Step-by-Step Guidelines for Propensity Score Weighting with Three or More Groups

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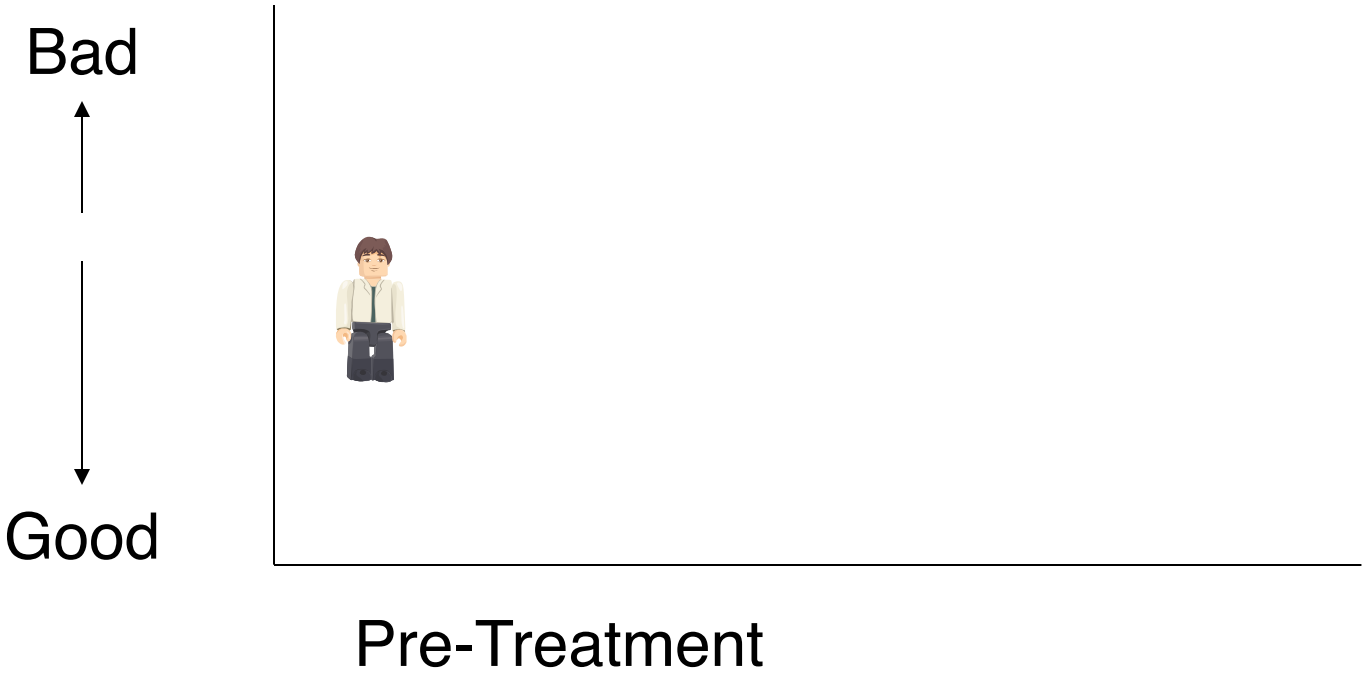
Motivating example

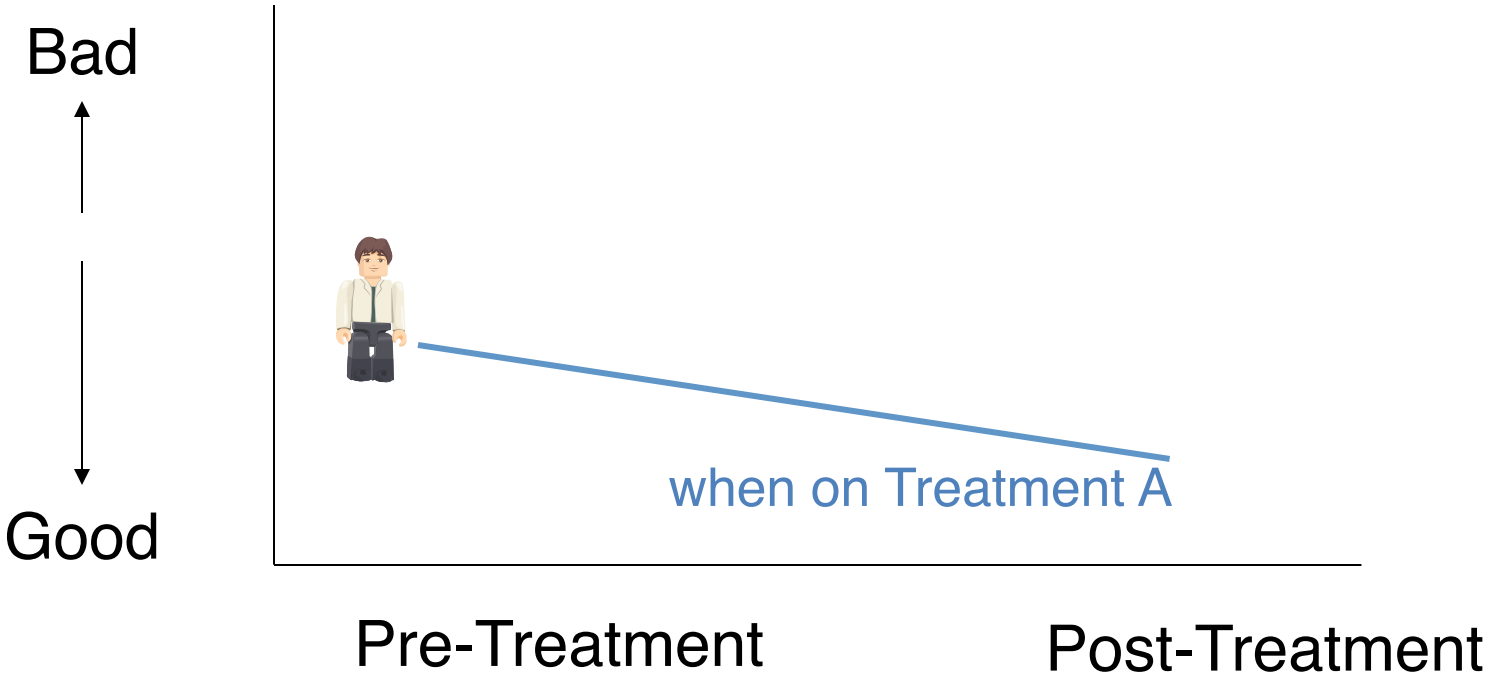
- Case study: To estimate the relative causal effect of MET/CBT5 vs "usual care" vs SCY
  - Data from 3 SAMSHA CSAT discretionary grants

MET/CBT5	"Usual Care"	SCY
• Observational	• Observational	• Observational
• MET/CBT5 at 37 EAT sites	• "Usual care" at 4 ATM sites	• Community strengthening at 8 SCY sites
• N = 2459	• N = 444	• N = 1351
• 2003/04 - 2007	• 1998 - 1999	• 2001 - 2002

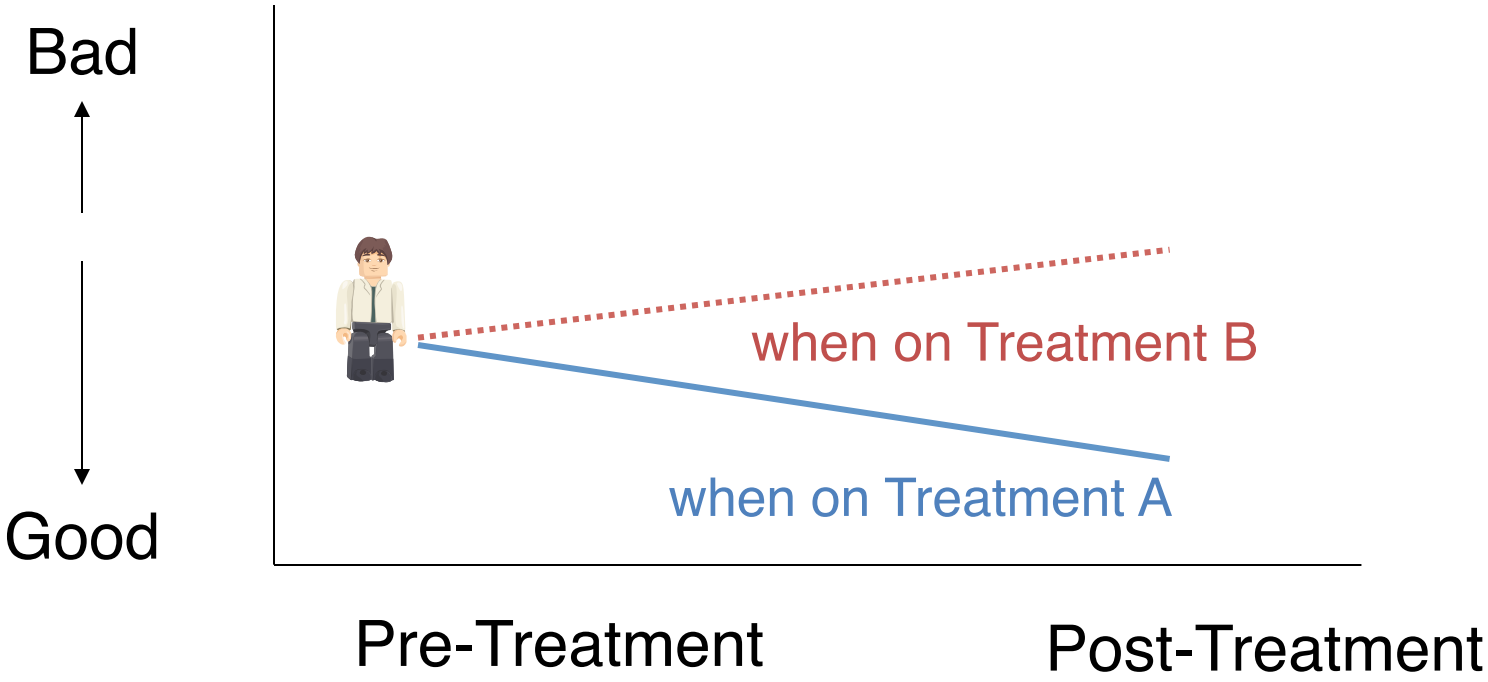
How do we get a causal effect estimate?



