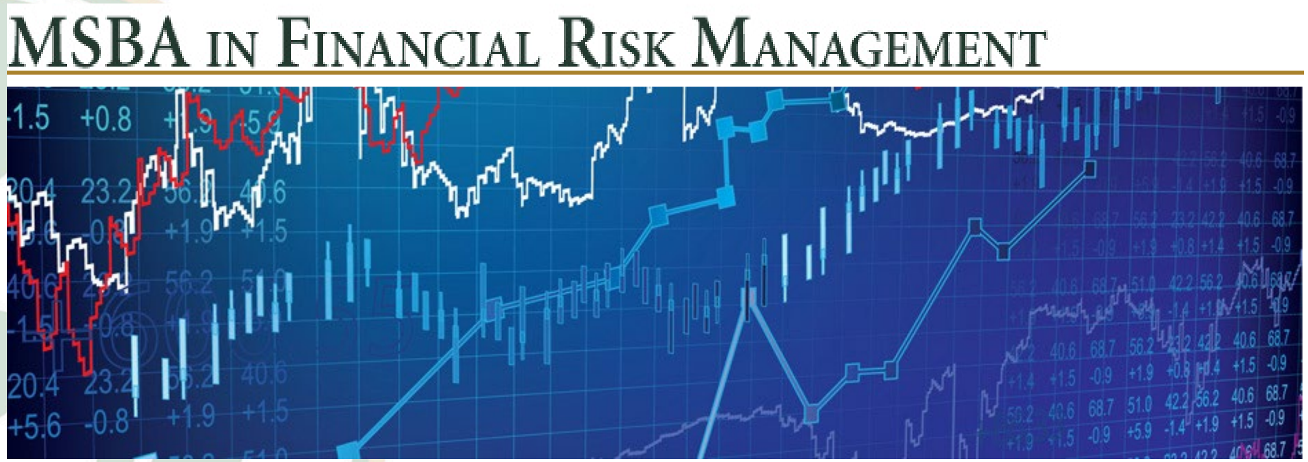
Financial Risk Management

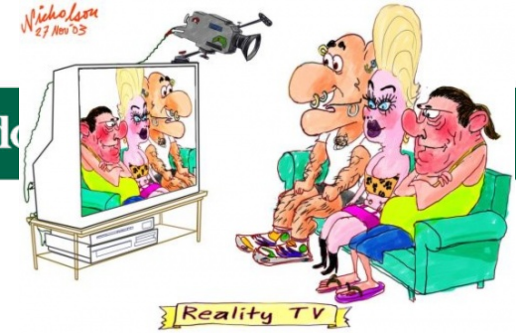


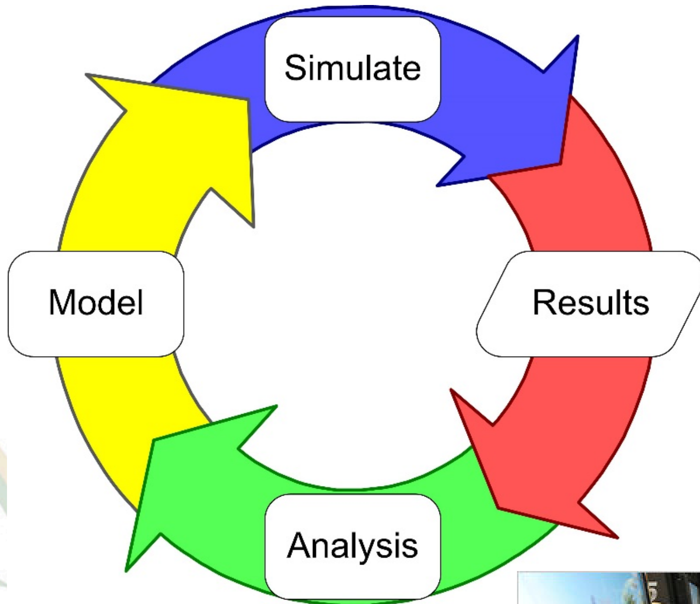
Colorado State University

Further Discussion On Simulation

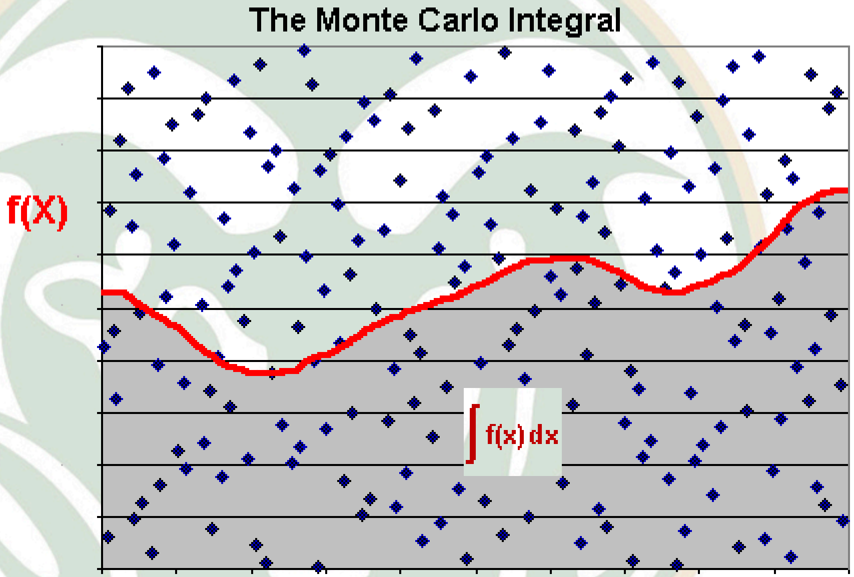
Colorad

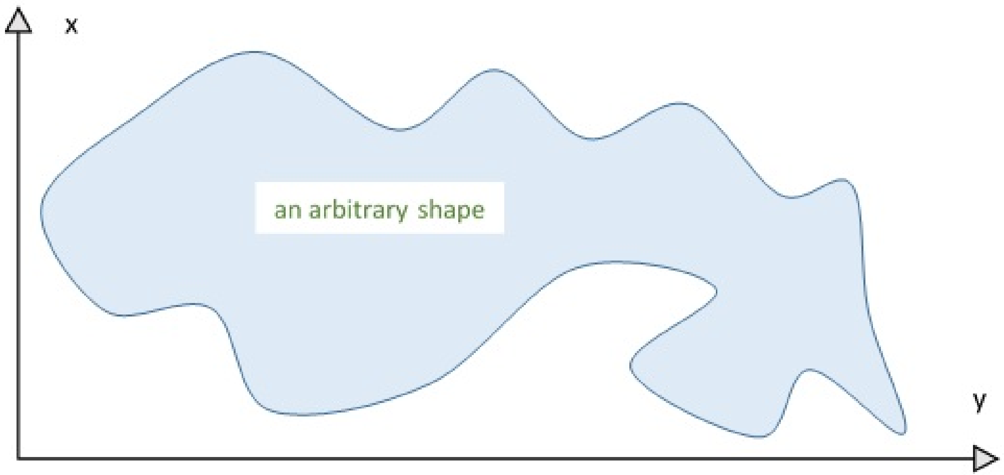
Simulation

