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# COLABSQUARE

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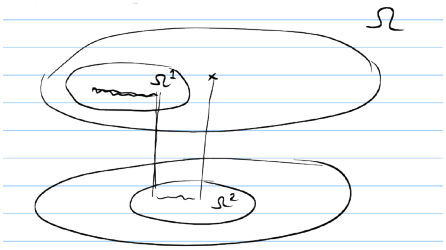
UT Austin | Portugal INTERNATIONAL COLLABORATORY FOR EMERGING TECHNOLOGIES, COLAB

## STUDENT HIGHLIGHT – Gabriele Terrone – "Bernstein Estimate for systems of weakly coupled fully nonlinear elliptic equations" (Mathematics)

It's not that easy to describe mathematicians' work, how they progress in scientific research. Working in a purely theoretical context makes really hard to find words to explain friends what you do all day long. Moreover, nowadays research areas are so specialized that dialogue can be difficult even among mathematicians. Often mathematicians, to justify their research, come out saying that their work has many applications. Sometimes this is true, sometimes it's not: mathematical research may be interesting in itself. Actually, what has kept me and prof. Diogo Gomes busy in recent months at Instituto Superior Técnico de Lisboa, has several applications.

The title: Bernstein Estimate for systems of weakly coupled fully nonlinear nonlinear elliptic equations. What?! Let's go step by step. Systems: those we studied at school, different conditions that must be satisfied at the same time. The solution of a system of weakly coupled equations is a vector valued function (say, with M components) which must satisfy M different differential equations.




The picture you may have in mind is this. A fancy dancer (a trajectory) is in a ballroom (a bounded domain) where the orchestra is playing waltz (is forced to move according to certain rules). The dancer at any time can decide whether to continue to dance the waltz in the room, or go to another room (switch to another bounded domain) where they're playing mazurka (where it is forced to move according to different rules). It is also possible that the dancer, changing room, takes the wrong door and then exits, and then he must go home (the particle exits the set through the boundary or through the switching). This image depicts in simple terms what happens in the control of hybrid systems. It is possible to associate to these systems a function which satisfies a system of weakly coupled fully nonlinear partial differential equations.

Our result is an estimate, namely a result of a qualitative nature. Rarely (almost never) we're able to exhibit explicitly the solution of a problem (in our case the solution of a system). Then it may be particularly useful to have an identikit of the solution. In our case we estimate the norm of the first and second derivatives of a solution with the norm of the solution itself (Bernstein estimate). This means that the size of the gradient cannot be much larger than that of the solution.

And the applications? Well, the study of such systems arises naturally in the optimal control of hybrid systems, in controlled Markov processes with random switching, in optimal starting-stopping problems with applications to finance... and of course the problem of fancy dancer!

## R&D PROJECT HIGHLIGHT – "Analysis of Nonlinear Partial Differential Equations" (Mathematics)

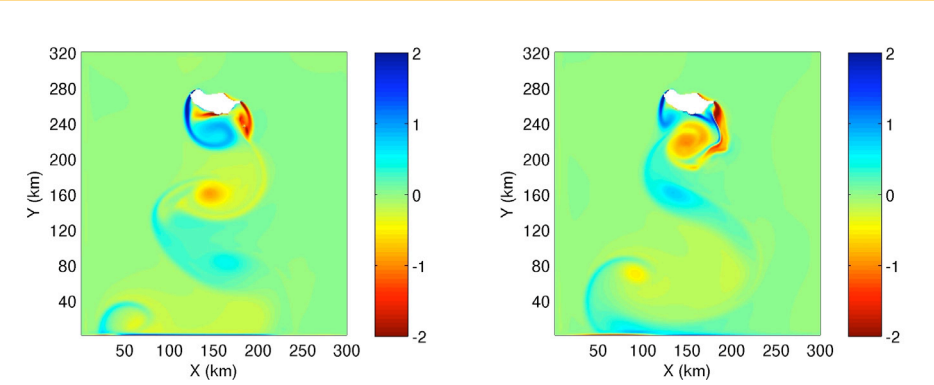



Figure 1 represents the normalized relative vorticity at two different times of the eddy shedding cycle corresponding to Re = 400 and lambda = 0.077. Cyclones and anticyclones are almost aligned, in contrast to the von Kármán wake theory.

