What is Interval Regression and how is it used in R for data analysis?

Authored by
stats writer

June 29, 2024

RECOMMENDED CITATION

stats writer (2024). *What is Interval Regression and how is it used in R for data analysis?*. PSYCHOLOGICAL SCALES. Retrieved from https://scales.arabpsychology.com/?p=158664

Interval regression is a statistical method used in data analysis that is specifically designed to handle response variables that have a defined lower and upper bound. It allows for the estimation of regression coefficients for predictor variables while taking into account the censoring or truncation of the response variable. This technique is commonly used in fields such as economics, psychology, and health sciences, where the response variable is often limited to a certain range. In R, interval regression can be implemented using the "interval" package, which provides functions for model estimation, prediction, and diagnostic checks. This tool is useful for accurately analyzing and interpreting data with censored or truncated response variables and can provide insights into the relationship between predictor variables and the response variable within the specified range.

Interval Regression | R Data Analysis Examples

Interval regression is used to model outcomes that have interval censoring.
In other words, you know the ordered category into which each observation falls,
but you do not know the exact value of the observation. Interval
regression is a generalization of censored regression.

This page uses the following packages. Make sure that you can load
them before trying to run the examples on this page. If you do not have
a package installed, run: `install.packages("packagename")`, or
if you see the version is out of date, run: `update.packages()`.

require(foreign)

require(ggplot2)

require(GGally)

require(survival)

require(rgl)

```
Version info: Code for this page was tested in R Under development (unstable)
(2012-11-16 r61126)
On: 2012-12-15
With: rgl 0.92.894; survival 2.36-14; GGally 0.4.2; reshape 0.8.4; plyr 1.8;
ggplot2 0.9.3; foreign 0.8-51; knitr 0.9
```

Please note: The purpose of this page is to show how to use various data analysis commands. It does not cover all aspects of the research process which researchers are expected to do. In particular, it does not cover data cleaning and checking, verification of assumptions, model diagnostics or potential follow-up analyses.

Examples of interval regression

Example 1. We wish to model annual income using years of education and marital status. However, we do not have access to the precise values for income. Rather, we only have data on the income ranges:

$100,000. Note that the extreme values of the categories on either end of the range are either left-censored or right-censored. The other categories are interval censored, that is, each interval is both left- and right-censored. Analyses of this type require a generalization of censored regression known as interval regression.

Example 2. We wish to predict GPA from teacher ratings of effort and from reading and writing test scores. The measure of GPA is a self-report response to the following item:

Select the category that best represents your overall GPA.
less than 2.0
2.0 to 2.5
2.5 to 3.0
3.0 to 3.4
3.4 to 3.8
3.8 to 3.9
4.0 or greater

Again, we have a situation with both interval censoring and left- and right-censoring.
We do not know the exact value of GPA for each student; we only know the interval in which their GPA falls.

Example 3. We wish to predict GPA from teacher ratings of effort, writing test scores and the type of program in which the student was enrolled (vocational, general or academic). The measure of GPA is a self-report response to the following item:

Select the category that best represents your overall GPA.
0.0 to 2.0
2.0 to 2.5
2.5 to 3.0
3.0 to 3.4
3.4 to 3.8
3.8 to 4.0

This is a slight variation of Example 2. In this example, there is only interval censoring.

Description of the data

Let's pursue Example 3 from above.
We have a hypothetical data file, `intreg_data.dta` with 30 observations.
The GPA score is represented by two values, the lower interval score (`lgpa`) and the upper interval score (`ugpa`). The writing test scores, the teacher rating and the type of program (a nominal variable which has three levels) are `write`, `rating` and `type`, respectively.
Let's look at the data. It is always a good idea to start with descriptive statistics.

```
dat <- read.dta("https://stats.idre.ucla.edu/stat/data/intreg_data.dta")

# summary of the variablessummary(dat)

## id lgpa ugpa write rating
## Min. : 1.00 Min. :0.0 Min. :2.0 Min. : 50 Min. :48.0
## 1st Qu.: 8.25 1st Qu.:2.0 1st Qu.:2.5 1st Qu.: 70 1st Qu.:51.6
```

