Tom S. Bertalan

POSTDOCTORAL FELLOW AT JOHNS HOPKINS WHITING SCHOOL OF ENGINEERING

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SKILLS

Software

LIBRARIES, PACKAGES, FRAMEWORKS, & TOOLS

- NumPy+SciPy+Matplotlib
- TensorFlow/Keras
- Linux and shell scripting
- Git and Subversion
- Eclipse+PyDev
- Scikit-Learn
- Python multiprocessing
- Amazon Elastic Compute Cloud
- Apache+MySQL

Languages

PROGRAMMING & MARKUP

- Python
- MATLAB
- LaTeX
- C/C++
- Java
- HTML+Javascript

Selected Graduate Classes

- Computer Vision
- Machine Learning and Artificial Intelligence
- Foundations of Probabilistic Modeling
- Probability Theory
- Mathematical Neuroscience
- Computation and Coding in Microcircuits
- Neuroscience
- Applied Dynamical Systems
- Mathematical Analysis of Massive Data Sets
- Introduction to Nonlinear Dynamics
- Chemical Reactor Engineering
- Mathematical Methods for Engineering Analysis
- Software Engineering for Scientific Computing

Selected Undergraduate Classes

- Mathematical Statistics with Applications
- Process Dynamics & Control
- Introduction to Linear Algebra
- Human Anatomy & Physiology
- Applied Differential Equations

Teaching

AT PRINCETON; AS ASSISTANT INSTRUCTOR

- Chemical & Biological Engineering Lab
- Differential Equations

Other Skills and Interests

- Arduino and Raspberry Pi
- Autonomous robotics with Robot Operating System (ROS)
- Small electronics manufacture
- Solo and orchestral violin performance

PROJECTS

1:10 scale autonomous vehicles (AVs)

Built a series of differential-drive and Ackermann rovers with LIDAR, and depth cameras, wheel encoders, and IMU; building experience in hardware, low-level embedded firmware, Robot Operating System (ROS) driver software, and high-level perception and planning software.

Simulation of circadian rhythms

Contributed to a successful $1.8MM grant for multi-university research project. Implemented core simulation, coarse-graining, and pseudo-arclength continuation. (Collaboration with Wash. U. St. Louis and U. Mass Amherst.)

Neural approximation of dynamical systems

Recast existing neural differential equation (DE) methods for time series analysis as recurrent networks, including extensions to convolutional neural networks (CNNs) for learning PDEs. Applied an unconventional loss for learning DEs with a conserved quantity. Implemented custom gradients for training neural networks with constraints.

Unsupervised learning (UL) for dynamical systems

Used UL to characterize the slow manifold underlying high-dimensional simulation dynamics. Helped develop a new variational autoencoder and applied it to end-to-end robotic localization (collaboration with Yale and The Technion).

Extraction of an emergent space and partial differential equation (PDE) underlying coupled oscillators

Used UL to obtain an pseudo-spatial ordering for a simulation of coupled biological neurons. Supervised a graduate student in using a CNN to train a PDE to approximate the dynamics.

Course in computer vision and control for AVs

Helped develop and teach a recurring summer course for high school and freshman students on using ROS, OpenCV, and CNNs to follow a road and stop at a traffic sign.

EDUCATION

Princeton University

M.A. AND PH.D

Chemical and Biological Engineering
Advised by Prof. Yannis Kevrekidis

The University of Alabama

B.S., MAGNA CUM LAUDE

Chemical and Biological Engineering, minor in Mathematics
Advised by Prof. Eric Carlson and Prof. Ryan Earley

AWARDS

- Princeton Program in Plasma Science and Technology research and academic fellowship
- National Science Foundation research fellowship
- William R. Schowalter fund for scholarly conferences
- National merit finalist scholarship
- University honors program
- University president's list
- $\Phi\mathrm{H}\Sigma$, $\Omega\mathrm{X}\mathrm{E}$, and $\mathrm{T}\mathrm{B}\Pi$ honor societies

PUBLICATIONS

"Local conformal autoencoder for standardized data coordinates"
Erez Peterfreund, Ofir Lindenbaum, Felix Dietrich, Tom Bertalan, Matan Gavish, Ioannis Kevrekidis, Ronald Coifman

