

# Knitr

## *Introduction to R for Public Health Researchers*

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The three “back ticks” (‘) must be followed by curly brackets “{”, and then “r” to tell the computer that you are using R code. This line is then closed off by another curly bracket “}”.

Anything before three more back ticks “```” are then considered R code (a script).

If any code in the document has just a backtick ‘ then nothing, then another backtick, then that word is just printed as if it were code, such as `hey`.

I’m reading in the bike lanes here.

```
# readin is just a "label" for this code chunk
## code chunk is just a "chunk" of code, where this code usually
## does just one thing, aka a module
### comments are still # here
### you can do all your reading in there
### let's say we loaded some packages
library(stringr)
library(dplyr)
library(tidyr)
fname <- "http://www.aejaffe.com/summerR_2016/data/Bike_Lanes.csv"
bike = read.csv(fname, as.is = TRUE)
```

You can write your introduction here.

### Introduction

Bike lanes are in Baltimore. People like them. Why are they so long?

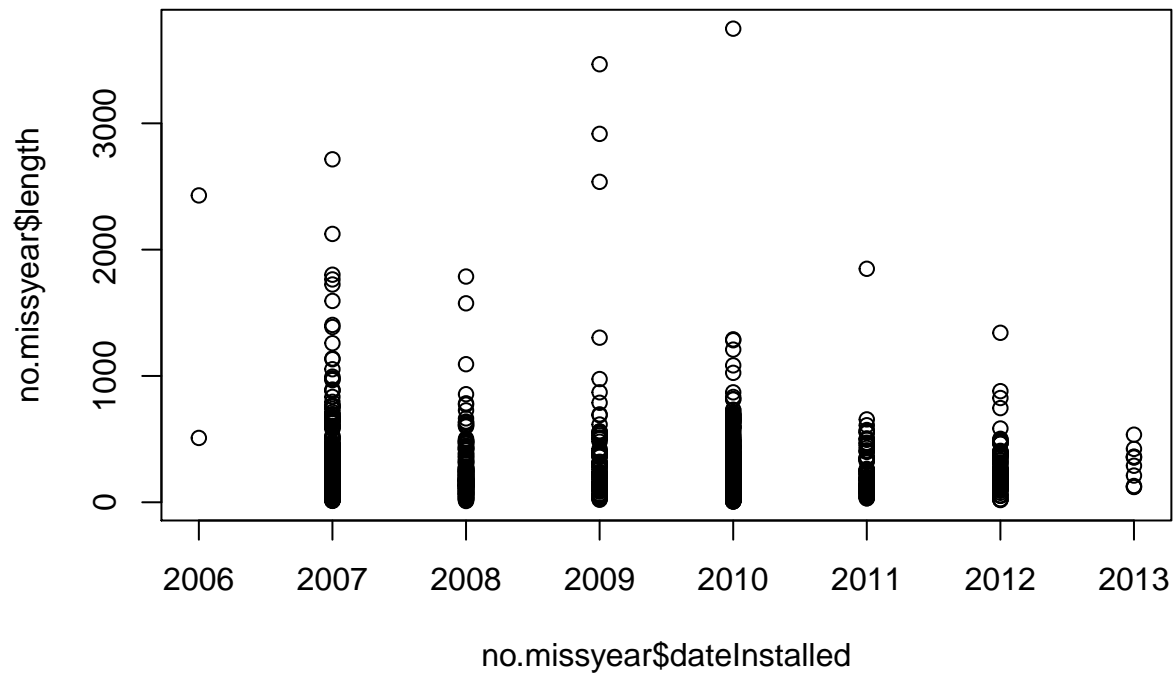
### Exploratory Analysis

Let’s look at some plots of bike length. Let’s say we wanted to look at what affects bike length.

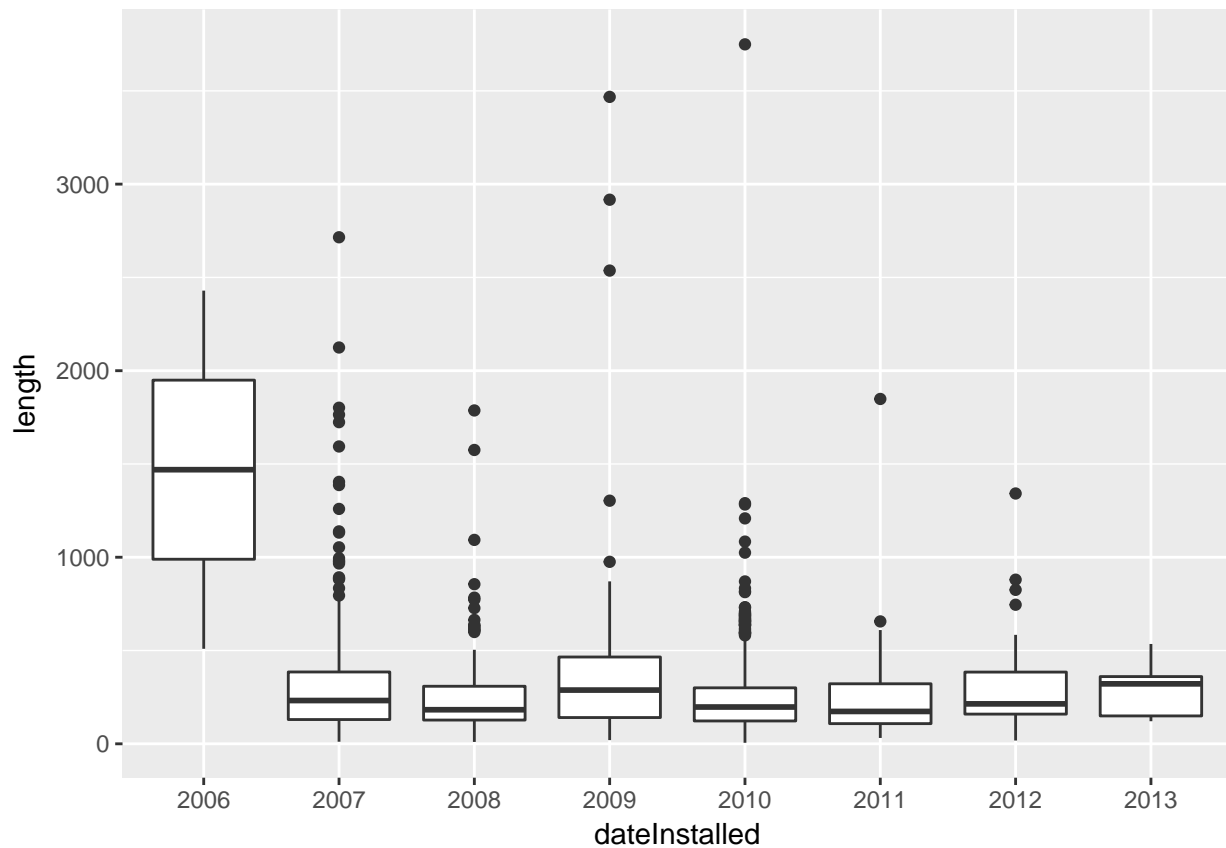
#### Plots of bike length

Note we made the subsection by using three “hashes” (pound signs): `###`.

We can turn off R code output by using `echo = FALSE` on the knitr code chunks.



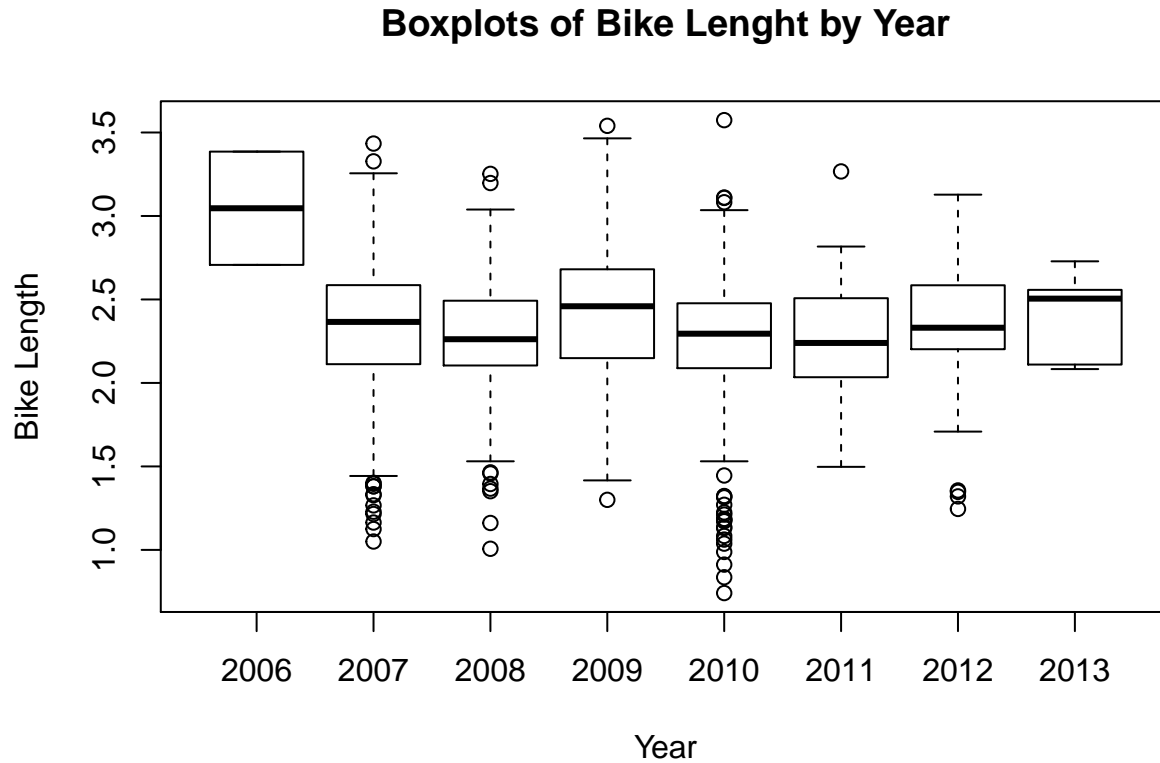
```
no.missyear = no.missyear %>% mutate(dateInstalled = factor(dateInstalled))
library(ggplot2)
gbox = no.missyear %>% ggplot(aes(x = dateInstalled, y = length)) + geom_boxplot()
print(gbox)
```



