

Joins and k-nn

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The Context

We're running short on tracking collars for leopard seals after pulling all of the collars from Budget Collars (they seem to be failing more often, and their battery life is terrible - putting our fish-harvesting team in danger).

One of our intrepid data science team members found an old box of collars and some data on all of the collars (it was a real challenge getting this data off of an old floppy drive, but she managed). So we're going to spend the next lessons tackling two tasks: first, we're to work to join data sets together. The main goal here is to create a single data set that includes the data we have previously looked at for collars, the data on the new collars, as well as the additional data on the old collars.

This is tricky, as we can't just do simple `rbinds` and `cbinds` like we've done in the past - the collar IDs need to be matched up with their counterparts across datasets, and new collars need to be added, but with the column that contains maker ID missing.

Second, we'll dive into some machine learning. We'll talk a bit about what machine learning is (and isn't) and then use a frequently used classification algorithm, k-nearest neighbors to predict which maker made which of our unidentified collars.

Joins

Being able to join together data from related tables is a key skill in data science, and for working with larger data structures (databases with their own languages, like SQL).

Group Discussion - Joins in R

Take 5 minutes to read through this article individually. <https://tinyurl.com/rfmnvcs>

After this 5 minutes, discuss the questions below with your group. We'll then discuss them as a class. Make sure that someone in the group (a reporter) can report out answers to each of the questions below.

1. What's the difference between a left join and an inner join?
2. Can you think of a reason you would use an anti-join?
3. What type of join should we use to bind the three tables we're working on with our seal collar data?
4. Can you draw a diagram that illustrates what a left-join does?

Working through our data

Let's load in the data we're working with and work through implementing our joins.

```
library(tidyverse)

## -- Attaching packages ----- tidyverse 1.3.0 --

## v ggplot2 3.3.0      v purrr  0.3.3
## v tibble  2.1.3      v dplyr  0.8.5
## v tidyr   1.0.0      v stringr 1.4.0
## v readr   1.3.1      v forcats 0.4.0

## -- Conflicts ----- tidyverse_conflicts() --
## x dplyr::filter() masks stats::filter()
## x dplyr::lag()    masks stats::lag()

#loading in the data
collars = read_csv("https://tinyurl.com/sp7b25x")

## Parsed with column specification:
## cols(
##   collar_id = col_double(),
##   maker = col_character(),
##   battery_life = col_double(),
##   signal_distance = col_double(),
##   fail = col_double()
## )

new_collars = read_csv("https://tinyurl.com/t3of8rk")

## Parsed with column specification:
## cols(
##   collar_id = col_double(),
##   maker = col_logical(),
##   battery_life = col_double(),
##   signal_distance = col_double(),
##   antenna_length = col_double(),
##   weight = col_double()
## )

old_collars_new_data = read_csv("https://tinyurl.com/ufawycq")

## Parsed with column specification:
## cols(
##   collar_id = col_double(),
##   maker = col_character(),
##   antenna_length = col_double(),
##   weight = col_double()
## )
```

```
#explore  
glimpse(collars)
```

```
## Observations: 100  
## Variables: 5  
## $ collar_id      <dbl> 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, ...  
## $ maker          <chr> "Collarium Inc.", "Collarium Inc.", "Collarium Inc....  
## $ battery_life    <dbl> 130.1015, 112.9715, 119.9972, 128.0610, 130.2711, 1...  
## $ signal_distance <dbl> 4164.346, 4197.603, 4208.998, 4157.144, 4218.150, 4...  
## $ fail            <dbl> 0, 1, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, ...
```

```
glimpse(new_collars)
```

```
## Observations: 50  
## Variables: 6  
## $ collar_id      <dbl> 101, 102, 103, 104, 105, 106, 107, 108, 109, 110, 1...  
## $ maker          <lgl> NA, NA, NA, NA, NA, NA, NA, NA, NA, NA, NA, NA, NA, NA,...  
## $ battery_life    <dbl> 116.99435, 126.17496, 130.60469, 115.19269, 124.481...  
## $ signal_distance <dbl> 4201.807, 4158.341, 4183.001, 4250.064, 4242.241, 4...  
## $ antenna_length  <dbl> 5.263709, 7.075396, 5.914348, 4.403713, 6.643748, 5...  
## $ weight          <dbl> 25.81248, 19.05661, 23.66526, 20.12864, 20.74899, 2...
```

```
glimpse(old_collars_new_data)
```

```
## Observations: 100  
## Variables: 4  
## $ collar_id      <dbl> 60, 27, 91, 80, 30, 98, 57, 88, 24, 58, 22, 49, 67, ...  
## $ maker          <chr> "Budget Collars LLC", "Collarium Inc.", "Budget Coll...  
## $ antenna_length  <dbl> 5.814570, 5.341758, 6.450990, 5.706432, 5.250706, 5....  
## $ weight          <dbl> 23.36542, 23.80769, 16.91091, 22.04722, 23.21354, 17...
```

```
# Tell me about these data, how are we going to join them?
```

Step 1. The join

```
old_collars_full_data = collars %>% left_join(old_collars_new_data,  
                                              by = c("collar_id", "maker"))
```

Step 2. a bind or a join?

So now we need to put the new collars in here...

How do we join this? Is it even a join at all?

```
full = bind_rows(old_collars_full_data, new_collars)
```

Prediction, Machine Learning

Now, we're going to work through an example of machine learning, which is used in a variety of ways in data science - and across industries and disciplines.

The goal here is that we have ~ 50 unlabeled collars, and we want to be able to predict who made them. Remember that Budget Collars LLC provided us with collars that are failing, which is a risk to human life! So we need to throw out any collars that we think were made by this company, and only incorporate new collars from our unlabeled batch that we think were made by Collarium Inc.

What is machine learning? Group reading and discussion.

Take 10 minutes to read this article.

I'll signal when 10 minutes is up. Get into your groups and discuss the following questions.

1. What is machine learning? Is it different than AI?
2. What types of general problems do machine learning techniques tackle?
3. Given what you've read, what kind of algorithm type might we employ for our problem?

knn in R

K-nearest neighbors is a classification algorithm (e.g. it attempts to predict labels that are classes in R). We're going to work through a small example on our data set before attempting to build the full model.

Check-in

What are our classes/labels here?

Data cleaning and prepping, splitting and normalizing

First, we need to process our data a bit before we jump into our algorithm.

```
# remind ourselves of what full contains  
glimpse(full)
```

```
## Observations: 150  
## Variables: 7  
## $ collar_id      <dbl> 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, ...  
## $ maker          <chr> "Collarium Inc.", "Collarium Inc.", "Collarium Inc....  
## $ battery_life   <dbl> 130.1015, 112.9715, 119.9972, 128.0610, 130.2711, 1...  
## $ signal_distance <dbl> 4164.346, 4197.603, 4208.998, 4157.144, 4218.150, 4...  
## $ fail           <dbl> 0, 1, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, ...  
## $ antenna_length <dbl> 6.077873, 6.031730, 6.056845, 5.870789, 6.453693, 6...  
## $ weight         <dbl> 19.41429, 25.72225, 19.89436, 20.55607, 22.25084, 2...
```

```
# First, we want to filter out the missing data - we'll run our full algorithm  
# on this later.
```

```
full_filtered = full %>%  
  filter(!is.na(maker))
```

```
collars_to_label = full %>%
  filter(is.na(maker))

# Next, let's get rid of some unneeded columns
filtered = full_filtered %>%
  select(-collar_id, -fail, -antenna_length, -weight) %>%
  mutate(maker = as.factor(maker))
```

Check-in

Why are we doing this? We're keeping it to two variables here... later on we'll do more!

On to normalization.

```
# custom function for normalizing
nor <-function(x){
  (x -min(x))/(max(x)-min(x))
}

knn_data = filtered %>%
  mutate(battery_life_norm = nor(filtered$battery_life),
         signal_distance_norm = nor(filtered$signal_distance)) %>%
  select(-battery_life, -signal_distance)
```

Check-in

Why are we doing this? Can you think of a good reason why we have to normalize the values here? What does normalize mean?

We have data that we're ready to put into our algorithm - but first we need

to figure out how the algorithm actually works.

We're going to watch a brief video: <https://www.youtube.com/watch?v=MDniRwXizWo>

After we're finished, get into your groups and discuss the following points:

1. For our small, filtered data set with two variables, how would you draw a simple diagram like in the video that demonstrates how k-nn is working?
2. Can you envision how this would work/what it would look like with more than two variables?
3. What would happen if you increase or decrease K in the GoT example above, or generally?

Let's try our hand at k-nn

```
#loading package to do knn
#install.packages('class')
library(class)

#splitting the data up
train = as.data.frame(knn_data[,-1])
cl = knn_data[,1] %>% pull()
```

```
test = expand.grid(x=seq(min(train[,1]-0.5), max(train[,1]+0.5),
                        by=0.1),
                  y=seq(min(train[,2]-0.5), max(train[,2]+0.5),
                        by=0.1))

mod_test = knn(train, test = test, cl, k = 7, prob=TRUE)

# Let's plot our outcome.

# We're going to use a complicated plotting function I built to inspect things
# You don't need to understand the guts of this....
source("https://tinyurl.com/r5bgd5h")
```

```
##
## Attaching package: 'MASS'

## The following object is masked from 'package:dplyr':
##
##      select
```

```
knn_plot(knn_data, mod = mod_test)
```

```
## [1] "Ready to plot"
##      x      y      prob      Budget Collars LLC      prob_cls
## 1  -0.5 -0.5 0.7142857 Budget Collars LLC          1
## 2  -0.4 -0.5 0.7142857 Budget Collars LLC          1
## 3  -0.3 -0.5 0.5714286 Budget Collars LLC          1
## 4  -0.2 -0.5 0.5714286 Budget Collars LLC          1
## 5  -0.1 -0.5 0.7142857 Budget Collars LLC          0
## 6   0.0 -0.5 0.8571429 Budget Collars LLC          0
## 7   0.1 -0.5 1.0000000 Budget Collars LLC          0
## 8   0.2 -0.5 1.0000000 Budget Collars LLC          0
## 9   0.3 -0.5 1.0000000 Budget Collars LLC          0
## 10  0.4 -0.5 1.0000000 Budget Collars LLC          0
## 11  0.5 -0.5 1.0000000 Budget Collars LLC          0
## 12  0.6 -0.5 1.0000000 Budget Collars LLC          0
## 13  0.7 -0.5 1.0000000 Budget Collars LLC          0
## 14  0.8 -0.5 1.0000000 Budget Collars LLC          0
## 15  0.9 -0.5 1.0000000 Budget Collars LLC          0
## 16  1.0 -0.5 1.0000000 Budget Collars LLC          0
## 17  1.1 -0.5 1.0000000 Budget Collars LLC          0
## 18  1.2 -0.5 1.0000000 Budget Collars LLC          0
## 19  1.3 -0.5 1.0000000 Budget Collars LLC          0
## 20  1.4 -0.5 1.0000000 Budget Collars LLC          0
## 21  1.5 -0.5 1.0000000 Budget Collars LLC          0
## 22 -0.5 -0.4 0.8571429 Budget Collars LLC          1
## 23 -0.4 -0.4 0.8571429 Budget Collars LLC          1
## 24 -0.3 -0.4 0.7142857 Budget Collars LLC          1
## 25 -0.2 -0.4 0.5714286 Budget Collars LLC          1
## 26 -0.1 -0.4 0.5714286 Budget Collars LLC          0
## 27  0.0 -0.4 0.7142857 Budget Collars LLC          0
## 28  0.1 -0.4 1.0000000 Budget Collars LLC          0
```

