INDIAN STATISTICAL INSTITUTE

THIRTY-EIGHTH ANNUAL REPORT

April 1969—March 1970

Volume 2

203 BARRACKPORE TRUNK ROAD
CALCUTTA-35

INDIAN STATISTICAL INSTITUTE

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* Died on 1 December 1969.

** Resigned.

*** Branch Chairman's name shown under additional Vice-Chairmen.

INDIAN STATISTICAL INSTITUTE

THIRTY-EIGHTH ANNUAL REPORT

April 1969—March 1970

Volume 2

CONTENTS

Annual Report, Vol. 1, which has been printed separately, contains (i) General Review of Work during the year, (ii) Annexures, and (iii) Statement of Accounts, Auditor's Report and Audited Statement of Accounts, 1969–70. The Report may be supplied on request.

INDIAN STATISTICAL INSTITUTE

THIRTY-EIGHTH ANNUAL REPORT

April 1969—March 1970

Volume 2

PART IV. SCIENTIFIC PAPERS SUBMITTED FOR PUBLICATION

(The journal/seminar/conference to which the paper has been submitted for publication is mentioned within brackets, followed by RTS Technical Report Number)

A. *Mathematics*

S1. BAGCHI, SOMESH (with Raha, Asit Baran): On maximal regular topologies (*Mathematische Zeitschrift*), Math-Stat/31/69.

S2. IYER, MUTHULAKSHMI R.: Some fibonacci relations (*Fibonacci Quarterly Journal*), Math-Stat/12/69.

S3. ———: Relations connecting the Pell numbers and the associated numbers (*Jour. Ann. Math. Soc.*), Math-Stat/32/69.

S4. ———: Fibonacci and Lucas quaternions (*Tohoku Math. Jour.*), Math-Stat/39/69.

S5. MENON, V. V.: Some partitions of, and the number of Borel fields on, large finite sets (*Collo. Comb. Maths.* Hungary). Math-Stat/13/69.

S6. RAHA, ASIT BARAN: A remark on completely regular spaces (*Proc. Amer. Math. Soc.*), Math-Stat/22/69.

(S1) ———: (with Bagchi, Somesh): On maximal regular topologies (*Mathematische Zeitschrift*), Math-Stat/31/69.

S7. RAO, A. RAMACHANDRA (with Rao, S. B.): Existence of triconnected graphs with prescribed degrees (*Pacific Jour. Math.*), Math-Stat/20/69.

S8. ———: (with Rao, S. B.): A note on Hamiltonian degree sequences (*Jour. Comb. Theo.*), Math-Stat/44/69.

S9. ———: (with Rao, S. B.): The number of cut vertices and cut arcs in a dingraph (*Jour. Comb. Theo.*). Math-Stat/55/69.

S10. RAO, B. V.: On Borel structures for function spaces (*Colloquium Mathematicum*), Math-Stat/24/69.

S11. ———: A further remark on analytic sets (*Fundamenta Mathematicae*), Math-Stat/20/69.

S12. ———: On discrete Borel spaces (communicated to Professor P. Erdos), Math-Stat/42/69.

S13. ———: Non-existence of certain Borel structures (*Fundamenta Mathematicae*), Math-Stat/43/69.

S14. RAO, B. V.: Lattice of Borel structure (*Colloquium Mathematicum*), Math-Stat/54/69.

S15. RAO, S. B.: On a problem of ore on maximal trees (Communicated to Professor O. Ore), Math-Stat/1/69.

(S7) RAO, S. B. (with Rao, A. Ramachandra): Existence of triconnected graphs with prescribed degrees (*Pacific Jour. Math.*), Math-Stat/29/69.

(S8) ———: (with Rao, A. Ramachandra): A note on Hamiltonian degree sequences (*Jour. Comb. Theo.*), Math-Stat/44/69.

(S9) ——— (with Rao, A. Ramachandra): The number of cut vertices and cut arcs in a diagraph (*Jour. Comb. Theo.*), Math-Stat/55/69.

B. *Statistics*

S16. BHIMASANKARAM, P. (with Mitra, Sujit Kumar): Some results on idempotent matrices and a matrix equation connected with the distribution of quadratic forms (*Sankhyā*), Math-Stat/46/69.

S17. CHAKRABORTY, RANJIT: Parent-offspring correlation in an equilibrium population (*Ann. Hum. Genet.*), Math-Stat/16/69.

S18. ———: A note on counting method of estimation for MNSs blood group system (*Human Biology*), Math-Stat/34/69.

S19. ———: (with Sarma, Y. R.): Some statistical models for human multiple births (*Ann. Hum. Genet.*), Math-Stat/52/69.

S20. DHARMADHIKARI, S. W.: A note on exchangeable processes with states of finite rank (*Ann. Math. Stat.*), Math-Stat/9/69.

S21. GHANGURDA, P. D. (with Rao, J. N. K.): Bayesian optimisation in sampling finite populations (*Jour. Amer. Stat. Assn.*), Math-Stat/37/69.

S22. GHOSH, J. K.: On the proportion of observations above a sample mean (*Ann. Math. Stat.*), Math-Stat/5/69.

S23. ———: A new proof of the Bahadur representation of quantiles (*Ann. Math. Stat.*), Math-Stat/28/69.

S24. HARTLEY, H. O. (with Rao, J. N. K. and Kiefer, Grace): Variance estimation with one unit per stratum (*Jour. Amer. Stat. Assn.*), Math-Stat/6/69.

S25. KHAMIS, SALEM H.: Neoteric index numbers, Math-Stat/3/69.

S26. KUMAR, AMOD: Independence and same distribution of two second degree polynomials in a normal vector (*Ann. Inst. Stat. Math*, Tokyo), Math-Stat/19/69.

S27. ———: Independence and same distribution of two second degree polynomials in a complex normal vector (*Ann. Inst. Stat. Math*, Tokyo), Math-Stat/20/69.

S28. ———: On the independence of second degree of polynomial statistics in a normal vector (*Biometrika*), Math-Stat/48/69.

S29. ———: Identical distribution of second degree polynomial statistics in a normal vector (*Aust. Jour. Stat.*), Math-Stat/49/69.

S30. ———: A note on Graybill and Milliken's paper, "Quadratic forms and idempotent matrices with random elements" (*Ann. Math. Stat.*), Math-Stat/56/69.

S31. ———: A matrix-variate Dirichlet distribution (*Bull. Cal. Stat. Assn.*), Math-Stat/57/69.

S32. MAHALANOBIS, P. C. : Basic problems of design of sample surveys, (International Conference on Computer Science organised by the Institute of Statistical Studies and Research, Cairo University, 16–19 December 1969).

S33. MAITRA, A. (with Parthasarathy, T.) : On stochastic games (*Jour. Opt. and its Appl.*), Math-Stat/27/69.

S34. MENON, V. V. (with Prabhakar, N. D.) : A note on continuous gambling houses (*Ann. Math. Stat.*), Math-Stat/30/69.

S35. MITRA, SUJIT KUMAR : Goodness of fit of a compound multimonial distribution and allied problems (*Bull. Int. Stat. Inst.*), Math-Stat/10/69.

S36. ———— : A density free approach to the matrix variate beta distribution (*Sankhyā*), Math-Stat/21/69.

S37. ———— : Inverse sampling and the treatment of complex contingency table interactions (*Proc. ISI Conf., London*), Math-Stat/38/69.

S38. ———— : Analogues of multivariate beta (Dirichlet) distribution (*Sankhyā*), Math-Stat/53/69.

(S16) MITRA, SUJIT KUMAR : (with Bhimasankaram, P.) : Some results on idempotent matrices and a matrix equation connected with the distribution of quadratic forms (*Sankhyā*), Math-Stat/46/69.

S39. MURTHY, M. N. : Approximate unbiasedness of a relative variance estimator based on independent sample (*American Statistician*).

S40. NADKARNI, M. G. : On structure of weakly stationary stochastic process (*Teoriya Vescyotnosti i ee primenenie*), Math-Stat/2/69.

S41. ———— : Prediction theory of infinite variate weakly stationary stochastic processes (*Sankhyā*), Math-Stat/36/69.

(S33) PARTHASARATHY, T. (with Maitra, A.) : On stochastic games (*Jour. Opt. and its Appl.*), Math-Stat/27/69.

(S34) PRABHAKAR, N. D. (with Menon, V. V.) : A note on continuous gambling houses (*Ann. Math. Stat.*), Math-Stat/30/69.

S42. RAMACHANDRAN, B. : (with Rao, C. Radhakrishna) : Solutions of functional equations arising in some regression problems, and a characterisation of the Cauchy law (*Sankhyā*), Math-Stat/35/69.

S43. RAMAKRISHNA, M. K. (with Rao, J. N. K.) : A note on A. Chaudhuri's paper, "A comparison between sampling with and without replacement from finite populations" (*Bull. Cal. Stat. Assoc.*), Math-Stat/25/69.

S44. ———— : A note on the comparison of sampling with and without replacement (*Sankhyā*), Math-Stat/45/69.

S45. ———— : (with Singh, M. P.) : On the hyper-admissibility of an estimator in survey sampling (*Jour. Amer. Stat. Assn.*), Math-Stat/50/69.

S46. RAO, C. RADHAKRISHNA : Estimation of heteroscedastic variances in linear models (*Jour. Amer. Stat. Assn.*), Math-Stat/4/69.

S47. ———— : A multidisciplinary approach for teaching statistics and probability (*International Conference, Teaching of Probability and Statistics at Pre-college Level*, U.S.A.), Math-Stat/14/69.

S48. ———— : Some comments on the logarithmic series distribution in the analysis of insect trap data (*Proc. International Symposium on Statistical Ecology*, New Haven, USA), Math-Stat/51/69.

(S42) ———— : (with Ramachandran, B.) : Solutions of functional equations arising in some regression problems, and a characterisation of the Cauchy law (*Sankhyā*), Math-Stat/35/69.

S49. RAO, J. N. K. : Some small sample results in ratio and regression estimation (*Jour. Ind. Agr. Stat.*), Math-Stat/15/69.

(S23) ———— (with Hartley, H. O. and Kiefer, Grace) : Variance estimation with one unit per stratum (*Jour. Amer. Stat. Assn.*), Math-Stat/6/79.

(S21) ———— (with Ghangurda, P. D.) : Bayesian optimisation in sampling finite populations (*Jour. Amer. Stat. Assn.*), Math-Stat/37/69.

(S43) ———— (with Ramakrishna, M. K.) : A note on A. Chaudhuri's paper, "A comparison between sampling with and without replacement from finite populations" (*Bull. Cal. Stat. Assn.*), Math-Stat/25/69.

S50. ———— (with Singh, M. P.) : On the criterion of 'Hyper-admissibility' and 'Necessary bestness' in survey-sampling (*Jour. Amer. Stat. Assn.*), Math-Stat/40/69.

S51. RAO, J. S. (with Sethuraman, J.) : Pitman efficiencies of tests based on spacings (*Proc. First. Int. Sym. Nonparametric Tech. Stat. Infer.*), Math-Stat/11/69.

S52. RAO, M. BHASKAR : On two-parameter family of BIB designs (*Sankhyā*), Math-Stat/47/69.

S53. ———— : On balanced designs (*Ann. Math. Stat.*), Math-Stat/41/69.

S54. RAY, SARIT : On determining optimal investments in L. P. Models (*Opsearch*), Math-Stat/8/69.

(S19) SARMA, Y. R. (with Chakraborty, R.) : Some statistical models for human multiple births (*Ann. Human. Genet.*), Math-Stat/52/69.

S55. SASTRY, M. N. : Weak compactness of a set of translates of Weiner measure (*Jap. Jour. Math.*), Math-Stat/17/69.

(S51) SETHURAMAN, J. (with Rao, J. S.) : Pitman efficiencies of tests based on spacings (*Proc. First. Int. Sym. Nonparametric Tech. Stat. Infer.*), Math-Stat/11/69.

(S45) SINGH, M. P. (with Ramakrishnan, M.K.) : On the hyper-admissibility of an estimator in survey sampling (*Jour. Amer. Stat. Assn.*), Math-Stat/50/69.

(S50) ———— (with Rao, J. N. K.) : On the criterion of 'Hyper-admisaiblity' and 'Necessary bestness' in survey sampling (*Jour. Amer. Stat. Assn.*), Math-Stat/40/69.

C. *Theoretical Physics and Electronics*

S56. BANDYOPADHYAYA, P. (with Raychaudhuri, P.) : Weak interaction of photons and neutrino-electron scattering (*Il Nuovo Cimento*, Italy), Elec/6/69.

S57. ——— (with Raychaudhiri, P. and Saha, S. K.) : Weak interaction of photons and the proton-neutrino elastic scattering (*Lettere al Nuovo Cimento*) Italy, Elec/7/69.

S58. ——— (with Raychaudhuri, P. and Saha, S. K.) : Propagation of electromagnetic waves in a degenerate neutrino sea (*Physical Review*), Elec/8/69.

S59. ——— (with Raychaudhuri, P.) : Weak interaction of photons and the photo-neutrino process (*Prog. Theo. Phys.*, Japan), Elec/9/69.

S60. ——— (with Raychaudhuri, P.) : Neutrino energy density of the universe (*Il Nuovo Cimento*, Italy), Elec/10/69.

S61. ——— (with Raychaudhuri, P.) : Pulsar as a radially pulsating neutron star (*Physical Rev. Letters*, U.S.A.), Elec/11/69.

S62. ——— : Theories of weak interactions and astrophysical evidence (*Prog. Theo. Phys.*, Japan), Elec/12/69.

S63. ——— : Weak interaction of photons, muon decay and scattering of leptons (*Lettere al Nuovo Cimento*, Italy),

S64. ——— (with Raychaudhuri, P.) : Possible pulsation of neutron stars and neutrino emission (*Lettere al Nuovo Cimento*, Italy).

S65. ——— (with Raychaudhuri, P.) : Some remarks on the possible origin of super-heavy nuclei in primary cosmic rays (*Jour. Phys.* A : General Physics, England).

S66. DAS, JYOTIRMAY (with Dutta Majumder, Dwijesh) : Reliability improvement in digital systems through redundancy (*J.I.T.E.*), Elec/15/69.

S67. DUTTA MAJUMDER, DWIJESH : The system design of a real-time computer controlled communication system (Annual Conference, Institute of Telecommunication Engineers (India), Calcutta Centre, 11 October 1969), Elec/13/69.

S68. ——— (with Das, Jyotirmay and Dutta, Asoke Kumar) : Studies on associative memory in relation to pattern recognition (Fifth Annual Conference, Computer Society of India, Madras, 8–10 January 1970), Elec/14/69.

(S66) ——— (with Das, Jyotirmay) : Reliability improvement in digital systems through redundancy (*J.I.T.E.*), Elec/15/69.

(S68) DUTTA, ASOKE KUMAR (with Das, Jyotirmay, and Dutta Majumder, Dwijesh) : Studies on associative memory in relation to pattern recognition (Fifth Annual Conference, Computer Society of India, Madras, 8–10 January 1970), Elec/14/69.

S69. GHOSH, AMBARISH (with Srinivasan, B.) : On approximation of 1940 resistance law by simple functions and its effect on trajectories of projectiles (*Sankhyā*), Elec/16/69.

S70. MITRA, SAMARENDRA KUMAR (with Banerjee, Sailendra Nath) : On the probability distribution of rounding-off errors in tabular differences of analytic functions (Parts I & II) (*Australian Comp. Jour.*).

S71. ———— : On the probability distribution of the sum of independent random variables distributed rectangularly (*Indian Science Congress*, 1970, Section on Statistics).

S72. ———— : On the probability distribution of the sum of random variables each distributed uniformly (*SIAM Journal of Applied Probability*).

S73. PRABHAKAR, N. D. (with Roj, A. K. and Ramachandran, G.) : Photo production of neutral pions on nuclei (*Nuclear Physics*), Phy/1/69.

S74. RAMACHANDRAN, G. : Recoil deuteron vector polarization in elastic electron scattering (*Physical Rev. Letters*), Phy/2/69.

(S73) ———— : (with Roj, A. K. and Prabhakar, N. D.) : Photo production of neutral pions on nuclei (*Nuclear Physics*), Phy/1/69.

S75. ———— : Theoretical nuclear physics in Indian Statistical Institute, (*Proc. Nuclear Phys. Symp., Saha Inst. Nuc. Phys.*, Calcutta), Phy/4/69.

S76. ———— : Is time reversal invariance violated in electromagnetic interactions ? (*Proc. 11th Sym. Cosmic Ray, Particle Physics, Astrophysic and Geophysics*), Delhi), Phy/5/69.

S77. ———— : Nucleon-deuteron scattering (*Il Nuovo Cimento*, Italy), Phy/7/69.

S78. RAYCHAUDHURI, P. : Weak interaction of photons and neutrino Bremsstrahlung (*Prog. Theo. Phys.*, Japan), Elec/1/69.

S79. ———— : Plasma neutrino emission from stars and its astrophysical evidence (*Canad. Jour. Phys*), Elec/2/69.

S80. ———— : Photoneutrino energy loss rates (*Canad. Jour. Phys*), Elec/3/69.

S81. ———— : Synchrotron radiation of neutrinos and astrophysical evidence I. Application to white dwarfs (*Ann. Phys.* USA), Elec/4/69.

S82. ———— : Synchrotron radiation of neutrinos and astrophysical evidence II. Application to neutron stars (*Ann. Phys.*, USA), Elec/5/69.

(S56) ———— : (with Bandyopadhyay, P.) : Weak interaction of photons and neutrino-electron scattering (*Il Nuovo Cimento*, Italy), Elec/6/69.

(S57) ———— : (with Bandyopadhyay, P. and Saha, S.K.) : Weak interaction of photons and the proton-neutrino elastic scattering (*Lettere al Nuovo Cimento*, Italy), Elec/7/69.

(S58) ———— : (with Bandyopadhyay, P. and Saha, S. K.) : Propagation of electromagnetic waves in a degenerate neutrino sea (*Physical Review*), Elec/8/69.

(S59) ———— : (with Bandyopadhyay, P.) : Weak interaction of photons and the photoneutrino process (*Prog. Theo. Phys.*, Japan), Elec/9/69.

(S60) ———— : (with Bandyopadhyay, P.) : Neutrino energy density of the universe (*Il Nuovo Cimento*, Italy), Elec/10/69.

(S61) RAYCHAUDHURI P. (with Bandyopadhyay, P.): Pulsar as a radially pulsating neutron star (*Physical Rev. Letters*, U.S.A.), Elec/11/69.

(S64) ———: (with Bandyopadhyay, P.): Possible pulsation of neutron stars and neutrino omission (*Lettere al Nuovo Cimento*, Italy).

(S65) ———: (with Bandyopadhyay, P.): Some remarks on the possible origin of superheavy nuclei in primary cosmic rays (*Jour. Phys.* A: General Physics, England).

S83. ———: Neutrinos and the arrow of time in cosmology (*Jour. Phys.* A: General Physics, England).

S84. ———: Plasma neutrino emission from stars and its astrophysical evidence (*Canad. Jour, Phys.*).

S85. ———: Photo-neutrino energy loss rates (*Canad. Jour, of Phys.*).

S86. ———: Some remarks on the role of neutrino processes in red giants. (*Canad. Jour. of Phys.*).

S87. ———: Synchrotron radiation of neutrinos and astrophysical evidence I, application to white dwarfs (*Astrophysics and Space Science*, Netherlands).

S88. ———: Synchrotron radiation of neutrinos and astrophysical evidence II, application to neutron stars (*Astrophysics and Space Science*, Netherlands).

S89. ———: Weak interaction of photons and neutrino Bremsstrahlung (*Canad. Jour. of Phys,*).

S90. ———: w and B exchange π photoproduction on nuclei (*Lettere al Nuovo Cimento*, Italy), Phy/3/69.

S91. ———: Regge-trajectories in nuclear photoproduction (*Il Nuovo Cimento*, Italy), Phy/6/69.

(S57) SAHA, S. K. (with Bandyopadhyay, P. and Raychaudhuri, P.): Weak interaction of photons and the proton-neutrino elastic scattering (*Lettere al Nuovo Cimento*, Italy), Elec/8/69.

(S58) ——— (with Bandyopadhyay, P. and Raychaudhuri, P.): Propagation of electro-magnetic waves in a degenerate neutrino sea (*Physical Review*), Elec/8/69.

(S69) SRINIVASAN, B. (with Ghosh, Ambarish): On approximation of 1940 resistance law by simple functions and its effect on trajectories of projectiles (*Sankhyā*), Elec/16/69.

D. *Anthropometry and Human Genetics*

S92. CHAKRAVARTY, R.: Heterozygosity with differential fitness (*Sankhyā*).

S93. CHAKRAVARTY R. : A note on parent-offspring correlation and inbreed (*Japanese Jour. Human Genetics*), Math-Stat/2/70.

S94. DAS, S. K. (with Mukherjee, B. N.) : The haptoglobin and transferrin types in West Bengal and a case of haptoglobin '*Johnson*', Nat/13/69.

S95. DAS, S. R. (with Das, S. K., Anathakrishnan, R. and Mukherjee, B. N., Blake, N. M. and Kirk, R. L.) : LDH Variants in India (*Humangenetik*), Nat/2/70.

S96. ——— (with Mukherjee, D. P., Bose, Lalita and Das, Asha) : *A Memoir on 'A radiological study of skeletal maturity in a group of Bengali boys and girls in the southern suburbs of Calcutta City'* (based on logitudinal findings on the hand and wrist bones), (*Anthropological Survey of India*), Calcutta.

S97. ——— (with Mukherjee, D. P. and Sastry, D. B.) : A somatological study of five tribes in the Koraput District, Orissa. *Bull. Anthro. Survey of India*, 1969.

S98. ——— (with Das, S. K., Mukherjee, B. N., Blake, N. M. and Kirk, R. L.) : The distribution of some enzyme group systems (red cell) among Bengalis, (*Ind. Jour. Med. Res.*, Delhi), Nat/1/70.

S99. HALDER, AJIT (with Pakrasi, Kanti) : Polygynists of Urban India, 1960-61 (*Ind. Jour. Soc. Work*), Nat/17/69.

(S94) MUKHERJEE, B. N. (with Das, S. K.) : The haptoglobin and transferrin types in West Bengal and a case of haptoglobin '*Johnson*', Nat/13/69.

S100. PAKRASI, KANTI : Effect of infanticide on sex-ratio in an Indian population, (*Zeitschrift fur Morphologie und Anthropologie*, West Germany), Nat/7/69.

(S99) ——— (with Halder, Ajit) : Polygynists of Urban India, 1960-61 (*Ind. Jour. Soc. Work*), Nat/17/69.

S101. RAO, D. C. : Analysis of family data I—introducing monozygotic multiple births (*Cal. Stat. Bull.*).

S102. ——— : A note on Li's paper, (*Jour. Ind. Soc. Agri. Stat.*)

S103. ——— : Statistical methods in blood groups (*Jour. Ind. Soc. Agri. Stat.*).

S104. ——— : A contribution to the genetics of Hypertrichosis of the ear rims (*Human Heredity*).

S105. RAO, G. B. K. : Natural selection and blood groups polymorphism, Nat/6/69.

E. *Biochemistry*

S106. PAL, P. R. : *N*-Acylation of glucosamine by a new method (*Jour. Org. Chem.*).

S107. ——— : Sugar contents of radish (*Jour. Food Sci. & Tech.*).

F. *Chemistry*

S108. GHOSAL, D. N. : Studies on the sorption and release of two basic antibiotics by and from clays, part I. Montomorillonite and little (*Jour. Ind. Soil. Sci.*), Nat//9/69.

S109. ———— : A spectrophotometric study of malachite greensentonite complex (*Sci. Cul.*), Nat/14/69.

G. *Crop Science*

S110. DAVIS, T. A. : Variacion en el numero de carpelos en frutos de palmeras. (*Agronomia Tropical*).

S111. ———— : Why Fibonacci system for palm leaf spirals (*Fibonacci Quarterly*).

S112. ———— : Effect of changing the direction of growth on fruit-yield in cowpea. (*Sankhyā*).

S113. ———— : Branching in *Chrysalidocarpus lutescens*, (*Phytomorphology*).

