



Polynomial Models (order 2)

The objective of this case study is to investigate how balance performance changes across adulthood and to quantify that relationship using nonlinear curve fitting in **Isalos Analytics Platform**. In this case study, the **Polynomial model (order 2)** is used to estimate the linear and quadratic components of age-related change using a standard second-order polynomial framework.

The dataset used in this case study is derived from the article: *Physical Performance Across the Adult Life Span: Correlates With Age and Physical Activity* by Hall et al. It contains age-group values and the corresponding **single leg stance** measurements reported in seconds. In this model, the independent variable (X) is the **age midpoint in years**, and the dependent variable (Y) is the **single leg stance time in seconds**.

The **Polynomial model (order 2)** describes a nonlinear relationship in which the response changes with age according to a quadratic function. The equation used in this analysis is:

$$Y = B0 + B1X + B2X^2$$

In this model, **B0** represents the intercept, **B1** represents the linear component of the relationship, and **B2** represents the quadratic component that determines the curvature of the fitted response.

The purpose of this analysis is to determine whether the observed data are consistent with a second-order polynomial relationship and to convert the measured balance values into meaningful quantitative outputs. The main results obtained from the fit are **B0**, **B1**, and **B2**, where **B0** reflects the intercept, **B1** reflects the linear contribution of age, and **B2** reflects the quadratic contribution across the studied age range. These results are useful because they allow quantitative description of age-related decline in balance performance and support interpretation of how the rate of decline changes across adulthood.

Isalos version used: 2.0.2

Scientific Article: <https://academic.oup.com/biomedgerontology/article/72/4/572/2629941>

Step 1: Import data from file

Right-click on the input spreadsheet panel on the left and choose **“Import from File”**. Then browse to the file containing the XY dataset for this case study and load the sheet in which each row corresponds to one age value and one single leg stance value.

	Col1	Col2	Col3	Col4	Col5	Col6	Col7	Col8
User Header	User Row ID							
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								
11								
12								
13								
14								
15								
16								

- Show Spreadsheet Toolbar
- Import from File
- Import from Spreadsheet
- Import from Multiple Spreadsheets
- Adjust Spreadsheet Precision
- Export Spreadsheet Data
- Clear Spreadsheet

The data will appear on the left spreadsheet.

The screenshot shows the Isalos Analytics Platform interface. At the top, there is a navigation bar with 'File', 'Edit', 'Data Transformation', 'Analytics', 'Statistics', and 'DOE' menus. Below this is a toolbar with icons for adding, saving, and other actions. The main area is divided into two sections: an 'Action' button on the left and a spreadsheet on the right. The spreadsheet has columns labeled 'User Header', 'Col1', 'Col2 (I)', 'Col3 (D)', 'Col4', 'Col5', and 'Col6'. The data is as follows:

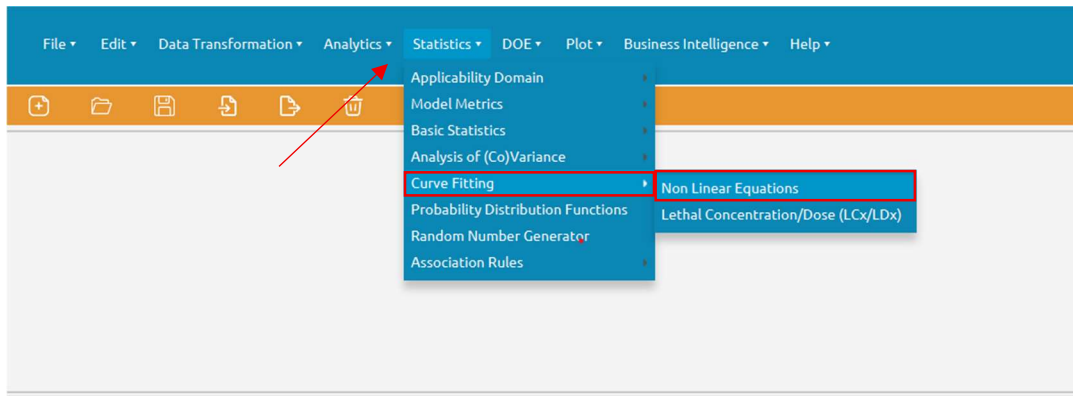
User Header	Col1	Col2 (I)	Col3 (D)	Col4	Col5	Col6
User Row ID	Age midpoint (years)	Single leg stance (s)				
1	35	57.4				
2	45	55.1				
3	55	44.8				
4	65	39.2				
5	75	26.4				
6	85	12.1				
7						
8						
9						
10						
11						
12						
13						
14						
15						

