2.1

Adjacency Matrix

– the network of exhibits

We can even consider the various exhibits in this book as nodes of a network. One way to build a network from these nodes is the following: if the mathematical concepts behind two exhibits are closely related, then these two nodes can be connected by an edge. For example, the standing waves on the spring are mathematically very closely related to the oscillations of a pendulum, so these two nodes in the "network of exhibits" are connected by an edge, but there is no immediate mathematical connection between these standing waves and the anamorphic maps, so they are not connected by an edge. The matrix representation is obtained by putting the number 1 when an edge (or a connection) exists between the two concepts and the number 0 when it does not. Such a matrix is shown in the left side of the figure 3. Empty entries indicate a 0.

This can now be used in many ways. For example, by using the powers of this matrix (the multiplication of this matrix with itself), we can obtain the minimum number of edges that are required to go from one node (i.e. mathematical concept) to another. This is shown in the right side of the figure 3.

One thing that is clear from this network is that mathematics has a great unifying power, because in many cases, the mathematical description of seemingly unrelated topics brings out a natural and close relation between them. For example, the fractal coastlines of a country may seem far removed from the sine wave exhibit, but from the network of exhibits, we see that fractals are closely related to chaotic pendulum, which in turn is a form of oscillation, which in turn is related to the sine wave, so there is a "degree 3" connection between fractals and sine waves! This is shown by the number 3 in the 15th row (fractal maps) of the 1st column (sine waves).

This phenomenon is not entirely surprising. Take the example of finding a relation between you and a randomly chosen person in a village in Australia. If you write down a list of all your friends and relatives on one line, then the list of their relatives and friends on the second line and so on and so forth, and if the other person in Australia starts making such a list, the surprising aspects of such lists seems to be that there will be common names appearing in both the list, usually within the first 3-6 lines! So you are related to everyone else on the earth with only about 6-7 links!

Code	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
20	1			1															1	
19						1											1			1
18	1				1															
17						1	1												1	
16								1						1						
15					1									1						
14									1	1					1	1				
13								1	1			1								
12			1										1							
11									1	1										
10									1		1			1						
9								1		1	1		1	1						
8									1				1			1				
7	1			1	1	1											1			
6	1			1	1		1										1		1	
5				1		1	1								1			1		
4	1	1	1		1	1	1													1
3	1	1		1								1								
2	1		1	1																
1		1	1	1		1	1											1		1
Exhibit Name	Sine Wave	Soliton Wave	Chladni + Wave	Oscillations	Chaotic Pendulum	SARS Networks	Adjacency Matrix	Knapsack	Minimal Surfaces	Tessellation tables	3D Escher	Tensegrity Sculpture	Collapsible stool & Tensegrity Sculpture	Anamorphic maps	Fractal maps	Kakeya needle	Permeability	Ecosystem	Weigh the Odds	Walk the function

Code	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
20	1	2	2	1	2	2	2	5	5	5	6	3	4	4	3	5	2	2	1	0
19	2	3	3	2	2	1	2	6	5	5	6	4	5	4	3	5	1	3	0	1
18	1	2	2	2	1	2	2	5	4	4	5	3	4	3	2	4	3	0	3	2
17	2	3	3	2	2	1	1	6	5	5	6	4	5	4	3	5	0	3	1	2
16	5	5	4	4	3	4	4	1	2	2	3	3	2	1	2	0	5	4	5	5
15	3	3	3	2	1	2	2	3	2	2	3	4	3	1	0	2	3	2	3	3
14	4	4	4	3	2	3	3	2	1	1	2	3	2	0	1	1	4	3	4	4
13	3	3	2	3	4	4	4	1	1	2	2	1	0	2	3	2	5	4	5	4
12	2	2	1	2	3	3	3	2	2	3	3	0	1	3	4	3	4	3	4	3
11	5	5	4	5	4	5	5	2	1	1	0	3	2	2	3	3	6	5	6	6
10	5	5	4	4	3	4	4	2	1	0	1	3	2	1	2	2	5	4	5	5
9	4	4	3	4	3	4	4	1	0	1	1	2	1	1	2	2	5	4	5	5
8	4	4	3	4	4	5	5	0	1	2	2	2	1	2	3	1	6	5	6	5
7	1	2	2	1	1	1	0	5	4	4	5	3	4	3	2	4	1	2	2	2
6	1	2	2	1	1	0	1	5	4	4	5	3	4	3	2	4	1	2	1	2
5	2	2	2	1	0	1	1	4	3	3	4	3	4	2	1	3	2	1	2	2
4	1	1	1	0	1	1	1	4	4	4	5	2	3	3	2	4	2	2	2	1
3	1	1	0	1	2	2	2	3	3	4	4	1	2	4	3	4	3	2	3	2
2	1	0	1	1	2	2	2	4	4	5	5	2	3	4	3	5	3	2	3	2
1	0	1	1	1	2	1	1	4	4	5	5	2	3	4	3	5	2	1	2	1
Exhibit Name	Sine Wave	Soliton Wave	Chladni + Wave	Oscillations	Chaotic Pendulum	SARS Networks	Adjacency Matrix	Knapsack	Minimal Surfaces	Tessellation tables	3D Escher	Tensegrity Sculpture	Collapsible stool & Tensegrity Sculpture	Anamorphic maps	Fractal maps	Kakeya needle	Permeability	Ecosystem	Weigh the Odds	Walk the function

Figure 3. The adjacency matrix of the network of exhibits.