Cognitive-Constructivism, Quine, Dogmas of Empiricism, and Münchhausen's Trilemma

Julio Michael Stern*
IME-USP, The Institute of Mathematics and Statistics
of the University of São Paulo, * *jstern@ime.usp.br*

Presented at the following discussion fora:
EBEB-2014 (Bayesian Statistics), March 10-14, Atibaia;
EBL-2014 (Brazilian Logic), April 07-11, LNCC Petrópolis;
ALFAn-2014 (Analytical Philosophy), May 27-31, Fortaleza;
LIAMF (Logic, AI & Formal Methods), June 05, IME-USP;
SINAPE-2014 (Probability and Statistics), July 20-25, Natal;
MaxEnt-2014 (Maximum Entropy), September 21-26, Amboise.

http://www.ime.usp.br/∼jstern/miscellanea/jmsslide/cogquis.pdf

Cog-Con + *e*-value Reserach Program

Cognitive Constructivism (Cog-Con):
- an epistemological framework for Bayesian *e*-values, truth-value or significance measure for sharp Hypotheses, $\text{ev}(H \mid X)$ - epistemic value of H given obseved data X;
- as Popperian Falsificationism for frequentist *p*-values;
- as von Neumann-Morgenstern Utility Theory or de-Finettian Decision Theory for Bayes Factors;

Lakatos (1977b, p.31-32): *Neyman and Popper found a revolutionary way to finesse the issue by replacing inductive reasoning with a deductive process of hypothesis testing. They then proceeded to develop this shared central idea in different directions, with Popper pursuing it philosophically while Neyman (in his joint work with Pearson) showed how to implement it in scientific practice.*

This Presentation (core)

Shared Premisses in Cog-Con & Quine epistem. frameworks:

- Acceptance / Rejection of Quine and Davidson's "dogmas of empiricism".

(1) ✗ *Analytic-synthetic dualism*;
(2) ✗ *Reductionism*;
(3) ✓ *Scheme-content dualism*;
(4) ✓ *Naturalism*; and
(5) ✓ *Confirmational holism*.

Holism $\Rightarrow$ Vicious circularity?
Circularity $\Rightarrow$ Skepticism?

Contrasting Premisses in Cog-Con & Quine frameworks:

- Regimentation structure for scientific theories;
- Münchhausen trilemma.

(6Q) Predicate logic;
(7Q) Finite regress.

(6CC) Statistical model;
(7CC) Virtuous circularity.

How to anchor scientific theories to reality?

Cognitive Constructivism - Autonomous System

- Autonomous (Living) or *Autopoietic System:*

A system organized as a network of processes of production of components that, through their interactions and transformations, recursively regenerate the same production network and its constituent components; see H.v Foerster (2001,2003), H.Maturana and F.Varela (1980).

- Example of concrete or abstract autonomous system interacting with its environment:

- Bacterium in its culture medium;
- Human individual living in his or her social environment;
- Commercial organization in its field of business;
- Scientific discipline and its field of study, that is, the discipline's standard language, theories, empirical means and methods, experimental tools and equipment, etc., that have been developed for the continuous research of its area of interest.