Median :15.50 Median :2.5 Median :3.0 Median :105 Median :54.0
Mean :15.50 Mean :2.6 Mean :3.1 Mean :114 Mean :57.5
3rd Qu.:22.75 3rd Qu.:3.3 3rd Qu.:3.7 3rd Qu.:154 3rd Qu.:66.2
Max. :30.00 Max. :3.8 Max. :4.0 Max. :205 Max. :72.0
type
vocational: 8
general :10
academic :12
##
##
##

bivariate plotsggpairs(dat, lower = list(combo = "box"), upper = list(combo = "blank"))

Note that there are two GPA responses for each observation,

`lgpa` for the lower end of the interval and

`ugpa` for the upper end. We can compare the means of the variables

by each type of program using `by`.

by(dat, dat$type, colMeans, na.rm = TRUE)

dat$type: vocational
lgpa ugpa write rating
1.750 2.438 71.875 52.500
--
dat$type: general
lgpa ugpa write rating
2.78 3.24 148.00 56.80
--
dat$type: academic
lgpa ugpa write rating
3.017 3.417 113.333 61.500

Analysis methods you might consider

Below is a list of some analysis methods you may have encountered. Some of the methods listed are quite reasonable, while others have
either fallen out of favor or have limitations.

Interval regression

We will use the `survival` package to run the interval regression.
First we setup a survival object that contains the censored intervals using

the `Surv` function. Note the special event status code, 3, used for all observations indicating that all had interval censoring.
Then we estimate the model using the `survreg` function.

```
# setup the survival object with interval censoring
(Y <- with(dat, Surv(lgpa, ugpa, event = rep(3, nrow(dat)), type = "interval")))

##
##
##
##
##

m <- survreg(Y ~ write + rating + type, data = dat, dist = "gaussian")

summary(m)

##
## Call:
## survreg(formula = Y ~ write + rating + type, data = dat, dist = "gaussian")
```

Value Std. Error z p
(Intercept) 1.10386 0.44529 2.48 1.32e-02
write 0.00528 0.00169 3.12 1.79e-03
rating 0.01331 0.00912 1.46 1.44e-01
typegeneral 0.37485 0.19275 1.94 5.18e-02
typeacademic 0.70975 0.16684 4.25 2.10e-05
Log(scale) -1.23726 0.15964 -7.75 9.17e-15
##
Scale= 0.29
##
Gaussian distribution
Loglik(model)= -33.1 Loglik(intercept only)= -51.7
Chisq= 37.24 on 4 degrees of freedom, p= 1.6e-07
Number of Newton-Raphson Iterations: 5
n= 30

We can get a test of the overall effect of type by examining an analysis
of deviance table, which reports the sequential deviances (-2*LL) adding
one term at a time.

analysis of deviance tableanova(m)

Df Deviance Resid. Df -2*LL Pr(>Chi)
NULL NA NA 28 103.49 NA
write 1 16.689 27 86.81 4.403e-05
rating 1 6.097 26 80.71 1.354e-02
type 2 14.450 24 66.26 7.280e-04

The two degree of freedom test for `type` indicates that it is
statistically significant.

Now let's make a 3d plot of the data and the predicted regression planes.
We will put the two continuous predictors on the X and Y axis, and the
outcome on the Z axis. Then we will use different colours to code the
program type. To do this, we will use the `rgl` package. Finally
because it is difficult to see a 3d image in two dimensions, let's
make it an animated image so we can see it from different angles.
For the final part, the free software, ImageMagick is used by

the `rgl` package behind the scenes.

