

# CEM Results

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## Summary

This is a document for Coarsened Exact Matching results.

## BIO104

```
grades <- read.csv("data/grades.csv")
si_visit <- read.csv("data/SLC Appointment.csv")
profiles <- read.csv("data/student_profiles_clean.csv")

convert_grades <- function(x) {
  A <- factor(x, levels=c("A+", "A", "A-",
                          "B+", "B", "B-",
                          "C+", "C", "C-",
                          "D+", "D", "D-", "F"))

  values <- c(4.3, 4, 3.7,
              3.3, 3, 2.7,
              2.3, 2, 1.7,
              1.3, 1, 0.7, 0)

  values[A]
}

grad <- grades %>% filter(Random.Course.ID == 14054) # BIO104

si_students <- si_visit %>% filter(Random.Course.ID == 14054)

temp3 <- si_students %>% group_by(Random.Student.ID) %>%
  summarise(n = sum(SLC.Attended.Flag))

data1 <- full_join(grad, temp3, by = "Random.Student.ID")

data1$n[is.na(data1$n)] <- 0

data1$n[data1$n > 0] <- 1

data1 <- data1 %>% select(Random.Student.ID, n, Student.Class.Official.Grade)

data2 <- profiles %>% select(Random.Student.ID, Gender.Code, IPEDS.Ethnicity, IPEDS.Ethnicity.URM.Non.U,
                           First.Generation.Flag, Entry.Enrollment.Type, HS.GPA, Student.Orientation.L)

data3 <- data1 %>% left_join(data2, by = 'Random.Student.ID')

# Remove Withdraws
```

```

data3 <- data3 %>% filter(Student.Class.Official.Grade != 'W') %>% filter(Student.Class.Official.Grade
data3$grade.num <- convert_grades(data3$Student.Class.Official.Grade)

data3 <- data3 %>% na.omit()

# factor(n) is a binary indicator for attending SI at least once
matching <- matchit(factor(n) ~ IPEDS.Ethnicity + Gender.Code + HS.GPA + Student.Orientation.Flag,
                     data = data3, method = 'cem', estimand = 'ATE')
summary(matching)

```

```

##
## Call:
## matchit(formula = factor(n) ~ IPEDS.Ethnicity + Gender.Code +
##       HS.GPA + Student.Orientation.Flag, data = data3, method = "cem",
##       estimand = "ATE")
##
## Summary of Balance for All Data:
##
##                                     Means Treated
## IPEDS.EthnicityAmerican Indian/Alaskan Native Only (American Indian) (Non-Hispanic) 0.0000
## IPEDS.EthnicityAsian (Non-Hispanic) 0.1044
## IPEDS.EthnicityBlack/African American (Non-Hispanic) 0.0110
## IPEDS.EthnicityHispanic/Latino (any race) 0.3242
## IPEDS.EthnicityNative Hawaiian/Other Pacific Islander (Non-Hispanic) 0.0055
## IPEDS.EthnicityNo Value 0.0000
## IPEDS.EthnicityNon-Resident Alien 0.0165
## IPEDS.EthnicityTwo or More Races (Non-Hispanic) 0.0275
## IPEDS.EthnicityUnknown 0.0495
## IPEDS.EthnicityWhite (Non-Hispanic) 0.4615
## Gender.CodeF 0.8077
## Gender.CodeM 0.1923
## Gender.CodeN 0.0000
## Gender.CodeN/V 0.0000
## Gender.CodeU 0.0000
## HS.GPA 3.4322
## Student.Orientation.FlagN 0.4231
## Student.Orientation.FlagY 0.5769
##
##                                     Means Control
## IPEDS.EthnicityAmerican Indian/Alaskan Native Only (American Indian) (Non-Hispanic) 0.0000
## IPEDS.EthnicityAsian (Non-Hispanic) 0.0758
## IPEDS.EthnicityBlack/African American (Non-Hispanic) 0.0606
## IPEDS.EthnicityHispanic/Latino (any race) 0.2879
## IPEDS.EthnicityNative Hawaiian/Other Pacific Islander (Non-Hispanic) 0.0000
## IPEDS.EthnicityNo Value 0.0000
## IPEDS.EthnicityNon-Resident Alien 0.0152
## IPEDS.EthnicityTwo or More Races (Non-Hispanic) 0.1061
## IPEDS.EthnicityUnknown 0.0758
## IPEDS.EthnicityWhite (Non-Hispanic) 0.3788
## Gender.CodeF 0.5909
## Gender.CodeM 0.4091
## Gender.CodeN 0.0000
## Gender.CodeN/V 0.0000
## Gender.CodeU 0.0000
## HS.GPA 3.3305

