SYMCOMP 2013

Lisbon, Portugal

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ECCOMAS Thematic Conference

1st International Conference on

Algebraic and Symbolic Computation

PROGRAM and ABSTRACTS

09-10 September, IST

Lisbon, Portugal

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APMTAC

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SYMCOMP 2013 - 1st International Conference on Algebraic and Symbolic Computation

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Edited by APMTAC – Associação Portuguesa de Mecânica Teórica, Aplicada e Computacional

Editors: Amélia Loja (IDMEC/IST, ISEL), Joaquim Infante Barbosa (IDMEC/IST, ISEL), José Alberto Rodrigues (CMAT/UM, ISEL)

September, 2013

1 – Introduction

The Organizing Committee of SYMCOMP2013 – 1st International Conference on Symbolic and Algebraic Computation welcomes all the participants and acknowledge the contribution of the authors to the success of this event.

This First International Conference on Symbolic and Algebraic Computation, is promoted by APMTAC - Associação Portuguesa de Mecânica Teórica, Aplicada e Computacional and it was organized in the context of IDMEC/IST - Instituto de Engenharia Mecânica. With this ECCOMAS Thematic Conference it is intended to bring together academic and scientific communities that are involved with Algebraic and Symbolic Computation in the most various scientific areas

SYMCOMP 2013 elects as main goals:

To establish the state of the art and point out innovative applications and guidelines on the use of Algebraic and Symbolic Computation in the numerous fields of Knowledge, such as Engineering, Physics, Mathematics, Economy and Management,...

To promote the exchange of experiences and ideas and the dissemination of works developed within the wide scope of Algebraic and Symbolic Computation.

To encourage the participation of young researchers in scientific conferences.

To facilitate the meeting of APMTAC members (Portuguese Society for Theoretical, Applied and Computational Mechanics) and other scientific organizations members dedicated to computation, and to encourage new memberships.

We invite all participants to keep a proactive attitude and dialoguing, exchanging and promoting ideas, discussing research topics presented and looking for new ways and possible partnerships to work to develop in the future.

The Executive Committee of SYMCOMP2013 wishes to express his gratitude for the cooperation of all colleagues involved in various committees, from the Scientific Committee, Organizing Committee and the Secretariat. We hope everyone has enjoyed helping to birth this project, which we are sure will continue in the future. Our thanks to you all.

- Amélia Loja (IDMEC/IST, ISEL)
- Joaquim Infante Barbosa (IDMEC/IST, ISEL)
- José Alberto Rodrigues (CMAT/UM, ISEL)
- Tiago Silva (IDMEC/IST, ISEL)
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2 – CONFERENCE BOARD

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IDMEC/LAETA – Instituto de Engenharia Mecânica/Laboratório Associado de Energia, Transportes e Aeronáutica.

PLACE OF THE EVENT

Anfiteatro VA05

Pavilhão de Engenharia Civil, Instituto Superior Técnico

Avenida Rovisco Pais, 1049-001 Lisboa

GENERAL INFORMATION

SECRETARIAT

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Registration on SYMCOMP2013

Monday, 09/09/2013, from 08:30 h until 17:00 h

Coffee break

Coffee break will take place near the Conference hall and is open to all the participants. We ask you please to use always your identification.

Lunches

The lunch tickets are included in the documentation that you receive at the registration process. The lunch will take place at Restaurant of the Pavilhão de Engenharia Civil (floor 0)

Each participant should give the corresponding ticket when asked to.

Conference dinner

The Conference dinner will take place at the restaurant of Holiday Inn Hotel, close to IST (5 minutes walk from the Conference hall), Monday at 20:00 h. Timberlake Prize will be delivered during the dinner.

PROGRAMME

	Monday: 09/09/2013	**Tuesday: 10/09/2013**
09:00 – 09:15	OPENING CEREMONY	
09:15 – 10:00	**PLENARY SESSION I** ***SYMBOLIC COMPUTING IN PROBABILISTIC AND STOCHASTIC ANALYSIS*** ***Prof. Marcin Kamiński*** - Head of Chair of Structural Reliability Technical University of Lódź - Poland	**PLENARY SESSION II** ***BRINGING NEW ADVANCES IN COMPUTER ALGEBRA INTO GENERAL PURPOSE MATHEMATICAL SOFTWARE*** ***Dr. John May*** - Maplesoft
10:00 – 10:30	**INVITED PAPER I** ***ECONOMIC GROWTH MODELS: SYMBOLIC AND NUMERICAL COMPUTATIONS*** ***Prof. Paulo Vasconcelos*** - Faculdade Economia and CMUP UPorto	**INVITED PAPER II** ***AN OVERVIEW OF SYMBOLIC COMPUTATION ON OPERATOR THEORY*** ***Prof. Ana Conceição*** - FCTUAlgarve
10:30 – 11:00	Coffee-Break	
11:00 – 12:30	Session I **Control Systems, Computer Vision and Image Processing**	Session V **Algebraic Computation for Scientific and Industrial Applications**
12:30 – 14:00	Lunch	
14:00 – 15:00	Session II **Computational Economics**	Session VI **Intelligent Systems**
15:00 – 16:00	Session III **Symbolic Computation and Didactical Tools**	Session VII **Theoretical and Applied Computational Mechanics**
16:00 – 16:30	Coffee-Break	
16:30 – 18:00	Session IV **Algebraic Computation for Scientific and Industrial Applications**	Session VIII **Computational methods applied to Heritage, Architecture and Engineering** [17:30 H] Closure - Submissions to Special Issue of the **AMCS**
20:00 – 23:00	**Conference Dinner** –Timberlake Prize and Honorable Mentions	