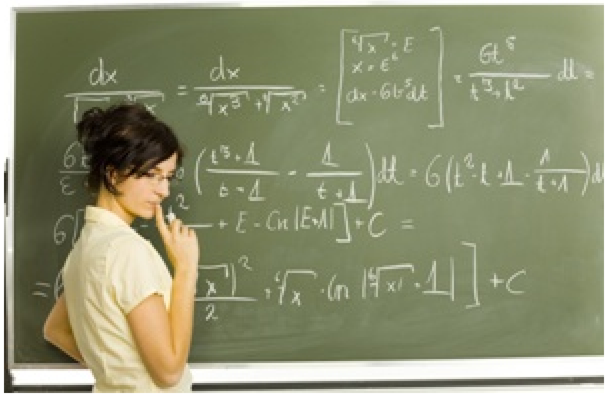




Numerical Integration

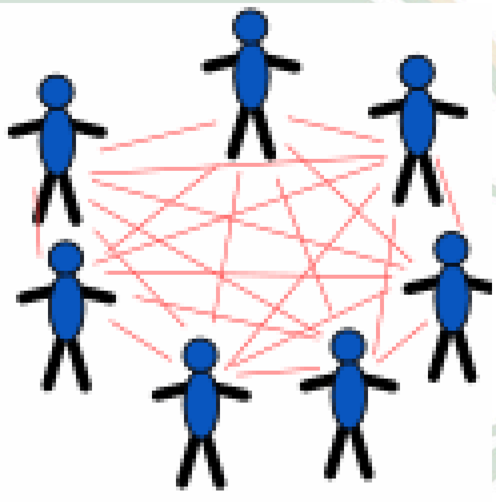


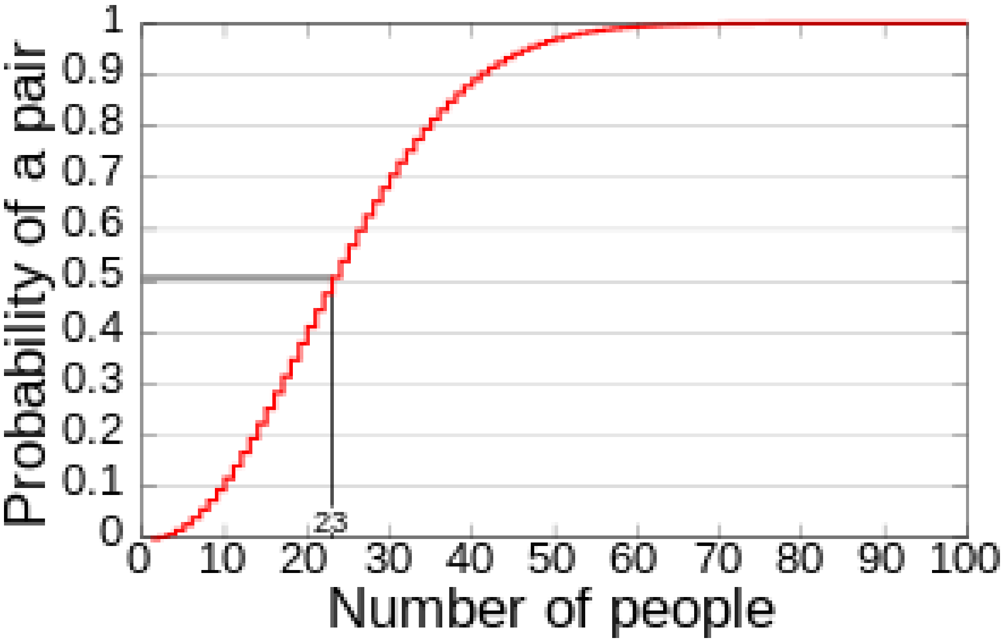




Shared Birthdays

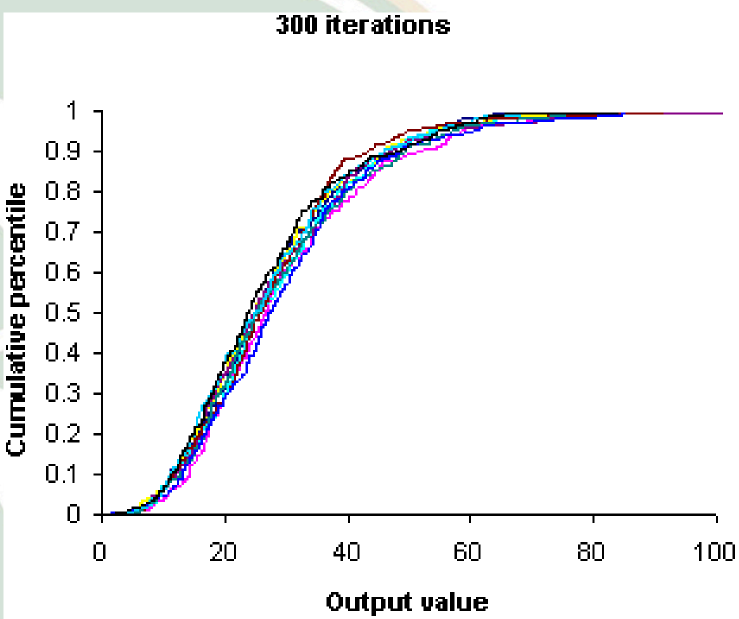
- There are 30 people in a room ... what is the chance that any two of them celebrate their birthday on the same day? Assume 365 days in a year.

