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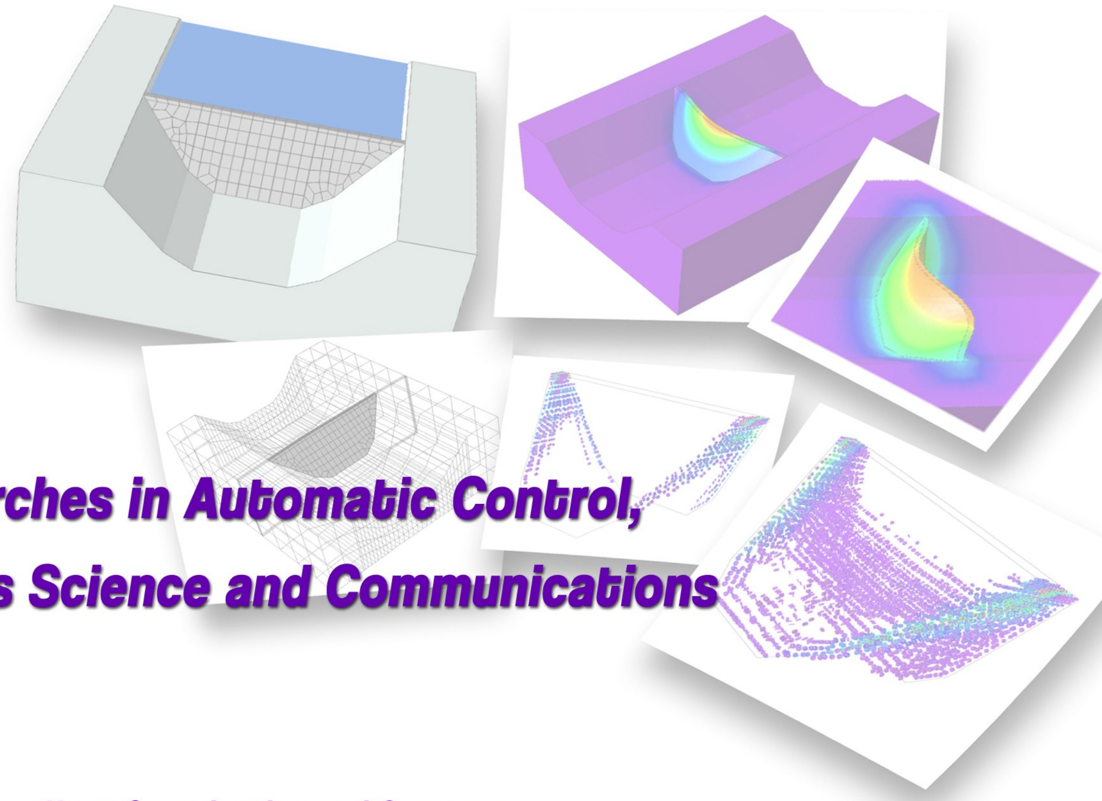

