Cybernetics

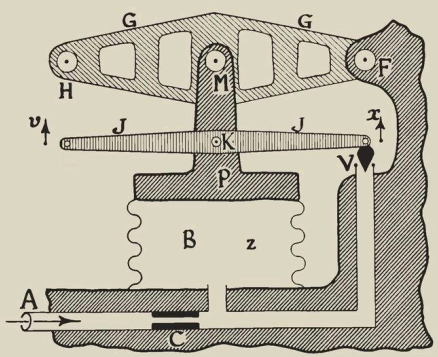
Merovius

c¼h - 2024-07-25

AN INTRODUCTION TO

CYBERNETICS

W. ROSS ASHBY

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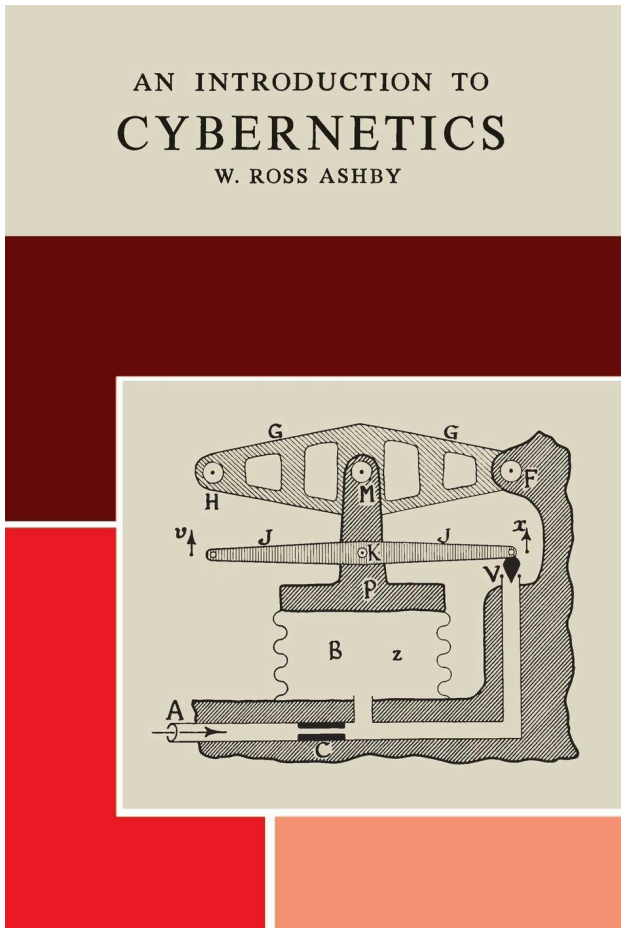
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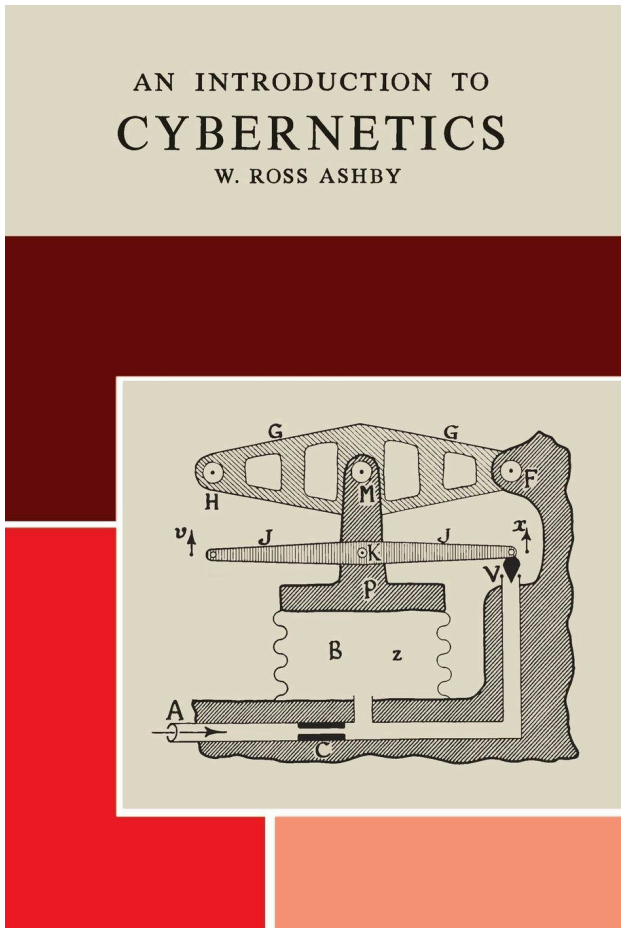
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Definitions

