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# Matrix operators for population models
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# place in R 'Resources/R/' folder

## maximum lambda function
max.lambda <- function(x) Re((eigen(x)$values)[1]) ## where 'x' is a Leslie matrix

## Maximum r function
max.r <- function(x) log(Re((eigen(x)$values)[1])) ## where 'x' is a Leslie matrix

## Stable stage distribution
stable.stage.dist <- function(x) ((x %*% (Re((eigen(x)$vectors)[,1])))/(sum((x %*% (Re((eigen(x)$vectors)[,1])))))[,1])

## Generation length function
R.val <- function(X,age.max) ## reproductive value (R0) where X = Leslie matrix; age.max = maximum age of females
{
  ## define the transition matrix
  T <- X[1:age.max,1:age.max]
  T[1,1:(age.max)] <- 0

  ## define the fertility matrix
  F <- X[1:age.max,1:age.max]
  diag(F[2:age.max,1:(age.max-1)]) <- 0

  ## define the identity matrix
  I <- matrix(data=0,nrow=age.max,ncol=age.max)
  diag(I) <- 1

  ## define the fundamental matrix
  library(MASS)
  N.fund <- ginv(I-T)

  ## define the reproductive matrix
  R <- F %*% N.fund

  ## define R0 (number of female offspring produced per female during lifetime)
  R0 <- Re((eigen(R)$values)[1])

  ## output
  print("number of female offspring produced per female during its lifetime")
  print("_____")
  print(R0)
}

## Mean generation time function
G.val <- function (X,age.max) ## where X is a Leslie Matrix
{
  G <- (log(R.val(X,age.max)))/(log(Re((eigen(X)$values)[1])))
  print("mean generation time")
  print("_____")
  print(G)
}

```