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Keynote Lecture 1

Dynamical Stability Control for the Compliant Walking Robots

Professor Luige Vladareanu
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Abstract: The walking robots motion control is included in the category of systems with a high degree of automation. The mechanical system must be equipped with a large number of degrees of mobility (DOF), in order to form complex synergies and to achieve coordinated movement of the legs. The action of such disturbances like an additional load, changes in weight, position of center of gravity and the robot platform inertial moments and may be a cause of significant deviations from the robot prescribed motion. A number of compliant control techniques are known for obtaining high performance in robot trajectory control, some of which include a dynamic model in the control loop: solved acceleration loop (Luh, Walker and Paul), operational space method (Khatib), impedance control (Hogan, Kazerooni, Sheridan) and other which do not include dynamic models: hybrid control (Railbert si Craig) and rigidity control (Salisbury). In order to increase mobility and stability in real conditions and to obtain superior results relating to the possibility of moving walking robots on terrains with close configuration to real situations such as slope walking, overtaking or avoiding obstacles, the paper presents research regarding the integration of compliant control and fuzzy control into the hybrid position force control system architecture for hexapod walking robots. Stability analyses and experimental implementations have shown not only that using dynamic models leads to a more precise control, but also that using an inadequate dynamic model can sometimes lead to unstable force control. A dynamic position-force control system is presented by integrating the multi-stage fuzzy method with solved acceleration in position-force control and dynamic control loops through the ZMP method. It is also noted that in addition to hybrid position-force control, three other main tasks are added, resulting from the analysis of the robot's walking cycle, conforming to movement characteristics: real time balance control, walking scheme control and predictable control of the walking robot movement. The first main task, balance control, leads to a control model that periodically modifies the walking scheme, depending on the sensory information received from the robot transducers. Real time balance control contains 4 types of reactive loops: damping control, ZMP compensation control, walk timing control and walk orientation control. The second main task, walking scheme control, represents a real time control of the robot equilibrium using the reactions of inertial sensors. The walking control scheme can be changed periodically in accordance with the information received from the inertial sensors during the walking cycle, by processing them into two real time loops: platform swing amplitude control and platform rotation/advance control. The third main task, predictable movement control, represents the control of predictable movement based on a fast decision from previous experimental data. The results obtained shows that this allows the robot to adapt to rough terrain through a real time control with increased stability during walking. In the end, a multi-microprocessor architecture is designed with multi-tasking control that allows a fast feedback loop for real time robot control, improving stability and flexibility performance.

Brief Biography of the Speaker: Luige Vladareanu received his M.Sc. degree in electronics from the Polytechnic Institute Bucharest, in 1977. From 1984, scientific researcher of the Institute of Physics and Material Technology, from 1990, team leader of data acquisition systems and real time control systems of the Institute of Solid Mechanics, from 1991, President General Manager of Engineering and Technology Industrial VTC Company. In 1998 he received Ph.D. degree in electronics field from the Institute of Solid Mechanics of Romanian Academy. From 2003, Ministry of Education and Research, executive Department for Financing Superior Education and of Scientific University Research - High Level Expert Consulting for MEC/CNCSIS project, from 2003-2005, member of Engineering Science Committee of Romanian National Research Council, from 2005, Scientific Researcher Gr.I (Professor) of Romanian Academy, from 2009 Head of Mechatronics Department of Institute of Solid Mechanics, Romanian Academy. His scientific work is focused on real time control in solid mechanics applied in robot trajectory control, hybrid position – force control, multi-microprocessor systems for robot control, acquisition and processing of experimental physical data, experimental methods and signal processing, nano-micro manipulators, semi-active control of mechanical system vibrations, semi-active control of magnetorheological dissipaters systems, complex industrial automations with programmable logical controllers in distributed and decentralized structure. He has published 4 books, over 20 book chapters, 11 edited books, over 200 papers in journals, proceedings and conferences in the areas. Director and coordinator of 7 grants of national research – development programs in the last 5 years, 15 invention patents, developing 17 advanced work methods resulting from applicative research activities and more then 60 research projects. In 1985 the Central Institute of Physics Bucharest awarded his research team a price for the first Romanian industrial painting robot. He is the winner of the two Prize and Gold of Excellence in Research 2000, SIR 2000, of the Romanian Government and the Agency for Science, Technology and Innovation. 9 International Invention and Innovation Competition Awards and Gold of World's Exhibition of Inventions, Geneva 2007 - 2009, and other 9 International Invention Awards and Gold of the Brussels, Zagreb, Bucharest International Exhibition. He received "Traian Vuia" (2006) award of the Romanian Academy, Romania's highest scientific research forum, for a group of scientific papers published in the real time control in the solid mechanics. He is team leader of two ANCS (Scientific Research National Agency) funded research projects: "Fundamental and Applied Researches for Position Control of HFPC MERO Walking Robots" from CNCSIS-Exploratory Researches Program and "Complex Modular Automation Systems for Technological Flux Control AUTMPG" from AMCSIT-Innovation Program. He is a member of the International Institute of Acoustics and Vibration (IIAV), Auburn University, USA (2006), ABI/s Research Board of Advisors, American Biographical Institute (2006), World Scientific and Engineering Academy Society, WSEAS (2005), International Association for Modelling and Simulation Techniques in Enterprises-AMSE, France (2004), National Research Council from Romania(2003-2005), etc. He is a PhD advisor in the field of mechanical engineering at the Romanian Academy. He was an organizer of several international conferences such as the General Chair of four WSEAS International Conferences (http://www.wseas.org/conferences/2008/romania/amta/index.html), chaired Plenary Lectures to Houston 2009, Harvard, Boston 2010 and Penang, Malaysia 2010 to the WSEAS International Conferences, is team leader of WSEAS scientific research project: Mechanics & Robotics Systems and is serving on various other conferences and academic societies.

