concepts of information 2

Shannon &
the mathematical model of
communication

context and background (PD)
Shannon (GN)
ramifications (GN & PD)

aob?

reading shannon

THE HEAD AND IN FRONTAL ATTACK ON AN ENGLISH WRITER THAT THE CHARACTER OF THIS POINT IS THEREFORE ANOTHER METHOD FOR THE LETTERS THAT THE TIME OF WHO EVER TOLD THE PROBLEM FOR AN UNEXPECTED

"frontal attack on an English [reader]"

If we have two arguments x and y (which may themselves be multidimensional) the joint and conditional entropies of $p(x,y)$ are given by

$$H(x,y) = -\iint p(x,y) \log p(x,y)\, dx\, dy$$

and

$$H_x(y) = -\iint p(x,y) \log \frac{p(x,y)}{p(x)}\, dx\, dy$$
$$H_y(x) = -\iint p(x,y) \log \frac{p(x,y)}{p(y)}\, dx\, dy$$

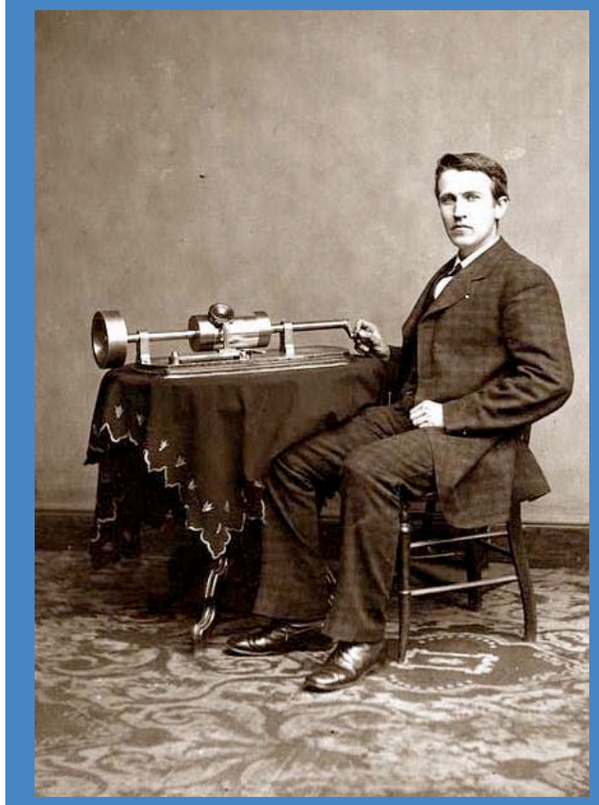
where

$$p(x) = \int p(x,y)\, dy$$
$$p(y) = \int p(x,y)\, dx.$$

"our intuitive feeling ..."

"it is clear that ..."