MONDAY, SEPTEMBER, 09, 2013

LOCAL: IST, Pavilhão de CIVIL – Anfiteatro VA5

Opening Ceremony: 09:00 – 09:15

SP I	**PLENARY SESSION I – CHAIR: Amélia Loja** ***SYMBOLIC COMPUTING IN PROBABILISTIC AND STOCHASTIC ANALYSIS*** ***Prof. Marcin Kamiński*** - Head of Chair of Structural Reliability, TUL, Poland	**09:15 10:00**
IP I	**INVITED PAPER I – CHAIR: Ana Conceição** ***ECONOMIC GROWTH MODELS: SYMBOLIC AND NUMERICAL COMPUTATIONS*** ***Prof. Paulo Vasconcelos*** - Faculdade Economia and CMUP Univ. Porto	**10:00 10:30**

SESSION I : Control Systems, Computer Vision and Image Processing, 11:00 – 12:30 **CHAIR: Lina Vieira and João Calado**		
ID	**COMMUNICATION TITLE**	**AUTHORS**
01	**Development of a visual loop closure detector in MATLAB**	**F. M. Campos, L. Correia, J. M. F. Calado, J. M. Molina**
02	**The influence of count's number in myocardium in the determination of reproducible parameters in Gated-SPECT studies simulated with GATE**	**T. Vaz, L. Vieira, E. Sousa, D. C. Costa, P. Almeida**
03	**Reproducibility of myocardial lesions simulated on a virtual phantom**	**F.C. Caldas, L. Martins, F.M. Campos, L. Vieira, M.A.R. Loja**
04	**Optimize the position of mechanical components of an external fixator using neural networks and genetic algorithms**	**M. Samarra, L. Roseiro, V. Maranha, M. A. Neto, J. Alves, C. Alcobia**

SESSION II : Computational Economics, 14:00 – 15:00 **CHAIR: Paulo Vasconcelos and José Alberto Rodrigues**		
ID	**COMMUNICATION TITLE**	**AUTHORS**
05	**Government spending objectives in a discrete stochastic growth model with taxes**	**T. Pinheiro, P. B. Vasconcelos, O. Afonso**
06	**Dynamic political effects in a neoclassic growth model with healthcare and creative activities**	**L. Guimarães, P. B. Vasconcelos, O. Afonso.**
07	**Economic growth and equilibria: a symbolic approach**	**J. Gaspar, P. B. Vasconcelos, O. Afonso.**

MONDAY, SEPTEMBER, 09, 2013

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SESSION III : Symbolic Computation and Didactical Tools, 15:00 – 16:00 CHAIR: Ana Conceição and Susana Fernandes		
ID	**COMMUNICATION TITLE**	**AUTHORS**
08	F-TOOL 2.0: Exploring the logistic function in the classroom	J. C. Pereira, A. C. Conceição
09	Two-variable linear programming: a graphical tool with MATHEMATICA	J. C. Pereira, S. Fernandes
10 (*)	Exploring the spectra of singular integral operators with rational coefficients	J. C. Pereira, A. C. Conceição
29 (**)	Automatizing symbolic computations for the elasticity direct method to obtain the three dimensional displacement field of a bar under uniaxial tension	M. M. Neves, H. Policarpo, M. A. A. Silva Matos

(*) Paper ID10 changed with paper ID16

(**) *Please download this paper at this hyperlink*

SESSION IV : Algebraic Computation for Scientific and Industrial Applications, 16:30 – 18:00 CHAIR: Stéphane Clain and António Ferreira		
ID	**COMMUNICATION TITLE**	**AUTHORS**
11	Automatic derivation of plate equations of motion	A. J. M. Ferreira
12	A new finite volume scheme for incompressible fluid flow	F. Marques, S. Clain, R. M. S. Pereira
13	Bending of a beam with finite volume schemes	R. Costa, S. Clain, G.J. Machado
14	Very high-order time scheme for the finite volume method	S. Clain, G.J. Machado

THUESDAY, SEPTEMBER, 10, 2013

LOCAL: IST, Pavilhão de CIVIL – Anfiteatro VA5

SP II	**PLENARY SESSION II – CHAIR: J Infante Barbosa** ***BRINGING NEW ADVANCES IN COMPUTER ALGEBRA INTO GENERAL PURPOSE MATHEMATICAL SOFTWARE*** ***Dr. John May*** - Maplesoft	**09:15 10:00**
IP II	**INVITED PAPER II – CHAIR: Paulo Vasconcelos** ***AN OVERVIEW OF SYMBOLIC COMPUTATION ON OPERATOR THEORY*** ***Ana Conceição*** and ***José C. Pereira*** - FCTUAlg	**10:00 10:30**

SESSION V : Algebraic Computation for Scientific and Industrial Applications, 11:00 – 12:30 **CHAIR: Pedro Areias and Luís Roseiro**		
ID	**COMMUNICATION TITLE**	**AUTHORS**
15	**Using symmetry groups to solve differential equations: analytical and numerical perspectives**	**C. Coelho, J. Videman**
16	**Solving second-order linear ordinary differential equations interactively**	**C. Coelho, R. Marreiros**
17	**Systematic symbolic generation of additive and multiplicative discrete constituents**	**P. Areias, T. Rabczuk**
18	**Optimal identification of elastic support parameters on Bernoulli-Euler beams**	**T. A. N. Silva, M. A. R. Loja, N. M. M. Maia, J. I. Barbosa**

