



DISVM'2015

**Differential Inclusions
and Set Valued Maps**

26-27 November, 2015
University of Florence
Italy

DIFFERENTIAL INCLUSIONS AND SET VALUED MAPS

International Conference on the occasion of
Giulio Pianigiani's 70th birthday

November 26 - 27, 2015

Florence, Italy

<http://disvm2015.weebly.com/>

Version of November 17, 2015

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Preface

This booklet contains information about the scientific program of DISVM'2015 conference and the list of abstracts of accepted communications. The abstracts are arranged according to their order of presentation in the program. The list of participants is published on the conference website.

We would like to express our recognition to the persons and institutions that made this conference possible:

- the Scientific Committee;
- the Keynote Speakers;
- all the Participants;
- and the Sponsors.

We wish all the participants a very fruitful conference and a pleasant stay in Florence.

The Organizing Committee

1 About the Conference

Plenary Speakers

- Andrea Bacciotti (Politecnico di Torino, Italy)
- Alberto Bressan (Penn State University, USA)
- Luciano Pandolfi (Politecnico di Torino, Italy)
- Nikolaos S. Papageorgiou (National Technical University of Athens, Greece)

Scientific Committee

- Giuseppe Anichini (University of Florence, Italy)
- Paolo Nistri (University of Siena, Italy)
- Maria Patrizia Pera (University of Florence, Italy)
- Fabio Zanolin (University of Udine, Italy)

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- Arrigo Cellina (chair), (University of Milan Bicocca, Italy)
- Giovanni Colombo (University of Padua, Italy)
- Eugénio Rocha (University of Aveiro, Portugal)
- Vasile Staicu (University of Aveiro, Portugal)

Conference Contact

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2 Presentation titles and abstracts

The presentations include:

- **4 Keynotes Presentations** of 60 minutes.
- **17 Contributed Talks** of 25 minutes.

List of Presentations

(following the schedule order)

P01 – EXTREMAL SOLUTIONS TO DIFFERENTIAL INCLUSIONS: PROBABILITY VS. BAIRE CATEGORY

Alberto Bressan

The talk will provide a survey of past and recent work on solutions to differential inclusions, where the time derivative takes values within a set of extreme points. Results based on Baire category and on probability arguments will be compared. In particular, a dual approach will be discussed, showing that for a “large” class of functionals (in the sense of Baire category) the corresponding constrained minimization problems select an extremal solution.

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T01 – RANDOM EXTREMAL SOLUTIONS OF DIFFERENTIAL INCLUSIONS

Vasile Staicu

Let $x \mapsto F(x) \subset \mathbb{R}^n$ be a Lipschitz continuous multifunction with compact values and consider the Cauchy problem

$$\dot{x}(t) \in F(x(t)), \quad t \in [0, T], \quad (1)$$

$$x(0) = 0. \quad (2)$$

Let \mathcal{F} be the set of Carathéodory solutions of (1)-(2) and call \mathcal{F}^{ext} the family of solutions of

$$\dot{x}(t) \in \text{ext } F(x(t)) \quad (3)$$

with initial data (2). The goal in the talk, based on the joint work with Alberto Bressan [1], is to present the construction of a probability measure P on the space of continuous functions $\mathcal{C}([0, T]; \mathbb{R}^n)$ which is supported on the set \mathcal{F} of Carathéodory solutions of (1)-(2) such that the following properties should hold:

(P1) With probability one, trajectories of (1)-(2) satisfy (3)-(2). Namely

$$P(\mathcal{F}^{ext}) = 1. \quad (4)$$

(P2) The support of P is dense on \mathcal{F} . Namely: for every open set $U \subset \mathcal{C}([0, T]; \mathbb{R}^n)$,

$$U \cap \mathcal{F} \neq \emptyset \quad \iff \quad P(U) > 0. \quad (5)$$

In the special case where the sets $F(x)$ are segments in the plane, a probability measure satisfying (4)-(5) was first constructed in [2]. Our approach, based on piecewise Lipschitz approximate selections, applies to any Lipschitz continuous multifunction with compact values in \mathbb{R}^n .

References:

- [1] A. Bressan and V. Staicu, Random Extremal Solutions of Differential Inclusions. *Nonlin. Diff. Equat. Appl.*, (submitted).
- [2] G. Colombo and V. Goncharov, Brownian motion and exposed solutions of differential inclusions. *Nonlin. Diff. Equat. Appl.*, **20** (2013), 323–343.