S114. ———— : Right-handed, left-handed and neutral palms (*Jour. Palm Soc.*).

S115. ———— : The Malayan dwarf coconut, a probable answer to the Kerala coconut wilt. (*Coco. Bull.*).

S116. ———— (with Dorairaj, S. & Gopalakrishnan, L.) : New cases of reversal of spadices in coconut palms. (*Jour. Palm Soc.*).

H. *Computer Science*

S117. ADHIKARI, A. K. : A note on the distribution of the most significant digit (*Math. Compt.*), Math-Stat/33/69.

S118. GUPTA, B. S. S. (with Halder, A. K.) : A study on the disparities of food prices (*Proc. Annual Meeting, Comp. Soc. Ind.*,) CSU/1/69.

(S118) HALDER, A. (with Gupta, B. S. S.) : A study on the disparities of food prices (*Proc. Annual Meeting Comp. Soc. Ind.*, 1969), CSU/1/69.

S119. ———— (with Sengupta, P.) : Some computer simulation techniques in demographic analysis, CSU/3/69.

S120. NARAYANAN, K. S. : Redesigning the Fortran II system for the IBM 1401, CSU/2/69.

(S119) SENGUPTA, P. (with Halder, A. K.) : Some computer simulation techniques in demographic analysis, CSU/3/69.

S121. SIKDAR, KRIPASINDHU : A note on multiple precision range transformations (*Trans. Elec. Comp., IEEE Inc.*), Math-Stat/18/69.

I. *Demography*

S122. BHATTACHARYYA, D. P. (with Mahalanobis, P. C.) : Growth of population of India and Pakistan : 1800–1961 (*General Congress*, 1969, *International Union for Scientific Study of Population*, London), Dem/6/69.

S123. BHATTACHARYA, N. (with Halder, A. K.): Fertility and sex-sequence of children of Indian couples (*Milbank Memorial Fund Quarterly*), Dem/1/69.

S124. CHAKRABORTY, B. (with Malakar, C. R.): A statistical study on exposure differential in contraceptive practices (*Amer. Jour. Soc.*), Dem/5/69.

S125. GUPTA, P. B. (with Ramakrishna, G.): Net reproductivity of West Bengal (India) by districts and its association with some socio-economic variables (*Dr. S. Chandrasekhar's 70th Birthday Volume*), Dem/3/69.

S126. ———: Demographic report of West Bengal 1901–1961, (*State Demographic Reports*).

(S123) HALDER, A. K. (with Bhattacharya, N.): Fertility and sex-sequence of children of Indian couples (*Milbank Memorial Fund Quarterly*), Dem/1/69.

(S122) MAHALANOBIS, P. C. (with Bhattacharyya, D. P.): Growth of population of India and Pakistan : 1800–1961 (*General Congress*, 1960, *International Union for Scientific Study of Population*, London), Dem/6/69.

S127. MAJUMDAR, MURARI: Some aspects of fertility and family planning in the urban areas of India (*General Congress*, 1960, *International Union for Scientific Study of Population*, London).

S128. ———: Urban Delhi—past growth and future prospects (*Jour. Socio-Econ. Res. Inst.*, Calcutta).

(S124) MALAKAR, C. R. (with Chakraborty, B.): A statistical study on exposure differential in contraceptive practices (*Amer. Jour. Soc.*), Dem/5/69.

S129. PACHAL, T. K. (with Raman, M. V.): Status of census and vital registration data in the ECAFE countries (*Jour. Inst. Econ. Res.*, Dharwar), Dem/4/69.

S130. ———: Construction of life table for Assam females, 1951–60 (*Sankhyā*).

S131. PAKRASI, KANTI: Momentous thoughts on population problems (*Bull. Soc. Econ. Res. Inst.*, Calcutta), Nat/2/69.

S132. RAMAKRISHNA, G. (with Raman, M. V.): A method to group the census industrial categories of workers (*Jour. Inst. Econ. Res.*), Dem/2/69.

(S125) ——— (with Gupta, P. B.): Net reproductivity of West Bengal (India) by districts and its association with some socio-economic variables (*Dr. S. Chandrasekhar's 70th Birthday Volume*), Dem/3/69.

S133. ——— (with Raman, M. V.): Gain in life expectancy with complete or partial elimination of some causes of death (*Professor Radhakamal Mukherjee Volume*).

(S129) RAMAN, M. V. (with Pachal, T. K.): Status of census and vital registration data in the ECAFE countries (*Jour. Inst. Econ. Res.*, Dharwar), Dem/4/69.

(S132) RAMAN M. V. (with Ramakrishna, G.) : A method to group the census industrial categories of workers (*Jour. Inst. Econ. Res.*,), Dem/2/69.

(S133) ——— (with Ramakrishna, G.) : Gain in life expectancy with complete or partial elimination of some causes of death (*Professor Radhakamal Mukherjee Volume*)

S134. SARKAR, B. N. : Population projections and growth rate of India (*Sankhyā*), Dem/7/69.

S135. SENGUPTA, SURANJAN (with Ghosh, M., Dutta, A. K. and Dasgupta, A.) : 1800 A.D. to 1908 A.D. Population of Asia—A reconstruct (*General Congress*, 1969, *International Union for Scientific Study of Population* London).

J. *Documentation and Library Science*

S136. BHATTACHARYYA, G. (with Ranganathan, S. R.) : Conflict of authorship : Corporate body *vs.* corporate body (*Lib. Sci.*) DRTC/2/69.

S137. GUPTA, B. S. S. : Program-Package for a system for document finding (*Lib. Sci.*).

S138. NEELAMEGHAN, A. : Seminal mnemonics as a management technique (*Lib. Sci.*). DRTC/7/70.

S139. ——— : Bank : depth classification version of CC (*Herald Lib. Sci.*). DRTC/6/70.

S140. ——— (with Ranganathan, S. R.) : Basis for study of compatibility and compatibility of the colon classification with the universal decimal classification (*FID/CR Meeting*, Rome, Oct., 1969), *DRTC*/10/69.

(S136) RANGANATHAN, S. R. (with Bhattacharya, G.) : Conflict of authorship : Corporate body vs. Corporate body (*Lib. Sci.*), DRTC/2/69.

(S140) ——— (with Neelameghan, A.) : Basis for study of compatibility, and compatibility of the colon classification with the universal decimal classification (*FID/CR Meeting*, Rome, Oct., 1969), DRTC/10/60.

K. *Embryology*

S141. BRAHMACHARY, R. L. : On the food habits of giraffe in East Africa (*Uganda Jour. Sci.*).

L. *Family Planning*

S142. SENGUPTA, A. : Socio-sexual aspects of oral contraceptive (*Jour. Social Work*).

S143. ——— (with Ghosal, A. K.) : Motivational aspects of fertility control in an industrial town in West Bengal (*Jour. Ind. Inst. Asian Studies*, Bombay).

M. *Geology*

S144. CHATTERJEE, SHANKAR : Rhynchosaurs in time and space (*Proc. Geol. Soc.*, London), Geo/1/69.

S145. KUTTY, T. S. : Two faunal associations from the Maleri formation of the Pranhita-Godavari Valley (*Bull. Geo. Soc. Ind.*, Bangalore), Geo/3/69.

S146. ——— (with Roy Chowdhury, T. K.) : The Gondwana sequence of the Pranhita-Godavari Valley, India, and its vertebrate faunas (*II Int. Sym. Gondwana Stratigraphy and Palaeontology*, June 1970, South Africa), Geo/9/69.

S147. ROY CHOWDHURY, T. : Two new dicynodonts from the Triassic Yerrapalli formation of Central India (*Palaeontology*), Geo/4/69.

S148. ——— : A new capitosaurid amphibian from the Triassic Yerrapalli formation of the Pranhita-Godavari Valley (*Jour. Geo. Soc. Ind.*, Bangalore), Geo/7/69.

S149. ——— : Indian Triassic vertebrate faunas (*17th Sym. Verts. and Comp. Anatomy*, Sept. 1969, Newcastle-upon-Tyne), Geo/10/69.

(S146) ——— (with Kutty, T. S.) : The Gondwana sequence of the Pranhita-Godavari Valley, India, and its vertebrate faunas (*II Int. Sym. Gondwana Stratigraphy and Palaeontology*, June 1970, South Africa), Geo/9/69.

N. *Phonetics*

S150. KOSTIC, DJORDJE (with Ilic, C., Keramitchievski, S., Nikolic, M., Kalic, D. D. and Mitter, Alokananda) : Phonetic audiometry.

O. *Planning, Economic Statistics and Econometrics*

S151. BARDHAN, P. K. : *Economic Growth and Foreign Trade : A Study in Pure Theory*, John Wiley and Sons, Inc. New York,

S152. ——— : Optimum trade and development policy in a dual economy (*Essays in honour of C. P. Kindleberger*) J. Bhagwati *et al.* (editors).

S153. ——— : Chinese and Indian agriculture : a broad comparison of recent policy and performance (*Jour. Asian Studies*).

S154. ——— : Optimum subsidy to a learning industry : an aspect of the theory of infant industry protection (*Int. Eco. Rev.*).

S155. BHAT, L. S. : Regional physical complexes for agricultural land-use planning in India (*Proc. 21st Int. Geographical Congress*, India, 1968).

S156. ——— : Regional development and national planning in India (*Proc. 21st Int. Geographical Congress*, India, 1968).

S157. ——— : Central place model as a spatial framework for regional and national planning in India (*Proc. Conference on the City as a Centre of Change in Asia*, University of Hongkong, 1969).

S158. BHATTACHARYA, DURGAPRASAD : *A Socio-economic Bibliography of India*, 1871–1961, Vol. I (Indian Institute of Advanced Study, Simla).

S159. BHATTACHARYYA, N. (with Chatterjee, G. S.) : Inter-regional and inter-temporal variations in size distributions of household consumer expenditure in India (*11th General Conference, International Association for Research in Income and Wealth*, 24 August–1 September 1969, Israel), Con/NIRU/3/69.

S160. ——— (with Chatterjee, G. S.) : On rural-urban differentials in consumer prices and per capita household consumption in India (*9th Ind. Econ. Conf.*, 23-24 December, 1969, Patna; also *Sankhyā*), NIRU/12/69.

S161. BHATTACHARYYA, SUDHIR (with Sengupta, Suranjan) : Some characteristics of Indian labour force, its projection upto 1981 and the problems of measurement of its components (*Volume on the Seminar on Employment and Income Distribution*, New Delhi, 29–30 March 1970, U.S.A.I.D. Programme).

S162. BOSE, DEB KUMAR (with Bose, Sanjit) : A computational algorithm for determination of Von Neumann Ray (*9th Ind. Econ. Conf.*, 23–24 December 1969, Patna) Econ/2/69.

S163. BOSE, SANJIT (with Dixit, A. K.) : *Development Planning : A Theoretical Analysis*, Holden Day Inc. San Francisco, and Oliver and Boyd Ltd, Edinburgh).

S164. BOSE, SANJIT : A note on optimal growth and wealth effects (*Int. Econ. Rev.*).

(S162) BOSE, S. (with Bose, Deb Kumar) : A computational alogorithm for determination of Von Neumann Ray (*9th Ind. Econ. Conf.*, 23–24 December 1969, Patna), Econ/2/69.

S165. CHATTERJEE, A. K. (with Mukherjee, M.) : Inter-connexions between size distribution and distributions by industrial origin, factor shares, final expenditures and regions (*11th General Conference, International Association for Research in Income and Wealth*, 24 August–1Se ptember 1969, Israel), Con/NIRU/1/69.

(S159) CHATTERJEE, G. S. (with Bhattacharyya, N.) : Inter-regional and inter-temporal variations in size distributions of household consumer expenditure in India (*11th General Conference, International Association for Research in Income and Wealth*, 24 August–1 September 1969, Israel), Con/NIRU/3/69.

(S160) CHATTERJEE G. S. (with Bhattacharyya, N.) : On rural-urban differentials in consumer prices and per capital household consumption in India (*9th Ind. Econ. Conf.*, 23–24 December 1969, Patna; also *Sankhyā*), NIRU/12/169.

S166. ——— : A preliminary note on the variation in urban-rural differential in consumer prices in India (*7th Indian Conference on Research in National Income and Wealth*, Hyderabad, January 1970).

S167. DEY, B. : Trend in mineral consumption in industries and growth of mining (*7th Indian Conference on Research in National Income and Wealth*, Hyderabad, January 1970).

S168. ——— : Inter-state flow and distribution of scientific and technical personnel (*Economic & Political Weekly*), NIRU/4/69.

S169. DEY, B.: Balanced economic growth of the eastern zone (*52nd Annual Conf. Ind. Econ. Asson.*), NIRU/9/69.

S170. DUTTA MAZUMDAR, DEBKUMAR: Changes in size distribution of income consumption and expenditure during the first two plan periods (*Volume, 7th Indian Econometrics Conference*).

S171. ———: Reference period in family budget enquiries (*Bull. Socio-Econ. Res. Inst.* Calcutta).

S172. KANSAL, S. M.: Structural changes in the consumption expenditure in India (*Papers on National Income and Allied Topics*).

S173. LAHIRI, R. K.: Some aspects of inter-state disparity in industrial development in India: 1956–65 (*Sankhyā*).

S174. MAHALANOBIS, P. C.: Social change, science and economic growth (*One Asia Assembly on New Directions for Asia organised by Press Foundation of Asia, Manila, Philippines*, 11-13 April, 1970).

S175. MAITI, PRADIP: Factor price equalisation theorem in linear programming (*9th Ind. Econ. Conf.*, 23-24 December 1969, Patna), Econ/4/69.

S176. MINHAS, B. S. (with Vaidyanathan, A.): Water requirements of crops and economic efficiency of irrigation water in India (*Proc. Symp. Soil and Water Management*, ICAR).

(S165) MUKHERJEE, M. (with Chatterjee, A. K.): Inter-connexions between size distribution and distributions by industrial origin, factor shares, final expenditures and regions (*11th General Conference, International Association for Research in Income and Wealth*, 24 August–1 September 1969, Israel), Con/NIRU/1/69.

S177. ———: Price information associated with principal distributions of national income in India (*11th General Conference, International Association for Research in Income and Wealth*, 24 August–1 September 1969, Israel), Con/NIRU/2/69.

S178. ———: A method of obtaining consistent price index numbers for interfractile comparison (*9th Ind. Econ. Conf.*, 23-24 December 1969, Patna), NIRU/11/69.

S179. ———: A method of aggregating sectors in an inter-industry transactions tables (*Econ. Ann. Ind. Econ. Jour.*).

S180. ———: Concentration of income within states (*7th Indian Conference on Research in National Income and Wealth*, Hyderabad, January 1970).

S181. NAQVI, S.: Marx on Indian history—a critical look (*Conference, Marxist Approach to Research in Social Sciences*, 5-9 *June* 1969, *Trivandrum, and Commemorative volume for the late Professor D. D. Kosambi*, ed. *Kamat, A. R., Gokhale Institute of Politics and Economics*), Econ/1/69.

S182. PAL, M. N.: Use of principal components in regional analysis (*Proc. 21st Int. Geographical Congress*, India, 1968).

S183. PAL, M. N. (with Prakasa Rao, V. L. S. and Tewari, V. K.) : A technique of ranking central places and determining linkages (*Proc. 21st. Int. Geographical Congress*, India, 1968).

S184. ———— : Quantitative Techniques for Regional Planning, Special Number of Economic Geography (*Proc. Invitational Conference, Commission on Quantitative Geography*, International Geographical Union, London, August 1969).

S185. RAO, D. S. PRASADA : On 'Additive von Neumann-Morgenstern utility functions' (*Econometrica*), NIRU/7/69.

S186. ———— : A remark on 'quasi equilibria in markets with non-convex preferences' (*Econometrica*), NIRU/8/69.

S187. ———— : On using production and allocation coefficients simultaneously Communicated to Professor P. N. Mathur), NIRU/10/69.

S188. ROY, B. : Growth of sectoral investment in India over the post-independence period (*7th Indian Conference on Research in National Income and Wealth*, Hyderabad, January 1970).

S189. SENGUPTA, NIRMAL : Towards a wage distribution function (*9th Ind. Econ. Conf.*, 23-24 December 1969, Patna), Econ/5/69.

(S161) SENGUPTA, SURANJAN (with Bhattacharyya, Sudhir) : Some characteristics of Indian labour force, its projection upto 1981 and the problems of measurement of its components (*Volume on the Seminar on Employment and Income Distribution*, New Delhi, 29-30 March 1970, U.S.A.I.D. Programme).

S190. SRINIVASAN, T. N. : A note on approximations to finite sample moments of an estimator whose exact sampling distribution is unknown (*Econometrica*).

S191. ———— : Choice of techniques (*Proc. Conference on Economic Development in South Asia*,, organised by the International Economic Association).

S192. TENDULKAR, S. D. : Interaction between domestic and foreign resources in economic growth : some experiments for India. *Essays on Development Planning*, Harvard University Press, H. B. Chenery (Editor).

P. *Psychometry*

S193. BASUMALLIK, T. : Factor analysis of a selection test battery (*Jour. Psychol. Res.*), Psych/13/69.

S194. ———— (with Nandi, D. N. and Ghosh, S.) : Relation between suicidal thoughts and other symptoms of depressive illness (*Ind. Jour. Psychiatry*).

S195. ———— (with Banerjee, D. (AIIH & PH) : Relationship between achievement motivation and risk-taking (*Ind. Jour. Psychology*).

S196. CHATTERJEE, S. (with Mukherjee, M.) Differential prediction of success through the use of psychological tests (*Educ. Rev.* Delhi), Psych/9/69.

S197. CHATTERJI, S. (with Ghosh, Dipti, Ganguly, D. and Mukherjee, M.) : An investigation into the validity of a scientific knowledge and aptitude test (*Psychol. Bull.*, Calcutta), Psych/11/69.

S198. ——— (with Banerjee, Chhabi, Dutta, Anath and Mukherjee, M.) : An investigation into the interest pattern of deaf children (*Psychol., Annual*, Tripura), Psych/12/69.

S199. ——— (with Mukherjee, M. and Mitra, Sadhana) : A comparative study of some of the environmental conditions of delinquent and school-going children (*Psychol. Res.*, Meerut), Psych/14/69.

(S196) MUKHERJEE, M. (with Chatterji, S.) : Differential prediction of success through the use of psychological tests (*Educ. Rev.*, Delhi), Psych/9/69.

(S197) ——— (with Chatterji, S., Ghosh, Dipti and Ganguly, D.) : An investigation into the validity of a scientific knowledge and aptitude test (*Psychol. Bull.*, Calcutta), Psych/11/69.

(S199) ——— (with Mitra, Sadhana and Chatterji, S.) : A comparative study of some of the environmental conditions of delinquent and school-going children (*Psychol. Res.*, Meerut), Psych/14/69.

Q. *Sociology*

S200. CHATTOPADHYAY, K. (with Bandyopadhyay, S.) : Technological innovation and people's reaction (*Human Organization*, U.S.A.), Nat/15/69.

S201. MUKHERJEE, R. : On the secondary analysis of variation in family structures, (*Current Anthropology*, U.S.A.).

S202. ——— : Data inventory on social sciences—India (*Social Science Information*, ISSC, Paris).

S203. ——— : Family in India : A Perspective (*Perspectives*, Indian Journal of Public Administration, New Delhi).

S204. ——— : On the study of social change and social development in the 'developing societies' (*Economic & Political Weekly*).

S205. ——— : Indian society and empirical social research (*A Volume of Essays on New Approaches in Humanities and Social Sciences*, Indian Institute of Advanced Study, Simla.)

R. *Statistical Quality Control*

S206. ARTHANARI, T. S. (with Ramamurthy, K. G.) : A branch and bound algorithm for m parallel processors sequencing problem (*Opsearch*).

S207. DESIKAN, G. V. S. (with Srinivasan, N.) : How many spindles to a sider ? (*Ind. Text. Jour.*, Bombay).

S208. MAHALANOBIS, P. C.: Extension of fractile graphical analysis (*International Conference on Quality Control*, Tokyo, 21–24 October 1969).

S209. MUKHOPADHYAY, A. C.: Construction of some general and two-level partially balanced arrays (*Sankhyā*).

(S206) RAMAMURTHY, K. G. (with Arthanari, T. S.): A branch and bound algorithm for m parallel processors sequencing problem (*Opsearch*).

(S207) SRINIVASAN, N. (with Desikan, G. V. S.): How many spindles to a sider ? (*Ind. Text. Jour.*, Bombay).

S. *Zoology*

S210. DAS CHAUDHURI, P. C.: Intestinal movements in the fourth instar larva of *Chaborus Crystallinus* de Geer (*Proc. Zool. Soc.*, Cal.), Nat/8/69.

PART V. RESEARCH SUMMARY

A brief account is given in this section of the progress of research in the different divisions and sections of the Institute. References are given in this section to the R.T.S. Technical Report Number and the List of Papers Submitted for Publication.

A. Mathematics

1. *On maximal regular topologies :* (*Mathematische Zeitschrift*) : Bagchi, Somesh and Raha, Asit Baran. Math-Stat/31/69, (S1).

In any topological space, the existence of the largest regular topology coarser than the original topology has been shown. This topology, in addition, makes any function continuous for the original topology into any regular space continuous. Some further properties are also investigated.

2. *Some fibonacci relations :* (*Fibonacci Quarterly Journal*) : Iyer, Muthulakshmi, R. Math-Stat/12/69, (S2).

In this paper, the author has found the particular Fibonacci Numbers F_n which satisfy the relation $F_n = N$ where $N = nk$ and k is a positive integer. This amounts to finding those Fibonacci Numbers F_n which are exactly divisible by n. It is found that such numbers are possible only in the following cases :

(i) When n is of the form 5^r where r is zero or positive integer.

(ii) When n is of the form $12t$. In this the following exceptions are observed : (a) If t is a prime other than 2, 3, 5, F_{12t} is not divisible by $12t$. (b) If t is an even multiple of 7, 23, F_{12t} is divisible by $12t$ but not for odd multiples of 7, 23.

The author has worked out the numbers up to 628.

3. *Relations connecting the pell numbers and the associated numbers* (*Jour. Ann. Math. Soc.*) : Iyer, Muthulakshmi, R. Math-Stat/32/69, (S3).

In this paper, the author has found the relations connecting the Pell numbers and the associated numbers. We know that Pell sequence is defined by $P_0 = 0$, $P_1 = 1$ and $P_{n+2} = 2P_{n+1} + P_n$ for $n \geqslant 0$. If we change the initial terms, keeping the recurrence relation same we get a different sequence which we call R_n say. The initial terms are taken to be $R_0 = 1$, $R_1 = 1$ and let $R_{n+2} = 2R_{n+1} + R_n$ for $n \geqslant 0$.

The rest of the paper deals with the identities and relations that are derived. In the last section the generating functions $P(x)$ and $R(x)$ are derived for P_n and R_n respectively.

4. *Fibonacci and Lucas quaternions* (*Tohoku Mathematical Journal*, Tokyo) : Iyer, Muthulakshmi, R. Math-Stat/39/69, (S4).

In this paper, the author has made use of the definition of the Fibonacci Quaternion and derived a modified form of the same in terms of Fibonacci and Lucas numbers. Then on similar lines the Lucas Quaternions T_n are derived.

5. *Some partitions of, and the number of Borel fields on, large finite sets* (*Proc. Colloquium Comb. Maths.*) : MENON, V. V. Math-Stat/13/69, (S5).

For a set of size n, let $S_{n,r}$ = number of partitions of the set into r subsets = number of Borel fields with r atoms on the set, $1 \leqslant r \leqslant n$. $S_{n,r}$ is a stirling number of the second kind and occurs in the classical occupancy problem. A simple and elementary technique is illustrated to investigate the asymptotic behaviour of $S_{n,r}$; starting with obvious inequalities for $S_{n,r}$, this technique yields the following results : as $n \to \infty$.