people & places



deep background

Morse
Edison
Bell
Baudot
Murray

Western Electric
AT&T
Bell Labs

00	01	02	03	04	05	06	07
NUL	E 3	LF	A -	SP	S '	I 8	U 7
08	09	0A	0B	0C	0D	0E	0F
CR	D ENQ	R 4	J BEL	N ,	F !	C :	K (
10	11	12	13	14	15	16	17
T 5	Z +	L)	W 2	H £	Y 6	P 0	Q 1
18	19	1A	1B	1C	1D	1E	1F
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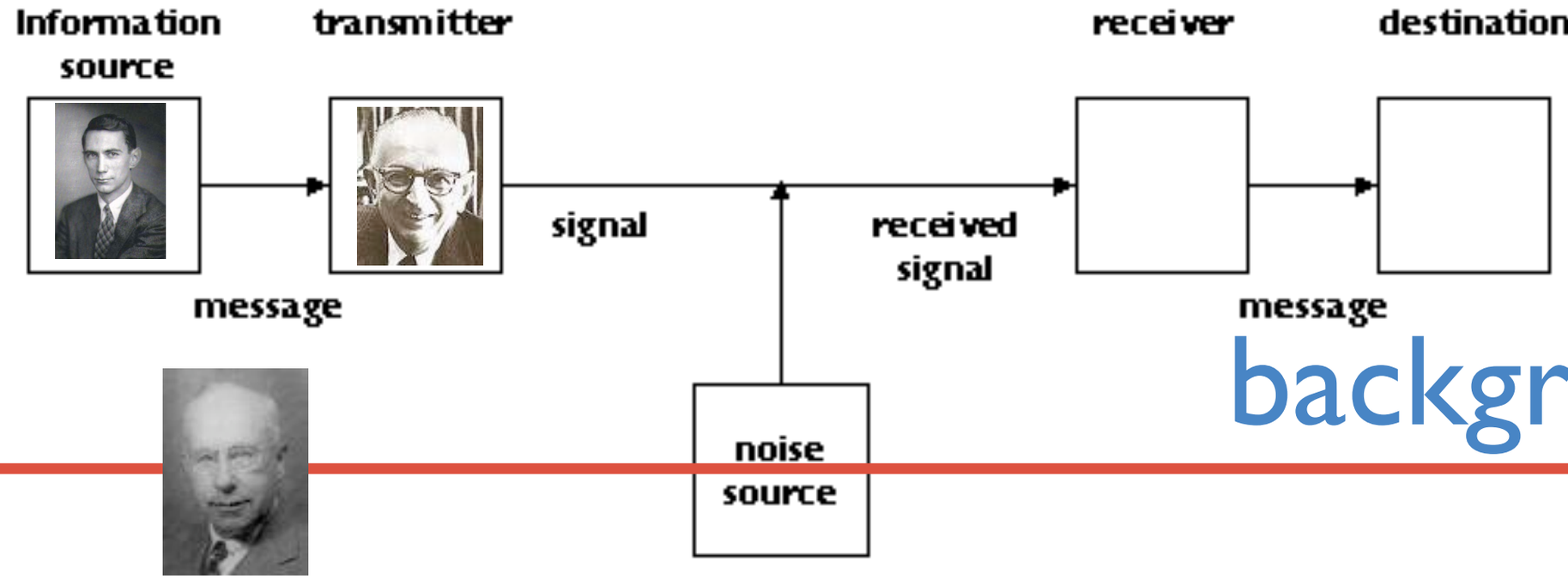
Letters			Figures			Control Chars.	

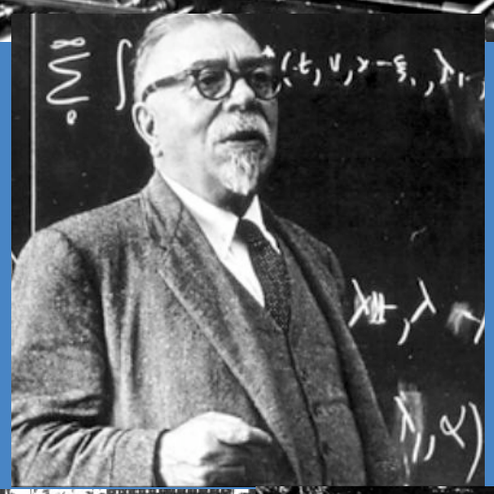


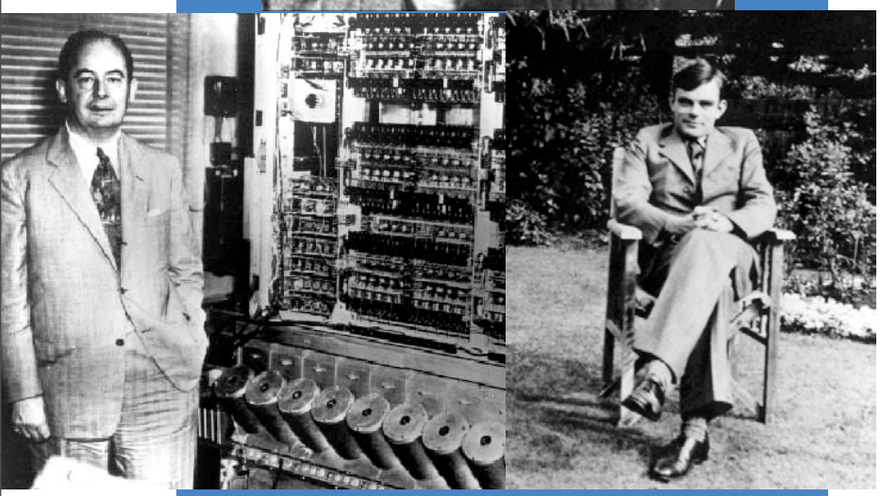
background

observer

"The word *communication* will be used here in a very broad sense to include all of the procedures by which one mind may affect another ... not only written and oral speech, but also music, the pictorial arts, the theatre, the ballet, and in fact all human behavior .... a still broader definition ... the procedures by means of which one mechanism (say automated equipment to track an airplane and to compute its future positions) affects other mechanisms (say a guided missile chasing this airplane."

