Allison K. Sullivan, PhD

ASSISTANT PROFESSOR OF COMPUTER SCIENCE AT THE UNIVERSITY OF TEXAS AT ARLINGTON

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Research Interest

Software Engineering, in particular: Test/Oracle Generation, Automated Bug Localization and Repair, Regression Testing, and Mutation Testing.

Formal Methods and Programming Languages, in particular: Model Based Testing, First-Order Logic, Program Synthesis, Model Checking and Symbolic Execution.

Academic Experience

SEPT 2020	**Assistant Professor**, The University of Texas at Arlington	*Arlington, TX*
2018 - 2020	**Assistant Professor**, North Carolina A&T State University	*Greensboro, NC*
2012 - 2017	**Research Assistant**, The University of Texas at Austin	*Austin, Texas*
2011 - 2012	**Undergraduate Research Assistant**, The University of Texas at Dallas	*Richardson, Texas*

Education

The University of Texas at Austin   *Austin, Texas*

PH.D. IN SOFTWARE ENGINEERING   *May 2017*

- **Dissertation:** Automated Testing and Sketching of Alloy Models | **Advisor:** Dr. Sarfraz Khurshid | **GPA:** 3.93

The University of Texas at Austin   *Austin, Texas*

M.S. IN SOFTWARE ENGINEERING   *May 2014*

- **Thesis:** AUnit - A Testing Framework for Alloy | **Advisor:** Dr. Sarfraz Khurshid

The University of Texas at Dallas   *Richardson, Texas*

B.S. IN SOFTWARE ENGINEERING   *May 2012*

- **Specialization:** Embedded Systems | **GPA:** 3.99

Industry Experience

Google, Inc.   *Mountain View, CA*

FACULTY IN RESIDENCE (FIR)   *Jun. 2019 - July. 2019*

- **Professional Development.** FIR is an immersive program that trained me to: design and implement classroom experiments related to project-based learning, conduct resume workshops, and give mock interviews. During this program, I re-designed "Comp 285: Design and Analysis of Algorithms" with feedback from fellow FIR faculty and Google engineers.

Naval Research Laboratory (NRL)   *Washington, D.C.*

RESEARCH INTERN IN THE CENTER FOR HIGH ASSURANCE COMPUTER SYSTEMS   *Jun. 2015 - Jan. 2016*

- **Model Based Testing.** I expanded the applicability of NRL's model based testing (MBT) infrastructure by extending the SCR toolset to automatically generate test cases that incorporate assumptions. This included updating the automated translations of SCR models into SPIN, NuSMV, and PVS with formulas that explore the assumption(s).

IBM Research   *Austin, Texas*

SOFTWARE TESTING INTERN IN THE VIRTUAL TEST SUITE AUTOMATION TEAM   *May. 2013 - Aug. 2013*

- **Test Automation Toolset.** I built a test automation toolset to ensue test suites automatically feed their output into RQM, IBM's project management tool. This toolset bridges existing automation scripts with the RQM and is in place at IBM today.

Funding

4 grants | **Total amount:** $8,555,000 | **My share:** $975,000

Grants obtained at UTA

[**Transfer**] **Source:** NSF Formal Methods in the Field – **Title:** Alloy Analyzer Plus: an Integrated Development Environment for Alloy – **PIs:** Allison Sullivan – **Amt:** $68,290 – **Start:** July 2020 – **End:** Jan 2022

Grants obtained at NC A&T SU

[**1**] **Source:** NSF Major Research Instrumentation – **Title:** MRI: Acquisition of a Testbed of Connected Autonomous MicroTransit Vehicles – **Lead PI:** Ali Karimoddini, **My Role:** Co-PI – **Amt:** $550k, **Share:** $55k – **Start:** July 2020 – **End:** June 2022

[**2**] **Source:** NASA University Leadership Initiative – **Title:** Secure and Safe Assured Autonomy (S^2A^2) – **Lead PI:** Abdollah Homaifar, **My Role:** Co-PI – **Amt:** $7.9M, **Share:** $635k – **Start:** Aug 2020 – **End:** Aug 2024

