- ## Classes and Methods New to the IMSL C# Numerical Library Version 6.5

`Imsl.Math`

Error Handling

`NoProgressException`	Exception thrown when More's technique is not making any progress.

Linear Systems

`ComplexLU.GetL`	Returns the lower triangular portion of the LU factorization of input matrix "a".
`ComplexLU.GetPermutationMatrix`	Returns the the permutation matrix which results from the LU factorization of input matrix "a".
`ComplexLU.GetU`	Returns the unit upper triangular portion of the LU factorization of input matrix "a".
`LU.GetL`	Returns the lower triangular portion of the LU factorization of input matrix "a".
`LU.GetPermutationMatrix`	Returns the the permutation matrix which results from the LU factorization of input matrix "a".
`LU.GetU`	Returns the unit upper triangular portion of the LU factorization of input matrix "a".

Optimization

`BoundedLeastSquares.Solve`	Solves a nonlinear least-squares problem subject to bounds on the variables using a modified Levenberg-Marquardt algorithm. This method is the identical replacement for the deprecated method BoundedLeastSquares.solve.

`Imsl.Stat`

Error Handling

`NoProgressException`	Exception thrown when More's technique is not making any progress.

- ## Changes in IMSL C# Numerical Numerical Library Version 6.5

`General`

	Changed links to Microsoft SDK webpages for HTML documentation.
	Added support for the FLEXLM_BATCH FlexNet environment variable. This prevents popups from being displayed for FlexNet errors/warnings.

	The properties NumberOfProcessors and/or Parallel have been added to many of the classes/methods which use the Task Parallel Library in .NET 4.0.
`Gallery`	
	Added TCB Spline to the Spline demo.
`Imsl.Chart2D`	
General	
	Corrected problem with charts with axes on both the left and right side which resulted in inconsistencies of the tick intervals and ticks which appear to be outside the axis range.
`Imsl.Math`	
Linear Systems	
`SuperLU`	Made corrections so that the warning about a singular matrix is printed.
`Cholesky`	Updated class description with $A = RR^T$.
`Matrix.Multiply`	Overloaded method with processors argument.
`ComplexMatrix.Multiply`	Overloaded method with processors argument.
Optimization	
`BoundedLeastSquares`	Implemented a fix for a potential infinite loop in More's technique.
`BoundedLeastSquares.solve`	This method has been deprecated and replaced by BoundedLeastSquares.Solve.
`NonlinLeastSquares`	Updated the documentation for the methods and properties SetXscale, SetFscale, GradientTolerance, and StepTolerance.
	Implemented a fix for a potential infinite loop in More's technique.
`QuadraticProgramming`	Modified the write statement in Example 3.
`Imsl.Stat`	
Regression	
`NonlinearRegression`	Implemented a fix for a potential infinite loop in More's technique.
Probability Distribution Functions and Inverses	
`Pdf.NoncentralBeta`	Corrected an equation in the documentation.
`GammaDistribution`	Enhanced the documentation.
`IDistribution`	Enhanced the documentation.
`IProbabilityDistribution`	Enhanced the documentation.

`LogNormalDistribution`	Enhanced the documentation.
`NormalDistribution`	Enhanced the documentation.
`PoissonDistribution`	Enhanced the documentation.
Random Number Generation	
	Added description for the valid value of the seeds for the Random constructor.
`Random.CanonicalCorrelation`	Changed from a static public method to a static method.
`Random.NextGaussianCopula`	Overloaded version using the k argument has been deprecated.
`Random.NextMultivariateNormal`	Overloaded version using the k argument has been deprecated.
`Random.NextStudentsTCopula`	Overloaded version using the k argument has been deprecated.
Probability Distribution Functions and Inverses	
`Cdf.Beta`	A new algorithm is used to improve accuracy in the tails of the distribution.
`Cdf.NoncentralF`	Improved performance.
Time Series and Forecasting	
`ARMA`	Removed extra terms from the difference equation in the documentation.
	Implemented a fix for a potential infinite loop in More's technique.

