

## ENIAC in Action

Making and Remaking the Modern Computer

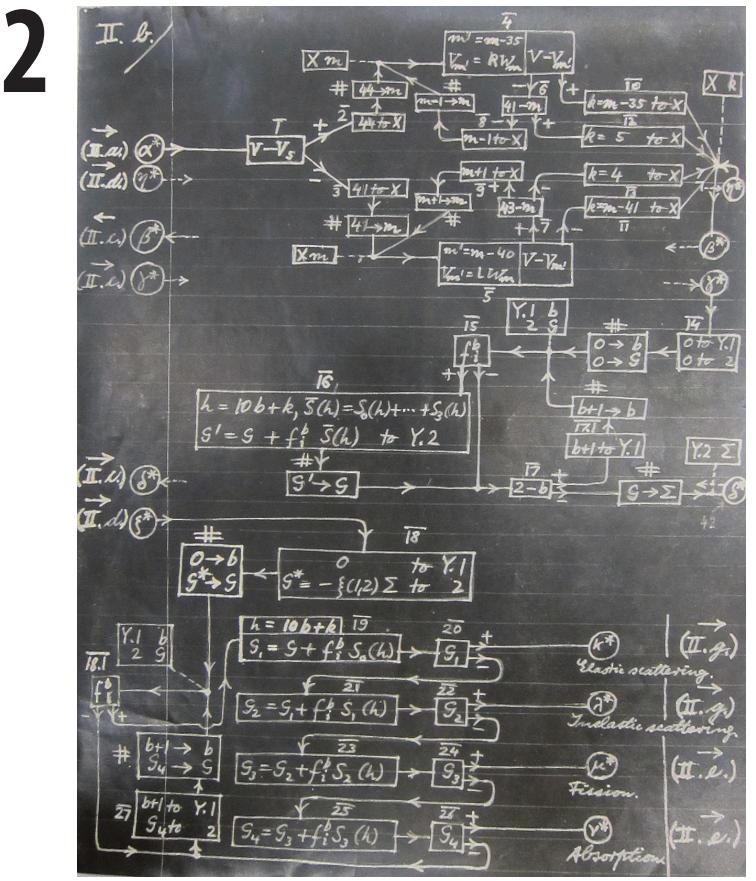
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# ENIAC Monte Carlo Flow Diagram, 1947

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STATISTICAL METHODS IN NEUTRON DIFFUSION		761
Instructions	Explanations	
44 41-42	$f = -\log \lambda$	
46 43-44	$d = f^2 \cdot P$	
47 45-46	$P = \frac{1}{2} \cdot Q$	
48 46-47	$C_1 = d^2 \cdot P$	
Only for $P > 50$	$C_2 = 4 + 45$	
Only for $P < 50$	$C_1 = 11$	
	$C_2 = 10$	
	$C_3 = 14$	
	$C_4 = 9$	
	$C_5 = 49$	
From here on only $Q$ :		
52 $S_1 = 26 \cdot Q_1$	$\bar{\mu} = \frac{d^2}{S_1}$	
53 $S_2 = 26 \cdot Q_2$	$\bar{\mu}_1 = \frac{d^2}{S_2}$	
54 $S_3 = 26 \cdot Q_3$	$\bar{\mu}_2 = \frac{d^2}{S_3}$	
55 $S_4 = 26 \cdot Q_4$	$\bar{\mu}_3 = \frac{d^2}{S_4}$	
56 $S_5 = 26 \cdot Q_5$	$\bar{\mu}_4 = \frac{d^2}{S_5}$	
57 $S_6 = 26 \cdot Q_6$	$\bar{\mu}_5 = \frac{d^2}{S_6}$	
58 $S_7 = 26 \cdot Q_7$	$\bar{\mu}_6 = \frac{d^2}{S_7}$	
Only for $Q_1 > 60$	$C_1 = C_1$	
	$C_2 = C_2$	
	$C_3 = \dots$	
	$C_4 = 0$	
	$C_5 = 49$	
From here on only $Q_1, \dots, Q_7$ :		
Only for $Q_1 > 60$	$\phi_n(r) = \phi$	