Scientific Production Diagram

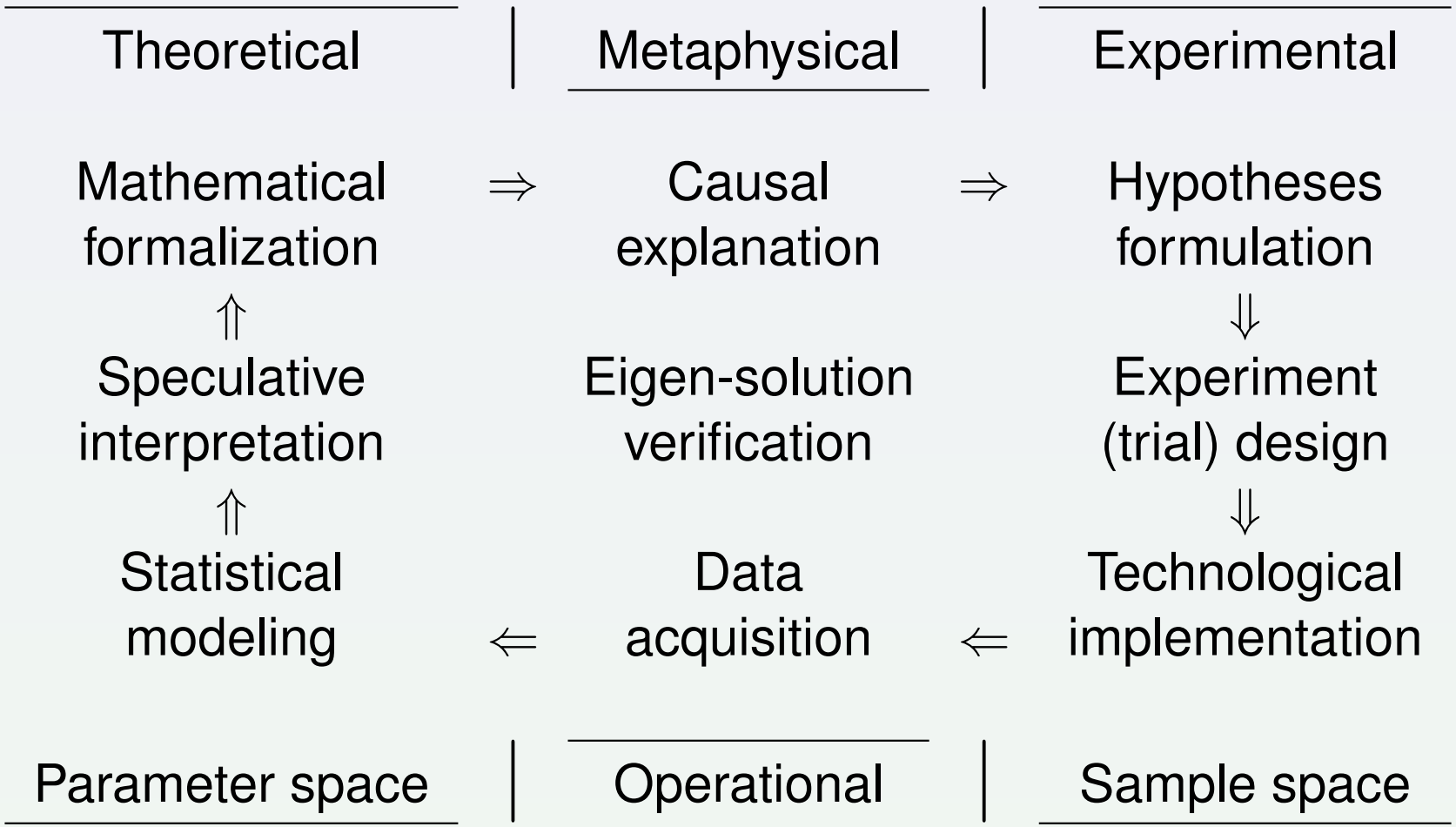


Figure 1: Scientific production diagram.

Objects are Tokens for Eigen-Solutions

- Heinz von Foerster's key metaphor:

- Objects are Tokens for Eigen-Solutions.

- Eigen-solutions emerge as invariant entities, that is, as operational eigen- equilibrium- invariant- fixed-... ...-solutions -states -behaviors -points, for an autonomous system interacting with its environment.

- Objects, and the names (words) we use to call (label) them, stand for and point at such invariant entities.

- Words can be articulated in language. The articulation rules defined for a given language, its grammar and semantics, only make the language useful if they somehow correspond to the composition rules for the objects the words stand for.

- Ontologies are carefully controlled languages used in the practice of science. They are developed as tools for procedure specification, thinking and communication.

Eigen-Solution - Essential Atributes - Ontology

- Eigen-solutions are characterized by four essential attributes, namely - *precision, stability, separability and composability*.
- Precise $\sim$ discrete, lower-dimensional, sharp, singular...
- Essential Attributes may lead to the concept of basis, as in: Linear algebra; Fourier or Wavelet analysis; Continuous or discrete group theory (generators); Matroid structures; etc.
- Fundamental metaphor in general (informal) contexts.

