Stage 2: Exploratory Data Analysis

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4/18/2019

EDA Main Report

Introduction

Our project plans to look into trend in animal treatment in Dallas animal shelters. Using a dataset containing information on all recent animals brought into the shelter, we are going to try to answer some of the following questions. What traits affect a dog's probability of adoption? Are there seasonal trends in the adoption of different animals? Are animals who enter the animal shelter with chips more likely to be returned to their owner? On the table below you can see some of the variables we are working with in the dataset.

Dogs

Dogs are the most common animal winding up in the animal shelters which form our dataset. From our total of 44,194 dogs, 35% were adopted, 30% were returned to owners, 16% were trasfered, and 15% were euthanized. The most common breed of dog in our dataset is the pitbull, with 10,033 being admited to animal shelters in between 10/01/2017 and 04/03/2019. We are especially interested in how pitbulls are treated within our datasets as these dogs have an infamous reputation of being overly agressive. Is it possible that this reputation results in a lower adoption rate for pitbulls that other breeds?

Pitbulls

To look into how pitbulls are handled within animal shelters, we decided to explore how the outcomes of pitbulls may differ from non-pitbulls. Table 1 describes the differences in outcome rates for non-pitbulls compared to pitbulls.

Table 1: Pitbull Outcomes

Outcome	Pitbull (%)	Non-Pitbull (%)
Adoption	32.10	36.04
Euthanized	28.67	10.43
Returned to owner	22.03	31.01
Transfer	10.98	17.74
Foster	2.16	1.57
Other	1.83	0.99
Dead on arrival	0.88	0.83
Treatment	0.79	0.95
Died	0.52	0.39
Missing	0.04	0.06

We see that pitbulls, while only adopted at a slightly lower rate (~5%), are euthanized at well over double the rate of other dogs. Further, we see that other dogs have a much higher chance of being trasfered to another facility or returned to their owner. It would be valuble to get a better understanding of this relationship, but we likely need to control for things like chip status and intake condition. Moving foward we would like to look into some binomial regression to look into the outcomes of pitbulls. To do this we plan to make a more general outcome variable of Dead or Alive status (to reduce the dimension of the current outcome_type variable). In fitting this model we plan to control for intake status (with which we still need to do some work on string analysis), chip_status, and month.

Dogs vs Cats

In Minnesota and Iowa, our home states, animal shelters often report having more difficulty dealing with stray cats. There are lots of problems that feral cats cause including environmental damage and spread of disease. We were interested if we can see these kinds of differences in our data. Do cats spend longer in animal shelters? Are they euthanized at higher rates? To describe some of these differences we looked we created a summary graph of different characteristics of dogs and cats. Since our dataset contains observations of 44194 dogs and only 12891 cats, we created this chart in terms of proportion of each animal matching a certain critera.

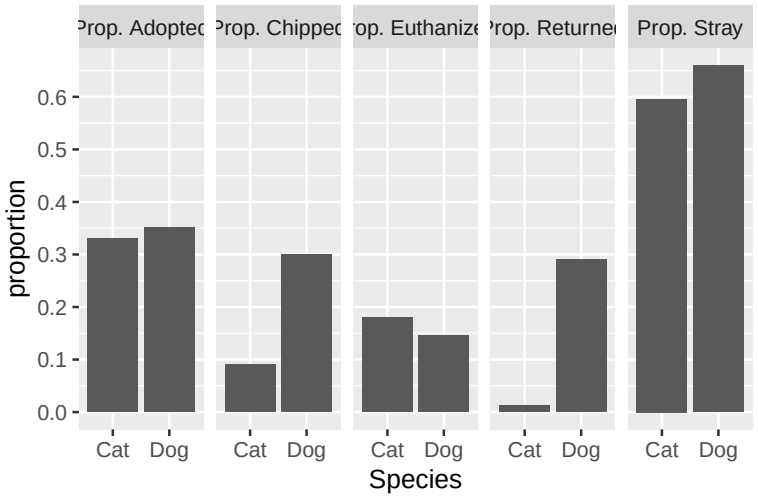


Figure 1: Cat vs Dog Characteristics

Interestingly enough, we see that the difference between proportions of cats and dogs adopted is not very pronounced. A slightly lower percentage of cats are adopted and a slightly higher percent of cats are euthanized compared to dogs. However, we do see that very few cats entering humane societys have scannable chips, and an even lower proportion are returned to their owner. Additionally it seems appears that fewer cats are brought into the shelter as strays. We may use this data to do another binomial analysis to piece apart differences between cat and dog adoptions. We may do a similar thing as the pitbull analysis with the creation of a dead or alive outcome variable. We would want to consider controlling for in this analysis would be breed, intake condition,and chip status.

Time of Year

Another question that we had in our Stage 1 report was what seasonal trends exists in adoptions. One could imagine a situation where more puppies are adopted in December or more rabbits are adopted in early spring. To explore this we did some ploting to see how many animals were adopted in each months.

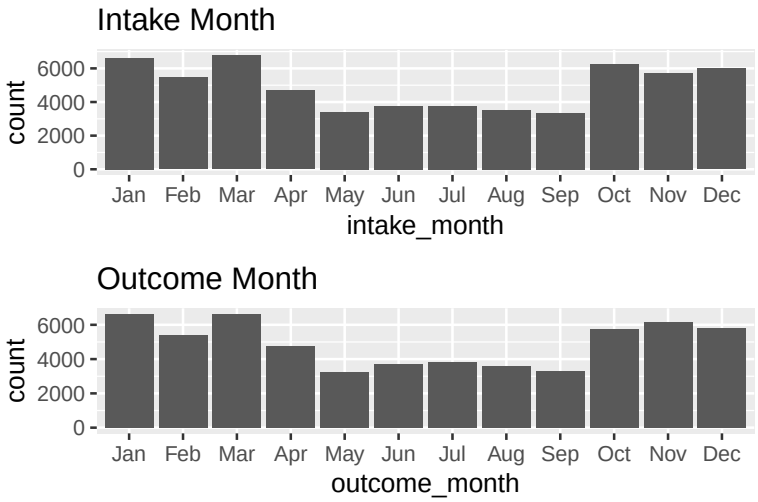


Figure 2: Animal Adoptions by Month

These trends surprised us. We see a large drop in adoptions during the summer but a spike in the fall, winter, and early spring. These trends were true for both Dog and Cat adoptions (see appendix). For rabbits, many were adopted in February and July. While we are unable to put together a rigourus defense for why these trends are occuring, we see that we may need to control for it in our binomial analysis.

Annotated Appendix and References

Variables

Table 2: Description of Variables

Variable Name	Variable Role	Variable Type	Range of Values	Units
animal_breed	explanatory	categorical	296 unique breeds	NA
animal_origin	explanatory	categorical	4 sources of shelter animals	NA
animal_type	explanatory	categorical	5 species of animal	NA
chip_status	explanatory	bianary	(0,1)	NA
intake_type	potential confounder	categorial	how animal came to be at the shelter	NA
outcome_type	reponse	categorial	how animals was removed from shelter	NA
intake_condition	potential confounder	categorial	keyword description of animal status at intake	NA
outcome_condition	potential confounder	categorial	keyword description of animal status at outcome	NA
intake_date	response	date	(2017-10-01, 2019-04-03)	y-m-d
outcome_date	response	date	(2017-10-01, 2019-04-03)	y-m-d

