A Comparative Study of Programming Models for Concurrency

PROJECT PLAN

Type of project: Bachelor thesis

Project period: 15.11.2011 – 15.07.2012

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1. PROJECT DESCRIPTION

Overview

The computing landscape has been radically changed by the recent transition of general-purpose computing to parallel architectures, in particular multi core processors. The reason for this transition are neither breakthroughs in programming nor processor architectures, but the simple fact that the processor manufacturing has hit physical limits that prevent further scaling of single processors. To **make use of parallel processing power** however, it no longer suffices to upgrade to the latest processor generation; instead, the software has to be written in a way that **makes effective use of the available parallelism** - a task that has long been recognized as **difficult and error-prone**. Various programming languages have therefore been proposed to make **writing correct concurrent programs simpler** than traditional multi threading: SCOOP, C-omega, Scala, Oz, Axum, Erlang, Chapel, X10, to name only a few [1].

Scope of the work

The goal of this empirical study is to provide a detailed comparison of the different approaches, discuss their strengths and weaknesses and identify the application areas they are best suited for.

Intended results

The results include: a survey of related work; a survey and categorization of concurrent programming languages; a methodology for comparing concurrent programming languages; study results showing the applicability of the methodology. As a research-oriented project, an international publication is planned.

2. BACKGROUND MATERIAL

Initial reading list

- Dewayne E. Perry, Adam A. Potter, Lawrence G. Votta: *Empirical Studies of Software Engineering: A Roadmap*. In: Proc. Conference on The Future of Software Engineering, pages 345-355. ACM, 2000.

- Sebastian Nanz, Faraz Torshizi, Michela Pedroni, Betrand Meyer: *Design of an Empirical Study for Comparing the Usability of Concurrent Programming Languages*. In: Proc. ESEM'11. IEEE Computer Society, 2011
- Michael Philippsen: *A survey of concurrent object-oriented languages*. Concurrency and Computation: Practice and Experience 12:917–980, 2000.

3. PROJECT MANAGEMENT

Objectives and priorities

The goal of this project is to provide a detailed comparison of the different approaches, discuss their strengths and weaknesses and identify the application areas they are best suited for. It will be an empirical study. The approaches will be compared in terms of **performance** and **ease of use**, and potentially other important metrics to be defined. This will require solving relevant problems (from a concurrency point of view) using each approach. It is also necessary to decide on the methodology of the comparison.

Criteria for success

The thesis is successful if it delivers a comparison of a substantial number of concurrent programming languages that allows insights into the strengths and weaknesses of each approach.

The survey of related work and of language approaches, the choice of methodology and the study results have to be properly documented.

The code of any of the example problems has to be properly tested, commented, and made available.

Method of work

The first 3 months of the master thesis will be spent working part-time in France. The next 5 months will be spent working full-time in Brazil. The distance advising will be done through biweekly video conference meetings, email contact, and shared online documents.

Quality management

Documentation

The results of the literature search and of the survey of concurrent programming languages will be documented. The solutions implemented using each approach for the performance and ease of use evaluations will be documented.

Validation steps

It will be verified that the evaluation tests effectively try to disprove the empirical study hypotheses.

4. PLAN WITH MILESTONES

Project steps

1 Literature Search:
  1.1 papers on categorizations of concurrent languages, survey papers of concurrent languages;
  1.2 empirical studies for comparing concurrent languages;

1.3 document the results of the literature search as a survey of related work.

2 Programming Approaches (languages, APIs):
- 2.1 identify and categorize relevant approaches;
- 2.2 choose the approaches that will be considered;
- 2.3 document the approaches identified and the selection.

3 Methodology:
- 3.1 define the study hypotheses;
- 3.2 identify evaluation metrics such as ease of use and performance;
- 3.3 select evaluation metrics for the study and decide how to evaluate them;
- 3.4 identify and categorize relevant evaluation problems;

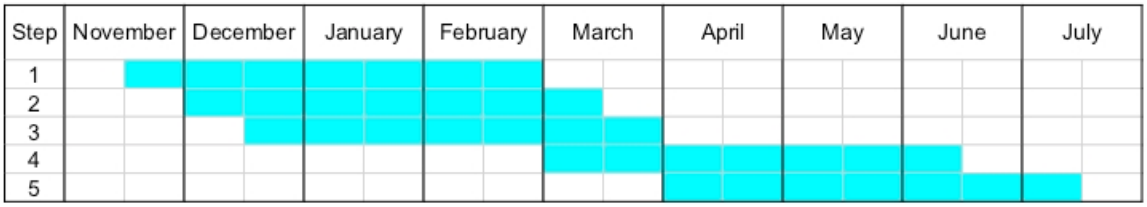
4 Study:
- 4.1 refine the study hypotheses if needed;
- 4.2 study the approaches one by one according to the methodology developed in step 3.

5 Conclusion:
- 5.1 evaluate the outcome of the study;
- 5.2 write up the results.

Deadline

The deadline for the project is 15.07.2012.

Tentative schedule



REFERENCES

[1] Chair of Software Engineering: *Concurrency Projects*; Online at: http://se.inf.ethz.ch/student_projects/concurrency.html, consulted in November 2011.

[2] Chair of Software Engineering: *Sebastian Nanz Profile Page*; Online at http://se.inf.ethz.ch/people/nanz/, consulted in November 2011.