

Matrix – a FORTRAN program for generating randomized ecological matrices

Version 1.0

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1. Introduction

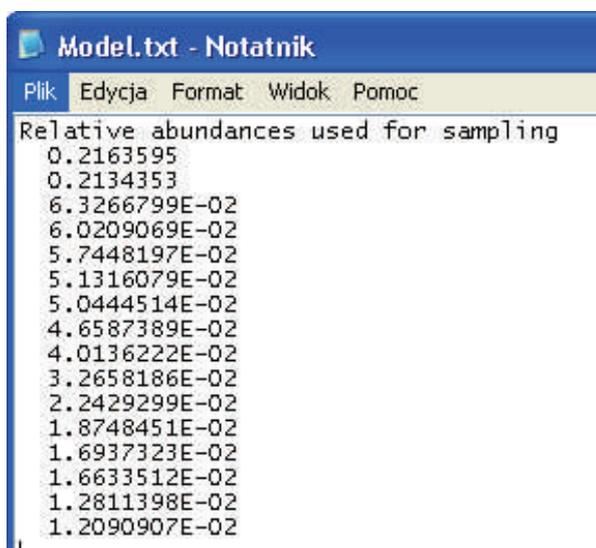
Ecological modelling often needs the use of appropriate null models. For this task randomly constructed abundance or presence - absence matrices (species x site matrices) are generated and the observed pattern under focus is then compared to the respective null pattern. There are now some programs available that generate random matrices (for instance, *Resampling* (Howell 2004), *EcoSim* (Gotelli and Entsminger 2005), *Sample* (Ulrich 2003), or *Random* (Ulrich 2005)) but these are restricted to a narrow range of predefined tasks and do not produce multiple random matrices needed for more sophisticated analyses.

Matrix tries to fill this gap. It is a small program designed to generate individual based random matrices either from a predefined sample model or from build in models. Hence, *Matrix* does not place species at random into the cells of the matrix but individuals. It uses therefore the mass effect for generating randomness. This feature distinguishes the program from most other matrix generators. Another unique feature is that the program allows for the generating of predefined individual or species

numbers per site. However, the program does not produce fixed row fixed column matrices.

2. Data structure

If you use a predefined abundance distribution (the species pool distribution) and if you further need predefined species or individual numbers per site you have to use two input files of the following structure. The file containing the abundance distribution must be a plain ASCII file with the first line being a comment line as shown below.



```
Model.txt - Notatnik
Plik  Edycja  Format  Widok  Pomoc
Relative abundances used for sampling
0.2163595
0.2134353
6.3266799E-02
6.0209069E-02
5.7448197E-02
5.1316079E-02
5.0444514E-02
4.6587389E-02
4.0136222E-02
3.2658186E-02
2.2429299E-02
1.8748451E-02
1.6937323E-02
1.6633512E-02
1.2811398E-02
1.2090907E-02
```

```

C:\Documents and Settings\Właściciel\Moje dokumenty\Modele\Matrix.exe
*****
* Program Matrix: Version 1; 06.04.2006 *
* *
* Copyright Dr. Werner Ulrich *
* *
* The author does not take responsibility for correct *
* program run or any damages caused by the program. *
* *
*****

Name of abundance file with extension. First line has to be a comment line.
If abundances have to be computed leave blank.

Type of species pool species abundance distribution:
Lognormal (n), power function (p), or logseries (l)
n
Shape parameter of the lognormal distribution
Default = 0.2 (canonical lognormal)

Name of species numbers per site file. First line has to be a comment line.
If species numbers have to be computed leave blank.

Number of sites, <200
10
Number of species of the species pool
50
Sampling individuals (i) or species (s)
i
Start number of file counting
1
Number of output files, <1000
3
Site diversities: equal (equal), random (ran), or unequal (ue)
ue
Iteration: 1 Cases: 50 Sites: 10
Iteration: 2 Cases: 50 Sites: 10
Iteration: 3 Cases: 50 Sites: 10
Runtime of program: 0hh 0min 17sec
Fortran Pause - Enter command<CR> or <CR> to continue.

```

The definition file is shown below. It contains also a comment line. The next lines contain the site name, the total number of species of the pool to be sampled (might be lower than the number of species in the abundance file) and the sample sizes. This sample sizes are either numbers of species or numbers of individuals. *Matrix* takes individuals from the pool until this predefined number is reached. Delimiters must be one or more spaces (not Tabs!).

3. Program run

First, *Matrix* asks about the file names. You can leave out one or both of these. In this case the program generates the respective data from build in distributions. If you leave out the abundance file

Matrix computes abundances either from a log-normal, from a log-series, or from a power function species abundance distribution. In each case you have to give the respective shape generating parameters. These will be in most cases in the range between 0 and 0.5 (lognormal), 0.01 and 0.3 (log-series), and 0.5 to 10 (power function). If you use the value of zero for the power function initial abundances of species will be identical.

If you leave out the site definition file *Matrix* assigns site species or individual numbers either randomly, uniformly (the same number for all sites), or unequal (a wider range than random).

