This post tries to accomplish several things concisely. I have used a  
function (chaid\_table()) inside the CGPFUNCTION package   
reviewing some graphing options and revisiting our old friend CHAID – Chi  
Squared \(\chi^2\) Automated Interaction Detection – to look at modeling a **“real  
world”** business problem.

The situation is drawn from the book *Quantitative Methods for Management. A  
Practical Approach*, **(Authors: Canela, Miguel Angel; Alegre, Inés; Ibarra,  
Alberto)** and the data are publicly available, you can access it from their  
Github repository as churn.csv and save it to a directory of your choice. We’re  
being asked to imagine we’re a wireless provider and we have a sample of 5,000  
customers with 13 possible predictor variables, a unique ID number, and data  
about whether a customer did (Yes) leave us for a different provider, or stayed  
with us (No).

The predictors are a nice mix of things we might know about our customers, how  
long they have been with us, what sort of data and international calling plan  
they have, how often they call us for support, how often they call other  
customers of ours, etc., etc.. The original blog post has a nice little table  
listing all the variables that I won’t reproduce here.

Looks like in the book they took a classic linear regression approach, and the  
blog post builds on a classic decision tree model. Both well known approaches  
with plenty of supporters. As written before,  
I actually love CHAID as an early modeling and explanation tool. Not necessarily  
because it is the most accurate, or the fastest, or the most modern but rather  
because it is easy to explain to our business customer, easy to  
understand the results, easy to use, and makes very few assumptions about the  
nature of our data.

**Our objective**

Let’s imagine that this is our first attempt at using the data we have on hand  
to predict “churn” and to look for opportunities to reduce it. Note that it is  
also good in a business setting to avoid unnecessary costs and reduce waste. So  
yes obviously we’d like to stop people from dropping our service  
and look for potential ways to retain them. We’d also like to avoid  
spending money or resources to induce people to stay when there is very little  
likelihood of them leaving. In other words, we are nearly equally interested in  
predicting who will leave and who will stay.

I’d also press the case that since this is our first attempt at modelling and since  
we are likely to be explaining our results to people who don’t natively talk  
about “p values” or “decision trees” or “model accuracy” that we should focus on  
being able to clearly explain our results rather than focus on how deep we go or  
how utterly accurate our model is.

For this post then, we’re going to explore a relatively shallow CHAID model  
and some tools for exploring the results in tabular and graphical format. Read  
on! I’ll say it again below but comments and critique are always welcomed via  
disqus or email. You’ll have no trouble finding the icon links in a couple of  
places.

Let’s load dplyr and CHAID (which requires partykit) and grab the dataset  
from github.

library(dplyr)

library(ggplot2)

theme\_set(theme\_bw())

library(forcats)

library(ggmosaic)

# library(ggrepel)

# install.packages("partykit")

# install.packages("CHAID", repos="<http://R-Forge.R-project.org>")

library(CHAID)

# devtools::install\_github("ibecav/CGPfunctions", build\_vignettes = TRUE)

library(CGPfunctions)

library(knitr)

# churn <- read.csv("<https://raw.githubusercontent.com/quants-book/CSV_Files/master/churn.csv>")

churn <- read.csv("churn.csv")

str(churn)

## 'data.frame': 5000 obs. of 15 variables:

## $ ID : Factor w/ 5000 levels "350-1149","350-1404",..: 2915 4687 2525 2883 3989 1281 2466 1968 3481 4789 ...

## $ ACLENGTH: int 77 105 121 115 133 95 50 157 35 96 ...

## $ INTPLAN : int 0 0 0 0 0 0 1 0 0 0 ...

## $ DATAPLAN: int 0 0 1 0 1 1 0 1 1 0 ...

## $ DATAGB : Factor w/ 7 levels "0","1.5G","100M",..: 1 1 2 1 2 7 1 6 7 1 ...

## $ OMMIN : num 80.8 131.8 212.1 186.1 166.5 ...

## $ OMCALL : int 70 66 57 64 61 85 96 73 56 99 ...

## $ OTMIN : num 166 132 195 231 176 ...

## $ OTCALL : int 67 105 140 125 74 98 73 71 77 99 ...

## $ NGMIN : num 18.6 5.1 14.9 26.5 36.1 11.1 34.5 15.3 21.6 12.4 ...

## $ NGCALL : int 6 6 14 16 11 2 10 8 7 2 ...

## $ IMIN : num 9.5 6.7 28.6 9.9 5.3 0 18.4 11.3 0 5.2 ...

## $ ICALL : int 4 2 8 4 2 0 7 3 0 2 ...

## $ CUSCALL : int 1 0 1 1 1 1 1 3 0 0 ...

## $ CHURN : int 0 0 0 0 0 1 1 0 1 0 ...

**Prepping the data**

I’ll simply focus on what we need to do to  
prepare it for our CHAID analysis.