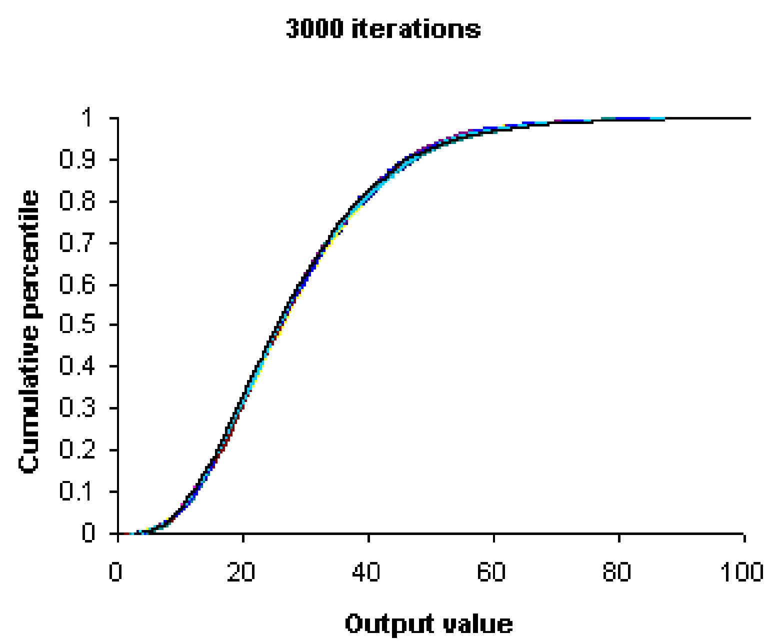




The Minimum Iterations to Run

- A short answer, burdened with many caveats, is "no less than 300'. At 300 iterations you start to get a reasonably well defined cumulative distribution





How Many Iterations to Run

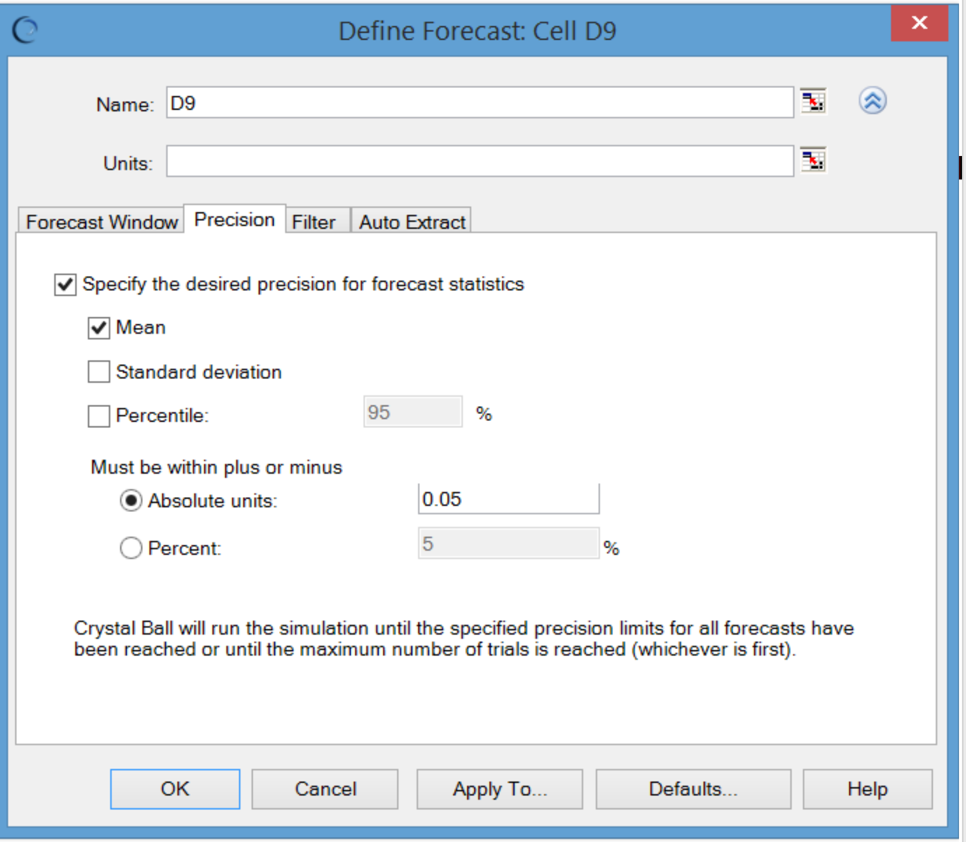
In general, you'll have two opposing pressures:

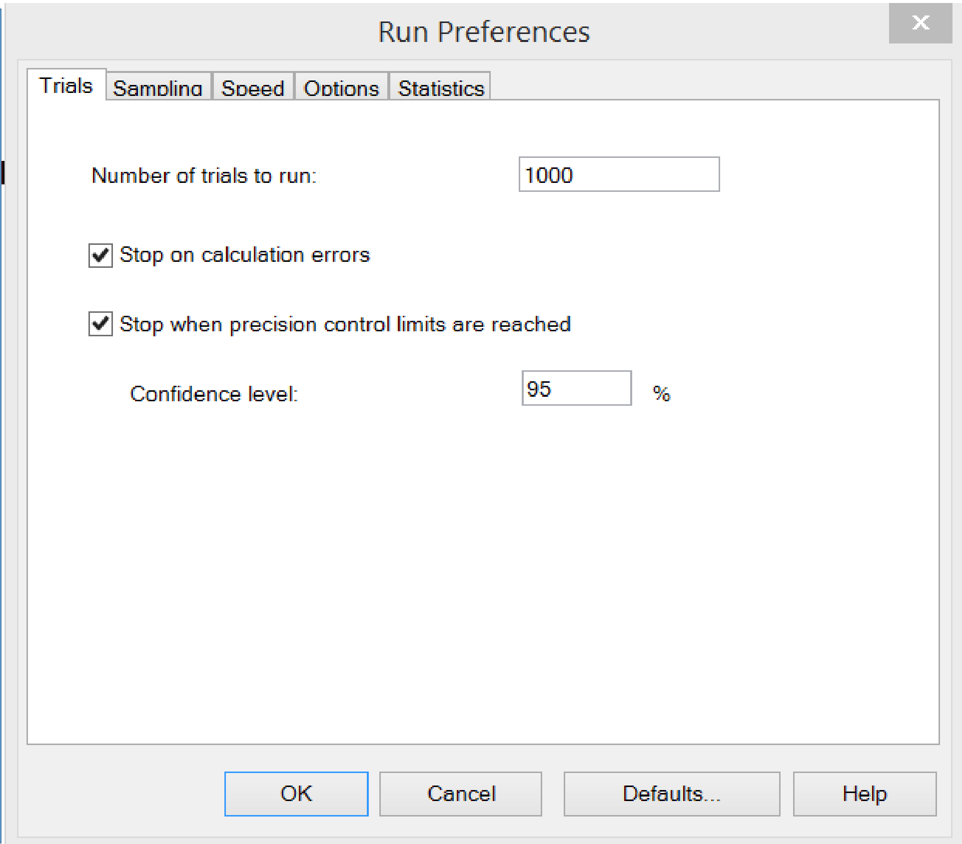
- Too few iterations and you get inaccurate outputs, graphs (particularly histogram plots) that look "scruffy';
- Too many iterations and it takes a long time to simulate, and it may take even longer to plot graphs, export and analyze data, etc. afterwards.