— Warren Weaver, 1949





people & places

R[alph] V.L. Hartley, 1888-1970
"Transmission of Information", 1928

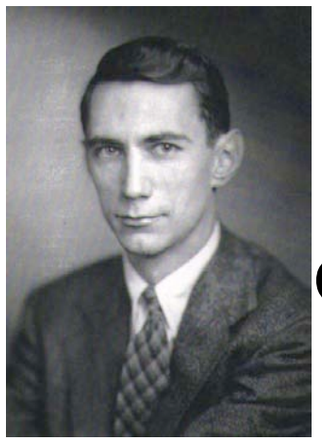
Harry Nyquist, 1989-1976
"Certain factors affecting telegraph speed", 1924

Vannevar Bush, 1890-1974

Norbert Wiener, 1894-1964

John Von Neumann, 1903-1957

Alan Turing, 1912-1954



Claude Shannon, 1916-2001

Hartley

precedented

[R[alph] V.L. Hartley, 'Transmission of Information, '
Bell System Technical Journal (1928): 535–564.

"While the frequency relations involved in electrical communication are interesting in themselves, I should hardly be justified in discussing them on this occasion unless we could deduce from them something of fairly general practical application to the engineering of communication systems.

"What I hope to accomplish in this direction is to set up a quantitative measure **whereby the capacities of various systems to transmit information may be compared.**"

Hartley

information is a very elastic term ... a more specific meaning ... the sender mentally selects ... At each selection there are eliminated all of the other symbols which might have been chosen ... more and more possible symbols sequences are eliminated ... the information becomes more precise ... Inasmuch as the precision of the information depends upon what ... might have been .. reasonable to hope to find in the number of these sequences the desired quantitative measure .... desirable ... to eliminate the psychological factors involved and to establish a measure of information in terms of purely physical quantities

Hartley

[the problem]: owing to the distortion of the cable the results ... to the receiver .. are not as clearly distinguishable ... the capacity of a system to transmit .. depends upon the possibility of distinguishing at the receiving end

in estimating the capacity ... to transmit information .. ignore the question of interpretation .. base our result on the possibility of the receiver's distinguishing the result of selecting any one symbol from that of selecting any other...

We may think of the various current values as primary symbols and the various sequences of these which represent characters as secondary symbols.

Hartley

[when psychological factors are considered] the amount of information transmitted would increase exponentially ... [but] we are setting up a measure .. independent of psychological factors ... A telegraph system finds one ten-word message no more difficult to transmit than another ... In order then for a measure of information to be of practical engineering value ... the information [should be] proportional to the number of selections. The number of possible sequences is therefore not suitable for use directly as a measure of information.

... a derived measure which does meet the practical requirements ....

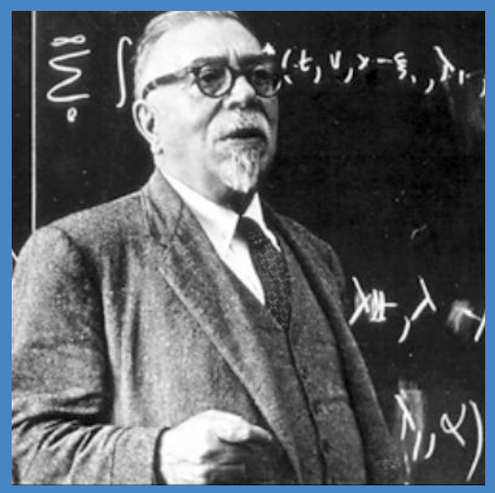
let H = Kn

$H = n \log S = \log S^n$

[n=number of selections; s number of symbols ...]

we have ... take[n] as our practical measure of information the logarithm of the number of possible symbol sequences