SESSION VI : Intelligent Systems, 14:00 – 15:00 **CHAIR: Ana Madureira and José Igreja**		
ID	**COMMUNICATION TITLE**	**AUTHORS**
19	**Toward ambient intelligence for intelligent manufacturing scheduling in decision making**	**A. Madureira, I. Pereira, J. P. Pereira**
20	**Dynamic adaptation for scheduling under rush manufacturing orders with case-based reasoning**	**A. Madureira, I. Pereira, D. Falcão**
21	**Multi-agent mechanical systems maneuvering with distributed model predictive control techniques**	**J. M. Igreja, D. Morgado, V. Faúlha**

TUESDAY, SEPTEMBER, 10, 2013

LOCAL: IST, Pavilhão de CIVIL – Anfiteatro VA5

SESSION VII : Theoretical and Applied Computational Mechanics, 15:00 – 16:00 CHAIR: António Pinto da Costa and José Eugénio Garção		
ID	**COMMUNICATION TITLE**	**AUTHORS**
22	Using symbolic computation in the detection of frictional instabilities	M.A. Agwa, A. P. Costa
23	Analytical solution for rectangular plates with viscoelastic and piezoelectric layers	J. E. S. Garção, J. I. Barbosa
24	Modelling of laminated composite multi-cell structure using Particle Swarm Optimization	I. C. J. Barbosa, M. A. R. Loja, M.H.F.M. Barros
25	A Numerical solution for structural vibration problems	P T Mendes, J.A. Rodrigues, P. Mendes

SESSION VIII : Computational methods applied to Heritage, Architecture and Engineering, 16:30 – 17:30 CHAIR: Luís Mateus and Victor Mota Ferreira		
ID	**COMMUNICATION TITLE**	**AUTHORS**
26	Characterization and modeling of building cracks using 3d laser scanning as rehabilitation support	M. Amaral, J. A. Rodrigues, M. A. R. Loja, V. Mota Ferreira, L. Mateus
27	Visual programming as tool for architectural design	L. Mateus, F. Roseta, F. V. Monteiro
28	An expeditious methodology to correct the closure error of point clouds registration	L. Mateus, M. Barbosa, V. M. Ferreira

[17:30 H] Closure - Submissions to
Special Issue of the International Journal of Applied Mathematics and Computer Science (AMCS)

ABSTRACTS

- **ID01 | Development of a visual loop closure detector in MATLAB (Control Systems, Computer Vision and Image Processing)**

Campos, F.M. (fcampos@dem.isel.pt), LabMAg and the Mechanical Engineering Department, Instituto Superior de Engenharia de Lisboa, Portugal
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Calado, João M.F. (jcalado@dem.isel.pt), IDMEC and the Mechanical Engineering Department, Instituto Superior de Engenharia de Lisboa, Portugal
Molina, José M. (molina@ia.uc3m.es), GIAA, Computer Science Department, Universidad Carlos III, Spain

A key factor for the high usage of MATLAB is the extension of the core functionalities with specific toolboxes, thus addressing the needs of different communities of users. In particular, the availability of efficient implementations and state of the art algorithms render MATLAB one of the languages of choice in Computer Vision (CV) systems development. In this paper we first present an overview of the existing MATLAB capabilities in the CV field, as provided by the MATLAB extensions, as well as user contributed toolboxes. Secondly, we contribute with a case study in CV systems prototyping that focuses on loop closure detection. Loop closing is a key problem in mobile robotics that requires tackling two fundamental aspects: the image representation and the image search algorithm. The first aspect is resolved with LBP-gist, a fast computing image feature that offers good descriptive power. As the name suggests, this feature builds on two popular image analysis techniques: the gist feature, which has been used in holistic scene description and the Local Binary Pattern (LBP) operator, originally designed for texture classification. Efficient image search is achieved through Winner Take All (WTA) hashing, a recently proposed hashing algorithm that exploits the robustness of rank correlation measures. The paper details the proposed MATLAB implementation of LBP-gist and WTA hashing and demonstrates the efficiency of the resulting loop closure detection system.

- **ID02 | The influence of count''s number in myocardium in the determination of reproducible parameters in Gated-SPECT studies simulated with (Control Systems, Computer Vision and Image Processing)**

Vaz, Tânia (tania.vaz@estesl.ipl.pt), ESTeSL, Portugal
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Myocardial Perfusion Gated Single Photon Emission Tomography (Gated-SPET) imaging is used for the combined evaluation of myocardial perfusion and left ventricular (LV). The purpose of this study is to evaluate the influence of the total number of counts acquired from myocardium, in the calculation of myocardial functional parameters using routine software procedures. Methods: Gated-SPET studies were simulated using Monte Carlo GATE package and NURBS phantom. Simulated data were reconstructed and processed using the commercial software package Quantitative Gated-SPECT. The Bland-Altman and Mann-Whitney-Wilcoxon tests were used to analyze the influence of the number of total counts in the calculation of LV myocardium functional parameters. Results: In studies simulated with 3MBq in the myocardium there were significant differences in the functional parameters: Left ventricular ejection fraction (LVEF), end-systolic volume (ESV), Motility and Thickness; between studies acquired with 15s/projection and 30s/projection. Simulations with 4.2MBq show significant differences in LVEF, end-diastolic volume (EDV) and Thickness. Meanwhile in the simulations with 5.4MBq and 8.4MBq the differences were statistically significant for Motility and Thickness. Conclusion: The total number of counts per simulation doesn't significantly interfere with the determination of Gated-SPET functional parameters using the administered average activity of 450MBq to 5.4MBq in myocardium.

