<table>
<thead>
<tr>
<th>Time</th>
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<tbody>
<tr>
<td>08:30-09:00</td>
<td>Registration and Welcome</td>
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<tr>
<td>09:00-10:00</td>
<td>Set Oriented Numerics</td>
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<tr>
<td>10:00-10:15</td>
<td>Coffee Break</td>
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<tr>
<td>10:15-11:20</td>
<td>Set Oriented Numerics</td>
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<tr>
<td>11:20-11:30</td>
<td>Coffee Break</td>
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<tr>
<td>11:30-12:50</td>
<td>Set Oriented Numerics</td>
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<tr>
<td>12:50-14:20</td>
<td>Lunch</td>
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<td>14:20-15:20</td>
<td>Health and Biomedicine</td>
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<td>15:20-15:35</td>
<td>Coffee Break</td>
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<tr>
<td>15:35-16:50</td>
<td>Health and Biomedicine</td>
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<tr>
<td>16:50-17:00</td>
<td>Coffee Break</td>
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<tr>
<td>17:00-18:10</td>
<td>Health and Biomedicine</td>
</tr>
</tbody>
</table>

**Wednesday**

| 09:00-10:00 | Genetic Programming   |
| 10:00-10:20 | Coffee Break          |
| 10:20-12:00 | Genetic Programming   |
| 12:00-14:00 | Lunch                 |
| 14:00-15:15 | Genetic Programming   |
| 15:15-15:25 | Coffee Break          |
| 15:25-16:15 | Genetic Programming   |
| 16:15-16:30 | Coffee Break          |
| 16:30-18:10 | Genetic Programming   |
| 19:30-23:20 | Gala Dinner           |

**Thursday**

| 09:00-10:00 | Modelling, Control and Industry |
| 10:00-10:20 | Coffee Break                   |
| 10:20-12:05 | Modelling, Control and Industry|
| 12:05-12:20 | Closing Comments              |
| 12:20-      | Other Activities              |

**Friday**

**Overview Programme**

- **09.25.15.**
- **09.24.15.**
- **09.23.15.**
- **09.22.15.**
The NEO 2015 local chair would like to give special thanks to all that follow.

To all of the researchers, authors and presenters that submitted and presented their fine work at NEO 2015, without you there is no NEO! Especial thanks are given to the invited speakers Dr. Jian-Qiao Sun, Dr. Leonardo Vanneschi, Dr. David Romero, Dr. Carlos Vera and Dr. André Deutz.

To Dr. Oliver Shütte, the NEO general chair, for the opportunity to host and organize NEO 2015 in our city of Tijuana, BX Mexico.

To all of the session chairs and colleagues that extended a much needed helping hand, particularly Dr. Yazmín Maldonado Robles, Dr. Pierrick Legrand, Dr. Carlos Vera, Dr. Youness El Hamzaoui and Dr. Miguel Aurelio Duarte Villaseñor.

To the Instituto Tecnológico de Tijuana and the Departamento de Ingeniería Eléctrica y Electrónica and the Posgrado en Ciencias de la Ingeniería, their support was invaluable; especially MC Manuel García de Jesús Ortega, MC Carlos Edgar Vázquez López, MC Arturo Sotelo Orozco, Ing. Valente Lares Bocanegra and Cinthya Angélica López Rodelas.

To the funding provided by CONACYT Basic Science Research Project No. 178323, DGEST Research Projects 5414.14-P and 5621.15-P, and FP7-PEOPLE-2013-IRSES project ACOBSEC financed by the European Commission with contract No. 612689. Also, to the funding provided by the CINVESTAV-IPN, without their support NEO 2015 would not have been possible.

To all the staff at the Real Inn Hotel for their assistance, especially Lic. Brenda Medina.

To my friends and family, particularly my wife Nuvia Arlette López Islas and all of the members of the band Wanted.

Finally, special thanks are extended to all the graduate students from the Tree-Lab that worked diligently as the local organizing team, this event would not be possible without you. For sure, you are the heart and soul of NEO 2015! Thank you MC Enrique Naredo García, MC. Yuliana Martínez Ramos, MC. Emigdio Z.Flores, MC Víctor López-López, Ing. Perla Sarahí Juárez Smith, MC. Luis Muñoz Delgado and Ing. Uriel Alberto López Islas.

Sincerely
Leonardo Trujillo
NEO 2015 General Chair
Appendix

NEO Participants

NEO Conference Programme

Invited Speakers

Getting Around Tijuana, Mx.

Welcome to Tijuana, México

NEO 2015 Organisers

Interest

- Human Face Classification
- Behavior Based Approach
- Automatic Random Tree Generator
- Specialist Predictors
- Semantic Genetic Programming
- Geometric Semantic Genetic Programming
- A Nonlinear Analysis
- The Ambulance Location Problem

Flexibility

- Detecting Falls Using Pareto Explorer
- Parameter Free Optimization Algorithm for GARCH Models
- Pareto Explorer for the Local Exploration of Many Objective Optimization Problems
- Detecting Falls Using a Wireless Sensor Network
- Flexibility in Biopharmaceutical Manufacturing Using Particle Swarm Algorithms and Genetic Algorithms
- The Ambulance Location Problem in the City of Tijuana BC México
- A Nonlinear Analysis of the Mammary Carcinoma Model
- Geometric Semantic Genetic Programming
- Semantic Genetic Programming for Sentiment Analysis
- Specialist Predictors of Expected Performance for Genetic Programming Classifier
- Automatic Random Tree Generator on FPGA
- Behavior Based Approach for Genetic Programming
- Profiting from Several Recommendation Algorithms Using a Scalable Approach
- Human Face Classification by Means of a Local Texture Analysis Using the CBIR Technique and Points of Interest

Appendix-A

Multi-Objective Optimal Design of Nonlinear Controls

On Steering Dominated Points in Hypervolume Gradient Ascent for Bicriteria Continuous Optimization

Hypervolume Newton Method as a Local Searcher for Indicator Based Evolutionary Algorithms

Archivers for the Set of Approximate Solutions on Multi-Objective Optimization

The Gradient Subspace Approximation for Scalar Optimization

Parameter Free Optimization Algorithm for GARCH Models

Numerical and Evolutionary Optimization

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### NEO 2015 Organisers

<table>
<thead>
<tr>
<th>Series Chair</th>
<th>Oliver Schütze</th>
<th><a href="mailto:schuetze@cs.cinvestav.mx">schuetze@cs.cinvestav.mx</a></th>
</tr>
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<tbody>
<tr>
<td>General Chair</td>
<td>Leonardo Trujillo</td>
<td><a href="mailto:leonardo.trujillo@tectijuana.edu.mx">leonardo.trujillo@tectijuana.edu.mx</a></td>
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<tr>
<td>Committee</td>
<td>Yazmín Maldonado</td>
<td><a href="mailto:yaz.maldonado@tectijuana.edu.mx">yaz.maldonado@tectijuana.edu.mx</a></td>
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<td></td>
<td>Carlos Vera</td>
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<td>Local Organization</td>
<td>Yuliana Martínez</td>
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<td>Perla Juárez</td>
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<tr>
<td></td>
<td>Uriel López</td>
<td><a href="mailto:uriel.lopez@tectijuana.edu.mx">uriel.lopez@tectijuana.edu.mx</a></td>
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</table>
Dear NEO 2015 Participant,

On behalf of NEO 2015 we are pleased to see you in Tijuana for this year’s NEO Workshop. The past two NEO’s have been held near Mexico City and CINVESTAV-IPN and organized by Dr. Oliver Shütze, head of the research team by the same name. In 2014 Oliver asked us if we were willing to help broaden NEO’s reach, and we were happy to take on the challenge. We hope that NEO 2015 meets the high standards set by Oliver and his students at the past NEO events.

NEO 2015 includes a total of 34 oral talks, including 5 invited speakers, organized into 6 sessions covering a broad variety of research devoted to numerical and evolutionary optimization. If we meet our goals, NEO will provide excellent opportunities to meet and make new friends, establish new working relationships and develop promising collaborations.

The venue for NEO 2015, the Real Inn Hotel, is located right at the heart of our city in the Zona Rio of Tijuana, where we hope you will feel comfortable and be able to enjoy all that our city offers. If you need any help during your visit, remember to look for the NEO 2015 Staff!

On behalf of the Tree-Lab, NEO 2015 organizers and all that helped shape this fine event, we wish you a pleasant and enjoyable visit!

Leonardo Trujillo and the Tree-Lab local organizers.
We have several activities that you can enjoy while you stay in Tijuana. You can enjoy a beautiful sunset at the beach, a fun night in Revolution Av., a nice dinner or even watch a movie in the mega imax theater, as known as CECUT. Before you go and get lost, this handbook have a map attached at the ending or you can find it in the souvenirs bag, in this map you can localize restaurants, bars and other attractions that are near of the hotel and the Revolution Av.

On the other hand we have planned a friendly lunch and of course the gala dinner at the Real Inn Hotel on Thursday night, after that we want invite you to have a lunch with us at Puerto Nuevo and then go to visit the famous Cervecería Tijuana at Friday night.

One of the beautiful thing here is that Tijuana have the open arms for everyone, we have very nice people and a great city to explore, one of the first thing that you have to do is to take a photo with the zonkey at the Revolution Av., visit the Casino Caliente and Race Track, eat at the Mazateño Seafood Restaurant, and if you like art you must visit the gallery at El Cubo, drink a relaxing coffee in front of the beach, listen mariachis at the Santa Cecilia Mall, and other things that you can do in this amazing city.

Also remember that you can go to the United States, the cross border is a few minutes of the hotel and if you want to visit other cities, don’t forget that 21 miles south from the city of Ensenada, lies one of the region’s most impressive natural attractions: La Bufadora, one of the largest marine geysers in the world. Without forgetting to toast the best wine booking here in the Baja, the most delicious Cuisine and the birthplace of surfing.
Invited Speakers

André Deutz
Leiden University, Netherlands.

Featured Talk
On Steering Dominated Points in Hypervolume Gradient Ascent for Bicriteria Continuous Optimization.

Bio
The current research focus of Dr. André Deutz is Multiobjective Optimization, also in the light of Natural Computing, more specifically Indicators and Multiobjective Optimization (and its generalizations such as Diversity oriented Optimization); secondly Geometric Algebra and its applications to Multiobjective Optimization and Quantum Computation.

André studied pure mathematics at the University of Amsterdam, specialization Algebraic Geometry (MSc cum laude). He wrote a doctoral thesis on Algebraic Topology at Wayne State University and UCLA. Subsequently he was invited by the Mathematical Association of America to participate in a 14-months study of Computer Science for ph.d. mathematicians. Furthermore he studied Computer Science at Cornell University (MSc).

Dr. Deutz has taught most of the courses of the standard curriculum of undergraduate Computer Science. He also taught graduate courses. Currently he is teaching Computer Systems for undergraduates and Quantum Computing for master level students.

David Romero
UNAM
México

Featured Talk
Optimization Applied in Large Scale

Bio
His research interests include the theory and applications of Operations Research and Combinatorics; developing models and methods -both exact and heuristic- to solve various optimization problems in Physics, Biochemistry, Finance, and Political Sciences, as well as in Industrial, Chemical and Electrical Engineering.

