Report

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Case 1: Continuous Outcome and Continuous Mediator

Data simulation

Simulation Procedures

1. Simulate the exposure variable A from Binom(1,P(A=1)).
2. Simulate the covariate C from $N(\mu_C, \sigma_C^2)$.
3. Simulate the mediator M from $N((\beta_0 + \beta_1 * A + \beta_2 * C), \sigma_M^2)$.
4. When there exists interaction between the exposure and the mediator, simulate the outcome Y from $N(\theta_0 + \theta_1 A + \theta_2 M + \theta_3 AM + \theta_4 C, \sigma_Y^2)$; When there doesn't exist interaction between the exposure and the mediator, simulate the outcome Y from $N(\theta_0 + \theta_1 A + \theta_2 M + \theta_4 C, \sigma_Y^2)$.

True Parameters

Table 1: True Model Parameters for Data Simulation

Sample Size	θ_0	θ_1	θ_2	θ_3	θ_4	β_0	β_1	β_2	P(A=1)	μ_C	σ_C	σ_M	σ_Y
10000	-3.2	0.1	0.1	0.1	0.1	-0.25	0.3	0.2	0.4	1	1	1	1

True Models and True Causal Effects

True model for the mediator:

$$E[M|a,c] = \beta_0 + \beta_1 a + \beta_2 c$$

True model for the outcome:

$$E[Y|a,m^*,c] = \theta_0 + \theta_1 a + \theta_2 m^* + \theta_3 am + \theta_4 c$$

True Causal Effects with $m^* = 0$, $a^* = 0$ and $a = 1$:

Table 2: True Causal Effects from 3 Way Decomposition for Cont Y and Cont M

cde	pnde	tnde	pnie	tnie	total effect	proportion mediated
0.100	0.095	0.125	0.030	0.060	0.155	0.240

Table 3: True Causal Effects from 4 Way Decomposition for Cont Y and Cont M

cde	intref	intmed	pie	total effect	cde prop	intref prop
0.100	-0.005	0.030	0.030	0.155	0.645	-0.032
intmed prop	pie prop	overall pm	overall int	overall pe		
0.194	0.194	0.387	0.161	0.355		

Estimated Causal Effects and Standard Errors from 3 Different Estimation Method

Delta Method

```r
causal_mediation(data = df, method="delta", outcome = "Y_cont_int", treatment = 'A',
                 mediator = 'M_cont', covariates = "C", interaction = TRUE,
                 yreg = "linear", mreg = "linear")
```

```
## $decomp3way
##          cde       cde_se         pnde      pnde_se         tnde
##  0.150057809  0.020812692  0.148260878  0.020952001  0.158773634
##      tnde_se         pnie      pnie_se         tnie      tnie_se
##  0.020811504 -0.004000957  0.003675867  0.006511799  0.004416459
##           te        te_se           pm        pm_se
##  0.154772677  0.020483227  0.021488708  0.015166838
##
## $decomp4way
##             cde          cde_se          intref       intref_se          intmed
##     0.150057809     0.020812692    -0.001796931     0.001082501     0.010512756
##       intmed_se             pie          pie_se              te           te_se
##     0.005726149    -0.004000957     0.003675867     0.154772677     0.020483227
##        cde_prop     cde_prop_se     intref_prop  intref_prop_se     intmed_prop
##     0.969536817     0.024403084    -0.011610130     0.007167604     0.067923851
## intmed_prop_se        pie_prop     pie_prop_se      overall_pm   overall_pm_se
##     0.038068903    -0.025850537     0.023994251     0.042073314     0.029070863
##     overall_int  overall_int_se      overall_pe   overall_pe_se
##     0.056313720     0.031520362     0.030463183     0.024403084
```