On the right side, there is a 'Curve Fitting - Non Linear E...' panel with the following settings:

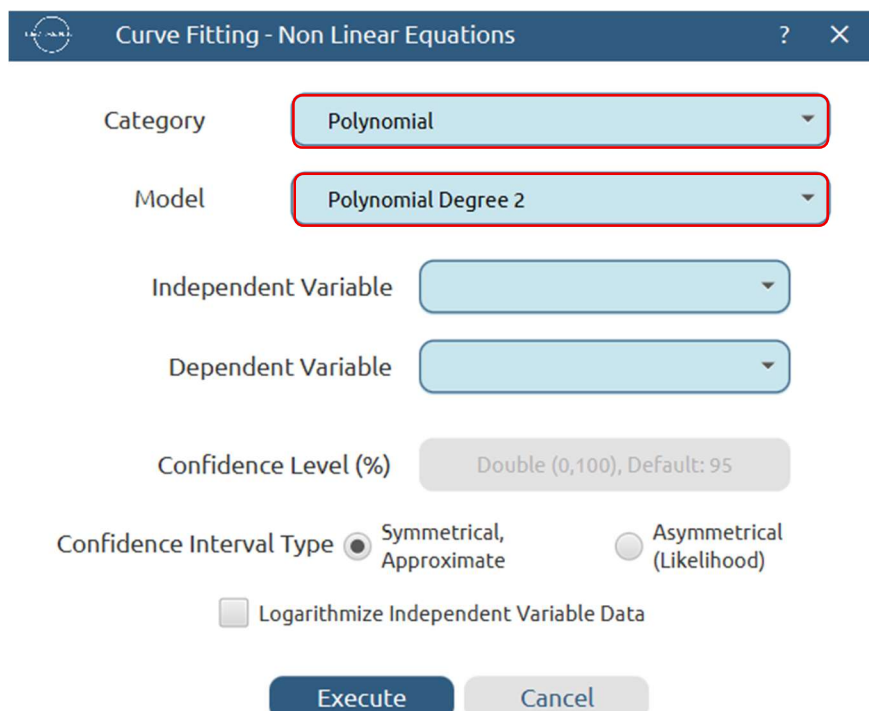
- Category: Polynomial
- Model: Polynomial Degree 2
- Independent Variable: Col2 -- Age midp...
- Dependent Variable: Col3 -- Single leg...
- Confidence Level (%): [input field]
- Confidence Interval Type: Symmetrical, Approximate
- Logarithmize Independent Variable D...
- Show Chart button

Step 2: Select the desired statistical analysis model

From the toolbar, open the **Statistics** drop-down list and navigate through **Statistics > Curve Fitting > Non Linear Equations**.

