

ISSUE 39 | APRIL 2011

SOCIETY OF ACTUARIES

Technology  
Section

# CompAct

ELECTRONIC NEWSLETTER



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### LETTER FROM THE CHAIR

by Jeffrey Pomerantz

Greetings!!! I have been doing a lot of thinking about what to write about in this edition of *CompAct* and doing some reading on technology whenever I get the chance. I am by no means what anyone would call a technology expert. However, a lot of people could tell you that there always seems to be something new coming out or at least in the works.

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## **APPS FOR ACTUARIES UPDATE**

by Meg Weber

It seems like everyone is entering the world of apps.

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## **ONLINE RESOURCES FOR ACTUARIES**

by Mary Pat Campbell

Warning: given the "dynamic" aspect of the Web, the links [in this article] may change between the time of this writing and the time you're reading it.

[\[ full article \]](#)

## **R CORNER: EXTREME GREY SWAN SCENARIOS—DMFBM**

by Steve Craighead

In "The Black Swan," Taleb makes a distinction between extreme scenarios that can be modeled (Mandelbrotian Grey Swans) and those that cannot (Black Swans).

[\[ full article \]](#)

## **NUMBER PUZZLE**

by Marc Whinston

A challenging, fun puzzle for the readers of CompAct. Answers are due to Marc Whinston, at [mwhinston@tiaa-cref.org](mailto:mwhinston@tiaa-cref.org), by May 24.

[\[ full article \]](#)

## **LAST ISSUE'S NUMBER PUZZLE SOLVED**

by Marc Whinston

Congratulations to the solvers of the January issue puzzle! They are: Andy Boyer (Milliman), Ken Klingler (Aegon USA), and Lee Michelson (Office of the Insurance Commissioner, Washington)

[\[ full article \]](#)

## **ARTICLES NEEDED FOR COMPACT NEWSLETTER**

Your help and participation are needed: Articles, book reviews and other information on technology useful to actuaries are needed!

[\[ full article \]](#)



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## LETTER FROM THE CHAIR

by Jeffrey Pomerantz

Greetings!!! I have been doing a lot of thinking about what to write about in this edition of *CompAct* and doing some reading on technology whenever I get the chance. I am by no means what anyone would call a technology expert. However, a lot of people could tell you that there always seems to be something new coming out or at least in the works. There have been so many recent innovations in technology that it's almost hard to keep up. Here are some of the things that have become more popular in recent years, with year of first use/launch noted:

- Texting—first used in 1992, but its use is exploding now
- Digital video recorders (TiVo launched in 1999)
- Smart phones (early 2000s)
- Business-oriented social networking—(e.g., LinkedIn in 2003)
- Personal social networking (e.g., Facebook in 2004, Twitter in 2006)
- Portable e-book readers (Kindle in November of 2007)
- Touchscreen tablet computers (iPad released in April of 2010)

Today, there is also a slew of articles on 3D-ready and Internet-enabled television sets, video streaming, and more. I'm sure I missed plenty of innovations, but these are the ones that stick out in my mind. Which is your favorite? Mine might still be the DVR—I can't even make a guess at how much time I have saved over the years

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by not watching commercials. I have missed a few good ones, but that's a trade-off I'd make any day.

Technology is truly everywhere, and it's clear that it's not slowing down. In addition to each of these innovations being significant on its own, their value, both individually and collectively, has been further increased by being connected to one another. For example, it is becoming easier and easier to post information to the Web with special buttons. Some phones actually have a Facebook button. YouTube and Facebook posting buttons are everywhere. Sharing information was never easier. Everything is literally at our fingertips.

Are there only positives to the technology revolution? As good as things are, and as cool as all the gadgets have become, there are some definite drawbacks that have been well-documented:

- Security/Privacy
  - People's identities, personal information, and location are being shared without their knowledge. This is a very hot topic, and everyone needs to be aware of the security/privacy being afforded to them through each application they use.
- Personal relationships/communication
  - One recent Wall Street Journal article I read estimated that the average 13-17-year-old sends and receives about 3,300 texts a month. One friend of mine mentioned that his 13-year-old daughter hardly talks to her friends on the phone. A lot of people today clearly seem to be texting more than they are talking. It's just easier. Texting is always available. People can always be reached. Who leaves voicemails anymore?