Plenary Lecture 1

Highly accurate bounds for the eigenvalues of symmetric tridiagonal matrices

Associate Professor Rui Manuel Silva Ralha
Department of Mathematics and Applications
University of Minho
Braga, Portugal

Abstract: The computation of accurate eigenvalues (and eigenvectors) plays an important role in many scientific problems. For symmetric tridiagonal matrices with eigenvalues of very different orders of magnitude, the number of correct digits in the computed approximations for the eigenvalues of smaller size depends on how well such eigenvalues are defined by the data. Some classes of matrices are known to define their eigenvalues to high relative accuracy but, in general, one can not be sure about the number of correct digits in the approximations computed. To solve this problem, we propose a modified bisection algorithm which produces an interval that is guaranteed to contain the desired eigenvalue. This interval has a very small relative gap when the eigenvalue is defined well.
We stress out that accurate computation of the eigenvalues is crucial to guarantee good orthogonality of eigenvectors computed with inverse iteration (this is the basis of the popular multiple relatively robust representation MRRR algorithm).

Brief Biography of the Speaker: Rui Ralha is Associate Professor at the Department of Mathematics and Applications, School of Sciences of the University of Minho. He got his first degree in Mathematics (University of Coimbra, 1981) and a PhD degree at the Faculty of Electronics and Computer Science of the University of Southampton (UK) in 1990. He is a member of the Centre of Mathematics of the University of Minho (CMAT) where he has been coordinating the research group Comapp (Computational Mathematics and Applications). His main research interests are in the areas of numerical linear algebra and parallel computing.

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Plenary Lecture 2

Geometrical Approach of Multidimensional Linear Systems

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Abstract: The Geometric Approach is an important trend in Systems and Control Theory developed to achieve a better and deaper investigation of the structural properties of linear dynamical systems and to provide efficient and elegant solutions of problems of controller synthesis such as decoupling and pole-assignment problems or the compensator and regulator synthesis for linear time-invariant multivariable systems.

The Geometric approach provides a very clear concept of minimality and explicit geometric conditions for controllability, observability, constructibility, pole assignability, tracking or regulation etc. The fundaments of this approach are some invariant subspaces with respect to a linear transformation.

In 1969 Basile and Marro introduced and studied the basic geometric tools named by them controlled and conditioned invariant subspaces which were applied to disturbance rejection or unknown-input observability. In 1970 Wonham and Morse applied a maximal controlled invariant method to decoupling and noninteracting control problems and later on Wonham's book imposed the name of "(A,B)-invariant" instead of "(A,B)-controlled invariant". Basile and Marro opened new prospects to many applications (disturbance rejection, noninteraction etc.) by the robust controlled invariant and the emphasis of the duality. Other properties analysed using geometric tools are invertibility, functional controllability or unknown input observability The LQ problem was also studied in a geometric framework by Silverman, Hautus and Willems. J.C. Willems also developed the theory of almost controlled and almost conditioned invariant subspaces used in high-gain feedback problems. Further contributions are due to numerous researchers among which Anderson, Akashi, Bhattacharyya, Kucera, Malabre, Molinari, Pearson, Francis and Schumacher. The range of the applications of the Geometric approach was extended to various areas, including, for instance, Markovian representations (Lindquist, Picci and Ruckebusch) or modeling and estimation of linear stochastic systems).

