

# Curriculum Vitae of Md Ariful Islam

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## RESEARCH OVERVIEW

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My primary research objective is to build **safe and reliable** Cyber-Physical Systems by combining techniques from formal methods and control theory. I have conducted research on modeling, verification and control of complex systems, specifically nonlinear biological systems. My research interest lies in the intersection of **Cyber-Physical Systems, Hybrid Systems, Formal Methods, Control Theory** and **Systems Biology**.

## EDUCATION

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- **Stony Brook University, Stony Brook, NY** *December 2015*  
*Ph.D.* in Computer Science  
*Dissertation title:* Formal verification of nonlinear biological systems  
*Advisors:* Scott Smolka and Radu Grosu  
*Committee:* Scott Smolka, Radu Grosu, Allen Tannenbaum, Sayan Mitra
- **Bangladesh University of Engineering and Technology (BUET), Dhaka** *March 2009*  
*Bachelor of Science (B.S.)* in Computer Science and Engineering

## AWARDS & HONORS

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- **Travel Grant**, SRI Summer School on Formal Techniques, 2014 & 2015
- **CMSB Student Travel Grant**, IST, Austria, 2013
- **RAP Travel Scholarship**, Graduate Student Organization, Stony Brook University, 2013
- **CCGG Student Travel Grant**, Waterloo, Canada, 2013
- **University Fellowship**, Stony Brook University, 2010
- **Academic Excellence Scholarship**, BUET, Bangladesh, 2005-2009
- **Dean's List Award**, BUET, Bangladesh, 2006-2009
- **Education Board Scholarship**, Government of Bangladesh, 2001 & 2001
- **Primary & Junior School Scholarship**, Government of Bangladesh, 1996 & 1999

## EMPLOYMENT

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- **Carnegie Mellon University, Pittsburgh** *January 2016-*  
*Postdoctoral Scholar*  
*Mentor:* Edmund Clarke  
*Project:* dReal, dReach
- **Stony Brook University, Stony Brook** *June 2011-December 2015*  
*Graduate Research Assistant*  
*Mentors:* Scott Smolka and Radu Grosu  
*Project:* CyberCardia, CMACS
- **Modeling and Simulation Group, Novartis, East Hanover** *June 2012-August 2012*  
*Research Intern*  
*Mentor:* Melissa Hallow  
*Project:* Modeling Hypertension

*Quantitative Developer*

*Mentor: Dr. Arif Doula*

*Project: Stock market analysis*

## SELECTED PUBLICATIONS

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### Peer-Reviewed Conference & Workshop Papers:

1. Abhishek Murthy, **Md Ariful Islam**, Radu Grosu and Scott Smolka. Computing bisimulation functions using SOS optimization and delta-decidability over the Reals. International Conference on Hybrid Systems: Computation and Control (HSCC), 2015. (**Best Paper Session**)
2. **Md Ariful Islam**, Richard DeFrancisco, Chuchu Fan, Radu Grosu, Sayan Mitra, Scott Smolka. Model checking tap withdrawal in C. Elegans. International Workshop on Hybrid Systems Biology (HSB), 2015.
3. Konstantin Selyunin, Denise Ratasich, Ezio Bartocci, **Md Ariful Islam**, Scott Smolka, Radu Grosu. Neural programming: towards adaptive controls in cyber-physical systems. IEEE Conference on Decision and Control (CDC), 2015.
4. **Md Ariful Islam**, Abhishek Murthy, Antoine Girard, Scott Smolka and Radu Grosu. Compositionality results for cardiac cell dynamics. International Conference on Hybrid Systems: Computation and Control (HSCC), 2014.
5. **Md Ariful Islam**, Abhishek Murthy, Ezio Bartocci, Scott Stoller, Scott Smolka and Radu Grosu. Tracking action potentials of nonlinear excitable cells using model predictive control. International Conference on Bioinformatics, Biocomputational Systems and Biotechnologies (BioTechno), 2014.
6. Abhishek Murthy, **Md Ariful Islam**, Ezio Bartocci, Elizabeth Cherry, Flavio Fenton, James Glimm, Scott Smolka and Radu Grosu. Approximate bisimulations for sodium channel dynamics. International Conference on Computational Methods in Systems Biology (CMSB), 2012.
7. Syed Ishtiaque Ahmed, Masud Hasan and **Md Ariful Islam**. Cutting a convex polyhedron out of a sphere. Workshop on Algorithms and Computation (WALCOM), 2010.
8. Syed Ishtiaque Ahmed, **Md Ariful Islam** and Masud Hasan. Cutting a cornered convex polygon out of a circle. International Conference on Communications and Information Technology (ICCIT), 2008.