- Represented in statistical models by *sharp hypotheses*, demanding well-adapted methods of statistical inference.
- ZPP - Zero Probability Paradox - Possible $H \mid Pr(H) = 0$!
- $\mathrm{ev}(H \mid X)$ - The Bayesian *epistemic value* or significance measure of hypothesis H given the observed data X. ✓
- Successful (statistical) testing of such sharp hypotheses implies an evaluation of "objectivity" or a verification of "existence" for a corresponding set of objects in a pertinent scientific ontology !!! = ! + ✓

Davidson's Third Dogma of Empiricism

- Donald Davidson (1974) rejects a third dogma, a
(3) *Dualism of scheme and content*, of an organizing system and something waiting to be organized...
...if we give [this third dogma] up it is not clear that there is anything distinctive left to call empiricism.
- Quine (1981) replied accepting this (third) premise, [that] ...remains intact. It has both a descriptive and a normative aspect, and in neither do I think of it as a dogma.
It is what makes scientific method partly empirical rather than solely a quest for internal coherence.
- There is an immediate correlation between:
- Cog-Con system-environment fundamental distinction and
- Quine's acceptance of scheme-content dualism.

Quine's Second Dogma of Empiricism

- Willard van Orman Quine (1953, 1981) rejects:

(2) *Reductionism*: the belief that each meaningful statement is equivalent to some logical construct upon terms which refer to immediate experience.

- Rejecting this dogma, Quine (1953, 1981) accepts:

(5) *Confirmational holism:* The totality of our so-called knowledge or beliefs... is a man-made fabric which impinges on experience only along the edges. A conflict with experience at the periphery occasions readjustments in the interior [that is] so undetermined by its boundary conditions, experience, that there is much latitude of choice...

- There is an clear compatibility between

- Quine's acceptance of confirmational holism, and
- Cog-Con's idea of eigen-solutions emerging at repeated iterations of full (complete) production cycles.

Quine's First Dogma of Empiricism

- Willard van Orman Quine (1953, 1981) rejects:

(1) *Analytic-synthetic dualism:* ...some fundamental cleavage between truths which are grounded in meanings independently of matters of fact, and truths which are grounded in fact.

- Rejecting this dogma, Quine (1953, 1981) accepts:

(4) *Naturalism:* ...the recognition that it is within science itself, and not in some prior philosophy, that reality is properly to be identified and described.

- There is a remarkable consonance between

- Quine's acceptance of naturalism, and

- Cog-Con's acceptance as Mathematics as a *quasi-empirical* science, an idea of Imre Lakatos (1976, 1978) analyzed at Stern (2011a).

Geting a Grip on the World - Quine

Confirmational holism may lead to vicious circularity and skepticism. Needed: Strategies to anchor science to reality.

- Quine's (1981) *Reply to Stroud*, implies:

(6Quine) Acceptance of a *predicate logic structure*, that is, assuming that Predicate Logic gives the symbolic structure of choice for the "regimentation" of science.

(7Quine) Acceptance of the *finite regress* premise, that is, assume the availability of terminal nodes for the parsing of well-formulated truth-bearing statements within the scope of a well-regimented theory.

- Furthermore, in Quine's framework, these terminal nodes come in the form of - observation sentences, conditioned holophrastically to stimulations - inserted peripherally in the fabric of knowledge.

Geting a Grip on the World - Cog-Con

- In contrast, the Cog-Con framework makes two alternative premises of a very different nature:

(6Cog-Con) Acceptance of a *statistical model structure*, that is, assuming that Probability and Mathematical Statistics gives a symbolic structure of choice for testing operations (verification/ falsification, validation, evaluation) in empirical science.

(7Cog-Con) Accept. of *objects as tokens for eigen-solutions*. By their very nature, these objects are deeply and recursively embedded in the fabric of knowledge.

- Furthermore, these premises are linked by assuming the availability of check points in the form of - *sharp statistical hypotheses*, whose successful testing implies an evaluation of "objectivity" (or verification of "existence") for a corresponding set of objects in the pertinent scientific ontology.

Hans Albert's - Münchhausen Trilemma

How do I know (for sure) that something is true?
The answer can follow three possible strategies:
(a) Infinite regress: Never-ending chains of arguments.
(b) Logical circle: Circular chains of arguments.
(c) Finite regress: Finite chains of arguments with terminal nodes that are somehow guaranteed to be accepted.

- Quine's framework chooses horn (c);
- Cog-Con framework choses horn (b).

