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## Highlights

- Specify, estimate, assess, and present models in an intuitive diagram.
  - Alternatively, use a non-graphical, programmatic method to specify models.
  - Non-programmers can easily specify a model without drawing the path diagram.
  - Increase the reliability of variables by including multiple indicators.
  - Impute missing values and latent scores.
  - Use for longitudinal studies, multiple-group and reliability analysis.
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# IBM SPSS Amos

*Test relationships in attitudinal and behavioral models*

IBM® SPSS® Amos is powerful structural equation modeling (SEM) software that enables you to support your research and theories by extending standard multivariate analysis methods, including regression, factor analysis, correlation, and analysis of variance.

In SPSS Amos, you can specify, estimate, assess, and present your model in an intuitive path diagram to show hypothesized relationships among variables. The latest release enables you to specify user-defined estimates using a simplified technique. You can use a non-graphical, programmatic method to specify models. SPSS Amos also provides a way for non-programmers to specify a model easily without drawing the path diagram.

## Confirm complex relationships

You can quickly build attitudinal and behavioral models in SPSS Amos that realistically reflect complex relationships. Any numeric variable, whether observed or latent, can be used to predict any other numeric variable. SPSS Amos includes expanded statistical options based on Bayesian estimation. You can:

- Perform estimation with ordered-categorical and censored data. This enables you to create models based on nonnumerical data without having to assign numerical scores to the data, and work with censored data without having to make assumptions other than the assumption of normality.
- Impute numerical values for ordered-categorical and censored data. The resulting dataset can be used as input to programs that require complete numerical data.
- Estimate posterior predictive distributions to determine probable values for missing or partially missing data values in a latent variable.



SPSS Amos enables you to simultaneously analyze data from several populations, such as multiple ethnic groups. Increase the reliability of variables in your analysis by including multiple indicators. Impute missing values and latent scores, such as factor scores, with multiple imputations. You can also use SPSS Amos for longitudinal studies, multiple-group analysis, and reliability analysis.

### Go from onscreen model to published results quickly

The SPSS Amos interactive, visual approach to SEM makes it easy for you to learn and use. Within the SPSS Amos interface you can create path diagrams of your analysis using drawing tools, rather than by writing equations or by typing commands.

### Easier model specification

IBM SPSS Amos now allows non-programmers to specify a model without drawing a path diagram. The model can be entered into a spreadsheet-like table that can be modified. For example, Figure 1 below shows an example of a path diagram from the Amos User's Guide.

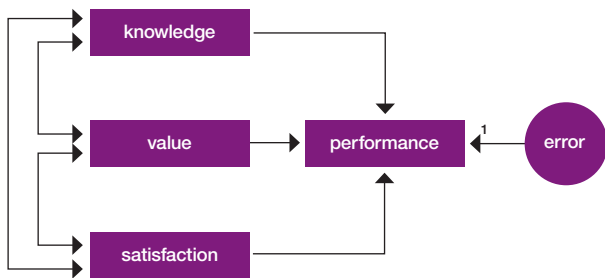


Figure 1: Example of a path diagram created in SPSS Amos

The equivalent table representation in the recent version of SPSS Amos is similar to the image in Figure 2.

Variables			
Name	Label	Observed	Variance
value		<input checked="" type="checkbox"/>	
knowledge		<input checked="" type="checkbox"/>	
performance		<input checked="" type="checkbox"/>	
satisfaction		<input checked="" type="checkbox"/>	
error		<input type="checkbox"/>	

Regression Weights		
Dependent	Independent	Parameter Name
performance	knowledge	
performance	value	
performance	satisfaction	
performance	error	1

Covariances		
Variable 1	Variable 2	Parameter Name
knowledge	satisfaction	
value	satisfaction	
knowledge	value	

Figure 2: An equivalent table representation of a path diagram in SPSS Amos

After a model has been fitted, parameter estimates will be displayed in the table (in additional columns), in the same way that parameter estimates can now be displayed on the path diagram after a model has been fitted.

The table representation and the path diagram representation will provide two alternate views of a model. The table view will occupy the same area in the main Amos Graphics window that the path diagram occupies. You will be able to switch back and forth between the table view and the path diagram view at any time.