### Peer-Reviewed Journal Articles:

9. Abhishek Murthy, **Md Ariful Islam**, Radu Grosu and Scott Smolka. Computing compositional proofs of input-to-output stability using SOS optimization and  $\delta$ -decidability. Nonlinear Analysis: Hybrid Systems (NAHS). [under review]
10. **Md Ariful Islam**, Abhishek Murthy, Ezio Bartocci, Elizabeth Cherry, Flavio Fenton, James Glimm, Scott A. Smolka and Radu Grosu. Model-order reduction of ion channel dynamics using approximate bisimulation. Theoretical Computer Science (TCS), 2014.
11. Syed Ishtiaque Ahmed, Masud Hasan and **Md Ariful Islam**. Cutting a convex polyhedron out of a sphere. Graphs and Combinatorics (GC), 2011.
12. Syed Ishtiaque Ahmed, **Md Ariful Islam** and Masud Hasan. Cutting a cornered convex polygon out of a circle. Journal of Computers (JCP), 2010.

### Theses:

14. **Md Ariful Islam**. Formal verification of nonlinear biological systems. Advised by Scott Smolka and Radu Grosu. PhD dissertation, Computer Science, Stony Brook University, , 2015.
15. **Md Ariful Islam**, Syed Ishtiaque Ahmed. Algorithms in computational geometry. Advised by Masud Hasan. Bachelor's Thesis, Computer Science and Engineering, BUET, Dhaka, 2009.

## RESEARCH EXPERIENCE

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### **CyberCardia**

with Scott Smolka

June 2015 - Present

Stony Brook, NY

- Working on closed-loop formal verification of ICDs using cardiac electro-physiological models as a part of NSF-funded project named *CyberCardia*. Formal verification techniques, such as simulation-based model checking & reachability analysis, will be applied to high-fidelity cardiac electro-physiological models that capture electrical excitation induced by the ICDs control software.

### **CMACS**

with Scott Smolka and Radu Grosu

June 2011 - May 2015

Stony Brook, NY

- Worked on formal verification of cardiac electro-physiological model to analyze Atrial Fibrillation (AFib) as a part of NSF expedition in computing named *Computational Modeling and Analysis of Complex Systems* (<http://cmacs.cs.cmu.edu>). Responsibilities included component-wise model abstraction and substitution to make the model amenable for formal verification.

### **Formal Verification of Nonlinear Models**

with Scott Smolka, Sayan Mitra and Radu Grosu

August 2014 - present

Stony Brook, NY

- Developed a formal verification framework for nonlinear ODE models using local discrepancy-based reach-tube analysis. Applied this framework to estimate key parameter ranges of *C. Elegans*' neural circuit representing the Tap Withdrawal behavior.

### **Model Predictive Controllers (MPCs) for Neuron**

with Scott Smolka, Scott Stoller and Radu Grosu

August 2013 - May 2014

Stony Brook, NY

- Designed and simulated both online and explicit MPCs to control a neuron plant based on nonlinear FitzHugh-Nagumo ODE model. Employed a piece-wise affine model for MPCs to predict plant behavior in a fixed horizon for generating optimal stimuli to track a time-varying reference of the plant. Implemented explicit MPC by extending multi-parametric toolbox (MPT) and online MPC using nonlinear programming (fmincon) in Matlab.

