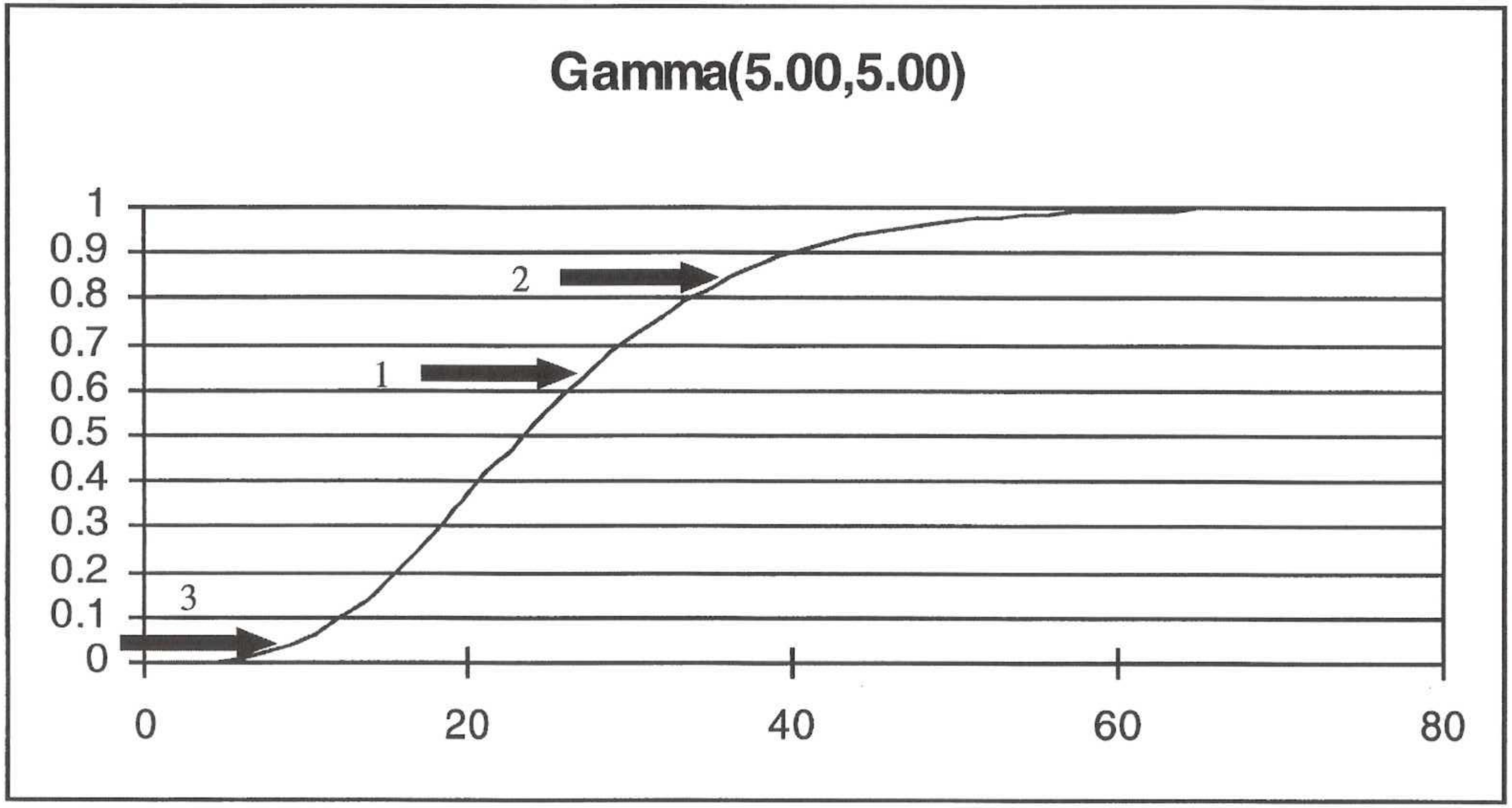
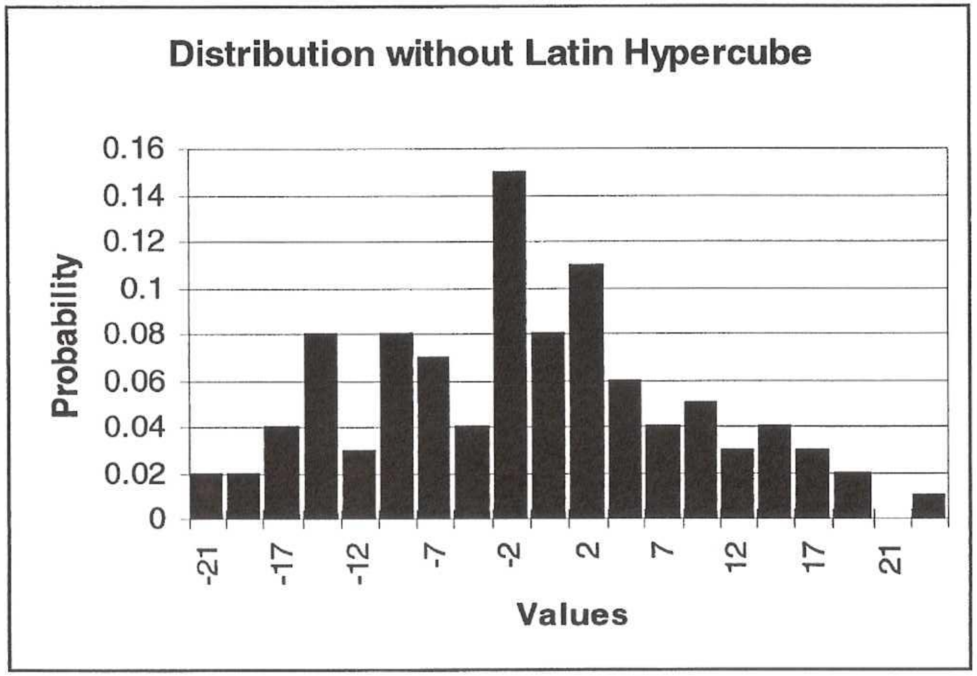