- Each choice needs justification and specialized analytical and mathematical tools. For the Cog-Con framework:

• Precise and stable eigen-solutions, represented by convergent sharp statistical hypotheses, involve continuous mathematics, while traditional predicate logic is discrete.

• Databases of circularly defined objects can be handled with tools based on Hypersets or Non-Well-Founded Set Theory.

Ontology and Metaphysics - Quine's Positivism

Quine (1948): Our acceptance of an ontology is similar to our acceptance of a scientific theory: We adopt the simplest conceptual scheme that fits available fragments of raw experience. To whatever extent the adoption of any system of scientific theory may be said to be a matter of language, the same - but no more - may be said of the adoption of an ontology.

- So far, in agreement with Cog-Con or Computer Science concept of ontologies as controlled languages for science.
- Quine's Positivism *à la* Auguste Comte:

- True sentences, observational and theoretical, are the alpha and omega of the scientific enterprise.
- Reference and ontology have the status of mere auxiliaries.
- The Vienna Circle espoused a verification theory of meaning, but did not take it seriously enough.
- The notion of cause itself has no firm place in science.
- Mark of progress: Disappearance of causal terminology.

Ontology and Metaphysics - Cognitive Constructivism

- Metaphysics concerns causal explanations telling why things are the way they do. These are the narratives and metaphors, often intertwined with abstracts symbolic statements, we use to build our understanding, to gain insight or intuition about objects in our world and the way they work.
- Good ontologies are an indispensable tool for metaphysical and theoretical reasoning and both, ontology and metaphysics, are of paramount importance in scientific life, taking part in all steps of the - Scientific Production Diagram, Fig.1.
- Max Planck (1950): Positivism lacks the driving force to be a leader on this road... its (critical) glace is directed backward. But progress, advancement, requires new associations of ideas and new queries, not based on the results of measurements alone, but going beyond them, and toward such things the fundamental attitude of Positivism is one of aloofness.
See also Max Born (1956) and Stern (2011a).

Miscellanea *** Future Research ***

- Neurath's Ship, in constant re-construction while afloat:
- Cog-Con ability to evaluate "objectivity" is a possible approach to the classic problem of external symbol grounding that, in turn, can be used for developing tools for
- Alignment of scientific ontologies, synchronic and diachronic.

Possible approach to solve important problems as:
- Synchronic: Cognitive openness and operational closure.
- Diachronic: (In)Comensurability of scientific theories.

- Handling *sticky things*, Quine (1981).
- Truth, meaning and belief are sticky concepts.

They stick together. ... Meaning and belief...
can be separated, like Siamese twins, only by artificial means.
But it is the remaining pair, truth and belief, that seems to me to have got unobservedly stuck.
- Same for the concepts of Objective, Subjective, and Inter-subjective, and their role in epistemology.

Miscellanea - CODATA application case

- Possible application case, concerning the meaning and epistemological role of - Fundamental Physical Constants, see Planck (1950) and Stern (2011a,b).

- A self-defined mission of CODATA, the International Committee on Data for Science and Technology, is:
- to periodically provide the scientific and technological communities with a self-consistent set of internationally recommended values of the basic constants and conversion factors of physics and chemistry based on all of the relevant data available at a given point in time.

- Such a project creates a large database where entities are circularly defined, a situation that can be handled using methods based on Hypersets or Non-well-founded set theory and its derivatives, see for example Aczel (1988), Akman and Pakkan (1996), Barwise and Moss (1996).

Miscellanea - CODATA application case

- Each (experimental) value obtained for one of these fundamental constants is a (non-linear) function of the value of several others constants.
- Furthermore, the reliability of each one of these experiments, the quality and conditions of its implementation and a variety of other influencing factors, must also be accounted for.
- This creates a second-order effect of circular propagation of uncertainties that, in turn, can be measured by variances and covariances, the second-order statistical moments.
- We would like to extend existing computational tools, like Pakkan and Akman (1995), for the easy handling of sets of circularly defined uncertainties.