## 29	0.2	-0.4	1.0000000	Budget	Collars	LLC	0
## 30	0.3	-0.4	1.0000000	Budget	Collars	LLC	0
## 31	0.4	-0.4	1.0000000	Budget	Collars	LLC	0
## 32	0.5	-0.4	1.0000000	Budget	Collars	LLC	0
## 33	0.6	-0.4	1.0000000	Budget	Collars	LLC	0
## 34	0.7	-0.4	1.0000000	Budget	Collars	LLC	0
## 35	0.8	-0.4	1.0000000	Budget	Collars	LLC	0
## 36	0.9	-0.4	1.0000000	Budget	Collars	LLC	0
## 37	1.0	-0.4	1.0000000	Budget	Collars	LLC	0
## 38	1.1	-0.4	1.0000000	Budget	Collars	LLC	0
## 39	1.2	-0.4	1.0000000	Budget	Collars	LLC	0
## 40	1.3	-0.4	1.0000000	Budget	Collars	LLC	0
## 41	1.4	-0.4	1.0000000	Budget	Collars	LLC	0
## 42	1.5	-0.4	1.0000000	Budget	Collars	LLC	0
## 43	-0.5	-0.3	0.8571429	Budget	Collars	LLC	1
## 44	-0.4	-0.3	0.8571429	Budget	Collars	LLC	1
## 45	-0.3	-0.3	0.8571429	Budget	Collars	LLC	1
## 46	-0.2	-0.3	0.7142857	Budget	Collars	LLC	1
## 47	-0.1	-0.3	0.5714286	Budget	Collars	LLC	1
## 48	0.0	-0.3	0.5714286	Budget	Collars	LLC	0
## 49	0.1	-0.3	0.7142857	Budget	Collars	LLC	0
## 50	0.2	-0.3	1.0000000	Budget	Collars	LLC	0
## 51	0.3	-0.3	1.0000000	Budget	Collars	LLC	0
## 52	0.4	-0.3	1.0000000	Budget	Collars	LLC	0
## 53	0.5	-0.3	1.0000000	Budget	Collars	LLC	0
## 54	0.6	-0.3	1.0000000	Budget	Collars	LLC	0
## 55	0.7	-0.3	1.0000000	Budget	Collars	LLC	0
## 56	0.8	-0.3	1.0000000	Budget	Collars	LLC	0
## 57	0.9	-0.3	1.0000000	Budget	Collars	LLC	0
## 58	1.0	-0.3	1.0000000	Budget	Collars	LLC	0
## 59	1.1	-0.3	1.0000000	Budget	Collars	LLC	0
## 60	1.2	-0.3	1.0000000	Budget	Collars	LLC	0
## 61	1.3	-0.3	1.0000000	Budget	Collars	LLC	0
## 62	1.4	-0.3	1.0000000	Budget	Collars	LLC	0
## 63	1.5	-0.3	1.0000000	Budget	Collars	LLC	0
## 64	-0.5	-0.2	1.0000000	Budget	Collars	LLC	1
## 65	-0.4	-0.2	0.8571429	Budget	Collars	LLC	1
## 66	-0.3	-0.2	0.8571429	Budget	Collars	LLC	1
## 67	-0.2	-0.2	0.8571429	Budget	Collars	LLC	1
## 68	-0.1	-0.2	0.7142857	Budget	Collars	LLC	1
## 69	0.0	-0.2	0.5714286	Budget	Collars	LLC	1
## 70	0.1	-0.2	0.7142857	Budget	Collars	LLC	0
## 71	0.2	-0.2	1.0000000	Budget	Collars	LLC	0
## 72	0.3	-0.2	1.0000000	Budget	Collars	LLC	0
## 73	0.4	-0.2	1.0000000	Budget	Collars	LLC	0
## 74	0.5	-0.2	1.0000000	Budget	Collars	LLC	0
## 75	0.6	-0.2	1.0000000	Budget	Collars	LLC	0
## 76	0.7	-0.2	1.0000000	Budget	Collars	LLC	0
## 77	0.8	-0.2	1.0000000	Budget	Collars	LLC	0
## 78	0.9	-0.2	1.0000000	Budget	Collars	LLC	0
## 79	1.0	-0.2	1.0000000	Budget	Collars	LLC	0
## 80	1.1	-0.2	1.0000000	Budget	Collars	LLC	0
## 81	1.2	-0.2	1.0000000	Budget	Collars	LLC	0
## 82	1.3	-0.2	1.0000000	Budget	Collars	LLC	0

## 83	1.4	-0.2	1.0000000	Budget	Collars	LLC	0
## 84	1.5	-0.2	1.0000000	Budget	Collars	LLC	0
## 85	-0.5	-0.1	1.0000000	Budget	Collars	LLC	1
## 86	-0.4	-0.1	1.0000000	Budget	Collars	LLC	1
## 87	-0.3	-0.1	0.8571429	Budget	Collars	LLC	1
## 88	-0.2	-0.1	0.8571429	Budget	Collars	LLC	1
## 89	-0.1	-0.1	0.8571429	Budget	Collars	LLC	1
## 90	0.0	-0.1	0.7142857	Budget	Collars	LLC	1
## 91	0.1	-0.1	0.5714286	Budget	Collars	LLC	1
## 92	0.2	-0.1	0.7142857	Budget	Collars	LLC	0
## 93	0.3	-0.1	1.0000000	Budget	Collars	LLC	0
## 94	0.4	-0.1	1.0000000	Budget	Collars	LLC	0
## 95	0.5	-0.1	1.0000000	Budget	Collars	LLC	0
## 96	0.6	-0.1	1.0000000	Budget	Collars	LLC	0
## 97	0.7	-0.1	1.0000000	Budget	Collars	LLC	0
## 98	0.8	-0.1	1.0000000	Budget	Collars	LLC	0
## 99	0.9	-0.1	1.0000000	Budget	Collars	LLC	0
## 100	1.0	-0.1	1.0000000	Budget	Collars	LLC	0
## 101	1.1	-0.1	1.0000000	Budget	Collars	LLC	0
## 102	1.2	-0.1	1.0000000	Budget	Collars	LLC	0
## 103	1.3	-0.1	1.0000000	Budget	Collars	LLC	0
## 104	1.4	-0.1	1.0000000	Budget	Collars	LLC	0
## 105	1.5	-0.1	1.0000000	Budget	Collars	LLC	0
## 106	-0.5	0.0	1.0000000	Budget	Collars	LLC	1
## 107	-0.4	0.0	1.0000000	Budget	Collars	LLC	1
## 108	-0.3	0.0	1.0000000	Budget	Collars	LLC	1
## 109	-0.2	0.0	1.0000000	Budget	Collars	LLC	1
## 110	-0.1	0.0	0.8571429	Budget	Collars	LLC	1
## 111	0.0	0.0	0.8571429	Budget	Collars	LLC	1
## 112	0.1	0.0	0.8571429	Budget	Collars	LLC	1
## 113	0.2	0.0	0.5714286	Budget	Collars	LLC	0
## 114	0.3	0.0	0.7142857	Budget	Collars	LLC	0
## 115	0.4	0.0	1.0000000	Budget	Collars	LLC	0
## 116	0.5	0.0	1.0000000	Budget	Collars	LLC	0
## 117	0.6	0.0	1.0000000	Budget	Collars	LLC	0
## 118	0.7	0.0	1.0000000	Budget	Collars	LLC	0
## 119	0.8	0.0	1.0000000	Budget	Collars	LLC	0
## 120	0.9	0.0	1.0000000	Budget	Collars	LLC	0
## 121	1.0	0.0	1.0000000	Budget	Collars	LLC	0
## 122	1.1	0.0	1.0000000	Budget	Collars	LLC	0
## 123	1.2	0.0	1.0000000	Budget	Collars	LLC	0
## 124	1.3	0.0	1.0000000	Budget	Collars	LLC	0
## 125	1.4	0.0	1.0000000	Budget	Collars	LLC	0
## 126	1.5	0.0	1.0000000	Budget	Collars	LLC	0
## 127	-0.5	0.1	1.0000000	Budget	Collars	LLC	1
## 128	-0.4	0.1	1.0000000	Budget	Collars	LLC	1
## 129	-0.3	0.1	1.0000000	Budget	Collars	LLC	1
## 130	-0.2	0.1	1.0000000	Budget	Collars	LLC	1
## 131	-0.1	0.1	1.0000000	Budget	Collars	LLC	1
## 132	0.0	0.1	0.8571429	Budget	Collars	LLC	1
## 133	0.1	0.1	0.8571429	Budget	Collars	LLC	1
## 134	0.2	0.1	0.7142857	Budget	Collars	LLC	1
## 135	0.3	0.1	0.5714286	Budget	Collars	LLC	0
## 136	0.4	0.1	0.8571429	Budget	Collars	LLC	0