Visiting Professor at the Department of Information Engineering, Computer Science and Mathematics (DISIM) of the University of L'Aquila, with financial support from the Portuguese Foundation for Science and Technology (FCT), within the Sabbatical Fellowship SFRH/BSAB/113647/2015.

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P02 – CONTROL AND IDENTIFICATION PROBLEMS FOR SYSTEMS WITH CONSISTENT MEMORY

Luciano Pandolfi

We give an overview of recent results on controllability and identification problems for systems with persistent memory which are encountered in viscoelasticity and nonfickian diffusion.

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T02 – CHAOS IN PERIODIC ODES: AN ELEMENTARY APPROACH

Fabio Zanolin

We briefly survey an approach, based on a variant of the theory of “Linked Twist Maps”, to prove the existence of infinitely many periodic solutions as well as the presence of chaotic dynamics in planar systems with periodic coefficients. Applications are given to some classical examples of second order periodically perturbed nonlinear ordinary differential equations.

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T03 – NONSMOOTH CRITICAL POINT RESULT AND APPLICATIONS

Giuseppina D'Agù

The aim of this talk is to present some recent results on critical point theory for locally Lipschitz functionals. In particular, applications to equations of Sturm-Liouville-type having nonlinearities on the right-hand side being possibly discontinuous and under various hypotheses on the nonlinearities are attained.

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P03 – ELLIPTIC EQUATIONS WITH INDEFINITE AND UNBOUNDED POTENTIAL AND A NONLINEAR CONCAVE BOUNDARY CONDITION

Nikolaos S. Papageorgiou

We consider an elliptic problem driven by the negative Laplacian plus an indefinite and unbounded potential and a superlinear reaction. The boundary condition is parametric, nonlinear and superlinear near zero. Thus, the problem is a new version of the classical “convex-concave” problem (problem with competing nonlinearities).

First, we prove a bifurcation-type result describing the set of positive solutions as the parameter $\lambda > 0$ varies. We also show the existence of a smallest positive solutions \bar{u}_λ and investigate the properties of the map $\lambda \mapsto \bar{u}_\lambda$. Finally, by imposing bilateral conditions on the reaction we generate two more solutions, one of which is nodal.

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P04 – ON THE CONTROL OF MOREAU'S SWEEPING PROCESS

Giovanni Colombo

Moreau's sweeping process is the differential inclusion

$$\dot{x}(t) \in -N_{C(t)}(x(t))$$

or, more generally,

$$\dot{x}(t) \in -N_{C(t)}(x(t)) + F(t, x(t))$$

where $C(\cdot)$ is a regular enough moving set and F is a set valued map, regular enough.

While the existence theory is a very active area of research since the '70s, the understanding of the dynamics and of the control of the sweeping process is an entirely new subject. The talk will focus on some models and open problems, together with recent results, obtained in collaboration with other authors (including Nguyen D. Hoang, B. Mordukhovich, R. Henrion, and Michele Palladino), on necessary conditions for various cases of optimal control for the sweeping process. In particular, the case where the moving set depends on control parameters will be considered and the obtained necessary conditions will be illustrated through examples. The characterization of the minimum time function through a HJ equation, for the case where the control acts on F , will be also addressed.

References:

- [1] G. Colombo, R. Henrion, Nguyen D. Hoang, B. S. Mordukhovich, Optimal control of the sweeping process: the polyhedral case, pp. 1–38, submitted.
- [2] G. Colombo, M. Palladino, The minimal time problem for the controlled sweeping process, submitted.

— * —

T05 – LOWER SEMICONTINUOUS DIFFERENTIAL INCLUSIONS WITH P-LAPLACIAN

Salvatore Angelo Marano

The existence of solutions to lower semicontinuous, closed-valued differential inclusions with p-Laplacian is investigated under various growth conditions. Proofs exploit the Bressan-Colombo-Fryszkowski Continuous Selection Theorem and fixed point arguments.

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T06 – A COINCIDENCE POINT THEOREM AND ITS APPLICATIONS

Pasquale Candito

The aim of this talk is to present a coincidence point theorem for sequentially weakly continuous maps. Moreover, as a consequence, an existence result for differential inclusion is pointed out. Finally, some applications to the study of different nonlinear boundary value problems are showed.