- **ID03 | Reproducibility of simulated myocardial lesions simulated on a virtual phantom (Control Systems, Computer Vision and Image Processing)**

Caldas, Frederico J. C. (frederico.j.c.caldas@gmail.com), ISEL - GI-MOSM, Portugal
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Campos, F.M. (fcampos@dem.isel.pt), LabMAg and the Mechanical Engineering Department, Instituto Superior de Engenharia de Lisboa, Portugal
Vieira, Lina (lina.vieira@estesl.ipl.pt), ISEL - GI-MOSM / ESTeSL, Portugal
Loja, Maria A. R. (amelialoja@dem.isel.ipl.pt), ISEL - GI-MOSM / IST - IDMEC, Portugal

Human virtual phantoms are being widely used to simulate and characterize the behavior of different organs, either in diagnosis stages but also to enable foreseeing the therapeutic effects obtained on a certain patient.
In the present work a typical patient's heart was simulated using XCAT2©, considering the possibility of a lesion and/or anatomical alteration being affecting the myocardium. These simulated images, were then used to carry out a set of parametric studies using Matlab©.
Although performed in controlled sceneries, these studies are very important to understand and characterize the performance of the methodologies used, as well as to determine to what extent the relations between the perturbation introduced at the myocardium and the resulting simulated images can be considered conclusive.

- **ID04| Optimize the position of mechanical components of an external fixator using neural networks and genetic algorithms (Control Systems, Computer Vision and Image Processing)**

Samarra, M. (mcs_samarra@hotmail.com), Mechanical Engineering Department, Faculty of Science and Technology, University of Coimbra, Portugal
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The external fixators are used to immobilize bones in order to allow the fractures to heal. An external fixator is a group of mechanical components, working together to maintain the stability and rigidity of the bone structure. According to the discretion of the surgeon, the installation of the components can vary in distance and angle between them, enabling the construction of several different configurations. The bone healing is sensitive to the mechanical stability of the fixator, and the degree of stability in the focus of fracture can be related to the type of configuration used. The aim of this work is to optimize the position of the pins and the beam of the external fixator in relation to the fracture focus in order to obtain maximum (or desired) stiffness. An external fixator with the unilateral-uniplanar configuration was considered in this study and an experimental setup have been developed in laboratory conditions in order to simulate a fracture in the diaphysis region and obtain the relation between applied force, displacement and force in the fracture focus and strain in the external fixator. Different positions of the mechanical components have been tested and a long series of experimental data was obtained and used to train an artificial neural network to model the behaviour of the fixator. After that it has been developed a genetic algorithm to determine the optimum position of the components of the fixator. The results are presented and discussed.

- **ID05 | GOVERNMENT SPENDING OBJECTIVES IN A DISCRETE STOCHASTIC GROWTH MODEL WITH TAXES (Computational Economics)**

Pinheiro, T. (100411027@fep.up.pt), FEP, Universidade Porto, Portugal
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Afonso, O. (oafonso@fep.up.pt), FEP and CEFUP, Universidade Porto, Portugal

Growth economic models play a crucial role in understanding countries development, inter-country macroeconomic relationship, and, ultimately, to anticipate the effects on endogenous variables due to political shocks on model parameters or exogenous variables. The ability to simulate, under initial assumptions, is, assuredly, a priceless tool for policy makers to take decisions and to adapt them along the time.
We present a discrete stochastic growth model to assess fiscal policy goals, namely, those of government spending stability. This framework is well suited for the European countries under the Stability and Growth Pact (SGP), a rule-based framework for the coordination of national fiscal policies in the economic and monetary union (EMU). Reference to the steady state of the model as well as to the required stability conditions for the convergence of the iterative process will be undertaken. Illustrative computer simulations will be provided, allowing for a clear understanding on the magnitude of the effects over economic recession or expansion.

- **ID06 | DYNAMIC POLITICAL EFFECTS IN A NEOCLASSIC GROWTH MODEL WITH HEALTHCARE AND CREATIVE ACTIVITIES (Computational Economics)**

Guimarães, L. (100421013@fep.up.pt), FEP, Universidade Porto, Portugal
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By considering microeconomic foundations, the Ramsey-Cass-Koopmans (RCK) model has made a great impact in the economic growth literature; however, the long-term economic growth remains unexplained (e.g., Acemoglu 2009). In the original RCK model, agents maximize their lifetime utility, dependent on the consumption level, and their labour supply is assumed to be constant. These assumptions are restrictive; for example, the number of hours worked by each individual is not constant through time and leisure, in which healthcare and creative activities are included, affects positively the utility (e.g., Fogel 2000, Ramey and Francis 2009).
The paper extends the RCK model to cope with its weakness, allowing that a well-known and established model be used to analyse the economic growth effects arising from governmental policies (e.g., Irmen and Kuehnel, 2009). In line with Fogel (2000) and Ramey and Francis (2009), among others, the utility function is modified to consider the fraction of time each individual devotes to healthcare and creative activities. In this context, governmental expenditures financed by lump-sum taxes and inefficient expenditures lead to a decrease in the short, medium and long-run economic growth.

- **ID07 | ECONOMIC GROWTH AND ENVIRONMENTAL QUALITY: EQUILIBRIA AND PROPERTIES (Computational Economics)**

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This paper analyses the local dynamics of a growth model in which environmental policies affect labour productivity and the utility. The utility is also influenced by environmental conscientiousness with future generations. Under certain conditions, it presents multiple equilibria. Numerical computations reveal that each equilibrium exhibits local saddle-path stability, which indicates that the economy experiences a relatively undiversified growth pattern when converging on high- and low-growth equilibria.

