

## Alex A. Gorodetsky

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### CONTACT

#### INFORMATION

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### RESEARCH INTERESTS

**Decision making under uncertainty:** Uncertainty quantification, autonomous systems, Bayesian inference, statistics, data analysis, machine learning, numerical analysis, tensor methods, stochastic optimal control and optimization, mathematical modeling

### EDUCATION

**Massachusetts Institute of Technology**, Cambridge, MA

Ph.D., Department of Aeronautics and Astronautics, February 2017

- Thesis: *Continuous low-rank tensor decompositions, with applications to stochastic optimal control and data assimilation*
- Advisers: Professor Sertac Karaman, Professor Youssef M. Marzouk
- Areas of Study: Computational Science, Control, Autonomy

S.M., Department of Aeronautics and Astronautics, June 2012

- Thesis: *A learning method for the approximation of discontinuous functions for stochastic simulations*
- Adviser: Professor Youssef M. Marzouk
- Area of Study: Computational Science

**University of Michigan**, Ann Arbor, MI

B.S.E., Aerospace Engineering, June 2010

- *Summa cum Laude*
- Minor in Mathematics

### AWARDS

- John von Neumann Postdoctoral Research Fellowship in Computational Science 2016
- Department of Energy Office of Science Graduate Fellowship (DOE SCGF), Finalist, 2012
- Chick Evans Scholarship, Full tuition at the University of Michigan, 2006–2010

### PROFESSIONAL EXPERIENCE

**Sandia National Laboratories**, Albuquerque, NM

*John von Neumann Postdoctoral Fellow*

**October 2016 – present**

*Optimization and Uncertainty Quantification Group*

*Computer Science Research Institute*

- Conducting independent research in decision making under uncertainty as part of the Fellowship
- Developing algorithms for multifidelity inference for complex physical systems
- Developing machine learning algorithms for regression and classification

**Massachusetts Institute of Technology**, Cambridge, MA

*Graduate Research Assistant*

**September 2010 – September 2016**

*Aerospace Computational Design Laboratory*

- PhD Candidate:
  - Developing algorithms for decision making under uncertainty in stochastic systems
  - Solving high-dimensional optimal nonlinear stochastic control problems
  - Applying developed algorithms on a range of problems including robotic motion planning, trajectory optimization, and dynamic resource allocation

- Creating algorithms to mitigate curse-of-dimensionality in Bayesian inference and data assimilation problems
- Masters student:
  - Developed algorithms for surrogate modeling for high-dimensional systems exhibiting discontinuities and nonlinearity
  - Utilized machine learning techniques such as support vector machines and active learning to develop an anytime approximation algorithm
  - Developed approximation method on a range of problems including aerodynamics, combustion, and biomass conversion
  - Consulted with industry sponsor, BP, to provide data analysis and instruction on machine learning methodology

**Video IQ (Acquired by Avigilon 2013), Bedford, MA**

*Intern*

**June 2013 – September 2013**

- Developed system for automated business analytics based on video analysis
- Utilized machine learning techniques including support vector machines and Gaussian mixture models
- Developed a python and Microsoft Cloud work-flow for automated analysis

**Schlumberger-Doll Research Center, Cambridge, MA**

*Intern*

**June 2012 – September 2012**

*Mathematics and Modeling Department*

- Developed methodology to assimilate Logging-While-Drilling time series data
- Implemented a Kalman filter and smoother allowing geologist input into data assimilation process
- Validated methodology on both experimental and field data

**Accio Energy Inc., Ann Arbor, MI**

*System simulation intern*

**September 2009 – May 2010**

- Developed requirements for system model while collaborating with company founders and technical advisors
- Developed a simulation of a novel, turbine-less wind energy system in Matlab

**NASA - Glenn Research Center, Cleveland, OH**

*Undergraduate Research*

**June 2009 – August 2009**

*Communications, Instrumentation, and Controls Division*

- Set up instrumentation for the spectral analysis of a pulse-generated plasma experiment
- Worked closely with technical staff to create a final report detailing the experimental setup and future direction of plasma research

