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TECHNICAL REPORT L293

A
COMPUTER PROGRAM
THAT
COMPUTES AND DRAWS
AN
EXACT OPERATING CHARACTERISTIC CURVE
USING THE
HYPERGEOMETRIC PROBABILITY DISTRIBUTION

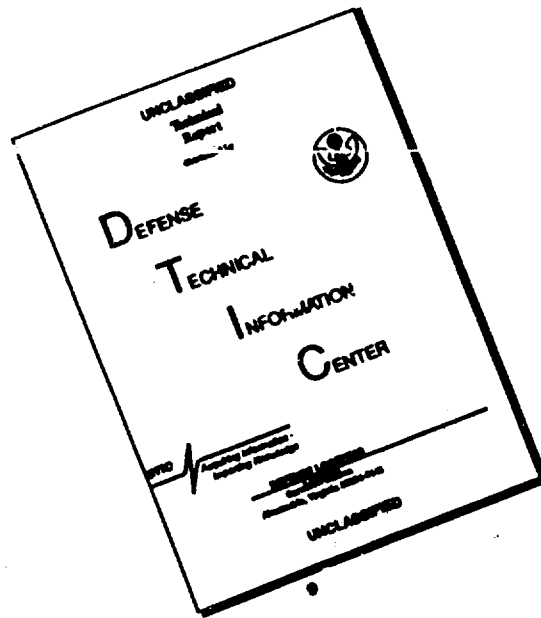
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• NOVEMBER 1971

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DOVER, NEW JERSEY

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1. ORIGINATING ACTIVITY (Corporate author) Picatinny Arsenal Dover, New Jersey		2a. REPORT SECURITY CLASSIFICATION UNCLASSIFIED	
		2b. GROUP	
3. REPORT TITLE A COMPUTER PROGRAM THAT COMPUTES AND DRAWS AN EXACT OPERATING CHARACTERISTIC CURVE USING THE HYPERGEOMETRIC PROBABILITY DISTRIBUTION			
4. DESCRIPTIVE NOTES (Type of report and inclusive dates)			
5. AUTHOR(S) (First name, middle initial, last name) Donald C. Rappaport			
6. REPORT DATE November 1971		7a. TOTAL NO. OF PAGES 24	7b. NO. OF REFS 2
8a. CONTRACT OR GRANT NO.		8b. ORIGINATOR'S REPORT NUMBER(S) Technical Report 4293	
a. PROJECT NO.			
c.		8c. OTHER REPORT NUMBER (Any other numbers that may be assigned this report)	
d.			
9. DISTRIBUTION STATEMENT Approved for public release; distribution unlimited.			
11. SUPPLEMENTARY NOTES		12. SPONSORING MILITARY ACTIVITY Picatinny Arsenal U.S. Army Munitions Command Dover, New Jersey	
13. ABSTRACT A computer program was developed which uses the Hypergeometric Probability Distribution in computing and plotting percent defective vs. 10 important probability of acceptance points (.99, .975, .95, .90, .75, .50, .25, .10, .05 and .01).			

DD FORM 1473

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UNCLASSIFIED

Security Classification

23

Security Classification

14. KEY WORDS	LINK A		LINK B		LINK C	
	ROLE	WT	ROLE	WT	ROLE	WT
Computer program Hypergeometric Probability Distribution Exact Operating Characteristic Curve						

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SUMMARY

A computer program was developed which uses the Hypergeometric Probability Distribution in computing and plotting percent defective vs. 10 important probability of acceptance points (.99, .975, .95, .90, .75, .50, .25, .10, .05 and .01).

DISCUSSION

An operating characteristic curve is a tool used in quality control for the purpose of buying or selling manufactured goods.

Using the formulae and solution as discussed in Reference 1 and altering the FORTRAN computer program described in that Reference, a new program was generated which computes and plots percent defective for 10 important probability of acceptance levels. Additional related information printed out is: defectives in original population, reliability, and confidence level.

Note: Since it is quite unusual that a sample will exceed 50% of the population, this condition has not been programmed. If it is desired to compute this, use the equalities as shown and discussed on page 4 of Reference 2.

