AlumniGiving

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# Alumni Giving Prediction Example

AlumniGiving <- structure(list(School = c("Arizona State University", "Arkansas State University—Jonesboro",   
"Auburn University", "United States Air Force Academy", "United States Military Academy",   
"University of Akron", "University of Arizona", "University of Arkansas",   
"Ball State University", "Baylor University", "Boise State University",   
"Boston College", "Bowling Green State University", "Brigham Young University—Provo",   
"University at Buffalo—SUNY", "University of Alabama", "Central Michigan University",   
"Clemson University", "Colorado State University", "University of California—Berkeley",   
"University of Cincinnati", "University of Colorado—Boulder",   
"California State University—Fresno", "Duke University", "East Carolina University",   
"Eastern Michigan University", "Florida Atlantic University",   
"Florida International University", "Florida State University",   
"University of Connecticut", "University of Florida", "Georgia Institute of Technology",   
"Georgia State University", "University of Georgia", "University of Hawaii—Manoa",   
"University of Houston", "Indiana University—Bloomington",   
"Iowa State University", "Kansas State University", "Kent State University",   
"University of Idaho", "University of Illinois—Urbana-Champaign",   
"University of Iowa", "University of Kansas", "University of Kentucky",   
"Louisiana State University—Baton Rouge", "Louisiana Tech University",   
"University of Louisiana—Lafayette", "University of Louisiana—Monroe",   
"University of Louisville", "Marshall University", "Miami University—Oxford",   
"Michigan State University", "Middle Tennessee State University",   
"Mississippi State University", "University of Maryland—College Park",   
"University of Massachusetts—Amherst", "University of Memphis",   
"University of Miami", "University of Michigan—Ann Arbor",   
"University of Minnesota—Twin Cities", "University of Missouri",   
"New Mexico State University", "North Carolina State University—Raleigh",   
"Northern Illinois University", "Northwestern University", "United States Naval Academy",   
"University of Nebraska—Lincoln", "University of Nevada—Las Vegas",   
"University of Nevada—Reno", "University of New Mexico", "University of North Carolina—Chapel Hill",   
"University of North Texas", "University of Notre Dame", "Ohio State University—Columbus",   
"Ohio University", "Oklahoma State University", "Oregon State University",   
"University of Mississippi", "University of Oklahoma", "University of Oregon",   
"Pennsylvania State University—University Park", "Purdue University—West Lafayette",   
"Rice University", "Rutgers,\n the State University of New Jersey—New Brunswick",   
"San Diego State University", "San Jose State University", "Southern Methodist University",   
"Stanford University", "University of Pittsburgh", "University of South Alabama",   
"University of South Carolina", "University of South Florida",   
"University of Southern Mississippi", "Syracuse University",   
