Data wrangling

AVOCADO

Read and format data

Block and randomization experimental design. Three blocks and 12 subjects each

```r
da <- fread('avocado_blackness.csv')
dim(da)
```

```
## [1] 50 37
```

```r
head(da)
```

```
##    hue_index   Bc1   Bc6   Bc8   Bc9  Bc11  Bc12   Bt2  Bt3   Bt4   Bt5   Bt7
## 1:         0 23.71 45.27 43.63 41.31 37.85 52.14 36.47 40.1 49.59 35.40 44.60
## 2:         1 23.71 45.27 43.63 41.31 37.87 52.43 36.56 40.1 49.71 35.52 44.87
## 3:         2 23.71 45.27 43.63 41.31 37.87 52.43 36.56 40.1 49.71 35.52 44.87
## 4:         3 23.71 45.27 43.63 41.31 37.87 52.43 36.56 40.1 49.71 35.52 44.87
## 5:         4 23.71 45.27 43.63 41.31 37.87 52.43 36.56 40.1 49.71 35.52 44.87
## 6:         5 23.71 45.27 43.63 41.31 37.87 52.43 36.56 40.1 49.71 35.52 44.87
##     Bt10   Nt1 Nc2   Nt3   Nc4   Nc5   Nt6   Nc7   Nt8   Nc9  Nt10  Nc11  Nt12
## 1: 45.68 28.10  30 39.39 28.56 28.83 30.35 29.79 29.93 32.58 23.50 30.05 25.81
## 2: 45.72 28.11  30 39.39 28.56 28.83 30.36 29.79 29.94 32.58 23.51 30.09 25.81
## 3: 45.72 28.11  30 39.39 28.56 28.83 30.36 29.79 29.94 32.58 23.51 30.09 25.81
## 4: 45.72 28.11  30 39.39 28.56 28.83 30.36 29.79 29.94 32.58 23.51 30.09 25.81
## 5: 45.72 28.11  30 39.39 28.56 28.83 30.36 29.79 29.94 32.58 23.51 30.09 25.81
## 6: 45.72 28.11  30 39.39 28.56 28.83 30.36 29.79 29.94 32.58 23.51 30.09 25.81
##      Jt1   Jt4   Jt7   Jt8   Jt9  Jt11  Jc2   Jc3  Jc5   Jc6  Jc10  Jc12
## 1: 23.37 25.69 24.22 26.37 26.62 21.58 29.4 27.77 28.5 25.84 28.69 29.58
## 2: 23.38 25.69 24.22 26.38 26.62 21.59 29.4 27.77 28.5 25.84 28.69 29.58
## 3: 23.38 25.69 24.22 26.38 26.62 21.59 29.4 27.77 28.5 25.84 28.69 29.58
## 4: 23.38 25.69 24.22 26.38 26.62 21.59 29.4 27.77 28.5 25.84 28.69 29.58
## 5: 23.38 25.69 24.22 26.38 26.62 21.59 29.4 27.77 28.5 25.84 28.70 29.58
## 6: 23.38 25.70 24.22 26.38 26.62 21.59 29.4 27.77 28.5 25.84 28.70 29.58
```

```r
tail(da)
```

```
##    hue_index Bc1 Bc6 Bc8 Bc9  Bc11  Bc12   Bt2 Bt3   Bt4   Bt5   Bt7  Bt10
## 1:        44 100 100 100 100 99.97 99.61 99.76 100 99.65 99.81 99.78 99.91
## 2:        45 100 100 100 100 99.97 99.61 99.76 100 99.65 99.81 99.78 99.91
## 3:        46 100 100 100 100 99.97 99.61 99.76 100 99.65 99.81 99.78 99.91
## 4:        47 100 100 100 100 99.97 99.61 99.76 100 99.65 99.81 99.78 99.91
## 5:        48 100 100 100 100 99.97 99.61 99.76 100 99.65 99.81 99.78 99.91
```

```
## 6:        49 100 100 100 100 99.97 99.61 99.76 100 99.65 99.81 99.78 99.91
##       Nt1 Nc2    Nt3   Nc4 Nc5   Nt6 Nc7   Nt8 Nc9 Nt10  Nc11  Nt12   Jt1   Jt4
## 1: 99.96 100  99.99 99.99 100 99.98 100 99.92 100  100 99.99 99.99 99.97 99.99
## 2: 99.96 100 100.00 99.99 100 99.98 100 99.93 100  100 99.99 99.99 99.97 99.99
## 3: 99.97 100 100.00 99.99 100 99.99 100 99.94 100  100 99.99 99.99 99.97 99.99
## 4: 99.97 100 100.00 99.99 100 99.99 100 99.95 100  100 99.99 99.99 99.97 99.99
## 5: 99.97 100 100.00 99.99 100 99.99 100 99.95 100  100 99.99 99.99 99.97 99.99
## 6: 99.97 100 100.00 99.99 100 99.99 100 99.95 100  100 99.99 99.99 99.97 99.99
##       Jt7    Jt8   Jt9  Jt11    Jc2    Jc3 Jc5 Jc6   Jc10 Jc12
## 1:  99.99  99.99 99.98 99.98  99.99  99.99 100 100  99.99  100
## 2:  99.99  99.99 99.99 99.98 100.00  99.99 100 100  99.99  100
## 3:  99.99 100.00 99.99 99.99 100.00 100.00 100 100  99.99  100
## 4: 100.00 100.00 99.99 99.99 100.00 100.00 100 100 100.00  100
## 5: 100.00 100.00 99.99 99.99 100.00 100.00 100 100 100.00  100
## 6: 100.00 100.00 99.99 99.99 100.00 100.00 100 100 100.00  100
```

```r
colnames(da)
```

```
##  [1] "hue_index" "Bc1"       "Bc6"       "Bc8"       "Bc9"       "Bc11"
##  [7] "Bc12"      "Bt2"       "Bt3"       "Bt4"       "Bt5"       "Bt7"
## [13] "Bt10"      "Nt1"       "Nc2"       "Nt3"       "Nc4"       "Nc5"
## [19] "Nt6"       "Nc7"       "Nt8"       "Nc9"       "Nt10"      "Nc11"
## [25] "Nt12"      "Jt1"       "Jt4"       "Jt7"       "Jt8"       "Jt9"
## [31] "Jt11"      "Jc2"       "Jc3"       "Jc5"       "Jc6"       "Jc10"
## [37] "Jc12"
```

```r
#convert wide to long extract data attribute
#and create new columns
df <-(melt(da, id.vars=c("hue_index")))
df$block<- substring(df$variable,0,1)
df$treatment <- substring(df$variable,2,2)
df$id <- substring(df$variable,3,4)
head(df)
```

```
##   hue_index variable value block treatment id
## 1         0      Bc1 23.71     B         c  1
## 2         1      Bc1 23.71     B         c  1
## 3         2      Bc1 23.71     B         c  1
## 4         3      Bc1 23.71     B         c  1
## 5         4      Bc1 23.71     B         c  1
## 6         5      Bc1 23.71     B         c  1
```