$$\mu = N\left(\bar{x}, \sigma / \sqrt{n}\right)$$

$$n > \left(\frac{\sigma * z}{\delta}\right)^2$$

Precision Control





The Chi-Squared Goodness-of-Fit Statistic

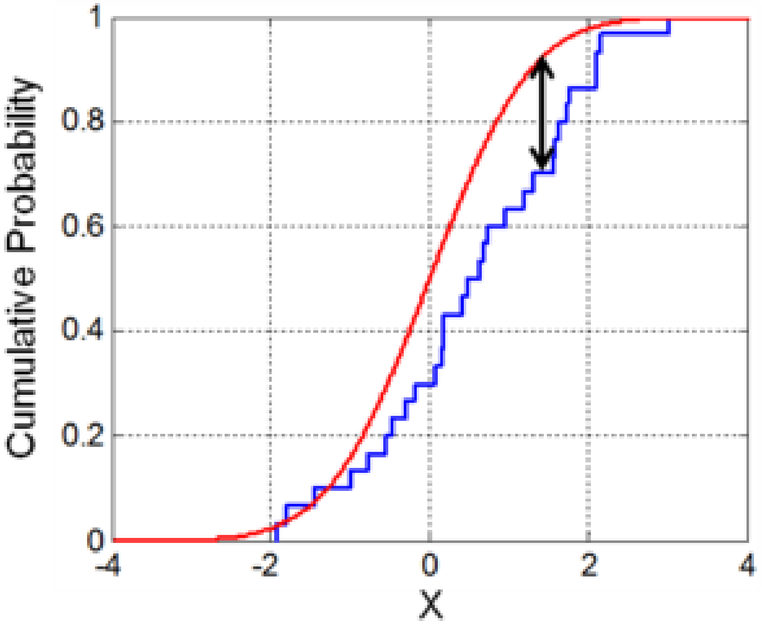
- The Chi-squared statistic measures how well the expected frequency of the fitted distribution compares with the observed frequency of a histogram of the observed data.

$$\chi^2 = \sum_i \frac{\{O(i) - E(i)\}^2}{E(i)}$$

Kolmogorov-Smirnoff (K-S) Statistic

The K-S statistic Dn is defined as:

$$Dn = \max \left[\,|\, Fn(x) - F(x) \,|\, \right]$$



where

Dn is know as the K-S distance

n = total number of data points

$F(x)$ = distribution function of the fitted distribution

$Fn(x) = i/n$

i = the cumulative rank of the data point

Anderson-Darling (A-D) Statistic

The A-D statistic is defined as:

$$A_n^2 = \int_{-\infty}^{\infty} \left| F_n(x) - F(x) \right|^2 \Psi(x) . f(x) dx$$

where $$\Psi(x) = \frac{n}{F(x).\{1 - F(x)\}}$$

n = total number of data points

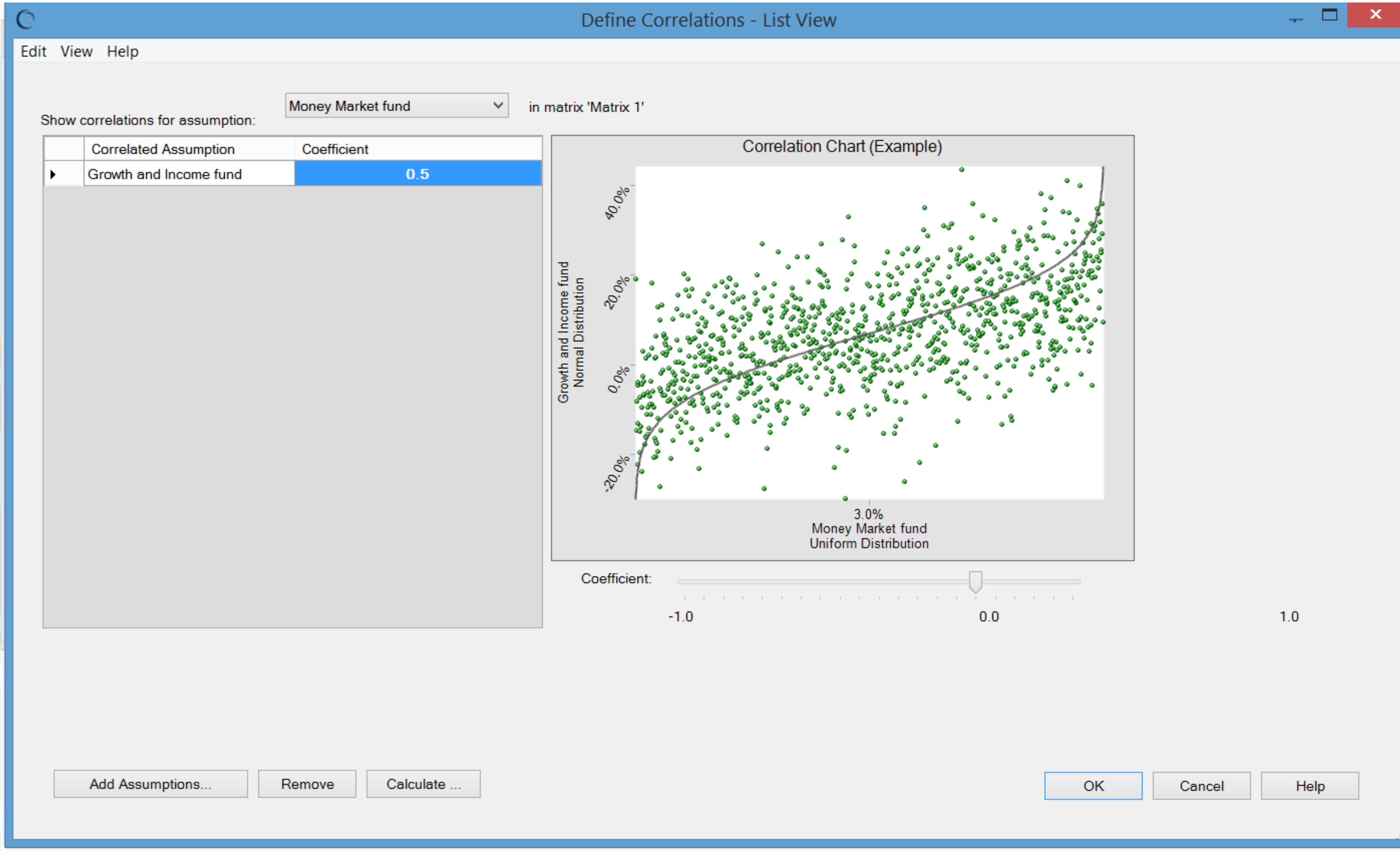
F(x) = distribution function of the fitted distribution

f(x) = density function of the fitted distribution

Fn(x) = *i/n*

i = the cumulative rank of the data point

Define Correlations



Crystal Ball Tools

Batch Fit

The Batch Fit tool lets you "automatically" fit (continuous) probability distributions to multiple data series.