"Temple University", "Texas A&M University—College Station",   
"Texas Christian University", "Texas State University—San Marcos",   
"Texas Tech University", "Troy University", "Tulane University",   
"University of Tennessee", "University of Texas—Austin", "University of Toledo",   
"University of Tulsa", "University of Alabama—Birmingham",   
"University of California—Los Angeles", "University of Central Florida",   
"University of Nevada—Las Vegas", "University of Southern California",   
"University of Texas—San Antonio", "University of Tulsa", "University of Utah",   
"Utah State University", "University of Virginia", "University of Washington",   
"University of Wyoming", "Vanderbilt University", "Virginia Tech",   
"Wake Forest University", "Washington State University", "West Virginia University",   
"Western Kentucky University", "Western Michigan University"),   
 SFR = c(24, 19, 18, 8, 8, 20, 20, 18, 18, 14, 21, 14, 19,   
 21, 16, 19, 22, 16, 18, 17, 17, 18, 20, 8, 17, 18, 21, 28,   
 22, 18, 21, 19, 20, 19, 14, 23, 19, 17, 21, 20, 18, 16, 16,   
 20, 18, 22, 22, 23, 18, 18, 20, 17, 16, 21, 20, 18, 19, 15,   
 11, 15, 21, 20, 20, 18, 17, 7, 9, 20, 22, 27, 22, 14, 23,   
 12, 19, 19, 19, 25, 18, 17, 20, 17, 14, 6, 15, 21, 25, 12,   
 6, 14, 22, 19, 28, 18, 16, 19, 19, 13, 19, 23, 20, 11, 15,   
 18, 19, 11, 17, 16, 31, 22, 9, 23, 11, 15, 19, 16, 12, 14,   
 8, 17, 11, 15, 23, 19, 19), Small.Classes = c(0.42, 0.49,   
 0.24, 0.74, 0.95, 0.39, 0.35, 0.28, 0.34, 0.49, 0.33, 0.47,   
 0.33, 0.46, 0.36, 0.46, 0.32, 0.51, 0.34, 0.62, 0.38, 0.38,   
 0.18, 0.71, 0.33, 0.39, 0.27, 0.23, 0.35, 0.44, 0.41, 0.4,   
 0.14, 0.35, 0.45, 0.28, 0.34, 0.3, 0.49, 0.45, 0.45, 0.34,   
 0.49, 0.42, 0.3, 0.34, 0.48, 0.3, 0.3, 0.25, 0.38, 0.32,   
 0.23, 0.32, 0.38, 0.35, 0.45, 0.36, 0.53, 0.48, 0.38, 0.47,   
 0.45, 0.3, 0.44, 0.75, 0.56, 0.38, 0.25, 0.33, 0.4, 0.37,   
 0.29, 0.55, 0.32, 0.42, 0.39, 0.36, 0.46, 0.41, 0.37, 0.39,   
 0.37, 0.69, 0.41, 0.22, 0.25, 0.58, 0.7, 0.42, 0.42, 0.38,   
 0.23, 0.43, 0.61, 0.33, 0.21, 0.4, 0.19, 0.22, 0.58, 0.67,   
 0.31, 0.34, 0.34, 0.7, 0.39, 0.52, 0.28, 0.25, 0.63, 0.24,   
 0.7, 0.42, 0.32, 0.52, 0.33, 0.42, 0.64, 0.25, 0.54, 0.37,   
 0.32, 0.43, 0.36), Big.Classes = c(0.16, 0.04, 0.17, 0.001,   
 0, 0.06, 0.17, 0.18, 0.12, 0.09, 0.11, 0.06, 0.07, 0.12,   
 0.21, 0.16, 0.11, 0.13, 0.19, 0.15, 0.11, 0.16, 0.1, 0.06,   
 0.14, 0.05, 0.15, 0.22, 0.16, 0.17, 0.16, 0.23, 0.16, 0.12,   
 0.1, 0.22, 0.18, 0.2, 0.11, 0.08, 0.1, 0.21, 0.12, 0.12,   
 0.16, 0.19, 0.09, 0.07, 0.13, 0.12, 0.04, 0.12, 0.21, 0.07,   
 0.14, 0.16, 0.17, 0.11, 0.07, 0.16, 0.19, 0.15, 0.1, 0.2,   
 0.12, 0.06, 0.001, 0.14, 0.18, 0.16, 0.14, 0.13, 0.2, 0.1,   
 0.2, 0.11, 0.12, 0.2, 0.13, 0.11, 0.17, 0.15, 0.17, 0.08,   
 0.2, 0.24, 0.09, 0.08, 0.13, 0.18, 0.08, 0.11, 0.16, 0.11,   
 0.09, 0.08, 0.23, 0.08, 0.19, 0.24, 0.04, 0.06, 0.08, 0.25,   
 0.31, 0.01, 0.15, 0.22, 0.23, 0.18, 0.11, 0.23, 0.01, 0.17,   
 0.18, 0.16, 0.21, 0.1, 0.09, 0.21, 0.03, 0.22, 0.19, 0.06,   
 0.11), Graduation.Rate = c(0.59, 0.37, 0.66, 0.81, 0.86,   
 0.35, 0.6, 0.58, 0.57, 0.71, 0.27, 0.91, 0.61, 0.78, 0.67,   
