Homework 6

1) 4 age groups 0 yo olds, 1 yo olds, 2 yo olds, 3 yo olds

P(survival) 0 to 1 = 0.95
1 to 2 = 0.97
2 to 3 = 0.9

fertility rate
0	0.1
1	1.2
2	0.9
3	0.1

0 yo olds today

$n_0(t) = 0.1\, n_0(t-1) + 1.2\, n_1(t-1) + 0.9\, n_2(t-1) + 0.1\, n_3(t-1)$

$n_1(t) = 0.95\, n_0(t-1)$

$n_2(t) = 0.97\, n_1(t-1)$

$n_3(t) = 0.9\, n_2(t-1)$

$n_1(t-1) = 0.95\, n_0(t-2)$

$n_2(t-1) = 0.97\, n_1(t-2) = 0.97(0.95)\, n_0(t-3)$

$n_3(t-1) = 0.9\, n_2(t-2) = 0.9(0.97)\, n_1(t-3) = 0.9(0.97)(0.95)\, n_0(t-4)$

$n_0(t) = 0.1\, n_0(t-1) + 1.2(0.95)\, n_0(t-2) + 0.9(0.9025)\, n_0(t-3) + 0.1(0.82935)\, n_0(t-4)$

$= 0.1\, n_0(t-1) + 1.14\, n_0(t-2) + 0.82935\, n_0(t-3) + 0.082935\, n_0(t-4)$

Maple notation :

REC = [0.1, 1.14, 0.82935, 0.082935]

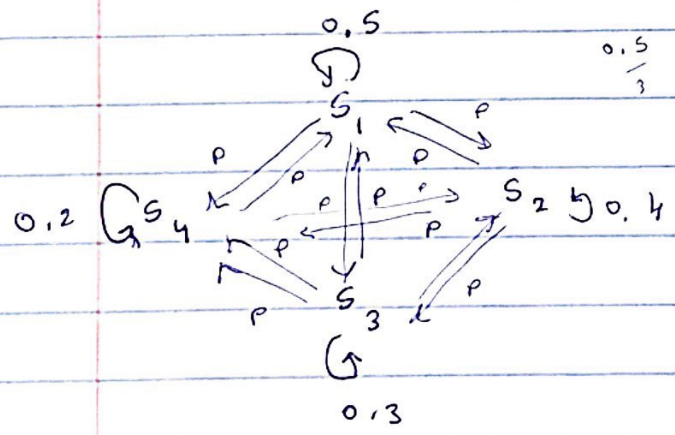
2) Done in maple

3) S_1, S_2, S_3, S_4

Stays 0.5, 0.4, 0.3, 0.2

a) Transition Matrix P

$$P = \begin{bmatrix} S_1 \\ S_2 \\ S_3 \\ S_4 \end{bmatrix}(t) = \begin{bmatrix} 0.5 & 0.1 & 0.2 & 0.2 \\ 0.1 & 0.4 & 0.2 & 0.2 \\ 0.1 & 0.1 & 0.3 & 0.2 \\ 0.1 & 0.1 & 0.2 & 0.2 \end{bmatrix} \begin{bmatrix} S_1 \\ S_2 \\ S_3 \\ S_4 \end{bmatrix}(t-1)$$



$S_1 \xrightarrow{P_1} S_2, S_3, S_4$

$S_2 \xrightarrow{P_2} S_1, S_3, S_4$

$$P = \begin{bmatrix} S_1 \\ S_2 \\ S_3 \\ S_4 \end{bmatrix}(t) = \begin{bmatrix} 0.5 & 0.2666 & 0.1666 & 0.0666 \\ 0.3666 & 0.4 & 0.1666 & 0.0666 \\ 0.3666 & 0.2666 & 0.3 & 0.0666 \\ 0.3666 & 0.2666 & 0.1666 & 0.2 \end{bmatrix} \begin{bmatrix} S_1 \\ S_2 \\ S_3 \\ S_4 \end{bmatrix}(t-1)$$

#Homework-6
#Richa
#Dynamic Models in Biology - Dr.Z

read "C:/Users/rmn74/Documents/M5.txt"

Help5( )

RecToSeq(INI,REC,N), GrowthC(INI,REC,K) , GrowthCe(REC)
LeslieMod(SUR,FER): e.g. LeslieMod([9/10,9/10],[0,1,1]);
LeslieMat(SUR,FER); e.g. LeslieMat([9/10,9/10],[0,1,1]); **(1)**

#1)

REC := [0.1, 1.14, 0.82935, 0.082935]

$$REC := [0.1,\ 1.14,\ 0.82935,\ 0.082935] \quad \textbf{(2)}$$

GrowthCe(*REC*)

$$1.385732629 \quad \textbf{(3)}$$

#2)

SUR := [0.95, 0.97, 0.9]:
FER := [0.1, 1.2, 0.9, 0.1]:
X := *LeslieMat*(*SUR*, *FER*)

$$X := \begin{bmatrix} 0.1 & 1.2 & 0.9 & 0.1 \\ 0.95 & 0 & 0 & 0 \\ 0 & 0.97 & 0 & 0 \\ 0 & 0 & 0.9 & 0 \end{bmatrix} \quad \textbf{(4)}$$

with(*LinearAlgebra*) :