Citations

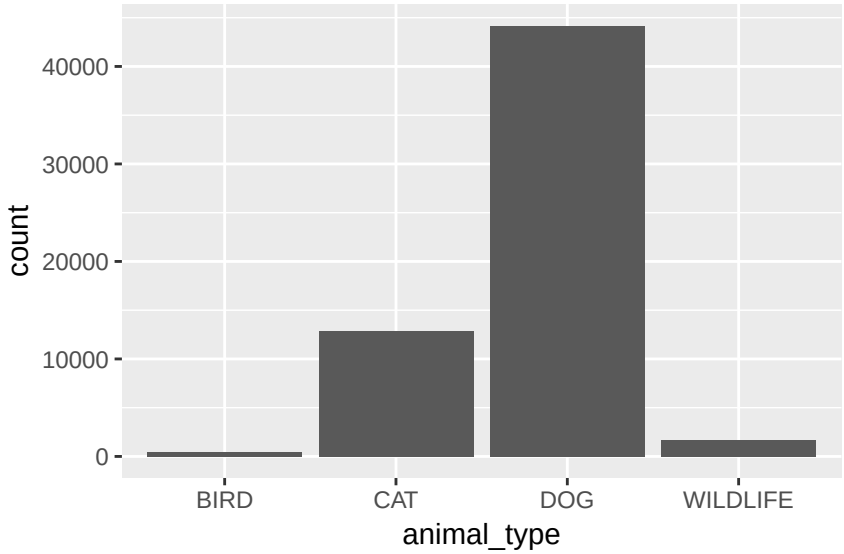
1. Lepper, M., Kass, P. H., & Hart, L. A. (2002). Prediction of adoption versus euthanasia among dogs and cats in a California animal shelter. Journal of Applied Animal Welfare Science, 5(1), 29-42.
2. Posage, J. M., Bartlett, P. C., & Thomas, D. K. (1998). Determining factors for successful adoption of dogs from an animal shelter. Journal of the American Veterinary Medical Association, 213(4), 478-482.
3. Lampe, R., & Witte, T. H. (2015). Speed of dog adoption: Impact of online photo traits. Journal of applied animal welfare science, 18(4), 343-354.

Exploring animal_type

```
# animal type
adoptions %>%
  group_by(animal_type) %>%
  count(sort = TRUE)
```

```
## # A tibble: 6 x 2
## # Groups:   animal_type [6]
##   animal_type     n
##   <chr>       <int>
## 1 DOG         44194
## 2 CAT         12891
## 3 WILDLIFE     1696
## 4 BIRD          485
## 5 LIVESTOCK      33
## 6 D               1
```

```r
adoptions %>%
  filter(!animal_type%in%c("D", "LIVESTOCK")) %>%
  ggplot(aes(x=animal_type))+
  geom_bar()
```



We see that most observations in our dataaset were of dogs, followed by cats. It seems there is 1 mislabeled dog which we will take care of in our data cleaning file.

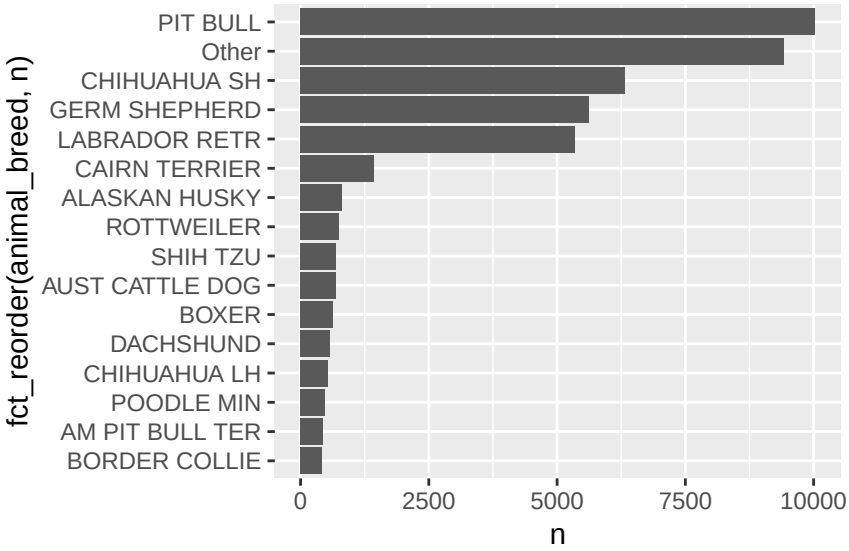
Exploring animal_breed

```r
## Which dog breeds are in our data?
adoptions %>%
  filter(animal_type == "DOG") %>%
  mutate(animal_breed = fct_lump(animal_breed, n=15)) %>%
  group_by(animal_breed) %>%
  count(sort = TRUE)
```

```
## # A tibble: 16 x 2
## # Groups:   animal_breed [16]
##    animal_breed        n
##    <fct>           <int>
##  1 PIT BULL        10033
##  2 Other            9423
##  3 CHIHUAHUA SH     6322
##  4 GERM SHEPHERD    5625
##  5 LABRADOR RETR    5353
##  6 CAIRN TERRIER    1430
##  7 ALASKAN HUSKY     812
##  8 ROTTWEILER        751
##  9 SHIH TZU          696
## 10 AUST CATTLE DOG   683
## 11 BOXER             629
## 12 DACHSHUND         581
## 13 CHIHUAHUA LH      528
## 14 POODLE MIN        476
## 15 AM PIT BULL TER   433
```

```
## 16 BORDER COLLIE     419
```

```
adoptions %>%
  filter(animal_type == "DOG") %>%
  mutate(animal_breed = fct_lump(animal_breed, n=15)) %>%
  group_by(animal_breed) %>%
  count(sort = TRUE)%>%
  ggplot(aes(x=fct_reorder(animal_breed,n), y=n))+
  geom_bar(stat="identity")+
  coord_flip()
```

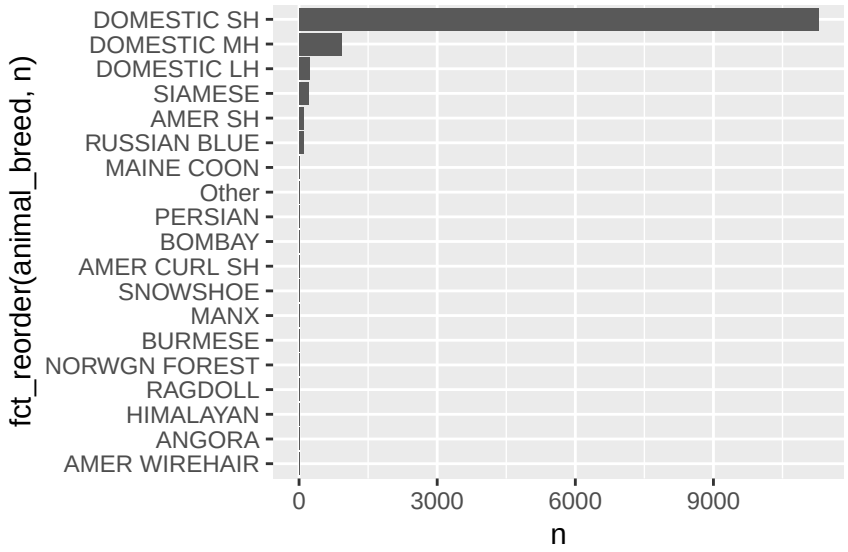


We have a huge variety of dog breeds in our data. The pmost common breed is the pitbull, which we are planning to use for our analysis. There are many other dog breeds that are seen as agressive (rottweilers and boxers) that we may make into a new variable `aggressive`.

```
## Which cat breeds are in our data?
adoptions %>%
  filter(animal_type == "CAT") %>%
  mutate(animal_breed = fct_lump(animal_breed, n=10)) %>%
  group_by(animal_breed) %>%
  count(sort = TRUE)
```

```
## # A tibble: 11 x 2
## # Groups:   animal_breed [11]
##    animal_breed     n
##    <fct>        <int>
##  1 DOMESTIC SH  11273
##  2 DOMESTIC MH    916
##  3 DOMESTIC LH    219
##  4 SIAMESE        214
##  5 AMER SH        101
##  6 RUSSIAN BLUE    96
##  7 Other           33
##  8 MAINE COON      19
##  9 PERSIAN          8
## 10 AMER CURL SH     6
## 11 BOMBAY           6
```

```
adoptions %>%
  filter(animal_type == "CAT") %>%
  mutate(animal_breed = fct_lump(animal_breed, n=15)) %>%
  group_by(animal_breed) %>%
  count(sort = TRUE)%>%
  ggplot(aes(x=fct_reorder(animal_breed,n), y=n))+
  geom_bar(stat="identity")+
  coord_flip()
```



Almost all of the cats in our data were domestic short hair cats.

