Committee II
Theoretical Empiricism: A General
Rationale for Scienctific Model Building

Draft --
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MEDICAL MODEL BUILDING AND HYPOTHESIS TESTING: ML, LS AND SUBSTANTIVE DYNAMIC DESIGNS (Maximum Likelihood Methods, Least Square Methods)

by

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Discussion Paper

on

Camilo Dagum's

SCIENTIFIC MODEL BUILDING: PRINCIPLES, METHODS AND HISTORY

The Thirteenth International Conference on the Unity of the Sciences
Washington, D.C. September 2-5, 1984

ABSTRACT

The building of medical scientific models is increasingly difficult because of unmanageable amounts of data. The introduction of computers to medical data management has had only a marginal influence on the development of medical experimentation and medical model building. A general practitioner who must daily match an increasing quantity of diagnostic models with the reality of his patients has no guidance from his over-specialized medical science colleagues. As a consequence, the expectations of contemporary society are not met and the costs of medical care increase beyond a reasonable acceptability. Government interventions are more and more frequent and less and less efficient. Malpractice suits are on the increase. The conflict lies in the virtual impossibility of matching the models with reality.

My contribution suggests that the predictive power of LS or PLS (Partial Least Squares) modeling in health management should be enforced by an emphasis on substantive dynamic designs in medical experimentation. The ML parameter estimation can yield valuable results in typical diagnostic applications in medical sub-specialties but will contribute very little to the development of medical knowledge.

SUBSTANTIVE MODELS AND DESIGNS

Medicine, like economics, is concerned with action. Its models must be pragmatic and they must unify and explain a vast amount of ordinary and extraordinary facts. Medicine is also concerned with deep facts of nature, like the facts of homeostasis or healing, and with ultimate facts of values and meanings (Carter). Thus the present medical science, by concentrating primarily on the models of ordinary and extraordinary facts, has largely neglected domains that were traditionally an inseparable part of medical art and science. In this way, medical science has deprived physicians of their creative responsibilities and patients of their expectations and rights. It is a popular belief among the medical establishment that "we cannot be everything for everybody". However, the practice convinces us that the public, often misled by the media advertisement, adheres to the belief that doctors - by virtue of their education - can solve virtually any human problem. These expectations are largely not fulfilled.

I hope that you will agree that it is the medical scientist and not the patient who is at fault.

As in economics, our models have to fulfill a number of criteria because:

1) Medicine is science in action - its models must be concerned with the substance of knowledge.

3) They must be dynamic and predictive dealing with therapy, decisions and prognosis.

4) They must be concerned with universal correspondences of empirical and theoretical domains.

5) They must reconcile the existing, often incompatible, partial models.

6) They must be derived from and deal with the logical, physical and ethical aspects of thinking.

Designs are needed to provide the dynamic reconciliation of a multitude of facts and models. Designs must be substantive and dynamic (Lieber). This means that: 1) they are concerned with the substance and not only with the form of knowledge and facts; and 2) they are concerned with the manifestations of forces and of processes arising from their re-distributions.

To admit substantive dynamic designs to medical modeling will require some changes in current medical thinking. Medicine now has available a vast quantity of partial models that explain the relations of structures (anatomical, cellular or chemical) with disease manifestations. Medicine lacks: 1) a unified theory; and 2) a development of a concept of medical experimentation which would take into account various modes of experimentation (Lieber).

UNIFIED THEORY OF HEALTH

A unified theory of health does not yet exist - probably such a theory would be useful for economics as well. The theory proposed here reconciles all partial models, holistic and reductionist, on the level of deep facts. It deals with aspects of health and disease in a consistent and continuous way. It is verified by experimentally testing the reproducibility of deep facts, i.e. of homeostasis and healing. The present mode of experimentation verifies only the reproducibility of ordinary facts (e.g. healing of fractured bone) or of extra-ordinary facts (e.g. healing of fractured bone in osteoporosis).

The salient features of a unified theory of health are:

1) partial theories or models are all included; those that are compatible with the largest number of facts being preferred to those that cover a smaller number.
2) All operations utilized in health maintenance or disease management are parts of the theory.
3) A unity of physical, logical and ethical aspects of health is achieved by substantive dynamic designs.

MODES OF MEDICAL EXPERIMENTATION

According to this theory, medicine cannot be predicated on one mode of experimentation. The mode presently used, that is the mode of physical experimentation limited by the Heisenberg 'Uncertainty Principle', is questionable even in modern physics. In medicine, alternative modes are emerging and have the same validity even if they lack, at this time, the precision of the physics mode. An example of an emerging mode of experimentation is biofeedback; its prominent feature being experimentation, very often involving the reconciliation of "inner" and "outer" experience. If we admit the biofeedback alternative, which is qualitatively different while at the same time quantifiable, we must logically proceed to other alternatives of experimentation. Thus, behavioural medicine is opening doors to new approaches, methods and concepts. This is typified by problems of chronic pain, eating disorders, sleep disorders and chemical dependence. Nowadays, there exists a large emerging domain in the health-disease field which was, until recently, untreatable within the traditional medical paradigm. This domain has forced us to accept team-work, multi-disciplinarity and patient self-care and self-experimentation. Thus, the last barrier in the East-West dialogue could be removed; generating new political and psycho-social consequences.

PROBLEMS OF STATISTICAL HYPOTHESES-TESTING

Eventually the question will emerge: how do we prove the validity of new models and modes of experimentation? The present models use almost exclusively the maximum likelihood (ML) methods of hypotheses-testing. They have now achieved such a high level of mathematical sophistication that they are being applied to test virtually everything. Nobody questions the fundamental assumptions of ML methods. However, some serious doubts about their universal applicability have emerged (Diamond, Forrester, Kryspin, Wold) and this trend will continue. In this line of thinking, the importance of alternative statistics, e.g. Partial Least Square (PLS) methods (Wold) or of Information Calculus (Kryspin and Norwich) will eventually be seen. The alternative statistical methods are distribution-free and do not assume independence of variables. This was the main objective to an uncritical widespread use of ML methods (Wold). The difference can be best illustrated by an example: a proof that compression fracture healing (an ordinary fact) can be improved by simultaneous administration of vitamin D and calcium when osteoporosis (an extraordinary fact) is present can be carried out by separating patients into two or four groups and testing in a "double-blind" manner the validity of a null-hypotheses: no significant difference between a treated and a not-treated group would invalidate the hypotheses. The assumptions are that treated variables (time-course of healing, bone density, age, pain, etc.) have a normal distribution and that they are mutually independent. If these two assumptions cannot be assured, the validity of ML methods is considerably restricted.

On the other hand, a model that reflects more accurately the clinical situation will take into consideration the inadequate initial information, their small number of data, their unknown distribution and their interdependence and will enable us to predict the outcome of treatment and to make decisions about therapy by combining the LS methods and dynamic designs: this will allow the physician not to neglect any of the relevant aspects should they emerge (e.g. inadequate nutrition due to unemployment, drinking, depression and pain augmentation in post-menopausal female, etc.) which usually modify the clinical decisions but cannot be accounted for by the more rigid metabolic pharmacological models.

It is concluded that dynamic designs with new statistical approaches to predictive and decision models will be needed to guide medical thinking in the exploration of reproducibility of deep and ultimate facts.

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