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T07 – VARIATIONAL METHODS FOR GENERAL SECOND ORDER DIFFERENTIAL INCLUSIONS

Antonio Iannizzotto

We discuss the application of variational methods to ordinary differential inclusions of the second order, involving a u.s.c. set-valued mapping with compact convex values, with no monotonicity assumption. By means of such methods we prove existence/multiplicity of solutions. We present a case study related to a Sturm-Liouville inclusion with mixed boundary conditions (collaboration with G. Bonanno and M. Marras).

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T08 – ABOUT MULTIPLICITY RESULTS FOR SCHRÖDINGER-POISSON SYSTEMS

Eugénio Rocha

We discuss some core ideas to obtain multiplicity of solutions of Schrödinger-Poisson systems

$$\begin{cases} -\Delta u + u + l(x)\phi u = f(x, u) & \text{in } \mathbb{R}^3, \\ -\Delta \phi = l(x)u^2 & \text{in } \mathbb{R}^3, \end{cases}$$

for some classes of nonlinearities f (e.g. indefinite, and involving the critical exponent). These systems can be seen as nonlocal equations where variational methods and critical point theory may be applied. Because of a (double) lack of compactness, a direct method will be considered which do not involve Palais-Smale condition or the Ekeland variational principle. Special phenomena of these systems, compared with semilinear elliptic equations, will be point out. We end addressing some remarks about the extension of these systems, the numerical analysis based on a recent reproducing kernel Hilbert technique (so-called Nonlinear Aveiro Discretization Method), and its relevance in applications as Nanoscience (computational chemistry). Joint work with L. Huang and J. Chen.

— * —

T09 – ON THE EXISTENCE OF CONSTANT SIGN SOLUTIONS FOR SOME DIFFERENTIAL INCLUSIONS

Giuseppina Barletta

We present some existence and multiplicity results for some variational-hemivariational inequalities. In particular we focus on problems on unbounded domains or involving a nonlinear term that may have critical growth.

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T10 – EXISTENCE AND SOLUTION SETS OF IMPULSIVE FUNCTIONAL DIFFERENTIAL INCLUSIONS WITH MULTIPLE DELAY

Mohamed Helal

In this talk, we present some existence results of solutions and study the topological structure of solution sets for the first-order impulsive neutral functional differential inclusions with some initial conditions. Our existence result relies on a nonlinear alternative for compact u.s.c. maps. We present some existence results and investigate the compactness of solution sets, some regularity of operator solutions and absolute retract (in short AR). The continuous dependence of solutions on parameters in the convex case is also examined.

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T11 – SECOND ORDER STATE DEPENDENT SWEEPING PROCESS

Mustapha Fateh Yarou

We present some existence results for time and state dependent sweeping process of second order with perturbation in a separable Hilbert space.

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P04 – A NECESSARY CONDITION FOR ASYMPTOTIC CONTROLLABILITY OF
PLANAR SWITCHED SYSTEMS

Andrea Bacciotti

Let F be a family of real square matrices $\{A_i\}$, and let S be the switched linear system defined by F . A well known result states that if there exists a Hurwitz matrix which can be written as a convex combination of the matrices A_i , then S can be stabilized at the origin by means of a periodic (of arbitrarily small period) switching signal independent of the initial state. In this talk, we propose a converse of this statement for the planar case.

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T12 – CYCLIC VECTORS OF ASSOCIATIVE MATRIX ALGEBRAS AND
REACHABILITY CRITERIA FOR LINEAR AND NON-LINEAR CONTROL SYSTEMS

Andrey Sarychev

Motivated by the controllability/reachability problems for switched linear control systems and some classes of nonlinear (mechanical) control systems we address a related problem of existence of a cyclic vector for an associative (matrix) algebra. We provide a sufficient criterion for existence of cyclic vector and draw conclusions for controllability.

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T13 – SET EVOLUTION EQUATIONS MODELING CROWD DYNAMICS

Rinaldo M. Colombo

This talk is devoted to a class of set evolution equations that can be used to describe population's movements as well as various instances of individual-population interactions. Optimal control/management problems can be formalized and tackled in this framework. A rigorous analytical structure is established and the basic well posedness results are obtained. Several examples show possible applications and their numerical integrations display possible qualitative behaviors of solutions.