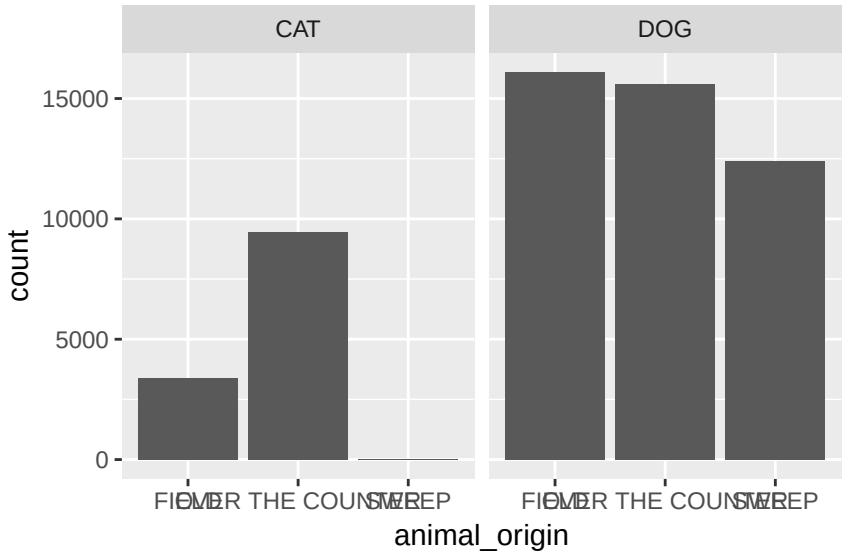
```
## Which types of wildlife are in our data?
adoptions %>%
  filter(animal_type == "WILDLIFE") %>%
  mutate(animal_breed = fct_lump(animal_breed, n=10)) %>%
  group_by(animal_breed) %>%
  count(sort = TRUE)
```

```
## # A tibble: 11 x 2
## # Groups:   animal_breed [11]
##    animal_breed     n
##    <fct>        <int>
##  1 RACCOON        471
##  2 OPOSSUM        404
##  3 TURTLE         190
##  4 GUINEA PIG     148
##  5 RABBIT SH      136
##  6 HAMSTER         98
##  7 SQUIRREL        82
##  8 Other           68
##  9 BAT             59
## 10 FOX             23
## 11 SKUNK           17
```

This variable is more for fun. Look at all these fun creatures they get to deal with at the animal shelter. We are kind of interested in rabbits so we will talk about that later.

Exploring animal origin

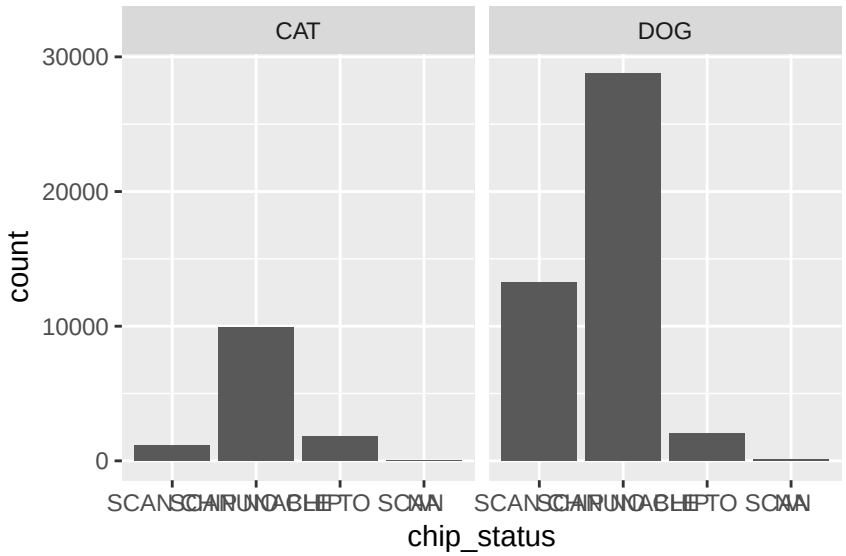
```
adoptions %>%
  filter(dog == 1 | cat == 1) %>%
  filter(!is.na(animal_origin)) %>%
  ggplot(aes(x=animal_origin))+
  geom_bar()+
  facet_grid(~animal_type)
```



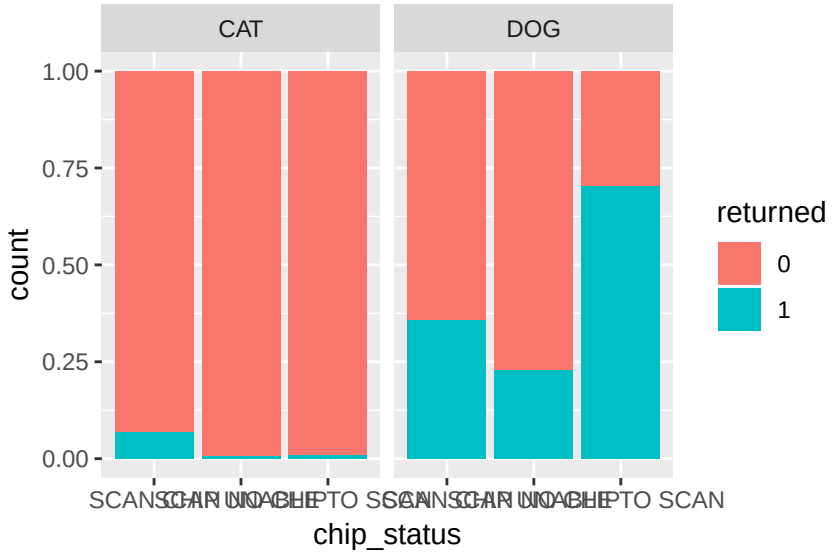
Dogs and cats can come from a 3 possible origins: field, over the counter, and sweep. As of this moment, we are not sure what the difference between field and sweep are. However, it is interesting that only dogs are brought in from sweeps.

Exploring chip status

```
## General distribution of variable
adoptions %>%
  filter(dog == 1 | cat == 1) %>%
  ggplot(aes(x=chip_status))+
  geom_bar()+
  facet_grid(~animal_type)
```




```
## Relationship with returned to owner status
adoptions %>%
  filter(dog == 1 | cat == 1) %>%
  filter(!is.na(chip_status)) %>%
  mutate(returned = as.factor(ifelse(outcome_type== "RETURNED TO OWNER", 1, 0))) %>%
  ggplot(aes(x=chip_status, fill = returned))+
  geom_bar(position = "fill")+
  facet_grid(~animal_type)
```



We see that most cats and dogs do not have chips. However, a larger proportion of dogs have chips than cats. A higher proportion of dogs are returned to owners than cats in all three categories of chip status.

