```
> with(LinearAlgebra)
```

[&x, Add, Adjoint, BackwardSubstitute, BandMatrix, Basis, BezoutMatrix, BidiagonalForm, BilinearForm, CharacteristicMatrix, CharacteristicPolynomial, Column, ColumnDimension, ColumnOperation, ColumnSpace, CompanionMatrix, ConditionNumber, ConstantMatrix, ConstantVector, Copy, CreatePermutation, CrossProduct, DeleteColumn, DeleteRow, Determinant, Diagonal, DiagonalMatrix, Dimension, Dimensions, DotProduct, EigenConditionNumbers, Eigenvalues, Eigenvectors, Equal, ForwardSubstitute, FrobeniusForm, 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, QRDecomposition, RandomMatrix, RandomVector, Rank, RationalCanonicalForm, ReducedRowEchelonForm, Row, RowDimension, RowOperation, RowSpace, ScalarMatrix, ScalarMultiply, ScalarVector, SchurForm, SingularValues, SmithForm, StronglyConnectedBlocks, SubMatrix, SubVector, SumBasis, SylvesterMatrix, SylvesterSolve, ToeplitzMatrix, Trace, Transpose, TridiagonalForm, UnitVector, VandermondeMatrix, VectorAdd, VectorAngle, VectorMatrixMultiply, VectorNorm, VectorScalarMultiply, ZeroMatrix, ZeroVector, Zip] **(1)**

```
#
```

$$> L1 := \begin{bmatrix} 0 & 0 & 0.19 & 0.44 & 0.5 & 0.5 & 0.45 \\ 0.87 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0.87 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0.87 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0.87 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0.87 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0.87 & 0.8 \end{bmatrix}$$

$$L1 := \begin{bmatrix} 0 & 0 & 0.19 & 0.44 & 0.5 & 0.5 & 0.45 \\ 0.87 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0.87 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0.87 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0.87 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0.87 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0.87 & 0.8 \end{bmatrix} \quad \textbf{(2)}$$

#

> $\lambda 1, x1 := evalf(Eigenvectors(L1))$

$$\lambda 1, x1 := \begin{bmatrix} 1.09857042700000006 + 0.\,I \\ 0.199671678099999998 + 0.594283337699999969\,I \\ 0.199671678099999998 - 0.594283337699999969\,I \\ -0.463625368300000007 + 0.\,I \\ -0.185207352399999996 + 0.348088742299999976\,I \\ -0.185207352399999996 - 0.348088742299999976\,I \\ 0.136126290300000008 + 0.\,I \end{bmatrix}, [[0.546945836699999966 + 0.\,I, -0.0744601876699999970 + 0.0814544959999999874\,I, -0.0744601876699999970 - 0.0814544959999999874\,I, -0.0314288909599999972 + 0.\,I, -0.00878296907300000000 - 0.0104970037299999992\,I, -0.00878296907300000000 + 0.0104970037299999992\,I, -0.000056629401910000006 + 0.\,I], [0.433147358099999991 + 0.\,I, 0.0742398247399999878 + 0.133949496199999990\,I, 0.0742398247399999878 - 0.133949496199999990\,I, 0.0589767881700000026 + 0.\,I, -0.0113443618899999998 + 0.0279878121300000012\,I, -0.0113443618899999998 - 0.0279878121300000012\,I, -0.00036192552939999996 + 0.\,I], [0.343025984000000006 + 0.\,I, 0.209016021899999986 - 0.0384565176899999972\,I, 0.209016021899999986 + 0.0384565176899999972\,I, -0.110670832999999996 + 0.\,I, 0.0662753949900000000 - 0.00690943227599999984\,I, 0.0662753949900000000 + 0.00690943227599999984\,I, -0.00231311093499999990 + 0.\,I], [0.271655415800000022 + 0.\,I, 0.0417921442300000016 - 0.291946989699999993\,I, 0.0417921442300000016 + 0.291946989699999993\,I, 0.207675488200000008 + 0.\,I, -0.0821484290399999984 - 0.121937585000000001\,I, -0.0821484290399999984 + 0.121937585000000001\,I, -0.0147833788000000002 + 0.\,I], [0.215134329200000002 + 0.\,I, -0.365570680799999992 - 0.184008653599999988\,I, -0.365570680799999992 + 0.184008653599999988\,I, -0.389706187599999976 + 0.\,I, -0.152383122499999996 + 0.286397104500000000\,I, -0.152383122499999996 - 0.286397104500000000\,I, -0.0944824069500000002 + 0.\,I], [0.170373115699999994 + 0.\,I, -0.403627204799999972 + 0.399562895299999998\,I, -0.403627204799999972 - 0.399562895299999998\,I, 0.731289542000000070 + 0.\,I, 0.715810224900000014 + 0.\,I, 0.715810224900000014 - 0.\,I, -0.603848778099999928 + 0.\,I], [0.496447730500000018 + 0.\,I, 0.584939366299999986 + 0.\,I, 0.584939366299999986 - 0.\,I, -0.503489339100000044 + 0.\,I, -0.561955573799999941 - 0.198547451399999990\,I, -0.561955573799999941 + 0.198547451399999990\,I, 0.791337914500000017 + 0.\,I]] \quad \textbf{(3)}$$