(1) let $a_{n,r} = (n\log n)^{-1} \log S_{n,r}$, then

$$0 < a_{n,r} - \left(1 - \frac{r}{n}\right) \frac{\log r}{\log n} = 0(1/\log n).$$

If r varies with n so that (i) $\lim_{n\to\infty} r/n = p \neq 0$, then $\lim a_{n,r} = 1-p$, and (ii) $\lim_{n\to\infty} r/n = 0$ and there is a constant $C(0 < C \leqslant 1)$ such that $rn^{-c} = \exp\{0(\log n)\}$, then $\lim_{n\to\infty} a_{n,r} = C$.

(2) Let $f(n) = \sum_{r=1}^{n} S_{n,r}$ denote the number of Borel fields on a set of size n, then

$$\frac{1}{n} \log f(n) = \log n \log\log n - 1 + 0(1)$$

(3) If $S_{n,r}$ is a maximum, for a given n, when $r = r_n$, then $n/r_n = \log n + 0(\sqrt{\log n})$.

This improves a result of A. J. Dobson, *J. Combinatorial Theory*, 1968.

6. *A remark on completely regular spaces* (*Proc. Amer. Math. Soc.*) : RAHA, ASIT BARAN. Math-Stat/22/69. (S6).

The aim of this paper is to show that for any topological space the topology generated by all real-valued continuous functions is the largest completely regular topology contained in the original topology. As a consequence of this result, a generalization of a theorem of Gillman and Jerison has been obtained.

7. *Existence of triconnected graphs with prescribed degrees* (*Pacific Jour. Math.*) : RAO, A. RAMACHANDRA and RAO, S. B. Math-Stat/29/69, (S7).

Let $d_1, d_2, \ldots, d_n$ be positive integers arranged in increasing order of magnitude. Then the following four conditions are necessary and sufficient for the existence of a triconnected graph with degrees $d_1, d_2, \ldots, d_n$;

(1) $d_1 \geqslant 3$

(2) There exists a graph with degrees $d_1, d_2, \ldots, d_n$.

(3) $d_n + d_{n-1} \leqslant m - n + 4$ where $2m = \sum_{i=1}^{n} d_i$

(4) If $d_n + d_{n-1} = m - n + 4$, then $m \geqslant 2n - 2$.

8. *A note on Hamiltonian degree sequences* (*Jour. Comb. Theo.*) : RAO, A. RAMACHANDRA and RAO, S. B. Math-Stat/44/69, (S8).

We say that $d_1, d_2, \ldots, d_n$ is traceable (resp. factorable, Hamiltonian) if there exists a graph with degrees $d_1, d_2, \ldots, d_n$ and with a Hamiltonian chain (resp. a factor, a Hamiltonian cycle). It is proved that a factorable sequence (d_i) is Hamiltonian if and only if

$$\sum_{i=1}^{k} d_i < k(n-k-1), + \sum_{j=0}^{k-1} d_{n-j} \text{ whenever } k < \frac{n}{2}$$

provided $d_1 \geqslant d_2 \geqslant \ldots \geqslant d_n$. Also it is shown that every factorable sequence is traceable.

9. *The number of cut vertices and cut arcs in a diagraph* (*Jour. Comb. Theo.*) : RAO, A. RAMACHANDRA and RAO. S. B. Math-Stat/55/69, (S9).

A cut vertex (cut arc) of a diagraph is a vertex (arc) whose removal increases the number of strong components of the diagraph. In this paper we find the ranges of the number of cut vertices (cut arcs) in a diagraph with n vertices and m arcs. Some extremal graphs are characterised. It is proved that a complete strong diagraph on n ($\geqslant 3$) vertices has at most $n-2$ cut vertices, without using Camion's theorem. This solves a problem raised by Korvin in the symposium on graph theory held in Rome, 1966.

10. *On Borel structures for function spaces* (*Colloquium Mathematicum*) : RAO, B. V. Math-Stat/24/69), (S10).

If (X, B) and (Y, C) are two separable Borel spaces and F is a collection of measurable maps for X to Y, then the problem is to define a Borel structure P on F such that the map $\phi : F \times X$ to Y given by $\phi(f, x) = f(x)$, is measurable. Anumann has shown that a necessary and sufficient condition for this to be possible is that F be of bounded Borel class in a certain sense. Unfortunately his proof is quite complicated. In this paper, this result is proved in an elegant way—by an entirely different method—using the classical notions of universal functions, and Marczewski function. Some remarks concerning consistent structures are also made. Finally an inequivalent formulation of a problem of Anumann is made and is observed to be connected with an interesting selection problem. However, the corresponding problems for non-separable Borel structures are still open.

11. *A further remark on analytic sets* (*Fundamenta Mathematicae*) : RAO, B. V. Math-Stat/26/69, (S11).

Let I denote the unit interval and B, A, O, C be the δ-algebras on I generated by its open sets, analytic sets, sets with Baire property, and all sets respectively. Let U be any universal analytic subset of $I \times I$, and E be any δ-algebra on I with $A \subseteq E \subseteq O$. The purpose of this note is to prove : *Theorem* 1—E is not separable.

Theorem 2—*UC* $O \times O$. That these theorems neither imply nor are implied by similar theorems obtained earlier —where O is replaced by L, the Lebesgue measurable sets—is also observed. Finally these theorems are combined with the Axiom of Determinateness to obtain resule contradictory to those obtained earlier.

12. *On discrete Borel spaces* (communicated to Professor P. Erdos) : RAO, B. V. Math-Stat/42/69, (S12).

This note extends some previous theorems of the author ('On discrete Borel spaces and projective sets' : *Bull. A. M. S.*, May 1969) on discrete Borel spaces. After introducing the concept of an N-algebra (for any infinite cardinal N) analogues of some previous theorems of the author are observed to be valid for the N-algebras as well.

13. *Non-existence of certain Borel structures* (*Fundamenta Mathematicae*) : RAO, B. V. Math-Stat/43/69, (S13).

This note conceptually simplifies and extends some previous theorems of the author ('Remarks on analytic sets' : to appear in *Fund. Math.*). This paper introduces the notions of mixing and Souslin algebras and puts the previous theorems of the author on a purely set-theoretical setting. Finally, an interesting question above Souslin algebras is also raised.

14. *Lattice of Borel structure* (*Colloquium Mathematicum*) : RAO, B. V. Math-Stat/54/69, (S14).

In this paper, we show that the lattice of Borel Structures on a set X is complemented if the set is countable. This incidentally answers that the minimal weak complements in the sense of D. Basu need not exist. Though some special sub-algebras of the Borel algebra of I are shown to possess minimal weak complements, the author could not characterize all such sub-algebras. Then some fixed maximal ideals of this lattice are characterized. The problem of characterizing all fixed maximal ideal is shown to be connected with 0-1 measurable cardinals. It should, however, be noted that this paper is only a start of the study of the deep properties of this lattice and consequently much is yet to be done.

15. *On a problem of ore on maximal trees* (Communicated to Professor O. Ore) : RAO, S. B. Math-Stat/1/69, (S15).

A connected graph $G = (X, E)$ is said to have the property P if for every maximal tree T of G there exists a vertex a_T such that $d_T(a_T, x) = d_G(a_T, x)$ for every $x \epsilon X$.

Theorem : A finite biconnected graph $G = (X, E)$ has the property P if and only if it is a cycle or a complete bipartite graph $K(V, X-V)$ with $|V| = 2$, and $|X-V| \geqslant 2$.

Further, the structure of all finite connected graph having the property P is determined.

B. STATISTICS

16. *Some results on idempotent matrices and matrix equation connected with the distribution of quadratic forms* (*Sankhyā*) : BHIMASANKARAM, P., and MITRA, SUJIT KUMAR. Math-Stat/46/69, (S16).

In this paper, general solutions (X) are obtained for matrix equations (i) $XBX = 0$. (ii) $XBXB = XB$, (iii) $XBXBX = XBX$, (iv) $XBX' XBX' = XBX'$. Further this paper obtains the most general form of a n.n.d. g-inverse for a n.n.d matrix.

17. *Parent-offspring correlation in an equilibrium population* (*Ann. Hum. Genet.*) : CHAKRABORTY, RANJIT. Math-Stat/16/69, (S17).

The main objective of the paper is to generalise Li's results (1954) on the same topic which was applicable for random mating alone. For a di-allelic autosomal character, the parent-offspring correlation is obtained under a general mating system. Expressions of the same were derived with one as well as two parental measurements. An expression, with special interest for plant population, is also established. Four tables are presented to check the theoretical results.

18. *A note on counting method of estimation for MNSs blood group system* (*Human Biology*) : CHAKRABORTY, RANJIT. Math-Stat/34/69, (S18).

The primary object of this note is to develop a gene count method for estimating the chromosome frequencies in MNS's system. The estimates are found to be in agreement with the maximum likelihood estimates but with slightly higher variances. But regarding the computational aspect of it, this is much simpler than the maximum likelihood method.

19. *Some statistical models for human multiple births* (*Ann. Hum. Genet.*) : CHAKRABORTY, RANJIT and SARMA, Y. R. Math-Stat/52/69, (S19).

It is well known that in the process of human multiple births the following factors play an important role : (i) The release of extra zygotes is a hereditary property, i.e. mothers who are themselves members of a multiple birth resulting from more than one zygote have more tendency to release extra zygotes during conceptions than mothers who come from a single zygote, (ii) The intensities of scission of zygotes and the release of extra zygotes vary with the time after the start of pregnancy and there is also a chance for parental mortality, (iii) The twining rates also depend on the age of the mother, monozygotic twining rate rises very slowly but steadily with the age of the mother, whereas the dizygote twining rate rises from puberty to a maximum at about 37 years and then falls abruptly.

Some stochastic models for the probabilities of multiple births are constructed taking into account the above factors. These models are observed to give some existing models as particular cases. Procedures for estimation of the parameters in the models are also indicated.

20. *A note on exchangeable processes with states of finite rank* (*Ann. Math. Stat.*) : DHARMADHIKARI, S. W. Math-Stat/9/69, (S20).

Gilbert conjectured that a finite-rank finite-state stationary process Y_n is a function of a finite stationary Markov chain. This conjecture has been disproved by Heller [*Ann. Math. Stat.*, 39, 938-946]. In this paper the author proves that, in the special case when Y_n is exchangeable, Gilbert's conjecture is correct.

21. *Bayesian optimisation in sampling finite populations* (*Jour. Amer. Stat. Assn.*) : GHANGURDA, P. D., and RAO, J. N. K. Math-Stat/3/769, (S21).

The problem of optimum allocation in sampling finite populations, when prior information in the form of a prior distribution is available, is considered. The following cases are investigated : (a) stratified sampling (with known or unknown strata sizes), (b) two-stage

sampling. (c) non-response problem. Two different allocations are derived in each case using two different approaches : a Bayesian posterior analysis and a Bayesian preposterior analysis. The solutions are based on a recent approach of Hartley and Rao (12), the essential feature of which is that a character y is measured on a known scale of measurement so that the character may attain a finite set of known 'scale-points' on the y-scale. Unlike the results available in the literature, the present solutions are distribution-free and also free from the assumptions of infinite populations or known variances. The results are extended to multiple priors and/or multiple characters.

22. *On the proportion of observations above a sample mean* (*Ann. Math. Stat.*) : GHOSH, J. K. Math-Stat/5/69, (S22).

Let X_i, $i = 1, \ldots, n$ be independent random variables with the same distribution function $F(x) = P_r\{X_i \leqslant x\}$. Let $\bar{X}_n = (\sum_1^N X_i)/n$ and P_n = number of X_i's above $\bar{X}_n$. David I proved the asymptotic normality of P_n when F is a normal distribution function. Using the same elegant trick, Mustafi has proved a similar result for bivariate normal distributions. We shall extend these results considerably by providing alternative proofs which dispense with the normality assumption on F. Moreover, in our proof we may consider—though we shall not do so for purposes of simplicity—instead of the sample mean $\bar{X}_n$ any U-statistic to which the central limit theorem of Hoeffding applies.

23. *A new proof of the Bahadur representation of quantiles* (*Ann. Math. Stat.*) : GHOSH, J. K. Math-Stat/28/69, (S23).

Let X_i be i.i.d and $\Pr(X_i \leqslant x) = F(x)$. Under some mild conditions on F, Bahadur (*Ann. Math. Stat.*) showed that the sample p-quantile $(0 \leqslant p \leqslant 1) Y_{p,n}$ may be represented as

$$Y_{p,n} = M_p + \{G_n(M_p) - (1-p)\}/F'(M_p) + R_n$$

where $P(M_p) = p$, $nG_n(M_p)$ is the number of X_i's among $(X_1, \ldots, X_n)$ which are $> M_p$' and the remainder term $R_n = 0(n^{-3/4} \log n)$ a.s. as $n \to \infty$. For most statistical applications it is enough to know $R_n = 0_p(1/\sqrt{n})$. A simple proof of this weaker result is given in this note. (Our result is stated without proof in Chernoff, Gastwirth and Johns (*Ann. Math. Stat.*, 1967).) The note contains also a slight extension needed for Ghosh (Tech. Rep. 5/69). Our result may be extended easily as in Sen (*Ann. Math. Stat.* 1968).

24. *Variance estimation with one unit per stratum* (*Jour. Amer. Stat. Assn.*) : HARTLEY, H. O. and RAO, J. N. K. and KIEFER, GRACE. Math-Stat/6/69, (S24).

A new solution to the problem of variance estimation with one unit per stratum is presented. This method may lead to smaller bias in variance estimation, in many situations, than the methods of 'collapsed strata'. It requires that we can associate with the strata concomitant variables which are correlated with the strata means. Several numerical examples with one or two concomitant variables are considered.

25. *Necteric index numbers :* KHAMIS, SALEM H. Math-Stat/3/69, (S25).

The system of homogeneous equations

$$P_i = \sum_{j=1}^{M} e^j p_i^j \Big/ \sum_{j=1}^{M} q_i^j$$

$$e^j = \sum_{i=1}^{N} p_i q_i^j \Big/ \sum_{i=1}^{N} p_i' q_i^j,$$

which defines a set of average prices p_i, $i = 1, 2, \ldots, N$ and a set of 'exchange rates' e^j, $j = 1, 2, \ldots, M$, for a given flow of N commodities during each of the M time periods, is utilized to define the set of price indexes P_{st} and quantum indexes Q_{st} through the equations

$$P_{st} = e^t/e^s \text{ and } Q_{st} = \sum_{i=1}^{N} p_i q_i^t \Big/ \sum_{i=1}^{N} p_i q_i^s,$$

with s and t referring to the base and current periods respectively. The letters j, s and t may also refer to different localities, socio-economic groups or marketing stages within the same country. They may also refer to different countries, in which case P_{st} will be an 'exchange rate' for the country t with respect to country s. The index numbers thus defined happen to satisfy almost all the desirable index number tests. As a special case when $M = 2$, the resulting equation comparable with that of the Laspeyres and of the Paasche type is

$$P_{12} = \sum_{i=1}^{N} P_i^2 \frac{p_i^1 \quad q_i^2}{q_i^1 + q_i^2} \Big/ \sum_{i=1}^{N} p_i^1 \frac{q_i^1 \quad q_i^2}{q_i^1 + q_i^2}$$

where the quantity weight coefficient for each commodity is proportional to the harmonic mean of the corresponding quantities for $j = 1$ and 2. Indications of the possible uses of the new system of index numbers and the results of two numerical examples are given. An advantage of the resulting index numbers is that they are based on a simple intuitive meaning of 'average price' and 'exchange rate' as indicated by the system of $M+N$ linear equations.

26. *Independence and same distribution of two second degree polynomials in a normal vector* (*Ann. Inst. Stat. Math.*, Tokyo) : KUMAR, AMOD. Math-Stat/19/69, (S26).

Suppose that the columns of a $p \times n$ matrix $X = (X_1, \ldots, X_n)$ are independent p-variate normal vectors such that cov. $(X_i) = \Sigma^{(i)}$, $i = 1, 2, \ldots, n$ $\Sigma^{(i)}$s may be different and singular. Let $Q(X) = XAX' + \frac{1}{2}(LX' + XL') + C = (q_{ij})$ and $U_{p \times p} = (u_{ij}$ be a real symmetric matrix. In this paper we express $\sum_{ij}^{p} u_{ij} q_{ij}$ as a quadratic expression in a normal vector. We have derived a necessary and sufficient condition as to when two expressions of the form of $Q(X)$ will be stochastically independent. Certain conditions under which two such expressions have the same distribution are also stated. Some applications of the above quadratic expression decomposition are shown.

27. *Independence and same distribution of two second degree polynomials in a complex normal vector* (*Ann. Inst. Stat. Math.*, Tokyo) KUMAR, AMOD. Math-Stat/20/69, (S27).

Some analogous results in complex normal case are obtained by using the same technique as used in real case shown in Technical Report No. Math-Stat/19/69.

28. *On the independence of second degree polynomial statistics in a normal vector* (*Biometrika*) KUMAR, AMOD. Math-Stat/48/69, (S28).

Suppose $X = (X_1 \dots X_n)$ be a $p \times n$ matrix whose columns are independently multivariate normally distributed such that $\text{cov}(x_i) = \Sigma^{(i)}$, $i = 1, 2, \dots, n$. $\Sigma^{(i)}$'s may be different and singular. Let $Q(X) = XAX' + \frac{1}{2}(LX' + XL') = (q_{ij})$ and $V = (u_{ij})$ be a $p \times p$ real symetric matrix. Then $\sum_{i=1, j=1}^{p} u_{ij} q_{ij}$ can be expressed as a quadratic expression in a normal vector. In this paper we have used this decomposition to establish some results concerning independence of statistics of the form $Q(X)$. Analogous results in complex case are also proved.

29. *Identical distribution of second degree polynomial statistics in a normal vector* (*Australian Jour. Stat.*) : KUMAR, AMOD. Math-Stat/49/69, (S29).

Suppose $X = (X_1, X_2, \dots X_n)$ be $p \times n$ matrix which columns are independently multivariate normally distributed such that $\text{cov}(X_p) = \Sigma^{(p)} = (p_{ij}^{(p)})$, $p = 1, 2, \dots, n$, $\Sigma^{(p)}$'s may be different and singular. Let $Q(X) = XAX' + \frac{1}{2}(LX' + XL') + C$ where A and C are symmetric matrices. Author (Technical Report No. 19/69) has obtained necessary and sufficient condition for two statistics of the form $Q(X)$ to have the identical distributions in some particular cases. In this paper necessary and sufficient condition is obtained in more general cases.

30. *A note on Graybill and Milliken's paper, 'Quadratic forms and idempotent matrices with random elements'* (*Ann. Math. Stat.*) : KUMAR, AMOD. Math-Stat/56/69, (S30).

In this note the author has given simpler proofs of theorems 3.2 and 3.3 by Graybill and Millibeu (Graybill and Millibeu, *Ann. Math. Stat.*, 40, 1430-1438). Conditions in Graybill and Millibeu's theorem 3.3 are given when covariance matrix is singular. Some further generalisations of theorem 3.1 and 3.2 by Graybill and Millibeu in Wishart case are also given.

31. *A matrix variate Dirichlet distribution.* (*Cal Stat. Asen. Bull.*) : KUMAR, AMOD. Math-Stat/57/69, (S31).

Mitra (1969) in his paper 'A density free approach to matrix variate beta distribution' (Tech. Rep. No. Math-Stat/21/69, submitted to *Sankhyā*) has treated the case when there are two independent Wishart distributed matrices. In this paper the author has derived the analogous results of Mitra (1969) when these are finite number of independently Wishart distributed matrices. The analogous results in complex normal random variables are also derived.

33. *On stochastic games* (*Jour. Opt. Appl.*) : MAITRA, A. and PRATHASARATHY, T. Math-Stat/27/69, (S33).

In this paper, we consider the stochastic games of Shapley, when the state and action spaces are all infinite. We prove that under certain conditions the stochastic game has a value and that both players have optimal strategies.

34. *A note on continuous gambling houses* (*Ann. Math. Stat.*) : MENON, V. V. and PRABHAKAR, N. D. Math-Stat/30/69, (S34).

We consider a gambler's problem where the fortune space is compact metric, the gambling house and the utility vary continuously and show that the gambler can restrict himself to Baire class I strategies but not necessarily to continuous strategies. This answers a question raised by Dubins and Savage in their book "How to Gamble if You Must."

35. *Goodness of fit of a compound multinomial distribution and allied problems* (*Bull. Inst. Stat. Inst*) : MITRA, SUJIT KUMAR, Math-Stat/10/69, (S35).

This paper deals with the problem of testing goodness of fit of a multinomial distribution, when the total number of possible observations (the sample size n) is an unobserved random variable with a known distribution. The data for analysis are the observed frequencies $0_1, 0_2, \ldots, 0_k$ in k classes of the multinomial distribution with the corresponding class probabilities $\pi_1, \pi_2, \ldots, \pi_k$ adding upto a number strictly less than 1. Given a specified value to the random variable n, the conditional distribution of $0_1, 0_2, \ldots, 0_k$, $n - \Sigma 0_i$ is positive multinomial. Marginally $0_1, 0_2, \ldots, 0_k$ follows a compound multinomial distribution. Consider a hypothesis H_0 which numerically determines the class probabilities π_i and accordingly the vector of expected frequencies $E_1, E_2, \ldots, E_k$. It is shown that under certain conditions the hypothesis could be tested by a suitable constructed goodness of fit chi-square statistic, based only the observables $0_1, 0_2, \ldots, 0_k$. The case of a composite hypothesis which determines the class probabilities only as known functions of certain unknown parameters is also considered.

36. *A density free approach to the matrix variate beta distribution* (*Sankhyā*) : MITRA, SUJIT KUMAR. Math-Stat/21/69, (S36).

Let $S_1 \sim W_k(n_1, \Sigma)$ and $S_2 \sim W_k(n_2, \Sigma)$ be independent Wishart matrices and Σ be p.d. Consider $S = S_1 + S_2$ and define $U = (S)^{-\frac{1}{2}} S_1 (S)^{-\frac{1}{2}}$, where $(S)^{\frac{1}{2}}$ is the unique lower triangular matrix with positive diagonal elements, such that $(S)^{\frac{1}{2}}[(S)^{\frac{1}{2}}]' = S$ and $(S)^{-1/2}$ is the inverse of $(S)^{1/2}$. The joint distribution of the elements of the symmetric matrix U is said to be 'matrix variate beta' and is denoted by the symbol $B_k\left(\frac{n_1}{2}\frac{n_2}{2}\right)$. Listed below are some of the properties of this distribution obtained in this paper.

(i) For each fixed vector a, $a'Ua/a'a \sim B\left(\frac{n_1}{2}, \frac{n_2}{2}\right)$. A counter example shows that this does not characterise the matrix variate beta distribution.

(ii) If $S_2 \sim W_k(n_1+n_2, \Sigma)$ and is independently distributed of $U, (S_2)^{\frac{1}{2}} U[(S_2)^{\frac{1}{2}}] \sim W_k(n_1, \Sigma)$,

(iii) If U_0 and U are independently distributed and

$$U_0 \sim B_k\left(\frac{n_1+n_2}{2}, \frac{n_2}{2}\right), \text{ then}$$

$$(U_0)^{\frac{1}{2}} U[(U_0)^{\frac{1}{2}}]' \sim B_k\left(\frac{n_1}{2}, \frac{n_2+n_3}{2}\right).$$

(iv) For each fixed vector a, $a'a/a'U^{-1}a \sim B\left(\frac{n_1-k+1}{2}, \frac{n_2}{2}\right)$

(v) If L is a fixed orthogonal matrix of order k.

$$LUL' \sim B_k\left(\frac{n_1}{2}, \frac{n_2}{2}\right).$$

The author shows how a given observation on a Wishart matrix S distributed as $W_k(n, \Sigma)$ can be expressed as the sum of n independent Wishart matrices each on 1d.f. and how to compute observations u_i on independent $N_k(o, \Sigma)$ variates, such $S = \sum_{i=1}^{n} u_i u_i$.

The distribution of the elements of U (in the central as well as noncentral case) has been studied in literature under the name 'multivariate beta distribution'. These studies establish certain properties of the distribution, other than (i)-(v) listed above, under the condition $\min(n_1, n_2) \geqslant p$. Using the density free approach the author is able to prove the same properties under a weaker conditions $n_1 \geqslant p$.

37. *Inverse sampling and the treatment of complex contingency table interactions* (*Proc. ISI Conf., London*) : MITRA, SUJIT KUMAR. Math-Stat/38/69, (S37).