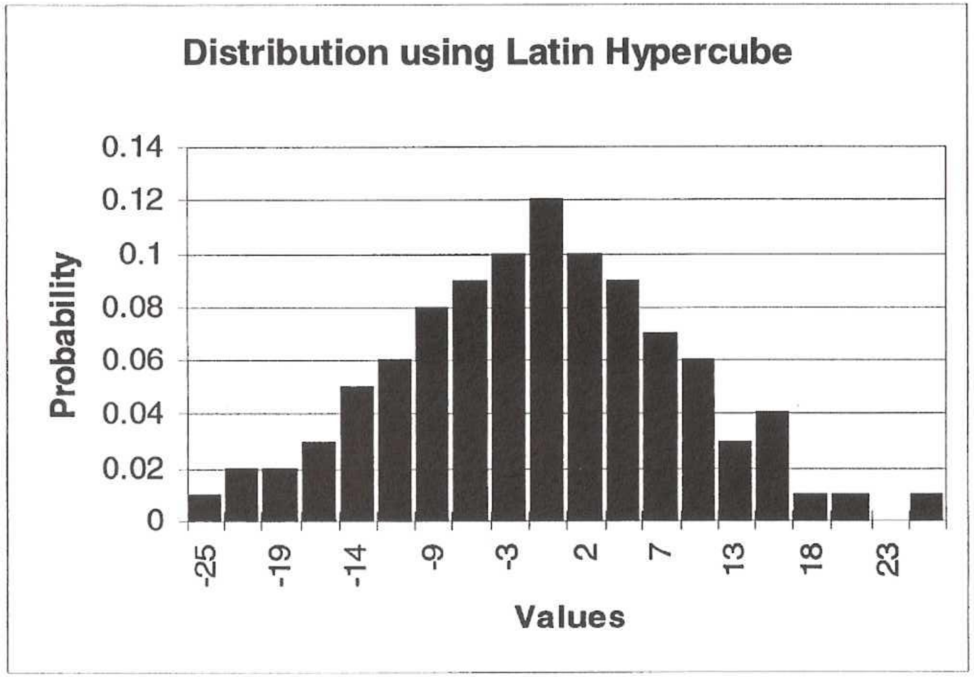
Sample from each section in random order