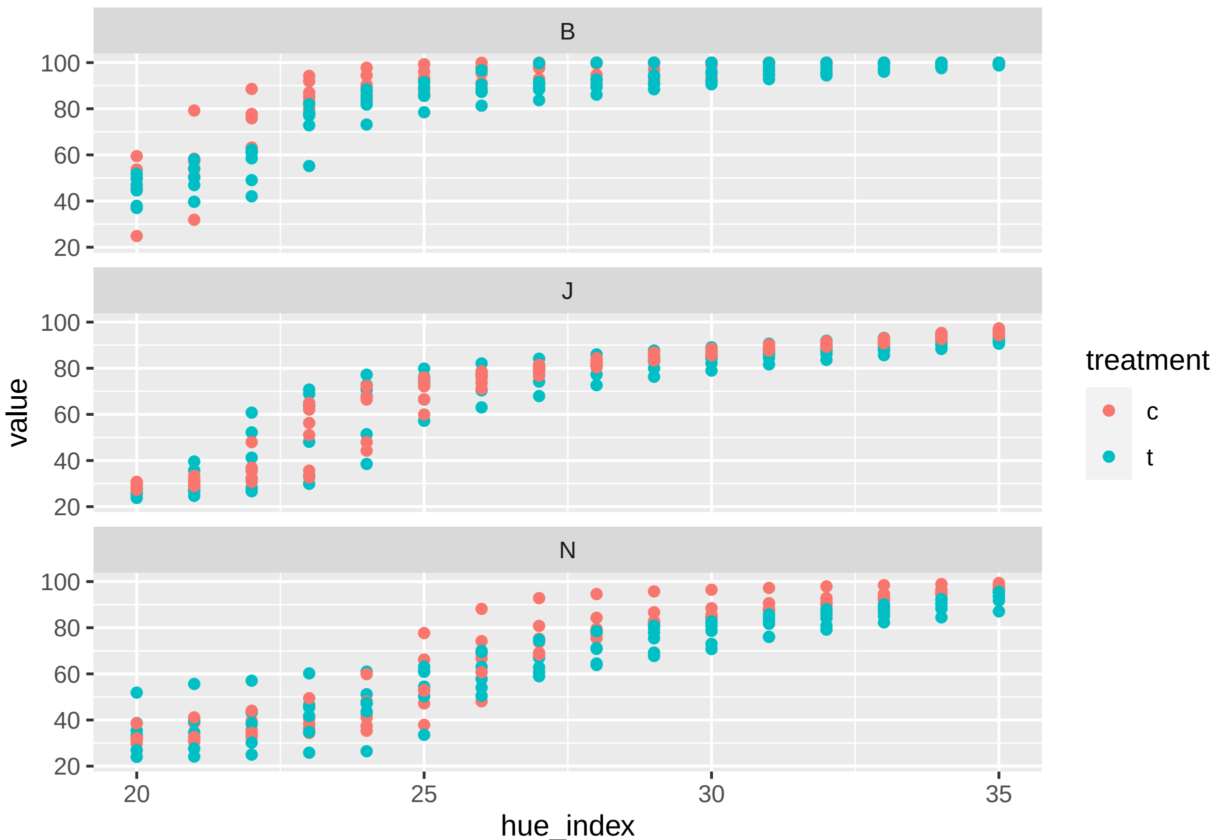
```r
d_avo_raw <- df[,c("block","treatment","id","hue_index","value")]
dim(d_avo_raw)
```

```
## [1] 1800    5
```

The following figure shows both fixed effect for block and individual level Y axis shows percent [TODO]

```r
d_avo_raw %>% ggplot(aes(x = hue_index, y = value, color=treatment)) +
  geom_point(aes(color = treatment)) + facet_wrap(~block,ncol = 1) + xlim(20,35)
```

```
## Warning: Removed 1224 rows containing missing values (geom_point).
```



Get individual hue count data

TODO The highter the value of hue, the stronger the filter effect. For an example, For Bill, the background was black For Nobu and Justin, it was white. So, we also need to evaluate the incremental effect

```r
## Get the length of data, hue_range
len <- dim(da)[2]

## empty matrix that will get the frequency data
avo_frequency <- as.matrix(0:49)

for (i in colnames(da)){
  if (i == "hue_index"){
   }
  else{
   ##Do something
   temp <- getIncre(as.matrix(da[[i]]))
```

```
    temp <- as.matrix(temp)
    ##get the increment
    avo_frequency  <- cbind(avo_frequency ,temp)
    ##start adding them
  }
}

#now add column names
d_avo <- data.frame(avo_frequency)
colnames(d_avo) <- colnames(da)
head(d_avo)
```

```
##   hue_index Bc1 Bc6 Bc8 Bc9 Bc11 Bc12  Bt2 Bt3  Bt4  Bt5  Bt7 Bt10  Nt1 Nc2 Nc3
## 1         0   0   0   0   0 0.00 0.00 0.00   0 0.00 0.00 0.00 0.00 0.00   0   0
## 2         1   0   0   0   0 0.02 0.29 0.09   0 0.12 0.12 0.27 0.04 0.01   0   0
## 3         2   0   0   0   0 0.00 0.00 0.00   0 0.00 0.00 0.00 0.00 0.00   0   0
## 4         3   0   0   0   0 0.00 0.00 0.00   0 0.00 0.00 0.00 0.00 0.00   0   0
## 5         4   0   0   0   0 0.00 0.00 0.00   0 0.00 0.00 0.00 0.00 0.00   0   0
## 6         5   0   0   0   0 0.00 0.00 0.00   0 0.00 0.00 0.00 0.00 0.00   0   0
##   Nc4 Nc5  Nt6 Nc7  Nt8 Nc9 Nt10 Nc11 Nt12  Jt1  Jt4 Jt7  Jt8 Jt9 Jt11 Jc2 Jc3
## 1   0   0 0.00   0 0.00   0 0.00 0.00    0 0.00 0.00   0 0.00   0 0.00   0   0
## 2   0   0 0.01   0 0.01   0 0.01 0.04    0 0.01 0.00   0 0.01   0 0.01   0   0
## 3   0   0 0.00   0 0.00   0 0.00 0.00    0 0.00 0.00   0 0.00   0 0.00   0   0
## 4   0   0 0.00   0 0.00   0 0.00 0.00    0 0.00 0.00   0 0.00   0 0.00   0   0
## 5   0   0 0.00   0 0.00   0 0.00 0.00    0 0.00 0.00   0 0.00   0 0.00   0   0
## 6   0   0 0.00   0 0.00   0 0.00 0.00    0 0.00 0.01   0 0.00   0 0.00   0   0
##   Jc5 Jc6 Jc10 Jc12
## 1   0   0 0.00    0
## 2   0   0 0.00    0
## 3   0   0 0.00    0
## 4   0   0 0.00    0
## 5   0   0 0.01    0
## 6   0   0 0.00    0
```

