

lasso

Getting Started

Libraries

Data

```
dust<- read_csv(here("data", "processed_data", "dust_master.csv")) #Different Dust attribut
```

```
Rows: 32 Columns: 9
```

```
-- Column specification -----
```

```
Delimiter: ","
```

```
dbl (8): t1, t7, t13, t19, tsum, tavg, t7sum, t7avg
```

```
date (1): date
```

```
i Use `spec()` to retrieve the full column specification for this data.
```

```
i Specify the column types or set `show_col_types = FALSE` to quiet this message.
```

```
data<- read_csv(here("data", "processed_data", "tx_master.csv")) #Master Data
```

```
New names:
```

```
Rows: 1005 Columns: 26
```

```
-- Column specification
```

```
----- Delimiter: "," chr
```

```
(3): hr_cst, site, Type dbl (22): ...1, SUM, dust, chl, sal, temp, do_mgl,
```

```
do_per, pH, secchi, amm,... date (1): date
```

```
i Use `spec()` to retrieve the full column specification for this data. i
```

```
Specify the column types or set `show_col_types = FALSE` to quiet this message.
```

```
* `` -> `...1`
```

Cleaning

Clean and Trim

```
dust<- dust %>%
  filter(!is.na(date),
         date %in% as.Date("2022-07-04"):as.Date("2022-07-19"))

data<- data %>%
  filter(date %in% as.Date("2022-07-04"):as.Date("2022-07-19"))
```

Make into one data set

```
master<-
  dust %>% full_join(data) %>%
  filter(hr_cst %in% "01") #While this is technically not for hour 1, this gets ride of al
```

Joining, by = "date"

```
master<- master %>%
  select(site, sal, temp, copies_mL,t7sum, date, orthop,nn, don,doc) %>%
  mutate(t7sum = log10(t7sum))
```

Site-specific Data sets and Clean df

```
b<- master %>%
  filter(site %in% "Blind Oso" | date %in% as.Date('2022-07-05') : as.Date('2022-07-06'))
b<- b %>%
  mutate(
    lag =Lag(b$t7sum, shift = 1)) %>% #Create 1 day lag
  filter(between(date, as.Date('2022-07-07'), as.Date('2022-07-19')) %>%
  select(!c(date,t7sum,site)) %>%
  rename("log10dust" = "lag")

c<- master %>%
  filter(site %in% "Canals" | date %in% as.Date('2022-07-05') : as.Date('2022-07-06'))
c<- c %>%
  mutate(
```

```

lag =Lag(c$t7sum, shift = 2)) %>% #Create 2 day lag
filter(between(date, as.Date('2022-07-07'), as.Date('2022-07-19')))) %>%
select(!c(date,t7sum,site)) %>%
  rename("log10dust" = "lag")

r<- master %>%
  filter(site %in% "Gulf" | date %in% as.Date('2022-07-05') : as.Date('2022-07-06'))
r<- r %>%
mutate(
  lag =Lag(r$t7sum, shift = 1)) %>% #Create 1 day lag
filter(between(date, as.Date('2022-07-07'), as.Date('2022-07-19')))) %>%
select(!c(date,t7sum,site)) %>%
  rename("log10dust" = "lag")

```

Models

0. Null Model:

Create 5 Fold

```

fold_bo <- vfold_cv(b, v = 5, repeats = 5)
fold_c2 <- vfold_cv(c, v = 5, repeats = 5)
fold_rd <- vfold_cv(r, v = 5, repeats = 5)

```

Make Models

Get Metrics for Null

RMSE

```

null_met_bo <-
  collect_metrics(null_fit_bo)
null_met_bo

```

A tibble: 2 x 6

	.metric	.estimator	mean	n	std_err	.config
	<chr>	<chr>	<dbl>	<int>	<dbl>	<chr>
1	rmse	standard	20868.	25	1513.	Preprocessor1_Model11

```
2 rsq      standard      NaN      0      NA Preprocessor1_Model1
```

```

null_met_c2 <-
  collect_metrics(null_fit_c2)
null_met_c2

```

```

# A tibble: 2 x 6
  .metric .estimator  mean      n std_err .config
  <chr>   <chr>      <dbl> <int>   <dbl> <chr>
1 rmse    standard  8231.    25    595. Preprocessor1_Model1
2 rsq     standard   NaN      0     NA  Preprocessor1_Model1

```

```

null_met_rd <-
  collect_metrics(null_fit_rd)
null_met_rd

```

```

# A tibble: 2 x 6
  .metric .estimator  mean      n std_err .config
  <chr>   <chr>      <dbl> <int>   <dbl> <chr>
1 rmse    standard  52605.    25   3067. Preprocessor1_Model1
2 rsq     standard   NaN      0     NA  Preprocessor1_Model1

```

```

rmnb<- 20178.47
rmnc<- 8091.394
rmnr<- 52065.59

```

AIC

```

bo_null_mod<-
  lm(copies_mL ~ 1, data = b)
AIC(bo_null_mod) %>% round(digits = 2)

```

```
[1] 275.93
```

```

c2_null_mod<-
  lm(copies_mL ~ 1, data = c)
AIC(c2_null_mod) %>% round(digits = 2)

```

```
[1] 253.19
```

```
rd_null_mod<-  
  lm(copies_mL ~ 1, data = r)  
AIC(rd_null_mod) %>% round(digits = 2)
```

```
[1] 296.98
```

Blind Oso Random Forest

Recipe

```
rec<- recipe(copies_mL ~ ., data = b)
```

```
cores <- parallel::detectCores()  
cores
```

```
[1] 8
```

Specify Model

```
rf_mod <-  
  rand_forest(mtry = tune(), min_n = tune(), trees = 1000) %>%  
  set_engine("ranger", num.threads = cores) %>%  
  set_mode("regression")
```

Creating Workflow

```
rf_wf <- workflow() %>%  
  add_model(rf_mod) %>%  
  add_recipe(rec)
```

Create Tuning Grid

```
rf_grid <- expand_grid(mtry = c(3, 4, 5, 6),  
                      min_n = c(40,50,60),  
                      trees = c(500,1000) )
```

Cross-validation

```
rf_resample <-  
  rf_wf %>%  
    tune_grid(fold_bo,  
              grid = 25,  
              control = control_grid(save_pred = TRUE),  
              metrics = metric_set(rmse))
```

i Creating pre-processing data to finalize unknown parameter: mtry

! Fold1, Repeat1: preprocessor 1/1, model 1/24: 37 samples were requested but there were 9 r

! Fold1, Repeat1: preprocessor 1/1, model 2/24: 30 samples were requested but there were 9 r

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! Fold2, Repeat3: preprocessor 1/1, model 8/24: 20 samples were requested but there were 9 r
! Fold2, Repeat3: preprocessor 1/1, model 9/24: 16 samples were requested but there were 9 r
! Fold2, Repeat3: preprocessor 1/1, model 10/24: 26 samples were requested but there were 9 r
! Fold2, Repeat3: preprocessor 1/1, model 11/24: 10 samples were requested but there were 9 r
! Fold2, Repeat3: preprocessor 1/1, model 13/24: 14 samples were requested but there were 9 r
! Fold2, Repeat3: preprocessor 1/1, model 14/24: 14 samples were requested but there were 9 r
! Fold2, Repeat3: preprocessor 1/1, model 15/24: 36 samples were requested but there were 9 r
! Fold2, Repeat3: preprocessor 1/1, model 18/24: 25 samples were requested but there were 9 r
! Fold2, Repeat3: preprocessor 1/1, model 19/24: 27 samples were requested but there were 9 r
! Fold2, Repeat3: preprocessor 1/1, model 20/24: 35 samples were requested but there were 9 r
! Fold2, Repeat3: preprocessor 1/1, model 21/24: 32 samples were requested but there were 9 r
! Fold2, Repeat3: preprocessor 1/1, model 23/24: 34 samples were requested but there were 9 r
! Fold2, Repeat3: preprocessor 1/1, model 24/24: 40 samples were requested but there were 9 r
! Fold3, Repeat3: preprocessor 1/1, model 1/24: 37 samples were requested but there were 10 r

