Big_match - Testing and Demo

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This R markdown document is used for testing and demoing the current functionality of bigmatch. We'll use the sample data from the MatchIt package for basic testing.

```
library(MatchIt)
library(ggplot2)
library(ggpubr)
library(dplyr)

data("lalonde")
source('big_match.R')
source('class_functions.R')

# adding a binary outcome
lalonde$outcome <- lalonde$re78 > 15000
lalonde$re78 <- NULL

# changing name of treat column to "treated" to demonstrate that any name will suffice
names(lalonde)[names(lalonde) == "treat"] <- "treated"
```

Strata Objects

The functions `auto_stratify` and `manual_stratify` return `auto_strata` and `manual_strata` S3 objects, respectively, which both inherit from class `strata`. The `plot`, `summary` and `print` methods for `strata` objects implement most of the diagnsostics we have for assessing the outcome of a stratification. The contents of `strata` objects is shown below:

Info for all strata objects:

- `data` **data.frame** with strata specified
- `treat` **string** of the name of the treatment assignment column in the data frame
- `covariates` **character vector** giving names of all covariates for stratification (may be NULL if prognostic scores were pre-specified)
- `call` **call object** of function call which produced object
- `issue_table` **data.frame** of Treated, Controls, and Total observations for each stratum

Additional info for manual_strata objects:

- `strata_table` **data.frame** of strata definitions

Additional info for auto_strata objects:

- `prog_scores` **numeric vector** of prognostic scores for each observation
- `prog_model` **glm object** prognostic score model (may be NULL if prognostic scores were pre-specified)
- `outcome` **string** with the name of the outcome variable
- `discarded` **???** rows deleted

Stratify

Manual Stratify

Testing errors and warnings

This call should return an error because "educ" is a continuous variable.

```
# manual stratification with a continuous variable
m.strat <- manual_stratify(lalonde, treat = "treat",
                           covariates = c("black", "hispan", "educ", "nodegree"))

# Error in warn_if_continuous(data[, covariates[i]], covariates[i]) :
#   There are 19 distinct values for educ. Is it continuous?

# manual stratification with a continuous variable, force = TRUE
m.strat <- manual_stratify(lalonde, treat = "treat",
                           covariates = c("black", "hispan", "educ", "nodegree"), force = TRUE)

# There are 19 distinct values for educ. Is it continuous?
```

Testing Functionality with Valid Inputs

This call should return six strata (since black and hispanic seem to be mutually exclusive categories in this dataset).

```
# allowable manual stratification
m.strat <- manual_stratify(lalonde, treat = "treated",
                           covariates = c("black", "hispan", "nodegree"))
```

```
## Warning: package 'bindrcpp' was built under R version 3.4.4
```

Auto Stratify

Testing Errors and Warnings

First, testing error handling. These should fail and/or give warnings.

```
# auto stratification with missing arguements
a.strat <- auto_stratify(lalonde, "treat", "outcome")

# Error in auto_stratify(lalonde, "treat", "outcome") :
#   At least one of covariates and prog_scores should be specified.
```

```
# auto stratification with covariates and prog scores specified, and prog_scores invalid
a.strat <- auto_stratify(lalonde, "treat", "outcome", c("age", "educ"), prog_scores = 1:4)

# covariates and prog_scores are both specified. Using prog_scores; ignoring covariates.
# Error in auto_stratify(lalonde, "treat", "outcome", c("age", "educ"), :
#   prog_scores must be the same length as the data
```

Testing Functionality with Valid Inputs

These should give valid results.

```
# auto stratification with pre-specified prognostic score
myprogscore <- runif(n = dim(lalonde)[1])
a.strat1 <- auto_stratify(data = lalonde, "treated", "outcome",
                          prog_scores = myprogscore, size = 100)

# auto stratification
a.strat2 <- auto_stratify(lalonde, "treated", "outcome",
                          covariates = c("age", "educ", "hispan", "nodegree", "black"),
                          size = 100)

# auto stratification with a non-continuous prognostic score
a.strat3 <- auto_stratify(lalonde, "treated", "outcome",
                          covariates = c("hispan", "nodegree", "black"), size = 100 )
```

Diagnostics

Most of this is implemented with the generic functions `print`, `summary`, and `plot`.