Exploring intake_subtype

```
## Which dog breeds are in our data?
adoptions %>%
  mutate(intake_subtype = fct_lump(intake_subtype, n=10)) %>%
  group_by(intake_subtype) %>%
```

```
  count(sort = TRUE)
```

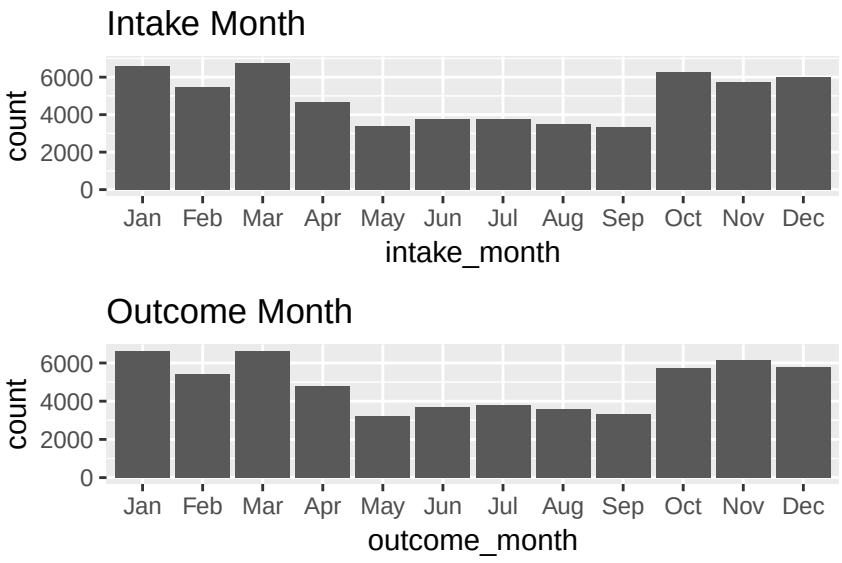
```
## # A tibble: 11 x 2
## # Groups:   intake_subtype [11]
##    intake_subtype           n
##    <fct>                <int>
##  1 AT LARGE             28889
##  2 GENERAL              15495
##  3 CONFINED              5598
##  4 POSSIBLY OWNED        2085
##  5 Other                 1813
##  6 QUARANTINE            1454
##  7 RETURN30              1312
##  8 INJURED                972
##  9 KEEP SAFE              781
## 10 UNINJURED              474
## 11 EUTHANASIA REQUESTED   427
```

This general intake listing does not give us a lot of infomration. However we do see that a few animals may have been returned (non-independent observation), and some animals are requested to be euthanized upon admission.

Exploring intake_date and outcome_date

```
intake <- adoptions %>%
  mutate(intake_month = month(intake_date, label = TRUE)) %>%
  ggplot(aes(x=intake_month))+
  geom_bar()+
  ggtitle("Intake Month")

outcome <- adoptions %>%
  filter(!is.na(outcome_date)) %>%
  mutate(outcome_month = month(outcome_date, label = TRUE)) %>%
  ggplot(aes(x=outcome_month))+
  geom_bar()+ ggtitle("Outcome Month")
gridExtra::grid.arrange(intake, outcome)
```

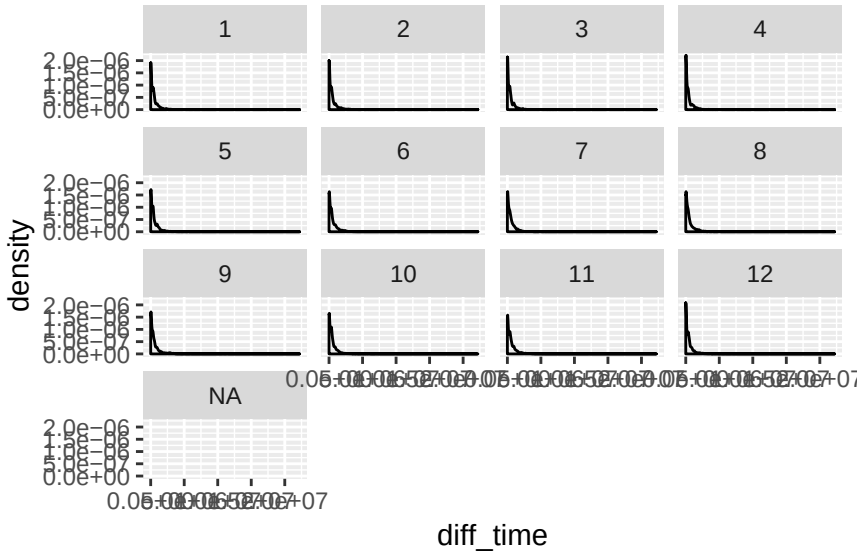


```
# Ammount of time spent at the humane society looks to be about the same from month to month.

adoptions %>%
  mutate(diff_time=difftime(outcome_date, intake_date))%>%
  select(diff_time, month)%>%
  ggplot(aes(x=diff_time))+
  geom_density()+
  facet_wrap(~as.factor(month))
```

```
## Don't know how to automatically pick scale for object of type difftime. Defaulting to continuous.
```

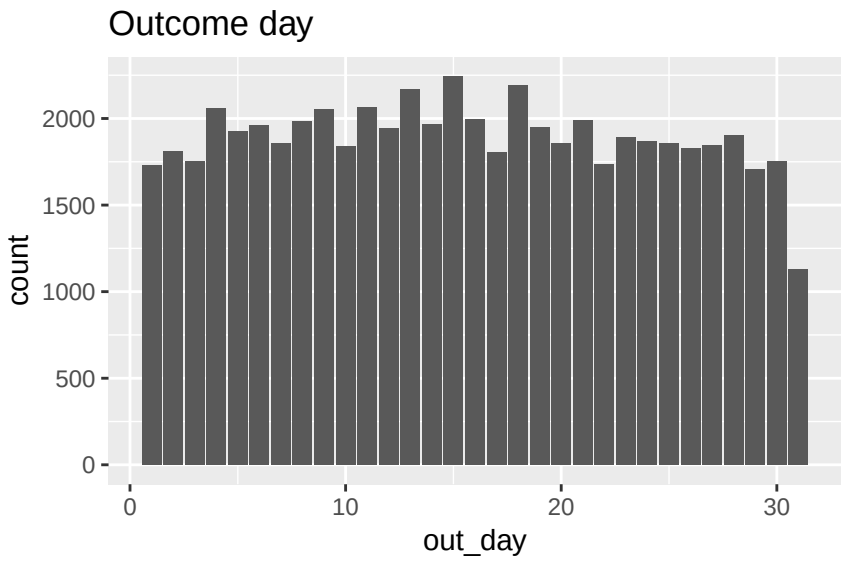
```
## Warning: Removed 642 rows containing non-finite values (stat_density).
```



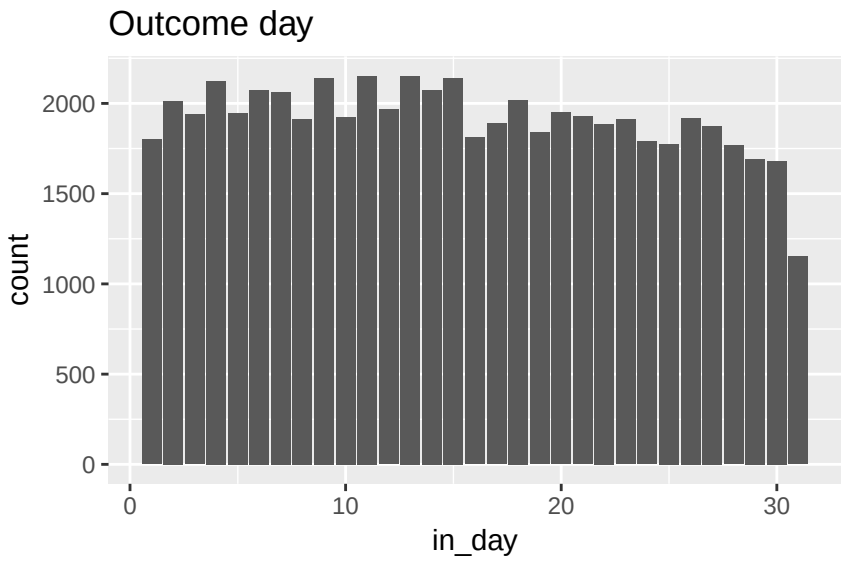
Differences in income day

```
adoptions%>%
  mutate(out_day=day(outcome_date))%>%
  ggplot(aes(x=out_day))+
  geom_bar()+ ggtitle("Outcome day")
```

```
## Warning: Removed 642 rows containing non-finite values (stat_count).
```

