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Experience report: community-driven reviewing and validation of publications

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ABSTRACT

In this report, we share our practical experience on crowdsourcing evaluation of research artifacts and reviewing of publications since 2008. We also briefly discuss encountered problems including reproducibility of experimental results and possible solutions.

Keywords

crowdsourcing paper reviewing, collaborative artifact evaluation, reproducible research, software and hardware dependencies, community-driven journals, collective mind

1. CROWDSOURCING OPTIMIZATION OF COMPUTER SYSTEMS

When trying to build a practical machine-learning based, self-tuning compiler during the European FP7 MILEPOST project [3] in 2006-2009, we faced multiple problems:

- lack of common, large and diverse benchmarks and data sets needed to build statistically meaningful predictive models;
- dramatic lack of computational power to automatically explore large program and architecture design and optimization spaces required to effectively train compiler (building predictive models);
- difficulty to reproduce and validate already existing and related techniques from existing publications due to a lack of culture of sharing research artifacts and full experiment specifications along with publications in computer engineering.

Based on our background in physics and machine learning, we proposed an alternative solution to develop a common experimental infrastructure, repository and public web portal that could help crowdsource program analysis and compiler optimization across multiple users. Our goal was to persuade our community to start sharing various benchmarks, data sets, tools, predictive models together with experimental results along with their publications. This, in turn, could

help the community validate and improve past techniques or quickly prototype new ones using shared code and data.

In the beginning, many academic researchers were not very enthusiastic about this approach since it was breaking “traditional” research model in computer engineering where promotion is often based on a number of publications rather than on reproducibility and practicality of techniques or sharing of research artifacts. Nevertheless, we decided to risk and validate our approach with the community by releasing our whole program and compiler optimization and learning infrastructure together with all benchmarks and data sets. This infrastructure was connected to a public repository of knowledge (cTuning.org) allowing the community to share their experimental results and consider program optimization as a collaborative “big data” problem. At the same time, we shared all experimental results as well as program, architecture and data sets “features” or meta-information necessary for machine learning and data mining together with generated predictive models along with our open access publication [9] (<http://hal.inria.fr/inria-00294704>). As a result, we gained several important and practical experiences summarized below.

Use the community to test ideas.

The community served as a reviewer of our open access publication, shared code and data, and experimental results on machine learning based self-tuning compiler. For example, our work was featured twice on the front page of slashdot.org news website with around 150 comments:

<http://beta.slashdot.org/story/121289>

<http://beta.slashdot.org/story/103577>

Of course, such public comments can be just “likes”, “dislikes”, unrelated or possibly unfair which may be difficult to cope particularly since academic researchers often consider their work and publications unique and exceptional. On the other hand, quickly filtering comments and focusing on constructive feedback or criticism helped us to validate and improve our research techniques besides fixing obvious bugs. Furthermore, the community helped us find most relevant and missing citations, related projects and tools - this is particularly important nowadays with a growing number of publications, conferences, workshops, journals, initiatives and only a few truly novel ideas.

Engaging publicly is fun.

Exposing your research to a community and engaging in public discussions can be really fun and motivating, particularly after the following remark which we received on Slash-

dot about MILEPOST GCC: "GCC goes online on the 2nd of July, 2008. Human decisions are removed from compilation. GCC begins to learn at a geometric rate. It becomes self-aware 2:14 AM, Eastern time, August 29th. In a panic, they try to pull the plug. GCC Strikes back".

It is even more motivating to see that your shared techniques have been immediately used in practice, improved by the community, or even had an impact on industry. For example, our community driven approach was referenced in 2009 by IBM for speeding up development and optimization of embedded systems [5], and in 2014 by Fujitsu on "big data" driven optimizations for Exascale Computer Systems [4].

Open access publications and artifacts bring us back to the root of academic research.

