Day 3, exercise 2: Extending to cause specific results

2022-05-07

In exercise 4, we decomposed life expectancy and lifespan disparity by age. Now, we will extend the decomposition by also considering cause of death. We will use the same data, packages and functions as before.

Let's load them.

```
load('AburtoBeltranSanchez.RData')

library(DemoDecomp)
library(tidyverse)

source("Functions_D3.R")
```

Following the method, we require two matrices of rates: one for 2005 and one for 2015, both by age (rows) and cause of death (column)

```
#we need age- and cause-specific mortality rates in each period
COD1 <- data %>%
  filter(year==2005, age>15) %>%
  select(Cause_1:Cause_9) %>%
  as.matrix()

COD2 <- data %>%
  filter(year==2015, age>15) %>%
  select(Cause_1:Cause_9) %>%
  as.matrix()
```

We cannot directly use the same functions to calucalte life expectancy and lifespan disparity. Rather, we need functions that can estimate life expectancy and lifespan dispairty from age- and cause-specific death rates. They are also included in the functions script. Let's have a look.

```
e0.frommxc
```

```
## function (mxcvec, sex = 1, start.age = 1)
## {
##     dim(mxcvec) <- c(94, length(mxcvec)/94)
##     mx <- rowSums(mxcvec)
##     e0.frommx(mx, sex, start.age = start.age)
## }
```

```
edagger.frommxc
```

```
## function (mxcvec, sex = 1, start.age = 1)
## {
##     dim(mxcvec) <- c(94, length(mxcvec)/94)
##     mx <- rowSums(mxcvec)
##     edagger.frommx(mx, sex, start.age = start.age)
## }
```

```
sd.frommxc
```

```
## function (mxcvec, sex = 1, age, start.age = 1)
## {
##     dim(mxcvec) <- c(94, length(mxcvec)/94)
##     mx <- rowSums(mxcvec)
##     sd.frommx(mx, sex, age = age, start.age = start.age)
## }
```

```
rG.frommxc
```

```
## function (mxcvec, sex = 1, age, start.age = 1)
## {
##     dim(mxcvec) <- c(94, length(mxcvec)/94)
##     mx <- rowSums(mxcvec)
##     rG.frommx(mx, sex, age = age, start.age = start.age)
## }
```

Now we can perform the decomposition and check the results. It might take a minute.

```
results <- horiuchi(func = e0.frommxc, pars1 = c(COD1), pars2 = c(COD2), N = 100)

#Go back to a matrix
dim(results) <- dim(COD1)
results
```

```
##                  [,1]          [,2]          [,3]          [,4]          [,5]
##  [1,] -1.379470e-05 -5.214695e-04 -2.425850e-04  3.197188e-04  1.663422e-06
##  [2,]  4.999096e-05 -5.247945e-04 -1.367463e-04 -3.533888e-04  2.748628e-05
##  [3,]  8.065985e-05 -5.410763e-04 -1.034975e-04  2.679550e-04  4.759979e-05
##  [4,]  1.234476e-04 -5.105796e-04 -8.674317e-05  2.569367e-04  6.879997e-05
##  [5,]  2.197505e-04 -4.026736e-04 -4.090400e-05 -1.903273e-05  1.008768e-04
##  [6,]  2.807474e-04 -3.240433e-04 -5.861642e-05  2.084585e-04  1.280487e-04
##  [7,]  3.339671e-04 -2.392786e-04 -9.934688e-05  3.484115e-04  1.548255e-04
##  [8,]  3.949589e-04 -1.331058e-04 -1.361428e-04  2.625402e-04  1.847119e-04
##  [9,]  4.286068e-04 -3.480018e-05 -1.871390e-04  2.077631e-04  2.083773e-04
## [10,]  5.065310e-04  1.079587e-04 -1.691512e-04 -5.930632e-04  2.455712e-04
## [11,]  4.799081e-04  1.698895e-04 -2.344268e-04  1.041681e-04  2.490121e-04
## [12,]  5.382958e-04  2.815793e-04 -2.005832e-04 -7.976847e-05  2.764033e-04
## [13,]  5.834255e-04  3.613393e-04 -1.720337e-04 -4.995292e-05  2.932401e-04
## [14,]  6.800553e-04  4.422920e-04 -9.827497e-05 -3.528859e-05  3.234810e-04
## [15,]  7.384214e-04  4.657000e-04 -6.770941e-05 -2.338835e-04  3.248444e-04
## [16,]  8.362490e-04  4.875909e-04 -1.594598e-06  3.154819e-04  3.359525e-04
## [17,]  9.229376e-04  4.873354e-04  5.462922e-05  7.138808e-05  3.348847e-04
## [18,]  1.006690e-03  4.788736e-04  1.123621e-04  2.076377e-04  3.294424e-04
## [19,]  1.086992e-03  4.718702e-04  1.846651e-04 -3.075408e-04  3.290014e-04
## [20,]  1.119128e-03  4.479982e-04  2.226872e-04  2.235473e-04  3.035335e-04
## [21,]  1.158338e-03  4.384209e-04  2.846982e-04  1.311521e-04  2.935344e-04
## [22,]  1.137865e-03  4.007276e-04  2.777770e-04  1.353198e-04  2.261465e-04
## [23,]  1.198167e-03  4.111457e-04  3.581336e-04 -1.730957e-04  2.247783e-04
## [24,]  1.203322e-03  3.889710e-04  3.526427e-04 -1.037712e-04  1.434572e-04
## [25,]  1.263161e-03  3.915219e-04  3.784900e-04 -2.873324e-05  7.783742e-05
## [26,]  1.325789e-03  3.960206e-04  3.915885e-04  1.179042e-04 -1.193186e-05
## [27,]  1.395736e-03  4.142010e-04  4.261719e-04  5.542313e-05 -9.318848e-05
## [28,]  1.456967e-03  4.469869e-04  4.946339e-04  3.772890e-05 -1.505221e-04
## [29,]  1.465725e-03  4.807552e-04  5.766853e-04 -5.696618e-05 -1.999501e-04
```

```
## [30,]   1.404422e-03   5.141290e-04   6.791112e-04  -3.068522e-05  -2.331142e-04
## [31,]   1.296248e-03   5.566333e-04   8.325332e-04   1.429732e-05  -2.072685e-04
## [32,]   1.144369e-03   5.941523e-04   1.002780e-03   2.487951e-04  -1.503236e-04
## [33,]   9.998598e-04   6.395144e-04   1.221390e-03  -6.735355e-05  -2.024091e-05
## [34,]   8.816489e-04   6.824651e-04   1.465850e-03  -7.150986e-05   1.783156e-04
## [35,]   8.309841e-04   7.245395e-04   1.735460e-03  -1.732415e-04   4.333810e-04
## [36,]   8.008187e-04   7.202390e-04   1.899971e-03   2.578616e-04   5.708767e-04
## [37,]   8.626097e-04   7.343948e-04   2.104677e-03   3.452956e-04   7.769934e-04
## [38,]   1.032915e-03   7.981804e-04   2.395788e-03   6.721069e-05   1.099279e-03
## [39,]   1.230553e-03   8.658743e-04   2.607230e-03  -3.953594e-05   1.279715e-03
## [40,]   1.496774e-03   9.947917e-04   2.834227e-03  -5.712503e-05   1.424445e-03
## [41,]   1.807044e-03   1.182084e-03   3.041900e-03   2.395266e-05   1.451966e-03
## [42,]   2.083013e-03   1.372347e-03   3.110453e-03   7.228859e-05   1.200908e-03
## [43,]   2.378623e-03   1.623831e-03   3.215434e-03  -1.827216e-05   9.249874e-04
## [44,]   2.596774e-03   1.867579e-03   3.227376e-03   5.381961e-06   4.419204e-04
## [45,]   2.716060e-03   2.106417e-03   3.207361e-03  -1.248997e-04  -1.302963e-04
## [46,]   2.703502e-03   2.314695e-03   3.136326e-03  -4.348458e-05  -8.139815e-04
## [47,]   2.595481e-03   2.492074e-03   3.040383e-03  -1.092427e-04  -1.541698e-03
## [48,]   2.473200e-03   2.665061e-03   2.996486e-03  -1.771872e-04  -2.199984e-03
## [49,]   2.350710e-03   2.785295e-03   2.923445e-03   0.000000e+00  -2.886427e-03
## [50,]   2.374237e-03   2.914104e-03   2.983588e-03  -1.350484e-04  -3.364382e-03
## [51,]   2.539643e-03   2.987267e-03   3.054179e-03   3.662141e-05  -3.793584e-03
## [52,]   2.897106e-03   3.078699e-03   3.269081e-03   2.493569e-04  -3.995174e-03
## [53,]   3.359645e-03   3.164788e-03   3.534891e-03  -1.339409e-04  -4.108871e-03
## [54,]   3.822439e-03   3.224643e-03   3.776488e-03   3.252863e-05  -4.198471e-03
## [55,]   4.165622e-03   3.248553e-03   3.929329e-03  -2.762590e-05  -4.326226e-03
## [56,]   4.247600e-03   3.203556e-03   3.888016e-03   1.915115e-04  -4.609333e-03
## [57,]   4.272451e-03   3.240397e-03   3.968578e-03   5.731416e-05  -4.663497e-03
## [58,]   4.189212e-03   3.254924e-03   3.997798e-03   3.012575e-06  -4.697132e-03
## [59,]   4.048336e-03   3.221841e-03   3.965766e-03  -2.578843e-05  -4.701762e-03
## [60,]   3.956872e-03   3.151929e-03   3.932956e-03   5.408541e-05  -4.597195e-03
## [61,]   4.054472e-03   3.081294e-03   3.994970e-03  -2.313683e-05  -4.303814e-03
## [62,]   4.090089e-03   2.843544e-03   3.792465e-03  -3.664176e-05  -4.165384e-03
## [63,]   4.151125e-03   2.546473e-03   3.474791e-03   1.644047e-04  -4.064461e-03
## [64,]   4.319996e-03   2.280605e-03   3.171447e-03  -1.952364e-05  -3.902218e-03
## [65,]   4.456043e-03   1.997960e-03   2.743465e-03   6.137547e-05  -3.790548e-03
## [66,]   4.623545e-03   1.768215e-03   2.298616e-03   6.033224e-05  -3.667353e-03
## [67,]   4.461899e-03   1.442743e-03   1.543080e-03   7.337918e-05  -3.736325e-03
## [68,]   4.201321e-03   1.178185e-03   8.553575e-04   2.860759e-05  -3.722578e-03
## [69,]   3.896456e-03   1.011455e-03   3.668512e-04   5.786037e-05  -3.563292e-03
## [70,]   3.668366e-03   9.933273e-04   2.506152e-04  -5.612826e-05  -3.169630e-03
## [71,]   3.300026e-03   1.018529e-03   3.137220e-04   5.970374e-05  -2.691334e-03
## [72,]   2.960662e-03   1.100677e-03   6.040214e-04  -2.650268e-05  -2.124340e-03
## [73,]   2.673693e-03   1.166589e-03   9.213409e-04   0.000000e+00  -1.616529e-03
## [74,]   2.434301e-03   1.163026e-03   1.116588e-03  -2.513446e-05  -1.238000e-03
## [75,]   2.182780e-03   1.048654e-03   1.057447e-03  -2.465386e-05  -1.032961e-03
## [76,]   1.933046e-03   8.361254e-04   7.441300e-04   0.000000e+00  -9.758978e-04
## [77,]   1.833353e-03   6.173926e-04   3.937425e-04   4.139265e-05  -9.583955e-04
## [78,]   1.616912e-03   3.861917e-04  -1.917847e-05  -2.483788e-05  -9.792140e-04
## [79,]   1.437819e-03   2.223564e-04  -2.803416e-04   0.000000e+00  -9.526131e-04
## [80,]   1.264625e-03   1.240858e-04  -3.961782e-04   7.443191e-05  -8.912291e-04
## [81,]   1.143903e-03   9.193347e-05  -3.533557e-04   3.744872e-05  -7.913242e-04
## [82,]   1.033528e-03   9.729109e-05  -2.221847e-04   3.892145e-05  -6.745549e-04
## [83,]   9.216937e-04   1.143808e-04  -6.895658e-05   0.000000e+00  -5.560190e-04
```

```
## [84,]  7.758577e-04  1.233252e-04  5.048018e-05  0.000000e+00 -4.480153e-04
## [85,]  6.084192e-04  1.197536e-04  1.216727e-04  0.000000e+00 -3.533621e-04
## [86,] -7.747772e-04 -1.859585e-04 -7.908441e-06  4.775015e-05 -7.315617e-06
## [87,] -2.495216e-05  2.189147e-04 -7.513290e-05  0.000000e+00 -2.456799e-05
## [88,]  1.542762e-04  2.002097e-04  8.184479e-05  0.000000e+00  3.251124e-05
## [89,] -5.420264e-05  8.883314e-05  1.959769e-04  0.000000e+00  4.577656e-05
## [90,]  9.788163e-05 -7.723462e-05 -3.519392e-05  0.000000e+00 -7.017450e-05
## [91,]  3.646965e-04 -6.877958e-05  2.284141e-04  0.000000e+00  0.000000e+00
## [92,] -1.742765e-04  9.781438e-05  4.766667e-05  0.000000e+00  2.383333e-05
## [93,]  1.655236e-05  0.000000e+00 -6.442396e-05  0.000000e+00  0.000000e+00
## [94,]  1.596678e-04 -3.160632e-05  7.152327e-05  0.000000e+00 -3.160632e-05
##                 [,6]          [,7]          [,8] [,9]
##   [1,] -4.026939e-03  1.890601e-03  3.791238e-03    0
##   [2,] -5.767100e-03  2.792291e-03  4.992775e-03    0
##   [3,] -7.704132e-03  3.408892e-03  5.500572e-03    0
##   [4,] -9.176056e-03  3.909002e-03  5.739664e-03    0
##   [5,] -9.679522e-03  4.659235e-03  6.267771e-03    0
##   [6,] -9.880699e-03  4.819489e-03  6.281701e-03    0
##   [7,] -9.762076e-03  4.759295e-03  6.212277e-03    0
##   [8,] -9.467240e-03  4.744520e-03  6.343822e-03    0
##   [9,] -9.400057e-03  4.625686e-03  6.388020e-03    0
## [10,] -9.260053e-03  4.940771e-03  6.982279e-03    0
## [11,] -9.862226e-03  4.638479e-03  6.650279e-03    0
## [12,] -1.009559e-02  4.791448e-03  7.106719e-03    0
## [13,] -1.042129e-02  4.697049e-03  7.427601e-03    0
## [14,] -1.052280e-02  4.600500e-03  8.198438e-03    0
## [15,] -1.067230e-02  4.053778e-03  8.555544e-03    0
## [16,] -1.052698e-02  3.560950e-03  9.208144e-03    0
## [17,] -1.032330e-02  3.045466e-03  9.690855e-03    0
## [18,] -1.006602e-02  2.657960e-03  1.009966e-02    0
## [19,] -9.667419e-03  2.497409e-03  1.047326e-02    0
## [20,] -9.344444e-03  2.471709e-03  1.042611e-02    0
## [21,] -8.912993e-03  2.677721e-03  1.052473e-02    0
## [22,] -8.666785e-03  2.821784e-03  1.009305e-02    0
## [23,] -8.257368e-03  3.189863e-03  1.051146e-02    0
## [24,] -8.018153e-03  3.327413e-03  1.040096e-02    0
## [25,] -7.780053e-03  3.434862e-03  1.080008e-02    0
## [26,] -7.529125e-03  3.407241e-03  1.123970e-02    0
## [27,] -7.183216e-03  3.314762e-03  1.183250e-02    0
## [28,] -6.713316e-03  3.181837e-03  1.249712e-02    0
## [29,] -6.110573e-03  2.983749e-03  1.289382e-02    0
## [30,] -5.391156e-03  2.747733e-03  1.293222e-02    0
## [31,] -4.600858e-03  2.526044e-03  1.278847e-02    0
## [32,] -3.840960e-03  2.313112e-03  1.232951e-02    0
## [33,] -3.184985e-03  2.172891e-03  1.186066e-02    0
## [34,] -2.662879e-03  2.103215e-03  1.130352e-02    0
## [35,] -2.343383e-03  2.140237e-03  1.080176e-02    0
## [36,] -2.199854e-03  2.182220e-03  9.774337e-03    0
## [37,] -2.099259e-03  2.267498e-03  8.949873e-03    0
## [38,] -1.975979e-03  2.369041e-03  8.520599e-03    0
## [39,] -1.811531e-03  2.366626e-03  7.808898e-03    0
## [40,] -1.548329e-03  2.278284e-03  7.253058e-03    0
## [41,] -1.206593e-03  2.105397e-03  6.739987e-03    0
## [42,] -8.442768e-04  1.857032e-03  5.927325e-03    0
```