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- By ensuring that a sample is taken from each probability range, Latin Hypercube sampling better represents the underlying distribution

Latin Hypercube - Shortcomings

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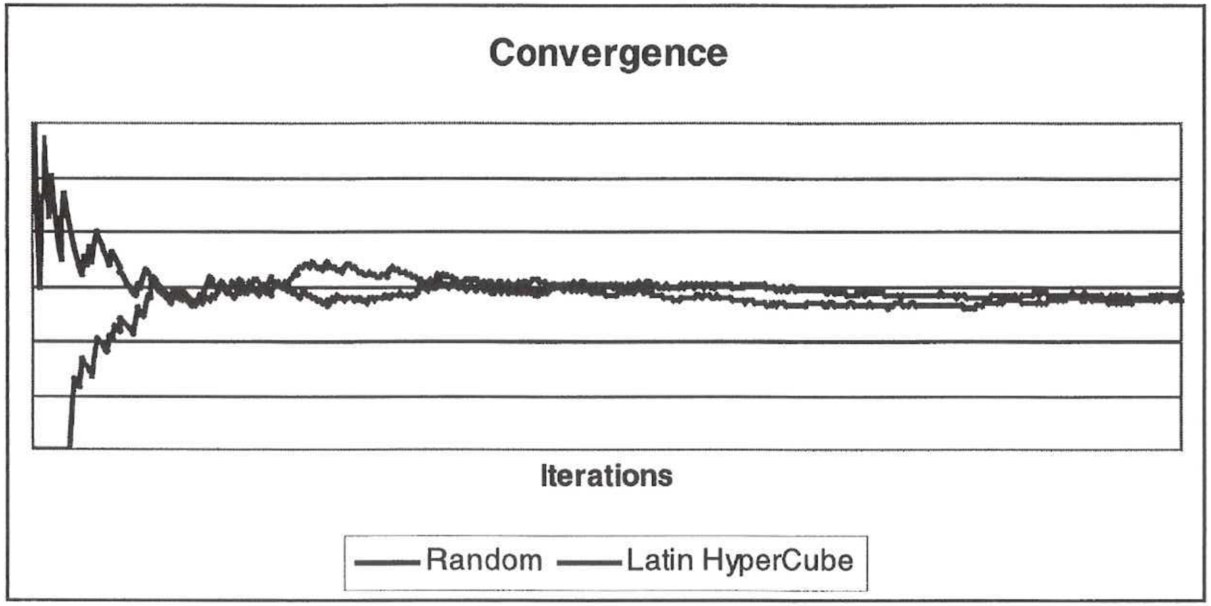
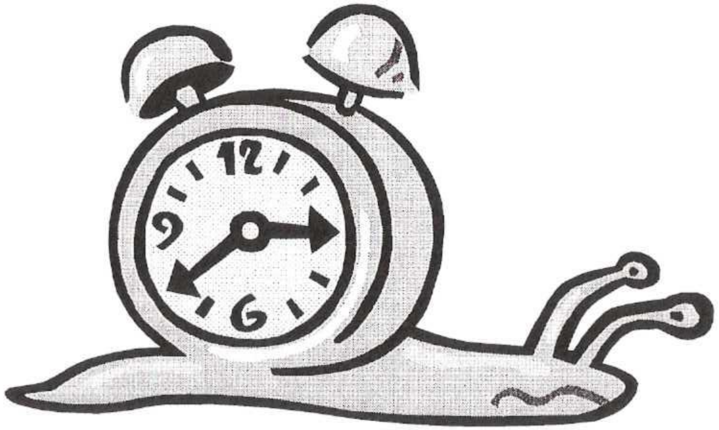


- Dimensionality:
  - you can't get three claims in a row from the top percentile
  - need a new sample distribution (dimension) for every claim

Latin Hypercube - Shortcomings

CLASSIC SOLUTIONS



- Speed:
  - – need to calculate the inverse cumulative density function
  - – need to store flags to show which sections have been used
  - – because of dimensionality a Latin Hypercube based model may take longer to converge

