**Amirhossein Mirhosseini**

My name is Amirhossein Mirhosseini and I am a PhD student in CS department working with Professor Josep Torrellas. I work generally on Computer Architecture and Compilers and I am currently working on designing reliable memory systems with incremental checkpointing capabilities.

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<th>Possible Projects</th>
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<td>I have different research projects for undergraduate students in various areas of Computer Architecture and Hardware like Memory Systems, On-Chip Networks, etc.</td>
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<th>Desired Coursework/Experience:</th>
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<td>Students who want to work with me need to have basic knowledge of computer architecture (at the level of CS233) or be willing to study and learn some concepts in that area on their own. I would of course, help them with this.</td>
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<th>Additional Questions for Applicant</th>
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</thead>
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High performance computing (HPC) has become a fundamental tool in many fields of science and engineering for cutting edge research. Researchers depend on the machine being reliable and efficient, but as HPC resources expand toward exascale, these mainstays need to be reevaluated. Due to the sheer number of components, component fabrication size, and strict power budgets, future HPC systems are expected to experience a higher rate of silent errors than current machines. Silent errors commonly known as bit-flips occur when cosmic radiation or radiation from chip packaging interferes either transiently or permanently with electronics operations causing bits being stored or transferred to invert themselves leading to silent data corruption (SDC). My research seeks to understand how HPC applications handle SDC and to develop efficient detection schemes and recovery schemes. For my research I’ve built a fault injection framework FlipIt to simulate silent errors in executing applications. For each application hundreds or even thousands of executions are performed to obtain meaningful statistics.

Possible Projects

Optimizing and extending the fault injection framework FlipIt. This project will consist of extending the current version of FlipIt threaded environments such as multi-core CPUs and many-core accelerators such as GPUs and Intel MIC. In addition, this project will seek to optimize the current and new extensions of FlipIt to obtain better performance. Experience with accelerators isn’t required and can be learned over the course of the project.

Desired Coursework/Experience:

C/C++, bash, python, OpenMP, Pthreads, CUDA, OpenCL

Additional Questions for Applicant

What interests do you have in parallel computing?

What interests do you have in system or software reliability?
Possible Projects

Android programming – Our group is doing some research related to analyzing data collected from keyboard applications on Android. The mentee's responsibility for this project can include browsing the most popular Android keyboard applications, compiling a list of unique features and then creating the Android keyboard application with selected features.

Web programming – The mentee will be working with the backend services that supports Code Hunt (https://www.codehunt.com/). The mentee’s responsibility for this project can include exploring what applications (web or mobile) can be created by accessing the backend services that supports Code Hunt and/or exploring ways of improving existing applications such as Code Hunt that is already making use of the backend services.

Desired Coursework/Experience:

Java, C# or web programming experiences is not necessary but recommended.

Additional Questions for Applicant

What about computer science are you excited about? How come you are excited about such things?
Since the beginning of time, a human has been fascinated by the moon. The National Aeronautical and Space Administration (NASA) solidified its goal of a ‘Colonization of the Moon’ as a reality in the near future. The Lunar outpost will be an inhabited facility on the surface of the Moon which NASA currently proposes to construct over the five years between 2019 and 2024. Waste treatment and removal for missions to moon will be more challenging due to the longer mission duration regardless of complications from the environment. Waste management for such missions may employ more efficient versions of technologies than developed for Shuttle or completely different approaches may be more cost effective. Depending on the mission protocols, indefinite stable storage for the end products of any waste processing scheme will be necessary. Historically wastes generated during human spaceflight are materials with no further utility requiring only storage until missions end. However, Exploration Waste Subsystems may reclaim resources from input wastes allowing greater closure within the overall life support system. The waste subsystem collects waste materials from life support subsystems and interfaces. Current NASA spacecraft waste handling approaches essentially rely on dumping and/or storage. For future long duration Lunar mission, it is practically impossible to get all the stored wastes back to the earth and the waste generated over a year cannot be dumped in Lunar surface. Several studies have highlighted the importance of a technology called ‘Anaerobic Digestion’ which not only reduces the wastes on the Lunar surface, but may provide significant fuel out of it during a year of exploration. anaerobic digestion or biogasification is a biological process in which microorganisms break down organic matter into methane and carbon dioxide under anaerobic (or no oxygen) conditions. The technology is ideally suited for space mission, as it does not require oxygen. The current research efforts focuses on developing a novel flow cytometry based method with concurrent utilization of a community fingerprinting technique based on automated ribosomal intergenic spacer analysis (ARISA) to characterize the dynamics of the microbial communities in anaerobic digesters mentioned above. We propose to use this novel ‘dual’ technique for potentially monitoring and analyzing dynamics of the microbial communities to yield informative models for understanding and engineering the function of other complex microbial communities, such as in the human gut, soils and oceans.