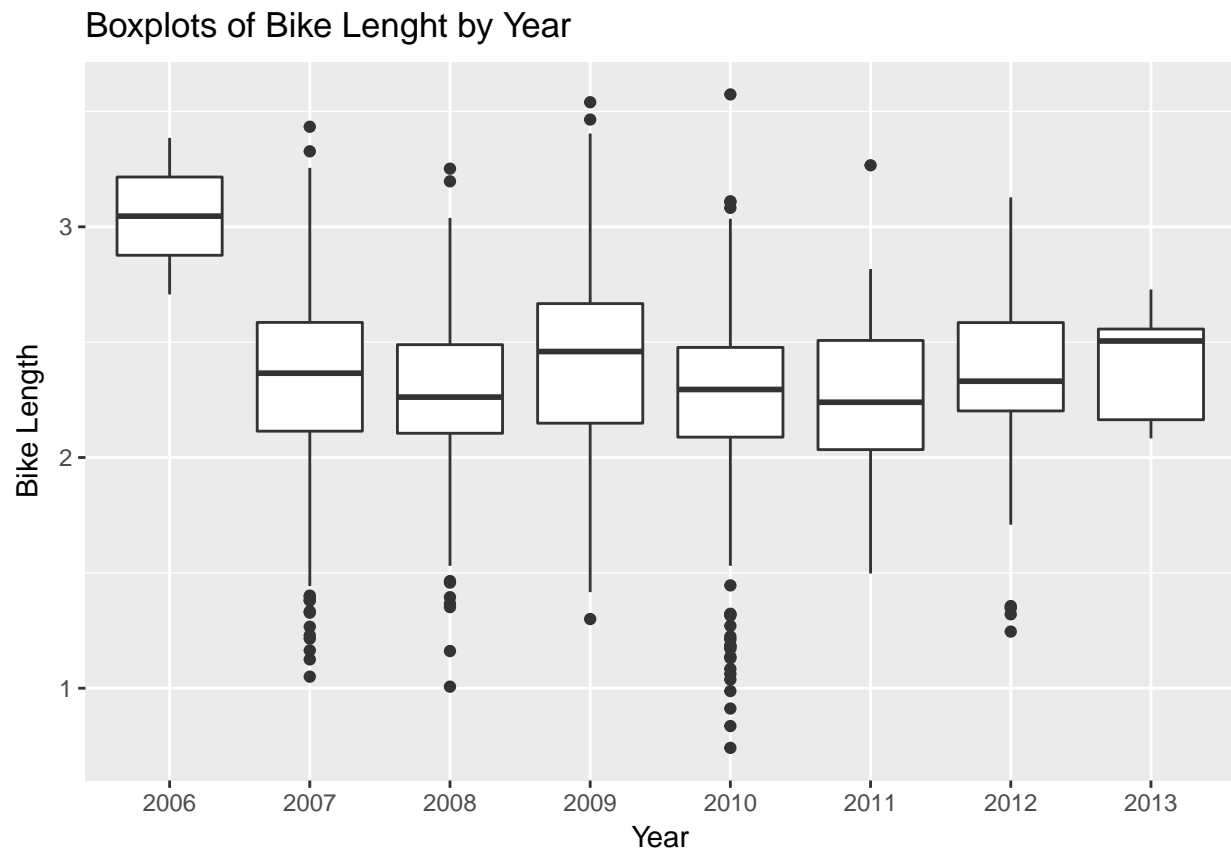
We have a total of 1505 rows.

What does it look like if we took the log (base 10) of the bike length:

```
no.missyear <- no.missyear %>% mutate(log.length = log10(length))  
### see here that if you specify the data argument, you don't need to do the $  
boxplot(log.length ~ dateInstalled, data = no.missyear,  
        main = "Boxplots of Bike Lenght by Year",  
        xlab="Year",  
        ylab="Bike Length")
```



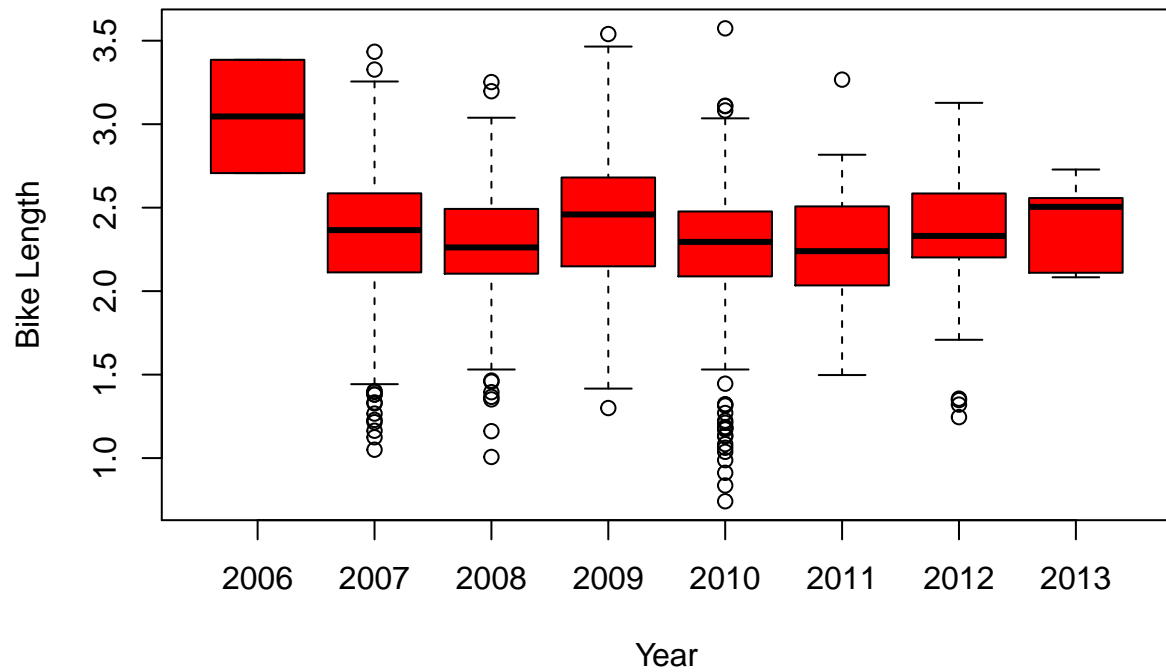
```
glogbox = no.missyear %>% ggplot(aes(x = dateInstalled, y = log.length)) + geom_boxplot() +  
  ggtitle("Boxplots of Bike Lenght by Year") +  
  xlab("Year") +  
  ylab("Bike Length")  
print(glogbox)
```



I want my boxplots colored, so I set the `col` argument.

