

Numerical Excellence in Finance

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NAG

*Practical use of GPUs and
Numerical Code in Finance*

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Experts in numerical algorithms
and HPC services

Agenda

- Who are NAG and what we do
- The NAG Libraries
 - Examples of using:
 - NAG C Library in C/C++ and Excel
 - NAG Library for .NET
 - NAG Toolbox for *MATLAB*[®]
- Conclusions

NAG: The Numerical Algorithms Group

- Founded in 1970 as a co-operative project in UK
- Operates as a commercial, not-for-profit organization
- Worldwide operations
 - Oxford, UK
 - Manchester, UK
 - Lisle, Illinois, US
 - Tokyo, Japan
 - Taipei, Taiwan
- Over 3,000 customer sites worldwide
- Staff of ~100, over 50% technical, over 25 PhDs

Some of NAG Libraries Users

- **Business Intelligence**

- Oracle, DemandTec, Thomson Reuters, ...

- **Finance**

- Morgan Stanley, UBS, HSBC, Barclays Capital, ...

- **Energy and Motor Industry**

- Shell, ExxonMobil, Ford, Toyota, ...

- **Electronics**

- Philips, Siemens, Xerox, ...

- **Others**

- UPS, P&G, GlaxoSmithKline ...

Collaborators & Partners

- University of Manchester (Prof. Nick Higham, Prof. Ser-Huang Poon),
- University of Oxford (Prof. Mike Giles),
- Aachen University (Prof. Uwe Naumann),
- Universita di Roma I/ NYU (Prof. Peter Laurence),
- Illinois Institute of Technology (Prof. Fred Hickernell),
- Stanford University (Prof. Michael Saunders et al),
- University of Tennessee (Prof. Jack Dongarra et al)
- University of Waikato (Prof. Stephen Joe)
- University of New South Wales
- National University of Singapore

THE NAG LIBRARIES

Why libraries are important

- Numerical computation is difficult to do accurately
- Problems of :
 - Overflow / underflow
 - How does the computation behave for large / small numbers?
 - Condition
 - How is it affected by small changes in the input?
 - Stability
 - How sensitive is the computation to rounding errors?
- Importance of:
 - Error analysis
 - Information about error bounds on solution

NAG Development Philosophy

- First priority: ***accuracy***
- Second priority: ***performance***
 - How fast do you want the wrong answer?
- Algorithms chosen for
 - usefulness
 - robustness
 - accuracy
 - stability
 - speed

The NAG Numerical Libraries

- Contain mathematical and statistical components
 - ~ 1600 of them
- Available on variety of different platforms
 - ~ 65 of them
 - Stringently tested on each platform
- Full documentation
 - Printed and on-line
 - Example programs
- Used as building blocks by package builders since 1971

The NAG Numerical Library Family

- NAG Fortran Library
- NAG C Library
- NAG Data Mining Components
- NAG Library for SMP and Multicore
 - for shared memory and multi-core machines (OpenMP)
- NAG Toolbox for MATLAB
- NAG Library for .NET
- NAG Library for GPUs

NAG Library Contents

- Root Finding
- Summation of Series
- Quadrature
- Ordinary Differential Equations
- Partial Differential Equations
- Numerical Differentiation
- Integral Equations
- Mesh Generation
- Interpolation
- Curve and Surface Fitting
- Optimization
- Approximations of Special Functions
- Dense Linear Algebra
- Sparse Linear Algebra
- Correlation and Regression Analysis
- Multivariate Methods
- Random Number Generators
- Univariate Estimation
- Nonparametric Statistics
- Smoothing in Statistics
- Contingency Table Analysis
- Survival Analysis
- Time Series Analysis
- Operations Research

Use of NAG Software in Finance

- **Portfolio analysis / Index tracking / Risk management**
 - Optimisation, linear algebra, copulas...
- **Derivative pricing**
 - PDEs, RNGs, multivariate normal density, closed-form solutions ...
- **Fixed Income/ Asset management / Portfolio Immunization**
 - Operations research, optimisation
- **Data analysis**
 - Time series (ARIMA, GARCH), principal component analysis, data smoothing, ...
- **Monte Carlo simulation**
 - RNGs
-