Next the program asks how many matrices it should generate and with which number to start. The matrices have the general file name *Matpax.txt* and *Matabx.txt* with x being a natural number. The *Matabx.txt* files are abundance files, the *Matpax.txt* files are the respective presence absence files. Hence, *Matrix* gives both types of matrices automatically.

```

sites.txt - Notatnik
Plik Edycja Format Widok Pomoc
Name PoolS Samples from 4 and 5 sites
a 100 10 50 100 200
b 100 20 60 60 30 80
c 100 30 70 10 20 30

```

```

Matoc1.txt - Notatnik
Plik Edycja Format Widok Pomoc
5 1.000 2.000 3.000 4.000 5.000 6.000 7.000 8.000 9.000 10.000
1 21288.0 19742.0 18318.0 16887.0 14684.0 13200.0 11787.0 10277.0 8572.0 7030.0
2 21101.0 19435.0 17758.0 16313.0 14851.0 13202.0 11526.0 10029.0 8451.0 7027.0
3 6309.0 5804.0 5251.0 4828.0 4362.0 3905.0 3531.0 2967.0 2509.0 2024.0
4 5892.0 5478.0 5080.0 4666.0 4134.0 3721.0 3256.0 2796.0 2363.0 1945.0
5 5529.0 5243.0 4699.0 4285.0 3995.0 3581.0 3075.0 2671.0 2264.0 1887.0
6 5058.0 4709.0 4330.0 3859.0 3634.0 3197.0 2695.0 2424.0 2138.0 1668.0
7 4834.0 4578.0 4227.0 3844.0 3370.0 3058.0 2711.0 2300.0 2010.0 1640.0
8 4616.0 4253.0 3900.0 3570.0 3262.0 2842.0 2565.0 2206.0 1903.0 1494.0
9 4005.0 3745.0 3356.0 3059.0 2711.0 2417.0 2241.0 1851.0 1595.0 1303.0
10 3195.0 2910.0 2637.0 2525.0 2233.0 2047.0 1784.0 1537.0 1244.0 973.0
11 2229.0 2051.0 1868.0 1775.0 1571.0 1380.0 1225.0 1106.0 939.0 675.0
12 1762.0 1701.0 1580.0 1454.0 1276.0 1176.0 1003.0 826.0 696.0 614.0
13 1654.0 1523.0 1433.0 1271.0 1155.0 1062.0 987.0 753.0 649.0 596.0
14 1629.0 1458.0 1358.0 1268.0 1168.0 1033.0 903.0 784.0 685.0 510.0
15 1298.0 1145.0 1035.0 1006.0 899.0 812.0 691.0 618.0 515.0 419.0
16 1172.0 1084.0 1038.0 942.0 879.0 741.0 676.0 555.0 476.0 397.0
17 1137.0 1090.0 1021.0 901.0 831.0 771.0 624.0 600.0 449.0 396.0
18 1103.0 1015.0 937.0 824.0 732.0 663.0 625.0 533.0 450.0 358.0
19 880.0 753.0 708.0 646.0 644.0 541.0 451.0 390.0 348.0 279.0
20 713.0 633.0 597.0 579.0 556.0 430.0 364.0 339.0 294.0 240.0
21 370.0 333.0 316.0 264.0 259.0 234.0 205.0 160.0 144.0 115.0
22 338.0 312.0 298.0 260.0 228.0 228.0 200.0 164.0 133.0 107.0
23 311.0 287.0 267.0 248.0 233.0 194.0 185.0 155.0 118.0 125.0
24 283.0 274.0 251.0 225.0 205.0 194.0 165.0 159.0 114.0 85.0
25 284.0 262.0 238.0 215.0 209.0 194.0 140.0 162.0 106.0 88.0
26 198.0 197.0 174.0 165.0 134.0 125.0 121.0 86.0 84.0 69.0
27 158.0 130.0 146.0 97.0 95.0 104.0 93.0 74.0 61.0 51.0
28 179.0 126.0 126.0 97.0 108.0 103.0 85.0 67.0 65.0 39.0
29 130.0 120.0 118.0 109.0 93.0 88.0 74.0 80.0 50.0 49.0
30 92.0 83.0 78.0 58.0 73.0 72.0 53.0 49.0 38.0 34.0
31 94.0 86.0 89.0 62.0 71.0 57.0 47.0 49.0 46.0 28.0
32 93.0 73.0 90.0 58.0 73.0 49.0 43.0 52.0 29.0 26.0
33 66.0 54.0 47.0 54.0 49.0 42.0 34.0 40.0 23.0 26.0
34 71.0 55.0 50.0 38.0 42.0 40.0 47.0 34.0 24.0 17.0
35 49.0 31.0 28.0 25.0 23.0 36.0 34.0 12.0 21.0 15.0
36 40.0 37.0 33.0 34.0 28.0 19.0 17.0 22.0 16.0 15.0
37 37.0 40.0 33.0 21.0 29.0 30.0 22.0 15.0 13.0 7.0
38 29.0 30.0 25.0 22.0 27.0 19.0 26.0 21.0 12.0 7.0
39 21.0 26.0 22.0 20.0 24.0 17.0 16.0 13.0 9.0 10.0
40 26.0 26.0 20.0 16.0 16.0 14.0 11.0 11.0 11.0 8.0
41 13.0 20.0 14.0 15.0 11.0 9.0 7.0 6.0 11.0 12.0
42 11.0 13.0 13.0 15.0 11.0 10.0 8.0 9.0 9.0 5.0
43 16.0 16.0 12.0 8.0 10.0 12.0 7.0 12.0 7.0 7.0
44 15.0 11.0 15.0 12.0 9.0 9.0 11.0 1.0 5.0 3.0
45 4.0 11.0 12.0 6.0 8.0 9.0 5.0 6.0 4.0 3.0
46 2.0 2.0 2.0 3.0 0.0 1.0 3.0 4.0 1.0 2.0
47 6.0 4.0 4.0 2.0 4.0 3.0 5.0 3.0 0.0 1.0
48 4.0 4.0 1.0 1.0 3.0 1.0 2.0 2.0 2.0 1.0
49 2.0 2.0 0.0 1.0 1.0 0.0 2.0 1.0 0.0 0.0
50 1.0 1.0 1.0 1.0 0.0 0.0 1.0 0.0 0.0 0.0