FORTRAN PROGRAM

PROGRAM	ANNEURO	TRACE	CDC 6600 FIN V3.0-P261 OPT1 11/09/71 13.37.26.
		PROGRAM ANNEURO INPUT, OUTPUT, TAPES=INPUT, TAPES=OUTPUT	
		DIMENSION G(60), BOPD(60), PAC(60), PACL(60), BOPL(60), PACCT(10),	
		IPD(20), PAT(20)	
		DATA PACCT/.99,.975,.95,.90,.75,.5,.25,.10,.05,.01/	
5		WRITE (6,871)	
		CALL PLOT (3,.3,-3)	
400		READ (5,200) POP, SAMPLE, DEF	
200		FORMAT (3F10.0)	
		IF (POP) 399,399,243	
10	243	IF (SAMPLE = DEF) 560,560,563	
	560	WRITE (6,561) DEF, SAMPLE	
	561	FORMAT (1H1,20(/),20X,*THE PROBABILITY OF OBTAINING *.F10.0,* DEFE	
		CTS OR LESS IN A SAMPLE OF *.F10.0,* IS */20X,* ALWAYS I REGARDLESS	
		2OF THE NUMBER OF INTERESTING ONES IN THE POPULATION.*)	
15		GO TO 400	
	563	IF (SAMPLE = POP/2.1565,565,564	
	564	WRITE (6,565) SAMPLE, POP	
	566	FORMAT (1H1,20(/),20X,*NOW YOU HAVE DONE IT. I TOLD YOU NOT TO EN	
20		TER A SAMPLE SIZE GREATER */20X,* THAN 1/2 OF THE POPULATION. YOU E	
		NTERED A SAMPLE SIZE OF *.F10.0,* AND */20X,* A POPULATION SIZE OF *	
		3F10.0 */20X,* IF YOU LIKE THIS PROGRAM, PAN MAIL WILL BE ACCEPTED,*	
	565	WRITE (6,201) POP, SAMPLE, DEF	
	201	FORMAT (1H1, //50X,30HOPENATING CHARACTERISTIC CURVE,	
25		1 //25X,13HPOPULATION SIZE, F10.0,5X,6HSAMPLE,	
		2F9.0,5X,10HACCEPTABLE DEFECTS,F6.0 //26X13HIF DEFECTIVES,7X,7HPERC	
		3ENT,5X,14HPROBABILITY OF 1X,14HRELIABILITY,5X,	
		410HCONFIDENCE/27X,11HIN ORIGINAL,7X,9HDEFECTIVE,6X,10HACCEPTANCE,	
30		510X,2HIS,1X,2HIS/25X,14HPOPULATION ARE,	
		610X,2HIS,13X,2HIS//)	
		ICON = 1	
	475	CONF = PACCT(ICON)	
		AREA = CONF = .5	
		IF (AREA = .499) 477,476,476	
35	476	GUESS=(DEF * 4.17 / SAMPLE) * POP	
		IF (GUESS = POP - SAMPLE) 260,261,261	
	261	GUESS = POP - 2. * DEF = SAMPLE	
	260	CALL BACK (POP, SAMPLE, GUESS, DEF, REL, OTHERS, A, SUM, BAC, POPD)	
		PAC(1) = BAC	
40		BOPD(1) = POPD	
		GUESS = (DEF * 2.17 / SAMPLE) * POP	
		CALL BACK (POP, SAMPLE, GUESS, DEF, REL, OTHERS, A, SUM, BAC, POPD)	
		PAC(2) = BAC	
		BOPD(2) = POPD	
45		IF (BOPD(1) = BOPD(2)) 778,779,778	
	779	GUESS = POPD = 4.	
		CALL BACK (POP, SAMPLE, GUESS, DEF, REL, OTHERS, A, SUM, BAC, POPD)	
		PAC(1) = BAC	
		BOPD(1) = POPD	
50	778	DO 787 I = 3,20	
		N = I * 1	
		G(I) = BOPD (I-2) - (.5 - PAC(I-2) - AREA) / (PAC(I-1) - PAC(I-2)	
		1) * (BOPD(I-2) - BOPD(I-1))	
		IF (G(I) = DEF) 401,402,402	
55	401	GUESS = DEF = 2.	