Bootstrapping

```r
causal_mediation(data = df, method="bootstrap", outcome = "Y_cont_int", treatment = 'A',
                 mediator = 'M_cont', covariates = "C", interaction = TRUE,
                 yreg = "linear", mreg = "linear")
```

```
## $decomp3way
##          cde       cde_se         pnde      pnde_se         tnde
##  0.150057809  0.021005858  0.148260878  0.021152805  0.158773634
##      tnde_se         pnie      pnie_se         tnie      tnie_se
##  0.021004507 -0.004000957  0.003832570  0.006511799  0.004450841
##           te        te_se           pm        pm_se
##  0.154772677  0.020476516  0.021488708  0.016128239
##
## $decomp4way
##             cde          cde_se          intref       intref_se          intmed
##     0.150057809     0.021005858    -0.001796931     0.001123203     0.010512756
##       intmed_se             pie          pie_se              te           te_se
##     0.005734305    -0.004000957     0.003832570     0.154772677     0.020476516
##        cde_prop     cde_prop_se     intref_prop  intref_prop_se     intmed_prop
##     0.969536817     0.025668536    -0.011610130     0.007703325     0.067923851
## intmed_prop_se        pie_prop     pie_prop_se      overall_pm   overall_pm_se
##     0.039408811    -0.025850537     0.025725582     0.042073314     0.030600136
##     overall_int  overall_int_se      overall_pe   overall_pe_se
##     0.056313720     0.032458974     0.030463183     0.025668536
```

Simulation-based Approach

```r
causal_mediation(data = df, method="simulation", outcome = "Y_cont_int", treatment = 'A',
                 mediator = 'M_cont', covariates = "C", interaction = TRUE,
                 yreg = "linear", mreg = "linear")[1:2]
```

```
## $decomp3way
##          cde       cde_se         pnde      pnde_se         tnde
##  0.150565806  0.020267799  0.148765030  0.020424241  0.159198925
##      tnde_se         pnie      pnie_se         tnie      tnie_se
##  0.020324403 -0.003926874  0.003676045  0.006507022  0.004470166
##           te        te_se           pm        pm_se
##  0.155272052  0.020037178  0.021975249  0.015852597
##
## $decomp4way
##            cde          cde_se         intref      intref_se          intmed
##    0.150565806     0.020267799   -0.001800776    0.001108824     0.010433895
##      intmed_se             pie         pie_se             te           te_se
##    0.005743927    -0.003926874    0.003676045    0.155272052     0.020037178
##       cde_prop     cde_prop_se    intref_prop intref_prop_se     intmed_prop
##    0.969275763     0.025330106   -0.011813042    0.007586155     0.068324969
## intmed_prop_se        pie_prop    pie_prop_se     overall_pm   overall_pm_se
##    0.039024586    -0.025787690    0.024668001    0.042537279     0.030220100
##    overall_int overall_int_se     overall_pe  overall_pe_se
##    0.056511927     0.032241912    0.030724237    0.025330106
```

Case 2: Continuous Outcome and Binary Mediator

Data simulation

Simulation Procedures

1. Simulate the exposure variable A from Binom(1,P(A=1)).
2. Simulate the covariate C from $N(\mu_C, \sigma_C^2)$.
3. Simulate the mediator M from $Binom(1, expit(\beta_0 + \beta_1 * A + \beta_2 * C))$.
4. When there exists interaction between the exposure and the mediator, simulate the outcome Y from $N(\theta_0 + \theta_1 A + \theta_2 M + \theta_3 AM + \theta_4 C, \sigma_Y^2)$; When there doesn't exist interaction between the exposure and the mediator, simulate the outcome Y from $N(\theta_0 + \theta_1 A + \theta_2 M + \theta_4 C, \sigma_Y^2)$.

True Parameters

Table 4: True Model Parameters for Data Simulation

Sample Size	θ_0	θ_1	θ_2	θ_3	θ_4	β_0	β_1	β_2	P(A=1)	μ_C	σ_C	σ_Y
10000	-3.2	0.1	0.1	0.1	0.1	-0.25	0.3	0.2	0.4	1	1	1

True Models and True Causal Effects

True model for the mediator:

$$logitE[M|a,c] = \beta_0 + \beta_1 a + \beta_2 c$$

True model for the outcome:

$$E[Y|a, m^*, c] = \theta_0 + \theta_1 a + \theta_2 m^* + \theta_3 am + \theta_4 c$$

