Statement of intent for Constrained random Vector Generator (CVG)

I am looking to research and implement a Constrained random Vector Generator (CVG) based on the work done in the fields of symbolic execution and test generation. This work will be based on research of work in symbolic executors and test generation. I am the CTO of Empower Operations Corp, the producer of a commercial optimizer, and am familiar with constraint solvers from my studies in CMPT 479 with Nick Sumner and in my work for my company. All work will be completely open source, with no IP being retained by Empower. I see this work as an opportunity to give back to the academic community than rather one of simple business or personal-accreditation gains. To this end this project represents a study of purely academic interest, unmolested by business needs, which I hope makes it suitable for credit in CMPT 415.

The majority of modern constraint solvers solve boolean or set based expressions paying little attention to solving systems of real-number constraints. Symbolic executors, and their use in test generation tools, are very relevant to this problem and can likely be modified to fit the purpose of solving these systems of real number constraints. Investigating these works and modifying them to solve the problem will be the bulk of the work in this semester, and should be wholly applicable back to the fields they were based on.

Symbolic Execution for Software Testing: Three Decades Later[1] discuss the various approaches taken by symbolic execution and related techniques to discover particular regions of a set of expressions. Can these strategies be modified to appropriately navigate a system of constraints rather than a collection of programming statements? How large and complex can the system of constraints be before these strategies break down? This work will likely answer this question definitively.

Building the CVG stands to further knowledge or at least the availability of a real-number constraint solver which has ramifications more areas than my use case. To make sure the community can access this work the CVG and all related research work will be done under the Apache 2.0 license, and a large part of the effort in this work will be to make the knowledge gained easily accessible by anybody, for any use.

---

[1] C. Cadar and K. Sen, “Symbolic Execution for Software Testing: Three Decades Later,” *Communications of the ACM*, pp. 82-90, 2013.

Objectives
O1: Design of Experiments (DOE), surrogates, and sensitivity analysis
O2: Report-generation, post-processing, and output control
O3: Plug-ins for ANSYS and AutoCAD
O4: Cloud Access with Simple API
O5: Large-scale constrained multiobjective optimization
O6: High Performance Computing (HPC) interfaces

The table on the left shows our stated business goals to our investors, including a research grant from the National Research Council. None of these goals have any relation to the CVG. Nor have any of our users asked for this feature. if this project is rejected, then we will simply continue to use our current strategy indefinitely, until either I am in the position where my current obligations are greatly reduced and I have enough of my own free-time to implement it entirely on my own, or some other academic group investigates the topic. This work is simply unrelated to business and financial objectives.

Indeed, rather than cheat SFU I saw this as a chance for Empower to give something back; Empower is not in a position to make simple monetary donations back to SFU, but we are in a position to give some time and expertise, and in this sense I was hoping to use Empower's time to donate some research and an implementation of that research back to the software and computing science community.

Optimization is the driving use case behind the development of this work, but the benefits to the company should be more incidental than direct: any other optimization or constraint-solving group, academic or industry, is free to come along and use the software in any way they see fit.

The open nature of the work, its sourcing from existing academic communities and its applicability to future academic work should keep this project in the realm of research. While I personally stand to benefit from the work and I will apply that benefit to my company, Empower's business needs will never enter the scope of this project. I am excited to get working on a problem that is not only of an interesting nature, but also one that stands to help others.