[**3**] **Source:** NSF Formal Methods in the Field – **Title:** Alloy Analyzer Plus: an Integrated Development Environment for Alloy – **PIs:** Allison Sullivan – **Amt:** $100k – **Transferred to UTA:** July 2020

[**4**] **Source:** NSF HBCU-UP ACE Implementation Project Scholarship of Teaching and Learning – **Title:** Project Based Learning in the Teaching of Analysis of Algorithms – **PIs:** Allison Sullivan – **Amt:** $5k – **Start:** June 2019 – **End:** Aug 2019

Publications

REFEREED CONFERENCE PAPERS

(C13) K. Wang, A. Sullivan, D. Marinov, and S. Khurshid. Fault Localization for Declarative Models in Alloy. In *Proceedings of the 31st International Symposium on Software Reliability Engineering (ISSRE)*, pages 391–402, October 2020. (Acceptance: 26%) **Invited for journal submission.**

This paper introduces AlloyFL$_{hy}$, the first fault localization technique for faulty Alloy models which brings the traditional spectrum-based and mutation-based fault localization techniques to Alloy and combines both techniques to locate faults.

(C12) G. Thompson and A. Sullivan. ProFL: A Fault Localization Framework for Prolog. In *Proceedings of the 29th ACM SIGSOFT International Symposium on Software Testing and Analysis (ISSTA), Tool Demonstrations Track*, pages 561–564, July 2020. (Acceptance: 33%)

ProFL is a fault localization tool that adapts imperative based fault localization techniques to Prolog's declarative environment and returns a list of suspicious program clauses to the user.

(C11) A. Sullivan, D. Marinov, and S. Khurshid. Solution enumeration abstraction - a modeling idiom to enhance a lightweight formal method. In *Proceedings of the 21st International Conference on Formal Engineering Methods (ICFEM)*, pages 336–352, November 2019. (Acceptance: 30%)

We introduce a novel idiom that allows users to define data abstractions to enhance solution enumeration by specifying how the solutions must differ, so enumeration creates a high quality set of solutions of a manageable size.

(C10) K. Wang, A. Sullivan, and S. Khurshid. ARepair: A repair framework for Alloy. In *Proceedings of the 41st International Conference on Software Engineering (ICSE) Tool Demonstration Track*, pages 103–106, May 2019. (Acceptance: 35%)

This paper describes our tool embodiment of ARepair (ASE 2018) and additionally address scalability and breadth of grammar concerns so ARepair can be broadly adopted.

(C09) K. Wang, A. Sullivan, D. Marinov, and S. Khurshid. Asketch: A sketching framework for Alloy. In *Proceedings of the 2018 ACM Joint European Software Engineering Conference and Symposium on the Foundations of Software Engineering (FSE) Tool Demonstration Track*, pages 916–919, November 2018. (Acceptance: 45%)

This paper describes our tool embodiment of ASketch (ABZ 2018) and additionally addresses support for a broader diversity of hole locations so ASketch can be broadly adopted.

(C08) K. Wang, A. Sullivan, and S. Khurshid. Automated model repair for Alloy. In *Proceedings of the 33rd International Conference on Automated Software Engineering (ASE)*, pages 577–588, September 2018. (Acceptance: 20%)

We introduce ARepair, the first technique for repairing Alloy models which integrates ideas from mutation testing and program synthesis to provide an effective solution for repairing Alloy models.

(C07) K. Wang, A. Sullivan, D. Marinov, and S. Khurshid. Solver-based sketching of Alloy models using test valuations. In *Proceedings of the 6th International ABZ Conference ASM, Alloy, B, TLA, VDM, Z*, pages 121–136, June 2018. (Acceptance: 39%) **Invited for journal submission.**

We introduce ASketch, the first framework for sketching models in the Alloy language by building a meta-model which completes encapsulates the synthesis problems and uses SAT solvers to find a solution.

