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:

```
library("ATEHonest")
X <- as.matrix(NSWexper[, 2:10])
d <- NSWexper$treated
y <- NSWexper$re78
```

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)
```

Next, construct a distance matrix used by the nearest neighbor variance estimator to estimate the conditional variance of the outcome. We use Mahalanobis distance:

```
DM <- distMat(X, chol(solve(cov(X))), method = "euclidean")
```

We are now ready to compute the root mean squared error optimal estimator:

```
c1 <- ATTOptEstimate(y = y, d = d, D0 = D0, C = 1, DM = DM,
    opt.criterion = "RMSE")
print(c1)
#>
#>
#> |     | Estimate| Max. bias|      SE|CI                  |  delta|
#> |:----|--------:|---------:|-------:|:-------------------|------:|
#> |CATT |   1.5895|    1.1858| 0.75503|(-0.83824, 4.0172)  | 1.2225|
#> |PATT |   1.5895|          | 0.76509|(-1.09587, 4.2748)  |       |
```

Next, we compute the estimator that's optimal for constructing two-sided CIs. We re-use the solution path returned by `c1`:

```
ATTOptEstimate(path = c1$path, C = 1, DM = DM, opt.criterion = "FLCI")
#> Increasing length of solution path to 100
#> Increasing length of solution path to 150
#>
#>
#> |     | Estimate| Max. bias|      SE|CI                 |  delta|
#> |:----|--------:|---------:|-------:|:------------------|------:|
#> |CATT |   1.6228|     1.235| 0.71342|(-0.78569, 4.0312) | 3.2898|
#> |PATT |   1.6228|          | 0.73821|(-1.05908, 4.3046) |       |
```

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(c1$path, DM = DM, C = 1)
#> Warning in ATTEffBounds(c1$path, DM = DM, C = 1): Path too short to compute one-
#> sided efficiency
#> Warning in ATTEffBounds(c1$path, DM = DM, 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 `c1$path` as an argument to `ATTOptPath` (at the moment, only the `ATTOptEstimate` can automatically compute extra steps in the solution path as needed):

```
op <- ATTOptPath(path = c1$path, maxsteps = 290)
ATTEffBounds(op, DM = DM, C = 1)
#> $onesided
#> [1] 0.99177
#>
#> $twosided
#> [1] 0.97502
```

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),
    C = 1, DM = DM)
#>
#>
#> |     | Estimate| Max. bias|      SE|CI                 |  M|
#> |:----|--------:|---------:|-------:|:------------------|--:|
#> |CATT |   1.9721|    1.1696| 0.77580|(-0.47359, 4.4177) |  1|
#> |PATT |   1.9721|          | 0.76518|(-0.69722, 4.6414) |   |
```

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, C = 1, DM = DM, opt.criterion = "FLCI")
#>
#>
#> |     | Estimate| Max. bias|      SE|CI                 |  M|
#> |:----|--------:|---------:|-------:|:------------------|--:|
#> |CATT |   1.9721|    1.1696| 0.77580|(-0.47359, 4.4177) |  1|
#> |PATT |   1.9721|          | 0.76518|(-0.69722, 4.6414) |   |
ATTMatchEstimate(mp, C = 1, DM = DM, opt.criterion = "RMSE")
#>
#>
#> |     | Estimate| Max. bias|      SE|CI                 |  M|
#> |:----|--------:|---------:|-------:|:------------------|--:|
#> |CATT |   1.9721|    1.1696| 0.77580|(-0.47359, 4.4177) |  1|
#> |PATT |   1.9721|          | 0.76518|(-0.69722, 4.6414) |   |
```

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.