! Fold3, Repeat3: preprocessor 1/1, model 2/24: 30 samples were requested but there were 10
! Fold3, Repeat3: preprocessor 1/1, model 3/24: 29 samples were requested but there were 10
! Fold3, Repeat3: preprocessor 1/1, model 4/24: 12 samples were requested but there were 10
! Fold3, Repeat3: preprocessor 1/1, model 5/24: 23 samples were requested but there were 10
! Fold3, Repeat3: preprocessor 1/1, model 7/24: 18 samples were requested but there were 10
! Fold3, Repeat3: preprocessor 1/1, model 8/24: 20 samples were requested but there were 10
! Fold3, Repeat3: preprocessor 1/1, model 9/24: 16 samples were requested but there were 10
! Fold3, Repeat3: preprocessor 1/1, model 10/24: 26 samples were requested but there were 10
! Fold3, Repeat3: preprocessor 1/1, model 13/24: 14 samples were requested but there were 10
! Fold3, Repeat3: preprocessor 1/1, model 14/24: 14 samples were requested but there were 10
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! Fold3, Repeat3: preprocessor 1/1, model 20/24: 35 samples were requested but there were 10
! Fold3, Repeat3: preprocessor 1/1, model 21/24: 32 samples were requested but there were 10
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! Fold3, Repeat3: preprocessor 1/1, model 24/24: 40 samples were requested but there were 10
! Fold4, Repeat3: preprocessor 1/1, model 1/24: 37 samples were requested but there were 10
! Fold4, Repeat3: preprocessor 1/1, model 2/24: 30 samples were requested but there were 10

! Fold4, Repeat3: preprocessor 1/1, model 3/24: 29 samples were requested but there were 10
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! Fold4, Repeat3: preprocessor 1/1, model 7/24: 18 samples were requested but there were 10
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! Fold5, Repeat3: preprocessor 1/1, model 1/24: 37 samples were requested but there were 10
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! Fold5, Repeat3: preprocessor 1/1, model 24/24: 40 samples were requested but there were 10 r

! Fold1, Repeat4: preprocessor 1/1, model 1/24: 37 samples were requested but there were 9 r

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! Fold4, Repeat4: preprocessor 1/1, model 24/24: 40 samples were requested but there were 10
! Fold5, Repeat4: preprocessor 1/1, model 1/24: 37 samples were requested but there were 10
! Fold5, Repeat4: preprocessor 1/1, model 2/24: 30 samples were requested but there were 10
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! Fold1, Repeat5: preprocessor 1/1, model 1/24: 37 samples were requested but there were 9 r

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! Fold1, Repeat5: preprocessor 1/1, model 11/24: 10 samples were requested but there were 9 r

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! Fold1, Repeat5: preprocessor 1/1, model 24/24: 40 samples were requested but there were 9 r

! Fold2, Repeat5: preprocessor 1/1, model 1/24: 37 samples were requested but there were 9 r

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! Fold3, Repeat5: preprocessor 1/1, model 1/24: 37 samples were requested but there were 10 r

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! Fold4, Repeat5: preprocessor 1/1, model 1/24: 37 samples were requested but there were 10
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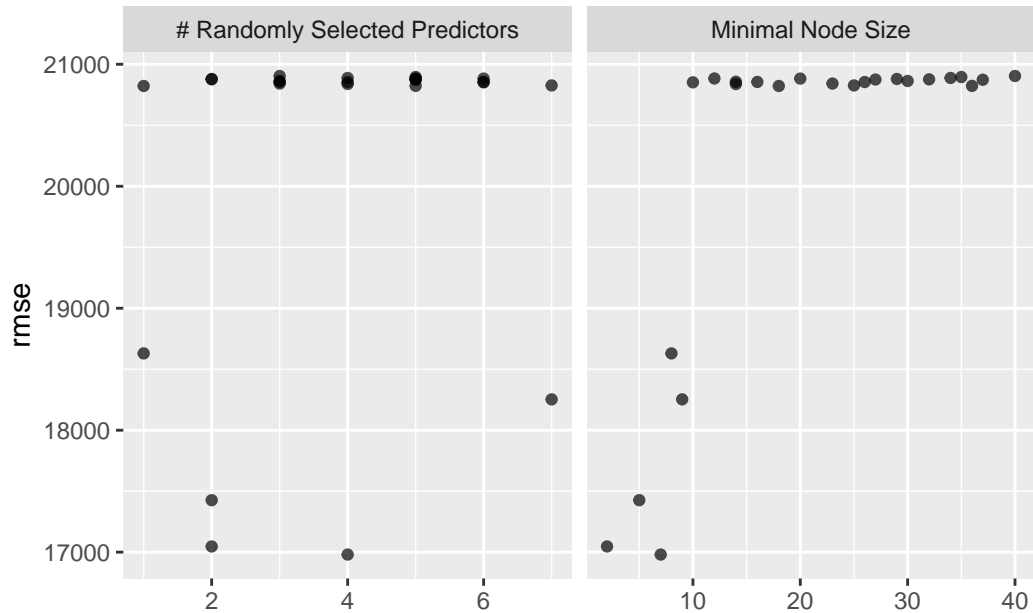
```
! Fold5, Repeat5: preprocessor 1/1, model 13/24: 14 samples were requested but there were 10
! Fold5, Repeat5: preprocessor 1/1, model 14/24: 14 samples were requested but there were 10
! Fold5, Repeat5: preprocessor 1/1, model 15/24: 36 samples were requested but there were 10
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! Fold5, Repeat5: preprocessor 1/1, model 23/24: 34 samples were requested but there were 10
! Fold5, Repeat5: preprocessor 1/1, model 24/24: 40 samples were requested but there were 10
```

```
rf_resample %>%
  collect_metrics()
```

```
# A tibble: 24 x 8
  mtry min_n .metric .estimator   mean     n std_err .config
  <int> <int> <chr>    <chr>    <dbl> <int>   <dbl> <chr>
1     5     37 rmse    standard 20873.    25   1507. Preprocessor1_Model01
2     3     30 rmse    standard 20863.    25   1527. Preprocessor1_Model02
3     2     29 rmse    standard 20880.    25   1509. Preprocessor1_Model03
4     5     12 rmse    standard 20884.    25   1500. Preprocessor1_Model04
5     3     23 rmse    standard 20842.    25   1512. Preprocessor1_Model05
6     7      9 rmse    standard 18253.    25   2101. Preprocessor1_Model06
7     1     18 rmse    standard 20822.    25   1513. Preprocessor1_Model07
8     6     20 rmse    standard 20883.    25   1505. Preprocessor1_Model08
9     6     16 rmse    standard 20855.    25   1515. Preprocessor1_Model09
10    4     26 rmse    standard 20855.    25   1510. Preprocessor1_Model10
# ... with 14 more rows
```

Plot Model Performance

```
#Plot of actual train data
rf_resample %>%
  autoplot()
```



Showing and Selecting Best Performing Models

```
#Showing best performing tree models
rf_resample %>%
  show_best(n=1)
```

```
# A tibble: 1 x 8
  mtry min_n .metric .estimator  mean     n std_err .config
<int> <int> <chr>   <chr>      <dbl> <int>   <dbl> <chr>
1     4     7 rmse     standard 16980.    25   2144. Preprocessor1_Model22
```

```
#Selects best performing model
best_rf <- rf_resample %>%
  select_best(method = "rmse")
rmb<- 15645.98
```

Create Final Fit

```
rf_final_wf <-  
  rf_wf %>%  
    finalize_workflow(best_rf)  
  
#Create workflow for fitting model to train_data2 predictions  
rf_final_fit <-  
  rf_final_wf %>%  
    fit(b)
```

Calculate Residuals

```
rf_residuals <- rf_final_fit %>%  
  augment(b) %>% #use augment() to make predictions from train data  
  select(c(.pred, copies_mL)) %>%  
  mutate(.resid = copies_mL - .pred) #calculate residuals and make new row.  
  
rf_residuals
```

```
# A tibble: 12 x 3  
  .pred copies_mL .resid  
  <dbl>     <dbl> <dbl>  
1 32619.    25462. -7157.  
2 31842.    33586.  1745.  
3 34360.    29093. -5267.  
4 39020.    45875.  6855.  
5 28766.    18960. -9806.  
6 32218.    30245. -1973.  
7 60907.    85816. 24909.  
8 35537.    34586.  -951.  
9 36577.    32447. -4130.  
10 63715.    69065.  5350.  
11 56577.    50214. -6363.  
12 66229.    71334.  5105.
```

