economy ~ ecology

Guattari, Three Ecologies, Chaosmosis
Ecology of Practices

algorithmic finance

limits of digital computation

limits of digital algorithms

digital representation
algorithm

digital / discrete representation

information ≠ meaning

telegraph ≠ speech

code ≠ language

data ≠ information ≠ knowledge

A Mathematical Theory of Communication

By C. E. SHANNON

INTRODUCTION

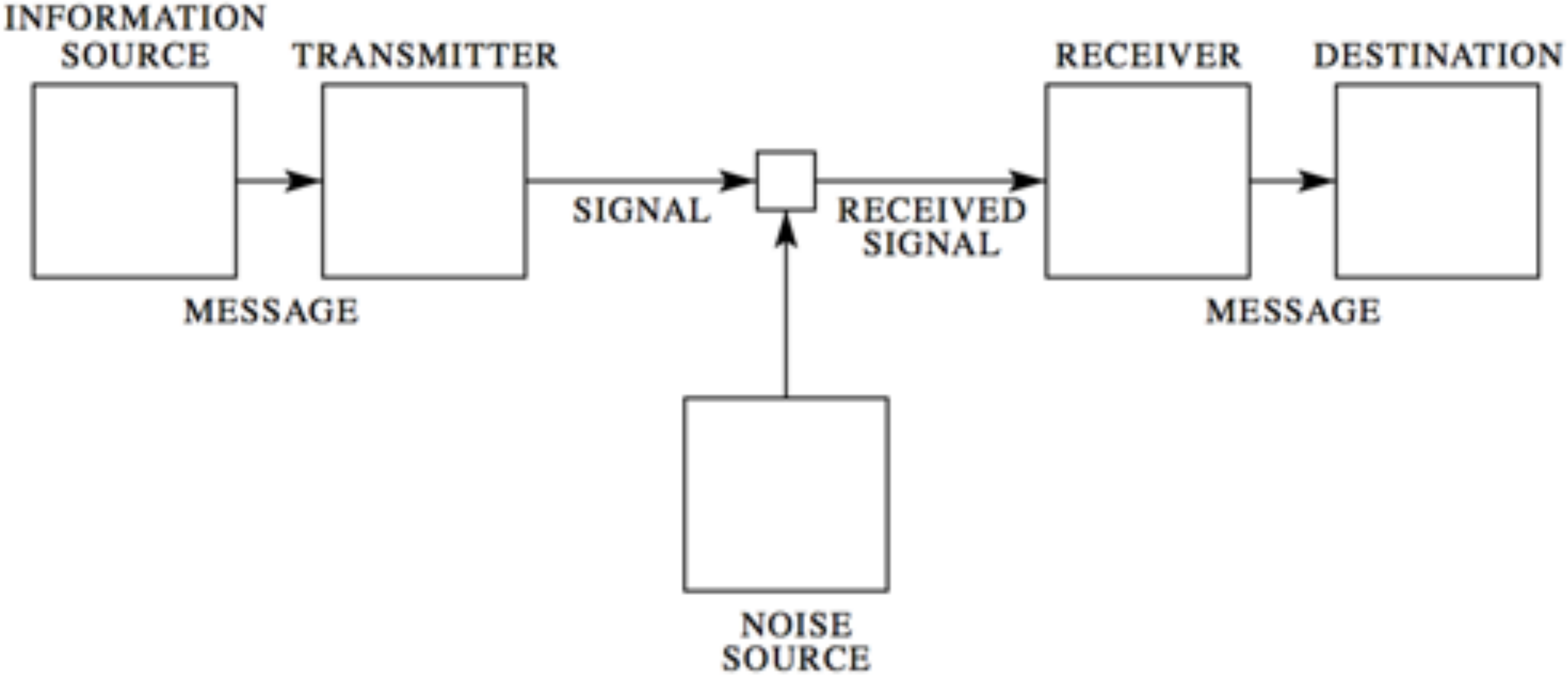
THE recent development of various methods of modulation such as PCM and PPM which exchange bandwidth for signal-to-noise ratio has intensified the interest in a general theory of communication. A basis for such a theory is contained in the important papers of Nyquist[1] and Hartley[2] on this subject. In the present paper we will extend the theory to include a number of new factors, in particular the effect of noise in the channel, and the savings possible due to the statistical structure of the original message and due to the nature of the final destination of the information.

The fundamental problem of communication is that of reproducing at one point either exactly or approximately a message selected at another point. Frequently the messages have *meaning*; that is they refer to or are correlated according to some system with certain physical or conceptual entities. These semantic aspects of communication are irrelevant to the engineering problem. The significant aspect is that the actual message is one *selected from a set* of possible messages. The system must be designed to operate for each possible selection, not just the one which will actually be chosen since this is unknown at the time of design.

If the number of messages in the set is finite then this number or any monotonic function of this number can be regarded as a measure of the information produced when one message is chosen from the set, all choices being equally likely. As was pointed out by Hartley the most natural choice is the logarithmic function. Although this definition must be generalized considerably when we consider the influence of the statistics of the message and when we have a continuous range of messages, we will in all cases use an essentially logarithmic measure.

Claude E. Shannon: Mathematical Theory of Communication, Bell System Technical Journal, Vol. 27, pp. 379–423, 623–656, July, October, 1948.

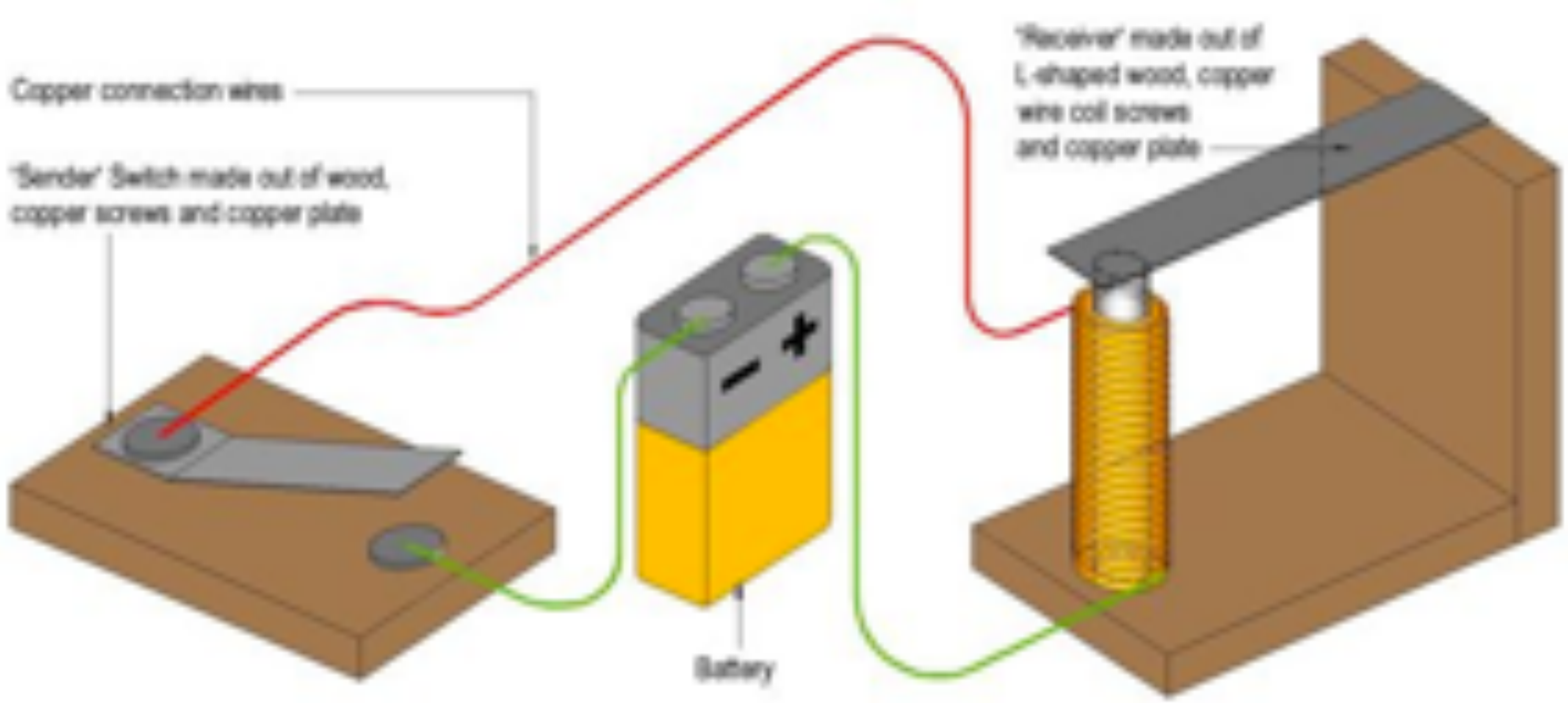
Shannon communication model

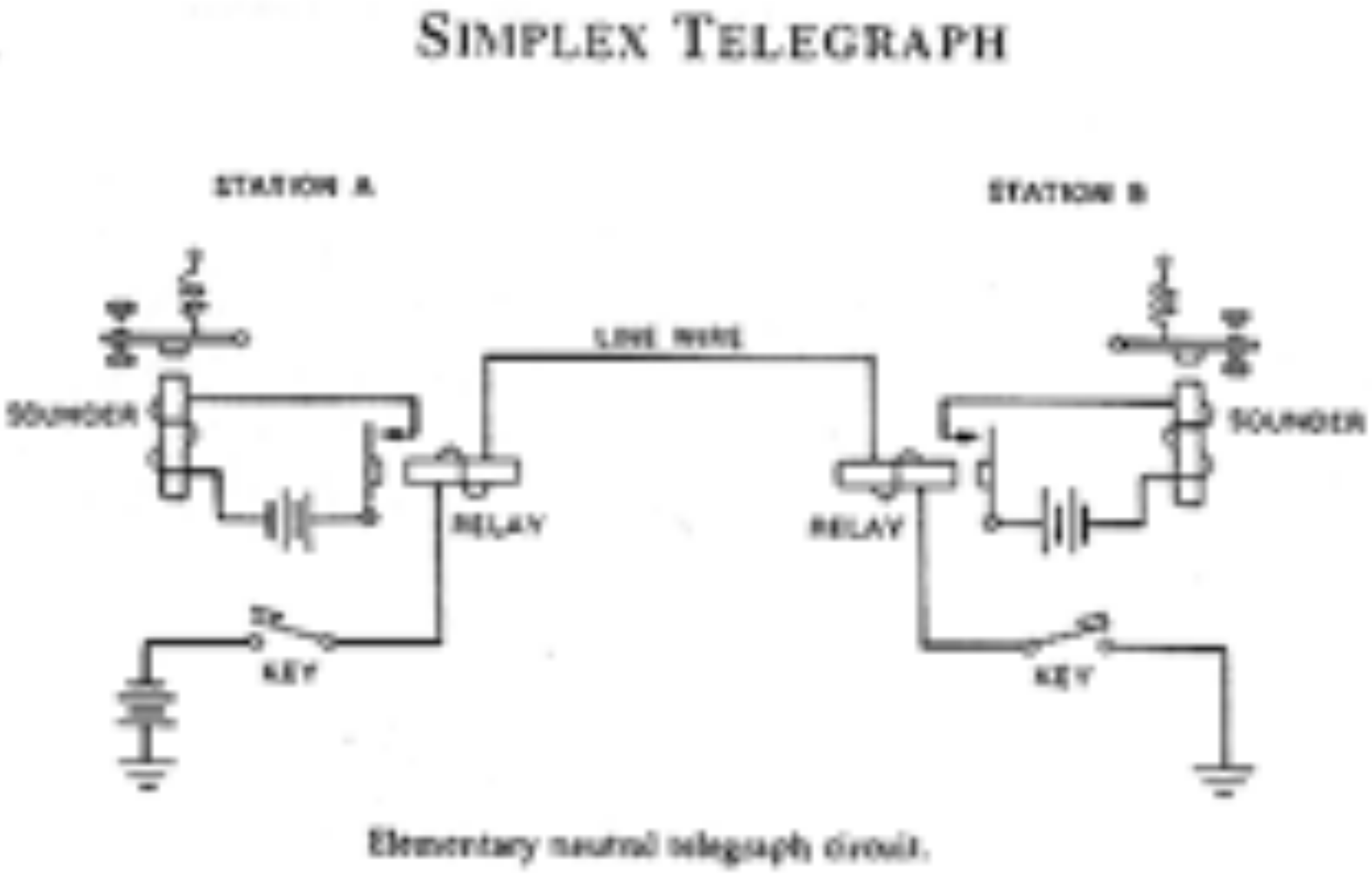


We may roughly classify communication systems into three main categories: discrete, continuous and mixed. By a discrete system we will mean one in which both the message and the signal are a sequence of discrete symbols. A typical case is **telegraphy** where the message is a sequence of letters and the signal a sequence of dots, dashes and spaces. A continuous system is one in which the message and signal are both treated as continuous functions, e.g., radio or television. A mixed system is one in which both discrete and continuous variables appear, e.g., PCM transmission of speech.

