Mathematics in the City Beautiful:
PDEs, SDEs, Control Theory, and Applications to Finance and Life Sciences

December 14-16, 2018
University of Central Florida
Orlando, Florida, United States

On the Occasion of Jiongmin Yong's 60th Birthday

Co-sponsored by
UCF Department of Mathematics
UCF College of Sciences
University of Central Florida

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The conference "*Mathematics in the City Beautiful: PDEs, SDEs, Control Theory, and Applications to Finance and Life Sciences*" is held at the University of Central Florida, Orlando, FL during December 14-16, 2018, on the occasion of Professor Jiongmin Yong's 60th Birthday. The theme is on advanced development of new theories, new methods and new results in partial differential equations, stochastic differential equations, and control theory, with applications to real world problems from finance and life sciences.

Scientific Committee

- **William Hager**, University of Florida
- **Suzanne Lenhart**, University of Tennessee
- **Xin Li**, University of Central Florida
- **Eduardo Teixeira**, University of Central Florida
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Conference Sponsors

- UCF Department of Mathematics
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CITY OF ORLANDO

December 14, 2018

Welcome! On behalf of the City of Orlando, it is my pleasure to welcome you to our community for “Mathematics in the City Beautiful: PDEs, SDEs, Control Theory, and Applications to Finance and Life Sciences.”

We’re thrilled to be hosting an event that showcases mathematics with a focus on advanced development of new theories, new methods and new results. The conference is also a wonderful opportunity to celebrate Professor Jiongmin Yong’s 60th birthday.

Your event is set in one of the country’s fastest-growing and most dynamic cities. With a vibrant dining scene, first-rate hotels, diverse arts and cultural opportunities, endless shopping options and many outdoor activities, Orlando has so much to offer. I invite you to explore our community during your visit. You probably know that Orlando is America’s most-visited destination, but there is so much more.

We’re proud that our city is diverse, inclusive and welcoming, which is reflected in our 10 Orlando Main Streets districts, which are filled with unique restaurants and shops. Downtown Orlando is experiencing an entertainment and sports renaissance thanks to venues like the Amway Center, Dr. Phillips Center for the Performing Arts, Camping World Stadium and Orlando City Soccer Stadium.

I hope you have a wonderful conference, but also take some time to discover the other half of Orlando!

Sincerely,

Buddy Dyer
Mayor

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University of Central Florida

Department of Mathematics

December 10, 2018

Dear MCB Conference Participants,

It is my pleasure to welcome you to the Conference "*Mathematics in the City Beautiful: PDEs, SDEs, Control Theory, and Applications to Finance and Life Sciences.*"

The mission of the Department of Mathematics at the University of Central Florida is to offer the opportunity for excellence and development to students with visionary and relevant programs of high quality at the undergraduate and graduate levels and to advance mathematical research to benefit society. To accomplish this mission the faculty and the staff of the department have set high goals. We aim to provide the best undergraduate mathematics program in the state of Florida. We offer doctoral and masters programs that encourages student to develop into mathematicians. We also foster a dedication to word-class research by faculty and students at all levels in a broad variety of areas of mathematics.

On behalf of the Scientific and Organizing Committees, I invite you to make the most of this conference by not only attending talks in a variety of research areas but also by reconnecting with friends and collaborators and meeting new colleagues. Also, I encourage you to take a walk together and explore the many different parts of our campus. Finally I would like to extend my congratulations to my departmental colleague Jiongmin Yong who is being honored at the conference on the occasion of his 60th birthday.

Enjoy your stay with us!

Xin Li
Professor and Chair
Department of Mathematics
University of Central Florida

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Mathematics in the City Beautiful: PDEs, SDEs, Control Theory, and Applications to Finance and Life Sciences

December 14-16, 2018, University of Central Florida, Orlando, Floirda, United States

Conference Schedule

	Friday (Dec 14)		Saturday (Dec 15)		Sunday (Dec 16)	
8:00-9:00	Registration (8:00-10:00) in BA1 119 Welcome Remarks (9:00-9:10) in BA1 119		Registration (8:00-10:00) in BA1 119		Registration (8:00-10:00) in BA1 119	
	BA1 119		BA1 119		BA1 119	
9:00-10:00	Tyrone Duncan		Mary Ann Horn		George Yin	
10:00-10:30	Coffee Break		Coffee Break		Coffee Break	
	BA1 121	BA1 122	BA1 121	BA1 122	BA1 121	BA1 122
10:30-11:00	Bingyu Zhang	Qing Zhang	Bozenna Pasik-Duncan	Bei Hu	Christian Keller	Ruoyu Wu
11:00-11:30	Scott Hansen	Qiji Zhu	Hongwei Long	Zhuangyi Liu	Michael Tseng	Tuan Phan
11:30-12:00	George Avalos	Ali Lazrak	Jianfeng Zhang	Rachel Leander	BA1 119 (11:30-12:30)	
12:00-12:30	Pelin Guven Geredeli	JJ Lay	Hongwei Mei	Yanqiu Guo	Xu Zhang	
12:30-14:30	Lunch Break		Lunch Break		Conference concludes at 12:30	
	BA1 121	BA1 122	BA1 121	BA1 122		
14:30-15:00	Chao Zhu	Hongwei Lou	Kandethody Ramachandran	William Hager		
15:00-15:30	Ilie Grigorescu	Yao Li	Tao Pang	Michael Kelly		
15:30-16:00	Haisen Zhang	Mozhgan Entekhabi	Haimei Shao	Ting-Hao Hsu		
16:00-16:30	Coffee Break		Group Picture (16:00-16:10) Coffee Break			
	BA1 119		BA1 119			
16:30-17:30	Jin Ma		Suzanne Lenhart			
17:30-19:00	Welcome Reception/Poster Session (17:30-19:00)		Cash bar starts at 18:00			
19:00-21:00			Banquet (19:00-21:00) in Live Oak Event Center			

Daily Schedule
Friday December 14

	8:00-9:00	Registration desk opens (BA1 119)
	9:00-9:10	Welcome Ceremony (BA1 119)

