

Using the NAG Library with Excel and VSTO

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A mandatory system requirement for the development of Excel applications from within the .NET Framework is either the Visual Studio 2005 Team Edition or the Visual Studio 2008 Professional Edition or higher. (Please note that other versions of Visual Studio 2005 do not include the Visual Studio 2005 Tools for Office and, as a consequence, are unsuitable for this purpose.)

For deployment of the final application developed using Visual Studio 2005 Team Edition, the Microsoft Visual Studio 2005 Tools for Office Second Edition (VSTO 2005 SE) redistributable package is required. This installs the Visual Studio Tools for Office runtime which is required for such applications and supports both Microsoft Office 2003 and 2007.

The following example, which demonstrates interpolation and approximation of data points, uses the Excel Workbook template to call the [NAG Fortran Library](#) from inside an Excel workbook. The use of Add-Ins is an alternative technique for the integration of an external DLL within Excel. The difference between these two approaches is that the workbook model, described in this note, is called a “document-level project” while an Add-In is an “application-level project”. At the document-level, all customization is unique to one or more sheets contained in a single workbook, but at the application-level, custom Excel functions would be available to all workbooks.

This example is created within Visual Studio 2008 for use with Microsoft Office 2007 using C#. [The DLL implementation of the NAG Fortran Library](#) (Product Code: FLDLL224M) is required to run this application.

Creating a Project under Visual Studio 2008

Creating a new project in Visual Studio 2008 is straightforward and is achieved via the “Create project” dialogue initiated from a link from the Recent Projects pane Visual Studio start page. For this example, we want to create a new Visual C# project for an Excel Workbook. To achieve this, browse under the Visual C# templates, and click on the Office section which shows that several templates are available one of which is an Excel Workbook. Select this template and save the project with a suitable name.

This action will bring up an empty Excel Workbook which will contain three blank worksheets. In the Solution Explorer pane, you will find C# code (.cs files) which contains the actual computational code behind each sheet and for the workbook as a whole. All these source files, with the exception of the Startup and Shutdown controls, contain empty methods created appropriately for the selected template,

In the project it is necessary to make the NAG Fortran Library DLLs available from within the .NET framework environment; this requires the usage of the directive:

```
using System.Runtime.InteropServices
```

For more information about calling the NAG Fortran Library from .NET, included examples featuring a variety of NAG Library routines, see the following link:
<http://www.nag.co.uk/numeric/csharpinfo.asp>

Example

We will demonstrate the techniques used by creating some [C# code](#) (suitable for use with Visual Studio 2008) that calls a number of routines from the E01 and E02 Chapters of the NAG Fortran Library. In this example different methods are enabled to interpolate or approximate data points using routines from the E01 and E02 Chapters; the selection of the various options available are handled using some standard controls and methods.

We start by using the toolbox to create three new controls (one button and two combo boxes) next to the existing Startup and Shutdown controls.

The combo boxes will control the set of data points on which NAG routines will operate and also which numerical technique will be applied by the NAG Library routines.

The Process button will control processing. Once the selections in the two combo boxes have been finalized and the data points selected, pressing the button will be the signal that processing can begin.

The 'comboBox1' enables the selection of three predefined sets of data points (Sin, Ocean depth, Stock price) or that the user wishes to supply a new set of data points. Once one of these options has been selected then the highlighted cells will be populated appropriately with x-values, y-values and, if relevant to the numerical method, weights. If user supplied data is selected then the highlighted cells are left empty and user must supply their own x-values, y-values and weights.

The 'comboBox2' enables the selection of the numerical technique to be applied to the data points. The fitting of a cubic spline or Hermite interpolant that passes through the data points requires just x-values and y-values to be supplied however there is a constraint that the x-values must be in strictly increasing order. The fitting of a least-squares polynomial approximant or a least-squares cubic spline approximant requires x-values, y-values and weights (for the predefined sets of data points weights are initialised to 1.0 for each pair of x- and y-values) to be provided and that the x-values are in non-decreasing order.

Once the data points and numerical method have been identified then the user must identify values that are to be operated upon. This is achieved by simply selecting the values of two in columns labeled X values, Y values and, if appropriate, Weights and pressing the Process button.

If a cubic spline or Hermite interpolation has been requested then a graph showing the supplied data points and the interpolating curve is displayed. In addition, cells in the Worksheet are populated with values of the fitted curve evaluated at points equally spaced across the range.

If a least-squares polynomial or a least-squares cubic spline approximation has been requested then more information is required from the user. In the case of least-squares polynomial approximation the desired degree of the approximating polynomial is required. Least-squares cubic spline approximation requires the number of interior intervals, ncap, of the spline (minimum value 8) and the values of the interior knots.

To implement these requests for additional information two techniques are used. The first technique requests an Integer value using an pop-up input box. It may be worth noting at this point that the use of these pop-up windows from Excel is enabled by the directive:

```
using Microsoft.VisualBasic;
```

The values of the internal knots are requested via a column of highlighted cells, suitably annotated, in the Worksheet. The knots must be supplied in non-decreasing order.

Once the information has been provided a graph showing the supplied data points and the approximating curve is displayed. In addition, cells in the Worksheet are populated with values of the fitted curve evaluated at points equally spaced across the range.

Publish Wizard

Applications developed using VSTO are often actually used on a different system from that used for the development. To simplify this Visual Studio provides a 'Publish Wizard' which packages the application in form that enables the application to be exported in a convenient form. To use this wizard navigate to the Properties of the project and choose Publish. Scrolling through the displayed options reveals button 'Publish now' which, when selected, will create a folder named 'publish' under the Project folder.

To make the published application available on another system simply copy the files in the publish folder to the new system where the following software must also be available:

- Office 2007 (2003)
- Microsoft .NET Framework 3.5
- Microsoft Visual Studio Tools for Office (version 3.0 Runtime) - VSTOR30.exe
- DLL implementation of the NAG Fortran Library

Numerical Computation Background Information

For the cubic spline interpolation NAG Library routine E01BAF is used to determine the cubic spline interpolant and E02BBF is used to evaluate the cubic spline at the regularly space points.

In the case of the Hermite interpolant NAG Library routine E01BEF is used to determine the interpolant and E01BFF is used to evaluate the interpolant at regularly spaced points.

Approximants are calculated as follows, E02ADF is used to compute the least-squares polynomial approximation and E02AEF is used to evaluate this approximant at different points. Similarly E02BAF is used to calculate a least-squares cubic spline approximation and E02BFF for the evaluation of the cubic spline at regularly spaced points.

For the mathematical background of the used routines please refer to the documentation of the [NAG Fortran Library](#).