- ## Classes and Methods New to the IMSL C# Numerical Library Version 6.0

`Imsl`

Error Handling

`Logger`	Logs intermediate results and notes from IMSL C# classes.
`IMSLUnexpectedErrorException`	Signals that an unexpected error has occurred.
`Messages.ThrowIllegalStateException`	Throws an `IllegalStateException` with a formatted String argument.

`Imsl.Math`

Linear Systems

`Matrix.InverseLowerTriangular`	Returns the inverse of the

	lower triangular matrix `a`.
`Matrix.InverseUpperTriangular`	Returns the inverse of the upper triangular matrix `a`.
Eigensystems Analysis	
`Eigen`	A constructor was added.
`Eigen.MaxIterations`	Set or returns the maximum number of iterations.
`Eigen.Solve`	Solves for the eigenvalues and (optionally) the eigenvectors of a real square matrix.
Interpolation and Approximation	
`CsTCB`	Extension of the Spline class to handle a tension-continuity-bias (TCB) cubic spline, also known as a Kochanek-Bartels spline and is a generalization of the Catmull-Rom spline.
`Spline2D.Integral`	Returns the value of an integral of a tensor-product spline on a rectangular domain.
`Spline2DLeastSquares`	Computes a two-dimensional, tensor-product spline approximant using least squares.
Differential Equations	
`ODE`	ODE represents and solves an initial-value problem for ordinary differential equations.
`FeynmanKac`	Solves the generalized Feynman-Kac PDE.
`OdeAdamsGear`	Extension of the ODE class to solve a stiff initial-value problem for ordinary differential equations using the

	Adams-Gear methods.
Nonlinear Equations	
ZerosFunction	Finds the real zeros of a real, continuous, univariate function, f(x).
ZeroSystem.Logger	Returns the logger object.
Optimization	
BoundedVariableLeastSquares	Solve a linear least-squares problem with bounds on the variables.
NonNegativeLeastSquares	Solves a linear least squares problem with nonnegativity constraints.
NumericalDerivatives	Compute the Jacobian matrix for a function f(y) with m components in n independent variables.
Special Functions	
Sfun.Erfce	Returns the exponentially scaled complementary error function.
Sfun.GammaIncomplete	Evaluates the incomplete gamma function.
Sfun.Psi	Returns the logarithmic derivative of the gamma function, also called the digamma function.
Sfun.Psi1	Returns the ψ_1 function, also known as the trigamma function.
Imsl.Stat	
Basic Statistics	
Regression	
StepwiseRegression.Intercept	Returns the intercept.
StepwiseRegression.SetMeans	Sets the means of the variables.
Analysis of Variance	
ANCOVA	Analyzes a one-way classification model with covariates.
ANOVA.GetConfidenceInterval	Computes the confidence

	interval associated with the difference of means between two groups using a specified method.
Time Series and Forecasting	
`AutoARIMA`	Automatically identifies time series outliers, determines parameters of a multiplicative seasonal model and produces forecasts that incorporate the effects of outliers whose effects persist beyond the end of the series.
`ARMAOutlierIdentification`	Detects and determines outliers and simultaneously estimates the model parameters in a time series whose underlying outlier free series follows a general seasonal or nonseasonal ARMA model. Allows computation of forecasts.
`LackOfFit`	Performs lack-of-fit test for a univariate time series or transfer function given the appropriate correlation function.
Multivariate Analysis	
`DiscriminantAnalysis.Classify`	Classifies a set of observations using the linear or quadratic discriminant functions generated during the training process.
`DiscriminantAnalysis.Downdate`	Removes a set of observations from the discriminant functions.
`DiscriminantAnalysis.NumberOfRowsMissing`	Returns the number of rows of data encountered containing missing values (`Double.NaN`).

Survival and Reliability Analysis

`KaplanMeierEstimates`	Computes Kaplan-Meier (or product-limit) estimates of survival probabilities for a sample of failure times that possibly contain right consoring.
`KaplanMeierECDF`	Computes the Kaplan-Meier reliability function estimates or the CDF based on failure data that may be multi-censored.
`LifeTables`	Computes population (current) or cohort life tables based upon the observed population sizes at the middle (for population table) or the beginning (for cohort table) of some user specified age intervals.
`ProportionalHazards`	Analyzes survival and reliability data using Cox's proportional hazards model.