Print

```
print(m.strat)
```

```
## manual_strata object from package big_match.
##
## Function call:
## manual_stratify(data = lalonde, treat = "treated", covariates = c("black",
##     "hispan", "nodegree"))
##
## Strata Sizes:
## # A tibble: 6 x 6
##   Stratum Treat Control Total Control_Proportion
##     <dbl> <int>   <dbl> <int>              <dbl>
## 1       1     9     127   136          0.9338235
## 2       2     9     154   163          0.9447853
## 3       3     2      15    17          0.8823529
## 4       4     9      46    55          0.8363636
## 5       5    43      31    74          0.4189189
## 6       6   113      56   169          0.3313609
## # ... with 1 more variables: Potential_Issues <chr>
```

```
print(a.strat1)
```

```
## auto_strata object from package big_match.
##
## Function call:
## auto_stratify(data = lalonde, treat = "treated", outcome = "outcome",
##     prog_scores = myprogscore, size = 100)
##
## Prognostic Scores prespecified.
##
## Strata Sizes:
## # A tibble: 7 x 6
##   Stratum Treat Control Total Control_Proportion Potential_Issues
##     <int> <int>   <dbl> <int>              <dbl>            <chr>
## 1       1    25      63    88          0.7159091             none
## 2       2    33      55    88          0.6250000             none
## 3       3    26      62    88          0.7045455             none
## 4       4    31      56    87          0.6436782             none
## 5       5    23      65    88          0.7386364             none
## 6       6    22      66    88          0.7500000             none
## 7       7    25      62    87          0.7126437             none
```

```
print(a.strat2)
```

```
## auto_strata object from package big_match.
##
## Function call:
## auto_stratify(data = lalonde, treat = "treated", outcome = "outcome",
```

```
##     covariates = c("age", "educ", "hispan", "nodegree", "black"),
##     size = 100)
##
## Prognostic Score Model:
##
## Call:  glm(formula = formula(formula_str), family = "binomial", data = data0)
##
## Coefficients:
## (Intercept)          age         educ       hispan     nodegree
##    -5.00887      0.04639      0.19183      0.09823      0.14705
##       black
##    -0.53706
##
## Degrees of Freedom: 428 Total (i.e. Null);  423 Residual
## Null Deviance:       388.2
## Residual Deviance: 361.1     AIC: 373.1
##
## Strata Sizes:
## # A tibble: 7 x 6
##   Stratum Treat Control Total Control_Proportion
##     <int> <int>   <dbl> <int>              <dbl>
## 1       1    40      48    88          0.5454545
## 2       2    37      51    88          0.5795455
## 3       3    39      49    88          0.5568182
## 4       4    26      61    87          0.7011494
## 5       5    22      66    88          0.7500000
## 6       6    16      72    88          0.8181818
## 7       7     5      82    87          0.9425287
## # ... with 1 more variables: Potential_Issues <chr>
```

Summary

```
# TODO: implement summary methods
summary(m.strat)
```

```
## $call
## manual_stratify(data = lalonde, treat = "treated", covariates = c("black",
##     "hispan", "nodegree"))
##
## $issue_table
## # A tibble: 6 x 6
##   Stratum Treat Control Total Control_Proportion
##     <dbl> <int>   <dbl> <int>              <dbl>
## 1       1     9     127   136          0.9338235
## 2       2     9     154   163          0.9447853
## 3       3     2      15    17          0.8823529
## 4       4     9      46    55          0.8363636
## 5       5    43      31    74          0.4189189
## 6       6   113      56   169          0.3313609
## # ... with 1 more variables: Potential_Issues <chr>
##
## $sum_before
## NULL
##
## attr(,"class")
## [1] "summary.strata"
```

```
summary(a.strat1)
```

```
## $call
## auto_stratify(data = lalonde, treat = "treated", outcome = "outcome",
##     prog_scores = myprogscore, size = 100)
##
## $issue_table
## # A tibble: 7 x 6
##   Stratum Treat Control Total Control_Proportion Potential_Issues
##     <int> <int>   <dbl> <int>              <dbl>            <chr>
## 1       1    25      63    88          0.7159091             none
## 2       2    33      55    88          0.6250000             none
## 3       3    26      62    88          0.7045455             none
## 4       4    31      56    87          0.6436782             none
## 5       5    23      65    88          0.7386364             none
## 6       6    22      66    88          0.7500000             none
## 7       7    25      62    87          0.7126437             none
##
## $sum_before
## NULL
##
## attr(,"class")
## [1] "summary.strata"
```

```
summary(a.strat2)
```

```
## $call
## auto_stratify(data = lalonde, treat = "treated", outcome = "outcome",
```

```
##     covariates = c("age", "educ", "hispan", "nodegree", "black"),
##     size = 100)
##
## $issue_table
## # A tibble: 7 x 6
##   Stratum Treat Control Total Control_Proportion
##     <int> <int>   <dbl> <int>              <dbl>
## 1       1    40      48    88          0.5454545
## 2       2    37      51    88          0.5795455
## 3       3    39      49    88          0.5568182
## 4       4    26      61    87          0.7011494
## 5       5    22      66    88          0.7500000
## 6       6    16      72    88          0.8181818
## 7       7     5      82    87          0.9425287
## # ... with 1 more variables: Potential_Issues <chr>
##
## $sum_before
## NULL
##
## attr(,"class")
## [1] "summary.strata"
```

Plot

There are three types of plots: `"scatter"`, `"residual"`, and `"hist"`. Any other plot options for a strata object will throw an error.