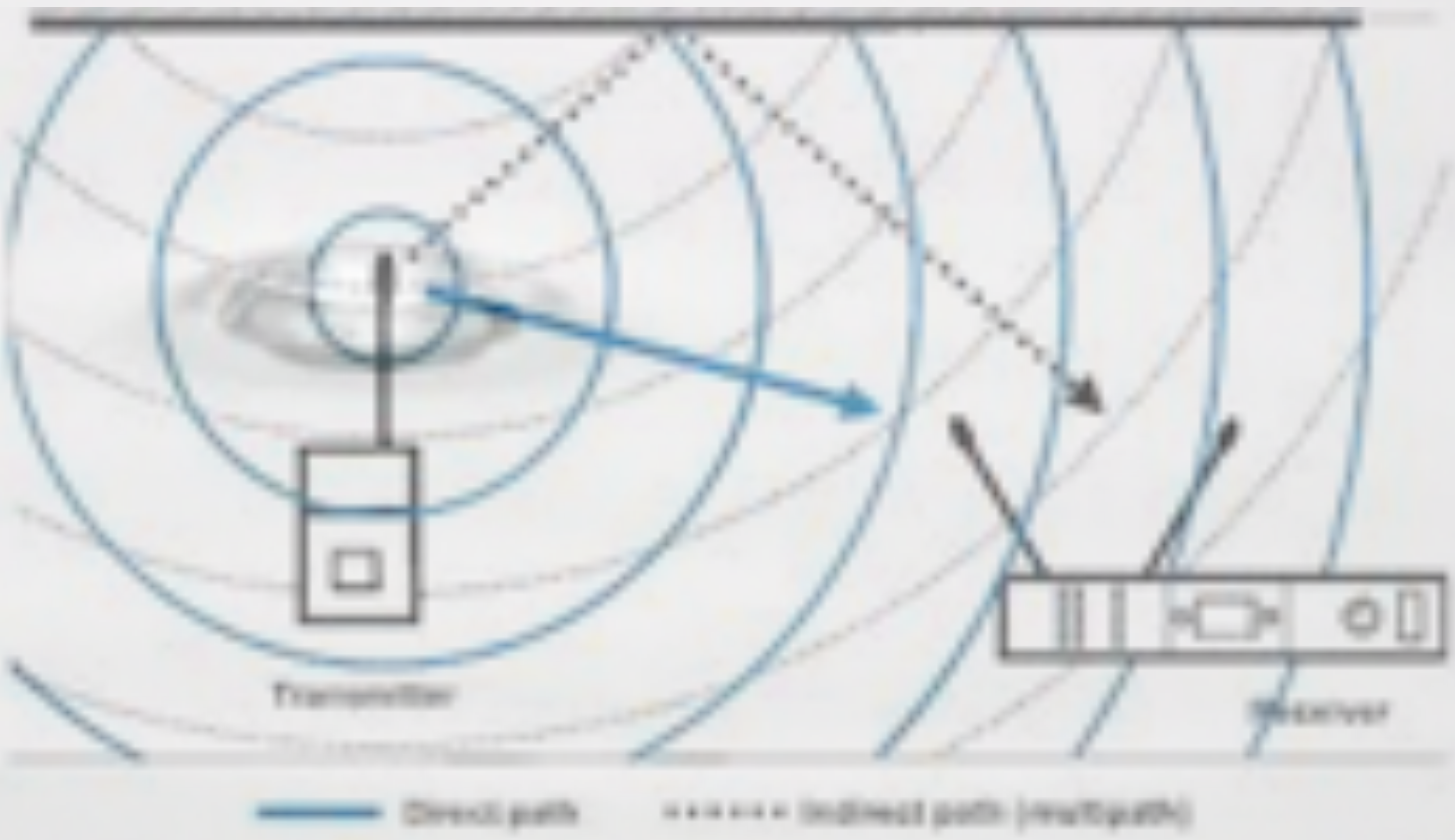
Claude E. Shannon: Mathematical Theory of Communication, Bell System Technical Journal, Vol. 27, pp. 379–423, 623–656, July, October, 1948.

telegraph model of communication





radio field model



CONTINUOUS FIELD, SUPERPOSITION,"WAVES NOT WIRES"

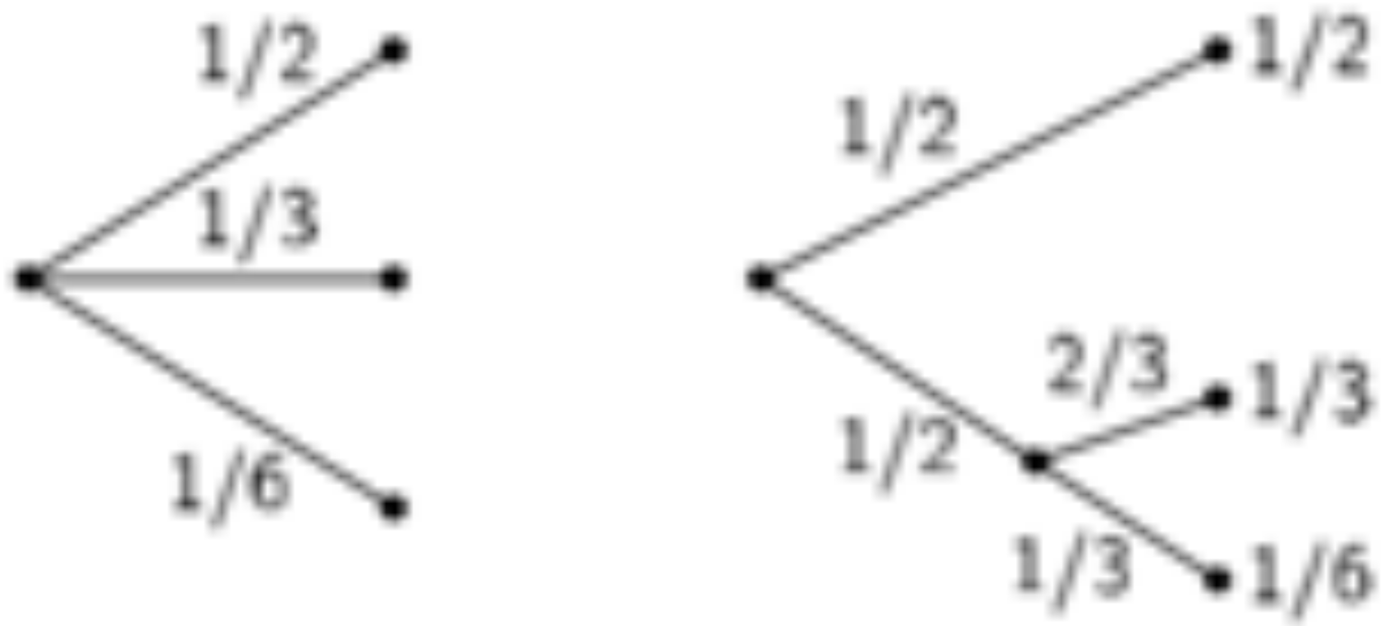
6. Choice, Uncertainty and Entropy

We have represented a discrete information source as a Markoff process. Can we define a quantity which will measure, in some sense, how much information is "produced" by such a process, or better, at what rate information is produced?

Suppose we have a set of possible events whose probabilities of occurrence are $p_1, p_2, \ldots, p_n$. These probabilities are known but that is all we know concerning which event will occur. Can we find a measure of how much "choice" is involved in the selection of the event or of how uncertain we are of the outcome?

If there is such a measure, say $H(p_1, p_2, \ldots, p_n)$, it is reasonable to require of it the following properties:

1. H should be continuous in the p_i.
2. If all the p_i are equal, $p_i = \frac{1}{n}$, then H should be a monotonic increasing function of n. With equally likely events there is more choice, or uncertainty, when there are more possible events.
3. If a choice be broken down into two successive choices, the original H should be the weighted sum of the individual values of H.



$$H = -K \sum_{i=1}^{n} p_i \log p_i$$

Decomposition of a choice from three possibilities.

1 $$H(\tfrac{1}{2}, \tfrac{1}{3}, \tfrac{1}{6}) = H(\tfrac{1}{2}, \tfrac{1}{2}) + \tfrac{1}{2} H(\tfrac{2}{3}, \tfrac{1}{3}).$$

continuous signal

18. SETS AND ENSEMBLES OF FUNCTIONS

We shall have to deal in the continuous case with sets of functions and ensembles of functions. A set of functions, as the name implies, is merely a class or collection of functions, generally of one variable, time. It can be specified by giving an explicit representation of the various functions in the set, or implicitly by giving a property which functions in the set possess and others do not. Some examples are:

1. The set of functions:

$$f_\theta(t) = \sin(t+\theta).$$

   Each particular value of θ determines a particular function in the set.

2. The set of all functions of time containing no frequencies over W cycles per second.

3. The set of all functions limited in band to W and in amplitude to A.

4. The set of all English speech signals as functions of time.

Claude E. Shannon: Mathematical Theory of Communication, Bell System Technical Journal, Vol. 27, pp. 379–423, 623–656, July, October,

5. The set of English speech functions with the probability measure given by the frequency of occurrence in ordinary use.

An ensemble of functions $f_\alpha(t)$ is *stationary* if the same ensemble results when all functions are shifted any fixed amount in time. The ensemble

$$f_\theta(t) = \sin(t+\theta)$$

is stationary if θ is distributed uniformly from 0 to 2π. If we shift each function by t_1 we obtain

$$\begin{aligned} f_\theta(t+t_1) &= \sin(t+t_1+\theta) \\ &= \sin(t+\varphi) \end{aligned}$$

with φ distributed uniformly from 0 to 2π. Each function has changed but the ensemble as a whole is invariant under the translation. The other examples given above are also stationary.

An ensemble is *ergodic* if it is stationary, and there is no subset of the functions in the set with a probability different from 0 and 1 which is stationary. The ensemble

$$\sin(t+\theta)$$

is ergodic. No subset of these functions of probability $\neq 0, 1$ is transformed into itself under all time translations. On the other hand the ensemble

$$a\sin(t+\theta)$$

with a distributed normally and θ uniform is stationary but not ergodic. The subset of these functions with a between 0 and 1 for example is stationary.

Of the examples given, 3 and 4 are ergodic, and 5 may perhaps be considered so. If an ensemble is ergodic we may say roughly that each function in the set is typical of the ensemble. More precisely it is known that with an ergodic ensemble an average of any statistic over the ensemble is equal (with probability 1) to an average over the time translations of a particular function of the set.[3] Roughly speaking, each function can be expected, as time progresses, to go through, with the proper frequency, all the convolutions of any of the functions in the set.