The past three decades have seen a continually growing interest in the theory of two-dimensional (2D) or, more generally, multidimensional (nD) systems, which become a distinct and important branch of the systems theory. The reasons for the interests in this domain are on one side the richness in potential application fields and on the other side the richness and significance of the theoretical approaches. The application fields include circuits, control and signal processing, image processing, computer tomography, gravity and magnetic field mapping, seismology, control of multipass processes, etc.

A quite new field of the nD systems theory is represented by the 2D hybrid models, whose state equation is of differential-difference type. These hybrid models have applications in various areas such as linear repetitive processes, pollution modelling, long-wall coal cutting and metal rolling or in iterative learning control synthesis.

In the present paper, a class of multidimensional hybrid systems described by differential-difference state equations is studied from the point of view of the geometric approach. The state space representation of these systems is given: a multidimensional hybrid systems is given by a set $\Sigma = (A_{c1}, \dots, A_{ci}, \dots, A_{cr}; A_{d1}, \dots, A_{dj}, \dots, A_{dq}; B; C)$ where A_{ci} and A_{dj} are the n x n continuous-time and discrete-time drift matrices, *B* is the n x m input-state matrix, *C* is the p x n state-output matrix and *D* is the p x m input-output matrix. The formulas of the state as well as of the input-output map are obtained. The considered systems represent extensions to multidimensional hybrid continuous-discrete models of Attasi's 2D discrete-time systems.

The notions of controllable and reachable states are defined, as well as the completely controllable and the completely reachable systems. states. A suitable reachability Gramian is constructed for time-invariant multidimensional systems and it is used to obtain conditions for the phase transfer and criteria of reachability. The controllability matrix is constructed and it is used to characterize the space of the reachable states as the minimal (A_{ci}, A_{dj})-invariant subspace which contains the columns of the matrix *B* and to obtain necessary and sufficient conditions of reachability for multidimensional hybrid systems.

An algorithm is provided which compute the minimal (A_{ci}, A_{dj}, B)-invariant subspace, (i.e. the subspace of the controllable states of the system) and which extends the 1D algorithm from.
By duality, similar results are obtained for the observability of the time-invariant multidimensional systems and an algorithm is proposed which compute the maximal (A_{ci}, A_{dj}, C)-invariant subspace.

Brief Biography of the Speaker: Valeriu Prepelita graduated from the Faculty of Mathematics-Mechanics of the University of Bucharest in 1964. He obtained Ph.D. in Mathematics at the University of Bucharest in 1974. He is currently Professor at the Faculty of Applied Sciences, the University Politehnica of Bucharest, Director of the Department Mathematics-Informatics. His research and teaching activities have covered a large area of domains such as Systems Theory and Control, Multidimensional Systems, Functions of a Complex Variables, Linear and Multilinear Algebra, Special Functions, Ordinary Differential Equations, Partial Differential Equations, Operational Calculus, Probability Theory and Stochastic Processes, Operational Research, Mathematical Programming, Mathematics of Finance.
Professor Valeriu Prepelita is author of more than 110 published papers in refereed journals or conference proceedings and author or co-author of 15 books. He has participated in many national and international Grants. He is member of the Editorial Board of some journals, member in the Organizing Committee and the Scientific Committee of several international conferences, keynote lecturer or chairman of some sections of these conferences. He is a reviewer for five international journals. He received the Award for Distinguished Didactic and Scientific Activity of the Ministry of Education and Instruction of Romania.