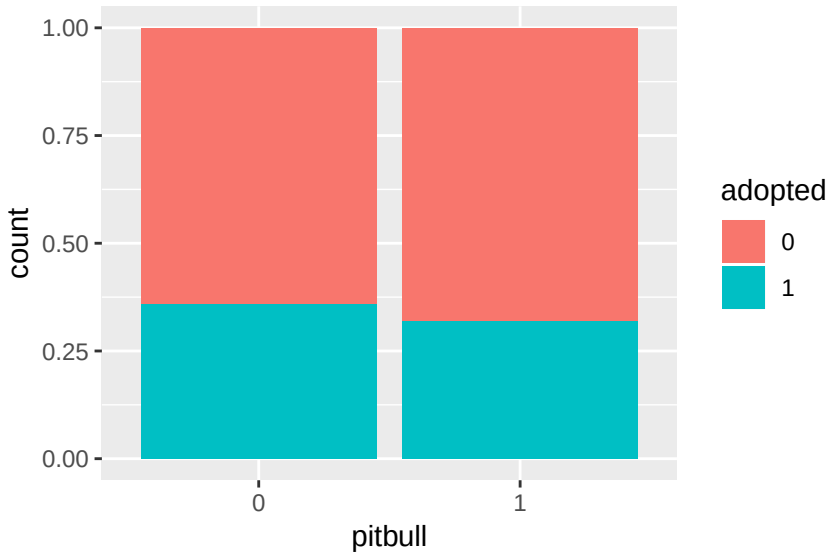



```
adoptions%>%
  mutate(in_day=day(intake_date))%>%
  ggplot(aes(x=in_day))+
  geom_bar()+ ggtitle("Outcome day")
```



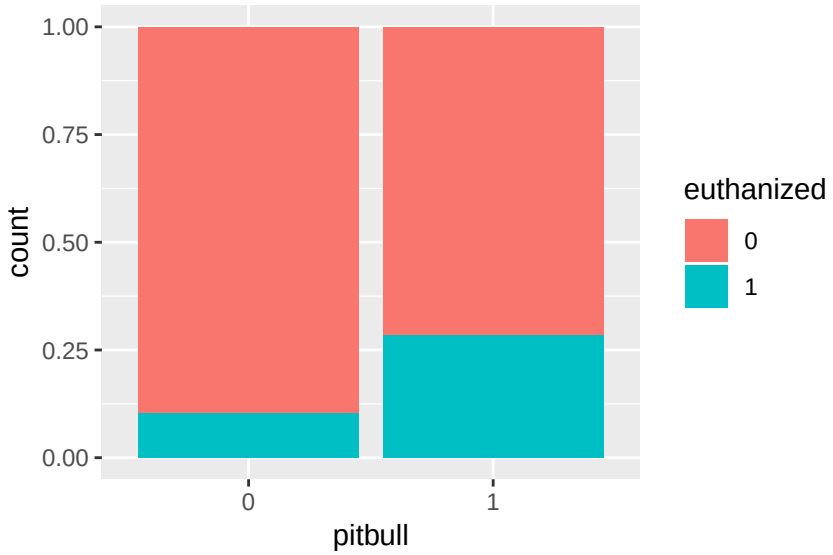
Pitbulls and Adoptions

```
adoptions %>%
  filter(dog == 1) %>%
  mutate(adopted = as.factor(adopted),
         pitbull = as.factor(pitbull)) %>%
  ggplot(aes(x = pitbull, fill = adopted))+
  geom_bar(position = "fill")
```



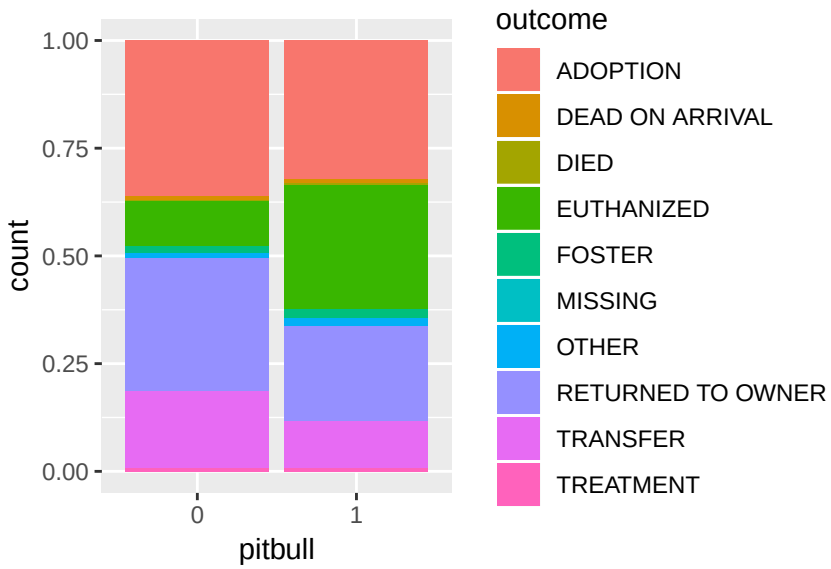
There does not seem to be a large difference between the adoption rates of pitbull and non-pitbulls. We should try and filter out some of the non-adopted dogs though, not all dogs come to the shelter to be adopted.

```
adoptions %>%
  filter(dog == 1) %>%
  mutate(euthanized = as.factor(euthanized),
         pitbull = as.factor(pitbull)) %>%
  ggplot(aes(x = pitbull, fill = euthanized))+
  geom_bar(position = "fill")
```



While pitbulls are not adopted at a higher rate, the are euthanized at a higher rate than other dogs. Lets look at all possible outcomes to see how this is possible.

```
adoptions %>%
  filter(dog == 1) %>%
  mutate(outcome = as.factor(outcome_type),
         pitbull = as.factor(pitbull)) %>%
  ggplot(aes(x = pitbull, fill = outcome))+
  geom_bar(position = "fill")
```




```
adoptions %>%
  filter(dog == 1) %>%
  mutate(outcome = as.factor(outcome_type),
         pitbull = as.factor(pitbull)) %>%
  group_by(pitbull, outcome_type) %>%
  count() %>%
  rename("freq"=n)%>%
  group_by(pitbull)%>%
  mutate(freq = freq/ sum(freq))%>%
  spread(outcome_type,freq)
```