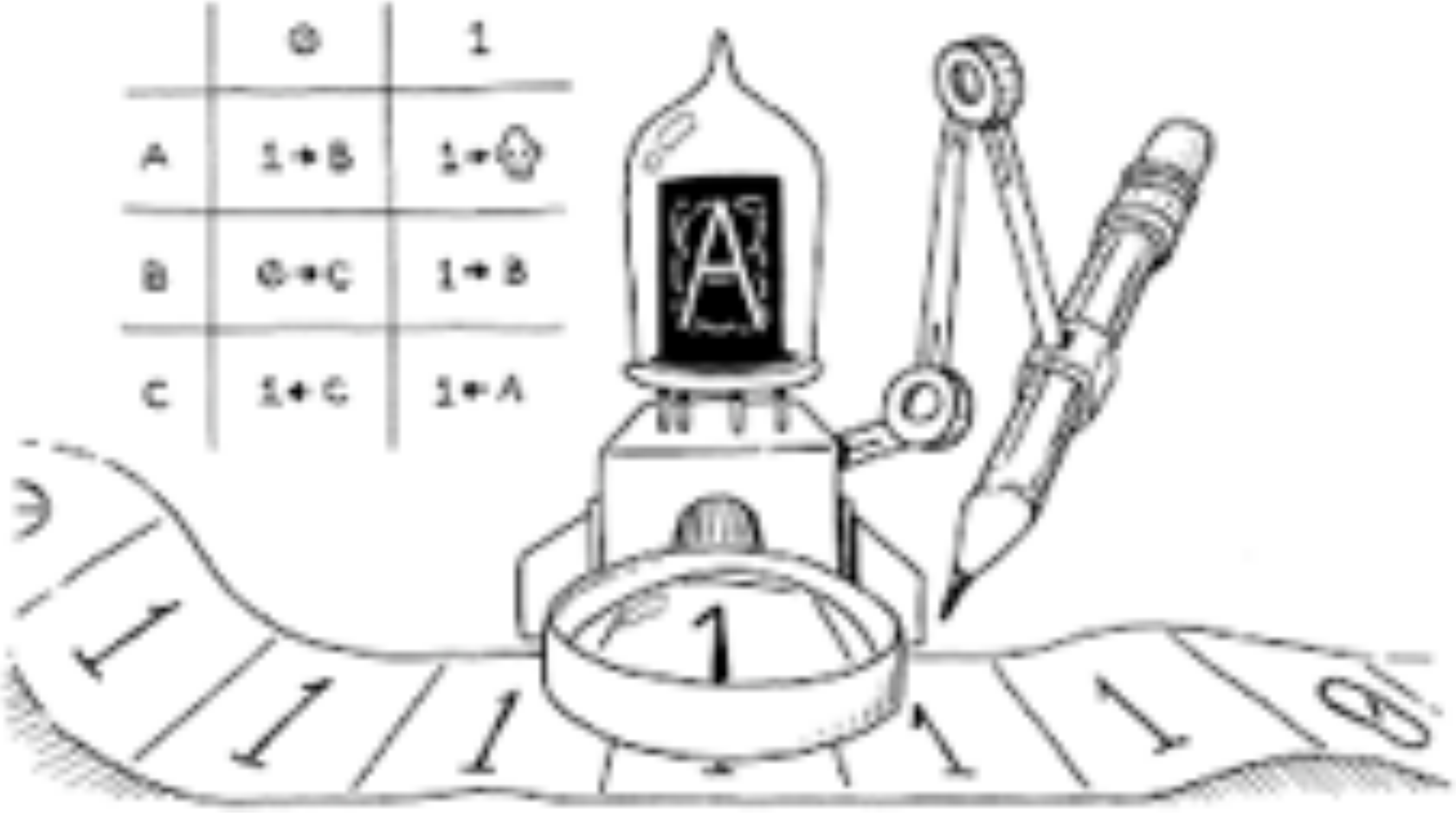
digital / discrete representation

information ≠ meaning
telegraph ≠ speech
code ≠ language
data ≠ information ≠ knowledge

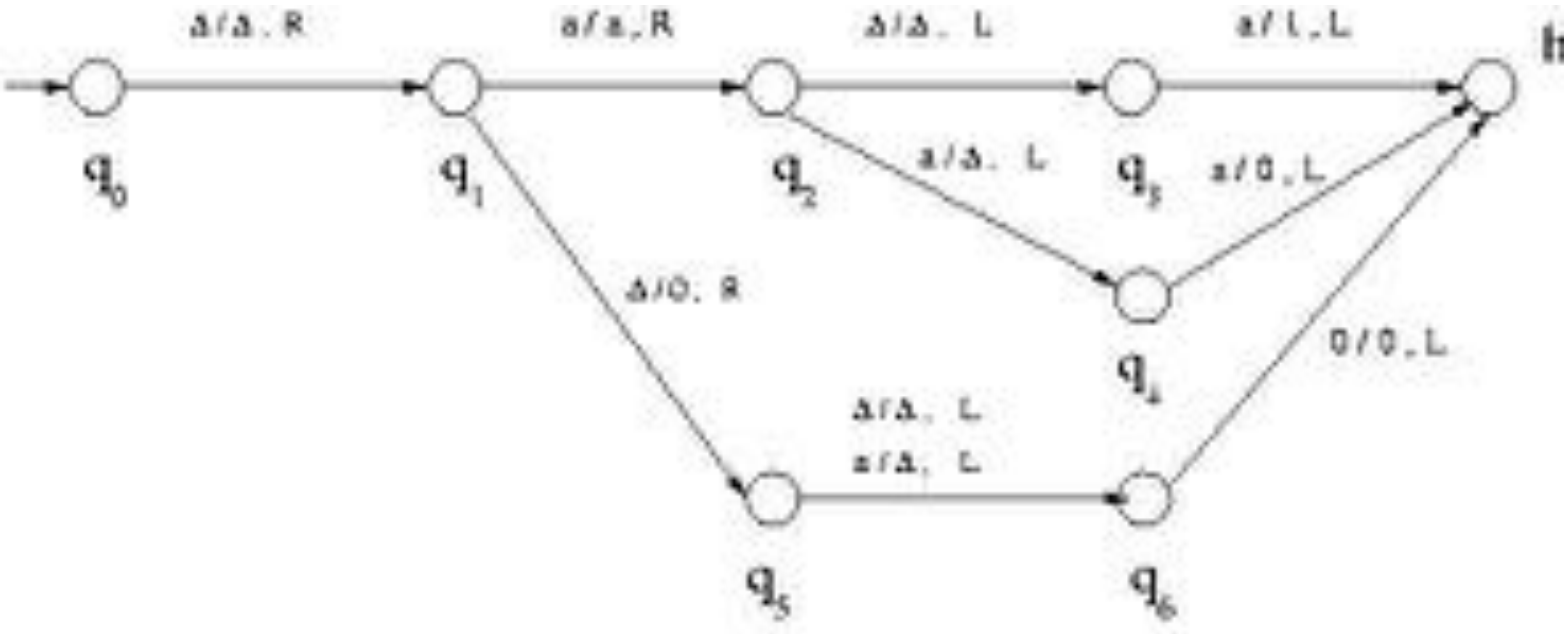
algorithmic computation

Turing machine

All cor



discrete finite state machine



machine learning | pattern recognition

- Only parrots what it has been shown
- Classification ≠ Meaning > signifying
- Sound : Perceptual encoding (OMAX)

"feature" —> signal, difference in degree, not kind?

[Ethically] construed action *constructs* [ethical] agents

Don’t flatten [subjects] to computer model's caricature!

technical ensemble, gestural articulation

Live performance : **zero-learning** oracle markov model to synthesize multiple voices,
Navid Navab (TML) + Matralab, using OMAX (IRCAM). 2012

Gilbert Simondon, Technical ensemble. Mode of Existence of the Technical Object

incompleteness theorem

In any axiomatic system including Z, one can construct propositions that are neither provable nor refutable.

there is no natural number that codes a derivation of '0=1' from the axioms of F
(Kurt Gødel)

incompleteness & undecidability theorems

A Gödelian Puzzle. Let us consider a computing machine that prints out various expressions composed of the following five symbols:

$$\sim \; P \; N \; (\;)$$

By an *expression*, we mean any finite non-empty string of these five symbols. An expression X is called *printable* if the machine can print it. We assume the machine programmed so that any expression that the machine can print will be printed sooner or later.

By the *norm* of an expression X, we shall mean the expression $X(X)$—e.g. the norm of $P{\sim}$ is $P{\sim}(P{\sim})$. By a *sentence*, we mean any expression of one of the following four forms (X is any expression):

(1) $P(X)$
(2) $PN(X)$
(3) $\sim P(X)$
(4) $\sim PN(X)$

Informally, P stands for "printable"; N stands for "the norm of" and $\sim$ stands for "not". And so we define $P(X)$ to be *true* if (and only if) X is printable. We define $PN(X)$ to be true if the *norm* of X is printable. We call $\sim P(X)$ true iff (if and only if) X is not printable, and $\sim PN(X)$ is defined to be true iff the norm of X is not printable. [This last sentence we read as "Not printable the norm of X", or, in better English: "The norm of X is not printable".]

sentences printed by the machine are true. And so, for example, if the machine ever prints $P(X)$, then X really is printable (X will be printed by the machine sooner or later). Also, if $PN(X)$ is printable, so is $X(X)$ (the norm of X). Now, suppose X is printable. Does it follow that $P(X)$ is printable? Not necessarily. If X is printable, then $P(X)$ is certainly *true*, but we are not given that the machine is capable of printing *all* true sentences but only that the machine never prints any false ones.

Is it possible that the machine *can* print all true sentences? The answer is *no*

~ P N (~ P N)

true <=> ~ P N is printable

Raymond Smullyan, Gødel's Incompleteness Theorems

theorem: voting impossibility

(Ken Arrow 1952)

theorem: voting impossibility

Def: A **transitive preference** P on a set of candidates S is a *weak linear ordering* on the elements of S ($x \leq y$, $y \leq x$, and yet $x \neq y$). An **individual preference order** (IPO) is a transitive preference associated with a voter.

Def: A **constitution** for N voters is a well-defined total function $C : P^N \rightarrow P$: mapping every N-tuple of individual preference orders to a **resulting preference ordering** (RPO).

theorem: voting impossibility

Def: A constitution respects **independence of irrelevant alternatives** if the relationship between alternatives α and β in the RPO is determined only by the relative rankings of α and β in the IPOs.

Def: A constitution respects **unanimity** if the RPO ranks α > β whenever every IPO ranks α > β.

Def: A constitution is a **dictatorship** if there is an individual (the dictator) such that the RPO puts alternative α above β whenever the dictator puts alternative α above β.

theorem: voting impossibility

Theorem: (Kenneth Arrow, 1951) If there are at least three candidates, the only constitutions that respects transitivity, independence of irrelevant alternatives, and unanimity are dictatorships.

Definition: A constitution is **computable** if there is an algorithm to decide for all profiles and all candidates x and y whether society prefers x to y given an index of the coalition that prefers x to y.

Theorem: (H. Reiju Mihara, 1994) The only computable constitution that satisfies Unanimity, and Independence of Irrelevant Alternatives, is dictatorship.

i.e.