## 137	0.5	0.1	1.0000000	Budget Collars LLC	0
## 138	0.6	0.1	1.0000000	Budget Collars LLC	0
## 139	0.7	0.1	1.0000000	Budget Collars LLC	0
## 140	0.8	0.1	1.0000000	Budget Collars LLC	0
## 141	0.9	0.1	1.0000000	Budget Collars LLC	0
## 142	1.0	0.1	1.0000000	Budget Collars LLC	0
## 143	1.1	0.1	1.0000000	Budget Collars LLC	0
## 144	1.2	0.1	1.0000000	Budget Collars LLC	0
## 145	1.3	0.1	1.0000000	Budget Collars LLC	0
## 146	1.4	0.1	1.0000000	Budget Collars LLC	0
## 147	1.5	0.1	1.0000000	Budget Collars LLC	0
## 148	-0.5	0.2	1.0000000	Budget Collars LLC	1
## 149	-0.4	0.2	1.0000000	Budget Collars LLC	1
## 150	-0.3	0.2	1.0000000	Budget Collars LLC	1
## 151	-0.2	0.2	1.0000000	Budget Collars LLC	1
## 152	-0.1	0.2	1.0000000	Budget Collars LLC	1
## 153	0.0	0.2	1.0000000	Budget Collars LLC	1
## 154	0.1	0.2	0.8571429	Budget Collars LLC	1
## 155	0.2	0.2	0.8571429	Budget Collars LLC	1
## 156	0.3	0.2	0.7142857	Budget Collars LLC	1
## 157	0.4	0.2	0.5714286	Budget Collars LLC	0
## 158	0.5	0.2	0.8571429	Budget Collars LLC	0
## 159	0.6	0.2	1.0000000	Budget Collars LLC	0
## 160	0.7	0.2	1.0000000	Budget Collars LLC	0
## 161	0.8	0.2	1.0000000	Budget Collars LLC	0
## 162	0.9	0.2	1.0000000	Budget Collars LLC	0
## 163	1.0	0.2	1.0000000	Budget Collars LLC	0
## 164	1.1	0.2	1.0000000	Budget Collars LLC	0
## 165	1.2	0.2	1.0000000	Budget Collars LLC	0
## 166	1.3	0.2	1.0000000	Budget Collars LLC	0
## 167	1.4	0.2	1.0000000	Budget Collars LLC	0
## 168	1.5	0.2	1.0000000	Budget Collars LLC	0
## 169	-0.5	0.3	1.0000000	Budget Collars LLC	1
## 170	-0.4	0.3	1.0000000	Budget Collars LLC	1
## 171	-0.3	0.3	1.0000000	Budget Collars LLC	1
## 172	-0.2	0.3	1.0000000	Budget Collars LLC	1
## 173	-0.1	0.3	1.0000000	Budget Collars LLC	1
## 174	0.0	0.3	1.0000000	Budget Collars LLC	1
## 175	0.1	0.3	1.0000000	Budget Collars LLC	1
## 176	0.2	0.3	1.0000000	Budget Collars LLC	1
## 177	0.3	0.3	0.8571429	Budget Collars LLC	1
## 178	0.4	0.3	0.7142857	Budget Collars LLC	1
## 179	0.5	0.3	0.8571429	Budget Collars LLC	0
## 180	0.6	0.3	1.0000000	Budget Collars LLC	0
## 181	0.7	0.3	1.0000000	Budget Collars LLC	0
## 182	0.8	0.3	1.0000000	Budget Collars LLC	0
## 183	0.9	0.3	1.0000000	Budget Collars LLC	0
## 184	1.0	0.3	1.0000000	Budget Collars LLC	0
## 185	1.1	0.3	1.0000000	Budget Collars LLC	0
## 186	1.2	0.3	1.0000000	Budget Collars LLC	0
## 187	1.3	0.3	1.0000000	Budget Collars LLC	0
## 188	1.4	0.3	1.0000000	Budget Collars LLC	0
## 189	1.5	0.3	1.0000000	Budget Collars LLC	0
## 190	-0.5	0.4	1.0000000	Budget Collars LLC	1

## 191	-0.4	0.4	1.0000000	Budget Collars LLC	1
## 192	-0.3	0.4	1.0000000	Budget Collars LLC	1
## 193	-0.2	0.4	1.0000000	Budget Collars LLC	1
## 194	-0.1	0.4	1.0000000	Budget Collars LLC	1
## 195	0.0	0.4	1.0000000	Budget Collars LLC	1
## 196	0.1	0.4	1.0000000	Budget Collars LLC	1
## 197	0.2	0.4	1.0000000	Budget Collars LLC	1
## 198	0.3	0.4	1.0000000	Budget Collars LLC	1
## 199	0.4	0.4	1.0000000	Budget Collars LLC	1
## 200	0.5	0.4	0.5714286	Budget Collars LLC	1
## 201	0.6	0.4	1.0000000	Budget Collars LLC	0
## 202	0.7	0.4	1.0000000	Budget Collars LLC	0
## 203	0.8	0.4	1.0000000	Budget Collars LLC	0
## 204	0.9	0.4	1.0000000	Budget Collars LLC	0
## 205	1.0	0.4	1.0000000	Budget Collars LLC	0
## 206	1.1	0.4	1.0000000	Budget Collars LLC	0
## 207	1.2	0.4	1.0000000	Budget Collars LLC	0
## 208	1.3	0.4	1.0000000	Budget Collars LLC	0
## 209	1.4	0.4	1.0000000	Budget Collars LLC	0
## 210	1.5	0.4	1.0000000	Budget Collars LLC	0
## 211	-0.5	0.5	1.0000000	Budget Collars LLC	1
## 212	-0.4	0.5	1.0000000	Budget Collars LLC	1
## 213	-0.3	0.5	1.0000000	Budget Collars LLC	1
## 214	-0.2	0.5	1.0000000	Budget Collars LLC	1
## 215	-0.1	0.5	1.0000000	Budget Collars LLC	1
## 216	0.0	0.5	1.0000000	Budget Collars LLC	1
## 217	0.1	0.5	1.0000000	Budget Collars LLC	1
## 218	0.2	0.5	1.0000000	Budget Collars LLC	1
## 219	0.3	0.5	1.0000000	Budget Collars LLC	1
## 220	0.4	0.5	1.0000000	Budget Collars LLC	1
## 221	0.5	0.5	0.8571429	Budget Collars LLC	1
## 222	0.6	0.5	1.0000000	Budget Collars LLC	0
## 223	0.7	0.5	1.0000000	Budget Collars LLC	0
## 224	0.8	0.5	1.0000000	Budget Collars LLC	0
## 225	0.9	0.5	1.0000000	Budget Collars LLC	0
## 226	1.0	0.5	1.0000000	Budget Collars LLC	0
## 227	1.1	0.5	1.0000000	Budget Collars LLC	0
## 228	1.2	0.5	1.0000000	Budget Collars LLC	0
## 229	1.3	0.5	1.0000000	Budget Collars LLC	0
## 230	1.4	0.5	1.0000000	Budget Collars LLC	0
## 231	1.5	0.5	1.0000000	Budget Collars LLC	0
## 232	-0.5	0.6	1.0000000	Budget Collars LLC	1
## 233	-0.4	0.6	1.0000000	Budget Collars LLC	1
## 234	-0.3	0.6	1.0000000	Budget Collars LLC	1
## 235	-0.2	0.6	1.0000000	Budget Collars LLC	1
## 236	-0.1	0.6	1.0000000	Budget Collars LLC	1
## 237	0.0	0.6	1.0000000	Budget Collars LLC	1
## 238	0.1	0.6	1.0000000	Budget Collars LLC	1
## 239	0.2	0.6	1.0000000	Budget Collars LLC	1
## 240	0.3	0.6	1.0000000	Budget Collars LLC	1
## 241	0.4	0.6	1.0000000	Budget Collars LLC	1
## 242	0.5	0.6	0.7142857	Budget Collars LLC	1
## 243	0.6	0.6	0.5714286	Budget Collars LLC	0
## 244	0.7	0.6	0.8571429	Budget Collars LLC	0

## 245	0.8	0.6	0.8571429	Budget Collars LLC	0
## 246	0.9	0.6	1.0000000	Budget Collars LLC	0
## 247	1.0	0.6	1.0000000	Budget Collars LLC	0
## 248	1.1	0.6	1.0000000	Budget Collars LLC	0
## 249	1.2	0.6	1.0000000	Budget Collars LLC	0
## 250	1.3	0.6	1.0000000	Budget Collars LLC	0
## 251	1.4	0.6	1.0000000	Budget Collars LLC	0
## 252	1.5	0.6	1.0000000	Budget Collars LLC	0
## 253	-0.5	0.7	1.0000000	Budget Collars LLC	1
## 254	-0.4	0.7	1.0000000	Budget Collars LLC	1
## 255	-0.3	0.7	1.0000000	Budget Collars LLC	1
## 256	-0.2	0.7	1.0000000	Budget Collars LLC	1
## 257	-0.1	0.7	1.0000000	Budget Collars LLC	1
## 258	0.0	0.7	1.0000000	Budget Collars LLC	1
## 259	0.1	0.7	1.0000000	Budget Collars LLC	1
## 260	0.2	0.7	1.0000000	Budget Collars LLC	1
## 261	0.3	0.7	1.0000000	Budget Collars LLC	1
## 262	0.4	0.7	1.0000000	Budget Collars LLC	1
## 263	0.5	0.7	1.0000000	Budget Collars LLC	1
## 264	0.6	0.7	0.7142857	Budget Collars LLC	1
## 265	0.7	0.7	0.5714286	Budget Collars LLC	0
## 266	0.8	0.7	0.8571429	Budget Collars LLC	0
## 267	0.9	0.7	0.8571429	Budget Collars LLC	0
## 268	1.0	0.7	0.8571429	Budget Collars LLC	0
## 269	1.1	0.7	0.8571429	Budget Collars LLC	0
## 270	1.2	0.7	1.0000000	Budget Collars LLC	0
## 271	1.3	0.7	1.0000000	Budget Collars LLC	0
## 272	1.4	0.7	1.0000000	Budget Collars LLC	0
## 273	1.5	0.7	1.0000000	Budget Collars LLC	0
## 274	-0.5	0.8	1.0000000	Budget Collars LLC	1
## 275	-0.4	0.8	1.0000000	Budget Collars LLC	1
## 276	-0.3	0.8	1.0000000	Budget Collars LLC	1
## 277	-0.2	0.8	1.0000000	Budget Collars LLC	1
## 278	-0.1	0.8	1.0000000	Budget Collars LLC	1
## 279	0.0	0.8	1.0000000	Budget Collars LLC	1
## 280	0.1	0.8	1.0000000	Budget Collars LLC	1
## 281	0.2	0.8	1.0000000	Budget Collars LLC	1
## 282	0.3	0.8	1.0000000	Budget Collars LLC	1
## 283	0.4	0.8	1.0000000	Budget Collars LLC	1
## 284	0.5	0.8	1.0000000	Budget Collars LLC	1
## 285	0.6	0.8	0.8571429	Budget Collars LLC	1
## 286	0.7	0.8	0.7142857	Budget Collars LLC	1
## 287	0.8	0.8	0.5714286	Budget Collars LLC	1
## 288	0.9	0.8	0.5714286	Budget Collars LLC	0
## 289	1.0	0.8	0.7142857	Budget Collars LLC	0
## 290	1.1	0.8	0.8571429	Budget Collars LLC	0
## 291	1.2	0.8	0.8571429	Budget Collars LLC	0
## 292	1.3	0.8	0.8571429	Budget Collars LLC	0
## 293	1.4	0.8	1.0000000	Budget Collars LLC	0
## 294	1.5	0.8	1.0000000	Budget Collars LLC	0
## 295	-0.5	0.9	1.0000000	Budget Collars LLC	1
## 296	-0.4	0.9	1.0000000	Budget Collars LLC	1
## 297	-0.3	0.9	1.0000000	Budget Collars LLC	1
## 298	-0.2	0.9	1.0000000	Budget Collars LLC	1