NAG Libraries - Ease of integration

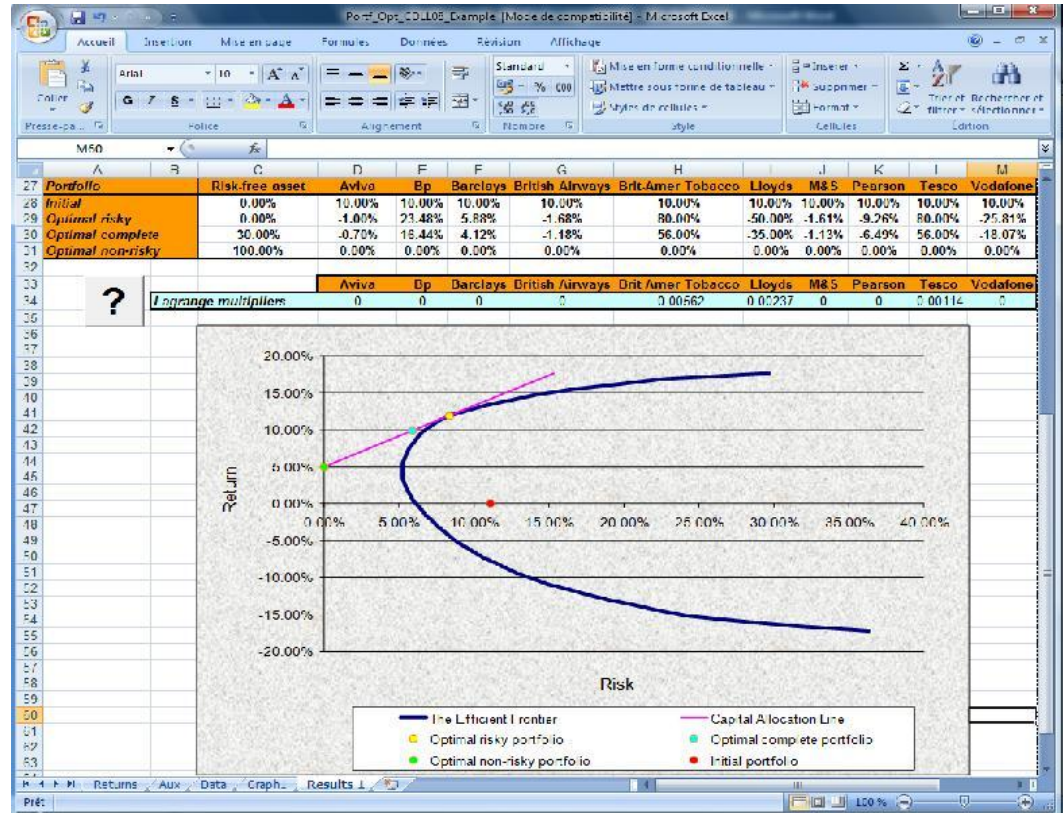
- Supporting Wide Range of Operating systems...
 - Windows, Linux, Mac, ...
- ...and a number of interfaces
 - C, C++,
 - Fortran,
 - VB, Excel & VBA
 - C#, F#, VB.NET
 - Java
 - Python
 - ...
 - LabVIEW
 - MATLAB,
 - Maple,
 - Mathematica
 - R, S-Plus,
 - Scilab, Octave
 - ...

EXAMPLES OF CALLING NAG LIBRARIES

NAG and Excel

■ Our libraries are easily accessible from Excel

- Calling **NAG DLLs** using VBA
 - NAG provide VB Declaration Statements and Examples
- Calling **NAG Library for .NET** using VSTO



NAG Toolbox for MATLAB

- Contains essentially all NAG functionality, *not* a subset
- Available for Windows and Linux (32/64-bit) and Mac OS X 10.5 (Intel 64 bit)
- Installed under the usual MATLAB toolbox directory
- Alternative to several specialist toolboxes
- You do not need to have preinstalled the library.
- **The latest (Windows) version exploits multicore!**

NAG Library for .NET

- Available for 32 bit and 64 bit Windows machines
- Aim to incorporate the whole NAG Library in the nearest future, currently provides around 400 of the most important ones
- All functions come with examples
- Fully integrated Help with Visual Studio (Intellisense)
- Released by NAG to address the needs of our users who have embraced .NET Framework

The NAG Library for GPUs

Stay tuned for
Robert Tong's talk 😊

Technical papers

- <http://www.nag.co.uk/numeric/nagandexcel.asp>
- <http://www.nag.co.uk/doc/techrep/index.asp>
 - “Calling NAG Library Routines from Scilab”
 - “Calling NAG Library Routines from Octave”
 - “Calling NAG Library Routines from Java”
 - “Calling the NAG Fortran Library from Python using F2PY”
- http://www.nag.co.uk/numeric/Num_DLLhelp.asp
 - “Calling NAG Fortran Routines from R”
 - “NAG DLLs and LabView”

Conclusions

- NAG supplies High Quality, World-leading Numerical Components which are:
 - accurate, reliable, stable, robust and fast
 - extensively tested, supported and maintained
 - regularly updated with new content and for new architectures
- NAG software covers many areas of mathematics and statistics, and all this functionality is available from within C, C++, C#, F#, MATLAB and other environments.

Questions?

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Thank you for your attention!