PROGRAM	NUMERO	TRACE	LOG 0000 PTH VS. 0-1000 0-100 11/00/71 10.27.20.
		1) = (BOPL(I)-1) - BOPL(I-1)	
		IF (G(I)) 791,791,792	
	791	G(I) = 0	
	792	GUESS = G(I)	
110		CALL BACK (POP,SAMPLE,GUESS,DEF,REL,OTHERS,STYBUN, (BAC,POPD)	
		BOPL(I) = POPD	
		PACL(I) = BAC	
		IF (ABS(BOPL(I) - BOPL(I-1)) - 3.1302,302,307	
	307	CONTINUE	
120	302	IF (PACL(N-1) - S - AREA) 307,307,300	
	307	DO 309 I = N,00	
		JEST = 1	
		IF (BAC = 0) = AREA/207320,000	
	320	G(I) = G(I-1) - 1.	
120		GUESS = G(I)	
		IF (GUESS) 02,04,04	
	02	GUESS = 0.0	
	04	CALL BACK (POP,SAMPLE,GUESS,DEF,REL,OTHERS,A,SUM,BAC,POPD)	
		PACL(I) = BAC	
130		BOPL(I) = POPD	
	308	CONTINUE	
		GO TO 404	
	300	DO 309 I = N,00	
		JEST = 1	
130	310	IF (BAC = 0) = AREA/0073107310	
		G(I) = G(I-1) - 1.	
		GUESS = G(I)	
		CALL BACK (POP,SAMPLE,GUESS,DEF,REL,OTHERS,A,SUM,BAC,POPD)	
		PACL(I) = BAC	
140		BOPL(I) = POPD	
	309	CONTINUE	
		GO TO 404	
	401	POPD = BOPL(JEST - 1)	
		POPD = BOPL(JEST - 2)	
150		PACB = PAC(JEST - 1)	
		PACB = PAC(JEST - 2)	
	402	IF (POPD = POPD(1997002,003	
	404	POPD = BOPL(JEST-1)	
150		POPD = BOPL(JEST - 2)	
		PACA = PACL(JEST-1)	
		PACB = PACL(JEST - 2)	
		GO TO 405	
	403	PCTD = POPD/POP * 100.	
		REL = 100. - PCTD	
150		SUM = 1. - PACB	
		PA (20 ICON - 1) = PACB	
		PD (20 ICON - 1) = PCTD	
		WRITE (6,550) POPD,PCTD,PACB,REL,SUM	
		IF (POPD = POPD(1997002,003	
160	431	PCTD = POPD/POP * 100.	
		REL = 100. - PCTD	
		SUM = 1. - PACA	
		PD (20 ICON) = PCTD	
		PA (20 ICON) = PACA	
160		WRITE (6,550) POPD,PCTD,PACB,REL,SUM	

[illegible]

SUBROUTINE BACK TRACE

CDC 6800 PTH VS.8-PE61 OPT=1 11/09/71 13.37.28.

```
      SUBROUTINE BACK (POP, SAMPLE, GUESS, DEF, REL, OTHERS, AT, SUM, BACT, POPD)
102  IGLOO = GUESS
      POPD = IGLOO * .1
103  IF (POP - POPD) 116, 116, 117
116  IGLOO = .9999 * POP
      POPD = IGLOO
      IF (POP - POPD = SAMPLE) 113, 117, 117
117  IGLOO = POP - SAMPLE + DEF * .1
      POPD = IGLOO
118  CONTINUE
      N = DEF
      IF (POPD - POP/2.) 119, 119, 111
119  X = POPD
      Y = SAMPLE
      Z = POP
120  SAC = ANNE (Z, Y, X, N)
      REL = (1. - (POPD/POP)) * 100.
      OTHERS = POP - POPD
      A = 100. - REL
      SUM = 1. - SAC
      RETURN
111  N = SAMPLE - N - 1.
      X = POP - POPD
      Y = SAMPLE
      Z = POP
121  SUM = ANNE (Z, Y, X, N)
      REL = (1. - (POPD/POP)) * 100.
      A = 100. - REL
      SAC = 1. - SUM
      OTHERS = POP - POPD
      RETURN
      E'J
```