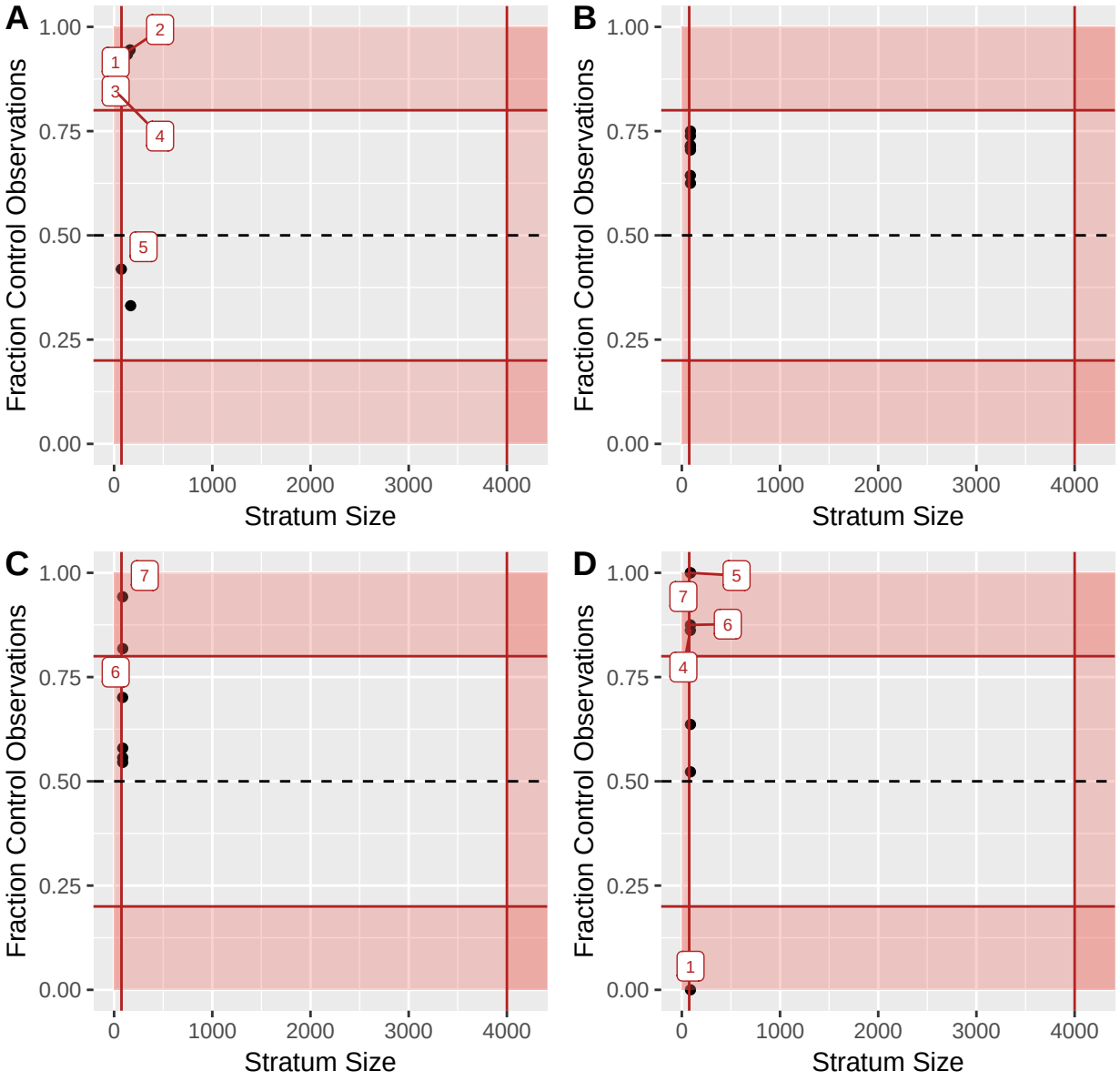
```
plot(m.strat, type = "QQ")
# Error in plot.strata(m.strat, type = "QQ") :
#   Not a recognized plot type.
```