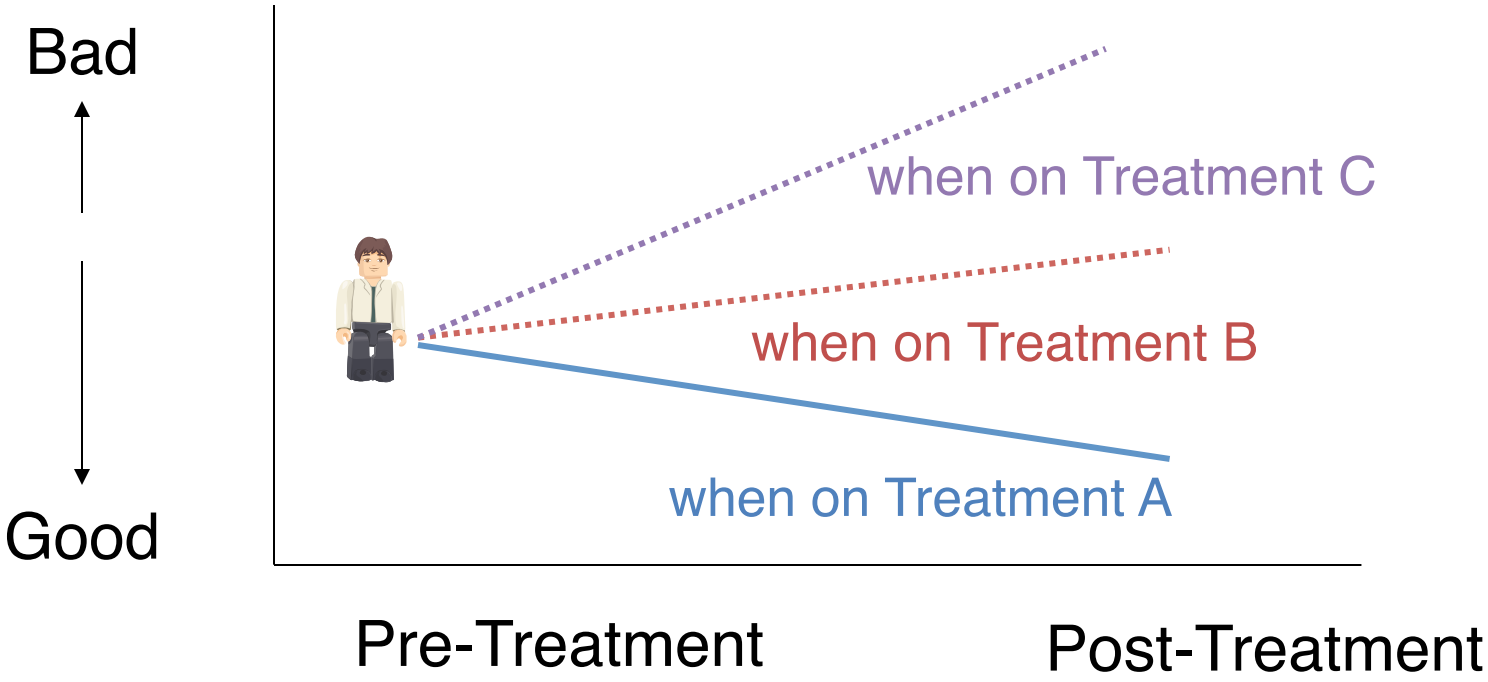
How do we get a causal effect estimate?



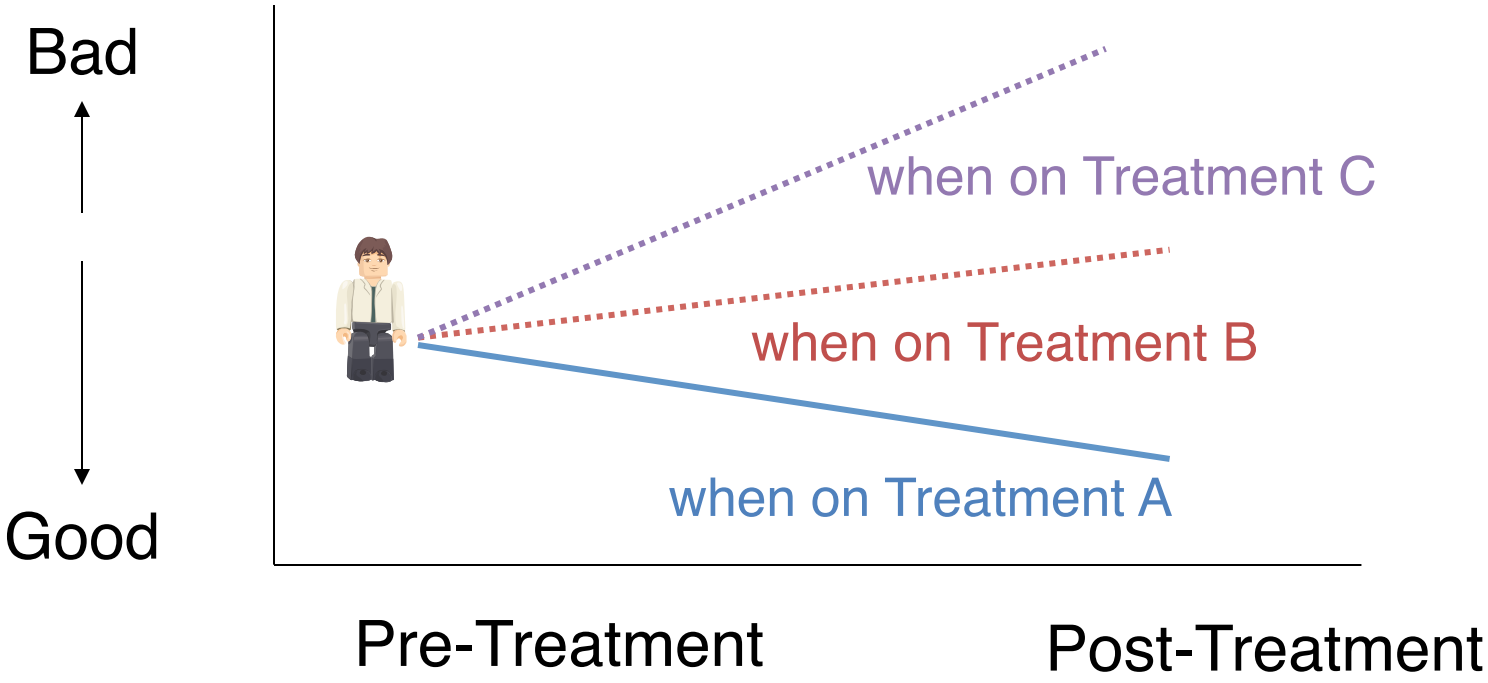
How do we get a causal effect estimate?



How do we get a causal effect estimate?



How do we get a causal effect estimate?