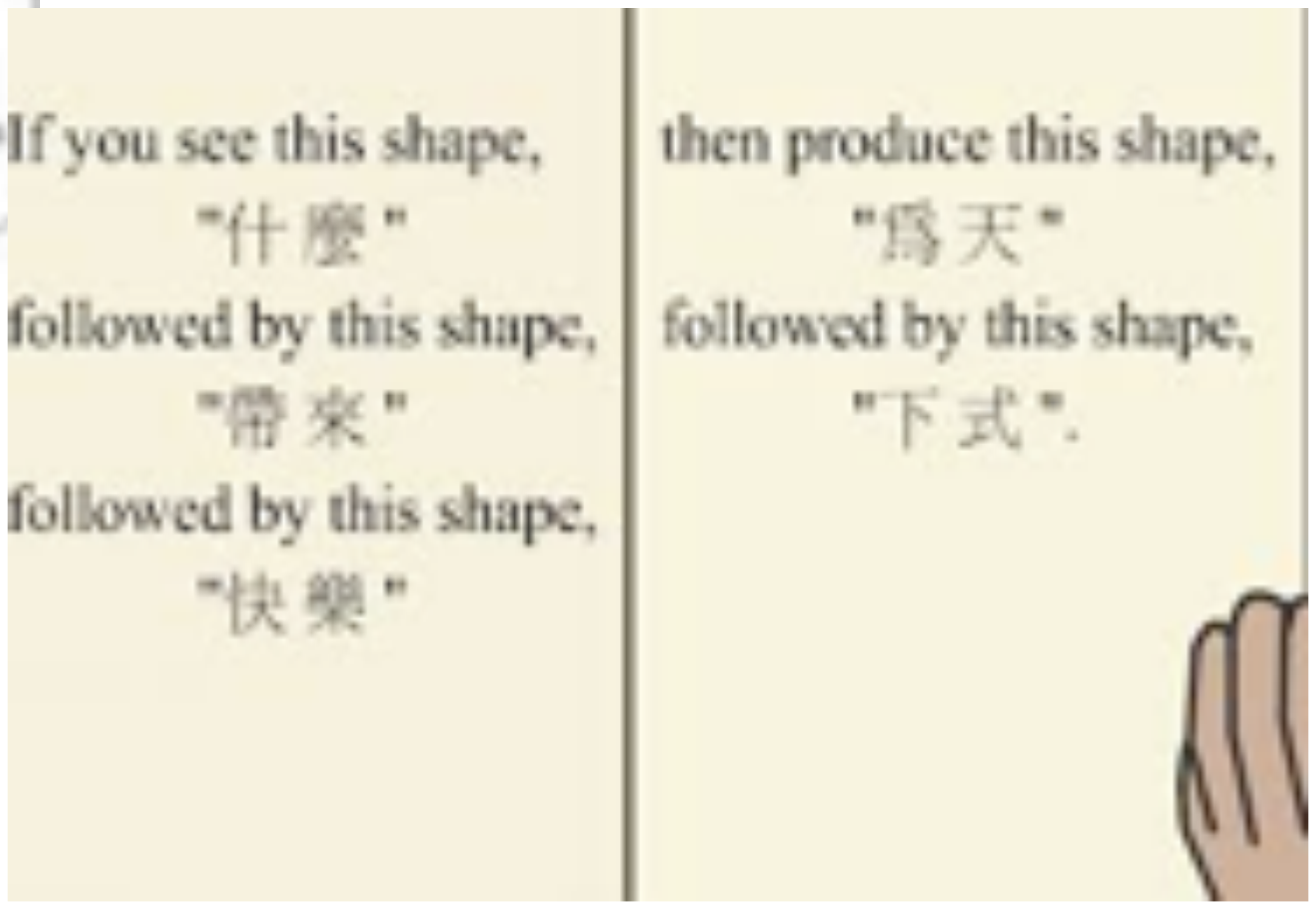
If a constitution satisfying Unanimity, and Independence of Irrelevant Alternatives is implemented in algorithm, then it is a dictatorship.

Geanakoplos, John. Three brief proofs of Arrow's Impossibility Theorem. Cowles Foundation for Research in Economics. (June 2001), pp.1-5.
Mihara, H. Reiju. Arrow's Theorem: precise statement and computability. http://www.aoc.nrao.edu/~jogle/TORG/arrow.txt. March 1994.

machine learning

Searle Chinese Box

table look-up



“conversation” “program” (table lookup)

```
IF input = “mother” | “mom”
THEN PRINT “Do you talk often with
your mother?”;

IF input = “father” | “dad” | “papa"
THEN PRINT “Are you close to your
father?”;
```

Eliza, Weizenbaum 1956, code

neural nets infrastructure??

machine learning / pattern recognition: analysis of sensor data (neural net)

human judgment or brittle code "if-then"

synthesis of pattern according to learned categories (neural net)

where does human judgment go?