Probability Distribution Functions and Inverses

`Cdf.NoncentralBeta`	Evaluates the noncentral beta cumulative distribution function (CDF).
`Cdf.NoncentralF`	Evaluates the noncentral F cumulative distribution function (CDF).
`Cdf.Logistic`	Evaluates the logistic cumulative probability distribution function.
`Cdf.Pareto`	Evaluates the Pareto cumulative probability distribution function.
`InvCdf.Logistic`	Returns the inverse of the logistic cumulative probability distribution function.

`InvCdf.NoncentralBeta`	Evaluates the inverse of the noncentral beta cumulative distribution function (CDF).
`InvCdf.NoncentralF`	Evaluates the inverse of the noncentral F cumulative distribution function (CDF).
`InvCdf.Pareto`	Returns the inverse of the Pareto cumulative probability distribution function.
`Pdf.Logistic`	Evaluates the logistic probability density function.
`Pdf.NoncentralBeta`	Evaluates the noncentral beta probability density function (PDF).
`Pdf.NoncentralChi`	Evaluates the noncentral chi-squared probability density function.
`Pdf.NoncentralF`	Evaluates the noncentral F probability density function (PDF).
`Pdf.NoncentralStudentsT`	Evaluates the noncentral Student's t probability density function.
`Pdf.Normal`	Evaluates the normal (Gaussian) probability density function.
`Pdf.Pareto`	Evaluates the Pareto probability density function.
`IDistribution`	Public interface for the user-supplied distribution function.
`IProbabilityDistribution`	Public interface for the user-supplied probability distribution function.
`GammaDistribution`	Evaluates a gamma probability distribution.
`LogNormalDistribution`	Evaluates a lognormal probability distribution.

NormalDistribution	Evaluates a normal (Gaussian) probability distribution.
PoissonDistribution	Evaluates a Poisson probability distribution.

Random Number Generation

Random.CanonicalCorrelation	Generates a canonical correlation matrix from an arbitrarily distributed multivariate deviate sequence with a Gaussian Copula dependence structure.
Random.NextGaussianCopula	Generate pseudorandom numbers from a Gaussian Copula distribution.
Random.NextStudentsTCopula	Generate pseudorandom numbers from a Student's t Copula distribution.
Random.NextZigguratNormalAR	Generates pseudorandom numbers using the Ziggurat method.

Imsl.Finance

Finance

BasisPart.GetDaysInYear	Component of DayCountBasis. The day count basis consists of a month basis and a yearly basis. Each of these components implements this interface.
DayCountBasis.GetDaysInYear	The Day Count Basis. Rules for computing the number or days between two dates or number of days in a year.

Imsl.Chart

Chart 2D

Annotation	Draws an annotation.
Draw.DrawClippedImage	Draws an image such that any portion of the image beyond the axis range is clipped.

Treemap	Treemap creates a chart from two arrays of double precision values or one data array and one array of java.awt.Color values.
Imsl.Datamining	
Data Mining	
NaiveBayesClassifier	Trains a Naive Bayes Classifier

- ## Changes in IMSL C# Numerical Numerical Library Version 6.0

General	
ErrorMessages Resource Bundle	Fixed misspelling, improved consistency and removed extra whitespace.
Gallery	The Gallery has been updated.
Optimization Chapter Introduction	Clarified documentation by stating that it is the responsibility of the user to ensure that the user-supplied evaluating function always returns valid results.
Quadrature Chapter Introduction	Clarified documentation by stating that it is the responsibility of the user to ensure that the user-supplied evaluating function always returns valid results.
Imsl.Math	
Linear Systems	
Matrix.Multiply	Performance increases can be realized by taking advantage of the MKL-enhanced version of the IMSL C# Numerical Library.
ComplexMatrix.Multiply	Performance increases can be realized by taking advantage of the MKL-enhanced version of the IMSL C# Numerical Library.
Eigensystem Analysis	
Eigen	Performance increases can be realized by taking advantage of the MKL-enhanced version of the IMSL C# Numerical Library.
SymEigen	Performance increases can be realized by taking advantage of the MKL-enhanced version of the IMSL C# Numerical Library.
Interpolation and Approximation	
CsShape	No longer issues an index out of bounds exception.