Plenary Lecture 3

Optimal Covariance Control Theory in Automotive Suspension Control System Design

Professor Sadko Mandzuka
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Abstract: The main motivation for use Optimal Constrained Covariance Control Theory (OC3) is that many real control performance requirements are often expressed in terms of the upper bounds on the steady-state variances. The classical LQG approach is impractical, because there is not physical (cause and effect) sense of weighting matrices Q and R (free design parameters). Thus, a very difficult iterative design process must be used to determine the necessary limitations on controlled variables and optimal control performance criterion. These disadvantages of the classical optimal control technique are avoided by proposed OC3 control design technique. The use of active suspension on road vehicles has been considered for many years. A large number of different arrangements from semi-active to fully active schemes have been investigated. There has also been interest in characterizing the degrees of freedom and constraints involved in active suspension design. In this plenary lecture, an active suspension system for a quarter car body using the optimal covariance control design technique will be presented.

Brief Biography of the Speaker: Prof. Sadko Mandzuka is currently a professor at the Department of Intelligent Transport System, Faculty of Traffic Science, University of Zagreb. He has wide experience in the area of floating vessels control theory, Intelligent Transport System, artificial intelligence, traffic incident management system etc. He had the opportunity to work both in academic and industrial environments including Brodarski Institute, consulting in the Innovation Area for SME's, etc. He is currently setting up a spin-off company providing consulting services for Intelligent Transport System (Incident Management System and other) while at the same time advancing his academic career. He is a founding member of Croatian Robotic Association, president of ITS-Croatia, and Collaborating member of Croatian Academy of Engineering. He is a member of Technical Committee on Marine Systems (Coordinating Committee on Transportation and Vehicle Systems - IFAC (International Federation of Automatic Control). Finally he has served in the program committees and as reviewer at several international congress and conferences. He is author of more than 70 internationally reviewed publications.

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Plenary Lecture 4

Methods and Techniques of Speed Control for the Electric Motors

Professor Aldo Pardo Garcia
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Abstract: This lecture focuses on the methods and techniques of speed control for the electric motors nowadays. Classical methods are shown as the most advanced methods for controlling the electrical motors. Intelligent control techniques such as, Fuzzy Logic and Optimized Fuzzy Logic Controller, are sufficiently robust and valid, starting with its ability to deal with disturbance in the control of various processes; in particular, with the speed control of induction motors and DC motors.
This lecture addresses the application of fuzzy logic control as a technique to be applied to electrical machines and control drives. Our main goal is to improve the speed characteristics and their recovery when load change in the motor, also called load disturbances.
Two examples of control are shown:
1. Fuzzy Logic Controller (FLC) design procedure for a DC motor servo-drive system.
2. Speed controller with genetic algorithm and fuzzy logic techniques based on the mathematical models of the motor and the drive was developed, along with its simulations.

Brief Biography of the Speaker: PhD. Aldo Pardo Garcia is an Electrical Engineer, graduated in University of Byelorussia, Byelorussia 1983, Esp 1982, MSc 1983, PhD. 1990, Postdoctoral research at Cinvestav Guadalajara, Mexico (2007/2 – 2007/4), Postdoctoral research at Florida International University, USA (2007/9 – 2009/3). Over 25 years of experience of teaching and research in Universities - of Camaguey, (Cuba, 12 years), of Byelorussia (Minsk, Byelorussia, 3 years) and Pamplona, Norte de Santander, Colombia (14 years and currently).
For 7 years was the head of the research in The Institute for Research and Applied Technology Development (IIDTA 2000 - 2007), University of Pamplona, Colombia, dedicated to create innovative products and researches processes for university and Industry. Lector plenary in Universities of Mexico, of Venezuela, of Spain, of Byelorussia, of Colombia, of Cuba, of Puerto Rico and of United State of America. The results in the last 5 years: Articles published (52), Projects research (4), Softwares with copyright (5), Books published (5), and Participation as an opponent for Masters (10) and PhD thesis (3).