Nonlinear partial differential equations (PDEs) are central in modern Applied Mathematics, both in view of the significance of the concrete problems they model and the novel techniques that their analysis generates. The subject has developed immensely in recent years, in many unexpected and challenging directions, and a new range of applications emerged with the advent of Biomathematics. This project is structured into two strongly connected branches - the analysis and the applications -

bridging the gap between the theoretical aspects related to the analysis of the PDEs and the production of sound information that may have a strong impact in terms of the applications. The ultimate goal is to solve concrete, relevant problems based on solid mathematical ground and on the mastery of up-to-date analytical techniques. We are addressing different aspects of the contemporary analysis of nonlinear PDEs, from regularity issues for singular and degenerate equations to free boundary problems, from kinetic equations to ocean and climate modeling.

An important trend of the project concerns the mathematical and numerical modeling of the ocean and climate, a major issue from an economic, environmental and public health perspective. Simulations of the Madeira island wake were obtained by the ROMS numerical model taking into account both the rotation of the Earth and the density stratification of the ocean. Several sensitivity studies were performed changing the values of the Reynolds number Re, the Rossby number Ro and the Burger number Bu. Together they control the three instabilities that may occur in the wake: centrifugal, barotropic and baroclinic.

Results were compared with similar simulations around an idealized circular island with the main difference being the predominance of cyclones, regardless of the value of Re, in our case. Contrary to expectations, no regime of anticyclonic eddy dominance, for moderate values of Re and increasing lambda = Ro/Bu, or dynamical symmetry, for small values of lambda, could be found, the only explanation being the particular island contour (see Figure 1). As a step closer to reality, future numerical Madeira island wake simulations should include the real ocean bathymetry, a time varying incoming flow, the effect of the bottom drag on the sloping nearshore topography and the interaction between the oceanic and atmospheric island wakes.

Our activity is also centered on the qualitative study of strongly coupled elliptic systems modeling, for example, a binary mixture of Bose-Einstein condensates; the trend to equilibrium of a chemically reactive mixture modeled by means of the spatially homogeneous Boltzmann equation; or the understanding of the local properties of solutions of singular and degenerate PDEs arising from different applications.

# COLAB News Center

## Advanced Computing students conduct research at UT Austin

This spring the CoLab Advanced Computing program welcomed Rui Gonçalves, Reus Salini, Edgar Sousa, João Barbosa, and Diogo Neves to spend several months at UT Austin. While here the students are collaborating with the Department of Computer Science, the Department of Electrical and Computer Engineering, the Institute for Computational Engineering and Sciences (ICES), the Texas Advanced Computing Center (TACC) and the Center for Transportation Research (CTR).

Their research covers a broad range of topics in the field of advanced computing. João Barbosa is currently examining high-performance computer graphics. "My focus is heterogeneous and core platforms for real-time ray tracing. The goal of my research is to explore and develop efficient scheduling mechanisms for distributed heterogeneous platforms for real-time problems, such as ray-tracing and ray casting (volume rendering)," Barbosa said.

Reus Salini's work may save countries millions of dollars in infrastructure costs. He is researching the application of neural networks to the modeling of asphalt pavement, hoping to make breakthroughs in longstanding civil engineering problems through recent advances in computing power.

Several of the students are working to improve the practice of parallel computing itself. "I am working on parallel programming methodologies that improve modularity and promote the incremental development of parallel applications," Rui Gonçalves said. Diogo Neves' focus is "to raise the abstraction level of parallel programming by developing a new set of constructs that promote a stronger separation of concerns in parallel computing. The idea is to separate the domain-specific code from parallelization issues – that is, to hide the complexity of parallel programming as much as possible," Neves said. (For more on Neves' topic, see "Separation of Concerns in Advanced Computing.")

Some students assist UT professors with their research. Edgar Sousa's interests lie in "aspect-oriented programming to develop tools for (semi-)automatic parallelization of legacy scientific codes," he said. "I am working closely with Professor Keshav Pingali and his research team and taking part in the development of the Galois framework."