In this paper the author derives a test of the hypothesis of no second order interactions in a three-way contingency table of the negative multinomial type.

38. *Analogues of multivariate beta* (*Dirichlet*) *distributions* (*Sankhyā*) : MITRA SUJIT KUMAR. Math-Stat/53/69, (S38).

Let $S \sim W_k(n, \Sigma)$. Write $W = S/\text{tr}\,\Sigma^{-}S$ and denote the distribution of W by $D_k(n, \Sigma)$. Also if $p \sim B\left(\frac{a}{2}, \frac{b}{2}\right)$, and p and W are independently distributed, denote the distribution of p^{w} by $n_k(a, b, n, \Sigma)$. In this paper we study these two families of multivariate distribution and obtain various interesting properties concerning them.

39. *Approximate unbiasedness of a relative variance estimator based on independent sample* (*Amer. Stat.*) : MURTHY, M. N. (S39).

Let t_1 and t_2 be unbiased estimates based on two independent samples, and $\bar{t} = \frac{1}{2}(t_1+t_2)$. Then two estimators of the relative variance of $\bar{t}$ unbiased to the second degree of approximation are given by

$$RV(\bar{t}) = (t_1-t_2)^2/4\bar{t}_1\bar{t}_2$$

and

$$RV(\bar{t}) = (t_1-t_2)^2/4\bar{t}^2$$

40. *On structure of weakly stationary stochastic processes* (*Teoriya Vescyotnosti i ee primenenie*): NADKARNI, M. G. Math-Stat/2/69, (S40).

For simplicity the results below are stated for q-variate weakly stationary stochastic processes, $0 < q < \infty$, even though the results are valid for $q = \infty$. Notations and terminology is that of Wiener and Masani, Prediction Theory of Multivariate Stochastic Processes I, II and Part III of same paper by Masani.

Theorem 1. A q-variate weakly stationary stochastic processes $(X_n)_{n=-\infty}^{\infty}$ is of rank m, $0 \leqslant m \leqslant q$ if and only if for each

$$X_n = X_n^1 + X_n^2 + \ldots + X_n^m + Z_n$$

where

i) $X_n^i \perp X_m^j$ if $i \neq j$, $Z_n \perp X_m^i$ for all i.

ii) each $(X_n^i)_{n=-\infty}^{\infty}$ is weakly stationary purely non-deterministic of rank 1.

iii) $(Z_n)_{n=-\infty}^{\infty}$ is deterministic, weakly stationary,

iv) X_n^i, $Z_n \epsilon y q_n$ for all n.

Definition. $(X_n)_{n=-\infty}^{\infty}$ is called minimal of rank r if $Y_0 = X_0 - (X_1 | \quad _0)$.

Theorem 2. $(X_n)_{n=-\infty}^{\infty}$ is minimal of rank r if and only if exactly r of

$$(X_n)_{n=-\infty}^{\infty} (X_n)_{n=-\infty}^{\infty} \ldots (X_n^m)_{n=-\infty}$$

are minimal of rank 1, where X_n^i are as in theorem 1.

Theorem 3 : $(X_n)_{n=-\infty}^{\infty}$ is minimal of rank 1 if and only if X_n is of the form

$$X_n = \begin{bmatrix} C_1 & Y_n \\ C_2 & Y_n \\ \vdots & \\ C_q & Y_n \end{bmatrix}$$

where $(Y_n)_{n=-\infty}^{\infty}$ is univariate minimal weakly stationary and $C_1, \ldots, C_q$ are complex numbers with at least one of $C_1, C_2, \ldots C_q$ non-zero.

41. *Prediction theory of infinite variate weakly stationary stochastic processes* (*Sankhyā*) : NADKARNI, M. G. Math-Stat/36/69, (S41).

In this paper we set down some of the main results of infinite variate weakly stationary stochastic processes. It is not assumed that the matrix spectral densities are necessarily bounded operator valued functions, but simply that they are infinite matrix valued functions on the circle group with summable entries. Following an idea of *R.* Gangolli, we give analytic conditions for prediction error matrix to be non-singular.

42. *Solutions of functional equations arising in some regression problems, and a characterization of the Cauchy law* (*Sankhyā*) : RAMACHANDRAN, B. and RAO, C. RADHAKRISHNA. Math-Stat/35/69, (S42).

In an earlier paper (Some results on characteristic functions and characterizations of the normal and generalized stable laws, *Sankhyā*, Ser. A, 30, 125-140), we considered solutions of the regression equation

$$E(a_1 X_1 + \ldots + a_n X_n \mid b_1 X_1 + \ldots + b_n X_n) = 0 \text{ almost surely} \qquad \ldots (1)$$

where the X_j are independent and identically distributed random variables (i.i.d.r.v.'s) with $EX_1 = 0$, for various possible sets of values of the coefficients a_j and b_j. Under suitable

conditions on them, the characteristic function (c.f.) f of the X_j is non-vanishing and satisfies the functional equation

$$f(t) = \prod_{1}^{p} f(\beta_j t)^{\gamma_j} \cdot \prod_{p+1}^{n} f(-\beta_j t)^{\gamma_j} \text{ for all real } t, \qquad \ldots (2)$$

where $0 \leqslant p \leqslant n \geqslant 1$, and the $\gamma_j > 0$ and $0 < \beta_j < 1$ for all j. Ignoring trivial solutions (i.e. where f pertains to a degenerate distribution), it was shown there that f is infinitely divisible (i.d.), and that if λ be the unique real number such that $\sum_1 \gamma_j \beta_j^{\lambda} = 1$, then $0 < \lambda \leqq 2$, f is a normal c.f. if $\lambda = 2$; and, if $\lambda < 2$, f corresponds to a distribution function (d.f.) which is absolutely continuous and has absolute moments of all orders $< \lambda$ but not of order λ.

In this paper, we briefly revert to the case $n = 1$, and show *inter alia* that if $X_1, X_2, \ldots$ be a sequence of i.i.d.r.v.'s and n_1 and n_2 are positive integers such that $\log n_1/\log n_2$ is irrational, then the arithmetic means $\bar{x}_{n_1}$ and $\bar{x}_{n_2}$ have the same distribution as X_1, if X_1 follows a Cauchy law (Theorem 1). We then obtain explicit forms for the Levy functions M and N in the Levy representation for $\log f$, in the general case (Theorem 3), following the fork of *R.* Shimizu (1968) relating to the case : $\gamma_j = 1$ for all j, but offering a much simpler and transparent proof as applicable to our more general case; an auxiliary result is stated and proved as Theorem 2.

Similarly, the regression equation.

$$E\Big(\sum_1^{\infty} a_j X_j \,\Big|\, \sum_1^{\infty} b_j X_j\Big) = 0 \quad \text{almost surely} \qquad \ldots (3)$$

gives rise, under suitable conditions on the i.i.d.r.v.'s X_j and the coefficients, to the functional equation (f is non-vanishing and)

$$f(t) = \prod_{1}^{\infty} f(a_j t)^{\gamma_j} \prod_{1}^{\infty} f(-b_j t)^{\gamma_j} \text{ for all } t \qquad \ldots (4)$$

where $0 < a_j, b_j < 1$ and $\gamma_j \delta_l > 0$ for all j. We first show that $\Sigma_j a_j^2 + \Sigma \delta_j b_j^2 \leqslant 1$ and that f is normal if this sum $= 1$ (Theorem 4). Theorems 5 and 6 concern themselves with 'infinite analogues' of Theorems 2 and 3; it being shown *inter alia* that f satisfying (4) is i.d. if a_j and $b_j \to 0$ of the regression equation (3). Theorem 8 postulates a set of sufficient conditions which the X_j satisfying (3) can be asserted to be normal, providing us incidentally with an extension of the well-known theorem of Marcinkiewicz on two identically distributed infinite linear forms in i.i.d.r.v.'s Theorems 9 and 12 state several characterizations of the Wiener process with linear mean value function which are obvious extensions of known results involving the independence, or the identical distribution, of two r.v.'s (Theorem 9 and Theorems 10 and 11 respectively) or the constancy of regression and scatter of one r.v. on another (Theorem 12), where one or both the r.v.'s are in the form of 'stochastic integrals', the only novelty perhaps being in the proof offered for Theorem 11.

43. *A note on A. Chaudhuri's paper "A comparison between sampling with and without replacement from finite population" (Bull. Cal. Stat. Assn.)* : RAMAKRISHNAN, M. K. and RAO, J. N. K. Math-Stat/25/69, (S43).

Chaudhuri (1968) had made some comparisons between simple random sampling with and without replacement. He proposed an estimator of the population mean for a with-

replacement sampling scheme and claimed that it is better than the usual sample mean for simple random sampling without replacement (srswor) for the same cost, assuming that the cost of a sample is proportional to the number of distinct units in the sample. The purpose of this note is to show that his claim is false and that most of his comparisons are either special cases of Seth and Rao (1964) [and Rao (1966)] or incorrect.

45. *On the hyperadmissibility of an estimator, in survey sampling* (*Jour. Amer. Stat. Assn.*): RAMAKRISHNAN, M. K. and SINGH, M. P. Math-Stat/50/69, (S45).

Unique hyper-admissibility of the Horvitz-Thompson estimator for the population total and also the Horvitz-Thompson estimator of its variance are established for wider classes of unbiased estimators than those considered by Rao and Singh[x].

46. *Estimation of heteroscedastic variances in linear models* (*Jour. Amer. Stat. Assn.*): RAO, C. RADHAKRISHNA. Math-Stat/4/69, (S46).

Let $Y = X\beta + \epsilon$ be Gauss-Markoff linear model such that $E(\epsilon) = 0$ and $D(\epsilon)$, the dispersion matrix of the error vector, is diagonal matrix with the i-th diagonal element as σ_i^2 the variance of the i-th observation y_i. Some of the σ_i^2 may be equal. The problem is to estimate all the different variances.

In this paper, a new method known as MINQUE (Minimum Norm Quadratic Unbiased Estimation) is introduced for the estimation of the heteroscedastic variances. This method satisfies some intuitive properties : (i) if S_1 is MINQUE of $\Sigma\, p_i\, \sigma_i^2$ and S_2 that of $\Sigma q_i\, \sigma_i^2$ then $S_1 + S_2$ is MINQUE of $\Sigma(p_i + q_i)\sigma_i^2$ (ii) it is invariant under orthogonal transformation etc.

Some sufficient conditions for the estimation of all linear functions of σ^2 are given. The use of estimated variances in problems of inference on the β parameters is briefly indicated.

47. *A multidisciplinary approach for teaching statistics and probability* (*International Conference on the teaching of Probability and Statistics at pre-college level*, U.S.A.): RAO, C. RADHAKRISHNA. Math-Stat/14/69, (S47).

The paper describes a multidisciplinary approach for teaching statistics and probability to first year students of an undergraduate course. Statistics may not be treated as a separate discipline but introduced as a body of techniques useful for research in other disciplines. Teaching has to be problem oriented rather than drilling the boys in the use of statistical techniques on what Fisher calls 'mock-up data, for the use of students only'.

Some examples are given to show how probability concepts can be introduced and statistical methods taught in a natural way in relation to live research projects or in the study of the basic disciplines such as physics, chemistry and biology. Two projects, viz., population projection and genetics of sex determination, in discussing which a wide range of topics in statistics and elements of probability were introduced and taught in the first year of B. Stat. course at the Indian Statistical Institute, are described in some detail.

The suggested approach to teaching of statistics was motivated by the concept of statistics as a key technology as advocated by Professor P. C. Mahalanobis.

48. *Some comments on the logarithmic series distribution in the analysis of insect trap data (Proc. International Symposium on Statistical Ecology,* New Haven, U.S.A.) : RAO, C. RADHAKRISHNA. Math-Stat/51/69 (S48).

Fisher's theory of the Logarithmic series distribution has been explained and the appropriate statistical methods for its application have been derived. It was noted that the statistical methods used in earlier publications by various authors are not valid.

In the analysis of insect trap data providing frequencies of species represented by one, two, ... insects, it is shown that an unstandardised negative binomial distribution (UNBD) involving three parameters, one of which is the number of species, provides an appropriate model. The unstandardised logarithmic series distribution (ULSD) is deduced as a limit of the UNBD in a rigorous manner. Appropriate statistical methods for estimation and tests of hypotheses associated with ULSD and UNBD have been developed. Some care is needed in fitting the unstandardised distribution involving an extra parameter, since the frequencies can no longer be considered as arising from independent smples of events from a multinomial distribution.

49. *Some small sample results in ratio and regression estimation (Jour. Ind. Agr. Stat.)*: RAO, J. N. K. Math-Stat/15/69, (S49).

Keep (*Amer. Stat.* 22, 29-30, 1968) has empirically shown that the customary approximate formula for the variance of the classical ratio estimator can grossly understate the true variance when the sample size n, is small. However, he has considered only three populations and $n = 4$. In this note we provide some theoretical justification for this result as well as empirical evidence based on a wide variety of natural populations and sample sizes $n = 4, 6, 8$ and 12. We also show that the customary approximate formula for estimator of variance can lead to serious underestimation of the true variance when n is small. Further, we show that the true variance of the classical regression estimator can be grossly understated by the use of customary approximate variance formula when n is small. In fact, the true variance of the regression estimator can often be larger than that of the ratio estimator. We also show that the customary approximate formula for estimator of variance can lead to serious underestimation of the true variance of the regression estimator.

50. *On the criterion of 'hyper-admissibility' and 'necessary bestness' in survey sampling (Jour. Amer. Stat. Assn.)*: RAO, J. N. K. with SINGH, M. P. Math-Stat/40/69, (S50).

The criteria of 'hyper-admissibility', due to Hanurav (1968), and 'necessary bestness', due to Ajgaonkar (1965), are considered in this paper. Necessary bestness (under a modified definition) of the Horvitz-Thompson (H.T.) estimator is shown in a general class of unbiased estimator of the population total and it is noted that the 'necessary bestness' implies that the H-T estimator is the only possible 'hyper-admissible' estimator. Our approach incidentally demonstrates that these two criteria are of doubtful value in practice. Unique 'hyperadmissibility' of the H. T. estimator and its estimator of variance (proposed by Horvitz-Thompson 1952) is also established for wide classes of unbiased estimators.

51. *Pitman efficiencies of tests based on spacings (Proc. First Int. Sym. Nonparametric Tech. in Stat. Infer.)* : RAO, J. S. with SETHURAMAN, J. Math-Stat/11/69, (S51).

This paper devoted to a comprehensive study of Pitman's asymptotic relative efficiencies (ARE's) of tests based on spacings i.e. differences between successive older statistics. Such tests have been utilised for the goodness of fit problems on the line (see e.g. Pyke (JRSS, 1965) as well as on the circle (see Rao, J. S. 1969), thesis submitted to the Indian Statistical Institute). The limiting distributions of the empirical distribution functions of the 'normalised' and 'modified' spacings, in the sense of weak convergence of measures in an appropriate complete separable metric space, have been obtained under the alternatives of interest. Then appealing to the invariance principle, one immediately has the asymptotic normality of a large class of statistics which are symmetric in the 'normalised' and 'modified' spacings. In the process, several interesting results of independent interest concerning the empirical distribution functions of 'perturbed' random variables and 'randomly scaled' random vriables are proved.

52. *On two-parameter family of BIB design (Sankhyā)* : RAO, M. BHASKAR. Math-Stat/47/69, (S52).

In this paper a method of construction for BIB designs with the parameters $v = 4s^2$, $b = 4st$, $r = (2s-1)t$, $k = s(2s-1)$, $\lambda = (s-1)t$ for $t = 2s-1$ is given and the construction of symmetric BIB designs for $t = s = 7, 19, 27$, unsolved in Shrikhande's paper (*Sankhyā*, Series A, 24, 1962), is included.

53. *On balanced designs (Ann. Math. Stat.)* : RAO, M. BHASKAR. Math-Stat/41/69, (S53).

Fisher (*Ann. Eugen.* London, 10, 52-75, 1940) proved the inequality $b = v$ for balanced incomplete block designs where b is the number of blocks and v the number of treatments. Atiqullah (*Biometrika*, 48, 215-218, 1961) extended this result in the case of equi-replicate binary balanced designs. In this paper study of the validity of this inequality for equi-replicate balanced designs and binary balanced designs is given. Also, it is proved that symmetric (i.e. $b = v$) binary balanced designs with different replications for $v \leqslant 15$ are non-existent.

54. *On determining optimal investments in L.P. Models (Opsearch)* : RAY, SABIT. Math-Stat/8/69, (S54).

The importance of linear programming in determining optimal product mix is well established. Once the optimal product mix is obtained, the next problem of interest is whether the situation can be further improved by relaxing some of the restrictions. For example, more production may be obtained from a bottleneck operation by paying overtime or buying some extra cost, etc. And the overall general problem that is of most importance to any industry is, how much extra investment should be made to get an optimal return and what should be the most profitable way of spending it. In this paper, the solution to this problem has been obtained by linear programming. It also gives a short-cut-technique for solving this problem of determining the optimal investment. Lastly, the paper discusses how the decisions on investments may vary with the variations in the interest rates.

55. *Weak compactness of a set of translates of Wiener measure* (*Jap. Jour. Math.*) : SASTRY, M. N. Math-Stat/17/69, (S55).

A necessary and sufficient condition for a set of translates of Wiener measure, on the Wiener Space to be weakly sequentially compact is derived in this paper.

C. THEORETICAL PHYSICS AND ELECTRONICS

56. *Weak interaction of photons and neutrino-electron scattering* (*Il Nuovo Cimento,*) : BANDYOPADHYAYA, P. (with RAYCHAUDHURI, P.). Elec/6/69, (S56).

The neutrino-electron scattering has been discussed according to the photon-neutrino weak coupling theory. The results are then compared with those obtained in the current-current coupling theory. The rate for neutrino-electron scattering has also been discussed for nondegenerate and degenerate gases. Astrophysical applications are then made by evaluating the ratio of the neutrino mean free path to the stellar radius. It is shown that, according to the photon-neutrino weak coupling, the neutrino mean free path exceeds the stellar radius for massive stars, white dwarfs and neutron stars. This result is significant in the sense that according to the current-current coupling theory, the ratio of the nutrino mean free path to the stellar radius for neutron stars can be much less than unity, though for other types of stars the neutrino mean free path exceeds the stellar radius. Finally, some remarks are made about the experiment attempted by Reins and Kropp to detect solar neutrinos using knock-on electron produced in the neutrino-electron scattering.

57. *Weak interaction of photons and the proton-neutrino elastic scattering* (*Il Nuovo Cimento Lettere*) : BANDYOPADHYAY, P. (with RAYCHAUDHURI, P. and SAHA, S. K.). Elec/7/69, (S57).

An analysis of the proton-enutrino elastic scattering has been made with reference to the existence of neutrino current and its possible weak coupling with photons. It is found that the proton-neutrino elastic scattering cross section is only 0.01 times the cross section expected on the basis of the current-current coupling theory. This is well in conformity with the CERN experimental upper limit of 3% for the ratio of the cross sections of the processes $\nu+p\rightarrow\nu+p$ and $\nu+p\rightarrow n+e^{+}$

58. *Propagation of electromagnetic waves in a degenerate neutrino sea* (*Physical Review*, U.S.A.) : BANDYOPADHYAY, P. (with RAYCHAUDHURI, P. and SAHA, S. K.), Elec/8/69, (S58).

The propagation of electromagnetic waves in a Fermi sea of neutrinos is investigated on the basis of the photon-neutrino weak coupling theory and is compared with the result obtained by Royer on the basis of the $(e\nu)$ $(e\nu)$ coupling. It is shown that a photon propagating through the neutrino sea satisfies a dispersion relation of the form $\omega^2=\omega_0^2+k^2C^2$, where $\hbar^2\omega_0^2\simeq 6.2\times10^{-28}E_F^2.E_F$ being the Fermi energy of the sea. Finally, some remarks are made as to the possibility of the destruction of a photon when propagating through the sea due to

the process $r+\nu \rightarrow \nu+\nu+\nu+$. It is found that the mean free path corresponding to the process is 10^{62} cm, much larger than the radius of the universe.

59. *Weak interaction of photons and the photoneutrino process* (*Prog. Theo. Phys.*, Japan): BANDYOPADHYAY, P. (with RAYCHAUDHURI, P.), Elec/9/69, (S59).

Assuming that photons can interact weakly with neutrinos, the cross section for the photo-neutrino process $e+r \rightarrow e+\gamma+\gamma+$ has been calculated. From this, the rate of stellar energy loss has been derived and is compared with the result obtained on the basis of the current-current coupling theory.

60. *Neutrino energy density of the universe* (*Il Nuovo Cimento*, Italy): BANDYOPADHYAY, P. (with RAYCHAUDHURI, P.), Elec/10/69, (S60).

Neutrino energy density of the universe has been investigated on the basis of the photon-neutrino weak coupling theory from a variety of condition. It is shown that for a steady state universe, the neutrino energy density of the universe becomes equal to the matter density. Certain cosmological consequences of this result are also discussed.

61. *Pulsar as a radially pulsating neutron star* (*Physical Rev. Letters*, U.S.A.): BANDYOPADHYAY, P. (with RAYCHAUDHURI, P.), Elec/11/69, (S61).

A model for pulsar as a radially pulsating magnetic neutron star is proposed. It is shown that the synchrotron radiation of neutrinos can well account for the dissipation mechanism and is found to be of the right order of magnitude to explain the rate of increase in period.

62. *Theories of weak interactions and astrophysical evidence* (*Prog. Theo. Phys.*, Japan): BANDYOPADHYAY, P. Elec/12/69, (S62).

It has been proposed in an earlier paper that photons can interact weakly with neutrinos. Assuming this photon-neutrino coupling, the effect of energy loss due to the pair-annihilation process and the photo-neutrino process on the evolutionary time-scales of a 15.6M star has been discussed. In the typical model of Hayashi, Hoshi and Sugimoto (HHS), the lifetime for carbon burning and latter phases have been calculated assuming the photon-neutrino coupling and is compared with the results obtained by HHS according to the $(e\nu)(e\nu)$ coupling. In case of the $\gamma\nu\bar{\nu}$ coupling, the ratio of the number of blue supergiants (He-burning stars) to red supergiants (stars in C-burning and later stages) is found to be $\leqslant 10$ with the initial concentration of carbon $X_a = 0.5$ whereas according to the $(e\nu)(e\nu)$ coupling, the corresponding ratio is found to be nearly 33. According to astrophysical observations, this ratio is found to be nearly unity within a factor 1.5. It is noted that the result according to the $\gamma\nu\bar{\nu}$ coupling becomes significantly better in comparison with the $(e\nu)(e\nu)$ coupling. Also, in view of the uncertainties regarding the rate of $C+C$ reaction, we can consider the result obtained according to the $\gamma\nu\bar{\nu}$ coupling to be in reasonable range of proximity with the 'observed' value. From this, we argue that stars seem to 'favour' the photon-neutrino coupling theory than the current-current coupling theory of weak interactions.

63. *Weak interaction of photons, muon decay, and scattering of leptons* (*Lettere al Nuovo Cimento*, Italy) : BANDYOPADHYAY, P. (S.63).

A scheme for muon decay and scattering of leptons has been proposed on the basis of the weak interaction property of photons and dynamical origin of charge. It is shown that the scheme can nicely interpret the V- A theory for decay processes. However, for scattering processes at high energies, it gives the energy dependence of the cross sections given by the relation $\sigma a \frac{1}{E^2}$ in place of the relation $\sigma a E^2$ obtained in case of the V-A theory, though at sufficiently low energy, the cross section is consistent with the $V-A$ theory of weak processes. Thus, the scheme avoids unitarity catastrophe, which is encountered in the current-current coupling theory of weak processes. Also, as the basic interaction in the scheme is the photon-neutrino weak coupling, the theory became renormalizable.

64. *Possible pulsation of neutron stars and neutrino emission* (*Lettere al Nuovo Cimento*, Italy) : BANDYOPADHYAY, P. (with RAYCHAUDHURI, P.) (S64).

A model for pulsar as a radially pulsating magnetic neutron star is proposed. It is shown that the synchrotron radiation of neutrinos can well account for the dissipation mechanism and is found to be of the right order of magnitude to explain the rate of increase in period.

