Supplementary Materials for "rbw: An R package for Constructing Residual Balancing Weights"

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Code for Constructing CBPS and IPW Weights

CBPS

Below we detail the steps for constructing the CBPS and IPW weights for our point treatment scenario using the functions from the `CBPS` and `ipw` packages.

```
library("rbw")
library("CBPS")
library("ipw")
data("advertisement")
```

We will consider the CBPS weights first. The treatment model proposed in Fong, Hazlett, and Imai (2018) includes the zip code's log population, population density, log median income, percent Hispanic, percent black, percent over age 65, percent college graduates, and a binary indicator of whether it is possible to commute to the zip code from a competitive state. We define the formula accordingly:

```
CBPS_pscore_form <- treat ~ log_TotalPop + PercentOver65 +
  log_Inc + PercentHispanic + PercentBlack +
  density + per_collegegrads + CanCommute
```

We first construct the parametric CBPS weights:

```
CBPS_fit <- CBPS(
  CBPS_pscore_form,
  data = advertisement,
  twostep = TRUE,
  method = "exact"
)
```

Next, the nonparametric CBPS weights:

```
npCBPS_fit <- npCBPS(CBPS_pscore.form,
                     data = advertisement,
                     corprior = 0.1 / nrow(advertisement))
```

We then attach the estimated weights to the data and use the `survey` package to specify a complex survey design that will allow us to estimate standard errors consistent with this specification:

```
library("survey")
advertisement$CBPS_weights <- CBPS_fit$weights
advertisement$npCBPS_weights <- npCBPS_fit$weights

CBPS_design <- svydesign(ids = ~ 1,
                         weights = ~ CBPS_weights,
                         data = advertisement)
```

```
npCBPS_design <- svydesign(ids = ~ 1,
                           weights = ~ npCBPS_weights,
                           data = advertisement)
```

Having completed the previous steps, we now can fit the MSM and estimate the causal effect of interest using the adjustments described in the main text for the case involving RBW weights:

```
CBPS_msm <- svyglm(Cont ~ treat + factor(StFIPS),
                   design = CBPS_design)
npCBPS_msm <- svyglm(Cont ~ treat + factor(StFIPS),
                     design = npCBPS_design)

dose <- log(1000 + 1)

CBPS_tau <- 1000 * coef(CBPS_msm)[2] * dose
npCBPS_tau <- 1000 * coef(npCBPS_msm)[2] * dose
```

We also compute the corresponding standard errors:

```
CBPS_vcov <- stats::vcov(CBPS_msm)
npCBPS_vcov <- stats::vcov(npCBPS_msm)
CBPS_se <- 1000 * dose * sqrt(CBPS_vcov[2, 2])
npCBPS_se <- 1000 * dose * sqrt(npCBPS_vcov[2, 2])
```

IPW

We use the `ipwpoint()` function from `ipw` package to construct our IPW weights using the same treatment model as above:

```
ipw_fit <- ipwpoint(
  exposure = treat,
  family = "gaussian",
  numerator = ~ 1,
  denominator = ~ log_TotalPop + PercentOver65 +
    log_Inc + PercentHispanic + PercentBlack +
    density + per_collegegrads + CanCommute,
  data = advertisement
)
```

The next steps are similar to the ones described above for the CBPS weights:

```
advertisement$ipw_weights <- ipw_fit$ipw.weights

ipw_design <- svydesign(ids = ~ 1,
                        weights = ~ ipw_weights,
                        data = advertisement)

ipw_msm <- svyglm(Cont ~ treat + factor(StFIPS),
                  design = ipw_design)

ipw_tau <- 1000 * coef(ipw_msm)[2] * dose

ipw_vcov <- stats::vcov(ipw_msm)
ipw_se <- 1000 * dose * sqrt(ipw_vcov[2, 2])
```

Bibliography

Fong, Christian, Chad Hazlett, and Kosuke Imai. 2018. "Covariate Balancing Propensity Score for a Continuous Treatment: Application to the Efficacy of Political Advertisements." *The Annals of Applied Statistics* 12 (1). https://doi.org/10.1214/17-AOAS1101.