Think about these questions for a second:

- Do you often hang up when you get someone's voicemail at work and send an e-mail or instant message instead?
- Do you see people staring at their phones when they're on the train, at a ballgame, etc.
- How many hours per week do you or your kids spend on the computer, where in prior years, or in your childhood, you would have played outside? Note that there's also a lack of exercise that results from too much technology use.

- Personal safety
  - Texting or talking on the phone on a handheld device while driving is clearly dangerous. Have you ever texted something while at a red light, and you didn't quite finish by the time the light turned green? Dangers in this behavior are clear.

So, we need to appreciate all of the positives that technology offers but be sure not to overlook any negatives.

### Final Thoughts

But what does this all mean for the world today? What does it mean for the actuarial profession? Think about how these apps might help you in your career. What apps could you or other actuaries use in your work and in taking exams. Be sure to take a look at the article "Apps For Actuaries Update" in this issue and to check out the "Apps for Actuaries" session at the Life and Annuity Symposium.

Also, the SOA Technology Section has a group on LinkedIn, so if you would like to learn more and contribute to the "Apps for Actuaries" and other discussions, please check that out as well. Please feel free to contact me or any Technology Section Council member with any ideas of how we as a section can better serve your needs.

I just want to end with a call for volunteers. Please contact [me](#), [Richard Junker](#), or [Eddie Smith](#) if you are willing to submit an article for a future issue of *CompAct*. We are also looking for any volunteers who would like to serve on next year's section council. Elections will be held in the late summer. Let me know and I will be glad to answer any questions you might have.



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## EDITOR'S NOTES

by Howard Callif

Are you really, really busy? I know all of the editors at *CompAct* are! As you may be aware, I am transitioning out of the co-editor position, and am very pleased to announce that Richard Junker is taking on the role. Richard serves on the [Technology Section council](#)—as does Eddie—so making time to solicit and edit articles is definitely a challenge.

Being editor of *CompAct* has been a lot of work, but it has also been a great learning experience. I am proud of all of the issues that I worked on, and happy that I have been able to contribute to the SOA. All of the people I have worked with have been willing to spend time to share wisdom and knowledge with me, and the *CompAct* readership, and that is a wonderful thing to be a part of. I think now is a good opportunity to point out that producing *CompAct* is a team effort, and there are a lot of people behind the scenes who help in the process. Thanks to all of them!

I would like to especially thank Sam Phillips and Meg Weber. Sam Phillips is our SOA staff editor, and he has worked hard to edit and set up every article for every issue. Many times articles were submitted with little time to spare, and Sam always got the job done. Meg Weber is the Technology Section staff partner, and her wisdom and advice has contributed immensely to the section. Whenever I needed information from the SOA, she either knew the answer, or knew who to contact to get it. Even more importantly, she made me feel welcome, and has been great to meet with at annual meetings. Thanks!

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I'd also like to thank Eddie & Richard. It is a lot easier to step down knowing that the both of you are so capable and energized. I know that *CompAct* will thrive because of your talent and enthusiasm. Good Luck!

This issue of *CompAct* has the first of a four part series of articles to introduce Database concepts and terminology. In addition, we have also included a summary of online resources that can be used as a starting point to find actuarial related information. If you have a resource that you use frequently, please share it with one of the editors, and we will ensure that it is added to the list! Hopefully, some of these tips can help you be more productive, and less busy!



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## INTRODUCTION TO NEW CO-EDITOR

by Rich Junker

A few short months ago I dipped myself into the Technology Section, seeking to identify a role that would fit my natural bent. Proofreading articles appealed to me, and there was a need. The surging current took over, and before I knew it I found myself in mid-stream, coursing along as new co-editor of the *CompAct* Newsletter! That's the way it is with every volunteer organization, you are leading as soon as you get your bearings.

The latest issue is loaded with introductions to new and powerful tools. I'm astounded at the warp increase to the pace of innovation over the past three or so years. Each of us has a personal history, a peculiar skill, of applying new technology. I was pricing life insurance when the first Lotus software came out, and rode it through the years, automating no end of formerly manual processes. Despite our skill of accommodating change, veteran actuaries need mentors and wizards to help us sift through the incredible mass of new tools and apps, available to us. We also need to unlearn some of the tools that we have relied on in the past.

