ladder — Ladder of powers

Description Options for ladder Stored results Also see Quick start Options for gladder Methods and formulas Menu Options for qladder Acknowledgment Syntax Remarks and examples References

Description

ladder searches a subset of the ladder of powers (Tukey 1977) for a transform that converts *varname* into a normally distributed variable.

gladder and qladder each display a graph matrix. gladder displays nine histograms of transforms of *varname* according to the ladder of powers. qladder displays the quantiles of transforms of *varname* according to the ladder of powers against the quantiles of a normal distribution.

Quick start

Table showing Tukey's ladder of powers transformations for v

ladder v

Same as above, but with separate tables for each level of the categorical variable catvar

by catvar: ladder v

Display transformations graphically using histograms

gladder v

Same as above, but using quantile plots

qladder v

Menu

ladder

Statistics > Summaries, tables, and tests > Distributional plots and tests > Ladder of powers

gladder

Statistics > Summaries, tables, and tests > Distributional plots and tests > Ladder-of-powers histograms

qladder

 $\label{eq:statistics} Summaries, \ tables, \ and \ tests > \ Distributional \ plots \ and \ tests > \ Ladder-of-powers \ quantile-normal \ plots$

Syntax

Ladder of powers

ladder varname [if] [in] [, generate(newvar) noadjust]

Ladder-of-powers histograms

gladder varname [if] [in] [, histogram_options combine_options]

Ladder-of-powers quantile-normal plots

qladder varname [if] [in] [, qnorm_options combine_options]

by and collect are allowed with ladder; see [U] 11.1.10 Prefix commands.

Options for ladder

🛛 Main 🛛

generate(*newvar*) saves the transformed values corresponding to the minimum χ^2 value from the table. We do not recommend using generate() because it is literal in interpreting the minimum, thus ignoring nearly equal but perhaps more interpretable transforms.

noadjust is the noadjust option to sktest; see [R] sktest.

Options for gladder

- *histogram_options* affect the rendition of the histograms across all relevant transformations; see [R] **histogram**. Here the normal option is assumed, so you must supply the nonormal option to suppress the overlaid normal density. Also, gladder does not allow the width(#) option of histogram.
- *combine_options* are any of the options documented in [G-2] **graph combine**. These include options for titling the graph (see [G-3] *title_options*) and for saving the graph to disk (see [G-3] *saving_option*).

Options for qladder

qnorm_options affect the rendition of the quantile–normal plots across all relevant transformations. See [R] **Diagnostic plots**.

combine_options are any of the options documented in [G-2] **graph combine**. These include options for titling the graph (see [G-3] *title_options*) and for saving the graph to disk (see [G-3] *saving_option*).

Remarks and examples

Example 1: ladder

We have data on the mileage rating of 74 automobiles and wish to find a transform that makes the variable normally distributed:

. use https://www.stata-press.com/data/r19/auto (1978 automobile data)				
Formula	chi2(2)	Prob > chi2		
mpg ³	43.59	0.000		
mpg^2	27.03	0.000		
mpg	10.95	0.004		
sqrt(mpg)	4.94	0.084		
log(mpg)	0.87	0.647		
1/sqrt(mpg)	0.20	0.905		
1/mpg	2.36	0.307		
1/(mpg^2)	11.99	0.002		
1/(mpg^3)	24.30	0.000		
	Formula mpg^3 mpg^2 mpg sqrt(mpg) log(mpg) 1/sqrt(mpg) 1/mpg 1/(mpg^2) 1/(mpg^3)	Formula chi2(2) mpg^3 43.59 mpg^2 27.03 mpg 10.95 sqrt(mpg) 4.94 log(mpg) 0.87 //sqrt(mpg) 0.20 1/mpg 2.36 1/(mpg^2) 11.99 1/(mpg^3) 24.30		

If we had typed ladder mpg, gen(mpgx), the variable mpgx containing $1/\sqrt{mpg}$ would have been automatically generated for us. This is the perfect example of why you should not, in general, specify the generate() option. We also cannot reject the hypothesis that the inverse of mpg is normally distributed and that 1/mpg—gallons per mile—has a better interpretation. It is a measure of energy consumption.