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```
## [43,]  -4.872952e-04   1.643353e-03   5.493416e-03   0
## [44,]  -1.968039e-04   1.466503e-03   5.049377e-03   0
## [45,]   1.820670e-06   1.376050e-03   4.880365e-03   0
## [46,]   9.261067e-05   1.373622e-03   4.891511e-03   0
## [47,]   1.029412e-04   1.423047e-03   5.005813e-03   0
## [48,]   6.408292e-05   1.499305e-03   5.231495e-03   0
## [49,]  -1.101231e-05   1.552532e-03   5.101436e-03   0
## [50,]  -9.319595e-05   1.576732e-03   4.827401e-03   0
## [51,]  -1.782908e-04   1.535337e-03   3.913238e-03   0
## [52,]  -2.426129e-04   1.458093e-03   2.894005e-03   0
## [53,]  -2.821637e-04   1.349785e-03   1.743715e-03   0
## [54,]  -2.919708e-04   1.214248e-03   5.424850e-04   0
## [55,]  -2.700726e-04   1.061064e-03  -5.982069e-04   0
## [56,]  -2.226930e-04   8.988099e-04  -1.739769e-03   0
## [57,]  -1.558790e-04   7.771170e-04  -2.110502e-03   0
## [58,]  -9.351070e-05   6.931952e-04  -2.274405e-03   0
## [59,]  -4.638091e-05   6.544345e-04  -2.352458e-03   0
## [60,]  -1.939288e-05   6.692610e-04  -2.290613e-03   0
## [61,]  -1.268453e-05   7.420780e-04  -1.953543e-03   0
## [62,]  -2.384687e-05   8.224167e-04  -2.128902e-03   0
## [63,]  -3.827493e-05   8.950873e-04  -2.343031e-03   0
## [64,]  -4.638717e-05   9.471305e-04  -2.144649e-03   0
## [65,]  -4.603248e-05   9.518979e-04  -1.735744e-03   0
## [66,]  -3.412370e-05   9.104279e-04  -8.105061e-04   0
## [67,]  -1.822291e-05   8.153671e-04  -4.282959e-04   0
## [68,]   1.176340e-06   7.085311e-04  -1.464708e-04   0
## [69,]   2.106840e-05   6.107329e-04  -3.504587e-05   0
## [70,]   3.987879e-05   5.354429e-04   8.303308e-05   0
## [71,]   5.301022e-05   4.754456e-04  -4.716763e-04   0
## [72,]   6.071260e-05   4.310534e-04  -1.148748e-03   0
## [73,]   6.309102e-05   3.943368e-04  -1.717283e-03   0
## [74,]   6.096995e-05   3.581911e-04  -2.005176e-03   0
## [75,]   5.544026e-05   3.182692e-04  -2.047473e-03   0
## [76,]   4.813848e-05   2.752792e-04  -1.762204e-03   0
## [77,]   4.114606e-05   2.357171e-04  -8.974256e-04   0
## [78,]   3.425144e-05   1.966987e-04  -3.428792e-04   0
## [79,]   2.857237e-05   1.637066e-04   1.063662e-04   0
## [80,]   2.426506e-05   1.376359e-04   2.484607e-04   0
## [81,]   2.136926e-05   1.186702e-04   1.973634e-04   0
## [82,]   1.947653e-05   1.045833e-04  -3.245092e-05   0
## [83,]   1.811900e-05   9.312007e-05  -2.418091e-04   0
## [84,]   1.679452e-05   8.201933e-05  -3.883567e-04   0
## [85,]   1.526663e-05   7.054509e-05  -4.247991e-04   0
## [86,]   0.000000e+00  -3.539244e-05   1.078385e-03   0
## [87,]   0.000000e+00   5.303857e-05  -6.523822e-05   0
## [88,]   0.000000e+00   0.000000e+00  -4.113125e-04   0
## [89,]   0.000000e+00   0.000000e+00  -2.368458e-04   0
## [90,]   0.000000e+00   0.000000e+00   1.113618e-04   0
## [91,]   0.000000e+00   0.000000e+00  -5.067243e-04   0
## [92,]   0.000000e+00   0.000000e+00   1.639018e-05   0
## [93,]   0.000000e+00   0.000000e+00   5.517452e-05   0
## [94,]   0.000000e+00   0.000000e+00  -1.553047e-04   0
```