The variables INTPLAN, DATAPLAN, and CHURN are currently stored as  
integers 0/1 let’s make them true factors and label them No/Yes respectively  
just for clarity. We’ll do that with a mutate\_at command.

DATAGB needs a little cleanup. It’s stored as a factor but the order is wrong  
because it was initially a character string. Far more convenient to store it as  
an ordered factor and specify the right order. You could reorder using base R  
but I’m going to use forcats::fct\_relevel as clearer cleaner code.

The remainder of the variables are either real numbers or integers. These we’re  
going to convert to factors by cutting them into five more or less equal  
bins per variable.

We’ll also use consistent ordering and labeling (“Low”,  
“MedLow”, “Medium”, “MedHigh”, “High”).

But first we have CUSCALL, which doesn’t want to be broken into 5 bins so we’ll  
make it 4 bins and label them clearly (“0”, “1”, “2”, and “More than 2”) using  
fct\_lump from forcats.

NB: There is a real difference between how factors and ordered factors are  
handled by CHAID because there are differences between nominal and  
ordinal variables. Factors can be split in any fashion. Ordered factors  
will always have sequence honored so you can’t have a split of 1:5 as  
1, 2, and 5 vs 3, and 4. Make sure you know which you wish to use and why.

Our code and the resulting dataframe look like this.

churn <-

churn %>% mutate\_at(c("INTPLAN", "DATAPLAN", "CHURN"),

factor,

labels = c("No", "Yes"))

churn$DATAGB <- as.ordered(forcats::fct\_relevel(churn$DATAGB,

"0",

"100M",

"250M",

"500M",

"1G",

"1.5G",

"2G"))

table(churn$DATAGB)

##

## 0 100M 250M 500M 1G 1.5G 2G

## 3449 74 168 291 410 522 86

churn$CUSCALL <- as.ordered(fct\_lump(as\_factor(churn$CUSCALL),

other\_level = "More than 2"))

table(churn$CUSCALL)

##

## 0 1 2 More than 2

## 1095 1680 1277 948

churn <-

churn %>%

mutate\_if(is.numeric,

~ ggplot2::cut\_number(.,

n=5,

labels = FALSE)

) %>%

mutate\_if(is.integer,

~ factor(.,

labels = c("Low", "MedLow", "Medium", "MedHigh", "High"),

ordered = TRUE)

)

churn <- churn %>% select(-ID)

str(churn)