Wikipedia: “The transdisciplinary study of circular processes such as feedback systems where outputs are also inputs.”

Norbert Wiener: Study of “control and communication in the animal and the machine.”

Macy cybernetics conferences: Study of “circular causal and feedback mechanisms in biological and social systems.”

Andrey Kolmogorov: “The study of systems of any nature which are capable of receiving, storing, and processing information so as to use it for control”

Machines

A machine is a *transformation*:

$$M \downarrow \begin{matrix} A & B & \ldots & G & H \\ C & D & \ldots & A & B \end{matrix}$$

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A machine is *closed*, if its image is a subset of its preimage.

Kinematic Graph

$T\downarrow$	A	B	C	D	E	F	G	H	I	J	K	L	M	N	P	Q
	D	H	D	I	Q	G	Q	H	A	E	E	N	B	A	N	E

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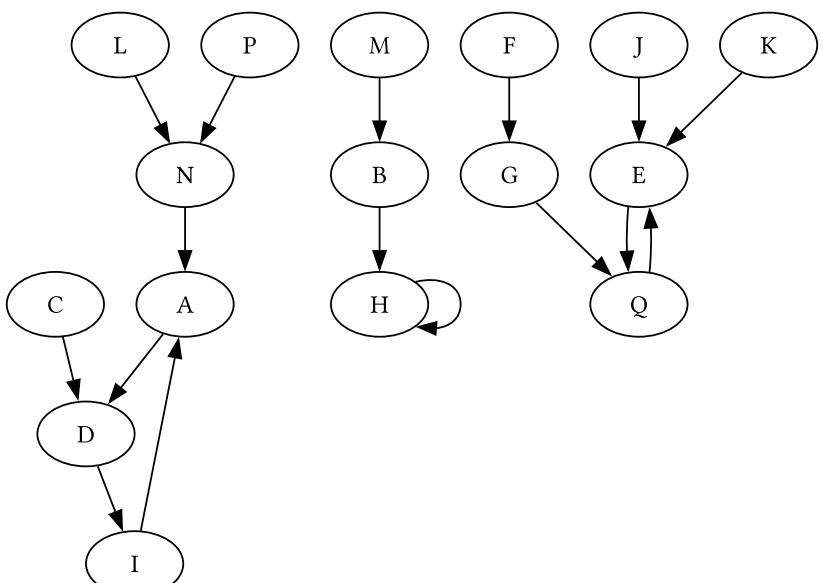
	D	H	D	I	Q	G	Q	H	A	E	E	N	B	A	N	E



Input

$R \downarrow$	a	b	c	d
R_1	c	d	d	b
R_2	b	a	d	c
R_3	d	c	d	b

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Input

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$$P\downarrow \begin{matrix} i & j & k \\ k & i & i \end{matrix}$$

$$Z\downarrow \begin{matrix} i & j & k \\ 2 & 3 & 2 \end{matrix}$$

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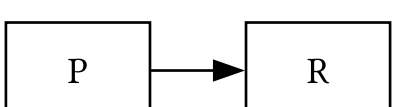