```r
#original
(original <- e0.frommxc(COD2) - e0.frommxc(COD1))
```

```
## [1] 0.547894
```

```r
#with decomp
(with.decomp <- sum(results))
```

```
## [1] 0.547894
```

```r
#error
with.decomp - original
```

```
## [1] -1.932243e-09
```
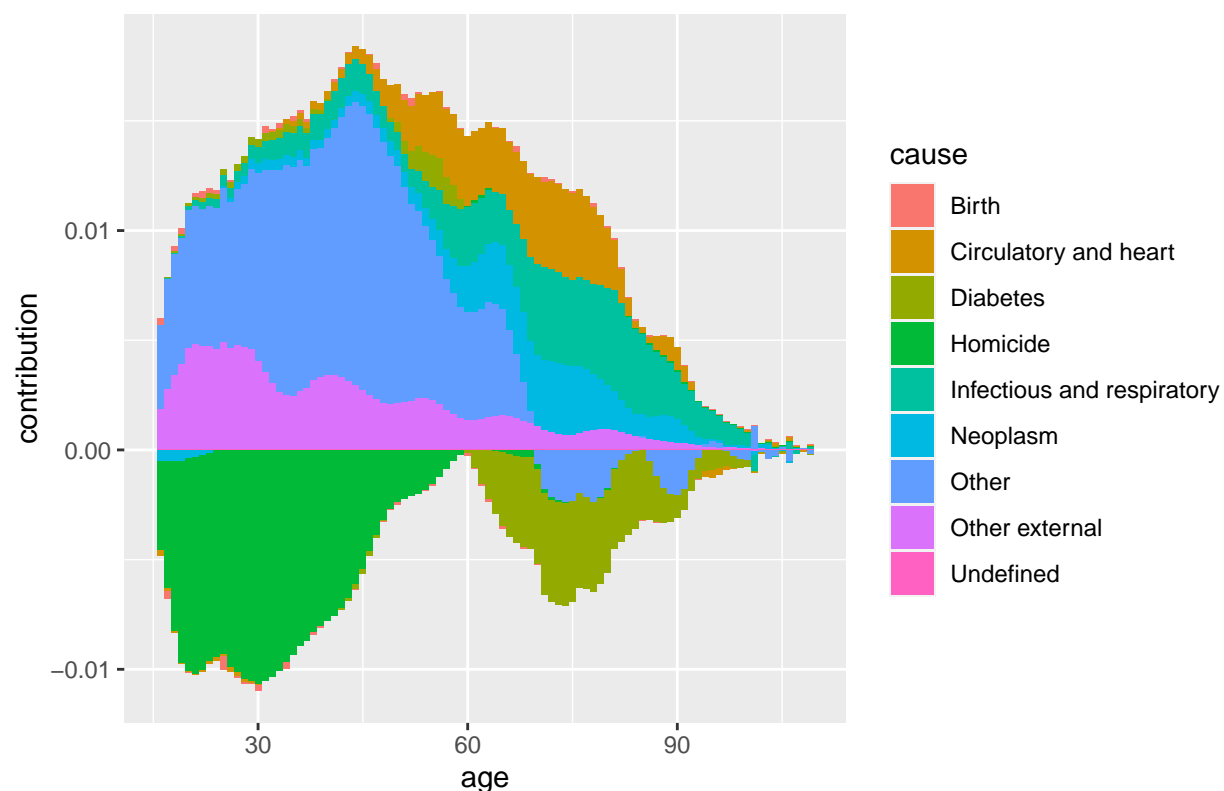
Do some data handling to have a nice dataset.

```r
results <- data.frame(results)
colnames(results) <- cause_names

results <- results %>%
  mutate(age = 16:109) %>%
  pivot_longer(cols=1:9, names_to="cause", values_to="contribution")
```

Finally, graph and interpret the results.

```r
#now graph results
ggplot(data=results, aes(x=age, y=contribution, fill=cause)) +
  ggtitle(bquote(~'Change in '~ e[15] ~'2005-2015' )) +
  geom_bar(stat = "identity", position = "stack")
```

Change in e_{15} 2005–2015

Now for lifespan disparity

```
#Now we can perfom the decomposition
results_edag <- horiuchi(func = edagger.frommxc, pars1 = c(COD1), pars2 = c(COD2), N = 100)
```

Go back to a matrix

```
#Go back to a matrix
dim(results_edag) <- dim(COD1)

#original
(original_edag <- edagger.frommxc(COD2) - edagger.frommxc(COD1))
```

```
## [1] -0.1440517
```

```
#with decomp
(with.decomp_edag <- sum(results_edag))
```

```
## [1] -0.1440517
```

```
#error
with.decomp_edag - original_edag
```

```
## [1] 2.406574e-09
```

Do some data handling to have a nice dataset and plotting

```
results_edag <- data.frame(results_edag)
colnames(results_edag) <- cause_names
```
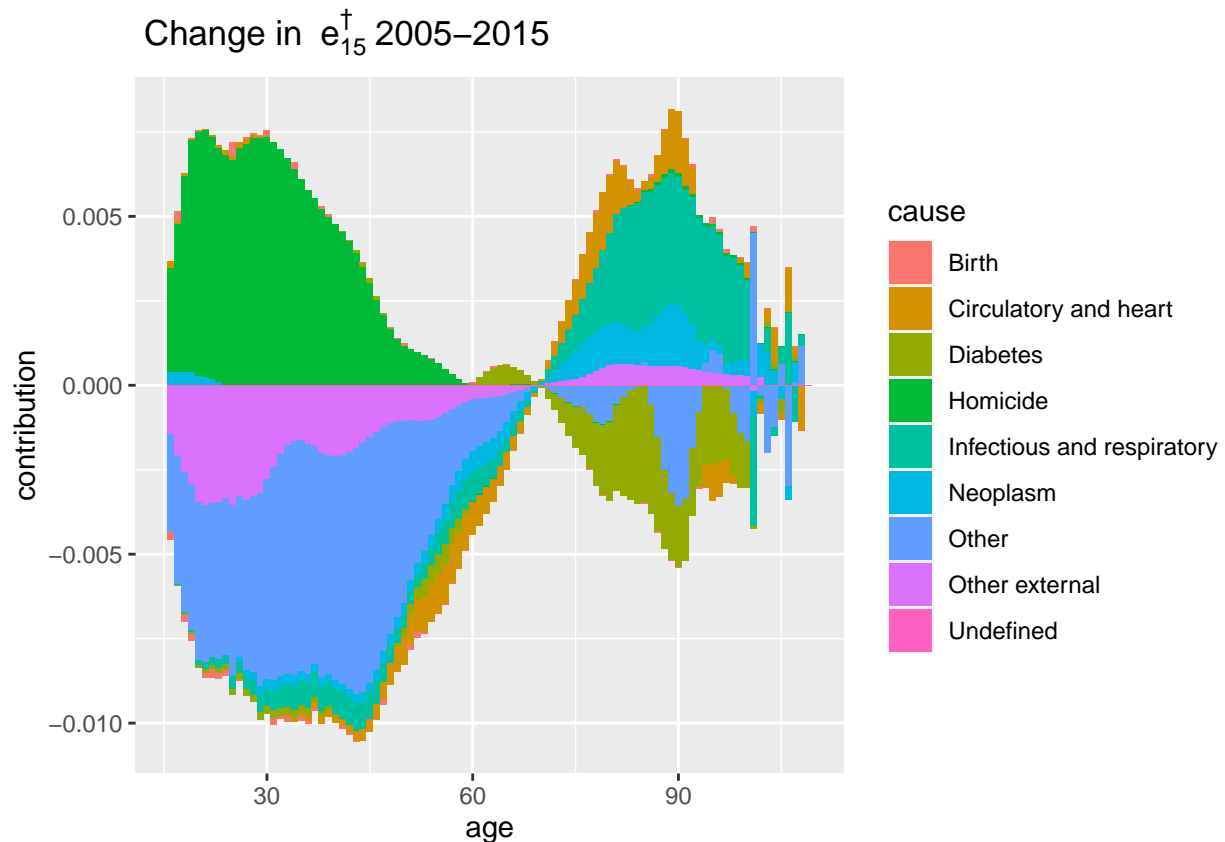
```r
results_edag <- results_edag %>%
  mutate(age = 16:109) %>%
  pivot_longer(cols=1:9, names_to="cause", values_to="contribution")