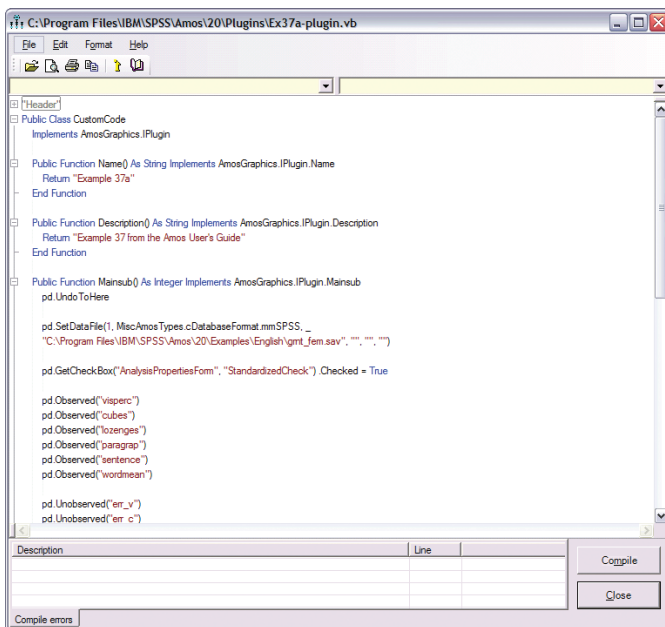


Figure 3: SPSS Amos allows you to create structural equation models programmatically. This capability is useful for: (a) a model that is so complex that drawing its path diagram is difficult; (b) those who prefer working either with a keyboard rather than a mouse or with text rather than graphics; (c) those who need to generate many similar models that differ only in some details (such as the number of variables or the variable names).

The alternative non-graphical, programmatic approach improves accessibility for those who can benefit by specifying models directly. Its scripting capabilities improve the productivity of users who need to run large, complicated models, and make it easy to generate many similar models that differ slightly.

Once you complete a model, you can assess fit with one click. Then, when your model is complete, you can print presentation-quality output. IBM SPSS Amos includes 36 completed examples as an introduction to structural equation modeling. It also has an extensive online help system.

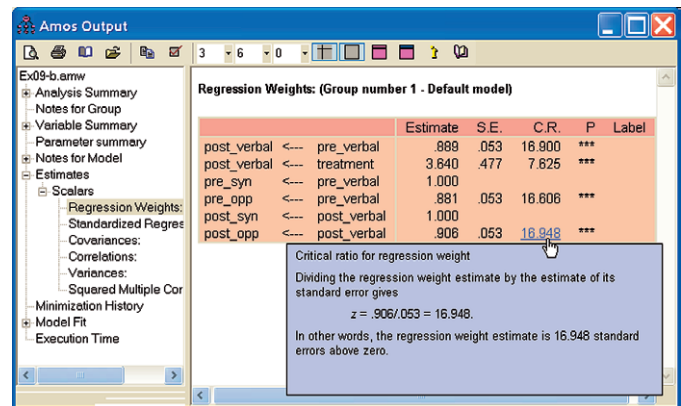


Figure 4: Advanced output options make it even easier to work in SPSS Amos. For example, quickly interpret or summarize results with “use-it-in-a-sentence” help.

## Find models that best fit your data

Use the SPSS Amos exploratory technique, SEM specification search, to choose a model from a large number of candidates. Take advantage of previous research by specifying constraints on parameter values in your model, or use Bayesian estimation to specify an informative prior distribution for the parameters. Use confirmatory factor analysis to specify and test a factor pattern, instead of relying on traditional exploratory factor analysis.

You can also fit multiple models in a single analysis. SPSS Amos examines every pair of models where one model can be obtained by placing parameter restrictions on the other. SPSS Amos even suggests how the model may be improved—for example, by adding an arrow to connect two variables. Graphs and statistics help you find an optimum trade-off between model simplicity and goodness of fit.

## Discover unexpected relationships

After you fit a model, the SPSS Amos path diagram shows the strength of the relationship between variables. For example, when working with data from a product survey on condiments, you might initially assume that the variable, “satisfaction of taste,” is the best brand loyalty indicator. Looking at the path diagram in SPSS Amos, however, you might discover that the best brand loyalty indicator is “package size purchased.”

## Apply Amos to explore the “hows and whys” in your data

Researchers and graduate students who have observational, or non-experimental, data apply SPSS Amos in a variety of fields to convince a committee or boss, secure funding, or get published. Examples include:

- Psychology—Develop models to understand how drug, clinical, and art therapies affect mood.
- Medical and healthcare research—Confirm which of three variables—confidence, savings, or research—best predicts a doctor’s support for prescribing generic drugs.
- Social sciences—Study how socioeconomic status, organizational membership, and other determinants influence differences in voting behavior and political engagement.
- Educational research—Evaluate training program outcomes to determine the impact on classroom effectiveness.
- Market research—Model how customer behavior impacts new product sales.
- Institutional research—Study how work-related issues affect job satisfaction.