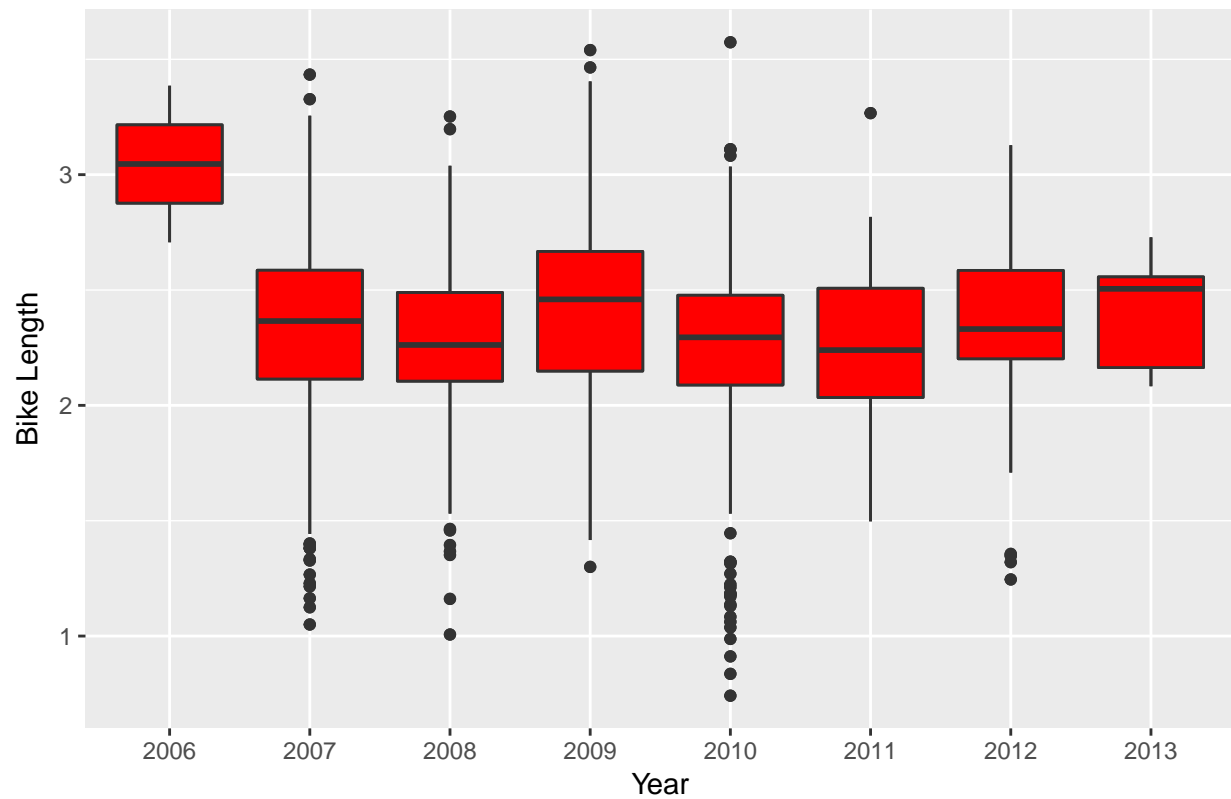
```
boxplot(log.length ~ dateInstalled,  
        data=no.missyear,  
        main="Boxplots of Bike Lenght by Year",  
        xlab="Year",  
        ylab="Bike Length",  
        col="red")
```

### Boxplots of Bike Lenght by Year



```
glogbox + geom_boxplot(fill = "red")
```

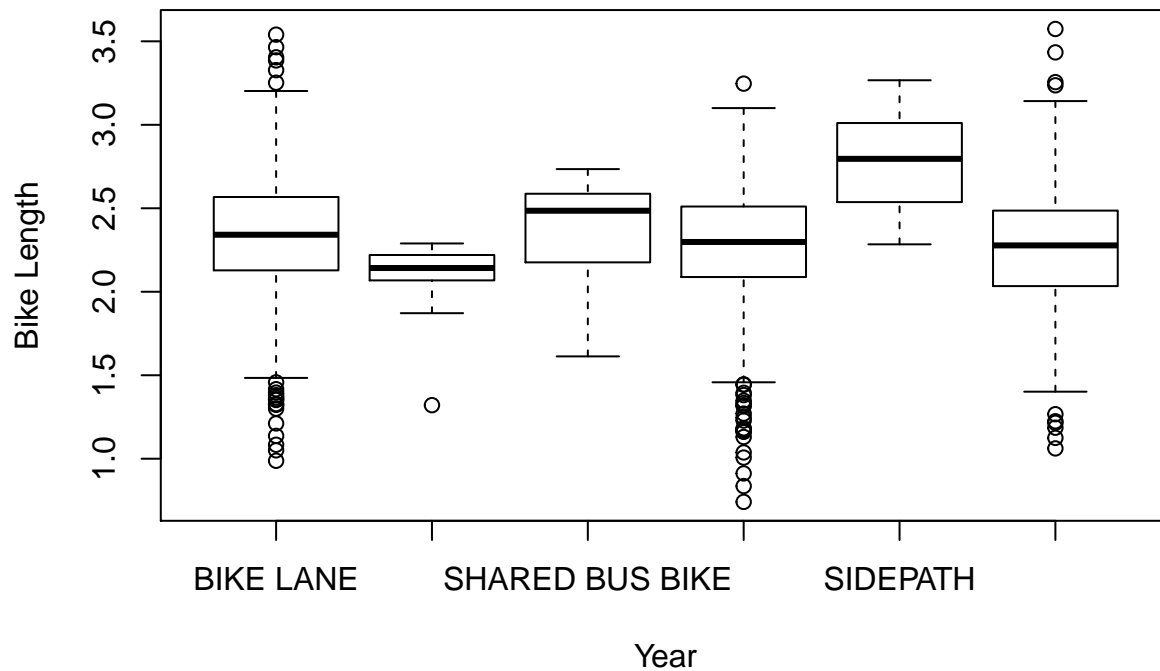
### Boxplots of Bike Lenght by Year



As we can see, 2006 had a much higher bike length. What about for the type of bike path?

```
### type is a character, but when R sees a "character" in a "formula", then it automatically converts it to a factor
### a formula is something that has a y ~ x, which says I want to plot y against x
### or if it were a model you would do y ~ x, which meant regress against y
boxplot(log.length ~ type, data=no.missyear, main="Boxplots of Bike Length by Year", xlab="Year", ylab="Bike Length")
```

## Boxplots of Bike Length by Year

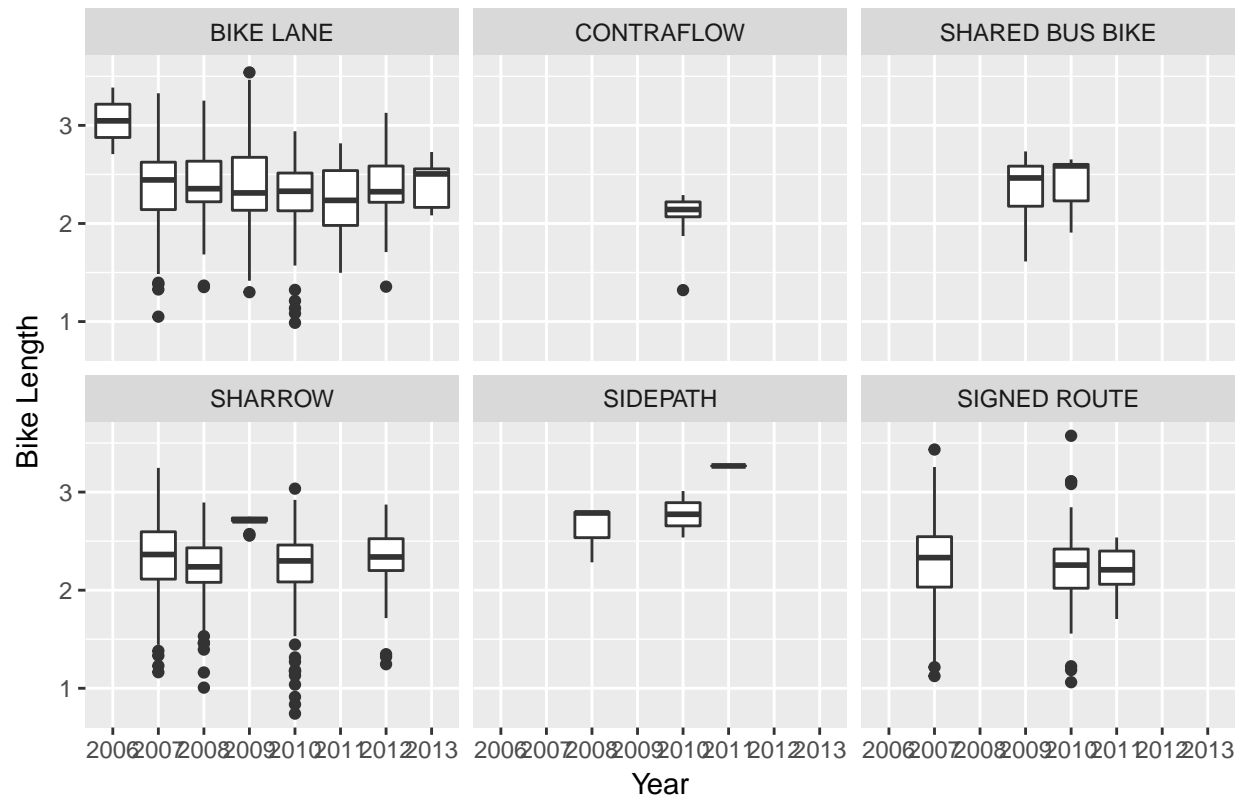


## Multiple Facets

We can do the plot with different panels for each type.