(4. Flow assisted cell sorting and subsequent Illumina® sequencing of methanogens in anaerobic digester)

Desired Coursework/Experience:
Desired but not required: A prior experience in Arduino based microcontrollers, Mathematical Modeling, R and synthetic biology lab skills.

Additional Questions for Applicant
1. Are you a dynamic individual who is genuinely passionate about environmental sustainability? Why?
2. Do you consider yourself an entrepreneurial personality who recognizes opportunities in waste-to-energy systems that would be simultaneously profitable and environmentally sustainable? If yes, please provide a brief overview of your vision.
3. Do you like getting challenged? Please explain briefly why do you feel you are ready for real responsibilities and want to make a real difference.
I'm Mohammad, a 3rd-year PhD student in Computer Science in the Systems & Networking group. Mobile and wearable systems, healthcare, and multimedia systems are my main three areas. I'm interested in any research topic targeting mobile and wearable devices (e.g. Energy-Efficiency, Adaptations, Protocols, etc.), healthcare systems (e.g. telemedicine, mobile healthcare, etc.) as well as multimedia systems, including games, Videos, and virtual environments.

Possible Projects

It is a real-world and high-impact project, which includes profiling of cellular network coverage in routes between two cities (Hoopeston to Champaign). The whole project combines mobile application development and software engineering, algorithms, data engineering, and real test-bed. The mentees will need to a) develop a mobile app to log and profile cellular coverage (3G, 4G), and b) drive through the two cities to collect coverage data. Optionally, we might extend the problem and mathematically model the problem for further analysis.

Desired Coursework/Experience:

- Experiences in Android or IOS development is required.
- Driving between the cities requires a car!
- being in ECE would be a plus

Additional Questions for Applicant

- What is your major (ECE or CS) and what year? (e.g. ECE, 3 or CS, 4)
- Do you have experiences in mobile app development? (Android, IOS, etc.)
- Are you willing to drive and log the 50 miles between the two cities?
I work on security and privacy, specifically privacy-preserving systems. Currently, my research focuses on two separate problems: secure outsourcing of cloud storage and computation, and privacy-preserving data publishing. Secure outsourcing of cloud storage and computation is about using cryptographic techniques to provide data security and privacy when entrusting sensitive data to cloud services. In particular, my work aims to build practical systems by combining well-established cryptographic techniques and system-level insights.

The second problem on privacy-preserving data publishing is about publically releasing a dataset while safeguarding the privacy of the individuals in the dataset. My work on this focuses on generative techniques, that is: how can synthetic (i.e., fake or dummy) data be used to protect privacy?

Possible Projects
- Using cryptography to prevent data breaches
- Privacy utility trade-offs in privacy-preserving data publishing
- Your own idea. (Must be a research project related to security and privacy.)

Desired Coursework/Experience:
- Time commitment of mentees is significant (e.g., 5 hours per week), but the scope and focus of the projects can be adjusted.
- Some projects require working knowledge of either cryptography, or probability and statistics.