True Causal Effects with $m^* = 0$, $a^* = 0$ and $a = 1$:

Table 5: True Causal Effects from 3 Way Decomposition for Cont Y and Bin M

cde	pnde	tnde	pnie	tnie	total effect	proportion mediated
0.100	0.149	0.156	0.007	0.015	0.107	0.058

Table 6: True Causal Effects from 4 Way Decomposition for Cont Y and Bin M

cde	intref	intmed	pie	total effect	cde prop	intref prop
0.100	0.049	0.008	0.007	0.107	0.935	0.052
intmed prop	pie prop	overall pm	overall int	overall pe		
0.075	0.065	0.140	0.533	0.598		

Estimated Causal Effects and Standard Errors from 3 Different Estimation Method

Delta Method

```
causal_mediation(data = df, method="delta", outcome = "Y_cont_int", treatment = 'A',
                 mediator = 'M_bin', covariates = "C", interaction = TRUE,
                 yreg = "linear", mreg = "logistic")
```

```
## $decomp3way
##         cde      cde_se        pnde     pnde_se        tnde     tnde_se
## 0.116548012 0.030021402 0.144033806 0.020567413 0.147947728 0.020528597
##        pnie     pnie_se        tnie     tnie_se          te       te_se
## 0.006977980 0.002085807 0.010891901 0.002748639 0.154925707 0.020490896
##          pm       pm_se
## 0.036432697 0.010583705
##
## $decomp4way
##             cde          cde_se          intref       intref_se          intmed
##     0.116548012     0.030021402     0.027485794     0.020216468     0.003913922
##       intmed_se             pie          pie_se              te           te_se
##     0.002934491     0.006977980     0.002085807     0.154925707     0.020490896
##        cde_prop     cde_prop_se     intref_prop  intref_prop_se     intmed_prop
##     0.752283235     0.145829678     0.177412736     0.132586567     0.025263216
## intmed_prop_se        pie_prop     pie_prop_se      overall_pm   overall_pm_se
##     0.019189662     0.045040812     0.014542562     0.070304029     0.019705412
##     overall_int overall_int_se     overall_pe   overall_pe_se
##     0.202675952     0.151424572     0.247716765     0.145829678
```

Bootstrapping

```
causal_mediation(data = df, method="bootstrap", outcome = "Y_cont_int", treatment = 'A',
                 mediator = 'M_bin', covariates = "C", interaction = TRUE,
                 yreg = "linear", mreg = "logistic")
```

```
## $decomp3way
##         cde      cde_se        pnde     pnde_se        tnde     tnde_se
## 0.116548012 0.030131769 0.144033806 0.020667617 0.147947728 0.020600265
##        pnie     pnie_se        tnie     tnie_se          te       te_se
```

```
## 0.006977980 0.002070357 0.010891901 0.002733369 0.154925707 0.020466233
##          pm       pm_se
## 0.036432697 0.011185787
##
## $decomp4way
##             cde          cde_se          intref       intref_se          intmed
##     0.116548012     0.030131769     0.027485794     0.020221868     0.003913922
##       intmed_se             pie          pie_se              te           te_se
##     0.002942273     0.006977980     0.002070357     0.154925707     0.020466233
##        cde_prop     cde_prop_se     intref_prop  intref_prop_se     intmed_prop
##     0.752283235     0.150527116     0.177412736     0.136624504     0.025263216
## intmed_prop_se        pie_prop     pie_prop_se      overall_pm   overall_pm_se
##     0.019779627     0.045040812     0.015078600     0.070304029     0.020677206
##     overall_int overall_int_se      overall_pe   overall_pe_se
##     0.202675952     0.155872464     0.247716765     0.150527116
```

