Ecology problem set 2

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Exercise 1f

```
wombat_LM <- rbind(c(0.6, 1.5), c(0.3, 0)) #Leslie matrix
wombat_eigen <- eigen(wombat_LM)
wombat_eigen
```

```
## $values
## [1]  1.0348469 -0.4348469
##
## $vectors
##           [,1]       [,2]
## [1,] 0.9604554 -0.8231194
## [2,] 0.2784340  0.5678684
```

```
#dominant eigen value
dom_eig_val <- wombat_eigen$values[1]
dom_eig_val
```

```
## [1] 1.034847
```

```
#stable age distribution
stable_age <- wombat_eigen$vectors[,1]/sum(wombat_eigen$vectors[,1]) #normalized
stable_age
```

```
## [1] 0.7752551 0.2247449
```

Exercise 1h

```
n_2015 <- matrix(c(2000, 1000), nrow = 2, byrow = TRUE)
n_2016 <- wombat_LM %*% n_2015
n_2016
```

```
##      [,1]
## [1,] 2700
## [2,]  600
```

Exercise 1i

```r
#proportion of pop growth 2067-2068
AA <- wombat_LM
tt <- 2067-2015
for (ii in 1:tt){
  AA <- wombat_LM %*% AA
}
n_2067 <- AA %*% n_2015
n_2067
```

```
##              [,1]
## [1,] 14922.379
## [2,]  4325.967
```

```r
tt <- 2068-2015
for (ii in 1:tt){
  AA <- wombat_LM %*% AA
}
n_2068 <- AA %*% n_2015
n_2068
```

```
##             [,1]
## [1,] 91679.46
## [2,] 26577.69
```

```r
sum(n_2068)/sum(n_2067)
```

```
## [1] 6.143756
```

```r
#proportion of pop growth 2068-2069
tt <- 2069-2015
for (ii in 1:tt){
  AA <- wombat_LM %*% AA
}
n_2069 <- AA %*% n_2015
sum(n_2069)/sum(n_2068)
```

```
## [1] 6.357847
```