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T14 – COMPUTING THE DISTRIBUTION OF THE SUM OF DEPENDENT
RANDOM VARIABLES VIA OVERLAPPING HYPERCUBES

Marcello Galeotti

The original motivation of this work comes from a classic problem in finance and insurance: that of computing the Value-at-Risk (VaR) of a portfolio of dependent risky positions, i.e., the quantile at a certain level of confidence of the loss distribution. In fact, it is difficult to overestimate the importance of the concept of VaR in modern finance and insurance. It

has been recommended, although with several warnings, as a measure of risk and the basis for capital requirement determination by both the guidelines of international committees (such as Basel 2 and 3 and Solvency 2) and the internal models adopted by major banks and insurance companies. However, the actual computation of the VaR of a portfolio constituted by several dependent risky assets is often a hard practical and theoretical task. To this purpose, here we prove the convergence of a geometric algorithm (alternative to Monte Carlo and quasi-Monte Carlo methods) for computing the Value-at-Risk of a portfolio of any dimension, i.e., the distribution of the sum of its components, which can exhibit any dependence structure. Moreover, although the original motivation is financial, our result has a relevant measure-theoretical meaning. What we prove, in fact, is that the H -measure of a d -dimensional simplex (for any $d \geq 2$ and any absolutely continuous with respect to Lebesgue measure H) can be approximated by convergent algebraic sums of H -measures of hypercubes (obtained through a self-similar construction).

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T15 – SOME FIXED POINT THEOREMS FOR SET-VALUED MAPPINGS IN METRIC SPACES

Elham Garaylikorpi

In this paper, we study the Generalized Hausdorff metric and we prove some fixed point theorems for weakly contractive multi-valued mappings in metric space and partially ordered metric space using the generalized Hausdorff metric. Presented theorems extend and generalize many existing results in the literature.

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T16 – INFECTION TIME IN MULTI-STABLE GENE NETWORKS. A BSDE WITH NON-CONVEX, TREND-DEPENDENT REFLECTION APPROACH

Eduard Rotenstein

We investigate a mathematical model associated to the infection time in multistable gene networks. The mathematical processes are of hybrid switch type. The switch is governed by pure jump modes and linked to DNA bindings. The differential component follows backward stochastic dynamics (of PDMP type) and is reflected in some mode-dependent non-convex domains. First, we study the existence of solution to these backward stochastic variational inclusions (BSVI) by reducing them to a family of ordinary variational inclusions with generalized reflection in semiconvex domains. Second, by considering control-dependent drivers, we hint to some model-selection approach by embedding the (controlled) BSVI in a family of regular measures. Regularity, support and structure properties of these sets are given.

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T17 – THE STABILITY OF GENERALIZED ADDITIVE SET-VALUED FUNCTIONAL EQUATIONS

Sun Jang

We define the following set-valued functional equations

$$f(x_1 + \cdots + x_l) = (l - 1)f\left(\frac{x_1 + \cdots + x_{l-1}}{l - 1}\right) + f(x_l)$$

where $l \geq 2$ is a natural number and prove the Hyers-Ulam stability of set-valued functional equations.

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on the occasion of Giulio Pianigiani's 70th birthday
26 - 27 November 2015, Florence, Italy



Final Program

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08:50-09:00		Opening Cerimony		
09:00-10:00	P01	Alberto Bressan	09:00-10:00	P04 Andrea Bacciotti
10:00-10:25	T01	<i>Vasile Staicu</i>	10:00-10:25	T12 <i>Andrey Sarychev</i>
10:25-10:40			10:25-10:40	
10:40-11:40	P02	Luciano Pandolfi	10:40-11:05	T13 <i>Rinaldo M. Colombo</i>
11:40-12:05	T02	<i>Fabio Zanolin</i>	11:05-11:30	T14 <i>Marcello Galeotti</i>
12:05-12:30	T03	<i>Giuseppina D'Agui</i>	11:30-11:55	T15 <i>Elham Garaylikorpi</i>
12:30-14:00		LUNCH	11:55-12:20	T16 <i>Eduard Rotenstein</i>
14:00-15:00	P03	Nikolaos Papageorgiou	12:20-12:45	T17 <i>Sun Jang</i>
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16:05-16:30	T06	<i>Pasquale Candito</i>		
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18:00-18:25	T10	<i>Mohamed Helal</i>		
18:25-18:50	T11	<i>M.F. Yarou</i>		

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