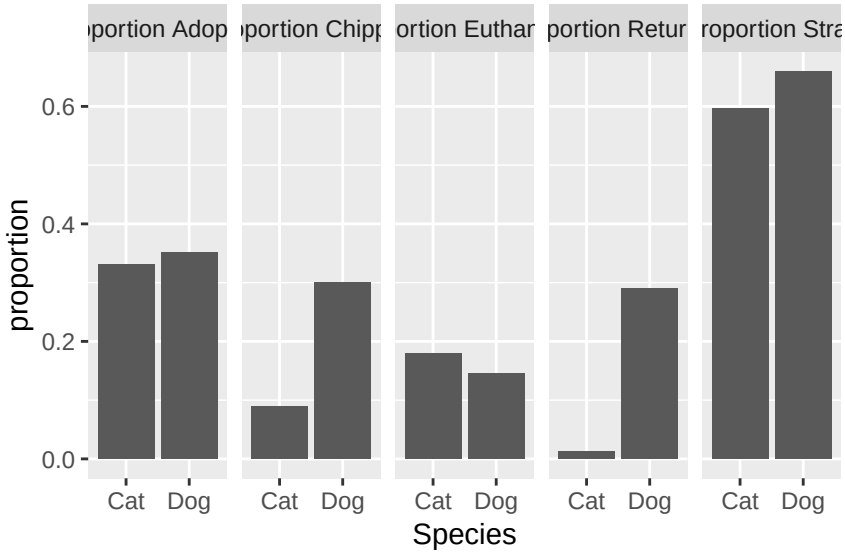
```
## # A tibble: 2 x 11
## # Groups:   pitbull [2]
##   pitbull ADOPTION `DEAD ON ARRIVA~    DIED EUTHANIZED FOSTER MISSING
##   <fct>      <dbl>            <dbl>   <dbl>      <dbl>  <dbl>   <dbl>
## 1 0          0.360          0.00831 0.00386      0.104 0.0157 6.15e-4
## 2 1          0.321          0.00877 0.00518      0.287 0.0216 3.99e-4
## # ... with 4 more variables: OTHER <dbl>, `RETURNED TO OWNER` <dbl>,
## #   TRANSFER <dbl>, TREATMENT <dbl>
```

A far higher percentage of pitbulls are euthanized than other breeds. Other dogs are adopted, returned to owners, and trasfered at a higher rate.

Differences between dogs and cats

```
adoptions %>%
  filter(dog == 1 | cat == 1) %>%
  mutate(Species = ifelse(dog == 1, "Dog", "Cat")) %>%
  mutate(returned = ifelse(outcome_type == "RETURNED TO OWNER", 1, 0)) %>%
  group_by(Species) %>%
  summarise(count = n(),
            meanDays = mean(shelter_days, na.rm = TRUE),
            `Proportion Euthanized` = sum(euthanized)/count,
            `Proportion Adopted` = sum(adopted)/count,
            `Proportion Stray` = sum(stray)/count,
           `Proportion Returned` = sum(returned)/count,
```

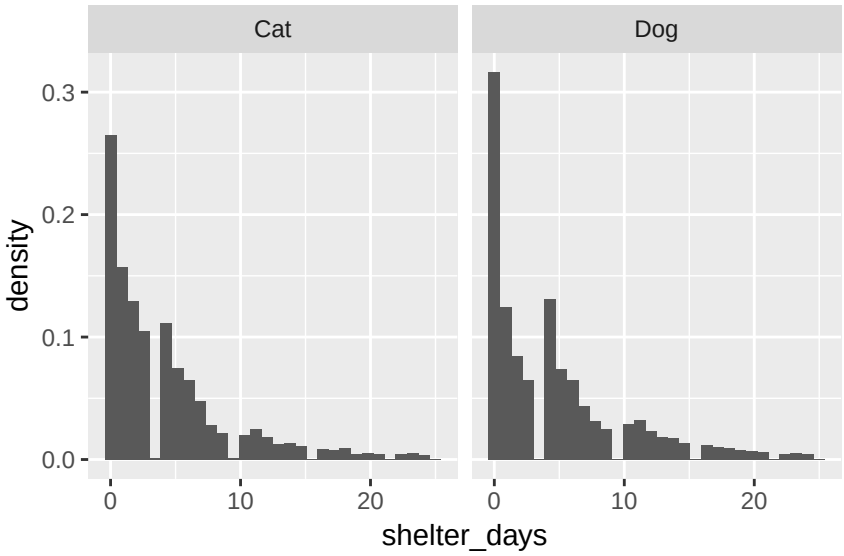
```
          `Proportion Chipped` = sum(chip_status == "SCAN CHIP", na.rm = TRUE)/count)%>%
  gather(key = key, value = proportion, 4:8) %>%
  ggplot(aes(x=Species, y= proportion)) +
    geom_bar(stat = "identity")+
    facet_grid(cols = vars(key))
```



Cats are returned at a much lower rate than dogs. Cats have a much lower proportion with scannable chips than dogs.

```
adoptions %>%
  filter(dog == 1 | cat == 1) %>%
  filter(shelter_days < 25) %>%
  mutate(DogCat = ifelse(dog == 1, "Dog", "Cat")) %>%
  ggplot(aes(x=shelter_days, y=..density..)) +
  geom_histogram()+
  facet_grid(~DogCat)
```

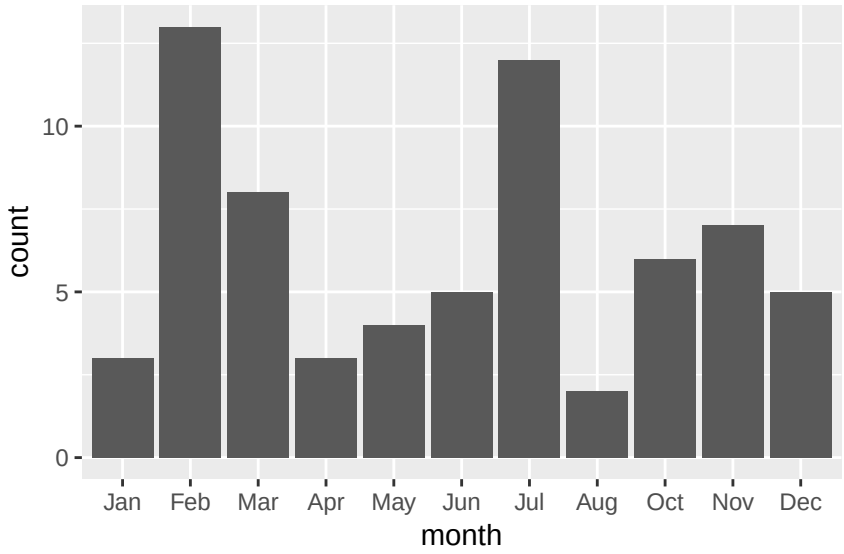
```
## `stat_bin()` using `bins = 30`. Pick better value with `binwidth`.
```



Dogs and cats show similar trends in the number of days until adoptions.

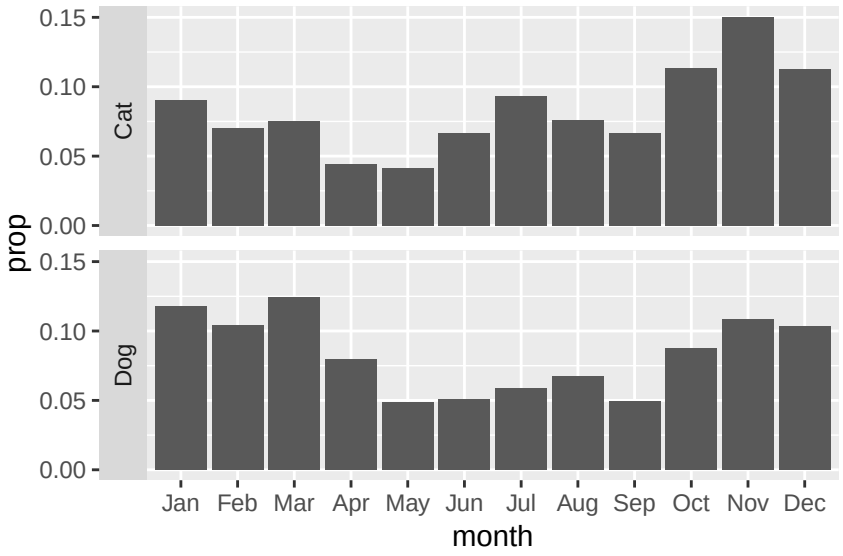
What about rabbits?

```
adoptions  %>%
  filter(animal_breed== "RABBIT SH") %>%
  filter(adopted == 1) %>%
  mutate(month = lubridate::month(outcome_date, label = TRUE)) %>%
  ggplot(aes(x=month)) +
  geom_bar()
```



Alright, so maybe it is not the case that more rabits are adopted over easter. Are there trends in dog adoptions?

```
adoptions  %>%
  filter(dog == 1 | cat == 1) %>%
  mutate(DogCat = ifelse(dog == 1, "Dog", "Cat")) %>%
  filter(adopted == 1, !is.na(month)) %>%
  mutate(month = lubridate::month(outcome_date, label = TRUE)) %>%
  ggplot(aes(x=month, y = ..prop.., group = 1)) +
  geom_bar()+
  facet_grid(rows = vars(DogCat), switch = "both")
```



These both seem to follow the trend of fewer adoptions in the summer.

