Akshay **Gopalakrishnan**

COMPUTER SCIENCE RESEARCHER

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"Keep Learning and Learning and Learning ;)"

Research Vision

My research is based on Memory Consistency models. A memory model specifies the rules of interaction with shared memory along with the behavior of programs under concurrent / parallel context of execution.Existing models with strong constraints have intuitive appeal, and are the focus of current proposals, but experience with other language systems shows that balancing ease of programmability with flexibility for aggressive optimization is difficult, and an excessive focus on being programmer friendly can have complex implications for performance. Ensuring compatibility between different memory models when compiling one language to the other is also a key problem identified by researchers in this domain. My goal is to help analyze / develop memory consistency models that assist in reducing the trade-off between ease of programmability and allowable set of optimizations for the sale of performance. in this endeavour, i would also want to help in identifying key factors pf memory model compatibility across different languages (mainly focus low and high-level languages) that may assist in correct compilation of concurrent code. .

Current Research

I am doing my master's thesis at the Sable Lab of McGill university with Professor Clark Verbrugge and Professor Brigitte Pientka in the domain of weak memory model of ECMAScript (also commonly misunderstood as just Javascript). For a long time, Javascript had stayed primarily a single threaded language. With the increasing need for concurrent programming, Javascript introduced Web-Workers that represented threads. However, communication among threads was message passing. ECMAScript standard recently came up with the specification of shared memory concurrency model. Our current focus involves analyzing the recently proposed live draft of ECMAScript memory model. We intend on formalizing the ECMAScript memory model in hopes to better clarify this complex relation. We aim for a detailed and clear axiomatic semantics that exposes and clarifies limits on optimizations implicit in the current live draft of the weak memory model.

Teaching Experience

Foundations of Programming (Course)

McGill University, Montreal, Canada

TEACHING ASSISTANT

Fall 2019(ongoing)

- Tutorials on basics of loops, strings, lists, dictionaries in python
- Grading assignments and final exam
- Holding weekly office hours

Concurrent Programming (Course)

McGill University, Montreal, Canada

TEACHING ASSISTANT

Winter 2019

- Rubric design for assignments and midterm exams
- Grading assignments and midterms giving constructive feedback
- Held weekly office hours

Operating Systems (Course)

McGill University, Montreal, Canada

TEACHING ASSISTANT

Fall 2018

- Assignment Design
- Rubric design for assignments and exams
- Grading assignments and exams giving constructive feedback
- Tutorial on C pointers, structures
- Held weekly office hrs

Exploration through Projects / Research

Compiler for GoLite (OCAML)

Compiler course project

MASTERS (GROUP PROJECT OF TWO MEMBERS)

2019

- A full fledged compiler for a subset of GO language
- Tremendous practical experience building each phase of compiler viz Lexical, Parsing, Semantics and Code gen.
- Tremendous experience gained in using OCAML language to build the compiler
- The target language was Python
- Project Link with report: GoLite Compiler

Predicting Compiler Optimizations in C (bash, C, Python)

Machine Learning course project

MASTERS (SOLO) *2018*

- Research based project wherein gcc compiler optimization levels were attempted to be predicted by training a simple machine learning model
- Data set was gathered from my own personal C programs written number theory and a few project euler problems.
- Experience gained in using autoencoders.
- Experience gained in data mining for machine learning purposes
- Critical insights were gained on analysis of training data and predictions.
- Project Link with report : Compiler Optimization Prediction

Ontology Based Intrusion Detection System (SPARQL, Python)

Undergraduate final year research project

UNDERGRADUATE RESEARCH (GROUP OF THREE) *2017 - 2018*

- Research based project involving building an proof of concept Intrusion Detection System (IDS) for a specific application layer based Denial of Service (DoS) attacks using HTTP protocol called as SlowDos.
- Experience gained in reading research papers, conducting exhaustive literature review and concretely defining research statement for our problem.
- Research work link : Ontology-based IDS

Generic Lex (C++)

Summer holidays personal project

UNDERGRADUATE (SOLO) *2017*

- A basic generic lexical analyzer to define any syntax whose grammar is given by the user in the form of many regular expressions as input.
- First major exposure to actually implementing the concept of parsing.
- Project Link : GenLex

Automata Generator (C++)

Summer holidays personal project

UNDERGRADUATE (SOLO) *2016*

- Automata generator used to define grammars in the form of regular expressions given by the user.
- Functionalities to convert from deterministic to non-deterministic automata and vice versa and verify if given input belongs to the grammar.
- First major exposure to coding in C++, using C++ templates and recursion style programming.
- Project Link : AutomataGen

Assembler for 8086 SIC (C)

Summer holiday personal project

UNDERGRADUATE (SOLO) *2016*

- A full fledged assembler for a subset of 8086
- Involved around 10 instructions of 8086

Interactive Debugger + Interpreter for 8086 (Python)

Principles of Programming Languages Course project

UNDERGRADUATE (GROUP PROJECT OF THREE MEMBERS) *2016*

- An interactive debugger for Assembly Language incorporated with GUI crafted using PyQT4 library.
- Involved around 20 instructions of the 8086 instruction set
- Project Link : Visualemu 8086

