

# MOHIT KUMAR TEKRIWAL

PhD Candidate, University of Michigan, Ann Arbor

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## RESEARCH EXPERIENCE

### Formal Verification of Numerical schemes

**Advisor: Prof. Jean Baptiste Jeannin, Dept. of Aerospace Engineering, University of Michigan**

📅 September 2018 – Ongoing

- Formalized the Lax-equivalence theorem (statement of convergence of finite difference schemes) in Coq proof assistant
- Formally verified stability of Forward in time and Central in Space (FTCS) scheme for 1D-heat diffusion equation
- Explored light weight verification techniques like Frama-C/VST for verification at code level
- Formalized the convergence of classical iterative methods in Coq

### Certified approximation of Transcendental functions

**Mentor: Prof. Eva Darulova, formerly at MPI-SWS, currently at the University of Uppsala**

📅 June 2021–August 2021

- Worked on formalization of the Remez algorithm for approximation of transcendental functions in HOL4 theorem prover
- Implemented a first version of the certificate checker in a static analysis tool, Daisy
- Formalized the McLaurin series approximation of transcendental functions and root finding methods in HOL4 theorem prover

### Instability and receptivity studies in Lid Driven Cavity Problem

**Mentor: Prof. Tapan K Sengupta, Dept. of Aerospace Engineering, Indian Institute of Technology, Kanpur, India**

📅 Aug 2017– May 2018

- Simulated and analyzed flow in a 2D Lid Driven Cavity
- Successfully obtained a narrow range of optimal excitation amplitude responsible for onset of temporal instabilities in the system for Reynolds number in the range: 8000 - 8660
- Carried Flow visualization studies using TecPlot
- Redrew bifurcation curve using vorticity time series data with respect to specific numerical method to obtain reported critical Reynolds number by other researchers

### Verified QR algorithm

**Sandia National Laboratories**

📅 June 2022–August 2022

- Worked on formalization of the QR factorization algorithm
- Formalized properties of Givens rotation algorithm for QR factorization

## RESEARCH INTERESTS

I am interested in programming languages, type theory, formal verification and numerical analysis. My current research work is on applying formal methods to the field of numerical analysis and Computational Science. In particular, I am working on developing an end-to-end verification framework for numerical programs.

## EDUCATION

### Ph.D. in Aerospace Engineering

**University of Michigan, Ann Arbor**

📅 Sept 2018 – Present

### MSE in Aerospace engineering

**University of Michigan, Ann Arbor**

📅 September 2018–April 2020

### B.Tech in Aerospace engineering

**Indian Institute of Technology (IIT), Kanpur, India**

📅 August 2014 – May 2018

## TECHNICAL SKILLS

- Programming Languages: C, C++, OCaml, Rust
- Software and Utilities: MATLAB, TecPlot, Coq Proof Assistant, Microsoft office suite, AutoCad, SolidWorks, LabVIEW, Frama-C, HOL4 theorem prover
- Operating System: Linux, Windows, Mac

## PROFESSIONAL EXPERIENCE

### Visiting research fellow

**INRIA Sophia Antipolis, France**

📅 Oct. 2022 – Present

### RnD Grad summer intern

**Sandia National Laboratories**

📅 Jun. 2022 – Aug. 2022

### Summer intern

**Max Planck Institute for Software Systems**

📅 Jun. 2021 – Aug. 2021

## RELEVANT COURSE PROJECTS

### Bayesian Games

#### AEROSP 740: Inference Estimation and Learning

- Carried literature survey on Bayesian games for adversarial machine learning
- Studied the relevance of Game theoretic approach in cyber-security applications

### Verification with Frama-C

#### EECS 590: Advanced Programming Languages

- Carried static analysis of C code using the Hoare Logic
- Motivation is to formally verify CFD solvers directly at the code level

## TEACHING EXPERIENCE

### Graduate Student Instructor

#### AEROSP 495: Introduction to Aerospace computing

📅 Fall-2019, Fall-2020

📍 Rating: 4.6/5.0

- Responsible for grading homework, take home examinations and conducting office hours
- In-charge of weekly labs for the course
- Delivered a couple of lectures in the class

## PUBLICATIONS

### Journal Articles:

- V. K. Suman, Siva Viknesh S., **Mohit Tekriwal**, Swagata Bhaumik, Tapan K. Sengupta. "Grid sensitivity and role of error in computing a lid-driven cavity problem". In: *Physical Review E* 99.1, p. 013305, 2019.
- **Mohit Tekriwal**, Karthik Duraisamy, and Jean-Baptiste Jeannin. "A formal proof of the Lax equivalence theorem for finite difference schemes." NASA Formal Methods Symposium, 2021.
- Heiko Becker, **Mohit Tekriwal**, Eva Darulova, Anastasia Volkova, Jean-Baptiste Jeannin. "Certified approximation of transcendental functions." ITP, 2022.
- **Mohit Tekriwal**, Ariel Kellison, Jean-Baptiste Jeannin, Geoffrey Hulette. "Towards Verified Rounding-Error Analysis for Stationary Iterative Methods". Software correctness workshop, 2022.

### In Review:

- **Mohit Tekriwal**, Joshua Miller, Jean-Baptiste Jeannin. "Formal verification of iterative convergence for numerical solutions of differential equations".
- **Mohit Tekriwal**, Andrew Appel, Ariel Kellison, David Bindel, and Jean-Baptiste Jeannin. "Verified Correctness, Accuracy, and Convergence of a Stationary Iterative Linear Solver: Jacobi Method".

## REFERENCES

- Prof. Yves Bertot, STAMP team lead, INRIA Sophia Antipolis
- Prof. Andrew W. Appel, Princeton University
- Prof. Jean-Baptiste Jeannin, University of Michigan, Ann Arbor

## ACHIEVEMENTS AND AWARDS



#### Chateaubriand fellowship (2022)

Awarded fellowship to conduct a part of my PhD research in France.



#### Max Plank Research fellowship (2021)

Awarded fellowship for summer research internship at the Max Plank Institute for Software systems(MPI-SWS), Germany

#### PhD candidacy (2020)

Advanced to PhD candidacy in Aerospace engineering



#### General Proficiency Medal (2018)

Awarded for the best academic performance in the graduating batch of Aerospace engineering



#### Proficiency Medal (2018)

Awarded for the best undergraduate Project in the graduating batch of Aerospace engineering department



#### SN Bose Scholarship (2017)

Selected for summer internship program in the United States of America. A total of 50 students from 78 reputed institutions in India, were selected for this award.



#### Academic Excellence award (2016-2017)

#### Qualified the Joint Entrance Examination (IIT-JEE)

Only 0.1% of the applied candidates are selected in the premier engineering college of India, Indian Institute of Technology (IIT)

## COURSEWORK

- Inference, Estimation and Learning
- Data driven modeling of Complex systems
- Advanced Programming Languages
- Formal Verification of Software and Hardware systems
- Compiler Construction
- Linear Systems theory
- Non-linear Systems theory
- Computational Fluid Dynamics
- Differential equations
- Optimization methods in engineering applications
- Applied numerical methods