#now graph results

ggplot(data=results_edag, aes(x=age, y=contribution, fill=cause)) +
  ggtitle(bquote(~'Change in '~ e[15]^"\u2020" ~'2005-2015' )) +
  geom_bar(stat = "identity", position = "stack")
```


Let's do the same thing with the stepwise replacement method

First, life expectancy

```r
results_step <- stepwise_replacement(func = e0.frommxc, pars1 = c(COD1), pars2 = c(COD2))

#Go back to a matrix
dim(results_step) <- dim(COD1)

#original
(original <- e0.frommxc(COD2) - e0.frommxc(COD1))
```

```
## [1] 0.547894
```

```r
#with decomp
(with.decomp <- sum(results_step))
```
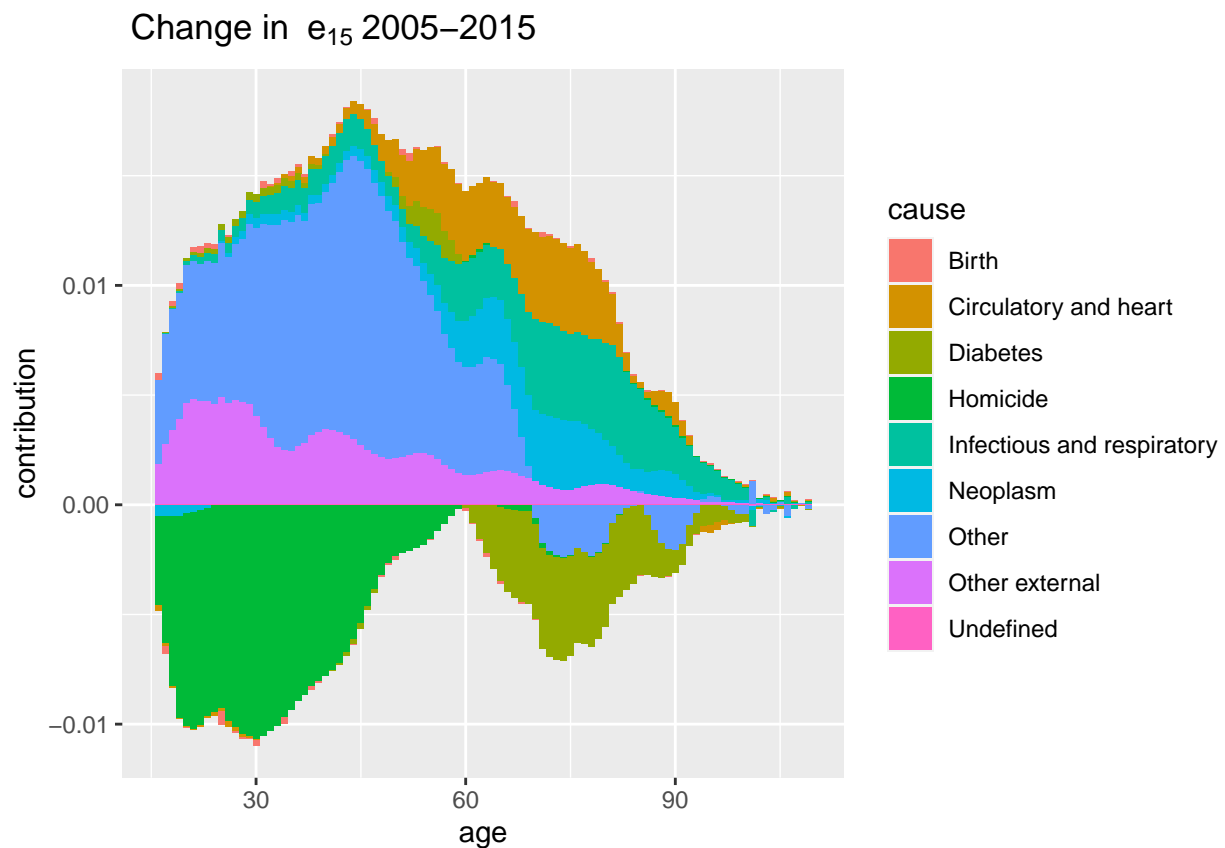
```
## [1] 0.547894
```

```
#error
with.decomp - original
```

```
## [1] 0
```

```
results_step <- data.frame(results_step)
colnames(results_step) <- cause_names
results_step <- results_step %>%
  mutate(age = 16:109) %>%
  pivot_longer(cols=1:9, names_to="cause", values_to="contribution")

#now graph results
ggplot(data=results_step, aes(x=age, y=contribution, fill=cause)) +
  ggtitle(bquote(~'Change in '~ e[15] ~'2005-2015' )) +
  geom_bar(stat = "identity", position = "stack")
```

Change in e_{15} 2005–2015

Now for lifespan disparity

```
#Now we can perfom the decomposition
results_step_edag <- stepwise_replacement(func = edagger.frommxc, pars1 = c(COD1), pars2 = c(COD2))

#Go back to a matrix
dim(results_step_edag) <- dim(COD1)

#original
(original_edag <- edagger.frommxc(COD2) - edagger.frommxc(COD1))
```

```
## [1] -0.1440517
```

```
#with decomp
(with.decomp_edag <- sum(results_step_edag))
```

```
## [1] -0.1440517
```

```
#error
with.decomp_edag - original_edag
```
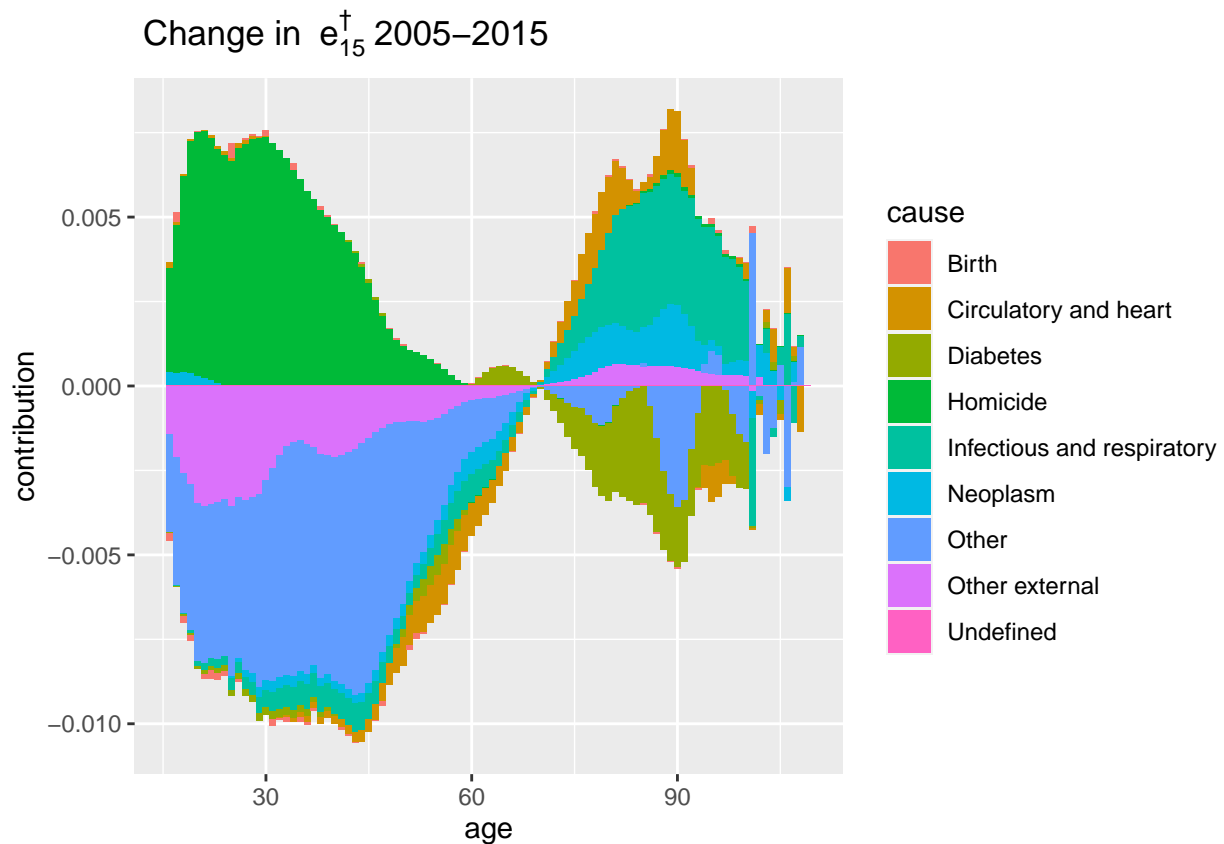
```
## [1] 0
```

```
results_step_edag <- data.frame(results_step_edag)
colnames(results_step_edag) <- cause_names
results_step_edag <- results_step_edag %>%
  mutate(age = 16:109) %>%
  pivot_longer(cols=1:9, names_to="cause", values_to="contribution")

#now graph results
ggplot(data=results_step_edag, aes(x=age, y=contribution, fill=cause)) +
  ggtitle(bquote(~'Change in '~ e[15]^"\u2020" ~'2005-2015' )) +
  geom_bar(stat = "identity", position = "stack")
```


Let's compare the two methods

```
results$contribution - results_step$contribution
```

```
##   [1]  2.739178e-10  4.874536e-10  2.700219e-09 -1.199104e-08 -6.346568e-11
##   [6] -6.445884e-09 -2.532853e-08 -2.466481e-08  0.000000e+00 -1.009944e-09
##  [11]  5.089404e-10  1.549349e-09  1.348959e-08 -1.066869e-09 -9.401710e-09
```