## Use with products you have

While you can use SPSS Amos on its own, you can also use it to extend the analyses you might already be doing using IBM SPSS Statistics. SPSS Amos especially complements your analyses if you use IBM SPSS Advanced Statistics or IBM SPSS Regression, because SEM extends algorithms available in these software products.

## Features

### Graphical user interface

- Display, through a path-diagram browser, a description and thumbnail image of all path diagrams in your folders
- Simply point-and-click to select program options
- Create variables in path diagrams with a single click
- Display a diagram for a different group or model with just one click
- View the contents of data files
- Drag variable names from the dataset to the path diagram

### Non-graphical, programmatic interface

- Use a non-graphical, programmatic method to specify models
  - Improved accessibility for those who can benefit by specifying models directly
  - Scripting capabilities improve the productivity of users who need to run large, complicated models
  - Easily generate many similar models that differ slightly
- IBM SPSS Amos now allows non-programmers to specify a model without drawing a path diagram
  - The model can be entered into a spreadsheet-like table that can be modified
  - Parameter estimates will be displayed in the table (in additional columns)
  - The table representation and the path diagram representation will provide two alternate views of a model

### **Modeling capabilities**

- Create structural equation models (including such special cases as path analysis and longitudinal data models) with observed and latent variables
- Specify candidate models using one of two methods:
  - Specify each individual candidate model as a set of equality constraints on model parameters
  - Use SEM in an exploratory way. SPSS Amos tries out many models and suggests promising ones, while using Akaike information criterion (AIC) and Bayes information criterion (BIC) statistics to compare models
- Fit confirmatory factor analysis models, variance components models, errors-in-variables models, and general latent variable models
- Analyze mean structures and multiple group datasets
  - Quickly specify and test multiple group data through automated specification
- Analyze data from several populations at once
- Save time by combining factor and regression models into a single model, and then fit them simultaneously
- Analyze multiple models simultaneously: SPSS Amos determines which models are nested and automatically calculates test statistics
- Translate a path diagram into a Visual Basic program
- Fit linear growth curve models using automatically generated parameter constraints

### **Latent class analysis (mixture modeling)**

- Perform market segmentation studies
- Estimate the size of each cluster or segment
- Perform mixture regression and mixture modeling
- Perform mixture factor analysis
- Estimate the probability of group membership for individual cases

- Train the classification algorithm. Assign some cases to groups ahead of time and allow the program to classify the remaining cases
- Require some model parameters to be equal across groups while allowing other parameters to vary across groups

### **Bayesian estimation**

- Estimate values for ordered-categorical and censored data
- Markov chain Monte Carlo (MCMC) simulation
- Specify an informative prior distribution: Normal, uniform, or custom
- Plot the marginal posterior distribution of any parameter
- Estimate any function of model parameters
- Avoid inadmissible solutions and unstable linear systems
- Obtain optimal asymmetric credible intervals for indirect effects

### **Computationally intensive modeling**

- Evaluate parameter estimates with normal or non-normal data using powerful bootstrapping options. The bootstrapping and Monte Carlo capabilities in SPSS Amos make it easy for you to obtain bias and standard error estimates for any parameter, including standardized coefficients and effect estimates
- Test multivariate normality and perform outlier analysis

### **Model creation**

- Use the path diagram as a model specification
- The model can be entered into a spreadsheet-like table that can be modified
- Modify the model by changing the path diagram with drawing tools
- Display parameter estimates and fit measures graphically on the path diagram
- Display degrees of freedom at any time while drawing on the path diagram
- Copy and paste part of one path diagram into another path diagram