 # for the regression surface
f <- function(x, y, type = "vocational") {
newdat <- data.frame(write = x, rating = y, type = factor(type, levels = levels(dat$type)))
predict(m, newdata = newdat)
}

 # Create X, Y, and Z grids
X <- with(dat, seq(from = min(write), to = max(write), length.out = 10))
Y <- with(dat, seq(from = min(rating), to = max(rating), length.out = 10))
Z <- outer(X, Y, f)

 # Create 3d scatter plot and add the regression surfaceopen3d(windowRect = c(100, 100, 700, 700))

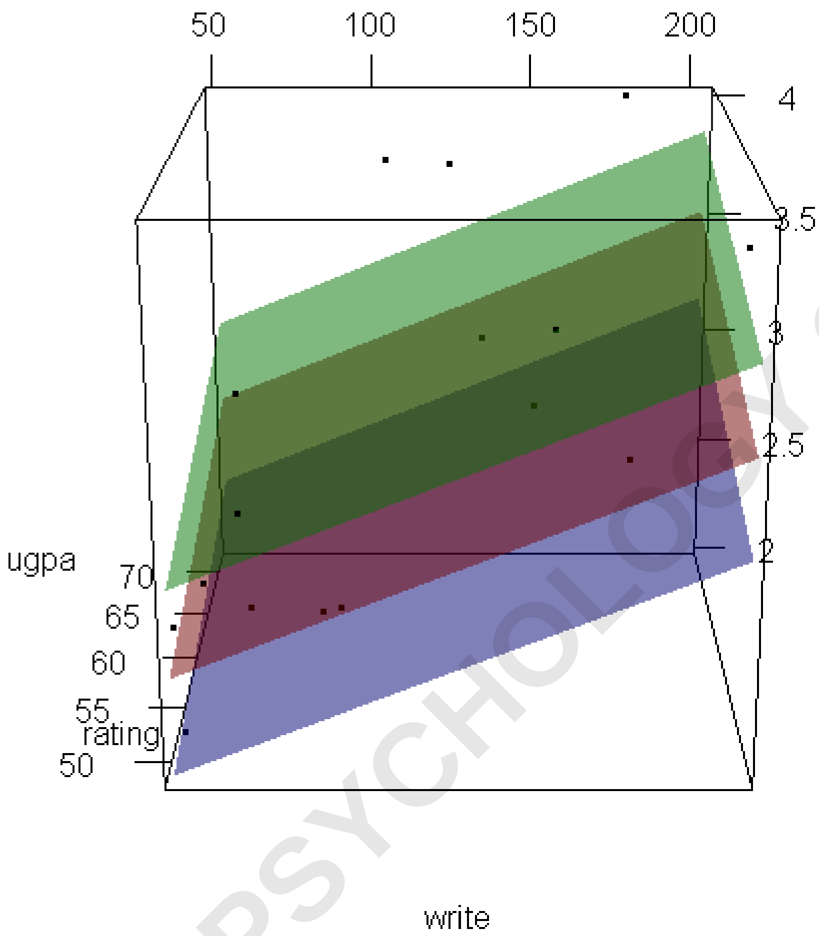
1

with(dat, plot3d(x = write, y = rating, z = ugpa, xlab = "write", ylab = "rating",
zlab = "ugpa", xlim = range(write), ylim = range(rating), zlim = range(ugpa)))

```
par3d(ignoreExtent = TRUE)

# add regression surface for each type of program in a different colour
# with 50 percent transparency (alpha = .5)
surface3d(X, Y, outer(X, Y, f, type = "vocational"), col = "blue", alpha = 0.5)
surface3d(X, Y, outer(X, Y, f, type = "general"), col = "red", alpha = 0.5)
surface3d(X, Y, outer(X, Y, f, type = "academic"), col = "green", alpha = 0.5)

# create an animated movie
movie3d(spin3d(axis=c(.5,.5,.5), rpm=5),
# duration=6, dir = 'intreg_fig')
```



It is not a true R2, but we can get a rough idea by computing the correlation between the expected values from the model

and the lower and upper bounds of gpa, `lgpa` and `ugpa`. Then the squared correlation is something like an R2.

(r <- with(dat, cor(cbind(yhat = predict(m), lgpa, ugpa))))

```
## yhat lgpa ugpa
## yhat 1.0000 0.7946 0.8430
## lgpa 0.7946 1.0000 0.9488
## ugpa 0.8430 0.9488 1.0000

# pseudo R2
r^2

## yhat lgpa ugpa
## yhat 1.0000 0.6314 0.7107
## lgpa 0.6314 1.0000 0.9002
## ugpa 0.7107 0.9002 1.0000
```

References