```

4. The Output files

Matrix generates two file types. The first are the already mentioned *Matabx.txt* and *Matpax.txt* files. They have a structure in accordance with the standard structure used for instance by the programs *EcoSim* (Gotelli and Entsminger 2006). The first row contains the site names. The next rows give species names and site abundances or presence - absences. Delimiters are always spaces. For use in *EstimateS* (Colwell 2004) spaces have to be transformed into Tabs.

The next file (*Output.txt*) gives basic information about the matrix and the specifications. It contains the file names, numbers of species and

sites, the sample size (individuals or species), the matrix fill, the quotient of maximum to minimum numbers of species per site and the species numbers per site. If the pool abundance distribution had to be computed it gives also the respective shape generating parameters.

5. System requirements

Matrix is written in FORTRAN 95 and runs under Windows 9.x, and XP. Computation abilities are only limited by the computer's memory. The maximum number of sites is 200.

6. Citing *Matrix*

Matrix is freeware but nevertheless if you use *Matrix* in scientific work you should cite *Matrix* as follows:

Ulrich W. 2006 - *Matrix* – a FORTRAN program for generating randomized ecological matrices - www.uni.torun.pl/~ulrichw

7. Acknowledgements

The development of this program was supported by a grant of the Polish Science Committee (KBN, 2 P04F 03929).

8. References

Colwell, R. K. 2004 - Statistical estimation of species richness and shared species from samples

File	File	Shape	spec	sites	ssize	Fill	Ma/Mi	species	numbers
a	Matab1.txt	2.50	13	4	360	0.5192	2.50	4	4 9 10
a	Matab2.txt	2.50	13	4	360	0.5962	2.75	4	7 9 11
a	Matab3.txt	2.50	13	4	360	0.6154	3.00	4	8 8 12
b	Matab4.txt	2.50	13	5	220	0.5385	2.00	5	8 7 5 10
b	Matab5.txt	2.50	13	5	220	0.5077	1.60	5	7 8 5 8
b	Matab6.txt	2.50	13	5	220	0.5077	1.60	7	5 8 5 8
c	Matab7.txt	2.50	13	5	280	0.4615	2.00	6	5 4 8 7
c	Matab8.txt	2.50	13	5	280	0.5692	1.50	8	6 6 9 8
c	Matab9.txt	2.50	13	5	280	0.6000	1.50	9	6 7 8 9

File	Spec	Sites	Ssize	Fill	Ma/Mi	Species	numbers
Matoc1.txt	50	10	653578	0.9760	1.06	50 50 49 50	48 48 48 48 48 48 48 48 48 48
Matoc2.txt	50	10	563800	0.9760	1.06	50 49 48 50	47 48 48 50 50 50 48
Matoc3.txt	50	10	665366	0.9800	1.06	49 49 49 49	48 48 50 47 50 49

- Version 7, www.purl.oclc.org/estimates.

Gotelli, N.J., Entsminger, G.L. 2005. Eco-Sim: Null models software for ecology. Version 7. - Acquired Intelligence Inc. & Kesey-Bear. Burlington, VT 05465.

Howell, D. C. 2000 - Resampling - Univ. Vermont.

Ulrich, W. 2003 - Sample - a FORTRAN

program for taking series of random samples from populations. www.uni.torun.pl/~ulrichw.

Ulrich, W. 2005 - Random – a FORTRAN program for generating random matrices - www.uni.torun.pl/~ulrichw.

Ulrich, W. 2006 - *Nestedness* – a FORTRAN program for calculating ecological matrix temperatures - www.uni.torun.pl/~ulrichw.