### Analytical and statistical capabilities

- Use full information maximum likelihood estimation in missing data situations for more efficient and less biased estimates
- Obtain an approximate confidence interval for any model parameter under any empirical distribution, including standardized coefficients, using fast bootstrap simulation
  - Assess model fit with Bollen and Stine’s bootstrap approach
  - Calculate percentile intervals and bias-corrected percentile intervals
- Perform randomized permutation tests to show whether equivalent or better-fitting models can be found
- Specify equality constraints in the path diagram by using the same label for two or more parameters, including means, intercepts, regression weights, and/or covariances, in the same group or across different groups
- Estimate means for exogenous variables
- Estimate intercepts in regression equations
- Perform parametric bootstraps to find an approximate confidence interval for any model parameter under normal distribution theory, including standardized coefficients with Monte Carlo simulation
- Use a variety of estimation methods, including maximum likelihood, unweighted least squares, generalized least squares, Browne’s asymptotically distribution-free criterion, and scale-free least squares
- Evaluate models using more than two dozen fit statistics, including Chi-square; AIC; Bayes and Bozdogan information criteria; Browne-Cudeck (BCC); ECVI, RMSEA, and PCLOSE criteria; root mean square residual; Hoelter’s critical n; and Bentler-Bonett and Tucker-Lewis indices
- Obtain bias and standard error estimates for any parameter and derived statistics with bootstrapping or Monte Carlo options
- Optionally, estimate standard errors using the observed information matrix
- View p values along with critical ratios for individual parameters Output
- Use additional navigation aids, display options, and table-formatting options with enhanced text output
  - Quickly navigate to and display portions of output in the navigation panel
  - Link section and table headings to context-sensitive help
  - Link numbers, such as p values displayed in the navigation panel, to “use-it-in-a-sentence” help, and receive a plain-English description of what the numbers represent
- View XHTML (web-based) output of your text files in your browser
  - Preserve table formatting when you use the clipboard or drag-and-drop editing to copy tables to other applications
  - Use XHTML-formatted files as an archival format
  - Parse SPSS Amos output using an XML parser; when writing programs to post-process SPSS Amos output, use an XPATH expression to extract any desired portion of the output
- Print preview

### Data imputation

- Impute numerical values for ordered-categorical and censored data
- Impute missing values and latent variable scores
- Choose from three different methods: Regression, stochastic regression, and Bayesian
- Single imputation
  - Regression imputation uses linear regression to replace missing values
- Single or multiple imputation
  - Stochastic regression imputation uses maximum likelihood (ML)-based parameter estimates of observed data; assumes parameters are equal to their ML estimates
  - Bayesian estimation is similar to stochastic regression imputation; however, it assumes that parameter values are estimated, not known

### Drawing and other tools

- Create presentation-quality path diagrams
  - Easily show or hide all variable names or labels in a path diagram
- Print or paste path diagrams into other applications
- Use toolbox buttons, including shape, copy, erase, fit-to-page, and align, to draw your model
- Customize the toolbar
  - Associate a toolbar button, menu item, or hot key with any SPSS Amos macro, including those you write yourself
  - Add an image to a toolbar button
  - Create a shortcut key for macro execution
- Fit your model by selecting buttons on the toolbar
- Work with variable names you assign, instead of Greek letters
- Add titles and annotations to your diagram
- Work with the toolbar, menus, and hot keys for frequently used tasks
- Use pop-up menus that show useful actions for each element in your diagram
- Re-arrange measurement models by using the reflect and rotate buttons
- Use plugins to extend program capabilities

### Programmability

- Extend the capabilities of SPSS Amos
  - In Bayesian analysis, find the posterior distribution of any function of the parameters
  - Define your own fit measures

### Documentation and help

- Extensive online help with cross-references to explanations of the output
- Includes User's Guide PDF file with 36 completed examples

### Data and file management

- File types supported include: dBASE (.dbf), Microsoft Excel (.xls), FoxPro (.dbf), Lotus (.wk1, .wk3, .wk4), Microsoft Access (.mdb), SPSS Statistics (.sav), and text (.txt, .csv)

### System requirements

Requirements vary according to platform. For details, see [ibm.com/spss/requirements](http://ibm.com/spss/requirements).

### About IBM Business Analytics

IBM Business Analytics software delivers data-driven insights that help organizations work smarter and outperform their peers. This comprehensive portfolio includes solutions for business intelligence, predictive analytics and decision management, performance management, and risk management.

Business Analytics solutions enable companies to identify and visualize trends and patterns in areas, such as customer analytics, that can have a profound effect on business performance. They can compare scenarios, anticipate potential threats and opportunities, better plan, budget and forecast resources, balance risks against expected returns and work to meet regulatory requirements. By making analytics widely available, organizations can align tactical and strategic decision-making to achieve business goals. For further information, please visit [ibm.com/business-analytics](http://ibm.com/business-analytics).

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Software Group  
Route 100  
Somers, NY 10589

Produced in the United States of America  
April 2013

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