Dr. Romero graduated as Civil Engineer from the National Autonomous University of Mexico (UNAM). He studied Computer Sciences at the University of Liege, Belgium, and earned his PhD in Applied Mathematics (Operations Research) at the University of Grenoble, France. Later, he spent some exchange time at the Polytechnic of Central London, England. He currently serves as a full-time researcher at the Institute of Mathematics, UNAM, in Cuernavaca, Mexico. His career includes positions as a researcher at the Institute of Electrical Research, Cuernavaca, Mexico, and the University of Ottawa, Canada. He was General Director in INEGI, Mexico, and Head of the Cuernavaca branch of the Institute of Mathematics, UNAM. Dr. Romero has participated in projects that require the development of mathematical models and methods, to provide scientific basis to the decision making process in various public and private institutions. Dr. Romero is member of the Mexican System of Investigators (SNI Level III).
Carlos J. M. Vera
Red Cross Director
Tijuana, México

Featured Talk
Big Data Science in Medicine and Biomedical Research

Bio
Dr. Carlos Vera Hernandez is researcher professor at the Medicine and Psychology Faculty of the Baja California University (UABC), support professor at Tijuana Technology Institute (ITT), and Instructor at the program COSMOS (California Summer School for Mathematics and Science) of Engineering School of University of California (UCSD). His education includes: Industrial Engineering on Electronics (ITT, 1985), Mathematics over Computation specialty (ITT, 1987), General Medicine (UABC, 1995), Master, PhD, and Post-PhD on Molecular Bioengineering (UCSD, 1996-2010). In 2007, thanks to a grant from the New York Carnagie Corporation, he received an expert training on bioterrorism at the Institute on Global Conflict and Cooperation (USCD). His academical research has been focused on the molecular bases elucidation of the eritroctatic membrane biomechanics, its mathematical model, and its biomedical application. Additionally, he has worked on the planning of major emergencies and disasters as well as the operative area. During the Mexico 1985 earthquake, he was Chief of Operations for Urban Rescue of the Halcones Rescue Group. He has been Subdirector for Civil Protection for Tijuana city (1992-1997). He was the founder of the State Group for Major Emergencies Response (1998-2002), founder of the Training and Standardization Committee of the Prehospital Services for First-aid and Rescue (2002), Disasters Coordinator (2003-2005) and Tijuana Red Cross First-aid Coordinator (2013-2014). His main concern in this area is the promotion of the continuous education to the operative personnel and the optimization of the response and planning during major emergencies or disasters.
Bio

Leonardo Vanneschi was born in Florence (Italy) on October 3rd, 1970. He took his University degree (Laurea) in Computer Science by the University of Studies of Pisa (Italy) in 1996 (110/110 summa cum Laude) and his PhD in Computer Science by the University of Lausanne (Switzerland) in 2004 (PhD thesis honoured with the Excellence Award of the Science Faculty of the University of Lausanne). He is an Associate Professor at NOVA Information Management School (NOVA IMS) of the Universidade Nova of Lisbon, Portugal. His main research interests are: Machine Learning, study of Complex Systems, Data Mining, and in particular Evolutionary Computation. His theoretical studies on the foundations of Evolutionary Computation, as well as his applicative works, covering several fields among which Computational Biology and Image Processing, have been consistently recognized and appreciated by the international community from 2000 to nowadays. He is a member of the editorial board of two international scientific journals. He is a member of the steering committee and program committee of various international conferences. He has been the editor of several international conference proceedings and of two scientific journals special issues. In 2015 he has received an Award for Outstanding Contributions in Evolutionary Computation from a panel of internationally renowned experts. He has about 150 scientific publications, among which 11 have been honoured with international awards.
Bio

Dr. Jian-Qiao Sun earned his PhD from University of California. He worked for Lord Corporation at their Corporate R&D Center in Cary, North Carolina, and since engaged in smart materials research and applications, and acoustic-structural controls. In 1994, Dr. Sun jointed the faculty of the department of Mechanical Engineering at the University of Delaware as an Assistant Professor, was promoted to Associate Professor in 1998 and to Professor in 2003. He is currently a professor in School of Engineering at University of California, Merced. He was an Associated Editor of ASME Journal of Vibration and Acoustics since 1994 to 2000, and was an Associated Editor of Communications in Nonlinear Science and Numerical Simulations from 2001 to 2012, an Editorial Board Member of Acta Mechanica Solida Sinica from 2003-2012, an Editorial Board Member of Journal of Vibration and Control since 2005 and Journal of Sound and Vibration since 2006. From October 2012, he started serving as the founding Editor-in-Chief of International Journal of Dynamics and Control published by Springer. His research interests include cell mapping methods, multi-objective optimization, nonlinear random vibrations, nonlinear controls, active structural-acoustic control, stochastic systems, modeling and physical therapy applications of smart materials, time-delayed dynamical systems, and optimal HVAC control and fault detection of energy efficiency of office buildings.
Set Oriented Numerics

- Multi-Objective Optimal Design of Nonlinear Controls.
- On Steering Dominated Points in Hypervolume Gradient Ascent for Bicriteria Continuous Optimization.
- Hypervolume Newton Method as a Local Searcher for Indicator Based Evolutionary Algorithms.
- Archivers for the Set of Approximate Solutions on Multi-Objective Optimization.
- The Gradient Subspace Approximation for Scalar Optimization.
- Parameter Free Optimization Algorithm for GARCH Models.
- Pareto Explorer for the Local Exploration of Many Objective Optimization Problems.

Health and Biomedicine

- Big Data Science in Medicine and Biomedical Research.
- Flexibility in Biopharmaceutical Manufacturing Using Particle Swarm Algorithms and Genetic Algorithms.
- The Ambulance Location Problem in the City of Tijuana BC México.
- A Nonlinear Analysis of the Mammary Carcinoma Model.
- Early Results on the Ambulance Location Problem in Tijuana.

Genetic Programming

- Geometric Semantic Genetic Programming.
- Specialist Predictors of Expected Performance for Genetic Programming Classifier.
- Semantic Genetic Programming for Sentiment Analysis.
- Automatic Random Tree Generator on FPGA.
- Behavior Based Approach for Genetic Programming.
Pattern Recognition

- Profiting from Several Recommendation Algorithms Using a Scalable Approach.
- Human Face Classification by Means of a Local Texture Analysis Using the CIR Technique and Points of Interest.
- Face Recognition with Correlation Filters Designed with Multi-Objective Combinatorial Optimization.
- Target Tracking with Template Matching Filtering.

EC Software and Theory

- Speeding Up Evolutionary Approaches to Face Recognition by Means of Hadoop.
- Evolutionary Computing on R with the ECR Package.
- Detecting Funnel Structures of Continuous Single Objective Optimization Problems by Means of Exploratory Landscape Analysis.
- Spectral and Eigenfunction Properties of a Model Based in Random Networks.

Modelling, Control and Industry

- Optimization Applied in Large Scale.
- Multi-Objective Optimization of Injection Molding Process by a Hybrid of Artificial Neural Network and NSGA-II.
- Local Search Approach to Genetic Programming for RF-PA Modeling Implemented in FPGA.
- Optimizing an Amplifier with a Many Objective Algorithm.
- Wastewater Treatment Modeling by Means of Memetic Genetic Programming.
- LSA Studio: Augmenting the LSA Technique in Pervasive Environments.

Note: If you want to read the abstract of each session, you could find it in Appendix-A.
<table>
<thead>
<tr>
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<td><strong>Registration and Welcome</strong></td>
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<tr>
<td>09:00-10:00</td>
<td><strong>Jian-Qiao Sun</strong>&lt;br&gt;Multi-Objective Optimal Design of Nonlinear Controls</td>
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<td><strong>André Deutz</strong>&lt;br&gt;On Steering Dominated Points in Hypervolume Gradient Ascent for Bicriteria Continuous Optimization&lt;br&gt;Yiyi Ren, André Deutz and Michael T.M. Emmerich</td>
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<tr>
<td>11:00-11:20</td>
<td><strong>Hypervolume Newton Method as a Local Searcher for Indicator Based Evolutionary Algorithms</strong>&lt;br&gt;Víctor Adrián Sosa Hernández, Oliver Schütze, Michael Emmerich and André Deutz</td>
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<td><strong>Coffee Break</strong></td>
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<td><strong>Archivers for the Set of Approximate Solutions on Multi-Objective Optimization</strong>&lt;br&gt;Carlos Hernández, Oliver Schütze and Jian-Qiao Sun</td>
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<tr>
<td>11:50-12:10</td>
<td>The Gradient Subspace Approximation for Scalar Optimization</td>
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<td><em>S. Alvarado, O. Schütze, C. Segura and R. Landa</em></td>
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<td>12:10-12:30</td>
<td>Parameter Free Optimization Algorithm for GARCH Models</td>
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<td><em>Benjamin Perea, Lourdes F. Uribe, Gerardo Hernández del Valle and Oliver Schütze</em></td>
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<td>12:30-12:50</td>
<td>Pareto Explorer for the Local Exploration of Many Objective Optimization Problems</td>
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<td><em>Oliver Cuate, Adanay Martín, Sebastian Peitz, Michael Dellnitz and Oliver Schütze</em></td>
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<tr>
<td>12:50-14:20</td>
<td>Lunch (Included in NEO 2015 for presenters, authors and invited guests)</td>
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<tr>
<td>14:20-15:20</td>
<td>Health and Biomedicine</td>
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<td><em>Carlos Vera</em></td>
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<td><strong>Big Data science in Medicine and Biomedical Research</strong></td>
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<td>Detecting Falls Using a Wireless Sensor Network</td>
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<td><em>Edgar Domínguez, Arnoldo Díaz-Ramírez and Luis Martínez-Alvarado, Verónica Quintero Rosas</em></td>
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<td>16:00-16:25</td>
<td>Flexibility in Biopharmaceutical Manufacturing Using Particle Swarm Algorithms and Genetic Algorithms</td>
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<td><em>Y. El. Hamzaoui, M. A. Duarte-Villaseñor, L. Escobedo, Jeannete Aguilar-Martínez, A. Bassam</em></td>
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<td>The Ambulance Location Problem in the City of Tijuana BC México</td>
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<td>A Nonlinear Analysis of the Mammary Carcinoma Model</td>
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<td>Early Results on the Ambulance Location Problem in Tijuana</td>
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<td><em>Mauricio Oliveira</em></td>
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<td><em>Cristián Castillo Olea</em></td>
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| 09:00-10:00  | **Leonardo Vanneschi**  
*Geometric Semantic Genetic Programming* |
| 10:00-10:20  | **Coffee Break**                                                       |
| 10:20-10:45  | **Semantic Genetic Programming for Sentiment Analysis**  
*Mario Graff, Hugo Jair Escalante, and Eric S. Tellez* |
| 10:45-11:10  | **Specialist Predictors of Expected Performance for Genetic Programming Classifier**  
*Y. Martínez, L. Trujillo, P. Legrand and E. Galván-López* |
| 11:10-11:35  | **Automatic Random Tree Generator on FPGA**  
*Carlos Goribar, Yazmín Maldonado and Leonardo Trujillo* |
| 11:35-12:00  | **Behavior Based Approach for Genetic Programming**  
*Enrique Naredo and Leonardo Trujillo* |
<p>| 12:00-14:00  | <strong>Lunch</strong> <em>(On your own)</em>                                               |</p>
<table>
<thead>
<tr>
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| 14:00-14:25  | Profiting from Several Recommendation Algorithms Using a Scalable Approach  
               | D. Lanza, F. Chavez, F. Fernandez, M. Garcia-Valdez, L. Trujillo and G. Olague | Mario García Valdez                        |
| 14:25-14:50  | Human Face Classification by Means of a Local Texture Analysis Using the CBIR Technique and Points of Interest  
               | Juan Villegas Cortez, César Benavides Álvarez, Graciela Román Alonso and Carlos Avilés Cruz | Juan Villegas Cortez                      |
| 14:50-15:15  | EEG Signal Implementation of Movement Intention for the Teleoperation of the Mobile Differential Robot  
               | Josué Cirilo Cruz, Juan Villegas Cortez, Carlos Avilés Cruz and Arturo Zúñiga López | Josué Cirilo Cruz                         |
| 15:15-15:25  | Coffee Break                                                            |                                            |
| 15:25-15:50  | Face Recognition with Correlation Filters Designed with Multi-Objective Combinatorial Optimization  
<pre><code>           | A. Cuevas and V. H. Diaz-Ramirez                                         | Andrés Cuevas                             |
</code></pre>
<p>| 15:50-16:15  | Target Tracking with Template Matching Filtering                         | Leopoldo Gaxiola                          |
| 16:15-16:30  | Coffee Break                                                            |                                            |</p>
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<td>16:30-16:55</td>
<td>Speeding Up Evolutionary Approaches to Face Recognition by Means of Hadoop D. Lanza, F. Chávez, F. Fernández de Vega, C. Benavides-Alvarez, J. Villegas</td>
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<td>16:55-17:20</td>
<td>Evolutionary Computing in R With the ECR Package J. Bossek</td>
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<td>17:20-17:45</td>
<td>Detecting Funnel Structures of Continuous Single Objective Optimization Problems by Means of Exploratory Landscape Analysis P. Kerschke, M. Preuss, S. Wessing and H. Trautmann</td>
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<td>17:45-18:10</td>
<td>Spectral and Eigenfunction Properties of a Model Based in Random Networks A. Alcazar-López</td>
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<td>19:30-23:30</td>
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| 09:00-10:00  | **David Romero**  
Optimization Applied in Large Scale                                                                                      |
| 10:00-10:10  | Coffee Break                                                             |
| 10:10-10:35  | Multi-Objective Optimization of Injection Molding Process  
by a Hybrid of Artificial Neural Network and NSGA-II  
Alejandro Alvarado-Iniesta, Jorge L. García-Alcaraz, Arturo Del Valle and Luis A. Pérez-Domínguez |
| 10:35-11:00  | Local Search Approach to Genetic Programming for RF-PA Modeling Implemented in FPGA  
R. Cárdenas, J. Núñez, E. Z-Flores and L. Trujillo                                             |
| 11:00-11:25  | Optimizing an Amplifier with a Many Objective Algorithm  
Luis Gerardo de la Fraga                                                                                                                                 |
| 11:25-11:45  | Wastewater Treatment Modeling by Means of Memetic Genetic Programming  
E. Z-Flores, Y. El-Hamzaoui, A. Bassam, M. Abatal and L. Trujillo                                             |
| 11:45-12:05  | LSA.Studio: Augmenting the LSA Technique in Pervasive Environments  
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MULTI-OBJECTIVE OPTIMAL DESIGN OF NONLINEAR CONTROLS
Jian-Qiao Sun

