Revue Internationale de

systémique

ISSN 0980-1472

Vol. 2, N° 3, 1988

afcet

Dunod

AFSCET

Revue Internationale de systémique

Revue Internationale de Sytémique

volume 02, numéro 3, pages 291 - 294, 1988

A Note on the Cybernetics of Evolution

Peter Fellgett

Numérisation Afscet, janvier 2016.

Les indicateurs de résultats

Les résultats, obtenus sous forme de graphiques, manuels ou informatiques, donnent plusieurs types d'indications :

1. Un suivi des flux d'information (cf. fig. 2)
Il indique le parcours suivi par l'initiateur de la situation professionnelle (entretien ou réunion).

2. La nature des interactions générées
Fait ressortir les microprocessus repérés comme étant généralement inducteurs de prise d'information, de conflits, de clarification, de confusion pour le ou les interlocuteurs...

3. L'émergence des redondances interactionnelles
Permet de décider sur quel type de microprocessus agir pour améliorer la cohérence d'un comportement par rapport à un objectif fixé.

4. Le temps d'émission de flux d'information de chaque interlocuteur (cf. fig. 3)
Représente un message analogique puissant pour permettre à la personne qui souhaite évoluer de se situer dans le temps par rapport à la situation qu'elle a vécue.

5. Comment la situation a été gérée par rapport au modèle proposé (cf. fig. 2 et 4)
Sert de référence à l'acteur/observateur pour «regarder» autrement comment il a fonctionné en comparaison avec le modèle proposé (figurée pour chaque étape par une barre horizontale). Il peut alors décider une modification éventuelle de son cheminement dans la gestion des flux.

Pour conclure, rappelons que ce mode de lecture s'inscrit bien entendu dans le cadre d'une approche globale destinée à accompagner des personnes qui souhaitent améliorer leur comportement dans des situations d'entretien individuel ou de conduite de réunion. Ceci sous entend que le simple travail de lecture systémique est en lui-même insuffisant.

En effet, il convient de prendre en compte à la fois en amont et en aval de cette opération de lecture, d'autres étapes de l'Approche systémique de manière à appréhender à la fois la complexité du système considéré, la subjectivité inhérente aux personnes concernées et les objectifs fixés.

REVUE INTERNATIONALE DE SYSTEMIQUE
Vol. 2, N° 3, 1988, pp. 291 à 294

A NOTE ON THE CYBERNETICS OF EVOLUTION

Peter FELLGETT [1]

University of Reading

Abstract
Natural selection is not confined to first-order selection of organisms or genes but includes second-order selection for selectability. Logical regression then implies that higher orders of selection may operate also.
Suitability for selection may involve rate of mutation, frequency of exchange of genetic material, and the form in which the genetic information is held.

Résumé
La sélection naturelle ne se réduit pas à la sélection du premier ordre, d'organismes ou de gènes, mais inclut aussi la sélection du second ordre en vue de la «sélectabilité». L'argument logique de réitération indéfinie entraîne alors que des sélections d'ordre supérieur peuvent aussi exister.
L'aptitude à la sélection peut faire intervenir le taux de mutation, la fréquence des échanges de matériel génétique et la forme sous laquelle l'information génétique est enregistrée.

Contributions to the Seventh Congress of Cybernetics and Systems have suggested the present note which returns to an aspect, previously published [1], of Evolution by Natural Selection seen as a cybernetic process of interaction and error-correction. In particular, Dr C.A. Musès [2] discussed the significance of the large amount of apparently unused human DNA, comparable tracts of apparently unused neurons

1. 48 Northcourt Avenue, Reading RG2 7HQ, Grande-Bretagne.

in the brain, and the relation of these observations to each other and to the progress of human evolution.

Although the qualitative and quantitative theory of evolution by natural selection is well established in considerable detail, and even its basis in molecular biology understood to considerable depth, the subject is notoriously prone to periodic attacks. Some of these come from critics who take extra-scientific *a priori* positions, who fail to appreciate the intervals of time involved, or who are insufficiently familiar with relevant mathematical developments, e.g. catastrophe theory and ergotic behaviour of deterministic systems. Even ignoring these, a certain uneasiness persists, a recent expression of which is the hypothesis of 'molecular drive' which however is easily seen to be scientifically empty. Such suggestions appear to be unnecessary if full account is taken of the power of selection.

Darwin and Wallace [3, 4] recognised that if offspring both resemble and differ from their parents, heritable characteristics favouring survival are more likely to be reproduced. This is effectively tautological and as such unassailable except by some such extreme assumption as that genotype or phenotype are completely uncorrelated (in which case a rabbit might give birth to a canary). Therefore evolution must proceed at least by natural selection, and will be progressive so long as mutations are possible. This argument does not of itself exclude the possibility of additional mechanisms ; natural selection is necessary, and the only question which remains is whether it is sufficient to explain the record. Moreover Occam's razor requires that only if there were positive evidence that natural selection was inadequate would there be justification for departing from the nullhypothesis that no other mechanism is required.

The present contention is that while first-order selection may not suffice, higher-orders enhance the power of selection to a fully adequate extent. In other words, selection fro selectabiliby is necessary both in the sense that the logic demands it and that the resultant power is required. Moreover the logical regression is unlimited ; there can be selection for selectability for selectability, etc.