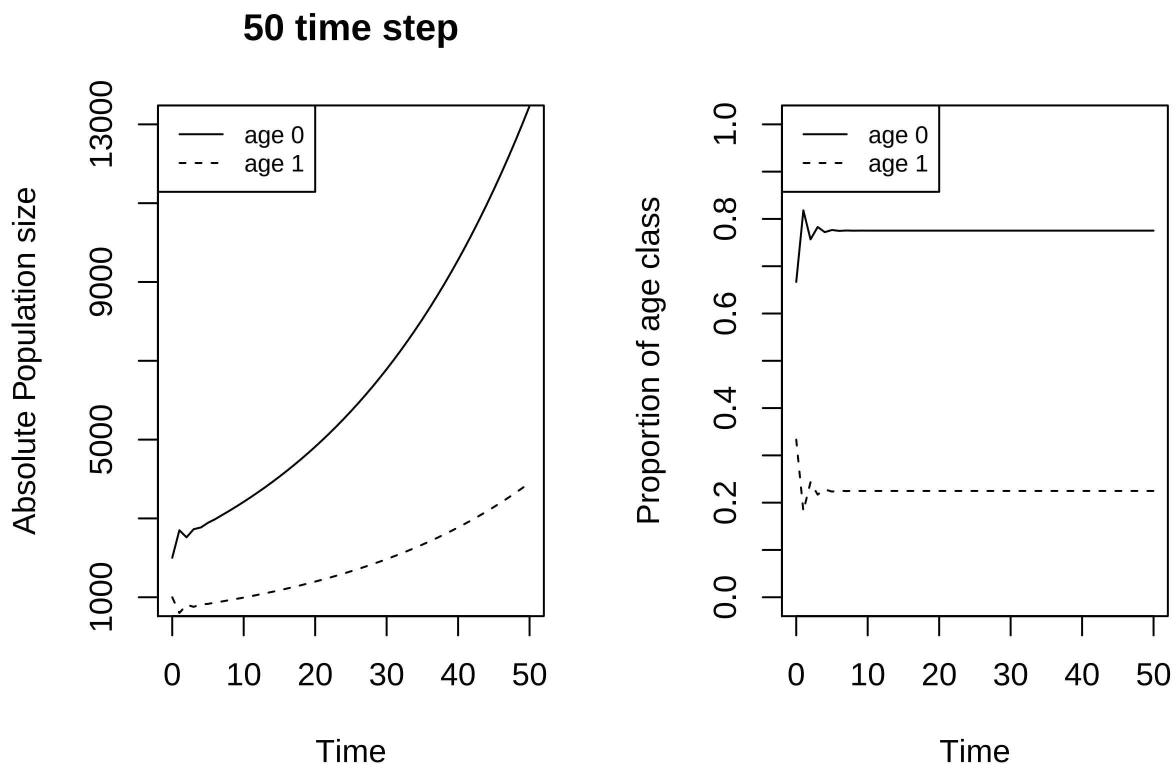
Exercise 1k

```r
pop <- n_2015
nn <- n_2015
for (ii in 1:50){
  pop <- wombat_LM%*%pop
  nn <- cbind(nn, pop)
}
nn
```

```
##       [,1] [,2] [,3] [,4]   [,5]    [,6]     [,7]      [,8]      [,9]
## [1,] 2000 2700 2520 2727 2770.2 2889.27 2980.152 3088.2627 3194.0260
## [2,] 1000  600  810  756  818.1  831.06  866.781  894.0456  926.4788
##          [,10]     [,11]    [,12]    [,13]    [,14]    [,15]    [,16]
## [1,] 3306.1338 3420.9920 3540.355 3663.660 3791.356 3923.460 4060.186
## [2,]  958.2078  991.8401 1026.298 1062.107 1099.098 1137.407 1177.038
##         [,17]    [,18]    [,19]    [,20]    [,21]    [,22]    [,23]
## [1,] 4201.669 4348.085 4499.602 4656.400 4818.661 4986.576 5160.343
## [2,] 1218.056 1260.501 1304.426 1349.881 1396.920 1445.598 1495.973
##         [,24]    [,25]    [,26]    [,27]    [,28]    [,29]    [,30]
## [1,] 5340.165 5526.253 5718.826 5918.110 6124.338 6337.752 6558.603
## [2,] 1548.103 1602.050 1657.876 1715.648 1775.433 1837.301 1901.326
##         [,31]    [,32]    [,33]    [,34]    [,35]    [,36]    [,37]
## [1,] 6787.150 7023.662 7268.415 7521.697 7783.805 8055.046 8335.740
## [2,] 1967.581 2036.145 2107.099 2180.524 2256.509 2335.141 2416.514
##         [,38]    [,39]    [,40]    [,41]    [,42]     [,43]     [,44]
## [1,] 8626.215 8926.812 9237.884 9559.795 9892.925 10237.663 10594.414
## [2,] 2500.722 2587.864 2678.044 2771.365 2867.939  2967.877  3071.299
##          [,45]     [,46]     [,47]     [,48]     [,49]     [,50]     [,51]
## [1,] 10963.597 11345.644 11741.005 12150.143 12573.538 13011.687 13465.104
## [2,]  3178.324  3289.079  3403.693  3522.302  3645.043  3772.061  3903.506
```

```r
par(mfrow = c(1, 2))
plot(0:50, nn[1, ], type = "l", lty = 1 , ylim = c(1000, 13000), yaxt = "n", xlab = "Time", ylab = "Abs
lines(0:50, nn[2, ], lty = 2)
axis(side = 2, at = seq(1000, 13000, by=2000))
legend("topleft", lty = c(1, 2) ,legend = c("age 0","age 1"), cex = 0.75)

plot(0:50, nn[1, ]/(nn[1, ]+nn[2, ]), type = "l", yaxt = "n", ylim = c(0, 1), lty = 1, xlab = "Time", yl
axis(side = 2, at = seq(0, 1, by=0.1))
lines(0:50, nn[2, ]/(nn[1, ]+nn[2, ]), lty = 2)
legend("topleft", lty = c(1, 2),legend = c("age 0","age 1"), cex = 0.75)
```



Exercise 1l

```
wombat_eigen$values[1]
```

```
## [1] 1.034847
```

```
#absolute increase of 0.01 in b0
wombat_LM1 <- rbind(c(0.61, 1.5), c(0.3, 0))
wombat_eigen1 <- eigen(wombat_LM1)
wombat_eigen1$values[1]
```

```
## [1] 1.041902
```

```
#absolute increase of 0.01 in s0
wombat_LM2 <- rbind(c(0.61, 1.5), c(0.31, 0))
wombat_eigen2 <- eigen(wombat_LM2)
wombat_eigen2$values[1]
```

```
## [1] 1.052011
```

```r
#Does 0.01 increase in b0 have greater impact on lamba than 0.01 increase in s0?
wombat_eigen1$values[1] - wombat_eigen$values[1] > wombat_eigen2$values[1] - wombat_eigen$values[1]
```

```
## [1] FALSE
```

```r
# 1% increase in b0
wombat_LM3 <- rbind(c(0.6*1.01, 1.5), c(0.3, 0))
wombat_eigen3 <- eigen(wombat_LM3)
wombat_eigen3$values[1]
```

```
## [1] 1.039077
```

```r
# 1% increase in s0
wombat_LM4 <- rbind(c(0.6, 1.5), c(0.3*1.01, 0))
wombat_eigen4 <- eigen(wombat_LM4)
wombat_eigen4$values[1]
```

```
## [1] 1.037902
```

```r
#Does 1% increase in b0 have greater impact on lamba than 1% increase in s0?
wombat_eigen3$values[1] - wombat_eigen$values[1] > wombat_eigen4$values[1] - wombat_eigen$values[1]
```

```
## [1] TRUE
```

An absolution increase of 0.01 in s0 has a bigger impact on long term growth rate than the corresponding b0 increase; however, a relative increase of 1% in b0 has a bigger impact than the corresponding s0 increase.