Automated curve

fitting and equation

discovery

Tired of using trial and error to find optimal equations for your data?

Quickly find the best equations that describe your data

TableCurve 2D gives engineers and researchers the power to find the ideal model for even the most complex data by putting thousands of equation at their fingertips. TableCurve 2D's built-in library includes a wide array of linear and nonlinear models for any application including equations that may never have been considered — from simple linear equations to high order Chebyshev polynomials. TableCurve 2D is the automatic choice for curve-fitting and data modeling for critical research. TableCurve 2D's state-of-the-art data fitting includes capabilities not found in other software packages:

A 38-digit precision math emulator for properly fitting high order polynomials and rationals.

A robust (maximum likelihood) optimization for nonlinear fitting that effectively copes with outliers and a wide dynamic Y data range.

An AI Expert option that automatically selects appropriate peak, transition or kinetics models for you.

## Automation takes trial and error out of curve fitting

Fit all of TableCurve 2D's 3,665 built-in equations or just the ones you need — instantly, no programming required! With TableCurve 2D, a single mouse click is all it takes to start the automated curve fitting process — there is no set up required. Before you start the process, you can preview the data. Once your data are loaded, start the automatic fitting process with a single mouse click. You can even set up TableCurve 2D to begin fitting the moment data are imported or modified with Background Thread Processing Fitting.

Accurately extrapolate any data set

Increase the accuracy of your predictions with state-of-the-art AR (Autoregressive) procedures that offer the means to effectively extrapolate any data set. Select from any one of the 9 different procedures for extrapolating your data — 3 to predict ahead, 3 to predict earlier data, and 3 that predict in both directions. Of these algorithms, six offer in-situ noise removal using advanced SVD and Eigen-decomposition methods.
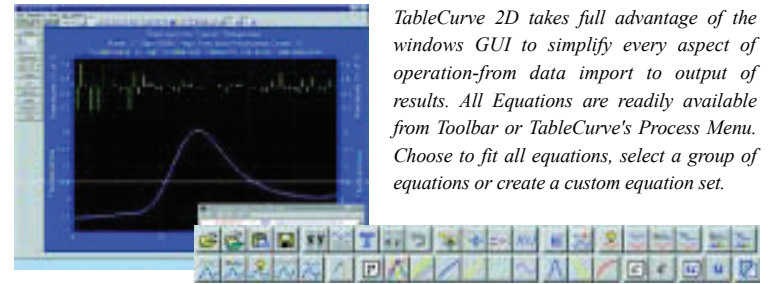
TableCurve 2D takes full advantage of the windows GUI to simplify every aspect of operation-from data import to output of results. All Equations are readily available from Toolbar or TableCurve's Process Menu. Choose to fit all equations, select a group of equations or create a custom equation set.

Fit user defined equation

Up to 15 user-defined equations can be entered and ranked along with the built-in equations. These specialized models can contain most mathematical constructs, including special functions, series convergence and conditional statements, differentiations, integrations, and parameter constraints. And, unlike most curve fitting programs, TableCurve 2D's user-defined functions are compiled so custom curve fitting can be performed quickly — at nearly the speed as with the built-in equations. You can also add up to 100 external C or FORTRAN language functions to the TableCurve 2D equation set. These equations and constraints can be of unlimited complexity.

USA's Young America optimize with TableCurve 2D

PACT95, the coalition that designed the fastest American yacht in the 1995 America's Cup race. Young America, chose TableCurve 2D to help optimize their design because it is the only software that, in seconds, searches through thousands of equations to describe difficult-to-model empirical data. Taking data samples from numerous sources, including wind tunnel tests, tank testing, and data from many other types of experiments, TableCurve was able to convert vast amounts of empirical data into simplified curve fits. These algorithms were then input into a Velocity Prediction Program (VPP) that balances the equations of motion while looking for the fastest boat.

TableCurve 2D

Automated Curve Fitting Analysis

All the tools you need to discover your ideal model.