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The most important part of the control design for nonlinear dynamic systems is to guarantee the stability. Then, the control is quantitatively designed to meet multiple and often conflicting performance objectives. The performance of the closed-loop system is a function of various system and control parameters. The quantitative design using multiple parameters to meet multiple conflicting performance objectives is a challenging task. In this talk, we present the recent results of quantitative design of controls for nonlinear dynamic systems by using the advanced algorithms of multi-objective optimization. The controls can be of linear PID type or nonlinear feedback such as sliding mode. The advanced algorithms of multi-objective optimization consist of parallel cell mapping methods with sub-division techniques. Interesting examples of linear and nonlinear controls will be presented with both numerical simulations and experimental validations.
Here we consider multiobjective optimization problem $f_1(x) \rightarrow \min, \ldots, f_m(x) \rightarrow \min, x \in \mathbb{R}^d$. We will later focus on the bicriteria case $m = 2$, though some methods that will be discussed are more general. In previous work ([1], [2], and [3]) the hypervolume gradient has been suggested as a direction for steering a set of points in the direction of sets with larger or maximal hypervolume indicator values. The set of points was interpreted as a vector of dimension $\mu \cdot d$, where $\mu$ is the number of points in the set and $d$ the dimension of any of these points. A search point, representing a set, is thus a vector $p \in (\mathbb{R}^d)^\mu$. We will refer to its components by $p^{(1)}, \ldots, p^{(\mu)}$, i.e. the concatenation $p^{(1)}, \ldots, p^{(\mu)}$ equals $p$. Given a sufficiently large reference point $r \in \mathbb{R}^m$ the hypervolume indicator of $p$ is defined by:

$$HI(p) = \lambda(\bigcup_{i=1}^{\mu} [f(p^{(i)}), r])$$

The hypervolume gradient $\nabla HI(p)$ is defined for non-degenerate cases (see [1]). Practically, the degenerate cases do not occur, i.e. they form a measure zero subset of $\mathbb{R}^{d\mu}$. However, two other problem occurs when using the gradient direction as a search direction. In order to discuss these problems we will introduce subgradients

$$\nabla^{(i)} HI(p) := \left(\frac{\partial HI}{\partial p_i^{(1)}}(p), \ldots, \frac{\partial HI}{\partial p_i^d}(p)\right)^T, i = 1, \ldots, \mu.$$

A component $p_i^{(i)}, i = 1, \ldots, \mu$ is called dominated w.r.t. $p$, if and only if there exists $p_j^{(j)}, j \in \{1, \ldots, \mu\}$ with $p_j^{(j)}$ (Pareto) dominates $p_i^{(i)}$. In this case the $i$-th subgradient is zero, i.e. $\nabla^{(i)} HI(p) = (0, \ldots, 0) \in \mathbb{R}^d$.

In the hypervolume gradient ascent method a zero subgradient leads to the unwanted effect that part of the points in the set – the dominated points – stay in the same position [3].

The goal of this work is to propose and test methods that replace zero subgradients by vectors that lead in the direction of the Pareto front approximation. Once the dominated components get non-dominated (relative to the other components) they can contribute to the hypervolume indicator and their subgradients will be non-zero again.

Besides, a known problem in hypervolume gradient ascent is that the length of the subgradients can differ widely, which leads to a slow convergence in some parts of the objective space. This phenomenon was analysed in [3] and termed ‘creepiness’. To counteract creepiness, it was proposed to normalize all subgradients before applying them in the gradient based search [5]. This strategy is also adopted in this work.
Five methods are proposed to replace subgradients. These are:

**M1** Use the gradient of \( f_1(p^{(i)}) + f_2(p^{(i)}) \). In regular cases this method will lead the dominated points to the Pareto front albeit the methods tends to steer the points towards the same point on the Pareto front (tangent of \(-45^\circ\)).

**M2** To avoid diversity loss as in M1, in M2 the proposed method is to use instead of the gradient of a randomly weighted aggregated sum \( w_1 f_1(p^{(i)}) + (1-w_1) f_2(p^{(i)}) \), with \( w_1 \sim U(0,1) \) being a uniformly distributed random number.

**M3** For this method a direction that points into the dominance cone of a single point was proposed in López as

\[
\frac{\nabla f_1(x)}{||\nabla f_1(x)||} + \frac{\nabla f_2(x)}{||\nabla f_2(x)||}.
\]

**M4** This methods seeks to find a point that fills the nearest gap of the current Pareto front approximation with respect to the dominated point. For this it computes the secant of the two neighboring points of the closest gap and the angle of this secant. The weights of the linear aggregation \( w_1 f_1 + w_2 f_2 \) are chosen in such a way that a tangential point on the Pareto front with this angle is approximated. In other words, if the secant has the slope \( m \), the weights are chosen such that \( w_1/w_2 = m \).

**M5** This method seeks to get closer to the midpoint of the secant described in M4. This midpoint we will term \( c \) and the subgradient is replaced by the subgradient of the squared Euclidean distance to this point. That is for a dominated component with index \( i \) we replace the subgradient by:

\[
\nabla \left( (f_1(p^{(i)}) - c_1)^2 + (f_2(p^{(i)}) - c_2)^2 \right)
\]

The five methods are tested on both convex and concave Pareto fronts and their convergence behavior will be compared. The study will reveal interesting patterns in the convergence behavior and provide explanations for these.
References


HYPERVOLUME NEWTON METHOD AS A LOCAL SEARCHER FOR INDICATOR BASED EVOLUTIONARY ALGORITHMS

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Nowadays, the importance of solving multi-objective optimization problems (MOPs) becomes crucial for different application areas such as chemistry, design, manufacture, medicine, among others. However, the task of solving this kind of problems is not straightforward, since several objectives have to be optimized at the same time. The solution set of a MOP is called the Pareto set, which typically forms a $(k-1)$ dimensional surface, where $k$ is the number of objectives that have to be optimized. The most common way to obtain a finite approximation of the solution set is by using deterministic techniques. Nevertheless, other techniques such as evolutionary algorithms have reported very promising results, and even being more robust than the mathematical techniques. In order to assess the finite approximation obtained by any algorithm researchers have proposed some performance indicators, which help us to select the best approximation between a set of them according to our needs. The Hypervolume is one of the most widely used indicators, since it has some desirable properties. Recently, the Hypervolume Newton method was proposed as standalone technique able to converge the whole population toward the best hypervolume distribution. One of the highlights of this method is its ability to converge quadratically which makes it a natural candidate to use within a global approach such as evolutionary algorithms. It is known, the success of hybridizing indicator based evolutionary algorithms with local searcher techniques for improving the performance or even refining the final solution. Here, we present the first integration of the proposed Hypervolume Newton Method into an evolutionary algorithm. To do this we first present the formulation of the Hypervolume Hessian matrix, since in previous works an approximation was used. Then, we formulate the Hypervolume Newton Method algorithm and we will show applications on some tests. In order to extend the applicability of the Hypervolume Newton method, we introduce a constrained handling technique for inequality constraints as well. Finally, we will present the numerical results of the memetic strategy against the evolutionary algorithms without our local search.
ARCHIVERS FOR THE SET OF APPROXIMATE SOLUTIONS ON MULTI-OBJECTIVE OPTIMIZATION

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In a variety of applications in industry and finance one is faced with the problem that several objectives have to be optimized concurrently leading to a \textit{multi-objective optimization problem} (MOP). A common goal for such problems is to identify the set of optimal solutions (the so-called \textit{Pareto set}, denote by \(P_0\)) and its image in objective space, the \textit{Pareto front}. Hereby optimality is typically defined on the concept of \textit{dominance}. Moreover, in certain situations it may be beneficial for the decision maker (DM) to consider in addition to the optimal solutions also nearly optimal ones, which are alternatively called approximate solutions or \textit{efficient} solutions. The reason for this is that by this the number of valid options for the current setting may increase (note that if two points \(x\) and \(y\) are near in objective space, i.e., if \(F(x) \approx F(y)\), this does not have to hold in parameter space. In fact, \(x\) and \(y\) can differ significantly depending on properties of \(F\) such as (quasi-) periodicities or symmetries).