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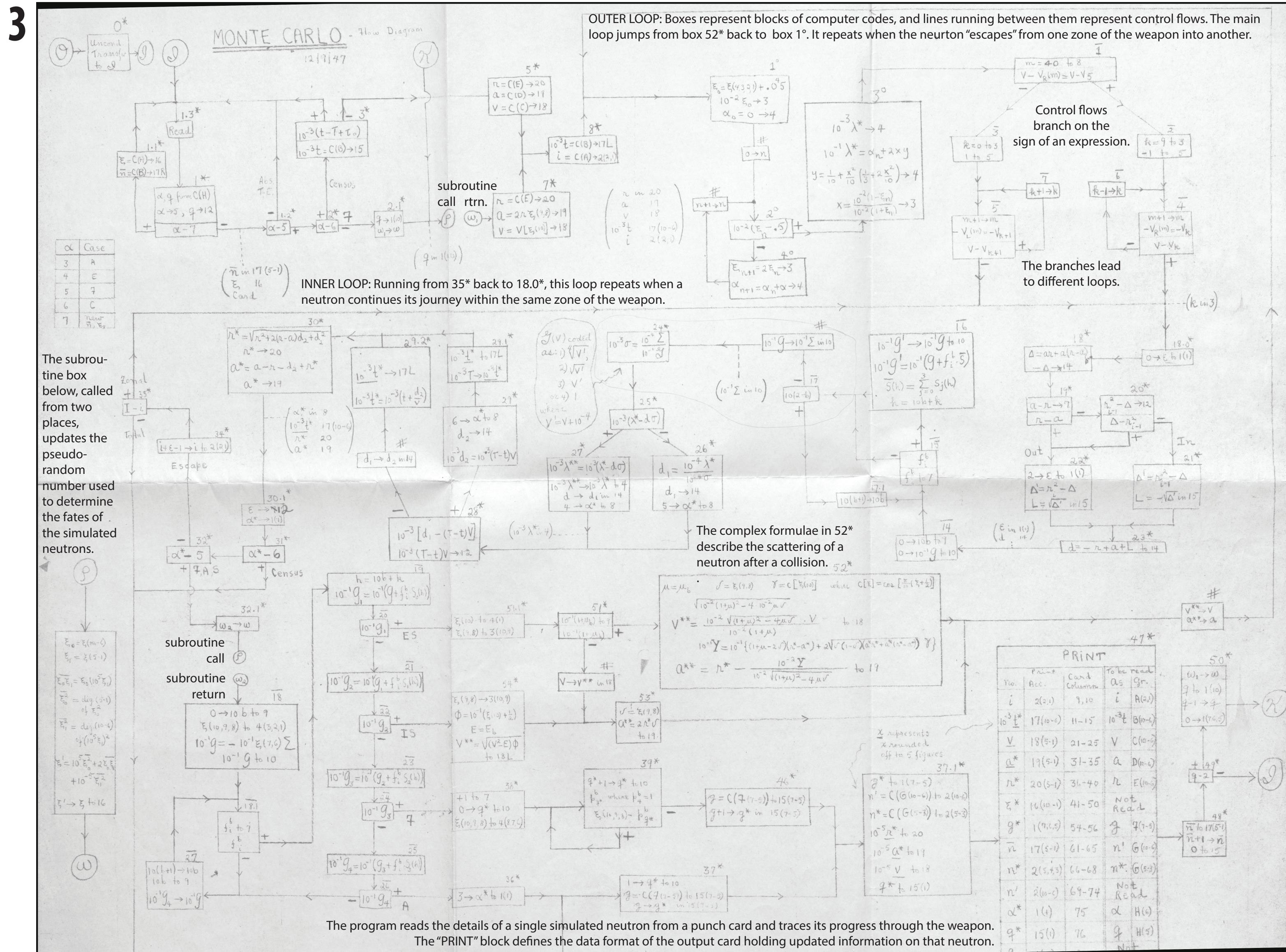
No.	Card	Column	To be read	Card	Column	To be read
i	2(2,i)	9,10	g	A(i,i)		
	17(10-i)	11-15		B(i,i)		
v	18(5-i)	21-25	v	C(i,i)		
g*	19(5-i)	31-35	a	D(i,i)		
x*	16(10-i)	41-50	r	E(i,i)		
y*	17(5-i)	54-56	f	F(i,i)		
n*	20(5-i)	61-65	n!	G(i,i)		
z*	21(5-i)	66-68	z	H(i,i)		
l*	22(5-i)	69-74	l	I(i,i)		
o*	23(5-i)	75	o	J(i,i)		
q*	15(1)	76	q	H(i,i)		

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Actual Technique.  
The Use of the ENIAC  
Before describing the details of the actual running of the first experimental problems based on the Monte Carlo method, it would be to discuss here briefly the preparation of the problem which was used for the first time on the ENIAC to compute these problems.  
This new method is based on a stochastic i.e. a set of random rules arranged for the machine in two levels, the "Background Coding" and the "Problem Coding". The "Background Coding" consists of the more or less permanent connection between the individual parts of the ENIAC: the accumulators, the transmission lines, the registers and stores and gives the information as read off the IBM cards and the function tables, the permanent memory organs. These connections are given in an appropriate panel, ready to execute the code or computation as required by the logical sequence of the problem. This system has the considerable advantage from the working point of view that once the machines are set up in the machine, no changes are required in them as long as any of the problems to be computed are running.

The main diagram (3) specifies the structure and operations of the Monte Carlo program run on ENIAC in March and April of 1948 to simulate the propagation of neutrons inside exploding atomic bombs. This was the first time modern code was run on any computer and the first electronic Monte Carlo simulation. John von Neumann came up with an original plan for the computation, in a letter sent to Los Alamos (detail as 1). He then drew up a draft flow diagram (detail as 2) which went through several revisions in collaboration with Klara von Neumann and Nick Metropolis before this version. We discovered a full listing (detail as 4) in Klara's handwriting for a revised version of the program run in late 1948. She described the procedures used in a report (first manuscript page as 5).

Boxes	Function
1* - 8*	Read a card and store neutron characteristics
1° - 4°	Calculate random parameter $\lambda^*$
1-7	Find neutron's velocity interval
18* - 23*	Calculate distance to zone boundary
14-17.1, 24*	Calculate cross-section of material in zone
25* - 27*	Determine if terminal event is collision or escape
28* - 30*	Determine if a census comes first
31* - 35*	Discriminate between terminal events
Subroutine p/w	Refresh random number
18-27	Determine collision type
51* - 52*	Elastic scattering
53* - 54*	Inelastic scattering
36* - 39*, 46*	Absorption/fission
37.1*, 47* - 50*	Print card and restart main loop



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