```
## [16]  -3.749534e-08  -3.228996e-08   0.000000e+00  -1.658488e-09   5.446310e-10
## [21]   1.193960e-09  -1.041325e-08  -1.881038e-09  -1.271149e-08  -4.564030e-08
## [26]  -3.521245e-08   0.000000e+00  -2.583903e-09   5.336425e-10   1.019160e-09
## [31]  -1.017107e-08  -2.768964e-09  -1.511842e-08  -5.196351e-08  -3.631318e-08
## [36]   0.000000e+00  -4.682065e-09   4.360530e-10   4.896101e-10   7.676348e-10
## [41]  -4.136286e-09  -1.562117e-08  -6.118723e-08  -3.913288e-08   0.000000e+00
## [46]  -6.088683e-09   3.622844e-10   7.149730e-10  -8.568236e-09  -5.350930e-09
## [51]  -1.527626e-08  -6.226339e-08  -3.867966e-08   0.000000e+00  -7.372591e-09
## [56]   2.756515e-10   1.235279e-09  -1.460184e-08  -6.596220e-09  -1.408877e-08
## [61]  -6.040128e-08  -3.776810e-08   0.000000e+00  -8.875556e-09   1.574207e-10
## [66]   1.726310e-09  -1.122322e-08  -8.025939e-09  -1.237857e-08  -5.910381e-08
## [71]  -3.811843e-08   0.000000e+00  -9.805387e-09   4.210676e-11   2.420741e-09
## [76]  -9.061921e-09  -9.237755e-09  -1.070645e-08  -5.652488e-08  -3.797362e-08
## [81]   0.000000e+00  -1.179757e-08  -1.331451e-10   2.233012e-09   2.639133e-08
## [86]  -1.111176e-08  -8.656471e-09  -5.910078e-08  -4.107195e-08   0.000000e+00
## [91]  -1.138194e-08  -2.126050e-10   3.159567e-09  -4.730925e-09  -1.150492e-08
## [96]  -6.763081e-09  -5.422553e-08  -3.876802e-08   0.000000e+00  -1.300325e-08
## [101]  -3.564935e-10   2.761070e-09   3.699679e-09  -1.304498e-08  -3.802782e-09
## [106]  -5.469446e-08  -4.114949e-08   0.000000e+00  -1.435552e-08  -4.610357e-10
## [111]   2.419554e-09   2.366839e-09  -1.414327e-08  -6.222223e-11  -5.224505e-08
## [116]  -4.278278e-08   0.000000e+00  -1.704387e-08  -5.666863e-10   1.412740e-09
## [121]   1.708798e-09  -1.595120e-08   4.535423e-09  -4.981015e-08  -4.707017e-08
## [126]   0.000000e+00  -1.884892e-08  -5.975593e-10   9.952998e-10   1.157860e-08
## [131]  -1.638477e-08   9.989417e-09  -4.277685e-08  -4.912673e-08   0.000000e+00
## [136]  -2.173888e-08  -6.257608e-10   2.400924e-11  -1.597760e-08  -1.734063e-08
## [141]   1.586314e-08  -3.674908e-08  -5.314969e-08   0.000000e+00  -2.442951e-08
## [146]  -6.249863e-10  -8.406680e-10  -3.700965e-09  -1.769761e-08   2.206006e-08
## [151]  -3.085459e-08  -5.661655e-08   0.000000e+00  -2.712792e-08  -6.135252e-10
## [156]  -1.770445e-09  -1.102412e-08  -1.783393e-08   2.840036e-08  -2.652484e-08
## [161]  -6.025506e-08   0.000000e+00  -2.981682e-08  -6.039080e-10  -2.980482e-09
## [166]   1.672649e-08  -1.825314e-08   3.434156e-08  -2.458616e-08  -6.448961e-08
## [171]   0.000000e+00  -3.124885e-08  -5.729959e-10  -3.683400e-09  -1.246156e-08
## [176]  -1.726808e-08   4.037803e-08  -2.397899e-08  -6.701816e-08   0.000000e+00
## [181]  -3.292796e-08  -5.605827e-10  -4.828692e-09  -7.499583e-09  -1.713298e-08
## [186]   4.567049e-08  -2.551214e-08  -7.143741e-08   0.000000e+00  -3.294021e-08
## [191]  -5.127276e-10  -4.833659e-09  -7.941669e-09  -1.354977e-08   5.164604e-08
## [196]  -2.626640e-08  -7.308134e-08   0.000000e+00  -3.533184e-08  -5.266010e-10
## [201]  -6.397656e-09   1.043025e-08  -1.383276e-08   5.634641e-08  -2.880806e-08
## [206]  -8.200611e-08   0.000000e+00  -3.615018e-08  -4.987584e-10  -6.470902e-09
## [211]   6.423136e-09  -9.072746e-09   6.182427e-08  -2.891745e-08  -8.829644e-08
## [216]   0.000000e+00  -3.866668e-08  -5.026202e-10  -7.138755e-09   1.828241e-09
## [221]  -5.061864e-09   6.711161e-08  -2.851890e-08  -1.006875e-07   0.000000e+00
## [226]  -4.135001e-08  -5.086065e-10  -7.597066e-09  -7.718345e-09   7.982948e-10
## [231]   7.200908e-08  -2.683273e-08  -1.162575e-07   0.000000e+00  -4.434826e-08
## [236]  -5.313332e-10  -8.510483e-09  -3.735725e-09   6.418649e-09   7.549692e-08
## [241]  -2.459355e-08  -1.372006e-07   0.000000e+00  -4.715601e-08  -5.710881e-10
## [246]  -1.017502e-08  -2.620194e-09   1.067969e-08   7.677109e-08  -2.207697e-08
## [251]  -1.641577e-07   0.000000e+00  -4.832683e-08  -6.090843e-10  -1.222949e-08
## [256]   4.079141e-09   1.462396e-08   7.517618e-08  -1.920397e-08  -1.935623e-07
## [261]   0.000000e+00  -4.719913e-08  -6.428600e-10  -1.485877e-08   2.267228e-09
## [266]   1.758764e-08   7.044677e-08  -1.625529e-08  -2.229938e-07   0.000000e+00
## [271]  -4.445342e-08  -6.824230e-10  -1.881039e-08  -1.091045e-09   1.614467e-08
## [276]   6.297165e-08  -1.358248e-08  -2.537084e-07   0.000000e+00  -4.010873e-08
## [281]  -7.082690e-10  -2.341887e-08  -1.962981e-08   1.210023e-08   5.427985e-08
```

