Scalability of Environment and Design Structure Matrices

Jim Everett and Ling Liu

PROJECT SUMMARY

With large software systems failing on a regular basis there has been a continuing search for the silver bullet that will make large system development manageable. Although no such method has been discovered, information hiding and modularization have been used to decrease complexity and help manage large software projects. Unfortunately, design decisions made early in a software's life are costly to change and have been the cause of numerous project failures. One reason optimizing modularity early is difficult is the shear size of the design space. The inherent malleability of software allows for many variations with respect to how to decompose a system around information hiding. Baldwin and Clark attempted to tackle the problem of how to evaluate which modularization is best for a particular system with their creation of Design Structure Matrices, Design Parameters, and modular operators. Basically, Baldwin and Clark created a way to add unique values to different modularizations, thereby allowing designers the ability to compare modularizations. Unfortunately, Baldwin and Clark's approach does not take into account how external environmental variables affect the decisions on how a system is decomposed. Sullivan, Griswold, and Ben Hallen modified the Baldwin and Clark's Design Structure Matrices to create Environment and Design Structure Matrices (EDSM), which tries to give the designer a more well rounded view of how the system is affected by environment parameters. Sullivan, Griswold, and Ben Hallen use the framework set down by Baldwin and Clark, with the addition of their Environment Parameters, to provide a useful way for designers to gather quantitative results on which modularization is the best for a given system. The system used by Sullivan, Griswold, and Ben Hallen, KWIC, is a well known benchmark for modularization studies, but is small in size and simple in complexity.

Our goal is to use the methods developed by Sullivan, Griswold, and Ben Hallen to discern whether scalability is an issue in applying EDSM to large systems. It is our hope to identify EDSM as an appropriate tool for use with large complex system, and provide sufficient evidence to promote its use in the commercial sector.

Intellectual Merit

EDSM uses environment parameters (EPs) in the DSM model to factor in external influences on the system. EDSM describes the dependencies between Design Parameters (DPs) and highlight the invariance of the DPs under the EPs. The total net value of a specific modular design is computed by summing the net option values, (NOV), and with the base value S_0.

The first problem we will encounter concerns the gathering of a potential list of EPs, simply due to the subjective nature of EPs. Once a potential list has been compiled, how will we decide which EPs have enough of an impact on the system to be included in the EDSM.

Our second challenge is the selection of the sigma for use in calculating NOV values. We noticed the Sullivan, Griswold, and Ben Hallen paper does not provide precision not only in determining sigma, but also in general factors of how to estimate the values for the real options.

In the Sullivan, Griswold, Ben Hallen paper, their conclusion affirming the already know benchmark example, KWIC, does not provide a clear understanding of how large a difference between net option values is required to make a clear case for one modularization over another. Their admission of imprecision in the calculating of real option values makes it difficult to justify a particular modularization when differences are small. We anticipate real world analysis will be difficult given the prevalence of information hiding in current software design.

Broader Impact

This proposal seeks to determine the scalability of the Environment and Design Structure Matrices (EDSM) as tool for analyzing modularity in large systems. Hopefully this paper will provide enough evidence to promote the creation of automated tools using this model. By extension we hope that the gap between research and commercial use will be bridged quickly, in hopes that fewer large projects will fail.