Correlation Matrix

The Correlation Matrix lets you enter a matrix of correlations between assumptions in one step.

Tornado Chart

The Tornado Chart Tool allows you to determine the impact of each model variable (one at a time) on one specific forecast.

Bootstrap

Crystal Ball's Bootstrap tool looks at how robust your simulation forecast statistics are. For example, given that you have done 10,000 iterations, the Bootstrap Tool determines how precisely the forecast statistics have been determined, meaning by how much would those statistics change if one were to run an essentially infinite number of iterations.

Crystal Ball Tools

Decision Table

The Decision Table tool allows you to run multiple simulations to test different values of one or two decision variables.

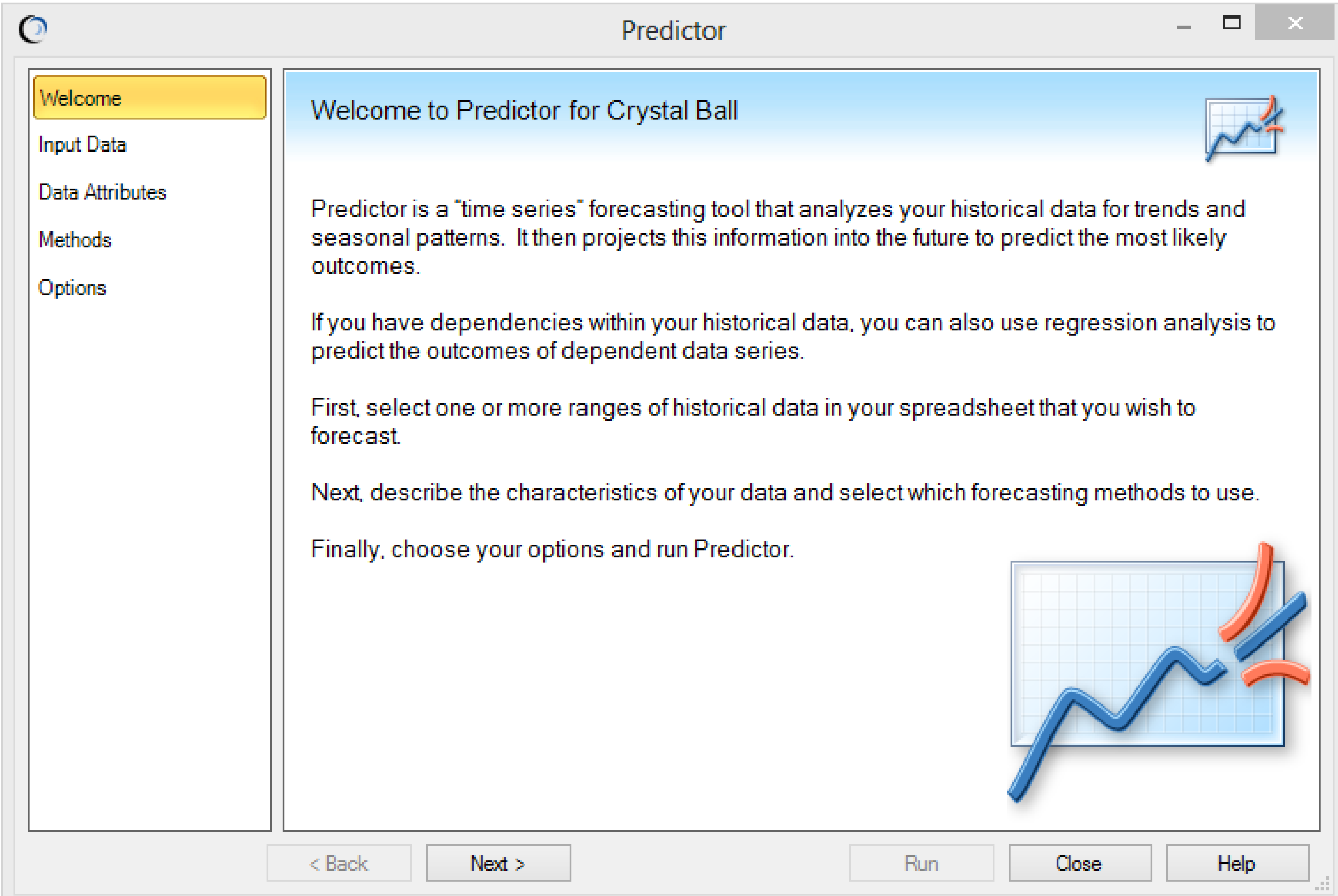
Scenario Analysis

The Scenario Analysis Tool allows you to examine which combination of assumption values gives you a certain forecast result. The tool runs a simulation after which it matches all the forecasts with their corresponding assumption values. In the resulting table, it shows all the forecast values in the range you specified (e.g. between 95% and 100% percentile) sorted, along with all the corresponding assumption (input) values. This tool can therefore be used as one of the methods to get a better understanding of an output of a simulation.

Two dimensional Simulation

The Two-Dimensional Simulation Tool in Crystal Ball lets you separate the effect of uncertainty (lack of knowledge) and variability and randomness in a forecast.

Predictor


Predictor
Welcome
Input Data
Data Attributes
Methods
Options
Welcome to Predictor for Crystal Ball
Predictor is a "time series" forecasting tool that analyzes your historical data for trends and seasonal patterns. It then projects this information into the future to predict the most likely outcomes.
If you have dependencies within your historical data, you can also use regression analysis to predict the outcomes of dependent data series.
First, select one or more ranges of historical data in your spreadsheet that you wish to forecast.
Next, describe the characteristics of your data and select which forecasting methods to use.
Finally, choose your options and run Predictor.
< Back
Next >
Run
Close
Help