- Now, `d_avo_frequency` contains frequency of pixles whose color changed when `hue` was incremented by 1

```
#convert wide to long extract data attribute
#and create new columns
dff <-(melt(d_avo, id.vars=c("hue_index")))
dff$block<- substring(dff$variable,0,1)
dff$treatment <- substring(dff$variable,2,2)
dff$id <- substring(dff$variable,3,4)
d_avo_frequency <- dff[,c("block","treatment","id","hue_index","value")]
```

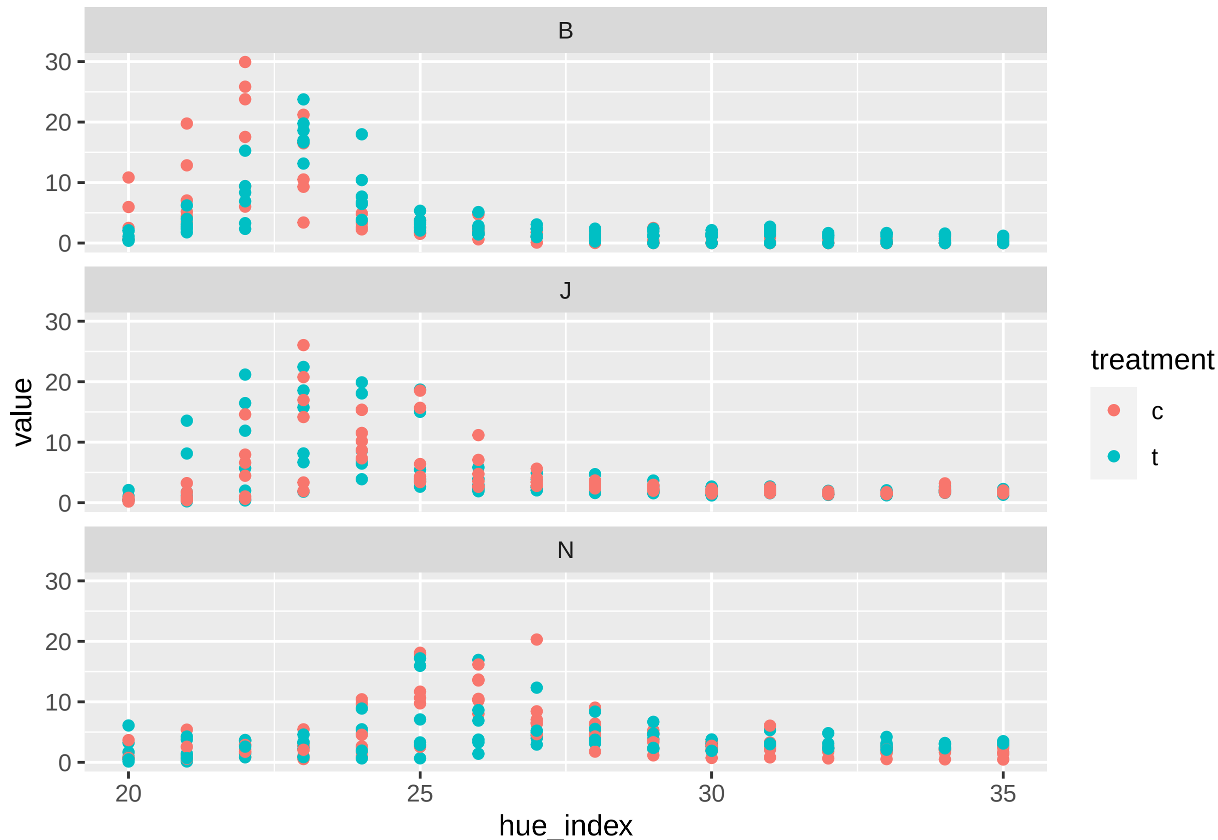
TODO: NEED TO CONVERT TO DENSITY PLOT

> Color wise, N > J and B. [TODO] 20 HUE indidate percent of avocado whose that became black when hue was changed from 19 to 20. (really bad)
>
> 25 HUE indicate percent of avocado that turn black when hue was increased from 24 to 25. (still good)

30 HUE indicate percent of avocado that turn black when hue changed from 29 to 30.

```r
d_avo_frequency %>% ggplot(aes(x = hue_index, y = value, color=treatment)) +
  geom_point(aes(color = treatment)) + facet_wrap(~block,ncol = 1) + xlim(20,35)
```

```
## Warning: Removed 1224 rows containing missing values (geom_point).
```



Is color good indicator?