VII - Bibliography (previous work)

- W.Borges, J.M.Stern (2007). The Rules of Logic Composition for the Bayesian Epistemic e-Values. *Logic J. IGPL*, 15, 401-420.
- F.V.Cerezetti J.M.Stern (2012). Non-arbitrage in Financial Markets: A Bayesian Approach for Verification. p.87-96 in AIP Conf.Proc. 1490.
- E.C.Colla, J.M.Stern (2009). Factorization of Bayesian Networks. *Studies in Computational Intelligence*, 199, 275-285.
- M.Diniz, C.A.B.Pereira, J.M.Stern (2011, 2012). Unit Roots / Cointegration. *Communications in Statistics - Theory and Methods*, 40, 4200-4213 / 41, 3562-3574.
- R.Inhasz, J.M.Stern (2010). Emergent Semiotics in Genetic Programming and the Self-Adaptive Semantic Crossover. *Studies in Computational Intelligence*, 314, 381-392.
- M.Lauretto, C.A.B.Pereira, J.M.Stern, S.Zacks (2003). Full Bayesian Signicance Test Applied to Multivariate Normal Structure Models. *Brazilian J.of Prob.& Statistics,* 17, 147-168.
- M.R.Madruga, L.G.Esteves, S.Wechsler (2001). On the Bayesianity of Pereira-Stern Tests. *Test*, 10, 291–299.
- C.A.B.Pereira, J.M.Stern (1999). Evidence and Credibility: Full Bayesian Significance Test Precise Hypotheses. *Entropy*, 1, 69-80.
- C.A.B.Pereira, S.Wechsler, J.M.Stern (2008). Can a Significance Test be Genuinely Bayesian? *Bayesian Analysis,* 3, 79-100.

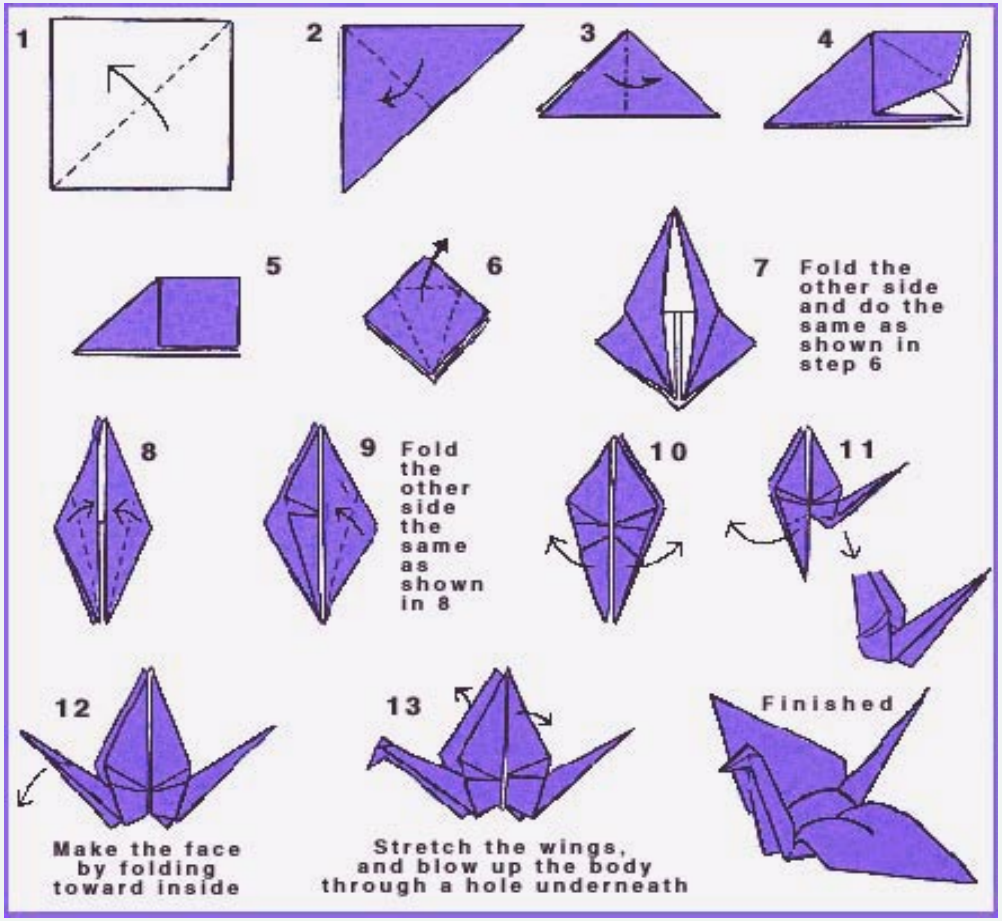
- J.M.Stern (2004). Paraconsistent Sensitivity Analysis for Bayesian Significance Tests. SBIA'04, *LNAI*, 3171, 134–143.
- J.M.Stern (2007a). Cognitive Constructivism, Eigen-Solutions, and Sharp Statistical Hypotheses. *Cybernetics & Human Knowing*, 14, 9-36.
- J.M.Stern (2007b). Language and the Self-Reference Paradox. *Cybernetics & Human Knowing*, 14, 71-92.
- J.M.Stern (2008a). Decoupling, Sparsity, Randomization, and Objective Bayesian Inference. *Cybernetics & Human Knowing*, 15, 49-68.
- J.M.Stern (2008b). *Cognitive Constructivism and the Epistemic Significance of Sharp Statistical Hypotheses.* Tutorial book for the 28th International Workshop on Bayesian Inference and Maximum Entropy Methods in Science and Engineering. São Paulo, Brazil.
- J.M.Stern (2011a). Constructive Verification, Empirical Induction, and Falibilist Deduction: A Threefold Contrast. *Information,* 2, 635-650.
- J.M.Stern (2011b). Symmetry, Invariance and Ontology in Physics and Statistics. *Symmetry,* 3, 611-635.
- J.M.Stern, C.A.B.Pereira (2014). Bayesian Epistemic Values: Focus on Surprise, Measure Probability. *Logic J. IGPL*, *22*, 2, 236-254.
- J.M.Stern (2014). Jacob's Ladder and Scientific Ontologies. Accepted for publication, *Cybernetics & Human Knowing*.
- J.M.Stern, F.Nakano (2014). Optimization Models for Reaction Networks: Information Divergence, Quadratic Programming and Kirchhoff's Laws. *Axioms*, 3, 109-118.