Low Discrepancy Sequences

- What is a low discrepancy sequence?
  - a special type mathematical function
  - not a random number sequence
  - remembers and avoids previous values in the sequence
  - increases “resolution” as the sequence progresses

Low Discrepancy Sequences

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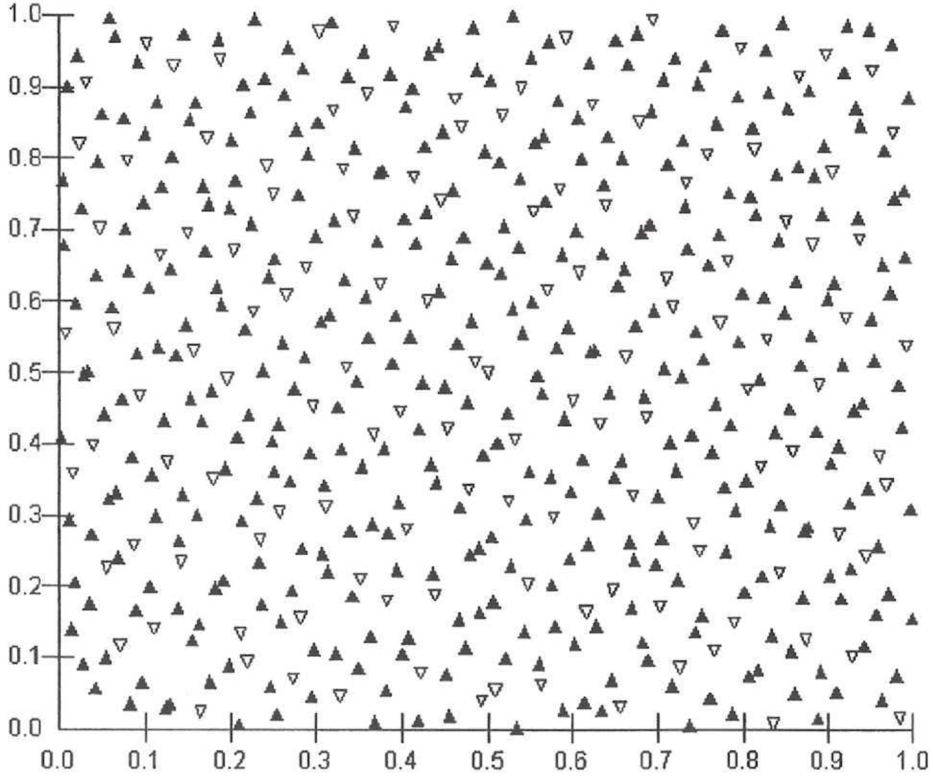


- no empty spots
- no clumping
- samples "around" previous values
- need fewer sample values to get a good estimate

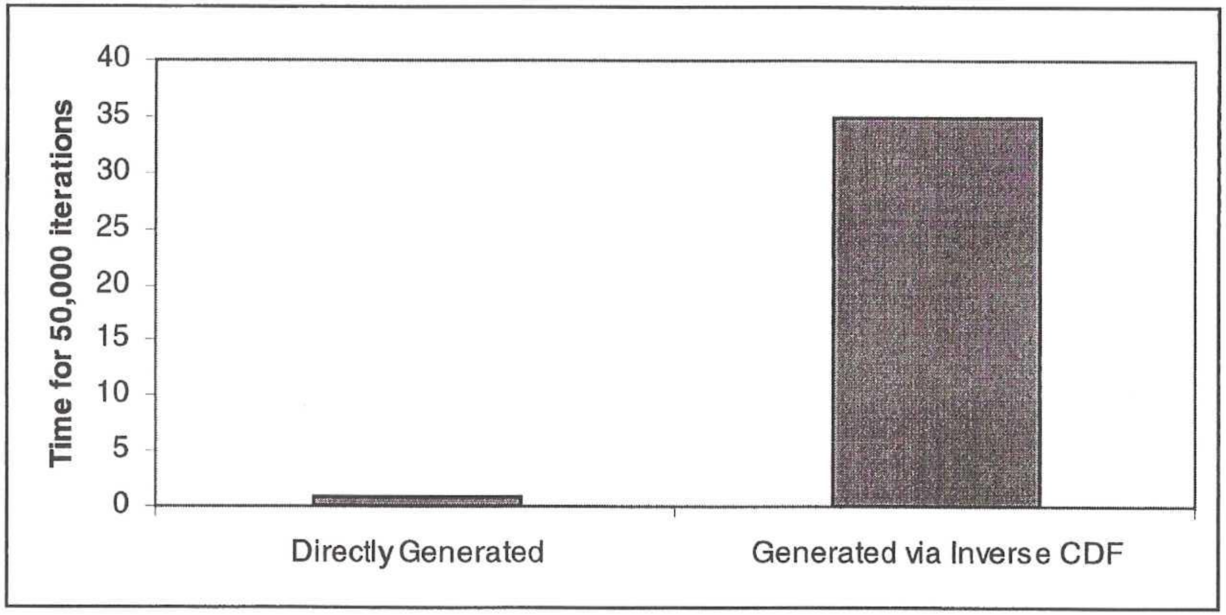
Low Discrepancy Sequences - Shortcomings