```
## [286] -1.113940e-08 -2.810263e-07  0.000000e+00 -3.587906e-08 -7.330812e-10
## [291] -2.951376e-08  5.499473e-09  1.685610e-09  4.584695e-08 -9.187207e-09
## [296] -3.095580e-07  0.000000e+00 -3.244720e-08 -7.414869e-10 -3.669332e-08
## [301]  6.046363e-09 -1.538301e-08  3.855008e-08 -7.570026e-09 -3.364366e-07
## [306]  0.000000e+00 -3.140702e-08 -7.319620e-10 -4.506462e-08  1.518258e-08
## [311] -3.878980e-08  3.374862e-08 -6.244271e-09 -3.650677e-07  0.000000e+00
## [316] -3.111088e-08 -6.609007e-10 -5.126067e-08 -2.345721e-08 -5.309639e-08
## [321]  3.124105e-08 -4.744386e-09 -3.727520e-07  0.000000e+00 -3.445703e-08
## [326] -5.936549e-10 -5.910603e-08 -3.266258e-08 -7.522167e-08  2.918308e-08
## [331] -3.109438e-09 -3.822903e-07  0.000000e+00 -4.239106e-08 -5.386944e-10
## [336] -7.018751e-08 -6.617846e-09 -1.110010e-07  2.667802e-08 -1.207233e-09
## [341] -4.057670e-07  0.000000e+00 -5.179891e-08 -4.406822e-10 -7.988936e-08
## [346]  4.055590e-09 -1.350740e-07  2.352494e-08  9.437784e-10 -4.129171e-07
## [351]  0.000000e+00 -6.446666e-08 -3.013056e-10 -9.111049e-08  6.112433e-09
## [356] -1.574956e-07  1.909728e-08  3.034767e-09 -4.239843e-07  0.000000e+00
## [361] -7.936489e-08 -5.030287e-11 -1.029558e-07 -2.677712e-09 -1.685193e-07
## [366]  1.389849e-08  4.772634e-09 -4.340582e-07  0.000000e+00 -9.292679e-08
## [371]  3.856364e-10 -1.112746e-07 -8.458766e-09 -1.465474e-07  8.889554e-09
## [376]  5.902663e-09 -4.186694e-07  0.000000e+00 -1.073348e-07  1.090822e-09
## [381] -1.221057e-07  2.241812e-09 -1.188225e-07  4.563052e-09  6.663004e-09
## [386] -4.238964e-07  0.000000e+00 -1.180134e-07  2.114078e-09 -1.307016e-07
## [391] -6.936247e-10 -5.980545e-08  1.581949e-09  7.166012e-09 -4.246646e-07
## [396]  0.000000e+00 -1.238708e-07  3.482246e-09 -1.391795e-07  1.694035e-08
## [401]  1.857961e-08 -1.204015e-11  7.802299e-09 -4.468684e-07  0.000000e+00
## [406] -1.234616e-07  5.139366e-09 -1.465294e-07  6.220123e-09  1.222526e-07
## [411] -4.642295e-10  8.795727e-09 -4.881228e-07  0.000000e+00 -1.186137e-07
## [416]  7.011529e-09 -1.536551e-07  1.651917e-08  2.436605e-07 -3.462830e-10
## [421]  1.007448e-08 -5.457146e-07  0.000000e+00 -1.131419e-07  9.085316e-09
## [426] -1.646027e-07  2.838548e-08  3.654761e-07 -1.046168e-10  1.152964e-08
## [431] -6.252799e-07  0.000000e+00 -1.076986e-07  1.107316e-08 -1.754112e-07
## [436]  0.000000e+00  5.033542e-07 -2.117417e-12  1.276048e-08 -6.702522e-07
## [441]  0.000000e+00 -1.088270e-07  1.303558e-08 -1.965863e-07  2.449086e-08
## [446]  6.151523e-07 -1.984439e-10  1.363207e-08 -6.975745e-07  0.000000e+00
## [451] -1.159464e-07  1.448041e-08 -2.223136e-07 -7.097256e-09  7.266730e-07
## [456] -7.481304e-10  1.373209e-08 -6.200454e-07  0.000000e+00 -1.305240e-07
## [461]  1.546717e-08 -2.646811e-07 -5.186083e-08  8.015581e-07 -1.551193e-09
## [466]  1.323284e-08 -4.995235e-07  0.000000e+00 -1.471157e-07  1.552979e-08
## [471] -3.208953e-07  2.997357e-08  8.639520e-07 -2.452698e-09  1.212517e-08
## [476] -3.252810e-07  0.000000e+00 -1.594031e-07  1.409169e-08 -3.875352e-07
## [481] -7.852883e-09  9.259601e-07 -3.228848e-09  1.045759e-08 -1.083543e-07
## [486]  0.000000e+00 -1.614751e-07  1.059613e-08 -4.592324e-07  7.220997e-09
## [491]  1.001512e-06 -3.625544e-09  8.381654e-09  1.266483e-07  0.000000e+00
## [496] -1.493210e-07  4.551072e-09 -5.203495e-07 -5.440956e-08  1.119768e-06
## [501] -3.501224e-09  6.104848e-09  3.861708e-07  0.000000e+00 -1.326170e-07
## [506] -4.337526e-09 -6.109161e-07 -1.775772e-08  1.188542e-06 -2.789108e-09
## [511]  4.076668e-09  4.874109e-07  0.000000e+00 -1.110197e-07 -1.712065e-08
## [516] -7.109123e-07 -1.019952e-09  1.256411e-06 -1.857547e-09  2.209035e-09
## [521]  5.450729e-07  0.000000e+00 -8.756667e-08 -3.417910e-08 -8.172363e-07
## [526]  9.562566e-09  1.320413e-06 -1.000483e-09  3.416680e-10  5.843131e-07
## [531]  0.000000e+00 -6.481525e-08 -5.573239e-08 -9.415190e-07 -2.202290e-08
## [536]  1.356534e-06 -4.447358e-10 -1.930790e-09  5.896837e-07  0.000000e+00
## [541] -4.232194e-08 -8.280255e-08 -1.114413e-06  1.036783e-08  1.337462e-06
## [546] -3.026344e-10 -5.373270e-09  5.228678e-07  0.000000e+00 -1.467307e-08
## [551] -1.096180e-07 -1.235026e-06  1.809801e-08  1.366677e-06 -5.780869e-10
```

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## [556]  -1.052914e-08   5.929964e-07   0.000000e+00   1.762977e-08  -1.348517e-07
## [561]  -1.319610e-06  -8.977309e-08   1.409620e-06  -9.178862e-10  -1.773829e-08
## [566]   6.761981e-07   0.000000e+00   5.760602e-08  -1.607229e-07  -1.401893e-06
## [571]   1.180489e-08   1.431994e-06  -1.066592e-09  -2.700072e-08   6.402355e-07
## [576]   0.000000e+00   1.063339e-07  -1.829275e-07  -1.407369e-06  -4.112493e-08
## [581]   1.473100e-06  -9.735430e-10  -3.724267e-08   5.386603e-07   0.000000e+00
## [586]   1.657241e-07  -2.065627e-07  -1.362831e-06  -4.488869e-08   1.509889e-06
## [591]  -6.238210e-10  -4.726460e-08   2.655672e-07   0.000000e+00   2.170000e-07
## [596]  -2.116970e-07  -1.049674e-06  -6.073572e-08   1.627022e-06  -2.571205e-10
## [601]  -5.480956e-08   1.508854e-07   0.000000e+00   2.580257e-07  -2.138673e-07
## [606]  -6.606833e-07  -2.638766e-08   1.708711e-06   9.809042e-12  -6.057879e-08
## [611]   5.619428e-08   0.000000e+00   2.875912e-07  -2.245365e-07  -3.188571e-07
## [616]  -5.961491e-08   1.721262e-06   1.466915e-11  -6.562360e-08   1.480759e-08
## [621]   0.000000e+00   3.143885e-07  -2.682121e-07  -2.441937e-07   6.471505e-08
## [626]   1.616515e-06  -3.718910e-10  -7.180649e-08  -3.904609e-08   0.000000e+00
## [631]   3.191224e-07  -3.344794e-07  -3.434859e-07  -7.727148e-08   1.461604e-06
## [636]  -1.182933e-09  -7.924109e-08   2.462530e-07   0.000000e+00   3.152442e-07
## [641]  -4.412026e-07  -7.492065e-07   3.861384e-08   1.245178e-06  -2.379299e-09
## [646]  -8.899240e-08   6.510482e-07   0.000000e+00   3.070003e-07  -5.742639e-07
## [651]  -1.311469e-06   0.000000e+00   1.039591e-06  -3.842747e-09  -1.003401e-07
## [656]   1.023101e-06   0.000000e+00   2.946487e-07  -7.068227e-07  -1.847288e-06
## [661]   4.648750e-08   8.861849e-07  -5.365809e-09  -1.112852e-07   1.212346e-06
## [666]   0.000000e+00   2.706247e-07  -7.875574e-07  -2.046817e-06   5.126154e-08
## [671]   8.291247e-07  -6.650868e-09  -1.188905e-07   1.214110e-06   0.000000e+00
## [676]   2.369719e-07  -7.711281e-07  -1.677898e-06   0.000000e+00   8.758492e-07
## [681]  -7.464763e-09  -1.211220e-07   9.999153e-07   0.000000e+00   2.095069e-07
## [686]  -6.918327e-07  -1.021383e-06  -1.079710e-07   9.524744e-07  -7.913133e-09
## [691]  -1.197805e-07   4.985621e-07   0.000000e+00   1.534734e-07  -5.185132e-07
## [696]   5.616058e-08   7.233117e-08   1.064558e-06  -8.000139e-09  -1.141333e-07
## [701]   1.991693e-07   0.000000e+00   8.759700e-08  -3.525193e-07   9.072539e-07
## [706]   0.000000e+00   1.121732e-06  -8.138144e-09  -1.087482e-07  -6.960992e-08
## [711]   0.000000e+00   7.891089e-09  -2.294289e-07   1.393066e-06  -2.731028e-07
## [716]   1.131937e-06  -8.602260e-09  -1.063320e-07  -1.958523e-07   0.000000e+00
## [721]  -9.167615e-08  -1.964974e-07   1.337948e-06  -1.565786e-07   1.086160e-06
## [726]  -9.693366e-09  -1.093187e-07  -1.935342e-07   0.000000e+00  -2.241925e-07
## [731]  -2.388805e-07   9.072151e-07  -1.866780e-07   1.005950e-06  -1.155555e-08
## [736]  -1.177902e-07   3.914520e-08   0.000000e+00  -3.966518e-07  -3.199097e-07
## [741]   3.060894e-07   0.000000e+00   9.073320e-07  -1.427329e-08  -1.308514e-07
## [746]   3.432298e-07   0.000000e+00  -5.807496e-07  -3.860597e-07  -2.451030e-07
## [751]   0.000000e+00   8.032034e-07  -1.762489e-08  -1.450751e-07   6.117696e-07
## [756]   0.000000e+00  -7.227018e-07  -4.047259e-07  -6.412824e-07   0.000000e+00
## [761]   6.943381e-07  -2.115811e-08  -1.563088e-07   7.030246e-07   0.000000e+00
## [766]   7.859414e-07   6.741409e-07   4.799476e-08  -4.054299e-07   1.962657e-08
## [771]   0.000000e+00   1.103293e-07  -3.085827e-06   0.000000e+00   8.543431e-09
## [776]  -8.335564e-07   4.723137e-07   0.000000e+00   8.162714e-08   0.000000e+00
## [781]  -2.029170e-07   3.112265e-07   0.000000e+00  -5.886224e-08  -1.082050e-06
## [786]  -6.128688e-07   0.000000e+00  -1.546324e-07   0.000000e+00   0.000000e+00
## [791]   2.215975e-06   0.000000e+00   2.269309e-08  -6.898550e-07  -2.001779e-06
## [796]   0.000000e+00  -3.229142e-07   0.000000e+00   0.000000e+00   1.291176e-06
## [801]   0.000000e+00  -4.194821e-08   7.443487e-07   4.711364e-07   0.000000e+00
## [806]   7.101430e-07   0.000000e+00   0.000000e+00  -8.511902e-07   0.000000e+00
## [811]  -9.039032e-07   7.225437e-07  -4.262476e-06   0.000000e+00   0.000000e+00
## [816]   0.000000e+00   0.000000e+00   3.491870e-06   0.000000e+00   5.936588e-07
## [821]  -1.419703e-06  -1.325066e-06   0.000000e+00  -4.174507e-07   0.000000e+00
```

```
## [826]  0.000000e+00 -7.962205e-08  0.000000e+00 -1.434200e-08  0.000000e+00
## [831]  1.993838e-06  0.000000e+00  0.000000e+00  0.000000e+00  0.000000e+00
## [836] -4.909740e-07  0.000000e+00 -2.017434e-06  1.269587e-06 -4.644199e-06
## [841]  0.000000e+00  1.669656e-06  0.000000e+00  0.000000e+00  1.919332e-06
## [846]  0.000000e+00
```

```
results_edag$contribution - results_step_edag$contribution
```

```
##   [1] -4.927623e-10  3.010483e-09  3.057909e-09  2.152886e-09  1.094147e-11
##   [6]  5.902345e-08  6.562732e-08  2.154916e-09  0.000000e+00  1.817380e-09
##  [11]  3.053430e-09  1.753014e-09 -2.421888e-09  1.841300e-10  8.529580e-08
##  [16]  9.693746e-08  2.475797e-11  0.000000e+00  2.984318e-09  3.172159e-09
##  [21]  1.350079e-09  1.869371e-09  3.247118e-10  1.143631e-07  1.176313e-07
##  [26] -3.753734e-09  0.000000e+00  4.648850e-09  3.016534e-09  1.151885e-09
##  [31]  1.826655e-09  4.780167e-10  1.356741e-07  1.334106e-07 -8.208592e-09
##  [36]  0.000000e+00  8.422179e-09  2.400824e-09  5.531842e-10 -1.378808e-10
##  [41]  7.141834e-10  1.413722e-07  1.563269e-07 -1.403283e-08  0.000000e+00
##  [46]  1.094903e-08  1.953651e-09  8.076562e-10  1.539341e-09  9.241177e-10
##  [51]  1.414213e-07  1.581468e-07 -1.942232e-08  0.000000e+00  1.325297e-08
##  [56]  1.461572e-09  1.394875e-09  2.624639e-09  1.139483e-09  1.358324e-07
##  [61]  1.524271e-07 -2.453724e-08  0.000000e+00  1.594746e-08  8.256533e-10
##  [66]  1.948133e-09  2.018504e-09  1.386949e-09  1.270838e-07  1.481050e-07
##  [71] -3.057468e-08  0.000000e+00  1.760912e-08  2.197877e-10  2.729515e-09
##  [76]  1.630536e-09  1.597028e-09  1.206981e-07  1.405633e-07 -3.645827e-08
##  [81]  0.000000e+00  2.117408e-08 -6.964447e-10  2.515441e-09 -4.746587e-09
##  [86]  1.922128e-09  1.125492e-07  1.457068e-07 -4.635394e-08  0.000000e+00
##  [91]  2.041463e-08 -1.122634e-09  3.555214e-09  8.503642e-10  1.991130e-09
##  [96]  1.117218e-07  1.324099e-07 -5.046590e-08  0.000000e+00  2.330680e-08
## [101] -1.910768e-09  3.103101e-09 -6.649579e-10  2.259126e-09  1.041167e-07
## [106]  1.321534e-07 -6.073154e-08  0.000000e+00  2.571095e-08 -2.525101e-09
## [111]  2.716425e-09 -4.252909e-10  2.451080e-09  9.492086e-08  1.247411e-07
## [116] -7.087999e-08  0.000000e+00  3.049868e-08 -3.190765e-09  1.584914e-09
## [121] -3.069864e-10  2.766774e-09  8.105937e-08  1.173717e-07 -8.680103e-08
## [126]  0.000000e+00  3.369410e-08 -3.474456e-09  1.116115e-09 -2.079291e-09
## [131]  2.844621e-09  6.505807e-08  9.940677e-08 -9.981786e-08  0.000000e+00
## [136]  3.881502e-08 -3.766099e-09  2.689049e-11  2.869293e-09  3.013565e-09
## [141]  4.523877e-08  8.421737e-08 -1.174915e-07  0.000000e+00  4.356112e-08
## [146] -3.899993e-09 -9.428458e-10  6.649152e-10  3.079083e-09  2.409511e-08
## [151]  6.974311e-08 -1.341967e-07  0.000000e+00  4.830007e-08 -3.972226e-09
## [156] -1.986817e-09  1.981250e-09  3.106484e-09  2.232859e-09  5.914857e-08
## [161] -1.504650e-07  0.000000e+00  5.299872e-08 -4.058541e-09 -3.348331e-09
## [166] -3.005614e-09  3.183732e-09 -1.944690e-08  5.406491e-08 -1.663029e-07
## [171]  0.000000e+00  5.544321e-08 -3.996050e-09 -4.144012e-09  2.238981e-09
## [176]  3.015895e-09 -4.055579e-08  5.192649e-08 -1.746771e-07  0.000000e+00
## [181]  5.830959e-08 -4.056263e-09 -5.442066e-09  1.348289e-09  2.996568e-09
## [186] -6.017226e-08  5.426147e-08 -1.841270e-07  0.000000e+00  5.821404e-08
## [191] -3.845726e-09 -5.458300e-09  1.428538e-09  2.373174e-09 -8.007489e-08
## [196]  5.465762e-08 -1.825171e-07  0.000000e+00  6.230897e-08 -4.093947e-09
## [201] -7.240126e-09 -1.876425e-09  2.426310e-09 -9.740949e-08  5.832330e-08
## [206] -1.945225e-07  0.000000e+00  6.360899e-08 -4.020947e-09 -7.340920e-09
## [211] -1.155172e-09  1.593564e-09 -1.154708e-07  5.653262e-08 -1.948787e-07
## [216]  0.000000e+00  6.787445e-08 -4.203669e-09 -8.118776e-09 -3.288321e-10
## [221]  8.901209e-10 -1.328352e-07  5.335552e-08 -2.023956e-07  0.000000e+00
## [226]  7.239612e-08 -4.420057e-09 -8.662334e-09  1.388909e-09 -1.405231e-10
## [231] -1.490389e-07  4.748782e-08 -2.074127e-07  0.000000e+00  7.742503e-08
```