Model Predictions from Tuned Model vs Actual Outcomes

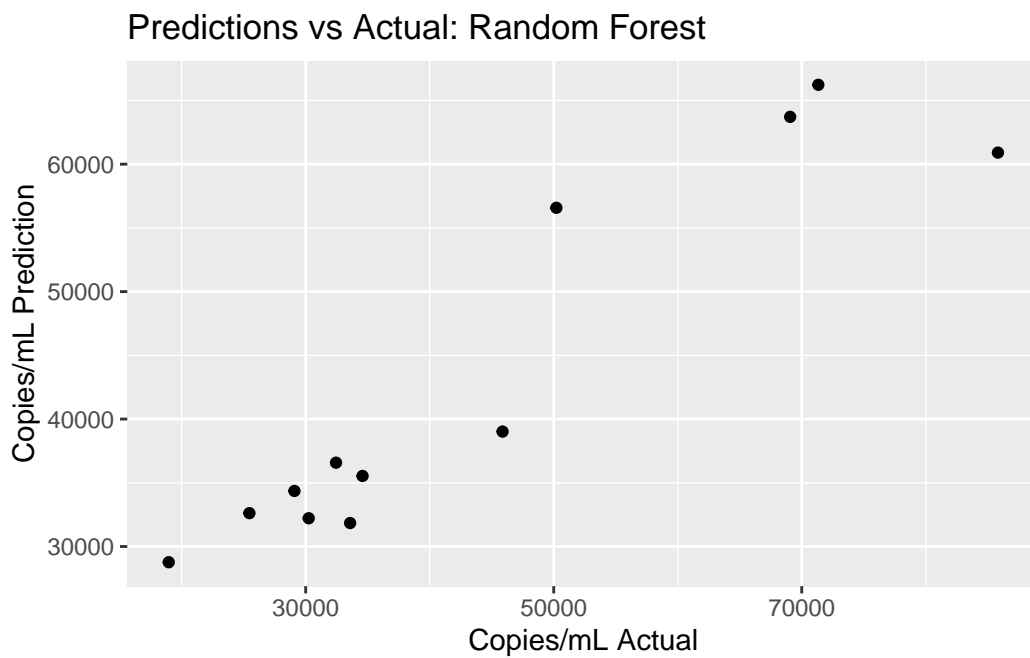
```
rf_pred_plot <- ggplot(rf_residuals,  
  aes(x = copies_mL,
```



```

    y = .pred)) +
  geom_point() +
  labs(title = "Predictions vs Actual: Random Forest",
       x = "Copies/mL Actual",
       y = "Copies/mL Prediction")
rf_pred_plot

```

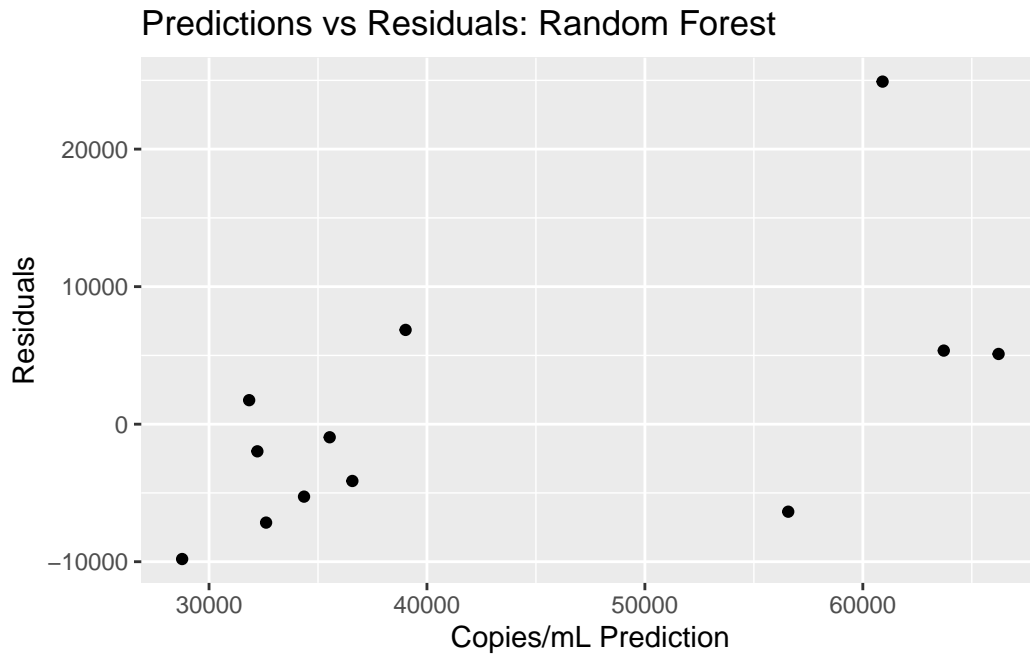


```

rf_residual_plot <- ggplot(rf_residuals,
                           aes(y = .resid,
                               x = .pred)) +

  geom_point() +
  labs(title = "Predictions vs Residuals: Random Forest",
       x = "Copies/mL Prediction",
       y = "Residuals")
plot(rf_residual_plot) #view plot

```



Canals Random Forest

Recipe

```
rec<- recipe(copies_mL ~ ., data = c)
```

```
cores <- parallel::detectCores()  
cores
```

```
[1] 8
```

Specify Model

```
rf_mod <-  
  rand_forest(mtry = tune(), min_n = tune(), trees = 1000) %>%  
  set_engine("ranger", num.threads = cores) %>%  
  set_mode("regression")
```

Creating Workflow

```
rf_wf <- workflow() %>%
  add_model(rf_mod) %>%
  add_recipe(rec)
```

Create Tuning Grid

```
rf_grid <- expand_grid(mtry = c(3, 4, 5, 6),
                      min_n = c(40,50,60),
                      trees = c(500,1000) )
```

Cross-validation

```
rf_resample <-
  rf_wf %>%
  tune_grid(fold_c2,
            grid = 25,
            control = control_grid(save_pred = TRUE),
            metrics = metric_set(rmse))
```

i Creating pre-processing data to finalize unknown parameter: mtry

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! Fold4, Repeat3: preprocessor 1/1, model 3/25: 30 samples were requested but there were 10

! Fold4, Repeat3: preprocessor 1/1, model 4/25: 40 samples were requested but there were 10
! Fold4, Repeat3: preprocessor 1/1, model 5/25: 25 samples were requested but there were 10
! Fold4, Repeat3: preprocessor 1/1, model 6/25: 18 samples were requested but there were 10
! Fold4, Repeat3: preprocessor 1/1, model 7/25: 33 samples were requested but there were 10
! Fold4, Repeat3: preprocessor 1/1, model 8/25: 14 samples were requested but there were 10
! Fold4, Repeat3: preprocessor 1/1, model 11/25: 37 samples were requested but there were 10
! Fold4, Repeat3: preprocessor 1/1, model 12/25: 11 samples were requested but there were 10
! Fold4, Repeat3: preprocessor 1/1, model 13/25: 32 samples were requested but there were 10
! Fold4, Repeat3: preprocessor 1/1, model 14/25: 15 samples were requested but there were 10
! Fold4, Repeat3: preprocessor 1/1, model 16/25: 24 samples were requested but there were 10
! Fold4, Repeat3: preprocessor 1/1, model 17/25: 37 samples were requested but there were 10
! Fold4, Repeat3: preprocessor 1/1, model 18/25: 16 samples were requested but there were 10
! Fold4, Repeat3: preprocessor 1/1, model 19/25: 23 samples were requested but there were 10
! Fold4, Repeat3: preprocessor 1/1, model 21/25: 35 samples were requested but there were 10
! Fold4, Repeat3: preprocessor 1/1, model 22/25: 28 samples were requested but there were 10
! Fold4, Repeat3: preprocessor 1/1, model 24/25: 26 samples were requested but there were 10
! Fold4, Repeat3: preprocessor 1/1, model 25/25: 21 samples were requested but there were 10
! Fold5, Repeat3: preprocessor 1/1, model 2/25: 20 samples were requested but there were 10
! Fold5, Repeat3: preprocessor 1/1, model 3/25: 30 samples were requested but there were 10