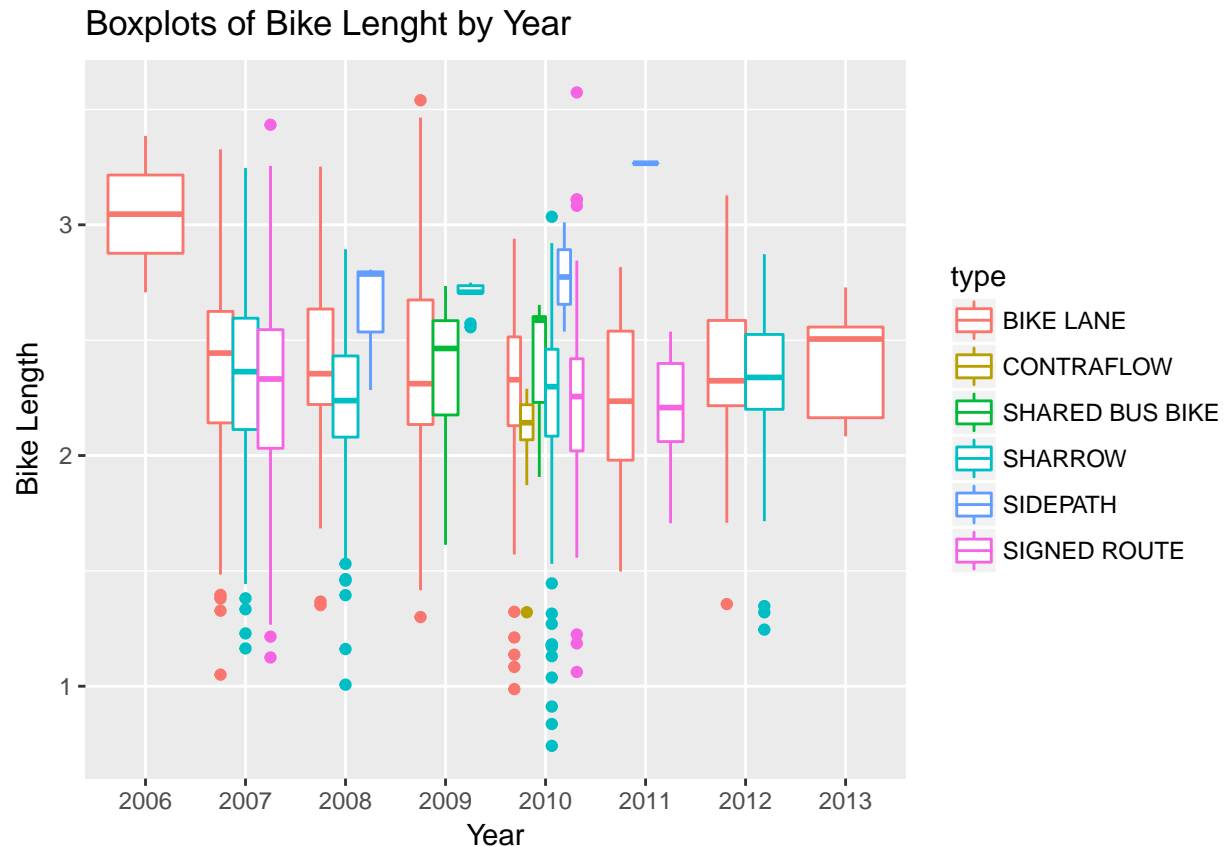
```
glogbox + facet_wrap(~ type)
```

Boxplots of Bike Length by Year



NOTE, this is different than if we colored on type:

```
glogbox + aes(colour = type)
```



### Means by type

What if we want to extract means by each type?

Let's show a few ways:

```
no.missyear %>% group_by(type) %>%
  dplyr::summarise(mean = mean(log.length))
```

```
## # A tibble: 6 × 2
##       type      mean
##   <chr>    <dbl>
## 1 BIKE LANE 2.330611
## 2 CONTRAFLOW 2.087246
## 3 SHARED BUS BIKE 2.363005
## 4 SHARROW 2.256425
## 5 SIDEPATH 2.781829
## 6 SIGNED ROUTE 2.263746
```

Let's show a what if we wanted to go over type and dateInstalled:

```
no.missyear %>% group_by(type, dateInstalled) %>%
  dplyr::summarise(mean = mean(log.length),
    median = median(log.length),
    Std.Dev = sd(log.length))
```

```
## Source: local data frame [22 x 5]
## Groups: type [?]
```



```
##
##           type dateInstalled      mean  median  Std.Dev
##           <chr>         <fctr>    <dbl>   <dbl>   <dbl>
## 1      BIKE LANE          2006 3.046261 3.046261 0.4797354
## 2      BIKE LANE          2007 2.351256 2.444042 0.4066225
## 3      BIKE LANE          2008 2.365728 2.354641 0.3891624
## 4      BIKE LANE          2009 2.381418 2.311393 0.4944744
## 5      BIKE LANE          2010 2.306994 2.328486 0.3207591
## 6      BIKE LANE          2011 2.242132 2.235462 0.3339777
## 7      BIKE LANE          2012 2.361510 2.323863 0.2852810
## 8      BIKE LANE          2013 2.408306 2.505012 0.2404060
## 9      CONTRAFLOW        2010 2.087246 2.142250 0.2565511
## 10 SHARED BUS BIKE       2009 2.350759 2.463997 0.3060951
## # ... with 12 more rows
```

## Linear Models

OK let's do some linear model

```
#### type is a character, but when R sees a "character" in a "formula", then it automatically converts it
#### a formula is something that has a y ~ x, which says I want to plot y against x
#### or if it were a model you would do y ~ x, which meant regress against y
mod.type = lm(log.length ~ type, data = no.missyear)
mod.yr = lm(log.length ~ factor(dateInstalled), data = no.missyear)
mod.yrtype = lm(log.length ~ type + factor(dateInstalled), data = no.missyear)
summary(mod.type)
```

```
##
## Call:
## lm(formula = log.length ~ type, data = no.missyear)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -1.51498 -0.19062  0.02915  0.23220  1.31021
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept)    2.33061    0.01487 156.703 < 2e-16 ***
## typeCONTRAFLOW -0.24337    0.10288  -2.366 0.018127 *
## typeSHARED BUS BIKE  0.03239    0.06062   0.534 0.593194
## typeSHARROW      -0.07419    0.02129  -3.484 0.000509 ***
## typeSIDEPATH     0.45122    0.15058   2.997 0.002775 **
## typeSIGNED ROUTE  -0.06687    0.02726  -2.453 0.014300 *
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.367 on 1499 degrees of freedom
## Multiple R-squared:  0.01956,    Adjusted R-squared:  0.01629
## F-statistic:  5.98 on 5 and 1499 DF,  p-value: 1.74e-05
```

That's rather UGLY, so let's use a package called `pander` and then make this model into an `pander` object and then print it out nicely.

## Grabbing coefficients

We can use the `coef` function on a summary, or do `smod$coef` to get the coefficients. But they are in a matrix:

```
smod = summary(mod.type)
coef(smod)

##              Estimate Std. Error    t value    Pr(>|t|)
## (Intercept)    2.33061129 0.01487281 156.7027729 0.0000000000
## typeCONTRAFLOW -0.24336564 0.10287662  -2.3656069 0.0181272020
## typeSHARED BUS BIKE 0.03239334 0.06062453   0.5343274 0.5931943055
## typeSHARROW    -0.07418617 0.02129463  -3.4837969 0.0005085795
## typeSIDEPATH    0.45121749 0.15057577   2.9966142 0.0027748128
## typeSIGNED ROUTE -0.06686556 0.02726421  -2.4525034 0.0142999055

class(coef(smod))

## [1] "matrix"
```

## Broom package

The broom package can “tidy” up the output to actually put the terms into a column of a data.frame that you can grab values from:

```
library(broom)
smod2 = tidy(mod.type)
class(smod2)

## [1] "data.frame"

better = smod2 %>% mutate(term = str_replace(term, "^type", ""))
better

##           term      estimate std.error  statistic    p.value
## 1 (Intercept)  2.33061129 0.01487281 156.7027729 0.0000000000
## 2 CONTRAFLOW -0.24336564 0.10287662  -2.3656069 0.0181272020
## 3 SHARED BUS BIKE 0.03239334 0.06062453   0.5343274 0.5931943055
## 4 SHARROW    -0.07418617 0.02129463  -3.4837969 0.0005085795
## 5 SIDEPATH    0.45121749 0.15057577   2.9966142 0.0027748128
## 6 SIGNED ROUTE -0.06686556 0.02726421  -2.4525034 0.0142999055

better %>% filter(term == "SIDEPATH")

##           term estimate std.error statistic    p.value
## 1 SIDEPATH 0.4512175 0.1505758  2.996614 0.002774813

write.csv(better, file = "Best_Model_Coefficients.csv")
```

BUT I NEEEEEEED an XLSX! The `xlsx` package can do it, but I still tend to use CSVs.

```
library(xlsx)
write.xlsx(better, file = "Best_Model_Coefficients.xlsx")
```

## Testing Nested Models

The `anova` command will test nested models and give you a table of results:

```
my_lrtest = anova(mod.yrtype, mod.yr)
print(my_lrtest)

## Analysis of Variance Table
##
## Model 1: log.length ~ type + factor(dateInstalled)
## Model 2: log.length ~ factor(dateInstalled)
##   Res.Df    RSS Df Sum of Sq    F    Pr(>F)
## 1    1492 199.10
## 2    1497 202.47 -5    -3.3681 5.048 0.000136 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

print(tidy(my_lrtest))
```

```
##   res.df    rss df    sumsq statistic    p.value
## 1    1492 199.0977 NA        NA        NA        NA
## 2    1497 202.4658 -5 -3.368136  5.048034 0.0001360178
```

Similarly with year:

```
my_lrtest = anova(mod.yrtype, mod.type)
print(tidy(my_lrtest))
```

```
##   res.df    rss df    sumsq statistic    p.value
## 1    1492 199.0977 NA        NA        NA        NA
## 2    1499 201.9321 -7 -2.834384  3.034333 0.003588298
```

ASIDE: the aov function fits what you think of when you think ANOVA.