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## [236]   -4.811198e-09   -9.730456e-09    6.727738e-10   -1.130479e-09   -1.617699e-07
## [241]    4.055638e-08   -2.105623e-07    0.000000e+00    8.207195e-08   -5.411775e-09
## [246]   -1.166918e-08    4.722436e-10   -1.881736e-09   -1.689276e-07    3.320564e-08
## [251]   -2.081580e-07    0.000000e+00    8.383067e-08   -6.078333e-09   -1.407528e-08
## [256]   -7.355396e-10   -2.577218e-09   -1.687056e-07    2.551579e-08   -1.925845e-07
## [261]    0.000000e+00    8.159446e-08   -6.801257e-09   -1.717254e-08   -4.089671e-10
## [266]   -3.099391e-09   -1.602607e-07    1.811457e-08   -1.627059e-07    0.000000e+00
## [271]    7.658682e-08   -7.721060e-09   -2.184734e-08    1.969225e-10   -2.844887e-09
## [276]   -1.444318e-07    1.151063e-08   -1.223286e-07    0.000000e+00    6.887557e-08
## [281]   -8.661852e-09   -2.736112e-08    3.548514e-09   -2.132402e-09   -1.249032e-07
## [286]    5.626467e-09   -7.273235e-08    0.000000e+00    6.142088e-08   -9.824425e-09
## [291]   -3.472537e-08   -9.955006e-10   -2.973417e-10   -1.053807e-07    4.415845e-10
## [296]   -1.900872e-08    0.000000e+00    5.538031e-08   -1.107763e-08   -4.352228e-08
## [301]   -1.094799e-09    2.719593e-09   -8.815597e-08   -4.580707e-09    3.749808e-08
## [306]    0.000000e+00    5.344425e-08   -1.246156e-08   -5.393151e-08   -2.748711e-09
## [311]    6.888401e-09   -7.650632e-08   -1.017557e-08    9.572622e-08    0.000000e+00
## [316]    5.277246e-08   -1.315696e-08   -6.190725e-08    4.252324e-09    9.492355e-09
## [321]   -6.998667e-08   -1.649597e-08    1.455049e-07    0.000000e+00    5.824237e-08
## [326]   -1.427818e-08   -7.199747e-08    5.946116e-09    1.358045e-08   -6.440817e-08
## [331]   -2.402342e-08    1.900345e-07    0.000000e+00    7.135040e-08   -1.656480e-08
## [336]   -8.615270e-08    1.209817e-09    2.033666e-08   -5.779268e-08   -3.285857e-08
## [341]    2.388994e-07    0.000000e+00    8.673049e-08   -1.925152e-08   -9.863301e-08
## [346]   -7.437233e-10    2.524990e-08   -4.976872e-08   -4.107267e-08    2.756887e-07
## [351]    0.000000e+00    1.072444e-07   -2.379283e-08   -1.127954e-07   -1.124988e-09
## [356]    3.019603e-08   -3.915914e-08   -4.781288e-08    3.114686e-07    0.000000e+00
## [361]    1.309687e-07   -3.056965e-08   -1.272621e-07    4.957190e-10    3.329877e-08
## [366]   -2.729640e-08   -5.199582e-08    3.437059e-07    0.000000e+00    1.518404e-07
## [371]   -3.857236e-08   -1.365599e-07    1.580719e-09    2.991652e-08   -1.640494e-08
## [376]   -5.276255e-08    3.512614e-07    0.000000e+00    1.733067e-07   -4.983527e-08
## [381]   -1.477520e-07   -4.241354e-10    2.506043e-08   -7.655162e-09   -5.275157e-08
## [386]    3.719289e-07    0.000000e+00    1.878744e-07   -6.283292e-08   -1.546769e-07
## [391]    1.333156e-10    1.300141e-08   -2.262901e-09   -5.242635e-08    3.861601e-07
## [396]    0.000000e+00    1.940044e-07   -7.788502e-08   -1.596421e-07   -3.318725e-09
## [401]   -4.141119e-09    1.250466e-11   -5.417405e-08    4.184170e-07    0.000000e+00
## [406]    1.898496e-07   -9.415345e-08   -1.613215e-07   -1.247339e-09   -2.771126e-08
## [411]    1.773399e-10   -5.904942e-08    4.688787e-07    0.000000e+00    1.787709e-07
## [416]   -1.114742e-07   -1.607202e-07   -3.407005e-09   -5.557471e-08   -3.407195e-10
## [421]   -6.635522e-08    5.366100e-07    0.000000e+00    1.668634e-07   -1.309227e-07
## [426]   -1.617714e-07   -6.038713e-09   -8.287021e-08   -5.635288e-10   -7.543149e-08
## [431]    6.286905e-07    0.000000e+00    1.551490e-07   -1.499341e-07   -1.600164e-07
## [436]    0.000000e+00   -1.118961e-07    1.603553e-10   -8.388983e-08    6.877085e-07
## [441]    0.000000e+00    1.527508e-07   -1.713796e-07   -1.640837e-07   -5.624596e-09
## [446]   -1.321280e-07    1.925136e-09   -9.110663e-08    7.278419e-07    0.000000e+00
## [451]    1.579202e-07   -1.911996e-07   -1.667560e-07    1.702901e-09   -1.485482e-07
## [456]    4.837100e-09   -9.445480e-08    6.541275e-07    0.000000e+00    1.713795e-07
## [461]   -2.134388e-07   -1.742735e-07    1.309323e-08   -1.536551e-07    8.243970e-09
## [466]   -9.504538e-08    5.288082e-07    0.000000e+00    1.843177e-07   -2.363295e-07
## [471]   -1.794881e-07   -7.955698e-09   -1.532680e-07    1.160955e-08   -9.269968e-08
## [476]    3.428069e-07    0.000000e+00    1.876814e-07   -2.576247e-07   -1.761598e-07
## [481]    2.186871e-09   -1.497109e-07    1.417391e-08   -8.731596e-08    1.127043e-07
## [486]    0.000000e+00    1.746879e-07   -2.754761e-07   -1.595384e-07   -2.110507e-09
## [491]   -1.445324e-07    1.513624e-08   -7.935049e-08   -1.288190e-07    0.000000e+00
## [496]    1.435911e-07   -2.858142e-07   -1.265240e-07    1.667545e-08   -1.389919e-07
## [501]    1.414380e-08   -6.942987e-08   -3.801273e-07    0.000000e+00    1.072618e-07
```

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## [506] -3.014199e-07 -8.856407e-08  5.680642e-09 -1.198020e-07  1.104443e-08
## [511] -6.162131e-08 -4.599522e-07  0.000000e+00  6.733813e-08 -3.126754e-07
## [516] -3.861066e-08  3.372653e-10 -9.400546e-08  7.290646e-09 -5.609355e-08
## [521] -4.894755e-07  0.000000e+00  2.815619e-08 -3.163844e-07  2.168494e-08
## [526] -3.235493e-09 -6.054468e-08  3.931648e-09 -5.374356e-08 -4.954677e-07
## [531]  0.000000e+00 -8.797717e-09 -3.130211e-07  9.071936e-08  7.549170e-09
## [536] -1.906731e-08  1.768268e-09 -5.546800e-08 -4.681919e-07  0.000000e+00
## [541] -4.774050e-08 -3.057877e-07  1.736033e-07 -3.556693e-09  2.573580e-08
## [546]  1.231793e-09 -6.168632e-08 -3.856887e-07  0.000000e+00 -8.909002e-08
## [551] -2.783938e-07  2.515495e-07 -6.119876e-09  7.391162e-08  2.443415e-09
## [556] -6.809688e-08 -4.016510e-07  0.000000e+00 -1.331217e-07 -2.430924e-07
## [561]  3.138164e-07  2.950924e-08  1.299398e-07  4.102924e-09 -7.334623e-08
## [566] -4.118134e-07  0.000000e+00 -1.840479e-07 -2.101286e-07  3.619741e-07
## [571] -3.696344e-09  1.919593e-07  5.166632e-09 -7.648315e-08 -3.416994e-07
## [576]  0.000000e+00 -2.367275e-07 -1.763304e-07  3.728345e-07  1.194041e-08
## [581]  2.653547e-07  5.297170e-09 -7.567396e-08 -2.450906e-07  0.000000e+00
## [586] -2.913478e-07 -1.488214e-07  3.519153e-07  1.172008e-08  3.486281e-07
## [591]  4.038445e-09 -7.148591e-08 -1.007174e-07  0.000000e+00 -3.165912e-07
## [596] -1.163107e-07  2.489581e-07  1.367450e-08  4.686425e-07  2.209635e-09
## [601] -6.371259e-08 -4.657710e-08  0.000000e+00 -3.180604e-07 -9.300298e-08
## [606]  1.327953e-07  4.815981e-09  6.029873e-07 -1.458149e-10 -5.572238e-08
## [611] -1.350965e-08  0.000000e+00 -2.986774e-07 -8.154752e-08  4.823125e-08
## [616]  7.959286e-09  7.290856e-07 -2.670356e-09 -4.905206e-08 -2.579940e-09
## [621]  0.000000e+00 -2.694795e-07 -8.655938e-08  2.226161e-08 -5.051126e-09
## [626]  8.010076e-07 -5.181815e-09 -4.466973e-08  4.304297e-09  0.000000e+00
## [631] -2.170709e-07 -1.023115e-07  8.138318e-09  1.275811e-09  8.251990e-07
## [636] -7.102334e-09 -4.220355e-08 -1.034346e-08  0.000000e+00 -1.586070e-07
## [641] -1.359635e-07 -3.682727e-08  1.995407e-09  7.815291e-07 -8.460852e-09
## [646] -4.216364e-08  2.647834e-08  0.000000e+00 -9.856859e-08 -1.876951e-07
## [651] -1.658310e-07  0.000000e+00  7.117758e-07 -9.284557e-09 -4.478226e-08
## [656]  1.466296e-07  0.000000e+00 -3.775404e-08 -2.553500e-07 -3.875406e-07
## [661]  1.005451e-08  6.561081e-07 -9.724753e-09 -5.045031e-08  3.274781e-07
## [666]  0.000000e+00  2.240911e-08 -3.246188e-07 -6.194072e-07  1.626206e-08
## [671]  6.660220e-07 -9.978281e-09 -5.937398e-08  5.171146e-07  0.000000e+00
## [676]  7.558266e-08 -3.709365e-07 -6.864331e-07  0.000000e+00  7.729343e-07
## [681] -1.026931e-08 -7.118844e-08  6.142341e-07  0.000000e+00  1.275571e-07
## [686] -3.917776e-07 -5.421479e-07 -6.093991e-08  9.347304e-07 -1.085708e-08
## [691] -8.578192e-08  4.081631e-07  0.000000e+00  1.563519e-07 -3.462236e-07
## [696]  3.753407e-08  5.133378e-08  1.168287e-06 -1.149870e-08 -1.000034e-07
## [701]  2.012918e-07  0.000000e+00  1.622547e-07 -2.757963e-07  7.440367e-07
## [706]  0.000000e+00  1.370490e-06 -1.236318e-08 -1.142315e-07 -8.184592e-08
## [711]  0.000000e+00  1.318704e-07 -2.085445e-07  1.370345e-06 -2.800529e-07
## [716]  1.519725e-06 -1.362586e-08 -1.296786e-07 -2.563172e-07  0.000000e+00
## [721]  5.375820e-08 -2.057256e-07  1.548077e-06 -1.856457e-07  1.573174e-06
## [726] -1.568814e-08 -1.495597e-07 -2.752806e-07  0.000000e+00 -1.063424e-07
## [731] -2.860575e-07  1.215307e-06 -2.512219e-07  1.542483e-06 -1.888842e-08
## [736] -1.760261e-07  5.990977e-08  0.000000e+00 -3.879412e-07 -4.367455e-07
## [741]  4.700734e-07  0.000000e+00  1.446567e-06 -2.351992e-08 -2.100588e-07
## [746]  5.612656e-07  0.000000e+00 -7.890938e-07 -6.015781e-07 -4.304271e-07
## [751]  0.000000e+00  1.310666e-06 -2.947875e-08 -2.486187e-07  1.055084e-06
## [756]  0.000000e+00 -1.227972e-06 -7.253322e-07 -1.296429e-06  0.000000e+00
## [761]  1.139816e-06 -3.623431e-08 -2.858246e-07  1.244735e-06  0.000000e+00
## [766]  1.485863e-06  1.344752e-06  1.083362e-07 -8.095675e-07  3.219046e-08
## [771]  0.000000e+00  2.080042e-07 -5.835402e-06  0.000000e+00  1.828276e-08
```