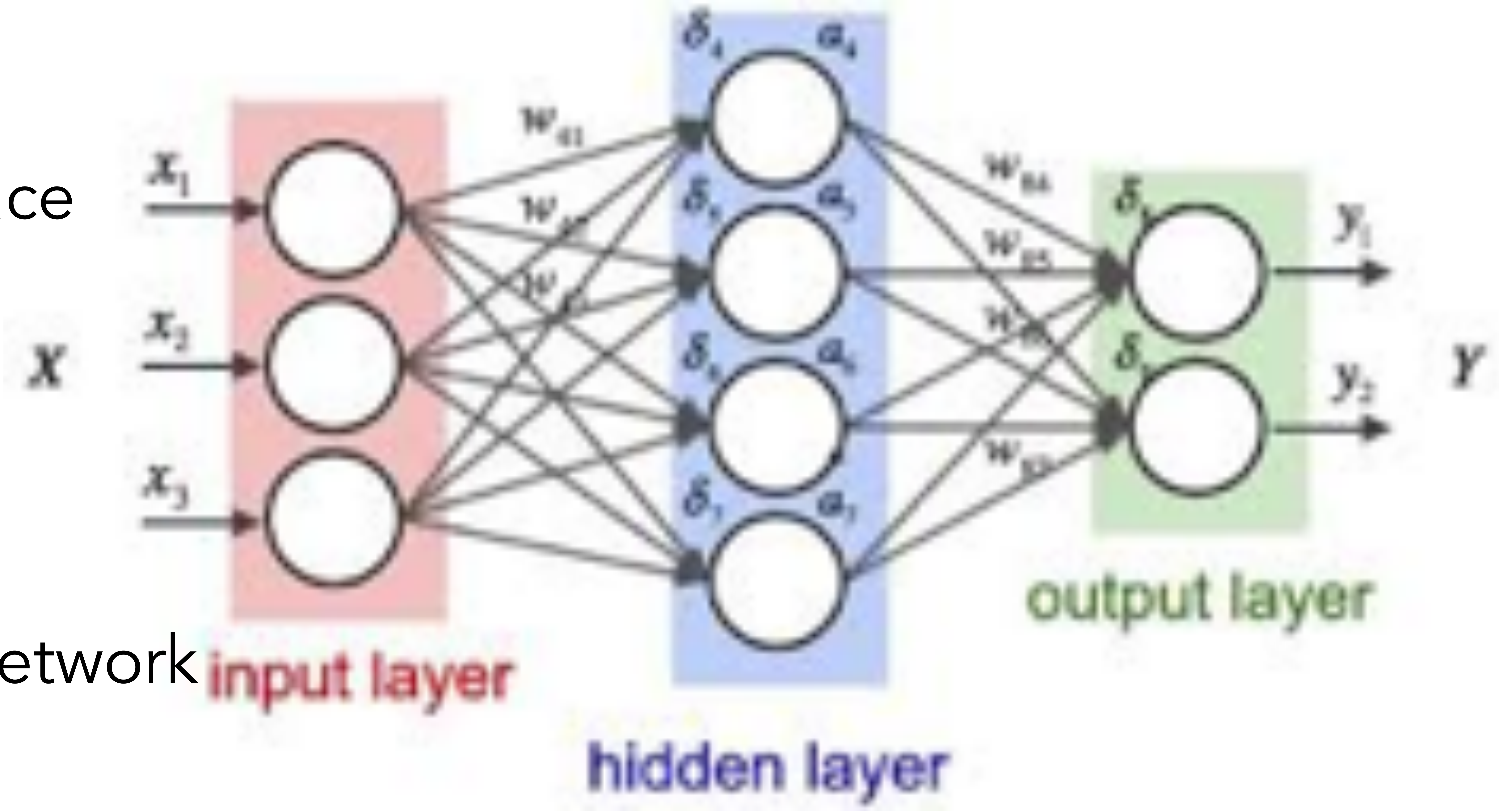
neural net

pattern "recognition" ~ correlation

Feature space

Classifiers

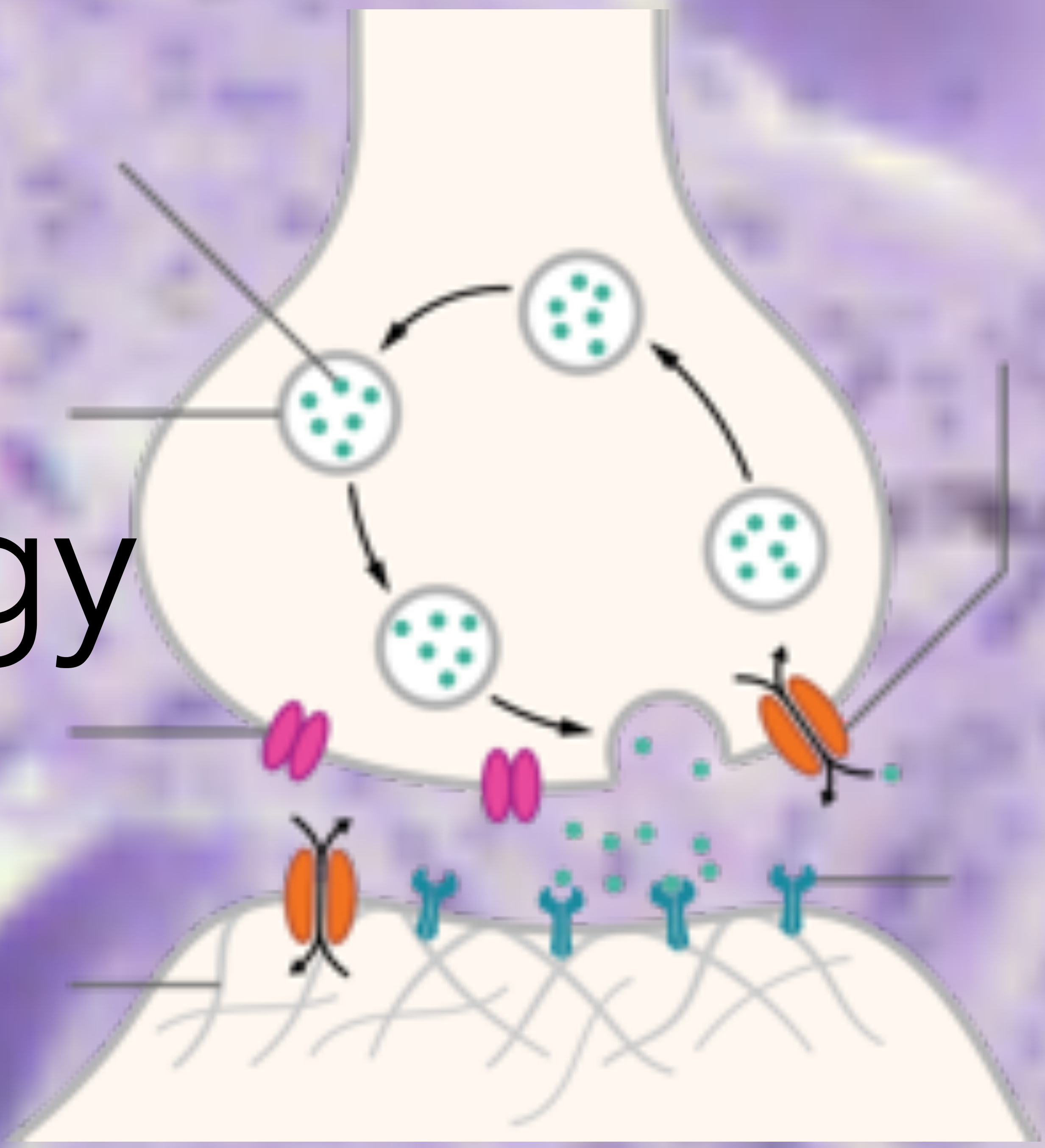
"Neural" Network

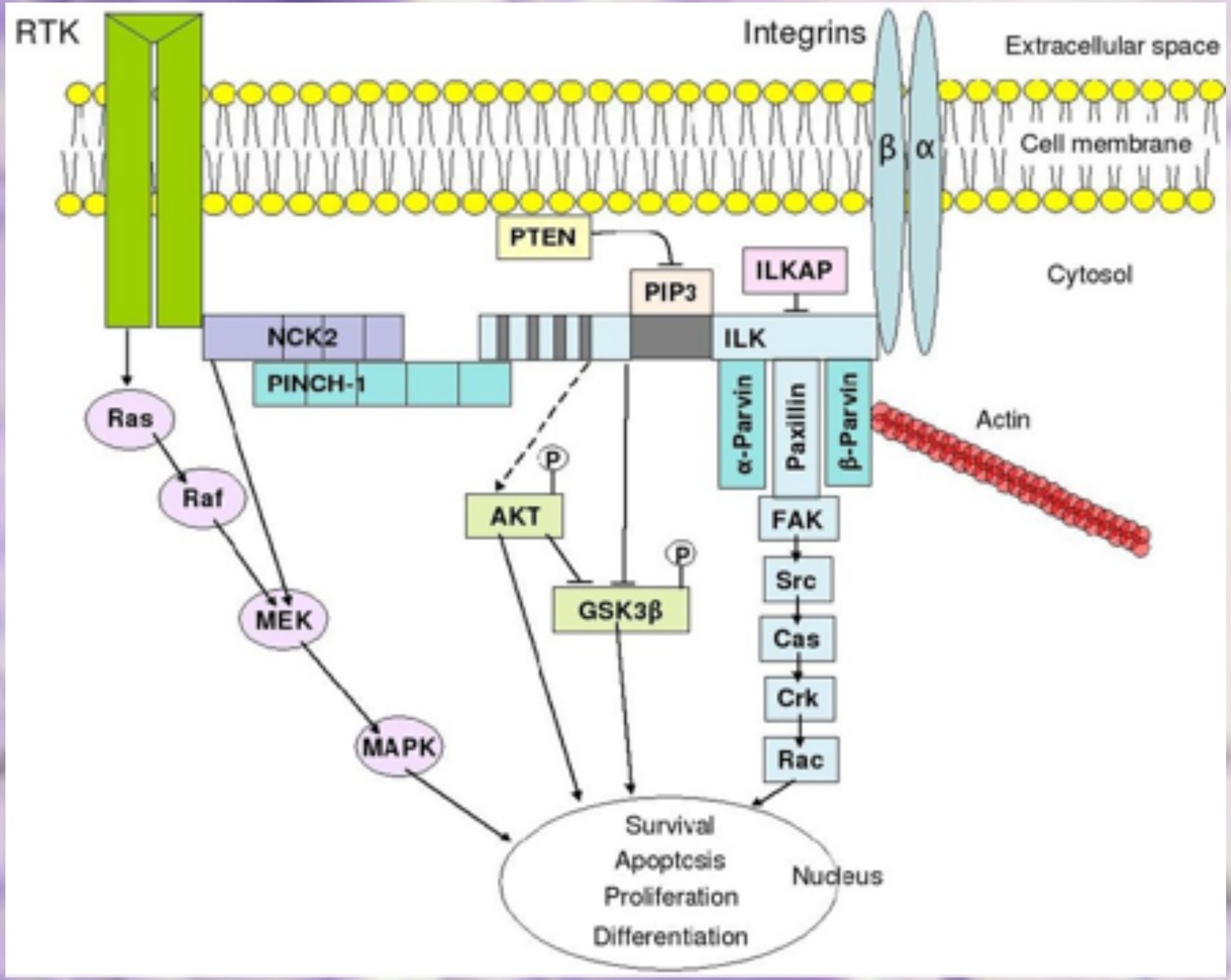


G. Longo: Physics conditions but does not determine biology

metabolism ≠ digital computation

neuronal physiology





https://sites.google.com/site/dominicanbiol152252/_/rsrc/1472183121340/histology/bio152-labs/nervous-tissue/Neuronal%20Slide.jpg?height=266&width=400

machine learning "criminal faces"

Xiaolin Wu and Xi Zhang, "Automated Inference on Criminality using Face Images" 2016

machine learning “criminal faces”

Xiaolin Wu and Xi Zhang, “Automated Inference on Criminality using Face Images” 2016

(a) Three samples in criminal ID photo set S_c.

(b) Three samples in non-criminal ID photo set S_n

theorem: “No Free Lunch” learning

Hume (1739–1740) pointed out that ‘even after the observation of the frequent or constant conjunction of objects, **we have no reason to draw any inference concerning any object beyond those of which we have had experience**’. More recently, and with increasing rigour, Mitchell (1980), Schaffer (1994) and Wolpert (1996) showed that **bias-free learning is futile**.

Wolpert (1996) shows that in a noise-free scenario where the loss function is the misclassification rate, if one is interested in off-training-set error, then there are no a priori distinctions between learning algorithms. More formally, where

d = training set;
m = number of elements in training set;
f = ‘target’ input-output relationships;
h = hypothesis (the algorithm's guess for f made in response to d); and
C = off-training-set ‘loss’ associated with f and h (‘generalization error’)
all algorithms are equivalent, on average, by any of the following measures of risk: E(C|d), E(C|m), E(C|f,d), or E(C|f,m).

How well you do is determined by how ‘aligned’ your learning algorithm P(h|d) is with the actual posterior, P(f|d).

NFL supervised machine learning (Wolpert 1996) ; NFL for search/optimization (Wolpert and Macready 1997).

- WOLPERT, David H., 1996. The lack of *a priori* distinctions between learning algorithms. *Neural Computation*, **8**(7), 1341–1390.
- WOLPERT, David H., 2001. The supervised learning no-free-lunch theorems. *In*: *Proceedings of the 6th Online World Conference on Soft Computing in Industrial Applications*.
- WOLPERT, David H., and William G. MACREADY, 1995. No free lunch theorems for search. Technical Report SFI-TR-95-02-010. Sante Fe, NM, USA: Santa Fe Institute.
- WOLPERT, David H., and William G. MACREADY, 1997. No free lunch theorems for optimization. *IEEE Transactions on Evolutionary Computation*, **1**(1), 67–82.
- WOLPERT, David H., and William G. MACREADY, 2005. Coevolutionary free lunches. *IEEE Transactions on Evolutionary Computation*, **9**(6), 721–735

neural-net synthesis “creativity"

Alternative to test whether humans can distinguish

Deep Dream vs. human-authored poetry

Test whether machine can distinguish:

Deep Dream vs human using Photoshop filter

poetry

here you live off to complain from the same men
down to make him, the rains the edge and a scratch
    and over the window
    and the moon
    that we fear
    but I said,
    he was remains and probably to what his books,
    to fell be break and but on the little
    and the able to hell

in the bride to me.
    I was to the thing for a fools to the street
    with a street
    and the windows of the thing in the streets and still
    on the streets and the sea ass and the streets while I
was a flashing the buses in the darkness in the lights
and stood to see the same one is not so for a stone and
the sky
    in a walls of the bare and she was a cigarette
    and the counter shoe of the streets

One must have a mind of winter
To regard the frost and the boughs
Of the pine-trees crusted with snow;

And have been cold a long time
To behold the junipers shagged with ice,
The spruces rough in the distant glitter

Of the January sun; and not to think
Of any misery in the sound of the wind,
In the sound of a few leaves,

Which is the sound of the land
Full of the same wind
That is blowing in the same bare place

~~recognition~~, ~~care~~ | enclosure of public space

final camera view, Uber self-driving car, Tempe, AZ

Boston Robotics

play & urban infrastructure

13 October 1955

Project for Rational Improvements to the City of Paris

All street-lamps should be equipped with switches; lighting should be for public use.

Lettrist intervention / Situationists

playable public space

Schouwburgplein / Theater Square, Rotterdam theorem:

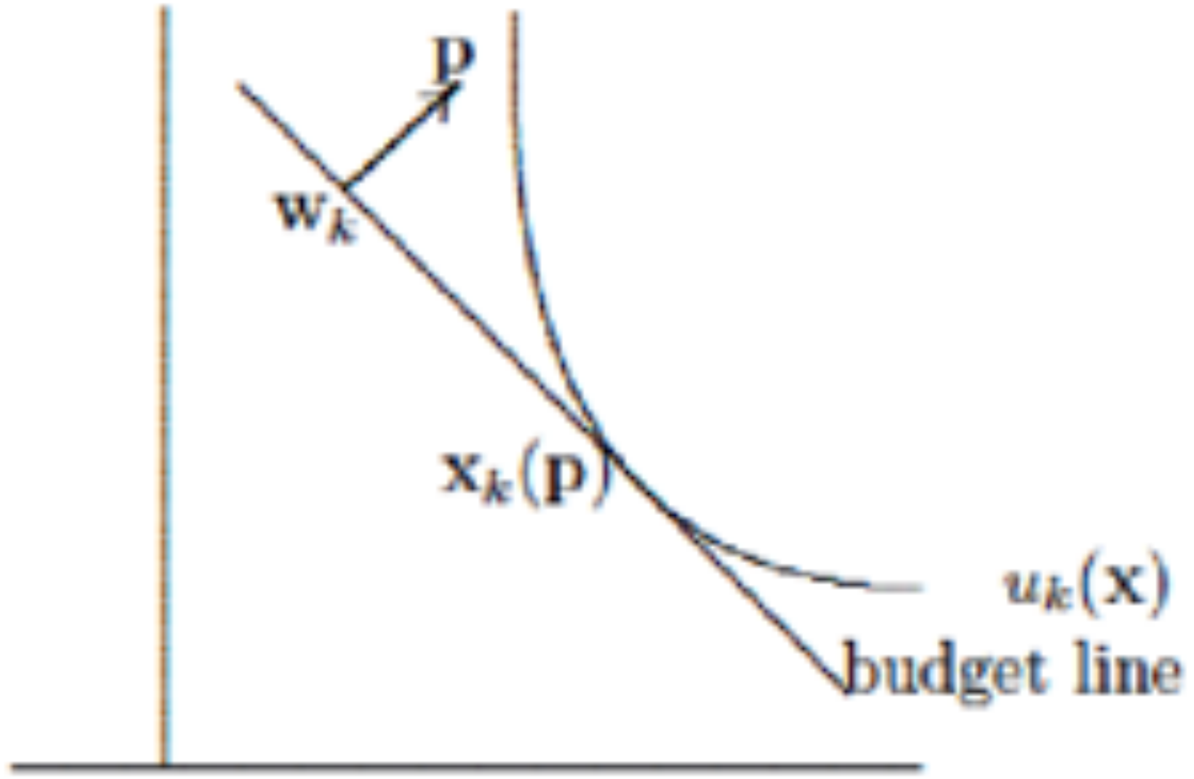
markets are **generically** chaotic

theorem: markets are generically chaotic

In a $n \geq 2$ commodity world without production, agents can exchange goods according to (positive) prices. If p_j is the price per unit of the jth commodity, the cost of $x_j > 0$ units is $p_j x_j$. So, letting vector $\mathbf{p}$ represent the prices of all commodities, the cost of a *commodity bundle* $\mathbf{x} = (x_1, \ldots, x_n) \in R^n_+$ is computed by the inner product $(\mathbf{p}, \mathbf{x})$. In an exchange economy, what the kth agent can afford is based on what he can sell – his *initial endowment* $\mathbf{w}_k$ – which provides wealth $(\mathbf{p}, \mathbf{w}_k)$. Thus at prices $\mathbf{p}$, agent k can afford a commodity bundle $\mathbf{x}_k$ satisfying *the budget constraint* $(\mathbf{p}, \mathbf{x}_k) \leq (\mathbf{p}, \mathbf{w}_k)$, or any $\mathbf{x}_k$ in the *budget set*

(2.1) $$\{\mathbf{x}_k \in R^n_+ \mid (\mathbf{p}, \mathbf{x}_k - \mathbf{w}_k) \leq 0\}$$

The boundary plane passing though $\mathbf{w}_k$ with the price vector $\mathbf{p}$ as a normal is the *budget plane*.



A person's choices at prices $\mathbf{p}$ are governed by personal preferences. As a natural ordering doesn't exist on R^n, $n \geq 2$, impose one by assuming each person's preferences are captured by a *utility function* $u_k : R^n_+ \to R$ where $u_k(\mathbf{y}) > u_k(\mathbf{x})$ iff the kth agent prefers bundle $\mathbf{y}$ to $\mathbf{x}$. To further simplify the mathematics, assume that individual preferences are strictly convex. This means that for any $\mathbf{x}$, those commodity bundles this person likes as much or better than $\mathbf{x}$, $\{\mathbf{y} \mid u_k(\mathbf{y}) \geq u_k(\mathbf{x})\}$, is a strictly convex set.

The kth agent's *excess demand*, $\xi_k(\mathbf{p}) = \mathbf{x}_k(\mathbf{p}) - \mathbf{w}_k$, is the difference between what is demanded, $\mathbf{x}_k(\mathbf{p})$, and what is supplied, $\mathbf{w}_k$. This elementary derivation immediately leads to the classical properties of the *aggregate excess demand function*, $\xi(\mathbf{p}) = \sum_{k=1}^{n} \xi_k(\mathbf{p})$, called *Walras' laws*.

1. $\xi(\mathbf{p})$ is single-valued and smooth (because of u_k's convexity and smoothness),
2. $\xi(\mathbf{p})$ is homogeneous of degree zero (because each $\xi_k(\mathbf{p})$ is defined by the tangency of the utility function with the budget plane, and for any positive scalar μ, both $\mathbf{p}$ and $\mu\mathbf{p}$ define the same budget plane), and
3. $\xi(\mathbf{p})$ is orthogonal to $\mathbf{p}$ (because both $\mathbf{w}_k$ and $\mathbf{x}_k(\mathbf{p})$ are in the budget plane).