PLENARY TALK

Page	Room: BA1 119	Session Chair: Suzanne Lenhart
6	9:10-10:10	**Tyrone Duncan**, *Explicit Solvability for Stochastic Control and Stochastic Differential Games*
	10:10-10:30	COFFEE BREAK

PARALLEL TALKS

	Room: BA1 121	Session Chair: Bei Hu
23	10:30-11:00	**Bingyu Zhang**, *Control and Stabilization of a Class of KdV-KdV Systems on a Periodic Domain*
13	11:00-11:30	**Scott Hansen**, *Spaces of Exact Controllability for PDEs Involving an Interior Point-Mass*
10	11:30-12:00	**George Avalos**, *Qualitative Properties of a Multilayered Structure-Fluid PDE*
12	12:00-12:30	**Pelin Guven Geredeli**, *A Semigroup Formulation and Qualitative Analysis of A Linearized Compressible Flow-Plate Interaction*

PARALLEL TALKS

	Room: BA1 122	Session Chair: Jin Ma
24	10:30-11:00	**Qing Zhang**, *Switching Between A Pair of Stocks: An Optimal Trading Rule*
25	11:00-11:30	**Qiji Zhu**, *Generalized Convex Duality in Contingent Claims Pricing and Hedging*
16	11:30-12:00	**Ali Lazrak**, *Belief Polarization and Investment*
15	12:00-12:30	**JJ Lay**, *An Antithetic Multilevel Monte Carl Implementation of the Stochastic Volatility and Interest Rate Model Using a Multi-GPU Cluster*
	12:30-14:30	LUNCH BREAK

Friday December 14 (cont.)

PARALLEL TALKS

Room: BA1 121 Session Chair: Jianfeng Zhang

25 14:30-15:00 **Chao Zhu**, *Regime-Switching Jump Diffusions with Non-Lipschitz Coefficients and Countably Many Switching States*

11 15:00-15:30 **Ilie Grigorescu**, *Particle Representation of a Heat Equation with Mass Creation*

23 15:30-16:00 **Haisen Zhang**, *Second-Order Necessary Conditions for Stochastic Optimal Control Problems*

PARALLEL TALKS

Room: BA1 122 Session Chair: Bingyu Zhang

18 14:30-15:00 **Hongwei Lou**, *Turnpike Properties of Optimal Relaxed Control Problems*

17 15:00-15:30 **Yao Li**, *Invariant Probability Measures of Stochastic Differential Equations: Theory and Computation*

10 15:30-16:00 **Mozhgan Entekhabi**, *Inverse Source Problem for Wave Propagation*

16:00-16:30 COFFEE BREAK

PLENARY TALK

Room: BA1 119 Session Chair: Tyrone Duncan

8 16:30-17:30 **Jin Ma**, *Conditional McKean-Vlasov SDEs and Some Related Stochastic Optimization Problems*

17:30-19:00 WELCOME RECEPTION / POSTER SESSION

26 **Hanxiao Wang**, *Recursive Utility Processes, Dynamic Risk Measures, and Quadratic BSVIEs*

26 **Wei Yan**, *Time-Inconsistent Mean-Field Optimal Control Problems and the Equilibrium HJB Equation*

27 **Shen Zhang**, *Positive Ground State Solutions for p-Laplacian Equations with a General Critical Nonlinearity*

Saturday December 15

	8:00-9:00	Registration desk opens (BA1 119)
		PLENARY TALK
Page	Room: BA1 119	Session Chair: George Yin
7	9:00-10:00	**Mary Ann Horn**, *There and Back Again: An Exploration of How a Control Theorist Journeyed from Elastic Systems to Biological Applications*
	10:00-10:30	COFFEE BREAK
		PARALLEL TALKS
	Room: BA1 121	Session Chair: Christian Keller
20	10:30-11:00	**Bozenna Pasik-Duncan**, *Linear-Quadratic Control for Bilinear Evolution Equations with Gauss-Volterra Processes*
18	11:00-11:30	**Hongwei Long**, *Generalized Moment Estimators for α-Stable*
24	11:30-12:00	**Jianfeng Zhang**, *Dynamic Programming Principle for Non-zero-sum Games*
19	12:00-12:30	**Hongwei Mei**, *Comparison Principle for a Hamilton-Jacobi Equation in the Context of Stochastic Vortex Dynamics*
		PARALLEL TALKS
	Room: BA1 122	Session Chair: Scott Hansen
14	10:30-11:00	**Bei Hu**, *PDE Tumor Models*
17	11:00-11:30	**Zhuangyi Liu**, *Finer and Sharper Energy Decay Rate for an Elastic String with Localized Kelvin-Voigt Damping*
16	11:30-12:00	**Rachel Leander**, *Modeling the Role of Memory in Cell Cycle Progression*
11	12:00-12:30	**Yanqiu Guo**, *Inertial Manifold for the Hyperviscous Navier-Stokes Equations*
	12:30-14:30	LUNCH BREAK

Saturday December 15 (cont.)

PARALLEL TALKS

Room: BA1 121 Session Chair: Qing Zhang

21	14:30-15:00	**Kandethody Ramachandran**, *Statistical Learning methods for Real Time Activity Recognition Using Smartphone Accelerometer*
19	15:00-15:30	**Tao Pang**, *A New Stochastic Model for Stock Price with Delay Effects*
21	15:30-16:00	**Haimei Shao**, *Manage RMBS in a Simple Way*

PARALLEL TALKS

Room: BA1 122 Session Chair: George Avalos

12	14:30-15:00	**William Hager**, *Solution of Optimal Control Problem by Orthogonal Collocation*
15	15:00-15:30	**Michael Kelly**, *Marine Reserves and Optimal Dynamic Harvesting When Fishing Damages Habitat*
13	15:30-16:00	**Ting-Hao Hsu**, *Growth on Two Limiting Essential Resources in a Self-Cycling Fermentor*
	16:00-16:10	GROUP PICTURE
	16:10-16:30	COFFEE BREAK