All of the works dealing with approximate solutions in multi-objective optimization are based on the concept of \textit{dominance} which has been introduced in [3, 9]. \textit{-dominance} or \textit{efficiency} has been studied and used by many researchers, e.g. to allow (or tolerate) nearly optimal solutions [3], [9], to approximate the set of optimal solutions \(P_0\) [4], or in order to discretize this set [2, 7, 8]. \textit{-efficient} solutions have also been used to tackle a variety of real world problems including portfolio selection problems [10], a location problem [1], or a minimal cost flow problem [4].

To tap the full potential of the additional consideration of approximate solutions \((P_{Q,c})\) against the `sole' consideration of the optimal solutions it is required to maintain a representation of the \textit{entire set} \(P_{Q,c}\). The challenge in this case is that for the consideration of a problem with \(n\) parameters and \(k\) objectives, the set \(P_{Q,c}\) forms an \(n\)-dimensional object while \(P_0\) is under some mild regularity assumptions on \(F\) only \((k-1)\)-dimensional (\(n \gg k\) can be assumed). Hence, for the effective extension from \(P_Q\) to \(P_{Q,c}\) as the basis for the decision making process a suitable discretization of the latter set is essential.
In this work, we design and investigate archiving strategies aiming for the approximation of this set. We will show that the first archiving strategy converges under certain assumptions on the generator in the probabilistic sense toward $P_{Q,\gamma}$. We present and investigate further a possible discretization strategies to maintain a finite size representation of $P_{Q,\gamma}$ in the limit in both parameter and objective space. We also give bounds on the approximation quality and on the cardinality of the limit solution set. Finally, we make a comparative study on some test problems in order to visualize the effect of all strategies. Preliminary studies of this work can be found in [5, 6].

References


Nowadays, the evolutionary algorithms have been widely used in order to approximate the solutions for optimization problems. The so-called memetic algorithms, hybridize evolutionary algorithms along with mathematical programing techniques in order to improve the convergence rate of the algorithm. However, a drawback of these methods is that in some cases the cost (in terms of function calls) of the mathematical programming techniques is higher than the cost of evolutionary mechanism. Furthermore, in some optimization problems the explicit gradient information that some of these techniques require is missing. In order to reduce the cost of the mathematical programming techniques, we propose a method that exploits the data calculated by the evolutionary algorithms. Given a candidate solution, the Gradient Subspace Approximation (GSA) aims to compute the most greedy direction exploiting the neighborhood information of the solution. Since the GSA uses information that is already calculated, the cost of this method in terms of function evaluations can be competitive in comparison with the mechanism of the evolutionary algorithm. In this study we perform an analysis of the GSA method and its behavior as the mathematical technique used within a memetic algorithm. A first approach of a memetic algorithm obtained via Differential Evolution (DE) and GSA have shown promising results.
In finance, GARCH models are widely used, for example to identify trend, risk and variation in the markets. Neverthess, the choice of the optimal parameters is a hard task. Because of this, in most of cases methods fail and solutions are not good enough.

The optimization algorithm presented in this work it’s a memetic algorithm, which uses two techniques, differential evolution coupled with mathematical programing techniques. The first one is used to find an initial value, and mathematical programing is use to guarantee convergence. We present numerical results on a benchmark related to time series and GARCH models.
Generally, the multiobjective optimization problem involves finding a set with the best solutions among mathematically incomparable compromises, i.e., vectors whose image can not be improved by other vectors in all its components, but it could be improved in at least one of them. However, there are real-world problems in which a decision maker has knowledge about the problem or he/she wants to obtain optimal solutions with certain characteristics instead of all solutions. The reference point methods are useful for this scenario, the idea is to get the closest solution to a given vector, usually infeasible, which is a guess of the decision maker. Nevertheless, the scenario in which a reference point changes over time has been poorly treated. Recently, continuation methods have been used to solve the multiobjective optimization problem, these methods have the advantage that they move through the Pareto front as Hillermeier method and Pareto Tracer. The method proposed here, called Pareto Explorer, is a continuation method which takes into account preferences of the decision maker to calculate the predictor, which makes it also an interactive method. In addition, if we change the corrector by an achievement function, this method can be used to solve dynamic reference point problems. We present results on some benchmark models, as well as on a 14-objective problem that arises in the design of a laundry system.
DETECTING FALLS USING A WIRELESS SENSOR NETWORK

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INTRODUCTION

The aging of the world population has lead to new health problems. People now live longer, but unfortunately the quality of life of the elderly is deplorable in many cases. The number of old people affected by brain disorders have increased significantly in recent years. Among these disorders, dementia, which has no cure, is one of the major health problems of the elderly.

Wandering and falls, which are closely related, are among the problems that most significantly affect patients with dementia. Wandering may lead to falls, and consequently, to severe injuries. In fact, nearly one third of people over 75 years old suffer at least one fall every year. Also, falls are one of the main causes of death or severe injuries of people over 65 years old. This is the reason why people with dementia need constant supervision, and impose a heavy burden to families and caregivers. To alleviate this problem, the development of fall detection systems for the elderly is an important research topic [1].

In this paper, a non-invasive falls detection system for the elderly, based on the use of WSN, is proposed. The main objective of the system is to detect in real-time if someone has fallen, and to alert the caregivers to provide assistance. A rapid response may help to provide timely medical assistance, and prevent as much damage as possible.
METHODOLOGY

The proposed system uses the acoustic signal sensed by the motes, as well as signal processing and pattern recognition techniques, to detect a fall. To illustrate this, Fig. 1 shows the block diagram for the proposed system.

Data sampling. The nodes of the WSN, placed at fixed locations (i.e., the room of the patient), are equipped with a microphone, and are constantly sensing the environment. When the intensity of the collected sound is larger than a threshold, the gathered data are sent to the sink. The sink uses these data as input of a signal-processing algorithm based on the use of cross-correlation. Since sampling rate is an important factor in pattern recognition, based on experimental results and to the Nyquist theorem [2], a fixed sampling rate of 4 KHz was used.

Cross-correlation (alignment). To avoid any missed event, sequences are aligned using a template as a reference, which was obtained using a real fall event. The cross-correlation of two time sequences measures the similarity between a sequence, and shifted similar sequences as a function of the lag.

Features extraction. The MFCC have been widely used for speech/audio recognition [3], and represents the short-term power spectrum of a sound, based on a linear cosine transform of a log power spectrum on a nonlinear Mel scale of frequency. The MFCCs take into consideration human perception sensitivity with respect to frequencies.

Initially, the sampled data are stored in small frames of N samples, where the most used value for N is 256. The frames then must be converted from time domain to frequency domain, this is archived by the use of fast Fourier transform (FFT). A Mel filters bank will process the frequency domain data. In order to create the filter bank on Mel scale, a frequency conversion is needed. Eqn. 1 is used to compute the Mel scale convention, where $M(f)$ is the frequency on Mel scale. A lower and an upper frequency cutoff are needed, where the upper frequency on the filter bank is limited to half the sampling rate frequency [4].

$$M(f) = 2595 \log_{10} \left(1 + \frac{f}{700}\right).$$  

This is the process to convert the log Mel spectrum into time domain using discrete cosine transform (DCT). The result of the conversion is called Mel frequency cepstrum coefficient. The set of coefficient is called the acoustic vectors. Therefore, each input utterance is transformed into a sequence of acoustic vector. The output, after applying the DCT, is known as Mel frequency cepstrum coefficient.
Matching process. The DTW algorithm measures the similarity between two temporal sequences, and it is also used for speech recognition [5]. The DTW algorithm can calculate the optimal alienation path from two series or templates, representing the measured similarity with a coefficient called the total distance cost [6]. The absolute distance between the values of two sequences is calculated using the Euclidean distance computation. Each matrix element \((i, j)\) corresponds to the alignment between \(i\) and \(j\). Eqn. 2 calculates the accumulated measured distance.

\[
D(i,j) = \min[D(i-1,j-1), D(i-1,j), D(i,j-1)] + d(i,j)
\]

Finally, when the calculated total distance cost is less or equal than a given threshold, the system concludes that a fall has occurred. Otherwise, the system ignores the event. It is important to note that this threshold is obtained for the particular scenario where the system is used, considering the patient, the floor of the room, the ambient noise, among others.

CONCLUSIONS

Many health problems have increased as the world’s population ages. Among them, accidental falls are one of the main causes of injuries of the elderly. In this paper, a non-invasive falls detection system, based on the use of WSN, was proposed. If a fall is detected, an alert signal is sent to caregiver in order to provide timely medical assistance, and prevent as much damage as possible.

To validate the proposed system, we built a prototype and conducted a series of experiments. The obtained results from the experimental tests showed that the proposed system has a detection rate of 90% when no acoustic interference is present. Otherwise, the detection rate is nearly 80%. However, it can be improved adding more sensors, which may allow the detection of other important causes of injuries, such as wandering.

References

The pharmaceutical research and biotechnology companies are devoted to inventing medicines as therapeutic proteins, human insulin, vaccine for hepatitis, food grade protein, chymosin detergent enzyme and cryophilic protease allow patients to live longer, healthier, and more productive lives, within this context, there is a high degree of consensus in the biomanufacturing industry that product quality, customer service and cost efficiency are fundamentals for success, based in our knowledge there has not been an adequate flexibility strategy to manufacture different multiproduct drug substances as designing a plant, determining the number of units for a specific task, assigning raw materials to different production processes deciding the production planning through the optimization of multiproduct batch plant design (MBPD) found in a biopharmaceutical manufacturing process. The aim of this work is to minimize the investment cost and find out the number and size of parallel equipment units in each stage. For this purpose, it is proposed to solve the problem in two different ways: the first way is by using particle swarm algorithms (PSA) and the second way is by genetic algorithms (GAs). This paper presents the effectiveness and performance comparison of PSA and GAs for optimal design of multiproduct batch plant. The calculation results (investment cost, number and size of equipment, computational time, and idle times in plant) obtained by GAs are better than PSA. This methodology can help the decision makers and constitutes a very promising framework for finding asset of good solutions.

**Keywords:** Biopharmaceutical manufacturing, mathematical modeling, particle swarm algorithms, genetic algorithms, batch plant design.
This work considers the ambulance location problem for the Red Cross in Tijuana, Baja California, Mexico. The solution to the ambulance location problem is to optimally locate all available ambulances within the city such that coverage of the city population is maximized and a quick response to any emergency is ensured. The problem is posed using three different coverage models, these are: the Location Set Covering Model (LSCM), Maximal Covering Location Problem (MCLP) and Double Standard Model (DSM). Using real-world data recovered from over 44 thousand emergency calls received by the Red Cross of Tijuana, several scenarios were generated that provide different perspectives of the demand throughout the city, considering such factors as the time of day, work and off-days, geographical organization and call priority. These models are solved using Integer Linear Programming, and solutions are compared with the current coverage provided by the Red Cross. Results show that coverage and response times can be substantially improved without additional resources.