```

## Student.Orientation.FlagN	0.6364
## Student.Orientation.FlagY	0.3636
##	Std. Mean Diff.
## IPEDS.EthnicityAmerican Indian/Alaskan Native Only (American Indian) (Non-Hispanic)	0.0000
## IPEDS.EthnicityAsian (Non-Hispanic)	0.1002
## IPEDS.EthnicityBlack/African American (Non-Hispanic)	-0.2695
## IPEDS.EthnicityHispanic/Latino (any race)	0.0788
## IPEDS.EthnicityNative Hawaiian/Other Pacific Islander (Non-Hispanic)	0.1051
## IPEDS.EthnicityNo Value	0.0000
## IPEDS.EthnicityNon-Resident Alien	0.0107
## IPEDS.EthnicityTwo or More Races (Non-Hispanic)	-0.3188
## IPEDS.EthnicityUnknown	-0.1088
## IPEDS.EthnicityWhite (Non-Hispanic)	0.1682
## Gender.CodeF	0.4865
## Gender.CodeM	-0.4865
## Gender.CodeN	0.0000
## Gender.CodeN/V	0.0000
## Gender.CodeU	0.0000
## HS.GPA	0.2554
## Student.Orientation.FlagN	-0.4374
## Student.Orientation.FlagY	0.4374
##	Var. Ratio
## IPEDS.EthnicityAmerican Indian/Alaskan Native Only (American Indian) (Non-Hispanic)	.
## IPEDS.EthnicityAsian (Non-Hispanic)	.
## IPEDS.EthnicityBlack/African American (Non-Hispanic)	.
## IPEDS.EthnicityHispanic/Latino (any race)	.
## IPEDS.EthnicityNative Hawaiian/Other Pacific Islander (Non-Hispanic)	.
## IPEDS.EthnicityNo Value	.
## IPEDS.EthnicityNon-Resident Alien	.
## IPEDS.EthnicityTwo or More Races (Non-Hispanic)	.
## IPEDS.EthnicityUnknown	.
## IPEDS.EthnicityWhite (Non-Hispanic)	.
## Gender.CodeF	.
## Gender.CodeM	.
## Gender.CodeN	.
## Gender.CodeN/V	.
## Gender.CodeU	.
## HS.GPA	0.8815
## Student.Orientation.FlagN	.
## Student.Orientation.FlagY	.
##	eCDF Mean
## IPEDS.EthnicityAmerican Indian/Alaskan Native Only (American Indian) (Non-Hispanic)	0.0000
## IPEDS.EthnicityAsian (Non-Hispanic)	0.0286
## IPEDS.EthnicityBlack/African American (Non-Hispanic)	0.0496
## IPEDS.EthnicityHispanic/Latino (any race)	0.0363
## IPEDS.EthnicityNative Hawaiian/Other Pacific Islander (Non-Hispanic)	0.0055
## IPEDS.EthnicityNo Value	0.0000
## IPEDS.EthnicityNon-Resident Alien	0.0013
## IPEDS.EthnicityTwo or More Races (Non-Hispanic)	0.0786
## IPEDS.EthnicityUnknown	0.0263
## IPEDS.EthnicityWhite (Non-Hispanic)	0.0828
## Gender.CodeF	0.2168
## Gender.CodeM	0.2168
## Gender.CodeN	0.0000

## Gender.CodeN/V	0.0000
## Gender.CodeU	0.0000
## HS.GPA	0.0599
## Student.Orientation.FlagN	0.2133
## Student.Orientation.FlagY	0.2133
##	eCDF Max
## IPEDS.EthnicityAmerican Indian/Alaskan Native Only (American Indian) (Non-Hispanic)	0.0000
## IPEDS.EthnicityAsian (Non-Hispanic)	0.0286
## IPEDS.EthnicityBlack/African American (Non-Hispanic)	0.0496
## IPEDS.EthnicityHispanic/Latino (any race)	0.0363
## IPEDS.EthnicityNative Hawaiian/Other Pacific Islander (Non-Hispanic)	0.0055
## IPEDS.EthnicityNo Value	0.0000
## IPEDS.EthnicityNon-Resident Alien	0.0013
## IPEDS.EthnicityTwo or More Races (Non-Hispanic)	0.0786
## IPEDS.EthnicityUnknown	0.0263
## IPEDS.EthnicityWhite (Non-Hispanic)	0.0828
## Gender.CodeF	0.2168
## Gender.CodeM	0.2168
## Gender.CodeN	0.0000
## Gender.CodeN/V	0.0000
## Gender.CodeU	0.0000
## HS.GPA	0.1650
## Student.Orientation.FlagN	0.2133
## Student.Orientation.FlagY	0.2133

