cer cells find good niches, always?), 'tapes' that may be re-edited constantly (as under continuous evolution) or from time to time (as under 'punctuated evolution') We have acquired considerable insights into the material bases of the preservation and/or modification of genetic information and transmission thereof, how it is transcribed and made manifest, via cell differentiation, as 'organisms' with the 'transparent lenses of the eye and hard enamel of the teeth', (Sherrington in '*Man on his Nature*' (1951)). We also seem to be well on our way to the unravelling of the exquisite molecular mechanisms of the immune reaction, an aspect of biological individuality, and have come to believe that we can imitate brain function by means of 'neural networks'. We can speculate on the possibility of 'recreating' extinct organisms in a 'Jurassic Park' which tourists can visit. We can look for 'enantiomeric or diastereoisomeric excess' in the chemical synthesis of asymmetric molecules, after receiving the necessary induction of asymmetry from something that is already asymmetric, following, almost, the original suggestions of Pasteur (an interesting question – Did 'life' intervene when Pasteur, with magnifying glass and a pair of tweezers in hand and equipped with the 'knowledge' necessary to recognize asymmetry, picked out the hemihedral crystals?). But we are nowhere near answering the question 'Is there spontaneous generation?'. We have only managed to reformulate the question in the past tense ('Was there... ?), pushing it back in space and time to the pre-Cambrian age and near the shores of the shallow lakes of primordial soup in Pangaea (if not in Rodinia). This reviewer is reminded here of a conversation he recently had the privilege to have with Abdus Salam in Trieste, Italy – a difficult conversation, indeed, because Salam was barely audible – revolving around, 'Where is the mirror of symmetry in the asymmetry of life – are life-forms based on both R and S amino acids present in the matter world, or are the two divided between matter and antimatter worlds? Did it so happen that life was lit (albeit in a wet place!) by an asymmetric 'spark' in a region where asymmetric molecules happened to congregate (in the endentropic fashion resembling those under which Pasteur managed to separate his 'privileged material' (the tartaric salts) into asymmetric forms? Did that asymmetry (and life) originate just when the Earth was passing through a magnetically 'screwed up' region of space during its wanderings, carried about in and by the Milky Way?

We still have to go through the contortions necessary to define what is 'knowledge' (the sense of satisfaction that comes when we 'absorb' the 'truth' of a statement like two plus two is equal to four'), something that must be intimately connected with sentience and, therefore, with the origin of life. While we are doing that we may as well read this book and make sure that our heads are screwed on in the right manner – between our shoulders – and supplied with well-oxygenated blood and nutrient.

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New Aspects in Interpolation and Completion Problems. Volume 64. Ed. I. Gohberg, **Operator Theory: Advances and Applications.** Birkhäuser, Basel. Price not stated. 1993.

A *partial matrix* is a matrix some of whose entries have not been specified. A *completion* of this matrix is a matrix obtained by filling in the previously unspecified entries. A *completion problem* demands a completion under some constraints, such as the completion be positive, have minimal norm or minimal rank.

The solution to completion problems can be hard or trivial. Often, the problem can become considerably more difficult by just a little change of expectations. For example, the minimal-norm completion problem is of this type.

Regard a matrix as an operator on the Euclidean n-space $\mathbb{C}^n$. The operator norm of A is the number

$$\| A \| = \sup \{ \| Ax \| : \| x \| = 1 \}$$

The Hilbert–Schmidt norm of A is the number

$$\| A \|_2 = (\mathrm{Tr}\, A^*A)^{1/2} = \left(\sum_{i,j} |a_{ij}|^2 \right)^{1/2}.$$

Consider the partial 2×2 matrix

$$\begin{bmatrix} 1 & 1 \\ ? & 1 \end{bmatrix},$$

in which the southwest entry is unspecified. What is a '*minimal-norm* completion' of this? If the norm in question is the Hilbert–Schmidt norm, the answer is obvious. The free entry can only be zero. If the norm is the operator norm, the answer is not so obvious. The matrix

$$\begin{bmatrix} 1 & 1 \\ 0 & 1 \end{bmatrix}$$

has norm $(\frac{3+\sqrt{5}}{2})^{1/2}$, while the matrix

$$\begin{bmatrix} 1 & 1 \\ -1 & 1 \end{bmatrix}$$

has norm $\sqrt{2}$, which is smaller Thus, the answer to the problem changes with the norm, and the complexity of the problem also changes.

The minimal (operator) norm completion problem for the partial block matrix

$$\begin{bmatrix} A & B \\ ? & C \end{bmatrix}$$

was solved by S. Parrott and by C. Davis, W. Kahan and H. Weinberger around 1980. This is of interest not only in operator theory but also in numerical analysis, control theory and other areas. The solutions for other interesting norms (like Schatten p-norms) have not been found.

These papers led to a flurry of activity. Specially noteworthy is the work of I Gohberg, M. A. Kaashoek and H. J. Woerdman, who introduced a maximum-entropy principle, which has been found to be very useful.

Interpolation means different things to different people. The meaning in the context of the papers in this book is the following.