One of the core problems for Emergency Medical Services (EMS) is the location problem of available ambulances [?]. The capability of these services to save lives depends greatly on the time it takes for an ambulance to arrive on the scene of an emergency. Hence, it is important to position all available ambulances in such a way that any emergencies that arise may be dealt with promptly.

The population in the city of Tijuana, Baja California, Mexico is approximately 1.6 million inhabitants [?]. Currently, the Red Cross of Tijuana (RCT) has 11 ambulances in service and 8 bases, that cover about 98% of the medical emergencies throughout the city [?]. On average, there is one ambulance for every 145,000 inhabitants. In 2013 the RCT provided EMS to 37,000 people. Average response time was approximately 14 minutes with a standard deviation of 7 minutes. In 75% of all incidents the ambulance arrived within 18 minutes and in 90% of all incidents it arrived within 23 minutes. In an emergency situation, the probability that a patient survives depends on the time it takes for the ambulance to arrive, if response time was not quick enough the patient may suffer permanent injury. Therefore, it is very important to ensure that all emergencies can be responded to as fast as possible, by properly locating all available ambulances in the city.
To solve the ambulance location problem in Tijuana, three models are used in this work. These are the Location Set Covering Model [?] , Maximal Covering Location Problem[?] and Double Standard Model [?]. Using the LSCM, MCLP and DSM models, several scenarios were solved to determine the optimal ambulance locations during different hours of the day and days of the week, in the city of Tijuana. Two sets of demand points were considered. The first is based on the locations of 92 neighborhoods and is merely artificial while the second was created from EMS records from the Red Cross using clustering.

Both sets offer different perspectives of the demand throughout the city. Accounting for the priority of EMS requests, ambulance locations that favor demand points with higher priority requests were obtained. Generally speaking, solving all these scenarios with these three models has shown that demand coverage and response times can be improved with the resources currently available.

The LSCM experiments have shown that all demand could be covered using about half the number of ambulances currently in service, with a response time of 14 minutes. With the MCLP experiments, it has been shown that demand coverage, with a response time of 10 minutes, could be improved by as much as 22% only by relocating the current 8 bases of the Red Cross. Also, almost all demand could be covered by properly locating all 11 ambulances in service. As for the DSM experiments, with these 11 ambulances it would be possible to cover all demand with a response time of 14 minutes, 95% of all demand within 10 minutes and still provide double coverage to more than 85% of all demand. However, all of this is theoretical, and, in practice, real coverage and response times may vary, as they depend on many other factors beyond what has been considered in this work so far, such as time dependent travel times, weather conditions, roadblocks, etc. Nonetheless, the results of this work may be used as tools to aid in the decision making about the location of ambulances in the city.

So far the ambulance location problem has been addressed, leaving the relocation problem to be solved. This arises when an ambulance is dispatched to the scene of an emergency and it becomes necessary to relocate one or more ambulances to maintain adequate coverage of the city population.
Mammary carcinoma is a common type of cancer that appears mostly in women under a certain age and can be inherited to future generations [2]. Biologists are exploring new treatments that can avoid the development of breast cancer in patients with high risk of malignant cell mutations by experimenting directly in mice. The genetically engineered mice (GEM) have proven extremely useful for studying breast cancer and have become the animal model for human breast cancer [2]. Studies in vivo are useful because they represent real dynamics of the tumor cells in the presence of immunotherapy for some complex types of cancer. Fomchenko et al. [3] have presented a model of brain tumors that can be applied in preclinical trials. Kwon et al. [4] presents a recent study of a possible model that describes the biological dynamics of the lung cancer by validating the results in mouse. Bianca et al. [6] presents the first nonlinear model of the carcinoma mammary cancer. Mathematical models are tools used in engineering and science to predict functional relationships between certain input and output variables. Mathematical modeling thus provides feedback to biologists on the suitability of experimental data, and they in turn can help improve and refine the mathematical models. Thus the mathematical modeling provides the opportunity of improving both the understanding and prediction of biological phenomena [5].

Using the method of localization compact invariant sets (LOCI) [8] in biological models [9],[10], we define a region that contains the whole complex dynamics of the model where the upper bound represents the maximal concentration of population that can exist and also inside the region we can analyze equilibrium points or define sufficient conditions of attractivity. In this paper is analyzed at the moment one case of study for the nonlinear tenth dimensional system describing the dynamics between the immune system and mammary carcinoma antigen by Bianca et al. [7], where the variables $X_i \in R^5_{+,0}, i = 1, 2, 5, 8, 9$. 
The model is shown below:

\[
\begin{align*}
\dot{X}_1 &= q - \mu_1 X_1 - \alpha_{19} X_9 X_1 \\
\dot{X}_2 &= \gamma_{21} \alpha_{19} X_9 X_1 + \gamma_{21} \mu_1 X_1 + \gamma_{28} \alpha_{88} X_8 + \gamma_{28} \alpha_{89} X_9 X_8 - \mu_2 X_2 \\
\dot{X}_5 &= \gamma_{51} \alpha_{19} X_9 X_1 + \gamma_{51} \mu_1 X_1 - \alpha_{59} X_9 X_5 - \mu_5 X_5 \\
\dot{X}_8 &= k X_8 - \frac{k X^2}{c_{\text{max}}} - \alpha_{88} X_8 - \alpha_{89} X_9 X_8 + p \\
\dot{X}_9 &= \gamma_{91} X_1 - \mu_9 X_9
\end{align*}
\]  

(1)

The variable \(X_1\) represents the number of injected vaccine cells, \(X_2\) is the number of P-185 tumor associated antigens, \(X_5\) the number of interleukin 12, \(X_8\) is the number of cancer cells and \(X_9\) the number of activated cytotoxic cells, the parameters are mention in [7] and all have positive values. In this case of study the vaccine can directly eradicate all the cancer cells and any antigen associate to the tumor due to the combination of cytotoxic cells and immunotherapy interleukin 12. Local stability is made by numerical simulation as well as finding equilibrium points. Has a result of this analysis we found four equilibrium points were three of them are negative equilibrium points. In this work are not consider the negative equilibrium points because they lack of biological sense, which leads to only one equilibrium point that is unique and locally stable. The Lyapunov function is shown below:

\[
V = (\alpha_{21} + \gamma_{51}) X_1 + X_2 + X_5 + \gamma_{28} X_8 + \frac{2}{\gamma_{91}} X_9 + X_1^2
\]  

(2)

Upper bounds for each of the variable stated are presented. The intersection of all the upper bounds provides the localization domain of all compact invariant sets of the model.

<table>
<thead>
<tr>
<th>Localizing function</th>
<th>Upper bound</th>
<th>Conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td>(h_1 = X_1)</td>
<td>(X_{1_{\text{max}}} \leq \frac{q}{\mu_1})</td>
<td></td>
</tr>
<tr>
<td>(h_2 = X_9)</td>
<td>(X_{9_{\text{max}}} \leq \frac{\gamma_{91}}{\mu_9} X_{1_{\text{max}}} := \frac{\gamma_{91}}{\mu_1 \mu_9} )</td>
<td>(k &gt; \alpha_{88})</td>
</tr>
<tr>
<td>(h_3 = X_8)</td>
<td>(X_{8_{\text{max}}} \leq \frac{c_{\text{max}}}{2k} (k - \alpha_{88}) + \sqrt{4pk^2 + \frac{c_{\text{max}}^2 (\alpha_{88} - k)^2}{4k^2}})</td>
<td></td>
</tr>
<tr>
<td>(h_4 = X_5)</td>
<td>(X_{5_{\text{max}}} \leq \frac{\gamma_{51}}{\mu_5} \alpha_{19} X_{9_{\text{max}}} X_{1_{\text{max}}} + \gamma_{51} \mu_1 X_{1_{\text{max}}})</td>
<td></td>
</tr>
<tr>
<td>(h_5 = X_2)</td>
<td>(X_{2_{\text{max}}} \leq \frac{\gamma_{21}}{\mu_2} X_{1_{\text{max}}} (\mu_1 + \alpha_{19} X_{9_{\text{max}}} + \frac{\gamma_{28}}{\mu_2} X_{8_{\text{max}}} (\alpha_{88} + \alpha_{89} X_{9_{\text{max}}})</td>
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For one case of study the model (1) which is a reduced dynamic model of Bianca [7] we present local stability by numerical simulation and using the Lyapunov function 2 we ensure global asymptotic stability of the equilibrium point. The upper bounds define the region that contains the dynamic of the model including the unique equilibrium point.
References


TELEHEALTH: FRAMEWORK FOR THE DESIGN OF DIGITAL INCLUSION PROJECT

Dra. Cristián Castillo Olea

Abstract

Technology has coevolved with mankind throughout its development generating a digital divide in the population. Throughout this frame of reference, the digital divide is conceptualized as the lack of access to Information and Communication Technologies (ICT) of a population for cultural reasons, limited internet connectivity or digital skills challenges. Moreover, the adoption of ICT in the health sector has contributed to reducing the digital divide specifically in the area of Telehealth providing health services to isolated and remote communities. Telehealth includes activities such as remote health care and monitoring, prevention and provision of public health services through the use of ICT, among others. In recent years, different authors have considered Telehealth as an open system, i.e, a complex dynamic system with interactions among various subsystems and stakeholders of the ecosystem.

In México government aim to strengthen their public health systems in order to increase the quality and coverage of services by taking advantage of Telehealth as a tool to achieve this objective. One of the existing challenges to implement Telehealth projects is the development of a comprehensive strategy for organizing the stakeholders involved in the management and implementation of projects.

This research presents an implementation of Telehealth projects and public policies in Mexico have managed to benefit the population. This research provides evidence of the feasibility of designing Telehealth public policies in Mexico in an integral manner involving stakeholders and decision-making agents in the different levels of operation (international-national-local).
Geometric Semantic Genetic Programming (GSGP) is a recently introduced version of Genetic Programming (GP) that uses new genetic operators called Geometric Semantic Operators (GSOs), instead of the traditional crossover and mutation. GSOs have the important property of inducing a unimodal error surface for any supervised learning problem in which fitness is calculated using a distance between outputs and targets on training data (like for instance in regression and classification). This property makes of GSGP one of the most exciting and promising advances in GP.

This presentation begins with an introduction to optimization and to fitness landscapes, essential concepts to understand the properties of GSOs. Then, GP is briefly introduced and GSGP is defined and discussed. In this discussion, the main drawback of GSOs is also presented. After this introduction, the presentation focuses on a new implementation of GSGP, that contains a workaround to GSOs’ drawback and thus makes GSGP usable in practice for the first time. Subsequently, some recent experimental results on a set of complex real-life problems is presented, showing how, together with a great optimization power on training data, GSGP can also have a good generalization ability, in some particular conditions. The presentation terminates discussing the most recent hot topics in GSGP, consisting in combining GSOs with local search strategies.
SEMANTIC GENETIC PROGRAMMING FOR SENTIMENT ANALYSIS.

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In last years, the production of textual documents in social media has increased exponentially. This evergrowing amount of available information promotes the research and business activities around opinion mining and sentiment analysis areas. In social media, people share comments about many disparate topics, i.e., events, persons, organization, etc. The main result is that social media has become a source of human opinion. For this reason, the text mining has received a lot of attention from many companies and governments.