Graphically review curve fit results

Once your XY data have been fit, TableCurve 2D automatically sorts and plots the fitted equations by the statistical criterion you select (r^2, DOF adjusted r^2, Fit Standard Error, Maximum Error, or the F Statistic). Graphically review the fitted results as you scroll through the equation list. Graphically review up to four references in a given curve-fit plot to determine your best-model. Compare results with other equations in the current fit or equations saved to disk from prior fits. Graph the residuals in one of five different formats or add confidence and prediction intervals to the graph to detect outliers in your data. Plot derivatives, cumulative area, or residuals on a second Y-axis.

Manually fitting a number of data sets using only one or two different models is a thing of the past! For example, it is possible to denoise 100 data sets in one unattended step, and then fit these sets to a target equation in a second unattended step, and get a detailed report of the results automatically. It's that easy!

Compare models using meaningful numeric information

Data, statistical and precision summaries are available so you can further analyze fit results. These summaries can be simultaneously displayed and are automatically updated when a different equation is selected for review. Evaluation option with automated table generation, includes function, derivatives, roots and cumulative area.

Effectively manage complex data sets

TableCurve 2D offers state-of-the-art smoothing and denoising techniques to remove the noise in your data. Select from a total of 6 smoothing/denoising algorithms. Of special importance is the Eigen-decomposition Denoising, a non-parametric procedure where separation is based on signal strength. For Fourier Denoising, TableCurve 2D offers a data taper to minimize spectral leakage and the means to filter either by the magnitude of FFT channels or by frequency threshold. Inspect analytic derivatives for all built-in equations, as well as all of the smoothing procedures. Mask outliers and refit your data. With TableCurve 2D, its all so easy!

Precisely model exotic data sets

For those rare equations that cannot be adequately managed by a parametric model, TableCurve 2D offers five non-parametric estimation/interpolation procedures. All offer true state-of-the-art algorithms. For example, there are seven different spline algorithms, including two least-squares minimizations, non-uniform rational B-splines (NURBS) and a least-squares spline with user-defined knots. TableCurve 2D also includes smoothing spline, local regression, and Fourier interpolation procedures.

Flexible output options

Preview your graph and output publication-quality graphs in several different formats. Produce files containing data and equations in Excel, Lotus, ASCII, and SigmaPlot formats. Easily produce professional reports with graphs and tables. TableCurve 2D speeds up your programming by generating actual function code and test routines for all fitted equations in FORTRAN, C, Basic, Pascal and VBA for Excel. All this with a single mouse click!

Maximize your productivity with automation

Save time with TableCurve 2D's batch processing capability to automatically process large numbers of data sets — no programming required! With this integrated automation capability, you can analyze large numbers of data sets while you are away from your PC! TableCurve 2D automatically generates the output for each data set. The output can be written to an MS Word (or generic RTF) file for all graphs and numeric summaries, and to MS Excel for numeric data. The automation capability is available for all of TableCurve 2D's major procedures.

"In a matter of seconds, TableCurve 2D can offer selection of numerical representation for data that does not conform to a 'standard' equation. TableCurve 2D cut in half the time it took to complete many of our operation!"

James Teeters

Head, Scientific Department, Naval Architectural Firm

Sparkman & Stephens, Inc.

TableCurve 2D®

Automated Curve Fitting Analysis

Equations for every application

Optimize process control...

Quite often, substantial cost savings can be realized by optimizing process control parameters. Since TableCurve 2D automatically reports the minima and maxima of both fitted functions and derivatives, process optimization is often a simple matter of using a single number within the report.

Generate calibration curves...

TableCurve 2D excels for applications in calibration science. Whether you need to calibrate a flow meter, wind tunnel measurements or satellite instrumentation signals, TableCurve 2D can furnish the ideal parametric model.

Fit tabulated data...