Simulation-based Approach

```
causal_mediation(data = df, method="simulation", outcome = "Y_cont_int", treatment = 'A',
                 mediator = 'M_bin', covariates = "C", interaction = TRUE,
                 yreg = "linear", mreg = "logistic")[1:2]
```

```
## $decomp3way
##         cde      cde_se        pnde     pnde_se        tnde     tnde_se
## 0.117851509 0.029486437 0.144438425 0.020277479 0.148146818 0.020256660
##        pnie     pnie_se        tnie     tnie_se          te       te_se
## 0.006830306 0.002004824 0.010538699 0.002788934 0.154977124 0.020176533
##          pm       pm_se
## 0.035927992 0.011223360
##
## $decomp4way
##             cde          cde_se          intref       intref_se          intmed
##     0.117851509     0.029486437     0.026586916     0.019970695     0.003708393
##       intmed_se             pie          pie_se              te           te_se
##     0.002869513     0.006830306     0.002004824     0.154977124     0.020176533
##        cde_prop     cde_prop_se     intref_prop  intref_prop_se     intmed_prop
##     0.756414865     0.149608858     0.174445540     0.135441820     0.024299507
## intmed_prop_se        pie_prop     pie_prop_se      overall_pm   overall_pm_se
##     0.019325292     0.044840087     0.014616120     0.069139594     0.020725818
##     overall_int overall_int_se      overall_pe   overall_pe_se
##     0.198745047     0.154232914     0.243585135     0.149608858
```

Case 3: Binary Outcome and Continuous Mediator

Data simulation

Simulation Procedures

1. Simulate the exposure variable A from Binom(1,P(A=1)).
2. Simulate the covariate C from $N(\mu_C, \sigma_C^2)$.
3. Simulate the mediator M from $N((\beta_0 + \beta_1 * A + \beta_2 * C), \sigma_M^2)$.

4. When there exists interaction between the exposure and the mediator, simulate the outcome Y from $Binom(1, expit(\theta_0 + \theta_1 A + \theta_2 M + \theta_3 AM + \theta_4 C, \sigma_Y^2))$; When there doesn't exist interaction between the exposure and the mediator, simulate the outcome Y from $Binom(1, expit(\theta_0 + \theta_1 A + \theta_2 M + \theta_4 C, \sigma_Y^2))$.

True Parameters

Table 7: True Model Parameters for Data Simulation

Sample Size	θ_0	θ_1	θ_2	θ_3	θ_4	β_0	β_1	β_2	P(A=1)	μ_C	σ_C	σ_M
10000	-3.2	0.1	0.1	0.1	0.1	-0.25	0.3	0.2	0.4	1	1	1

True Models and True Causal Effects

True model for the mediator:

$$E[M|a, c] = \beta_0 + \beta_1 a + \beta_2 c$$

True model for the outcome:

$$logitE[Y|a, m^*, c] = \theta_0 + \theta_1 a + \theta_2 m^* + \theta_3 am + \theta_4 c$$

True Causal Effects with $m^* = 0$, $a^* = 0$ and $a = 1$:

Table 8: True Causal Effects from 3 Way Decomposition for Bin Y and Cont M

RRcde	RRpnde	RRtnde	RRpnie	RRtnie	RRte	proportion mediated
1.105	1.116	1.150	1.030	1.062	1.185	0.373

Table 9: True Causal Effects from 4 Way Decomposition for Bin Y and Cont M

ERRcde	ERRintref	ERRintmed	ERRpie	ERRte	ERRcde prop
0.105	0.011	0.039	0.030	0.185	0.568
ERRintref prop	ERRintmed prop	ERRpie prop	overall pm	overall int	overall pe
0.059	0.211	0.162	0.373	0.270	0.432

