

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('MexicoMen.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-cause specific mortality rates in each period
COD1 <- data %>%
  filter(year==2005) %>%
  select(Cause_1:Cause_9) %>%
  as.matrix()

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

We cannot directly use the same functions to calculate life expectancy and lifespan disparity. Rather, we need functions that can estimate life expectancy and lifespan disparity 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)
## {
##   dim(mxcvec) <- c(94, length(mxcvec)/94)
##   mx <- rowSums(mxcvec)
##   e0.frommx(mx, sex)
## }

edagger.frommxc

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

Now we can perform the decomposition and check the results

```
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
## [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
```

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

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

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

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

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

```
## [1] -1.932243e-09
```

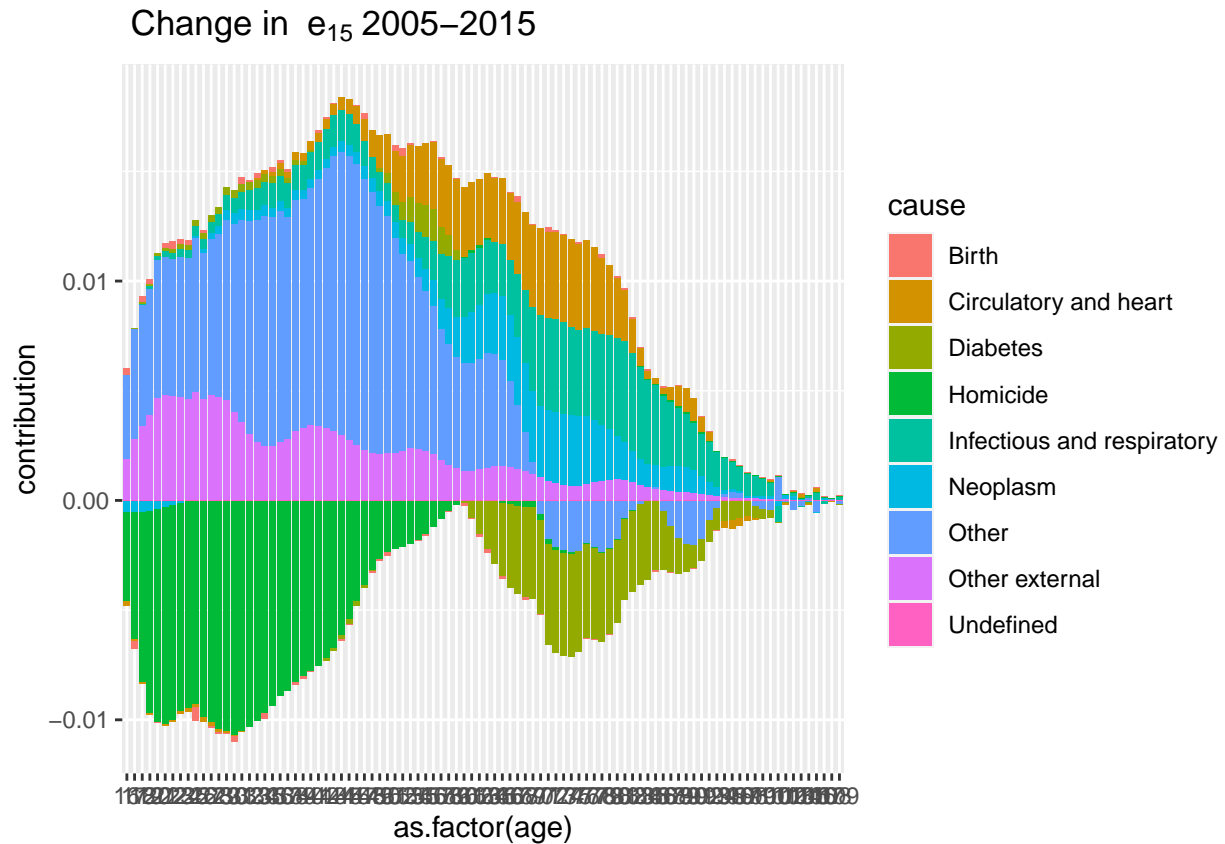
Do some data handling to have a nice dataset.

```
results <- data.frame(results)
colnames(results) <- cause_names
results$age <- 16:109
results <- gather(data = results, key = cause, value = contribution, -age)
```

Finally, graph and interpret the results.