"Coarse-grained and emergent distributed-parameter systems from data
Hassan Arbabi, Felix Kemeth, Tom Bertalan, Ioannis Kevrekidis

"Transformations between deep neural networks
Tom Bertalan, Felix Dietrich, Ioannis Kevrekidis

"Noninvertibility and initialization of RNNs for time-series prediction"
Felix Kemeth, Tom Bertalan, Tianqi Cui, Nikolaos Evangelou, Yannis Kevrekidis

"Learning the PDE to close a multiphase flow"
Cristina Linares, Tom Bertalan, Seungjoon Lee, Jicai Lu, Gretar Tryggvason, Ioannis Kevrekidis

"Grey-box LSTM modeling with applications in chemical reaction dynamics identification"
Saurabh Malani, Tom Bertalan, Felix Kemeth, Tianqi Cui, Nikolaos Evangelou, Ioannis Kevrekidis

"Learning emergent PDEs in a learned emergent space"
Felix Kemeth, Tom Bertalan, Thomas Thiem, Seungjoon Moon, Carlo Laing, Ioannis Kevrekidis

"Implicit integrators as constrained RNNs for time series learning"
Tom Bertalan, Rob Farber, Yannis Kevrekidis

"Backward-time dynamics of nonlinear systems"
Tianqi Cui, Tom Bertalan, Rob Farber, Yannis Kevrekidis

"Emergent spaces for coupled oscillators"
Thomas Thiem, Mahdi Kooshkbaghi, Tom Bertalan, Carol Laing, Ioannis Kevrekidis

"On Learning Hamiltonian Systems from Data"
Tom Bertalan, Felix Dietrich, Igor Mezic, and Ioannis Kevrekidis

"An Emergent Space for Distributed Data with Hidden Internal Order through Manifold Learning"
Felix Kemeth, Sindre Haugland, Felix Dietrich, Tom Bertalan, Kevin Höhlein, Qianxiao Li, Erik Bollt, Ronen Talmon, Katharina Krischer, and Ioannis Kevrekidis

"Coarse-grained descriptions of dynamics for networks with both intrinsic and structural heterogeneities"
Tom Bertalan, Yan Wu, Carlo Laing, C. William Gear, and Ioannis Kevrekidis.

"Dimension reduction in heterogeneous neural networks: Generalized Polynomial Chaos (gPC) and ANalysis-Of-VAriance (ANOVA)"
Minseok Choi, Tom Bertalan, Carlo Laing, and Ioannis Kevrekidis.

"OpenMG: a new multigrid implementation in Python"
NUMERICAL LINEAR ALGEBRA WITH APPLICATIONS   *2014*
Paper. Tom Bertalan, Akand Islam, Roger Sidje, and Eric Carlson

CONFERENCES

"Data-driven model reduction and discovery"   *Poster and Talk*
AMERICAN INSTITUTE OF CHEMICAL ENGINEERS ANNUAL MEETING   *2020*
Thomas Thiem, Tom Bertalan, Felix Kemeth, Yorgos Psarellis, Ioannis Kevrekidis

"Dynamical-systems-guided learning of PDEs from data"   *Talk*
AMERICAN INSTITUTE OF CHEMICAL ENGINEERS ANNUAL MEETING   *2020*
Hassan Arbabi, Tom Bertalan, Anthony Roberts, Ioannis Kevrekidis

"On the data-driven discovery and calibration of closures"   *Poster and Talk*
AMERICAN INSTITUTE OF CHEMICAL ENGINEERS ANNUAL MEETING   *2020*
Seungjoon Lee, Yorgos Psarellis, Constantinos Siettos, Tom Bertalan,Daniel Amchin, Tapomoy Bhattacharjee, Sujit Datta, Ioannis Kevrekidis

"Connections between residual networks and explicit numerical integrators, and applications to identification of noninvertible dynamical systems"   *Poster and Talk*
AMERICAN INSTITUTE OF CHEMICAL ENGINEERS ANNUAL MEETING   *2020*
Tianqi Cui, Tom Bertalan, Yorgos Psarellis, Ioannis Kevrekidis