### **Cardio-Vascular Renal Simulator (CVR-sim)**

with Melissa Hallow

May 2012 - August 2012

East Hanover, NJ

- Worked in cardio-vascular drug development team to extend multi-scale physiological modeling platform (CVR-sim) to design therapeutic strategies for the progression of diabetic kidney diseases.

*Major Contribution:*

- Extended CVR-sim by incorporating the effect of inhibiting Epithelial Sodium Channel (ENaC) in distal tubule of kidney to the progression of diabetic nephropathy.
- Extended CVR-sim by adding the effect of inhibiting Sodium-Glucose Linked Transporter (SGLT) to regulate blood glucose level and showed that inhibiting both SGLT1 and SGLT2 led to more reduction in blood glucose level as opposed to inhibiting only SGLT2.

### **Undergraduate Project in Computational Geometry**

with Masud Hasan and Syed Ishtiaque Ahmed

March 2008 - March 2009

Dhaka, Bangladesh

- Presented  $O(n \log n)$ -approximation algorithm with  $O(n)$  time and a PTAS algorithm with  $O(n^3)$  time for cutting a convex polygon out of a circle.
- Presented  $O(\log^2 n)$ -approximation algorithm with  $O(n^3)$  time for cutting a convex polyhedron out of a sphere.

## TEACHING EXPERIENCE

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- Fall 2010

*Teaching Assistant:* ISE 320 - Information Management

*Grader:* CSE 102 - Introduction to Web Design and Programming

- Spring 2011  
*Teaching Assistant: CSE 215 - Foundations of Computer Science*

## POSTERS & PRESENTATIONS

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1. Computing bisimulation functions using SOS optimization and  $\delta$ -decidability over the reals. International Conference on Hybrid Systems: Control and Computation, Seattle, April, 2015.
2. Compositionality results for cardiac cell dynamics. Tutorial Workshop on Parameter Estimation for Biological Models, NC State University, Raleigh, NC, August, 2014.(Poster)
3. Compositionality results for cardiac cell dynamics. Computational Methods in Systems Biology (CMSB), IST Austria, 2013. (Poster)
4. Approximate bisimulations for sodium channel dynamics. Computational Methods in Systems Biology, The Royal Society, London, UK. October, 2012.
5. Bisimulation-based abstraction of sodium channel dynamics in cardiac cell models. Workshop on Systems Biology and Formals Methods, NYU, NY, Mar. 30, 2012.
6. Cutting a cornered convex polygon out of a circle. International Conference on Computer and Information Technology (ICCIT), Khulna, Bangladesh, Dec. 2008.

## PROFESSIONAL ACTIVITIES

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### External Reviewer:

- 2015 Int'l Symposium on Automated Technology for Verification and Analysis (ATVA 2015)
- 2015 Int'l Conference on Hybrid Systems: Computation and Control (HSCC 2015)
- 2015 Int'l Workshop Hybrid Systems Biology (HSB 2015)
- 2015 Int'l Conference on Formal Engineering Methods (ICFEM 2015)
- 2015 Int'l Conference on Tools and Algorithms for the Construction and Analysis of Systems (TACAS 2015)
- 2014 Int'l Conference on Formal Methods in Macro-Biology (FMMB 2014)
- 2014 Int'l Conference on Formal Engineering Methods (ICFEM 2014)
- 2013 Int'l Conference on Computational Methods in Systems Biology (CMSB 2013)
- 2013 Int'l Conference on Hybrid Systems: Computation and Control (HSCC 2013)
- 2012 Int'l Conference on Hybrid Systems: Computation and Control (HSCC 2012)
- 2011 Int'l Conference Formal Modeling and Analysis of Timed Systems (FORMATS 2011)
- 2011 Int'l Conference Runtime Verification (RV 2011)

## REFERENCES

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Scott A. Smolka  
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Department of Computer Science  
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Radu Grosu  
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Faculty of Informatics  
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