Create avocado pdf

```r
#now df_avo cotains percent of pixles whose color changed when
head(d_avo)
```

```
##   hue_index Bc1 Bc6 Bc8 Bc9 Bc11 Bc12  Bt2 Bt3  Bt4  Bt5  Bt7 Bt10  Nt1 Nc2 Nt3
## 1         0   0   0   0   0 0.00 0.00 0.00   0 0.00 0.00 0.00 0.00 0.00   0   0
## 2         1   0   0   0   0 0.02 0.29 0.09   0 0.12 0.12 0.27 0.04 0.01   0   0
## 3         2   0   0   0   0 0.00 0.00 0.00   0 0.00 0.00 0.00 0.00 0.00   0   0
## 4         3   0   0   0   0 0.00 0.00 0.00   0 0.00 0.00 0.00 0.00 0.00   0   0
## 5         4   0   0   0   0 0.00 0.00 0.00   0 0.00 0.00 0.00 0.00 0.00   0   0
## 6         5   0   0   0   0 0.00 0.00 0.00   0 0.00 0.00 0.00 0.00 0.00   0   0
##   Nc4 Nc5  Nt6 Nc7  Nt8 Nc9 Nt10 Nc11 Nt12  Jt1  Jt4 Jt7  Jt8 Jt9 Jt11 Jc2 Jc3
```

```
## 1   0   0 0.00   0 0.00   0 0.00 0.00    0 0.00 0.00   0 0.00   0 0.00   0   0
## 2   0   0 0.01   0 0.01   0 0.01 0.04    0 0.01 0.00   0 0.01   0 0.01   0   0
## 3   0   0 0.00   0 0.00   0 0.00 0.00    0 0.00 0.00   0 0.00   0 0.00   0   0
## 4   0   0 0.00   0 0.00   0 0.00 0.00    0 0.00 0.00   0 0.00   0 0.00   0   0
## 5   0   0 0.00   0 0.00   0 0.00 0.00    0 0.00 0.00   0 0.00   0 0.00   0   0
## 6   0   0 0.00   0 0.00   0 0.00 0.00    0 0.00 0.01   0 0.00   0 0.00   0   0
##   Jc5 Jc6 Jc10 Jc12
## 1   0   0 0.00    0
## 2   0   0 0.00    0
## 3   0   0 0.00    0
## 4   0   0 0.00    0
## 5   0   0 0.01    0
## 6   0   0 0.00    0
```

```
## empty matrix that will get the frequency data
avo_pdf <- as.matrix(0:49)

for (i in colnames(d_avo)){
  if (i == "hue_index"){
   }
  else{
   ##Do something
   temp <- sum(d_avo[[i]])
   temp <- d_avo[[i]]/temp
   ##start adding them
   avo_pdf   <- cbind(avo_pdf  ,temp)
  }
}

#now add column names
d_avo_pdf <- data.frame(avo_pdf)
colnames(d_avo_pdf) <- colnames(da)
head(d_avo_pdf)
```

```
##   hue_index Bc1 Bc6 Bc8 Bc9         Bc11         Bc12         Bt2 Bt3
## 1         0   0   0   0   0 0.0000000000 0.000000000 0.000000000   0
## 2         1   0   0   0   0 0.0003219575 0.006109122 0.001422026   0
## 3         2   0   0   0   0 0.0000000000 0.000000000 0.000000000   0
## 4         3   0   0   0   0 0.0000000000 0.000000000 0.000000000   0
## 5         4   0   0   0   0 0.0000000000 0.000000000 0.000000000   0
## 6         5   0   0   0   0 0.0000000000 0.000000000 0.000000000   0
##           Bt4         Bt5         Bt7         Bt10          Nt1 Nc2 Nt3 Nc4 Nc5
## 1 0.000000000 0.000000000 0.000000000 0.0000000000 0.0000000000   0   0   0   0
## 2 0.002397123 0.001863065 0.004893077 0.0007375991 0.0001391401   0   0   0   0
## 3 0.000000000 0.000000000 0.000000000 0.0000000000 0.0000000000   0   0   0   0
## 4 0.000000000 0.000000000 0.000000000 0.0000000000 0.0000000000   0   0   0   0
## 5 0.000000000 0.000000000 0.000000000 0.0000000000 0.0000000000   0   0   0   0
## 6 0.000000000 0.000000000 0.000000000 0.0000000000 0.0000000000   0   0   0   0
##            Nt6 Nc7          Nt8 Nc9        Nt10         Nc11 Nt12          Jt1
## 1 0.0000000000   0 0.0000000000   0 0.000000000 0.0000000000    0 0.0000000000
## 2 0.0001435956   0 0.0001428163   0 0.000130719 0.0005719188    0 0.0001305483
## 3 0.0000000000   0 0.0000000000   0 0.000000000 0.0000000000    0 0.0000000000
## 4 0.0000000000   0 0.0000000000   0 0.000000000 0.0000000000    0 0.0000000000
## 5 0.0000000000   0 0.0000000000   0 0.000000000 0.0000000000    0 0.0000000000
```

```
## 6 0.0000000000   0 0.0000000000   0 0.000000000 0.0000000000    0 0.0000000000
##              Jt4 Jt7          Jt8 Jt9         Jt11 Jc2 Jc3 Jc5 Jc6         Jc10
## 1 0.0000000000   0 0.0000000000   0 0.0000000000   0   0   0   0 0.0000000000
## 2 0.0000000000   0 0.0001358142   0 0.0001275348   0   0   0   0 0.0000000000
## 3 0.0000000000   0 0.0000000000   0 0.0000000000   0   0   0   0 0.0000000000
## 4 0.0000000000   0 0.0000000000   0 0.0000000000   0   0   0   0 0.0000000000
## 5 0.0000000000   0 0.0000000000   0 0.0000000000   0   0   0   0 0.0001402328
## 6 0.0001345895   0 0.0000000000   0 0.0000000000   0   0   0   0 0.0000000000
##   Jc12
## 1    0
## 2    0
## 3    0
## 4    0
## 5    0
## 6    0
```

```
#convert wide to long extract data attribute
#and create new columns
dff <-(melt(d_avo_pdf, id.vars=c("hue_index")))
dff$block<- substring(dff$variable,0,1)
dff$treatment <- substring(dff$variable,2,2)
dff$id <- substring(dff$variable,3,4)
d_avo_pdf_long <- dff[,c("block","treatment","id","hue_index","value")]
head(d_avo_pdf_long)
```

```
##   block treatment id hue_index value
## 1     B         c  1         0     0
## 2     B         c  1         1     0
## 3     B         c  1         2     0
## 4     B         c  1         3     0
## 5     B         c  1         4     0
## 6     B         c  1         5     0
```

