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OCTAV ONICESCU'S CONTRIBUTION TO INFORMATIONAL THEORY

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Academician Professor Octav Onicescu remains in history as a remarkable mathematician, who introduced important concepts in Theory of Probabilities. In this paper, are presented Onicescu's Informational Energy, Onicescu's Informational Correlation and Onicescu's Coefficient of Informational Information. He found the links between some general stochastics processes in different domains in which he activated such as statistics, mechanics, mathematics and economy. His books are dedicated to any engineers, researchers, students, teachers, anyone who works with random processes.

Keywords: Onicescu's Informational Energy, probability, random variables, Onicescu's Informational Correlation, Onicescu's Coefficient of Informational Information

INTRODUCTION

In 2021 we mark 129 years since birth of Octav Onicescu (1892–1983). He was a remarkable mathematician, who activated in statistics. He is recognized in the entire world[1] for the contributions to the Theory of Probabilities with applications in vast fields such as mathematics, statistics, sociology, economy for the Informational Energy, Informational Correlation, Coefficient of Informational Information, also for his merits in mechanics for his discovery Invariantive Mechanics[2,3].

The professors Octav Onicescu and Gheorghe Mihoc (1906–1981) laid the foundations of first School of Statistics in Romania. They introduced the concept of the Chains with complete connections.[4]

CRONOLOGY

1892 – On August 20, Octav Onicescu is born at Botoşani, Romania, his parents were Vlad and Aneta Onicescu.[5] His father was a public servant. Father's ancestors were from Oniceni-Roman families from Bacău. His mother was from Bucovina and had a Macedonian origin.
1903 – Finishes first clicle "Boys Primary School" from Botoşani.[6]

Portrait[5] Octav Onicescu
(20 Aug 1892–19 Aug 1983)

1903–1911 – Follows courses at the "August Treboniu Laurian" High School from Botoşani and graduates with the maximum grade 10.[5,6]
1911 – Follows two university programmes at University of Bucharest: Mathematics at Faculty of Science (major teachers were Gheorghe Țițeica, Dimitrie Pompeiu and Traian Lalescu) and Philosophy(major teachers Constantin Rădulescu-Motru, Petre P. Negulescu, Nicolae Iorga, O. Densusianu) at Philology-Philosophy Faculty.[5–7]
1913 – Graduates both faculties Mathematics and Philosophy.
1914 – 1916 – Teacher at Military High School at Dealu Monastery, near Târgovişte.
1916 – Marries Luiza Zorio, of Italian origin.[7]
1916 – 1918 – is mobilized at the General Staff Headquarters and after he is retreated with the army to Iasi[7]
1918 – Returns as a teacher at Military High School at Dealu Monastery

1919 – Goes to Rome[6,7]
1920 – Writes the Ph.D thesis "Sopra gli spazi ensteinieni a grupi continui di transformazioni", coordonated by Tullio Levi-Civita[8,13]

– Goes to Paris and on fall attends the lectures of the mathematicians E.Picard and E.Cartan[7]
1921 – Returns at Bucharest and collaborate with C.Rădulescu Motru, Nae Ionescu and Ştefan Nițescu for publishing the review.
1922 – Starts to teach at the Faculty of Sciences a course about mechanics and the theory of relativity.
1924 – In premiere for Romania, he teaches courses on the theory of probability and statistical mechanics.[1,7]
1925 – Teaches the human body mechanics at the National Academy of Physical Training[5,7]
1929–1940 – Is rector at National Academy of Physical Training.[6]
1930 – With Central Statistics Institute puts the foundations of School of Statistics (In 1941, the school becomes Institute of Statistics, Actuarial Science and Calculus and in 1947 is dissolved).[1,5,13]
1931 – Professor at the Department of Mechanics and The Theory of Relativity of The Faculty of Science and starts a collaboration with Gheorghe Mihoc.[6]
1932 – Founds Romanian Institute for the Study of the Economic Conjuncture (dissolved in 1940).

– Founds Romanian Society of Science.[7]
1933 – Is elected as corresponding member of the Romanian Academy.[7]
1935 – Is elected member of International Statistic Institute.[7]
1940 – 1942 – Leads a scientific seminar on the philosophy of science. Also, Dan Barbilian, Grigore C. Moisil were contributors.[7]
1941 – Becomes member of the Romanian Social Institute and member of Council of Social Assistance of the Ministry of Labour.[7]

– Becomes president of the General Pension Establishment in the Ministry of Finance and president of the Private Insurance Control Council in the Ministry of the Economy.[7]
1949 – Leads Probability Theory Section of the Mathematical Institute of the Romanian Academy.[7]
1962 – Together with Gheorghe Mihoc receive State Prize[13]
1965 – Becomes member of the Romanian Academy.[5,13]
1968 – is cofounder of the International Center for Mechanical Sciences in Udine, Italy[7]
1976 – is elected as member of the Academy of Science in Torino[6]
1982 – becomes honorary member of the International Statistical Institute[7]
1983 – On 19 august dies, at 90 years old. Next day would have been his 91th anniversary.[5,6,7]

ACCOMPLISHMENTS

1.BOOKS

1923 – Publishes "Galileo Galilei and the Scientific Renaissance", Cultura Națională, Bucharest.
1928 – Publishes "Vector Calculus:I:Vector Operations in Two and Three-Dimensional Spaces", Cultura Națională, Bucharest.
1935 – On 26 November, he and Gheorghe Mihoc, publish "Sur les chaînes de variables statistiques", Bulletin des Sciences Mathématiques, p.174–192.
1937 – Octav Onicescu and Gheorghe Mihoc publish "La dèpendence statistique. Chaînes et familles de chaînes discontinue", Actualitesés Scientifiques et Industrielles, Herman, Paris.
1939 – Octav Onicescu and Gheorghe Mihoc publish "Probability Calculus", Foundation for Literature and Art "King Carol II", Bucharest, 1939.
1943 – Octav Onicescu and Gheorghe Mihoc publish "Les chaînes de variable aléatoire. Problèmes asymptotiques", Études et Recherches, XIV, Romanian Academy, Bucharest.
1944 – Publishes "Principles of Scientific Knowledge", Library "Natura", no4, Oficiul de librărie, Bucharest.