Intake Condition

We are doing a preliminar investigation into this. There is no domunetation on what exactly all the different levels mean. For example we do not know what the difference between a manageable animal and a treatable animal are or what the differnce between a normal and a healthy animal are.

```
adoptions_expanded_intake=adoptions%>%
  mutate(healthy_intake=ifelse(grepl("^HEALTHY.*",intake_condition),1,0),
         contagious_intake=ifelse(grepl(".*[^NON-]CONTAGIOUS", intake_condition),1,0),
         untreatable_intake=ifelse(grepl(".*(UNTREATABLE).*", intake_condition),1,0),
         treatable_intake=ifelse(grepl("^TREATABLE.*", intake_condition),1,0),
         manageable_intake=ifelse(grepl(".*MANAGEABLE.*", intake_condition),1,0),
         rehabitable_intake=ifelse(grepl(".*REHABILITABLE.*", intake_condition),1,0),
         normal_intake=ifelse(grepl(".*NORMAL.*", intake_condition),1,0))
```

Healthy

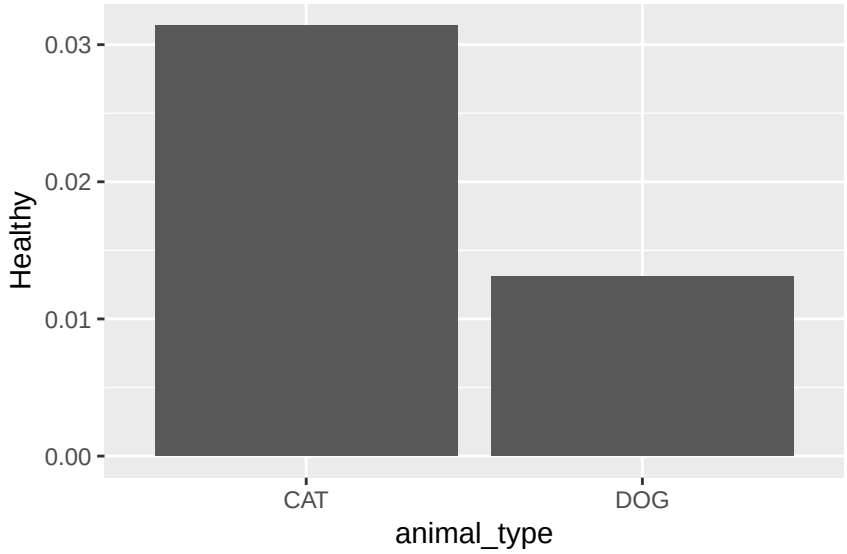
It looks like a slightly higher proportion of cats are healthy (0.0314) than dogs (0.0131), however both of there are suprisingly low.

```
adoptions_expanded_intake%>%
  filter(cat==1|dog==1)%>%
  group_by(animal_type)%>%
  summarise(Healthy=mean(healthy_intake))
```

```
## # A tibble: 2 x 2
##   animal_type Healthy
##   <chr>         <dbl>
## 1 CAT          0.0314
## 2 DOG          0.0131
```

```
adoptions_expanded_intake%>%
  filter(cat==1|dog==1)%>%
  group_by(animal_type)%>%
  summarise(Healthy=mean(healthy_intake))%>%
```

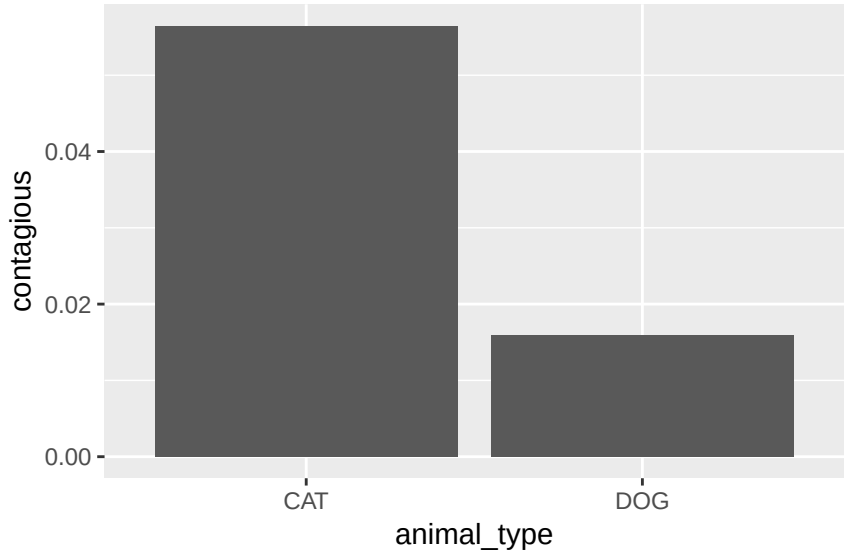
```
  ggplot(aes(x=animal_type, y=Healthy))+
  geom_bar(stat="identity")
```



Contagious

Even though a larger proportion of cats are found or given up healthy, a larger proportion of cats are contagious on intage (cats 0.0565 and dogs 0.0159).

```
adoptions_expanded_intake%>%
  filter(cat==1|dog==1)%>%
  group_by(animal_type)%>%
  summarise(contagious=mean(contagious_intake))%>%
  ggplot(aes(x=animal_type, y=contagious))+
  geom_bar(stat="identity")
```




```
adoptions_expanded_intake%>%
  filter(cat==1|dog==1)%>%
  group_by(animal_type)%>%
```

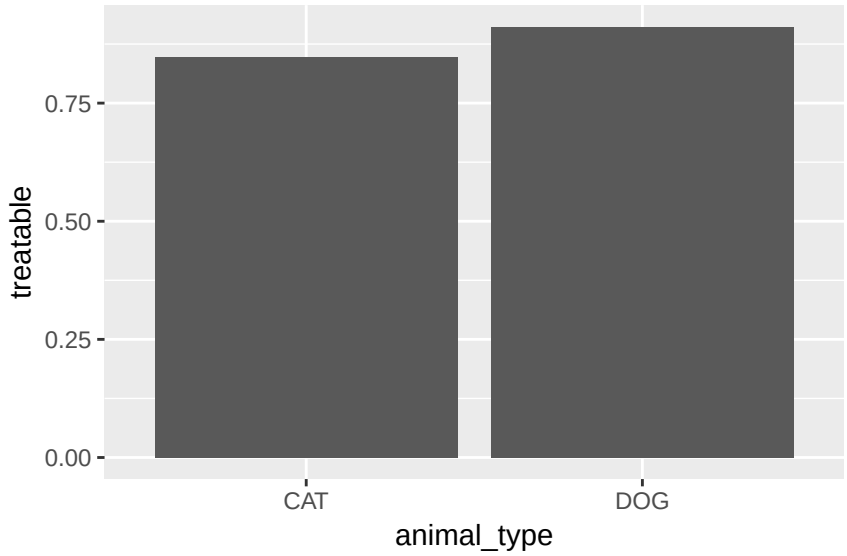
```
  summarise(contagious=mean(contagious_intake))
```

```
## # A tibble: 2 x 2
##   animal_type contagious
##   <chr>            <dbl>
## 1 CAT             0.0565
## 2 DOG             0.0159
```