Frequently, engineers and scientists need to convert tables of data found in handbooks or journals into a simple equation, often for use in software or microcode. TableCurve 2D is capable of producing equations that preserve all or most of the accuracy present within the tabulated data. TableCurve 2D even furnishes a Precision Summary for instrument designers who must use fixed point math in their microprocessors.

Create black box models...

At times, an engineer or scientist wants to study a highly complex process, such as human biochemistry, where underlying models are poorly defined. For such instances, TableCurve 2D can provide important insights into the subtle mechanisms in play. A successful model may suggest further experiments in pharmacokinetics, high energy physics or crystal chemistry.

Produce equations for complex modeling or Monte-Carlo simulations...

TableCurve 2D can be used to convert empirical data from hundreds of sources into simplified equations. These equations can then be input into complex models or Monte-Carlo simulations to simulate the effects of hundreds or even thousands of variables upon a given model.

Or simply interpolate data...

There is no simpler, faster or more automated way to interpolate data than with TableCurve 2D. Data tables or individual interpolated points are effortlessly generated for even the most demanding data sets.

The Essential Desktop Tools for Scientists and Engineers

- **SYSTAT**®, More graphs, more statistics, less effort
- **AutoSignal**™, Transform time in no time
- **TableCurve 2D**®, Automated curve fitting and equation discovery
- **TableCurve 3D**®, Automated surface fitting and equation discovery
- **PeakFit**®, Automated peak separation and analysis

TableCurve 2D®

Automated Curve Fitting Analysis

TableCurve2D Features

INTERFACE

- Full 32-bit performance
- Multitasking with 17 background thread curve-fit options
- Advanced online help system
- Drag and drop file for immediate fitting
- Fully customizable 2D graphs
- Smooth bitmap rendering of graphs
- XY meter in graphs displays cursor coordinates
- Global Reset option to undo all changes made to the data table*

DATA INPUT

- Up to 65,536 points in data table*
- 16.4 million points can be filtered into table using averaging digital import filter
- File types: ASCII, Excel (all version through Excel 2000)*, Lotus, Quattro Pro, SigmaPlot, SPSS, dBase, DIF, Binary
- Graphical XY column selection
- Weights or standard deviations optionally assigned
- Compare up to five data sets*
- Automatically process replicate data sets

DATA MANAGEMENT

- Real-time smoothing with FFT, Loess, Savitzky-Golay, Gaussian Convolution, Eigen-decomposition and Kaiser-Bessel time-domain smoothing* procedures
- Real-time Fourier domain editing with exact-N FFT; data tapering
- Eigen-decomposition filtering to isolate components based on signal strength*
- Graphical and numerical sectioning; graphically enable or disable data points
- First and second order analytic derivatives for all built-in equations*
- Multiple curve-fit references on a single graph (up to 4 references)*
- Apply calculations to X, Y and Weight values
- Spreadsheet-like data editing with optional graphing of data as they are entered

EQUATION DISCOVERY AND CURVE FITTING

- 3,656 built-in equations
- 3,205 mixed basis function linear
- Even order and half order polynomials
- 18 Chebyshev polynomials
- 17 High-precision polynomials (fitted to 38 digits precision)
- 10 Fourier-series polynomials
- 57 standard, ln x, sqrt even, y-transformed, even order, and half order rationals
- 17 Chebyshev rationals
- 17 High-precision rationals (fitted to 38 digits precision)
- 5 Fourier-series rationals
- 36 Constrained (no singularity) non-linearly fit SVD rationals
- 74 nonlinear peak equations
- 29 nonlinear transition equations
- 58 nonlinear kinetic equations
- 13 nonlinear waveform and miscellaneous equations
- Rapid searching, sorting and filtering of equations
- User customizable equation sets
- Full control of fit process, including goodness of fit criteria, matrix methods, minimization, and other options
- AI Expert for automatic selection of peak, transition or kinetic models to be fitted
- Robust straight-line fit option
- Three robust fitting methods available for all non-linear equations, user function and external C/Fortran functions