I am a consulting actuary, with a long-time focus on modeling life and annuity products in direct companies. In that role, I've been blessed to among the first to pioneer the hottest hardware and the most powerful software.

The Technology Section will be an ever more valuable Section for actuaries in coming years. It fulfills practitioners' need to identify new tools rapidly, that improve the quality and productivity of their work output. It's just too much to try to dig it out for yourself, when carrying

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a full workload already. With the continuing education standard now enhanced with the "Attestation of Compliance" requirement in place, your Technology Section stands as a preeminent resource for keeping your skills up-to-date.

When the Internet first emerged 15 years or so as a mainstream phenomenon, it was my golden discovery. I have always loved sharing cool websites and calculation engines with friends and colleagues. To serve as co-editor with Eddie Smith puts me alongside a person of similar temperament. And a person possessed of an amazing knowledge of Web 2.0 in all its manifestations.

We are the few, you the readers, are the many. If our publication is to meet your needs during Eddie's and my stewardship, your contributions will be the rocket fuel that propels the success of the *CompAct* Newsletter.

I look forward to serving you.



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## SPEAKING "DATA" PROPERLY

by Dan Rachlis

**This article is the first in a four-part series about eliminating the confusion with using data terminology.**

Data Mining, Data Analysis, Data Warehouse, Data Mart, Data Modeling, Data Requirements, Data Integration, Data Visualization, Data Cleansing, Data Transformation, Relational Database, Business Intelligence, Data Management, Data Architecture, Data Privacy, Data Security, Data Access, Data Integrity, Metadata, Data Backup, Disaster Recovery, Business Continuity Planning, Data Governance, Data Asset Customer Relationship Management (CRM) Software, Records Management, Data Structure, Data Movement.

Have you ever used any of the above terms? Chances are that you have and that you may be using them incorrectly. In an era where technology is continually advancing, electronic data can be found everywhere. In the healthcare actuarial industry especially, data and understanding how to manage the constant flow of information is vital to an organization's operational and financial viability. Actuaries need to be sure the analysis and opinions they provide are accurate; asking for the wrong data or not understanding what data to ask for can have a significant impact. This article defines and explains commonly-used data terms and aims to assist you with understanding and using them correctly in the future.

Let's start with the basics: What are data? **Data** refers to information about an event or transaction that has been translated and usually put into some tabular format. It can represent the qualitative or quantitative attributes of a variable from which it represents. Data

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(plural of datum, which is seldom used, at least by me) can also be used as the basis of graphs or analysis and is usually viewed as the lowest level from which information and knowledge are derived. Data by itself does not mean anything. For instance "99281"; what does that mean? Is it a zip code, a CPT code, my laptop combination lock code? Combining data together with a description about each variable creates the meaningful explanation of an event or transaction.

Now that we understand what data refers to, let's move on to managing it. Generally data can be categorized into the following data management groups.

### **Data Governance**

An asset can be defined as something that has a useful or valuable quality. Therefore, a **data asset** is a collection of data that can be said to provide useful information. **Data governance** refers to the overall formal management of data assets with respect to availability, usability, integrity, and security throughout the enterprise. Data governance ensures that data can be trusted and that people can be made accountable for any adverse event that happens because of low data quality. It assigns responsibilities to fix and prevent issues with data so that an enterprise can become more efficient. Data governance is an emerging discipline with an evolving definition. The discipline embodies a convergence of data quality, data management, data policies, business process management, and risk management surrounding the handling of data in an organization. Through data governance, organizations look to control the processes and methods used by their data stewards and data custodians. **Data Stewards** are commonly responsible for managing data as an enterprise asset. They have responsibility for data content, context and associated business rules. **Data Custodians** are primarily responsible for the underlying infrastructure and activities required to keep data intact as well as the safe custody, transport and storage of data. Simply put, data stewards are responsible for what is stored in a data field, while data custodians are responsible for the technical environment and database structure.

Future articles in this series will focus on data analysis and database management, data warehousing and business intelligence, and document and records management.