Auto and Manual Stratify : Size-Balance Scatterplot

Below are the basic size × control fraction scatterplots for (A) manual stratification by `black`, `hispan` and `nodegree`, (B) auto-stratification with a uniform random prognostic score, (C) auto-stratification with a prognostic score that is relatively continuous, and (D) auto-stratification with a prognostic score that is discontinuous (built solely from discrete variables with few distinct values). As you can see, this sample data contains a relatively small number of examples to begin with, so most strata are quite small.

```
a <- plot(m.strat) # equivalently: plot(m.strat, type = "scatter")
b <- plot(a.strat1)
c <- plot(a.strat2)
d <- plot(a.strat3)

ggarrange(a, b, c, d, ncol = 2, nrow = 2,
          labels = "AUTO")
```



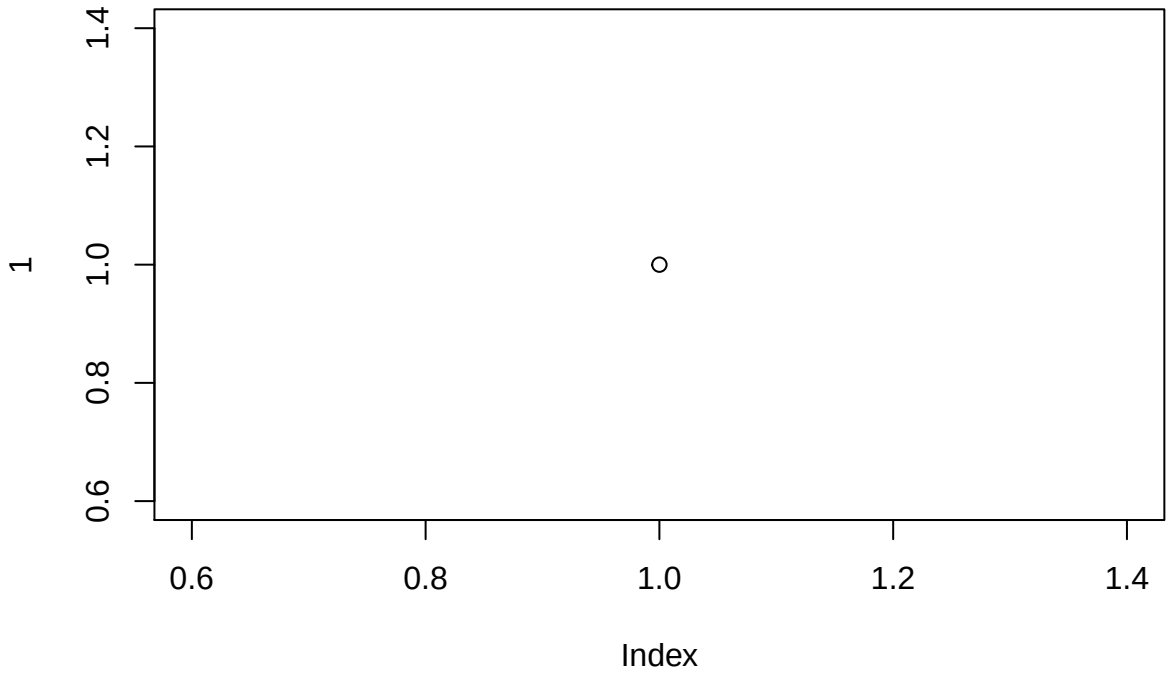
Auto Stratify: Prognostic Score Residual Plot

This function is only meant for auto-stratified data for which prognostic scores were not prespecified. Running it on a `manual_strata` object or an `auto_strata` object where prognostic scores were prespecified will throw an error.

```
plot(m.strat, type = "residual")
# Error in plot.strata(m.strat, type = "residual") :
#   Prognostic score residual plots are only valid for auto-stratified data.

plot(a.strat1, type = "residual")
# Error in plot.strata(a.strat1, type = "residual"):
#  Cannot make prognostic score residual plots. Prognostic model is unknown.
```

```
# TODO: implement this plot
plot(a.strat2, type = "residual")
```



Auto Stratify: Prognostic Score Histograms

This function is only meant for auto-stratified data. Running it on a `manual_strata` object will throw an error.

```
plot(m.strat, type = "hist")

# Error in plot.strata(m.strat, type = "hist"):
#  Prognostic score histograms are only valid for auto-stratified data.
```

```
# uniformly generated prognostic score. Nicely continuous from 0 to 1
a <- plot(a.strat1, type = "hist")
```