##

##

## Summary of Balance for Matched Data:

##

	Means Treated
## IPEDS.EthnicityAmerican Indian/Alaskan Native Only (American Indian) (Non-Hispanic)	0.0000
## IPEDS.EthnicityAsian (Non-Hispanic)	0.0458
## IPEDS.EthnicityBlack/African American (Non-Hispanic)	0.0131
## IPEDS.EthnicityHispanic/Latino (any race)	0.3464
## IPEDS.EthnicityNative Hawaiian/Other Pacific Islander (Non-Hispanic)	0.0000
## IPEDS.EthnicityNo Value	0.0000
## IPEDS.EthnicityNon-Resident Alien	0.0000
## IPEDS.EthnicityTwo or More Races (Non-Hispanic)	0.0196
## IPEDS.EthnicityUnknown	0.0458
## IPEDS.EthnicityWhite (Non-Hispanic)	0.5294
## Gender.CodeF	0.8235
## Gender.CodeM	0.1765
## Gender.CodeN	0.0000
## Gender.CodeN/V	0.0000
## Gender.CodeU	0.0000
## HS.GPA	3.4564
## Student.Orientation.FlagN	0.5163
## Student.Orientation.FlagY	0.4837

##

	Means Control
## IPEDS.EthnicityAmerican Indian/Alaskan Native Only (American Indian) (Non-Hispanic)	0.0000
## IPEDS.EthnicityAsian (Non-Hispanic)	0.0458
## IPEDS.EthnicityBlack/African American (Non-Hispanic)	0.0131
## IPEDS.EthnicityHispanic/Latino (any race)	0.3464
## IPEDS.EthnicityNative Hawaiian/Other Pacific Islander (Non-Hispanic)	0.0000
## IPEDS.EthnicityNo Value	0.0000
## IPEDS.EthnicityNon-Resident Alien	0.0000

## IPEDS.EthnicityTwo or More Races (Non-Hispanic)	0.0196
## IPEDS.EthnicityUnknown	0.0458
## IPEDS.EthnicityWhite (Non-Hispanic)	0.5294
## Gender.CodeF	0.8235
## Gender.CodeM	0.1765
## Gender.CodeN	0.0000
## Gender.CodeN/V	0.0000
## Gender.CodeU	0.0000
## HS.GPA	3.4435
## Student.Orientation.FlagN	0.5163
## Student.Orientation.FlagY	0.4837
##	Std. Mean Diff.
## IPEDS.EthnicityAmerican Indian/Alaskan Native Only (American Indian) (Non-Hispanic)	0.0000
## IPEDS.EthnicityAsian (Non-Hispanic)	0.0000
## IPEDS.EthnicityBlack/African American (Non-Hispanic)	0.0000
## IPEDS.EthnicityHispanic/Latino (any race)	0.0000
## IPEDS.EthnicityNative Hawaiian/Other Pacific Islander (Non-Hispanic)	0.0000
## IPEDS.EthnicityNo Value	0.0000
## IPEDS.EthnicityNon-Resident Alien	0.0000
## IPEDS.EthnicityTwo or More Races (Non-Hispanic)	0.0000
## IPEDS.EthnicityUnknown	0.0000
## IPEDS.EthnicityWhite (Non-Hispanic)	0.0000
## Gender.CodeF	-0.0000
## Gender.CodeM	0.0000
## Gender.CodeN	0.0000
## Gender.CodeN/V	0.0000
## Gender.CodeU	0.0000
## HS.GPA	0.0325
## Student.Orientation.FlagN	0.0000
## Student.Orientation.FlagY	0.0000
##	Var. Ratio
## IPEDS.EthnicityAmerican Indian/Alaskan Native Only (American Indian) (Non-Hispanic)	.
## IPEDS.EthnicityAsian (Non-Hispanic)	.
## IPEDS.EthnicityBlack/African American (Non-Hispanic)	.
## IPEDS.EthnicityHispanic/Latino (any race)	.
## IPEDS.EthnicityNative Hawaiian/Other Pacific Islander (Non-Hispanic)	.
## IPEDS.EthnicityNo Value	.
## IPEDS.EthnicityNon-Resident Alien	.
## IPEDS.EthnicityTwo or More Races (Non-Hispanic)	.
## IPEDS.EthnicityUnknown	.
## IPEDS.EthnicityWhite (Non-Hispanic)	.
## Gender.CodeF	.
## Gender.CodeM	.
## Gender.CodeN	.
## Gender.CodeN/V	.
## Gender.CodeU	.
## HS.GPA	0.9157
## Student.Orientation.FlagN	.
## Student.Orientation.FlagY	.
##	eCDF Mean
## IPEDS.EthnicityAmerican Indian/Alaskan Native Only (American Indian) (Non-Hispanic)	0.0000
## IPEDS.EthnicityAsian (Non-Hispanic)	0.0000
## IPEDS.EthnicityBlack/African American (Non-Hispanic)	0.0000
## IPEDS.EthnicityHispanic/Latino (any race)	0.0000