## 'data.frame': 5000 obs. of 14 variables:

## $ ACLENGTH: Ord.factor w/ 5 levels "Low"<"MedLow"<..: 2 3 4 4 4 3 1 5 1 3 ...

## $ INTPLAN : Factor w/ 2 levels "No","Yes": 1 1 1 1 1 1 2 1 1 1 ...

## $ DATAPLAN: Factor w/ 2 levels "No","Yes": 1 1 2 1 2 2 1 2 2 1 ...

## $ DATAGB : Ord.factor w/ 7 levels "0"<"100M"<"250M"<..: 1 1 6 1 6 4 1 7 4 1 ...

## $ OMMIN : Ord.factor w/ 5 levels "Low"<"MedLow"<..: 1 1 4 3 3 4 2 1 3 3 ...

## $ OMCALL : Ord.factor w/ 5 levels "Low"<"MedLow"<..: 3 2 2 2 2 4 5 3 2 5 ...

## $ OTMIN : Ord.factor w/ 5 levels "Low"<"MedLow"<..: 2 1 3 4 2 3 2 1 2 3 ...

## $ OTCALL : Ord.factor w/ 5 levels "Low"<"MedLow"<..: 1 4 5 5 1 3 1 1 2 3 ...

## $ NGMIN : Ord.factor w/ 5 levels "Low"<"MedLow"<..: 3 1 3 4 5 2 5 3 4 2 ...

## $ NGCALL : Ord.factor w/ 5 levels "Low"<"MedLow"<..: 2 2 5 5 4 1 3 2 2 1 ...

## $ IMIN : Ord.factor w/ 5 levels "Low"<"MedLow"<..: 3 2 5 3 2 1 5 3 1 2 ...

## $ ICALL : Ord.factor w/ 5 levels "Low"<"MedLow"<..: 4 2 5 4 2 1 5 3 1 2 ...

## $ CUSCALL : Ord.factor w/ 4 levels "0"<"1"<"2"<"More than 2": 2 1 2 2 2 2 2 4 1 1 ...

## $ CHURN : Factor w/ 2 levels "No","Yes": 1 1 1 1 1 2 2 1 2 1 ...

**Build the model**

Now that we have the data organized the way we want it we can let CHAID do  
its’ thing and tell us what we want to know. What combination of our 13  
predictor variables best explain or predict why our customers are leaving us (or  
as I mentioned before which customers are most likely to stay). The way it does  
that is devilishly simple and elegant. For all 13 predictors it runs a \(\chi^2\)  
test of independence (a.k.a. association) between the predictor and our outcome  
churn. Unlike some other tree models it can be a multi-way split. It will  
compute a p value for all these possible splits (see note above about ordinal  
versus nominal splits) and choose the split out of all possible splits with the  
smallest Bonferroni adjusted p value. That is the simplest explanation please  
see the ?chaid help page for complete details.

Just to break up the long passages of text and because I’m a visual learner let’s  
make a mosaic plot using ggmosaic of  
CUSCALL vs CHURN. We’ll even do a little magic to display the percentage of  
churn within the categories of CUSCALL. chaid will test not only this 4 x 2  
table but also see if combining any adjacent categories is a better split.

p <-

ggplot(data = churn) +

geom\_mosaic(aes(x = product(CUSCALL), fill = CHURN))

xxx <- ggplot\_build(p)$data[[1]]

XXX <- xxx %>%

group\_by\_at(vars(ends\_with("\_\_CUSCALL"))) %>%

mutate(NN = sum(.wt)) %>%

mutate(pct = paste0(round(.wt/NN\*100, 1), "%")) %>%

select(-(xmin:weight))

p + geom\_text(data = xxx,

aes(x = (xmin + xmax)/2,

y = (ymin + ymax)/2,

label = XXX$pct)) +

labs(y = NULL,

x = "Number of Customer Calls",

title = "Amount of Churn by # of Customer Calls") +

scale\_y\_continuous(labels = scales::label\_percent(accuracy = 1.0),

breaks = seq(from = 0,

to = 1,

by = 0.10),

minor\_breaks = seq(from = 0.05,

to = 0.95,

by = 0.10))

Clearly, visually, something is going on but we’ll let the algorithm decide what  
the best splits are. It will keep on going until it runs out of significant  
splits or some other criteria we set such as the size of the bins or the number  
of levels we want in the model.

Since we’re pretending this is our first time through the data, and since we  
want clear, easy to understand, recommendations to give our business leaders to  
act on, we’re going to tell chaid to limit itself to just three “levels” of  
prediction. If you want a better understanding of what you can change to control  
the chaid model Let’s build a **“solution”** and put it in an object called solution and then  
print and plot it using the built-in methods from partykit.

solution <- CHAID::chaid(CHURN ~ .,

data = churn,

control = chaid\_control(maxheight = 3))

print(solution)