 0.67, 0.54, 0.76, 0.64, 0.91, 0.56, 0.68, 0.49, 0.94, 0.57,   
 0.38, 0.42, 0.46, 0.74, 0.81, 0.84, 0.8, 0.48, 0.82, 0.5,   
 0.46, 0.71, 0.7, 0.6, 0.5, 0.55, 0.84, 0.7, 0.61, 0.58, 0.61,   
 0.49, 0.4, 0.3, 0.49, 0.44, 0.8, 0.77, 0.45, 0.58, 0.81,   
 0.69, 0.4, 0.8, 0.9, 0.7, 0.69, 0.45, 0.71, 0.56, 0.94, 0.89,   
 0.64, 0.41, 0.5, 0.44, 0.9, 0.48, 0.96, 0.78, 0.65, 0.59,   
 0.6, 0.59, 0.64, 0.68, 0.85, 0.69, 0.92, 0.77, 0.66, 0.44,   
 0.74, 0.95, 0.78, 0.37, 0.68, 0.51, 0.47, 0.82, 0.65, 0.79,   
 0.74, 0.55, 0.63, 0.4, 0.74, 0.6, 0.81, 0.45, 0.65, 0.41,   
 0.9, 0.63, 0.41, 0.89, 0.26, 0.65, 0.57, 0.56, 0.93, 0.8,   
 0.53, 0.91, 0.8, 0.89, 0.69, 0.59, 0.49, 0.52), Freshman.Retention = c(0.81,   
 0.69, 0.87, 0.88, 0.92, 0.69, 0.79, 0.83, 0.78, 0.85, 0.67,   
 0.96, 0.75, 0.84, 0.88, 0.85, 0.78, 0.91, 0.83, 0.97, 0.84,   
 0.84, 0.83, 0.97, 0.78, 0.72, 0.77, 0.81, 0.9, 0.93, 0.96,   
 0.93, 0.83, 0.94, 0.78, 0.79, 0.9, 0.85, 0.79, 0.76, 0.78,   
 0.94, 0.84, 0.79, 0.8, 0.85, 0.73, 0.74, 0.72, 0.78, 0.71,   
 0.89, 0.91, 0.81, 0.83, 0.94, 0.87, 0.76, 0.9, 0.96, 0.89,   
 0.85, 0.76, 0.9, 0.75, 0.97, 0.97, 0.84, 0.76, 0.78, 0.78,   
 0.97, 0.76, 0.98, 0.93, 0.8, 0.79, 0.82, 0.8, 0.83, 0.84,   
 0.93, 0.87, 0.97, 0.91, 0.83, 0.82, 0.89, 0.98, 0.92, 0.68,   
 0.87, 0.86, 0.74, 0.91, 0.87, 0.92, 0.86, 0.78, 0.82, 0.72,   
 0.89, 0.85, 0.92, 0.68, 0.88, 0.79, 0.97, 0.86, 0.76, 0.97,   
 0.58, 0.88, 0.83, 0.74, 0.97, 0.93, 0.73, 0.97, 0.92, 0.94,   
 0.83, 0.8, 0.73, 0.74), Giving = c(0.08, 0.11, 0.31, 0.11,   
 0.28, 0.15, 0.05, 0.23, 0.11, 0.14, 0.08, 0.27, 0.08, 0.17,   
 0.09, 0.34, 0.08, 0.28, 0.07, 0.12, 0.11, 0.08, 0.04, 0.36,   
 0.05, 0.03, 0.04, 0.06, 0.19, 0.17, 0.15, 0.28, 0.06, 0.14,   
 0.08, 0.13, 0.16, 0.15, 0.19, 0.04, 0.11, 0.13, 0.12, 0.18,   
 0.12, 0.14, 0.13, 0.07, 0.05, 0.12, 0.1, 0.16, 0.14, 0.06,   
 0.17, 0.1, 0.11, 0.06, 0.17, 0.15, 0.13, 0.16, 0.06, 0.11,   
 0.06, 0.3, 0.21, 0.22, 0.05, 0.09, 0.07, 0.22, 0.05, 0.41,   
 0.15, 0.08, 0.15, 0.12, 0.13, 0.19, 0.13, 0.21, 0.19, 0.32,   
 0.1, 0.02, 0.02, 0.19, 0.34, 0.13, 0.02, 0.17, 0.15, 0.13,   
 0.17, 0.08, 0.21, 0.18, 0.05, 0.15, 0.09, 0.19, 0.11, 0.14,   
 0.05, 0.22, 0.13, 0.13, 0.16, 0.05, 0.39, 0.05, 0.22, 0.11,   
 0.08, 0.22, 0.15, 0.1, 0.23, 0.15, 0.29, 0.13, 0.12, 0.13,   
 0.1), Special = c("No", "No", "Yes", "No", "No", "No", "No",   
 "No", "No", "No", "No", "No", "No", "No", "No", "Yes", "No",   
 "No", "No", "No", "No", "No", "No", "No", "No", "No", "No",   
 "No", "No", "No", "No", "No", "No", "No", "No", "No", "No",   
 "No", "No", "No", "No", "No", "No", "No", "No", "No", "No",   
 "No", "No", "No", "No", "No", "No", "No", "No", "No", "No",   
 "No", "No", "No", "No", "No", "No", "No", "No", "No", "No",   
 "No", "No", "No", "No", "No", "No", "Yes", "No", "No", "No",   
 "No", "No", "No", "No", "No", "No", "No", "No", "No", "No",   
 "No", "No", "No", "No", "No", "No", "No", "No", "No", "No",   
 "No", "No", "No", "No", "No", "No", "No", "No", "No", "No",   
 "No", "No", "No", "No", "No", "No", "No", "No", "No", "No",   
 "No", "No", "No", "No", "No", "No", "No", "No")), class = "data.frame", row.names = c(NA,   
-125L))