PREDICTION METHODS*

- State-of-the-art Autoregressive procedures for forward/backward predictions /extrapolations.
- 9 different procedures - 3 to predict ahead, 3 to predict earlier data, and 3 that predict in both directions.
- In-situ noise removal using advanced SVD and Eigen-decomposition methods
- View complex roots, order selection criteria, singular values, residuals and numeric summaries
- AR filter code generation is supported in all languages, plus export filter to disk

USER-DEFINED FUNCTIONS (UDFs)

- UDF editor with push button help for inserting functions
- UDFs automatically compiled for speed
- Up to 15 UDFs can be fit at one time, each with up to 10 adjustable parameters
- Graphical UDF adjustment procedure for refining starting estimates
- UDFs can be saved as libraries
- Add up to 100 external FORTRAN or C models;*select all, none or specific equations

ESTIMATION AND INTERPOLATION

- Eight spline procedures*, 3 interpolation and 5 smoothing*including NURBS and least-squares B-splines with fixed, optimized, or user-specified knots*
- Six procedures for spline estimation of smoothed data; 1st and 2nd derivatives*
- Local regression spline estimation; 1st and 2nd derivatives*
- Savitzky-Golay spline estimation; accurate derivatives orders 1-8: fitter coefficients*
- Fourier Interpolation; derivatives orders 1-4*
- Directly specify and plot output: for all Estimation procedures*

CURVE-FIT ANALYSIS AND OUTPUT

Numerical:

- Evaluation option with automated table generation, includes function, derivatives, roots and cumulative area; save evaluations to disk; evaluations are automatically update whenever an equation or algorithm setting changes*
- Full numeric and statistical summary, including coefficients, standard error, confidence limits, ANOVA, goodness of fit, measured function and derivative, minima and maxima, maximum error*, and poles reported for rational functions
- Data summary with predicted values, residuals and confidence/prediction limits
- Precision summary and term significance analysis
- Sort equations by r^2, DOF Adjusted r^2, Std error, F- statistic. Floating Point
- Speed, Equation Number and Maximum Error; arrange by parameter count.*

Graphical:

- Curve-fit graph with zoom-out, customizable layout, labels, grids, scaling, points, font, titles and resolution
- Confidence/prediction intervals (90,95, 99, 99.9 and 99.99 percent)
- Error bars for replicate-based data
- Residuals graphs, separate or on Y2 axis of curve-fit graph, including bar graphs, histogram, and stabilized normal probability plot for assuring normality of residuals
- Copy numerical data for any graph to clipboard as a spreadsheet block
- Exclude and Refit enables disabling of outliers and immediate refitting during equation inspection*

CODE GENERATION

- Fortran 90, Fortran 77, C (64 and 80 bit). Visual Basic, QBasic and Pascal
- Function code or function code with full test routines
- Available for all built-in equations and autoregression procedures*

OUTPUT AND EXPORT

- Publication quality printed graphs with full print preview
- Image formats include bitmaps, metafiles, enhanced metafiles and device-independent bitmaps
- File formats include ASCII, Excel, Lotus, SigmaPlot and Harvard Graphics Professional reports with MS Word or RTF export that includes graphs and numeric results; available for all major procedures*
- Graphs can be half or full page, landscape or portrait mode all in a single document*

INTEGRATED AUTOMATION*

- Batch processing for automatically processing large number of data sets unattended; available for all major procedures
- Multiple data sets in an Excel spreadsheet processed with the ease of single data set
- Stream reports directly to MS Word 95/97/2000 or RTF format
- DLL support for writing external data acquisition interface
- Professional DLL automation interface for instrument manufacturers

New in TableCurve 2D 5.0

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System Requirements: Microsoft Windows*95, 98 and NT Pentiums or clone and above; 32MB RAM minimum (64MB for wavelet and production facility recommended); 15MB hard disk space; SVGA or better