! Fold5, Repeat3: preprocessor 1/1, model 4/25: 40 samples were requested but there were 10 r

! Fold5, Repeat3: preprocessor 1/1, model 5/25: 25 samples were requested but there were 10 r

! Fold5, Repeat3: preprocessor 1/1, model 6/25: 18 samples were requested but there were 10 r

! Fold5, Repeat3: preprocessor 1/1, model 7/25: 33 samples were requested but there were 10 r

! Fold5, Repeat3: preprocessor 1/1, model 8/25: 14 samples were requested but there were 10 r

! Fold5, Repeat3: preprocessor 1/1, model 11/25: 37 samples were requested but there were 10 r

! Fold5, Repeat3: preprocessor 1/1, model 12/25: 11 samples were requested but there were 10 r

! Fold5, Repeat3: preprocessor 1/1, model 13/25: 32 samples were requested but there were 10 r

! Fold5, Repeat3: preprocessor 1/1, model 14/25: 15 samples were requested but there were 10 r

! Fold5, Repeat3: preprocessor 1/1, model 16/25: 24 samples were requested but there were 10 r

! Fold5, Repeat3: preprocessor 1/1, model 17/25: 37 samples were requested but there were 10 r

! Fold5, Repeat3: preprocessor 1/1, model 18/25: 16 samples were requested but there were 10 r

! Fold5, Repeat3: preprocessor 1/1, model 19/25: 23 samples were requested but there were 10 r

! Fold5, Repeat3: preprocessor 1/1, model 21/25: 35 samples were requested but there were 10 r

! Fold5, Repeat3: preprocessor 1/1, model 22/25: 28 samples were requested but there were 10 r

! Fold5, Repeat3: preprocessor 1/1, model 24/25: 26 samples were requested but there were 10 r

! Fold5, Repeat3: preprocessor 1/1, model 25/25: 21 samples were requested but there were 10 r

! Fold1, Repeat4: preprocessor 1/1, model 2/25: 20 samples were requested but there were 9 r

! Fold1, Repeat4: preprocessor 1/1, model 3/25: 30 samples were requested but there were 9 r

! Fold1, Repeat4: preprocessor 1/1, model 4/25: 40 samples were requested but there were 9 r
! Fold1, Repeat4: preprocessor 1/1, model 5/25: 25 samples were requested but there were 9 r
! Fold1, Repeat4: preprocessor 1/1, model 6/25: 18 samples were requested but there were 9 r
! Fold1, Repeat4: preprocessor 1/1, model 7/25: 33 samples were requested but there were 9 r
! Fold1, Repeat4: preprocessor 1/1, model 8/25: 14 samples were requested but there were 9 r
! Fold1, Repeat4: preprocessor 1/1, model 11/25: 37 samples were requested but there were 9 r
! Fold1, Repeat4: preprocessor 1/1, model 12/25: 11 samples were requested but there were 9 r
! Fold1, Repeat4: preprocessor 1/1, model 13/25: 32 samples were requested but there were 9 r
! Fold1, Repeat4: preprocessor 1/1, model 14/25: 15 samples were requested but there were 9 r
! Fold1, Repeat4: preprocessor 1/1, model 15/25: 10 samples were requested but there were 9 r
! Fold1, Repeat4: preprocessor 1/1, model 16/25: 24 samples were requested but there were 9 r
! Fold1, Repeat4: preprocessor 1/1, model 17/25: 37 samples were requested but there were 9 r
! Fold1, Repeat4: preprocessor 1/1, model 18/25: 16 samples were requested but there were 9 r
! Fold1, Repeat4: preprocessor 1/1, model 19/25: 23 samples were requested but there were 9 r
! Fold1, Repeat4: preprocessor 1/1, model 21/25: 35 samples were requested but there were 9 r
! Fold1, Repeat4: preprocessor 1/1, model 22/25: 28 samples were requested but there were 9 r
! Fold1, Repeat4: preprocessor 1/1, model 24/25: 26 samples were requested but there were 9 r
! Fold1, Repeat4: preprocessor 1/1, model 25/25: 21 samples were requested but there were 9 r
! Fold2, Repeat4: preprocessor 1/1, model 2/25: 20 samples were requested but there were 9 r

! Fold2, Repeat4: preprocessor 1/1, model 3/25: 30 samples were requested but there were 9 r
! Fold2, Repeat4: preprocessor 1/1, model 4/25: 40 samples were requested but there were 9 r
! Fold2, Repeat4: preprocessor 1/1, model 5/25: 25 samples were requested but there were 9 r
! Fold2, Repeat4: preprocessor 1/1, model 6/25: 18 samples were requested but there were 9 r
! Fold2, Repeat4: preprocessor 1/1, model 7/25: 33 samples were requested but there were 9 r
! Fold2, Repeat4: preprocessor 1/1, model 8/25: 14 samples were requested but there were 9 r
! Fold2, Repeat4: preprocessor 1/1, model 11/25: 37 samples were requested but there were 9 r
! Fold2, Repeat4: preprocessor 1/1, model 12/25: 11 samples were requested but there were 9 r
! Fold2, Repeat4: preprocessor 1/1, model 13/25: 32 samples were requested but there were 9 r
! Fold2, Repeat4: preprocessor 1/1, model 14/25: 15 samples were requested but there were 9 r
! Fold2, Repeat4: preprocessor 1/1, model 15/25: 10 samples were requested but there were 9 r
! Fold2, Repeat4: preprocessor 1/1, model 16/25: 24 samples were requested but there were 9 r
! Fold2, Repeat4: preprocessor 1/1, model 17/25: 37 samples were requested but there were 9 r
! Fold2, Repeat4: preprocessor 1/1, model 18/25: 16 samples were requested but there were 9 r
! Fold2, Repeat4: preprocessor 1/1, model 19/25: 23 samples were requested but there were 9 r
! Fold2, Repeat4: preprocessor 1/1, model 21/25: 35 samples were requested but there were 9 r
! Fold2, Repeat4: preprocessor 1/1, model 22/25: 28 samples were requested but there were 9 r
! Fold2, Repeat4: preprocessor 1/1, model 24/25: 26 samples were requested but there were 9 r
! Fold2, Repeat4: preprocessor 1/1, model 25/25: 21 samples were requested but there were 9 r

! Fold3, Repeat4: preprocessor 1/1, model 2/25: 20 samples were requested but there were 10
! Fold3, Repeat4: preprocessor 1/1, model 3/25: 30 samples were requested but there were 10
! Fold3, Repeat4: preprocessor 1/1, model 4/25: 40 samples were requested but there were 10
! Fold3, Repeat4: preprocessor 1/1, model 5/25: 25 samples were requested but there were 10
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! Fold3, Repeat4: preprocessor 1/1, model 16/25: 24 samples were requested but there were 10
! Fold3, Repeat4: preprocessor 1/1, model 17/25: 37 samples were requested but there were 10
! Fold3, Repeat4: preprocessor 1/1, model 18/25: 16 samples were requested but there were 10
! Fold3, Repeat4: preprocessor 1/1, model 19/25: 23 samples were requested but there were 10
! Fold3, Repeat4: preprocessor 1/1, model 21/25: 35 samples were requested but there were 10
! Fold3, Repeat4: preprocessor 1/1, model 22/25: 28 samples were requested but there were 10
! Fold3, Repeat4: preprocessor 1/1, model 24/25: 26 samples were requested but there were 10
! Fold3, Repeat4: preprocessor 1/1, model 25/25: 21 samples were requested but there were 10