Eigenvalues([[0.1, 1.2, 0.9, 0.1], [0.95, 0, 0, 0], [0, 0.97, 0, 0], [0, 0, 0.9, 0]])

$$\begin{bmatrix} 1.38573262885364 + 0.\ \mathrm{I} \\ -0.583351516086360 + 0.403125877485025\ \mathrm{I} \\ -0.583351516086360 - 0.403125877485025\ \mathrm{I} \\ -0.119029596680917 + 0.\ \mathrm{I} \end{bmatrix} \quad \textbf{(5)}$$

Doubt: What type does LeslieMat function return? Because when I use X for eigenvalues it gives me an error stating that X
#*is not a square matrix*

#3)

P := *MATRIX*([[0.5, 0.1, 0.1, 0.1], [0.1, 0.4, 0.1, 0.1], [0.1, 0.1, 0.3, 0.1], [0.1, 0.1, 0.1, 0.2]])

$$P := \begin{bmatrix} 0.5 & 0.1 & 0.1 & 0.1 \\ 0.1 & 0.4 & 0.1 & 0.1 \\ 0.1 & 0.1 & 0.3 & 0.1 \\ 0.1 & 0.1 & 0.1 & 0.2 \end{bmatrix} \quad \textbf{(6)}$$

$with(LinearAlgebra)$

$$[\&x, Add, Adjoint, BackwardSubstitute, BandMatrix, Basis, BezoutMatrix, BidiagonalForm, BilinearForm, CARE, CharacteristicMatrix, CharacteristicPolynomial, Column, ColumnDimension, ColumnOperation, ColumnSpace, CompanionMatrix, CompressedSparseForm, ConditionNumber, ConstantMatrix, ConstantVector, Copy, CreatePermutation, CrossProduct, DARE, DeleteColumn, DeleteRow, Determinant, Diagonal, DiagonalMatrix, Dimension, Dimensions, DotProduct, EigenConditionNumbers, Eigenvalues, Eigenvectors, Equal, ForwardSubstitute, FrobeniusForm, FromCompressedSparseForm, FromSplitForm, GaussianElimination, GenerateEquations, GenerateMatrix, Generic, GetResultDataType, GetResultShape, GivensRotationMatrix, GramSchmidt, HankelMatrix, HermiteForm, HermitianTranspose, HessenbergForm, HilbertMatrix, HouseholderMatrix, IdentityMatrix, IntersectionBasis, IsDefinite, IsOrthogonal, IsSimilar, IsUnitary, JordanBlockMatrix, JordanForm, KroneckerProduct, LA\_Main, LUDecomposition, LeastSquares, LinearSolve, LyapunovSolve, Map, Map2, MatrixAdd, MatrixExponential, MatrixFunction, MatrixInverse, MatrixMatrixMultiply, MatrixNorm, MatrixPower, MatrixScalarMultiply, MatrixVectorMultiply, MinimalPolynomial, Minor, Modular, Multiply, NoUserValue, Norm, Normalize, NullSpace, OuterProductMatrix, Permanent, Pivot, PopovForm, ProjectionMatrix, QRDecomposition, RandomMatrix, RandomVector, Rank, RationalCanonicalForm, ReducedRowEchelonForm, Row, RowDimension, RowOperation, RowSpace, ScalarMatrix, ScalarMultiply, ScalarVector, SchurForm, SingularValues, SmithForm, SplitForm, StronglyConnectedBlocks, SubMatrix, SubVector, SumBasis, SylvesterMatrix, SylvesterSolve, ToeplitzMatrix, Trace, Transpose, TridiagonalForm, UnitVector, VandermondeMatrix, VectorAdd, VectorAngle, VectorMatrixMultiply, VectorNorm, VectorScalarMultiply, ZeroMatrix, ZeroVector, Zip] \tag{1}$$

$P := Matrix([[0.5, 0.2666, 0.1666, 0.0666], [0.3666, 0.4, 0.1666, 0.0666], [0.3666, 0.2666, 0.1666, 0.0666], [0.3666, 0.2666, 0.1666, 0.0666]])$

$$P := \begin{bmatrix} 0.5 & 0.2666 & 0.1666 & 0.0666 \\ 0.3666 & 0.4 & 0.1666 & 0.0666 \\ 0.3666 & 0.2666 & 0.1666 & 0.0666 \\ 0.3666 & 0.2666 & 0.1666 & 0.0666 \end{bmatrix} \tag{2}$$

P^{1000}

$$\begin{bmatrix} [1.17755971993659\ 10^{-72}, 1.44711329288097\ 10^{-72}, 1.41109749926993\ 10^{-72}, 1.24477913800334\ 10^{-72}], \\ [9.62845658193895\ 10^{-73}, 1.18324933111685\ 10^{-72}, 1.15380059071100\ 10^{-72}, 1.01780841187520\ 10^{-72}], \\ [8.34197203914430\ 10^{-73}, 1.02515213643153\ 10^{-72}, 9.99638123156087\ 10^{-73}, 8.81816233039392\ 10^{-73}], \\ [7.35874932065746\ 10^{-73}, 9.04323048811121\ 10^{-73}, 8.81816233039392\ 10^{-73}, \end{bmatrix} \tag{3}$$

$7.77881366105487\ 10^{-73}\ ]]$