## Pander

Pander can output tables (as well as other things such as models), so let's print this using the `pander` command from the `pander` package. So `pander` is really good when you are trying to print out a table (in html, otherwise make the table and use `write.csv` to get it in Excel and then format) really quickly and in a report.

```
# devtools::install_github('Rapporter/pander') # need this version!
library(pander)
pander(mod.yr)
```

Table 1: Fitting linear model: `log.length ~ factor(dateInstalled)`

	Estimate	Std. Error	t value	Pr(> t )
(Intercept)	3.046	0.26	11.71	2.181e-30
factor(dateInstalled)2007	-0.7332	0.2608	-2.812	0.004987
factor(dateInstalled)2008	-0.7808	0.2613	-2.988	0.002852
factor(dateInstalled)2009	-0.6394	0.2631	-2.431	0.01518
factor(dateInstalled)2010	-0.7791	0.2605	-2.991	0.002825
factor(dateInstalled)2011	-0.8022	0.2626	-3.055	0.002292
factor(dateInstalled)2012	-0.7152	0.2625	-2.725	0.006509
factor(dateInstalled)2013	-0.638	0.2849	-2.239	0.02527

It is the same if we write out the summary, but more information is in the **footer**.

```
pander(summary(mod.yr))
```

	Estimate	Std. Error	t value	Pr(> t )
(Intercept)	3.046	0.26	11.71	2.181e-30
factor(dateInstalled)2007	-0.7332	0.2608	-2.812	0.004987
factor(dateInstalled)2008	-0.7808	0.2613	-2.988	0.002852
factor(dateInstalled)2009	-0.6394	0.2631	-2.431	0.01518
factor(dateInstalled)2010	-0.7791	0.2605	-2.991	0.002825
factor(dateInstalled)2011	-0.8022	0.2626	-3.055	0.002292
factor(dateInstalled)2012	-0.7152	0.2625	-2.725	0.006509
factor(dateInstalled)2013	-0.638	0.2849	-2.239	0.02527

Table 3: Fitting linear model:  $\log(\text{length}) \sim \text{factor}(\text{dateInstalled})$

Observations	Residual Std. Error	$R^2$	Adjusted $R^2$
1505	0.3678	0.01697	0.01237

## Formatting

Let's format the rows and the column names a bit better:

## Changing the terms

```
phtable = tidy(mod.yr)
phtable$term = phtable$term %>%
  str_replace(fixed("factor(dateInstalled)"), "") %>%
  str_replace(fixed("(Intercept)"), "Intercept")
```

## Column Names

Now we can reset the column names if we didn't like them before:

```
colnames(phtable) = c("Variable", "Beta", "SE", "tstatistic", "p.value")
pander(phtable)
```

Variable	Beta	SE	tstatistic	p.value
Intercept	3.046	0.26	11.71	2.181e-30
2007	-0.7332	0.2608	-2.812	0.004987
2008	-0.7808	0.2613	-2.988	0.002852
2009	-0.6394	0.2631	-2.431	0.01518
2010	-0.7791	0.2605	-2.991	0.002825
2011	-0.8022	0.2626	-3.055	0.002292
2012	-0.7152	0.2625	-2.725	0.006509
2013	-0.638	0.2849	-2.239	0.02527

## Confidence Intervals

Let's say we want the beta, the 95% CI. We can use `confint` on the model, `merge` it to `phtable` and then

paste the columns together (after rounding) with a comma and bound them in parentheses.

```
cint = confint(mod.yr)
print(cint)
```

```
##              2.5 %      97.5 %
## (Intercept)      2.536168  3.55635353
## factor(dateInstalled)2007 -1.244725 -0.22177042
## factor(dateInstalled)2008 -1.293400 -0.26827336
## factor(dateInstalled)2009 -1.155435 -0.12345504
## factor(dateInstalled)2010 -1.289978 -0.26816090
## factor(dateInstalled)2011 -1.317344 -0.28710724
## factor(dateInstalled)2012 -1.229999 -0.20032262
## factor(dateInstalled)2013 -1.196733 -0.07917559
```

```
print(class(cint))
```

```
## [1] "matrix"
```

Tidying it up

```
cint = tidy(cint)
colnames(cint) = c("Variable", "lower", "upper")
cint$Variable = cint$Variable %>%
  str_replace(fixed("factor(dateInstalled)"), "") %>%
  str_replace(fixed("(Intercept)"), "Intercept")
ptable = left_join(ptable, cint, by = "Variable")
ptable = ptable %>% mutate(lower = round(lower, 2),
                          upper = round(upper, 2),
                          Beta = round(Beta, 2),
                          p.value = ifelse(p.value < 0.01, "< 0.01",
                                           round(p.value, 2)))
ptable = ptable %>% mutate(ci = paste0("(", lower, ", ", upper, ")"))
ptable = dplyr::select(ptable, Beta, ci, p.value)
pander(ptable)
```

Beta	ci	p.value
3.05	(2.54, 2.54)	< 0.01
-0.73	(-1.24, -1.24)	< 0.01
-0.78	(-1.29, -1.29)	< 0.01
-0.64	(-1.16, -1.16)	0.02
-0.78	(-1.29, -1.29)	< 0.01
-0.8	(-1.32, -1.32)	< 0.01
-0.72	(-1.23, -1.23)	< 0.01
-0.64	(-1.2, -1.2)	0.03

## Multiple Models

OK, that's pretty good, but let's say we have all three models. You can't put doesn't work so well with *many* models together.

```
# pander(mod.yr, mod.yrtype) does not work
# pander(list(mod.yr, mod.yrtype)) # will give 2 separate tables
```

If we use the `memisc` package, we can combine the models:

```

library(memisc)
mtab_all <- mtable("Model Year" = mod.yr,
                  "Model Type" = mod.type,
                  "Model Both" = mod.yrtype,
                  summary.stats = c("sigma", "R-squared", "F", "p", "N"))
print(mtab_all)

##
## Calls:
## Model Year: lm(formula = log.length ~ factor(dateInstalled), data = no.missyear)
## Model Type: lm(formula = log.length ~ type, data = no.missyear)
## Model Both: lm(formula = log.length ~ type + factor(dateInstalled), data = no.missyear)
##
## =====
##               Model Year  Model Type  Model Both
## -----
## (Intercept)          3.046***    2.331***    3.046***
##                   (0.260)    (0.015)    (0.258)
## factor(dateInstalled): 2007/2006 -0.733**          -0.690**
##                   (0.261)          (0.259)
## factor(dateInstalled): 2008/2006 -0.781**          -0.742**
##                   (0.261)          (0.260)
## factor(dateInstalled): 2009/2006 -0.639*          -0.619*
##                   (0.263)          (0.262)
## factor(dateInstalled): 2010/2006 -0.779**          -0.736**
##                   (0.260)          (0.259)
## factor(dateInstalled): 2011/2006 -0.802**          -0.790**
##                   (0.263)          (0.261)
## factor(dateInstalled): 2012/2006 -0.715**          -0.700**
##                   (0.262)          (0.261)
## factor(dateInstalled): 2013/2006 -0.638*          -0.638*
##                   (0.285)          (0.283)
## type: CONTRAFLOW/BIKE LANE          -0.243*    -0.224*
##                   (0.103)    (0.103)
## type: SHARED BUS BIKE/BIKE LANE          0.032    -0.037
##                   (0.061)    (0.069)
## type: SHARROW/BIKE LANE          -0.074***    -0.064**
##                   (0.021)    (0.023)
## type: SIDEPATH/BIKE LANE          0.451**    0.483**
##                   (0.151)    (0.150)
## type: SIGNED ROUTE/BIKE LANE          -0.067*    -0.067*
##                   (0.027)    (0.029)
## -----
## sigma                0.4          0.4          0.4
## R-squared             0.0          0.0          0.0
## F                    3.7          6.0          4.3
## p                    0.0          0.0          0.0
## N                    1505         1505         1505
## =====

```

If you want to write it out (for Excel), it is tab delimited:

```
write.mtable(mtab_all, file = "my_tab.txt")
```

```
pander(mtab_all)
```

	Model Year	Model Type	Model Both
(Intercept)	3.046*** (0.260)	2.331*** (0.015)	3.046*** (0.258)
factor(dateInstalled): 2007/2006	-0.733** (0.261)		-0.690** (0.259)
factor(dateInstalled): 2008/2006	-0.781** (0.261)		-0.742** (0.260)
factor(dateInstalled): 2009/2006	-0.639* (0.263)		-0.619* (0.262)
factor(dateInstalled): 2010/2006	-0.779** (0.260)		-0.736** (0.259)
factor(dateInstalled): 2011/2006	-0.802** (0.263)		-0.790** (0.261)
factor(dateInstalled): 2012/2006	-0.715** (0.262)		-0.700** (0.261)
factor(dateInstalled): 2013/2006	-0.638* (0.285)		-0.638* (0.283)
type: CONTRAFLOW/BIKE LANE		-0.243* (0.103)	-0.224* (0.103)
type: SHARED BUS BIKE/BIKE LANE		0.032 (0.061)	-0.037 (0.069)
type: SHARROW/BIKE LANE		-0.074*** (0.021)	-0.064** (0.023)
type: SIDEPATH/BIKE LANE		0.451** (0.151)	0.483** (0.150)
type: SIGNED ROUTE/BIKE LANE		-0.067* (0.027)	-0.067* (0.029)
sigma	0.4	0.4	0.4
R-squared	0.0	0.0	0.0
F	3.7	6.0	4.3
p	0.0	0.0	0.0
N	1505	1505	1505