## IPEDS.EthnicityNative Hawaiian/Other Pacific Islander (Non-Hispanic)	0.0000
## IPEDS.EthnicityNo Value	0.0000
## IPEDS.EthnicityNon-Resident Alien	0.0000
## IPEDS.EthnicityTwo or More Races (Non-Hispanic)	0.0000
## IPEDS.EthnicityUnknown	0.0000
## IPEDS.EthnicityWhite (Non-Hispanic)	0.0000
## Gender.CodeF	0.0000
## Gender.CodeM	0.0000
## Gender.CodeN	0.0000
## Gender.CodeN/V	0.0000
## Gender.CodeU	0.0000
## HS.GPA	0.0215
## Student.Orientation.FlagN	0.0000
## Student.Orientation.FlagY	0.0000
##	eCDF Max
## IPEDS.EthnicityAmerican Indian/Alaskan Native Only (American Indian) (Non-Hispanic)	0.0000
## IPEDS.EthnicityAsian (Non-Hispanic)	0.0000
## IPEDS.EthnicityBlack/African American (Non-Hispanic)	0.0000
## IPEDS.EthnicityHispanic/Latino (any race)	0.0000
## IPEDS.EthnicityNative Hawaiian/Other Pacific Islander (Non-Hispanic)	0.0000
## IPEDS.EthnicityNo Value	0.0000
## IPEDS.EthnicityNon-Resident Alien	0.0000
## IPEDS.EthnicityTwo or More Races (Non-Hispanic)	0.0000
## IPEDS.EthnicityUnknown	0.0000
## IPEDS.EthnicityWhite (Non-Hispanic)	0.0000
## Gender.CodeF	0.0000
## Gender.CodeM	0.0000
## Gender.CodeN	0.0000
## Gender.CodeN/V	0.0000
## Gender.CodeU	0.0000
## HS.GPA	0.1002
## Student.Orientation.FlagN	0.0000
## Student.Orientation.FlagY	0.0000
##	Std. Pair Dist.
## IPEDS.EthnicityAmerican Indian/Alaskan Native Only (American Indian) (Non-Hispanic)	0.0000
## IPEDS.EthnicityAsian (Non-Hispanic)	0.0000
## IPEDS.EthnicityBlack/African American (Non-Hispanic)	0.0000
## IPEDS.EthnicityHispanic/Latino (any race)	0.0000
## IPEDS.EthnicityNative Hawaiian/Other Pacific Islander (Non-Hispanic)	0.0000
## IPEDS.EthnicityNo Value	0.0000
## IPEDS.EthnicityNon-Resident Alien	0.0000
## IPEDS.EthnicityTwo or More Races (Non-Hispanic)	0.0000
## IPEDS.EthnicityUnknown	0.0000
## IPEDS.EthnicityWhite (Non-Hispanic)	0.0000
## Gender.CodeF	0.0000
## Gender.CodeM	0.0000
## Gender.CodeN	0.0000
## Gender.CodeN/V	0.0000
## Gender.CodeU	0.0000
## HS.GPA	0.1884
## Student.Orientation.FlagN	0.0000
## Student.Orientation.FlagY	0.0000
##	
## Percent Balance Improvement:	