Now even more potential outcomes/counterfactuals and more treatment effects that might be of interest

Expand potential outcomes for J treatments

- J potential outcomes for each study participant
  - Potential outcome after receiving treatment $1,\ldots J = Y\downarrow 1 ,\ldots, Y\downarrow J$
- $Y\downarrow 1 ,\ldots, Y\downarrow J$ exist for all individuals in the population regardless of the treatment they actually received
- Still only one of these outcomes observed for each participant

Primary types of causal effects

- Average treatment effect in the population (ATE)
  - Answers the question:
    - *What is the relative effectiveness of all the treatments on average in the population?*
  - $E(Y1-Y2)$, $E(Y1-Y3)$,..., $E(Y1-YJ)$, $E(Y2-Y3)$, etc.
- Average treatment effect in the treated population (ATT)
  - Answers the question:
    - *How would those who received a particular treatment have done had they received any of the other treatments?*
  - $E(Y1-Y2|Z=1)$, $E(Y1-Y3|Z=1)$,..., $E(Y1-YJ|Z=1)$

Primary types of causal effects: case study

- Average treatment effect in the population (ATE)
  - Answers the question:
    - *What is the relative effectiveness of MET/CBT5, usual care, and SCY on average in the population?*
  - $E(Y1-Y2)$, $E(Y1-Y3)$,..., $E(Y1-YJ)$, $E(Y2-Y3)$, etc.
- Average treatment effect in the treated population (ATT)
  - Answers the question:
    - *How would youth like those who received usual care have done had they received MET/CBT5 or SCY?*
  - $E(Y1-Y2|Z=1)$, $E(Y1-Y3|Z=1)$,..., $E(Y1-YJ|Z=1)$

Propensity scores with more than 2 groups

- Let Z denote the categorical treatment assignment measure (values = $1,\ldots,J$)
- Propensity score is an individual's probability of receiving one of the treatments given pretreatment characteristics
  - $pj(X)=\Pr(Z=j|X)$
- Propensity scores still have balancing property
  - All needed to control for pretreatment differences between the groups
  - Assumes no unobserved differences between groups and overlap (strong ignorability)

Weighting with more than 2 groups

- For ATE:
  - weight individuals in each sample by the inverse probability of receiving the treatment they received
  - For an individual receiving treatment *j*, the weight equals $1/pj(X)$
- For ATT:
  - weight individuals in each sample by the ratio of the probability receiving the target treatment to the probability of receiving the treatment they received
  - For an individual receiving treatment *j* and where target treatment equals *j**, the weight equals $p\downarrow j\uparrow*\ (X)/pj(X)$

STEP-BY-STEP GUIDELINES

Four Key Steps

1) Choose the primary treatment effect of interest (ATEs or ATTs)
2) Estimate propensity score (ps) weights
3) Evaluate the quality of the ps weights
4) Estimate the treatment effects

Step 1: Choose the primary treatment effect (ATE or ATT)

- Today, we chose to focus on estimating ATE
- Why?
  - We want to know how well each treatment is doing in general
  - Thus, the policy question we want to address is:

What are the relative causal treatment effects of MET/CBT5, SCY, and usual care on average for youth in our population?

Step 2: Estimate the ps weights

- Only 1 command needed for this step
- Multiple treatment command in TWANG currently available in R and SAS
  - STATA available in Fall 2015

Command to estimate ps weights in SAS

```
%mnps(treatvar=trtvar,
      vars=age female race4g sfs sps sds ias ces eps
                imds bcs prmhtx,
      class = race4g,
      dataset=sasin.subdata,
      ntrees=5000,
      stopmethod=es.max,
      estimand = ATE,
      treatatt = NULL,
      output_dataset=subdata_wgts,
      Rcmd=C:\Program Files\R\R-3.0.1\bin\R.exe,
      plotname=multi_twang_ate.pdf,
   objpath=C:\Users\bethg\Documents\TWANG\SAS work);
```

Command to estimate ps weights in SAS

```
%mnps(treatvar=trtvar,
      vars=age female race4g sfs sps sds i
                imds bcs prmhtx,
      class = race4g,
      dataset=sasin.subdata,
      ntrees=5000,
      stopmethod=es.max,
      estimand = ATE,
      treatatt = NULL,
      output_dataset=subdata_wgts,
      Rcmd=C:\Program Files\R\R-3.0.1\bin\R.exe,
      plotname=multi_twang_ate.pdf,
  objpath=C:\Users\bethg\Documents\TWANG\SAS work);
```

`treatvar` is the treatment indicator; it must have 3 or more values and it must be a factor in R

Command to estimate ps weights in SAS

```
%mnps(treatvar=trtvar,
      vars=age female race4g sfs sps sds ias ces eps
           imds bcs prmhtx,
      class = race4g,
      dataset=sasin.subdata,
      ntrees=5000,
      stopmethod=es.max,
      estimand = ATE,
      treatatt = NULL,
      output_dataset=subdata_wgts,
      Rcmd=C:\Program Files\R\R-3.0.1\bin\R.exe,
      plotname=multi_twang_ate.pdf,
  objpath=C:\Users\bethg\Documents\TWANG\SAS work);
```

Specifies list of pretreatment covariates to balance on

Command to estimate ps weights in SAS

```
%mnps(treatvar=trtvar,
      vars=age female race4g sfs sps sds ias ces eps
                imds bcs prmhtx,
      class = race4g,
      dataset=sasin.subdata,
      ntrees=5000,
      stopmethod=es.max,
      estimand = ATE,
      treatatt = NULL,
      output_dataset=subdata_wgts,
      Rcmd=C:\Program Files\R\R-3.0.1\bin\R.exe,
      plotname=multi_twang_ate.pdf,
   objpath=C:\Users\bethg\Documents\TWANG\SAS work);
```

Specifies which pretreatment variables are categorical

Command to estimate ps weights in SAS

```
%mnps(treatvar=trtvar,
      vars=age female race4g sfs sps sds ias ces eps
                imds bcs prmhtx,
      class = race4g,
      dataset=sasin.subdata,
      ntrees=5000,
      stopmethod=es.max,
      estimand = ATE,
      treatatt = NULL,
      output_dataset=subdata_wgts,
      Rcmd=C:\Program Files\R\R-3.0.1\bin\R.exe,
      plotname=multi_twang_ate.pdf,
  objpath=C:\Users\bethg\Documents\TWANG\SAS work);
```

Specifies name of dataset

Command to estimate ps weights in SAS

```
%mnps(treatvar=trtvar,
      vars=age female race4g sfs sps sds ias ces eps
                imds bcs prmhtx,
      class = race4g,
      dataset=sasin.subdata,
      ntrees=5000,
      stopmethod=es.max,
      estimand = ATE,
      treatatt = NULL,
      output_dataset=subdata_wgts,
      Rcmd=C:\Program Files\R\R-3.0.1\bin\R.exe,
      plotname=multi_twang_ate.pdf,
  objpath=C:\Users\bethg\Documents\TWANG\SAS work);
```

Specifies the maximum number of iterations used by GBM. Should be large (5000 to 10000)

Command to estimate ps weights in SAS

```
%mnps(treatvar=trtvar,
      vars=age female race4g sfs sps sds ias ces eps
                imds bcs prmhtx,
      class = race4g,
      dataset=sasin.subdata,
      ntrees=5000,
      stopmethod=es.max,
      estimand = ATE,
      treatatt = NULL,
      output_dataset=subdata_wgts,
      Rcmd=C:\Program Files\R\R-3.0.1\b...\R.exe,
      plotname=multi_twang_ate.pdf,
  objpath=C:\Users\bethg\Documents\TWANG\SAS work);
```

Specifies the criteria for choosing the optimal number of iterations. Available choices include mean or max ES and mean or max KS statistics

Command to estimate ps weights in SAS

```
%mnps(treatvar=trtvar,
      vars=age female race4g sfs sps sds ias ces eps
                imds bcs prmhtx,
      class = race4g,
      dataset=sasin.subdata,
      ntrees=5000,
      stopmethod=es.max,
      estimand = ATE,
      treatatt = NULL,
      output_dataset=subdata_wgts,
      Rcmd=C:\Program Files\R\R-3.0.1\bin\R.exe,
      plotname=multi_twang_ate.pdf,
  objpath=C:\Users\bethg\Documents\TWANG\SAS work);
```

Specifies primary estimand of interest (ATT or ATE)

Command to estimate ps weights in SAS

```
%mnps(treatvar=trtvar,
      vars=age female race4g sfs sps sds ias ces eps
                imds bcs prmhtx,
      class = race4g,
      dataset=sasin.subdata,
      ntrees=5000,
      stopmethod=es.max,
      estimand = ATE,
      treatatt = NULL,
      output_dataset=subdata_wgts,
      Rcmd=C:\Program Files\R\R-3.0.1\bin\R.exe,
      plotname=multi_twang_ate.pdf,
objpath=C:\Users\bethg\Documents\TWANG\SAS work);
```

Specifies which treatment condition is considered "the treated" for estimating ATTs

Command to estimate ps weights in SAS

```
%mnps(treatvar=trtvar,
      vars=age female race4g sfs sps sds ias ces eps
                imds bcs prmhtx,
      class = race4g,
      dataset=sasin.subdata,
      ntrees=5000,
      stopmethod=es.max,
      estimand = ATE,
      treatatt = NULL,
      output_dataset=subdata_wgts,
      Rcmd=C:\Program Files\R\R-3.0.1\bin\R.exe,
      plotname=multi_twang_ate.pdf,
  objpath=C:\Users\bethg\Documents\TWANG\SAS work);
```

Specifies name of outputted dataset with ps weights

Command to estimate ps weights in SAS

```
%mnps(treatvar=trtvar,
      vars=age female race4g sfs sps sds ias ces eps
                imds bcs prmhtx,
      class = race4g,
      dataset=sasin.subdata,
      ntrees=5000,
      stopmethod=es.max,
      estimand = ATE,
      treatatt = NULL,
      output_dataset=subdata_wgts,
      Rcmd=C:\Program Files\R\R-3.0.1\bin\R.exe,
      plotname=multi_twang_ate.pdf,
  objpath=C:\Users\bethg\Documents\TWANG\SAS work);
```