Create sample data based on the pdf

TODO Need to create function

```
BT <- d_avo_pdf_long %>% filter(block=="B" & treatment =="t") %>%
      group_by(hue_index) %>% dplyr::summarize(Mean = mean(value, na.rm=TRUE))
```

```
## `summarise()` ungrouping output (override with `.groups` argument)
```

```
BC <- d_avo_pdf_long %>% filter(block=="B" & treatment =="c")%>%
      group_by(hue_index) %>% dplyr::summarize(Mean = mean(value, na.rm=TRUE))
```

```
## `summarise()` ungrouping output (override with `.groups` argument)
```

```
NT <- d_avo_pdf_long %>% filter(block=="N" & treatment =="t")%>%
      group_by(hue_index) %>% dplyr::summarize(Mean = mean(value, na.rm=TRUE))
```

```
## `summarise()` ungrouping output (override with `.groups` argument)
```

```r
NC <- d_avo_pdf_long %>% filter(block=="N" & treatment =="c")%>%
      group_by(hue_index) %>% dplyr::summarize(Mean = mean(value, na.rm=TRUE))
```

```
## `summarise()` ungrouping output (override with `.groups` argument)
```

```r
JT <- d_avo_pdf_long %>% filter(block=="J" & treatment =="t")%>%
      group_by(hue_index) %>% dplyr::summarize(Mean = mean(value, na.rm=TRUE))
```

```
## `summarise()` ungrouping output (override with `.groups` argument)
```

```r
JC <- d_avo_pdf_long %>% filter(block=="J" & treatment =="c")%>%
      group_by(hue_index) %>% dplyr::summarize(Mean = mean(value, na.rm=TRUE))
```

```
## `summarise()` ungrouping output (override with `.groups` argument)
```

```r
#treatment
s1 <- get_ind_data(BT)
t1 <- data.frame(block="B", control = "treatment", value = s1)

s2 <- get_ind_data(JT)
t2 <- data.frame(block="J", control = "treatment", value = s2)

s3 <- get_ind_data(NT)
t3 <- data.frame(block="N", control = "treatment", value = s3)

three_treats <- rbind(t1,t2,t3)

#control
s4 <- get_ind_data(BC)
t4 <- data.frame(block="B", control = "control", value = s4)

s5 <- get_ind_data(JC)
t5 <- data.frame(block="J", control = "control", value = s5)

s6 <- get_ind_data(NC)
t6 <- data.frame(block="N", control = "control", value = s6)
three_control <- rbind(t4,t5,t6)

data <- rbind(three_treats,three_control)

p1 <- data%>% ggplot(.,aes(x=value)) +
           geom_density(aes(fill=control),adjust=1.5,alpha=0.3)  +
           facet_wrap(~block, ncol = 1) +
           xlim(20, 45) +
           theme(
                  legend.position="top",
                  panel.spacing = unit(0.1, "lines"),
                  axis.ticks.x=element_blank(),
                  plot.title = element_text(hjust = 0.5)
```

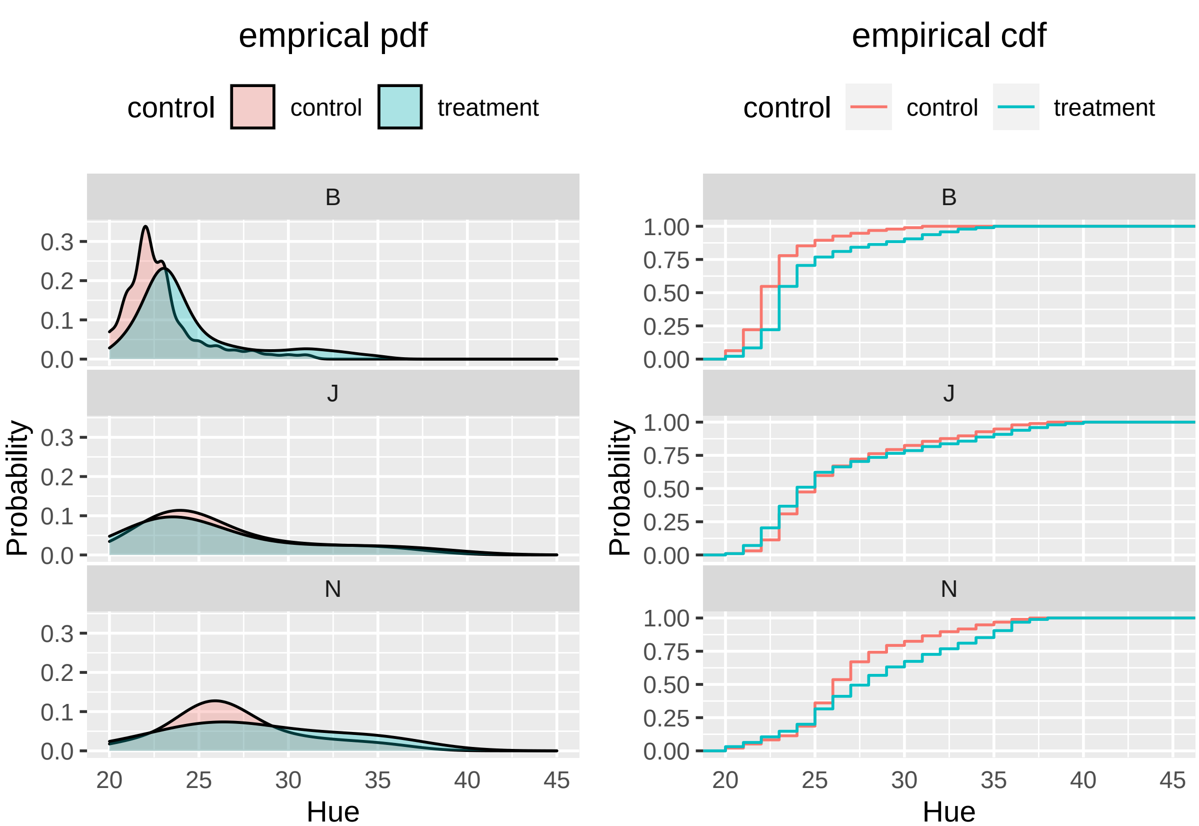
```
            ) +
      ggtitle("emprical pdf") +
      xlab("Hue") + ylab("Probability")


p2 <- data %>% ggplot(.,aes(x=value, colour = control)) + stat_ecdf() +
  facet_wrap(~block, ncol = 1) +
        xlim(20, 45) +
        theme(
              legend.position="top",
              panel.spacing = unit(0.1, "lines"),
              axis.ticks.x=element_blank(),
              plot.title = element_text(hjust = 0.5)
            ) +
      ggtitle("empirical cdf") +
      xlab("Hue") + ylab("Probability")

p1 | p2
```

```
## Warning: Removed 10 rows containing non-finite values (stat_density).

## Warning: Removed 10 rows containing non-finite values (stat_ecdf).
```



