```
turtle = {{0, 0, 0, 0, 127, 4, 80}, {0.675, 0.737, 0, 0, 0, 0, 0}, {0, 0.049, 0.661, 0, 0, 0, 0}, {0, 0, 0.015, 0.691, 0, 0, 0},
  {0, 0, 0, .052, 0, 0, 0}, {0, 0, 0, 0, 0.809, 0, 0}, {0, 0, 0, 0, 0, 0.809, 0.808}}; MatrixForm[turtle]
```
行列形式

$$\begin{pmatrix} 0 & 0 & 0 & 0 & 127 & 4 & 80 \\ 0.675 & 0.737 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0.049 & 0.661 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0.015 & 0.691 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0.052 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0.809 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0.809 & 0.808 \end{pmatrix}$$

Setting the population matrix of tutle

```
lambda = Eigenvalues[turtle]; lambda[[1]]
```
固有値

```
0.946422 + 0. i
```

Population growth rate

```
turtle2 = {{0, 0, 0, 0, 2 * 127, 2 * 4, 2 * 80}, {0.675, 0.737, 0, 0, 0, 0, 0},
  {0, 0.049, 0.661, 0, 0, 0, 0}, {0, 0, 0.015, 0.691, 0, 0, 0}, {0, 0, 0, .052, 0, 0, 0},
  {0, 0, 0, 0, 0.809, 0, 0}, {0, 0, 0, 0, 0, 0.809, 0.808}}; MatrixForm[turtle2]
```
行列形式

Setting the doubled fertility

$$\begin{pmatrix} 0 & 0 & 0 & 0 & 254 & 8 & 160 \\ 0.675 & 0.737 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0.049 & 0.661 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0.015 & 0.691 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0.052 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0.809 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0.809 & 0.808 \end{pmatrix}$$

```
lambda = Eigenvalues[turtle2]; lambda[[1]]
```
固有値

```
0.983198 + 0. i
```

Population growth rate

```
turtle3 = {{0, 0, 0, 0, 127, 4, 80}, {1, 0.737, 0, 0, 0, 0, 0}, {0, 0.049, 0.661, 0, 0, 0, 0}, {0, 0, 0.015, 0.691, 0, 0, 0},
  {0, 0, 0, .052, 0, 0, 0}, {0, 0, 0, 0, 0.809, 0, 0}, {0, 0, 0, 0, 0, 0.809, 0.808}}; MatrixForm[turtle3]
```
行列形式

$$\begin{pmatrix} 0 & 0 & 0 & 0 & 127 & 4 & 80 \\ 1 & 0.737 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0.049 & 0.661 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0.015 & 0.691 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0.052 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0.809 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0.809 & 0.808 \end{pmatrix}$$

Setting the survival of hatched egg as 100 %

```
lambda = Eigenvalues[turtle3]; lambda[[1]]
```
固有値

```
0.966505 + 0. i
```

Population growth rate

```
vec = Eigenvalues[turtle]
```
固有値

```
{0.946422 + 0. i, 0.746356 + 0.214949 i, 0.746356 - 0.214949 i,
 0.360069 + 0. i, 0.276638 + 0. i, -0.0894208 + 0.120706 i, -0.0894208 - 0.120706 i}
```

```
right = Eigenvectors[turtle];
```
固有ベクトル

```
u = right[[1]]
```

```
{0.292402 + 0. i, 0.942457 + 0. i, 0.161797 + 0. i,
 0.00950172 + 0. i, 0.00052206 + 0. i, 0.000446256 + 0. i, 0.00260812 + 0. i}
```

```
b = Transpose[turtle];
```
転置

```
left = Eigenvectors[b];
```
固有ベクトル

```
v = left[[1]]
```

```
{-0.00104885 + 0. i, -0.0014706 + 0. i, -0.00628525 + 0. i,
 -0.119597 + 0. i, -0.587455 + 0. i, -0.522591 + 0. i, -0.606176 + 0. i}
```

```
sensitivity = Transpose[{v}].{u} / u.v;
              転置
MatrixForm[Re[sensitivity]]
行列形式      実部
```

$$\begin{pmatrix} 0.0513985 & 0.165665 & 0.0284406 & 0.00167021 & 0.0000917678 & 0.0000784429 & 0.000458455 \\ 0.0720662 & 0.23228 & 0.0398768 & 0.00234182 & 0.000128668 & 0.000109985 & 0.000642803 \\ 0.308005 & 0.992748 & 0.17043 & 0.0100087 & 0.000549918 & 0.000470069 & 0.00274729 \\ 5.86077 & 18.8902 & 3.24298 & 0.190448 & 0.0104639 & 0.00894455 & 0.0522758 \\ 28.7879 & 92.7878 & 15.9294 & 0.935474 & 0.0513985 & 0.0439353 & 0.256777 \\ 25.6093 & 82.5427 & 14.1705 & 0.832184 & 0.0457233 & 0.0390842 & 0.228425 \\ 29.7053 & 95.7448 & 16.437 & 0.965286 & 0.0530364 & 0.0453354 & 0.26496 \end{pmatrix}$$

Sensitivity matrix

```
elasticity = MatrixForm[turtle * Re[sensitivity] / 0.946222]
             行列形式                実部
```

$$\begin{pmatrix} 0. & 0. & 0. & 0. & 0.0123169 & 0.000331605 & 0.0387609 \\ 0.0514094 & 0.18092 & 0. & 0. & 0. & 0. & 0. \\ 0. & 0.0514094 & 0.119057 & 0. & 0. & 0. & 0. \\ 0. & 0. & 0.0514094 & 0.139079 & 0. & 0. & 0. \\ 0. & 0. & 0. & 0.0514094 & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0.0390925 & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0.0387609 & 0.226255 \end{pmatrix}$$

Elasticity matrix