Specifies the R executable by name and path

Command to estimate ps weights in SAS

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%mnps(treatvar=trtvar,
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                imds bcs prmhtx,
      class = race4g,
      dataset=sasin.subdata,
      ntrees=5000,
      stopmethod=es.max,
      estimand = ATE,
      treatatt = NULL,
      output_dataset=subdata_wgts,
      Rcmd=C:\Program Files\R\R-3.0.1\bin\R.exe,
      plotname=multi_twang_ate.pdf,
   objpath=C:\Users\bethg\Documents\TWANG\SAS work);
```

Specifies name of file where diagnostic plots will go

Command to estimate ps weights in SAS

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%mnps(treatvar=trtvar,
      vars=age female race4g sfs sps sds ias ces eps
                imds bcs prmhtx,
      class = race4g,
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      stopmethod=es.max,
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      output_dataset=subdata_wgts,
      Rcmd=C:\Program Files\R\R-3.0.1\bin\R.exe,
      plotname=multi_twang_ate.pdf,
  objpath=C:\Users\bethg\Documents\TWANG\SAS work);
```
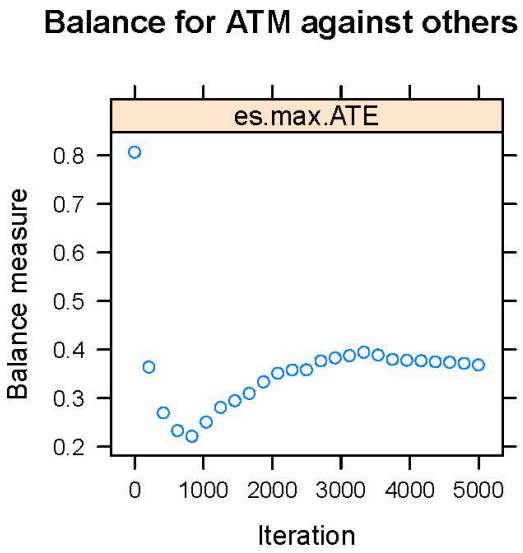
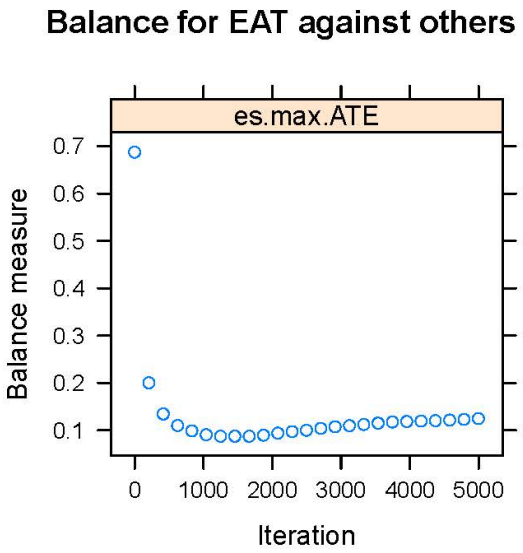

Specifies folder where outputted data and plots will go

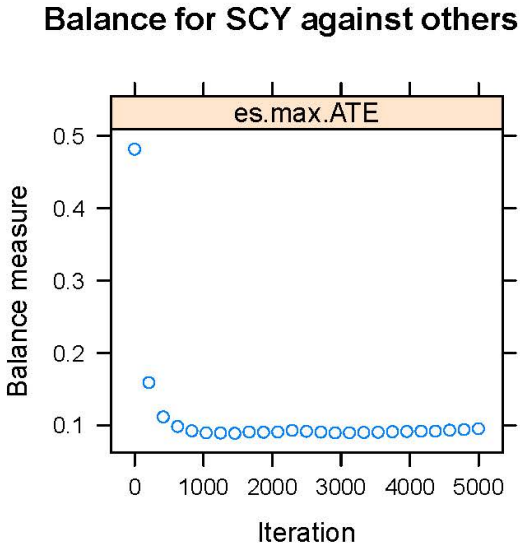
Step 3: Evaluate the quality of the ps weights

- Key issues that should be checked
  - Convergence = did the algorithm run long enough
  - Balance = how well matched the groups look after weighting
  - Overlap = whether there is evidence that the distributions of the pretreatment covariates in the groups line up well

