

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 |    1.5892|    1.1858| 0.75552|(-0.83932, 4.0178) | 1.2231|
#> |PATT |    1.5892|          | 0.76482|(-1.09561, 4.2740) |          |
```

Next, we compute the estimator that's optimal for constructing two-sided CIs. We re-use the

solution path returned by c1:

```

ATTOptEstimate(op = c1$op, 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 |   1.6229|   1.235| 0.71403|(-0.78663, 4.0324) | 3.2898|
#> |PATT |   1.6229|      | 0.73808|(-1.05875, 4.3045) |      |

```

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$op, DM = DM, C = 1)
#> Warning in ATTEffBounds(c1$op, DM = DM, C = 1): Path too short to compute one-
#> sided efficiency
#> Warning in ATTEffBounds(c1$op, 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$op` 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$op, maxsteps = 290)
ATTEffBounds(op, DM = DM, C = 1)
#> $onesided
#> [1] 0.99177
#>
#> $twosided
#> [1] 0.97503

```

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

```

ATTMatchEstimate(ATTMatchPath(y, d, DO, M = 1, tol = 1e-12),
  C = 1, DM = DM)
#>
#>
#> |      | Estimate| Max. bias|      SE|CI      | M|
#> |:----|-----:|-----:|-----:|-----:|---:|
#> |CATT |   1.9721|   1.1696| 0.77635|(-0.47449, 4.4186) | 1|
#> |PATT |   1.9721|      | 0.76497|(-0.69680, 4.6409) |  |

```

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 `ATTMatchEstimate`:

```
mp <- ATTMatchPath(y, d, DO, 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| 0.77635|(-0.47449, 4.4186) | 1|
#> |PATT |  1.9721|      | 0.76497|(-0.69680, 4.6409) |  |
ATTMatchEstimate(mp, C = 1, DM = DM, opt.criterion = "RMSE")
#>
#>
#> |      | Estimate| Max. bias|      SE|CI      | M|
#> |:----|-----:|-----:|-----:|:-----|---:|
#> |CATT |  1.9721|  1.1696| 0.77635|(-0.47449, 4.4186) | 1|
#> |PATT |  1.9721|      | 0.76497|(-0.69680, 4.6409) |  |
```

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.