Section 8.3: Stochastic Models

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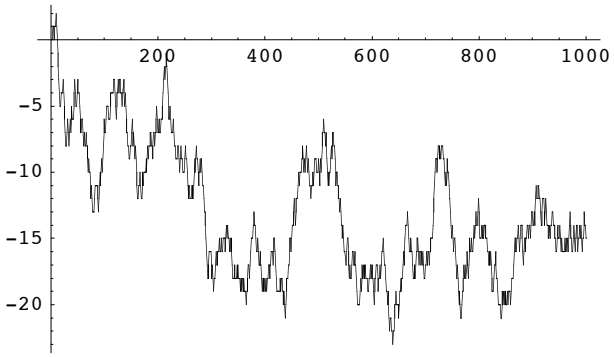
Simple 1-Dimensional Random Walk

```
randomwalk = NestList[(# + Random[Integer, {-1, 1}]) &, 0, 1000];

ListPlot[randomwalk, PlotJoined → True]
```




```
- Graphics -
```

If we simulate a 1000 steps of a large number of walkers, the final distribution of individuals in space will be a gaussian:

```
data = Array[Nest[(# + Random[Integer, {-1, 1}]) &, 0, 1000] &, {1000}];
```

These two packages allow to calculate the frequency distribution and then generate a Bar chart

```
<< Statistics`DataManipulation`
<< Graphics`Graphics`
```

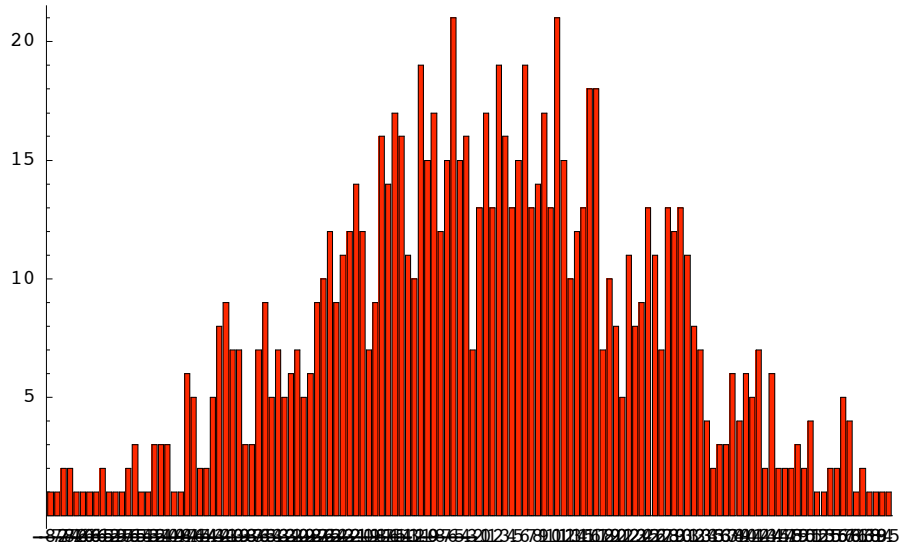
Compute frequencies:

```
freq = Frequencies[data]
```

```
{{1, -82}, {1, -78}, {2, -74}, {2, -72}, {1, -70}, {1, -68}, {1, -66}, {1, -65}, {2, -62},
 {1, -59}, {1, -57}, {1, -56}, {2, -55}, {3, -54}, {1, -53}, {1, -52}, {3, -51},
 {3, -50}, {3, -49}, {1, -48}, {1, -47}, {6, -46}, {5, -45}, {2, -44}, {2, -43},
 {5, -42}, {8, -41}, {9, -40}, {7, -39}, {7, -38}, {3, -37}, {3, -36}, {7, -35},
 {9, -34}, {5, -33}, {7, -32}, {5, -31}, {6, -30}, {7, -29}, {5, -28}, {6, -27},
 {9, -26}, {10, -25}, {12, -24}, {9, -23}, {11, -22}, {12, -21}, {14, -20}, {12, -19},
 {7, -18}, {9, -17}, {16, -16}, {14, -15}, {17, -14}, {16, -13}, {11, -12}, {10, -11},
 {19, -10}, {15, -9}, {17, -8}, {12, -7}, {15, -6}, {21, -5}, {15, -4}, {16, -3},
 {7, -2}, {13, -1}, {17, 0}, {13, 1}, {19, 2}, {16, 3}, {13, 4}, {15, 5}, {19, 6},
 {13, 7}, {14, 8}, {17, 9}, {13, 10}, {21, 11}, {15, 12}, {10, 13}, {12, 14}, {13, 15},
 {18, 16}, {18, 17}, {7, 18}, {10, 19}, {8, 20}, {5, 21}, {11, 22}, {8, 23}, {9, 24},
 {13, 25}, {11, 26}, {7, 27}, {13, 28}, {12, 29}, {13, 30}, {11, 31}, {8, 32}, {7, 33},
 {4, 34}, {2, 35}, {3, 36}, {3, 37}, {6, 38}, {4, 39}, {6, 40}, {5, 41}, {7, 42}, {2, 43},
 {6, 44}, {2, 45}, {2, 47}, {2, 48}, {3, 49}, {2, 50}, {4, 51}, {1, 52}, {1, 53}, {2, 55},
 {2, 56}, {5, 57}, {4, 58}, {1, 61}, {2, 63}, {1, 68}, {1, 69}, {1, 84}, {1, 85}}
```

Generate a bar chart:

```
BarChart[freq]
```




```
- Graphics -
```

The mean of data should be approximately 0:

```
<< Statistics`DescriptiveStatistics`
```

```
Mean[data] // N
```

```
-0.096
```