Dan Rachlis, ASA, is a specialist master in the Chicago office of Deloitte Consulting LLP. He has more than 20 years experience in

business, consulting and data management. He earned undergraduate degrees in Mathematics and Business Administration from Southern Illinois University and a master's degree from Loyola University in MSISM—Masters of Information Systems Management, a Certificate in Data Warehousing and Business Intelligence from Loyola University. He can be reached at [drachlis@deloitte.com](mailto:drachlis@deloitte.com) or at 312.486.5631.



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## APPS FOR ACTUARIES UPDATE

by Meg Weber

It seems like everyone is entering the world of apps. The term apps may not be so new for members of the Technology Section, but the proliferation of them is and so are the providers. You can even get apps from the U.S. Government: <http://apps.usa.gov/>.

Apps (for you more casual members of the Technology Section) are not just for Apple devices such as iPhones, iPods and iPads. There are apps available for all handheld devices, mobile phones of all types, and personal computers.

SOA Staff and members of the Technology Section converged on the idea that there were opportunities for the SOA to create or obtain apps for our members and candidates. Also, the section can provide real value to its members by identifying apps especially useful to actuaries. There have already been discussion threads on the Technology Section's LinkedIn site (join the group, if you haven't already: Society of Actuaries Technology Section on LinkedIn). Technology Section Council members Tim Deitz and Eddie Smith are serving in an important advisory capacity for the SOA in app development.

Here are some of the apps the SOA will pilot or launch in 2011:

- At the Health Meeting in June: a Meeting App available to attendees that will provide information on sessions, speakers and handouts via various mobile devices.
- Currently under development: SOA e-learning available for iPads.

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- Later this year: a simplified version of the Online Directory of Actuarial Memberships from which users will be able to search, initiate phone calls, emails, and add contacts to their iPhones/iPads, Blackberries, or Androids.

At both the Life & Annuity Symposium and the Health Meeting the Technology Section is hosting sessions that include demonstrations of these, information about other business apps, and the chance for attendees to provide input as to what the SOA should do next. All great ideas are welcome. Feel free to contact [Tim](#), [Eddie](#) or [me](#).



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## ONLINE RESOURCES FOR ACTUARIES

by Mary Pat Campbell

Warning: given the "dynamic" aspect of the Web, the links for the below may change between the time of this writing and the time you're reading it. In many cases, the resources will still exist, just at a different location. I hope I have given enough information that it will be findable via normal Internet search methods if the links have changed.

### Mortality tables and studies

*SOA Resources*

If you visit the [SOA Tech Section webpage](#), you will see three links under the heading "Mortality and Morbidity Tables." As of my writing, **there are 944 tables on offer** in the project, and the tables can either be downloaded **directly in XTbML format** or you can use the **convenient Excel Add-In** which will retrieve the desired table directly into your spreadsheet.

In addition to getting the tables themselves, you will get a short description as well as any references in literature (e.g., which issue of the *Transactions of the SOA* the table was published in.).

In addition, one can access the SOA's experience studies via its [research page](#). There are studies in life insurance, annuities and pensions.

### **The Continuous Mortality Investigation**



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On the other side of the pond, our British brethren have their own experience studies. They have CMI reports going back to 1973, but what I've also found interesting are their working papers on mortality trend models as well as stochastic mortality modeling.

For example, their [most recent mortality projection](#) comes with a very [large Excel spreadsheet](#) with full inputs (so one could, say, change the base mortality rates and other parameters) that could be adapted for use in other countries. (U.K. experience has a very strong cohort effect in mortality improvement effects, perhaps due to the deprivations during and following World War II—U.S. experience has looked very different.) Perhaps one of the readers here would like to do this ... here is a link to [the user guide](#).

### **The Human Mortality Database**

The data to be found at the Human Mortality Database are less detailed than you'll find in the SOA and the U.K./Irish experience studies. That said, it covers a wide number of countries, with documentation on methodologies and provenance of the data. These tables are divided by period and/or cohort, and sex.

You have to register for this site to get access to data and papers, but access is free. The database is supported by the Department of [Demography at UC-Berkeley](#) and the [Max Planck Institute for Demographic Research](#). Researchers from around the world have contributed to the project.