##

## Model formula:

## CHURN ~ ACLENGTH + INTPLAN + DATAPLAN + DATAGB + OMMIN + OMCALL +

## OTMIN + OTCALL + NGMIN + NGCALL + IMIN + ICALL + CUSCALL

##

## Fitted party:

## [1] root

## | [2] INTPLAN in No

## | | [3] CUSCALL in 0

## | | | [4] OMMIN in Low: No (n = 206, err = 3.4%)

## | | | [5] OMMIN in MedLow, Medium, MedHigh: No (n = 593, err = 7.4%)

## | | | [6] OMMIN in High: No (n = 179, err = 15.6%)

## | | [7] CUSCALL in 1

## | | | [8] OMMIN in Low, MedLow: No (n = 577, err = 6.4%)

## | | | [9] OMMIN in Medium, MedHigh: No (n = 597, err = 10.9%)

## | | | [10] OMMIN in High: No (n = 330, err = 19.1%)

## | | [11] CUSCALL in 2

## | | | [12] OMMIN in Low, MedLow: No (n = 466, err = 8.4%)

## | | | [13] OMMIN in Medium, MedHigh, High: No (n = 679, err = 19.0%)

## | | [14] CUSCALL in More than 2

## | | | [15] OMMIN in Low, MedLow, Medium: No (n = 516, err = 20.0%)

## | | | [16] OMMIN in MedHigh, High: No (n = 334, err = 36.8%)

## | [17] INTPLAN in Yes

## | | [18] OMMIN in Low, MedLow

## | | | [19] OMCALL in Low, MedLow, Medium: No (n = 186, err = 46.2%)

## | | | [20] OMCALL in MedHigh, High: Yes (n = 32, err = 21.9%)

## | | [21] OMMIN in Medium, MedHigh, High

## | | | [22] IMIN in Low, MedLow, Medium: No (n = 33, err = 45.5%)

## | | | [23] IMIN in MedHigh, High: Yes (n = 272, err = 25.0%)

##

## Number of inner nodes: 9

## Number of terminal nodes: 14

plot(solution,

main = "churn dataset, maxheight = 3",

gp = gpar(

lty = "solid",

lwd = 2,

fontsize = 8

))

With an overall churn rate of about 20% we can see that even this simple chaid  
model gives us a much clearer picture of where our risks and opportunities lie.  
We can identify hundreds of  
customers who pose little risk of changing carriers on the left side of the  
plot and conversely several high risk hotspots towards the right with the  
prediction for churn approaching 80%!

Makes sense at this point to check the accuracy of our model. if we were  
primarily interested in squeezing as much accuracy as possible we might  
follow the approach demonstrated here,  
but for a very simple first step I’m happy to sacrifice details and the  
risk of over-fitting for the simplicity of this design and the ease with  
which we can make suggestions for changing business practice.

caret::confusionMatrix(predict(solution), churn$CHURN)

## Confusion Matrix and Statistics

##

## Reference

## Prediction No Yes

## No 3957 739

## Yes 75 229

##

## Accuracy : 0.8372

## 95% CI : (0.8267, 0.8473)

## No Information Rate : 0.8064

## P-Value [Acc > NIR] : 1.013e-08

##

## Kappa : 0.2948

##

## Mcnemar's Test P-Value : < 2.2e-16

##

## Sensitivity : 0.9814

## Specificity : 0.2366

## Pos Pred Value : 0.8426

## Neg Pred Value : 0.7533

## Prevalence : 0.8064

## Detection Rate : 0.7914

## Detection Prevalence : 0.9392

## Balanced Accuracy : 0.6090

##

## 'Positive' Class : No

##

As with the original blog post we can clearly tell our management team that  
additional focus is needed on our clients who have international calling plans.

**More with what we have**

I have to give partykit credit, the print and plot methods pack a lot of  
information into some efficient space. But they also leave me wanting for  
information, especially with regards to the “inner nodes”. To be fair, part of  
the problem is that chaid is a bit old and doesn’t take maximum advantage of  
partykit but regardless I’m a big fan of getting back an object I can do more  
analysis on.

That’s what I told myself when I started writing a function I called  
chaid\_table(). It takes our solution object and converts it to a tibble  
that is chock full of information about our analysis/model.

A quick look at the first 5 rows should give you an idea of what’s in there.  
Hopefully nodeID, parent, NodeN, No, and Yes are obvious. Note that  
“no” and “yes” are actually pulled from the levels of the outcome variable so it  
will match your data. “ruletext” is a plain English summary of the complete rule  
to arrive at this node. “split.variable” is the variable that will be used to  
split the current node and produce child nodes.