! Fold4, Repeat4: preprocessor 1/1, model 2/25: 20 samples were requested but there were 10
! Fold4, Repeat4: preprocessor 1/1, model 3/25: 30 samples were requested but there were 10
! Fold4, Repeat4: preprocessor 1/1, model 4/25: 40 samples were requested but there were 10
! Fold4, Repeat4: preprocessor 1/1, model 5/25: 25 samples were requested but there were 10
! Fold4, Repeat4: preprocessor 1/1, model 6/25: 18 samples were requested but there were 10
! Fold4, Repeat4: preprocessor 1/1, model 7/25: 33 samples were requested but there were 10
! Fold4, Repeat4: preprocessor 1/1, model 8/25: 14 samples were requested but there were 10
! Fold4, Repeat4: preprocessor 1/1, model 11/25: 37 samples were requested but there were 10
! Fold4, Repeat4: preprocessor 1/1, model 12/25: 11 samples were requested but there were 10
! Fold4, Repeat4: preprocessor 1/1, model 13/25: 32 samples were requested but there were 10
! Fold4, Repeat4: preprocessor 1/1, model 14/25: 15 samples were requested but there were 10
! Fold4, Repeat4: preprocessor 1/1, model 16/25: 24 samples were requested but there were 10
! Fold4, Repeat4: preprocessor 1/1, model 17/25: 37 samples were requested but there were 10
! Fold4, Repeat4: preprocessor 1/1, model 18/25: 16 samples were requested but there were 10
! Fold4, Repeat4: preprocessor 1/1, model 19/25: 23 samples were requested but there were 10
! Fold4, Repeat4: preprocessor 1/1, model 21/25: 35 samples were requested but there were 10
! Fold4, Repeat4: preprocessor 1/1, model 22/25: 28 samples were requested but there were 10
! Fold4, Repeat4: preprocessor 1/1, model 24/25: 26 samples were requested but there were 10
! Fold4, Repeat4: preprocessor 1/1, model 25/25: 21 samples were requested but there were 10

! Fold5, Repeat4: preprocessor 1/1, model 2/25: 20 samples were requested but there were 10
! Fold5, Repeat4: preprocessor 1/1, model 3/25: 30 samples were requested but there were 10
! Fold5, Repeat4: preprocessor 1/1, model 4/25: 40 samples were requested but there were 10
! Fold5, Repeat4: preprocessor 1/1, model 5/25: 25 samples were requested but there were 10
! Fold5, Repeat4: preprocessor 1/1, model 6/25: 18 samples were requested but there were 10
! Fold5, Repeat4: preprocessor 1/1, model 7/25: 33 samples were requested but there were 10
! Fold5, Repeat4: preprocessor 1/1, model 8/25: 14 samples were requested but there were 10
! Fold5, Repeat4: preprocessor 1/1, model 11/25: 37 samples were requested but there were 10
! Fold5, Repeat4: preprocessor 1/1, model 12/25: 11 samples were requested but there were 10
! Fold5, Repeat4: preprocessor 1/1, model 13/25: 32 samples were requested but there were 10
! Fold5, Repeat4: preprocessor 1/1, model 14/25: 15 samples were requested but there were 10
! Fold5, Repeat4: preprocessor 1/1, model 16/25: 24 samples were requested but there were 10
! Fold5, Repeat4: preprocessor 1/1, model 17/25: 37 samples were requested but there were 10
! Fold5, Repeat4: preprocessor 1/1, model 18/25: 16 samples were requested but there were 10
! Fold5, Repeat4: preprocessor 1/1, model 19/25: 23 samples were requested but there were 10
! Fold5, Repeat4: preprocessor 1/1, model 21/25: 35 samples were requested but there were 10
! Fold5, Repeat4: preprocessor 1/1, model 22/25: 28 samples were requested but there were 10
! Fold5, Repeat4: preprocessor 1/1, model 24/25: 26 samples were requested but there were 10
! Fold5, Repeat4: preprocessor 1/1, model 25/25: 21 samples were requested but there were 10

! Fold1, Repeat5: preprocessor 1/1, model 2/25: 20 samples were requested but there were 9 r
! Fold1, Repeat5: preprocessor 1/1, model 3/25: 30 samples were requested but there were 9 r
! Fold1, Repeat5: preprocessor 1/1, model 4/25: 40 samples were requested but there were 9 r
! Fold1, Repeat5: preprocessor 1/1, model 5/25: 25 samples were requested but there were 9 r
! Fold1, Repeat5: preprocessor 1/1, model 6/25: 18 samples were requested but there were 9 r
! Fold1, Repeat5: preprocessor 1/1, model 7/25: 33 samples were requested but there were 9 r
! Fold1, Repeat5: preprocessor 1/1, model 8/25: 14 samples were requested but there were 9 r
! Fold1, Repeat5: preprocessor 1/1, model 11/25: 37 samples were requested but there were 9 r
! Fold1, Repeat5: preprocessor 1/1, model 12/25: 11 samples were requested but there were 9 r
! Fold1, Repeat5: preprocessor 1/1, model 13/25: 32 samples were requested but there were 9 r
! Fold1, Repeat5: preprocessor 1/1, model 14/25: 15 samples were requested but there were 9 r
! Fold1, Repeat5: preprocessor 1/1, model 15/25: 10 samples were requested but there were 9 r
! Fold1, Repeat5: preprocessor 1/1, model 16/25: 24 samples were requested but there were 9 r
! Fold1, Repeat5: preprocessor 1/1, model 17/25: 37 samples were requested but there were 9 r
! Fold1, Repeat5: preprocessor 1/1, model 18/25: 16 samples were requested but there were 9 r
! Fold1, Repeat5: preprocessor 1/1, model 19/25: 23 samples were requested but there were 9 r
! Fold1, Repeat5: preprocessor 1/1, model 21/25: 35 samples were requested but there were 9 r
! Fold1, Repeat5: preprocessor 1/1, model 22/25: 28 samples were requested but there were 9 r
! Fold1, Repeat5: preprocessor 1/1, model 24/25: 26 samples were requested but there were 9 r

! Fold1, Repeat5: preprocessor 1/1, model 25/25: 21 samples were requested but there were 9 r
! Fold2, Repeat5: preprocessor 1/1, model 2/25: 20 samples were requested but there were 9 r
! Fold2, Repeat5: preprocessor 1/1, model 3/25: 30 samples were requested but there were 9 r
! Fold2, Repeat5: preprocessor 1/1, model 4/25: 40 samples were requested but there were 9 r
! Fold2, Repeat5: preprocessor 1/1, model 5/25: 25 samples were requested but there were 9 r
! Fold2, Repeat5: preprocessor 1/1, model 6/25: 18 samples were requested but there were 9 r
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! Fold2, Repeat5: preprocessor 1/1, model 14/25: 15 samples were requested but there were 9 r
! Fold2, Repeat5: preprocessor 1/1, model 15/25: 10 samples were requested but there were 9 r
! Fold2, Repeat5: preprocessor 1/1, model 16/25: 24 samples were requested but there were 9 r
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! Fold2, Repeat5: preprocessor 1/1, model 21/25: 35 samples were requested but there were 9 r
! Fold2, Repeat5: preprocessor 1/1, model 22/25: 28 samples were requested but there were 9 r

! Fold2, Repeat5: preprocessor 1/1, model 24/25: 26 samples were requested but there were 9 1

! Fold2, Repeat5: preprocessor 1/1, model 25/25: 21 samples were requested but there were 9 1

! Fold3, Repeat5: preprocessor 1/1, model 2/25: 20 samples were requested but there were 10 1

! Fold3, Repeat5: preprocessor 1/1, model 3/25: 30 samples were requested but there were 10 1

! Fold3, Repeat5: preprocessor 1/1, model 4/25: 40 samples were requested but there were 10 1

! Fold3, Repeat5: preprocessor 1/1, model 5/25: 25 samples were requested but there were 10 1

! Fold3, Repeat5: preprocessor 1/1, model 6/25: 18 samples were requested but there were 10 1

! Fold3, Repeat5: preprocessor 1/1, model 7/25: 33 samples were requested but there were 10 1

! Fold3, Repeat5: preprocessor 1/1, model 8/25: 14 samples were requested but there were 10 1

! Fold3, Repeat5: preprocessor 1/1, model 11/25: 37 samples were requested but there were 10 1

! Fold3, Repeat5: preprocessor 1/1, model 12/25: 11 samples were requested but there were 10 1