- **ID08 | F-Tool 2.0: Exploring the Logistic Function in the Classroom (Symbolic Computation and Didactical Tools)**

Pereira, José C. (unidadeimaginaria@gmail.com), Universidade do Algarve, CEAF, Portugal
Conceição, Ana C. (aicdoisq@gmail.com), Universidade do Algarve, CEAF, Portugal

It is not possible to achieve the objectives and skills of a modern mathematics course, at the secondary and undergraduate levels, without resorting to graphic concepts. Current digital technology allows students to work with a large number and variety of graphics, in an interactive way. Obviously, calculations with the support of technology are not a replacement for paper and pencil calculations, and they should be properly combined with other methods of calculation, including mental calculation. In article [1], we presented the concept of F-Tool, an interactive Mathematica notebook, designed specifically to explore the concept of real function, by analyzing the effects caused by changing the values of the parameters present in general analytical expressions. Each F-Tool allows the study of a typical class of functions providing graphical and analytical information in real time. The main goal of this paper is to present a new and improved F-Tool, called F-Logistic, and to describe how this dynamic tool can be used in the classroom.

[1] Conceição A. C., Pereira, J. C., Silva, C. M., and Simão, C. R., 2012. Mathematica in the ClassRoom: New Tools for Exploring Precalculus and Differential Calculus. Proceedings of the 1st National Conference on Symbolic Computation in Education and Research.

- **ID09 | Two-variable linear programming: a graphical tool with Mathematica (Symbolic Computation and Didactical Tools)**

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This paper presents the GLP-Tool, an interactive tool for graphical linear programming involving two variables. The GLP-Tool is designed to solve any linear programming problem for two variables. Implemented on a computer using the algebra system Mathematica, this interactive tool allows the user to dynamically explore different objective functions and restriction sets, and also perform post-optimal analysis. All the GLP-Tool functionalities are represented graphically and updated in real time. These interactive, dynamic, and graphical features make the GLP-Tool a powerful tool for teaching linear programming both in undergraduate and high school courses. After completing its development, we intend to make the GLP-Tool available at the Wolfram Demonstrations Project website.

- **ID10 | Exploring the spectra of singular integral operators with rational coefficients (Symbolic Computation and Didactical Tools)**

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Spectral theory has many applications in the main scientific research areas (Structural Mechanics, Aeronautics, Quantum Mechanics, Ecology, Probability Theory, Electrical Engineering, among others) and the importance of their study is globally acknowledge. We present some results on the spectra of some classes of singular integral operators, with rational coefficients, defined on the unit circle. It is shown how the symbolic computation capabilities of the computer algebra system Mathematica can be used to check, for each considered class of singular integral operators, if a complex number (chosen arbitrarily) belongs to its spectrum. The implementation of the spectral algorithms with the Mathematica software system makes the results of lengthy and complex calculations available in a simple way. It is also described how we used parts of the [SInt] ([1]) and [ARFact-Scalar] ([2]) algorithms in the creation of the spectral algorithms.

[1] Conceição, A. C., Kravchenko, V. G., and Pereira, J. C., 2012. Computing some classes of Cauchy type singular integrals with Mathematica software. Adv. Comput. Math.. Springer. DOI 10.1007/s10444-012-9279-7

[2] Conceição, A. C., Kravchenko, V. G., and Pereira, J. C., 2012. Rational Functions Factorization Algorithm: a symbolic computation for the scalar and matrix cases. Proceedings of the 1st National Conference on Symbolic Computation in Education and Research

- **ID11 | Automatic derivation of plate equations of motion FLOW (Algebraic Computation for Scientific and Industrial Applications)**

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The Unified Formulation (UF) proposed by Carrera is a powerful framework for the analysis of beams, plates and shells. This formulation has been applied in several finite element analyses, either using the Principle of Virtual Displacements, or by using the Reissner's Mixed Variational theorem. The stiffness matrix components, the external force terms or the inertia terms can be obtained directly with this UF, irrespective of the shear deformation theory being considered.
In this paper, for the first time, we propose to use this UF to derive automatically the equations of motion and boundary conditions to analyze isotropic and cross-ply laminated plates by various meshless and finite element techniques.

- **ID12 | A NEW FINITE VOLUME SCHEME FOR INCOMPRESSIBLE FLUID FLOW (Algebraic Computation for Scientific and Industrial Applications)**

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The 2D Stokes problem for incompressible fluid involves condition $\nabla.U=0$ augmented with the constraint that the pressure average over domain Ω is fix to guarantee the uniqueness of the solution. Classical finite volume scheme using staggered grids have been developed since the eighties [1] and the new mean pressure condition has been implemented in several ways.
We propose a new mathematical formulation for the Stokes problem and a new finite volume scheme where we guarantee both incompressibility and the null mean pressure constraint in the same equation. The model writes:
$-\vartheta\Delta U+\nabla P=g$, $\nabla.U=\int P d\Omega$
and the compatibility condition is assumed. We first show that condition $\int U.n\, dS$ calculated in $\partial\Omega$ is assumed.
We first show that condition, $\nabla.U=\int P d\Omega=0$ is achieved ,and design a new scheme based on the new formulation.
Numerical evidences are provided to show the efficiency of the method, in particular, we obtain a null numerical divergence, a second-order convergence for the velocity and the first-order rate for the pressure.
[1] Patankar S. V., Numerical Heat Transfer and Fluid Flow , Series in computational methods in mechanics and thernal sciences, Hemisphere Publishing Corporation, ISBN 0-089116-522-3, 1980.

