Supplement to "Industry Dynamics with Knowledge-Based Competition: A Computational Study of Entry and Exit Patterns"

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Properties of the Technology Landscape

I report below my findings which parallel what Kauffman (*1*993) reported in his book. I generated 10 random landscapes given (N, K). On each landscape, 10,000 initial positions were randomly chosen. From each of these initial positions, search was carried out to find a local optimum over 800 periods. At the end of 800 periods, the final position was tested for optimality. The results I report are the averages over 10 separate landscapes.

First, landscapes were created with $N = 16$ and $K \in \{0, 1, 2, 3, 5, 7, 9, 11, 13, 15\}$. The initial positions were randomly chosen 10,000 times. Out of those initial positions, some of them were identical. I confirmed that there were 9,306 distinct initial positions. For every one of the 10,000 separate searches, a local optimum was attained at the end of 800 periods. Comparing among the resulting local optima (attained from 10,000 initial positions and over 10 landscapes), I computed the number of local optima that are distinct. Even distinct local optima can sometimes have identical fitness values and, hence, I also computed the number of local optima with distinct fitness values. These are reported below:

K	No. Distinct Init. Positions	Freq. of Optimum	No. Distinct Optima	No. Optima w/ Distinct Values
0	9,306	10,000	1	1
1	9,306	10,000	17.3	5.4
2	9,306	10,000	37.5	36.9
3	9,306	10,000	52.6	52.6
5	9,306	10,000	184.8	184.6
7	9,306	10,000	451.4	450.8
9	9,306	10,000	915.1	910.2
11	9,306	10,000	1489.0	1474.5
13	9,306	10,000	2171.8	2139.4
15	9,306	10,000	3184.4	3141.8

Clearly, the landscape becomes more rugged as K rises for a given value of N. The number of distinct local optima increases in K.

How does the value of N affect the ruggedness of the landscape? I report below the results for $K = 5$ and $N \in \{6, 8, 10, 12, 14, 16\}$. An increase in N clearly raises the number of distinct

local optima.

N	No. Distinct Init. Positions	Freq. of Optimum	No. Distinct Optima	No. Optima w/ Distinct Values
6	64	10,000	10.7	10.7
8	256	10,000	11.8	11.8
10	1023	10,000	24.3	24.3
12	3729	10,000	56.3	56.3
14	7432	10,000	107.4	107.4
16	9306	10,000	184.8	184.6

The table below captures the general relationship between (N, K) and the number of local optima on the landscape:

		N				
		2	4	8	12	16
	0	1	1	1	1	1
	1	1.8	1.9	3.7	2.2	17.3
	2		2.1	4.4	7.1	37.5
K	3		3.6	8.5	17.6	52.6
	5			11.8	56.3	184.8
	7			28.6	107.0	451.4
	11				328.8	1489.0
	15					3184.4

References

[1] Kauffman, S. A., 1993, *The Origins of Order*, Oxford University Press, Oxford.