**PROFESSIONAL  
SERVICE**

**Referee Service**

- *SIAM Journal of Scientific Computing*
- *SIAM/ASA Journal on Uncertainty Quantification*
- *Journal of Intelligent and Robotic Systems*
- *Robotics: Science and Systems Conference (RSS)*
- *Neural Computation*
- *ASME Turbine Technical Conference and Exposition 2015*
- *Mathematical Methods in the Applied Sciences*
- *IEEE Transactions on Aerospace and Electronic Systems*

JOURNAL  
PUBLICATIONS

- [1] Gorodetsky A., Karaman, S., and Marzouk Y. M. High-dimensional stochastic optimal control using continuous tensor decompositions. (2016) *Submitted*
- [2] Gorodetsky A., Karaman, S., and Marzouk Y. M. Function-train: a continuous analogue of the tensor-train decomposition. (2016) *Submitted*
- [3] Kramer, B., and Gorodetsky, A. System identification via CUR-factored Hankel approximation. (2016) *Submitted*
- [4] Gorodetsky, A., and Marzouk, Y. M. Mercer kernels and integrated variance experimental design: connections between Gaussian process regression and polynomial approximation *SIAM/ASA Journal on Uncertainty Quantification*, 4:1 (2016): 796-828
- [5] Gorodetsky, A., and Marzouk, Y. M. Efficient localization of discontinuities in complex computational simulations. *SIAM Journal on Scientific Computing*, 36.6 (2014): A2584-A2610

REFEREED  
CONFERENCE  
PUBLICATIONS

- [6] Gorodetsky, A., Karaman S., and Marzouk, Y. M. Low-rank tensor integration for Gaussian filtering of continuous time nonlinear systems In: *56th IEEE Conference on Decision and Control*, Melbourne, Australia, December, 2017.
- [7] Alora, J., Gorodetsky, A., Karaman S., Lowry, N., and Marzouk, Y. M. Automated synthesis of low-rank control systems from sc-LTL specifications using tensor-train decompositions In: *55th IEEE Conference on Decision and Control*, Las Vegas, NV, USA, December, 2016.
- [8] Gorodetsky, A., Karaman S., and Marzouk, Y. M. Efficient high-dimensional stochastic optimal motion control using tensor-train decomposition. In: *Proceedings of Robotics: Science and Systems*, Rome, Italy, July, 2015.

CONFERENCE  
TALKS

- [9] Gorodetsky, A. Low rank functional decompositions, with application to stochastic optimal control. In: *2017 Meeting of the International Linear Algebra Society*, Ames, IA, USA, July 24 – July 28 2017.
- [10] Gorodetsky, A. Exploiting low-rank structure in stochastic optimal control and filtering problems. In: *SIAM Conference on Control and its Applications*, Pittsburgh, PA, USA, July 10 – July 12 2017.
- [11] Gorodetsky, A. and Jakeman J. D. Continuous alternating least squares for regression of low-rank functions. In: *SIAM Conference on Computational Science and Engineering*, Atlanta, GA, USA, February 27 – March 3 2017.
- [12] Gorodetsky, A., Karaman, S., and Marzouk, Y. M. Function-train: a continuous analogue of the tensor-train decomposition. In: *Approximation Theory 15*, San Antonio, TX, USA, May 2016.
- [13] Gorodetsky, A., Karaman, S., and Marzouk, Y. M. Exploiting tensor structure in Bayesian inference problems: application to Gaussian filtering. In: *SIAM Conference on Uncertainty Quantification*, Lausanne, Switzerland, April 2016.
- [14] Gorodetsky, A., Karaman, S., and Marzouk, Y. M. Function-train: a continuous analogue of the tensor-train decomposition. In: *14th Copper Mountain Conference on Iterative Methods*, Copper Mountain, CO, USA, March 2016.
- [15] Gorodetsky, A., Karaman, S., and Marzouk, Y. M. High-dimensional optimal stochastic control using tensor decompositions. In: *MIT ROBOCON 2016*, Cambridge MA, Feb. 13 2016.