Estimated Causal Effects and Standard Errors from 3 Different Estimation Method

Delta Method

```
causal_mediation(data = df, method="delta", outcome = "Y_bin_int", treatment = 'A',
                 mediator = 'M_cont', covariates = "C", interaction = TRUE,
                 yreg = "logistic", mreg = "linear")
```

```
## $decomp3way
##     cde_rr   cde_rr_se    pnde_rr pnde_rr_se    tnde_rr tnde_rr_se
## 1.13871962 0.10460652 1.13869927 0.10449607 1.14378078 0.10409356
##    pnie_rr pnie_rr_se    tnie_rr tnie_rr_se      te_rr   te_rr_se
## 1.01116135 0.01689346 1.01567371 0.01903890 1.15654691 0.10365767
##         pm      pm_se
## 0.11400824 0.15181425
##
## $decomp4way
##           cde_err        cde_err_se        intref_err
##      0.1388758602      0.1047243981     -0.0001765893
##     intref_err_se        intmed_err     intmed_err_se
##      0.0008261387      0.0066862930      0.0270062967
##           pie_err        pie_err_se         total_err
```

```
##       0.0111613452       0.0168934556       0.1565469090
##       total_err_se       cde_err_prop    cde_err_prop_se
##       0.1036576731       0.8871197844       0.1549166451
##    intref_err_prop intref_err_prop_se    intmed_err_prop
##      -0.0011280283       0.0052215818       0.0427111148
## intmed_err_prop_se       pie_err_prop    pie_err_prop_se
##       0.1735731513       0.0712971292       0.1173597233
##         overall_pm      overall_pm_se        overall_int
##       0.1140082440       0.1518142517       0.0415830864
##     overall_int_se         overall_pe      overall_pe_se
##       0.1741984955       0.1128802156       0.1549166451
```

Bootstrapping

```r
causal_mediation(data = df, method="bootstrap", outcome = "Y_bin_int", treatment = 'A',
                 mediator = 'M_cont', covariates = "C", interaction = TRUE,
                 yreg = "logistic", mreg = "linear")
```

```
## $decomp3way
##     cde_rr  cde_rr_se    pnde_rr pnde_rr_se    tnde_rr tnde_rr_se
## 1.13871962 0.10325142 1.13869927 0.10331939 1.14378078 0.10393623
##    pnie_rr pnie_rr_se    tnie_rr tnie_rr_se      te_rr   te_rr_se
## 1.01116135 0.01783798 1.01567371 0.01896028 1.15654691 0.10355903
##         pm      pm_se
## 0.11400824 1.33602577
##
## $decomp4way
##            cde_err         cde_err_se         intref_err
##       0.1388758602       0.1031704940      -0.0001765893
##      intref_err_se         intmed_err      intmed_err_se
##       0.0048919072       0.0066862930       0.0268792926
##            pie_err         pie_err_se          total_err
##       0.0111613452       0.0178379849       0.1565469090
##       total_err_se       cde_err_prop    cde_err_prop_se
##       0.1035590323       0.8871197844       1.2227667882
##    intref_err_prop intref_err_prop_se    intmed_err_prop
##      -0.0011280283       0.2027446924       0.0427111148
## intmed_err_prop_se       pie_err_prop    pie_err_prop_se
##       1.7646989191       0.0712971292       0.8671367695
##         overall_pm      overall_pm_se        overall_int
##       0.1140082440       1.3360257697       0.0415830864
##     overall_int_se         overall_pe      overall_pe_se
##       1.6028120779       0.1128802156       1.2227667882
```

Simulation-based Approach

```r
causal_mediation(data = df, method="simulation", outcome = "Y_bin_int", treatment = 'A',
                 mediator = 'M_cont', covariates = "C", interaction = TRUE,
                 yreg = "logistic", mreg = "linear")[1:2]
```

```
## $decomp3way
##      cde_rr   cde_rr_se     pnde_rr  pnde_rr_se     tnde_rr  tnde_rr_se
##  1.13873710  0.10020762  1.13837171  0.10079788  1.14275168  0.09884837
##     pnie_rr  pnie_rr_se     tnie_rr  tnie_rr_se       te_rr    te_rr_se
```

```
## 1.01056843 0.01710824 1.01466656 0.01858656 1.15461539 0.09924886
##          pm      pm_se
## -0.09433172 5.74500280
##
## $decomp4way
##        cde_err     cde_err_se     intref_err  intref_err_se     intmed_err
##   0.1388919926   0.1003323161  -0.0005202874   0.0029598833   0.0056752491
##  intmed_err_se        pie_err     pie_err_se      total_err   total_err_se
##   0.0262753513   0.0105684346   0.0171082370   0.1546153890   0.0992488564
##       cde_prop    cde_prop_se    intref_prop intref_prop_se    intmed_prop
##   1.0681615747   4.8872020654   0.0261701436   0.9163436907  -0.1758702410
## intmed_prop_se       pie_prop    pie_prop_se     overall_pm  overall_pm_se
##   6.2023791284   0.0815385228   1.9467290664  -0.0943317183   5.7450028016
##    overall_int overall_int_se     overall_pe  overall_pe_se
##  -0.1497000975   5.2894831343  -0.0681615747   4.8872020654
```