`RadialBasis`	Added examples for `RadialBasis.Function`, `RadialBasis.Gaussian` and `RadialBasis.HardyMultiquadric` to highlight the explicit use of different basis functions. Documentation was added for `RadialBasis.Gaussian` and `RadialBasis.HardyMultiquadric`.
Transforms	
`FFT`	Performance increases can be realized by taking advantage of the MKL-enhanced version of the IMSL C# Numerical Library.
`ComplexFFT`	Performance increases can be realized by taking advantage of the MKL-enhanced version of the IMSL C# Numerical Library.
Nonlinear Equations	
`ZeroFunction`	This class has been deprecated. It has been replaced by the class `ZerosFunction`.
`ZeroSystem`	Logging enabled in `ZeroSystem`.
`ZeroSystem`	A paragraph was added to the class description.
Optimization	
`DenseLP`	`DenseLP` now throws exceptions for infeasible problems.
`MinUncon`	Fixed resource name so that warnings are printed.
`NonlinLeastSquares`	Added warnings for the 4 error types.
`QuadraticProgramming`	A new exception was added to handle inconsistent system exceptions.
`Imsl.Finance`	
Finance	
`BasisPart.GetDaysInYear`	Deprecated for this release and replaced by a new `BasisPart.GetDaysInYear`.
`Bond`	Added Monthly and BiMonthly options.
`Bond.Accrint`	Corrected accrued interest calculation.
`Bond.Yearfrac`	Corrected problem where the method gave a wrong result for input days in a leap year.
`DayCountBasis.GetDaysInYear`	Deprecated for this release and replaced by a new `DayCountBasis.GetDaysInYear`.
`Finance.Xirr`	Modified to return better results.
`Imsl.Stat`	

Basic Statistics	
`NormOneSample`	Increased accuracy of p-values.
`NormOneSample.ConfidenceMean`	Clarified documentation.
`NormTwoSample`	Increased accuracy of p-values.
`PartialCovariances`	Increased accuracy of p-values.
`TableTwoWay.GetFrequencyTableUsingClassmarks`	Corrected description in documentation.
`TableTwoWay.GetFrequencyTableUsingCutpoints`	Corrected description in documentation.
Regression	
`LinearRegression.GetCoefficients`	Replaced the SingularMatrixException exception by a LinearRegression.NotFullRank warning.
`NonlinearRegression`	Added missing `NonlinearRegression` resource entries.
	Added warnings for the 4 error types.
`RegressorsForGLM`	Increased accuracy of p-values.
`SelectionRegression`	Modified to correctly account for missing values.
	Increased accuracy of p-values.
`StepwiseRegression`	Increased accuracy of p-values.
Analysis of Variance	
`ANOVA`	Increased accuracy of p-values.
`ANOVA.GetDunnSidak`	This method has been deprecated and replced by `ANOVA.GetConfidenceInterval.`
`ANOVAFactorial`	Increased accuracy of p-values.
Categorical and Discrete Data Analysis	
`CategoricalGenLinModel`	Increased accuracy of p-values.
	Removed confusing statement from documentation.
	Added a test for rank deficiency.
`CategoricalGenLinModel.LowerEndpointColumn`	Corrected implementation.
`ContingencyTable`	Increased accuracy of p-values.
Tests of Goodness of Fit	
`ChiSquaredTest`	Increased accuracy of p-values.
	Expanded documentation of nParameters and property DegreesOfFreedom.
`ChiSquaredTest`	Overloaded the `Update` method to make the frequencies optional.
`NormalityTest.LillieforsTest`	Corrected the way ties are identified.