##	299	-0.1	0.9	1.0000000	Budget	Collars	LLC	1
##	300	0.0	0.9	1.0000000	Budget	Collars	LLC	1
##	301	0.1	0.9	1.0000000	Budget	Collars	LLC	1
##	302	0.2	0.9	1.0000000	Budget	Collars	LLC	1
##	303	0.3	0.9	1.0000000	Budget	Collars	LLC	1
##	304	0.4	0.9	1.0000000	Budget	Collars	LLC	1
##	305	0.5	0.9	1.0000000	Budget	Collars	LLC	1
##	306	0.6	0.9	1.0000000	Budget	Collars	LLC	1
##	307	0.7	0.9	0.8571429	Budget	Collars	LLC	1
##	308	0.8	0.9	0.7142857	Budget	Collars	LLC	1
##	309	0.9	0.9	0.5714286	Budget	Collars	LLC	0
##	310	1.0	0.9	0.5714286	Budget	Collars	LLC	0
##	311	1.1	0.9	0.7142857	Budget	Collars	LLC	0
##	312	1.2	0.9	0.7142857	Budget	Collars	LLC	0
##	313	1.3	0.9	0.8571429	Budget	Collars	LLC	0
##	314	1.4	0.9	0.8571429	Budget	Collars	LLC	0
##	315	1.5	0.9	0.8571429	Budget	Collars	LLC	0
##	316	-0.5	1.0	1.0000000	Budget	Collars	LLC	1
##	317	-0.4	1.0	1.0000000	Budget	Collars	LLC	1
##	318	-0.3	1.0	1.0000000	Budget	Collars	LLC	1
##	319	-0.2	1.0	1.0000000	Budget	Collars	LLC	1
##	320	-0.1	1.0	1.0000000	Budget	Collars	LLC	1
##	321	0.0	1.0	1.0000000	Budget	Collars	LLC	1
##	322	0.1	1.0	1.0000000	Budget	Collars	LLC	1
##	323	0.2	1.0	1.0000000	Budget	Collars	LLC	1
##	324	0.3	1.0	1.0000000	Budget	Collars	LLC	1
##	325	0.4	1.0	1.0000000	Budget	Collars	LLC	1
##	326	0.5	1.0	1.0000000	Budget	Collars	LLC	1
##	327	0.6	1.0	1.0000000	Budget	Collars	LLC	1
##	328	0.7	1.0	1.0000000	Budget	Collars	LLC	1
##	329	0.8	1.0	0.8571429	Budget	Collars	LLC	1
##	330	0.9	1.0	0.8571429	Budget	Collars	LLC	1
##	331	1.0	1.0	0.5714286	Budget	Collars	LLC	0
##	332	1.1	1.0	0.5714286	Budget	Collars	LLC	0
##	333	1.2	1.0	0.5714286	Budget	Collars	LLC	0
##	334	1.3	1.0	0.7142857	Budget	Collars	LLC	0
##	335	1.4	1.0	0.7142857	Budget	Collars	LLC	0
##	336	1.5	1.0	0.8571429	Budget	Collars	LLC	0
##	337	-0.5	1.1	1.0000000	Budget	Collars	LLC	1
##	338	-0.4	1.1	1.0000000	Budget	Collars	LLC	1
##	339	-0.3	1.1	1.0000000	Budget	Collars	LLC	1
##	340	-0.2	1.1	1.0000000	Budget	Collars	LLC	1
##	341	-0.1	1.1	1.0000000	Budget	Collars	LLC	1
##	342	0.0	1.1	1.0000000	Budget	Collars	LLC	1
##	343	0.1	1.1	1.0000000	Budget	Collars	LLC	1
##	344	0.2	1.1	1.0000000	Budget	Collars	LLC	1
##	345	0.3	1.1	1.0000000	Budget	Collars	LLC	1
##	346	0.4	1.1	1.0000000	Budget	Collars	LLC	1
##	347	0.5	1.1	1.0000000	Budget	Collars	LLC	1
##	348	0.6	1.1	1.0000000	Budget	Collars	LLC	1
##	349	0.7	1.1	1.0000000	Budget	Collars	LLC	1
##	350	0.8	1.1	1.0000000	Budget	Collars	LLC	1
##	351	0.9	1.1	1.0000000	Budget	Collars	LLC	1
##	352	1.0	1.1	0.7142857	Budget	Collars	LLC	1

## 353	1.1	1.1	0.5714286	Budget Collars LLC	0
## 354	1.2	1.1	0.5714286	Budget Collars LLC	0
## 355	1.3	1.1	0.5714286	Budget Collars LLC	0
## 356	1.4	1.1	0.7142857	Budget Collars LLC	0
## 357	1.5	1.1	0.7142857	Budget Collars LLC	0
## 358	-0.5	1.2	1.0000000	Budget Collars LLC	1
## 359	-0.4	1.2	1.0000000	Budget Collars LLC	1
## 360	-0.3	1.2	1.0000000	Budget Collars LLC	1
## 361	-0.2	1.2	1.0000000	Budget Collars LLC	1
## 362	-0.1	1.2	1.0000000	Budget Collars LLC	1
## 363	0.0	1.2	1.0000000	Budget Collars LLC	1
## 364	0.1	1.2	1.0000000	Budget Collars LLC	1
## 365	0.2	1.2	1.0000000	Budget Collars LLC	1
## 366	0.3	1.2	1.0000000	Budget Collars LLC	1
## 367	0.4	1.2	1.0000000	Budget Collars LLC	1
## 368	0.5	1.2	1.0000000	Budget Collars LLC	1
## 369	0.6	1.2	1.0000000	Budget Collars LLC	1
## 370	0.7	1.2	1.0000000	Budget Collars LLC	1
## 371	0.8	1.2	1.0000000	Budget Collars LLC	1
## 372	0.9	1.2	1.0000000	Budget Collars LLC	1
## 373	1.0	1.2	1.0000000	Budget Collars LLC	1
## 374	1.1	1.2	0.5714286	Budget Collars LLC	1
## 375	1.2	1.2	0.5714286	Budget Collars LLC	1
## 376	1.3	1.2	0.5714286	Budget Collars LLC	0
## 377	1.4	1.2	0.5714286	Budget Collars LLC	0
## 378	1.5	1.2	0.7142857	Budget Collars LLC	0
## 379	-0.5	1.3	1.0000000	Budget Collars LLC	1
## 380	-0.4	1.3	1.0000000	Budget Collars LLC	1
## 381	-0.3	1.3	1.0000000	Budget Collars LLC	1
## 382	-0.2	1.3	1.0000000	Budget Collars LLC	1
## 383	-0.1	1.3	1.0000000	Budget Collars LLC	1
## 384	0.0	1.3	1.0000000	Budget Collars LLC	1
## 385	0.1	1.3	1.0000000	Budget Collars LLC	1
## 386	0.2	1.3	1.0000000	Budget Collars LLC	1
## 387	0.3	1.3	1.0000000	Budget Collars LLC	1
## 388	0.4	1.3	1.0000000	Budget Collars LLC	1
## 389	0.5	1.3	1.0000000	Budget Collars LLC	1
## 390	0.6	1.3	1.0000000	Budget Collars LLC	1
## 391	0.7	1.3	1.0000000	Budget Collars LLC	1
## 392	0.8	1.3	1.0000000	Budget Collars LLC	1
## 393	0.9	1.3	1.0000000	Budget Collars LLC	1
## 394	1.0	1.3	1.0000000	Budget Collars LLC	1
## 395	1.1	1.3	1.0000000	Budget Collars LLC	1
## 396	1.2	1.3	0.5714286	Budget Collars LLC	1
## 397	1.3	1.3	0.5714286	Budget Collars LLC	1
## 398	1.4	1.3	0.5714286	Budget Collars LLC	0
## 399	1.5	1.3	0.5714286	Budget Collars LLC	0
## 400	-0.5	1.4	1.0000000	Budget Collars LLC	1
## 401	-0.4	1.4	1.0000000	Budget Collars LLC	1
## 402	-0.3	1.4	1.0000000	Budget Collars LLC	1
## 403	-0.2	1.4	1.0000000	Budget Collars LLC	1
## 404	-0.1	1.4	1.0000000	Budget Collars LLC	1
## 405	0.0	1.4	1.0000000	Budget Collars LLC	1
## 406	0.1	1.4	1.0000000	Budget Collars LLC	1