Test based on the maximum distance between empirical distributions

```r
#control <- getIncre(df1)
#treatment <- getIncre(df2)
control <- BT$Mean
treatment <- BC$Mean

#sharp null distribution
par(mfrow=c(3,1))
get_ks_permutation(BT$Mean,BC$Mean,5000)
```

```
## Warning in ks.test(A, B): cannot compute exact p-value with ties

## Warning in ks.test(A, B): cannot compute exact p-value with ties

## Warning in ks.test(A, B): cannot compute exact p-value with ties

## Warning in ks.test(A, B): cannot compute exact p-value with ties

## Warning in ks.test(A, B): cannot compute exact p-value with ties

## Warning in ks.test(A, B): cannot compute exact p-value with ties

## Warning in ks.test(A, B): cannot compute exact p-value with ties

## Warning in ks.test(A, B): cannot compute exact p-value with ties

## Warning in ks.test(A, B): cannot compute exact p-value with ties

## Warning in ks.test(A, B): cannot compute exact p-value with ties

## Warning in ks.test(A, B): cannot compute exact p-value with ties

## Warning in ks.test(A, B): cannot compute exact p-value with ties

## Warning in ks.test(A, B): cannot compute exact p-value with ties

## Warning in ks.test(A, B): cannot compute exact p-value with ties

## Warning in ks.test(A, B): cannot compute exact p-value with ties

## Warning in ks.test(A, B): cannot compute exact p-value with ties

## Warning in ks.test(A, B): cannot compute exact p-value with ties

## Warning in ks.test(A, B): cannot compute exact p-value with ties

## Warning in ks.test(A, B): cannot compute exact p-value with ties

## Warning in ks.test(A, B): cannot compute exact p-value with ties

## Warning in ks.test(A, B): cannot compute exact p-value with ties
```

```
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## [1] 0.5118
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get_ks_permutation(JT$Mean,JC$Mean,5000)
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## [1] 0.9624
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get_ks_permutation(NT$Mean,NC$Mean,5000)
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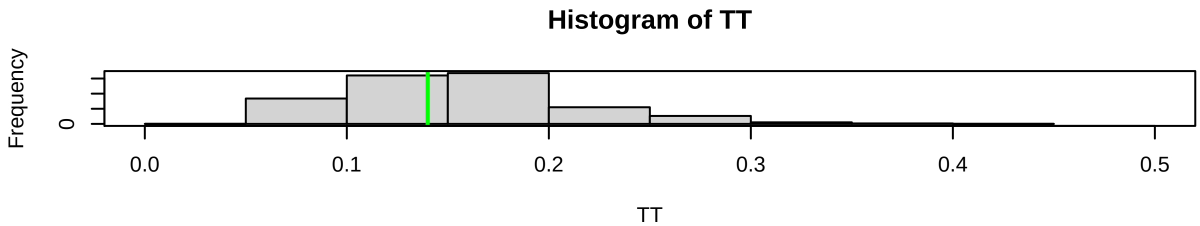
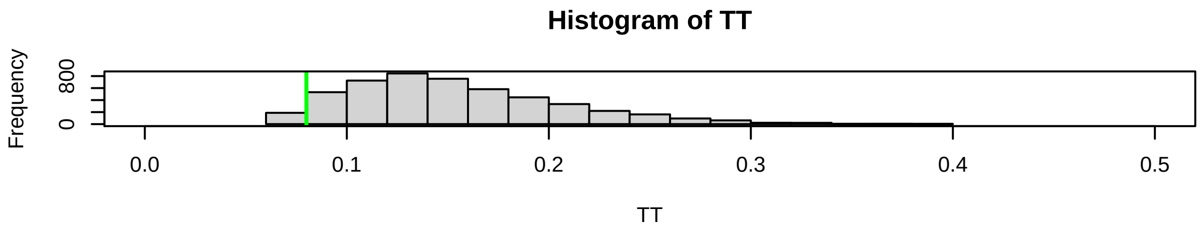
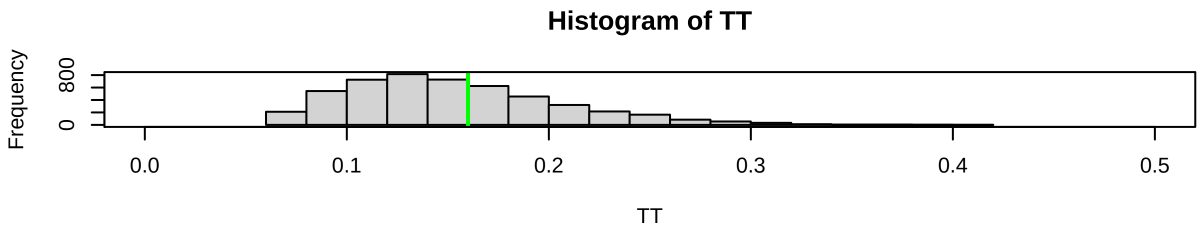







```
## [1] 0.395
```

```
par(mfrow=c(1,1))
Z <- c(control,treatment)
n <- length(control )
m <- length(treatment)
N <- length(Z)
```

Measure 2

```
#raw data converted to long format
head(d_avo_raw)
```

```
##   block treatment id hue_index value
## 1     B         c  1         0 23.71
## 2     B         c  1         1 23.71
## 3     B         c  1         2 23.71
## 4     B         c  1         3 23.71
## 5     B         c  1         4 23.71
## 6     B         c  1         5 23.71
```

```r
#arrange the data by block, treatement, id and hue_index
d <- as.data.table(d_avo_raw)
d <- d %>% filter(hue_index > 18 & hue_index < 44)
db <- d[order(rank(block), treatment,id,hue_index)]
head(db)
```

```
##    block treatment id hue_index value
## 1:     B         c  1        19 24.21
## 2:     B         c  1        20 24.84
## 3:     B         c  1        21 31.88
## 4:     B         c  1        22 61.81
## 5:     B         c  1        23 83.02
## 6:     B         c  1        24 89.56
```

```r
dim(db)/36
```

```
## [1] 25.0000000  0.1388889
```

Code for mannual confirmation

```
##    block treatment id hue_index value
## 1:     N         t  8        38 98.67
## 2:     N         t  8        39 99.35
## 3:     N         t  8        40 99.63
## 4:     N         t  8        41 99.77
## 5:     N         t  8        42 99.84
## 6:     N         t  8        43 99.89
```

```
## [1] 4
## [1] 23
## [1] 3
## [1] 22
## [1] 4
## [1] 23
## [1] 3
## [1] 22
## [1] 3
## [1] 22
## [1] 2
## [1] 21
## [1] 4
## [1] 23
## [1] 5
## [1] 24
## [1] 4
## [1] 23
## [1] 4
## [1] 23
## [1] 4
## [1] 23
## [1] 4
## [1] 23
```

```
## [1] 6
## [1] 25
## [1] 7
## [1] 26
## [1] 5
## [1] 24
## [1] 5
## [1] 24
## [1] 4
## [1] 23
## [1] 5
## [1] 24
## [1] 4
## [1] 23
## [1] 6
## [1] 25
## [1] 4
## [1] 23
## [1] 5
## [1] 24
## [1] 4
## [1] 23
## [1] 7
## [1] 26
## [1] 7
## [1] 26
## [1] 8
## [1] 27
## [1] 8
## [1] 27
## [1] 6
## [1] 25
## [1] 8
## [1] 27
## [1] 6
## [1] 25
## [1] 12
## [1] 31
## [1] 8
## [1] 27
## [1] 7
## [1] 26
## [1] 11
## [1] 30
## [1] 7
## [1] 26
## [1] 10
## [1] 29
```

```
##    block avocado_number treatment hue_turn
## 1      B              1         c       23
## 2      B             11         c       22
## 3      B             12         c       23
## 4      B              6         c       22
```

