ATEHonest: Honest CIs for Average Treatment Effects

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The package `ATEHonest` implements honest confidence intervals and estimators for estimating average treatment effects under unconfoundedness from Armstrong and Kolesár [2018]. Here we illustrate the use of the package using NSW data from Dehejia and Wahba [1999].

The data is shipped with the package, as two data frames, `NSW` (where the treated units are from the experimental sample and control units are from PSID), and `NSWexper`, where both treated and control units are from the experimental sample. We'll use the experimental sample here.

First we extract the design matrix, and the treatment and outcome vectors, and we construct a nearest neighbor estimate of the variance of the regression errors using Mahalanobis distance:

```
library("ATEHonest")
X <- as.matrix(NSWexper[, 2:10])
d <- NSWexper$treated
y <- NSWexper$re78
DMvar <- distMat(X, chol(solve(cov(X))), method = "euclidean")
sigma2 <- nnvar(DMvar, d, y, J = 3)
```

Next, we compute matrix of distances between treated and control units, using the same weight matrix to compute distances as in Armstrong and Kolesár [2018]:

```
Ahalf <- diag(c(0.15, 0.6, 2.5, 2.5, 2.5, 0.5, 0.5, 0.1,
    0.1))
D0 <- distMat(X, Ahalf, method = "manhattan", d)
```

We now compute the first few steps of the solution path. 120 steps will be sufficient for computing the optimal estimator. Given the solution path, we then compute the root mean squared error optimal estimator, as well as estimator that's optimal for constructing two-sided CIs:

```
op <- ATTOptPath(y, d, D0, maxsteps = 120)
ATTOptEstimate(op, mean(sigma2), C = 1, sigma2final = sigma2,
    opt.criterion = "RMSE")
#>
#>
#> Estimate   Max. bias   SE          CI                          delta
#> ---------  ----------  ----------  -----------------------  ---------
#> 1.58946    1.185779    0.7550322   (-0.8382422, 4.017163)    1.222475
ATTOptEstimate(op, mean(sigma2), C = 1, sigma2final = sigma2,
    opt.criterion = "FLCI")
```

```
#>
#>
#> Estimate   Max. bias   SE          CI                         delta
#> ---------  ----------  ---------   ------------------------  ---------
#> 1.62276    1.234971    0.713424    (-0.7856902,  4.03121)    3.289756
```

For computing efficiency of one- and two-sided CIs at smooth functions (see Appendix A in Armstrong and Kolesár [2018]), the solution path is not long enough:

```
ATTEffBounds(op, mean(sigma2), C = 1)
#> Warning in ATTEffBounds(op, mean(sigma2), C = 1): Path too short to compute one-
#> sided efficiency
#> Warning in ATTEffBounds(op, mean(sigma2), C = 1): Path too short to compute two-
#> sided efficiency
#> $onesided
#> [1] NaN
#>
#> $twosided
#> [1] NaN
```

We therefore make it longer, by passing the output `op` as an argument to `ATTOptPath`

```
op <- ATTOptPath(path = op, maxsteps = 290)
ATTEffBounds(op, mean(sigma2), C = 1)
#> $onesided
#> [1] 0.9917693
#>
#> $twosided
#> [1] 0.9750232
```

For comparison, we also consider matching estimators. First, a matching estimator with a single match:

```
ATTMatchEstimate(ATTMatchPath(y, d, D0, M = 1, tol = 1e-12),
    mean(sigma2), C = 1, sigma2final = sigma2)
#>
#>
#> Estimate   Max. bias   SE          CI                         M
#> ---------  ----------  ----------  ------------------------  ---
#> 1.972065   1.169562    0.7758019   (-0.4735895,  4.41772)     1
```

Next, we optimize the number of matches. For that we first compute the matching estimator for a vector of matches `M`, and then optimize the number of matches using `ATTMatchEstmate`:

```
mp <- ATTMatchPath(y, d, D0, M = 1:10, tol = 1e-12)
ATTMatchEstimate(mp, mean(sigma2), C = 1, sigma2final = sigma2,
    opt.criterion = "FLCI")
#>
#>
#> Estimate   Max. bias   SE          CI                         M
```

```
#> ---------   ----------   ----------   ----------------------   ---
#> 1.972065    1.169562     0.7758019    (-0.4735895,  4.41772)     1
ATTMatchEstimate(mp, mean(sigma2), C = 1, sigma2final = sigma2,
    opt.criterion = "RMSE")
#>
#>
#> Estimate    Max. bias    SE           CI                         M
#> ---------   ----------   ----------   ----------------------   ---
#> 1.972065    1.169562     0.7758019    (-0.4735895,  4.41772)     1
```

We can see that a single match is in fact optimal for both estimation and construction of two-sided CIs.

References

Tim Armstrong and Michal Kolesár. Finite-sample optimal estimation and inference on average treatment effects under unconfoundedness. arXiv: 1712.04594, December 2018. URL https://arxiv.org/abs/1712.04594.

Rajeev H. Dehejia and Sadek Wahba. Causal effects in nonexperimental studies: Reevaluating the evaluation of training programs. *Journal of the American Statistical Association*, 94(448):1053–1062, December 1999. doi: 10.1080/01621459.1999.10473858.