Not covered - making mtable better:

```
renamer = function(model) {
  names(model$coefficients) = names(model$coefficients) %>%
    str_replace(fixed("factor(dateInstalled)"), "") %>%
    str_replace(fixed("(Intercept)"), "Intercept")
  names(model$contrasts) = names(model$contrasts) %>%
    str_replace(fixed("factor(dateInstalled)"), "") %>%
    str_replace(fixed("(Intercept)"), "Intercept")
  return(model)
}
mod.yr = renamer(mod.yr)
mod.yrtype = renamer(mod.yrtype)
mod.type = renamer(mod.type)

mtab_all_better <- mtable("Model Year" = mod.yr,
```

```

    "Model Type" = mod.type,
    "Model Both" = mod.yrtype,
    summary.stats = c("sigma", "R-squared", "F", "p", "N"))
pander(mtab_all_better)

```

	Model Year	Model Type	Model Both
<b>Intercept</b>	3.046*** (0.260)	2.331*** (0.015)	3.046*** (0.258)
<b>2007</b>	-0.733** (0.261)		-0.690** (0.259)
<b>2008</b>	-0.781** (0.261)		-0.742** (0.260)
<b>2009</b>	-0.639* (0.263)		-0.619* (0.262)
<b>2010</b>	-0.779** (0.260)		-0.736** (0.259)
<b>2011</b>	-0.802** (0.263)		-0.790** (0.261)
<b>2012</b>	-0.715** (0.262)		-0.700** (0.261)
<b>2013</b>	-0.638* (0.285)		-0.638* (0.283)
<b>type: CONTRAFLOW/BIKE LANE</b>		-0.243* (0.103)	-0.224* (0.103)
<b>type: SHARED BUS BIKE/BIKE LANE</b>		0.032 (0.061)	-0.037 (0.069)
<b>type: SHARROW/BIKE LANE</b>		-0.074*** (0.021)	-0.064** (0.023)
<b>type: SIDEPATH/BIKE LANE</b>		0.451** (0.151)	0.483** (0.150)
<b>type: SIGNED ROUTE/BIKE LANE</b>		-0.067* (0.027)	-0.067* (0.029)
<b>sigma</b>	0.4	0.4	0.4
<b>R-squared</b>	0.0	0.0	0.0
<b>F</b>	3.7	6.0	4.3
<b>p</b>	0.0	0.0	0.0
<b>N</b>	1505	1505	1505

Another package called `stargazer` can put models together easily and print them out. So let's use `stargazer`. Again, you need to use `install.packages("stargazer")` if you don't have function.

```
require(stargazer)
```

OK, so what's the difference here? First off, we said results are "markup", so that it will not try to reformat the output. Also, I didn't want those # for comments, so I just made comment an empty string "".

```
stargazer(mod.yr, mod.type, mod.yrtype, type = "text")
```

```

=====
Dependent variable:
-----
(1)                                log.length                                (3)

```



2007	-0.733*** (0.261)		-0.690*** (0.259)
2008	-0.781*** (0.261)		-0.742*** (0.260)
2009	-0.639** (0.263)		-0.619** (0.262)
2010	-0.779*** (0.260)		-0.736*** (0.259)
2011	-0.802*** (0.263)		-0.790*** (0.261)
2012	-0.715*** (0.262)		-0.700*** (0.261)
2013	-0.638** (0.285)		-0.638** (0.283)
typeCONTRAFLOW		-0.243** (0.103)	-0.224** (0.103)
typeSHARED BUS BIKE		0.032 (0.061)	-0.037 (0.069)
typeSHARROW		-0.074*** (0.021)	-0.064*** (0.023)
typeSIDEPATH		0.451*** (0.151)	0.483*** (0.150)
typeSIGNED ROUTE		-0.067** (0.027)	-0.067** (0.029)
Constant	3.046*** (0.260)	2.331*** (0.015)	3.046*** (0.258)
Observations	1,505	1,505	1,505
R2	0.017	0.020	0.033
Adjusted R2	0.012	0.016	0.026
Residual Std. Error	0.368 (df = 1497)	0.367 (df = 1499)	0.365 (df = 1492)
F Statistic	3.691*** (df = 7; 1497)	5.980*** (df = 5; 1499)	4.285*** (df = 12; 1492)

Note:

\*p<0.1; \*\*p<0.05; \*\*\*p<0.01

If we use

```
stargazer(mod.yr, mod.type, mod.yrtype, type="html")
```

Dependent variable:

log.length

(1)  
 (2)  
 (3)  
 2007  
 -0.733\*\*\*  
 -0.690\*\*\*  
 (0.261)  
 (0.259)  
 2008  
 -0.781\*\*\*  
 -0.742\*\*\*  
 (0.261)  
 (0.260)  
 2009  
 -0.639\*\*  
 -0.619\*\*  
 (0.263)  
 (0.262)  
 2010  
 -0.779\*\*\*  
 -0.736\*\*\*  
 (0.260)  
 (0.259)  
 2011  
 -0.802\*\*\*  
 -0.790\*\*\*  
 (0.263)  
 (0.261)  
 2012  
 -0.715\*\*\*  
 -0.700\*\*\*  
 (0.262)  
 (0.261)  
 2013  
 -0.638\*\*  
 -0.638\*\*

	(0.285)
	(0.283)
typeCONTRAFLOW	
	-0.243**
	-0.224**
	(0.103)
	(0.103)
typeSHARED BUS BIKE	
	0.032
	-0.037
	(0.061)
	(0.069)
typeSHARROW	
	-0.074***
	-0.064***
	(0.021)
	(0.023)
typeSIDEPATH	
	0.451***
	0.483***
	(0.151)
	(0.150)
typeSIGNED ROUTE	
	-0.067**
	-0.067**
	(0.027)
	(0.029)
Constant	
	3.046***
	2.331***
	3.046***
	(0.260)
	(0.015)
	(0.258)
Observations	
	1,505

```

1,505
1,505
R2
0.017
0.020
0.033
Adjusted R2
0.012
0.016
0.026
Residual Std. Error
0.368 (df = 1497)
0.367 (df = 1499)
0.365 (df = 1492)
F Statistic
3.691*** (df = 7; 1497)
5.980*** (df = 5; 1499)
4.285*** (df = 12; 1492)
Note:


$p < 0.1$ ;  $p < 0.05$ ;  $p < 0.01$


```

## Data Extraction

Let's say I want to get data INTO my text. Like there are N number of bike lanes with a date installed that isn't zero. There are 1505 bike lanes with a date installed after 2006. So you use one backtick ` and then you say "r" to tell that it's R code. And then you run R code that gets evaluated and then returns the value. Let's say you want to compute a bunch of things:

```

### let's get number of bike lanes installed by year
n.lanes = no.missyear %>% group_by(dateInstalled) %>% dplyr::summarize(n())
class(n.lanes)

```

```

## [1] "tbl_df"      "tbl"        "data.frame"

print(n.lanes)

```

```

## # A tibble: 8 × 2
##   dateInstalled `n()`
##       <fctr> <int>
## 1      2006      2
## 2      2007     368
## 3      2008     206
## 4      2009      86
## 5      2010     625
## 6      2011     101

```

```
## 7      2012    107
## 8      2013     10
```

```
n.lanes = as.data.frame(n.lanes)
print(n.lanes)
```

```
##   dateInstalled n()
## 1      2006      2
## 2      2007    368
## 3      2008    206
## 4      2009     86
## 5      2010    625
## 6      2011    101
## 7      2012    107
## 8      2013     10
```

```
colnames(n.lanes) <- c("date", "nlanes")
n2009 <- filter(n.lanes, date == 2009)
n2010 <- filter(n.lanes, date == 2010)
getwd()
```

```
## [1] "/Users/johnmuschelli/Dropbox/Teaching/winterR_2017/Knitr/lecture"
```

Now I can just say there are 2009, 86 lanes in 2009 and 2010, 625 in 2010.

```
fname <- "http://www.aejaffe.com/summerR_2016/data/Charm_City_Circulator_Ridership.csv"
## file.path takes a directory and makes a full name with a full file path
charm = read.csv(fname, as.is=TRUE)
```

```
library(chron)
days = levels(weekdays(1, abbreviate=FALSE))
charm$day <- factor(charm$day, levels=days)
charm$date <- as.Date(charm$date, format="%m/%d/%Y")
cn <- colnames(charm)
daily <- charm[, c("day", "date", "daily")]
```

```
charm$daily <- NULL
require(reshape)
long.charm <- melt(charm, id.vars = c("day", "date"))
long.charm$type <- "Boardings"
long.charm$type[ grepl("Alightings", long.charm$variable)] <- "Alightings"
long.charm$type[ grepl("Average", long.charm$variable)] <- "Average"
```

```
long.charm$line <- "orange"
long.charm$line[ grepl("purple", long.charm$variable)] <- "purple"
long.charm$line[ grepl("green", long.charm$variable)] <- "green"
long.charm$line[ grepl("banner", long.charm$variable)] <- "banner"
long.charm$variable <- NULL
```

```
long.charm$line <-factor(long.charm$line, levels=c("orange", "purple",
"green", "banner"))
```

```
head(long.charm)
```

```
##      day      date value      type  line
## 1  Monday 2010-01-11   877 Boardings orange
## 2  Tuesday 2010-01-12   777 Boardings orange
```