Plenary Lecture 5

Weak Chaos in the Nonlinear Schroedinger Equation: Why Subdiffusion?

Dr. Alexander Iomin
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Abstract: The nonlinear Schroedinger equation (NLSE) in the presence of disorder is considered. The dynamics of an initially localized wave packet is studied. A subdiffusive spreading of the wave packet is explained in the framework of a continuous time random walk. A probabilistic description of subdiffusion is suggested and a transport exponent of subdiffusion is obtained to be 1/3. This problem is relevant to experiments in nonlinear optics, for example disordered photonic lattices, where Anderson localization was found in the presence of nonlinear effects, as well as to experiments on Bose-Einstein condensates in disordered optical lattices.

Brief Biography of the Speaker: Dr. Alexander Iomin graduated from Krasnoyarsk State University(USSR) in 1978 and started to work at the theoretical department of the Kirensky Institute of Physics of the USSR Academy of Sciences. In 1988 he successfully defended his dissertation (Ph.D) in the field of quantum chaos. Since 1991 he works at the Technion - Israel Institute of Technology at the Department of Physics as a researcher and since 1998 as a senior researcher. The main scientific interests are: Quantum Chaos, Classical and Quantum Chaos in Mesoscopic Systems, Fractional Diffusion and Quantum Dynamics, Fractional Transport in Biological Systems.

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Plenary Lecture 6

Chaos Emerging in Selection or Election Process Due to Simple Iterations – Game of Choosing Model

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Abstract: I will present a simple biologically inspired computational model of selection or election process, so called Game of Choosing, GoC. Due to multiple repetitions of a simple iteration chaos can emerge in the system in which the process takes place - state of the system after certain time period strongly depends on initial conditions and on boundary conditions. Several special cases will be discussed.

Brief Biography of the Speaker: Wlodzimierz Klonowski, Ph.D., D.Sc. holds a Master of Science (M.S.) in Physics with specialization in Biophysics, from the University of Warsaw (1968), Doctor of Philosophy (Ph.D.) from the Institute of Physics, Polish Academy of Sciences (1973), and Doctor of Science (D.Sc.) in Biophysics from Humboldt University, Berlin (1990). He has worked as a professor of Physics in the French-speaking l'Univesite National du Zaire a Kinshasa, Republic of Congo, as a Max Planck Fellow at MPI fur Biophysikalische Chemie in Goettingen, as a visiting professor at Brandeis University in Waltham, MA, as the President of Canadian Consulting and Tutoring Services at Halifax, NS. In addition to being a researcher, a professor, and an author, he has been a distinguished member of several organizations including Polish Physical Society, European Physical Society, New York Academy of Sciences, American Association of
University Professors, and American Association for the Advancement of Science. He is a Bio-Scientific Advisory Board Member of the International Brain Research Foundation Inc. New York, Vice-President and Board Member of the International Consortium for Uncertainty Theory (ICUT), and a Board Member of the International Association for Information and Management Sciences (IMS), Beijing.
He is currently a Professor at the Nalecz Institute of Biocybernetics and Biomedical Engineering Polish Academy of Sciences in Warsaw, and is the Head of the Lab of Biosignal Analysis Fundamentals. He has been active for more than 40 years in the theory of complex nonlinear systems with applications in medicine and biology. He was an initiator and organizer of a series of European Summer Schools EUROATTRACTOR. He has contributed seriously to the theory of structure-property relationships in crosslinked polymer materials through his topological theory of networks, so called Systems with Discrete Interactions. Currently, he is involved in the research on nonlinear methods of biosignal analysis and its applications for monitoring the depth of anesthesia and for assessment of medical therapies.
Prof. Klonowski is the Founding Editor and an Editor-in-Chief of Nonlinear Biomedical Physics, an interdisciplinary open access journal (BioMed Central, London, part of Springer Science+Business Media). His biograms are included in several European and American Who's Who's, in Wikipedia, and he has a molecular informational structure named after him (Klonowski-Klonowska Conformon, term proposed by S.Ji in 'Molecular Theories of Cell Life and Death', Rutgers U. Press, 1991). W.Klonowski is also interested in philosophical problems, in particular in theory of consciousness, and emotions vs logical thinking, that he proposed to call Chaosensology.