Wiener



Tufts, Cornell, Harvard, Cambridge, Göttingen

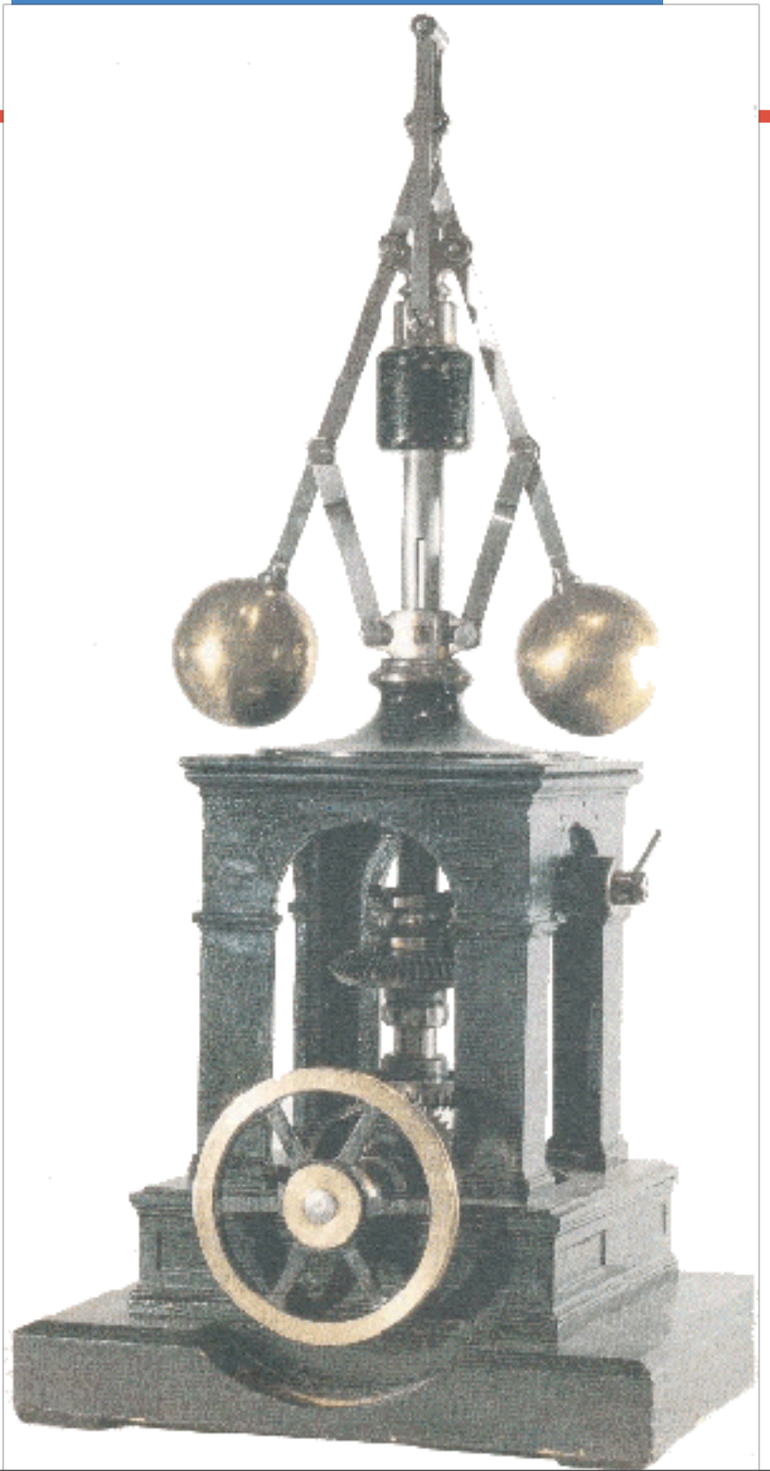
1918, ballistics group, Aberdeen Training Ground

1933, Harvard Medical School

1942, "control and communication engineering"

"our main work was the design of a commuting machine to be used in the control of anti-aircraft fire ... the way decisions ... could be realized in action"