Step 3: Checking convergence

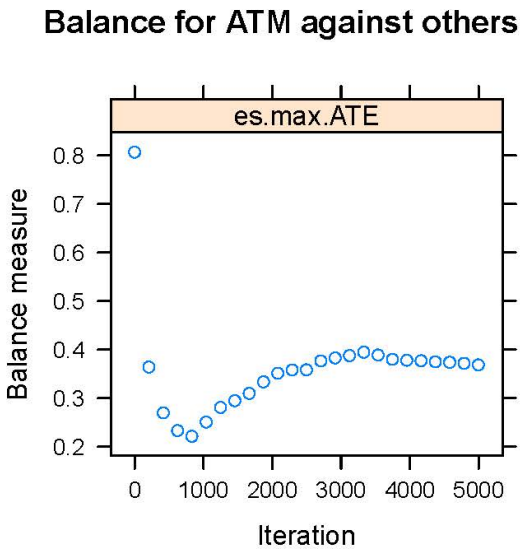


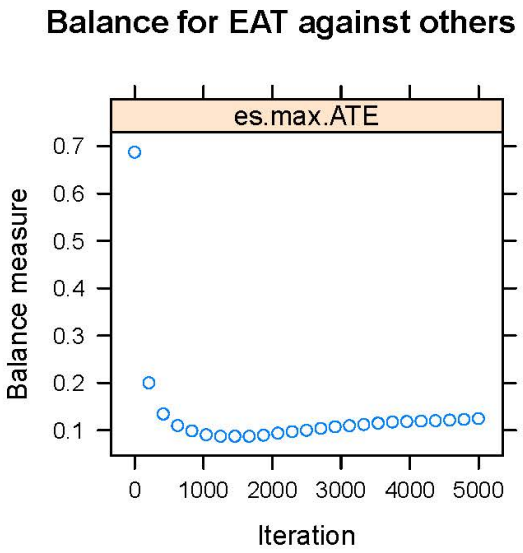


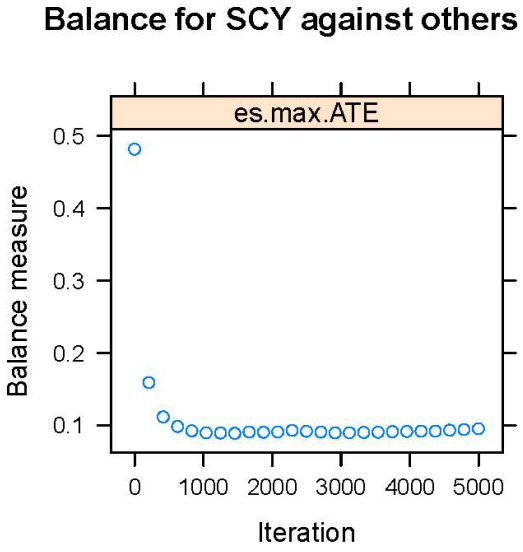


Note:
ATM = Usual care group
EAT = MET/CBT5 group

Step 3: Checking convergence







There are three convergence plots because there are three GBM fits

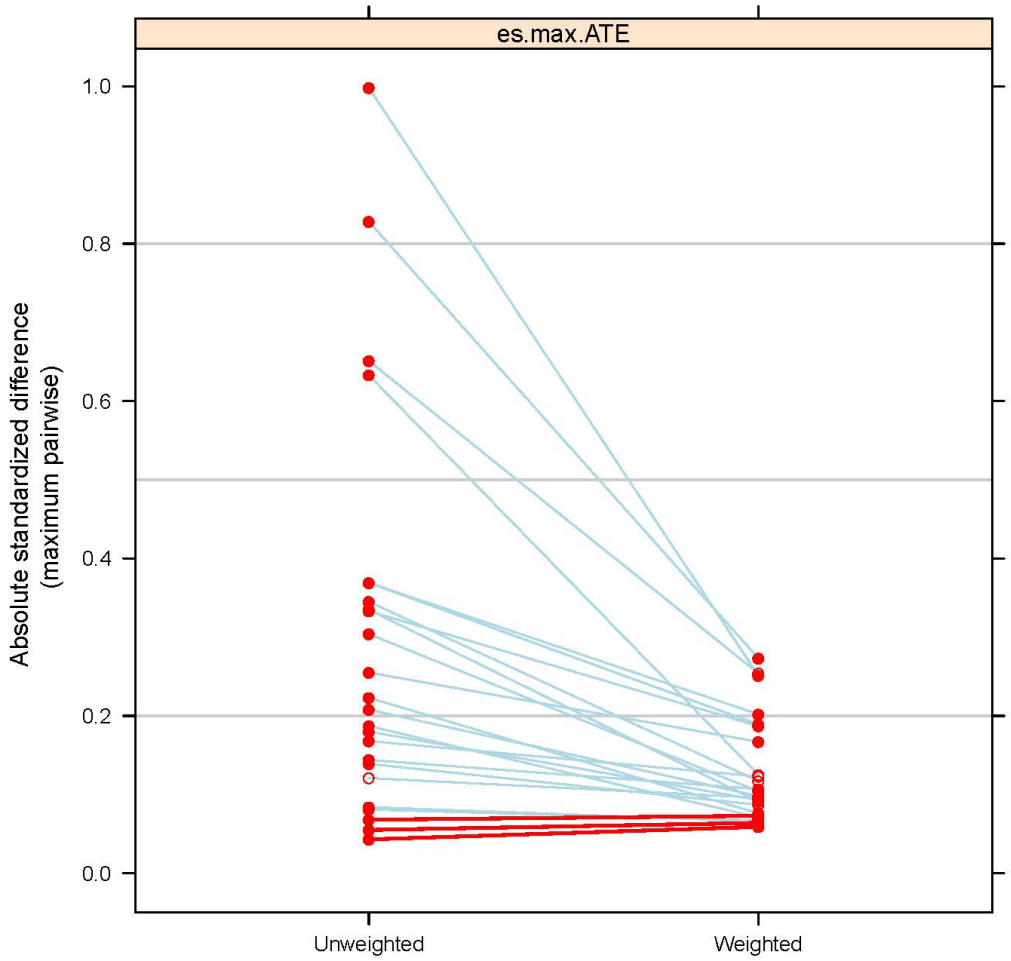
Step 3: Checking balance

- What does balance mean for more than 2 groups?
  - For ATE: All possible pairs of treatment conditions are balanced
  - For ATT: *J–1* groups each balance with the target group of interest
- Multiple pairwise sets of balance metrics can be difficult to navigate if there are more than a 3 or 4 treatments, especially for ATE
  - There are *J* choose 2 pairs for ATE and *J-1* for ATT
- Summarize over all pairs using the maximum of each pairwise balance metric for each covariate and then the maximum or mean across covariates
  - For p-values use the minimum

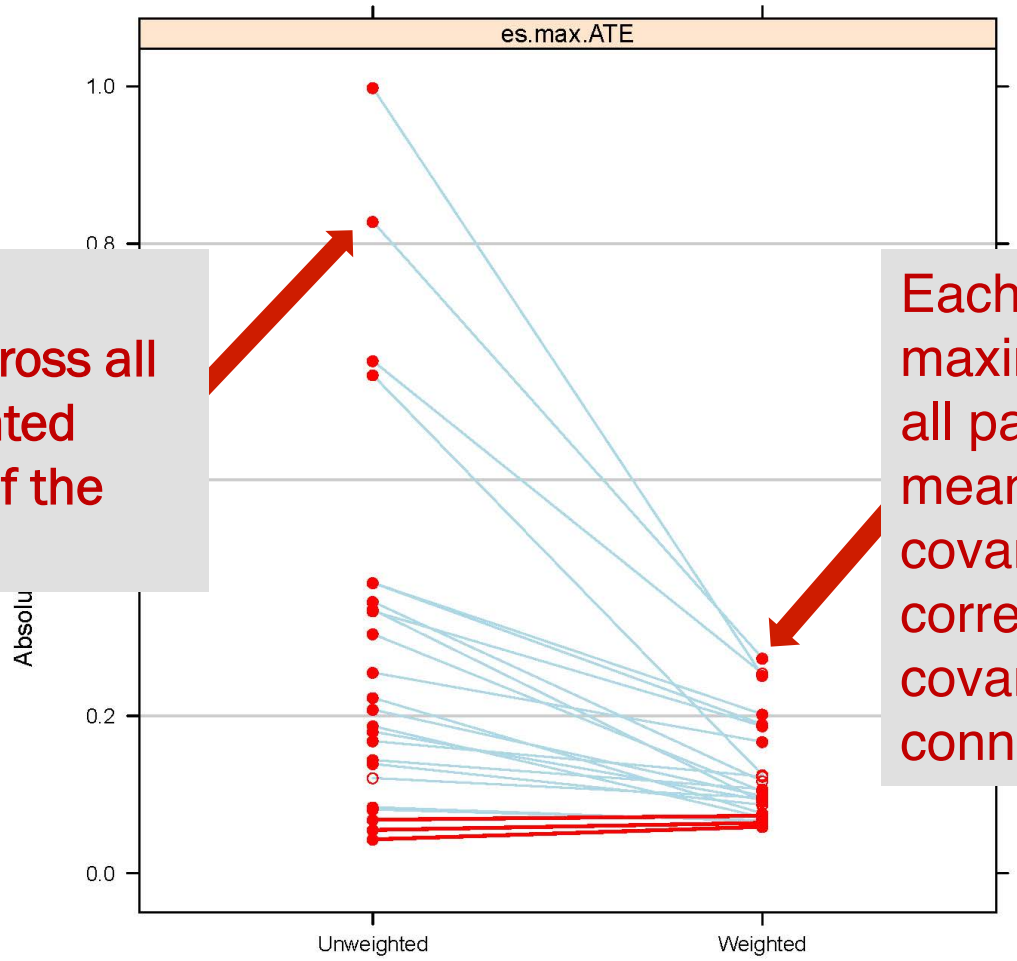
Step 3: Checking balance

- For more than 2 treatment groups, it is recommended to check balance across groups first and then to dive in if there appears to be a problem
- Summary measures one can use to assess balance in that first sweep
  - Maximum of the pairwise ES (or ASMDs)
  - Maximum of the pairwise KS or correspondingly the minimum of the pairwise KS statistic *p*-values
  - Also could use *p*-values from ANOVA's or joint *F*-tests to test if the means of the groups are different

Step 3: Checking balance graphically – Maximum ES plot



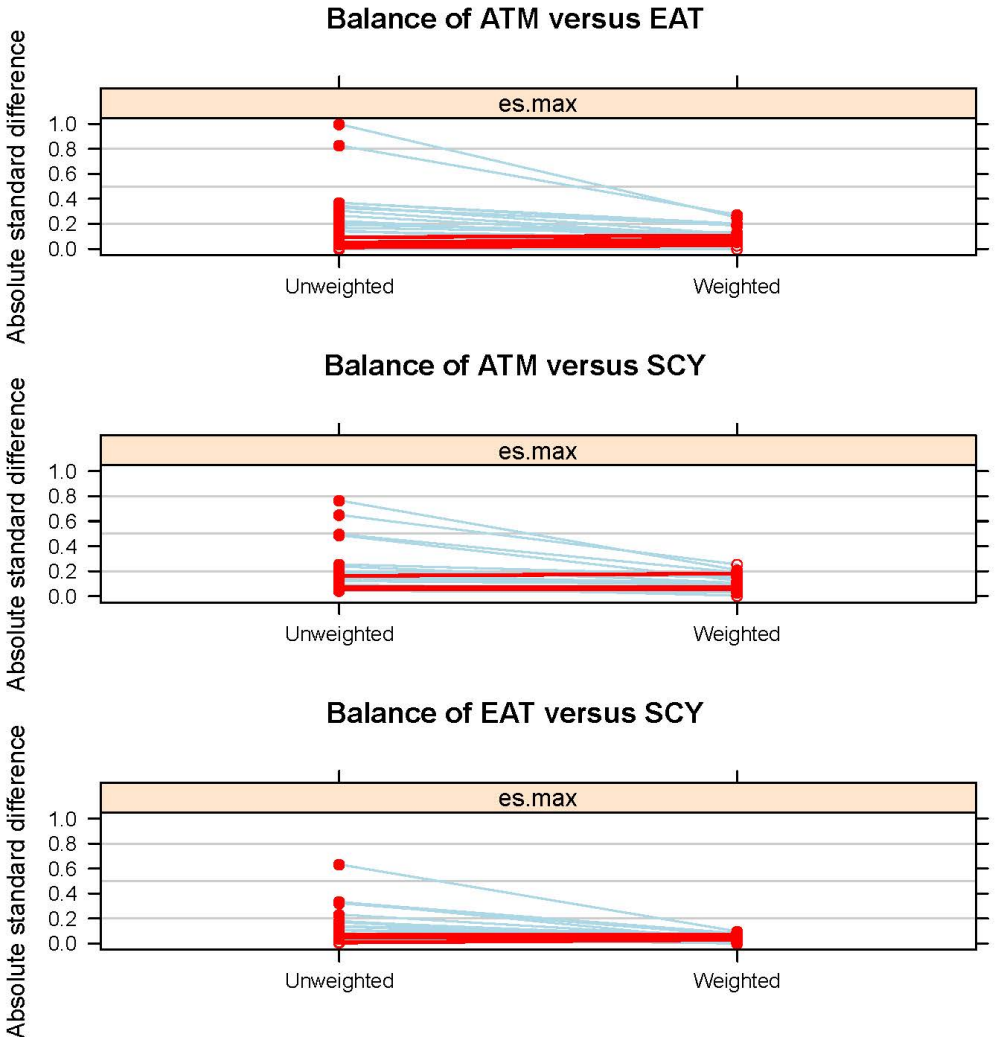
Step 3: Checking balance graphically – Maximum ES plot