## 407	0.2	1.4	1.0000000	Budget Collars LLC	1
## 408	0.3	1.4	1.0000000	Budget Collars LLC	1
## 409	0.4	1.4	1.0000000	Budget Collars LLC	1
## 410	0.5	1.4	1.0000000	Budget Collars LLC	1
## 411	0.6	1.4	1.0000000	Budget Collars LLC	1
## 412	0.7	1.4	1.0000000	Budget Collars LLC	1
## 413	0.8	1.4	1.0000000	Budget Collars LLC	1
## 414	0.9	1.4	1.0000000	Budget Collars LLC	1
## 415	1.0	1.4	1.0000000	Budget Collars LLC	1
## 416	1.1	1.4	1.0000000	Budget Collars LLC	1
## 417	1.2	1.4	1.0000000	Budget Collars LLC	1
## 418	1.3	1.4	0.5714286	Budget Collars LLC	1
## 419	1.4	1.4	0.5714286	Budget Collars LLC	1
## 420	1.5	1.4	0.5714286	Budget Collars LLC	0
## 421	-0.5	1.5	1.0000000	Budget Collars LLC	1
## 422	-0.4	1.5	1.0000000	Budget Collars LLC	1
## 423	-0.3	1.5	1.0000000	Budget Collars LLC	1
## 424	-0.2	1.5	1.0000000	Budget Collars LLC	1
## 425	-0.1	1.5	1.0000000	Budget Collars LLC	1
## 426	0.0	1.5	1.0000000	Budget Collars LLC	1
## 427	0.1	1.5	1.0000000	Budget Collars LLC	1
## 428	0.2	1.5	1.0000000	Budget Collars LLC	1
## 429	0.3	1.5	1.0000000	Budget Collars LLC	1
## 430	0.4	1.5	1.0000000	Budget Collars LLC	1
## 431	0.5	1.5	1.0000000	Budget Collars LLC	1
## 432	0.6	1.5	1.0000000	Budget Collars LLC	1
## 433	0.7	1.5	1.0000000	Budget Collars LLC	1
## 434	0.8	1.5	1.0000000	Budget Collars LLC	1
## 435	0.9	1.5	1.0000000	Budget Collars LLC	1
## 436	1.0	1.5	1.0000000	Budget Collars LLC	1
## 437	1.1	1.5	1.0000000	Budget Collars LLC	1
## 438	1.2	1.5	1.0000000	Budget Collars LLC	1
## 439	1.3	1.5	0.8571429	Budget Collars LLC	1
## 440	1.4	1.5	0.5714286	Budget Collars LLC	1
## 441	1.5	1.5	0.5714286	Budget Collars LLC	1
## 442	-0.5	-0.5	0.7142857	Collarium Inc.	0
## 443	-0.4	-0.5	0.7142857	Collarium Inc.	0
## 444	-0.3	-0.5	0.5714286	Collarium Inc.	0
## 445	-0.2	-0.5	0.5714286	Collarium Inc.	0
## 446	-0.1	-0.5	0.7142857	Collarium Inc.	1
## 447	0.0	-0.5	0.8571429	Collarium Inc.	1
## 448	0.1	-0.5	1.0000000	Collarium Inc.	1
## 449	0.2	-0.5	1.0000000	Collarium Inc.	1
## 450	0.3	-0.5	1.0000000	Collarium Inc.	1
## 451	0.4	-0.5	1.0000000	Collarium Inc.	1
## 452	0.5	-0.5	1.0000000	Collarium Inc.	1
## 453	0.6	-0.5	1.0000000	Collarium Inc.	1
## 454	0.7	-0.5	1.0000000	Collarium Inc.	1
## 455	0.8	-0.5	1.0000000	Collarium Inc.	1
## 456	0.9	-0.5	1.0000000	Collarium Inc.	1
## 457	1.0	-0.5	1.0000000	Collarium Inc.	1
## 458	1.1	-0.5	1.0000000	Collarium Inc.	1
## 459	1.2	-0.5	1.0000000	Collarium Inc.	1
## 460	1.3	-0.5	1.0000000	Collarium Inc.	1

## 461	1.4	-0.5	1.0000000	Collarium Inc.	1
## 462	1.5	-0.5	1.0000000	Collarium Inc.	1
## 463	-0.5	-0.4	0.8571429	Collarium Inc.	0
## 464	-0.4	-0.4	0.8571429	Collarium Inc.	0
## 465	-0.3	-0.4	0.7142857	Collarium Inc.	0
## 466	-0.2	-0.4	0.5714286	Collarium Inc.	0
## 467	-0.1	-0.4	0.5714286	Collarium Inc.	1
## 468	0.0	-0.4	0.7142857	Collarium Inc.	1
## 469	0.1	-0.4	1.0000000	Collarium Inc.	1
## 470	0.2	-0.4	1.0000000	Collarium Inc.	1
## 471	0.3	-0.4	1.0000000	Collarium Inc.	1
## 472	0.4	-0.4	1.0000000	Collarium Inc.	1
## 473	0.5	-0.4	1.0000000	Collarium Inc.	1
## 474	0.6	-0.4	1.0000000	Collarium Inc.	1
## 475	0.7	-0.4	1.0000000	Collarium Inc.	1
## 476	0.8	-0.4	1.0000000	Collarium Inc.	1
## 477	0.9	-0.4	1.0000000	Collarium Inc.	1
## 478	1.0	-0.4	1.0000000	Collarium Inc.	1
## 479	1.1	-0.4	1.0000000	Collarium Inc.	1
## 480	1.2	-0.4	1.0000000	Collarium Inc.	1
## 481	1.3	-0.4	1.0000000	Collarium Inc.	1
## 482	1.4	-0.4	1.0000000	Collarium Inc.	1
## 483	1.5	-0.4	1.0000000	Collarium Inc.	1
## 484	-0.5	-0.3	0.8571429	Collarium Inc.	0
## 485	-0.4	-0.3	0.8571429	Collarium Inc.	0
## 486	-0.3	-0.3	0.8571429	Collarium Inc.	0
## 487	-0.2	-0.3	0.7142857	Collarium Inc.	0
## 488	-0.1	-0.3	0.5714286	Collarium Inc.	0
## 489	0.0	-0.3	0.5714286	Collarium Inc.	1
## 490	0.1	-0.3	0.7142857	Collarium Inc.	1
## 491	0.2	-0.3	1.0000000	Collarium Inc.	1
## 492	0.3	-0.3	1.0000000	Collarium Inc.	1
## 493	0.4	-0.3	1.0000000	Collarium Inc.	1
## 494	0.5	-0.3	1.0000000	Collarium Inc.	1
## 495	0.6	-0.3	1.0000000	Collarium Inc.	1
## 496	0.7	-0.3	1.0000000	Collarium Inc.	1
## 497	0.8	-0.3	1.0000000	Collarium Inc.	1
## 498	0.9	-0.3	1.0000000	Collarium Inc.	1
## 499	1.0	-0.3	1.0000000	Collarium Inc.	1
## 500	1.1	-0.3	1.0000000	Collarium Inc.	1
## 501	1.2	-0.3	1.0000000	Collarium Inc.	1
## 502	1.3	-0.3	1.0000000	Collarium Inc.	1
## 503	1.4	-0.3	1.0000000	Collarium Inc.	1
## 504	1.5	-0.3	1.0000000	Collarium Inc.	1
## 505	-0.5	-0.2	1.0000000	Collarium Inc.	0
## 506	-0.4	-0.2	0.8571429	Collarium Inc.	0
## 507	-0.3	-0.2	0.8571429	Collarium Inc.	0
## 508	-0.2	-0.2	0.8571429	Collarium Inc.	0
## 509	-0.1	-0.2	0.7142857	Collarium Inc.	0
## 510	0.0	-0.2	0.5714286	Collarium Inc.	0
## 511	0.1	-0.2	0.7142857	Collarium Inc.	1
## 512	0.2	-0.2	1.0000000	Collarium Inc.	1
## 513	0.3	-0.2	1.0000000	Collarium Inc.	1
## 514	0.4	-0.2	1.0000000	Collarium Inc.	1

## 515	0.5	-0.2	1.0000000	Collarium Inc.	1
## 516	0.6	-0.2	1.0000000	Collarium Inc.	1
## 517	0.7	-0.2	1.0000000	Collarium Inc.	1
## 518	0.8	-0.2	1.0000000	Collarium Inc.	1
## 519	0.9	-0.2	1.0000000	Collarium Inc.	1
## 520	1.0	-0.2	1.0000000	Collarium Inc.	1
## 521	1.1	-0.2	1.0000000	Collarium Inc.	1
## 522	1.2	-0.2	1.0000000	Collarium Inc.	1
## 523	1.3	-0.2	1.0000000	Collarium Inc.	1
## 524	1.4	-0.2	1.0000000	Collarium Inc.	1
## 525	1.5	-0.2	1.0000000	Collarium Inc.	1
## 526	-0.5	-0.1	1.0000000	Collarium Inc.	0
## 527	-0.4	-0.1	1.0000000	Collarium Inc.	0
## 528	-0.3	-0.1	0.8571429	Collarium Inc.	0
## 529	-0.2	-0.1	0.8571429	Collarium Inc.	0
## 530	-0.1	-0.1	0.8571429	Collarium Inc.	0
## 531	0.0	-0.1	0.7142857	Collarium Inc.	0
## 532	0.1	-0.1	0.5714286	Collarium Inc.	0
## 533	0.2	-0.1	0.7142857	Collarium Inc.	1
## 534	0.3	-0.1	1.0000000	Collarium Inc.	1
## 535	0.4	-0.1	1.0000000	Collarium Inc.	1
## 536	0.5	-0.1	1.0000000	Collarium Inc.	1
## 537	0.6	-0.1	1.0000000	Collarium Inc.	1
## 538	0.7	-0.1	1.0000000	Collarium Inc.	1
## 539	0.8	-0.1	1.0000000	Collarium Inc.	1
## 540	0.9	-0.1	1.0000000	Collarium Inc.	1
## 541	1.0	-0.1	1.0000000	Collarium Inc.	1
## 542	1.1	-0.1	1.0000000	Collarium Inc.	1
## 543	1.2	-0.1	1.0000000	Collarium Inc.	1
## 544	1.3	-0.1	1.0000000	Collarium Inc.	1
## 545	1.4	-0.1	1.0000000	Collarium Inc.	1
## 546	1.5	-0.1	1.0000000	Collarium Inc.	1
## 547	-0.5	0.0	1.0000000	Collarium Inc.	0
## 548	-0.4	0.0	1.0000000	Collarium Inc.	0
## 549	-0.3	0.0	1.0000000	Collarium Inc.	0
## 550	-0.2	0.0	1.0000000	Collarium Inc.	0
## 551	-0.1	0.0	0.8571429	Collarium Inc.	0
## 552	0.0	0.0	0.8571429	Collarium Inc.	0
## 553	0.1	0.0	0.8571429	Collarium Inc.	0
## 554	0.2	0.0	0.5714286	Collarium Inc.	1
## 555	0.3	0.0	0.7142857	Collarium Inc.	1
## 556	0.4	0.0	1.0000000	Collarium Inc.	1
## 557	0.5	0.0	1.0000000	Collarium Inc.	1
## 558	0.6	0.0	1.0000000	Collarium Inc.	1
## 559	0.7	0.0	1.0000000	Collarium Inc.	1
## 560	0.8	0.0	1.0000000	Collarium Inc.	1
## 561	0.9	0.0	1.0000000	Collarium Inc.	1
## 562	1.0	0.0	1.0000000	Collarium Inc.	1
## 563	1.1	0.0	1.0000000	Collarium Inc.	1
## 564	1.2	0.0	1.0000000	Collarium Inc.	1
## 565	1.3	0.0	1.0000000	Collarium Inc.	1
## 566	1.4	0.0	1.0000000	Collarium Inc.	1
## 567	1.5	0.0	1.0000000	Collarium Inc.	1
## 568	-0.5	0.1	1.0000000	Collarium Inc.	0