	Std. Mean Diff.
##	
## IPEDS.EthnicityAmerican Indian/Alaskan Native Only (American Indian) (Non-Hispanic)	0.0
## IPEDS.EthnicityAsian (Non-Hispanic)	100.0
## IPEDS.EthnicityBlack/African American (Non-Hispanic)	100.0
## IPEDS.EthnicityHispanic/Latino (any race)	100.0
## IPEDS.EthnicityNative Hawaiian/Other Pacific Islander (Non-Hispanic)	100.0
## IPEDS.EthnicityNo Value	0.0
## IPEDS.EthnicityNon-Resident Alien	100.0
## IPEDS.EthnicityTwo or More Races (Non-Hispanic)	100.0
## IPEDS.EthnicityUnknown	100.0
## IPEDS.EthnicityWhite (Non-Hispanic)	100.0
## Gender.CodeF	100.0
## Gender.CodeM	100.0
## Gender.CodeN	0.0
## Gender.CodeN/V	0.0
## Gender.CodeU	0.0
## HS.GPA	87.3
## Student.Orientation.FlagN	100.0
## Student.Orientation.FlagY	100.0
##	
	Var. Ratio
## IPEDS.EthnicityAmerican Indian/Alaskan Native Only (American Indian) (Non-Hispanic)	.
## IPEDS.EthnicityAsian (Non-Hispanic)	.
## IPEDS.EthnicityBlack/African American (Non-Hispanic)	.
## IPEDS.EthnicityHispanic/Latino (any race)	.
## IPEDS.EthnicityNative Hawaiian/Other Pacific Islander (Non-Hispanic)	.
## IPEDS.EthnicityNo Value	.
## IPEDS.EthnicityNon-Resident Alien	.
## IPEDS.EthnicityTwo or More Races (Non-Hispanic)	.
## IPEDS.EthnicityUnknown	.
## IPEDS.EthnicityWhite (Non-Hispanic)	.
## Gender.CodeF	.
## Gender.CodeM	.
## Gender.CodeN	.
## Gender.CodeN/V	.
## Gender.CodeU	.
## HS.GPA	30.2
## Student.Orientation.FlagN	.
## Student.Orientation.FlagY	.
##	
	eCDF Mean
## IPEDS.EthnicityAmerican Indian/Alaskan Native Only (American Indian) (Non-Hispanic)	0.0
## IPEDS.EthnicityAsian (Non-Hispanic)	100.0
## IPEDS.EthnicityBlack/African American (Non-Hispanic)	100.0
## IPEDS.EthnicityHispanic/Latino (any race)	100.0
## IPEDS.EthnicityNative Hawaiian/Other Pacific Islander (Non-Hispanic)	100.0
## IPEDS.EthnicityNo Value	0.0
## IPEDS.EthnicityNon-Resident Alien	100.0
## IPEDS.EthnicityTwo or More Races (Non-Hispanic)	100.0
## IPEDS.EthnicityUnknown	100.0
## IPEDS.EthnicityWhite (Non-Hispanic)	100.0
## Gender.CodeF	100.0
## Gender.CodeM	100.0
## Gender.CodeN	0.0
## Gender.CodeN/V	0.0
## Gender.CodeU	0.0

```