Measures of Accuracy

- The forecast error is the difference between the actual value and the forecast, $E_{\mathrm{t}\text{-}k,t} = Y_{\mathrm{t}} - F_{t\text{-}k,t}$.
- Forecasting software packages report several summary measures of the forecast errors.
- Mean Absolute Error: $\mathrm{MAE} = (\sum_{t=1}^{N} | E_t |) / N$
- Root Mean Square Error: $\mathrm{RMSE} = \sqrt{(\sum_{t=1}^{N} E_t^2) / N}$
- Mean Absolute Percentage Error:

$$\mathrm{MAPE} = 100\% \times (\sum_{t=1}^{N} | E_t / Y_t |) / N$$

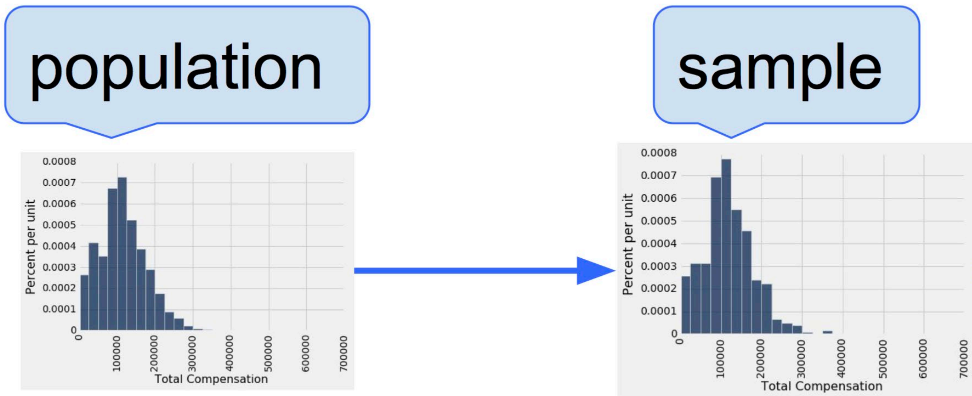
- One other measure of the forecast error is the average of all errors.

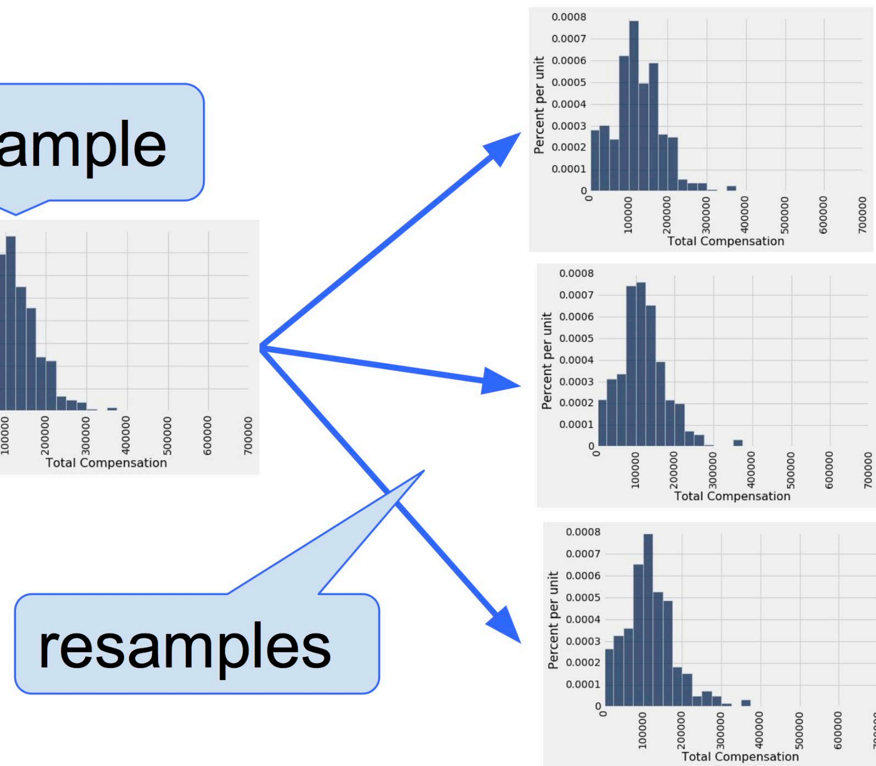
Determining Performance

- **Theil's *U*** determins the forecasting performance of the model.
- The interpretation in daily language is as follows:

- **Interpret (1- Thei'l *U*)**
- 1.00 – 0.80 High (strong) forecasting power
- 0.80 – 0.60 Moderately high forecasting power
- 0.60 – 0.40 Moderate forecasting power
- 0.40 – 0.20 Weak forecasting power
- 0.20 – 0.00 Very weak forecasting power

Boot Strap





All of these look pretty similar, most likely.

Jackknife

- The Bootstrap was originally developed from a much earlier technique called the Jackknife, invented by the brilliant and practical statistician John Wilder Tukey (1915-2000). The Jackknife was used to review the robustness of a statistic calculated from a set of data.
- A Jackknife value was the statistic of interest calculated with the ith value removed from the data set and is given the notation θ(i). With a data set of n values, one thus has n Jackknife values, the distribution of which gives a feel for the uncertainty one has about the true value of the statistic. We say "gives a feel" because the reader is certainly not recommended to use the Jackknife as a method for obtaining any precise estimate of uncertainty. The Jackknife turns out to be an awful estimation of uncertainty.
- like a physical jack-knife (a compact folding knife), it is a rough-and-ready tool that can improvise a solution for a variety of problems even though specific problems may be more efficiently solved with a purpose-designed tool.

The “analytics” realm

Descriptive
What happened

Predictive
What might happen

Prescriptive
What to do about it

Next bottle

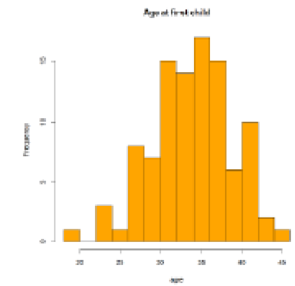
20%

80%

Probability distributions in simulation modeling

Heterogeneity/inter-individual variability: collection of differences between individuals/entities

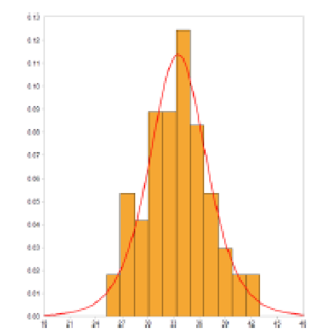
e.g. Heights, Income, FICO scores



Randomness/variability: differences observed due to **chance**.

Natural: inherent to the system evaluated e.g. equipment failure rates, loan defaults, natural disasters

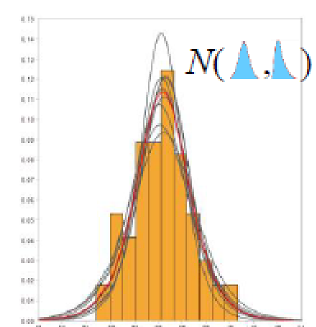
Artificial: sampling. e.g. quality control, surveys



Uncertainty: What we don't know. Unlike two above, a *function of the **observer***.