## 569	-0.4	0.1	1.0000000	Collarium Inc.	0
## 570	-0.3	0.1	1.0000000	Collarium Inc.	0
## 571	-0.2	0.1	1.0000000	Collarium Inc.	0
## 572	-0.1	0.1	1.0000000	Collarium Inc.	0
## 573	0.0	0.1	0.8571429	Collarium Inc.	0
## 574	0.1	0.1	0.8571429	Collarium Inc.	0
## 575	0.2	0.1	0.7142857	Collarium Inc.	0
## 576	0.3	0.1	0.5714286	Collarium Inc.	1
## 577	0.4	0.1	0.8571429	Collarium Inc.	1
## 578	0.5	0.1	1.0000000	Collarium Inc.	1
## 579	0.6	0.1	1.0000000	Collarium Inc.	1
## 580	0.7	0.1	1.0000000	Collarium Inc.	1
## 581	0.8	0.1	1.0000000	Collarium Inc.	1
## 582	0.9	0.1	1.0000000	Collarium Inc.	1
## 583	1.0	0.1	1.0000000	Collarium Inc.	1
## 584	1.1	0.1	1.0000000	Collarium Inc.	1
## 585	1.2	0.1	1.0000000	Collarium Inc.	1
## 586	1.3	0.1	1.0000000	Collarium Inc.	1
## 587	1.4	0.1	1.0000000	Collarium Inc.	1
## 588	1.5	0.1	1.0000000	Collarium Inc.	1
## 589	-0.5	0.2	1.0000000	Collarium Inc.	0
## 590	-0.4	0.2	1.0000000	Collarium Inc.	0
## 591	-0.3	0.2	1.0000000	Collarium Inc.	0
## 592	-0.2	0.2	1.0000000	Collarium Inc.	0
## 593	-0.1	0.2	1.0000000	Collarium Inc.	0
## 594	0.0	0.2	1.0000000	Collarium Inc.	0
## 595	0.1	0.2	0.8571429	Collarium Inc.	0
## 596	0.2	0.2	0.8571429	Collarium Inc.	0
## 597	0.3	0.2	0.7142857	Collarium Inc.	0
## 598	0.4	0.2	0.5714286	Collarium Inc.	1
## 599	0.5	0.2	0.8571429	Collarium Inc.	1
## 600	0.6	0.2	1.0000000	Collarium Inc.	1
## 601	0.7	0.2	1.0000000	Collarium Inc.	1
## 602	0.8	0.2	1.0000000	Collarium Inc.	1
## 603	0.9	0.2	1.0000000	Collarium Inc.	1
## 604	1.0	0.2	1.0000000	Collarium Inc.	1
## 605	1.1	0.2	1.0000000	Collarium Inc.	1
## 606	1.2	0.2	1.0000000	Collarium Inc.	1
## 607	1.3	0.2	1.0000000	Collarium Inc.	1
## 608	1.4	0.2	1.0000000	Collarium Inc.	1
## 609	1.5	0.2	1.0000000	Collarium Inc.	1
## 610	-0.5	0.3	1.0000000	Collarium Inc.	0
## 611	-0.4	0.3	1.0000000	Collarium Inc.	0
## 612	-0.3	0.3	1.0000000	Collarium Inc.	0
## 613	-0.2	0.3	1.0000000	Collarium Inc.	0
## 614	-0.1	0.3	1.0000000	Collarium Inc.	0
## 615	0.0	0.3	1.0000000	Collarium Inc.	0
## 616	0.1	0.3	1.0000000	Collarium Inc.	0
## 617	0.2	0.3	1.0000000	Collarium Inc.	0
## 618	0.3	0.3	0.8571429	Collarium Inc.	0
## 619	0.4	0.3	0.7142857	Collarium Inc.	0
## 620	0.5	0.3	0.8571429	Collarium Inc.	1
## 621	0.6	0.3	1.0000000	Collarium Inc.	1
## 622	0.7	0.3	1.0000000	Collarium Inc.	1

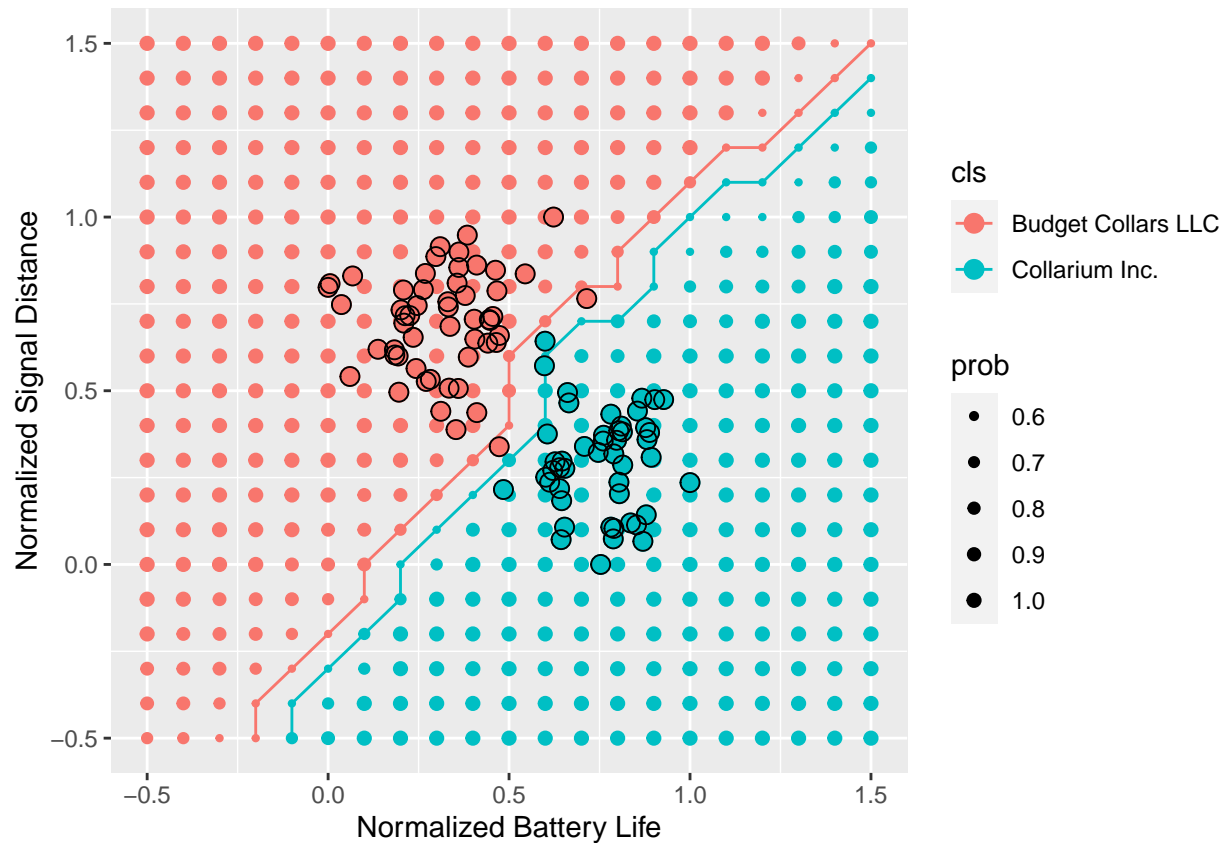
## 623	0.8	0.3	1.0000000	Collarium Inc.	1
## 624	0.9	0.3	1.0000000	Collarium Inc.	1
## 625	1.0	0.3	1.0000000	Collarium Inc.	1
## 626	1.1	0.3	1.0000000	Collarium Inc.	1
## 627	1.2	0.3	1.0000000	Collarium Inc.	1
## 628	1.3	0.3	1.0000000	Collarium Inc.	1
## 629	1.4	0.3	1.0000000	Collarium Inc.	1
## 630	1.5	0.3	1.0000000	Collarium Inc.	1
## 631	-0.5	0.4	1.0000000	Collarium Inc.	0
## 632	-0.4	0.4	1.0000000	Collarium Inc.	0
## 633	-0.3	0.4	1.0000000	Collarium Inc.	0
## 634	-0.2	0.4	1.0000000	Collarium Inc.	0
## 635	-0.1	0.4	1.0000000	Collarium Inc.	0
## 636	0.0	0.4	1.0000000	Collarium Inc.	0
## 637	0.1	0.4	1.0000000	Collarium Inc.	0
## 638	0.2	0.4	1.0000000	Collarium Inc.	0
## 639	0.3	0.4	1.0000000	Collarium Inc.	0
## 640	0.4	0.4	1.0000000	Collarium Inc.	0
## 641	0.5	0.4	0.5714286	Collarium Inc.	0
## 642	0.6	0.4	1.0000000	Collarium Inc.	1
## 643	0.7	0.4	1.0000000	Collarium Inc.	1
## 644	0.8	0.4	1.0000000	Collarium Inc.	1
## 645	0.9	0.4	1.0000000	Collarium Inc.	1
## 646	1.0	0.4	1.0000000	Collarium Inc.	1
## 647	1.1	0.4	1.0000000	Collarium Inc.	1
## 648	1.2	0.4	1.0000000	Collarium Inc.	1
## 649	1.3	0.4	1.0000000	Collarium Inc.	1
## 650	1.4	0.4	1.0000000	Collarium Inc.	1
## 651	1.5	0.4	1.0000000	Collarium Inc.	1
## 652	-0.5	0.5	1.0000000	Collarium Inc.	0
## 653	-0.4	0.5	1.0000000	Collarium Inc.	0
## 654	-0.3	0.5	1.0000000	Collarium Inc.	0
## 655	-0.2	0.5	1.0000000	Collarium Inc.	0
## 656	-0.1	0.5	1.0000000	Collarium Inc.	0
## 657	0.0	0.5	1.0000000	Collarium Inc.	0
## 658	0.1	0.5	1.0000000	Collarium Inc.	0
## 659	0.2	0.5	1.0000000	Collarium Inc.	0
## 660	0.3	0.5	1.0000000	Collarium Inc.	0
## 661	0.4	0.5	1.0000000	Collarium Inc.	0
## 662	0.5	0.5	0.8571429	Collarium Inc.	0
## 663	0.6	0.5	1.0000000	Collarium Inc.	1
## 664	0.7	0.5	1.0000000	Collarium Inc.	1
## 665	0.8	0.5	1.0000000	Collarium Inc.	1
## 666	0.9	0.5	1.0000000	Collarium Inc.	1
## 667	1.0	0.5	1.0000000	Collarium Inc.	1
## 668	1.1	0.5	1.0000000	Collarium Inc.	1
## 669	1.2	0.5	1.0000000	Collarium Inc.	1
## 670	1.3	0.5	1.0000000	Collarium Inc.	1
## 671	1.4	0.5	1.0000000	Collarium Inc.	1
## 672	1.5	0.5	1.0000000	Collarium Inc.	1
## 673	-0.5	0.6	1.0000000	Collarium Inc.	0
## 674	-0.4	0.6	1.0000000	Collarium Inc.	0
## 675	-0.3	0.6	1.0000000	Collarium Inc.	0
## 676	-0.2	0.6	1.0000000	Collarium Inc.	0