#

> $\lambda IL1 := \max(\mathrm{Re}(\lambda 1))$

(4)

$$\lambda 1L1 := 1.09857042700000006 \quad \textbf{(4)}$$

#

> $H1 := \left(1 - \frac{1}{\lambda 1L1}\right) \cdot 100\ \%$

$$H1 := 9.857042703 \quad \textbf{(5)}$$

,

> $x1L1 := Column(x1, 1)$

$$x1L1 := \begin{bmatrix} 0.546945836699999966 + 0.\,\mathrm{I} \\ 0.433147358099999991 + 0.\,\mathrm{I} \\ 0.343025984000000006 + 0.\,\mathrm{I} \\ 0.271655415800000022 + 0.\,\mathrm{I} \\ 0.215134329200000002 + 0.\,\mathrm{I} \\ 0.170373115699999994 + 0.\,\mathrm{I} \\ 0.496447730500000018 + 0.\,\mathrm{I} \end{bmatrix} \quad \textbf{(6)}$$

> #task2.2

#

> $L2 := \begin{bmatrix} 0 & 0 & 0.19 & 0.44 & 0.5 & 0.5 & 0.45 \\ 0.83 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0.83 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0.83 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0.83 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0.83 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0.83 & 0.78 \end{bmatrix}$

$$L2 := \begin{bmatrix} 0 & 0 & 0.19 & 0.44 & 0.5 & 0.5 & 0.45 \\ 0.83 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0.83 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0.83 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0.83 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0.83 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0.83 & 0.78 \end{bmatrix} \quad \textbf{(7)}$$

#

> $\lambda 2, x2 := evalf(Eigenvectors(L2))$

(8)

$$\lambda 2, x2 := \begin{bmatrix} -0.461452666999999983 + 0.\,I \\ -0.202362269200000000 + 0.347834090699999986\,I \\ -0.202362269200000000 - 0.347834090699999986\,I \\ 0.183944529599999989 + 0.584044983999999934\,I \\ 0.183944529599999989 - 0.584044983999999934\,I \\ 1.05930665099999998 + 0.\,I \\ 0.218981494999999998 + 0.\,I \end{bmatrix}, [\quad \textbf{(8)}$$