FUNCTION	ANNE	TRACE	CDC 6800 PTH V3.0-PEBI OPTM1 11/09/71 13.37.26.
		FUNCTION ANNE (HILARY, RAY, DIANE, DEP)	
		II = DEF * .1	
	17	IF (RAY = DIANE) 10,10,11	
	10	MOE = RAY * 1.1	
9		GO TO 15	
	11	MOE = DIANE * 1.1	
		GO TO 15	
	15	FLO = 0.0	
10		JOYCE = 1	
		LENNY = 0	
		CLARA = 1	
		SYDELL = HILARY = DIANE	
		ALORA = HILARY = RAY	
		XHARC = SYDELL = RAY	
19		IF (XHARC = SYDELL) 19,19	
	2	BEN = ALORA	
		TOBY = SYDELL	
		GO TO 3	
	1	BEN = SYDELL	
20		TOBY = ALORA	
	3	JOSS = HILARY = BEN * .1	
		HERB = 0.0	
	25	IF (JOYCE = JOSS) 22,22,4	
	22	CONTINUE	
25		HERB = ALOG10 (TOBY/HILARY) * HERB	
		TOBY = TOBY - 1.	
		HILARY = HILARY * 1.	
		JOYCE = JOYCE * 1	
		GO TO 25	
30	4	CONTINUE	
		DO IS ISDOOR = 1,MOE	
		IF (HERB * 90.) 0.0,20	
	20	FLO = FLO * 1.10, 0.0 HERB,	
	21	TRUDY = 1. - FLO	
35	5	SEN = 10. 0.0 HERB	
		IF (II - LENNY) 23,23,0	
	0	LENNY = LENNY * 1	
		HERB = HERB * ALOG10 ((RAY*DIANE)/((XHARC * 1.)* CLARA))	
		CLARA = CLARA * 1.	
40		XHARC = XHARC * 1.	
		DIANE = DIANE * 1.	
		RAY = RAY - 1.	
	18	CONTINUE	
	23	ANNE = FLO	
45		RETURN	
		END	

REFERENCES

1. Donald C. Rappaport, A Computer Program for Exact Reliability and Confidence Using the Hypergeometric Probability Distribution, Picatinny Arsenal Technical Report 4181, January 1971.
2. G. J. Lieberman and D. B. Owen, Tables of the Hypergeometric Probability Distribution, Stanford University Press, Stanford, California, 1961.

APPENDIX A

Input

INPUT

F - format

<u>Column Numbers</u>	<u>Input</u>	<u>Format</u>
1-10	Population	F 10.0
11-20	Sample	F 10.0
21-30	Defectives	F 10.0

APPENDIX B
Sample Output

14a

OPERATING CHARACTERISTIC CURVE

POPULATION SIZE	50.	SAMPLE	10.	ACCEPTABLE DEFECTS	1.
IF DEFECTIVES IN ORIGINAL POPULATION ARE	PERCENT DEFECTIVE IS	PROBABILITY OF ACCEPTANCE IS	RELIABILITY IS	CONFIDENCE IS	
1.	2.00	1.000000	98.00	.000000	
2.	4.00	.963265	96.00	.036735	
1.	2.00	1.000000	98.00	.000000	
2.	4.00	.963265	96.00	.036735	
2.	4.00	.963265	96.00	.036735	
3.	6.00	.902041	94.00	.097959	
3.	6.00	.902041	94.00	.097959	
4.	8.00	.825836	92.00	.174164	
4.	8.00	.825836	92.00	.174164	
5.	10.00	.741900	90.00	.258100	
7.	14.00	.570934	86.00	.429066	
8.	16.00	.490502	84.00	.509498	
11.	22.00	.288817	78.00	.711183	
12.	24.00	.236449	76.00	.763551	
15.	30.00	.120975	70.00	.879025	
16.	32.00	.094463	68.00	.905537	
18.	36.00	.055430	64.00	.944570	
19.	38.00	.041607	62.00	.958393	
23.	46.00	.011315	54.00	.988685	
24.	48.00	.007817	52.00	.992183	

OPERATING CHARACTERISTIC CURVE

POPULATION SIZE	12345.	SAMPLE	456.	ACCEPTABLE DEFECTS	12.
IF DEFECTIVES IN ORIGINAL POPULATION ARE	PERCENT DEFECTIVE IS	PROBABILITY OF ACCEPTANCE IS	RELIABILITY IS	CONFIDENCE IS	
169.	1.37	.990082	98.63	.009918	
170.	1.38	.989609	98.62	.010391	
191.	1.55	.975010	98.45	.024990	
192.	1.56	.974058	98.44	.025942	
211.	1.71	.950528	98.29	.049472	
212.	1.72	.948980	98.28	.051020	
236.	1.91	.901517	98.09	.098483	
237.	1.92	.899096	98.08	.100904	
283.	2.29	.751692	97.71	.248308	
284.	2.30	.747811	97.70	.252189	
342.	2.77	.501683	97.23	.498317	
343.	2.78	.497393	97.22	.502607	
408.	3.30	.252853	96.70	.747147	
409.	3.31	.249799	96.69	.750201	
475.	3.85	.100760	96.15	.899240	
476.	3.86	.099233	96.14	.900767	
518.	4.20	.050349	95.80	.949651	
519.	4.20	.049500	95.80	.950500	
605.	4.90	.010041	95.10	.989959	
606.	4.91	.009842	95.09	.990158	

NOT REPRODUCIBLE