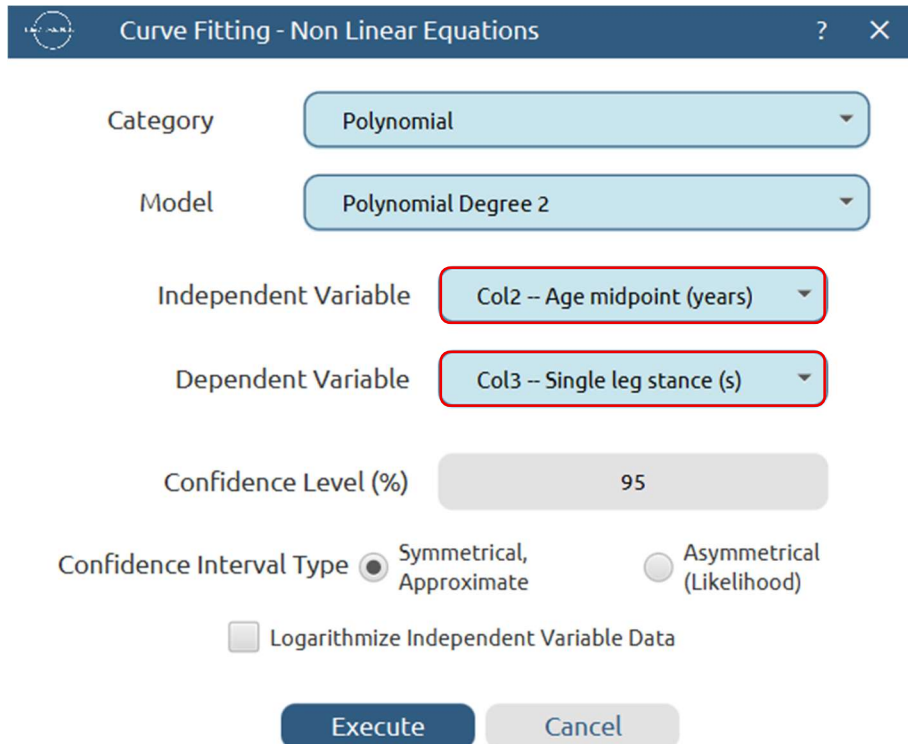


In the category list, select the **Polynomial** category and then choose **Polynomial model (Degree 2)** from the model menu.

A screenshot of the 'Curve Fitting - Non Linear Equations' dialog box. The dialog has a title bar with a question mark and a close button. The 'Category' dropdown is set to 'Polynomial'. The 'Model' dropdown is set to 'Polynomial Degree 2'. The 'Independent Variable' and 'Dependent Variable' fields are empty. The 'Confidence Level (%)' field is set to 'Double (0,100), Default: 95'. The 'Confidence Interval Type' section has two radio buttons: 'Symmetrical, Approximate' (selected) and 'Asymmetrical (Likelihood)'. There is a checkbox for 'Logarithmize Independent Variable Data' which is unchecked. At the bottom, there are 'Execute' and 'Cancel' buttons.

Step 3: Configure variables and confidence intervals

Set the column containing the **age midpoint (years)** values as the independent variable (X), and set the column containing the **single leg stance time (seconds)** values as the dependent variable (Y). Set the confidence level to **95%** and choose **Symmetrical Approximate** as the confidence interval type.



Curve Fitting - Non Linear Equations

Category: Polynomial

Model: Polynomial Degree 2

Independent Variable: Col2 -- Age midpoint (years)

Dependent Variable: Col3 -- Single leg stance (s)

Confidence Level (%): 95

Confidence Interval Type: Symmetrical, Approximate Asymmetrical (Likelihood)