The automatic sentiment analysis of given text is one of the most important tasks in text mining. This is a classification task that consists in determining whether a particular document has a positive, negative or neutral opinion. There also exists variations considering intermediate levels of the sentiments. Determining whether a text document has a positive or negative opinion is turning on an essential tool for both public and private companies [7]. This tool is useful to know "What people think"; so, it could be a significant help to any decision-making process (for any level of government, marketing, etc.) [6].

On the other hand, Genetic Programming (GP) is an evolutionary algorithm that has received a lot of attention due to its success in solving hard real-world problems [8]. Surprisingly, for the best of our knowledge, GP has not been used to tackle the problem of sentiment analysis. In fact, the use of GP in the field of text analysis is scarce, being one of these exceptions our previous research work (see [3]). In that paper, GP was used to optimize the weights in a vector space model for text classification, or the works in Automatic text summarization presented in [9, 10].

Sentiment analysis poses a number of challenges where semantic GP might be a feasible option. Some of these problems come from its high-dimensional representation and the considerable training set size. Just to fix ideas, a typical real-world dataset for text-mining is represented using tens to hundred of thousands coordinates and tens of thousands examples. These characteristics make traditional GP to suffer from finding an optimal solution in reasonable time. The interested reader in how a document collection is processed to obtain a vector representation is referenced to the specialized literature [1].
The fast convergence rate of novel semantic GP indicates that they may provide a feasible solution for text mining problems. The semantic genetic operators that seem to have the highest convergence rate are the ones proposed by [5, 2]. These both techniques were inspired by the geometric crossover and both use a more aggressive approach than the original one. The key idea for these new approaches consists in creating the best offspring that can be produced by a linear combination of the parents. However, these methods suffer from overfitting. On the other hand, in [4], we applied the idea of a linear combination at the level of the individual, i.e., an individual is composed of a set of expressions which are linearly combined to produce the final output. This latter work presents a better tradeoff between learning and generalization. In this contribution, we propose to combine both strategies, i.e., orchestrate the crossover and the local optimization of individuals, to tackle the problem of semantic analysis.

References


Determining problem difficulty has been an important issue in evolutionary computation for several years [2]. From an algorithmic perspective, problem difficulty can be related to the total runtime (or memory) required to find an optimal solution, difficult problems require exponential runtime while easy problems can be solved in linear time. Limiting our overview of previous works related to GP research, this work focuses on two groups of methods used to measure problem difficulty in GP, these are: Evolvability Indicators (EIs) and Predictors of the Expected Performance (PEP). Broadly speaking, EIs attempt to provide a measure related to the underlying difficulty of the search process and on the other hand a PEP provides a prediction of the expected performance of a GP search, which might or might not coincide with the difficulty of the search. Currently, the development of PEP's represents the minority of research devoted to problem difficulty in GP, with only a few recent proposals. In particular, Graff and Poli [1] have studied the development of such predictive models, for symbolic regression, boolean and time-series problems.

This work is an extension of our previous work [3], where PEP's were first proposed for a GP algorithm applied to supervised classification. The general process relies on posing a supervised learning task, where each problem instance is described by a domain-specific feature vector and the performance of the GP system on a set of synthetic problems is used as the ground truth to learn a PEP. The learned model is then used to predict the performance on unseen problem instances. Of particular interest is the fact that learning can be done on an arbitrarily generated set of synthetic problems and testing can then be performed on real-world datasets. Our goal is to improve performance prediction on real-world problems by using an ensemble approach several PEP models, each one referred to as an SPEP.
The proposal is depicted in Figure 1, an extension of the basic PEP approach.

Figure 1: Block diagram shows the proposed SPEP approach.

Figure 2: Performance prediction of the best Ensemble-2 solutions.

(a) RMSE = 0.0736  (b) $\rho = 0.8981$

Where given a classification problem we do the following. First, apply a preprocessing step to simplify the feature extraction process and deal with multidimensional representations. Second, perform feature extraction to obtain an abstraction of the problem. Third, each problem is classified into a specific group using its corresponding feature vector $\beta$. Fourth, to use an Ensemble SPEP model that takes as input the extracted features and produces as output the predicted classification error (PCE) for a given problem, each group is associated to a particular SPEP in the ensemble, hence if a problem is classified into the $i$-th group then the $i$-th SPEP in the ensemble is used to compute the performance prediction.

Focusing on the real-world problems, Figure 2 summarize the performance of the Ensemble-2 predictors using 5 features. In particular, the left column shows plot of the ground truth $CE_M$ of each problem (triangles) and the Ensemble-2 prediction $PCE$. In particular, these plots show three types of PCE: (1) correctly classified problems for which the appropriate SPEP was selected (CC-PCE); (2) misclassified problems for which an incorrect SPEP was selected (MC-PCE); and (3) for the misclassified problems, the oracle SPEP prediction (O-PCE), which is the PCE produced by the correct SPEP. Moreover, the second column of Figure 2 presents a scatter plot of the true $CE_M$ and the PCE, using the same notations and different predictions. These plots provide a graphical confirmation of the quality of the performance prediction achieved. It is important to highlight the impact of a misclassified problem (shown as a black circle) compared to the prediction on the same problem if the correct SPEP had been chosen (O-PCE). For all problems for which the correct SPEP was chosen the PCE is highly correlated with the ground truth with only marginal differences in most cases. Finally, we build the SPEP models with a synthetics benchmark and tested over real-world classification problems. These showing a good results an interesting way for to solve the problem of to predict performance.
References


AUTOMATIC RANDOM TREE GENERATOR ON FPGA

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Abstract:
This work deals with the implementation of the automatic generation of random syntax trees on FPGAs, these trees are used as the initial population in genetic programming (GP) algorithms and serve as the mean of how genetic material is inherited through the generations. GP is an evolutionary computation technique that allows to find the solution of a search problem without requiring the user to provide prior information about the structure or form of the solution. Trees are the most used data structure in GP applications found in literature for the representation of programs, these programs are normally mathematical functions although they may be computer code or movement instruction in the case of robotic applications.

Initially, GP was run using software on a desktop computer or workstation, however as the paradigm matured, GP was used on the resolution of more complex problems leading to longer times and larger memory consumption. One method to reduce time consumption is to use multicore microprocessor, this technique allows the whole program to run in concurrent threads that accelerate the calculation process, however the number of cores found in commercial microprocessor are limited to four or so. On the other hand, one can take advantage of the massive parallel processing power that a Graphics Processor Unit (GPU) exhibits. GPU may seem the natural choice when high parallel processing power is needed, however the strength of GPUs is also its own weakness because high parallelization works well when the very same operation needs to be performed on a vast amount of data, but it is not efficient when different operations on different data is required, the latter is a normal case when GP is used in real world applications. Here is when another well-known device comes to the rescue: the Field Programmable Gate Array (FPGA). FPGA is a very flexible device that allows the implementation of complex digital systems in a small silicon chip or Integrated Circuit. FPGA is less expensive compared to the GPU or a CPU not to mention compared to other high performance computing technologies. Another good characteristic of FPGAs is that it is possible to perform parallel computing because it is able to handle multiple parallel processes.

Finally, one should point to the fact that FPGA is reconfigurable so it provides additional flexibility. Some works have addressed the issue of GP hardware implementation on GPU like in [3] and [5], some others have done implementations on FPGAs like in [1], [2] and [4], nevertheless, none of the previous works implemented true tree data structure as means of evolving programs.
In this work the implementation of the automatic generation of random trees is totally embedded on a FPGA and allows flexibility in the tree instantiation in contrast to previous works, this means that besides the tree-like structure implementation on the FPGA, a Pseudo-Random Number Generator is used, so random function or variable/constant selection is enabled. As several processes may be parallelized on the FPGA, each tree is generated in parallel, so it means that a significant reduction in the amount of time consumed is expected when compared to traditional runs on CPUs, more significant is the fact that true embedded tree-like data structures are embedded on the FPGA.

References


BEHAVIOR BASED APPROACH FOR GENETIC PROGRAMMING

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Evolutionary algorithms (EAs) are a broad family of search and optimization algorithms that are based on a simplified model of Neo-Darwinian evolution, with impressive results in many domains [1]. EAs are guided by an objective function and specially designed search operators, in this sense can be said that they are objective-based search (OS), this is a key difference with respect to natural evolution, an open-ended process that lacks a predefined purpose. Open-ended artificial evolution does not use an objective function to drive the search, at least not an explicit one. Only recently has open-ended search been proposed to solve mainstream problems, one promising algorithm is Novelty Search (NS) proposed by Lehman and Stanley [2].

The core idea behind NS is that using an objective function to determine fitness in challenging problems may mislead the search and prevent it from reaching the global optima. Therefore, the proposal of NS is to abandon the objective function, and instead determine selective pressure based on the novelty or “uniqueness” of each individual by considering a description of the behavior each individual exhibits. From the NS perspective, a behavior refers to a description of the interaction between a candidate solution and it’s domain-specific context. Even though, NS has achieved promising results in different areas of evolutionary robotics, such as navigation [2, 4], morphology design and gait control [3], has not been tested on machine learning problems.

This work makes the following contributions. We apply NS on a common machine learning problem; supervised classification with GP, while previously works have mostly focused on evolutionary robotics. The NS approach is tested on real-world datasets, and using two new versions of NS are proposed; Probabilistic NS (PNS), and a variant of Minimal Criteria NS(MCNS), and lastly a combination of both named as MCPNS. The former models the behavior of each solution as a random vector and eliminates all the NS parameters while reducing the computational overhead of the NS algorithm; the latter uses a standard objective function to constrain and bias the search towards high performance solutions. The paper also discusses the effects of NS on GP search dynamics and code growth.

Table 1 shows results about the dataset Teaching Assistant Evaluation (TAE)¹, we can note that in general, all NS algorithms are very competitive relative to OS. To illustrate the performance differences for the TAE

¹ Real-world and synthetic datasets for binary and multiclass classification problems, taken from the UC Irvine Machine Learning Repository.
When we consider the average program size it is clear that all NS variants evolve much smaller populations. In particular, NS and MCNS show an intrinsic bloat-control property in this domain. In summary, this work will help to establish the behavior-based approach with NS as a viable alternative for GP-based systems.

Table 1: Binary classification performance, showing the median classification error on the test data (Test) for the best solution found, and the median of the average program size in the last generation (A-size). Statistically significant with respect to the control method with a p-value less than 0.05 is marked with an asterisk (*).

<table>
<thead>
<tr>
<th>Dataset</th>
<th>Measure</th>
<th>OS</th>
<th>NS</th>
<th>MCNS</th>
<th>PNS</th>
<th>MCPNS</th>
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<tr>
<td>TAE</td>
<td>Test</td>
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<td>0.393</td>
<td>0.375</td>
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<td>0.321</td>
<td>0.321</td>
<td>0.393</td>
</tr>
<tr>
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<table>
<thead>
<tr>
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<th>NS</th>
<th>MCNS</th>
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<tbody>
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<td>49.03*</td>
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<td>81.73*</td>
<td>87.27</td>
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</table>

Figure 1: For the TAE dataset and all the methods tested, Fig.(a) shows the average size evolution of the population at each generation, showing the median value over all runs. Fig.(b) shows the median classification error.
References


PROFITING FROM SEVERAL RECOMMENDATION ALGORITHMS USING A SCALABLE APPROACH

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Introduction

Internet has become the biggest world market: thousand of companies reach every connected home offering millions of products to global customers, and recommender systems (RSs) are required to present products that may be of interest to the users. Although different approaches have been applied to develop RSs in the last decade \cite{1}\cite{2}, we consider in this paper the possibility of using several algorithms instead of a single one, trying to produce better recommendations, which requires high performance computing platforms to run all of the algorithms together. The system response must be then selected among those provided by each of the RSs responses. We apply a Fuzzy Rule-Based System (FRBS) to take the decision required. The parameters used by the FRBS are calculated from historical data from users and items.