PLENARY TALK

Room: BA1 119 Session Chair: Hongwei Lou

7	16:30-17:30	**Suzanne Lenhart**, *Optimal Control Techniques for Management Strategies in Ecological Models*
	18:00-19:00	CASH BAR (UCF Live Oak Event Center)
	19:00-21:00	BANQUET (UCF Live Oak Event Center)

Sunday December 16

	8:00-9:00	Registration desk opens (BA1 119)
		PLENARY TALK
Page	Room: BA1 119	Session Chair: Chao Zhu
8	9:00-10:00	**George Yin**, *Stochastic Kolmogorov Systems: Some Recent Results*
	10:00-10:30	COFFEE BREAK
		PARALLEL TALKS
	Room: BA1 121	Session Chair: Hongwei Mei
14	10:30-11:00	**Christian Keller**, *Fully Nonlinear Stochastic and Rough PDEs: Classical and Viscosity Solutions*
22	11:00-11:30	**Michael Tseng**, *Price Discovery for Options*
		PARALLEL TALKS
	Room: BA1 122	Session Chair: Wei Yan
22	10:30-11:00	**Ruoyu Wu**, *SDE with Vanishing Rates and Reflection: Large Deviations and Calculus of Variations Problems*
20	11:00-11:30	**Tuan Phan**, *A Stochastic Cholera Epidemic Model with a General Nonlinear Incidence*
		PLENARY TALK
Page	Room: BA1 119	Session Chair: Zhisheng Shuai
9	11:30-12:30	**Xu Zhang**, *An Invitation to Control Theory of Stochastic Distributed Parameter Systems*
	12:30	CONFERENCE CONCLUDES

Abstracts of Plenary Talks

Dec 14, 9:10–10:10, Room 119

Explicit Solvability for Stochastic Control and Stochastic Differential Games

Tyrone E. Duncan
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Determining explicit optimal control strategies is a significant impediment for the realization of solutions to many stochastic control and stochastic differential game problems. Historically the methods of solutions for these problems have been the solutions of some nonlinear partial differential equations or the solutions of some forward-backward stochastic differential equations. Both of these methods limit the possibility of solutions for many interesting control and game problems. In particular nonlinear equation problems with Brownian motion noise or linear equation problems with non-Markovian noise are particularly difficult with the latter problems not feasible by partial differential equation methods which require Markovian processes. A direct method for solutions is given to extend the family of solvable stochastic control and stochastic differential game problems. Various examples are provided for this method that include some problems for nonlinear equations with Brownian motions that evolve in symmetric spaces and some problems for linear equations having Gauss-Volterra process noise that include fractional Brownian motions and (non-Gaussian) Rosenblatt processes.

Dec 15, 9:00–10:00, Room 119

There and Back Again: An Exploration of How a Control Theorist Journeyed from Elastic Systems to Biological Applications

Mary Ann Horn
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Trained in a applied mathematics department, my graduate studies were in control theory with a focus on engineering applications, but with a strong theoretical bent. My work focused on boundary control of elastic systems, primarily plate equations, three-dimensional elasticity, and coupled elastic systems. The questions I addressed included issues of existence and uniqueness, as well as unique continuation, stability, and controllability, through the use of techniques from applied functional analysis and partial differential equations. Yet, as the years went by, I was drawn to problems in the biological sciences and took advantage of opportunities for collaboration stemming from my time at Vanderbilt to use many of the modeling and analytical skills I developed in my earlier work to address questions about the development and spread of antibiotic resistance in bacteria, as well as to study cellular signaling cascades in more complex systems. Ironically, although it initially seemed that these biological applications were leading away from my roots, questions of control consistently keep arising. This talk provides an overview of various aspects of my research through the years.

Dec 15, 16:30–17:30, Room 119

Optimal Control Techniques for Management Strategies in Ecological Models

Suzanne Lenhart
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This talk will illustrate the application of optimal control of ODEs or PDEs to achieve desired management goals in ecological systems. One example will involve control of a system of ordinary differential equations representing native and invasive populations. Another example has a stochastic feature but can be reduced to optimal control of differential equations. In making decisions relating to a large scale forest fire, we incorporate the stochasticity of the time of a fire into our model and explore the trade-offs between prevention management spending and suppression spending. We also present a model with spatiotemporal dynamics of a fish stock and its habitat. Techniques of optimal control of PDEs are used to investigate the harvest rates that maximize the discounted value while minimizing the negative effects on the habitat.

Dec 14, 16:30–17:30, Room 119

Conditional McKean-Vlasov SDEs and Some Related Stochastic Optimization Problems

Jin Ma
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We study a class of conditional McKean-Vlasov SDEs (CMVSDEs, for short), in which all dynamics involve both the state and the conditional law of the solutions. We first investigate the (weak) well-posedness of the CMVSDEs in its most general form, and then look at two applications based on particular cases of such equations: a mean-field type stochastic control problems with partial observations and an extended form of the so- called Kyle-Back strategic insider trading equilibrium problem. In the former we prove the corresponding Pontryagin's Stochastic Maximum Principle, and in the latter we seek a rigorous theoretical basis for the general Kyle-Back strategic insider trading equilibrium model, in the case when the insider is allowed to have dynamic information of the underlying asset rather than only the static one. The theoretical results on CMVSDEs will enable us to tie some loose ends of the heuristic arguments in the literature of this problem.

This talk is based on the joint works with Rainer Buckdahn, Juan Li, Yonghui Zhou, and Rentao Sun.

Dec 16, 9:00–10:00, Room 119

Stochastic Kolmogorov Systems: Some Recent Results

George Yin
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In this talk, we study stochastic Kolmogorov systems. The motivation stems from the need for treatment of ecological, biological, and environmental systems. Concentrating on environmental noise, the fundamental issues that we wish to address are: What are the minimal conditions for long-term persistence of a population, or for the long-term coexistence of interacting species? We present some recent work in this direction.