Case 4: Binary Outcome and Binary Mediator

Data simulation

Simulation Procedures

1. Simulate the exposure variable A from Binom(1,P(A=1)).
2. Simulate the covariate C from $N(\mu_C, \sigma_C^2)$.
3. Simulate the mediator M from $Binom(1, expit(\beta_0 + \beta_1 * A + \beta_2 * C))$.
4. When there exists interaction between the exposure and the mediator, simulate the outcome Y from $Binom(1, expit(\theta_0 + \theta_1 A + \theta_2 M + \theta_3 AM + \theta_4 C, \sigma_Y^2))$; When there doesn't exist interaction between the exposure and the mediator, simulate the outcome Y from $Binom(1, expit(\theta_0 + \theta_1 A + \theta_2 M + \theta_4 C, \sigma_Y^2))$.

True Parameters

Table 10: True Model Parameters for Data Simulation

Sample Size	θ_0	θ_1	θ_2	θ_3	θ_4	β_0	β_1	β_2	P(A=1)	μ_C	σ_C
10000	-3.2	0.1	0.1	0.1	0.1	-0.25	0.3	0.2	0.4	1	1

True Models and True Causal Effects

True model for the mediator:

$$logitE[M|a, c] = \beta_0 + \beta_1 a + \beta_2 c$$

True model for the outcome:

$$logitE[Y|a, m^*, c] = \theta_0 + \theta_1 a + \theta_2 m^* + \theta_3 am + \theta_4 c$$

True Causal Effects with $m^* = 0$, $a^* = 0$ and $a = 1$:

Table 11: True Causal Effects from 3 Way Decomposition for Bin Y and Bin M

RRcde	RRpnde	RRtnde	RRpnie	RRtnie	RRte	proportion mediated
1.105	1.165	1.173	1.007	1.015	1.182	0.095

total_err <- te_rr - 1

```
cde_err_prop <- cde_err/total_err

intmed_err_prop <- intmed_err/total_err

intref_err_prop <- intref_err/total_err

pie_err_prop <- pie_err/total_err

overall_pm <- (pie_err+intmed_err)/total_err

overall_int <- (intref_err+intmed_err)/total_err

overall_pe <- (intref_err+intmed_err+pie_err)/total_err
```

Table 12: True Causal Effects from 4 Way Decomposition for Bin Y and Bin M

ERRcde	ERRintref	ERRintmed	ERRpie	ERRte	ERRcde prop
0.100	0.065	0.010	0.007	0.182	0.549
ERRintref prop	ERRintmed prop	ERRpie prop	overall pm	overall int	overall pe
0.357	0.055	0.038	0.093	0.412	0.451

Estimated Causal Effects and Standard Errors from 3 Different Estimation Method

Delta Method

```
causal_mediation(data = df, method="delta", outcome = "Y_bin_int", treatment = 'A',
                 mediator = 'M_bin', covariates = "C", interaction = TRUE,
                 yreg = "logistic", mreg = "logistic")
```

```
## $decomp3way
##      cde_rr   cde_rr_se     pnde_rr  pnde_rr_se     tnde_rr  tnde_rr_se
## 1.070674124 0.147922338 1.139560468 0.102689391 1.148802668 0.103349182
##     pnie_rr  pnie_rr_se     tnie_rr  tnie_rr_se       te_rr    te_rr_se
## 1.007258248 0.008353451 1.015427435 0.009929004 1.157140963 0.103731519
##          pm       pm_se
## 0.111877227 0.095093026
##
## $decomp4way
##            cde_err         cde_err_se         intref_err
##        0.067071753        0.138608685        0.072488715
##      intref_err_se         intmed_err      intmed_err_se
##        0.234102594        0.010322247        0.013779512
##            pie_err         pie_err_se          total_err
##        0.007258248        0.008353451        0.157140963
##       total_err_se       cde_err_prop    cde_err_prop_se
##        0.103731519        0.426825393        0.728317698
##    intref_err_prop intref_err_prop_se    intmed_err_prop
##        0.461297381        1.490895417        0.065687817
## intmed_err_prop_se       pie_err_prop    pie_err_prop_se
##        0.093252723        0.046189410        0.061074187
##         overall_pm      overall_pm_se        overall_int
##        0.111877227        0.095093026        0.526985198
##     overall_int_se         overall_pe      overall_pe_se
##        1.583613441        0.573174607        1.568779594
```