4

Example 2: gladder

gladder explores the same transforms as ladder but presents results graphically:



. gladder mpg, fraction

Technical note

gladder is useful pedagogically, but be careful when using it for research work, especially with many observations. For instance, consider the following data on the average July temperature in degrees Fahrenheit for 954 US cities:

. use https://www.stata-press.com/data/r19/citytemp (City temperature data)				
. ladder tempjuly				
Transformation	Formula	chi2(2)	Prob > chi2	
Cubic	tempjuly^3	47.49	0.000	
Square	tempjuly ²	19.70	0.000	
Identity	tempjuly	3.83	0.147	
Square root	sqrt(tempjuly)	1.83	0.400	
Log	log(tempjuly)	5.40	0.067	
1/(Square root)	1/sqrt(tempjuly)	13.72	0.001	
Inverse	1/tempjuly	26.36	0.000	
1/Square	1/(tempjuly^2)	64.44	0.000	
1/Cubic	1/(tempjuly^3)	116.16	0.000	

4

From the table, we see that there is certainly a difference in normality between the square and squareroot transform. If, however, you can see the difference between the transforms in the diagram below, you have better eyes than we do:

. gladder tempjuly, l1title("") ylabel(none) xlabel(none)



```
Histograms by transformation
```

Example 3: qladder

A better graph for seeing normality is the quantile-normal graph, which can be produced by qladder.



. qladder tempjuly, ylabel(none) xlabel(none)

Quantile-normal plots by transformation

This graph shows that for the square transform, the upper tail—and only the upper tail—diverges from what would be expected. This divergence is detected by sktest (see [R] sktest) as a problem with skewness, as we would learn from using sktest to examine tempjuly squared and square rooted.

4

Stored results

ladder stores the following in r():

Scalars

r(N)	number of observations
r(invcube)	χ^2 for inverse-cubic transformation
r(P_invcube)	<i>p</i> -value for normality test after inverse-cubic transformation
r(invsq)	χ^2 for inverse-square transformation
r(P_invsq)	p-value for normality test after inverse-square transformation
r(inv)	χ^2 for inverse transformation
r(P_inv)	p-value for normality test after inverse transformation
r(invsqrt)	χ^2 for inverse-root transformation
r(P_invsqrt)	p-value for normality test after inverse-root transformation
r(log)	χ^2 for log transformation
r(P_log)	p-value for normality test after log transformation
r(sqrt)	χ^2 for square-root transformation
r(P_sqrt)	p-value for normality test after square-root transformation
r(ident)	χ^2 for untransformed data
r(P_ident)	p-value for normality test of untransformed data
r(square)	χ^2 for square transformation
r(P_square)	p-value for normality test after square transformation
r(cube)	χ^2 for cubic transformation
r(P_cube)	p-value for normality test after cubic transformation

Methods and formulas

For ladder, results are as reported by sktest; see [R] sktest. If generate() is specified, the transform with the minimum χ^2 value is chosen.

gladder sets the number of bins to $\min(\sqrt{n}, 10 \log_{10} n)$, rounded to the closest integer, where n is the number of unique values of *varname*. See [R] **histogram** for a discussion of the optimal number of bins.

Also see Findley (1990) for a ladder-of-powers variable transformation program that produces oneway graphs with overlaid box plots, in addition to histograms with overlaid normals. Buchner and Findley (1990) discuss ladder-of-powers transformations as one aspect of preliminary data analysis. Also see Hamilton (1992, 18–23) and Hamilton (2013, 129–132).

Acknowledgment

qladder was written by Jeroen Weesie of the Department of Sociology at Utrecht University, The Netherlands.

References

- Buchner, D. M., and T. W. Findley. 1990. Research in physical medicine and rehabilitation: VIII. Preliminary data analysis. American Journal of Physical Medicine and Rehabilitation 69: 154–169. https://doi.org/10.1097/00002060-199006000-00011.
- Cox, N. J. 2005. Speaking Stata: Density probability plots. Stata Journal 5: 259-273.
- Findley, T. W. 1990. sed3: Variable transformation and evaluation. *Stata Technical Bulletin* 2: 15. Reprinted in *Stata Technical Bulletin Reprints*, vol. 1, pp. 85–86. College Station, TX: Stata Press.
- Hamilton, L. C. 1992. Regression with Graphics: A Second Course in Applied Statistics. Belmont, CA: Duxbury.

. 2013. Statistics with Stata: Updated for Version 12. 8th ed. Boston: Brooks/Cole.

Tukey, J. W. 1977. Exploratory Data Analysis. Reading, MA: Addison-Wesley.

Also see

- [R] **boxcox** Box–Cox regression models
- [R] Diagnostic plots Distributional diagnostic plots
- [R] Inskew0 Find zero-skewness log or Box-Cox transform
- [R] **lv** Letter-value displays
- [R] sktest Skewness and kurtosis tests for normality

Stata, Stata Press, Mata, NetCourse, and NetCourseNow are registered trademarks of StataCorp LLC. Stata and Stata Press are registered trademarks with the World Intellectual Property Organization of the United Nations. StataNow is a trademark of StataCorp LLC. Other brand and product names are registered trademarks or trademarks of their respective companies. Copyright © 1985–2025 StataCorp LLC, College Station, TX, USA. All rights reserved.



For suggested citations, see the FAQ on citing Stata documentation.