! Fold3, Repeat5: preprocessor 1/1, model 13/25: 32 samples were requested but there were 10 1

! Fold3, Repeat5: preprocessor 1/1, model 14/25: 15 samples were requested but there were 10 1

! Fold3, Repeat5: preprocessor 1/1, model 16/25: 24 samples were requested but there were 10 1

! Fold3, Repeat5: preprocessor 1/1, model 17/25: 37 samples were requested but there were 10 1

! Fold3, Repeat5: preprocessor 1/1, model 18/25: 16 samples were requested but there were 10 1

! Fold3, Repeat5: preprocessor 1/1, model 19/25: 23 samples were requested but there were 10 1

! Fold3, Repeat5: preprocessor 1/1, model 21/25: 35 samples were requested but there were 10 1

! Fold3, Repeat5: preprocessor 1/1, model 22/25: 28 samples were requested but there were 10 1

! Fold3, Repeat5: preprocessor 1/1, model 24/25: 26 samples were requested but there were 10

! Fold3, Repeat5: preprocessor 1/1, model 25/25: 21 samples were requested but there were 10

! Fold4, Repeat5: preprocessor 1/1, model 2/25: 20 samples were requested but there were 10

! Fold4, Repeat5: preprocessor 1/1, model 3/25: 30 samples were requested but there were 10

! Fold4, Repeat5: preprocessor 1/1, model 4/25: 40 samples were requested but there were 10

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! Fold4, Repeat5: preprocessor 1/1, model 16/25: 24 samples were requested but there were 10

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! Fold5, Repeat5: preprocessor 1/1, model 3/25: 30 samples were requested but there were 10
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! Fold5, Repeat5: preprocessor 1/1, model 5/25: 25 samples were requested but there were 10
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! Fold5, Repeat5: preprocessor 1/1, model 21/25: 35 samples were requested but there were 10
! Fold5, Repeat5: preprocessor 1/1, model 22/25: 28 samples were requested but there were 10
! Fold5, Repeat5: preprocessor 1/1, model 24/25: 26 samples were requested but there were 10
! Fold5, Repeat5: preprocessor 1/1, model 25/25: 21 samples were requested but there were 10

```
rf_resample %>%
  collect_metrics()
```

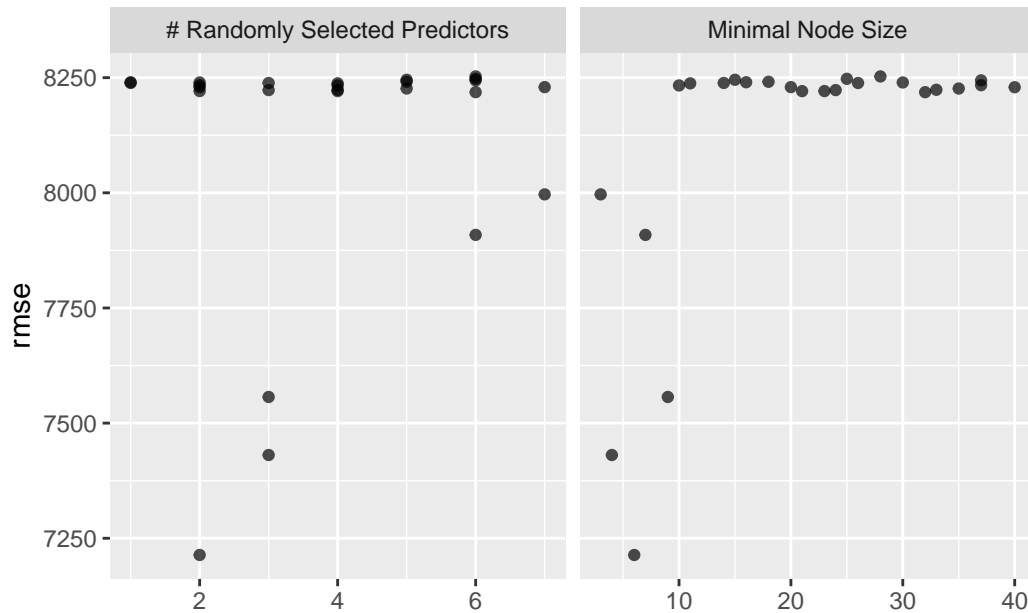
A tibble: 25 x 8

	mtry	min_n	.metric	.estimator	mean	n	std_err	.config
	<int>	<int>	<chr>	<chr>	<dbl>	<int>	<dbl>	<chr>
1	3	9	rmse	standard	7557.	25	545.	Preprocessor1_Model01
2	7	20	rmse	standard	8229.	25	594.	Preprocessor1_Model02
3	2	30	rmse	standard	8240.	25	595.	Preprocessor1_Model03
4	2	40	rmse	standard	8229.	25	594.	Preprocessor1_Model04
5	6	25	rmse	standard	8247.	25	593.	Preprocessor1_Model05
6	5	18	rmse	standard	8241.	25	593.	Preprocessor1_Model06
7	4	33	rmse	standard	8224.	25	594.	Preprocessor1_Model07
8	1	14	rmse	standard	8239.	25	598.	Preprocessor1_Model08
9	6	7	rmse	standard	7909.	25	611.	Preprocessor1_Model09
10	3	4	rmse	standard	7431.	25	526.	Preprocessor1_Model10

... with 15 more rows

Plot Model Performance

```
#Plot of actual train data
rf_resample %>%
  autoplot()
```



Showing and Selecting Best Performing Models

```
#Showing best performing tree models
rf_resample %>%
  show_best(n=1)
```

```
# A tibble: 1 x 8
  mtry min_n .metric .estimator  mean     n std_err .config
<int> <int> <chr>   <chr>      <dbl> <int>   <dbl> <chr>
1     2     6 rmse     standard  7214.    25    525. Preprocessor1_Model123
```

```
#Selects best performing model
best_rf <- rf_resample %>%
  select_best(method = "rmse")
rmc<- 7038.47
```

Create Final Fit

```
rf_final_wf <-
  rf_wf %>%
```

```

finalize_workflow(best_rf)

#Create workflow for fitting model to train_data2 predictions
rf_final_fit <-
  rf_final_wf %>%
  fit(c)

```

Calculate Residuals

```

rf_residuals <- rf_final_fit %>%
  augment(c) %>% #use augment() to make predictions from train data
  select(c(.pred, copies_mL)) %>%
  mutate(.resid = copies_mL - .pred) #calculate residuals and make new row.

rf_residuals

```

```

# A tibble: 12 x 3
  .pred copies_mL .resid
  <dbl>     <dbl>   <dbl>
1 19055.    21658.   2603.
2 12210.    14290.   2081.
3  9077.     4354.  -4723.
4  9686.     6607.  -3079.
5 13697.    14343.    646.
6 16780.    16787.     7.55
7 11705.    10762.   -943.
8 13317.     9155. -4162.
9 18275.    20656.   2381.
10 13221.     8377. -4844.
11 23161.    28785.   5623.
12 23582.    28578.   4996.