“chisq” is obvious, “df” is the degrees of freedom, “adjustedp” is the p value  
after the bonferroni correction while “rawpvalue” is the uncorrected value. The  
split rule columns are the R code that would produce the split.

review\_me <- CGPfunctions::chaid\_table(solution)

kable(review\_me[1:5, ])

| **nodeID** | **parent** | **NodeN** | **No** | **Yes** | **ruletext** | **split.variable** | **chisq** | **df** | **adjustedp** | **rawpvalue** | **splitrule** | **split1** | **split2** | **split3** |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 1 | NA | 5000 | 4032 | 968 | NA | INTPLAN | 715.70973 | 1 | 0.0000000 | 0.00e+00 | NA | NA | NA | NA |
| 2 | 1 | 4477 | 3839 | 638 | INTPLAN is ‘No’ | CUSCALL | 149.78455 | 3 | 0.0000000 | 0.00e+00 | INTPLAN %in% c(‘No’) | INTPLAN %in% c(‘No’) | NA | NA |
| 3 | 2 | 978 | 899 | 79 | INTPLAN is ‘No’ & CUSCALL is ‘0’ | OMMIN | 20.21648 | 2 | 0.0002445 | 4.07e-05 | INTPLAN %in% c(‘No’) & CUSCALL %in% c(‘0’) | INTPLAN %in% c(‘No’) | CUSCALL %in% c(‘0’) | NA |
| 4 | 3 | 206 | 199 | 7 | INTPLAN is ‘No’ & CUSCALL is ‘0’ & OMMIN is ‘Low’ | NA | NA | NA | NA | NA | INTPLAN %in% c(‘No’) & CUSCALL %in% c(‘0’) & OMMIN %in% c(‘Low’) | INTPLAN %in% c(‘No’) | CUSCALL %in% c(‘0’) | OMMIN %in% c(‘Low’) |
| 5 | 3 | 593 | 549 | 44 | INTPLAN is ‘No’ & CUSCALL is ‘0’ & OMMIN is ‘MedLow’, ‘Medium’, ‘MedHigh’ | NA | NA | NA | NA | NA | INTPLAN %in% c(‘No’) & CUSCALL %in% c(‘0’) & OMMIN %in% c(‘MedLow’, ‘Medium’, ‘MedHigh’) | INTPLAN %in% c(‘No’) | CUSCALL %in% c(‘0’) | OMMIN %in% c(‘MedLow’, ‘Medium’, ‘MedHigh’) |

The best part IMHO about this tibble format is that you can ask the data lots of  
additional questions in a dplyr pipeline. here are two obvious ones:

1. What percentage of customers are leaving if they have an international  
   plan versus don’t? (14% versus 63%)
2. Can you provide an ordered list of where our churns are most likely to occur?  
   (of course – allows us to make good business decisions. For example while  
   node # 20 has the most churn at 78% there’s only 30 some people in that node  
   while #23 has slightly less churn and a lot more people to influence.)

# Question #1

review\_me %>%

select(nodeID:ruletext) %>%

mutate(pctLeaving = Yes/NodeN \* 100) %>%

filter(parent == 1) %>%

kable(digits = 1, caption = "Question #1 answer")

| (#tab:chaid\_table4)Question #1 answer | | | | | | |
| --- | --- | --- | --- | --- | --- | --- |
| **nodeID** | **parent** | **NodeN** | **No** | **Yes** | **ruletext** | **pctLeaving** |
| 2 | 1 | 4477 | 3839 | 638 | INTPLAN is ‘No’ | 14.3 |
| 17 | 1 | 523 | 193 | 330 | INTPLAN is ‘Yes’ | 63.1 |

# Question #2

review\_me %>%

select(nodeID:split.variable) %>%

mutate(pctLeaving = Yes/NodeN \* 100) %>%

filter([is.na](http://is.na)(split.variable)) %>%

select(-parent, -split.variable) %>%

arrange(desc(pctLeaving)) %>%

kable(digits = 1, caption = "Question #2 answer")