What else happens. As only elementary concepts are used, one might anticipate only well-behaved properties to emerge. But, as already promised, this is not true. To place this problem in a mathematically more convenient framework, notice that Prop. 2 allows us to scale the prices to norm 1; so, treat prices as points on the *price simplex* S^{n-1}_+ – the intersection of the unit sphere S^{n-1} with the positive orthant R^n_+. On the price simplex, $\xi(\mathbf{p})$ is a smooth, tangent vector field (Prop. 1, 3).

Donald G. Saari, Mathematical Complexity of Simple Economics (1978-1986)

theorem: markets are generically chaotic

Mathematically, this forces the vector field $\xi(\mathbf{p})$ to point toward the interior of the price simplex all along the boundary, so, from the Brouwer fixed point theorem (e.g., see [M]), $\xi(\mathbf{p})$ has a zero; thus, price equilibria exist. This description captures the essence of the important Arrow-Debreu construction [AD, AH, De2] establishing in quite general settings the existence of Adam Smith's equilibria.

Price equilibria exist, but do prices tend toward them? In differential form, the commonly told story about the price dynamic, where an increase in demand results in an increase in prices, is

$$\mathbf{p}' = \xi(\mathbf{p}), \qquad (2.3)$$

To re-express Sonnenschein's question, let $\Xi(n)$ be the set of continuous tangent vector fields on S^{n-1}_{+}, $\mathcal{U}$ the set of continuous (smoothness is dropped as the tangency of a level set and the budget plane suffices), strictly convex utility functions, and R^n_+ the space for initial endowments. With a agents, the construction of the aggregate excess demand function defines a mapping

$$\mathcal{F} : [\mathcal{U} \times R^n_+]^a \rightarrow \Xi(n) \qquad (2.5)$$

Using this notation, we can interpret Sonnenschein's question as seeking a characterization of the $\mathcal{F}$ image set in $\Xi(n)$.

Sonnenschein provided an answer, Mantel [M] improved it, and Debreu [De1] proved the version of the SMD theorem which, in our notation, follows. In this theorem, $S^{n-1}_{+,\epsilon} = \{\mathbf{p} \in S^{n-1}_{+} \mid \text{each } p_j \geq \epsilon\}$ is a trimmed price simplex bounding prices away from zero, and $\Xi_\epsilon(n)$ is the set of continuous tangent vector fields on $S^{n-1}_{+,\epsilon}$.

SMD Theorem. *For $n \geq 2$ and $\epsilon > 0$, the price mapping*

$$\mathcal{F}_\epsilon : [\mathcal{U} \times R^n_+]^a \rightarrow \Xi_\epsilon(n) \qquad (2.6)$$

is surjective iff $a \geq n$.

In other words, with at least as many agents as commodities, anything can happen! Whatever dynamic on $S^{n-1}_{+,\epsilon}$ is contemplated, no matter how complex, or how it may imitate a favored example from physics or the newest form of chaotic dynamics, the SMD theorem ensures there exist endowments and continuous, strictly convex preferences for the $a \geq n$ agents so that, at least on the trimmed price simplex, the aggregate excess demand function is the chosen vector field. It now is trivial to dismiss the Smith story simply by choosing a vector field of the kind illustrated in Fig. 2a with a lone, unstable equilibrium. While this economy admits an equilibrium, the prices move away from it.

It now is clear how to construct a dynamic with as complicated a dictionary as desired. The main ingredient is for the map to be sufficiently expansive so that the f image over a specified region covers several other specified regions. As the

might suspect from Eq. 2.2 that expansiveness of individual demands must, in some way, correspond to preferences where the level sets of u_k are fairly flat with small curvature. this is a common choice for utility functions.

If the GNM doesn't work, what does? Simon and I [SS] investigated this question by seeking the minimal conditions that would allow a market mechanism to work. Instead of a particular procedure, we assumed the general form

$$\mathbf{p}' = M(\xi(\mathbf{p}), D_{\mathbf{p}}\xi) \qquad (3.1)$$

where M is piecewise smooth and where the dynamics stops iff $\xi(\mathbf{p}) = \mathbf{0}$;

discouraging for $n \geq 3$ commodities. Namely, should prices adjust as suspected – with some choice of M – then M needs most of the differential information required by GNM to always ensure convergence to at least one of the price equilibria.

equilibria.) So, trying to preserve the Adam Smith story even in this general Eq. 3.1 framework carries the heavy cost of needing an unrealistic amount of information.

s* time derivatives, time lag *j

chaotic behavior of Eq. 3.2 inherited from the SMD Theorem, for any choice of M, s, and j, there exists an open set of aggregate excess demand functions (in any reasonable topology on function space) and an open set of initial conditions where convergence never occurs.

Donald G. Saari, Mathematical Complexity of Simple Economics (1978-1986)

theorem: markets are chaotic

While Williams and I found (in a more general setting) that this is true, we also found that the space of economies is σ-compact with this topology where the obstacles preventing compactness are singularities. So, for any $\epsilon > 0$, if one is willing to exclude a set of economies of (an appropriate) measure less than ϵ (which eliminates a region around singularities), the remaining set of economies (i.e., the remaining choices of initial endowments and preferences) are covered by a finite number of price adjustment procedures. A successful mechanism exists for each economy, but we don't know which one. To relate this assertion to actual practice, notice that the purpose of "market regulations" is to change the price dynamic. So these results imply that while an unregulated free market might not work as widely advertised, if *correct* regulations are imposed, the market now might behave as desired. This conclusion probably would not be to Smith's liking, but it finally is a positive assertion and we might not be able to do much better.

All of these topics involve the tacit assumption that, in some way, the excess demand function for different sets of economies are related. But, are they? Must a well behaved economy of ten goods remain well behaved if one good is taken off the market, or could it become highly chaotic? To explore the reality of this

Theorem ([S5]). *Let $\epsilon > 0$ be given. For $n \geq 2$ commodities, the mapping*

$$\mathcal{F}_\epsilon : [\mathcal{U} \times R^n_+]^a \to \prod_{j=1}^{2^n-(n+1)} \Xi_\epsilon(C_j) \tag{4.2}$$

is surjective iff $a \geq n$.

In other words, the "excess demand" tree description is full and chaotic; anything and everything can happen. This permits us to design all sorts of disturbing scenarios such as where with four goods the aggregate excess demand function carefully adheres to Smith's story with a single globally attracting price equilibrium. Then, withholding commodity c_j from the market creates a chaotic three-commodity vector field with an attractor of, say, fractal dimension $1 + \sqrt{\frac{j}{5}}$, $j = 1, \ldots, 4$.

K sets of endowments & preferences with $K = 2$ and only the full set of three commodities, the three agents' preferences could define a well behaved aggregate excess demand function that would delight Adam Smith should they use one set of initial endowments, but, using different endowments with the same preferences, any imaginable (two-dimensional) form of chaos can break out!

In other words, the SMD Theorem describes what happens with the single set of all commodities and a single assignment of initial endowments; the above result extends this disturbing conclusion to all sets of commodities and it shows that the conclusion can vary significantly with changes in endowments. In particular, this more general conclusion not only causes worry about the invisible hand story, but it forces us to question those tacit assumptions – assumptions basic to several tools from economics – about how the aggregate excess demand function for one commodity set relates to that of others. One might argue (and this is a common reaction during a colloquium lecture – particularly in a department of economics) that there may exist conditions imposing strong relationships. Yes, but it is obvious from the theorem that such constraints cannot be based upon the aggregate excess demand function (as is a common practice); instead they appear to require imposing unrealistically harsh global restrictions on the agents' preferences – restrictions similar to those shown in [CM] to be needed to justify the consumer surplus approach.

Donald G. Saari, Mathematical Complexity of Simple Economics (1978-1986)

theorem: large* databases contain spurious correlations

data-mining will not save us

* threshold depends on correlation

theorem: data-mining and spurious correlation

Pitfalls of exaggerating the value of prediction based on correlated observables have been discussed in the literature for many years. For example, the conclusion of Ferber's 1956 analysis [14] is:

> Clearly the coefficient of **correlation is not a reliable measure** for [the practical problem of selecting functions (hypotheses) **for predictive purposes**], nor does there appear to be at the present time any alternative single statistic adequate in this respect relating to the period of observation. Unsettling as it may seem, **there does not appear to be any statistical substitute for a priori consideration of the adequacy of the basic hypothesis underlying a particular function**.

Even more importantly, it is well-known that **correlation does not imply causation**. In the analysis of the Illinois survey referred above, one notes [1]:

> However, a correlation does not tell us about the underlying cause of a relationship. We do not know from the Illinois data whether drinking was correlated with lower grades because (1) alcohol makes people stupid, or (2) the students who tend to drink tend to be poorer students to begin with, or (3) people who are hung-over from a drinking binge tend to skip class, or (4) students in academic trouble drink in order to drown their sorrows, or some other reason. There can be hundreds of possible explanations for a correlation: the number is limited only by your imagination and ingenuity in thinking up possible reasons for a relationship between two variables.

Cristian S. Calude, Giuseppe Longo, "The Deluge of Spurious Correlations in Big Data ," Foundations of Science, pp. 1-18, March, 2016

spurious correlations in large databases

Let D be a relational database. In full generality, we may consider that *a correlation of variables in D is a set B of size b whose sets of n elements form the correlation (the set of n-ary relations on B, or n values that are considered to be correlated, or monochromatic using the language of colours)*. In other words, when a correlation function – defined according to some given criteria (proximity or, conversely, apartness of some observable values or whatever) – selects a set of n-sets, whose elements form a set of cardinality b, then they become correlated. Thus, the process of selection may be viewed as a colouring of the chosen set of b elements with the same colour – out of c possible ones. We insist that *the criterion of selection – the correlation function – has no relevance here, it is arbitrary: it only matters that, for some reason which may be spurious, all n-sets of a set with b elements have the same colour, that is, turn out to be correlated.* Then Ramsey theorem shows that, given any correlation function and any b, n and c, there always exists a large enough number γ such that *any* set A of size greater than γ contains a set B of size b whose subsets of n elements are all correlated – that is, monochromatic. In other words: Do we want a size b set of values that are correlated by sets of n elements out of c possibilities, for whatever b, n and c *you* choose? Ramsey theorem gives us a large enough number γ such that in *any* set with more elements than γ if we choose in *any* way a partition of n-sets into c classes, we are guaranteed to find a correlation of size b and arity n. We do not know *a priori* what will be the colour of the monochromatic set, in the same way as the data miner does not know in advance which correlation will pop out from the data. However, in every particular instance we can algorithmically find all the monochromatic elements and their colourings.

The analysis above, as well as the one in the following section, are independent of any possible (or not) law-like origin (determination) of the processes modelled in the database, as it is only based on cardinality (number of elements in the database). This analysis complements the one in Section 5. Moreover, the arguments also reinforce each other, as the search for regularities require, by the previous results on the low probabilities of recurrences in deterministic systems, very large databases.

Cristian S. Calude, Giuseppe Longo, "The Deluge of Spurious Correlations in Big Data," Foundations of Science, pp. 1-18, March, 2016

facts ≠ data ≠ life | experience

data-mining won't save us

No Free Lunch theorems

NFL supervised machine learning (Wolpert 1996) ; NFL for search/optimization (Wolpert and Macready 1997).

- WOLPERT, David H., 1996. The lack of *a priori* distinctions between learning algorithms. *Neural Computation*, **8**(7), 1341–1390.
- WOLPERT, David H., 2001. The supervised learning no-free-lunch theorems. *In*: *Proceedings of the 6th Online World Conference on Soft Computing in Industrial Applications*.
- WOLPERT, David H., and William G. MACREADY, 1995. No free lunch theorems for search. Technical Report SFI-TR-95-02-010. Sante Fe, NM, USA: Santa Fe Institute.
- WOLPERT, David H., and William G. MACREADY, 1997. No free lunch theorems for optimization. *IEEE Transactions on Evolutionary Computation*, **1**(1), 67–82.
- WOLPERT, David H., and William G. MACREADY, 2005. Coevolutionary free lunches. *IEEE Transactions on Evolutionary Computation*, **9**(6), 721–735

What you see is what you expect.

wysiwye

No Free Lunch theorems

Hume (1739–1740) pointed out that ‘even after the observation of the frequent or constant conjunction of objects, **we have no reason to draw any inference concerning any object beyond those of which we have had experience**’. More recently, and with increasing rigour, Mitchell (1980), Schaffer (1994) and Wolpert (1996) showed that **bias-free learning is futile**.