The main problem is the time required to compute each of the RSs every time a new recommendation must be generated. We decided to employ a Big Data approach relying on the well known Hadoop framework \cite{3} which allows to parallelize the task, thus shortening execution time.

Methodology

Our methodology relies in two processes, an offline and online process. The offline process, which is split and run as a number of Hadoop jobs, generates user profiles which are used in the online process to decide what recommendation algorithm should generate the final recommendation.

Several parameters are calculated by this offline process to obtain the necessary knowledge from users and items. The number of items that each user has rated are the basis for computing user profiles and parameters required, which are later employed to feed the FRBS in charge of selecting the final output of the system among those provided by each of the RSs. for the FRBS, it enables us to obtain the best recommendation depending on the user profile.
Results

In order to test the scalability of the proposal, we have run the recommender system using different number of computing nodes in a hadoop based cluster. As we notice in figure 1, the system shows scalability. Along the tests, the machine resources have been monitored. We noticed that CPU usage has been equally distributed along the machines, and the memory usage was not high. Reading and writing phases of Hadoop jobs were done in local disks, instead of using remote disks, leading to lower network traffic. In contrast, HBase scalability was not as expected. We detected that when several clients are writing into HBase, adding new nodes does not notably improve the performance. However, Hadoop jobs that reads from HBase data have a high performance, obtaining a very good scalability.

Conclusions

The solution presented in this paper has shown the benefits of using Hadoop for distributing and parallelizing a recommender system where different recommendation algorithms are joined by an FRBS.

Acknowledgments

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References


HUMAN FACE CLASSIFICATION BY MEANS OF A LOCAL TEXTURE ANALYSIS USING THE CBIR TECHNIQUE AND POINTS OF INTEREST

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Abstract

The recognition of human faces represents an ongoing and very active area of research. This interest derives from the challenges posed by illumination occlusions and temporality. On the other hand, its applications continue to be very important, and more oriented toward security. During this lecture I am going to present a tested methodology for human faces classification on the basis of the analysis of the local texture of the face and contemplating the points of interest and the Content–Based Image Retrieval (CBIR) technique. The results achieved are excellent and the challenges lying ahead are of great interest, both for numerical floating point computing and Big Data applications.

References

EEG SIGNAL IMPLEMENTATION OF MOVEMENT INTENTION FOR THE TELEOPERATION OF THE MOBILE DIFFERENTIAL ROBOT

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Abstract

In the year 1929 a German psychiatrist, named Hans Berger, demonstrated for the first time that the electric activity of the human brain was related to the person’s mental state. He also announced the possibility of registering such type of electric activities without opening the human head, i.e. non invasive procedure, and that such electric activities could be plotted on a graph. Berger called such type of registration as electroencephalogram (EEG). EEG signals research has been growing over the years due to the their increasing use to control electronic devices in all sorts of contexts. The present work developed a prototype to control a differential robot by means of EEG signals using the detection of movement intention of the right and left hand. The study covered on one hand, the analysis and design of the teleoperation system, and on the other hand, the robot tele operational tests. It is important to point out that the robot was designed and built to meet the technical research purposes. The programming of the EEG signal processing was made using the API provided by MATLAB. In turn, the programming for controlling the mobile differential robot was made with Wiring and Python. Lastly, several tests and experiments were carried out, and they showed that the objective in view was met.

References


A reliable approach for face recognition using composite correlation filters is presented. The filters are designed by combining several face images which are chosen by means of multi-objective combinatorial optimization. Given a vast search space of available face images, an iterative algorithm is used to synthesize a filter bank with an optimized performance in terms of several performance metrics. Computer simulation results obtained with the proposed method for face recognition in noisy scenes are discussed and compared in terms of recognition performance with existing state-of-the-art methods.
TARGET TRACKING WITH TEMPLATE MATCHING FILTERING

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An efficient algorithm for target tracking based on template matching filtering is presented. The algorithm is able to track the position of a target with invariance to appearance deformations, occlusions, and clutter. The target is defined by the user at the beginning of the algorithm. Next, a composite filter is designed to recognize the target in the next frame. The filter is adapted for each frame using information of current and past scene frames. Results obtained with the proposed algorithm using real-life scenes, are presented and compared with those obtained with a recent state-of-the-art tracking method, in terms of detection efficiency, tracking accuracy, and speed of processing.
SPEEDING UP EVOLUTIONARY APPROACHES TO FACE RECOGNITION BY MEANS OF HADOOP

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Introduction

Although face recognition may be considered as an easy task for humans, it becomes very complex when performed by a computer. Different approaches have been proposed \cite{1}\cite{2}, but current algorithms still incur substantial computational cost. Algorithms most typically explore a big database containing hundreds of photographs, and these photographs are employed for both training and testing the algorithm. For each of the image considered, a fixed number of interest points locations are fed to the algorithm by researchers from the human face, and these set of points must be extracted and employed by the machine learning algorithm during the training process first, and the testing step afterwards. We discuss here the possibility of enabling the algorithm to learn and decide which points should be used, which would require longer computing time but would probably allow to improve recognition rates.

We propose a new approach consisting of allowing the algorithm to learn which is the best subset of points for the problem at hand. The subset of points will be obtained by means of an Evolutionary Algorithm (EA). This learning stage requires a training and test steps, which, in this particular problem, is very costly. We employ Hadoop \cite{3} as the basis for running the algorithms proposed.

Methodology

Face Recognition Algorithms (FRAs) require large image databases that must be intensively processed for the algorithm to learn. Each image includes meta information related to specific face locations which are known as Points of Interest (POI).

We introduce an EA with the aim of selecting the subset of POIs that should be used. We use a simple EA: Individuals are represented by a string of zeros and ones, each bit referred to a specific location, where zero means that the POI is not used and a one the opposite. Although the global goal is to obtain similar or better results than previous approaches with a reduced number of POIs, this paper focuses in reducing computing time required for the whole algorithm proposed. We thus focus on the phase requiring longer computing time: the fitness evaluation (intensive image processing operations required).
Two jobs will be run on Hadoop for each individual, these jobs correspond to the two phases that the FRA is divided into: training and querying.

Once the evaluation phase starts, one job is run for each individual, which are part of FRA training process. Hadoop jobs are executed along two phases known as Map and Reduce, each of them requiring several tasks that are distributed along the architecture and are executed in parallel. The first stage (Map) will apply the same set of operations to every image. The Map output is a descriptor vector per image, this output is used as the input of the next phase, the Reduce. The Reduce phase generates a final matrix which contains the knowledge for recognizing faces. This matrix is used in the next job, the query job, where the algorithm tries to recognize the faces. Results obtained are checked with actual classes, and the hits percentage is used as the fitness. Once all jobs have finished, the evaluation phase of the EA concludes.

**Results**

We tested the implementation using different number of computing nodes, and the time required in each case is shown in figure 1. We notice a significant reduction in time and a good scalability.

These promising results will allow us to execute the EA with larger populations for a higher number of generations. It will help to optimize the FRA using less POIs and likely with similar or better results.
Conclusions

This paper proposes a new EA based approach to face recognition that would allow in the future to automatically decide best POIs to be employed. The long computing time required has led us to develop a Hadoop based implementation, which distribute fitness evaluations by means of map/reduce jobs. The solution presented allows us to run a face recognition algorithm into an unlimited number of machines using commodity hardware notably reducing computing time.

Acknowledgments

Spanish Ministry of Economy, Project UEX:EPHEMÉC (TIN2014-56494-C4-2-P); Gobex, FEDER GRU10029.

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EVOLUTIONARY COMPUTING IN R WITH THE ECR PACKAGE

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Evolutionary algorithms are efficient general purpose stochastic optimization procedures, which evolve solutions for specific problems based on the Darwinian principle of evolution theory. Different evolutionary algorithms mainly distinguish themselves by the applied building blocks, i.e., variation and selection operators as well as problem representation and fitness function.

We introduce the R package ecr, short for evolutionary computing in R. The package offers a comprehensive collection of building blocks for the construction of evolutionary algorithms for both single- and multiobjective optimization problems in the famous statistical programming language R. An extensible plugin system allows for the easy creation of evolutionary problems solvers build up of predefined or even selfimplemented evolutionary operators. Besides a set of popular evolutionary multi-objective algorithms like NSGA-II and SMS-EMOA is included. This work introduces the package, describes the main underlying principles and gives some introductory examples on how to use it.
DETECTING FUNNEL STRUCTURES OF CONTINUOUS SINGLE-OBJECTIVE OPTIMIZATION PROBLEMS BY MEANS OF EXPLORATORY LANDSCAPE ANALYSIS

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In single-objective optimization, the performance of an optimization algorithm strongly relies on the structure and characteristics of the optimization problem at hand. The knowledge of its structure allows to choose between algorithms, which aim at exploring the entire search space, and algorithms that focus on exploiting the function’s global structure. The latter is advisable, if the underlying structure represents a so-called funnel, i.e. a function whose local optima lead towards the global optimum as exemplarily shown in the second panel of Figure 1. In recent years, the concept of Exploratory Landscape Analysis has evolved [1, 2, 3]. It automatically identifies problem characteristics based on a moderately small initial sample of the objective function. Furthermore, in combination with efficient machine learning techniques, it has proven to be a very effective approach for algorithm selection problems in continuous black-box optimization.

In this work, specific features for detecting funnel structures are introduced and then combined with already existing ones. The entire set is used for fitting different classification models on specifically generated multimodal test instances. All classifiers are binary, i.e. they classify whether the underlying structure of an optimization problem is a funnel or a random structure. The quality of those models is then validated on standard benchmark problems.
Figure 1: Generated multimodal test instances with 40 local optima each. The function on the left is based on a completely random structure, whereas the right one resembles a simple funnel topology.

The ability to detect, whether an unknown black-box optimization problem has the funnel property, can be considered as the first, necessary step for algorithm selection. Therefore, we suggest a two-stage approach when creating the algorithm selection model. First, the unknown optimization instance should be classified into funnel / random. In a second step, this binary feature will be included in the feature set and used for selecting the best optimization algorithm (out of a portfolio of algorithms) for that specific instance.

References


SPECTRAL AND EIGENFUNCTION PROPERTIES OF A MODEL BASED IN RANDOM NETWORKS
A. Alcázar-López

Based in the Erdös-Rényi [1] model for random networks, we construct a model that describes systems in the transition from regular to chaotic dynamics analyzed in the Random Matrix Theory context [2].

