

# NSOS - Nonlinear Systems Optimization and Statistics

**Algoritmi R&D Centre**  
University of Minho

16 January 2008

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- 2 PhD permanent members and interests
- 3 NSOS mission
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- 5 Software publicly available
- 6 Achievements in last 5 years: resumé

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## Research team

### Permanent members – 11 PhD & 1 PhD student

E Fernandes (U M) – coordinator	
P Oliveira (U M)	MT Monteiro (U M)
AC Braga (U M)	C Leão (U M)
J Matias (U T A D)	Al Vaz (U M)
L Costa (U M)	AM Rocha (U M)
Al Pereira (I P B)	IA Espírito Santo (U M)
C Rodrigues (U M)	

1 Post-doc (5 years, from April 2008) + 11 PhD & 10 MSc students

## Research team

PhD permanent members and interests

NSOS mission

NSOS organization by projects

Software publicly available

Achievements in last 5 years: *résumé*

# PhD permanent members – staff at UMinho



School of Engineering  
Department of Production and Systems  
Campus de Gualtar  
4710 - 057 Braga  
Portugal

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## PhD permanent members

### E Fernandes (U Minho)

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Full Professor

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1st degree

Applied Mathematics

PhD

Nonlinear Optimization

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#### research interests

Systems Optimization, Semi-Infinite Programming

Swarm Intelligent Algorithms, Mixed Integer Programming

Optimal Design of Wastewater Treatment Plants

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[emgpf@dps.uminho.pt](mailto:emgpf@dps.uminho.pt)

## PhD permanent members

### P Oliveira (U Minho)

Associate Professor with Aggregation

1st degree

Chemical Engineering

PhD

Multi-objective Optimization

#### research interests

Multi-objective Optimization, Evolutionary Computation

Statistics Applied to Medicine

[pno@dps.uminho.pt](mailto:pno@dps.uminho.pt)



## PhD permanent members

### T Monteiro (U Minho)

Assistant Professor

1st degree

Systems and Informatics Engineering

PhD

Nonlinear Optimization

#### research interests

Numerical Modeling, Optimization in Biomedicine

Filter Method in Nonlinear Optimization - C programming

Mathematical Programs with Complementarity Constraints:

application to electric power market

penalty & regularization in SQP - programming in Matlab

tm@dps.uminho.pt

## PhD permanent members

### AC Braga (U Minho)

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Assistant Professor

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1st degree

Chemical Engineering

PhD

Applied Statistics

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**research interests**

Decision Problems, Statistical Modeling

Comparison of ROC curves

Development of algorithms and software applications

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**acb@dps.uminho.pt**

## PhD permanent members

### C Leão (U Minho)

Assistant Professor

1st degree

Textile Production Engineering

PhD

Dynamic Systems Modeling

**research interests**

Process Modeling and Simulation

ICT in Engineering Education

[cpl@dps.uminho.pt](mailto:cpl@dps.uminho.pt)

## PhD permanent members

J Matias (U Trás-os-Montes e Alto Douro)

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Assistant Professor

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1st degree

Applied Mathematics

PhD

Derivative-Free Optimization

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**research interests**

Systems Optimization

Derivative-Free Optimization

Network computing, Internet, Java

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`j_matias@utad.pt`

## PhD permanent members

### Al Vaz (U Minho)

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Assistant Professor

---

1st degree

Applied Mathematics

PhD

Semi-Infinite Programming

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**research interests**

Global Optimization

Multi-local Optimization

Semi-Infinite Programming

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[aivaz@dps.uminho.pt](mailto:aivaz@dps.uminho.pt)

## PhD permanent members

### L Costa (U Minho)

Assistant Professor

1st degree

Systems and Informatics Eng.

PhD

Multi-objective Optimization

#### research interests

Dimensionality reduction of multi-objective problems

Metrics for comparison of multi-objective algorithms

Multi-objective evolutionary approaches

Applications to real world problems

lac@dps.uminho.pt

## PhD permanent members

### AM Rocha (U Minho)

Assistant Professor

1st degree

Systems and Informatics Engineering

PhD

Linear & Integer Programs

#### research interests

Stochastic algorithms to solve TSP problems

Application of swarm intelligent algorithms to real problems

Solving TSP problems by swarm intelligent algorithms

[arocha@dps.uminho.pt](mailto:arocha@dps.uminho.pt)