## A Linear Model

Mod.AG <- lm(Giving~SFR+Small.Classes+Big.Classes+Graduation.Rate+Freshman.Retention+Special, data=AlumniGiving)  
summary(Mod.AG)

##   
## Call:  
## lm(formula = Giving ~ SFR + Small.Classes + Big.Classes + Graduation.Rate +   
## Freshman.Retention + Special, data = AlumniGiving)  
##   
## Residuals:  
## Min 1Q Median 3Q Max   
## -0.124888 -0.030048 -0.005409 0.027063 0.145876   
##   
## Coefficients:  
## Estimate Std. Error t value Pr(>|t|)   
## (Intercept) -0.188483 0.096503 -1.953 0.05317 .   
## SFR -0.001085 0.001519 -0.715 0.47620   
## Small.Classes 0.166839 0.054459 3.064 0.00271 \*\*   
## Big.Classes -0.023674 0.101584 -0.233 0.81613   
## Graduation.Rate 0.108767 0.081848 1.329 0.18645   
## Freshman.Retention 0.250587 0.148554 1.687 0.09428 .   
## SpecialYes 0.184869 0.028313 6.529 1.74e-09 \*\*\*  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Residual standard error: 0.04809 on 118 degrees of freedom  
## Multiple R-squared: 0.6626, Adjusted R-squared: 0.6454   
## F-statistic: 38.61 on 6 and 118 DF, p-value: < 2.2e-16

A predicted value for each row is:

Let’s see the first row of the data.

library(tidyverse)  
Arkansas <- AlumniGiving %>% filter(School == "University of Arkansas")  
Arkansas

## School SFR Small.Classes Big.Classes Graduation.Rate  
## 1 University of Arkansas 18 0.28 0.18 0.58  
## Freshman.Retention Giving Special  
## 1 0.83 0.23 No

So the predicted value for Arkansas is:

-0.1884827 + -0.0010855*18 + 0.1668386*0.28 + -0.0236738*0.18 + 0.1087666*0.58 + 0.2505868*0.83 + 0.1848693*0

which computes to:

predict(Mod.AG, newdata=Arkansas)

## 1   
## 0.105504

or a 0.1055 giving rate. Their actual giving rate is 0.23, so the residual is 0.1245 or +12.45% residual giving. Or giving that is 0.1245 more than expected given Arkansas’s data. The R code for it is fitted.values so I tend to use that term also.

AlumniGiving$resids <- residuals(Mod.AG)  
AlumniGiving$FV <- fitted.values(Mod.AG)  
Arkansas <- AlumniGiving %>% filter(School == "University of Arkansas")  
Arkansas

## School SFR Small.Classes Big.Classes Graduation.Rate  
## 1 University of Arkansas 18 0.28 0.18 0.58  
## Freshman.Retention Giving Special resids FV  
## 1 0.83 0.23 No 0.124496 0.105504