(C06) K. Wang, A. Sullivan, M. Koukoutos, D. Marinov, and S. Khurshid. Systematic generation of non-equivalent expressions for relational algebra. In *Proceedings of the 6th International ABZ Conference ASM, Alloy, B, TLA, VDM, Z*, pages 105–120, June 2018. (Acceptance: 39%)

This paper introduces the first generator for relational expressions that are non-equivalent with respect to the semantics of relational algebra. The generator takes a bottom-up approach and has multiple pruning levels.

(C05) K. Wang, A. Sullivan, and S. Khurshid. MuAlloy: A mutation testing framework for Alloy. In *Proceedings of the 40th International Conference on Software Engineering (ICSE) Tool Demonstration Track*, pages 29–32, May 2018. (Acceptance: 42%)

This paper describes our tool embodiment of MuAlloy which provides mutation testing (mutation operators, mutant generation, and equivalent mutant checking) for Alloy. MuAlloy is used for test generation in our ICST 2017 paper.

(C04) A. Sullivan, K. Wang, and S. Khurshid. AUnit: A test automation tool for Alloy. In *International Conference on Software Testing, Verification and Validation (ICST) Tool Demonstration Track*, pages 398–403, April 2018. (Acceptance: 35%)

(C03) | *This paper is the foundational work for our NSF FmitF grant that extends the Alloy Analyzer with GUI support for AUnit and automated test generation and extends the efforts of our ICST 2017 paper to encompass the entirety of the Alloy grammar.*

(C03) | A. Sullivan, K. Wang, R. N. Zaeem, and S. Khurshid. Automated test generation and mutation testing for Alloy. In *Proceedings of the 2017 IEEE Conference on Software Testing, Validation and Verification (ICST)*, pages 264–275, June 2017. (Acceptance: 27%)

We present two novel approaches of automated test generation for models written in Alloy – a coverage-driven approach and a mutation-driven approach.

(C02) | N. Dini, A. Sullivan, M. Gligoric, and G. Rothermel. The effect of test suite type on regression test selection. In *International Symposium on Software Reliability Engineering (ISSRE)*, pages 47–58, October 2016. (Acceptance: 35%)

We investigate the impact of how of test suites obtained with different automated test case generation techniques can impact the effectiveness of regression test selection techniques.

(C01) | A. Sullivan, R. N. Zaeem, S. Khurshid, and D. Marinov. Towards a test automation framework for Alloy. In *International Symposium on Model Checking of Software (SPIN)*, pages 113-116, July 2014. (Acceptance: 63%)

We propose a theory to blend how developers write unit tests in commonly used programming languages with how Alloy users formulate their models in Alloy, to facilitate the development and testing of Alloy models.

Refereed Workshop Papers

(W01) | A. Sullivan, K. Wang, S. Khurshid, and D. Marinov. Evaluating state modeling techniques in Alloy. In *Workshop on Software Quality Analysis, Monitoring, Improvement, and Applications (SQAMIA)*, pages 16:1–16:09, September 2017.

We quantitatively evaluate the techniques for modeling state and state transitions in Alloy by considering the runtime for solving the ensuing SAT formulas.

Thesis and Dissertation

(T02) | A. Sullivan. Automated testing and sketching of Alloy models. In *Texas ScholarWorks - UT Electronic Theses and Dissertations*, May 2017.

(T01) | A. Sullivan. AUnit: A testing framework for Alloy. In *Texas ScholarWorks - UT Electronic Theses and Dissertations*, May 2014.