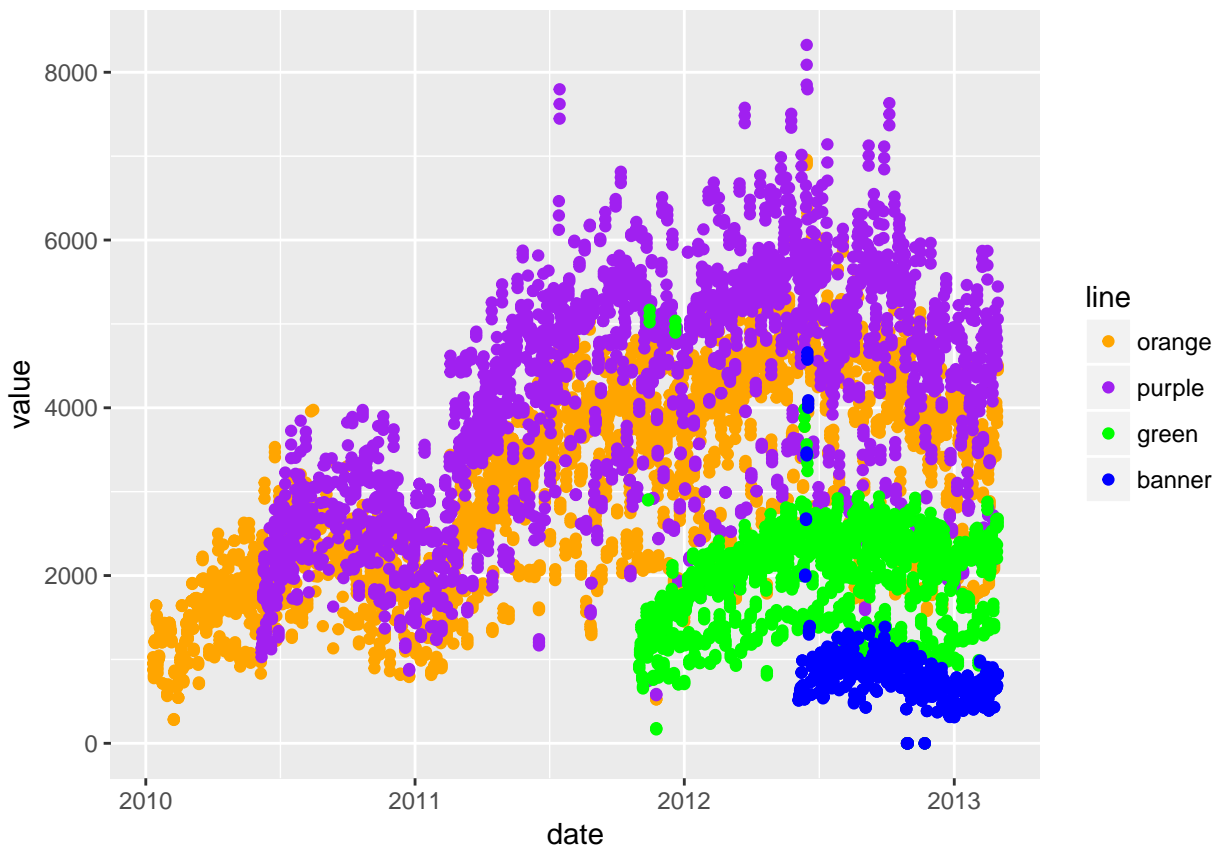
```
## 3 Wednesday 2010-01-13 1203 Boardings orange
## 4 Thursday 2010-01-14 1194 Boardings orange
## 5 Friday 2010-01-15 1645 Boardings orange
## 6 Saturday 2010-01-16 1457 Boardings orange

### NOW R has a column of day, the date, a "value", the type of value and the
### circulator line that corresponds to it
### value is now either the Alightings, Boardings, or Average from the charm dataset
```

Let's do some plotting now!

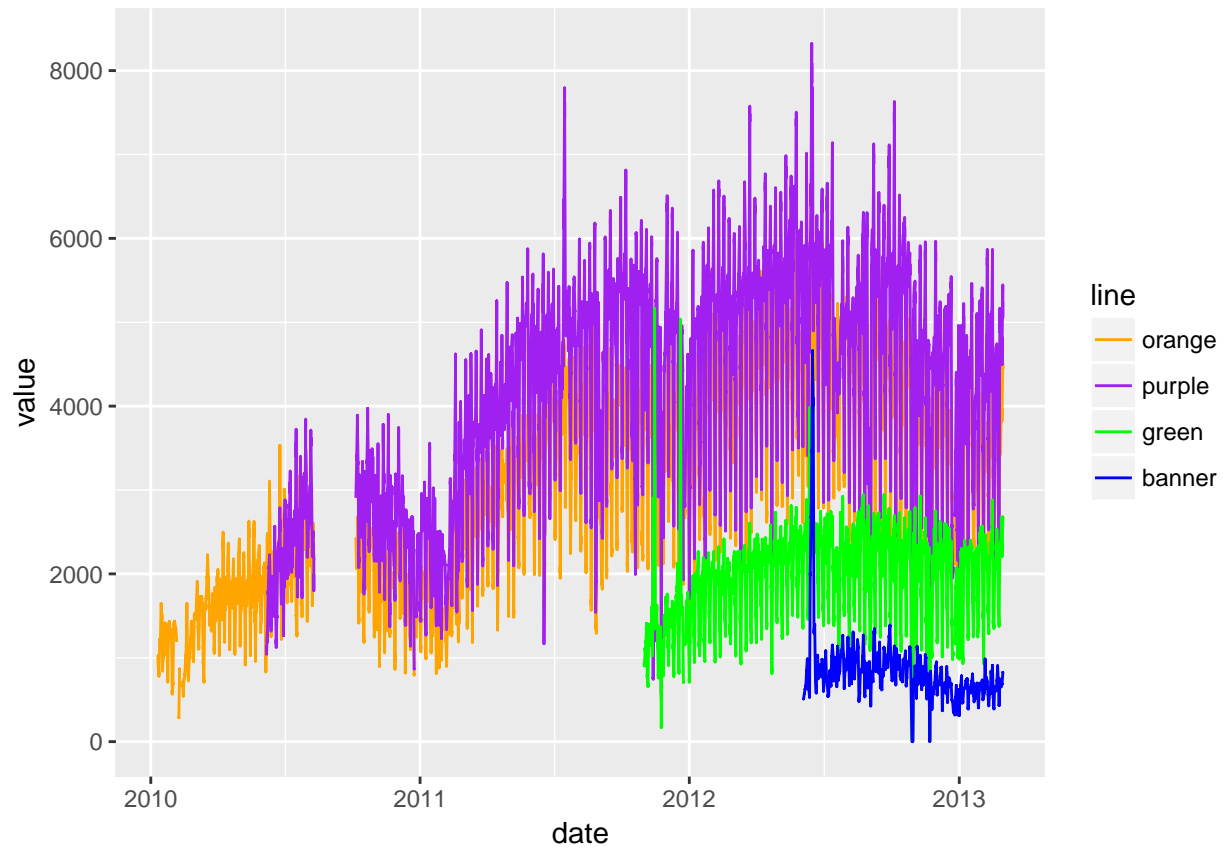
```
require(ggplot2)
### let's make a "ggplot"
### the format is ggplot(dataframe, aes(x=COLNAME, y=COLNAME))
### where COLNAME are colnames of the dataframe
### you can also set color to a different factor
### other options in AES (fill, alpha level -which is the "transparency" of points)
g <- ggplot(long.charm, aes(x=date, y=value, color=line))
### let's change the colors to what we want- doing this manually, not letting it choose
### for me
g <- g + scale_color_manual(values=c("orange", "purple", "green", "blue"))
### plotting points
g + geom_point()
```

```
## Warning: Removed 5328 rows containing missing values (geom_point).
```