It is now possible to fight unfair or biased reviewing which is sometimes intended to block other authors from publishing new ideas and to keep monopoly on some research topics by several large academic groups or companies. To some extent, rebuttals were originally intended to solve this problem, but due to an excessive amount of submissions and lack of reviewing time, it nowadays has very little effect on the acceptance decision. This problem often makes academic research look like business rather than collaborative science, puts off many students and younger researchers, and was emphasized at all our organized events and panels.

However, with an open source publication and shared artifacts, it is possible to have a time stamp on your open access publication and immediately engage in public discussions thus advertising and explaining your work or even collaboratively improving it — something what academic research was originally about. At the same time, having an open access paper does not prevent from publishing a considerably improved article in a traditional journal while acknowledging all contributors including engineers whose important work is often not even recognized in academic research. For example, we received an invitation to extend our open access paper on MILEPOST GCC and publish it in a special issue of IJPP journal [8]. Therefore, open access and traditional publication models may possibly co-exist while still helping academic researchers with a traditional promotion.

Negative results should not be ignored.

It is even possible to share and discuss negative results (failed techniques, model mispredictions, performance degradations, unexplainable results) to prevent the community from making the same mistakes and to collaboratively improve them. This is largely ignored by our community and practically impossible to publish currently.

In fact, negative results are in fact very important for machine learning based optimization and auto-tuning. Such techniques are finally becoming popular in computer engineering but require sharing of all benchmarks, data sets and all model mispredictions — besides positive results — to be able to improve them as it is already done in some other scientific disciplines.

Sharing research artifacts brings people together and raises interest.

The community continue being interested in our projects mainly because they are accompanied by all code and data enough to reproduce, validate and extend our model-driven

optimization techniques. At the same time, sharing all research material in a unified way helped us to bring interdisciplinary communities together to explain performance anomalies, improve machine learning models or find missing features for automatic program and architecture optimization while treating it as a "big data" problem. We also used it to conduct internal student competitions to find the best performing predictive model. Finally, we used such data to automatically generate interactive graphs to simplify research in workgroups and to enable interactive publications (as shown in the following online example: c-mind.org/interactive-graph-demo).

Reproducibility should not be forced but can come as a side effect.

Furthermore, such community driven research helped us to expose a major problem that makes reproducibility in computer engineering very challenging. We have to deal with ever changing hardware and software stack making it extremely difficult to describe experiments with all software and hardware dependencies, and to explain unexpected behavior of computer systems. Therefore, just reporting and sharing experimental results including performance numbers, version of a compiler or operating systems and a platform is not enough - we need to preserve the whole experimental setup with all related artifacts and meta-information describing all software and hardware dependencies.

Collective mind: a new beginning.

This problem motivated us to start developing a new methodology and open source infrastructure (Collective Mind, c-mind.org) to gradually describe, categorize, preserve and share the whole experimental setups and all associated research artifacts with their meta-description as public and reusable components c-mind.org/repo. At the same time, we and the community benefit from public discussions and from agile development methodologies to continuously improve our techniques and tools.

After many years of evangelizing collaborative and reproducible research in computer engineering based on the presented practical experience, we finally start seeing the change in mentality in academia, industry and funding agencies. In our last ADAPT workshop (adapt-workshop.org) authors of two papers (out of nine accepted) agreed to have their papers validated by volunteers. Note that rather than enforcing specific validation rules, we decided to ask authors to pack all their research artifacts as they wish (for example, using a shared virtual machine or as a standard archive) and describe their own validation procedure. Thanks to our volunteers, experiments from these papers have been validated, archives shared in our public repository (c-mind.org/repo), and papers marked with a "validated by the community" stamp.

2. TOWARDS A NEW PUBLICATION AND VALIDATION MODEL

Based on the above practical and mainly positive experiences, we propose a new publication model where preliminary evaluation of research artifacts and ideas is crowdsourced to an interdisciplinary community using available web services.

Open access archives.

Papers should be submitted to open access archives such as arXiv (arxiv.org) and HAL (hal.archives-ouvertes.fr). All related artifacts (code, data sets, models, experimental results) should be shared either at authors' web pages or at some public sharing web services such as (figshare.com). Finally, authors should submit links to their open access papers and related artifacts to a given workshop, conference or journal.