Variety

Variety is the number of distinct states of a set of machines

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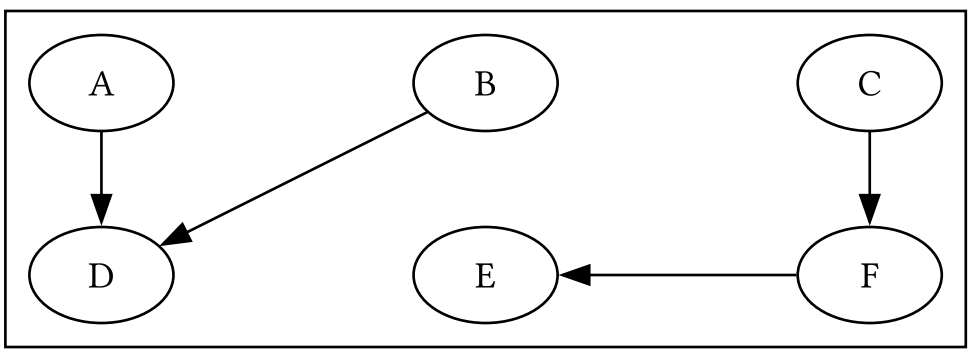
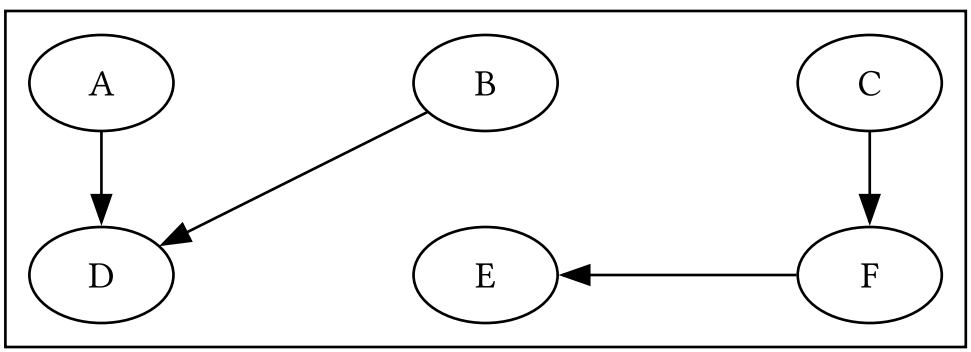
(or sometimes its logarithm).

Decay of variety

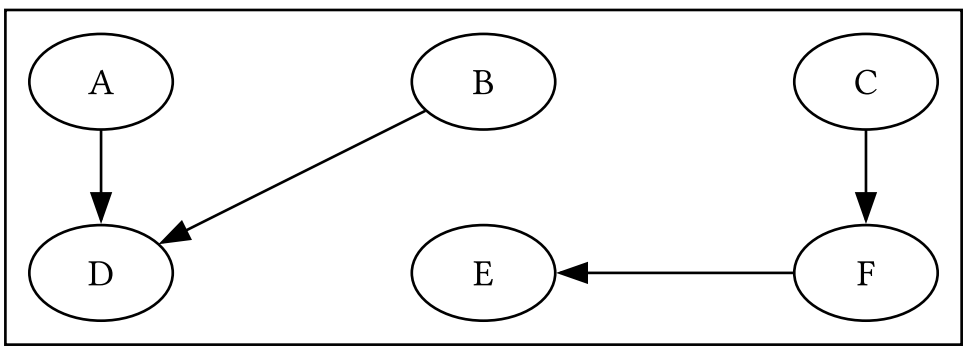


Decay of variety

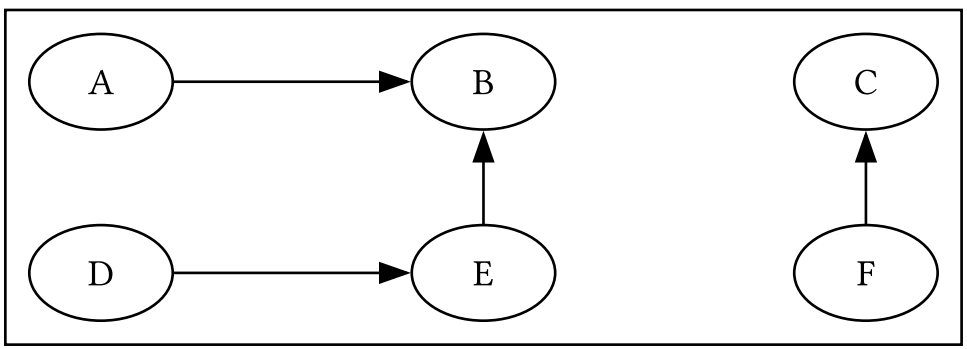


“As time progresses the variety in the set cannot increase and will usually diminish."