Let $c = \{c_n\}$ be a doubly infinite complex sequence with $c_{-k} = \bar{c}_k$. Such a sequence is called a *moment sequence*. The classical *trigonometric moment problem* asks for a positive measure $d\mu$ on $[-\pi, \pi]$ such that

$$c_k = \frac{1}{2\pi} \int_{-\pi}^{\pi} e^{-ik\theta} d\mu(\theta), \qquad k \in \mathbb{Z}.$$

This is an example of an interpolation problem. Closely related to this is the *Carathéodory problem* A *Carathéodory function* is a complex analytic function

on the unit disk whose range is in the right-half plane Given a moment sequence c, associate with it a function F on the unit disk

$$F(z) = c_0 + 2c_1 z + 2c_2 z^2 + \cdots,$$

The Caratheodory problem is the problem of finding necessary and sufficient conditions on c so that F is a Caratheodory function. This condition is that, for each n, the Toeplitz matrix $T_n = [c_{i-j}]_{i,j=0,1,\ldots,n}$ be positive-semidefinite. If each T_n is positive-definite then the distribution function $\mu(\theta)$ for the measure in the trigonometric moment problem is unique and

$$d\mu(\theta) = \mathrm{Re}\, F(\theta)\, d\theta.$$

This shows the equivalence of the two problems

Since the unit disk and a half-plane are conformally equivalent, this problem is the same as that of analytic functions mapping the upper-half-plane onto itself Such functions are called *Pick functions* and there is an integral representation for them due to Navanlinna.

All this would suggest that this is a rich subject where classical function theory, harmonic analysis and functional analysis come together. One of the very spectacular applications of this theory was the work of C. Loewner on operator monotone functions.

In the recent years there has been significant work on extensions of these ideas to matrix-valued analytic functions. Much of this has been motivated by problems in systems control engineering, particularly the H^∞-control theory.

The book under review is a collection of papers on interpolation and completion problems It has eight papers, three of which deal with completion problems and five with interpolation problems. All the authors are prominent workers in the subject. These papers should be of interest to experts in these areas, who are already familiar with the literature and know where the heart of the matter lies.

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Constructive Dissent: A Case Study in Science & Technology Policy-Making. Lost at the Frontier. Deborah Shapley and Rustom Roy. ISI Press, Philadelphia, PA 19104, USA.

Published in 1985, the book bearing this intriguing title demonstrates the legitimacy of constructive dissent on policies relating to public funding in an open society. It focuses attention on the link between policy-making and national objectives in science & technology (S&T). It also illustrates the dangers of distortion of 'public interest' values over time even when a national policy is initially established on the basis of a broad consensus.

In a report prepared for President Roosevelt in 1945 by a Committee, headed by Vannevar Bush, of scientists and technologists outside the government hierarchy, the image of science as 'an endless frontier' was created. The report led to the establishment of the National Science Foundation and initiated US Federal funding for the development of basic and applied science. The Vannevar Bush Report highlighted the major contributions of science to the war effort and recommended that government should step in 'with generous and stable funding for research, especially basic research in universities'. The report described basic research 'as one of the steps in a chain of endeavours that leads to industrial advance, better public health and stronger national defence', and stressed the 'interconnectedness' of basic research to other parts – 'to applied science, to engineering, to technology, to public national needs'.

Shapley and Roy's book is a critique of the manner in which these recommendations were implemented in reality over the period 1950–1980. While some people anticipated 'a science-based industrial revolution', they are sceptical if 'the USA science profession (as structured in 1985) will serve that revolution as well as it *should*'. The theme of this closely argued book, which the authors call an 'experiment in science criticism', is 'the severance of ties between basic science and applications' and its adverse impact on many areas – industrial competitiveness, translation of innovation into saleable products and education.

US Science funding (1950–1980)

The Vannevar Bush Report resulted in the creation of the National Science Foundation. The criticism of Shapley and Roy is about the effect of 'basic research is the best' mindset which became the dominant approach and which vested basic science 'with its own protected keep'; consequently, they point out that the 'interconnectedness' concept was effectively ignored Alan Waterman, the first Director of the National Science Foundation is quoted in the book: 'basic research has certain characteristics which .... distinguish it from other forms of scientific activity. *The search is systematic but without direction save that which the investigator himself gives it to meet the challenge of the unknown He is strictly on his own, guided primarily by his interest in learning more about the workings of nature*' (emphasis added) The implication was that basic scientific research, something separate by itself, yielded far-reaching benefits although the incubation period between discovery and product could be even 30 years. This belief led to many proposals for grants (even those of obvious potential practical use) being sponsored in the garb of undirected basic research to win acceptance. This attitude percolated to industry in due course so that even major industries rarely made use of the findings of their own 'gleaming laboratories'. The consequence was easy to see: when times got tough, they cut back much long-term applied work and 'closed down basic research to hunker down for what remains ... a long winter of discontent'. It required the shock of sustained competition from Japan for the US industry to wake up and discover the *true* importance of basic as well as applied science. The authors trace the decline in creativity and innovative skills and the consequent adverse impact on the national economy to this biased implementation of the Vannevar Bush Report's recommendations.

The 'basic research is the best' mindset

The authors delve into the history of the US science policy over the period 1950–1980 and trace the impact of the dominance of the 'basic research is the best' mindset on several related aspects