| (#tab:chaid\_table4)Question #2 answer | | | | | |
| --- | --- | --- | --- | --- | --- |
| **nodeID** | **NodeN** | **No** | **Yes** | **ruletext** | **pctLeaving** |
| 20 | 32 | 7 | 25 | INTPLAN is ‘Yes’ & OMMIN is ‘Low’, ‘MedLow’ & OMCALL is ‘MedHigh’, ‘High’ | 78.1 |
| 23 | 272 | 68 | 204 | INTPLAN is ‘Yes’ & OMMIN is ‘Medium’, ‘MedHigh’, ‘High’ & IMIN is ‘MedHigh’, ‘High’ | 75.0 |
| 19 | 186 | 100 | 86 | INTPLAN is ‘Yes’ & OMMIN is ‘Low’, ‘MedLow’ & OMCALL is ‘Low’, ‘MedLow’, ‘Medium’ | 46.2 |
| 22 | 33 | 18 | 15 | INTPLAN is ‘Yes’ & OMMIN is ‘Medium’, ‘MedHigh’, ‘High’ & IMIN is ‘Low’, ‘MedLow’, ‘Medium’ | 45.5 |
| 16 | 334 | 211 | 123 | INTPLAN is ‘No’ & CUSCALL is ‘More than 2’ & OMMIN is ‘MedHigh’, ‘High’ | 36.8 |
| 15 | 516 | 413 | 103 | INTPLAN is ‘No’ & CUSCALL is ‘More than 2’ & OMMIN is ‘Low’, ‘MedLow’, ‘Medium’ | 20.0 |
| 10 | 330 | 267 | 63 | INTPLAN is ‘No’ & CUSCALL is ‘1’ & OMMIN is ‘High’ | 19.1 |
| 13 | 679 | 550 | 129 | INTPLAN is ‘No’ & CUSCALL is ‘2’ & OMMIN is ‘Medium’, ‘MedHigh’, ‘High’ | 19.0 |
| 6 | 179 | 151 | 28 | INTPLAN is ‘No’ & CUSCALL is ‘0’ & OMMIN is ‘High’ | 15.6 |
| 9 | 597 | 532 | 65 | INTPLAN is ‘No’ & CUSCALL is ‘1’ & OMMIN is ‘Medium’, ‘MedHigh’ | 10.9 |
| 12 | 466 | 427 | 39 | INTPLAN is ‘No’ & CUSCALL is ‘2’ & OMMIN is ‘Low’, ‘MedLow’ | 8.4 |
| 5 | 593 | 549 | 44 | INTPLAN is ‘No’ & CUSCALL is ‘0’ & OMMIN is ‘MedLow’, ‘Medium’, ‘MedHigh’ | 7.4 |
| 8 | 577 | 540 | 37 | INTPLAN is ‘No’ & CUSCALL is ‘1’ & OMMIN is ‘Low’, ‘MedLow’ | 6.4 |
| 4 | 206 | 199 | 7 | INTPLAN is ‘No’ & CUSCALL is ‘0’ & OMMIN is ‘Low’ | 3.4 |

Those are just a sample of what you can do with the data in a tibble. Feel free  
to experiment.

**A plot is worth a thousand words**

I’m a huge fan of displaying data graphically any time it can be done. I find it  
helps to drive home your messaging from data science projects. The other new  
function I added to ibecav  
recently is PlotXTabs2() which is built to display bivariate crosstabs. I  
borrowed heavily from ggstatsplot to allow you to optionally include  
statistical information.

Let’s use it to display information about the relationship between churn  
and our clients international plan. First some simple plots just displaying  
different x and y axis orientation and with and without pipelining. There  
are too many options to talk about here *My next project is to bring mosaic plots to the function.*

CGPfunctions::PlotXTabs2(churn,

CHURN,

INTPLAN,

bf.display = "sensible")

churn %>% CGPfunctions::PlotXTabs2(INTPLAN,

CHURN,

bf.display = "sensible")

The ability to pipe from the data to the graph is immensely useful for  
displaying practical data. The two final plots will focus on the second level of  
the model, where our customers have no international calling plan. Once again  
we’ll display the same data in reversed x/y order and in the second plot since  
there are more levels we’ll select a palette that is more friendly to users with  
potential sight challenges.

churn %>%

filter(INTPLAN == "No") %>%

CGPfunctions::PlotXTabs2(CUSCALL,

CHURN,

bf.display = "sensible")

churn %>%

filter(INTPLAN == "No") %>%

CGPfunctions::PlotXTabs2(CHURN,

CUSCALL,

bf.display = "sensible",

package = "ggthemes",

palette = "Color Blind")

**A final look at why it matters**

So I wanted to end this post by reinforcing why chaid can be a useful tool  
even if it isn’t the newest algorithm or the coolest. Note that the accuracy  
wasn’t quite as good as some other methods but it is a fantastic tool for  
initial modelling. Note that it is also very robust and gives you answers that  
are easily explained to business leaders.