■ Demographic Stochasticity in matrix Models

```
<<Statistics`MultiDiscreteDistributions`
<<Statistics`DiscreteDistributions`
<<Graphics`MultipleListPlot`
```

From the same example as in Chapter 2, we now build demographic stochasticity. This section uses an example from Caswell (2001).

```
T = {{0, 0, 0, 0}, {0.9775, 0.9111, 0, 0}, {0, 0.0736, 0.9534, 0}, {0, 0, 0.0452, 0.9804}};

F = {{0, 0.0043, 0.1132, 0}, {0, 0, 0, 0}, {0, 0, 0, 0}, {0, 0, 0, 0}};

T̃_ := Join[T, {1 - Total /@ Transpose[T]}];
```

Note that a multinomial distribution is used for the transitions matrix, and binomial for fecundities. The following code, just iterates so individuals move from stage to stage.

```
IterateSurvival[n_, T_] := Drop[Total /@
    (Array[Random[MultinomialDistribution[n[[#]], T̃[[All, #]]]] &, {Length[n]}]ᵀ), -1]

IterateFecundity[n_, F_] := Total /@
  Table[Random[BinomialDistribution[n[[j]], F[[i, j]]]], {i, Length[n]}, {j, Length[n]}]
```

The following code does this for the the whole population:

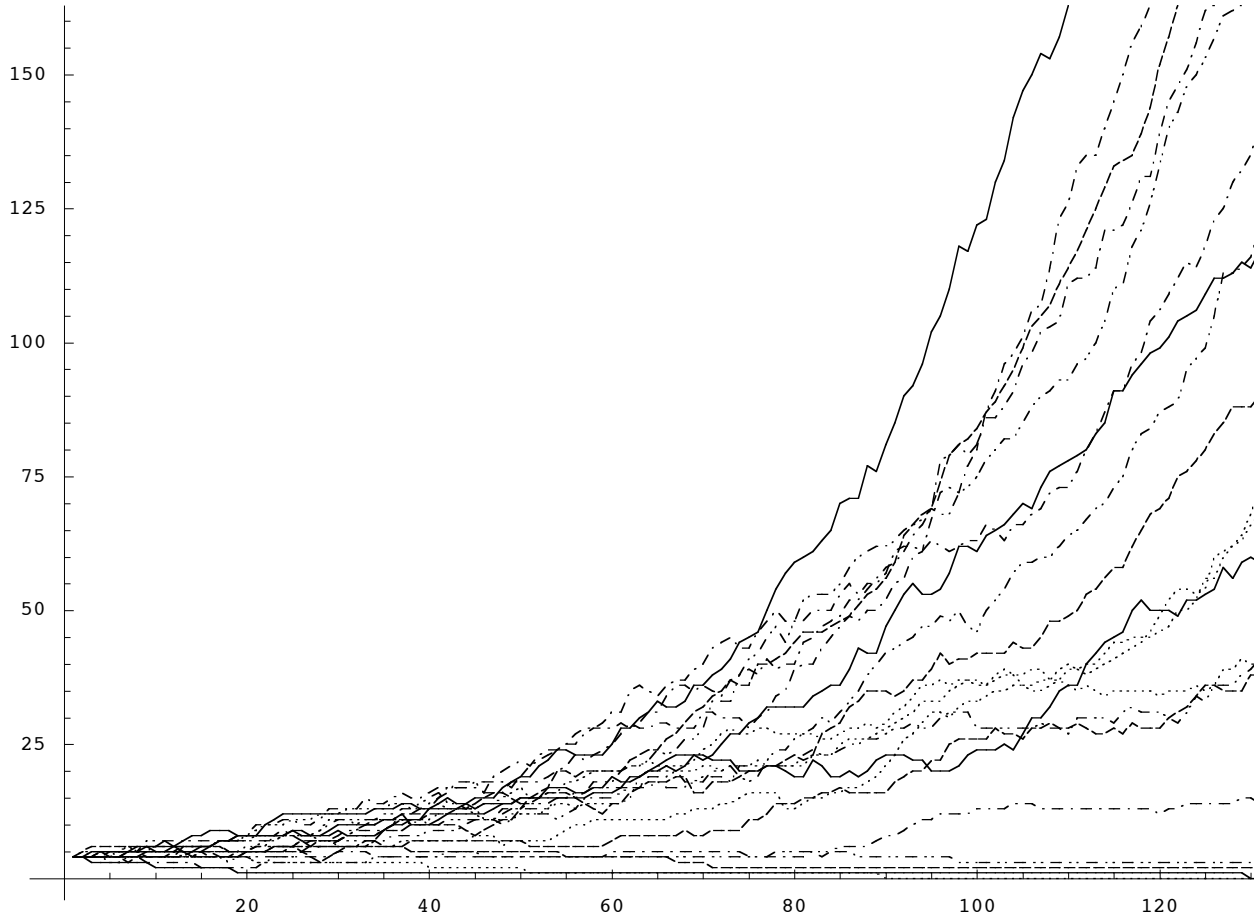
```
IteratePopulation[n_, T_, F, t_] :=
 NestList[IterateSurvival[#, T] + IterateFecundity[#, F] &, n, t]
```

■ Example

```
p = IteratePopulation[{1, 1, 1, 1}, T, F, 30];

mult = Array[Total /@ IteratePopulation[{1, 1, 1, 1}, T, F, 150] &, {20}];
```

```
MultipleListPlot[mult, PlotJoined → True, SymbolShape → None]
```




```
- Graphics -
```

■ References

Caswell H. 2001. Matrix population models : construction, analysis, and interpretation, 2nd edn. Sinauer Associates, Sunderland, Mass. .