Whereas the students know and love their research, the CoLab program introduces them to unfamiliar topics. Diogo Neves explained how his time with CoLab changed his understanding of UT's reputation. "Before attending UT, I knew that it was recognized as a top university. After being here, I'm realizing that it's at the top because" it's home to great scientists and "several top research groups, such as Dr. Keshav Pingali's group, with whom I am developing my work. It seems that tight relations between UT and the outside world exist which enable UT scientists to perform applied science," Neves said. According to Rui Gonçalves, UT researchers focus on smaller problems than their Portuguese counterparts but are able to explore the problems more deeply. However, the biggest difference between graduate education programs in both countries is the amount of time spent in classrooms. In Austin, students "spend less time listening to the professor in a classroom" and more time doing homework and other assignments outside of class, Gonçalves said. Variety is another differing factor. "The freedom of choice related to the curriculum" is much greater in Austin, João Barbosa said.

There are more educational and research-related resources at UT, Barbosa added. Many UT researchers and visitors from other institutions give talks outside of class schedules. Neves elaborated, "Is there a day without a seminar? No! It is really awesome!" Another benefit of CoLab participation is the development of professional soft skills. Edgar Sousa plans to use the teamwork and team management skills he is learning from CoLab in his future work with Portuguese research teams.

Technical resources offer another appeal for many CoLab participants. Reus Salini plans to use TACC's supercomputer to process his "large databases and, together with UT's team, start a deep cooperation between the advanced computing and pavement engineering areas," Salini said. "While Portugal is just starting to create its own infrastructure, UT has a rock-solid infrastructure with which to develop world-class research."

# UNIVERSITY OF PORTO Vice Rector Visits Texas


Left to Right: At Austin Film Studios: Cliff Zintgraff, UTEN Austin; Jorge Goncalves, Joana Miranda, Mark Hall; Clara Goncalves, and David Gibson.

During April 22-23, 2010 Professor Jorge Gonçalves, Vice Rector; Clara Gonçalves, Director UPTEC, and Joana Miranda, UPMEDIA all from the University of Porto visited UTEN Austin as a follow-on to previous visits concerning the University of Porto's growing partnerships with Austin and Texas in creative industries and medical-bio incubation. Visits to San Antonio, Texas included discussions with Dr. Mary Pat Moyer, Founder, President, CEO and Chief Science Officer and James V. Janowiak, Vice President, Finance & Administration, INCELL Corporation, LLC **(http://www.incell.com)** about sharing lessons learned for UPTEC in the building of Porto's new bio and wet-lab facilities and also about bringing the INCELL incubation model to Porto. While in San Antonio, the Portuguese guests also visited South Texas Technology Management **(http://www.utsystem.edu/sttm/index.shtml)** to thank STTM for hosting three Portuguese TTO interns during the past months and also to learn more about the general operation of STTM as a South Texas TTO concerning lessons learned for the University of Porto.

Austin visits focused on the College of Communication Film Production Facilities during which Keefe Boerner, Technical Facilities Manager and Karen Gustafson, Program Manager, CoLab Advanced Digital Media provided an overview and discussion of "best practices" for the design, building, and outfitting of Porto's film and TV studio's which are currently under construction. (See photo.)

Visits concerning a closer collaboration between creative industries in Porto with the City of Austin were also arranged with Jim Butler, Creative Industries Development Manager for the city and Mark Hall, Austin-based film producer and director. The visit included a tour of Austin Studios **(http://www.austinstudios.org)** by Martin Parrington, Facilities Manager that occurred during the filming of "True Grit," the current Coen Brothers film being shot in Austin and Texas. (See photo.) Again the focus was on how to most effectively stimulate and build the Porto Creative Industries Initiative and to foster collaboration with UT Austin and Austin film and creative arts communities. As an example of this building collaboration, the Austin Film Society is currently featuring six Portuguese films in Austin theaters during April 13 to May 7, 2010 **(see www.austinfilm.org)**.

The Portuguese visitors also visited UT Austin's Visual Arts Center (as a follow-up of Director Jade Walker's April visit to Porto) to meet with Associate Professor Dan Olsen and Xochi Q. Solis, Director of Events & Public Programming **(www.utvac.org)** as well as with Peter Hall and Daniel Olsen, professors of Design. Discussion focused on how UT Austin's and Porto's Creative Industries education and production activities in digital media and visual arts might work together including the possibility of student internships in both Porto and Austin and also by featuring Porto's creative arts at UT Austin's recently renovated Visual Arts Center.

Left to Right: At College of Commutation Film and TV Studios, UT-Austin: Prentiss Riddle, CoLab Austin; Karen Gustafson, Joana Miranda, Clara Goncalves; Keefe Boerner, and Jorge Goncalves.

