Mining Application Development for Research

Johannes Fähndrich, Sebastian Ahrndt, and Sahin Albayrak

Abstract Nowadays, many research institutes are largely dependent on third party funding. This situation leads to practical work or in other words project work which exceeds the research typical proof of concept implementation. As we were tired of seeing a downward trend in the number of accepted application oriented (full) papers in the major agent conference, we conducted a survey to provide evidence for the thesis that researchers can gain relevant benefits from project work for their research work. Hence, in this paper, we present the results of this survey and discuss different scientific questions researchers should ask themselves during project work.

1 Introduction

The dependence on third party funding [18] of research institutes leads to a lot of practical work that exceeds the research typical proof of concept implementation. As this practical work is mostly some kind of time- and topic-limited collaboration with external partners, we will further refer to it as project work (PW). However, as it is quite common for researchers to publish their achievements in more abstract and theoretical results and adopt these results to the more practical work, the other way around is not [1]. To counter this issue, the IFAAMAS stated in its charter [8] (Point 1, 5, 6) to foster the links between the more theoretical agent community and the more practical community and further to promote applied research. Nevertheless, we were tired of seeing the results of a survey done by *Hirsch et al.* [7] in 2011. The work emphasises a downward trend in the number of accepted application oriented (full) papers in the agent conference *AAMAS (International Conference on Autonomous Agents and Multiagent Systems)*. The survey present results showing that the number of accepted full papers stays almost the same, while the number of

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accepted application papers drops – from 13 or 10.2% in 2006 to 6.3% in the 2011 edition of the AAMAS.
However, our thesis is, that application papers are very relevant for the agent community and should address different stakeholders, such as industry, academia and reviewers, to name but a few (see [14, 7]). After discussing the survey results, we conduct a own survey to provide evidence for the thesis that researchers can gain relevant benefits from project work for their research work. Further, this paper shell provide guidance while identifying a good [13] research questions in project work. Commencing with the description of the used survey methodology (See Section 2), we will present the results of that survey (See Section 3). Afterwards we proceed with a discussion through the author guidelines presented by *Hirsch et al.* [7] (See Section 4) and wrap up with a conclusion (See Section 5).

2 Basics & Methodology of the Survey

In order to give a brief introduction to the survey methodology, we will next describe four scientific principles, which are typically taken into account, when researchers find a seminal question [15] and that we used as foundation of the questionnaire:

- *Significance* is quit important for the question of funding. Meaning that if it is foreseeable that the research will not do any good to anyone, then most likely no one will invest into it. The first meta question the researchers should ask themselves about there research could be: ”What will the results change?”. By finding a good answer to this question, the research can be defended and will not become a pernicketiness. Here lies a grade difference of project and research work. In projects, exceeding pure research, this questions is vital at the beginning to get funding. Arguing why extra time and effort should be invested to create scientific evidence is often hard work. Especially with industry partners, which have to argue their return of investment (ROI) [16].
- *Innovation* means that the results have to extend the *State of the Art* (SotA) or optimise a existing result. Consequently, the principal of innovation is twofold [5]: On the one hand process innovation, on the other hand product innovation. The first optimise the way a solution is created. The latter provides a new solution to a problem. Following *Schumpeter* (e.g. [6]), the so called ”creative destruction” is an elementary need of our economic. Taking the differences of product and process innovation into account, the impact of R&D is subject to research [4]. The next meta question to capture the innovation of the possible solution for the research question could be: ”What is the SotA regarding this problem?”.
- *Traceability* means to uncover and document the steps made towards an solution, referring to all used existing fragments [2] and to follow strict rules on how these references have to be published [18]. Project work has some similar rules. For an example we point to the licensing of software, where the reference has to be established in a research comparable manner.

- *Clearness* is improved by investing additional time to make results better understandable. Due to the lack of resources, this principle is often neglected. Further, one of the reasons why there are less application papers might be, that enterprises – applying the research results – do not want to publish there knowledge, they rather want to sell it, to increase there ROI [4].

Based on the presented scientific principles, we elaborated a questionnaire that circulated mainly at research institutes which have a scientific focus on distributed artificial intelligence. The questionnaire has been created taking the work of *Pfleeger* and *Kitchenham* [10, 11, 12, 17] into account – among others the questions have to be resistant to bias, appropriate to the respondent and cost-effective. As the objective of the survey lies on the area of conflict between research and project work, we send our questionnaire to institutes which are mainly third party founded. In order to outline the discrepancy between the project and research work, we started the survey with the following explanation to clarify the separation between both:

> To distinguish between project work and research work, we intend research work as the methodical search of new knowledge in order to extend the actual state of the art. In contrast to this, we refer to project work as the appliance of previously available skills to establish approaches for well-formed problems.