## PhD permanent members

### Al Pereira (I Politécnico Bragança)

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Assistant Professor

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1st degree

Applied Mathematics

PhD

Semi-Infinite Programming

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**research interests**

Systems Optimization, Semi-Infinite Programming

Parallel computing in Semi-Infinite Programming

Stochastic Methods in Global Optimization

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**apereira@ipb.pt**



## PhD permanent members

### IA Espírito Santo (U Minho)

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Assistant Professor

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1st degree

Biological Engineering

PhD

Systems Optimization

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**research interests**

Systems Optimization

Optimal Design of Wastewater Treatment Plants

Dynamic Modeling of Wastewater Treatment Processes

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**iapinho@dps.uminho.pt**

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## NSOS themes

The mission of the NSOS group is to **foster excellence** in

**Mathematical Problem Design**

**Systems Optimization**

**Heuristics**

**Applied Statistics**

Research is **interdisciplinary**, involving close links with mathematics, engineering and other scientific disciplines.

## Collaborative interdisciplinary research units

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Biological Engineering Centre U Minho

Production Technologies and Energy Centre

Officina Mathematica

Department of Polymers

Textile Science and Technology Centre

Computer Science and Technology Center

Health Science School

Child Studies Institute

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Department of Economics U Porto

Department of Chemical Engineering

Institute for Cell and Molecular Biology

Dental Medical Faculty

North Health Science superior Institute

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## Collaborative interdisciplinary research units

Department of Mathematics	U Coimbra
Department of Mathematics	U Trás-os-Montes e Alto Douro
Department of Mathematics	Polytechnic Institute of Bragança
Barcelona University	Spain
Sevilha University	Spain
S. Marcos Hospital	Braga
N.S. Oliveira Hospital	Guimarães

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# NSOS organization by projects

depending on the **characteristics** of the mathematical formulation of **real application** to be solved.

There are **links** between projects.

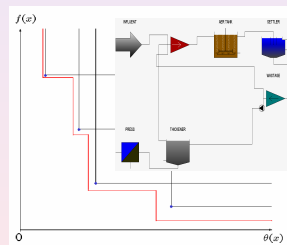


# CNO – Continuous Nonlinear Optimization

Challenging algorithm developments

Theoretical convergence issues

Mathematical problem design – Wastewater  
Treatment Plant Optimization





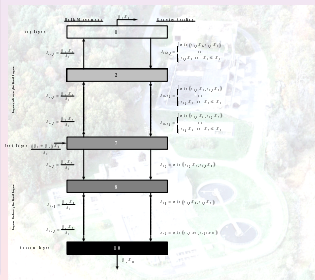
# DFO – Derivative-Free Optimization

Algorithm developments – handling constraints – integer variables

Software availability

Incorporate dynamic processes in the Wastewater Treatment Plant Design

Address practical problem in Astrophysics

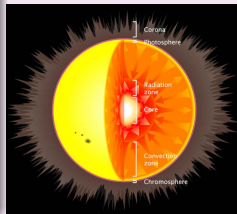


# GO – Global Optimization

Stochastic algorithm developments – handling constraints – integer variables

Software production

Address practical problem in Astrophysics (stellar parameters estimation)



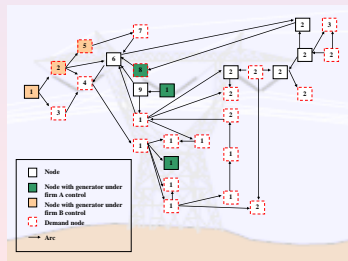
# MPCC – Mathematical Program with Complementarity Constraints

Nonlinear reformulation

Modeling real applications

Application to semi-infinite programming

Software development

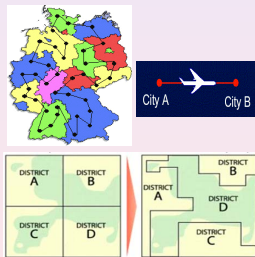


# MIP – Mixed Integer Programming

Stochastic algorithm development – integer variables

Swarm intelligent algorithms performance

Address traveling salesman, repairman, airline scheduling problems ...