65. *Some remarks on the possible origin of super heavy nuclei in primary cosmic rays* (*Jour. Phys.*) : BANDYOPADHYAY, P. (with RAYCHAUDHURI, P.) (S65).

Neutron stars (pulsars) are here proposed as the sources of superheavy (SH) nuclei $Z \geqslant 110$ in primary cosmic rays. Taking into account the 1969 result of Berlovich and Novikov that these SH nuclei can be formed by the process when the temperature is greater than 1.8×10^9 °K and at sufficiently high neutron number density, it is here pointed out that this temperature condition can prevail in a neutron star for $\simeq 10^3$ years when the cooling behaviour is governed by the synchrotron radiation of neutrinos according to the photon-neutrino weak coupling theory. On the basis of this result, it is argued that the formation of SH nuclei in our galaxy can be considered as a continuous event. Finally, some remarks are made about the expected flux of these SH nuclei.

66. *Reliability improvement in digital systems through redundancy* (*J.I.T.E.*) : DAS, JYOTIRMAY (with DUTTA MAJUMDER, DWIJESH), Elec/15/69, (S66).

The paper deals with the crucial problems of improving reliability in digital systems. The different parameters involved in reliability improvement are explained. The improvement pattern in reliability, the application of redundancy at the circuit level and systems level are explained and computed assuming exponential law. It is explained that, in the state of the art of conventional electronics, the method does not seem to be generally economically viable, but with the emergence of micro-miniaturisation, integrated circuit packages and cryogenics, the situation is changing very fast.

67. *The system design of a real-time computer controlled communication system* (*Annual Conference, Institute of Telecommunication Engineers, Calcutta Centre*, 11 Oct. 1969), DUTTA MAJUMDER, DWIJESH, Elec/13/69, (S67).

The application of a digital computer in a communication system presents a complex combination of problems to the system designer. Apart from solving normal problems in

communication system with a computer, the added complexity is because the system must operate in real-time. Real time system design is an art, that has just crossed its infancy.

The paper presents the scheme of an integrated computer controlled communication plant. The computer system utilises large capacity fast drum memories for storage of messages in transit and tables of routing information. Such a system is expected to be capable of responding quickly to the widest possible range of circumstances without losing data or halting. The need for a variable cycle traffic processing programme for the system is also explained.

68. *Studies on associative memory in relation to pattern recognition (Fifth Annual Conference, Computer Society of India, Madras*, 8-10 January 1970), DUTTA MAZUMDER, DWIJESH (with DAS, JYOTIRMOY and DUTTA, ASHOKE KUMAR) Elec/14/69, (S68).

The concept of "Associatively Addressed", "Distributed" memory is receiving a great deal of attention because apparently it forms the most important design feature of the Biological System. The concept concerns with an ability to interpolate or extrapolate in a field of *statistically related* memory entries.

The paper attempts to explain the theoretical basis of an associative addressing scheme where the retrieval of the stored information is done on the basis of a certain criterion which forms certain portion of the word or words to be retrieved, that is, content of the location rather than the location itself. A Magnetic Associative Memory is also explained with the help of a schematic diagram. One section of the paper is devoted to indicate the suitability of associative memory systems for pattern recognition problems.

69. *On approximation of* 1940 *resistance law by simple functions and its effect on trajectories of projectiles (Sankhyā)* : GHOSH, AMBARISH (with SRINIVASAN, B.), Elec/16/69, (S69).

For computing the trajectory of a projectile the retardation co-efficient is generally taken from Resistance Law Tables which have been constructed from a large number of experimental data. To calculate the trajectories on an electronic computer one has to store the tables in the memory of the computer. Here attempts have been made to replace 1049 Resistance Law Tables by one or more simple functions by the methods of least squares. The effect of this approximation on the trajectories has also been studied. In the final form of the approximation in which the 1940 Resistance Law Tables are replaced by three simple functions valid in three different ranges it is found that the maximum error of approximation is 0.2% and that in most of the part it is much less. On computing a trajectory by using these functions instead of the tables one finds an error 0.01 ft. in a range of 86,503 ft. and of 9.84 ft. in a maximum altitude of 17,165 ft.

70. *On the probability distribution of rounding-off errors in tabular differences of analytic functions* (Parts I & II) (*Australian Comp. Journal*) : MITRA, S. K. (with BANERJEE, S. N.) (S70).

Part I :

On the customary assumption that the rounding-off error present in tabular values are stochastically independent and are each distributed uniformly between $\pm\frac{1}{2}$ unit of the last place of decimal, the probability distribution of these random errors propagated in the

higher order differences is derived exactly. The exact expressions for the second and all the higher order moments are also deduced. The more general problem of determining the probability distribution function of any weighted sum of random variables, each having a rectangular distribution, has also been solved completely. An asymptotic formula for the density distribution has also been deduced independently. The probabilities have been computed for differences up to the fifth order and the results are compared with those of Comrie and Miller in Part II.

Part II :

In this part the theoretical probabilities have been computed from the exact distribution and the asymptotic formulae obtained from the Edgeworth Series. Both the asymptotic formulae do not give very satisfactory results. The theoretical probabilities have been compared with the observed probabilities of Comrie showing good agreement. The theoretical values have been compared with the same obtained from the formulae deduced by Lowan and Laderman for the differences upto the third order showing an exact agreement. These have also been compared with the numerical values given by Miller which shows a close agreement.

72. *On the probability distribution of the sum of random variables each distributed uniformly* (*SIAM Journal of Applied Probability*) : MITRA, S. K. (S72).

The probability distribution of the sum of independent random variables, each of which is distributed uniformly between different ranges is of theoretical and practical importance in many branches of science, particularly in Numerical Analysis. Though for the particular case when the distribution parameters are identical an exact expression has been given by Cramer, the general solution of the problem has not yet been worked out. An "anshaulich" geometrical approach gives the distribution function as the volume of a unit hypercube out-off by the hyperplanes $\omega_1 t_1 + \omega_2 t_2 + \ldots + \omega_n t_n = \frac{x}{2} + \bar{\omega}$, $t_1 = \ldots t_n = 1$ $\omega_1 \ldots \omega_n$ being the distribution parameters and $\bar{\omega}$ the mean of these parameters. The same expression has also been obtained by Fourier transform in the sense of Generalised Functions. This volume has been evaluated by sub-dividing the region into a finite set of nested regions, the volume of such a nested region can be evaluated by the well-known Dirichlet's Integral. The variance is $\frac{1}{3}(\omega_1^2 + \omega_2^2 + \ldots \omega_n^2)$. The semi-invariants $K_{s,\nu}$ are very simple in form and are given by

$$K_{s,\nu} = (-1)^{\nu+1} 2^{2\nu-1}$$

$$\frac{2B_\nu}{\nu}(\omega_1^{2\nu} + \omega^{2\nu} + \omega_n^{2\nu}) B_\nu$$

denoting the usual Bernoulli number.

73. *Photo production of neutral pions on nuclei* (*Nuclear Physics*) : PRABHAKAR, N. D. (with REJ, A. K. and RAMACHANDRAN, G.), Phy/1/69 (S73).

The photo production of neutral pions on ^{9}Be, ^{12}C and ^{16}O at 166 MeV is discussed using the impulse approximation and the theoretical amplitudes of CGIN, Berends *et al* and

Schwela. Best fits with experiment are obtained using oscillator wave functions and varying the nuclear radius as a parameter. This leads to the values $R = 2.29$ fm for ^{9}Be, $R = 2.52fm$ for ^{12}C and $R = 2.27fm$ for ^{16}O.

74. *Recoil deuteron vector polarization in elastic electron scattering* (*Physical Rev. Letters*): RAMACHANDRAN, G. Phy/2/69, (S74).

The vector polarization of the recoil deuterons in the elastic scattering of electrons on deuteron is shown to be non zero, if the deutron S and D states differ in phase and an expression for the polarization is given in terms of the isoscalar electro-magnetic form factors of the nucleon and the deuteron radial integrals.

75. *Theoretical nuclear physics in Indian Statistical Institute* (*Proc. Nuclear Phy. Symp., Saha Inst. Nuc. Phys.*, Calcutta): RAMACHANDRAN, G., Phy/4/69, (S75).

This report outlines briefly the problems related to nuclear physics that are receiving attention at the I.S.I.

76. *Is time reversal invariance violated in electro-magnetic interactions?* (*Proc. 11th Sym. Cosmic Ray, Particle Physics, Astrophysics and Geophysics*, Delhi): RAMACHANDRAN, G., Phy/5/69, (S76).

This paper discusses electron scattering experiments on nuclei with span-1 suggested by Bernstein, Feinberg and Lee to discover possible violation of time reversal invariance of the electromagnetic interaction and examines experimental data available at present from a different point of view.

77. *Nucleon-deuteron scattering* (*Il Nuovo Cimento*): RAMACHANDRAN, G., Phy/7/69, (S77).

The importance of the D-state and its relative phase with respect to the leading S-state of deuteron in the context of nucleon-deuteron scattering is discussed. The impulse approximation is used and the validity of the model at low energies is also discussed in the light of experimental data at these energies.

78. *Weak interaction of photons and neutrino bremsstrahlung* (*Prog. Theo. Phys.*, Japan): RAYDHAUDHURI, P. Elec/1/69, (S78).

Assuming that photons can interact weakly with neutrinos, the cross-section for the neutrino bremsstrahlung $e+z \rightarrow e^-+\gamma+\gamma+z$ has been calculated. From this, the rate of stellar energy loss due to neutrino pair emission has been derived and is compared with the result obtained on the basis of the current-current coupling theory.

79. *Plasma neutrino emission from stars and its astrophysical evidence* (*Canad. Jour. Phys.*): RAYCHAUDHURI, P. Elec/2/69, (S79).

The emission of neutrino pairs by a stellar plasma is calculated according to the photon-neutrino coupling theory and is compared with the result obtained on the basis of the current-current coupling theory of the plasma neutrino emission and the evolution of white

dwarfs. It is observed that the small fraction of the observed white dwarfs with masses above $0.9M_{\odot}$ can be interpreted when the plasma neutrino emission is considered from the point of view of the photon-nutrino coupling theory.

80. *Photoneutrino energy loss rates* (*Canad. Jour. Phys.*) : RAYCHAUDHURI, P. Elec/3/69, (S80).

The neutrino energy loss rate due to the photoneutrino process in a hot plasma, including the contributions from positions in the blackbody radiation according to the photon-neutrino coupling theory has been obtained. This is then compared with that obtained on the basis of the current-current coupling theory of weak interactions for a variety of conditions.

81. *Synchroton radiation of neutrinos and astrophysical evidence I. Application to white dwarfs* (*Ann. Phys.*, U.S.A.) : RAYCHAUDHURI, P. Elec/4/69, (S81).

The neutrino luminosity of several model of neutron stars are computed according to the photon-neutrino coupling theory and compared with that of the current-current coupling theory. It is shown that the NSR process alone should have cooled the core of the neutron star created in supernova explosion in 1054 A.D. to a temperature around 2×10^{9}°K according to the photon-neutrino coupling theory. The emission power of the star is greater than the emission power of the X-ray source discovered in the Crab nebula; so the source may be interpreted as the thermal radiation of the star according to the photon-neutrino coupling theory.

82. *Synchrotron radiation of neutrinos and astrophysical evidence II. Application to neutron stars* (*Ann. Phys.*, U.S.A.) : RAYCHADUHURI, P. Elec/5/69, (S82).

The neutrino synchrotron radiation for a completely relativistic electron gas in the presence of large magnetic field is computed according to the photon-neutrino coupling theory of weak interactions. The radiation is also estimated in the case of a non-relativistic case. The neutrino luminosity of several model white dwarfs are computed according to the photon-neutrino coupling theory and compared with that of the current-current coupling theory. It is shown that according to the photon-neutrino coupling theory the neutrino luminosity is greater than the photon luminosity and therefore most likely to have astrophysical significance in the evolution of stars with large electron energies and potentially large magnetic field, such as white dwarfs.

83. *Neutrinos and the arrow of time in cosmology* (*Jour. Phys. 3A :* General Physics, England) : RAYDHAUDHURI, P., (S83).

The arrow of time in case of neutrinos is investigated taking into account photon-neutrino weak coupling theory. It is shown that in both steady state and Einstein-de Sitter Cosmological Models, the advanced effect can be avoided.

84. *Plasma neutrino emission from stars and its astrophysical evidence* (*Canad. Jour. Phys.*) : RAYCHAUDHURI, P. (S84).

The emission of neutrino pairs by a stellar plasma is calculated according to the photon neutrino coupling theory and is compared with the result obtained on the basis of the current-

current coupling theory of weak interactions. We have also discussed the effect of the plasma neutrino emission on the evolution of white dwarfs. It is observed that the small fraction of the observed white dwarfs with masses above $0.9M_\odot$ can be interpreted when the plasma neutrino emission is considered from the point of view of the photon-neutrino coupling theory.

85. *Photoneutrino energy loss rates* (*Canad. Jour. Phys.*) : RAYCHAUDHURI, P. (S85).

The neutrino energy loss rate due to the photoneutrino process in a hot plasma, including the contributions from positrons in the blackbody radiation according to the photon-neutrino coupling theory has been obtained. This is compared with that obtained on the basis of the current-current coupling theory of weak interactions for a variety of conditions.

86. *Some remarks on the role of neutrino process in red giants* (*Canad. Jour. Phys.*) : RAYCHAUDHURI, P. (S86).

It is shown that the plasma neutrino emission rate, when calculated according to photon-neutrino weak coupling theory, has significant effects on the evolution of red giants.

87. *Synchrotron radiation of neutrinos and astrophysical evidence I. Application to white dwarfs* (*Astrophysics and Space Science*, Netherlands) : RAYCHAUDHURI, P. (S87).

The neutrino synchrotron radiation for a completely relativistic electron gas in the presence of large magnetic field is computed according to the photon-neutrino coupling theory of weak interactions. The radiation is also estimated in the case of a non-relativistic case. The neutrino luminosity of several model white dwarfs are computed according to the photon-neutrino coupling theory and compared with that of the current-current coupling theory. It is shown that according to the photon-neutrino coupling theory, the neutrino luminosity is greater than the photon-luminosity and therefore most likely to have astrophysical significance in the evolution of stars with large electron energies and potentially large magnetic field such as white dwarfs.

88. *Synchrotron radiation of neutrinos and astrophysical evidence II. Application to neutron stars* (*Astrophysics and Space Science*, Netherlands) : RAYCHAUDHURI, P. (S88).

The neutrino luminosity of several models of neutron stars are computed according to the photon-neutrino coupling theory. It is shown that the NSR process alone should have cooled the core of the neutron star created in supernova explosion in 1054 A.D., to a temperature and 2×10^{9}°K according to the photon-neutrino coupling theory. The emission power of the star is greater than the emission power of the X-ray source discovered in the Crab nebula. So the source may be interpreted as the thermal radiation of the star according to the photon-neutrino coupling theory.

89. *Weak interaction of photons and neutrino bremsstrahlung* (*Canad. Jour. Phys.*) : RAYCHAUDHURI, P. (S89).

Assuming that photons can interact weakly with neutrinos, the cross section for the neutrino bremsstrahlung $e^- + z \rightarrow e^- + \upsilon + \upsilon^- + z$ has been calculated. From this, the rate of

stellar energy loss due to neutrino pair emission has been derived and is compared with the results obtained on the basis of the current-current coupling theory. Also, for a comparative study, the neutrino luminosity has been calculated according to both the theories.

90. *ω and B exchange and π^0 photoproduction on nuclei* (*Lettere al Nuovo Cimento,*) : RAYCHAUDHURI, P. Phy/3/69, (S90).

ω and B^{00} exchange contributions to neutral pion photon-production on ^{7}Li, ^{9}Be, ^{12}C and ^{16}O are calculated at 160 MeV while only ω exchange contributes to the spin zero nuclei like ^{12}C and ^{16}O both ω and B exchange mechanisms contribute to the nuclei like ^{9}Be and ^{7}Li with definite spin. The B contribution is however small even if we consider a pure spin flip transition like that to the 2.43 MeV excited state in ^{9}Be with spin parity 5/2, this is to even at a higher energy like 500 MeV.

91. *Regge-trajectories in nucleur photoproduction* (*Il Nuovo Cimento*) : REJ, A. K. Phy/6/69 (S91.)

Following V. A. Tsarev's recent preprint on photoproduction of neutral pions we give a comprehensive discussion for various other photoproduction processes on nuclei; the possibilities of separating the different trajectories are studied. Particular nuclear transitions are examined for the different reactions to study the Regge trajectories of the exchanged mesons.

D. ANTHROPOMETRY AND HUMAN GENETICS

92. *Heterozygosity with differential fitness* (*Sankhyā*) : CHAKRABORTY, R. (S92).

A general expression is derived for studying the maintenance of balanced polymorphism of a gene, lethal in homozygous condition, under a system of non-random mating. The gene responsible for sickling human red cells is studied as an eqample of the main theory.

93. *A note of parent-offspring correlation and inbreeding* (*Japanese Jour. Human Genetics*) : CHAKRABORTY, P. Math-Stat. 2/70, (S93).

For a diallelic autosomal character the correlation between parental total score and offspring total score (known as the parents-offspring correlation). given by M

$$\frac{s(1+3F)}{(s+1)+(3s-1)F}$$

is used here to estimate F, the constant which is popularly interpreted as coefficient of inbreeding. When the family records include varying number of children, reasonably good estimate of F is exhibited which agrees fairly with other available estimates of F.

94. *The haptoglobin and transferrin types in West Bengal and a case of haptoglobin 'Johnson'* DAS, S. K. (with MUKHERJEE, B. N.) Nat/13/16, (S94).

A series of 456 serum samples from blood donors in Calcutta Central Blood Bank were studied for *Hp* types and 424 samples for transferrin types. The gene frequencies,

Hp^1 and Hp^2 were respectively 0.1543 and 0.8457 in 311 Bengali Hindus, 0.1827 and 0.8173 in 54 Muslims and 0.1758 and 0.8242 in 91 mixed groups. With the exception of the Todas ($Hp^2 = 0.63$), the Hp^2 frequencies are high in Indian populations, and that for Irulas is the highest in the world (0.93).

Of special interest is the single case of Haptoglobin (Johnson) which is the only case so far reported in India in about 1800 serum samples studied. Transferrin phenotype CC alone was found in 424 sera tested.

95. *'LDH Variants in India'* (*Human Genetic*) : Das, S. R., (with Das, S. K., Mukherjee, B. N., Ananthakrishnan, R., Blake, N. M. and Kirk, R. L.), (S95).

The enzyme lactate dehydrogenase present in haemolysates and its genetic variants were screened by starch gel electrophoresis. Blood samples collected from Madras (717) and Calcutta (614) were tested. The Calcutta samples were tested at Calcutta (ISI) and at Canberra. A new genetic variant of LDH so far found nowhere else in the world was first detected in the Calcutta samples. It has been named 'Calcutta 1'. All the 10 variants found in the Calcutta blood samples were of type, and 5 of the 7 variants found in the Madras samples were also of this kind.

96. *A memoir on 'A radiological study of skeletal maturity in a group of Bengali boys and girls in the southern suburbs of Calcutta City (based on longitudinal findings on the hand and wrist bones)* (Anthropological Survey of India) : Das, S. R., (with Bose, Lolita, Das, Asha and Mukherjee, D. P.) (S96).

The longitudinal data were collected over 16 years studying each Research Series child at or very near the birth days or half birth days (as the case may be). A total of 294 boys and 251 girls or upper caste Bengali Hindu families belonging to the Low-middle to Middle-middle class were included in the study. The results for all the centres of ossification in the hand and wrist have been discussed and compared with those of similar series in the USA. The girls mature earlier than the boys. The Indian children, in general, are more backward in skelotal development than their American counterparts of the same chronological age. But at each chronological age, a certain percentage (through small, 1-10%) of the children of the Bengali Series are found to be more advanced in skeletal development than the nodal level of the U.S. children of Gruelich and Pyle, although the nutritional level of all Bengali children in the present Series was definitely much inferior to that of the US children (from above average American families). The report contains 23 pages of tables and 50 pages of text.

97. *A somatological survey of five tribes in the Koraput district of Orissa* (*Bull. Anthrop. Sur. India*) : Das, S. R. (with Mukherjee, D. P. and Sastry, D. B.) (S97).

The five tribes studied are : The Bado Gadaba, Bareng Paroja, the Pareng Gadaba, the Ollaro Gadaba, and the Konda Paroja. Their languages are respectively, Gutob or Gadaba (Austro-Asiatic), Deshiya Oriya, Mundari, Ollari (Dravidian) and Konda (Dravidian). Twenty linear anthropometric dimensions were measured in the villages. Two hundred men and 200 women from each tribe were measured between the ages 20 and 50. Only 120 in 2000 mea-

surel were within 41-50. Discussion of C.R.L., shape distance, size distance and generalised distance (D^2) has been given. The paper includes 24 tables covering 12 pages, and 12 pages of text.

98. *The distribution of some enzyme group systems (red cell) among Bengalis (Ind. Jour. Med. Res.)* : DAS, S. R., (with DAS, S. K., MUKHERJEE, B. N., BLAKE, N. M. and KIRK, R. L. Nat/1/70 (S98).

Nine red cell enzyme systems were studied in 721 Bengali Hindus of Calcutta and rural areas. There have been several published studies on the enzyme G-6-PD in India, but for other red cell enzyme systems, the only published work, so far, investigated were 6-PGD, AK (adenylate kinase) and PHs (acid phosphatase) in Madras City.

In the present study, the samples were tested at Calcutta (ISI) and checked up at Canberra (John Curtin School of Medical Research). Of the nine enzyme systems investigated, five were found to be polymorphic in Bengalis. These were : 6-phosphogluconate dehydrogenase, adenylate kinase, acid phosphatase, phosphoglucomutase and lactate dehydrogenase. The AK^1 gene frequency observed is the highest in the world so far (.0867). In the 6-PGD system, PGD^A and PGD^O had frequencies, 0.98 and 0.02 respectively. In acid phosphatase, PHs^B had a rate of 0.726, PHs^C very low (0.004) and PHs^A (0.270). The PGM_1 locus has two alleles, $PGM_1^1 = 0.70$ and $PGM_1^2 = 0.30$. Lactate dehydrogenase is of special interest because of a new genetic variant (Calcutta 1) with an incidence of 1.86% which is the highest reported frequency for LDH variant in the world.

99. *Polygynists of Urban India (Ind. Jour. Soc. Work)* : HALDER, AJIT (with PAKRASI, KANTI) Nat/17/69, (S99).

The magnitude of polygynous marriage in present India has been studied in the paper utilizing a part of the data collected by NSS. Moreover, observations have been made on certain social, demographic and economic characteristics of the Indian polygynists concerned. Highest incidence of polygynous mating occur in two contiguous littoral states of Orissa and Andhra Pradesh taken together. All India *prevalence rate* of polygyny is 6.88 for urban population only, for the urban Hindus 6.65 and for the urban Muslims 8.61. Except for the class of minor and related workers polygyny is favoured by the people engaged in all other occupation classes in urban India. It has been found that the Hindu and Muslim polygynists prefer equally young women (below 21 years in age at effective marriage) as their first spouse. The Muslims only share relatively more aged women (above 21 years) as second spouse. When the polygynous units are classified by the criterion of per capita monthly expenditure they do not present any sharp singular concentration in any level from the lowest to the highest. In this background nothing can be asserted if the affluent condition or otherwise may act as a promotive or deterrent factor in influencing polygyny in urban India of present time.

100. *Effect of infanticide on sex-ratio in an Indian population (Zeitschrift fur Morphologie und Anthropologie*, West Germany) : PAKRASI, KANTI. Nat/7/69 (S100).