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

```
# prognostic score generated from some continuous and some distcrete variables.
# Fairly continuous
b <- plot(a.strat2, type = "hist")
```

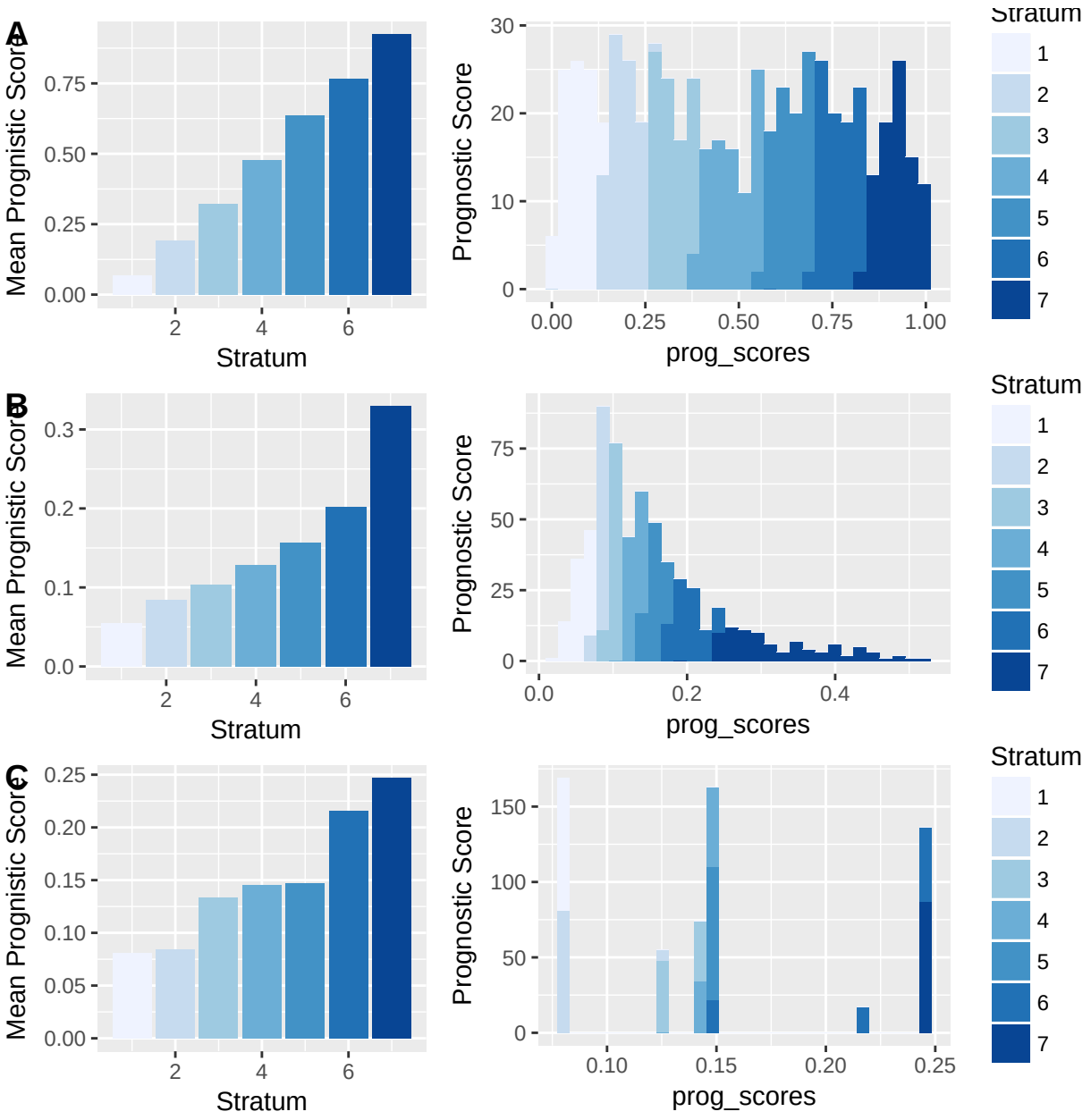
```
## `stat_bin()` using `bins = 30`. Pick better value with `binwidth`.
```

```
# prognostic score generated from only a few discrete variables.
# Since prog_score only takes on a few different values,
# strata quantiles are less evenly distributed from 0 to 1
```

```
c <- plot(a.strat3, type = "hist")
```

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

```
ggarrange(a, b, c, ncol = 1, nrow = 3, labels = "AUTO")
```



Matching

This is not implemented yet.