As stated by Vice Rector Jorge Gonçalves, "On top of the common interests that both parties have on this (CoLab) project, I am learning that people from Portugal and Texas share other characteristics. These institutional contacts are becoming also personal and this, from my point of view, is an advantage because will make people more involved for sustainable partnerships."

# SUMMER INSTITUTE applications close on May 30th! – Apply Now!


The third edition of the Summer Institute in Digital Media is now on the way, with the applications open for the Lisbon courses.

The Lisbon courses will take place at FCSH/UNL (Av. Berna, 26) and will cover the subjects of: Digital Journalism for Network Society (June 21st to July 2nd), with Rosental Alves, Documentary Mash Up (June 14th to July 2nd), led by Karen Kocher, Intermediate Animation (July 12th to 30th), with Geoff Marslett and Digital Cinema (June 21st to July 2nd), led by Tom Schatz.

All interested students may apply to one or more courses by email to **utaustinportugal@fct.mctes.pt.** The application must have the students' Résumé and a Motivation Letter to up to 350 words, as well as the person's basic info (name, telephone, address, contacts). The name of the course should be stated in the email's subject (one email per course).

For more information on the courses' schedules and professors' bios please visit **http://www.utaustinportugal.org.**

# ZON LAB WINNERS prepare to go to Austin

Nuno Cintra Torres ZON presents the Program to the ZON Lab winners

The Portuguese students that were chosen to participate in the 1st ZON Intensive Script Development Lab at UT Austin gathered at ZON headquarters last May 7th to discuss the final details before their trip to Texas.

There, Nuno Cintra Torres (ZON) explained the program for the Lab and how the time at Austin will be spent. The students will have an intensive two-month course in script-writing with UT Austin professors, Richard Lewis and Stuart Kelban. During that time they will develop the script for their own film, based on the project that was submitted by them for this competition, which will be shot and post-produced back in Portugal, at their respective universities.

First group of ZON Lab winners with ZON's Nuno Cintra Torres.

The students embarking on this first ZON Lab, a partnership with UT Austin and CoLab are: José Azevedo, from Universidade do Porto with "Suspended Time", Raquel Martins, from Escola Superior de Comunicação Social with "Who's looking at You", Pierre Jézéquel, from Escola Superior de Música e Artes do Espectáculo with "Grounded", Ricardo Feio, from Escola Superior de Teatro e Cinema with "A Good Rascal", Ana Martins, from Faculdade de Ciências Sociais e Humanas da Universidade Nova de Lisboa with "Book of Odds", Patrícia Brásia and Fábio Veríssimo, from Universidade da Beira Interior with "Spotlight Me" and "Lights, Camera, Robbery" respectively, Luís Brás, from Universidade Lusófona with "As the Night Falls", Susana Neves, from Universidade do Minho with "Love Recipe", Nuno Castilho, from Universidade Católica do Porto with "One Day I Spent the Day Laughing" and Danilo Nascimento, from Universidade de Aveiro with "The Crayon".

# THE UTEN CORNER
## S&T COMMERCIALISATION

UTEN Portugal
University Technology Enterprise Network

### Avepark welcomed 3rd UTEN Training Week

UTEN Portugal organized the third Training Week of 2010, which took place between 24 to 26 May, at Avepark. The 2010 3rd UTEN Training Week focused on University-Based Technology Business Incubation, presenting different perspectives and practical overviews of trends in incubation models and key tasks and responsibilities of incubators and TTOs regarding company growth and internationalization. Brief presentations were augmented by group discussions and hands-on assignments focusing on: "Internationalization and soft-landing", "Incubator formation, growth, and sustainability", "Regional context and business incubation" and "Company selection and growth: Challenges and Successes".

On 26 May, there was a meeting with the speakers where all participants had an opportunity to present and discuss their most promising/ challenging opportunities for US on-shoring. Participants were given the opportunity of scheduling "one-on-one" meetings with both the workshop's speakers and David Gibson, UTEN@Austin Director.

The workshop's main speakers were Aruni Gunasegaram, Director of Internal Operations at Austin Technology Incubator (ATI), Laura Kilcrease, Founding Director at ATI, and Omar Hakim, General Manager at Research Valley Innovation Center (RVIC).

This event was organized by UTEN Portugal with the support of **UTEN@Austin** and of AvePark (as sponsor and local host).