Richard Shaw (*Amer. Jour. Phy. Anth.* 19, 1961) has observed recently that 'neither polygamy nor infanticide can, by itself, have any effect on the primary sex-ratio. That

female infanticide can also have no perpetual effect on the secondary or tertiary sex-ratio has been discussed in the present paper. Official records on socio-demographic characteristics of *Jhareja* population in Kathiawar (Gujarat) have been utilised in the study. These Jhareja Rajputs were once notoriously addicted to the cruel practice of killing of all new-born females in their society. To stop the inhuman practice the then British Government of Bombay took up several anti-infanticide measures especially in between 1805 and 1855. Regular enumerative checks of all births and deaths in Jhareja society were made and in the long run considerable demographic data piled up at the disposal of the Government. These data pertaining particularly to the period 1840-1854 have been examined here to learn (a) the nature of growth of female population among the Jhareja families, and (b) the effect of the infanticide custom on the sex-ratios in Jhareja population as a whole. It has been found that with gradual improvement in their social understanding about and attitude towards the inviolability of the custom of infanticide under Governmental pressure, the Jharejas had to preserve more and more new-born females and the result was that the *high sex-ratio* among them could not but decline simultaneously. In the paper the features associated with such phenomena of rising female population and declining high sex ratio in Jhareja population have been highlighted.

101. *Analysis of family data I—introducing monozygotic plural births* (*Cal. Stat. Bull.*) : Rao, D. C. (S101).

For the diallelic inheritance with complete dominance the usual family data analysis does not take into account the monozygotic multiple births. The present author gives the modified analysis introducing monozygotic plural births.

102. *A note on Li's paper* (*Jour. Ind. Soc. Agri. Stat.*): Rao, D. C. (S102).

This note extends the main results in 'Fisher, Wright, and path coefficients' of Li to any general mating system, from which Li's results can be obtained directly as particular cases. On these lines, using path coefficients, a general expression for the correlation between two half-sibs, with respect to a phenotype measurement, has been given in this note.

103. *Statistical methods in blood groups* (*Jour. Ind. Soc. Agri. Stat.*) : Rao D. C. (S103).

Boyd considered the problem of estimating chromosome frequencies from MNS and blood groups data by the maximum likelihood method under random mating. The author here gives the maximum likelihood procedures for estimating (g) Chromosome frequencies from MNSs blood group data under random mating, and (b) chromosome frequencies and inbreeding coefficient from MNS and MNSs blood group data. The text is followed by two illustrations.

104. *A contribution to the genetics of hypertrichosis of the ear rims* (*Human Heredity*) : Rao, D. C. (S104).

Data on 168 families from West Bengal are analysed to test the following three theories for the inheritance of hypertrichosis of the ear rims : (1) *Y*-linkage, (2) Autosomal dominance, and (3) Autosomal recessiveness. The present data support the Y-linkage theory only.

Most of the methods here are found in Slatis and Apelbaum, *Amer. Jour. Hum. Genet.*, 15 : 74), though some of them are modified here. Also some association studies are carried out between age, hypertrichosis, chest hair and baldness.

105. *Natural selection and ABO blood groups polymorphism* : Rao, G. B. K. (S105).

The theory of natural selection postulated by Darwin has not been observed in men. The theory of natural selection may be re-stated very simply in terms of population genetics. If we study an area into which there is no immigration, and classify them both for sharply defined characters and for variable characters and notice some change which may not be due to selection. Similarly with the help of another population we may observe that the selection has occurred. The reasons are carefully stated.

Natural selection can produce evolutionary change. A valuable line of enquiry which does not yet seem to have been pursued in any detail would be to study the blood group distribution in patients suffering from a wide variety of diseases.

Nevertheless, simply amazing correlations between blood-groups and diseases is by itself, somewhat pointless, and work should be so planned that biochemical or serological investigations can follow up any associations that may be found.

E. Biochemistry

106. *N-acylation of glucosamine by a new method* (*Jour. Org. Chem.*) : Pal, P. R. (S106).

A new method for the *N*-acylation of various amino sugars has been developed. Para nitrophenyl esters of different carboxylic acids were used as the group transfer reagents. Acylated amino sugars were obtained in high yields by using this method.

107. *Sugar contents of radish* (*Jour. Food Sci. & Tech.*) : Pal, P. R. (S107).

In continuation of the work on the sugar contents of Indian radish, two other varieties of radish were studied. The sugars, both reducing and non-reducing were identified by paper chromatography and their concentrations were determined by chemical analysis.

F. Chemistry

108. *Studies on the sorption and release of two basic antibiotics by and from clays* (*Jour. Ind. Soc. Soil Sci.*) : Ghosal, D. N. Nat/9/69 (S108).

H-Bentonite (Akli, Rajasthan) and *H*-Illite (Giridih, Bihar) have been found to adsorb streptomycin and dihydrostreptomycin from an aqueous solution to the extent of their respective cation exchange capacities. The isotherms are familiar *S*-type curves. A proton-transfer mechanism has been suggested in the paper for the type of adsorption. The non-standard free-energies for the bentonite and illite surfaces for the adsorption of dihydrostreptomycin are found to be 5140K- per mole, and 4372K-calories per mole respectively. The expanding three-layer lattice structure of the montmorillonite with a possible two fold surface to sorbate iteraction for the interrelated antibiotic molecule can account for the higher value of the free energy for montmorillonite surface.

In the study of desorption, antibiotic-complexes of both the clay-types have been found to release an appreciable quantities of streptomycin and dihydrostreptomycin in water-extract, a fact held in doubt by previous workers. Inorganic cations, viz. Ca^{++}, Ba^{++} and K^{+} have been found to displace a maximum of 40 per cent of the bound antibiotic from illite complexes and 25 per cent from the bentonite-complex within the range of electrolyte concentration studied, which corroborates a stronger binding force in bentonite-complex than in illite and is in conformity with the free-energy data.

The order of selectivity of the inorganic cations is found to be $Ba^{++} > Ca^{++} > k^{+}$ for bentonite-complex and $Ba^{++} > K^{+} > Ca^{++}$ for illite complex.

109. *A spectrophotometric study of malachite green-sentonite complex* (*Sci. Cult.*) : Ghosal, D. N. Nat/14/69 (S109).

Malachite green, a triphenyl methane dye, has been found to exhibit large spectral changes when adsorbed on *H*-bentonite (Akli Rajasthan). This blue shift of 35 to 45 *m* has been attributed to a protonation of the dye molecule on the surface phase of the clay. At the same time a variation of the hydrogen ion concentration between the clay micell near sorbed dye and the bulk solution may be responsible for the colour change.

G. Crop Science

110. *Variacion en el numero de carpelos en frutos de palmeras* (*Agronomia Tropical*) : Davis, T. A. Nat/16/69, (S110).

Variation in the number of carpels per fruit from over eleven species of palms are briefly described. In some of these, one or two of the usual three carpels do not develop at all, over develop only partially, or do not bear a seed. In the others, the number of carpels per fruit exceeds the usual number due to the multiplication of carpels, fusion of fruits, or the development of other floral parts into structures resembling ovary. Usually one of the three carpels in a palm fruit bears the seed. But several exceptional cases of fruits bearing two, three or more functional carpels have also been reported. Of the different types of variation reported in the carpel number, some occur very frequently as it is the normal feature for a palm, while others are of infrequent occurrence. Causes for this variation should be more than one and investigations on this aspect have not yet been carried out.

H. Computer Science

117. *A note on the distribution of the most significant digit* (*Math. Compt.*) : Adhikari, A. K. Math-Stat/33/69 (S117).

In this paper the distribution of the most significant digit (m.s.d.) of some functions of random variables have been studied. Let X be uniformly distributed random variable from $U(0, 1)$. Let V and W be defined as $V = 1-X^n$ and $W = 1-X^{1/n}$. The probability that the most significant digit is less than or equal to $A(A = 1, 2, \ldots, 9)$ of V and W have been found. It has been shown that Prob {m.d.s.$(V) = A$} tends to 1 as n tends infinity for $A = 9$; and Prob {m.s.d. $(W) \leqslant A$} does not converge to a limit for any positive integer $A < 9$ as n tends to infinity. This oscillates around $\log_{10}(A+1)$, and an approximate expression, valid for large n, is given in this paper.

118. *A study on the disparities of food prices (Annual Meeting of Computer Society of India,* 1969) : GUPTA, B. S. S. (with HALDAR, A. K.), CSU/1/69, (S118).

A method to study the disparities of the prices of different food items is presented in the paper. First by L.P. technique a number of food items are selected which satisfy some optimality criteria. The 'economic price' which is defined to be z_j's at the optimal solution stage are obtained for all the remaining items by the process. The percentage differences reflecting the disparities are evaluated next.

The method is illustrated with the help of National Sample Survey data.

119. *Some computer simulation techniques in demographic analysis* : HALDAR, A. (with SENGUPTA, P. CSU/3/69, (S119).

It may be seen that almost all large-scale simulation can be attempted on electronic computer in demographic analysis. It is advisable to start with small projects to overcome the conceptual weakness and to make a meaningful approach to the problem. It is possible to reproduce, through computer simulation, the complexities of demographic processes within a suitable framework to the great advantage of the social scientist.

120. *Redesigning the Fortran II system for the IBM* 1401 : NARAYANAN, K. S. CSU/2/69, (S120).

Further modifications in the FORTRAN II system have been carried out to provide for additional core-storage at the compilation and the object-time. The arithmetic and the I/0 operations are executed independently, thus allowing for an overlay of the auxiliary routines and the programme strings. The library functions, in the disk, are called in as overlays whenever required.

121. *A note on multiple precision range transformations (Trans. Elec. Comp., IEEE Inc.)*: SIKDAR, KRIPASINDU, Math-Stat/18/69, (S121).

Results pertaining to existence and economic choice of suitable multipliers for a class of range transformations of multiple precision floating-point numbers with integral mantissa are presented.

1. DEMOGRAPHY

122. *Growth of population of India and Pakistan* : 1800–1961 (*General Congress*, 1969, *International Union for Scientific Study of Population*, London) : BHATTACHARYA, D. P. and MAHALANOBIS, P. C. Dem/6/69, (S122).

In India a series of enumerations undertaken in different regions in early 1870's are usually called the Census of 1872. The first all-India census taken in 1871 was followed by decennial censuses. The average annual (arithmetical) rate of growth of population was 0.4 per cent, during the fifty years, 1871–1921; and was much higher, namely 1.85 per cent, during the next four decades, 1921–1961. In the earlier period, there were large annual fluctuations due to famines and epidemics. Steady growth from 1921 was possible because of gradual elimination of those disturbing causes.

Very little information is available for the country as a whole for the period, 1801–1871. There exists, however, a large volume of data relating to population changes in particular regions of India since the early nineteenth century. Examination of such regional data shows highly fluctuating changes in the population with a slow rate of growth, possibly of the same order as in the period 1871–1921.

Decennial estimates were made for different regions in India. Data of relevant regional enumerations, where available, were used for this purpose, making suitable adjustments for under-enumeration and under-coverage, as far as possible. For regions for which such data were not available, it was assumed that the normal growth rate was the same as the average rate based on the two census decades of good seasons, 1881–1891, and 1901–1911. Growth rates were worked out for each decades. Finally, an all-India series was constructed from the different regional series, starting with a population of 207 million in 1801.

Accepting a population 125 million in 1600, as suggested by Kingsley Davis, the average annual (arithmetical) increase of population appears to have been 0.33 per cent between 1600 and 1800, 0.34 per cent between 1801 and 1871, 0.40 per cent between 1871 and 1921, and 1.85 per cent between 1921 and 1961.

A predominantly agricultural economy, an unchanging occupational pattern, a slow rate of urbanisation, and a high birth rate and a high death rate were the characteristics of the historical demography of India upto 1921. Death rates began to fall after 1921, and reached to three-fifths of the 1920–30 level in 1951–60. This decline in death rate brought about a rapid population increase.

123. *Fertility and sex-sequence of children of Indian couples (Milbank Memorial Fund Quarterly)* : BHATTACHARYA, D. (with HALDAR, A. K.), Dem/1/69, (S123).

This paper examines the data on fertility history of Indian couples collected in NSS 17th Round for studying the influence of the sex of the first two children born to a couple on the incidence of a third child-birth within three years of the second child-birth. It appeared that for both rural and urban sectors of India, a larger proportion of couples with two female children (FF) had a third child within three years of the second child-birth than of couples with other sex-combinations of the first two children-male-male (MM), male-female (MF), and female-male (FM). This, in time, might be indicative of the common desire of having a male child and of the prevalence of some form of family limitation practices among couples with one or more male child. The statistical significance of these differences is examined by non-parametric tests.

In course of this investigation, a large excess of the number of 'MT couples' over the number of 'FM couples' became evident. This point has been examined in detail. Presumably, the dead first child was not reported more often if it was a female child. Other factors might have aggravated the situation, such as the tendency of reporting the first son as older than the first daughter although this is not true or the possibly higher masculinity of first births.

124. *A statistical study on exposure differential in contraceptive practices (Amer. Jour. Soc.)* : CHAKRABORTY, B. (with MALAKAR, C. R.), Dem/5/69, (S124).

In this paper an attempt has been made to find out the effect of pregnancy termination, the why of use of family planning methods and their interaction on the effectiveness of contraceptive practices. Analysis of variance technique for nonarthogonal data has been used. It is observed that the way of use of family planning methods plays a most significant part in the reduction of fertility. Neither the termination effects nor their interaction with the way to use of family planning methods has been found out to be significant. An alternative method for finding out the differential effectiveness ratio of contraceptive method amongst social groups by pregnancy termination has been obtained. An objective basis for the formulation of fertility models based on variable probability of conception has also been suggested.

125. *Net reproductivity of West Bengal (India) by districts and its association with some socio-economic variables (Dr. S. Chandrasekhar's 70th Birthday Volume)* : GUPTA, P. B. (with RAMAKRISHNA, G.), Dem/3/69, (S125).

The differentials in the net reproductivity of West Bengal districts, and its association with some socio-economic factors, have been studied with the help of the Replacement Index, J, with as a measure of net reproductivity is derived by dividing the number of female children in the age-group, 0–5 in the actual population by the number of women in the corresponding higher age-group 20–45 in the actual population who would have been in the reproductive period when these children were born, and then dividing this quotient by the corresponding quotient in the life table population of females, derived from current mortality rates. For evaluating J for the district populations (as also for those of the rural and urban areas and of the state as a whole), as at the 1961 census, the female age-structures, virtually unaffected by migration, have been corrected for Census enumerations by graduation, except for West Bengal for which corred Age-Tables are available, and appropriate Life-Tables selected from U.N. Model Life T ies on the basis of the respective registered (Female) infant mortality rates, 1957-60, inflated by a suitable factor. A geographical distribution of J, being higher in the northern distri ts and lower in the southern is apparent. Further, it appears to be inversely associated with literacy, age at marriage, degree of urbanization and of industrialisation. Also these associations can explain the large rural-urban differential in J, when compared to the corresponding large differentials in the above socio-economic factors.

126. *Demographic report of West Bengal, 1901–61 (State Demographic Reports)* : GUPTA, P. B. (S126).

The Report examines the trends in the demographic situation in West Bengal involving the various elements, viz., mortality, fertility and migration and also such composite variables as growth and age structure of the population during the period under review.

The findings briefly are :

(i) a steady decline in mortality from the beginning of the century with a retardation during 1941–52 but precipitated during the next decade.

(ii) a near constant fertility with a fall during 1941–51 but regaining perhaps more than the usual level during the next decade.

(iii) fresh migration rates have been small throughout the period with the exception of the decade 1941–51 when the rate was large on account of the influx of displaced persons from East Pakistan.

(iv) age-distribution of West Bengal has remained fairly stable from 1891 to 1961 except for small deviations due to migration and famine (C_1).

127. *Some aspects of fertility and family planning in the urban areas of India* (*General Congress*, 1969, *International Union for Scientific Study of Population*, London): MAJUMDAR, MURARI (S127).

The data on total number of children born by wife's age at marriage available from the National Sample Survey indicate progressively larger declines in total fertility with rise in the age at marriage. The relatively smaller contribution to total fertility at later years of the reproductive period is reflected in the attitude to family planning at advanced ages. The data do not provide definite evidence of a relationship between age at marriage and practice of family planning.

128. *Urban Delhi—past growth and future prospects* (*Jour. Socio-Econ. Res. Inst.*, Calcutta): MAJUMDAR, MURARI (S128).

The growth of Urban Delhi during the past decades and its characteristics are examined in relation to the whole of Delhi both rural and urban and the growth is compared with that of other selected urban areas. The likely trend in the future population of urban Delhi is estimated from a growth curve fitted to the populations of past decennial years.

129. *Status of census and vital registration data in the CAFE countries* (*Jour. Inst. Econ. Res.*, Dharwar): PACHAL, T. K. (with RAMAN, A. V.), Dem/4/69, (S129).

The paper briefly discusses the present status of census and vital registration data in the ECAFE countries. An attempt has been made to examine the improvement that had taken place in vital registration in these countries during 1957–66. The improvement was only marginal.

130. *Construction of life table for Assam females* 1951–60 (*Sankhyā*): PACHAL, T. K. (S130).

The object was to prepare a separate life table for a State included in the Eastern Zone. It has been found that the expectation of life at birth of Assam females was about the same as Eastern Zone females in the same period (C_2).

131. *Momentous thoughts on population problems* (*Bull. Soc. Econ. Res. Inst.*, Calcutta): PARRASI, K. Nat/2/69, (S131).

Since Malthus (1798), storms of controversy have been raised repeatedly to discuss if 'the power of population is indefinitely greater than the power in the earth to produce

subsistence for man . Scholars of the early nineteenth century experienced the continous rise in population in that time when such rise ought to have been restrained. Consequently, William Lloyd (1832) declared that the fault might rest, not with the people of overpopulous countries as individuals, but with the constitution of the society, of which they form part'. Unequal concentration of property was thought to be the prime factor to generate such 'fault'. After more than a century Colin Clark observes that natural human fertility has nothing to do with 'undernourishment' when the probability of conception, if not impeded, in fertile human couples appears to average 0.1 per menstrual cycle. We are also given to understand that the world is still capable of supporting 28 billion people. Population and social researchers like Lorimer, Corca Du Bois, Stycos have stressed lately on socio-cultural factors in stemming rapid population growth. Significance of numerous beliefs, attitudes, values and above all the *mores* of each social group, irrespective of their economic status, has been emphasised while appraising the biological aspects of maximum fertility or otherwise. That the problem of over-population *relative to available resources* needs proper examination of the most basic customs and values governing human procreative behaviours has particularly been highlighted in the paper.

132. *A method to group the census industrial categories of workers* (*Jour. Inst. Econ. Res.* Dharwar) ; RAMAKRISHNA, G. Dem/2/69, (S132).

The census of India 1961 classifies the workers into nine industrial categories. It might facilitate further statistical analysis if these categories could be suitably grouped. An attempt has been made in this paper to form such groups by computing B-coefficients. The nine categories could thus be allocated to six groups. This study is based on data relating to West Bengal towns. Similar procedure may be tried for group formation of industrial categories in the other states also.

133. *Gain in life expectancy with complete or partial elimination of some causes of death* (*Professor Radhakamal Mukherjee Volume*) : RAMAKRISHNA, G. (with RAMAN, M. V.), (S133).

With the effective application of public health measures there will be further reduction in the incidence of preventable diseases which will have a direct effect on the mortality rate. Vital statistics of West Bengal are examined to study the effect of complete and partial elimination of some selected causes of death on life expectancy (C_3).

134. *Population projections and growth rate of India* (*Sankhyā*) : SARKAR, B. N. Dem/7/69 (S134).

In recent years, a number of projections have been made on the Indian population in India and abroad. Almost all the projections have either been based on the common technique of mathematical method or have been based on the component method which implies estimation of detailed mortality and fertility rates. Projections made by Das Gupta and Mazumdar in 1954 at the Indian Statistical Institute and those under the guidance of Dr. Lokanathan in 1960 at the National Council of Applied Economic Research, are based on the component method.

The author has used the Indian National Sample Survey data of the ninth round (reference period—May to September, 1955) to estimate the growth and migration rates.

Total rural population estimates were prepared in zonal break-downs from the survey and then growth rates were estimated by use of 1951 census as the base. Migration rates were determined from the survey alone. The growth rates were used to project the population of India for 1956, 1961, 1966, 1971 and 1976 with 1951 census as the base by use of usual mathematical method.

A second set of projected populations were worked out by applying migration adjustments on the growth rates.

135. 1800 *A.D. to* 1968 *A.D. Population of Asia—A Reconstruct* (*Proc. General Congress*, 1969, *International Union for Scientific Study of Poupulation*, London) : SENGUPTA, SURANJAN (with DASGUPTA, A., DUTTA, A. K. and GHOSH, M. (S135).

Out of the total world population of 3,518 million, Asia is estimated to have 2,009 million or about 58 per cent, at the end of 1968. Asia's importance is therefore predominant in the population field, and study of Asia's population essential to understand the world trends. Out of Asia's population again, the big five, China, India, Indonesia, Pakistan and Japan, are estimated to contain 737 million 529 million, 133 million, 11 million and 101 million respectively at the end of 1968, that is in aggregate about 80 per cent of Asia's population. The population in the Asian parts of the USSR and Turkey were included in the aggregates for Asia.

On account of lack of resources and time, separate estimates of the 19th century and later populations of only the above big five countries were made, and from them the Asian aggregate approximated in the present paper. Particular reference is made to the estimates recently made by Durand (1965); subsequently, the authors (1969) had themselves worked out independent 19th century population estimates separately for India and Pakistan, on basis of available contemporary material not used by earlier investigators and Paper (1967) had also done similar original work for Indonesia. On basis of such revised information and approach, the authors estimate the populations of Asia at 1800 A.D., 1850 A.D., 1900 A.D. and 1950 A.D. as 670 million, 870 million, 1070 million and 1460 million, respectively.

J. DOCUMENTATION AND LIBRARY SCIENCE

136. *Conflict of authorship : corporate body vs. corporate body* (*Lib. Sci.*) : BHATTACHARYA, G. (with RANGANATHAN, S. R.), DRTC/2/69 (S136).

A conflict of authorship should get resolved at the stage of the definition of the term 'Author' and of the terms denoting the different kinds of author. In the case of the conflict 'Corporate Body *vs* Corporate Body', each of the initial Formal Definitions requires to be propped up by an appropriate interpretative definition as a sequel to it. Many of the Cataloguing Codes do not give an explicit Interpretative Definition. But they are implied in their rules for Choice and Rendering of Heading; and they can be distilled out of these rules. A critical and comparative study of how RDC and the different editions of AACR and of CCC resolve the conflict 'Corporate Body *vs* Corporate Body' is made on the basis of the relevant Interpretative Definitions—either explicitly stated or distilled out from the rules implying them. Conflicts centering round the following kinds of Corporate Bodies are considered : (1) Government; (2) Near-Sovereign Body; (3) Local Body; (4) Institution;

and (5) Conference. A separate part is devoted to each kind of Corporate Body. Each part begins with a section on Terminology giving the precise definitions of term needed to develop the ideas systematically. The specific issues considered generally in relation to each kind of Corporate Body are : (1) Whole Corporate Body *vs* Its Organ of Remove 1; (2) Organ of Remove 1 *vs* Organ of Remove 2; (3) Corporate Body *vs* Its Quasi Independent Institution; (4) Corporate Body as a Delegated-from-Body *vs* Conference. Impact, if any, received by any Code from the earlier codes, is indicated. Wherever necessary, the Interpretative Definitions for inclusion in CCC (Ed 6) are given.

137. *Programme-package for a system for document finding* (*Lib. Sci.*) : GUPTA, B. S. S. (S137).

A Programme-Package containing fifteen programmes for use in the design, development, and operation of a system for document finding (SDF) is described. The computer-based SDF integrates within it a Freely-faceted Scheme for Classification of subjects. The system provides for : (1) Retrospective search for entries of documents relevant to a reader's query in a Catalogue-on-Tape; (2) SDI service; (3) Reader's approach by name of subject, author, collaborator, series, etc.; (4) Reader Profile Catalogue in which the subject of interest to the reader may be in the form of Class Number, or Feature Heading only, or Class Number and Feature Heading; (5) Acceptance of reader's query about a subject in the form of Kernel Terms in random sequence; (6) Replacement of non-standard terms, if any, in the query by standard terms in the classification schedules through a built-in thesaurus of a special kind; (7) Rearrangement of the Kernel Terms of a subject in the facet structure sequence using schedules in which the kernel ideas are arranged in a special way; (8) Synthesis of Class Number for Subject of document or of query using Colon Classification; (9) Translation of Class Number into Kernel Terms to form Feature Heading; (10) Direct reader-computer "dialogue"; (11) Browsing in the output documentation list among its classified entries fitted with adequate Feature Headings; (12) Alphabetical Index to the Subjects, etc., of the output documentation list; (13) Different formats of Main Entry in the output; (14) Output on line-printer, punched card, and magnetic tape; (15) Updating the Catalogue-on-Tape, the Catalogue of Reader Profile-on-Tape, and the Classification Schedules; and (16) Guidance by computer to help reader to use the system.

