

An Introduction to CodeCogs.com and its use within Excel

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In Brief

CodeCogs (www.codecogs.com) is a scientific numerical library of C/C++ code that has been created for technical users. It is in every sense an “open” system, which gives users full access to the raw source code of anything they licence, while also allowing anyone to submit new or improved solutions on their terms (licensing and price).

Currently the library has over 500 numerical functions, approximately 200 of which are in statistics and 50 in finance. The majority of these can be used with Excel, indeed all Excel functions are also provided as C/C++ equivalents within the library. Shortly you will be able to use these functions with VB, C#, R, PHP and Fortran.

The CodeCogs system is designed to be transparent and quick to use. Considerable effort has been invested in a documentation wizard to facilitate the creation of high quality documentation, with the aim of making the site a technical reference as well as a code library.

Motivation

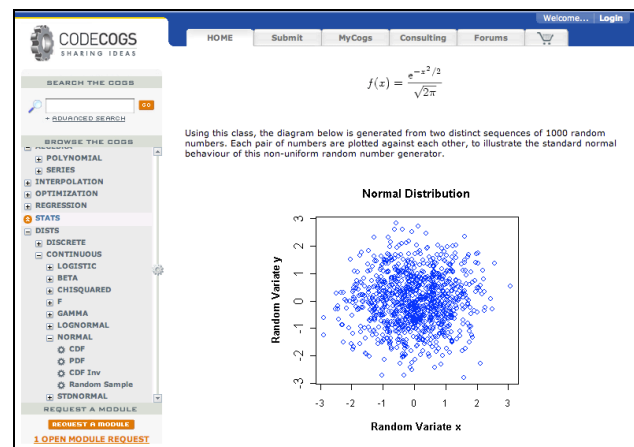
CodeCogs was designed in response to the problems its founders had in finding well-documented, easily-navigable and affordable numerical C/C++ code. In particular we wanted high-quality software that could be used by both commerce (where it can be incorporated into proprietary software with commercial support) and in open-source software systems. Furthermore, we wanted to be able to download only the code we needed, at the point of use, rather than an entire library.

Pricing

There is no fixed price structure, with the cost of commercial licences set by the contributing developers. As such, almost 80% of all components on CodeCogs are free to use under the GNU GPL licence, with most functions being available under a commercial licence for an average of only £2. Excel integration for a function costs an additional £1.

Navigating CodeCogs

On entry to the website you are immediately presented with a browser on the left side that contains a complete list of all published modules. Along the top are the key section tags, which allow you to make new submissions, view your own activities or enter a discussion through the forum. The central area of the site is dedicated to displaying the documentation and code.



At the top of each module page is a dropdown menu listing all dependencies required by each module. To the right of this is the licensing area, which summarises the licences you own and the corresponding download options available.

Available under **GPL (Free)** and **Commercial** licence

MY LICENCES	COST (GBP)
GPL: YES	THIS UNIT: 2.48
COM: NO	SUB-UNITS: 0.00

The source code behind a module can either be viewed on screen; downloaded as a single file or compressed zip (which also contains the complete directory paths) or, when available, downloaded as an Excel extension.

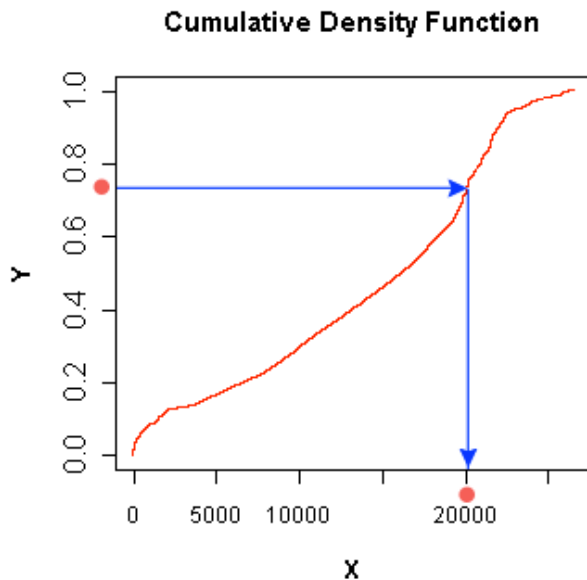
Installing a module from CodeCogs into Excel

There are two quick steps to install a module from CodeCogs into Excel. First download the extension (as described above). Next open Microsoft Excel with your chosen workbook and click on the **Add-Ins** option located within the **Tools** menu. Finally choose **Browse**, locate the extension (.xll) file that you downloaded from CodeCogs and select it to install.

Example: Simulating Losses to a Treaty

Suppose you want to simulate the payout on an insurance treaty due to a sequence of randomly generated events. Using your historical data (perhaps previous payouts) and other observations, you compiled a list of independent events with a particular return period (or rate) and a mean cost/loss. There are many systems that may fit this model, including losses from river flooding, hurricanes, or even ships lost at sea. All can be characterised by a rate and associated with a loss.

Next you assume that the Poisson distribution is representative of the number of events you expect in any given period (say 1 year). So in your model, we'll use a randomly generated Poisson¹ number to give you the number of events in each year you simulate. For each of these events, you now randomly select events from your event list, in proportion to their rate. Obviously events with a high rate of occurrence should be selected more often, so we use a Discrete² random generator, which essentially converts a uniformly generated number from 0-1 (Y) into a corresponding event number (X), using the normalised cumulative rates from the rates you've supplied (see illustration below).



With the main numerical calculations being handled by the CodeCogs add-ins, setting up an efficient system within Excel is comparatively simple:

- Download and install the random sampling routines you need from CodeCogs.
- Define your event sets, with rates and losses – for example use columns A and B, respectively, and we'll assume you have 100 unique events.

- Calculate the total rate by entering “=sum(A1:A100)” into cell C1.
- In D1 calculate the number of events in the first simulated year, with “=cc_PoissonSample(\$C\$1)”
- In E1 enter “=if(\$D\$1>(column(E1)-5), index(\$B\$1:\$B\$100,cc_DiscreteSample(\$A\$1:\$A\$100)),”)”. The calculated value is the loss from a newly sampled event.
- Repeatedly copy the last equation into cells F1, G1, H1, I1, J1, etc, up to the maximum number of events you may possibly expect in any one year.
- Add your treaty structure and compute the losses due to the events in cells F1 to J1.
- Copy everything from cell D1 to J1+ “treaty calculations”, downwards, creating a new row for each simulation you require.
- Finally sum up the treaty losses across all simulations to calculate the overall simulated loss of your insurance treaty.

You can rapidly expand this basic model to include many other alterations. For example, if you have an idea about the variance in your loss estimates for each event, then you can add randomness about the mean - perhaps through the use of normal or beta random sampling function.

Summary

Adding CodeCogs functions to Excel, means you get the ease of use and flexibility of Excel, combined with the performance and accuracy of the CodeCogs software.

In addition, you get a much broader range of mathematical, statistical and engineering methods at your disposal.

CodeCogs have also emulated all the standard Excel functions in C/C++. So if you decide to turn your Excel solution into a standalone package, then you can download all the source code behind any CodeCogs or Excel functions that you use.

Thanks to Lucian Bentea for producing the figures and setting up the example Excel sheet. A copy of this can be downloaded from:

<http://www.codecogs.com/pages/tutorial/example1.zip>

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¹ Available from CodeCogs.com in section **stats > dists > discrete > poisson > RandomSample**

² Available from CodeCogs.com in section **stats > dists > discrete > discrete > RandomSample**