Bootstrapping

```r
causal_mediation(data = df, method="bootstrap", outcome = "Y_bin_int", treatment = 'A',
                 mediator = 'M_bin', covariates = "C", interaction = TRUE,
                 yreg = "logistic", mreg = "logistic")
```

```
## $decomp3way
##      cde_rr   cde_rr_se     pnde_rr  pnde_rr_se     tnde_rr  tnde_rr_se
## 1.070674124 0.153887088 1.139560468 0.104791250 1.148802668 0.105526244
##     pnie_rr  pnie_rr_se     tnie_rr  tnie_rr_se       te_rr    te_rr_se
## 1.007258248 0.008424789 1.015427435 0.010470995 1.157140963 0.105694307
##          pm       pm_se
## 0.111877227 2.067042460
##
## $decomp4way
##             cde_err         cde_err_se         intref_err
##         0.067071753        0.143059374        0.072488715
##       intref_err_se         intmed_err      intmed_err_se
##         0.101202423        0.010322247        0.014695141
##             pie_err         pie_err_se          total_err
##         0.007258248        0.008424789        0.157140963
##        total_err_se       cde_err_prop    cde_err_prop_se
##         0.105694307        0.426825393       11.534222842
##     intref_err_prop intref_err_prop_se    intmed_err_prop
##         0.461297381        9.622170852        0.065687817
## intmed_err_prop_se       pie_err_prop    pie_err_prop_se
##         1.495825263        0.046189410        0.932138097
##          overall_pm      overall_pm_se        overall_int
##         0.111877227        2.067042460        0.526985198
##      overall_int_se         overall_pe      overall_pe_se
##        11.114862947        0.573174607       11.534222842
```

Simulation-based Approach

```r
causal_mediation(data = df, method="simulation", outcome = "Y_bin_int", treatment = 'A',
                 mediator = 'M_bin', covariates = "C", interaction = TRUE,
                 yreg = "logistic", mreg = "logistic")[1:2]
```

```
## $decomp3way
##       cde_rr    cde_rr_se      pnde_rr   pnde_rr_se      tnde_rr
##  1.069969325  0.143926543  1.126434420  0.099231735  1.135078591
##   tnde_rr_se      pnie_rr   pnie_rr_se      tnie_rr   tnie_rr_se
##  0.098415922  1.006879350  0.007588974  1.014750073  0.009534537
##        te_rr     te_rr_se           pm        pm_se
##  1.142860400  0.099097267  0.649132850 18.880240410
##
## $decomp4way
##       cde_err     cde_err_se     intref_err  intref_err_se     intmed_err
##    0.063535110    0.135314176    0.062899310    0.084140056    0.009546630
##  intmed_err_se        pie_err     pie_err_se      total_err   total_err_se
##    0.012778463    0.006879350    0.007588974    0.142860400    0.099097267
##       cde_prop    cde_prop_se    intref_prop intref_prop_se    intmed_prop
##   -2.519777916  105.450931999    2.870645066   86.597219400    0.415636396
## intmed_prop_se       pie_prop    pie_prop_se     overall_pm  overall_pm_se
##   12.366628516    0.233496454    6.554594066    0.649132850   18.880240410
```

```
##    overall_int overall_int_se     overall_pe  overall_pe_se
##    3.286281462   98.962509406    3.519777916  105.450931999
```