- **ID13 | BENDING OF A BEAM WITH FINITE VOLUME SCHEMES (Algebraic Computation for Scientific and Industrial Applications)**

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The paper is dedicated to a new very high-order finite volume method based on polynomial reconstruction operators to solve the one-dimensional problem of beams subjected to a combination of tensile and bending forces. The model involves the classical linear elasticity model coupled with a shell model for the bending.
To achieve the objective of this work, we consider three types of bending of beam problems, which differ in the type of supports, type of strength/moments applied and, therefore, in boundary conditions. Finally, we considered a simplified problem of the bending and the tensile of an intramedullary nail in which we want to determine the stress critical point.

- **ID14 | VERY HIGH-ORDER TIME SCHEME FOR THE FINITE VOLUME METHOD (Algebraic Computation for Scientific and Industrial Applications)**

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We present a new class of very-high-order finite volume schemes for the unstationary convection-diffusion problem providing a sixth-order accuracy both in space and time. The method is based on local polynomial reconstructions dedicated to the convective \cite or the diffusive part of the operator where the Dirichlet boundary condition is explicitly integrated in the polynomial reconstruction. The study focus on the time discretization problem where both explicit and implicit accurate time schemes are considered whereas no operator splitting is performed to easily preserve the sixth-order accuracy in time. Numerical tests are proposed to demonstrate the efficiency of the method.

\bibitem Clain, S., Diot S., Loub\`ere R.,
"A high-order polynomial finite volume method for hyperbolic system of conservation laws with Multi-dimensional Optimal Order Detection (MOOD)", Journal of computational Physics, \textbf{230}, pp. 4028-4050, 2011.

- **ID15 | Solving differential equations using symmetry groups: analytical and numerical perspectives (Algebraic Computation for Scientific and Industrial Applications)**

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In the last decade or so the importance of the symmetry groups to the area of the differential equations has been constantly increasing, whether in the analytical or numerical approaches. For the analytical case, this theory enables the construction of a totally different method to obtain the analytical solutions for ODE's and PDE's. In the numerical case, the conjugation of this theory with some of the classical numerical schemes give rise to a completely different type of numerical schemes, used to solve very specific characteristics of some physical problems modeled by differential equations. In the first part of this talk it will be shown how to solve EDO's and PDE's applying the theory of the symmetry groups, following the main concepts presented in [1], [2] and [3], while in the second part the attention will be directed to the evolution of the invariant numerical schemes, presenting the fundamental ideas behind every approach known, and exemplifying the implementation of the r-adaptive mesh schemes, or moving frames, [4].

[1] P.J. Olver. Equivalence, Invariants and Symmetry. Cambridge University Press, 1995.
[2] M. Fels and P.J. Olver. Moving Coframes. I. A practical algorithm. Acta. Appl. Math., Vol. 51, 161-213, 1997.
[3] E.L. Mansfield. A Practical Guide to the Invariant Calculus. Cambridge University Press, 2010.
[4] W. Huang and R.D. Russell. Adaptive Moving Mesh Methods. Applied Mathematical Sciences, Vol. 174, 2010.

- **ID16 | SOLVING SECOND-ORDER LINEAR ORDINARY DIFFERENTIAL EQUATIONS INTERACTIVELY (Algebraic Computation for Scientific and Industrial Applications)**

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The CDF document, presented recently by Wolfram Research, is a very different type format of documents. The major advantage associated to the use of this document format type is the possibility of interaction between the user and the document, giving the user a more accurate perception of the topics associated with subjects covered in the document. Our goal is to show an interactive way of teaching linear second order ODE's with constant coefficients using a CDF document.
Refs.
[1] Garrett Birkhoff and Gian-Carlo Rota, Ordinary Differential Equations, fourth edition, John Wiley & Sons 1989, 399pp.
[2] James C. Robinson, An Introduction to Ordinary Differential Equations, Cambridge University Press 2004, 415pp.

- **ID17 | SYSTEMATIC SYMBOLIC GENERATION OF ADDITIVE AND MULTIPLICATIVE DISCRETE CONSTITUENTS (Algebraic Computation for Scientific and Industrial Applications)**

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The introduction of equality constraints in a finite element discretization is performed by matrix transformation methods on the clique format of sparse matrices. Topological ordering allows interdependent constraints to be applied without pre-assignment. Besides the standard finite element cliques, constraints generate pseudo-elements which are consequence of the second derivatives of the constraint functions. A partition by classes of constituents is achieved: elements, external loads, Lagrange multiplier-enforced constraints are \emph{additive} constituents. Rigid body constraints, essential boundary conditions, symmetry relations, etc are \emph{multiplicative} constituents. Decomposition order follows from an analysis of transformed cliques.

- **ID18 | Optimal Identification of Elastic Support Parameters on Bernoulli- Euler Beams (Algebraic Computation for Scientific and Industrial Applications)**

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The formulation of a bending vibration problem of an elastically restrained Bernoulli Euler beam carrying a finite number of concentrated elements along their length is presented. In this study, the authors exploit the application of the differential evolution optimization technique to identify the torsional stiffness properties of the elastic supports of a Bernoulli-Euler beam. The strategy allows for the determination of the natural frequencies and mode shapes of continuous beams, taking into account the effect of attached concentrated masses and rotational inertias, followed by a reconciliation step between the theoretical model results and the experimental ones. The proposed optimal identification of the elastic support parameters is computationally demanding. Hence, the use of a Gaussian process regression as a meta-model is addressed. A experimental example is given in order to assess the accuracy of the estimated parameters throughout the comparison of the experimentally obtained natural frequency, from impact tests, and the correspondent computed eigenfrequency.