## 677	-0.1	0.6	1.0000000	Collarium Inc.	0
## 678	0.0	0.6	1.0000000	Collarium Inc.	0
## 679	0.1	0.6	1.0000000	Collarium Inc.	0
## 680	0.2	0.6	1.0000000	Collarium Inc.	0
## 681	0.3	0.6	1.0000000	Collarium Inc.	0
## 682	0.4	0.6	1.0000000	Collarium Inc.	0
## 683	0.5	0.6	0.7142857	Collarium Inc.	0
## 684	0.6	0.6	0.5714286	Collarium Inc.	1
## 685	0.7	0.6	0.8571429	Collarium Inc.	1
## 686	0.8	0.6	0.8571429	Collarium Inc.	1
## 687	0.9	0.6	1.0000000	Collarium Inc.	1
## 688	1.0	0.6	1.0000000	Collarium Inc.	1
## 689	1.1	0.6	1.0000000	Collarium Inc.	1
## 690	1.2	0.6	1.0000000	Collarium Inc.	1
## 691	1.3	0.6	1.0000000	Collarium Inc.	1
## 692	1.4	0.6	1.0000000	Collarium Inc.	1
## 693	1.5	0.6	1.0000000	Collarium Inc.	1
## 694	-0.5	0.7	1.0000000	Collarium Inc.	0
## 695	-0.4	0.7	1.0000000	Collarium Inc.	0
## 696	-0.3	0.7	1.0000000	Collarium Inc.	0
## 697	-0.2	0.7	1.0000000	Collarium Inc.	0
## 698	-0.1	0.7	1.0000000	Collarium Inc.	0
## 699	0.0	0.7	1.0000000	Collarium Inc.	0
## 700	0.1	0.7	1.0000000	Collarium Inc.	0
## 701	0.2	0.7	1.0000000	Collarium Inc.	0
## 702	0.3	0.7	1.0000000	Collarium Inc.	0
## 703	0.4	0.7	1.0000000	Collarium Inc.	0
## 704	0.5	0.7	1.0000000	Collarium Inc.	0
## 705	0.6	0.7	0.7142857	Collarium Inc.	0
## 706	0.7	0.7	0.5714286	Collarium Inc.	1
## 707	0.8	0.7	0.8571429	Collarium Inc.	1
## 708	0.9	0.7	0.8571429	Collarium Inc.	1
## 709	1.0	0.7	0.8571429	Collarium Inc.	1
## 710	1.1	0.7	0.8571429	Collarium Inc.	1
## 711	1.2	0.7	1.0000000	Collarium Inc.	1
## 712	1.3	0.7	1.0000000	Collarium Inc.	1
## 713	1.4	0.7	1.0000000	Collarium Inc.	1
## 714	1.5	0.7	1.0000000	Collarium Inc.	1
## 715	-0.5	0.8	1.0000000	Collarium Inc.	0
## 716	-0.4	0.8	1.0000000	Collarium Inc.	0
## 717	-0.3	0.8	1.0000000	Collarium Inc.	0
## 718	-0.2	0.8	1.0000000	Collarium Inc.	0
## 719	-0.1	0.8	1.0000000	Collarium Inc.	0
## 720	0.0	0.8	1.0000000	Collarium Inc.	0
## 721	0.1	0.8	1.0000000	Collarium Inc.	0
## 722	0.2	0.8	1.0000000	Collarium Inc.	0
## 723	0.3	0.8	1.0000000	Collarium Inc.	0
## 724	0.4	0.8	1.0000000	Collarium Inc.	0
## 725	0.5	0.8	1.0000000	Collarium Inc.	0
## 726	0.6	0.8	0.8571429	Collarium Inc.	0
## 727	0.7	0.8	0.7142857	Collarium Inc.	0
## 728	0.8	0.8	0.5714286	Collarium Inc.	0
## 729	0.9	0.8	0.5714286	Collarium Inc.	1
## 730	1.0	0.8	0.7142857	Collarium Inc.	1

## 731	1.1	0.8	0.8571429	Collarium Inc.	1
## 732	1.2	0.8	0.8571429	Collarium Inc.	1
## 733	1.3	0.8	0.8571429	Collarium Inc.	1
## 734	1.4	0.8	1.0000000	Collarium Inc.	1
## 735	1.5	0.8	1.0000000	Collarium Inc.	1
## 736	-0.5	0.9	1.0000000	Collarium Inc.	0
## 737	-0.4	0.9	1.0000000	Collarium Inc.	0
## 738	-0.3	0.9	1.0000000	Collarium Inc.	0
## 739	-0.2	0.9	1.0000000	Collarium Inc.	0
## 740	-0.1	0.9	1.0000000	Collarium Inc.	0
## 741	0.0	0.9	1.0000000	Collarium Inc.	0
## 742	0.1	0.9	1.0000000	Collarium Inc.	0
## 743	0.2	0.9	1.0000000	Collarium Inc.	0
## 744	0.3	0.9	1.0000000	Collarium Inc.	0
## 745	0.4	0.9	1.0000000	Collarium Inc.	0
## 746	0.5	0.9	1.0000000	Collarium Inc.	0
## 747	0.6	0.9	1.0000000	Collarium Inc.	0
## 748	0.7	0.9	0.8571429	Collarium Inc.	0
## 749	0.8	0.9	0.7142857	Collarium Inc.	0
## 750	0.9	0.9	0.5714286	Collarium Inc.	1
## 751	1.0	0.9	0.5714286	Collarium Inc.	1
## 752	1.1	0.9	0.7142857	Collarium Inc.	1
## 753	1.2	0.9	0.7142857	Collarium Inc.	1
## 754	1.3	0.9	0.8571429	Collarium Inc.	1
## 755	1.4	0.9	0.8571429	Collarium Inc.	1
## 756	1.5	0.9	0.8571429	Collarium Inc.	1
## 757	-0.5	1.0	1.0000000	Collarium Inc.	0
## 758	-0.4	1.0	1.0000000	Collarium Inc.	0
## 759	-0.3	1.0	1.0000000	Collarium Inc.	0
## 760	-0.2	1.0	1.0000000	Collarium Inc.	0
## 761	-0.1	1.0	1.0000000	Collarium Inc.	0
## 762	0.0	1.0	1.0000000	Collarium Inc.	0
## 763	0.1	1.0	1.0000000	Collarium Inc.	0
## 764	0.2	1.0	1.0000000	Collarium Inc.	0
## 765	0.3	1.0	1.0000000	Collarium Inc.	0
## 766	0.4	1.0	1.0000000	Collarium Inc.	0
## 767	0.5	1.0	1.0000000	Collarium Inc.	0
## 768	0.6	1.0	1.0000000	Collarium Inc.	0
## 769	0.7	1.0	1.0000000	Collarium Inc.	0
## 770	0.8	1.0	0.8571429	Collarium Inc.	0
## 771	0.9	1.0	0.8571429	Collarium Inc.	0
## 772	1.0	1.0	0.5714286	Collarium Inc.	1
## 773	1.1	1.0	0.5714286	Collarium Inc.	1
## 774	1.2	1.0	0.5714286	Collarium Inc.	1
## 775	1.3	1.0	0.7142857	Collarium Inc.	1
## 776	1.4	1.0	0.7142857	Collarium Inc.	1
## 777	1.5	1.0	0.8571429	Collarium Inc.	1
## 778	-0.5	1.1	1.0000000	Collarium Inc.	0
## 779	-0.4	1.1	1.0000000	Collarium Inc.	0
## 780	-0.3	1.1	1.0000000	Collarium Inc.	0
## 781	-0.2	1.1	1.0000000	Collarium Inc.	0
## 782	-0.1	1.1	1.0000000	Collarium Inc.	0
## 783	0.0	1.1	1.0000000	Collarium Inc.	0
## 784	0.1	1.1	1.0000000	Collarium Inc.	0