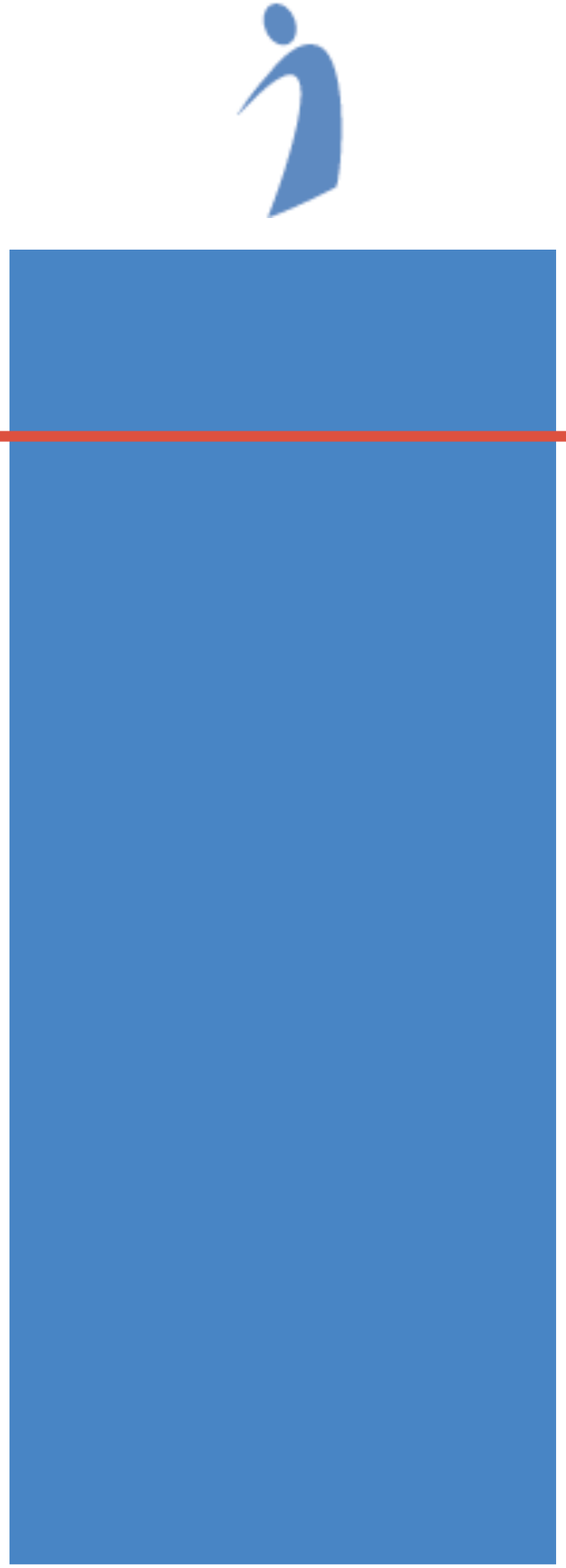
1948, *Cybernetics or Control and Communication in the Animal Kingdom*



cybernetics

"That beautiful contrivance, the governor of the steam-engine."
BABBAGE 1832

"And if you despise the swimmers, I will tell you of another and greater art, the art of the pilot, who not only saves the souls of men, but also their bodies and properties from the extremity of danger, just like rhetoric."
Plato, *Gorgias*

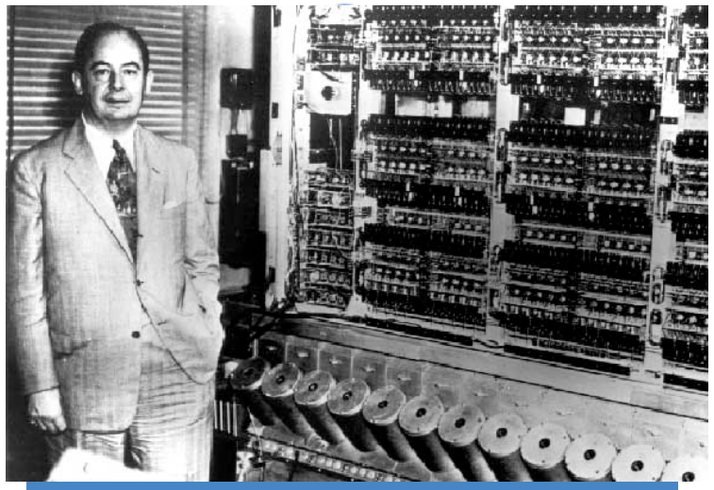


cybernetics

"communication .. is the cement of society.... [since] sociology and anthropology are primarily sciences of communication ... therefore fall under the general head of cybernetics. That particular branch of sociology which is known as economics .. is a branch of cybernetics."
—Weiner

concepts of cybernetics

"He had a feeling that the whole things was flattened and became a little ridiculous. He may have had ... himself some exaggerated ideas occasionally ... but with all his fantasies he always had his heavy legs planted firmly on the ground."