Thus, **can be reduced** as more data is collected

e.g. Demand growth, stock drift, true prevalence of a disease



ORACLE
CRYSTAL BALL

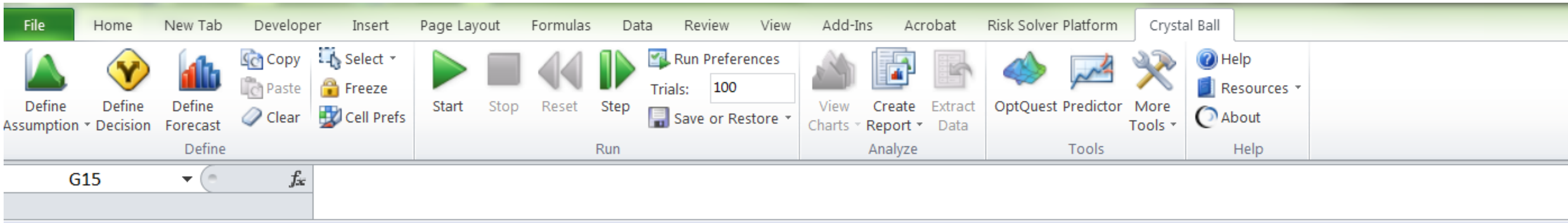
Applications with Crystal Ball

Walton Bookstore Using Crystal Ball

- Let's assume a different demand distribution this time.
- Demand follows a triangular distribution with

Demand distribution - triangular	
Minimum	100
Most likely	175
Maximum	300

Crystal Ball Examples



Crystal Ball Examples Guide

Model Name	Industry	Application	Product Demonstrated	Feature Demonstrated
Cell Phone			Crystal Ball simulation Crystal Ball Tools	Sensitivity Analysis
Cost Estimation	Construction	Project Management Cost Estimation	Developer Kit	
Critical Path	Consumer Goods	Project Management Six Sigma	Crystal Ball simulation Developer Kit	Cell Referencing Crystal Ball Functions
DCF Analysis	Pharmaceuticals	Financial Analysis Valuation	Crystal Ball simulation	Trend Chart
DFSS Fluid Pump	Manufacturing	Design For Six Sigma (DFSS)	OptQuest	Capability Metrics Scatter Charts
Drill Bit Replacement	Mining Oil & Gas		OptQuest	
Futura Apartments			Crystal Ball simulation Crystal Ball Tools	Bootstrap

Vision Research

- Vision Research has completed preliminary development of a new drug, code-named ClearView, that corrects nearsightedness. This revolutionary new product could be completely developed and tested in time for release next year if the FDA approves the product.

- Uncertainty around costs, # of patients cured, and market potential for product

- Should the company scrap the ClearView project or proceed to develop and market this revolutionary new drug?

Vision Research

Pharmaceutical Research - ClearView Project

		Suggested Assumptions:	P1	P2	P3
Costs (in millions)					
Development Cost of ClearView to Date	$10.0				
Testing Costs	$4.0	*Uniform*	$3	$5	
Marketing Costs	$16.0	*Triangular*	$12	$16	$18
Total Costs	$30.0				
Drug Test (sample of 100 patients)					
Patients Cured	100	*Binomial*	25%	100	
FDA Approved if 20 or More Patients Cured	TRUE				
Market Study (in millions)					
Persons in U.S. with Nearsightedness Today	40.0				
Growth Rate of Nearsightedness	2.00%	*Custom*	0%	5%	75%
Persons with Nearsightedness After One Year	40.8		-15%	-5%	25%
Gross Profit on Dosages Sold					
Market Penetration	8.00%	*Normal*	8%	2.0%	
Profit Per Customer in Dollars	$12.00				
Gross Profit if Approved (MM)	$39.2				
Net Profit (MM)	$9.2				

DCF Analysis

- Your pharmaceutical company is very interested in acquiring AllergyGone, a potential new anti-allergy drug with no known side effects. You have been asked to produce a Discounted Cash Flow (DCF) analysis of AllergyGone over a five-year period to determine if this product is worth acquiring.
- Because of the uncertainty in the product pricing, demands, and costs, your company has decided to use Crystal Ball to simulate the Net Present Value (NPV) and Internal Rate of Return (IRR) prior to negotiations. Crystal Ball can help you determine a bottom-line negotiation price and the model variables that drive the variability in the NPV and IRR forecasts.