- Dimensionality
  - need an extra dimension for every sample (e.g. every individual claim)
  - some e.g. Sobol sequence will not extend to higher dimensions
  - others e.g. Halton need a new prime number for each dimension
  - the number of dimensions that can be used in practice is 15 - 40

Low Discrepancy Sequences - Shortcomings

CLASSIC SOLUTIONS

- Speed:
  - need to calculate the inverse cumulative density function



Low Discrepancy Sequences - Shortcomings

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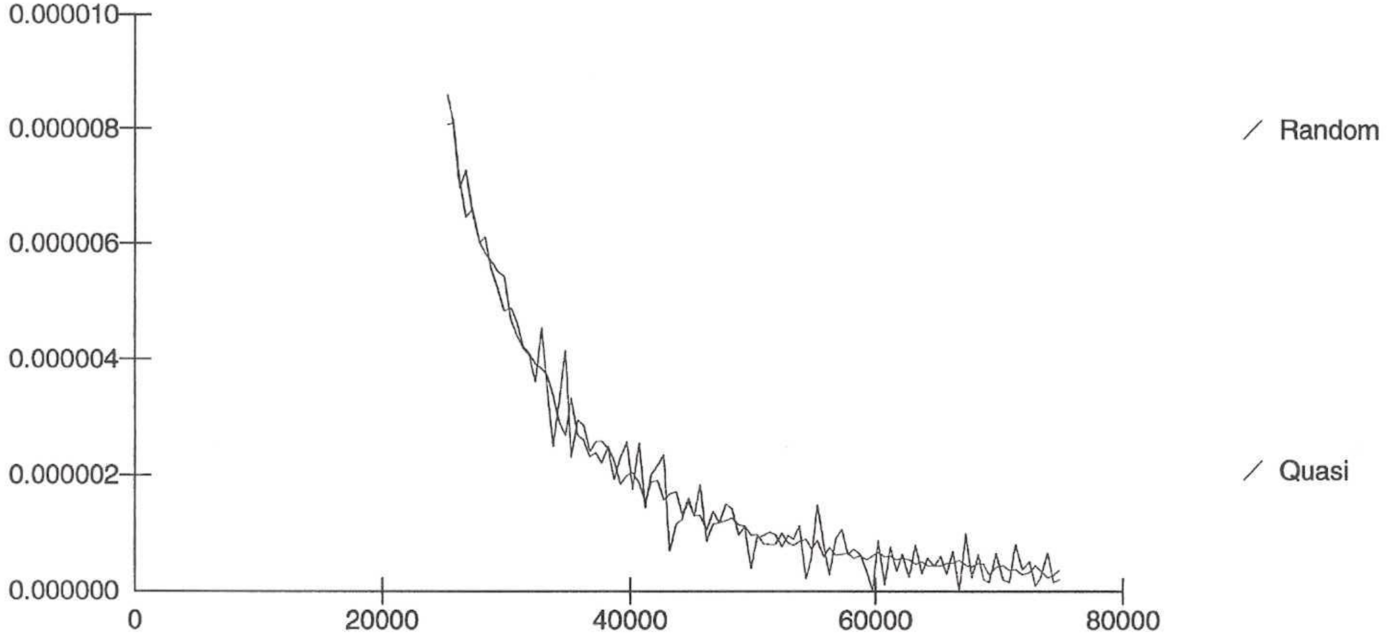
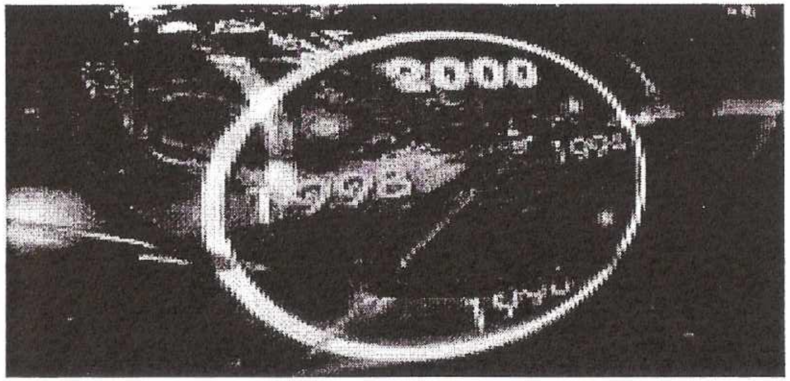
- density function not smooth
  - – however, summary values (e.g. the area under a tail) converge faster