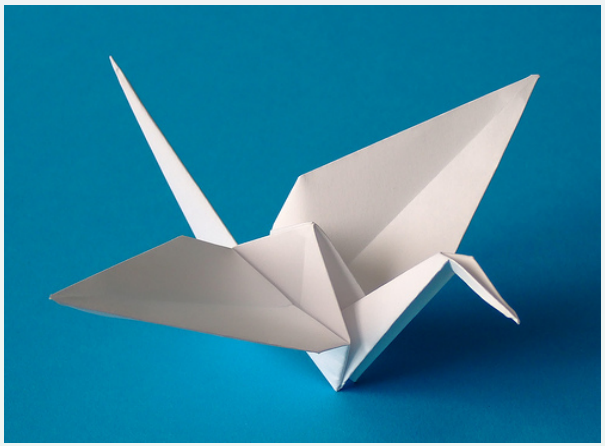
FAQ1 - Living, Autopoietic and Inferential Systems

- Ex1: Football, passive object that interacts with a player according to FIFA's Law 2 of the Game: Spherical symmetry, 26±1in size, 15±1oz weight, 0.6-1.1atm inflation pressure, etc; characteristics determining the exact form of a *stable behavior*.
- Ex2: Virus (RNA), active autocatalytic objects, but not *alive*.
- Ex3: Bacterium (DNA), strange-loop that recursively renews its molecular components during its lifetime, Bertalanffy (1969).

- Autopoietic systems are organized (defined as a unity) as a network of processes of production (transform., destruction) of components that, through their interactions and transformations, continuously regenerate and realize the same network.
- This circular organization implies predictions: Interactions that took place once will take place again... Every interaction is a particular interaction, but every prediction is a prediction of a class of interactions. This makes living systems inferential systems, and their domain of interactions a cognitive domain. Maturana, Varela (1980, p.10, 78-79, 84).