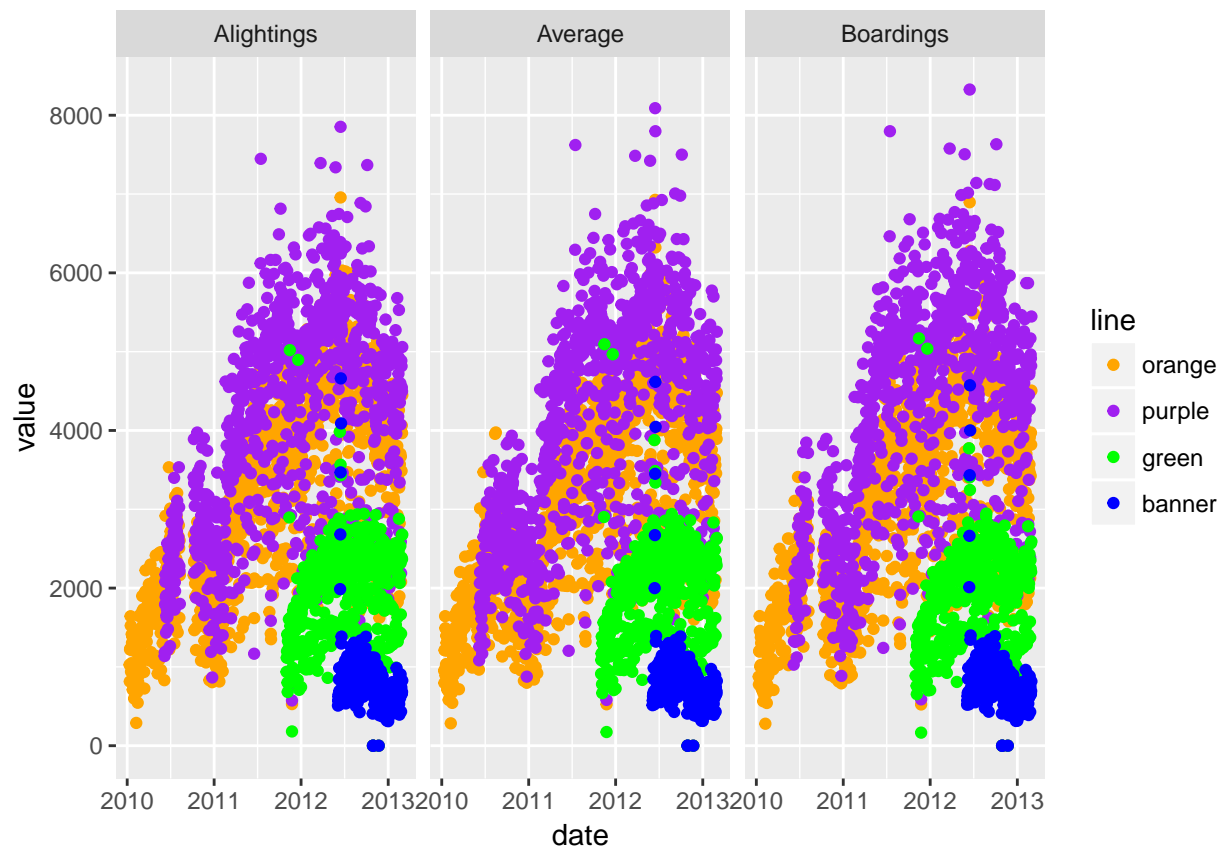
```
### Let's make Lines!
g + geom_line()
```

```
## Warning: Removed 5043 rows containing missing values (geom_path).
```



```
### let's make a new plot of poitns
gpoint <- g + geom_point()
### let's plot the value by the type of value - boardings/average, etc
gpoint + facet_wrap(~ type)
```

```
## Warning: Removed 5328 rows containing missing values (geom_point).
```



OK let's turn off some warnings - making `warning=FALSE` (in knitr) as an option.

```
## let's compare vertically
gpoint + facet_wrap(~ type, ncol=1)
```



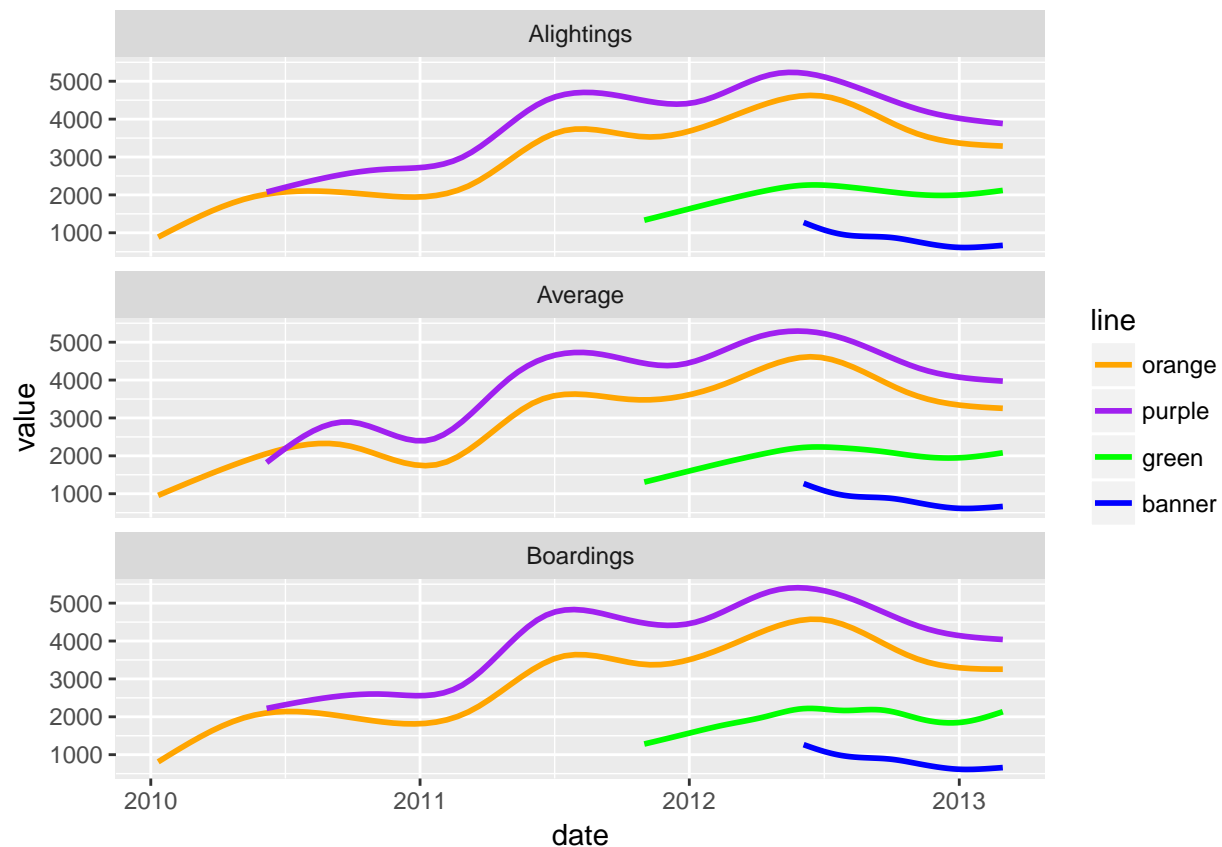


```
gfacet = g + facet_wrap(~ type, ncol=1)
```

We can also smooth the data to give us a overall idea of how the average changes over time. I don't want to do a standard error (se).

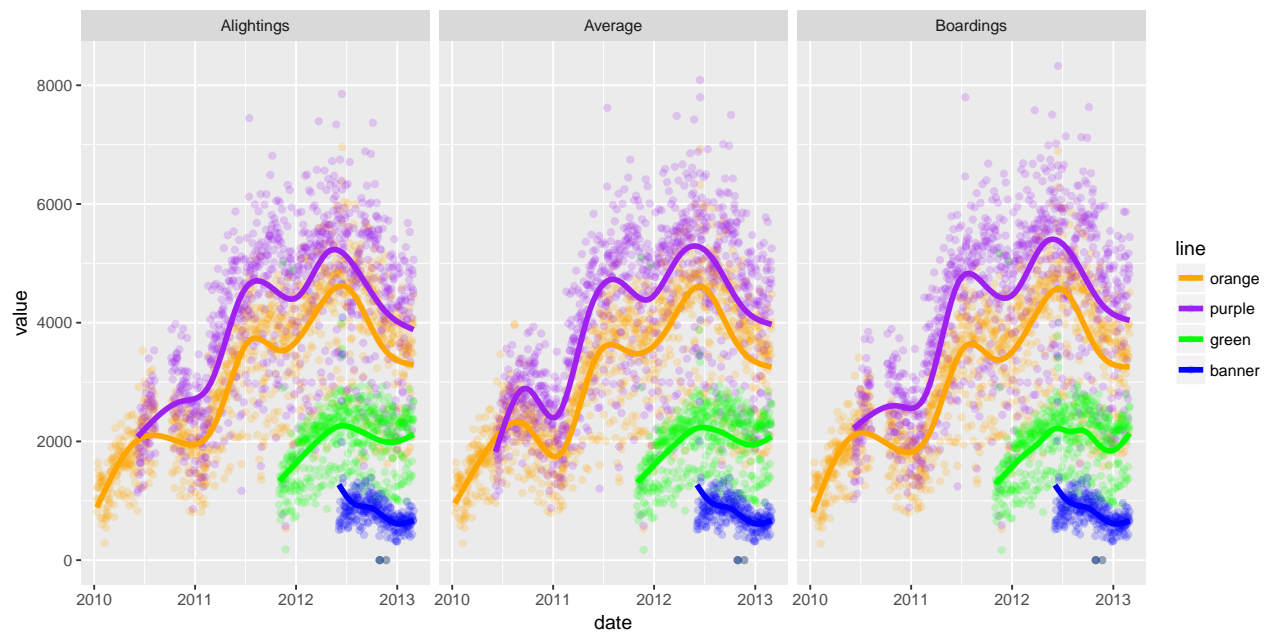
```
## let's smooth this - get a rough estimate of what's going on
gfacet + geom_smooth(se=FALSE)
```

```
## `geom_smooth()` using method = 'gam'
```



OK, I've seen enough code, let's turn that off, using `echo=FALSE`.

```
## `geom_smooth()` using method = 'gam'
```



There are still messages, but we can turn these off with `message = FALSE`