138. *Seminal mnemonics as a management technique* (*Lib. Sci.*) : NEELAMEGHAN, A. DRTC/7/70, (S138).

The General Theory of Library Classification recommends that a scheme for classification should conform to the Canon of Seminal Mnemonics. Students of library science need to be familiarised with the concept of Seminal Mnemonics and guided into its use in the design and development of schemes for classification. However, the concept of Seminal Mnemonics is sometimes considered as something abstract, "mysterious" and beyond the comprehension of the average intellect. Therefore, it may become difficult to communicate the idea of Seminal Mnemonics in the class. Some students even tend to develop an inhibition to the idea and hence may not be able to take full advantage of this powerful guiding principle in classification work. Recently, in the course of a discussion in a class in DRTC, the idea of Seminal Mnemonics was considered as a useful management technique. From the discussions, it appeared to be a helpful approach in communicating and learning about Seminal Mnemonics. A summary of the ideas that developed in the first part of the discussion is reported in this paper.

139. *Bank : depth classification version of CC* (*Herald Lib. Sci.*) : NEELAMEGHAN, A. DRTC/6/70 (S139).

A depth classification version of Colon Classification for compound subjects going with the Host Subject "Bank" is given. The methodology of design is based on the freely faceted classification with explicitly stated postulates, canons, and principles. Two schedules of recurring ideas are given and the use of such an idea in forming arrays of order 2, order 3, etc. with the special isolates, is described. This device helps the design to conform to the Canon of Helpful Sequence, the Canon of Relevant Sequence, the Canon of Consistent Sequence, and the Canon of Mnemonics. An index to the schedules and thirty-two examples of subjects classified according to the depth version are given.

140. *Basis for study of compatibility, and compatibility of the colon classification with the universal decimal classification* (*FID/CR Meeting* Rome, Oct. 1969), DRTC/10/69, (S140).

Five types of compatibility studies are possible between document finding systems. A Basis of Reference for compatibility studies is given, in terms of the dominant purpose and of the factors in the mental set of the majority of the readers seeking the service of the system. A document finding system should have an efficient scheme for classification built into it. The latter should be based on a sound and dynamic theory of classification. The essential features of the current general theory of classification are indicated. The extent to which CC and UDC conform to it is examined. Illustrates, with examples, the compatibility of CC-in-Theory with UDC-in-Theory and of CC-in-Action with UDC-in-Action. Even though UDC-in-Theory may not be fully compatible with CC-in-Theory, UDC-in-Action can be made compatible with CC-in-Action and with the Basis of Reference, with the aid of the guiding principles given in the *Guide to UDC* (1963). These principles are in conformity with the general theory of classification. The advantages of basing an electronic document finding system on an efficient scheme for classification and the compatibility of UDC and CC for the purpose are mentioned. The additional advantage of using CC is indicated.

K. EMBRYOLOGY

141. *On the food habits of giraffe in East Africa* (*Uganda Journal of Science*) : BRAHMACHARY, R. L. (S141).

The giraffe in the Ghobe area where the elephants have destroyed their natural habitat live on about a dozen species of plants besides Acacia, their well-known diet. They do not graze on grass but eat the very small plants of those species growing in grass. These plants have been collected and identified. At Namsika, the giraffe feed on a restricted diet of two plant species, one of which is the staple food, in fact, the only food in a certain season. This plant has been identified and its protein contents measured in the laboratory.

L. FAMILY PLANNING

142. *Socio-sexual aspects of oral contraceptive* (*Jour. Social Work*) : SENGUPTA, A. (S142).

A programme on oral contraception has been in operation since August 1967 in the Calcutta City Project area through a doctor-operated clinic. The results of the study of two oral contraceptives (Lyndiol and Ovulen) at varying doses with an analysis of 597 cycles involving 100 women are presented in this paper. The adopters generally (60%) came from

the age groups 25–29 (35%) and 30–34 (25%) over an overall marriage duration of 12.9 years, and 2.02 sons and 1.55 daughters. The proportion of acceptors was higher in the cases of women with higher educational levels of husbands among the pill users, 53% had previous experience with some form of contraception which was not convenient for them to continue. After the use of the oral tablet, 69% of the women reported that their sex urge was normal, 16% had diminishing and 11% increasing urge. The average coitus frequency per week was 1.4.

M. Geology

144. *Rhynchosaurs in time and space* (*Proc. Geol. Soc.*, London) : Chatterjee, Sankar, Geo/1/69, (S144).

Rhynchosaurs were a widely distributed group of land vertebrates during the Triassic period, recorded from all continents except Australia and Antarctica. The family Rhynchosauridae includes seven well established genera. These genera may be grouped on their cranial characters into three well-defined sub-families. The least specialised sub-family Mesosuchinae includes *Mesosuchus* and *Howesia*. The intermediate sub-family Rhynchosaurinae includes *Rhynchosaurus Stenaulorhynchus*. The most highly specialised forms *Hyperodapedon*, *Paradapedon* and *Scaphonyx* are grouped into a new sub-family Hyperodapedontinae. These three sub-families 'primitive', 'intermediate' and 'advanced' represent successive stages in rhynchosaur evolution and occur in Lower, Middle and Upper Triassic beds respectively. Thus rhynchosaurs seem to be extremely useful in continental Triassic correlation. Rhynchosaurs do not show 'explosive evolution' as Romer (1960) has suggested, but are more evenly distributed throughout the Trias.

145. *Two faunal associations from the Maleri formation of the Pranhita-Godavari valley*, (*Jour. Geo. Soc. Ind.*, Bangalore) : Kutty, T. S. Geo/3/69, (S145).

The fossil occurrences in a part of the outcrop of the Maleri formation have been studied. Five members of the fauna were met with in the course of this study, two of which are aquatic forms, two others amphibians and one terrestrial. A comparison of the faunal assemblages from the various fossil localities, along with the probable depositional environments of the sediment in which they are found, show that no palaeo-ecological associations can be recognised.

146. *The Gondwana sequence of the Pranhita-Godavari Valley, India, and its vertebrate faunas* (*II Int. Sym. on the Gondwana Stratigraphy and Palaeontology*, June 1970, South Africa) : Kutty, T. S. (with Roy Chowdhury, T.) Geo/9/69, (S146).

The sequence of continental Gondwana formations of the Pranhita-Godavari Valley, Central India, and their vertebrate faunas are discussed in the light of recent work in stratigraphy and palaeontology. It is now seen that the sequence in this outcrop is unbroken for the most part and it has already yielded four distinct vertebrate faunas. In these respects, it holds a unique position among the Gondwana outcrops of India and may well prove to be of importance in the correlation of Mesozoic continental sequence of the world.

147. *Two new dicynodonts from the Triassic Yerrapalli formation of Central India* (*Palaeontology*) : ROY CHOWDHURY, T. Geo/4/69, (S147).

Two new dicynodonts recently collected from the Triassic Yerrapalli formation of India are described.

The first, *Rechnisaurus cristarhynchus*, is a Stablockeriid and the first of its kind to be reported for Asia, *Rechnisaurus* shows considerable similarities to *Dinodontosaurus* of the Middle Triassic of Brazil and Argentina. The second dicynodont, *Wadiasaurus indicus* is the first kannemeyeriid to be described from India and its nearest relative is thought to be *Sangusaurus* of the Middle Triassic of Zambia.

148. *A new capitosaurid amphibian from the Triassic Yerrapalli formation of the Pranhita-Godavari valley* (*Jour. Geo. Soc. Ind.*, Bangalore) : ROY CHOWDHURY, T. Geo/7/69, (S148).

A new capitosaurid amphibian, *Parotosaurus rajareddvi*, from the Tirassic Yerrapalli formation of the Pranhita-Godavari valley is described and a restoration of the skull roof is given. General features of the skull, particularly the constricted otic notch, indicate that the new Indian species is perhaps more close to the Middle Triassic capitosaurids.

149. *Indian Triassic vertebrate faunas* (*17th Sym. Verte. Palae. and Comp. Anatomy*, Sept. 1969, Newcastle-upon-Tyne) : ROY CHOWDHURY, T. Geo/10/69, (S149).

The sequence of Triassic vertebrate faunas from the Gondwana formations of the Pranhita-Godvari Valley are discussed. For the first time, some information about the presence of a Middle Triassic Vertebrate fauna in India are presented in the paper.

N. PHONETICS

150. *Phonetic Audiometry* (*Report for the Education Directorate, Govt. of Tripura*) : KOSTIC, DORDJE, ILIC, C. KERAMITCHIEVSKI, S., NIKOLIC, M., KALIC, D. D. and MIT.EB, ALOKANANDA. Phonetic/1/69, (S150).

This is the first presentation in English of the principles on which phonetic audiometry is based, and the empirical findings for the Serbo-Croatian language. Phonetic audiometry is contrasted with pure tone or tonal audiometry and with speech audiometry. Pure tone audiometry uses pure tones at selected frequencies to test hearing acuity. Speech audiometry employs words from the spoken languages to test hearing acuity. While pure tone audiometry uses meaningless acoustic signals, the tones used have no relevance to the sound structure of the language. Speed audiometry does reflect the sound structure of the language, but requires knowledge of the meaning of spoken words, which, for example, congenitally deaf persons may not have. Phonetic audiometry is based on the concentrations of acoustic energy characteristic of the particular language, using these concentrations as acoustic signals which are linguistically meaningless. This provides a test of ability to hear the sound elements of the language which the person being tested needs to hear. For the Serbo-Croatian vowel system, the acoustic signals are of the formant type at 270 c/s, 350 c/s, 600 c/s, 75) c/s, 1000 c/s, 1350 c/s 1800 c/s, 2400 c/s, and 4000 c/s. For the Serbo-Croatian consonant system, the signals are in the form of acoustic noise energy at 100 c/s, 200 c/s, 280 c/s, 400 c/s, 500 c/s. 1700 c/s, 2800 c/s, 4800 c/s, and 7500 c/s. An illustration is given of the acoustic concentrations of the Macedonian vowels to show that these concentrations vary from language to language.

O. Planning, Economic Statistics and Econometrics

153. *Chinese and Indian agriculture : a broad comparison of recent policy and performance* (*Jour. Asian Studies*) : Bardhan, P. K. (S153).

In both China and India agriculture is the key sector and yet detailed comparisons of recent agricultural development in the two economies are hard to come by. A major problem is, of course, the availability and reliability of data. This paper puts together some of the information that is now available and assesses its reliability to draw some rough generalisation. In Section II of the paper we consider relative performance in agricultural production and productivity in the two countries; in Section III we discuss the trends in the use of inputs and the pattern and effectiveness of investment in the agricultural sector; in Section IV we study the framework of land relations in which the agricultural sector operates in the two countries; the Section V provides a brief overall conclusion.

154. *Optimum subsidy to a learning industry : An aspect of the theory of infant-industry protection* (*Inter. Econ. Rev.*) : Bardhan, P. K. (S154).

In this paper we describe a dynamic model of 'learning by doing' in an open economy in which production experience enhances productivity. The optimum time paths of different variables, including that of the rate of subsidy to the 'learning' industry (infant-industry' protection) are analysed with a view to maximising a discounted stream of social utility from consumption over an infinite horizon.

155. *Regional physical complexes for agricultural land-use planning in India* (*Proc. 21st International Geographical Congress*, India, 1968) : Bhat, L. S. (S155).

This paper analyses the role of natural environment in agricultural land-use planning in India. Natural environment is often liberally interpreted and evaluated by studying different elements of the natural environment of a region such as rainfall or land-forms or soils in their spatial pattern of distribution and examining their influence on land-use. Complex approach to the study of natural environment emphasises an integrated approach in which the different physical elements are studied in their interaction in different parts of the country. This enables a systematic evaluation of different physical elements and their role in land-use planning. After stating the salient features of physical complexes and formulating the principles for the identification of distinct regional physical complexes an attempt is made to delineate regions and sub-regions in which the combined action of different physical elements is evident. In order to analyse the influence of physical complexes on land-use, districts are grouped according to their similarity in physical complexes and their land-use structure aggregated on the basis of these regions. The results reveal that there are distinct 'core' areas of crops in which their *norm* of specialisation should be related to the occurrence of 'optimal' physical conditions for crops. The transitional areas between the 'core' areas need further investigation on the basis of large scale maps and using the land-use data on maps and using the land-use data on the basis of tehsils and in some areas with the village as the unit of study.

156. *Regional development and national planning in India* (*Proc. 21st International Geographical Congress*, India, 1968) : Bhat, L. S. (S156).

An attempt is made in this paper to spell out such of the regional dimensions that have an important role in the content of regional and national planning in India. The

formal regions are identified and their structure analysed for the location of production complexes as a basic long-term strategy of regional development. The targets of production of selected commodities at the national level are also analysed in relation to the spatial distribution (existing and potential). Analysis of functional and space relations facilitated the delineation of macro-regions and to understand the relationship between the formal and functional regions in regions with varied levels of development. The problems of integrated development and the area levels at which they need analysis are then illustrated.

157. *Central place model as a spatial framework for regional and national planning in India*, (*Proc. Conference on the City as a Centre of Change in Asia*, University of Hong Kong, 1969) : BHAT, L. S. (S157).

Panning for the development of a region of a system of regions in the national framework involves problems of integration of different sectors or activities in their locational and spatial dimension. Regions and locations are complementary and are hierarchic. An attempt is made in this paper to illustrate the regularity in the distribulon of towns in selected regions and to explain the spatial pattern of towns in a regional context. The locational pattern of market towns within the limits of the formal regions fits with the central place Model on the basis of transport principle. This pattern seems to recur in regions like central and western U.P., the Punjab plains and the northern part of the Mysore plateau. This illustrates the potentiality for the application of Central Place Model in planning the development of a region. In a multi-regional framework the patterns of central places and their tributary areas could be a realistic spatial framework for the choice of growth-points and regions from the point of view of the national plan and in promoting regional development.

158. *A Socio-economic Bibliography of India* : 1871–1961, Vol. 1. (*Indian Institute of Advanced Study, Simla*, pp. approx. 3,500) : BHATTACHARYA, DURGAPRASAD, (S158).

The purpose of this bibliography is to compile an inventory of printed works—books, pamphlets, reports, documents—bearing on economic conditions and related social conditions of India from 1871 up-to-date.

The bibliography has been prepared on the basis of a catalogue of about 25,000 volumes available at four Calcutta Libraries—National Library, West Bengal Secretariat Library, Asiatic Society Library, and Indian Statistical Institute Library. It contains (a) books or pamphlets by individual authors, (b) publications by the Central and State Governments and other Corporate bodies, (c) an inventory of census publications from 1871 to 1961 as far as available, (d) a complete inventory of documents laid before the British Parliament from 1871 to 1949; (e) an inventory of published volumes of National Sample Survey from its inception up-to-date. It should be mentioned that articles published in journals are outside the scope of the present bibliography. Most of the books were physically verified to note author, title, edition, year and place of publication, publishers, pagination as well as contentents therein. The first volume contains writings of individual authors and publications of private organisations. The material has been classified according to a schedule prepared following the Dewy Decennial Classification. The classified section is followed by an author index and an index of subjects.

159. *Inter-regional and inter-temporal variations in size distributions of household consumer expenditure in India* (11*th General Conf. Inter. Assn. Res. Income and Wealth*, 24 August—1 September, 1969, Israel) : BHATTACHARYYA, N. (with CHATTERJEE, G. S.), Con/NIRU/3/69, (S159).

In this paper we have analysed the size distributions of persons by per capita household consumer expenditure based on different rounds of the NSS. We have examined the disparities in such distributions for rural and urban sectors of India and its constituent states, the inter-temporal and inter-regional differences in disparity, the inter-temporal and inter-regional differences in disparity, the inter-state and rural-urban variations in average per capita consumer expenditure, and regional disparities as a component of overall disparity of the all-region distribution. While much of the analysis is based on expenditure distributions as nominal prices, some comparisons in real terms have been attempted, using indices of inter-temporal and inter-regional consumer price differentials, which may vary systematically with the level of living.

160. *On rural-urban differentials in consumer prices and per capita household consumption in India* (9*th. Ind. Econ. Conf.*, 23-24 December 1969, Patna, also *Sankhyā*) : BHATTACHARYYA, N. (with CHATTERJEE, G. S.), NIRU/12/69, (S160).

This paper presents (in Section 2) some indices of rural urban consumer price differentials in India utilizing NSS 18th round (February 1963–January 1964) household budget data for estimating the weighting diagram and the item-wise average prices. The indices were calculated at all-India level but separately for the ten decile groups of the population in the two sectors (formed after ranking the households in increasing order of per capita consumer expenditure) and also for the general population. Laspeyres', Paatche's and Fisher's formulae were used. Separate indices were also computed for groups of consumer items like cereals and cereal substitutes, other food and non-food.

Consumer price level is about 15 per cent higher in urban India than in rural India; this differential rises from about 10 per cent when we compare the bottom decile groups in the two sectors to about 20 per cent when we compare the top decile groups. Such indices are utilized for urban-rural comparisons of level of living in real terms.

161. *Some characteristics of the Indian labour force, its projection up to* 1981 *and the problems of measurement of its Components* (*Volume on the Seminar on Employment and Income Distribution*, New Delhi, 29-30 March 1970 under the U.S.A.I.D. Programme) : BHATTACHARYYA, SUDHIR (with SENGUPTA, SURANJAN), (S161).

In view of the heterogeneous character of labour supply and the typical socio-economic conditions of the country, the tools of measurement used in the industrially advanced countries are ineffective in India. Furthermore, the problem of underemployment in the country is more serious than the problem of unemployment, continuance of households as the most important economic unit for productive activity in almost all the industrial sectors are the noteworthy features which inherently complicate the quantitative measurement of the various characteristics of labour force. Gainful and non-gainful work of unpaid helpers (consisting mainly women and children) are so interwoven that their unqualified inclusion in or outright exclusion from the labour force is thus extremely misleading and unrealistic.

Only seeking work criterion is inadequate to qualify the number of unemployed persons. It is proper to introduce a less restricted criteria like 'available for gainful work' for the purpose.

An alternative procedure to classify population is to try to form different homogeneous groups of population and to present the disaggregated summary of the participation behaviour of each such group separately. Sufficiently homogeneous groups may, however, be formed on the basis of additional information on usual activity particular of each individual.

Projection results show that the population of 439 million in 1961 is expected to grow to 560 million in 1971 and to 695 million in 1981 and the labour force of 177 million in 1961 and 291 million in 1981. During the twenty-year period between 1961 and 1981, the activity rate will rise by about 2 per cent and that change will only be due to the change in the sex age composition of the population (S_3).

162. *A computational algorithm for determination of von Neumann Ray* (*9th Ind. Econ. Conf.*, 23-24 December 1969, Patna): BOSE, DEB KUMAR (with BOSE, SANJIT), Econ/2/69, (S162).

A linear programming model is set up to determine the maximal balanced rate of growth attainable in a von Neumann System. The procedure is based on parametric variation of the rate of growth appearing as a factor in some of the constraints. An upper bound for the maximal rate is first established. The optimal value is reached after a few iterations.

165. *Inter-connexions between size distribution and distributions by industrial origin, factor shares, final expenditure and regions* (*11th General Conf. Int. Assn. Res. Income and Wealth*, 24 August–1 September, 1969, Israel): CHATTERJEE, A. K. (with MUKHERJEE, M.), Con/NIRU/1/69, (S165).

From purely definitional relations, one could expect some inter-connections between the size distribution of personal income on the one hand and on the other four customary national income distributions by industrial origin, by factor shares, by final expenditures and by regions. It follows from the above that when the size distribution of personal incomes undergoes a change, there should be certain associated changes in the other distributions.

166. *A preliminary note on the variation in urban-rural differential in consumer prices in India* (*7th Indian Conference on Research in National Income and Wealth*, Hyderabad, January 1970): CHATTERJEE, G. S. (S166).

In an earlier study, some indices of urban-rural differential in consumer prices in India were presented utilising the NSS 18th round (February 1963—January 1964) household budget data for estimating the weighting diagram and the itemwise price averages. In the present paper, an attempt has been made to measure the above differential during another period of time, using a different source material, to examine how it compares with the previous findings. While the commoditywise price relatives have been worked out from the retail market prices given in the NSS Weekly Price Bulletins for the 11th and 12th rounds (June 1956–August 1957), the weighting diagram is based on the NSS 18th round household budget data.

The present indices seem to be reasonably accurate, at least from the dimensional point of view, for all practical purposes. In a low price situation as prevailing during NSS 11th and 12th rounds, the urban price level may be taken as about 5 per cent higher than the rural price level for the poorer sections of the population; the corresponding percentage rose to about 11 in a high price situation as prevailing during NSS 18th round.

167. *Trend in mineral consumption in industries and growth of mining (7th Indian Conference on Research in National Income and Wealth*, Hyderabad, January 1970): DEY, B. (S167).

In this paper, an attempt has been made to ascertain the growth of consumption of minerals in home industries and to find out how far mining activities have been influenced by the rapid industrialization of the Indian Union. A flow chart of values of 26 important minerals at constant prices used as inputs in 1938 industry groups has been prepared for four years 1960, 1961, 1964 and 1965. From this, it may be observed how the use of minerals has been influenced by the growth of the industry-groups.

It is evident that some of the minerals like asbestos, barytes, bauxite, bentonite and fuller's earth, calcite and ochre are being produced in large quantities depending mostly on internal consumption. Moderate expansion is noticed in cases of coal mining, dolomite, china clay, fire clay, gypsum, etc., which are mainly used in indigenous industries like iron and steel, fertilizer, refractories, etc. But for exportable minerals like mica and manganese, production is not so satisfactory. Minerals which have both foreign market as well as large internal demand have exhibited encouraging progress.

168. *Inter-state flow and distribution of scientific and technical personnel (Econ. & Pol. Weekly)* : DEY, B., NIRU/4/69, (S168).

An attempt has been made in this paper to reveal inter-state migration of scientific and technical personnel with the help of a matrix. This paper also shows statewise distribution of such persons. The basis of this study is the data collected by the Census Authorities by a special enumeration of scientific and technical personnel during February 10 to March 5, 1969, and published in Vol. 1, Part IIC(i), Social and Cultural Tables.

169. *Balanced economic growth of the eastern zone (52nd Annual Conf. Ind. Econ. Assn.)* : DEY, B., NIRU/9/69 (S169).

In a study of the Eastern Zone submitted in the 44th Conference of the Indian Economic Association held in 1961, the conclusion was drawn that regional disparities were tending to be eliminated but at a very slow pace, although the Conference could not take a definite decision on this point. The present study has further examined the position with the help of larger number of comparatively more sound economic indicators and has arrived at the conclusion that the plan allotments beginning from the Third Five Year Plan have been directed with greater success for redressing inter-state economic inequalities.

But one thing is to be noted that to achieve this goal, retardation of economic growth of the advanced states has been made to play a more important role than by improving the economies of the backward states. As a result, the efforts to raise the economies of the

poor states have not been able to counter-balance the extent of retardation of growth of the advanced ones and the total economy of the Eastern Zone has been seriously affected and is lagging behind the all-India average.

It may further be observed that although there is a definite sign of minimization of regional disparities, inequalities in the individual level do not show any sign of improvement.

172. *Structural changes in the consumption expenditure in India (Paper on National Income and Allied Topics)* : KANSAL, S. M. (S172).