Each dot is the maximum ES across all pairs of unweighted means for one of the covariates

Each dot is the maximum ES across all pairs of weighted means for one of the covariates, corresponding covariates are connected with lines

Step 3: Checking balance graphically – Pairwise ES plots



Note:
ATM = Usual care group
EAT = MET/CBT5 group

Sas Code for ES plots

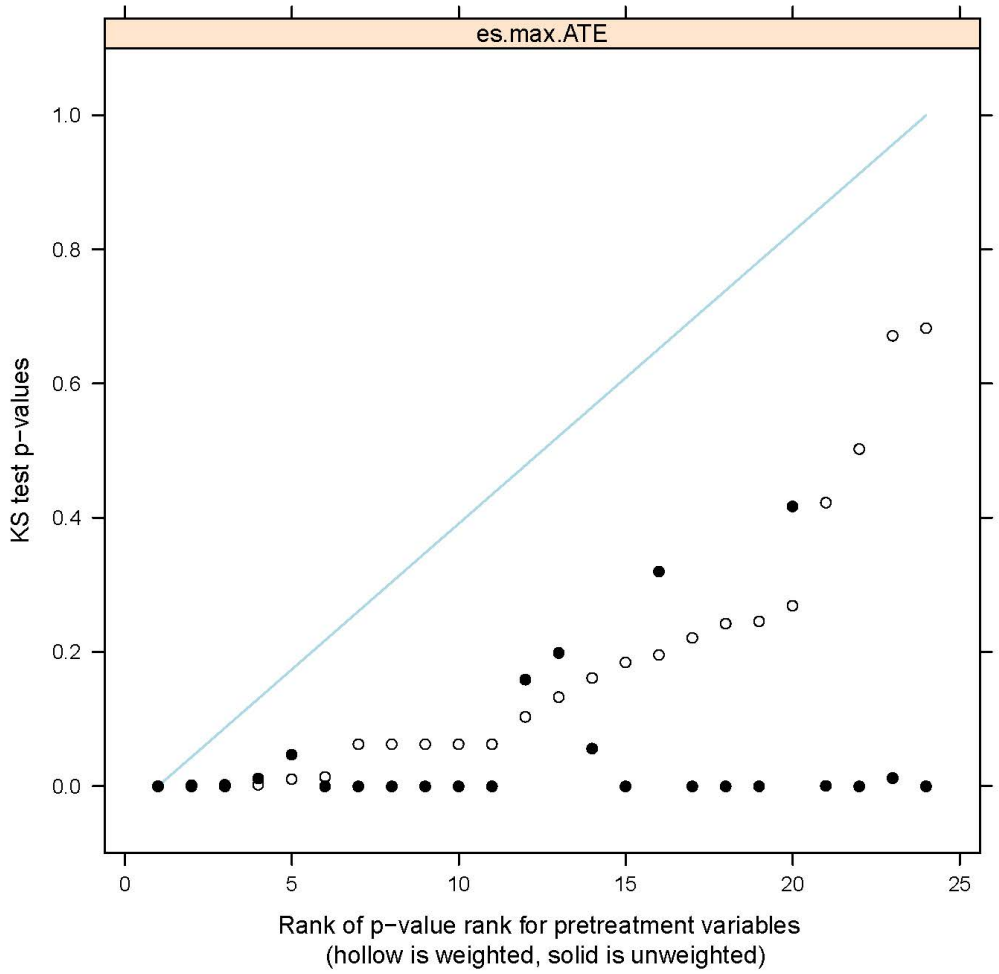
Maximum plot

%*mnplot*(inputobj=mnps.RData,
plotname=mnps_example_plot_es_max.pdf,
plotformat=pdf,
plots=3,
pairwisemax=TRUE,
Rcmd=C:\Program Files\R\R-3.0.1\bin\R.exe,
objpath=C:\Users\bethg\Documents\TWANG\SAS work);

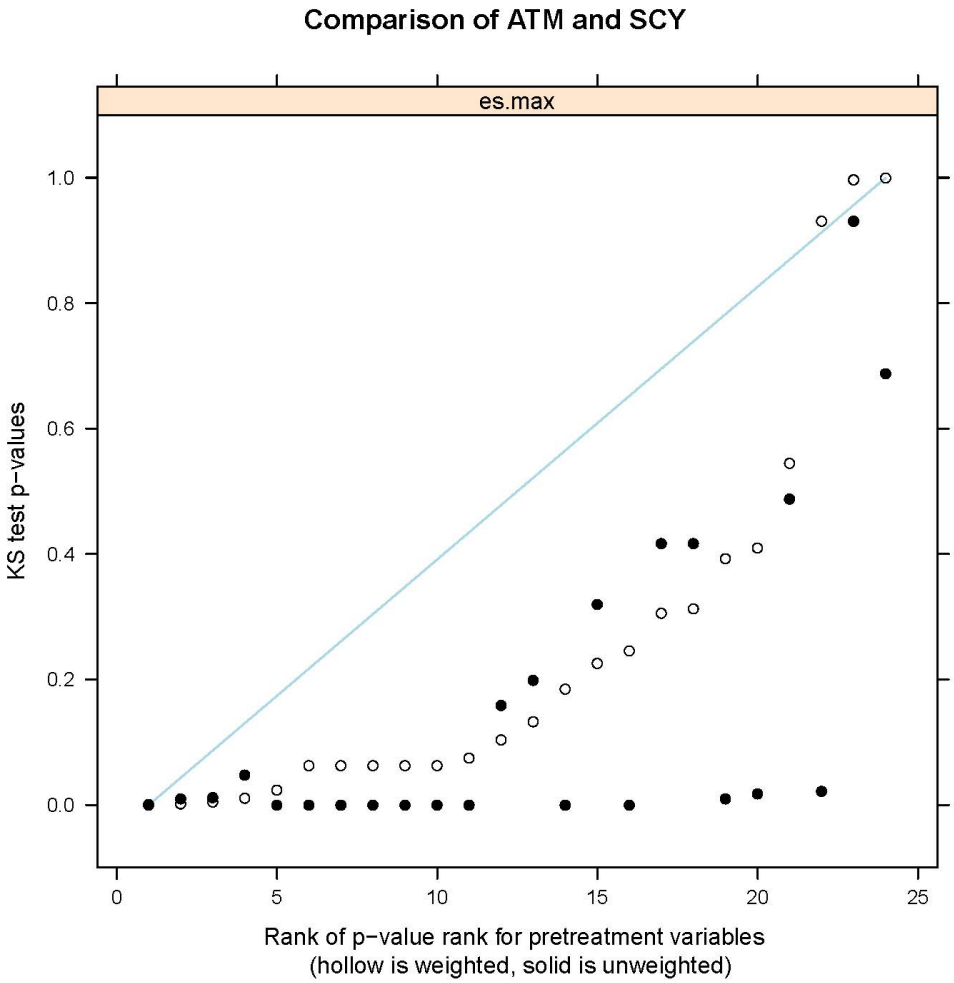
Pairwise plots

%*mnplot*(inputobj=mnps.RData,
plotname=mnps_example_plot_es_pairwise.pdf,
plotformat=pdf,
plots=3,
pairwisemax=FALSE,
figurerows=3,
Rcmd=C:\Program Files\R\R-3.0.1\bin\R.exe,
objpath=C:\Users\bethg\Documents\TWANG\SAS work);

Step 3: Checking balance graphically – Minimum KS p-values plot



Step 3: Checking balance graphically – Pairwise KS plots



Sas Code for KS plots

Maximum plot

%*mnplot*(inputobj=mnps.RData,
plotname=mnps_example_plot_ks_max.pdf,
plotformat=pdf,
plots=5,
pairwisemax=TRUE,
Rcmd=C:\Program Files\R\R-**3.0.1**\bin\R.exe,
objpath=C:\Users\bethg\Documents\TWANG\SAS work);

Pairwise plots

%*mnplot*(inputobj=mnps.RData,
plotname=mnps_example_plot_ks_pairwise.pdf,
plotformat=pdf,
plots=5,
pairwisemax=FALSE,
multipage=TRUE,
singleplot=2,
Rcmd=C:\Program Files\R\R-3.0.1\bin\R.exe,
objpath=C:\Users\bethg\Documents\TWANG\SAS work);