Law of Experience

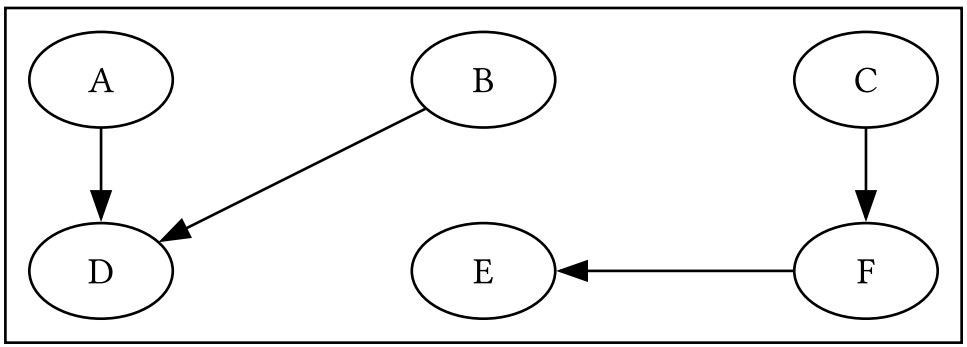


P_1



P_2

Law of Experience



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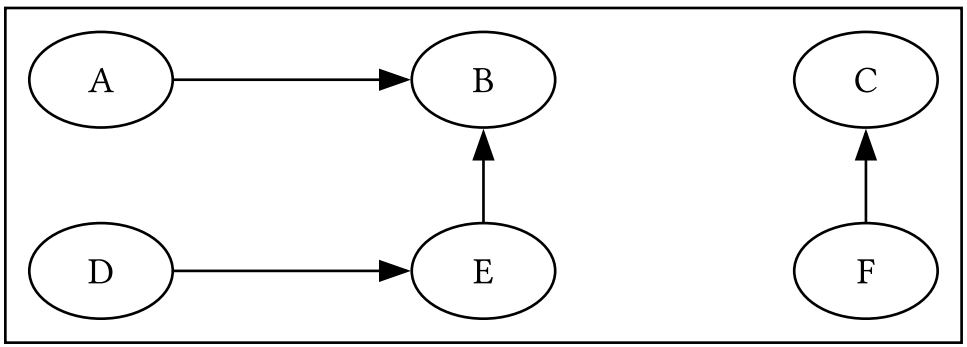

P_2

“Uniform change at the inputs ofa set oftransducers tends to drive the set’s variety down."

Survival

Suppose a mouse is trying to escape from a cat, so that the survival of the mouse is in question. As a dynamic system, the mouse can be in a variety of states; thus it can be in various postures, its head can be turned this way or that, its temperature can have various values, it may have two ears or one. These different states may occur during its attempt to escape and it may still be said to have survived. On the other hand if the mouse changes to the state in which it is in four separated pieces, or has lost its head, or has become a solution of amino-acids circulating in the cat's blood then we do not consider its arrival at one of these states as corresponding to "survival".

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A "stable" system tries to keep its state in a certain set.

Thus it tries to reduce input variety.