#now graph results

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



Now for lifespan disparity

#Now we can perform 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] -0.1421836
```

#with decomp

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

```
## [1] -0.1421836
```

#error

```
with.decomp_edag - original_edag
```

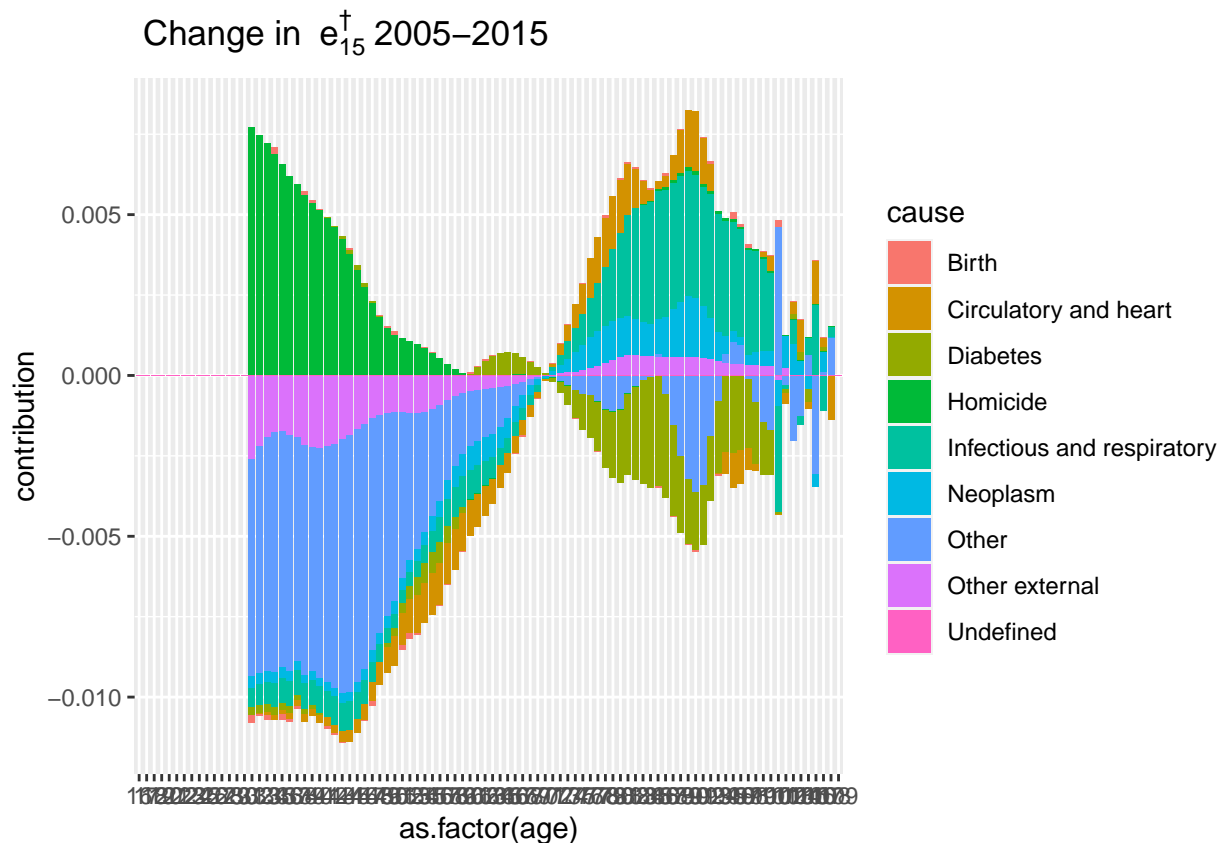
```
## [1] 2.345871e-09
```

Do some data handling to have a nice dataset and plotting

```
results_edag <- data.frame(results_edag)
colnames(results_edag) <- cause_names
results_edag$age <- 16:109
results_edag <- gather(data = results_edag, key = cause, value = contribution, -age)
```

#now graph results