- **ID19 | TOWARD AMBIENT INTELLIGENCE FOR INTELLIGENT MANUFACTURING SCHEDULING IN DECISION MAKING (Intelligent Systems)**

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This paper addresses the design of scheduling support systems for manufacturing environments where dynamic adaptation and optimization become increasingly important incorporating expert's knowledge from Ambient Intelligence perspective. Ambient Intelligence (AmI) refers to an innovative and creative vision of the future of Information Society where intelligent interfaces enable people and devices to interact with each other and with the environment. It gives relevance to the idea of human-centered design and the intelligence needed to allow systems to foresee user's needs and preferences. A multi-agent system autonomic architecture is proposed to model the AmI Decision Support System for manufacturing environments.

- **ID20 | DYNAMIC ADAPTATION FOR SCHEDULING UNDER RUSH MANUFACTURING ORDERS WITH CASE-BASED REASONING (Intelligent Systems)**

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This paper addresses the problem of integrating new rush orders into the current schedule of a manufacturing shop floor level. To enhance the scheduling of manufacturing orders in dynamic environments, a self-organized integration mechanism module based on Case-based Reasoning (CBR) is proposed in order to decide autonomously which integration mechanism will be used to incorporate new orders in the current plan. Agility refers to the manufacturing system ability to rapidly adapt to market and environmental changes in efficient and cost-effective ways. With this proposal, we intend contribute to increase organizations productivity and effectiveness while minimizing complexity for users.

- **ID21 | MULTI-AGENT MECHANICAL SYSTEMS MANEUVERING WITH DISTRIBUTED MODEL PREDICTIVE CONTROL (Intelligent Systems)**

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Distributed Model Predictive Control is used to maneuver mechanical agents in multi-agent environment in spacial 2-D scenario with obstacles avoidance. These algorithms solve a sequence of multiple static convex optimization problems with coupled constraints using a typical receding horizon policy for predictive control design. In distributed control setups, each agent moves according to the distributed control algorithm and shares information with other agents in a way that individual behavior may be related with a global outcome or cost. Distributed predictive control systems can be seen as a set of computational agents that communicate and eventually cooperate with their neighbors, in an open information interchange infrastructure, to achieve local performance indexes suitable to a global objective.
The developed application is helpful to understand how Predictive Control is related with Dynamic Games, where agents are seen as game players in a strategy space, and Computational Intelligence, where agents show some kind of intelligent collective behavior.
The reported algorithms are suitable for unmanned vehicles maneuvers in mazy scenarios, convoys, collision avoidance and noncooperative dynamic games between agents. The distributed algorithm was applied to control a system of multiple mechanical agents (point masses in 2-D) whose dynamics are independent and the state evolution is described by the Newton's laws of motion. Results are shown with MATLAB animations.

- **ID22 | USING SYMBOLIC COMPUTATION IN THE DETECTION OF FRICTIONAL INSTABILITIES (Theoretical and Applied Computational Mechanics)**

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The present work addresses the problem of determining under what conditions the impending slip state or the steady sliding of a linear elastic orthotropic layer or half space with respect to a rigid flat obstacle is dynamically unstable. In other words, we search the conditions for the occurrence of smooth exponentially growing dynamic solutions with perturbed initial conditions arbitrarily close to the steady sliding state, taking the system away from the equilibrium state or the steady sliding state.
Previous authors showed that a linear elastic isotropic half space compressed against and sliding with respect to a rigid flat surface may get unstable by flutter when the coefficient of friction μ and the Poisson's ratio ν are sufficiently large; in the isotropic case they were able to derive closed form analytic expressions for the exponentially growing unstable solutions as well as for the borders of the stability regions in the space of parameters because in the isotropic case there are only two non dimensional parameters (μ and ν).
Already for the simplest version of orthotropy (an orthotropic transversally isotropic material) there are seven governing parameters (μ, five independent material constants and the orientation of the principal directions of orthotropy) and the expressions become very lengthy and literally impossible to manipulate manually. The orthotropic case is not possible to solve with simple closed form expressions, therefore the intervention of a symbolic manipulator software is required.

- **ID23 | Analytical solution for rectangular plates with viscoelastic and piezoelectric layers (Theoretical and Applied Computational Mechanics)**

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In this work an analytical solution for simply supported laminated rectangular plates, including piezoelectric and viscoelastic layers with linear behaviour, is presented. The governing equations of motion, electromagnetic fields and energy are solved under a small displacement assumption. The solution is obtained by separation of variables. The unknowns variations along the laminate planar dimensions (x1,x2) are considered harmonic functions satisfying the laminate edge boundary conditions, multiplied by unknown functions of the thickness direction variable (x3) and harmonic functions of the time (t). The governing equations reduce to a system of linear ordinary differential equations in (x3), for which the solution is obtained in closed form whenever possible, using Maple.
The whole solution process is performed in algebraic form, except for some cases of material properties for which the involved matrix exponential cannot be obtained without using some numerical computations, or in the case of free vibrations (wave equation) for which the solution derives from the null determinant of a matrix with dimension greater than 10, that is not affordable or possible to calculate in algebraic form.
The behaviour of laminates under different sets of constant and time evolving loads is studied and results are presented enabling comparison with numerical codes. The solution for a delaminated plate can be also obtained and presented.