von Neumann

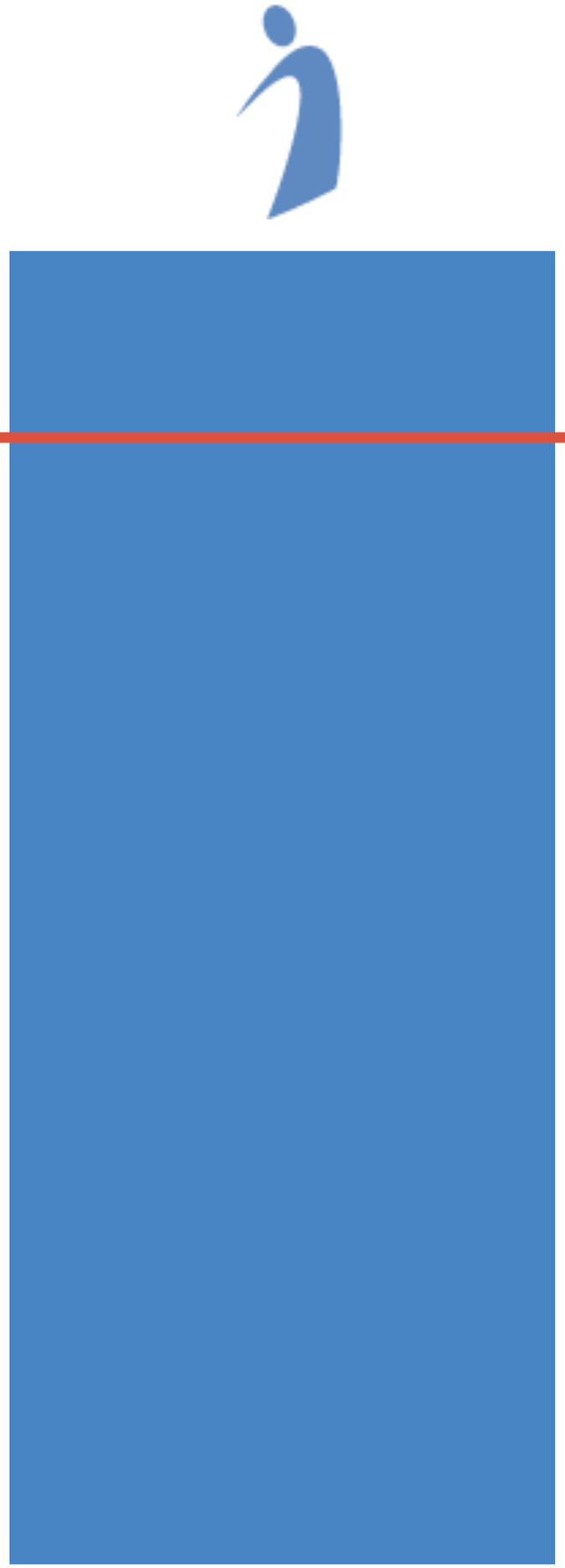
Budapest, Zürich, Göttingen, Berlin, Hamburg, Princeton

1928, Theory of Parlor Games

1932, quasi-ergodic hypothesis

1943, Los Alamos

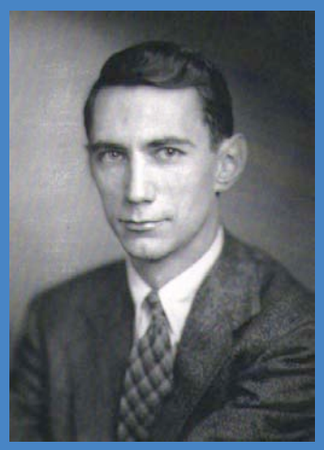
1944, *Theory of Games and Economic Behavior*



von Neumann

"You should call it entropy for two reasons: first, the function is already in use in thermodynamics under the same name; second, and more importantly, most people don't know what entropy really is, and if you use the word entropy in an argument you will win every time."

—von Neumann, quoted by Golan, 2002



Shannon

1937, MIT, thesis with Bush
Boolean algebra for switching circuits
"most important masters degree ever completed"

1939, Bell Labs, with Weaver
anti-aircraft missile control
[qv John Tukey]

