

CSE/ECE 848

Introduction to

Evolutionary Computation

Module 2, Lecture 8, Part 1b
Introduction to Schema Theory

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How Do Schemata Propagate?

Proportional Selection Favors “Better” Schemata

- Select the INTERMEDIATE population, the “parents” of the next generation, via *fitness-proportional selection*
- So if $M(H,t)$ is number of instances (samples) of schema H in the population at time t , then *fitness-proportional selection* yields an *expectation* of:

$$M(H, t + \textit{intermed}) = M(H, t) \frac{f(H, t)}{\bar{f}}$$

- In an example, the actual number of instances of schemata (next page) in the intermediate generation tracked the expected number pretty well, in spite of small pop size

Expected vs. Observed # Schemata in Example Intermediate (Breeding) Population

Schemata and Fitness Values										
Schema	Mean	Count	Expect	Obs		Schema	Mean	Count	Expect	Obs
101*...*	1.70	2	3.4	3		*0**...*	0.991	11	10.9	9
111*...*	1.70	2	3.4	4		00**...*	0.967	6	5.8	4
1*1*...*	1.70	4	6.8	7		0***...*	0.933	12	11.2	10
01...*	1.38	5	6.9	6		011*...*	0.900	3	2.7	4
**1*...*	1.30	10	13.0	14		010*...*	0.900	3	2.7	2
11...*	1.22	5	6.1	8		01**...*	0.900	6	5.4	6
11**...*	1.175	4	4.7	6		0*0*...*	0.833	6	5.0	3
001*...*	1.166	3	3.5	3		*10*...*	0.800	5	4.0	4
1***...*	1.089	9	9.8	11		000*...*	0.767	3	2.3	1
0*1*...*	1.033	6	6.2	7		**0*...*	0.727	11	8.0	7
10**...*	1.020	5	5.1	5		*00*...*	0.667	6	4.0	3
*1**...*	1.010	10	10.1	12		110*...*	0.650	2	1.3	2
****...*	1.000	21	21.0	21		1*0*...*	0.600	5	3.0	4
						100*...*	0.566	3	1.70	2

Results of example run (Whitley) showing that observed numbers of instances of schemata track expected numbers pretty well. "Count" is # instances of schema in pop, "Expect" is exp. # of instances in offspring pop, "Obs" is actual # observed in in offspring

Figure from Whitley, A Genetic Algorithm Tutorial, <https://www.cs.colostate.edu/~genitor/MiscPubs/tutorial.pdf>

Crossover Effect on Schemata

- One-point Crossover Schema Disruption Examples

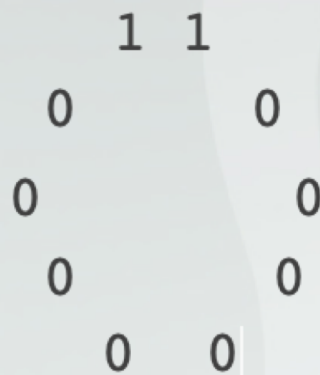
11***** and 1*****1

$$^1 1/(L-1)$$

$$^{(L-1)} (L-1)/(L-1) = 100\%$$

- Two-point Crossover Schema Disruption Examples

11***** and 1*****1 are SAME, viewed as a ring:



same probability of
disruption, $2/L - 1/L^2$

- The closer together loci are, the less likely to be disrupted by crossover, right? One-pt xover USUALLY breaks up schemata with large defining lengths, while two-pt xover is more forgiving, reducing the probability of disrupting a schema, and makes that probability *independent* of position on the chromosome.

Linkage and Defining Length

- Linkage -- “coadapted alleles”
- Argument that probability of disruption of schema H of length $\Delta(H)$ by one-point crossover is:

$$\Delta(H)/(L-1)$$

(= possible places to *disrupt* schema /
all possible places to do one-pt crossover)

- Example:

$$\begin{array}{ccc} 11***** & \text{and} & 1*****1 \\ 1/(L-1) & & 1 \end{array}$$