### **Web 2.0**

#### **Twitter**

I understand many may be put off by the faddishness of sites such as Twitter, and may be concerned about risks they may be opening themselves up to. So here I am to present a relatively low-risk and low-involvement method to use Twitter: think of it as the world's largest searchable news feed.

You do not need an account at Twitter to look at content that comes through its system. One of the best ways to use Twitter is to look for tweets (i.e., individual messages posted to the network) with particular search terms. This link will suck up anything [mentioning actuaries](#):

I did not search on the string "actuar" alone, as many different languages are posted, and "actuar" appears in many Spanish

tweets.

You can also take a look at lists set up by specific twitter users (a.k.a. "tweeps") on actuarial subjects. Below are two actuarial- and insurance-related twitter lists.

<http://twitter.com/#!/meepbobeep/actuary-insurance-pension>

[http://twitter.com/eddie\\_smith/actuarial](http://twitter.com/eddie_smith/actuarial)

I cannot promise that everything appearing in these lists will actually be actuarial or business in nature. The first list is mine, and I've added all the tweeps I follow who have an insurance, pension, or actuarial connection. Many of us use Twitter for a variety of purposes, not just news or not just talking about one specific topic. If you check my list out, Twitter will also show you my other lists (I have 14 right now) that cover such things as tweeps local to me (the Westchester and NYC metro area) or news feeds.

That said, it can be useful to dip into the huge info stream coming from Twitter from time to time. Never be concerned that you're missing something (one's attention is always going to be limited), but take advantage of the serendipity that can result.

### **LinkedIn**

Unfortunately, one does need a LinkedIn account (currently) to get to its best stuff right now. Supposedly it will be changed soon such that those outside the site can read items posted, but that currently is not the case. While many use the site to post their resume, more or less, and network for career purposes (or, in the case of recruiters, to post job listings), one of the more useful features is groups.

In addition to the SOA-related groups (the Tech section has its own group), there are groups such as Financial Modeling in Excel or Excel Blackbelts where one can discuss issues based on day-to-day tech issues.

Alas, I cannot link to the groups directly as of now. One must join LinkedIn (the amount of information you need to divulge about yourself to join is very low—just a name and an e-mail address—you do not need to put your employment info in if you don't want to) and then search on groups to find these groups. I hope they change over to a more user-friendly version soon with regards to groups.

For more Web 2.0 for actuaries info, check out Eddie Smith's article from the July 2010 issue of CompAct, "[Web 2.0 Offers Many Opportunities for Actuaries](#)".

## **Business Education**

### **Harvard Business IdeaCast**

The Harvard Business Ideacast is produced by the Harvard Business Review, often interviewing recent authors of HBR articles or books. And it's available for free on YouTube. I've been following this series for a couple years now. You can also subscribe to this via iTunes, and there's an audio-only series in addition to the video series.

I have found Ideacast to be very practical and immediately applicable to my day-to-day work. For example, a recent video is titled "Can Introverts Lead?" which relates to recently published research on comparisons of introverted-style management versus extroverted-style; another useful one recently is titled "How to Stop Good Ideas from Getting Shot Down." Unlike many other business school offerings, which are either too academic or are simply advertising for their business schools, the Ideacast keeps delivering.

### **Khan Academy**

When you first go to this site, you may think "How does this help me? Unless I need to help my kids with their math homework." But wait, page down to the sections on the Credit Crisis or Finance (also check out Geithner Plan and Paulson Bailout) and you'll see it's much more than algebra videos.

Perhaps you've missed these subjects as assets such as CDOs may have come on the scene after you've taken exams, and Salman Khan walks you through the concepts in a relatively painless manner. Mr. Khan is [Bill Gates' favorite teacher](#) (don't worry, Sal puts out good product) and is putting out new videos all the time. Perhaps you don't need a brush-up on corporate finance or mortgage-backed securities, or someone to help with your kids' homework (not just math—also chemistry!), there's also a brain teaser section ... including a couple that some people like to use in job interviews.

For more free business education resources, see my articles in The Stepping Stone, the newsletter for the Management and Personal Development Section:

[Get Your Personal MBA](#). *The Stepping Stone*, Issue 35, July 2009, pp 19 - 21

[Stop Paying for Business Education!](#) *The Stepping Stone*, Issue 32,  
October 2008, pp 1, 14 - 15.