- **ID24 | Modelling of Laminated Composite Multi-cell Structures using Particle Swarm Optimization (Theoretical and Applied Computational Mechanics)**

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Laminated composite multi-cell structures can provide along with good strength and stiffness characteristics, a low weight, which is not only very interesting but also very important for many purposes that we can find in several engineering areas ranging from the aeronautical and mechanical to the civil applications.
Because of their structure, when sustaining variable twist loadings, the laminated composite multi-cell structure has to support both axial and shear stresses. This is a problem with some complexity, as the material properties and the design of the laminate may not be the most adequate within a certain cross-section to enable supporting the torsion imposed on the cells.
With this study it is intended to characterize the effect of some material and geometric parameters on the optimal mechanical behavior of the multi-cell composite laminate structure under torsion. This characterization will be done by applying particle swarm optimization technique to maximize the multi-cell structure torsion stiffness which can be further used to obtain other interest quantities of the laminated composite. The optimal solution profiles will be discussed.

- **ID25 | A NUMERICAL SOLUTION FOR STRUCTURAL VIBRATION PROBLEMS (Theoretical and Applied Computational Mechanics)**

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A specific implementation of the Newmark method is studied in this paper although there are several possible implementations for this integration method. It seems numerical properties of the Newmark method in the solution of linear elastic systems can be entirely captured by the newly developed technique. Although this technique is only aimed at a specific time step, it is still indicative for the whole step-by-step integration procedure since this procedure consists of each time step.
We use freeFEM++ to obtain a numerical finite element method solution for structural vibration problems during earthquakes. Earthquakes are dynamic random actions that can create damage or even total collapse structures.

- **ID26 | CHARACTERIZATION AND MODELING OF BUILDING CRACKS USING 3D LASER SCANNING AS REHABILITATION SUPPORT (Computational methods applied to Heritage, Architecture and Engineering)**

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Surface reconstruction is an important issue in geometric modelling. It has received a lot of attention in the computer graphics community in recent years because of image technologies development, namely laser scanning technology, and their wide applications in areas such as reverse engineering, product design, medical devices design and archaeology, among others.
In building and rehabilitation areas, laser scanning has been widely applied in the field of architecture for the survey of geometric characteristics of historic buildings. The high speed and accuracy of data acquisition allows the reconstitution of 3D models with a level of detail and precision, exceeding conventional techniques.
With this work, it is intended to visualize data acquired from 3D laser scanning and develop a crack characterization and modelling algorithm. This study is developed and implemented using Mathematica algebraic and symbolic platform tools, and in a final stage the opensource application Meshlab is used for the global assembly visualization.
Concerning the methodology used, the first approach is the development of automatic extraction of several non-disjoint points process, corresponding to a surface portion. After this, two types of filters are used: the first to eliminate redundant points and thus providing a more efficient cloud, the other to detect crack points. Mathematica allowed us to visualize the interpolations surface of the points sample and obtain an approximation of the surface reconstruction.

- **ID27 | VISUAL PROGRAMMING AS TOOL FOR ARCHITECTURAL DESIGN (Computational methods applied to Heritage, Architecture and Engineering)**

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This paper describes the use of the visual programming interface Grasshopper, which runs in Rhinoceros software, in the development a parametric paneling solution for the design of a kiosk's interior cladding. The specific design problem includes: i) the geometric definition of the inner surfaces of the kiosk, ii) the subdivision of the surfaces into small components defining a stereotomic pattern, taking into account the milling fabrication technology that will be used to fabricate the pieces, and iii) laying out the numbered pieces for fabrication. Firstly, we describe the programming interface; secondly, we explain the constraints of the problem and how they were used as parameters; thirdly, we describe the parametric modeling workflow; and, fourthly, we explain how the fabrication technology and the materials selected for the fabrication affected the conceptual strategy. Additionally, we indicate how this kind of modeling strategy can be used in other contexts, such as reverse engineering using laser scanning data as input.

- **ID28 | AN EXPEDITIOUS METHODOLOGY TO CORRECT THE CLOSURE ERROR OF POINT CLOUDS REGISTRATION (Computational methods applied to Heritage, Architecture and Engineering)**

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This paper describes an expeditious methodology to correct the closure error of the registration of a set of terrestrial laser scanning point clouds aligned sequentially. We start by defining what a closure error is and how it can be expressed in terms of matrix notation. Then we explain the valid setting from which a closure error can be obtained. After we describe the algorithm developed to dissipate the closure error. Finally we present an application of the algorithm and a comparison with an automatic procedure, describing the pros and cons of the adoption of the developed algorithm.

- **ID29 | AUTOMATIZING SYMBOLIC COMPUTATIONS FOR THE ELASTICITY DIRECT METHOD TO OBTAIN THE THREE DIMENSIONAL DISPLACEMENT FIELD OF A BAR UNDER UNIAXIAL TENSION Classroom (Symbolic Computation and Didactical Tools)**

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We present a simple symbolic computation (SC) code developed to illustrate a possible use of basic SC in solid mechanics courses. It is here applied to solve the linear elasto-static problem of a bar under uniaxial tension. The problem is solved analytically from its strong formulation, which comprises Cauchy's first law of motion from the conservation of linear momentum, Hooke's law as the constitutive law, and Dirichelet's boundary conditions. By applying the direct method with knowledge of the stress field, it is possible to obtain by direct integration its respective displacement fields. Assuming that the functions resulting from the indefinite integrals are polynomial, we propose an automatic procedure for the determination of the three components u, v and w of the displacement field. Two cases are presented: i) bar fixed in one extremity and axially loaded in the other extremity; ii) bar fixed in one extremity and subjected to its own-weight.