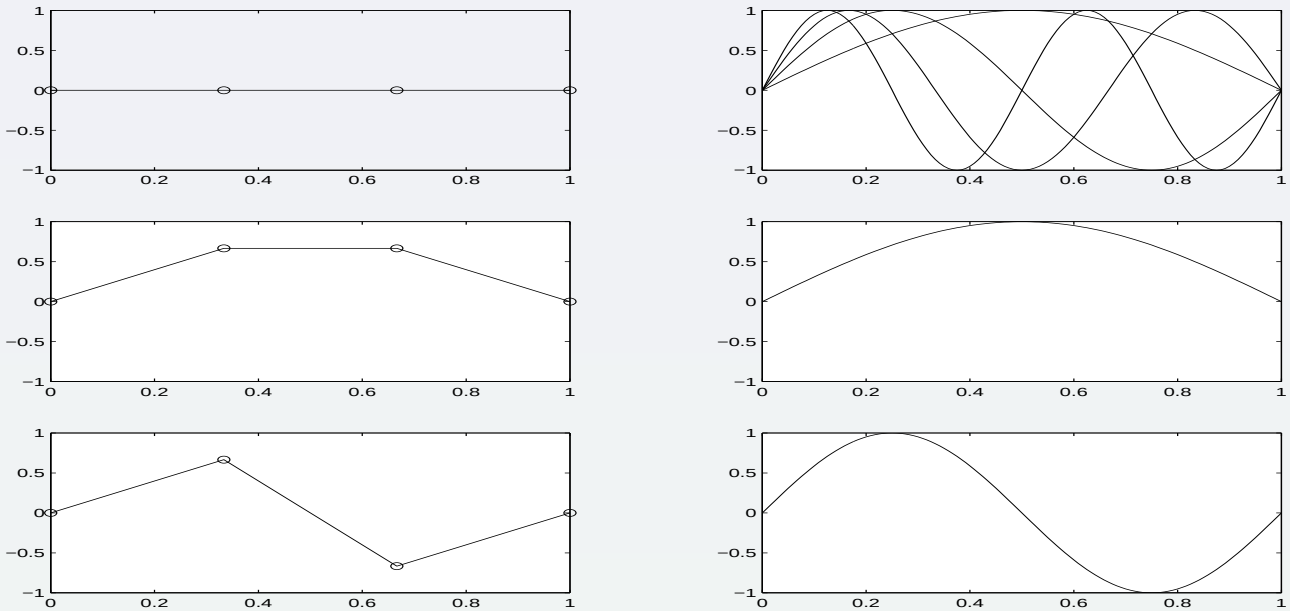
FAQ2 - Eigen-Solutions - Essential Properties

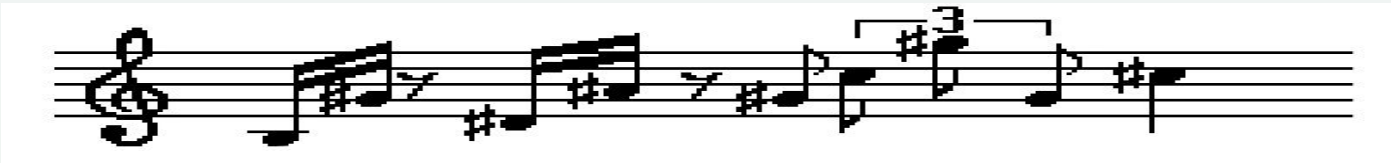




Origami folding instructions for a Crane (Tsuru). Richard Dawkins: What happens when we play Chinese whispers game with both cranes? Why? Folds are: Exact, Stable, Separable and Composable! Biology: Self-assembly by tissue foldings, organic morphogenesis.

FAQ2 - Eigen-Solutions - Essential Properties





Eigen-Solutions of continuous and discrete vibrating chords. Musical notes are precise, stable, separable and composable; the “atoms” or “building blocks” for all western musical systems. Sumerian musical notation in diatonic scale precedes functional analysis by 40 centuries!

FAQ3 - Metaphysical (latent) vs. Observable Variable

Metaphysics concerns:

- Non (directly) observable entities (beyond physical).
- Causal explanations, that is, answers for why-questions giving reasons for things being the way they are (Aristotle).
- Systematic account of possible forms of understanding, valid forms of explanation or rational principles of intelligibility (gnoseological sense).
- In Statistical models:
  - Theoretical, latent or non-observable (random) variables are Greek letters in the Parameter space;
  - versus experimental, directly observed or state variables, that are Latin letters in the Sample space.

Hamlet: My father! - methinks I see my father.
Horatio (Royal court Statistician): Where, my lord?
Hamlet: In my mind's eye! (a metaphysical entity)
(Horatio: Fatherly variables are Greek!)