```
## 5      B            8       c      22
## 6      B            9       c      21
## 7      B           10       t      23
## 8      B            2       t      24
## 9      B            3       t      23
## 10     B            4       t      23
## 11     B            5       t      23
## 12     B            7       t      23
## 13     J           10       c      25
## 14     J           12       c      26
## 15     J            2       c      24
## 16     J            3       c      24
## 17     J            5       c      23
## 18     J            6       c      24
## 19     J            1       t      23
## 20     J           11       t      25
## 21     J            4       t      23
## 22     J            7       t      24
## 23     J            8       t      23
## 24     J            9       t      26
## 25     N           11       c      26
## 26     N            2       c      27
## 27     N            4       c      27
## 28     N            5       c      25
## 29     N            7       c      27
## 30     N            9       c      25
## 31     N            1       t      31
## 32     N           10       t      27
## 33     N           12       t      26
## 34     N            3       t      30
## 35     N            6       t      26
## 36     N            8       t      29
```

Abrupt change detection in HUE

TODO there is an error in the code here. Need to fix it

```
# #raw data converted to long format
# head(d_avo_raw)
#
# #arrange the data by block, treatement, id and hue_index
# d <- as.data.table(d_avo_raw)
# db <- d[order(rank(block), treatment, id,hue_index)]
# head(db)
#
# d <- as.data.table(d_avo_raw)
# d <- d %>% filter(hue_index > 18 & hue_index < 44)
# db <- d[order(rank(block), treatment,id,hue_index)]
#
# b_result <- data.frame(block = numeric(0),avocado_number= numeric(0),
#                         treatment = numeric(0),
#                         hue_turn = numeric(0) )
# #has 160 rows
```

```
# for (val in 1:36)
# {
#  #selected only upto min hue + 25
#  start <- 1 + (val-1)*24
#  end <- (25*val)
#  #get the subject information
#  val_block   <- db[start,block]
#  val_subject <- db[start,id]
#  val_treat   <- db[start,treatment]
#
#  # # print(paste(start,":",end))
#  d_temp <- db[start:end,]
#  #abrupt change detection point
#  dg <- d_temp$value
#  dg.amoc=cpt.mean(dg)
#  #19 is the minimum number of Hue when the black ratio started to change
#  hue_turn <- cpts(dg.amoc)
#  b_result[val,] <- c(val_block,val_subject,val_treat,hue_turn)
# }
#
# b_result
```

Regression Estimator for Block Randomization

We have 3 blocks, B, N, and J with 12 samples in each block.

```
b_result
```

```
##    block avocado_number treatment hue_turn
## 1      B              1         c       23
## 2      B             11         c       22
## 3      B             12         c       23
## 4      B              6         c       22
## 5      B              8         c       22
## 6      B              9         c       21
## 7      B             10         t       23
## 8      B              2         t       24
## 9      B              3         t       23
## 10     B              4         t       23
## 11     B              5         t       23
## 12     B              7         t       23
## 13     J             10         c       25
## 14     J             12         c       26
## 15     J              2         c       24
## 16     J              3         c       24
## 17     J              5         c       23
## 18     J              6         c       24
## 19     J              1         t       23
## 20     J             11         t       25
## 21     J              4         t       23
## 22     J              7         t       24
## 23     J              8         t       23
```

```
## 24     J            9        t       26
## 25     N           11        c       26
## 26     N            2        c       27
## 27     N            4        c       27
## 28     N            5        c       25
## 29     N            7        c       27
## 30     N            9        c       25
## 31     N            1        t       31
## 32     N           10        t       27
## 33     N           12        t       26
## 34     N            3        t       30
## 35     N            6        t       26
## 36     N            8        t       29
```

```
mod_b1 <- lm(hue_turn ~ as.factor(treatment) + as.factor(block),data = b_result)
mod_b2 <- lm(hue_turn ~ as.factor(treatment)*as.factor(block),data = b_result)

mod_b2
```

```
##
## Call:
## lm(formula = hue_turn ~ as.factor(treatment) * as.factor(block),
##     data = b_result)
##
## Coefficients:
##                              (Intercept)
##                                   22.167
##                    as.factor(treatment)t
##                                    1.000
##                        as.factor(block)J
##                                    2.167
##                        as.factor(block)N
##                                    4.000
## as.factor(treatment)t:as.factor(block)J
##                                   -1.333
## as.factor(treatment)t:as.factor(block)N
##                                    1.000
```

```
coefficients(mod_b1)
```

```
##           (Intercept) as.factor(treatment)t     as.factor(block)J
##            22.2222222             0.8888889             1.5000000
##     as.factor(block)N
##             4.5000000
```

```
coeftest(mod_b1, vcov = vcovHC(mod_b1, type = "HC1"))
```

```
##
## t test of coefficients:
##
##                         Estimate Std. Error t value  Pr(>|t|)
## (Intercept)             22.22222    0.29200 76.1042 < 2.2e-16 ***
```

```
## as.factor(treatment)t  0.88889    0.42853  2.0743 0.0461824 *
## as.factor(block)J      1.50000    0.41002  3.6584 0.0009047 ***
## as.factor(block)N      4.50000    0.52347  8.5966 7.994e-10 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```r
coeftest(mod_b2, vcov = vcovHC(mod_b2, type = "HC1"))
```

```
##
## t test of coefficients:
##
##                                          Estimate Std. Error t value  Pr(>|t|)
## (Intercept)                              22.16667    0.30732 72.1294 < 2.2e-16
## as.factor(treatment)t                     1.00000    0.34960  2.8604 0.0076326
## as.factor(block)J                         2.16667    0.52175  4.1527 0.0002506
## as.factor(block)N                         4.00000    0.50553  7.9126 7.862e-09
## as.factor(treatment)t:as.factor(block)J -1.33333    0.75277 -1.7712 0.0866826
## as.factor(treatment)t:as.factor(block)N  1.00000    1.02198  0.9785 0.3356562
##
## (Intercept)                              ***
## as.factor(treatment)t                    **
## as.factor(block)J                        ***
## as.factor(block)N                        ***
## as.factor(treatment)t:as.factor(block)J .
## as.factor(treatment)t:as.factor(block)N
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```r
stargazer(mod_b1, mod_b2, type = "text")
```

```
##
## =====================================================================================
##                                                      Dependent variable:
##                                         ---------------------------------------------
##                                                           hue_turn
##                                                  (1)                    (2)
## -------------------------------------------------------------------------------------
## as.factor(treatment)t                          0.889**                 1.000
##                                                (0.429)                (0.704)
##
## as.factor(block)J                              1.500***               2.167***
##                                                (0.525)                (0.704)
##
## as.factor(block)N                              4.500***               4.000***
##                                                (0.525)                (0.704)
##
## as.factor(treatment)t:as.factor(block)J                               -1.333
##                                                                       (0.996)
##
## as.factor(treatment)t:as.factor(block)N                                1.000
##                                                                       (0.996)
##
## Constant                                      22.222***              22.167***
```