# UTEN INTERNS talk about their experiences at CMU

"Through the UTEN Program, from FCT, my insertion on a Professional Development Program at Carnegie Mellon University (CTTEC and CMU General Counsel) from 29 mars till 25 April, represented a unique opportunity to contact, in a labor context, with the legal procedures and methods regarding the use and implementations of intellectual property, technology transfer and commercialization strategies. Thanking to all the great "Professional Teachers" at CMU the goal of my Professional development program was achieved and a new step was given on the implementation of new methodologies regarding the knowledge development and a new era for enterprises creation." - Sofia Vairinho

"The Professional development program, developed at the Centre for Technology Transfer and Enterprise Creation (CTTEC) of Carnegie Mellon University (CMU) from March 1st to April 23rd, aimed to the development and consolidation of competences in technology licensing and commercialization, as well as benchmarking good practices on entrepreneurship and technology transfer from CMU and from the Pittsburgh region. The professional development program was an amazing opportunity to learn and share experiences with some extraordinary individuals and institutions in one of the best Universities in the world, as well as to develop a network of international contacts." - Hugo Barros

# ONGOING OPPORTUNITIES

## Digital Media:

### INTERNSHIP OPPORTUNITIES IN AUSTIN COMPANIES (DIGITAL MEDIA)

We have recently updated our internship program and encourage graduate students and early-career professionals interested in gaining hands-on experience working at Austin-based companies to apply. The program includes airfare to Austin, housing for up to 3 months, health insurance, and visa fees. We also list interns as "visiting researchers" at the University of Texas, which grants them access to the university library system, gyms, and other campus amenities as well as the city bus system. Those interested in applying can find more information about the program, including application procedures at **http://colab.ic2.utexas.edu/dm/internships/**

Applications may be submitted at any time, but the minimum time for processing and placement is 4 months, so those interested must plan ahead.

Internships will last a minimum of 6 weeks, and interns will be placed at digital media companies in Austin. During their time in Austin, interns will not only have the opportunity to learn about the digital media industry through their internship assignment, but will also be able to participate in professionalization and leadership training with University of Texas students enrolled in the Digital Media Leadership Program.

### ADVANCED DIGITAL MEDIA MOBILITY AWARDS

The UT Austin | Portugal Digital Media Program is pleased to offer three categories of mobility grants to allow faculty and students at our Portuguese partner institutions to spend time at the University of Texas at Austin.

**1. Sabbatical fellowships for Digital Media faculty**

These awards support one semester of teaching and research at the University of Texas at Austin for Digital Media faculty based in Portugal.

Eligibility is open to personnel at our Portuguese partner institutions who have the rank of assistant professor or higher, as well as to researchers participating in our FCT-funded R&D projects. Support includes travel, housing expenses and a living stipend. Fellowships are available for the fall 2010, spring 2011 and fall 2011 semesters.

**2. Semester fellowships for Digital Media PhD students**

These awards support one semester of study and research at UT Austin for students in the UT Austin | Portugal-associated doctoral programs in Digital Media at the New University of Lisbon and the University of Porto. Support includes travel, living expenses, and UT Austin course fees. Students must be available to attend a full semester (equivalent to three classes) of courses at UT Austin (typically mid-August through mid-December for the fall semester and early January through mid-May for the spring semester). Fellowships are available for the fall 2010, spring 2011 and fall 2011 semesters.

**3. Exploratory visits by Digital Media PhD students**

These awards support short visits at UT Austin for students in the UT Austin | Portugal-associated doctoral programs in Digital Media at the New University of Lisbon and the University of Porto. Students will spend their time meeting with faculty advisors, visiting classes, exploring research opportunities and planning for possible long-term enrollment at UT Austin. Support includes travel and living expenses for up to ten days. Exploratory visits will typically last one week. Students should visit during the fall or spring long semesters, i.e., from mid-August through the middle of May.

To inquire about these opportunities please contact:
- Karen Gustafson – **kegustafson@mail.utexas.edu.**
Please check how to apply in **http://utaustinportugal.org/calls/dm-travel.**

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**Useful links**

www.utaustinportugal.org www.fct.mctes.pt www.utexas.edu www.ic2.org

www.ati.utexas.edu www.austin-chamber.org http://colab.ic2.utexas.edu/dm/ www.utenportugal.org

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