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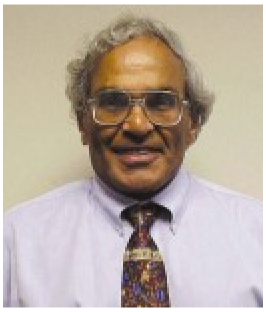
Plenary Lecture 7

Local Traversal in Complex Networks for Identifying Communities



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Abstract: Complex networks are large, dynamic, random graphs modeled to replicate interactions among entities in real-world complex systems (e.g., the Internet, the World Wide Web, online social networks - Facebook, Twitter-- and many biological networks). These networks differ from the classical Erdös-Rényi random graphs in terms of network properties such as degree distribution, average distance, and clustering. Existence of communities is one such property inherent to complex networks. A community may be defined informally as a locally-dense subgraph, of a significant size, in a large, globally-sparse graph. Such communities are of interest in various disciplines- including graph theory, physics, statistics, sociology, biology, and linguistics. Global exploration of these complex networks to detect and extract communities is time- and memory-consuming. In this paper, we explore a more efficient strategy for mining communities in a given complex network. This problem is referred as community identification and can be formally stated as follows: Given a node (seed) in the network, identify the best community that the given node belongs to, if there exists one. A thorough discussion on the existing community identification algorithms and a comparison of their computational complexities are presented. We also present an improved definition of a community in terms of the subgraph that has the maximum average degree in the given neighborhood. A novel divisive algorithm based on breadth-first traversal from the seed node to identify the subgraph with the maximum average degree is proposed. The comparative results on executing the algorithm on several synthetic and real-world benchmark graphs are also present.

Brief Biography of the Speaker: Prof. Narsingh Deo is known for his work in computational graph theory and in parallel algorithms. He holds the Charles N. Millican Eminent Scholar's Chair in Computer Science at University of Central Florida. Prior to this, he was a Professor of Computer Science at Washington State University, where he also served as the department chair. Before that he was a Professor of Electrical Engineering and Computer Science at the Indian Institute of Technology, Kanpur, and a Member of Technical Staff at Jet Propulsion Laboratory. He holds a Ph.D. (EE) from Northwestern University.

He has held Visiting professorships at numerous institutions—including at the University of Illinois, Urbana; University of Nebraska, Lincoln; Indian Institute of Science, Bangalore; and IBM's T. J. Watson Research Center; ETH, Zurich; University of Sao Paulo, Brazil; Oak Ridge National Lab.; Australian National University, Canberra; Chuo University, Tokyo; Monash University, Melbourne, Australia; and IIT/Kharagpur.

A Fellow of the IEEE, a Fellow of the ACM, and Fellow of the ICA, and a Fellow of the AAAS, Dr. Deo has authored four graduate/senior-level textbooks and about 250 refereed research papers. He holds a number of patents in computer hardware and is a recipient of NASA's Apollo Achievement Award (1969). Among his other awards are: Gold Medal of Patna University; Drake Scholar at Caltech, Governor's Award for Outstanding Contribution to High Tech Research in Florida (1989); UCF's Distinguished Researcher Award-89; UCF's Professorial Excellence Program Award (1997); UCF's Teaching Incentive Program Award (1999); and UCF's Excellence in Graduate Teaching Award (2001). He has served as an editor/guest-editor/ member-editorial- board for several journals.

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