



DEPARTMENT OF COMPUTER SCIENCE AND AUTOMATION  
INDIAN INSTITUTE OF SCIENCE BANGALORE



PROFESSOR **V.V.S. SARMA MEMORIAL LECTURE**

# *Software Fault Tolerance via Environmental Diversity*

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**Abstract:** Complex systems in different domains contain significant amount of software. Several studies have established that a significant fraction of system outages are due to software faults. Traditional methods of fault avoidance, fault removal based on extensive testing/debugging, and fault tolerance based on design/data diversity are found inadequate to ensure high software dependability. The key challenge then is how to provide highly dependable software. We discuss a viewpoint of fault tolerance of software-based systems to ensure high dependability. We classify software faults into *Bohrbugs* and *Mandelbugs*, and identify aging-related bugs as a subtype of the latter. Traditional methods have been designed to deal with Bohrbugs. The next challenge then is to develop mitigation methods for Mandelbugs in general and *aging-related bugs* in particular. We submit that mitigation methods for Mandelbugs utilize *environmental diversity*. Retry operation, restart application, failover to an identical replica (hot, warm or cold) and reboot the OS are examples of mitigation techniques that rely on environmental diversity. For *software aging* related bugs it is also possible to utilize proactive environmental diversity technique known as *software rejuvenation*. We discuss environmental diversity both from experimental and analytic points of view and cite examples of real systems employing these techniques.



**Biosketch:** Kishor S. Trivedi holds the Hudson Chair in the Department of Electrical and Computer Engineering at Duke University, Durham, NC. He has a B.Tech (EE, 1968) from IIT Mumbai, M.S.(CS, 1972) and PhD (CS, 1974) from the University of Illinois, Urbana-Champaign. He has been on the Duke faculty since 1975. He is the author of a well-known text entitled, *Probability and Statistics with Reliability, Queuing and Computer Science Applications*, first published by Prentice-Hall; a thoroughly revised second edition (including its Indian edition) of this book has been published by John Wiley. He has authored several other books. He is a Life Fellow of the Institute of Electrical and Electronics Engineers. He is a Golden Core Member of IEEE Computer Society. He has published over 600 articles and has supervised 48 Ph.D. dissertations.

His h-index is 107. He is a recipient of IEEE Computer Society Technical Achievement Award for his research on Software Aging and Rejuvenation. He is a recipient of IEEE Reliability Society's Lifetime Achievement Award. He has worked closely with industry in carrying out reliability/availability analysis, providing short courses on reliability, availability, performability modeling and in the development and dissemination of software packages such as SHARPE and SPNP.

**Professor V.V.S. Sarma** (May 1944 – January 2018)

Professor Vallury Subrahmanya Sarma, an extraordinary teacher and researcher, passed away on 13th January 2018 at his home in Bangalore. He is survived by his wife Mrs. Subbalaxmi and three daughters Vijaya, Janaki and Aruna. Professor V.V.S. Sarma was born on May 7, 1944 in Vijayawada. After graduation with a University gold medal in Mathematics, Physics and Chemistry (called MPC) from Andhra University in 1961, he obtained his BE, ME and PhD degrees from IISc, Bangalore. He served the IISc as faculty in various capacities from 1967. He became a full professor in 1983, and continued his service until his retirement in 2006. He was a visiting Professor at the University of Southwestern Louisiana, USA between 1984-86 and at Tata Research Development and Design Centre, Pune between 1995-97. He was elected to the fellowships of Indian Academy of Science, Indian National Science Academy and Indian National Academy of Engineering. Post retirement, he was an Honorary Professor in CSA and an INAE Distinguished Professor.

Professor V.V.S. Sarma fondly called VVS by his students and friends, spent most of his academic career at the Indian Institute of Science (IISc), Bangalore. Over nearly four decades, he has initiated research at IISc in the then emerging areas of reliability engineering, pattern recognition, artificial Intelligence and machine learning, which are areas of utmost importance in the industry today. His survey paper in a special issue on AI in management with some new material in IEEE Transactions on Knowledge and Data Engineering entitled "Knowledge-based approaches for scheduling problems: A survey" was widely cited. He has guided a generation of researchers in these areas. His students were drawn from CSA, ECE, Aerospace, Mathematics and Metallurgy departments and engineers from organizations such as IAF, NAL, ISRO, DRDO, BHEL under the external registration program. Many of his students are currently senior professors in universities or senior engineering researchers in Defense and ISRO across India, USA and Canada. With his friends N.Viswanadham and M.G. Singh, he has written a book *Reliability of Computer and Control Systems* published by North-Holland Systems and Control series in 1987. He co-edited the book "Artificial Intelligence and Expert Systems in Indian Context," published by TataMcGraw-Hill, 1990 jointly with N.Viswanadham, B.L.Deekshatulu, and B. Yegnanarayana.

Date: Friday, 19 Mar 2021 | Time: 7 PM | Online Networking: 6:30 PM

Meeting Link: <http://bit.do/vvssarma>