AIMS² Research Project in Computer Science

Research Duration: 2020-21 (September 15, 2020 – May 31, 2021)

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Title of Project: Adding Features to the Proteus Programming Language

Project Background: In space applications, software correctness is of paramount importance. Humans are rarely physically available to reset malfunctioning software, and software bugs can (and have) lead to mission failure. For these reasons, the Jet Propulsion Lab (JPL) is particularly interested in the development and use of specialized programming languages (PLs) which can provide correctness guarantees about written software. To this end, we have been designing and implementing a new PL named *Proteus* for writing software with correctness guarantees. Proteus compiles to C++. Proteus is currently in an early state and is missing many common PL features.

Goals and Objectives of the Project: The goal of this project is to add a number of essential common PL features to Proteus. A non-exhaustive list of possible features includes user-defined data structures, references, and function pointers. For each feature, we would discuss the impact on Proteus' syntax and semantics, including how we could ensure the user uses the feature correctly (with types), and how we could compile the feature to C++. Once we understand the impact, we would incrementally add the feature to Proteus, which will likely require working with the entire Proteus compiler.

Project Outcomes: Students will gain hands-on experience in PL design and implementation, in the context of developing an experimental compiler targeted for space applications. Students will become acquainted with industry-standard software development tools and techniques, including version control systems (specifically git and GitHub) and unit testing. Ideally, student code will be integrated into Proteus' final version, and may be used by systems engineers at JPL.

Expectations from Students: Students will meet virtually ~2 hours per week to learn PL development background and to provide project status. All communication will be via free software, namely Zoom (video), Slack (text), and GitHub (project management). Additional reading may be needed. Students will contribute significant amounts of well-tested code to Proteus' compiler. Students may be expected to form teams focused on individual features.

Incoming students must have taken at least a CS2 equivalent (e.g., CSUN's COMP 182/L), and prior experience using multiple PLs is ideal. No prior experience in PL development, version control, or unit testing is necessary. Students must provide their own computer; no special software or hardware is needed. **After the project**, students are expected to make an oral presentation and present a poster at the AIMS² research symposium, tentatively in March 2021.