Dec 16, 11:30–12:30, Room 119

An Invitation to Control Theory of Stochastic Distributed Parameter Systems

Xu Zhang
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Control theory for ODE systems is now relatively mature. There exist a huge list of works on control theory for (deterministic) distributed parameter systems though it is still quite active; while the same can be said for control theory for stochastic systems in finite dimensions. In this talk, I will give a short introduction to control theory of stochastic distributed parameter systems (governed by stochastic differential equations in infinite dimensions, typically by stochastic PDEs), which is, in some sense, almost at its very beginning stage. I will mainly explain the new phenomenon and difficulties in the study of controllability and optimal control problems for these sort of equations. In particular, I will show by some examples that both the formulation of stochastic control problems and the tools to solve them may differ considerably from their deterministic/finite-dimensional counterparts. Interestingly enough, one has to develop new mathematical tools to solve some problems in this field.

Abstracts of Parallel Talks

Dec 14, 11:30–12:00, Room 121

Qualitative Properties of a Multilayered Structure-Fluid PDE

George Avalos
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In this talk, we consider a partial differential equation (PDE) system which models a fluid-structure interaction of current interest in mathematical literature. Each PDE component evolves on its own distinct geometry. The structure component is composed of a thin layer and a thick layer; the thin layer serves as an interface between the respective fluid and (thick layer) structure dynamics. We will discuss some preliminary results of the corresponding fluid-structure solutions, including results of long time decay.

This is joint work with Pelin Guven Geredeli and Boris Muha.

Dec 14, 15:30–16:00, Room 122

Inverse Source Problem for Wave Propagation

Mozhgan (Nora) Entekhabi
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Inverse source scattering problem arises in many areas of science. It has numerous applications to surface vibrations, acoustical and bio-medical industries, and material science. In particular, inverse source problem seeks the radiating source which produces the measured wave field. This research aims to provide a technique for recovering the source function of the classical elasticity system and the Helmholtz equation from boundary data at multiple wave numbers when the source is compactly supported in an arbitrary bounded C^2 boundary domain, establish uniqueness for the source from the Cauchy data on any open non empty part of the boundary for arbitrary positive K, and increasing stability when wave number K is getting large. Various studies showed that the uniqueness can be regained by taking multifrequency boundary measurement in a non-empty frequency interval $(0, K)$ noticing the analyticity of wave-field on the frequency. One of important examples is recovery of acoustic sources from boundary measurement of the pressure. This type of inverse source problem is also motivated by the wide applications in antenna synthesis, medical imaging and geophysics.

Dec 14, 15:00–15:30, Room 121

Particle Representation of a Heat Equation with Mass Creation

Ilie Grigorescu
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We solve the heat equation for a second-order linear operator L on the bounded domain $D \subseteq \mathbb{R}^d$ under non-classical boundary conditions (super-critical) which prescribe that the inward flux entering D at interior points with a given distribution γ be equal to $\bar{K} > 1$ times the outward flux on ∂D. A weak solution to the forward equation exists and can be represented as the the expected value of a non-conservative particle process driven by L inside D, branching at ∂D with branching constant $\bar{K}$. We provide exact estimates on its growth rate and study the associated backward equation. Uniqueness requires a mild condition on the density of the exit time from D of the diffusion driven by L. In the spacial case of $\gamma = \delta_c$, $c \in D$, we prove the existence of a strong solution. The main application and motivation is that, normalized to have total mass equal to one, the solution is the hydrodynamic limit of the conservative Branching Diffusions particle system.

Dec 15, 12:00–12:30, Room 122

Inertial Manifold for the Hyperviscous Navier-Stokes Equations

Yanqiu Guo
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We prove the existence of an inertial manifold, i.e., a globally invariant, exponentially attracting, finite-dimensional smooth manifold, for the hyperviscous Navier-Stokes equations on a three-dimensional torus. Since the spectral gap condition is not available for the problem in three dimensions, we employ the spatial averaging method introduced by Mallet-Paret and Sell.

Dec 14, 12:00–12:30, Room 121

A Semigroup Formulation and Qualitative Analysis of A Linearized Compressible Flow-Plate Interaction

Pelin Guven Geredeli
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We address semigroup wellposedness for a linear, compressible viscous fluid interacting at its boundary with an elastic plate. We derive the model by linearizing the compressible Navier-Stokes equations about an arbitrary flow state, so the fluid PDE includes an ambient flow profile U. The non-dissipative flow structure model is considered (i) with a pure velocity matching condition at the interface; (ii) with an interface condition given in terms of the material derivative of the structure, $(\partial t + U \cdot \nabla)w$. We adopt here a Lumer-Phillips approach, with a view of associating fluid-structure solutions with a C_0-semigroup e^{At} on a suitable finite energy space of initial data.

Dec 15, 14:30–15:00, Room 122

Solution of Optimal Control Problem by Orthogonal Collocation

William Hager
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The talk examines the convergence rates for Gauss and Radau-based orthogonal collocation methods applied to optimal control problems.

Dec 14, 11:00–11:30, Room 121

Spaces of Exact Controllability for PDEs involving an Interior Point-Mass

Scott Hansen
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I will describe a number of results related to the problem of controlling a one-dimensional Schrodinger equation, beam equation, or heat equation from a single endpoint when there is an internal point mass.

Dec 15, 15:30–16:00, Room 122

Growth on Two Limiting Essential Resources in a Self-Cycling Fermentor

Ting-Hao Hsu
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A system of impulsive differential equations with state-dependent impulses is used to model the growth of a single population on two limiting essential resources in a self-cycling fermentor. The self-cycling fermentation process is a semi-batch process and the model is an example of a hybrid system. In this case, a well-stirred tank is partially drained, and subsequently refilled using fresh medium when the concentration of both resources falls below some prescribed threshold. We consider the process successful if the threshold for emptying and refilling the reactor can be reached indefinitely without the time between successive emptying/refilling becoming unbounded and without interference by the operator. We prove that whenever the process is successful, the model predicts that the concentrations of the population and the resources converge to a positive periodic solution. We derive conditions for the successful operation of the process that are show to be initial condition dependent and prove that if these conditions are not satisfied, then the reactor fails after at most finitely many impulses. We show numerically that there is an optimal fraction of the medium drained from the tank at each impulse that maximizes the output of the process. Potential applications include water purification and biological waste remediation.