University Service

Faculty Supervisor

- **Anahita Samadi** – **Level:** Doctoral, **Focus:** Machine Learning and Software Engineering, **Projected grad date:** Spring 2024
- **Tanvir Ahmed Khan** – **Level:** Doctoral, **Focus:** Formal Methods Education, **Projected grad date:** Spring 2024
- **Prajkta Krishna Jagtap** – **Level:** Thesis, **Focus:** Fault Localization for Alloy, **Projected grad date:** Spring 2021

Graduated Students

- **Jasmine Mabrey**
  - **MS May 2020:** Automated Defect Classification using Machine Learning
  - **First job:** Sandia National Laboratory, Albuquerque, NM
  - **Award:** Named NC A&T Rising Scholar
- **George Thompson**
  - **MS May 2020:** Towards Automated Fault Localization for Prolog *Nominated for Outstanding Thesis Award*
  - **First job:** Sandia National Laboratory, Albuquerque, NM
- **Regina Bunch**
  - **MS December 2018:** AMail: Email for Autism
  - **First job:** Cigna, Philadelphia, PA
- **Joelle Banks** – **Level:** Undergraduate, **Focus:** Empirical Study of Program Repair Techniques, **Graduation date:** May 2020
- **William Dunston** – **Level:** Undergraduate, **Focus:** Extending Java-Based Program Repair, **Graduation date:** May 2020

Student Committee Member

I have had the honor of serving on the following student committees:

- **PhD Committee Member:** Hanan Alshahr (Fall 2019, NC A&T)
- **Master Thesis Committee Member:** Derrick Leflore (Fall 2019, NC A&T), Shannon Wiggins Brown (Spring 2020, NC A&T)
- **External Member:** Yuanrui Ren (Fall 2018, The University of Texas at Austin).

UTA CSE Broadening Participation in Computing Committee Member

- Member of three subcommittees: BPC Student Awards, External BPC Conferences and K-12 Outreach.
- Staffed UTA's virtual booths at TAPIA and CMD-IT Graduate Fair.

Club Advisor
- **UT Arlington:** I am the co-advisor for "Society of Women Engineers (SWE)"
- **NC A&T:** I was the faculty advisor for "Girls Who Code Loops" and "Society of Women Engineers (SWE)"

Faculty Advisor for Student Teams
- Coach for NC A&T's Advancing Minorities' Interest in Engineering (AMIE) Design Challenge teams (Spring 2019 and Spring 2020).
- Coach for NC A&T's 2019 Black Enterprise 2019 BE SMART Hackathon team. *Placed 1st*

Faculty Mentor for NC A&T's SAE International AutoDrive Challenge Student Team from Fall 2018 to Spring 2020
- Placed 2nd overall in Year 2 (2018-2019), my first year on the project.
- **Functional Safety Group.** Mentored 4 graduate students, 1 undergraduate student.
- **Mapping Group.** Mentored 4 graduate students. *Placed 3rd in Year 2 Mapping Challenge*

Organizer for the Triad Programming Contest
- 2020: Lead organizer for the contest (https://triad-pc-2020.github.io/).
- 2019: Co-organized the contest and served as a judge for the contest.

Former member of NC A&T's Center of Excellence in Cybersecurity Research, Education and Outreach (CREO)
- 2018 -2020: I worked with an interdisciplinary group to apply formal methods to the cybersecurity field.

Corporate Outreach and Professional Development
- Attended "Engaging Students in Online Synchronous Class Meetings"
- Reviewer for Google's "Technical Writing One/Two" courses designed to help graduate students learn academic writing.
- Member of the NC A&T team that helped bring Facebook's Engineer in Residence Program to A&T's CS department.
- NC A&T's CS Representative to Intel's HBCU Consortium, worked on NC A&T's submission to Intel's HBCU Beyond 2020 grant.
- NC A&T Representative to Facebook T3 "Train the Trainer" summit on Data Structures and Algorithms.

Open Source Contributions

Fault Localization Tool for Prolog
- **ProFL.** ProFL is a command-line fault localization tool for Prolog models.The toolset provides spectrum-based and mutation-based fault localization techniques: *https://github.com/geoorge1d127/ProFL*.

Solution Enumeration Tool for Alloy
- **Seabs.** Toolset to guide solution enumeration for Alloy models using abstract functions, which specify how the solutions must differ: *https://github.com/Allisonius/Seabs*.