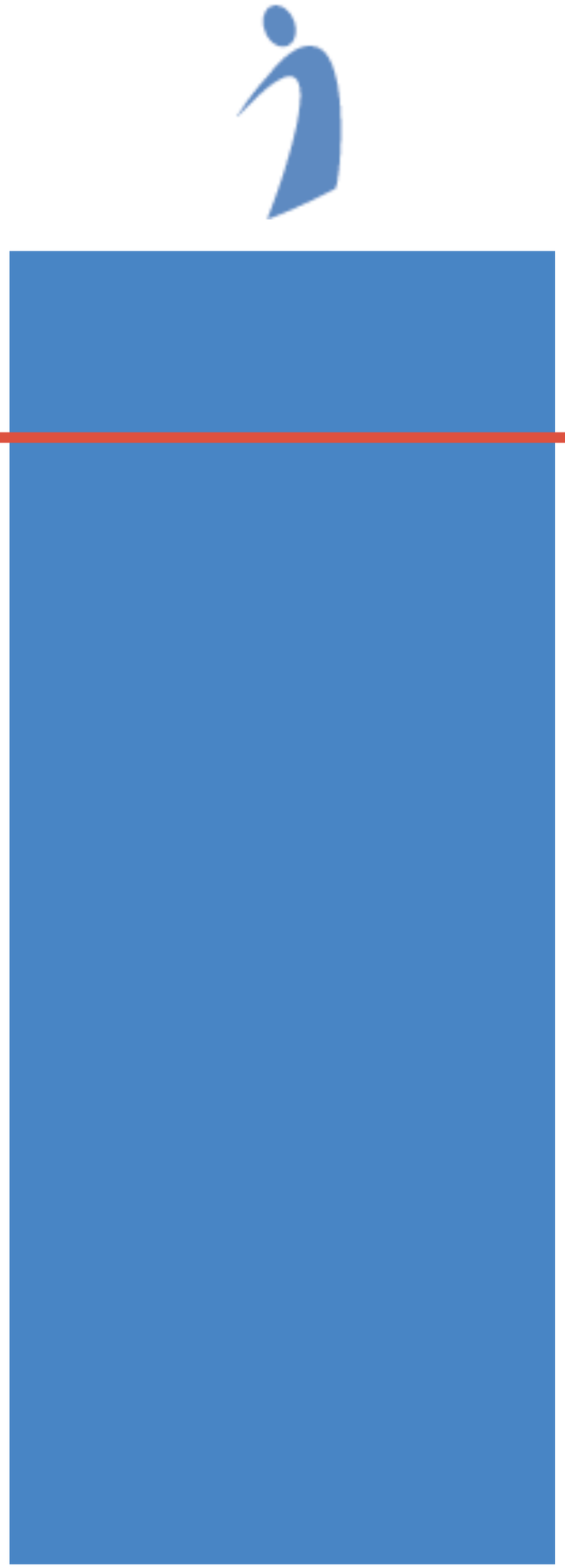
Shannon

1940, starts work on cryptography
adding noise, redundancy

"I started thinking about cryptography and secrecy systems. There is this connection; they are very similar things., in one case trying to conceal information, and in the other case trying to transmit it."

1942 SIGSALY

1945, "A Mathematical theory of Cryptography"



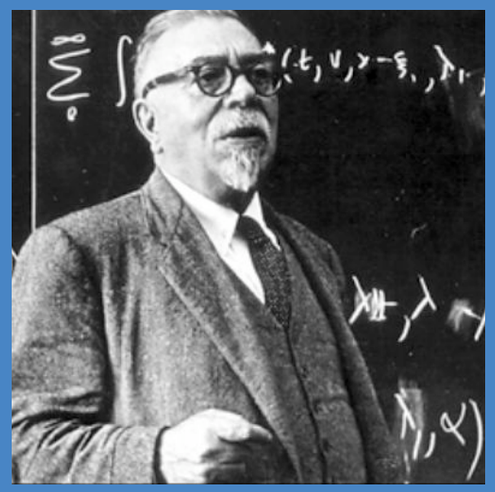
afterwords

cybernetics

literary theory

business theory

cybernetics

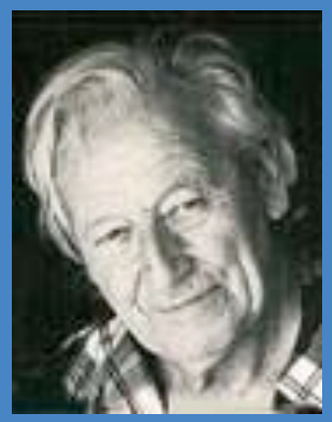


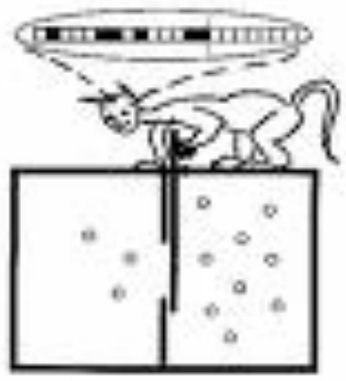
the legacy

Cognitive Science
George Miller ....