This is joint work with Tyler Meadows, Lin Wang, and Gail S.K. Wolkowicz.

Dec 15, 10:30–11:00, Room 122

PDE Tumor Models

Bei Hu
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We shall discuss the most recent progress (joint work with many others) on the PDE tumor models, the bifurcation diagram near the bifurcation point, the bifurcation diagram extensions and the intersection of bifurcation diagram for different bifurcation branch, stability, and the numerical implementation, including special numerical solutions. The talk includes most recent results on the study of behaviors of the system.

Dec 16, 10:30–11:00, Room 121

Fully Nonlinear Stochastic and Rough PDEs: Classical and Viscosity Solutions

Christian Keller
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We study fully nonlinear second-order (forward) stochastic PDEs. They can also be viewed as forward path-dependent PDEs and will be treated as rough PDEs under a unified framework. We develop first a local theory of classical solutions and define then viscosity solutions through smooth test functions. Our notion of viscosity solutions is equivalent to the alternative one using semi-jets. Next, we prove basic properties such as consistency, stability, and a partial comparison principle in the general setting. When the diffusion coefficient is semi-linear (but the drift can be fully nonlinear), we establish a complete theory, including global existence and comparison principle. Our methodology relies heavily on the method of characteristics.

This is joint work with Rainer Buckdahn, Jin Ma, and Jianfeng Zhang.

Dec 15, 15:00–15:30, Room 122

Marine Reserves and Optimal Dynamic Harvesting When Fishing Damages Habitat

Michael Kelly
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Marine fisheries are a significant source of protein for many human populations. In some locations, however, destructive fishing practices have negatively impacted the quality of fish habitat and reduced the habitat's ability to sustain fish stocks. Improving the management of stocks that can be potentially damaged by harvesting requires improved understanding of the spatiotemporal dynamics of the stocks, their habitats, and the behavior of the harvesters.We develop a mathematical model for both a fish stock as well as its habitat quality. Both are modeled using nonlinear, parabolic partial differential equations, and density-dependence in the growth rate of the fish stock depends upon habitat quality. The objective is to find the dynamic distribution of harvest effort that maximizes the discounted net present value of the coupled fishery-habitat system. The value derives both from extraction (and sale) of the stock and the provisioning of ecosystem services by the habitat. Optimal harvesting strategies are found numerically. The results suggest that no-take marine reserves can be an important part of the optimal strategy and that their spatiotemporal configuration depends both on the vulnerability of habitat to fishing damage and on the timescale of habitat recovery when fishing ceases.

Dec 14, 12:00–12:30, Room 122

An Antithetic Multilevel Monte Carl Implementation of the Stochastic Volatility and Interest Rate Model Using a Multi-GPU Cluster

JJ Lay
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The Black-Scholes equation introduced a mathematical solution to the pricing of financial options. This model required a constant interest rate and volatility, while Heston provided a model that allowed volatility to be stochastic. Simulation is a frequently used method to solve systems of SDEs such as the stochastic volatility, stochastic interest rate model. We explore different methods of improving the performance of such solutions through the use of antithetic multilevel Monte Carlo and GPUs. This implementation provides a significant reduction in the time of the simulation and can be extended to other problems in areas such as those in wind speed simulation and cybersecurity.

Dec 14, 11:30–12:00, Room 122

Belief Polarization and Investment

Ali Lazrak
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We study a canonical real option model where the decisions to acquire and exercise an option are made sequentially by a group of agents with heterogeneous beliefs. Applying results from the political economy literature on spatial voting, we show that when the group mediates disagreement through voting, inefficient underinvestment can occur: although each group member would acquire the option if he had post-acquisition control rights, the group votes against acquisition. We show that this inefficiency occurs when group members' beliefs are polarized, that is, divided into two opposing factions of equal size. Given the pervasive nature of group decisions in the life of organizations and institutions, our theory is particularly relevant for the behavior of venture capitalists, financing syndicates, corporate boards, and committees at large.

Dec 15, 11:30–12:00, Room 122

Modeling the Role of Memory in Cell Cycle Progression

Rachel Leander
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Recent work suggests that "memories" of mitotic signaling are passed from mother to daughter cell and can heavily influence the dynamics with which a cell progresses through the cell cycle. Motivated by these experimental findings, we investigate alternative models of memory in stochastic cell cycle progression and evaluate the ability of these models to describe both division time distributions and correlations in the division times of related cells. In this talk, I will discuss our biological results as well as the numerical challenges/techniques for model selection and parameter estimation in this context.

Dec 14, 15:00–15:30, Room 122

Invariant Probability Measures of Stochastic Differential Equations: Theory and Computation

Yao Li
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In this talk I will summarize some of my recent result on the rigorous estimations and numerical computations of invariant probability measures of stochastic differential equations. The rigorous result is based on my joint papers with Yingfei Yi, which gives upper and lower bound of concentration of the invariant probability measure at the global attractor. Then I will introduce a novel data-driven approach to compute the density function of the invariant probability measure with low cost, high accuracy, and little restrictions on the domain.

Dec 15, 11:00–11:30, Room 122

Finer and Sharper Energy Decay Rate for an Elastic String with Localized Kelvin-Voigt Damping

Zhuangyi Liu
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This presentation is on the asymptotic behavior of the elastic string equation with localized Kelvin-Voigt damping

$$u_{tt}(x,t) - [u_x(x,t) + b(x)u_{xt}(x,t)]_x = 0,\ x \in (-1,1),\ t > 0,$$

where $b(x) = 0$ on $x \in (-1,0]$, and $b(x) = a(x) > 0$ on $x \in (0,1)$. Under the assumption that $a(x) = x^\alpha \geq 0$, we investigate the decay rate and regularity of the solution in terms of α. Moreover, when $a(x)$ behaves like $x^\alpha(-\log x)^{-\beta}$ near $x = 0$ for $0 \leq \alpha < 1,\ 0 \leq \beta$ or $0 < \alpha < 1,\ \beta < 0$, we show that the system can achieve a mixed polynomial-logarithmic decay rate.