```

Model Predictions from Tuned Model vs Actual Outcomes

```

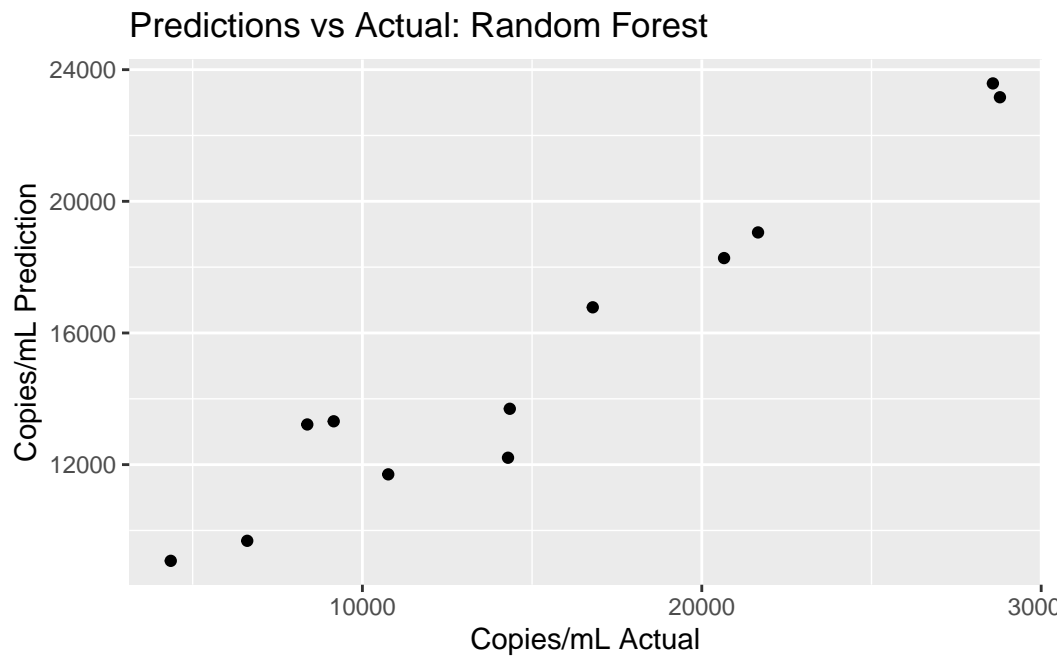
rf_pred_plot <- ggplot(rf_residuals,
  aes(x = copies_mL,
      y = .pred)) +
  geom_point() +
  labs(title = "Predictions vs Actual: Random Forest",

```

```

    x = "Copies/mL Actual",
    y = "Copies/mL Prediction")
rf_pred_plot

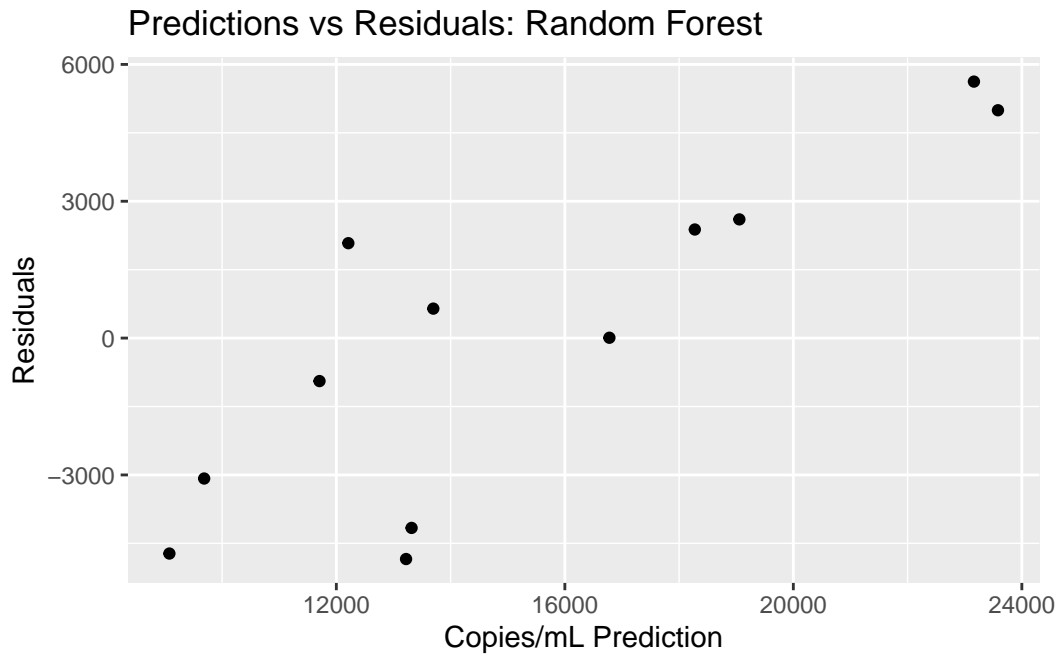
```



```

rf_residual_plot <- ggplot(rf_residuals,
                           aes(y = .resid,
                               x = .pred)) +
  geom_point() +
  labs(title = "Predictions vs Residuals: Random Forest",
       x = "Copies/mL Prediction",
       y = "Residuals")
plot(rf_residual_plot) #view plot

```

Gulf Random Forest

Recipe

```
rec<- recipe(copies_mL ~ ., data = r)
```

```
cores <- parallel::detectCores()  
cores
```

```
[1] 8
```

Specify Model

```
rf_mod <-  
  rand_forest(mtry = tune(), min_n = tune(), trees = 1000) %>%  
  set_engine("ranger", num.threads = cores) %>%  
  set_mode("regression")
```

Creating Workflow

```
rf_wf <- workflow() %>%
  add_model(rf_mod) %>%
  add_recipe(rec)
```

Create Tuning Grid

```
rf_grid <- expand_grid(mtry = c(3, 4, 5, 6),
                      min_n = c(40,50,60),
                      trees = c(500,1000) )
```

Cross-validation

```
rf_resample <-
  rf_wf %>%
  tune_grid(fold_rd,
            grid = 25,
            control = control_grid(save_pred = TRUE),
            metrics = metric_set(rmse))
```

i Creating pre-processing data to finalize unknown parameter: mtry

! Fold1, Repeat1: preprocessor 1/1, model 1/25: 23 samples were requested but there were 9 r

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! Fold5, Repeat3: preprocessor 1/1, model 11/25: 33 samples were requested but there were 10 r

! Fold5, Repeat3: preprocessor 1/1, model 13/25: 20 samples were requested but there were 10 r

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! Fold1, Repeat4: preprocessor 1/1, model 1/25: 23 samples were requested but there were 9 r

! Fold1, Repeat4: preprocessor 1/1, model 3/25: 32 samples were requested but there were 9 r

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! Fold3, Repeat5: preprocessor 1/1, model 1/25: 23 samples were requested but there were 10 1

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```
rf_resample %>%
  collect_metrics()
```

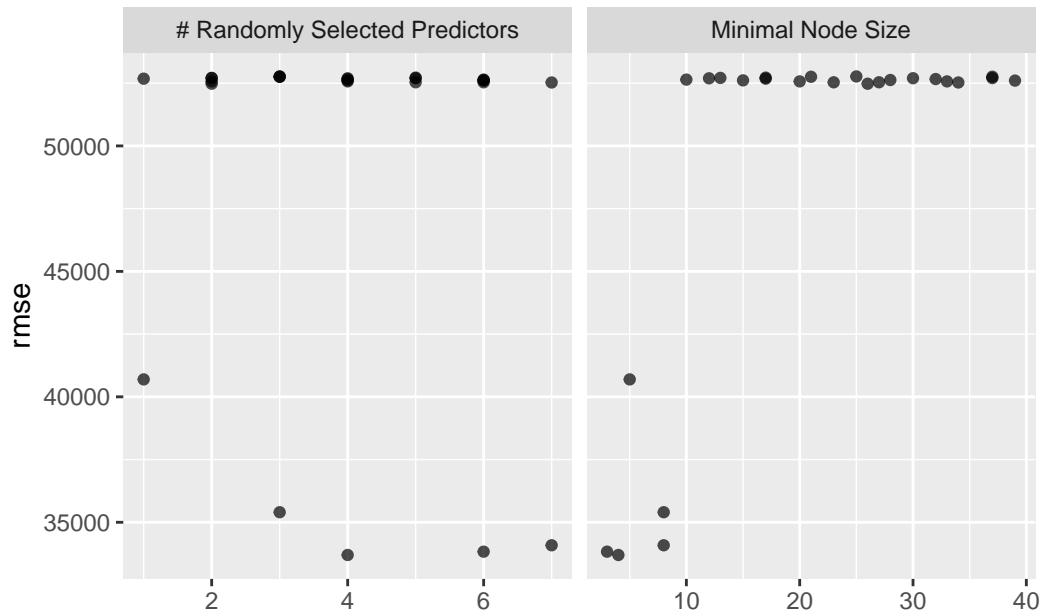
A tibble: 25 x 8

	mtry	min_n	.metric	.estimator	mean	n	std_err	.config
	<int>	<int>	<chr>	<chr>	<dbl>	<int>	<dbl>	<chr>
1	6	23	rmse	standard	52535.	25	3060.	Preprocessor1_Model01
2	7	8	rmse	standard	34085.	25	3870.	Preprocessor1_Model02
3	4	32	rmse	standard	52664.	25	3062.	Preprocessor1_Model03
4	5	30	rmse	standard	52698.	25	3047.	Preprocessor1_Model04
5	5	17	rmse	standard	52722.	25	3074.	Preprocessor1_Model05
6	1	5	rmse	standard	40695.	25	3112.	Preprocessor1_Model06
7	6	28	rmse	standard	52626.	25	3109.	Preprocessor1_Model07
8	2	37	rmse	standard	52704.	25	3077.	Preprocessor1_Model08
9	6	3	rmse	standard	33830.	25	4152.	Preprocessor1_Model09
10	1	17	rmse	standard	52679.	25	3047.	Preprocessor1_Model10

... with 15 more rows

Plot Model Performance