Regulation

		D								
		1	2	3	4	5	6	7	8	9
	α	f	k	m	b	c	h	j	a	l
R	β	f	e	k	b	q	h	d	p	n
	γ	k	f	a	b	c	m	d	j	h

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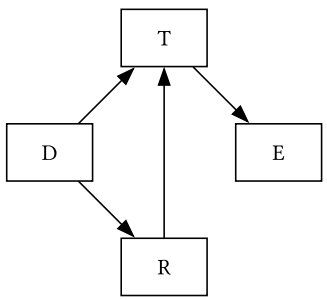

Regulation

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		1	2	3	4	5	6	7	8	9
	α	f	k	m	b	c	h	j	a	l
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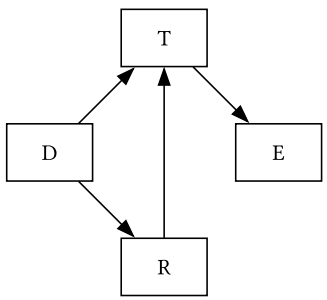
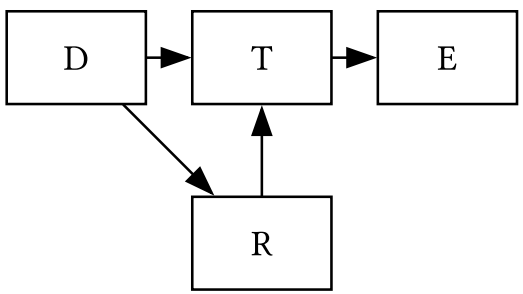


Law of requisite variety: $\log(V_{\text{Outcome}}) \geq \log(V_D) - \log(V_R)$.

“Only variety in R can force down the variety due to D; variety can destroy variety."

Regulation



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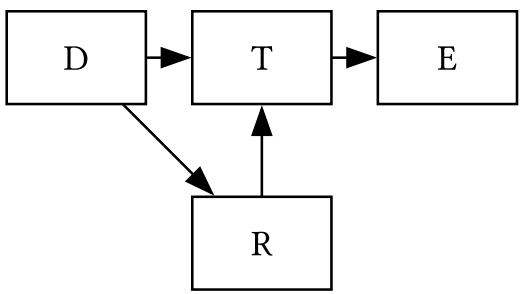

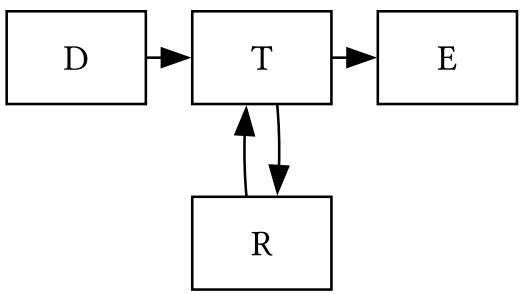

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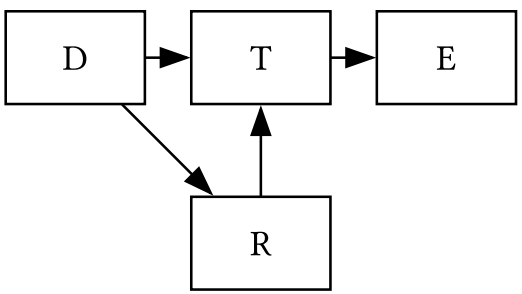

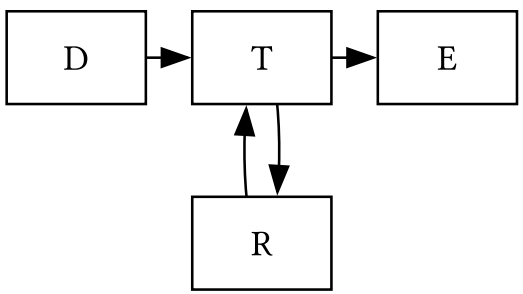

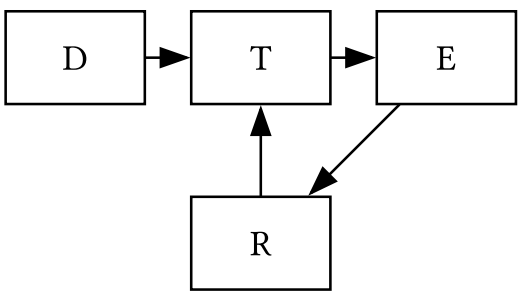

To be continued