Sampling Sequences



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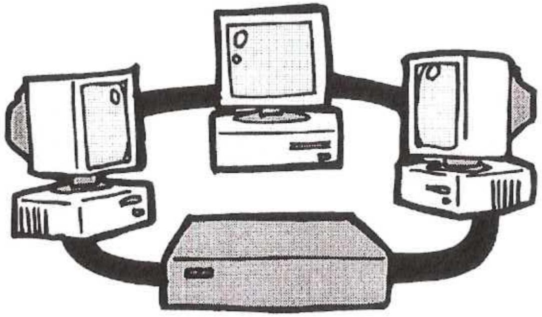
- not just a one year situation
  - multi year - what about when exposure is stochastic?
  - first scenario: exposure = 100,000
  - generate claim count from Poisson(10)
  - second scenario: exposure = 110,000
  - generate claim count from Poisson(11)

Parallel Processing

CLASSIC SOLUTIONS



- can it be done?
  - at least three software packages do it
- independence of iterations
  - need to co-ordinate seed values
- information bottlenecks

Parallel Processing

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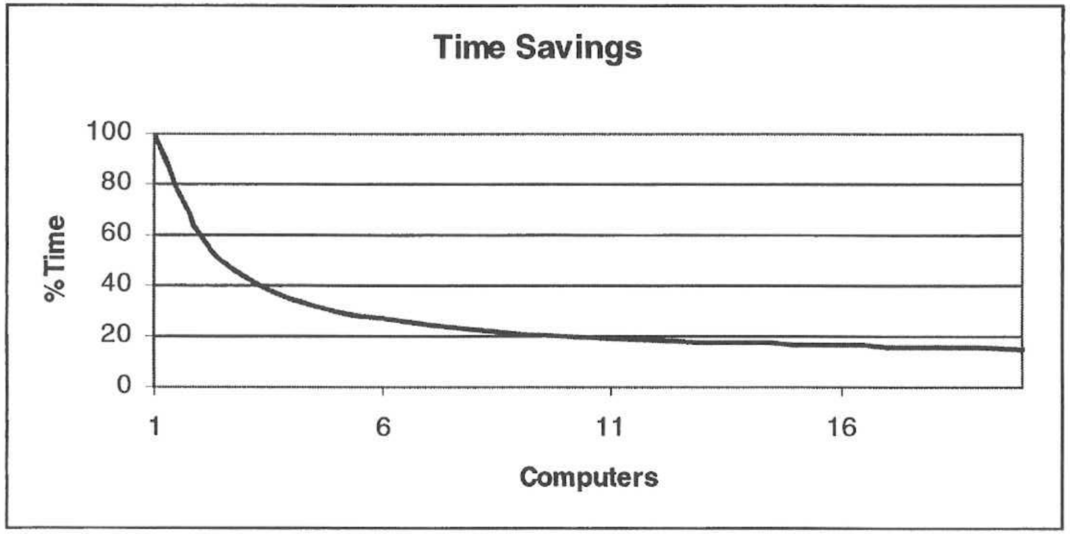
- what are the speed advantages?
  - 2 machines = 60% time requirements