Time Series and Forecasting

ARMA	Resolved seg fault and flat forecast issue.
ARMAEstimateMissing	MaxIterations setting now applies to LeastSquares estimation. A TooManyIterationsException is thrown rather than rethrowing ARMA exceptions TooManyIterationsExceptions and TooManyFcnEvaluations which may occur during the LeastSquares estimation

Multivariate Analysis

ChiSquaredTest	Increased accuracy of p-values.
DiscriminantAnalysis	Increased accuracy of p-values.
DiscriminantAnalysis.NRowsMissing	This property has been deprecated. It has been replaced by the property NumberOfRowsMissing.
DiscriminantAnalysis.Update	Some Update methods have been deprecated. Each has been replaced by an equivalent Update method.
FactorAnalysis	Changed NoDegreesOfFreedomException exception to a warning.
	Increased accuracy of p-values.

Probability Distribution Functions and Inverses

The Cdf class has been divided into the three classes Cdf, InvCdf, and Pdf. Therefore the methods which have been moved from the Cdf class have been deprecated and replaced by the functionally equivalent versions in the new class. Below is a list of the methods which have been deprecated followed by the functionally equivalent version which has been added.

Cdf.BinomialProb	Pdf.Binomial
Cdf.PoissonProb	Pdf.Poisson
Cdf.BetaProb	Pdf.Beta
Cdf.FProb	Pdf.F
Cdf.HypergeometricProb	Pdf.Hypergeometric
Cdf.GammaProb	Pdf.Gamma
Cdf.ExponentialProb	Pdf.Exponential
Cdf.ChiProb	Pdf.Chi
Cdf.WeibullProb	Pdf.Weibull
Cdf.LognormalProb	Pdf.Lognormal

Cdf.ExtremevalueProb	Pdf.Extremevalue
Cdf.RayleighProb	Pdf.Rayleigh
Cdf.DiscreteUniformProb	Pdf.DiscreteUniform
Cdf.GeometricProb	Pdf.Geometric
Cdf.InverseBeta	InvCdf.Beta
Cdf.InverseF	InvCdf.F
Cdf.InverseGamma	InvCdf.Gamma
Cdf.InverseNormal	InvCdf.Normal
Cdf.InverseChi	InvCdf.Chi
Cdf.InverseNoncentralchi	InvCdf.Noncentralchi
Cdf.InverseStudentsT	InvCdf.StudentsT
Cdf.InverseNoncentralstudentsT	InvCdf.NoncentralstudentsT
Cdf.InverseWeibull	InvCdf.Weibull
Cdf.InverseLogNormal	InvCdf.LogNormal
Cdf.InverseExponential	InvCdf.Exponential
Cdf.InverseExtremeValue	InvCdf.ExtremeValue
Cdf.InverseRayleigh	InvCdf.Rayleigh
Cdf.InverseUniform	InvCdf.Uniform
Cdf.InverseDiscreteUniform	InvCdf.DiscreteUniform
Cdf.InverseGeometric	InvCdf.Geometric

`Cdf.Chi`	Expanded the range of allowable arguments for degrees of freedom.
`Cdf.F`	Improved lower tail accuracy.
`Cdf.Chi`	Improved lower tail accuracy.
`Cdf.Noncentralchi`	Improved lower tail accuracy.
`InvCdf.F`	Corrected results for large denominator df.
`Pdf.Gamma`	Corrected calculation of gamma pdf.

Random Number Generation

`General`	Added Usage Notes.
`Random.NextNormal`	Eliminated cases where +infinity/-infinity is returned.

`Imsl.Io`

`Imsl.Datamining.Neural`

Neural Nets

`ScaleFilter`	Corrected possible divide by zero.
`Imsl.Chart`	
Chart 2D	
`AxisLabel.Paint`	Added checks to avoid printing labels beyond the extent of the chart window.
`Contour`	Modified logic where negative values for Max X and Y data caused distortions.
`Colormap`	Renamed the WHITE_BLUE_LINEAR to WB_LINEAR and documented as the reverse of BW_LINEAR. The name WHITE_BLUE_LINEAR no long exists since BLUE_WHITE should be used instead.
`HeatMap`	Modified logic where negative values for Max X and Y data caused distortions.