Project Othello (C language)

Data Structures Course project

UNDERGRADUATE (SOLO) *2015*

- First major programming project as a two player board game known as Othello (or Reversi)
- Common effective strategies of the game integrated as an AI opponent
- Ncurses graphics library used for the visual aspects
- Project Link : Project Othello

Designed Content

Foundations of Programming for grade 6 students

McGill University, Montreal, Canada

CORE MEMBER (GROUP WORK FOR COURSE) *2018*

- Designed an entire course for grade 6 students for programming foundations
- Designed and presented lectures for a subset of the designed course throughout the term.
- Designed rubrics to grade assignments and work done by peers on designing other computer science courses

Coding competition at College Technical Fest

College of Engineering Pune, India

PROBLEM SETTER *2017*

- Designed competitive coding problems for a coding contest held at my undergraduate university
- Problems were designed catering to algorithm and data-structure basics involving concepts like dynamic programming, number theory, linked lists, trees, etc
- Designed rubric for grading the contest code submissions.

Academic Writing

Vocabulary and its Influence on Computer Science Research — *McGill University, Montreal, Canada*

Individual (part of course — *2019*

- Wrote a research paper that talks about how vocabulary in CS research helps in influencing CS education across different communities.
- Inspired by Pierre Bourdieu's work on "Reproduction in Education, Society and Culture".
- Link to paper : Vocabulary in CS research and its Impact

Attended Conferences

Systems, Programming, Languages, and Applications: Software for Humanity(SPLASH) - 2019 — *Athens, Greece*

Received funding from SIGPLAN to attend conference — *Oct 2019*

- Attended Programming Languages Mentoring Workshop (PLMW)
- Attended tracks of MPLR, REBASE and OOPSLA

COHESA Annual Meeting — *Toronto, Canada*

Poster Presentation of our Master's Thesis Research topic — *July 2019*

- Introduced the concept of Weak Memory Consistency models in concurrency
- Proposed our current research statement, current progress and future scope

CS-Can Student Symposium — *Montreal, Canada*

Poster Presentation of our Undergraduate Research Project — *June 2019*

- Introduced the concept of Ontology Based Intrusion Detection System
- Described how an Ontology can help us detect stealthy attacks such as HTTP-Slow DoS

Academic Responsibilities Held

Programming languages and compilers reading group — *McGill University, Montreal, Canada*

Coordinator — *Fall 2019(ongoing)*

- Managing timeline for regular reading group meetings
- Manage coordination between members to decide presentation of particular research paper every meeting

Lab meetings — *McGill University, Montreal, Canada*

Coordinator — *Fall 2019(ongoing)*

- Managing timeline for our regular lab meeting
- Manage coordination between lab members to decide presentation of particular research topic

Funding / Grants Received

NSERC COHESA — *Montreal, Canada*

Master's Thesis Student Aid Funding — *2019*

NSERC COHESA Travel Grant — *Toronto, Canada*

For attending the COHESA Annual meeting — *July 2019*

ACM SIGPLAN Travel Grant — *Athens, Greece*

For attending SPLASH 2019 conference — *Oct 2019*

Education

McGill University — *Montreal, Quebec, Canada*

Masters in Computer Science (Thesis) - Ongoing — *2018 - Today*

College of Engineering Pune — *Pune, Maharashtra, India*

Bachelors in Information Technology — *2014 - 2018*

Other Hobbies / Interests

Gamerrr - Love to play games

Since childhood

Some genres and games played

- Strategy based games (eg: Age of Empires ,DOTA 2, Rise of Nations, Stronghold, Wesnoth etc)
- Challenging third person games (eg: Dark Souls series, Darksiders, Tomb Raider, etc)
- Adventure games (eg: Elder Scrolls, Vanishing of Ethan Carter, Assasin's Creed , etc)

Yoga - Love to practice yoga daily

Since 4th Grade

Training received

- Was part of BKS Iyengar Yoga Institute for 8 years.

Avid manga reader and anime watcher

Since Childhood

A brief definition of the above two

- Mangas are Japanese form of illustration that deeply connect to their culture and way of life
- Animes are Japanese form of animated mangas (although some anime exist without mangas)

Music - Part of my life

Since childhood

Few interests and received training

- Received carnatic music lessons from Shrimati Rama Parthasarathi for 8 years.
- Interested in bhajans of different kinds
- Fond of the blues music

Philosophy - Knowledge can only teach us that much

Since dunno when..

A few influential excerpts

- It is inner strength that makes one fearless, and it is the fearless one who crosses the individual consciousness and becomes one with the universal consciousness - Swami Rama (Living with the Himalayan Masters)
- When there is death, there is something totally new. Freedom from the known is death, and then you are living - Jiddu Krishnamurthy (Freedom from the Known)
- It is neither happiness nor sorrow that one wants. When one is no longer seeking, they are neither happy nor sad, but are content - Anonymous