In addition, when $\beta = 0$, we obtain the decay rate $t^{-\frac{2-\alpha}{1-\alpha}}$ which improves the rate $t^{-\frac{1}{1-\alpha}}$ earlier. The new rate is consistent with the optimal decay rate t^{-2} in the limit case $\alpha = 0$ and $a(x)$ is a constant.

Dec 15, 11:00–11:30, Room 121

Generalized Moment Estimators for α-Stable

Hongwei Long
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We study the parameter estimation problem for discretely observed Ornstein-Uhlenbeck processes driven by α-stable Levy motions. A method of moments via ergodic theory and via sample characteristic functions is proposed to estimate all the parameters involved in the Ornstein-Uhlenbeck processes. We obtain the strong consistency and asymptotic normality of the proposed joint estimators when the sample size $n \to \infty$ while the sampling time step h remains arbitrarily fixed.

Dec 14, 14:30–15:00, Room 122

Turnpike Properties of Optimal Relaxed Control Problems

Hongwei Lou
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In this talk, three kinds of turnpike properties for optimal relaxed control problems are considered. Under some convexity and controllability assumptions, we obtain the uniform boundedness of the optimal pairs and the adjoint functions. Then we get the integral turnpike property, the mean square turnpike property and the exponential turnpike property, respectively.

Joint work with Weihan Wang, Shanghai Normal University.

Dec 15, 12:00–12:30, Room 121

Comparison Principle for a Hamilton-Jacobi Equation in the Context of Stochastic Vortex Dynamics

Hongwei Mei
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I introduce a Hamilton-Jacobi equation from stochastic vortex dynamics and prove its comparison principle.

Dec 15, 15:00–15:30, Room 121

A New Stochastic Model for Stock Price with Delay Effects

Tao Pang
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We consider a portfolio optimization problem over an infinite time horizon, in which the stock price follows a generalized geometric Brownian motion model with delay effects. The problem is formulated as a stochastic control problem where the goal is to choose the optimal investment and consumption controls that maximize total expected discounted utility. Dynamic programming method is used to derive the Hamilton-Jacobi-Bellman (HJB) equation and we then establish the existence and uniqueness results.

This is joint work with Y. Yong.

Dec 15, 10:30–11:00, Room 121

Linear-Quadratic Control for Bilinear Evolution Equations with Gauss-Volterra Processes

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Some control problems are explicitly solved for bilinear evolution equations where the noise is a Gauss-Volterra process. The controls are chosen from the family of linear feedback gains. The optimal gain is different from the control problem for a linear equation with a quadratic cost functional. Some examples are given.

Dec 16, 11:00–11:30, Room 122

A Stochastic Cholera Epidemic Model with a General Nonlinear Incidence

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Cholera is an ancient disease that became a worldwide health problem with six out of the seven cholera pandemics since 1816. Although various mathematical models and clinical studies published in recent years have made important contribution to cholera epidemiology, our knowledge of the disease mechanism remains incomplete at present. In this talk, I will discuss the long time behavior of a cholera epidemic model with a non-linear environment-dependent-only incidence perturbed by white noise. The dynamics of the model is largely determined by the reproduction number R_0 and noise intensities, which help us develop appropriate control strategies. When noises are small and $R_0 \leq 1$, the disease will extinct. When noises are small and $R_0 > 1$, there exists a stationary distribution of the model, meaning the disease is prevalent. As noises are sufficiently large, the disease will be washed out more likely in population, no matter how large the reproduction number is.

This is joint work with Jianjun Paul Tian.

Dec 15, 14:30–15:00, Room 121

Statistical Learning Methods for Real Time Activity Recognition Using Smartphone Accelerometer

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Human activity recognition (HAR) by the smartphones with embedded sensors is a modern time series application, which is applied in many areas, such as therapeutic applications and sensors of cars, etc. The important procedures related to the HAR problem includes classification, clustering, feature extraction, dimension reduction and segmentation. Segmentation as the first step of HAR analysis attempts to represent the time interval more effectively and efficiently. The traditional segmentation method of HAR is to partition the time series into short and fixed length segments. However, these segments might not be long enough to capture the sufficient information for the entire activity time interval. In this talk, we segment the observations of a whole activity as a whole interval using Online Bayesian Kernel Segmentation algorithm at the first step. The smartphone with built-in accelerometer generates such observations of these activities. Based on the segmenting result, we introduce a two-layers random forest classification method. Continuously, considering the real-time activity recognition application on the smartphones by the embedded accelerometers, the first layer classifies the activities as static and dynamic, the second layer classifies each main groups into the sub-classes depending on the first layer result. We evaluate the performance of our method based on the six activities: sitting, standing, laying, walking, walking upstairs, walking downstairs on 30 volunteers. For the data collected, we get an overall accuracy 92.4% based on the six activities.

Dec 15, 15:30–16:00, Room 121

Manage RMBS in a Simple Way

Haimei Shao
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The valuation and risk management of agency passing-through Mortgage Backed Securities in practice has been massively human-power and computational power required. This talk is to discover a cutting edge, but still effective, method that do not require a team of Ph.Ds armed with super computational power computers. Starting from empirical facts of agency MBS, we derive the prepayment from the price. We find that the price change does not necessarily reflect the change of actual prepayment. The explicit formula discovered provides an alternative way to analyze and valuate the MBS.

Dec 16, 11:00–11:30, Room 121

Price Discovery for Options

Michael Tseng
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Traditional market microstructure models consider price discovery in the financial market where agents have asymmetric information regarding the mean return of a underlying asset. We extend this setting to an equilibrium model where agents have asymmetric information regarding arbitrary higher moments of asset return. Our model allows consideration of price discovery of derivatives, as well as the underlying asset. The trading strategies of the informed agent in our model reflect those used by traders in the market when trying to exploit higher order moment information, such as the volatility straddle.

Dec 16, 10:30–11:00, Room 122

SDE with Vanishing Rates and Reflection: Large Deviations and Calculus of Variations Problems

Ruoyu Wu
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We consider large deviation principles for several different stochastic processes with jumps arising from various models in random graph theory and queueing theory. The process evolution has (multi-dimensional) reflection features and the jump rates may vanish at the boundary. Several calculus of variations problems related to the large deviation rate function are analyzed.