$[0.0386062132700000018 + 0.\,I,\ 0.00933661156600000022 + 0.0168087671500000008\,I,$
$0.00933661156600000022 - 0.0168087671500000008\,I,\ 0.123468143899999994$
$+ 0.00558741583899999978\,I,\ 0.123468143899999994 - 0.00558741583899999978\,I,$
$-0.557140770499999994 + 0.\,I,\ -0.000707617482600000014 + 0.\,I],$
$[-0.0694397482300000007 + 0.\,I,\ 0.020282607229999994$
$- 0.034078954139999993\,I,\ 0.020282607229999994 + 0.034078954139999993\,I,$
$0.057498995999999968 - 0.157354204100000006\,I,\ 0.057498995999999968$
$+ 0.157354204100000006\,I,\ -0.436537275599999996 + 0.\,I,\ -0.0026820645759999994$
$+ 0.\,I],$
$[0.124899031199999996 + 0.\,I,\ -0.0817922141399999998$
$- 0.000813335893000000001\,I,\ -0.0817922141399999998$
$+ 0.000813335893000000001\,I,\ -0.180026834699999999 - 0.138412485899999994\,I,$
$-0.180026834699999999 + 0.138412485899999994\,I,\ -0.342040653099999980 + 0.\,I,$
$-0.0101657612599999996 + 0.\,I],$
$[-0.224651851099999994 + 0.\,I,\ 0.0833836240199999912 + 0.146661410500000006\,I,$
$0.0833836240199999912 - 0.146661410500000006\,I,\ -0.252255921100000002$
$+ 0.176392536399999994\,I,\ -0.252255921100000002 - 0.176392536399999994\,I,$
$-0.267999584199999974 + 0.\,I,\ -0.0385310267500000026 + 0.\,I],$
$[0.404074024899999995 + 0.\,I,\ 0.174981368999999998 - 0.300769929200000008\,I,$
$0.174981368999999998 + 0.300769929200000008\,I,\ 0.125337781499999996$
$+ 0.397961835300000012\,I,\ 0.125337781499999996 - 0.397961835300000012\,I,$
$-0.209986083500000002 + 0.\,I,\ -0.146043172299999996 + 0.\,I],$
$[-0.726794890700000028 + 0.\,I,\ -0.717695728700000090 + 0.\,I,$
$-0.717695728700000090 - 0.\,I,\ 0.565552880899999998 + 0.\,I,\ 0.565552880899999998$
$- 0.\,I,\ -0.164530685399999988 + 0.\,I,\ -0.553543727300000010 + 0.\,I],$
$[0.485914425300000008 + 0.\,I,\ 0.538828590800000006 + 0.190788020700000005\,I,$
$0.538828590800000006 - 0.190788020700000005\,I,\ -0.401776977500000021$
$- 0.393681192600000007\,I,\ -0.401776977500000021 + 0.393681192600000007\,I,$
$-0.488926662800000022 + 0.\,I,\ 0.818941424599999968 + 0.\,I]]$

#

> $\lambda 2L2 := \max(\mathrm{Re}(\lambda 2))$

$$\lambda 2L2 := 1.05930665099999998 \quad \textbf{(9)}$$

#

> $H2 := \left(1 - \frac{1}{\lambda 2L2}\right) \cdot 100\ \%$

$$H2 := 5.930665095 \quad \textbf{(10)}$$

,

> $x2L2 := Column(x2, 1)$

$$x2L2 := \begin{bmatrix} 0.0386062132700000018 + 0.\,\mathrm{I} \\ -0.0694397482300000007 + 0.\,\mathrm{I} \\ 0.124899031199999996 + 0.\,\mathrm{I} \\ -0.224651851099999994 + 0.\,\mathrm{I} \\ 0.404074024899999995 + 0.\,\mathrm{I} \\ -0.726794890700000028 + 0.\,\mathrm{I} \\ 0.485914425300000008 + 0.\,\mathrm{I} \end{bmatrix} \quad \textbf{(11)}$$

> *#через зміну факторів, що впливають на швидкість зростання популяції, спостерігається зменшення цієї швидкості, а також зменшився відсоток кількісті особин, доступних для вилову*