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## R CORNER: EXTREME GREY SWAN SCENARIOS—DMFBM

by Steve Craighead

In "The Black Swan," Taleb<sup>1</sup> makes a distinction between extreme scenarios that can be modeled (Mandelbrotian Grey Swans) and those that cannot (Black Swans). A Grey Swan model would consider the fractal nature of the markets that Mandelbrot first described in the 1960s.<sup>2</sup> Mandelbrot and Van Ness in [Fractional Brownian Motions, Fractional Noises and Applications](#) outlined how to model Fractional Brownian Motion (FBM).<sup>3</sup>

I recently located the paper [Basic properties of the Multivariate Fractional Brownian Motion](#) by Amblard, et al. I was pleasantly surprised that this article outlined how to create dependent multivariate fractional Brownian motion (DMFBM) scenarios. I have created the DMFBM R function that implements their procedure. The rest of this article will outline how to use the DMFBM function and the next article will discuss how the function works and the assumptions and limitations of it.

The DMFBM function and the two associated functions buildportfolio and HurstExp require the use of three packages and their supporting packages. These packages are tseries, dVfBm, and fBasics. When you use the package installer to install these three packages, make sure that the install dependencies switch is set so that all of the supporting packages are included.

The DMFBM function is available [here](#). The buildportfolio function, described in the last newsletter, is [here](#) and it is used to build a historical portfolio of assets indicated by their ticker symbols. The

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HurstExp function is here and is used to determine the Hurst Exponent for each asset index within a portfolio. Open each of these in a browser and copy and paste the contents into your R workspace.

The DMFBM function requires the input as described in Table 1.

**Table 1 : DMFBM Calling Parameters**

Parameter Name	Description
HurstList	A list of Hurst exponents, which are determined from each asset in the price return portfolio.
covar	This is the covariance matrix of the price return portfolio.
correl	This is the correlation matrix of the price return portfolio.
projperiod	This is the projection period associated with the scenarios. This defaults to 120 months.
numscen	This is the number of scenarios generated.
delta	This variable allows the change of modality. For example, if the price return portfolio has daily frequency, using delta = 21, the scenarios will be approximately monthly (there are approximately 21 working days a month).
GenKernel	Generation kernel. The default value is NULL. If supplied DMFBM will not regenerate the kernel and will proceed directly to scenario generation.

The output of DMFBM is described in Table 2:

Parameter Name	Description
cusumX	The cumulative sum of the innovations, which corresponds to hydrological applications. The dimension is (numscen)(asset count)(projperiod+1).
cuprodX	The cumulative product of 1+innovations, which corresponds to return indices. Its dimension is (numscen)(asset count)(projperiod+1).

DelX	The individual innovations from the projection. Its dimension is (numscen)(asset count)(projperiod+1).
GenKernel	Generation Kernel used in the projection process.

As outlined in the prior newsletter, the sample historical equity portfolio is built by these commands:

```
(library(tseries))
(ticker<-c("^DJ","^GSPC","^FTSE","^GDAXI","^N225","^HSI"))
(startdate <- "1990-12-03")
(enddate <- "2010-08-02")
(freq<-1)
test<-buildportfolio(ticker,startdate,enddate,freq)
```

If you pasted the entire contents of the buildportfolio html, the commands above should have already been processed in the R workspace.

The test portfolio contains two elements, which are test\$PricePortfolio and test\$PRPortfolio. Our interest is in the price return component test\$PRPortfolio. The next required step is to determine the covariance and correlation matrices of the price return portfolio and estimate the Hurst Exponents for each equity index. This is done with these commands:

```
(covar <-var(test$PRPortfolio))
(correl<-cor(test$PRPortfolio))
(HurstList<-HurstExp(test$PRPortfolio)$HurstList)
```

Now, since all of the components for DMFBM are now available, a small set of scenarios are generated using this command:

```
a<-DMFBM(HurstList,covar,correl,projperiod=12,numscen=10)
```

The DelX or the cuprodX components will be key in using the scenarios for models. If a simulation model requires price indices (or RBC-C3- phase II wealth factors) use a\$cuprodX, but if price returns or total returns at a point in time are required, use a\$DelX.