Wolpert (1996) shows that in a noise-free scenario where the loss function is the misclassification rate, if one is interested in off-training-set error, then there are no a priori distinctions between learning algorithms. More formally, where

d = training set;
m = number of elements in training set;
f = ‘target’ input-output relationships;
h = hypothesis (the algorithm's guess for f made in response to d); and
C = off-training-set ‘loss’ associated with f and h (‘generalization error’)
all algorithms are equivalent, on average, by any of the following measures of risk: $E(C|d)$, $E(C|m)$, $E(C|f,d)$, or $E(C|f,m)$

How well you do is determined by how ‘aligned’ your learning algorithm $P(h|d)$ is with the actual posterior, $P(f|d)$.

NFL supervised machine learning (Wolpert 1996) ; NFL for search/optimization (Wolpert and Macready 1997).

WOLPERT, David H., 1996. The lack of *a priori* distinctions between learning algorithms. *Neural Computation*, **8**(7), 1341–1390. • WOLPERT, David H., 2001. The supervised learning no-free-lunch theorems. In: Proceedings of the 6th Online World Conference on Soft Computing in Industrial Applications. • WOLPERT, David H., and William G. MACREADY, 1995. No free lunch theorems for search. Technical Report SFI-TR-95-02-010. Sante Fe, NM, USA: Santa Fe Institute. • WOLPERT, David H., and William G. MACREADY, 1997. No free lunch theorems for optimization. *IEEE Transactions on Evolutionary Computation*, **1**(1), 67–82. • WOLPERT, David H., and William G. MACREADY, 2005. Coevolutionary free lunches. *IEEE Transactions on Evolutionary Computation*, **9**(6), 721–735

prototyping alternative economies-ecologies?

Abhay Mathur
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Ariane Middel
Assegid Kidane
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Barbara Formis
Ben Nandin
Brandon Mechtley
Brenda McCaffrey

play in improvisational environments

synthesiscenter.net • ame.asu.edu

value-producing social activity

Social?

Value?

Activity => ~~structure~~ | ~~category~~ << process, experience

economics

Value-producing social activity based on

- Transactions
- Discrete entities, actions
- A priori entities

economics

Value-producing social activity based on

- Transactions
- Discrete entities, actions
- A priori entities

nuance | play

- **Multiple, superposed, polyvalent**
- **Nuance**: arbitrarily fine variation can have boundless effect
- **Rare events** can have significant effect (mutation!)

significance | meaning

- Significance | meaning is **relational**
- **Meaning of signal is its response**
- **Distinctions** between signal | substrate is **conventional**
- Construction of observable renders all other aspects of experience invisible
- Peter Brook: Theater is the art of *making the invisible visible*


abductive
enactive
ensemble
ecosystemic
experimental experience
experiential experiment

nudging, navigating

Participatory steering

prototyping complex biosocial systems

modes of articulation

graph ≠ radio | gas

ontogenesis, play ≠ game

improvisational environments

TML + Alkemie, Hexagram Blackbox, April 2013

poetic-material translation | play virtual

PLAY > GAME’ VIRTUAL > POTENTIAL + ACTIAL

~~representation >~~ articulation

~~representational >~~
performative, enactive

animated light-field, non-anthropocentric rhythm

Forest3 / Cosmos, Chris Ziegler, Chris Zlatek, Connor Rawls, I Shelansky, D Nichols, iStage Synthesis@ASU, 2015-2019

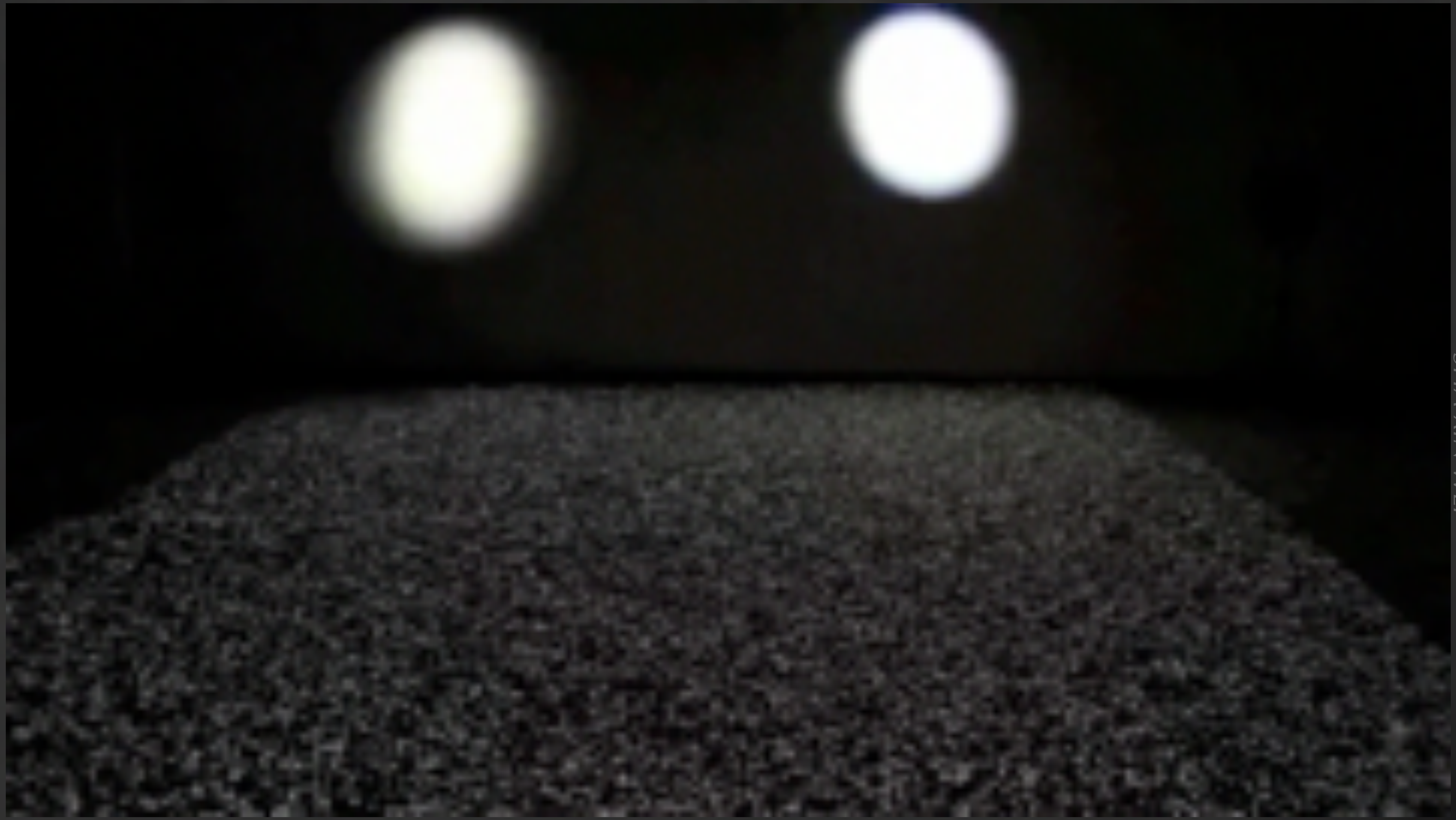
animated light-field, non-anthropocentric rhythm

Forest3, Chris Ziegler, Shelansky, D, Connor Rawls, iStage Synthesis@ASU, 2015-2019

rhythmanalysis

Lanterns apparatus, rhythmic entrainment of ensembles, Garrett L Johnson, Synthesis, Britta J Peterson, 2017

persona



Einstein dream, Topological Media Lab + Alkemie, Hexagram Blackbox, April 2013

SHA XIN WEI

candle time ≠ computer time

time-conditioning

Einsteins Dream, activity-accumulator as measure, TML 2012

SHA XIN WEI

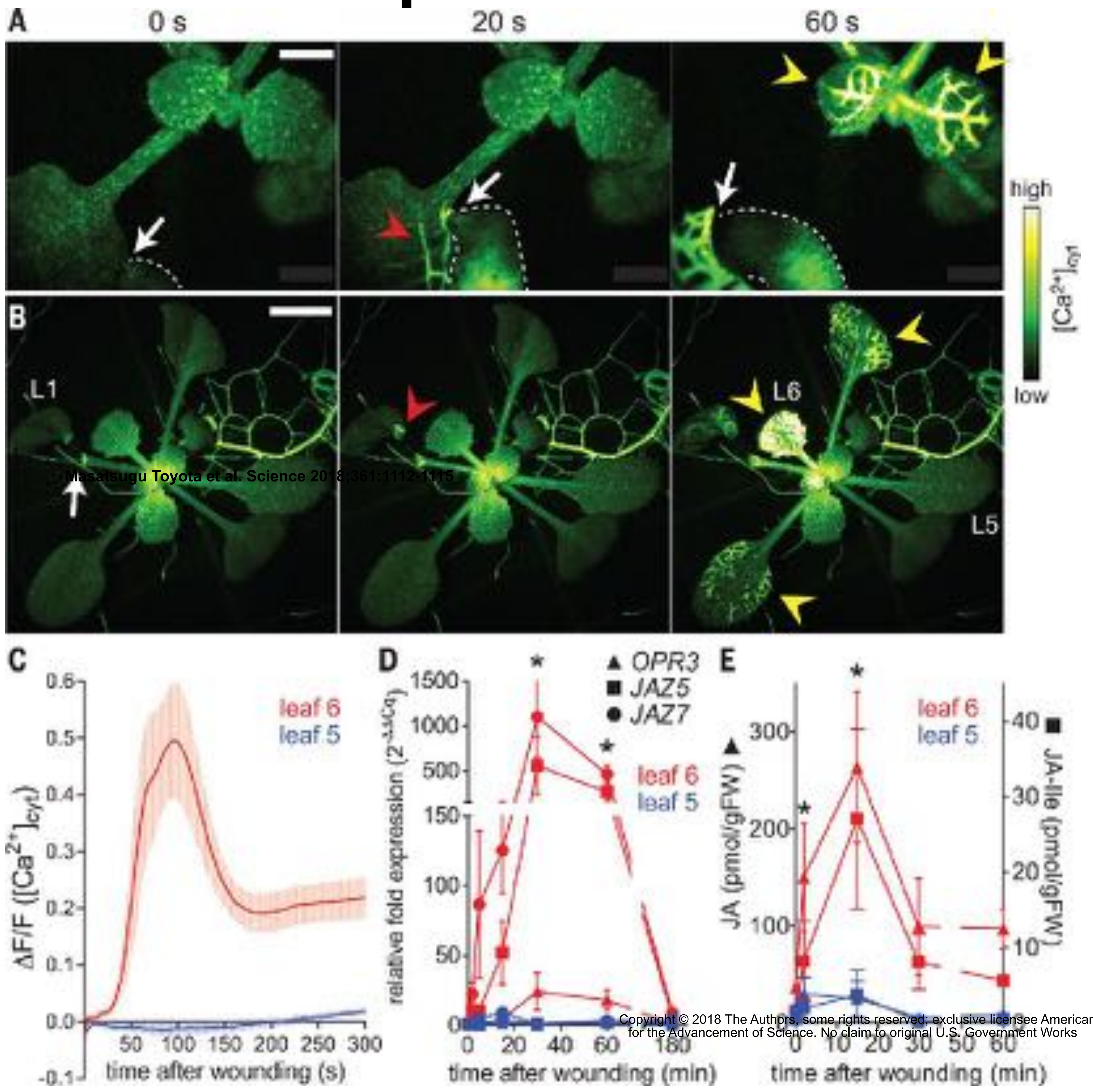
thermal economies

Garrett L Johnson, Media Arts and Sciences PhD, Synthesis, AME ASU

vegetal experience

non-anthropocentric design

plant communication



Masatsugu Toyota et al. Science 2018;361:1112-1115

Masatsugu Toyota, Dirk Spencer, Satoe Sawai-Toyota, Wang Jiaqi, Tong Zhang, Abraham J. Koo, Gregg A. Howe, and Simon Gilroy "Glutamate triggers long-distance, calcium-based plant defense signaling,"

Fig. 1 Wounding triggers long-distance transmission of [Ca2+]cyt increases and systemic defense responses.