```
##                                                          (0.429)              (0.498)
##
## ----------------------------------------------------------------------------------------
## Observations                                                36                   36
## R2                                                       0.716                0.760
## Adjusted R2                                              0.689                0.720
## Residual Std. Error                                1.286 (df = 32)      1.220 (df = 30)
## F Statistic                                   26.846*** (df = 3; 32) 18.985*** (df = 5; 30)
## ========================================================================================
## Note:                                                          *p<0.1; **p<0.05; ***p<0.01
```

(see page 77 of Analysis of Categorical data) `anova()` from the `stat` package performs type I test (i.e., sequentially adding the additional terms) while `Anova()` from `car` package performs type II test (i.e,)

```r
#anova(long_mod, short_mod, test = 'F')
anova(mod_b2, mod_b1, test = 'F')
```

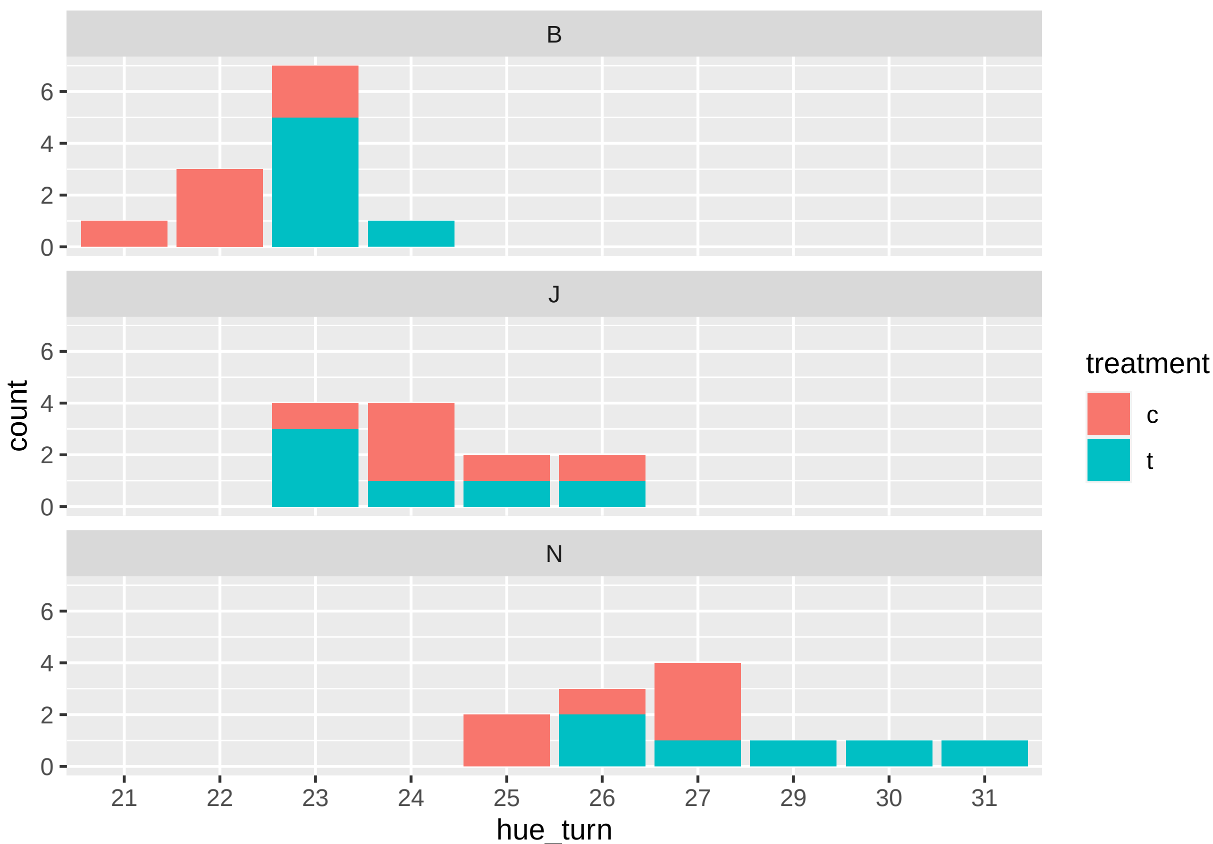
```
## Analysis of Variance Table
##
## Model 1: hue_turn ~ as.factor(treatment) * as.factor(block)
## Model 2: hue_turn ~ as.factor(treatment) + as.factor(block)
##   Res.Df    RSS Df Sum of Sq      F Pr(>F)
## 1     30 44.667
## 2     32 52.889 -2   -8.2222 2.7612 0.0793 .
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```r
b_result
```

```
##    block avocado_number treatment hue_turn
## 1      B              1         c       23
## 2      B             11         c       22
## 3      B             12         c       23
## 4      B              6         c       22
## 5      B              8         c       22
## 6      B              9         c       21
## 7      B             10         t       23
## 8      B              2         t       24
## 9      B              3         t       23
## 10     B              4         t       23
## 11     B              5         t       23
## 12     B              7         t       23
## 13     J             10         c       25
## 14     J             12         c       26
## 15     J              2         c       24
## 16     J              3         c       24
## 17     J              5         c       23
## 18     J              6         c       24
## 19     J              1         t       23
## 20     J             11         t       25
## 21     J              4         t       23
```

```
## 22      J              7         t       24
## 23      J              8         t       23
## 24      J              9         t       26
## 25      N             11         c       26
## 26      N              2         c       27
## 27      N              4         c       27
## 28      N              5         c       25
## 29      N              7         c       27
## 30      N              9         c       25
## 31      N              1         t       31
## 32      N             10         t       27
## 33      N             12         t       26
## 34      N              3         t       30
## 35      N              6         t       26
## 36      N              8         t       29
```

```
b_result %>% ggplot(aes(x = hue_turn, fill=treatment)) + geom_bar() +  facet_wrap(~block,ncol = 1)
```




```
db <- as.data.table(b_result)
b_result2 <- db[, .(round(mean(as.integer(hue_turn))),0), by = .(block,treatment)][,1:3]
print(b_result2)
```

```
##    block treatment V1
## 1:     B         c 22
## 2:     B         t 23
```

```
## 3:      J          c 24
## 4:      J          t 24
## 5:      N          c 26
## 6:      N          t 28
```