Logarithmize Independent Variable Data

Execute Cancel

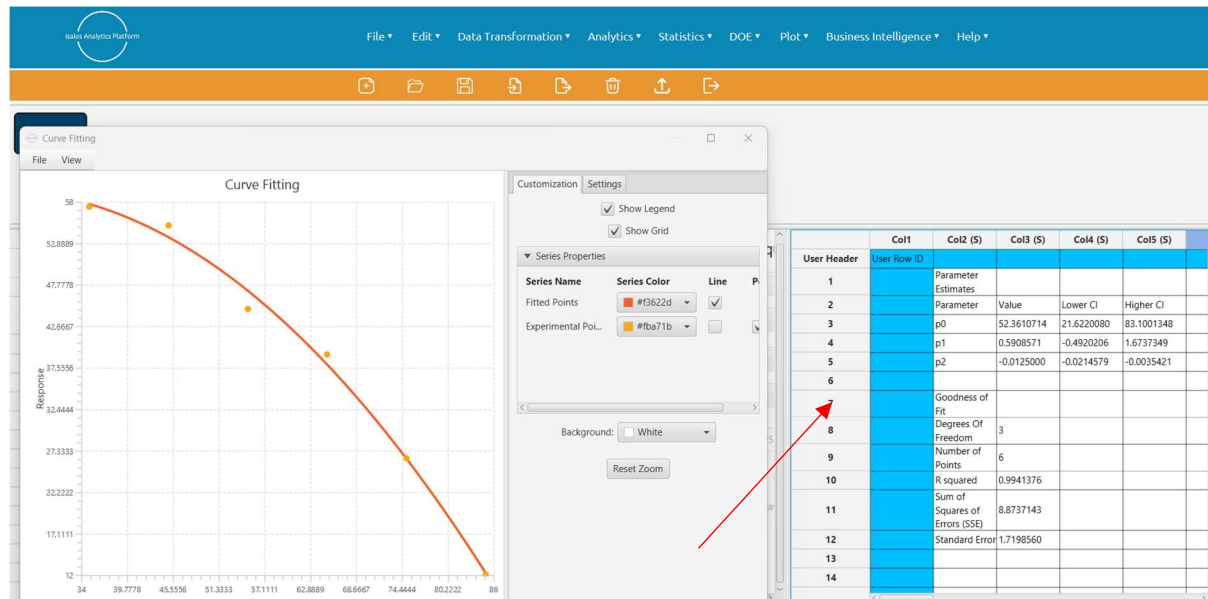
Step 4: Analyze the output and fitted curve

Once the analysis is completed, Isalos presents the fitted polynomial curve together with the experimental data points, allowing direct visual assessment of how well the model captures the age-related decline in balance performance. In this study, the graph shows a downward-curving trajectory rather than a simple straight-line decrease, supporting the use of a second-order polynomial model.

The results page presents the estimated model parameters with their confidence limits, together with goodness-of-fit statistics and the corresponding fitted plot. In the **Polynomial model (order 2)**, the main fitted parameters are the **intercept**, the **linear coefficient**, and the **quadratic coefficient**, and these values collectively determine the height, slope, and curvature of the fitted line.

The **Goodness of Fit** section of the table summarizes key fitting statistics such as the **number of data points used**, **degrees of freedom**, **residual sum of squares**, and the **standard error of**

the regression. These outputs should be interpreted together with the fitted plot in order to evaluate how well the model describes the data and how reliable the estimated parameters are.



The fitted results indicate that the published single leg stance data are well described by a **Polynomial model (order 2)**, showing that balance performance declines with age in a nonlinear rather than purely linear manner. The estimated **p0** of **52.361** represents the intercept of the model, the estimated **p1** of **0.591** represents the linear component of the age-related trend, and the estimated **p2** of **-0.0125** represents the quadratic component, with the negative value of **p2** indicating a downward-curving relationship in which the decline in balance performance becomes steeper at older ages.

The confidence interval for **p2** does not include zero, which supports the presence of a meaningful quadratic component in the fitted response. Together with the high **R²** value of **0.99414** and the relatively low residual error, these results indicate that the second-order polynomial model provides an excellent description of the age-related balance data and that the fitted parameters are reliable for this study.

References:

- (1) Hall, K.S., Cohen, H.J., Pieper, C.F., Fillenbaum, G.G., Kraus, W.E., Huffman, K.M., Cornish, M.A., Shiloh, A., Flynn, C., Sloane, R. and Newby, L.K., 2017. Physical performance across the adult life span: correlates with age and physical activity. *Journals of Gerontology Series A: Biomedical Sciences and Medical Sciences*, 72(4), pp.572-578.