This paper relates to the study of structural changes in consumption expenditure over time. The time series estimates of consumption expenditure are derived by using the commodity flow approach and are worked out at constant prices of 1960-61. It is observed that during the period 1950-51 to 1965-66, the share of expenditure on food has declined and that of non-food and services have increased. Itemwise analysis indicates that most of the items in food group show a declining tendency and most of the items in non-food group show an increasing trend. In the latter group, the relative share of expenditure on durables has increased very considerably followed by that of transport. In this study, comparison has also been made between the consumption structures based on commodity flow approach and as obtained from the NSS consumption data.

173. *Some aspects of inter-state disparity in industrial development in India* : 1956–65 (*Sankhyā*) : LAHIRI, R. K. (S173).

Simple measures of inter-state disparity in industrial employment in India were presented in the study which also examined the changes in such disparity during 1956–65. The main findings are : (a) inter-state disparities in the level of industrialization decreased between 1956 and 1965; and (b) there was also a decrease in the states component of the concentration of the size distribution of factory employment, or in plain words, the average factory sizes in the different states moved closer to one another during this period.

175. *Factor price equalisation theorem in linear programming (9th Ind. Econ. Conference,* 23-24 December 1969, Patna) : MAITI, PRADIP, Econ/4/69, (S175).

In this paper, we prove the factor price equalisation theory in international trade in a linear programming set-up. Lionel W. McKenzie has proved the same theorem by means of activity analysis (*Econometrica,* 1955). Our paper is based on his analysis, but an additional advantage of our model is that factor prices can be determined explicitly, whether equalised or not.

Considering different countries, each trying to maximise the value of its output (when the world prices of goods are given) subject to its own resource constraints, we have determined here a condition under which different countries in competitive equilibrium would have equal factor prices. The condition has been obtained by proving a theorem in linear programming, namely that if the primal problem (one of maximisation) has a non-degenerate optimal dual solution is unique.

176. *Water requirements of crops and economic efficiency of irrigation water in India* (*Proc. Symposium on Soil and Water Management*, ICAR) : MINHAS, B. S. (with VAIDYANATHAN, A.) (S176).

This paper prepared jointly by Dr. B. S. Minhas of the Planning Unit and Dr. A. Vaidyanathan of the Planning Commission aims at sorting out some of the issues relevant to a proper assessment of efficiency in water use in Indian irrigation systems. It presents a brief description of the nature of plant-water relationships and the factors determining the water requirements of crops. It is argued that the upper limit of the net total water requirements of field crops is given by the potential evapotranspiration. The irrigation requirements are given by the excess of total water requirements over effective precipitation with due allowance for irrigation efficiency. Given these relationships the paper provides estimates of (a) potential evapotranspiration in selected areas in different parts of the country; (b) monthwise moisture deficits and surpluses in each of these centres; (c) the gross amount of irrigation water required from a technological view point under patterns of cropping prevailing in the selected areas. These estimates of gross irrigation requirements are compared with the actual volume of water used per unit irrigated area to verify the oftrepeated criticism that Indian irrigation systems generally tend to spread water too thinly. It also points out the limitations of such comparisons in the present state of data availability. Finally the paper comments on the considerations relevant to verifying *economic* efficiency in water use and suggests a number of specific problem areas on which research is urgently needed.

177. *Price information associated with principal distributions of national income in India* (*11th General Conf., Inter. Asso. Res. Income and Wealth*, 24 August–1 Sept., Israel) : MUKHERJEE, M. (with Chatterjee, A. K.) Con/NIRU/2/69, (S183).

Corresponding to any distribution of national income or any system of national accounts, since we can conceive of all, or most of the entries both at current prices and at constant prices, we can think of an associated price structure obtained by dividing the entries at current prices by those at constant prices. In the Indian national income statistics, the prices used have relatively inadequate coverage and are probably less accurate while the corresponding quantities or values are not infrequently based on a reasonably complete coverage of the universe and are likely to be more accurate.

In view of this, when value flows at current prices are accurate, those in real terms could be inaccurate. When, on the other hand, the quantity elements, such as production index numbers are reasonably accurate, weakness of price data could lead to larger inaccuracy in the corresponding values at current prices.

The problem of lack of comparability of available information on prices and values in this context is considered in some details in the paper. Initially, the discussion is in general terms, and the propositions that emerge are applicable whenever valuation is based on independently collected price and volume information. Next, the actual situation in India is taken up particularly with reference to the official national income statistics in

considerable details thus covering the distribution by industrial origin. Finally, the problems of valuation in the context of the other distributions: by factor share, by size, by final expenditures and by regions are also discussed but in a more summary fashion.

178. *A method of obtaining consistent price index numbers for inter-fractile comparison* (*9th Ind. Econ. Conf.*, 23-24 December 1969, Patna): MUKHERJEE, M. NIRU/11/69, (S178).

Given price and quantity vectors for $(n-1)$ commodities and only the expenditure $_m(=p_m \times q_m)$ for the mth commodities relating to n fractile groups, a method has been proposed for obtaining a system of index numbers for inter-fractile comparison of prices satisfying the reversal and circular tests. A proof is given demonstrating that the solution of a set of $(m+n-1)$ equations on which the index numbers depend is unique. An example based on NSS 18th round data is presented to illustrate the method. Neoteric index numbers of S.H. Khamis are similar; these are considered by way of introducing the problem.

179. *A method of aggregating sectors in an inter-industry transactions table* (*Economic Annual, Indian Economic Journal*): MUKHERJEE, M. (S179).

The method suggested a grouping of sectors with relatively similar input coefficient vectors. For this, $a_i - a_j = i_j$ is defined as the "distance" between sectors i and i where a_i represents the input coefficient vector of the ith industrial sector Group of sectors have been formed by following a procedure which ensures, when n original sectors are reduced to k groups, that the average of i_j within a group is almost invariably smaller than the distance of the average coefficient vector of the group from that of any other group. Since such grouping reduces variability of input coefficients within groups, matrices condensed in this manner are likely to perform better for projection purposes than matrices condensed by following other usual methods. Indian input-output table for 1955-56 has been used to illustrate the method.

180. *Concentration of income within states* (*7th Indian Conference on Research in National Income and Wealth*, Hyderabad, January 1970): MUKHERJEE, M. (S180).

An attempt has been made in the paper to rank the different states of India by their relative levels of inequality at a point of time. Size distribution of household consumption expenditure for 1963-64 based on the 18th round of the NSS supplied the basic information. But statewise rates of savings were used to construct income distributions, and inter-sectoral disparities of average incomes per worker were computed for corroborative purposes. Finally, distributions were roughly adjusted by interfractile variations in cereals prices to get an idea of the real disparity. Half the sum of the absolute differences of the percentage shares of two varieties was used as the measure of disparity. The measure appeared to be easy to re-compute, for slight alterations of the distribution.

181. *Marx on Indian history—a critical look (Conf. Marxist Approach to Res. Soc. Sci.*, 5–9 June 1969, Trivandrum and commemorative volume for the late Professor D. D. Kosambi, *ed.* Kamat, A. R., Gokhale Institute of Politics and Economics) : NAQVI, S. Econ/1/69 (S181).

There is an old controversy among economic historians regarding the character and pattern of the economic structure and power structure in pre-British India, particularly in connection with the question of social and economic development in India in the seventeenth and first half of the eighteenth century which were beginning to create the material and institutional pre-conditions for the development of a class of material entrepreneurs, which could have taken the lead in undertaking industrial construction in the country.

Marx and Engels not merely answered the question in the negative, but held that as a result of certain unique features of Indian geography and climate etc. Indian economy had acquired a stationary character and the establishment of British rule alone, by breaking up the institutional basis of the stationary economy, created the pre-conditions for the rise of a national bourgeois class.

The present paper has sought to examine Marx's formulations critically and shown that basing himself on stray and partial data, he arrived at an altogether erroneous understanding of the pre-British situation in the Indian society.

For this contemporary account, foreign and Indian writers have been pressed into service.

182. *Use of principal components in regional analysis, Symposium on Regional Planning (Proc. 21st International Geographical Congress*, India 1968) : PAL, M. N. (S182).

This paper reviews critically the applications of principal component analysis in regional studies. Relative merits of different kinds of applications, such as the construction of regional indices by (i) multiple sub-group first principal components, (ii) group principal components, and (iii) rotated group principal components by the normal varimax criterion, have also been examined. It is concluded that the interpretation of regional indices is best possible in the first kind of application and also that the definition of "simplicity" of a component (or factor) whose maximisation for all components together is supposed to yield "simple structures" for meaningful interpretations of component matrix, is not satisfactory. Alternative criteria for defining simplicity have been hinted for further investigations.

183. *A technique of ranking central places and determining linkages : Symposium on Quantitative Methods in Geography (Proc. 21st International Geographical Congress*, India, 1968) : PAL, M. N. (with RAO, PRAKASA and TEWARI, V. K.) (S183).

With reference to central places (towns and important villages) of Muzaffarnagar district, U.P., a method has been developed and illustrated for establishing linkages among central places of varying functional ranks under simultaneous consideration of functional pull and locational nearness between central places. This method yields a hierarchical

linkage pattern with irregular hinterland shape around a central place, which is more realistic than that visualised in the central place theory of Christaller and Losch, based on a very regular scheme of hexagonal market areas. This linkage pattern is an expected one under certain consistent considerations of optimality and not the actual pattern ; it is difficult to establish empirically an actual pattern because of the limitations of data on details of trade flows and consumer travels.

185. *On 'Additive Von Neumann-Morgenstern utility functions'* (*Econometrica*) : Rao, D. S. Prasada, NIRU/7/69, (S185).

In this paper, we show that Robert A. Pallak's (*Econometrica*, 1967) theorem 2 is not true. The result is shown through a contradiction by constructing an axiom relating to consumer's preferences. Further, we prove that the class of Von Neumann-Morgenstern utility functions considered by Robert A. Pallak is empty.

186. *A remark on 'quasi equilibria in markets with non-convex preferences'* (*Econometrica*) : Rao, D. S. Prasada, NIRU/8/69, (S186).

We show, in this paper, that the existence of Rothenberg Equilibrium in Markets with non-convex preferences can be proved without the Spannability Assumption. The existence of the equilibrium with Spannability Assumption is shown by Ross M. Starr (*Econometrica*, 1969).

187. *On using production and allocation coefficients simultaneously* (Communicated to Professor P. N. Mathur) : Rao, D. S. Prasada, NIRU/10/69, (S187).

In this paper we give a procedure to determine the output vector to be attained at a future date, satisfying some conditions on the value added and final demands to be attained, given the inter-industry transactions matrix, where allocation as well as production coefficients are relevant. The procedure is illustrated by a numerical example, taking the transactions matrix of the Indian Union for the year 1955-56.

188. *Growth of sectoral investment in India over the post-independence period* (*7th Indian Conference on Research in National Income and Wealth*, Hyderabad, January 1970) : Roy, B., (S188).

An attempt has been made in this study to estimate the investment by the various purchasing sectors of the economy during the post-independence period and to assess the growth rates.

The study consists of two sections : (1) on presentation of the method adopted and actual estimates, and (2) a consideration of the growth of sectoral investments in its various aspects such as, (a) percentage growth of investment in various sectors compared with the growth of corresponding sectoral output; (b) growth of capital-output ratios by sectors, and (c) growth of the percentages of total investment to total output.

189. *Towards a wage distribution function* (9th *Ind. Econ. Conf.*, 23-24 December 1969, Patna) : SENGUPTA, NIRMAL, Econ/5/69, (S189).

Most of the empirical works on production functions assume homogeneous labour force and take it as the number of heads counted. But the proper description of the labour force will be one heterogeneous in skills and instead of the number of heads simply, something like total skill requirements will be relevant for empirical studies. Hence, an empirical relationship like the Arrow-Chenery-Minhas-Solow fit ;

$$y = aw^b$$

y = value added per labour

w = wage rate per labour

a, b = constants

obtained in terms of labour force not adjusted for skill is conceivable only when one considers there is a relationship between the skill requirements and total man-hour requirements. Or in other words such a fit may be used to obtain the skill composition or the wage distribution of labour force. This may be termed the shadow-distribution underlying the particular production function.

We have deduced here the shadow wage distribution corresponding to the constant elasticity of substitution production functions. The parameters of the distribution are related directly to the parameters of the CES production function. Hence the method proposed here will enable one to describe the production functions at least approximately from the wage-structure used in the production process.

Unfortunately the form of the wage distribution is non-linear. We have suggested a method for fitting the form. But the procedure requires tremendous amount of calculation and possible suitably in computers.

190. *A note on approximations to finite sample moments of estimators whose exact sampling distribution is unknown* (*Econometrica*) : SRINIVASAN, T. N. (S190).

In cases where the exact sampling distribution of an estimator is unknown, approximations to its finite sample moments are often derived on the basis of a few terms of the infinite series expansion of the sampling error of the estimator. This note shows that this approach can be misleading in that it can (a) yield incorrect approximations when true moments exist, (b) yield finite valued approximations to the true moments that are infinite, (c) result in the incorrect conclusion that true moments are infinite when they are finite.

191. *Choice of techniques* (*Proc. Conference on Economic Development in South Asia*, organised by the International Economic Association) : SRINIVASAN, T. N. (S191).

The paper discusses the choice among alternative techniques of production in the context of uncertainty regarding prices of inputs and outputs.

192. *Interaction between domestic and foreign resources in economic growth : some experiments for India (Essays on Development Planning*, Chenery, H. B. (*Ed.*), Harvard University Press) : TENDULKAR, S. D. (S192).

The paper presents a multi-sectoral, single-period, optimising programming model that explicitly incorporates two bottleneck constraints on economic growth, namely, domestic saving and foreign exchange. Numerical computations have been carried out with Indian data to analyse the interaction between domestic and foreign resources and their effects on economic development. It is shown, among other things, that the effectiveness of the same amount of foreign assistance is higher in an economy where both savings and foreign exchange constraints are binding than in the case when only foreign exchange constraint is binding.

P. PSYCHOMETRY

193. *Factor analysis of a selection test battery (Jour. Psychol. Res.)* : BASUMALLIK, T. Psych/13/69, (S193).

A selection test battery consisting of six tests (viz., Mathematical Comprehension, English Knowledge and Comprehension, Quantitative Reasoning, Verbal Reasoning, Graph and Table Reading, and Breadth of Knowledge) was factor analysed by Lowley's method of maximum-likelihood. Three common factors were found to be adequate. Communalities ranged from .826 to .191. Breadth of Knowledge and Graph and Table Reading turned out to be the most specific tests while the other four tests were quite high in common factor variance. Varimax analytical rotation produced a positive manifold but not a clear simple structure. The three factors were identified as reasoning (R), numerical (N) and verbal (V) factors, respectively. Regression weights were determined for obtaining factor scores from test scores. Contributions of test variables to factor estimates were also worked out.

194. *Relation between suicidal thoughts and other symptoms of depressive illness (Ind. Jour. Psychiatry)* : BASUMALLIK, T., (with NANDI, D. N. and GHOSH, S.) (S194).

One hundred depressive patients, both male and female, were studied to see if suicidal thoughts were significantly associated with other cardinal symptoms of depression, like hypochondriasis, loss of energy, insomnia, depersonalization, diurnal variation in mood, loss of affect, anorexia, loss of interest, impaired concentration, etc. The chi-square test showed that significantly more depressive *with* suicidal tendency exhibited several of the other symptoms also. It was concluded that as suicide is the gravest risk met in the treatment of depression, the possible existence of suicidal tendency, even latent, should not be ignored when other symptoms are present and preventive measures be taken to minimize the risk of suicide.

195. *Relationship between achievement motivation and risk-taking (Ind. Jour. Psychology*, Delhi) : BASUMALLIK, T. (with BANERJEE, D.) (S195).

Measures of achievement motivation based on the *n* Ach scale of the Edwards Personal Preference Schedule and levels of risk-taking behaviour using a Choice Dilemmas Procedure Instrument were obtained from 75 post-graduate students. Statistical analysis

of the data failed to confirm the hypothesis that high *n* Ach subjects significantly more often choose intermediate levels of risk, which is the usual finding when *n* Ach is measured by the standard projective technique and risk-taking behaviour in actual situation. It was concluded that the expected curvilinear relationship does not hold between the questionnaire measure of *n* Ach and risk-taking behaviour in hypothetical situation.

196. *Differential prediction of success through the use of psychological tests* (*Educ. Rev.*, Delhi) : CHATTERJI, S. (with MUKHERJEE, M.) Psych/9/69, (S196).

Examination of the abilities required for success in various fields of endeavour shows that such measurable aptitude is usable in a number of occupations and hence it is economical to construct standard test batteries from which it is possible to get scores indicating an individual's expected success in number of specific occupations by suitably utilising the test scores. There are several methods of utilising the test scores for classifying the individual and these are briefly discussed here. From the literature it is further observed that most of the aptitude tests developed in India are in a developing stage and even with respect to other tests not much systematic work has been done as far as differential production is concerned.

197. *An investigation into the validity of a scientific knowledge and aptitude test* (*Psychol., Bull.*, Calcutta) : CHATTERJI, S. (with GHOSH, DIPTI, GANGULY, D. and MUKHERJEE, M.), Psych/11/69, (S197).

The scientific knowledge and aptitude test, suitable for use at the Higher Secondary level, was administered on 476 students reading in class XI. These students were divided into five groups, *viz.*, Boy's Science, Girl's Science, Boy's Humanities, Girl's Humanities, and Boy's Commerce. Among the five groups the Boy's Science Group had the maximum mean score whereas the Commerce Group had the lowest mean score. The score was validated against the school examination marks as well as the Higher Secondary Examination marks. Validity coefficient as high as .71 was observed.

198. *An investigation into the interest pattern of deaf children* (*Psychol., Annual*, Tripura) : CHATTERJI, S. (with BANERJEE, CHHABI, DUTTA, ANATH and MUKHERJEE, M.), Psych/12/69, (S198).

In this study the interest pattern of a group of 100 deaf children is compared with that of normal school going children. It is observed that the deaf children are more interested in the field of fine arts, agriculture, outdoor sports and household work than the normal children. The normal children were more interested in science, medicine and technical fields. The interest patterns of these two groups were however completely different.

199. *A comparative study of some of the environmental conditions of delinquent and school-going children* (*Psychol. Res.*, Meerut) : CHATTERJI, S. (with MUKHERJEE, M. and MITRA, SADHANA), Psych/14/69 (S199).

This study compared the economic, educational and the environmental conditions at home of the delinquents with those of the school-going children. A biographical questionnaire enquiring into these aspects was administered on a group of 125 children living in

a "detention home" and on another group of 125 children residing in school. The age ranges of these two groups were almost the same. The responses given by the children were analysed and it was observed that the environmental conditions of the inmates of the detention home was completely different from those of the school-going children. The ideals, aspirations, etc. of the two groups of children also differed widely. Low income, low educational level, lack of parental love and care, family occupations with low prestige value were found to be more frequent for the delinquent children than for the other group. The information gleaned through this study shed some light into the root causes of delinquency.

Q. Sociology

200. *Technological innovation and people's reaction* (*Human Organization*, U.S.A.) : Chattopadhyay, K. (with Bandyopadhyay, S.) : Nat/15/69, (S200).

The report presents the results of an enquiry conducted in May 1962 in 15 villages of the district of Birbhum, covered by a project directed towards providing irrigational facilities (Mayurakshi River Project), as well as Community Development Projects. The purpose of the study was to explore the variations in motivations of villagers with regard to utilization of the newly introduced technological opportunities, with a view (i) to ascertain whether there existed any regularity—within a range of variation—in the motivations of the villagers (as contrasted with limitless or individual or random phenomena); and if there did exist any regularity, (ii) to isolate the groups, and (iii) to identify the societal characteristics by which these groups could be mutually differentiated. The villages were selected purposively from those villages that already enjoyed irrigational and other facilities as well as from those that did not do so yet.

Observations suggest a pattern of groupwise differentiation of the villagers. A number of groups are isolated with regard to motivations of villagers, and it is observed that whereas "small-scale" landowners—Hindus as well as Muslims—who are dependent upon agriculture as primary occupation are keenly receptive to both of those projects; on the other hand, some "big landowners" are providing most of the resistance. It is seen though economic status is an effective factor of group-differentiation, some other factors like social affiliation, etc., need to be considered. Some problems of further work are posed before closing.

201. *On the secondary analysis of variations in family structures* (*Current Anthropology*, USA) : Mukherjee, Ramkrishna (S201).

Primary data on the family have been collected over a long period of time and in many places of the world through social surveys conducted with or without the study of the family as their objective. It is possible, therefore, to undertake secondary analyses of these data in order to ascertain cross-cultural and longitudinal variations in family structures. Also, since the secondary analyses will comprise large samples of family-units, many useful information can be elicited from their detailed categorization which may not be feasible in the case of corresponding primary analyses. The course of secondary analysis, however, will require certain conceptual considerations and methodological aids. These are discussed in this paper with special reference to the categorization of family structures in the dimensions of their kinship composition and intra-family kinship distances.

204. *On the study of social change and social development in the 'developing societies'* (*Economic & Political Weekly*) : MUKHERJEE, R. (S204).

Social change and social development, which were of primary concern to the pioneers in India, have re-emerged as key concepts in the usefulness of the discipline in contemporary India (Becker and Barnes 1962 : II, 1135–1148; Mukherjee 1969). Usually, however, the two concepts are not evaluated critically before their application in the Indian context, resulting more in confusing the situation than clarifying it (Mukherjee 1965). Evaluation is required on four counts, two for either concept : 1) what is its content, and 2) how can it be examined in the given situation. Specified in this manner, the two concepts will maintain their universal validity while being useful particularistically : a position which their imitative and a contextual application to different societies may fail to attain. The paper briefly discusses these four points with reference to the Indian society, and presents an analytical model, at the end, on how to organize empirical social research on contemporary India. The discussion may be found to have a general bearing on all those which are euphemistically labelled "the developing societies."

References :

Becker, Howard and Barnes, Harry Elmer, 1952, *Social Thought from Lore to Science*. Washington, D.C., Harren Press.

Mukherjee, Ramkrishna, 1965, *The Sociologist and Social Change in India Today*. New Delhi, Prentice-Hall.

——— 1969, *"Empirical social research on contemporary India"*, Social Science Information, ISSC, Paris 8(6), 69–83.

R. STATISTICAL QUALITY CONTROL

206. *A branch and bound algorithm for m parallel processors sequencing problem* (*Opsearch*) : ARTHANARI, T. S. (with RAMAMURTHY, K. G.), (S206).

In this paper, a branch and bound algorithm for sequencing n jobs on m parallel processors is given. Lowerbounds for partial assignments have been derived and used in the proposed algorithm. Waiting cost is worked out based on the time a job waits before being taken up for processing. The same results with slight modifications can be used, if waiting costs were to be worked on the basis of finishing time of a job.

207. *How many spindles to a sider ?* (*Indian Textile Journal*, Bombay) : DESIKAN, G. V. S. (with SRINIVASAN, N.), (S207).

This paper describes the procedure for determining the optimum workload for operators assigned to attend to more than one machine. This has specific reference to a burning problem in textile industry on fixing the workload for the siders in spinning. Taking the distribution of end breakages as Poisson, the paper derives a formula for estimating the average waiting time for the spindles and discusses the method of choosing the optimum workload on cost considerations. The method has been illustrated with a live example from the textile industry.

209. *Construction of some general and two-level partially balanced arrays* (*Sankhyā*) : MUKHPADHYAY, A. C. (S209).

In this paper, a method is given for constructing Partially Balanced Arrays (PBA)- of strength 3 from pairwise balanced designs. It is proved that the existence of PBA $[N, k, 2, 2p]$ implies the existence of PBA $[2N, k, 2, 2p+1]$. Also is given a method for obtaining PBA's of strength 2 from tactical configurations.

S. ZOOLOGY

210. *Intestinal movements in the fourth instar larva of Chabroue Crystallinus de Geer* (*Proc. Zool. Soc.* Cal.) : DAS CHAUDHURI, P. C. : Nat/8/69, (S210).

The pharynx shows four types of movements : peristalsis, antiperistalsis, gross contraction and up-and-down movements. The œsophagus shows three types of movements : persistalsis, antipersistalsis and jerking movements. The hunger cycle and prolonged starvation directly influence all movements of the intestine. It is calculated that the number of contractions of the pharyngeal valve is 270 per hour in fed larvae and 155 per hour in unfed larvae.

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