Science AAAS

https://science.sciencemag.org/content/361/6407/1112

Jens Rohloff, Atle M. Bones, “Volatile profiling of Arabidopsis thaliana – Putative olfactory compounds in plant communication”, Phytochemistry 66 (2005) 1941–1955.

Abstract Arabidopsis thaliana from the Brassicaceae family has arisen as the model organism in plant biology research. The plants genome has been characterized and worldwide studies are conducted at the genetic, protein and metabolic level to unravell the function of genes involved in growth, reproduction, biosynthesis, and plant communication. As part of the multidisciplinary project BIOEMIT at NTNU, metabolomic studies of Arabidopsis T-DNA knock-out mutants and ecotypes have been carried out. Volatile profiles of autolyzed, intact plants and single plant organs were obtained by solid-phase microextraction coupled with gas chromatography– mass spectrometry. The studies were aimed at the diversity of defense-related compounds from the glucosinolate–myrosinase system – the isothiocyanates and nitriles. Metabolites from methionine, leucine and phenylalanine-derived glucosinolates were most abundant (4-methylthiobutyl, 4-methylpentyl, 2-phenylethyl). In addition, 24 monoterpenes, 26 sesquiterpenes and 12 aromatic structures, predominantly observed in inflorescenses, are described. Excluding the vast group of straight chain aliphatic structures, a total of 102 volatile compounds were detected, of which 59 are reported in Arabidopsis thaliana for the first time, thus emphasizing the sensitivity and applicability of solid-phase microextraction for volatile profiling of plant secondary metabolites.

https://www.researchgate.net/profile/Atle_Bones/publication/7679209_Volatile_profiling_of_Arabidopsis_thaliana_-_Putative_olfactory_compounds_in_plant_communication/links/5a78262c0f7e9b41dbd26a8b/Volatile-profiling-of-Arabidopsis-thaliana-Putative-olfactory-compounds-in-plant-communication.pdf

Hirokazu Ueda, 1 Yukio Kikuta, 2 and Kazuhiko Matsuda 1, "Plant communication mediated by individual or blended VOCs?" Plant Signal Behav. 2012 Feb 1; 7(2): 222–226.

Introduction

Plants are exposed to various stress factors such as disease, injury, herbivory, extreme heat/cold, etc. Hence, they must adjust their physiological state either in response to, or in preparation for, such threats to their well-being and survival.1-5 To achieve this adjustment, plants have developed a communication system to transmit information based on volatile organic compounds (VOCs).

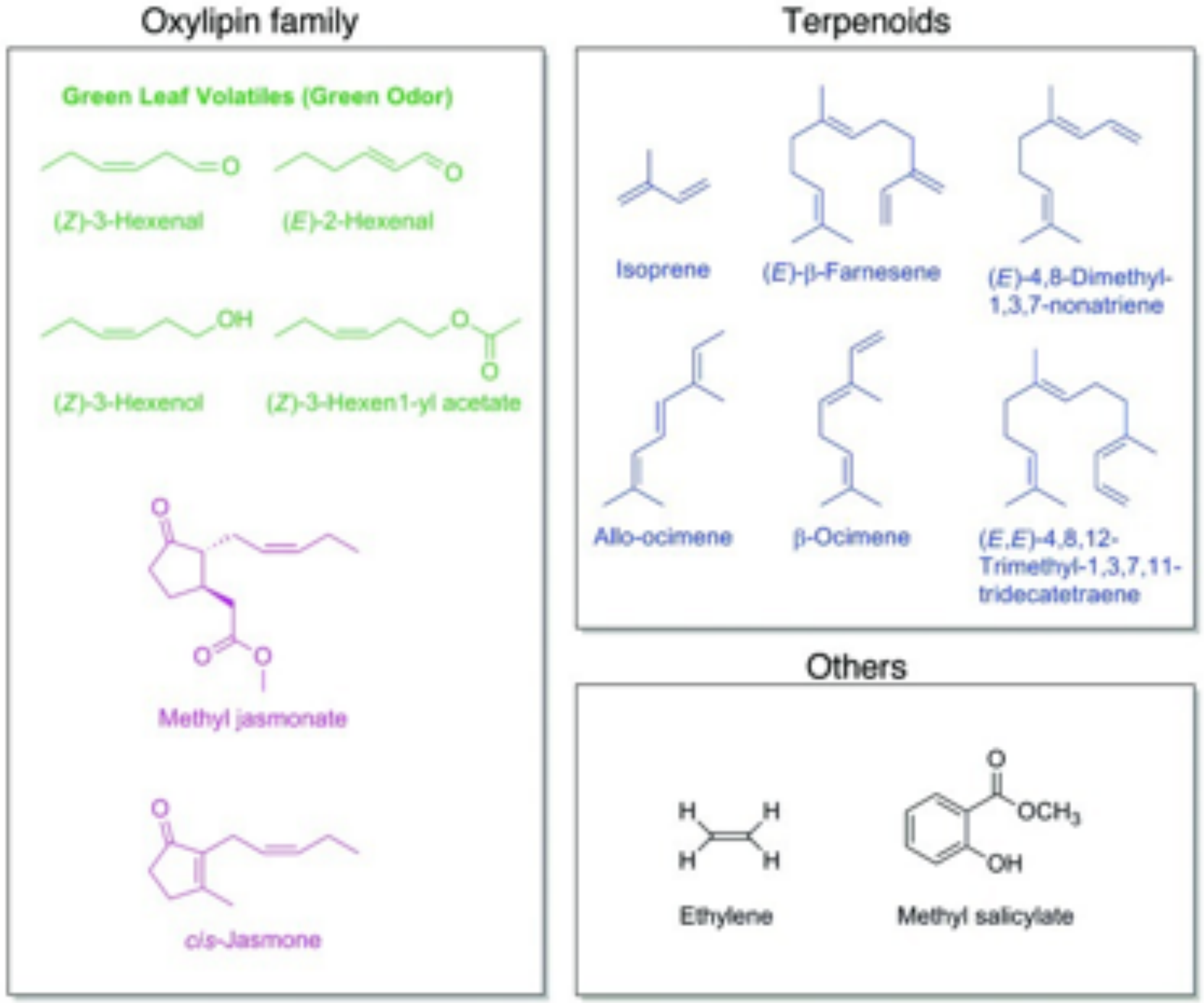
Plants emit VOCs under other circumstances besides the threat of danger. Notably, flowers use VOCs to attract pollinators and ensure reproduction.6,7 Induced VOCs provide more than just a scent. In a damaged plant, VOCs are also used as nonvolatile signals to transmit SOS messages within the plant itself. The airborne signals are diffused to reach undamaged plants nearby, giving them the chance to strengthen their own defense system. The receivers are not limited to conspecies. Natural enemies can also catch the SOS signals and locate the place of battle.

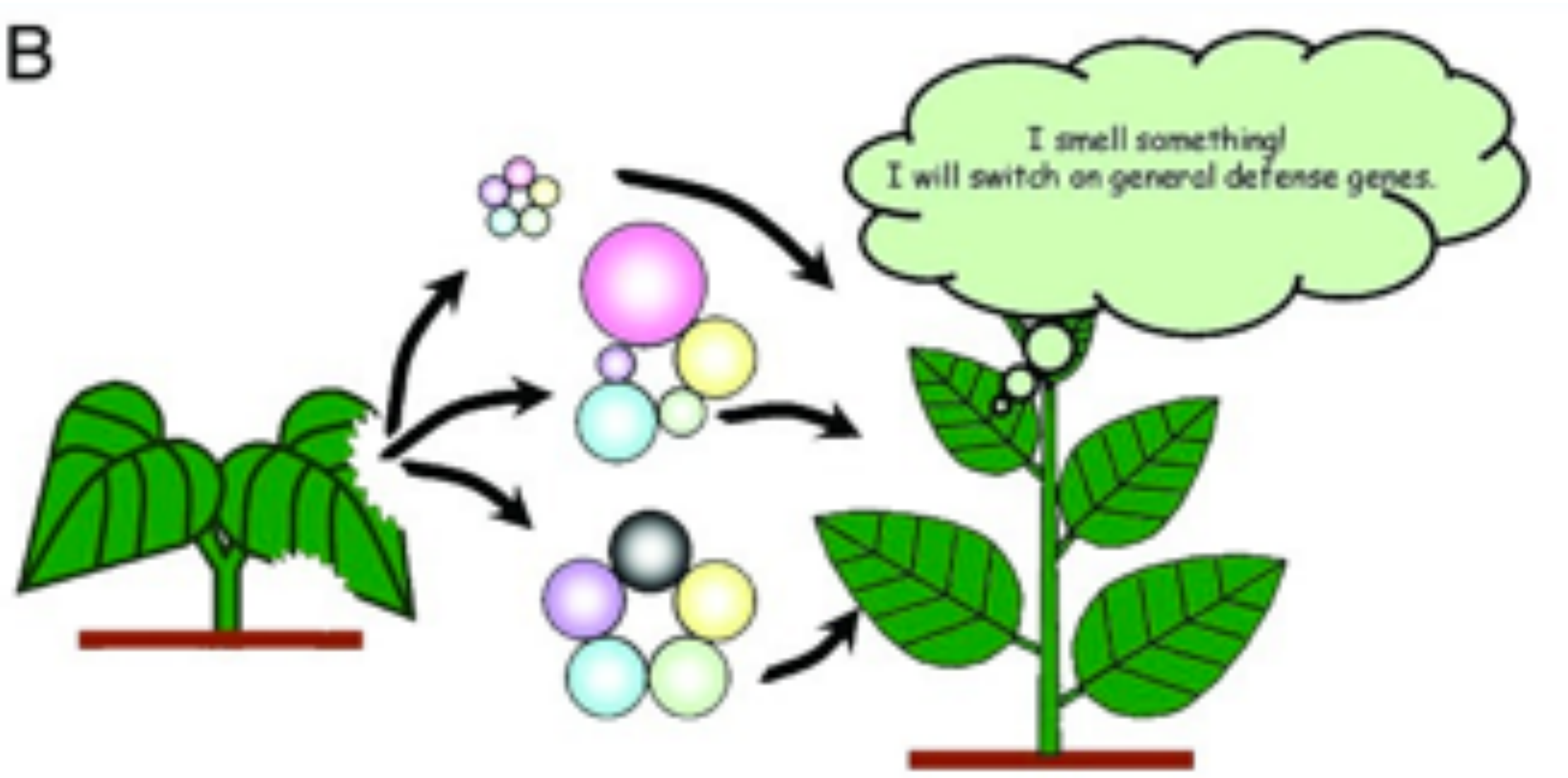
By changing the volatile components and their blend ratios, plants can create specific messages for communication. Earlier studies mainly investigated the effects of individual VOCs on plant defense systems because a single compound is easier to test than a blend of compounds. However, there is increasing evidence that VOCs work as blends in plant-plant communication. Thus, we look at the current status of VOCs in studies on within-plant and plant-plant communications to address the question, "Plant communication: mediated by individual or blended VOCs?"

Plant-Plant Communication

The trigger for development in this field was the discovery that undamaged poplar and sugar maple trees accumulated phenolics and tannins when situated close to damaged trees.14 However, in this original report, no active principle was identified. Methyl jasmonate (MeJA) emitted by sagebrush (Artemisia tridentata) was the first compound shown to render intact plants resistant to herbivores by increasing the proteinase inhibitor production.15 Later on, other VOCs emitted by damaged plants were found to influence the receiver plants, regardless of whether or

communication via gas ~~discrete tokens~~





Serra Vegetal Life

Oana Suteu Khintirian, Todd Ingalls, Sha Xin Wei, Ginette Laurin, O Vertigo + Synthesis
https://vimeo.com/synthesiscenter/serramay2018

Serra full paper sky

Synthesis Serra workshop, iStage ASU, May 2018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