Problem EVOP-2

Goal: Determine optimum conversion using Evolutionary Operations Technique

Given: Reactor Conversion as function of Temperature & Feed Concentration

Conversion = $84 + T + C + 0.4\,T*C + T^2/4 + C^2/4 + error$

Assume: with random measurement error ADDED
Starting Point: T = 9, C = 2; step sizes of 1

Approach: Set up initial EVOP Simplex
evaluate each point, rank & discard lowest
EVOP move & repeat
when move sends back, repeat and average all results at those conditions

Calculations:

	Step	T	C	CON	random	Yield		
Initial Search								
	1	9	2	80.95	0.159	81.109		2nd discard
Initial Simplex	2	10	2	78	2.273	80.273	lowest	1st discard
	3	9.5	3	83.0875	0.041	83.129	best	reject 2 — 3rd discard
EVOP move 1	4	8.5	3	85.3875	-1.132	84.256	reject 1	4th discard
	5	9	4	87.15	0.768	87.918	reject 3	5th discard
	6	8	4	88.8	0.375	89.175	reject 4	6th discard
	7	8.5	5	90.1875	-0.513	89.675	reject 5	7th discard, replicate 11
	8	7.5	5	91.1875	0.292	91.480	reject 6	8th discard, replicate 14
Simplex (9; 16; 13r)	9	8	6	92.2	1.026	93.226	reject 7	9th discard
	10	7	6	92.55	-1.334	91.216	new point is lowest, move back to 7, replicate 12	
replicate 7	11	8.5	5	90.1875	-0.287	89.79	89.901	average #7 & 11 — new point is lowest, move back to 10
replicate 10	12	7	6	92.55	0.161	91.96	92.711	average #10 & 12 — reject 8
Simplex (9; 16; 13r)	13	7.5	7	93.1875	-1.346	91.842	new point is lowest, move back to 8, replicate 13	
replicate 8	14	7.5	5	91.1875	1.250	91.96	92.438	average #8 & 14 — new point is lowest, move back to 13
replicate 13	15	7.5	7	93.1875	0.63	92.83	93.818	average #13 & 15 — reject 10, 12
Simplex (9; 16; 13r)	16	8.5	7	92.9875	0.375	93.363	reject 13, 15	
	17	9	6	91.35	-1.420	89.930	new point is lowest, move back to 13,15	
replicate 13,15	18	7.5	7	93.1875	-0.151	92.90	93.037	average #13,15 & 18; reject & move back to 17
replicate 17	19	9	6	91.35	-0.309	90.49	91.041	average #17 & 19; reject & move back to 13,15,18
replicate 13,15,18	20	7.5	7	93.1875	0.424	93.08	93.612	average #13,15,18 & 20; reject
Just flip-flopping on 9-16 axis now, so go back and reject second worst point = 9								
Simplex (16; 13r; 21)	21	8	8	93.6	0.593	94.193	reject 13,15,18,20	
Simplex (16; 13r; 21)	22	9	8	93.55	0.862	94.412	reject 16	
Simplex (21; 22; 23)	23	8.5	9	93.7875	0.235	94.023	new point is lowest, move back to 16	
replicate 16	24	8.5	7	92.9875	-0.853	92.75	92.135	average #16 & 24; reject & move back to 23
replicate 23	25	8.5	9	93.7875	0.137	93.97	93.925	average #23 & 25; reject & move back to 16,24
replicate 16,24	26	8.5	7	92.9875	-2.526	91.99	90.462	average #16,24 & 26; reject & move back to 23,25
replicate 23,25	27	8.5	9	93.7875	-0.354	93.79	93.434	average #23,25 & 27; reject
Just flip-flopping on 21-22 axis now, so go back and reject second worst point = 21								

Simplex (22; 23r; 28)	28	9.5	9	93.8875	-0.473	93.4145	new point is lowest, move back to 21	
replicate 21	29	8	8	93.6	-0.355	93.72	93.245	average #21 & 29 reject 23,25,27, move back to 16,24,26
replicate 16,24,26	30	8.5	7	92.9875	-0.313	92.16	92.675	average #16,24,26 & 30; reject & move back to 23,25,27
replicate 23,25,27	31	8.5	9	93.7875	-1.055	93.53	92.733	average #23,25,27 & 31; reject & move back to 16,24,26,30
eplicate 16,24,26,3	32	8.5	7	92.9875	-0.488	92.23	92.500	average #16,24,26,30 & 32; reject & move back to 23,25,27,31
eplicate 23,25,27,3	33	8.5	9	93.7875	0.756	93.73	94.544	average #23,25,27,31 & 31; reject 21,29 & move back to 28
replicate 28	34	9.5	9	93.8875	0.225	93.76	94.113	average #28 & 34

Out of random numbers = re-state current Simplex & move to next point

Final Simplex (22; 23	33	8.5	9			93.73	lowest	average #23,25,27,31 & 33
	22	9	8			94.412		
	34	9.5	9			93.76		average #28 & 34
	33	8.5	9					
Next point	35	10	8	93		93		
best value)	36	10	10	94	← This is the best value			
				True Optimum	-0.0684	0.911	Random error average & deviation	
					Average error	± Std.Deviation		

Discussion:

The standard deviation of the random error is +/- one and hence larger than the true response after approaching conversions in excess of 90%

Thus numerous replicate measurements must be taken to suppress the random error noise and provide an average representative of the true response to the independent variables.