Treatable

It looks like there is little difference in the proportion of cats and dogs that on intake are treatable.

```
adoptions_expanded_intake%>%
  filter(cat==1|dog==1)%>%
  group_by(animal_type)%>%
  summarise(treatable=mean(treatable_intake))%>%
  ggplot(aes(x=animal_type, y=treatable))+
  geom_bar(stat="identity")
```




```
adoptions_expanded_intake%>%
  filter(cat==1|dog==1)%>%
  group_by(animal_type)%>%
  summarise(treatable=mean(treatable_intake))
```

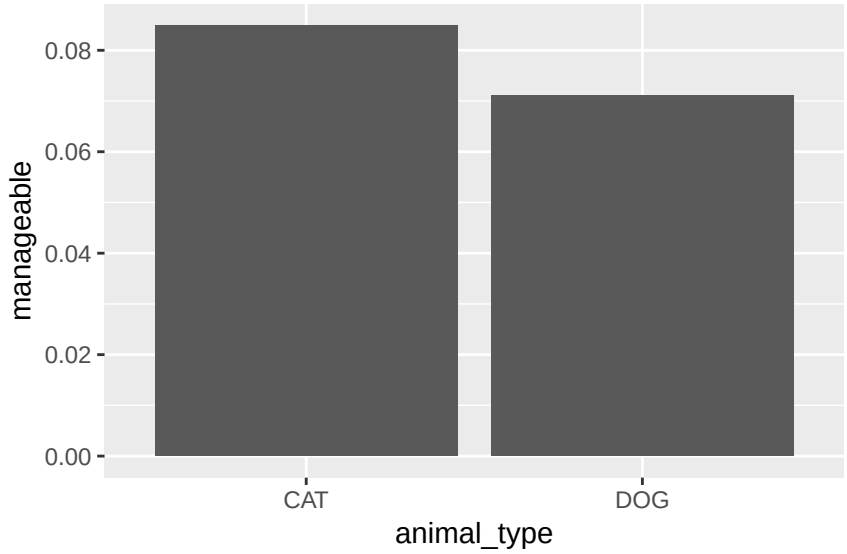
```
## # A tibble: 2 x 2
##   animal_type treatable
##   <chr>           <dbl>
## 1 CAT             0.847
## 2 DOG             0.912
```

Manageable

It appears that these are about the same for both cats and dogs

```
adoptions_expanded_intake%>%
  filter(cat==1|dog==1)%>%
  group_by(animal_type)%>%
  summarise(manageable=mean(manageable_intake))%>%
```

```
  ggplot(aes(x=animal_type, y=manageable))+
  geom_bar(stat="identity")
```



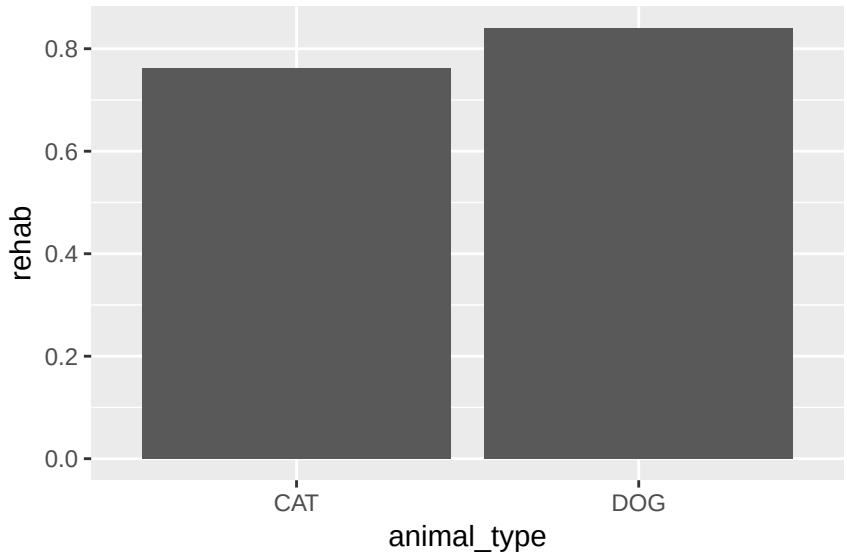

```
adoptions_expanded_intake%>%
  filter(cat==1|dog==1)%>%
  group_by(animal_type)%>%
  summarise(manageable=mean(manageable_intake))
```

```
## # A tibble: 2 x 2
##   animal_type manageable
##   <chr>            <dbl>
## 1 CAT             0.0849
## 2 DOG             0.0711
```

Rehabilatable

It appears that these are about the same for both cats and dogs.

```
adoptions_expanded_intake%>%
  filter(cat==1|dog==1)%>%
  group_by(animal_type)%>%
  summarise(rehab=mean(rehabitable_intake))%>%
  ggplot(aes(x=animal_type, y=rehab))+
  geom_bar(stat="identity")
```



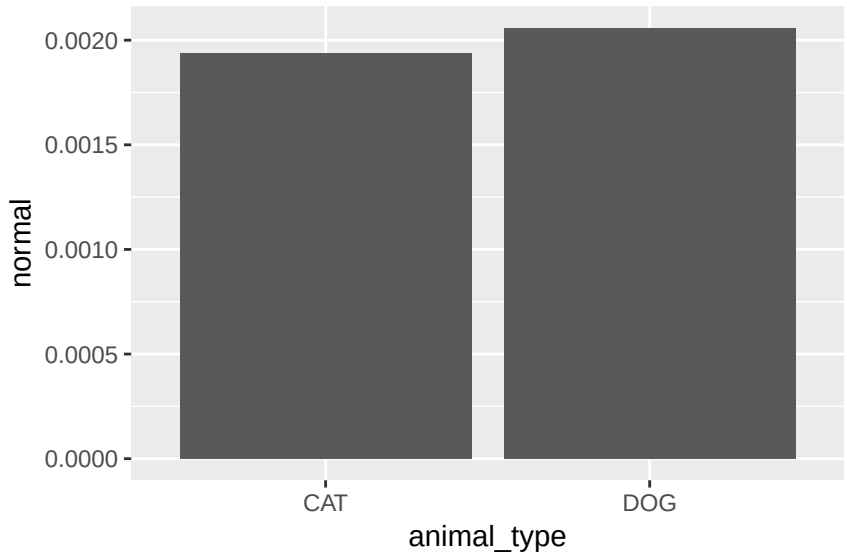

```
adoptions_expanded_intake%>%
  filter(cat==1|dog==1)%>%
  group_by(animal_type)%>%
  summarise(rehabitable=mean(rehabitable_intake))
```

```
## # A tibble: 2 x 2
##   animal_type rehabitable
##   <chr>             <dbl>
## 1 CAT               0.762
## 2 DOG               0.841
```

Normal

It looks like this was only used a few times and most likely is not important.

```
adoptions_expanded_intake%>%
  filter(cat==1|dog==1)%>%
  group_by(animal_type)%>%
  summarise(normal=mean(normal_intake))%>%
  ggplot(aes(x=animal_type, y=normal))+
  geom_bar(stat="identity")
```




```
adoptions_expanded_intake%>%
  filter(cat==1|dog==1)%>%
  group_by(animal_type)%>%
  summarise(normal=mean(normal_intake))
```

```
## # A tibble: 2 x 2
##   animal_type  normal
##   <chr>         <dbl>
## 1 CAT         0.00194
## 2 DOG         0.00206
```