```
ggplot(data=results_edag, aes(x=as.factor(age), y=contribution, fill=cause)) +
  ggtitle(bquote(~'Change in ' ~ e[15] ~ "\u2020" ~ '2020' ~ '2005-2015' )) +
  geom_bar(stat = "identity", position = "stack")
```



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

First, life expectancy

```
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
```

```

#with decomp
(with.decomp <- sum(results_step))

## [1] 0.547894

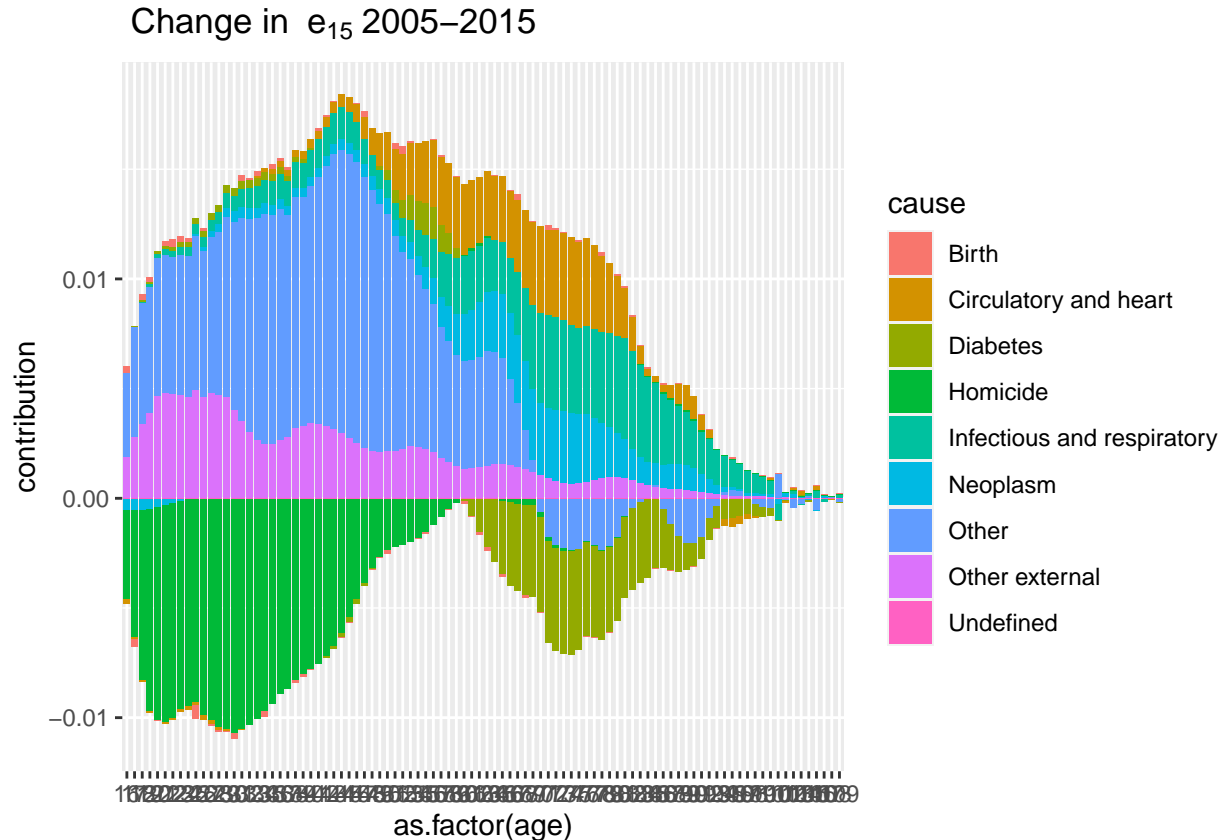
#error
with.decomp - original

## [1] 0

results_step <- data.frame(results_step)
colnames(results_step) <- cause_names
results_step$age <- 16:109
results_step <- gather(data = results_step, key = cause, value = contribution, -age)

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

```



Now for lifespan disparity

```

#Now we can perform 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.frommx(c(COD2) - edagger.frommx(c(COD1)))

## [1] -0.1421836

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

## [1] -0.1421836

#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$age <- 16:109
results_step_edag <- gather(data = results_step_edag, key = cause, value = contribution, -age)

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

```