Dec 14, 10:30–11:00, Room 121

Control and Stabilization of a Class of KdV-KdV Systems on a Periodic Domain

Bingyu Zhang
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In this talk, using the recently discovered new smoothing properties of a class of KdV-KdV systems, we show that the systems are exactly controllable and exponentially stabiliizable.

Dec 14, 15:30–16:00, Room 121

Second-Order Necessary Conditions for Stochastic Optimal Control Problems

Haisen Zhang
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In this talk we will present some new results about the second-order necessary conditions for stochastic optimal controls with the control variable entering into both the drift and the diffusion terms. In particular, for the state-unconstrained cases, when the control region is convex, a pointwise second-order necessary condition for stochastic singular optimal controls in the classical sense is established; while when the control region is allowed to be nonconvex, we obtain a pointwise second-order necessary condition for stochastic singular optimal controls in the sense of the Pontryagin-type maximum principle. In addition, using some techniques in variational analysis, we give some integral-type second order necessary conditions for stochastic optimal control problems with state constraints.

Dec 15, 11:30–12:00, Room 121

Dynamic Programming Principle for Non-zero-sum Games

Jianfeng Zhang
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In this talk we shall first explain that for stochastic control problems and zero-sum game problems we prefer closed loop controls than open loop controls. We then consider non-zero-sum game problems with closed loop controls. Such problems typically have multiple equilibriums with multiple values. We propose to study the set of all possible values. It turns out that these value sets enjoy nice properties, in particular the dynamic programming principle, which one can hardly expect for individual values corresponding to individual equilibriums. We finally use the so called moving scalarization to choose an "optimal" equilibrium in a time consistent manner.

The talk is based on an ongoing joint work with Feinstein and Rudloff.

Dec 14, 10:30–11:00, Room 122

Switching Between A Pair of Stocks: An Optimal Trading Rule

Qing Zhang
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This talk is about a stock trading rule involving two stocks. The trader may have a long position in either stock or in cash. She may also switch between them any time. Her objective is to trade over time to maximize an expected return. We reduce the problem to the optimal trading control problem under a geometric Brownian motion model with regime switching. We use a two-state Markov chain to capture the general market modes. In particular, a single market cycle consisting of a bull market followed by a bear market is considered. We also impose a fixed percentage cost on each transaction. We focus on simple threshold type policies and study all possible combinations. We establish algebraic equations to characterize these threshold levels. We also present sufficient conditions that guarantee the optimality of these policies. Finally, some numerical examples are provided to illustrate our results.

Dec 14, 14:30–15:00, Room 121

Regime-Switching Jump Diffusions with Non-Lipschitz Coefficients and Countably Many Switching States

Chao Zhu
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This work focuses on a class of regime-switching jump diffusion processes, which is a two component Markov processes $(X(t), \Lambda(t))$, where $\Lambda(t)$ is a component representing discrete events taking values in a countably infinite set. Considering the corresponding stochastic differential equations, our main focus is on treating those with non-Lipschitz coefficients. We first show that there exists a unique strong solution to the corresponding stochastic differential equation. Then Feller and strong Feller properties are investigated.

Dec 14, 11:00–11:30, Room 122

Generalized Convex Duality in Contingent Claims Pricing and Hedging

Qiji Zhu
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The crucial role convex duality played in the Black-Scholes formula is perhaps one of the best kept secret in financial mathematics. A generalization of this duality can also enable us to deal with problems of hedging and pricing contingent claims using other contingent claims. We will discuss interesting applications of this generalized convex duality along with some open questions.

This talk is based on joint research with Dr. Peter Carr.

Abstracts of Posters

The poster session is held on Friday December 14, 17:30–19:00.

Recursive Utility Processes, Dynamic Risk Measures, and Quadratic BSVIEs

Hanxiao Wang
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For an $\mathcal{F}_T$-adapted payoff of a European type contingent claim, the recursive utility process/dynamic risk measure can be described by the adapted solution to a backward stochastic differential equation (BSDE). For an $\mathcal{F}_T$-adapted stochastic process (called a position process), time-consistent equilibrium recursive utility process/dynamic risk measure should be described by the adapted solution to a backward stochastic Volterra integral equation (BSVIE), instead of a BSDE. With such a motivation, we consider BSVIEs with generators having quadratic growth. The existence and uniqueness for the so-called adapted solutions and adapted M-solutions are obtained. The comparison theorem for adapted solutions is established as well. As consequences of these results, continuous-time equilibrium dynamic risk measures and equilibrium recursive utility processes can be constructed.

Time-Inconsistent Mean-Field Optimal Control Problems and the Equilibrium HJB Equation

Wei Yan
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We considered the time inconsistent problem which is generated by the appearance of conditional expectation in the cost functional through a nonlinear function. The method of differential games is used here to derive the equilibrium HJB equation.

Positive Ground State Solutions for p-Laplacian Equations with a General Critical Nonlinearity

Shen Zhang
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In this paper, we study the following quasilinear elliptic equation

$$-\Delta_p u + V(x)|u|^{p-2}u = f(u), \quad u \in W^{1,p}(\mathbb{R}^N),$$

where $p \in (1, N)$, V is a trapping potential and $f \in C^1(\mathbb{R}, \mathbb{R})$ is a general critical nonlinearity. By using the monotone method developed by Jeanjean and Hardy inequality, we prove the existence of positive ground state solutions for the given problem.

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University of Central Florida

The University of Central Florida, founded in 1963, is one of the fastest growing universities in the United States, and it is currently ranked the second largest university with a total enrollment over 67,000 students.

The university and its 13 colleges offer 216 degree programs from UCF's main campus, hospitality campus, health sciences campus, online and through its 12 regional locations. Regional campuses are located throughout Central Florida and include a fully accredited College of Medicine in the Medical City at Lake Nona. In addition to its impressive size and strength, UCF is ranked as a best-value university by *Kiplinger's*, as well as one of the nation's most affordable colleges by *Forbes*.