- [16] Gorodetsky, A., Karaman, S., and Marzouk, Y. M. Continuous tensor-train decomposition with applications to Bayesian inference. In: *International Congress on Industrial and Applied Mathematics*, Beijing, China, August 10–14, 2015.
- [17] Gorodetsky, A., Karaman, S., and Marzouk, Y. M. Continuous tensor-train decomposition with applications to Bayesian inference. In: *13th U.S. National Congress on Computational Mechanics*, San Diego, CA, July 26–30, 2015.
- [18] Gorodetsky, A., and Marzouk, Y. M. Experimental design for Gaussian process regression. In *SIAM Conference on Uncertainty Quantification*, Savannah, GA, March 31 – April 3, 2014.
- [19] Gorodetsky, A., and Marzouk, Y. M. A learning method for approximation of discontinuous functions. In *SIAM Conference on Uncertainty Quantification*, Raleigh, NC, April 2–5, 2012.
- INVITED TALKS [20] Compression for stochastic optimal control. In *Los Alamos National Laboratory.*, Los Alamos, NM, USA, June 20, 2017.
- [21] Real-time control and uncertainty quantification of autonomous systems using low-rank multilinear compression. In *University of Michigan Aerospace Engineering Seminar*, Ann Arbor, MI, USA, April 12, 2017.
- [22] Low-rank computation for optimal stochastic control and function approximation. In *MIT Aerospace Computational Design Laboratory Seminar*, Cambridge, MA, USA, November 3, 2015.
- [23] Tensor-based computation for stochastic control and filtering. In *MIT Joint Inference and Control Seminar*, Cambridge, MA, USA, August 22, 2014.
- [24] Experimental design for Gaussian process regression. In *Centro de Investigación en Matemáticas*, Guanajuato, Mexico, July 11, 2014.
- [25] Regression of short-form models and more fundamental models: Naphtha reforming case study. In *Semi-Annual Review Meeting of the BP-MIT Conversion Research Program*, York, England, June 11, 2014.
- CONFERENCE POSTERS [26] Gorodetsky, A., Low-rank functional approximation for Gaussian filtering In: *Uncertainty quantification and data-driven modeling workshop*, Austin, TX, USA, March 23, 2014.
- [27] Gorodetsky, A., and Marzouk, Y. Experimental design for Gaussian process regression. In: *12th World Meeting of International Society of Bayesian Analysis (ISBA2014)*, Cancun, Mexico, July 14–18, 2014.
- [28] Gorodetsky, A., Moselhy, T., and Marzouk, Y. On the relationship between polynomial chaos expansions and Gaussian process regression. In: *SIAM Conference on Computational Science*, Boston, MA, February 25 – March 1, 2013.
- [29] Gorodetsky, A., and Marzouk, Y. A learning method for approximation of discontinuous functions. In *Computation for Design and Optimization / Center for Computational Engineering Student Symposium*, Cambridge, MA, March 2012.
- [30] Gorodetsky, A., and Marzouk, Y. Surrogate development for Uncertainty Analysis. In *Semi-Annual Review Meeting of the BP-MIT Conversion Research Program*, Naperville, IL, November 17, 2011.
- [31] Gorodetsky, A., and Marzouk, Y. A learning method for approximation of discontinuous functions in high-dimensions. In *SAMSI Workshop on High Dimensional Approximation for Uncertainty Quantification*. Research Triangle Park, NC, April 6, 2011.

OPEN SOURCE  
SOFTWARE

*GPEXP: Experimental design for Gaussian process regression*

- Python package for performing experimental design for Gaussian process models
- Github source code: <https://github.com/goroda/GPEXP>

*C<sup>3</sup>: Compressed Continuous Computation*

- Set of libraries (in c) to compute with multidimensional functions in a compressed format
- Has utilities to aid computation in the context of control, optimization, probabilistic inference, multilinear algebra, and integration
- Github source code: <https://github.com/goroda/Compressed-Continuous-Computation>

PROFESSIONAL  
MEMBERSHIPS  
CITIZENSHIP

Society for Industrial and Applied Mathematics (SIAM), Member, 2010–present

USA