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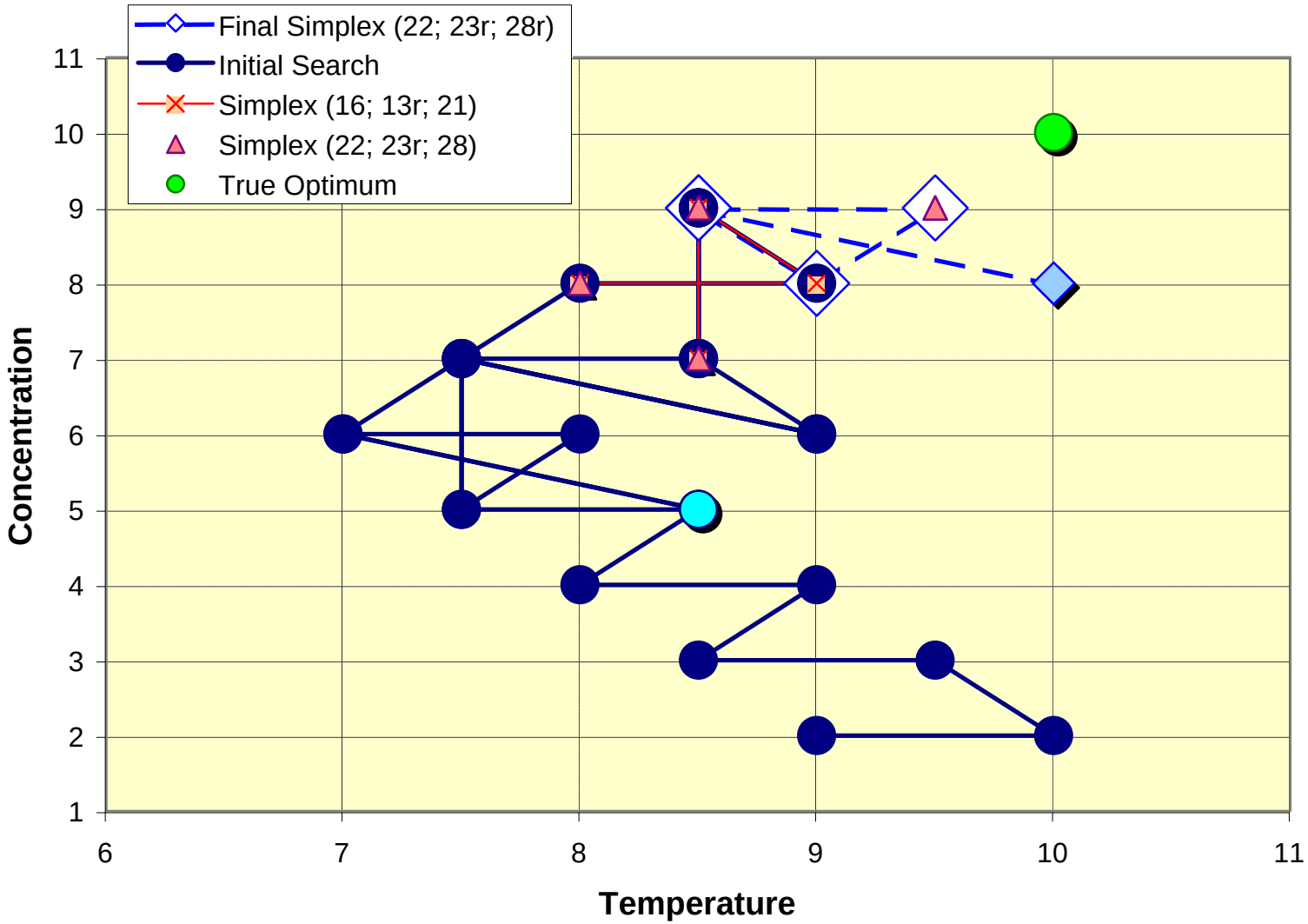
EVOP-2 with random measurement error
Final Simplex (22; 23r; 28r)
Initial Search
Simplex (16; 13r; 21)
Simplex (22; 23r; 28)
True Optimum
Concentration
Temperature
11
10
9
8
7
6
5
4
3
2
1
6
7
8
9
10
11