Anthropology ....
Gregory Bateson
Steps towards an Ecology of Mind, 1972

"complex functional system capable of evolutionary change"
"restraints"
"the concept of redundancy is at least a partial synonym of "meaning"





quotable moments

"What is a difference? ...an abstract matter ... "effects" ... are brought about by *differences* ... the sort of thing that gets on the map from the territory ... the word "idea" ... is synonymous with "difference" ... what we mean by information—the elementary unit of information—is *a difference which makes a difference*, and it is able to make a difference because the neural pathways along which it travels and is continually transformed are themselves provided with energy."
—Bateson, "Form, Substance, and Difference" [1970]

literary theory

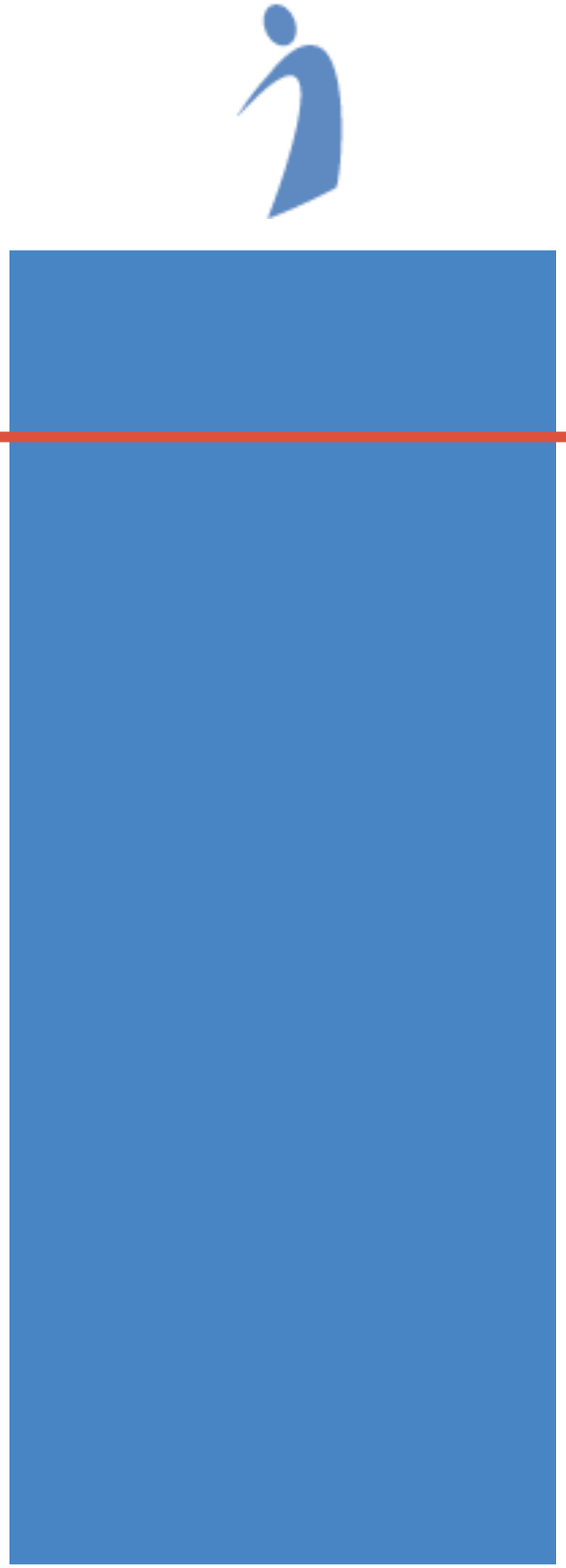
on writing poetry
Howard Nemerov

structuralism
"the language speaks us"

"When we write English, half of what we write is determined by the structure of the language and half is chosen freely"

anxiety of influence

reader-response



down to business

lineage

Herbert Simon & Chester Barnard, *Administrative Behaviour: A Study of Decision Processes in Administrative Organization*, 1947

James Beninger, *The Control Revolution: Technological and Economic Origins of the Information Society*, 1986

JoAnne Yates, *Control through Communication*, 1989