- cost of computers versus cost of clever solutions

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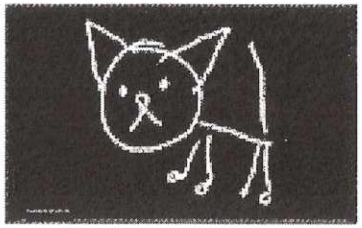
Modelling Shortcuts

- aggregate distributions
  - reinsurance considerations
  - risk shape considerations
  - difficult to measure risk management options
- only recalculate changes

Modelling Shortcuts

- correlations versus causative relationships
  - correlated samples are slow to generate
- choose the number of iterations to match the resolution required

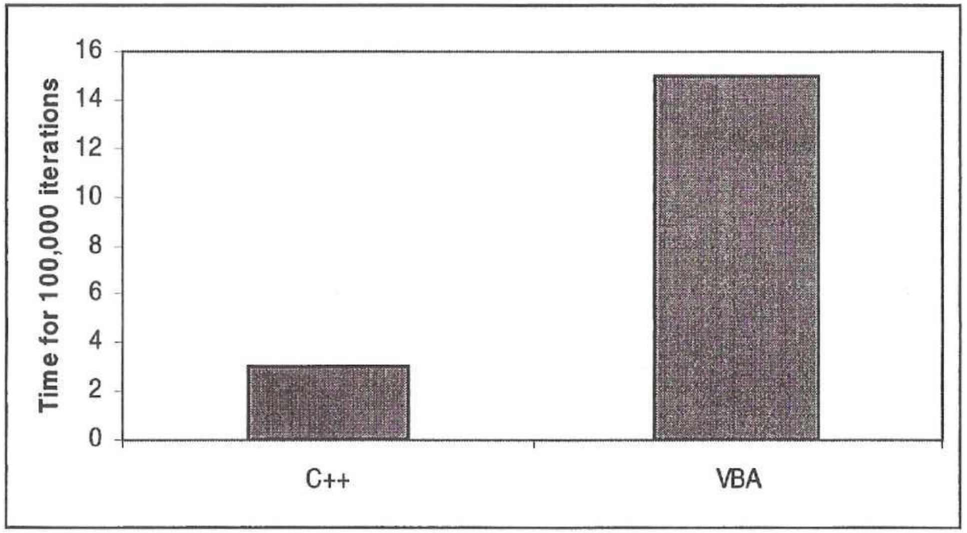


Platform

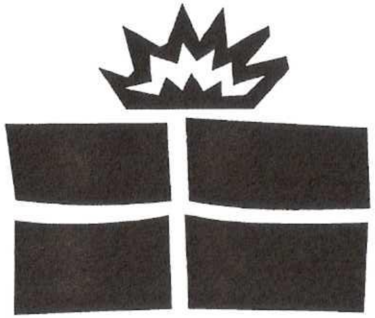
CLASSIC SOLUTIONS

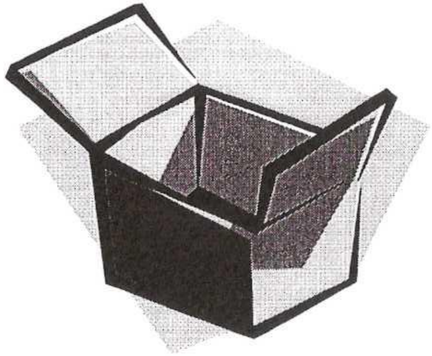
```
Private Sub cmdSystem_Click()
    frmSystem.Show 1
    Unload frmSystem
    LoadRunParms
End Sub
```

- compiled code versus interpreted languages
  - compiled code runs faster



Platform





- black box versus open system
  - nothing is standard
  - everything needs to be customised
  - how do things work