Step 3: Checking balance with tables: Unweighted pairwise balance table

Obs	tmt1	tmt2	var	mean1	mean2	pop_sd	std_eff_sz	p	ks	ks_pval	stop_method
1	ATM	EAT	age	15.818	15.54	1.444	0.192	0	0.116	0	unw
2	ATM	EAT	female	0.214	0.315	0.451	0.223	0	0.101	0.001	unw
8	ATM	EAT	sfs	0.145	0.109	0.137	0.265	0	0.12	0	unw
9	ATM	EAT	sfs:<NA>	0	0	0.022	0	1	0	1	unw
	…	…	…	…	…	…	…	…	…	…	…
25	ATM	SCY	age	15.818	15.45	1.444	0.255	0	0.118	0	unw
26	ATM	SCY	female	0.214	0.252	0.451	0.085	0.092	0.038	0.688	unw
32	ATM	SCY	sfs	0.145	0.154	0.137	0.07	0.235	0.045	0.488	unw
33	ATM	SCY	sfs:<NA>	0	0.001	0.022	0.068	0	0.001	0.417	unw
	…	…	…	…	…	…	…	…	…	…	…
49	EAT	SCY	age	15.54	15.45	1.444	0.062	0.057	0.046	0.048	unw
50	EAT	SCY	female	0.315	0.252	0.451	0.138	0	0.062	0.002	unw
56	EAT	SCY	sfs	0.109	0.154	0.137	0.335	0	0.143	0	unw
57	EAT	SCY	sfs:<NA>	0	0.001	0.022	0.068	0	0.001	0.056	unw

Note: ATM = Usual care group; EAT = MET/CBT5 group

Red highlights denote rows with absolute ES < 0.20

Unweighted pairwise balance table for AOP example

Obs	tmt1	tmt2	var	mean1	mean2	pop_sd	std_eff_sz	p	ks	ks_pval	stop_method
1	ATM	EAT	age	15.818	15.54	1.444	0.192	0	0.116	0	unw
2	ATM	EAT	female	0.214	0.315	0.451	0.223	0	0.101	0.001	unw
8	ATM	EAT	sfs						0.12	0	unw
9	ATM	EAT	sfs:<NA>						0	1	unw
	…	…	…						…	…	…
25	ATM	SCY	age							0	unw
26	ATM	SCY	female						.038	0.688	unw
32	ATM	SCY	sfs						.045	0.488	unw
33	ATM	SCY	sfs:<NA>						.001	0.417	unw
	…	…	…						…	…	…
49	EAT	SCY	age						.046	0.048	unw
50	EAT	SCY	female	0.315	0.252	0.451	0.138	0	0.062	0.002	unw
56	EAT	SCY	sfs	0.109	0.154	0.137	0.335	0	0.143	0	unw
57	EAT	SCY	sfs:<NA>	0	0.001	0.022	0.068	0	0.001	0.056	unw

stop_method variable equal unw to indicate unweighted comparison

Red highlights denote rows with absolute ES < 0.20

Note: ATM = Usual care group; EAT = MET/CBT5 group

Unweighted pairwise balance table for AOP example

Obs	tmt1	tmt2	var	mean1	mean2	pop_sd	std_eff_sz	p	ks	ks_pval	stop_method
1	ATM	EAT	age	15.818	15.54	1.444	0.192	0	0.116	0	unw
2	ATM	EAT	female	0.214	0.315	0.451	0.223	0	0.101	0.001	unw
8	ATM	EAT	sfs	0.145	0.109	0.137	0.265	0	0.12	0	unw
9	ATM	EAT	sfs:<NA>	0	0	0.022	0	1	0	1	unw
	...	...	...	...						...	...
25	ATM	SCY	age	15.818	1					0	unw
26	ATM	SCY	female	0.214	0					0.688	unw
32	ATM	SCY	sfs	0.145	0					0.488	unw
33	ATM	SCY	sfs:<NA>	0	0					0.417	unw
	...	...	...							...	...
49	EAT	SCY	age	15.54	15.45	1.444	0.062	0.057	0.046	0.048	unw
50	EAT	SCY	female	0.315	0.252	0.451	0.138	0	0.062	0.002	unw
56	EAT	SCY	sfs	0.109	0.154	0.137	0.335	0	0.143	0	unw
57	EAT	SCY	sfs:<NA>	0	0.001	0.022	0.068	0	0.001	0.056	unw

One group of comparisons for each group of treatments

Red highlights denote rows with absolute ES < 0.20

Note: ATM = Usual care group; EAT = MET/CBT5 group

Step 3: Checking balance with tables: Weighted pairwise balance table

Obs	tmt1	tmt2	var	mean1	mean2	pop_sd	std_eff_sz	p	ks	ks_pval	stop_method
73	ATM	EAT	age	15.736	15.547	1.444	0.131	0.069	0.077	0.364	es.ma
74	ATM	EAT	female	0.267	0.302	0.451	0.076	0.356	0.034	0.994	es.ma
80	ATM	EAT	sfs	0.135	0.123	0.137	0.091	0.257	0.069	0.503	es.ma
81	ATM	EAT	sfs:<NA>	0	0	0.022	0	1	0	1	es.ma
	…	…	…	…	…	…	…	…	…	…	…
97	ATM	SCY	age	15.736	15.495	1.444	0.167	0.025	0.088	0.246	es.ma
98	ATM	SCY	female	0.267	0.269	0.451	0.004	0.965	0.002	1	es.ma
104	ATM	SCY	sfs	0.135	0.125	0.137	0.073	0.373	0.068	0.544	es.ma
105	ATM	SCY	sfs:<NA>	0	0.002	0.022	0.073	0	0.002	0.306	es.ma
	…	…	…	…	…	…	…	…	…	…	…
121	EAT	SCY	age	15.547	15.495	1.444	0.036	0.31	0.025	0.742	es.ma
122	EAT	SCY	female	0.302	0.269	0.451	0.073	0.053	0.033	0.424	es.ma
128	EAT	SCY	Sfs	0.123	0.125	0.137	0.018	0.605	0.019	0.957	es.ma
129	EAT	SCY	sfs:<NA>	0	0.002	0.022	0.073	0	0.002	0.162	es.ma

Note: ATM = Usual care group; EAT = MET/CBT5 group

Red highlights denote rows with absolute ES < 0.20

Step 3: Checking balance with tables: Unweighted covariate balance table

Balance table: unw

Obs	var	max_std_eff_sz	min_p	max_ks	min_ks_pval	stop_method
1	age	0.255	0	0.118	0	unw
2	female	0.223	0	0.101	0.001	unw
3	race4g:1	0.651	0	0.324	0	unw
4	race4g:2	0.633	0	0.235	0	unw
5	race4g:3	0.345	0	0.144	0	unw
6	race4g:4	0.208	0	0.076	0	unw
7	race4g: <NA>	0.139	0	0.002	0	unw
8	sfs	0.335	0	0.143	0	unw
9	sfs: <NA>	0.068	0	0.001	0.056	unw
10	sps	0.369	0	0.141	0	unw
11	sps: <NA>	0.043	0	0.001	0.417	unw
12	sds	0.333	0	0.147	0	unw
13	sds: <NA>	0.18	0	0.015	0	unw
14	ias	0.998	0	0.485	0	unw
15	ias: <NA>	0.144	0	0.014	0.012	unw
16	ces	0.828	0	0.262	0	unw
17	eps	0.369	0	0.186	0	unw
18	eps: <NA>	0.081	0	0.004	0.199	unw
19	imds	0.187	0	0.081	0	unw
20	imds: <NA>	0.055	0	0.002	0.32	unw
21	bcs	0.304	0	0.177	0	unw
22	bcs: <NA>	0.084	0	0.004	0.159	unw
23	prmhtx	0.168	0.001	0.082	0.012	unw
24	prmhtx: <NA>	0.121	0.051	0.011	0.047	unw

Red highlights denote rows with absolute ES < 0.20

Step 3: Checking balance with tables: Weighted covariate balance table

Balance table: es.ma

Obs	var	max_std_eff_sz	min_p	max_ks	min_ks_pval	stop_method
25	age	0.167	0.025	0.088	0.246	es.ma
26	female	0.076	0.053	0.034	0.424	es.ma
27	race4g:1	0.254	0.063	0.126	0.063	es.ma
28	race4g:2	0.125	0.063	0.046	0.063	es.ma
29	race4g:3	0.117	0.063	0.049	0.063	es.ma
30	race4g:4	0.098	0.063	0.036	0.063	es.ma
31	race4g: <NA>	0.087	0.063	0.001	0.063	es.ma
32	sfs	0.091	0.257	0.069	0.503	es.ma
33	sfs: <NA>	0.073	0	0.002	0.162	es.ma
34	sps	0.189	0.044	0.085	0.243	es.ma
35	sps: <NA>	0.059	0	0.002	0.269	es.ma
36	sds	0.187	0.053	0.087	0.221	es.ma
37	sds: <NA>	0.093	0	0.008	0.002	es.ma
38	ias	0.251	0.004	0.176	0	es.ma
39	ias: <NA>	0.107	0	0.01	0.002	es.ma
40	ces	0.273	0	0.154	0.002	es.ma
41	eps	0.202	0.012	0.132	0.014	es.ma
42	eps: <NA>	0.067	0	0.003	0.133	es.ma
43	imds	0.071	0.242	0.046	0.68	es.ma
44	imds: <NA>	0.064	0	0.003	0.196	es.ma
45	bcs	0.104	0.233	0.094	0.184	es.ma
46	bcs: <NA>	0.066	0	0.003	0.104	es.ma
47	prmhtx	0.123	0.153	0.06	0.672	es.ma
48	prmhtx: <NA>	0.096	0.035	0.009	0.011	es.ma