– Publishes "Reflections on Science", Library "Natura", no.7, Oficiul de librărie, Bucharest.
1945 – Publishes "Calcul des probabilites. Etudes critiques et recherches", Institute of Statistics, Actuarial Science and Calculus, Bucharest.
1948 – Octav Onicescu and G. Galbură publish "Algebra", vol I, library "Natura", Bucharest
1956 – Publishes "Probability Calculus", Editura Tehnică, Bucharest.
1958 – Octav Onicescu and G. Galbură publish "Lectures on Mathematical Statistics", "Editura Tehnică", Bucharest.
1961 – publishes "Games, Strategy, with Applications to Linear Programming", "Editura Academiei", Bucharest.
1962 – Publishes "Random Numbers and Systems", Editura Academiei, Bucharest.

– Revised in 1963 as "Nombres et systems aleatoires", Editura Academiei and Editure Eyrolles, Bucharest and Paris.

1963 – Publishes the book "Probabilities Theory and Applications", Editura Didactică şi Pedagogică, Bucharest.
1966 – On 26 November publishes "Theorie de l'information. Energie informationnelle", Paris, C.R. Acad. Sci, Serie A, p.841-842.
1969 – Publishes "Principles of probabilities", Editura Academiei, Bucharest.
– Publishes "Mechanics", Editura Didactică şi Pedagogică, Bucharest
– Publishes "Probability Theory and Applications", Editura Didactică şi Pedagogică, Bucharest.
1971 – Publishes "Mécanique statique. Principes mathématiques", Springer, Wien-New York
– Publishes "Principes de logique et de philosophie mathématique", Editura Academiei, Bucharest.
1974 – Publishes "Invariante Mechanics and Cosmology", Editura Academiei, Bucharest, also the revised edition in English is published in 1975 at Springer, Wien-NewYork.
1975 – Publishes "Men of Science", Collection "Lyceum", Editura Albatros.
1976 – Octav Onicescu and I. Cuculescu, publishes "Probability Theory on Boolean Algebras of Events", Editura Academiei, Bucharest
1977 – Publishes "Probabilities and Aleatory Process", Ştiinţifică şi Enciclopedică.
1979 – Octav Onicescu and Vasile Stefanescu publish "Elements of informational statistics with applications", Editura Tehnică.
1981 – Publishes "On Life's Paths", Editura Didactică şi Pedagogică, Bucharest.
– Publishes "Memories" in two volumes, "Ştiinţifică şi Eciclopedică"
1983 – Octav Onicescu, G. Cenuşă and I. Săcuiu publishes "Random Functions Almost Periodical in Probability", Editura Academiei, Bucharest.

II.2.THEORETICAL CONCEPTS

During the time, many mathematicians, statisticians and physicists implemented the Claude Shannon's concept of entropy in applications. Claude Shannon[14] laid the foundations of the Informational Theory, introducing the formula of Informational Entropy in 1948 as

$$H(x) = -\sum_{i=1}^{n} p_i \log p_i \quad (1)$$

where p_i are the probabilities for an event.

In statistics, Octav Onicescu came with a similar view for multivariate data analysis.

Starting with the fact that the weights, frequencies or probabilities, which characterize the system, are number positives, additive and complementary, Octav Onicescu found a better approach to describe the changes in the system.[10,11,12]

Onicescu's Informational Energy is exactly the sum of the squared probabilities from a stochastic process.[9,15,16]

$$E = \sum_j p_j^2(A) \quad (2)$$

Where $j = \overline{1,n}$

n = maximum number of probabilities

A = any event of the chosen field

$$\sum_j p_j(A) = 1 \quad (3)$$

Onicescu's Informational Correlation is the sum of the products of every two weights p and q from S, respectively T, where S and T are two populations with n common features.[9]

$$C_{S,T} = \sum_{j=1}^{n} p_j q_j \quad (4)$$

$$0 \leq C_{S,T} \leq 1 \quad (5)$$

$C_{S,T} = 0$ if and only if $\forall j \in [1,n]$, $p_j = 0 \; or \; q_j = 0$, which means the two populations don't have any common feature.

Onicescu's Informational Correlation with itself is its Informational Energy.[9]

$$C_{S,S} = \sum_j p_j^2(A) = E_s \quad (6)$$

Onicescu's Informational Correlation Coefficient.[9]

$$R_{S,T} = \frac{\sum_{j=1}^{n} p_j q_i}{\sqrt{(\sum_{j=1}^{n} p_j)(\sum_{j=1}^{n} q_j)}} = \frac{C_{S,T}}{\sqrt{E_S E_T}} \quad (7)$$

Theorem: $R_{S,T} = 1$ if and only if S and T are identical.[9]

CONCLUSIONS

Academician Octav Onicescu was a remarkable professor and theoretician in statistics. He found a link between probabilities and other domains, such as economy, mechanics, medicine, education,

sociology and improved the researches in the interdisciplinary area.

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