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## [776] -1.844577e-06  1.189791e-06  0.000000e+00  1.319553e-07  0.000000e+00
## [781] -3.909585e-07  6.228954e-07  0.000000e+00 -1.509859e-07 -2.572035e-06
## [786] -1.651801e-06  0.000000e+00 -2.543469e-07  0.000000e+00  0.000000e+00
## [791]  4.264528e-06  0.000000e+00  6.414335e-08 -1.708041e-06 -5.697520e-06
## [796]  0.000000e+00 -5.285182e-07  0.000000e+00  0.000000e+00  2.177889e-06
## [801]  0.000000e+00 -1.394485e-07  1.844865e-06  1.389792e-06  0.000000e+00
## [806]  1.095815e-06  0.000000e+00  0.000000e+00 -1.359129e-06  0.000000e+00
## [811] -3.578539e-06  1.741295e-06 -1.355243e-05  0.000000e+00  0.000000e+00
## [816]  0.000000e+00  0.000000e+00  5.605777e-06  0.000000e+00  2.443174e-06
## [821] -3.021423e-06 -4.196276e-06  0.000000e+00 -4.161254e-07  0.000000e+00
## [826]  0.000000e+00 -8.353337e-08  0.000000e+00 -4.580939e-07  0.000000e+00
## [831]  1.251799e-05  0.000000e+00  0.000000e+00  0.000000e+00  0.000000e+00
## [836] -9.174358e-07  0.000000e+00  0.000000e+00  0.000000e+00  0.000000e+00
## [841]  0.000000e+00  0.000000e+00  0.000000e+00  0.000000e+00  0.000000e+00
## [846]  0.000000e+00
```