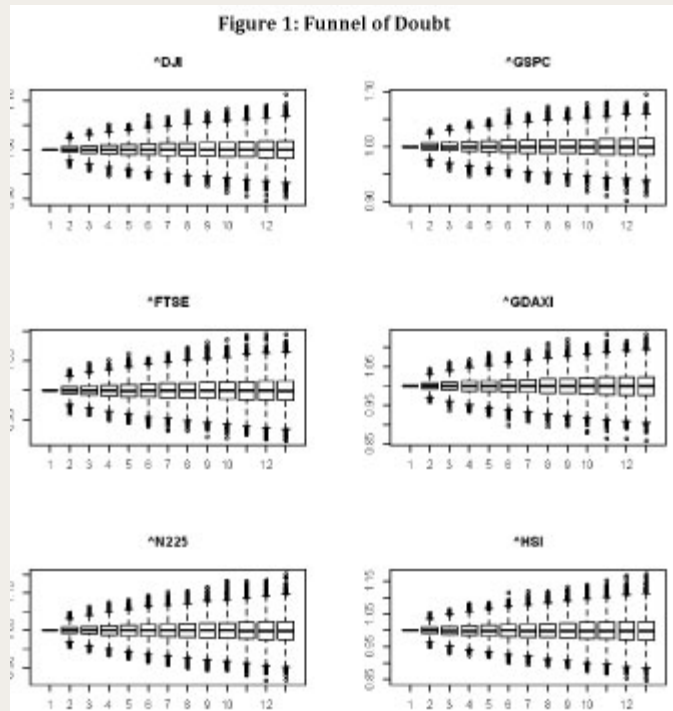
As will be discussed in the next newsletter, the generation kernel a\$GenKernel uses the greatest amount of process time. The process time increases as the generation period increases. Because of this, it is wise to first generate a small set of scenarios and reuse the generation kernel to generate a larger scenario set. For instance, the following command will generate 10,000 scenarios, by reusing

```
a$GenKernel:
```

```
big<-DMFBM(HurstList, covar, correl, projperiod=12,
numscen=10000, delta=1, GenKernel=a$GenKernel)
```

From the six price indices over 10,000 scenarios, a collection of box plots through time, also known as a funnel of double, for each asset in the portfolio is displayed using these two commands:

```
par(mfrow=c(3,2))
for(i in 1:6) boxplot(big$scuprodX[,i,],main=ticker[i])
```



Don't forget to use the summary command to display actual statistics on the entire set of scenarios for a specific index through time. For example,

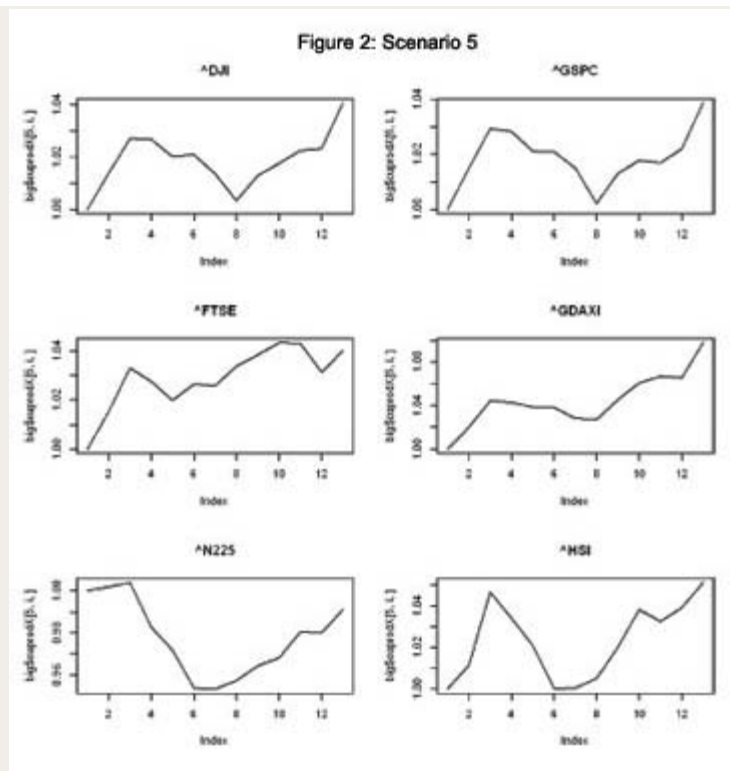
```
summary(big$scuprodX[,1,])
```

displays various sample statistics on the Dow Jones scenarios (results not shown).

