1 Introduction

`varCKMR` is a pseudo R package to showcase a method of estimating the variance in the distribution of number of offspring. It does this using within birth-cohort sibling comparisons.

It contains an individual based simulation that installs as the `R` package `varCKMR` along with some helper functions. The `TMB` models used in the analysis are in the `models` folder with the `ssmodelAdj.cpp` being the model using within-cohort sibling comparisons and the `ssmodelNoSC.cpp` model omitting them.

The `scripts` folder contains the scripts to recreate the simulations used in the analysis. `populations` is where the `populations` used in the analysis would be kept althought they are ommitted here for space reasons. `sims` contains all the samples from each population but are again ommitted for space reasons.

The org file `varCKMR.org` contains all the files to make all the files in this folder.

2 A note on σ_{tot}^2

The code here uses a more complicated derivation to break up σ_{tot}^2 (and $Var(R)$) then what is given in the paper:

$$\sigma_{tot}^2 = Var(X) = \sum_{a=0}^{A} Var(X|D=a)\Delta_a + \sum_{a=0}^{A} E[X|D=a]^2(1-\Delta_a)\Delta_a -$$

$$2\sum_{a=1}^{A}\sum_{b=0}^{a-1} E[X|D=a]\Delta_a E[X|D=b]\Delta_b. \quad (1)$$

This form assumes that X is also mutually exclusive (which age of death and age of parent are) but if that is the case then the form above and the form given in the paper will agree.

```
##See README
##here is a small example using the sim parameters from one of the populations

surv = c(0.215,0.280)
death_probs = c(1-surv[1],surv[1]*(1-surv[2]),surv[1]*surv[2])
fecundity = 2*c(0.380,1.518,3.416)
theta = 0.1

EXD = cumsum(fecundity)
V1 = fecundity+fecundity^2/theta
varXD = cumsum(V1)


oldform <- function(varXD,EXD,Delta){
  firstsum <- sum(varXD*Delta)
  secondsum <- sum(EXD^2*(1-Delta)*(Delta))

  thirdsum <- 0
  for(i in 2:length(EXD)){
```

```
    for(j in 1:(i-1)){
      thirdsum = thirdsum + EXD[i]*Delta[i]*EXD[j]*Delta[j]
    }
  }

  total <- firstsum + secondsum -2*thirdsum
  total



}

newform <- function(varXD,EXD,Delta){
  mu_tot = sum(EXD*Delta)
  firstsum = sum(varXD*Delta)
  secondsum = sum(EXD^2*Delta)
  total = firstsum+secondsum-mu_tot^2
  total
}

oldv = oldform(varXD,EXD,death_probs)
newv = newform(varXD,EXD,death_probs)
print(paste0("old: ",round(oldv,3)," new: ", round(newv,3)))

old: 61.673 new: 61.673
```