Examples abound of such second- or higher-order selection, and it is rather astonishing that they seem not to have been interpreted explicity in this sense. Perhaps the most obvious and widespread is sexual reproduction. Evidently an organism has the best chance of transmitting its genetic material in the short term if it is reproduced asexually. Moreover mutations may be presumed to permit evolution of an asexual line. The fact that most (possibly all) organisms found

on our planet have some means of exchanging genetic material, if only occasionally, suggests that a major advantage in selectability results from the possibility of an organism recombining its genetic endowment with that of another individual which has also already passed the test of first-order natural selection.

There is presumably an optimal frequency of genetic exchange which will be selected for. Alternation of sexual and asexual reproduction in aphids, or the non-zero incidence of monozygotic twinning in human or other mammals, may be seen as examples. The same optimisation is manifest in the refined adaptations of flowering plants (phanerogamia) to control self-pollination.

It may be significant also that classes of animals that are most 'successful' (however we define or measure this) are those which seem able to repond to selection with the richest diversity. For example, the ability of insects to fill almost any niche not prohibited by their external skeleton, and the enormous diversity of mammalian adaptations on land, in water and in the air, contrast with the slowness with which reptiles 'learnt' to attach their limbs in a mechanically efficient way.

Advances in molecular biology also indicate the importance not only of the genetic information itself but also of the way it is encoded. An artifical but suggestive illustration is provided by the recent observation that in tissue culture and of certain crop plants some strains retain stable characteristics, while other change rapidly ; one or the other kind will be selected by the experimenter depending on the purpose in view.

It is always dangerous to assume natural systems resemble the latest technology ; the brain was once thought to be like a telephone exchange, then like a digital computer, but almost certainly works in a quite different way from either. Nevertheless what can be done artificially is thereby proved to be fundamentally possible, and hence possible in principle for biological systems. We know how to program computers so that procedures or subroutines may be activated by a number of programs or repeatedly within any one of these programs. We are also learning how to incorporate redundancy giving protection against copying errors, and in particular arranging that an error will perhaps not result in the programming crashing but may give rise to a changed but still viable sequence to be executed. Genes used to be thought of as discrete pieces of deoxynucleic (DNA), but it now seems that the functional unit may involve a number of DNA sequences at separate sites, and some of these sequences may be accessed by more than one 'gene' in a way distinctly suggestive of a computer program containing subroutines. Moreover there is known to be redundancy in the form of DNA that is apparently inactive but which may provide back-up or alternative functional possibilities.

It is a sobering thought that the optimum rate of exchange of genetic material must be a function of the rate of mutation. Life on a very radiocative planet might be no fun at all.

References

1. FELGETT P.B., «Cybernetics of Evolution», Nature, 230, p. 230. 15 th March 1984.

2. MUSES C., «Cybernetics and Ongoing Human Evolution», Proc. 7th International Congress of Cybernetics & Systems, London, 1987, September 7-11, 1, p. 8 (Abstract only), Thales Publications (W.O.), Ltd., Lytham-St. Annes, England, G.B.

3. DARWIN C., «The Origin of Sepcies by Natural Selection», John Murray, London, 1859.

4. DARWIN C. and WALLACE H.R., «On the Tendency of Species to form Varieties». Read at Linnean Society 1858, July lst. J. Proc. Linn. Soc. Zoology, 3, No. 9, pp. 45-62, 1858.

vue INTERNATIONALE DE SYSTEMIQUE
l. 2, N° 3, 1988, pp. 295 à 319

FONCTIONS BIOLOGIQUES, NIVEAUX D'ORGANISATION ET DIMENSIONS FRACTALES

Francis BAILLY*, Françoise GAILL**, et Rémy MOSSERI*

*Laboratoire de Physique des Solides, CNRS [1]
**Centre de Biologie Cellulaire, EPHE, CNRS [2]

Résumé
Les données d'observation recueillies sur nombre d'objets biologiques suggèrent que la présence de dimensions fractales est principalement associée à l'établissement et aux conditions d'exercice de fonctions biologiques, en même temps qu'à la caractérisation de niveaux d'organisation qui leur correspondent.
Nous discutons ces hypothèses et tentons d'expliciter les raisons pour lesquelles une géométrie fractale d'objets biologiques peut constituer en effet une solution pour satisfaire des conditions variées (parfois difficilement compatibles) nécessitées par l'existence et la coopération d'entités biologiques.
La recherche et l'observation de caractères fractals, décelés au moyen de méthodes morphométriques, peut alors représenter un moyen efficace dans la recherche d'indices d'un rôle fonctionnel et pour la définition des niveaux d'organisation correspondants.

Abstract
Numerous biological objects (organs, organels...) exhibit fractal dimensions. We interpret this fact by postulating strong relationships between geometrical fractality, biological functionality and changes of organization. We propose that this fractality corresponds to an optimalization for systems submitted to divergent constraints as : exchanges enhancement, steric limitations, organic homogeneity.

1. 1, place Aristide Briand, F. 92190 Meudon-Bellevue, France.
2. 67, rue Maurice Günsbourg, F. 94200 Ivry-sur-Seine, France.