Using the same `par(mfrow=c(3,2))` configuration as before, to display scenario 5 as in Figure 2, use the command:

```
for(i in 1:6) plot(big$scuprodX[5,i,],type="l",main=ticker[i])
```





On a personal note, in the early 1990s, I created a collection of independent Grey Swan scenarios using FBM and determined what the reserve requirements were for GMDB riders on a block of variable annuities. I found that the reserves calculated with these scenarios were three to five times larger than when using lognormal scenarios. At that time, I was frustrated with having to create single variable independent scenarios, because there was no easy technique to model multivariate and dependence into the modeling as was for regular Brownian motion. Even though these results were considered too extreme and were disregarded, it caused us to realize that our reserves were woefully inadequate if certain major institutions failed, such as the U. S. government and Wall Street.

This article has introduced a method to create dependent multivariate fractional Brownian motion scenarios. However, to fully implement Grey Swan scenario generation an additional feature is required. This feature is called MMAR, which is short for Multifractal Model of Asset Returns. MMAR adds the capability to DMFBM to have a stochastic trading time component. However, in the market, asset returns reflect various trading ranges. There are times when the market is slow and the volatility is insignificant. At the other extreme, when the market is fast, the volatility changes frequently and it becomes difficult for market observers to keep up with what is happening. Also, during an extremely fast market, the market resets, correlations tighten and prices are discontinuous.

An MMAR model is a composition of an FBM BH(t) or a DMFBM

$BH_1, \dots, H_n(t)$ ) with a cumulative distribution function  $\tau(t)$  of a multiracial measure. The MMAR resulting process is  $X(t) = BH(\tau(t))$ . The function  $\tau(t)$  supplies a random trading time to the MMAR that models both slow and fast markets and the corresponding volatility.

In the next article, I will outline what MMAR is and how it is constructed and what it can do. I will describe what  $\tau(t)$  actually is and how to compose it with Brownian motion and DMFBM models.

<sup>1</sup>Nassim Taleb (2010), "The Black Swan, the Impact of the Highly Improbable, 2nd Edition," Random House Trade Paperbacks, New York, NY.

<sup>2</sup>Benoit Mandelbrot (1997), "Fractals and Scaling in Finance, Discontinuity, Concentration, Risk," Springer-Verlag, New York, NY.

<sup>3</sup>The variance ( $\text{var}\{B(t) = t\}$ ) of a Brownian motion becomes infinity as time  $t$  goes to infinity. The variance ( $\text{var}\{FBM(t) = t^{2H}\}$ ) of an FBM also goes to infinity as time  $t$  increases. The constant  $H$  is called the Hurst Exponent and it takes on values between 0 and 1. When  $H = 1/2$  FBM corresponds to Brownian motion. If  $0 < H < 1/2$ , FBM is called anti-persistent and if  $1/2 < H < 1$ , FBM is called persistent. Persistent means that if an FBM moves upward, the next move will tend to be upward, or if it moves downward, the next move is downward. If  $H < 1/2$ , the FBM tended to be noisier and more jagged as  $H$  gets closer to 0. If  $H > 1/2$  the FBM becomes smoother as  $H$  approaches 1. All FBM paths are continuous but not differential. See my paper [Chaotic Analysis](#) for an in-depth discussion around the properties of the Hurst Exponent and other chaos topics.

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### ARTICLES NEEDED FOR COMPACT NEWSLETTER

Your help and participation are needed: Articles, book reviews and other information on technology useful to actuaries are needed! All articles will include a byline to give you full credit for your effort. An annual prize is awarded for the best article of the year. If you would like to submit or discuss an idea for an article, please contact [Richard Junker](#) or J. Eddie Smith.

Submissions for future editions are also welcome!

Submission deadline is May 18 for the July issue.

Thank you for your ideas!

J. Eddie Smith can be reached at [j.eddie.smith.iv@gmail.com](mailto:j.eddie.smith.iv@gmail.com).

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