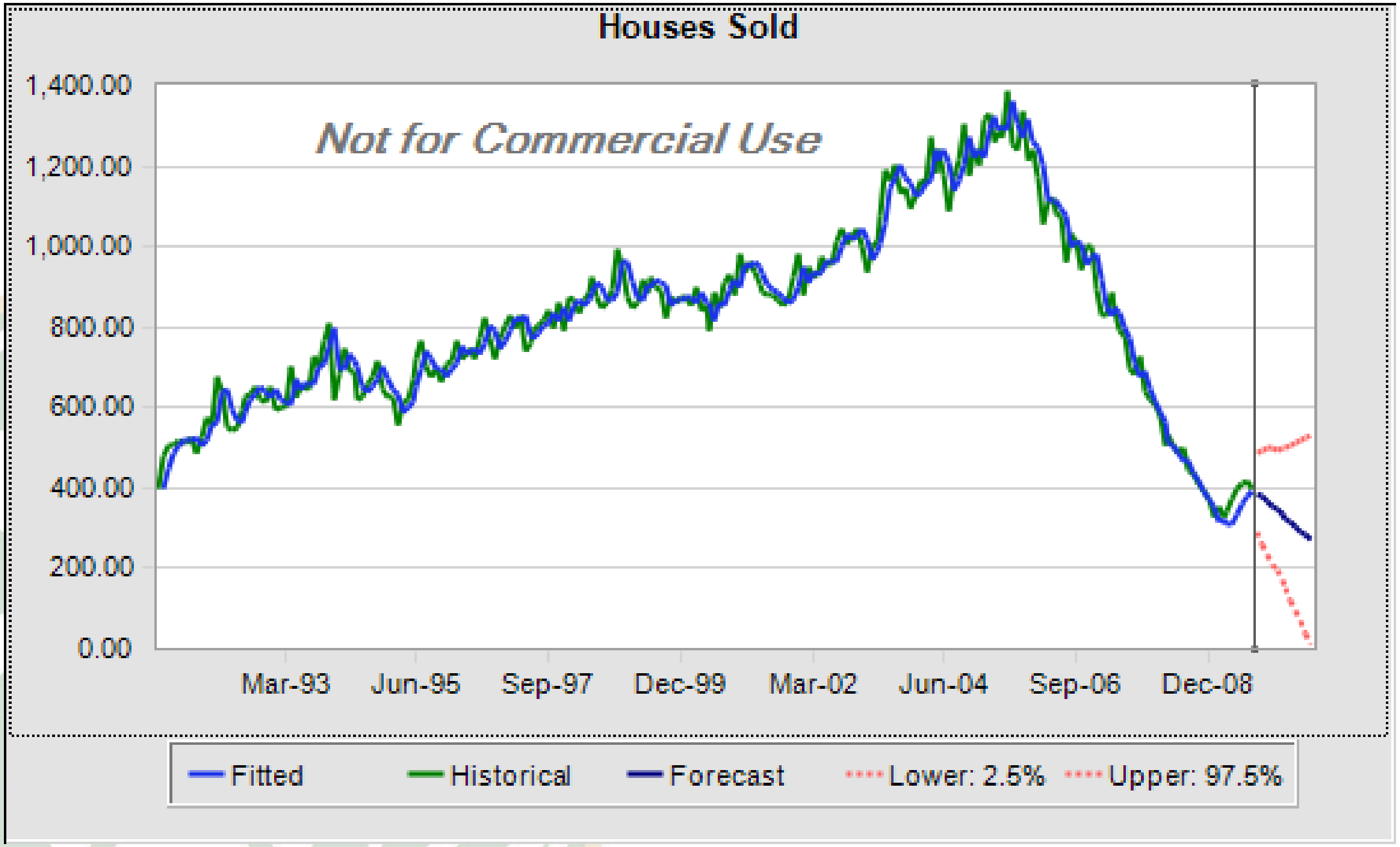
Inventory Management

- In inventory systems, demand is usually uncertain, and the lead time can also vary. To avoid shortages, managers often maintain a safety stock. In such situations, it is not clear what order quantities and reorder points will minimize expected total inventory cost.
- Uncertainty around weekly product demand
- Use Crystal Ball to determine the range of expected costs and quantify the impact of changes in order policy.

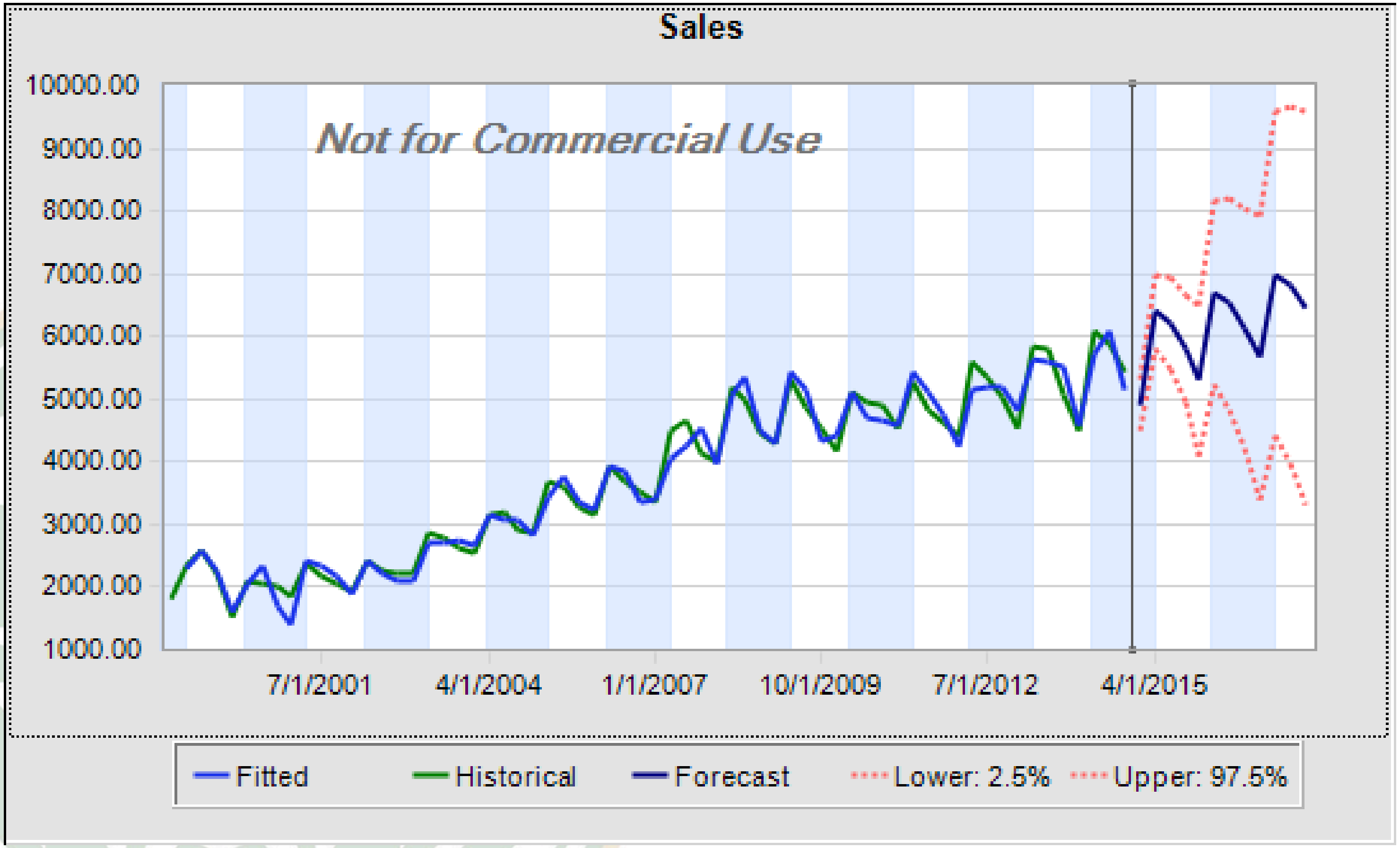
Brain Teaser…

- A) The average number of tosses until HTH is larger than the average number of tosses until HTT.
- B) The average number of tosses until HTH is the same as the average number of tosses until HTT.
- C) The average number of tosses until HTH is smaller than the average number of tosses until HTT.

House Sales


Houses Sold
Not for Commercial Use
1,400.00
1,200.00
1,000.00
800.00
600.00
400.00
200.00
0.00
Mar-93
Jun-95
Sep-97
Dec-99
Mar-02
Jun-04
Sep-06
Dec-08
Fitted
Historical
Forecast
Lower: 2.5%
Upper: 97.5%

Soft Drink Sales



Magazine Sales

Magazine Checkout Sales

	Magazine A	*Magazine B*	*Magazine C*	*Magazine D*
Sales Volume	562	362	646	508
Retail Price	$4.95	$7.95	$3.95	$5.95
Cost of Goods	$2.20	$3.80	$1.95	$2.40
Gross Profit	$1,546	$1,502	$1,292	$1,805

Total Gross Profit: $6,144

Cartoon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FLIGHT SIMULATOR
search ID: mba0785


I'M AFRAID HE CAN'T COME TO THE PHONE, HE'S IN THE MIDDLE OF A MONTE CARLO SIMULATION
Deals Department
BRMM BRMM!
RALLY!
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