In order to raise a matrix to some power, use the MatrixPower command. Here is the syntax, along with a couple of examples.

```
? MatrixPower
```

MatrixPower[m, n] gives the n^{th} matrix power of the matrix m.

MatrixPower[m, n, v] gives the n^{th} matrix power of the matrix m applied to the vector v. ≫

```
a = {{1, 2, 1}, {-1, 2, 0}, {0, 4, 2}};
```

```
MatrixForm[a]
```

$$\begin{pmatrix} 1 & 2 & 1 \\ -1 & 2 & 0 \\ 0 & 4 & 2 \end{pmatrix}$$

```
MatrixForm[a.a]
MatrixForm[MatrixPower[a, 2]]
MatrixForm[a.a.a]
MatrixForm[MatrixPower[a, 3]]
MatrixForm[MatrixPower[a, 20]]
```

$$\begin{pmatrix} -1 & 10 & 3 \\ -3 & 2 & -1 \\ -4 & 16 & 4 \end{pmatrix}$$

$$\begin{pmatrix} -1 & 10 & 3 \\ -3 & 2 & -1 \\ -4 & 16 & 4 \end{pmatrix}$$

$$\begin{pmatrix} -11 & 30 & 5 \\ -5 & -6 & -5 \\ -20 & 40 & 4 \end{pmatrix}$$

$$\begin{pmatrix} -11 & 30 & 5 \\ -5 & -6 & -5 \\ -20 & 40 & 4 \end{pmatrix}$$

$$\begin{pmatrix} 424\,004\,599 & -124\,592\,230 & 185\,511\,743 \\ -185\,511\,743 & 609\,516\,342 & 123\,903\,929 \\ 495\,615\,716 & 246\,431\,256 & 361\,708\,484 \end{pmatrix}$$

Here is the transformation matrix “trans” that we used when discussing the Markov chain for the coin flip game (discussed on p. 301 of the textbook).

```
trans = {{1, .5, 0, 0, 0, 0}, {0, 0, .5, 0, 0, 0}, {0, .5, 0, .5, 0, 0}, {0, 0, .5, 0, .5, 0}, {0, 0, 0, .5, 0, 0}, {0, 0, 0, 0, .5, 1}};
```

```
MatrixForm[trans]
```

$$\begin{pmatrix} 1 & 0.5 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0.5 & 0 & 0 & 0 \\ 0 & 0.5 & 0 & 0.5 & 0 & 0 \\ 0 & 0 & 0.5 & 0 & 0.5 & 0 \\ 0 & 0 & 0 & 0.5 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0.5 & 1 \end{pmatrix}$$

```
MatrixForm[
 MatrixPower[trans, 5] ]
```

$$\begin{pmatrix} 1. & 0.6875 & 0.375 & 0.21875 & 0.0625 & 0. \\ 0. & 0. & 0.15625 & 0. & 0.09375 & 0. \\ 0. & 0.15625 & 0. & 0.25 & 0. & 0. \\ 0. & 0. & 0.25 & 0. & 0.15625 & 0. \\ 0. & 0.09375 & 0. & 0.15625 & 0. & 0. \\ 0. & 0.0625 & 0.21875 & 0.375 & 0.6875 & 1. \end{pmatrix}$$

We can use the Manipulate command to easily see how things change as some paramter changes. Below is the documentation, plus the example of the transformation matrix raised to some power.

```
? Manipulate
```

Manipulate[*expr*, {*u*, u_{min}, u_{max}}] generates a version of

expr with controls added to allow interactive manipulation of the value of *u*.

Manipulate[*expr*, {*u*, u_{min}, u_{max}, *du*}] allows the value of *u* to vary between u_{min} and u_{max} in steps *du*.

Manipulate[*expr*, {{*u*, u_{init}}, u_{min}, u_{max}, ...}] takes the initial value of *u* to be u_{init}.

Manipulate[*expr*, {{*u*, u_{init}, u_{lbl}}, ...}] labels the controls for *u* with u_{lbl}.

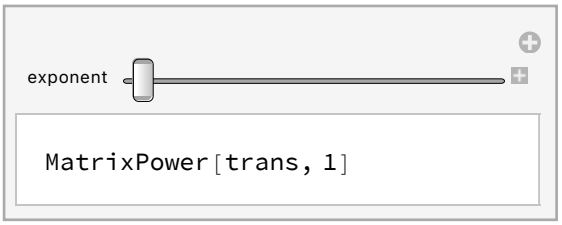
Manipulate[*expr*, {*u*, {u_1, u_2, ...}}] allows *u* to take on discrete values u_1, u_2, ...

Manipulate[*expr*, {*u*, ...}, {*v*, ...}, ...] provides controls to manipulate each of the *u*, *v*, ...

Manipulate[*expr*, $c_u \to$ {*u*, ...}, $c_v \to$ {*v*, ...}, ...]

links the controls to the specified controllers on an external device. ≫

```
Manipulate[MatrixForm[
  MatrixPower[trans, exponent] ], {exponent, 1, 50, 1}]
```



It seems the best way to display numbers to a fixed number of decimal places is to use the NumberForm command, specifically the second example listed in the documentation below. (Note that it behaves a bit unexpectedly when it comes to very small numbers and scientitfic notation, as you will see in examples.)

```
? NumberForm
```

NumberForm[*expr*, *n*] prints with approximate real numbers in *expr* given to *n*-digit precision.

NumberForm[*expr*, {*n*, *f*}] prints with approximate real numbers having *n* digits, with *f* digits to the right of the decimal point. ≫

```
NumberForm[MatrixForm[
  MatrixPower[trans, 5] ], {10, 3}]
```

$$\begin{pmatrix} 1.000 & 0.688 & 0.375 & 0.219 & 0.063 & 0.000 \\ 0.000 & 0.000 & 0.156 & 0.000 & 0.094 & 0.000 \\ 0.000 & 0.156 & 0.000 & 0.250 & 0.000 & 0.000 \\ 0.000 & 0.000 & 0.250 & 0.000 & 0.156 & 0.000 \\ 0.000 & 0.094 & 0.000 & 0.156 & 0.000 & 0.000 \\ 0.000 & 0.063 & 0.219 & 0.375 & 0.688 & 1.000 \end{pmatrix}$$

This shows our transformation matrix raised to a power, and we have modified the number format and made it so that the exponent also appears to the right of the slider bar.

```
Manipulate[NumberForm[MatrixForm[
   MatrixPower[trans, exponent] ], {4, 3}],
 {exponent, 1, 60, 1, Appearance → "Labeled"}]
```