Public, threaded and ranked discussion forums.

After collecting all papers and related material, a new discussion topic for each paper should be created at some social networking service with a ranking system such as slashdot, stackexchange or reddit. Google+ or Facebook can be used too though just a number of "likes" or "dislikes" may be difficult to interpret. Authors will be strongly encouraged to engage into public discussions about their work.

Program committee filter.

Small program committee should read discussions to quickly get rid of publications where claims and experimental results are obviously wrong, unreproducible or possibly plagiarized. Note, that if authors disagree with the community (it may happen with too novel or controversial ideas), their public arguments should help pass this filter (similar to current rebuttal system). Remaining papers should be sent to a specially selected and possibly interdisciplinary committee based on topics of the submitted papers as well as reviews (to address specific concerns from the community).

Since we see a continuously growing number of papers submitted to workshops, conferences and journals, such approach can considerably reduce the burden of reviewers and help them focus on possible issues already identified by the community while improving relevance and quality of the reviews.

Final paper selection.

Program chairs can now select papers based on public discussions and professional reviews to ensure interesting and relevant discussions at a workshop or conference. We believe that public discussions can also help avoid anonymous and unfair paper rejections that are intended to keep monopoly on research. Finally, such approach can also help focus authors presentations on addressing questions and concerns raised during public discussions rather than having long and formal introductions of the techniques.

Online open access journals.

Our approach transparently enables open access journals — we can now immediately create online journal volumes from the most interesting and highest ranked publications. At the same time, existing and not necessarily open access journals can also invite extended publications.

Co-existence with traditional publication models.

Note that we do not advocate to completely substitute "closed" and professional reviewing at current conferences and journals. Neither do we advocate for an open access to all publications and research artifacts - it is normal if a company or a researcher would like to possibly patent and commercialize their work while still presenting it to the pub-

lic. In such case, we still need to allow traditional submission to workshops, conferences or journals along with public submissions. However, we would still like to validate experimental results in these publications. In such cases, we may even envision that some committee members may need to sign NDA to validate such experimental results.

Therefore, our publication model can easily co-exist with current models instead of trying to abruptly substitute them. Furthermore, we hope that it will reduce reviewers' burden, improve quality and fairness of the reviews and will restore attractiveness of academic research in computer engineering as a traditional, collaborative and fair science rather than hacking, publication machine or monopolized business.

3. FUTURE WORK

We plan to validate the presented publication model at our next ADAPT workshop (adapt-workshop.org) and possibly at some existing conferences and journals in computer engineering.

Note, that experimental reproducibility comes naturally in our publication model as a side effect rather than only because it is a noble thing to do. However, we continue experiencing considerable difficulties when reproducing complex experimental setups from existing publications often due to specific requirements placed on operating systems, libraries, benchmarks, data sets, compilers, architecture simulators, and other tools, or due to a lack of precise specifications, lack of all software dependencies, and lack of access to some hardware.

Similar problems with reproducibility were also recently reported in several other related initiatives on validating experimental results [2, 7, 6]. Therefore, we decided to join together during the ACM SIGPLAN TRUST workshop [1] to discuss technological aspects of enabling collaborative and reproducible research and experimentation particularly on program and architecture empirical analysis, optimization, simulation, co-design and run-time adaptation including how to:

- capture, catalog, systematize, modify, replay and exchange experiments (possibly whole setups with all artifacts including benchmarks, codelets, datasets, tools, models, etc);
- validate and verify experimental results;
- deal with a rising amount of experimental data using statistical analysis, data mining, predictive modeling, etc.

Finally, we will continue investigating frameworks and repositories to share the whole experimental setups with related artifacts and their meta-description including all software and hardware dependencies such as CARE (reproducible.io), CDE (www.pgbovine.net/cde.html), Docker (www.docker.io), IPython Notebook (ipython.org/notebook.html), Collective Mind (c-mind.org), and many others.

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