```
#Plot of actual train data
rf_resample %>%
  autoplot()
```



Showing and Selecting Best Performing Models

```
#Showing best performing tree models
rf_resample %>%
  show_best(n=1)
```

```
# A tibble: 1 x 8
  mtry min_n .metric .estimator   mean     n std_err .config
<int> <int> <chr>   <chr>     <dbl> <int>   <dbl> <chr>
1     4     4 rmse     standard 33698.    25   3615. Preprocessor1_Model12
```

```
#Selects best performing model
best_rf <- rf_resample %>%
  select_best(method = "rmse")
rmr<- 33826.74
```

Create Final Fit

```
rf_final_wf <-
  rf_wf %>%
```

```

finalize_workflow(best_rf)

#Create workflow for fitting model to train_data2 predictions
rf_final_fit <-
  rf_final_wf %>%
  fit(r)

```

Calculate Residuals

```

rf_residuals <- rf_final_fit %>%
  augment(r) %>% #use augment() to make predictions from train data
  select(c(.pred, copies_mL)) %>%
  mutate(.resid = copies_mL - .pred) #calculate residuals and make new row.

rf_residuals

```

```

# A tibble: 12 x 3
  .pred copies_mL .resid
  <dbl>     <dbl>   <dbl>
1  15962.     442. -15520.
2  11588.    2670.  -8919.
3   9417.    3243.  -6174.
4  10650.     695.  -9954.
5  37736.   47081.   9345.
6  53028.   51604.  -1424.
7  93275.   97906.   4631.
8  94582.  110322.  15741.
9  83158.   71864. -11294.
10 81388.   69089. -12299.
11 108875.  149150.  40274.
12 103999.  107384.   3385.

```

Model Predictions from Tuned Model vs Actual Outcomes

```

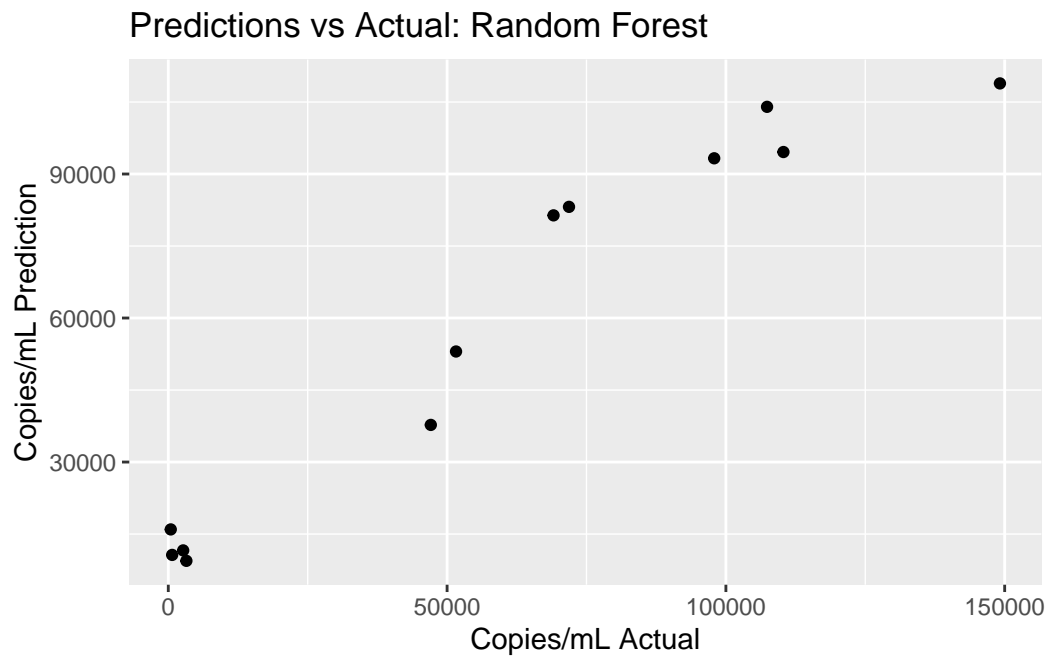
rf_pred_plot <- ggplot(rf_residuals,
  aes(x = copies_mL,
      y = .pred)) +
  geom_point() +
  labs(title = "Predictions vs Actual: Random Forest",

```

```

    x = "Copies/mL Actual",
    y = "Copies/mL Prediction")
rf_pred_plot

```



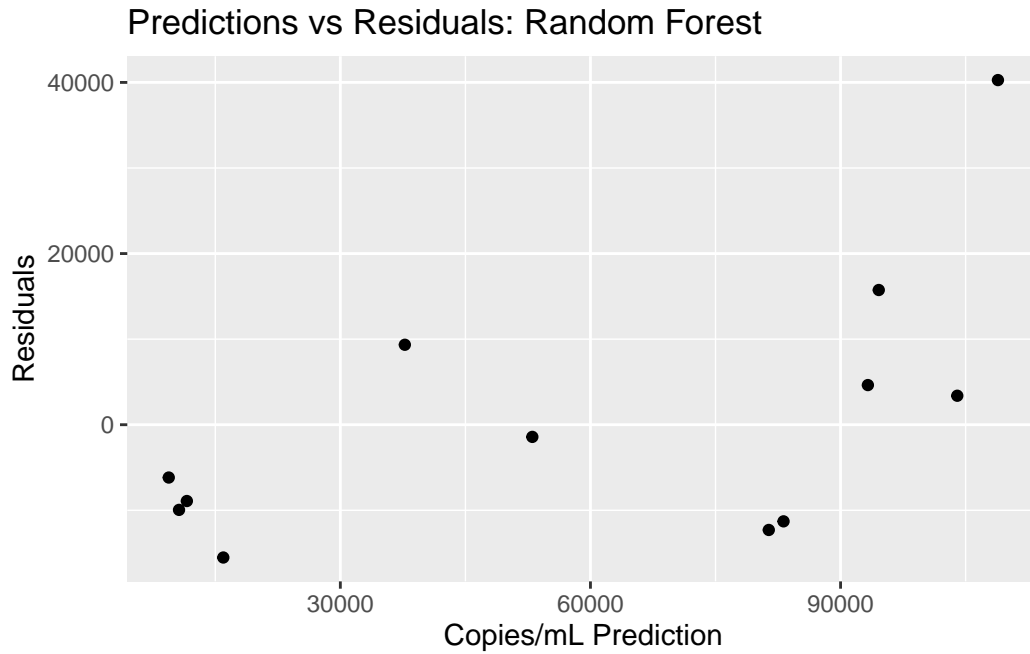
```

rf_residual_plot <- ggplot(rf_residuals,
                           aes(y = .resid,
                               x = .pred)) +
  geom_point() +
  labs(title = "Predictions vs Residuals: Random Forest",
       x = "Copies/mL Prediction",
       y = "Residuals")
plot(rf_residual_plot) #view plot

```

Table 1: Random Forest Regression Model Metrics

Model	Blind_Oso	Canals	Gulf
Null RMSE	20178.47	8091.394	52065.59
Actual RMSE	15645.98	7038.470	33826.74



Conclusion

Table

```
kable(data.frame(Model = c("Null RMSE", "Actual RMSE"),
  Blind_Oso = c(rmnb, rmb),
  Canals = c(rmnc, rmc),
  Gulf = c(rmnr, rmr)),
  caption = "Random Forest Regression Model Metrics")
```