"Neural network approach to reduced order modeling of multiphase flows"   *Talk*
AMERICAN PHYSICAL SOCIETY   *2020*
Cristina Linares, Tom Bertalan, Seungjoon Lee, Jicai Lu, Gretar Tryggvason, Ioannis Kevrekidis

"PDE+PINN: Learning and Solving a PDE at the Same Time"   *Poster and Talk*
AMERICAN INSTITUTE OF CHEMICAL ENGINEERS ANNUAL MEETING   *2020*
Tom Bertalan, Felix Kemeth, Tianqi Cui, Ioannis Kevrekidis

"Learning Partial Differential Equations from Discrete Space Time Data: Convolutional and Recurrent Networks, and Their Relations to Traditional Numerical Methods"   *Talk*
AMERICAN INSTITUTE OF CHEMICAL ENGINEERS ANNUAL MEETING   *2019*
Tom Bertalan, Felix Dietrich, Thomas Thiem, Rob Farber, Ioannis Kevrekidis, Anthony Roberts

"Recurrent Neural Networks, Numerical Integrators and Nonlinear System Identification"   *Talk*
AMERICAN INSTITUTE OF CHEMICAL ENGINEERS ANNUAL MEETING   *October 2018*
Tom Bertalan, Rob Farber, Thomas Thiem, Felix Dietrich, Ioannis Kevrekidis

"Coarse-Scale PDEs from Microscopic Observations Via Machine Learning"   *Talk*
AMERICAN INSTITUTE OF CHEMICAL ENGINEERS ANNUAL MEETING   *November 2019*
Seungjoon Lee, Mahdi Kooshkbaghi, Constantinos Siettos, Ioannis Kevrekidis, Tom Bertalan

"When Have Two Networks Learned the Same Task? Data-Driven Transformations between System Representations"   *Talk*
AMERICAN INSTITUTE OF CHEMICAL ENGINEERS ANNUAL MEETING   *November 2019*
Tom Bertalan, Felix Dietrich, Thomas Thiem, Ioannis Kevrekidis

"Learning Partial Differential Equations from Discrete Space Time Data: Convolutional and Recurrent Networks, and Their Relations to Traditional Numerical Methods"   *Talk*
AMERICAN INSTITUTE OF CHEMICAL ENGINEERS ANNUAL MEETING   *November 2019*
Tom Bertalan, Felix Dietrich, Thomas Thiem, Ioannis Kevrekidis, Rob Farber, Anthony Roberts

"Coarse modeling of circadian rhythms in heterogeneous neural networks"   *Poster and Talk*
DYNAMICS DAYS 2017; AMERICAN INSTITUTE OF CHEMICAL ENGINEERS ANNUAL MEETING   *January 2017; November 2016*
Tom Bertalan, C. William Gear, Yannis G. Kevrekidis, Michael Henson, Erik, and Carlo Laing.

"Coarse-graining of heterogeneous neural dynamics"

Talk

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS ANNUAL MEETING

November 2015

Tom Bertalan, Minseok Choi, Carlo Laing, Ioannis Kevrekidis.

"Heterogeneity and reduction for complex network dynamics"

Talk

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS ANNUAL MEETING

November 2014

Ioannis Kevrekidis, Alexander Holiday, Tom Bertalan, and Carlo Laing.

"Polynomial representations of populations with multiple heterogeneities"

Poster

PRINCETON GRADUATE STUDENT SYMPOSIUM

October 2014

Tom Bertalan, Yan Wu, Brianna Hnath, and Yannis Kevrekidis

"OpenMG: a new multigrid implementation in Python"

Talk

SCIPY: SCIENTIFIC COMPUTING WITH PYTHON

July 2012

Tom Bertalan, Akand Islam, Roger Sidje, and Eric Carlson

"ESIM: a framework for simulation of dominance hierarchy formation in small animal groups"

Poster

UNIVERSITY OF ALABAMA SYSTEM HONORS UNDERGRADUATE RESEARCH CONFERENCE

April 2012

Tom Bertalan and Ryan Earley

"An open-source computing cluster for virtual experiments with variable parameters"

Poster

UNIVERSITY OF ALABAMA SYSTEM HONORS UNDERGRADUATE RESEARCH CONFERENCE

April 2011

Tom Bertalan and Eric Carlson

REFERENCES