Red highlights denote rows with absolute ES < 0.20

Step 3: Checking balance with tables

SAS code for previous 2 tables

```
%mnbaltable(inputobj=mnps.RData,
        collapseto=covariate,
        Rcmd=C:\Program Files\R\R-3.0.1\bin\x64\R.exe,
        objpath=C:\Users\bethg\Documents\TWANG\SAS work);
```

Step 3: Checking balance with tables – Using es_cutoff

Balance table: es.max

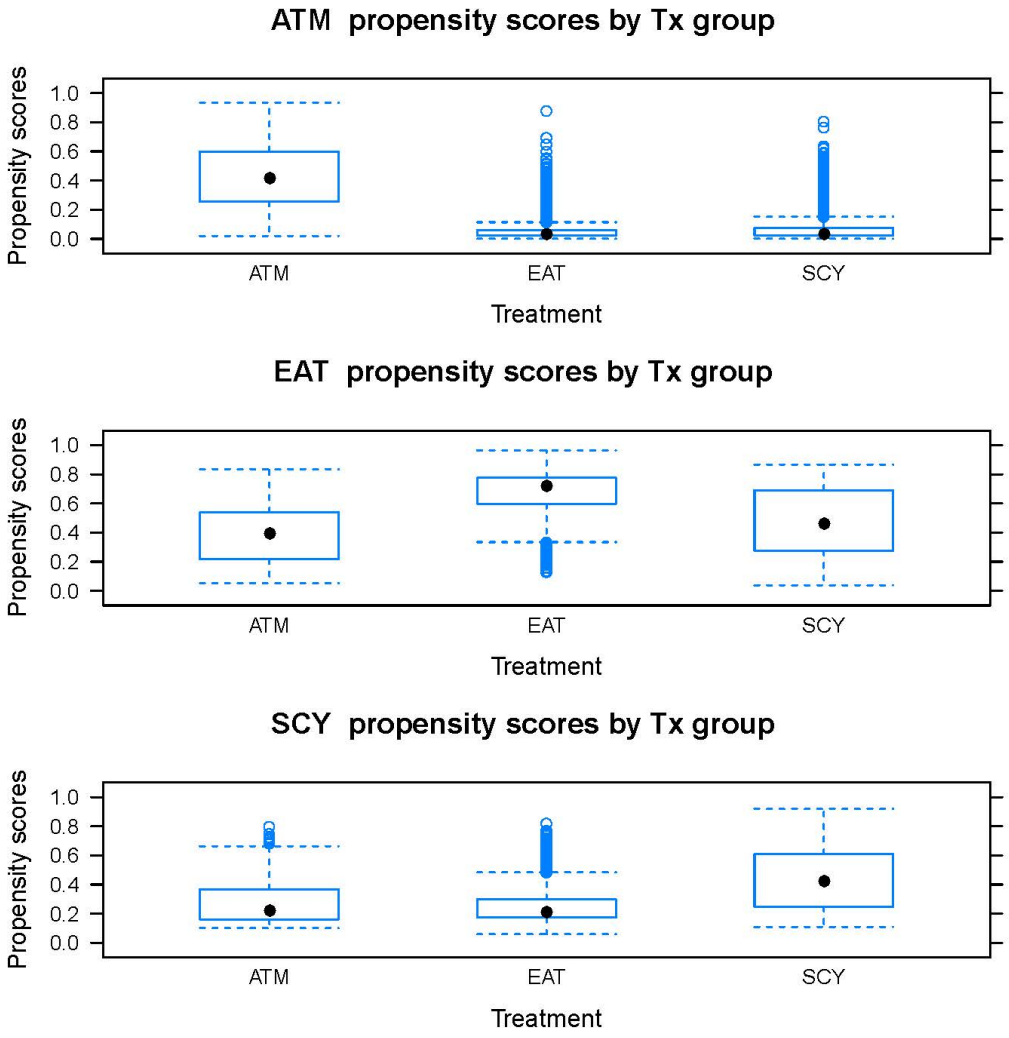
Obs	tmt1	tmt2	var	mean1	mean2	pop_sd	std_eff_sz	p	ks	ks_pval	stop_method
1	ATM	EAT	ias	0.137	0.103	0.137	0.251	0.004	0.176	0	es.max
2	ATM	EAT	ces	0.139	0.076	0.23	0.273	0	0.154	0.002	es.max
3	ATM	EAT	eps	0.257	0.218	0.193	0.202	0.012	0.132	0.014	es.max
4	ATM	SCY	race4g:1	0.577	0.45	0.498	0.254	0.063	0.126	0.063	es.max
5	ATM	SCY	ias	0.137	0.108	0.137	0.21	0.016	0.174	0.001	es.max

Note: ATM = Usual care group; EAT = MET/CBT5 group

SAS Code:

```
%mnbaltable(inputobj=mnps.RData,
        es_cutoff=.2,
        ks_cutoff=,
        p_cutoff=,
        ks_p_cutoff=,
        Rcmd=C:\Program Files\R\R-3.0.1\bin\x64\R.exe,
        objpath=C:\Users\bethg\Documents\TWANG\Sas work);
```

Step 3: Checking overlap



Note: ATM = Usual care group; EAT = MET/CBT5 group

Step 4: Estimate the treatment effect (cont.)

SAS Code:

```
proc surveyreg data=subdata_wgts;
model sfs8p12 = metcbt5 scy;
weight es_max_ate;
run;
```

Estimated Regression Coefficients

Parameter	Estimate	Standard Error	t Value	Pr > |t|
Intercept	0.111	0.013	8.81	<.0001
metcbt5	-0.039	0.013	-3	0.0027
scy	-0.036	0.013	-2.72	0.0065

Step 4: Estimate the treatment effect (cont.)

SAS Code:

```
proc surveyreg data=subdata_wgts;
model sfs8p12 = metcbt5 scy;
weight es_max_ate;
run;
```

Estimated Regression Coefficients

Parameter	Estimate	Standard Error	t Value	Pr > |t|
Intercept	0.111	0.013	8.81	<.0001
metcbt5	-0.039	0.013	-3	0.0027
scy	-0.036	0.013	-2.72	0.0065

Results show that youth would have fared better had they received either MET/CBT5 or SCY vs "usual care"

Comparison with unweighted treatment effect

SAS Code:

```
proc reg data=sasin.subdata;
model sfs8p12 = metcbt5 scy;
run;
```

Parameter Estimates

Parameter Standard

Parameter	DF	Estimate	Standard Error	t Value	Pr > |t|
Intercept	1	0.114	0.006	19.83	<.0001
metcbt5	1	-0.047	0.006	-7.52	<.0001
scy	1	-0.038	0.007	-5.65	<.0001

Comparison with unweighted treatment effect

SAS Code:

```
proc reg data=sasin.subdata;
model sfs8p12 = metcbt5 scy;
run;
```

Parameter Estimates
Parameter Standard

Parameter	DF	Estimate	Standard Error	t Value	Pr > |t|
Intercept	1	0.114	0.006	19.83	<.0001
metcbt5	1	-0.047	0.006	-7.52	<.0001
scy	1	-0.038	0.007	-5.65	<.0001

Similar evidence, though magnitude of the effect for MET/CBT5 vs usual care changes the most, likely because greatest pretreatment differences between MET/CBT5 and usual care

Step 4: Doubly robust estimation Adding in covariates with lingering imbalances

SAS Code:

```
proc surveyreg data=subdata_wgts;
class race4g;
model sfs8p12 = metcbt5 scy ces eps ias race4g/solution;
weight es_max_ate;
where race4g ne "NA";
run;
```

Estimated Regression Coefficients

Parameter	Estimate	Standard Error	t Value	Pr > |t|
Intercept	0.072	0.015	4.83	<.0001
metcbt5	-0.032	0.014	-2.38	0.0173
scy	-0.030	0.014	-2.22	0.0262
ces	-0.003	0.014	-0.25	0.8042
eps	0.048	0.020	2.35	0.0190
ias	0.128	0.027	4.79	<.0001
race4g 1	0.012	0.007	1.65	0.0993
race4g 2	-0.008	0.008	-0.99	0.3200
race4g 3	0.021	0.011	2.00	0.0451
race4g 4	0.000	0.000	.	.

Conclusions

- Propensity score weights improved balance on observed pretreatment covariates
- Greatest changes in treatment effect estimate comparing MET/CBT5 vs usual care
  - Likely because group of youth were more dissimilar than SCY vs usual care
- Doubly robust model which controlled for lingering imbalances provides our most robust inferences concerning causal effects

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photo by Iz Marty/flickr.com

In 2014, TWANG macros were developed for SAS to support the use of these tools without requiring researchers and analysts to learn R. At this time, the SAS TWANG macros can support estimation of propensity scores and their associated weights for comparisons involving two treatment groups. SAS macros will be made available shortly for handling the case of three or more treatment groups.

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History

Project Researchers

Beth Ann Griffin
Senior Statistician

Beth Ann Griffin is a senior statistician at the RAND Corporation, where she codirects the RAND Center for Causal Inference. Her statistical research focuses on causal effects estimation when using observational data and innovative techniques for the analysis of time-to-event data. Her...

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