We study statistical properties for spectral and eigenfunction using extensive numerical simulations in which we find universal properties for fixed average degree $\xi = \alpha N$ ($\alpha$ and $N$ being the average network connectivity and the network size, respectively). Finally, we demonstrate that the distribution for nearest neighbor energy-level spacing is well describe by Brody distribution[3].

References


In this talk some Mexican, nationwide projects are succinctly presented. They involve the use of models and methods of simulation or mathematical optimization, as tools to provide scientific support along the decision making process.

- The realm of these projects is varied:
  - Finance. The payment system, Bank of Mexico.
  - Logistics. Automatic teller machines supply, HSBC.
  - Electrical engineering. Constrained economic dispatch, CFE (the Mexican government agency, responsible for generating, transmitting and selling electricity).
  - Political science. Political districting, INE (the Mexican government agency responsible for elections).
MULTI-OBJECTIVE OPTIMIZATION OF INJECTION MOLDING PROCESS BY A HYBRID OF ARTIFICIAL NEURAL NETWORK AND NSGA-II

Alejandro Alvarado-Iniesta\textsuperscript{a}, Jorge L. García-Alcaraz\textsuperscript{a}, Arturo Del Valle\textsuperscript{b}, and Luis A. Pérez-Domínguez\textsuperscript{a}

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Abstract: This study presents a hybrid of artificial neural network and NSGA-II for multi-objective optimization of plastic injection molding process. The objectives to be optimized are a dimension of the finished plastic product (product quality), processing time (productivity), and energy consumption (manufacturing cost). The data collection and results validation is made in a 330 ton plastic injection machine. The design variables considered are mold temperature, material temperature, injection time, packing pressure, packing pressure time, and cooling time. Artificial neural network is used to map the relationship between design variables and output variables. Then, NSGA-II is used to find the set of Pareto optimal solutions. The results show that the methodology gives the designer flexibility and robustness to choose different scenarios according to current design requirements in terms of quality, productivity and energy saving.
LOCAL SEARCH APPROACH TO GENETIC PROGRAMMING FOR RF-PA MODELING IMPLEMENTED IN FPGA.

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In this article is presented a genetic programming (GP) with a local search heuristic (LSHS) to emulate the Radio Frequency (RF) Power Amplifier (PA) Doherty 7W @2.11 GHz conversion curves. The full data package related to the conversion curves that describe the PA behavior has a length of 122,880 data. The basic RF-PA modeling techniques involves special truncations of the Volterra Series [1-3], but for very complex nonlinear models with wide data range is required the use of the whole Volterra Series [4-5], Fuzzy Neural Network [6-7] or GP [8-9]. By other hand, GP performs an evolutionary search within the space of possible program syntaxes, achieving the expression that best solves a given model.

GP can be viewed as a biologic evolutionary inspired algorithm where a pool of symbolic expressions are built in a synergy fashion upon a target. Each expression competes for survival at each iteration by measuring its fitness value. This is usually expressed by an error metric toward the objective. In general, each symbolic expression consist of a mathematical equation that represent a potential candidate model in the imposed problem. Standard GP can solve complex problems by searching in the syntax space, however accuracy on the solutions can be stagnated through the evolution and expressions might grow in size.

In this work we propose a similar approach as performed in other population based algorithms: a combination of explorative search by using genetic operators and an exploitative search by numerical optimization means is designed. This synergy produces better quality solutions in faster times. The numerical optimization is performed by an iterative algorithm called Trust Region which minimizes the error for a parameterized non-linear function. This deterministic optimization is usually called Local Search (LS), since the optimum usually locates closer to the actual model by searching only in the parameter space given by the current symbolic expression. A set of small candidates models are picked up to be optimized during evolution. We call this approach LSHS [10-11]. The Fig. 1 shows the LSHS flowchart.
The Fig. 2 shows the implementation done for the obtained LSHS model through Simulink in the DSP/FPGA Development Kit Cyclone III EP3C120.

Experimental results show that LSHS's best models accuracy outperforms Canonical GP ones. The selected model including 17 parameters shows that produced model by GP for the AM/PM conversion curve has a MSE of 0.26033 during the implementation. The implementation stage for the AM/AM conversion curve is done in DSP Development Board Cyclone III-ALTERA. The test performed on the development board in the laboratory indicate that the GP model accuracy is very high.

Table 1. FPGA overall resources for the AM/AM using the LSHS model.

<table>
<thead>
<tr>
<th>Total Logic Elements</th>
<th>Total combinational functions</th>
<th>Dedicated Logic Registers</th>
<th>Total memory bits</th>
</tr>
</thead>
<tbody>
<tr>
<td>862/119088 (&lt;1%)</td>
<td>509/119088 (&lt;1%)</td>
<td>724/119088 (&lt;1%)</td>
<td>211382/3981312 (1%)</td>
</tr>
</tbody>
</table>

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References


OPTIMIZING AN AMPLIFIER WITH A MANY OBJECTIVE ALGORITHM

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In this work a Miller CMOS amplifier [1], with integrated circuit technology of 35 \( \mu \)m, is optimized using the many objective algorithm MOMBI [2] which is based in the R2 indicator. Five objectives are used: a DC gain bigger than 80 dBV, a unity gain frequency bigger than 17 MHz, a phase margin bigger than 60\( ^\circ \), slew rate bigger than 18 MV/s, and a CMRR bigger than 90 dBV. Also this problem has eight constraints [3] (all transistors must be working in saturation mode). Results are compared with the amplifier obtained in [1].

References


WASTEWATER TREATMENT MODELING BY MEANS OF MEMETIC GENETIC PROGRAMMING

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One of the methods used in the wastewater treatment is the adsorption process, a type of physicochemical treatment that commonly uses activated carbon as the absorbent. In this particular application, the removal of Phenol and Nitrophenol is required, and thus a prediction of adsorption removal (W\%) is modeled based on a contaminant, pH and an initial concentration (Ci) for a given contact time. Given experimental data, a symbolic regression model is built with the premise of predicting reasonable well unseen data based on a well known family of techniques from the Evolutionary Computation (EC) domain, a branch of a broader Artificial Intelligence (AI) research area. Particularly, a novel framework is proposed called Memetic Genetic Programming (MGP), which essentially uses the advantages of explorative search, present on the majority of population based algorithms, and the explotative procedure using a deterministic method to build altogether a model. This model exhibit a pair of benefits: first, the interpretability is high which could be explained by an expert on account of its symbolic nature, and second, the accuracy is high enough to compete with other state-of-art techniques used in model extraction.

The MGP is designed by incorporating numerical Local Search (LS) optimization into a Canonical or Standard Genetic Programming (SGP). LS is explained in the context of the search space where the solutions are being explored, which can be in different layers of the algorithm, like syntaxis, fitness, output, etc. In our case, the LS space matches the solution output space given by SGP.

In SGP, a common representation for the solution is given by syntactic trees, which can be also viewed as mathematical expressions built during the evolutionary process by elementary units called functions. Each of these expressions or potential solutions represents an individual model in our problem, and are ranked by a fitness function that measures the error with respect to a desired output (the adsorption removal rate in our case). The evolutionary process mimics an optimization process where this fitness function is minimized to reach an acceptable value. However, this process usually takes computational resources to produce accurate solutions. This is because SGP is more eager to improve solutions by extending syntactic
trees. Nonetheless, this takes more resources and there is no guarantee that significant improved solutions are ever going to be found.

The LS process is designed by optimizing a specific solution toward the target. To be able to do this, firstly, syntax trees are transformed by incorporating a parameter for each node. Second, a linear tree of the expression $\theta_1 + \theta_2 K(x)$ is inserted at the root node of each tree, where $\theta$ is the parameter set and $K(x)$ is the tree before transformation.

The optimization is performed by a well-known technique, the Trust Region, a variant of Levenberg-Marquardt, where an approximate model is found in a neighborhood during a given iteration of the algorithm. The Trust Region method excels by simultaneously finding the step size and direction toward the optimum, which could be local or global.

Not all solutions are picked up in the population to be optimized. This reduces resources and at the same time produces sufficient improvement in the overall population fitness. A heuristic method was used to choose the solutions, which is based on a ratio of the average population size and individual size. The size is expressed as the number of nodes in a given tree, and it has a direct relationship with the length of the mathematical expression. Small expressions are preferred to be optimized by this heuristic. The fitness function integrates an error measure given by the Mean Squared Error (MSE).

Data was randomly partitioned in training and testing subsets during the experimental procedure, with a 75% of total data for the former and the rest for the latter. 30 independent runs where performed for the experiment. The MGP setup was the following: 250 generations, 200 individuals, 0.9 probability of crossover, 0.1 probability of mutation, approximated 50% of population is optimized, 500 iterations for the Trust Region method, 17 maximum depth level, ramped half-and-half initialization and keep best as elitism.

Experimental statistical results shows good performance for unseen data in terms of Pearson correlation and MSE. The required correlation beforehand was to overpass $\rho = 0.96$, which was successfully accomplished. In the other hand, in terms of algorithm performance, there is no evident presence of over-fitting which gives a rough idea of the model generalization capabilities. Preliminary results are shown in figures 1(a) and 1(b) for training and testing data respectively.

Train Wastewater dataset correlation ($\rho=0.9639$)  Test Wastewater dataset correlation ($\rho=0.9615$)

![Figure 1: Pearson correlation for best models of 15 runs for the MGP method.](image)
References


Ubicomp researchers have given the importance to the use of the technique LSA (Lag Sequential Analysis) [8, 7] to evaluate the impact of their systems. LSA is a technique for gathering quantitative data by observing users as they perform their normal activities. It is traditionally used in the field of developmental psychology to study the behavior of person to person interaction by measuring the number of times certain behaviors precede or follow a selected behavior; the behaviors are defined by the study evaluators. Data can be captured live with paper and pencil or coded from video. Recent work of pervasive environments [2, 1] and social sciences [4, 6] shows that LSA is widely used for the analysis and evaluation, since it allows to capture the natural work of the user, also allows to obtain quantitative and statistical results from the data encoded.

An advantage of LSA is that it is conducted in the users environment, and it is conducted while the user performs his normal activities. With LSA, evaluators can generate statistics that capture aspects of observed behavior such as frequency and conditional probabilities of events. If video is used to capture the data, it can be recoded for different information as evaluation needs change, and it can be used for qualitative observational purposes. A significant disadvantage of LSA is cost; coding video for LSA is time consuming. There are many advantages for the use of LSA however there is a need to develop strategies to reduce the cost of its use [2].

This paper presents a tool that uses state of art computer vision techniques that allows the user to automate the process of encoding in LSA. Our aim is to augment LSA, reducing its burden, providing an specialized LSA. The tool presents a graphical interface for the user. How the tool works can be divided into four main steps: load video, select reference image, tracking process and classification. In the load video, the user manually selects a video. In the next main step, the user manually selects the image of the video where the behavior of interest is present. Then, a composite filter correlation [3] is used to process the reference image. At this point, the tool is ready to track the reference image in the video, this is done automatically by the tracking process; the TLD (Tracking Learning Detector) [5] tracking algorithm in computer vision is used for this process. When the TLD algorithm finds a possible match, the correlation peak threshold is used to determine a positive match between the processed reference image and possible image match. Finally, a time-stamp is registered at every positive match indicating that a behavior of interest occurred in that moment.
References