Additional Questions for Applicant
- Why do you want to do research?
- How much time per week can you devote to a research project?
I work on high-accuracy computational methods for materials. The methods I use include density functional theory (DFT), complete active space self-consistent field (CASSCF), coupled-cluster (CC) and quantum Monte Carlo (QMC). These methods are relevant for material analysis, material discovery and understanding fundamental physical and chemical processes in materials. For example, electron/proton transfer/transport and photosynthesis. Besides using existing packages to analyze materials, I also work on method development which involves "hard-core" programming in C++ or Fortran. In addition, I recently became involved in scripting automatic workflow between different scientific packages using python.

Possible Projects

1. Analysis of a material using one or more computational packages. This option will be more physicsy and/or material sciencey.

2. Extension or implementation of a computational method. This option will be programming intensive

3. Automating workflow. This option will be computer sciency and will involve the creation and management of databases.

Desired Coursework/Experience:

1. Enthusiastic about research

2. Enjoy problem solving and learning new things

3. Do not hate programming

4. Prior chemistry/physics knowledge is preferred but not required

Additional Questions for Applicant

I have gathered quite some experience in computational science (summarized on my website) and am very excited about the perspective of being able to share it.
At the Cognition and Brain Lab, we study the cognitive and neural basis of language and memory function across the lifespan. As a mentee, you would have the opportunity to learn about multiple ongoing projects at the lab. Your primary mentor would be Cybelle Smith, whose research centers around how contextual cues, both verbal and in the environment, shape our understanding of language and meaningful images. Cybelle is working on developing a Minecraft server for running psychological experiments that require a complex virtual environment, and is also interested in using machine learning techniques to conduct exploratory analyses on neural data. She is also currently working on two projects in which she will employ electroencephalography (EEG; recording electrical ‘brainwaves’ at the scalp) to answer questions about the role of working and associative memory in language comprehension and category learning.

Help develop a Minecraft server for collecting behavioral data as participants navigate through complex virtual environments. This would involve converting some existing client-side code into server-side code (in Java), getting the Minecraft server and data collection server set up on our server space, and adding a number of functions that would allow the experimenter to record where participants are at each time point, when they take various actions in the virtual world, etc. We would also like to emphasize making the project clean and easy to use for experimenters who may not have as much programming experience – this could involve developing user documentation and an interface so that simple experiments could be conducted with minimal scripting.

Use machine-learning techniques to analyze EEG data. For example, you could help build a classifier to categorize EEG data. In the process, we would develop some scripts that would make formatting and preprocessing EEG data for that kind of analysis easier for other researchers at the lab (i.e. we would make a pipeline). The preprocessing pipeline could potentially lead into a machine learning toolbox for MATLAB that is currently under development by another group of researchers on campus (Aki Nikolaidis and Drew Goatz at the Beckman Institute).

Help run participants for one of our experiments and learn how to use EEG.

Develop an iOS or Android application that would eliminate the need for using paper forms at our lab.

Clean up some php code for running an online norming task in which participants complete a sentence and then later have to make judgments about their completion. (We use these to get essential information about the stimuli we use in our language tasks). We would want to make it well documented and more generalizable to other related norming tasks, as well as patch some security loopholes, so that it can be shared with researchers outside our lab.

Desired Coursework/Experience:

Applicant must have programming experience (in any language).

In addition to the main project, mentee(s) would be encouraged to help out with smaller scripting / programming tasks, such as programming experiments, making scripts that generate lists of stimuli satisfying multiple constraints, etc. This could be a great way to learn about multiple research projects going on at the lab, and about considerations in experimental design, while helping out in a substantial way!

There are other opportunities to get more involved at the lab – for example, even if you choose to work on a project that does not involve EEG (brainwave) data collection, if you would be interested in helping to collect that data, we would be willing to train you. We also have bi-weekly lab meetings which are optional but which you are very welcome to attend. During these meetings, we discuss ongoing research projects at the lab in more depth.

Additional Questions for Applicant

1. What is your programming background? How comfortable are you with programming / scripting and what languages do you know?
2. Which projects above seem the most interesting to you, or do you have any other ideas for potentially interesting and helpful projects?

3. What would you most like to take away from this experience, and what time commitment are you hoping to make? We can likely handle about 3-6 hours / week, depending on how well you are able to work independently.