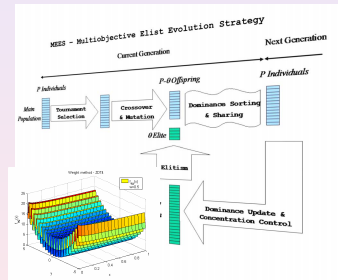


# MOO – Multi-Objective Optimization

Dimensionality reduction

Metrics for comparison of algorithms

Application to piezoelectric problems

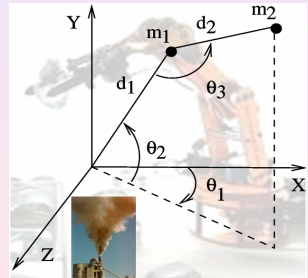


# SIP – Semi-Infinite Programming

Open source software improvements

Specific algorithm developments

Address problems in robot trajectory planning, air pollution and fed-batch control

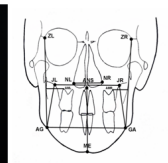
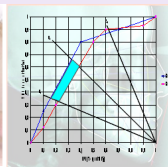


# SA – Statistics and Applications

Medical decision support

Statistical modeling of real life problems

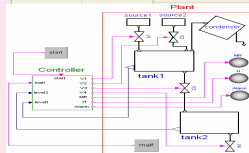
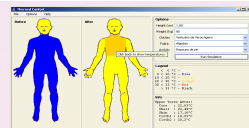
Development of algorithms and software applications



## Other collaborative projects

Innovativeness and Network  
Competence: an integration and  
empirical examination

ICTs in engineering education:  
application of new methodologies  
in engineering education and  
assessment in Numerical  
Methods, Process Control and  
Automation

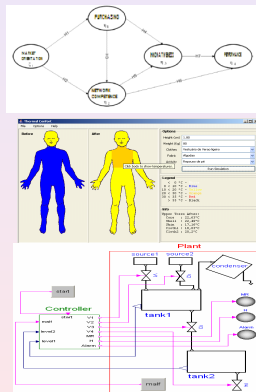




## Other collaborative projects

Thermal Comfort model  
applicable to clothing design  
(POCTI/EME/62786/2004)

Safety Control of Automated  
Problems Systems, SCAPS  
(POCTI/EME/61425/2004)



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## Software publicly available

**PNL-Pesdir** tool - software for non-smooth constrained nonlinear optimization (<http://www.norg.uminho.pt>).

**PPSDONL** - Augmented Lagrangian pattern search solver for non-smooth nonlinear optimization problems with interface to AMPL

**MLOPSOA** - Software for multi-local optimization with interface to AMPL

**PSwarm** - Software for global optimization with interface to AMPL. Developed in C (serial and parallel versions) and MATLAB. (<http://neos.mcs.anl.gov/neos/solvers/go:PSwarm/AMPL.html>)

**SIPAMPL** - an extension of AMPL to semi-infinite programming problems

**NSIPS** - solver for semi-infinite programming with interface to AMPL. (<http://neos.mcs.anl.gov/neos/solvers/sio:nsips/AMPL.html>)

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## MSc & PhD Supervision

	2003	2004	2005	2006	2007
MSc theses	0	2	9	9	10
PhD theses	8	6	6	8	12
MSc examinations			18		
PhD examinations			26		
Agg degree examination			4		
Journal/Conf. Paper review			53		

## Publication Ratios

	2003/.../2007 (total number)	average per year	<b>ratio</b> per year & PhD
Number of PhD	8/8/9/10/11	9.2	
INTERN journal & book papers	43	8.6	0.93
NAT journal papers	3	-	-
<b>TOTAL</b>	<b>46</b>	9.2	<b>1.00</b>
INTERN conference papers	57	11.4	1.24
NAT conference papers	11	-	-
<b>TOTAL</b>	<b>68</b>	13.6	<b>1.48</b>

## Funded projects

POCTI/EQU/32470/2000	member: C Leão	59855,75
POCI/MAT/58957/2004	Coordinator: Al Vaz members: E Fernandes, MT Monteiro, L Costa, Al Pereira	12000,00
POCI/MAT/59442/2004	member: Al Vaz	23000,00
POCI/MAT/59502/2004	members: P Oliveira, L Costa	9904,00
POCTI/EME/62786/2004	member: C Leão	20000,00
POCTI/EME/61425/2004	member: C Leão	33600,00
Reequipment program, FCT	member: C Leão	195000,00
P-VI-ID355	Coordinator: Al Pereira	10000,00
P-VI-ID880	member: Al Pereira	2000,00
PTDC/EAT/68361/2006	member: AC Braga	180966,00
TOTAL		<b>544325,75</b>

Some PhD thesis proposals in these areas  
will be sent to Scientific Commission of  
MAP-i



Thanks for your attention

Additional information in

[www.norg.uminho.pt/NSOS](http://www.norg.uminho.pt/NSOS)