## HS.GPA 64.1
## Student.Orientation.FlagN 100.0
## Student.Orientation.FlagY 100.0
## eCDF Max
## IPEDS.EthnicityAmerican Indian/Alaskan Native Only (American Indian) (Non-Hispanic) 0.0
## IPEDS.EthnicityAsian (Non-Hispanic) 100.0
## IPEDS.EthnicityBlack/African American (Non-Hispanic) 100.0
## IPEDS.EthnicityHispanic/Latino (any race) 100.0
## IPEDS.EthnicityNative Hawaiian/Other Pacific Islander (Non-Hispanic) 100.0
## IPEDS.EthnicityNo Value 0.0
## IPEDS.EthnicityNon-Resident Alien 100.0
## IPEDS.EthnicityTwo or More Races (Non-Hispanic) 100.0
## IPEDS.EthnicityUnknown 100.0
## IPEDS.EthnicityWhite (Non-Hispanic) 100.0
## Gender.CodeF 100.0
## Gender.CodeM 100.0
## Gender.CodeN 0.0
## Gender.CodeN/V 0.0
## Gender.CodeU 0.0
## HS.GPA 39.3
## Student.Orientation.FlagN 100.0
## Student.Orientation.FlagY 100.0
##
## Sample Sizes:
## Control Treated
## All 66. 182.
## Matched (ESS) 32.03 100.32
## Matched 45. 108.
## Unmatched 21. 74.
## Discarded 0. 0.

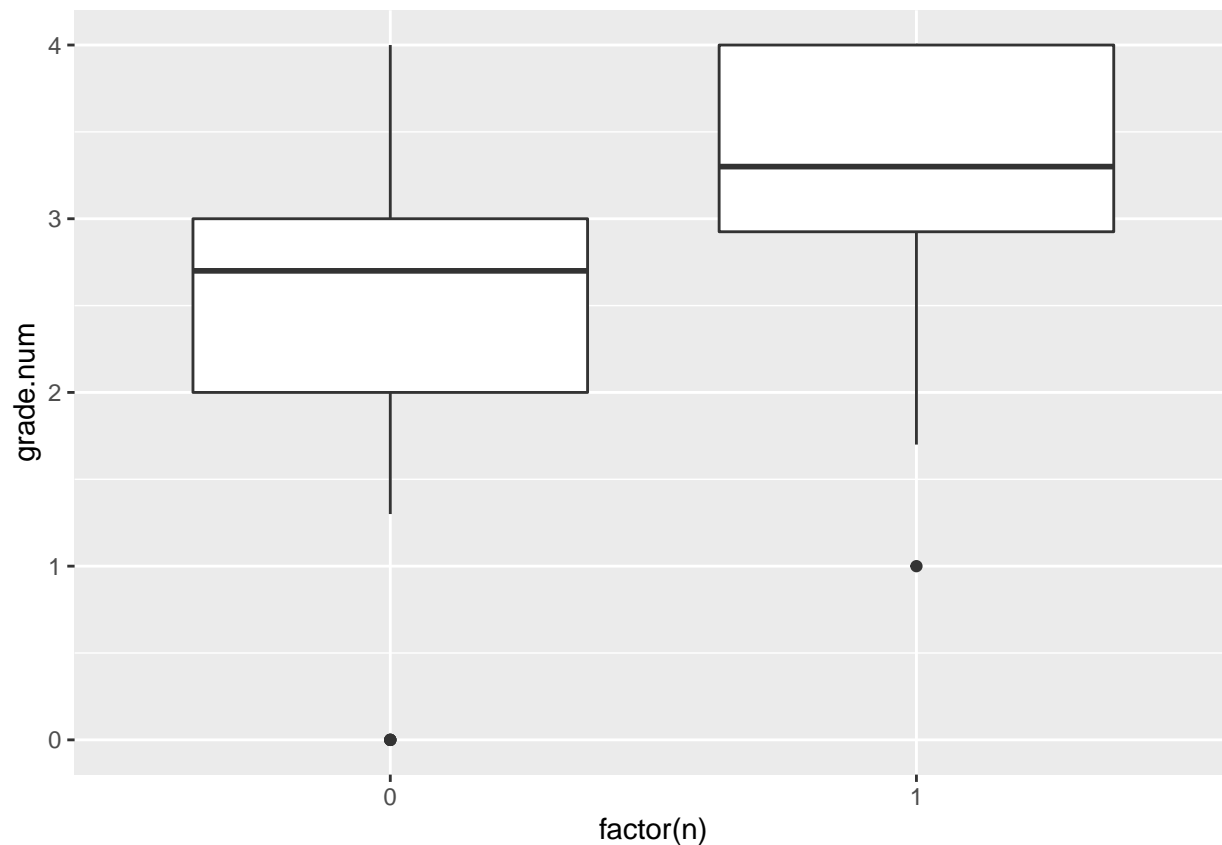
# Extract Matchings

matched_df1 <- match.data(matching) %>% arrange(subclass, n)

# Estimate Causal Impact

matched_df1 %>% ggplot(aes(factor(n), grade.num)) + geom_boxplot()
```





```
matched_df1 %>% group_by(n) %>% summarise(mean = mean(grade.num))
```

```
## # A tibble: 2 x 2
```

```
##       n   mean
```

```
##   <dbl> <dbl>
```

```
## 1     0  2.39
```

```
## 2     1  3.28
```

```
model1 <- lm(grade.num ~ factor(n), data = matched_df1,
             weights = weights)
coeftest(model1, vcov. = vcovCL,
          cluster = ~subclass)
```

```
##
```

```
## t test of coefficients:
```

```
##
```

```
##           Estimate Std. Error t value Pr(>|t|)
```

```
## (Intercept)  2.47146    0.16039 15.4086 < 2.2e-16 ***
```

```
## factor(n)1   0.79596    0.15037  5.2932 4.163e-07 ***
```

```
## ---
```

```
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```