## 785	0.2	1.1	1.0000000	Collarium Inc.	0
## 786	0.3	1.1	1.0000000	Collarium Inc.	0
## 787	0.4	1.1	1.0000000	Collarium Inc.	0
## 788	0.5	1.1	1.0000000	Collarium Inc.	0
## 789	0.6	1.1	1.0000000	Collarium Inc.	0
## 790	0.7	1.1	1.0000000	Collarium Inc.	0
## 791	0.8	1.1	1.0000000	Collarium Inc.	0
## 792	0.9	1.1	1.0000000	Collarium Inc.	0
## 793	1.0	1.1	0.7142857	Collarium Inc.	0
## 794	1.1	1.1	0.5714286	Collarium Inc.	1
## 795	1.2	1.1	0.5714286	Collarium Inc.	1
## 796	1.3	1.1	0.5714286	Collarium Inc.	1
## 797	1.4	1.1	0.7142857	Collarium Inc.	1
## 798	1.5	1.1	0.7142857	Collarium Inc.	1
## 799	-0.5	1.2	1.0000000	Collarium Inc.	0
## 800	-0.4	1.2	1.0000000	Collarium Inc.	0
## 801	-0.3	1.2	1.0000000	Collarium Inc.	0
## 802	-0.2	1.2	1.0000000	Collarium Inc.	0
## 803	-0.1	1.2	1.0000000	Collarium Inc.	0
## 804	0.0	1.2	1.0000000	Collarium Inc.	0
## 805	0.1	1.2	1.0000000	Collarium Inc.	0
## 806	0.2	1.2	1.0000000	Collarium Inc.	0
## 807	0.3	1.2	1.0000000	Collarium Inc.	0
## 808	0.4	1.2	1.0000000	Collarium Inc.	0
## 809	0.5	1.2	1.0000000	Collarium Inc.	0
## 810	0.6	1.2	1.0000000	Collarium Inc.	0
## 811	0.7	1.2	1.0000000	Collarium Inc.	0
## 812	0.8	1.2	1.0000000	Collarium Inc.	0
## 813	0.9	1.2	1.0000000	Collarium Inc.	0
## 814	1.0	1.2	1.0000000	Collarium Inc.	0
## 815	1.1	1.2	0.5714286	Collarium Inc.	0
## 816	1.2	1.2	0.5714286	Collarium Inc.	0
## 817	1.3	1.2	0.5714286	Collarium Inc.	1
## 818	1.4	1.2	0.5714286	Collarium Inc.	1
## 819	1.5	1.2	0.7142857	Collarium Inc.	1
## 820	-0.5	1.3	1.0000000	Collarium Inc.	0
## 821	-0.4	1.3	1.0000000	Collarium Inc.	0
## 822	-0.3	1.3	1.0000000	Collarium Inc.	0
## 823	-0.2	1.3	1.0000000	Collarium Inc.	0
## 824	-0.1	1.3	1.0000000	Collarium Inc.	0
## 825	0.0	1.3	1.0000000	Collarium Inc.	0
## 826	0.1	1.3	1.0000000	Collarium Inc.	0
## 827	0.2	1.3	1.0000000	Collarium Inc.	0
## 828	0.3	1.3	1.0000000	Collarium Inc.	0
## 829	0.4	1.3	1.0000000	Collarium Inc.	0
## 830	0.5	1.3	1.0000000	Collarium Inc.	0
## 831	0.6	1.3	1.0000000	Collarium Inc.	0
## 832	0.7	1.3	1.0000000	Collarium Inc.	0
## 833	0.8	1.3	1.0000000	Collarium Inc.	0
## 834	0.9	1.3	1.0000000	Collarium Inc.	0
## 835	1.0	1.3	1.0000000	Collarium Inc.	0
## 836	1.1	1.3	1.0000000	Collarium Inc.	0
## 837	1.2	1.3	0.5714286	Collarium Inc.	0
## 838	1.3	1.3	0.5714286	Collarium Inc.	0

## 839	1.4	1.3	0.5714286	Collarium Inc.	1
## 840	1.5	1.3	0.5714286	Collarium Inc.	1
## 841	-0.5	1.4	1.0000000	Collarium Inc.	0
## 842	-0.4	1.4	1.0000000	Collarium Inc.	0
## 843	-0.3	1.4	1.0000000	Collarium Inc.	0
## 844	-0.2	1.4	1.0000000	Collarium Inc.	0
## 845	-0.1	1.4	1.0000000	Collarium Inc.	0
## 846	0.0	1.4	1.0000000	Collarium Inc.	0
## 847	0.1	1.4	1.0000000	Collarium Inc.	0
## 848	0.2	1.4	1.0000000	Collarium Inc.	0
## 849	0.3	1.4	1.0000000	Collarium Inc.	0
## 850	0.4	1.4	1.0000000	Collarium Inc.	0
## 851	0.5	1.4	1.0000000	Collarium Inc.	0
## 852	0.6	1.4	1.0000000	Collarium Inc.	0
## 853	0.7	1.4	1.0000000	Collarium Inc.	0
## 854	0.8	1.4	1.0000000	Collarium Inc.	0
## 855	0.9	1.4	1.0000000	Collarium Inc.	0
## 856	1.0	1.4	1.0000000	Collarium Inc.	0
## 857	1.1	1.4	1.0000000	Collarium Inc.	0
## 858	1.2	1.4	1.0000000	Collarium Inc.	0
## 859	1.3	1.4	0.5714286	Collarium Inc.	0
## 860	1.4	1.4	0.5714286	Collarium Inc.	0
## 861	1.5	1.4	0.5714286	Collarium Inc.	1
## 862	-0.5	1.5	1.0000000	Collarium Inc.	0
## 863	-0.4	1.5	1.0000000	Collarium Inc.	0
## 864	-0.3	1.5	1.0000000	Collarium Inc.	0
## 865	-0.2	1.5	1.0000000	Collarium Inc.	0
## 866	-0.1	1.5	1.0000000	Collarium Inc.	0
## 867	0.0	1.5	1.0000000	Collarium Inc.	0
## 868	0.1	1.5	1.0000000	Collarium Inc.	0
## 869	0.2	1.5	1.0000000	Collarium Inc.	0
## 870	0.3	1.5	1.0000000	Collarium Inc.	0
## 871	0.4	1.5	1.0000000	Collarium Inc.	0
## 872	0.5	1.5	1.0000000	Collarium Inc.	0
## 873	0.6	1.5	1.0000000	Collarium Inc.	0
## 874	0.7	1.5	1.0000000	Collarium Inc.	0
## 875	0.8	1.5	1.0000000	Collarium Inc.	0
## 876	0.9	1.5	1.0000000	Collarium Inc.	0
## 877	1.0	1.5	1.0000000	Collarium Inc.	0
## 878	1.1	1.5	1.0000000	Collarium Inc.	0
## 879	1.2	1.5	1.0000000	Collarium Inc.	0
## 880	1.3	1.5	0.8571429	Collarium Inc.	0
## 881	1.4	1.5	0.5714286	Collarium Inc.	0
## 882	1.5	1.5	0.5714286	Collarium Inc.	0



Group discussion

Can you interpret this plot? Focus on a few points:

1. What are the gridded points?
2. What do the large points represent?
3. What are the lines here?

Final steps - making predictions

So we've gotten to a point where we have a model we think is good (let's go with $k = 5$). Let's use it on the test data we want to predict labels for!

```
glimpse(collars_to_label)
```

```
## Observations: 50
## Variables: 7
## $ collar_id      <dbl> 101, 102, 103, 104, 105, 106, 107, 108, 109, 110, 1...
## $ maker          <chr> NA, NA, NA, NA, NA, NA, NA, NA, NA, NA, NA, NA, ...
## $ battery_life    <dbl> 116.99435, 126.17496, 130.60469, 115.19269, 124.481...
## $ signal_distance <dbl> 4201.807, 4158.341, 4183.001, 4250.064, 4242.241, 4...
## $ fail            <dbl> NA, NA, NA, NA, NA, NA, NA, NA, NA, NA, NA, NA, ...
## $ antenna_length  <dbl> 5.263709, 7.075396, 5.914348, 4.403713, 6.643748, 5...
## $ weight          <dbl> 25.81248, 19.05661, 23.66526, 20.12864, 20.74899, 2...
```

```

# Getting ready to feed data in
collars_to_label_norm = collars_to_label %>%
  dplyr::select(battery_life, signal_distance) %>%
  mutate(battery_life_norm = nor(battery_life),
         signal_distance_norm = nor(signal_distance)) %>%
  dplyr::select(battery_life_norm, signal_distance_norm)

mod = knn(train = train, test = collars_to_label_norm, cl = cl, k = 5)

collars_to_label %>%
  mutate(pred_class = mod)

```

```

## # A tibble: 50 x 8
##   collar_id maker battery_life signal_distance fail antenna_length weight
##   <dbl> <chr>    <dbl>         <dbl> <dbl>      <dbl> <dbl>
## 1      101 <NA>      117.         4202.   NA         5.26  25.8
## 2      102 <NA>      126.         4158.   NA         7.08  19.1
## 3      103 <NA>      131.         4183.   NA         5.91  23.7
## 4      104 <NA>      115.         4250.   NA         4.40  20.1
## 5      105 <NA>      124.         4242.   NA         6.64  20.7
## 6      106 <NA>      145.         4156.   NA         5.66  23.1
## 7      107 <NA>      125.         4249.   NA         6.92  17.4
## 8      108 <NA>      118.         4258.   NA         6.49  23.9
## 9      109 <NA>      114.         4161.   NA         8.07  26.7
## 10     110 <NA>      132.         4235.   NA         5.68  23.8
## # ... with 40 more rows, and 1 more variable: pred_class <fct>

```