The university benefits from a diverse faculty and staff who create a welcoming environment and opportunities for students to grow, learn and succeed.

Department of Mathematics at the University of Central Florida

The Department of Mathematics at the University of Central Florida has 39 research faculty and 13 teaching faculty serving over 5,000 undergraduate and over 100 graduate students and invest heavily on research. Faculty members include invited speakers at the International Congress of Mathematics, the Marcus Wallenberg Prize winner, the ICTP Ramanujan Prize winner, Fellow of the Brazilian Academy of Sciences, Fellows of the American Mathematical Society, and a National Science Foundation CAREER awardee.

The UCF Mathematics Department has offered the PhD program in Mathematics since Fall 1993, with a Financial Mathematics track added in Fall 2017, the Master program in Mathematics since Spring 1971, with an Industrial Mathematics track added in Fall 2000 and a Financial Mathematics track added in Fall 2017, and the Graduate Certificates in Mathematical Sciences since Fall 2009. The current graduate program has 55 active PhD students, 13 active master students, and 38 active graduate certificate students. As of Fall 2018, the department has awarded 71 PhD degrees, 356 Master degrees, and 11 Mathematical Science Certificates.

The emphasis in the program is on contemporary areas of applied mathematics and traditional areas of core mathematics. A wide variety of graduate courses are offered to train students in mathematics and its application in a collegial, friendly environment with small classes and high student-faculty interaction. For appropriately trained students opportunities may exists to work under the Cooperative Education Program with local industries like *Lockheed Martin*, *NASA*, *Siemens*, and *Harris Corporation*.

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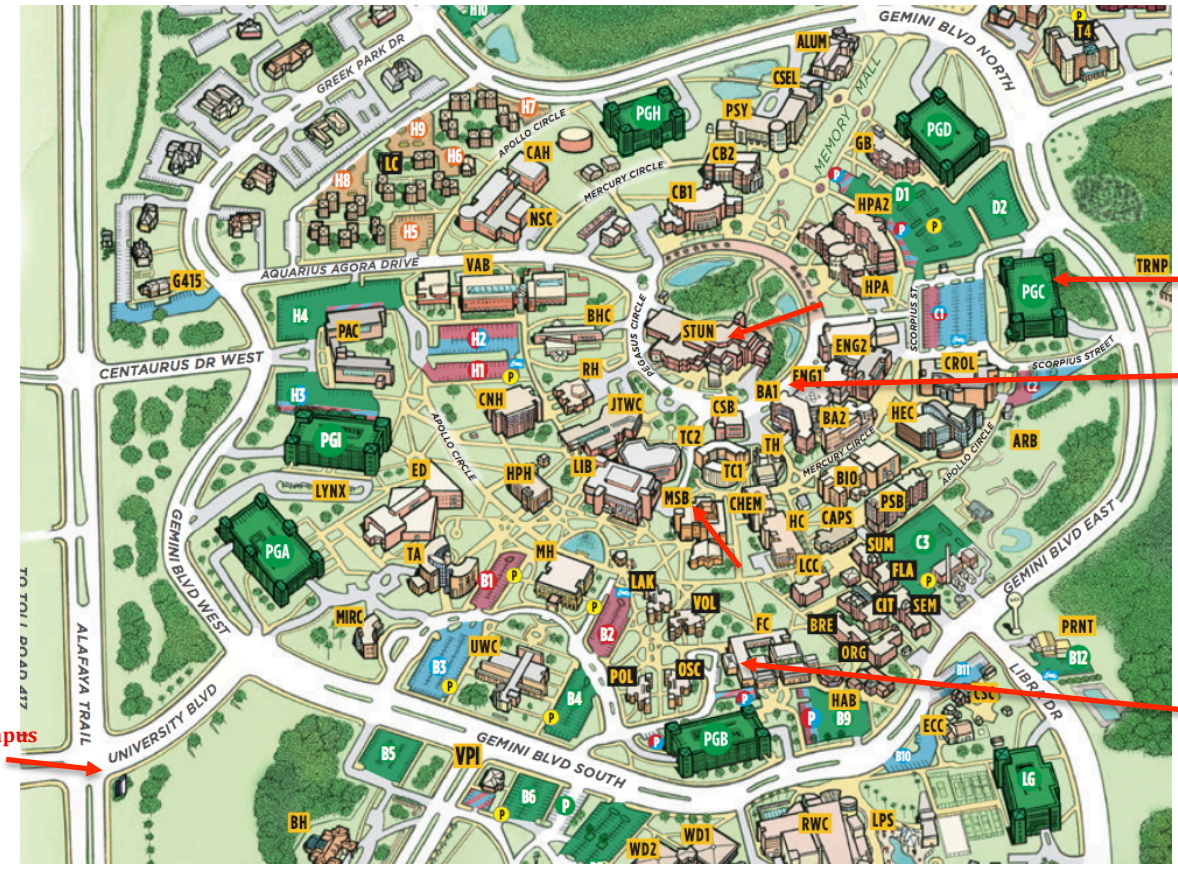
University of Central Florida Map



Guidance for MCB Conference Participants

BA1: Business Administrative Building 1
(*all conference talks, registration and welcome reception/poster session*)
PGC: Parking Garage C (*free conference parking*)
MSB: Mathematical Sciences Building (*for your information o*nly)
STUN: Student Union (*on-campus weekday lunch*)

Please notice that the hotel DoubleTree by Hilton Orlando East - UCF Area (12125 High Tech Ave, Orlando, FL 32817) locates the west of the campus.

To drive from the hotel to Parking Garage C, take High Tech Ave to University Blvd. Make a left turn to University Blvd East and continuing University Blvd East for 0.4 mile. After entering the Main Campus Entrance (the intersection of University Blvd and Alafaya Trail), make a right turn to Gemini Blvd South. Continuing Gemini Blvd South and then East for 1.2 mile, parking Garage C is on your left (the fifth traffic light). It is free of charge for conference participants as long as you park your car on spaces without any special designation.

Parking Garage C is 0.2 mile away from BA1 (about a 5-minute walk).

Thank You!