Verification and Synthesis Tools for Alloy
- **AUnit Analyzer.** Extension to the Alloy Analyzer that provides support for AUnit, namely: test creation and execution, coverage reporting, and automated test generation: *https://sites.google.com/view/aunitanalyzer*.
- **MuAlloy.** A command line tool built on top of Alloy 4.2 that provides mutation testing and mutation-based test generation for Alloy models: *https://github.com/kaiyuanw/MuAlloy*.
- **ARepair.** A command line tool built on top of Alloy 4.2 that automatically repairs faulty Alloy models, including models with multiple faults: (*https://github.com/kaiyuanw/ARepair*).
- **ASketch.** A command line tool built on top of Alloy 5.0 that can synthesis partial Alloy models, producing complete models which are correct w.r.t. a test suite: *https://github.com/kaiyuanw/ASketch*.

Honors & Awards

Oct 2019	**Grace Hopper Celebration 2019 Faculty Scholarship** from AnitaB.org
2012 - 2016	**Virginia and Ernest Cockrell Jr. Fellowship in Engineering Recipient,** University of Texas at Austin.
Spring 2012	**ECS Departmental Honors,** University of Texas at Dallas.
2008 - 2012	**Academic Excellence Scholarship Recipient,** University of Texas at Dallas.

Teaching Experience

Spring 2021	**Instructor**, CSE 5320/6392: Computer-Aided Verification for Systems, University of Texas at Arlington.	*Graduate*
Fall 2020	**Instructor**, CSE 5311: Design and Analysis of Algorithms, University of Texas at Arlington.	*Graduate*
Spring 2020	**Instructor**, COMP 496: Senior Design, North Carolina A&T State.	*Undergrad*
Spring 2020	**Instructor**, COMP 681: Formal Methods, North Carolina A&T State.	*Graduate*
Fall 2019	**Instructor**, COMP 285: Analysis of Algorithms, North Carolina A&T State.	*Undergrad*
Fall 2019	**Instructor**, COMP 611: System Testing and Evaluation, North Carolina A&T State.	*Graduate*
Spring 2019	**Instructor**, COMP 496: Senior Design, North Carolina A&T State.	*Undergrad*

Spring 2019	**Instructor**, COMP 681: Formal Methods, North Carolina A&T State.	*Graduate*
Fall 2018	**Instructor**, COMP 285: Analysis of Algorithms, North Carolina A&T State.	*Undergrad*
Spring 2016	**Teaching Assistant**, EE 382C: Verification and Validation, University of Texas at Austin.	*Graduate*
Spring 2014	**Teaching Assistant**, EE 382C: Requirements Engineering, University of Texas at Austin.	*Graduate*
Fall 2011	**Teaching Assistant**, CS 3345: Data Structures & Algorithms, University of Texas at Dallas.	*Undergrad*

Professional Service

Panelst	2 panels at the National Science Foundation (NSF), Alexandria, VA in 2020
PC Member	The ACM Joint European Software Engineering Conference and Symposium on the Foundations of Software Engineering Tools and Demostration Track (FSE Demo 2020)
PC Member	The 27th International SPIN Symposium on Model Checking of Software (SPIN 2020)
PC Member	Special Interest Group on Computer Science Education Technical Symposium (SIGCSE 2020)
PC Member	5th International Conference on Research in Equity and Sustained Participation in Engineering, Computing, and Technology (RESPECT 2020)
Reviewer	Software Tools for Technology Transfer (STTT)
Co-Reviewer	27th International Symposium on Software Testing and Analysis (ISSTA 2018)
Co-Reviewer	11th International Conference on Software Testing, Verification and Validation (ICST 2018)
Co-Reviewer	25th International Symposium on the Foundations of Software Engineering (FSE 2017)
Co-Reviewer	10th International Conference on Software Testing, Verification and Validation (ICST 2017)
Co-Reviewer	31st IEEE/ACM International Conference on Automated Software Engineering (ASE 2016)