In order to provide evidence to our thesis the survey consists of 30 questions separated in nine categories. The answers were given through different provided lickert scales [3]. However, the survey offers an additional tenth category, where the interviewee had the possibility to write down the most important questions they ask themselves during research work – we will further refer to these answers as *scientific questions*.
To provide some structure to the obtained data we applied a research methodology based on *Value-Focused Thinking* [9] (VFT). VFT follows a – especially in AI popular – backward search approach. We had to perform two activities: First deciding which questions are needed to be answered and second figuring out how to get the achieved data with a minimal amount of survey questions. Analysing the survey results we interpreted the likert scale as ordinal scale using the appropriate statistical values like the median (M) and the mean deviation from the median (MD).

3 Survey Results

Overall we received 54 responses during October 2011. Given the breadth of the answers, we feel the results will be usefully for future works, too. However, for this work we will concentrate our interest on the scientific principles we preliminary introduced and the analysis of the collected questions. First of all we want to present the result to the question on experience gained form project work and research (R). Figure 1 shows these results and emphasises that the experience gained during project work exceeds the one gained during research (M = 3, MD = 0.98).

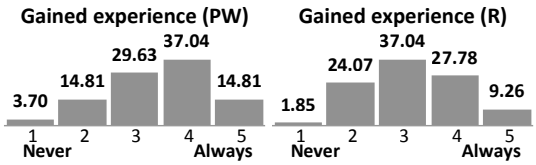

Fig. 1 (1) Gained experience during project work (M = 4, MD = 1.19); (2) Gained experience during research (M = 3, MD = 0.98)

Figure 2 illustrates the distributions of the responses to the questions how often the four preliminary introduced scientific principles. We can see, that almost no researcher disregards the principles (1) in their project work but neither always uses them (5).

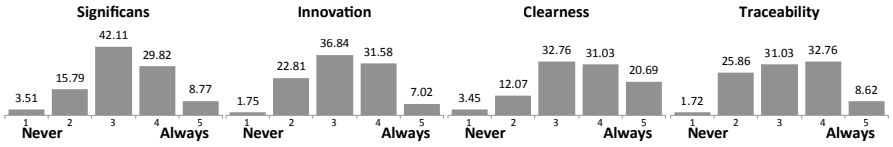

Fig. 2 (1) Significans (M = 3, MD = 0.83); (2) Innovation (M = 3, MD = 0.85) ; (3) Clearness (M = 3, MD = 1); (4) Traceability (M = 3, MD = 0.88)

Analysing Figure 2 and the amount of scientific questions obtained through our survey, we found an interesting discrepancy between the emergence of scientific questions referring to Traceability and Clearness – here we obtained only 4 (2.9%) – and Significance and Innovation, where we obtained 47 or 34.8%. Because of that, Traceability and Clearness seam more important in project work then they are during research. Additionally, we asked about the correlation between project work and research and the researchers motivation.

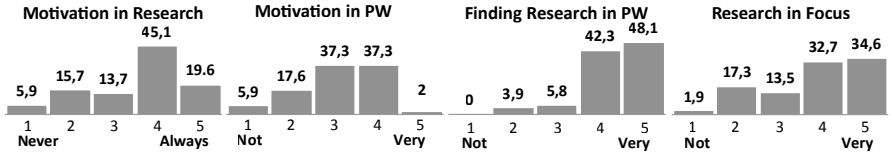

Fig. 3 (1) Motivation during R (M = 4, MD = 1.32); (2) Motivation during PW (M = 3, MD = 1.06); (3) Motivation increase through finding R in PW (M = 4, MD = 1.08); (4) Motivation during PW with R in focus (M = 4, MD = 1.32)

Figure 3 emphasises the impact on the motivation for different topics. One can clearly see, that the motivation during research work is much higher then during project work. Moreover if the researchers find interesting scientific questions in their

project work we clearly see an increasing motivation, even more if R and PW are on the same topic. Spending time on thinking about the degree of significance and innovations regarding the results of project work, not only leads to seminal research question which can bear a scientific delta regarding the SotA, but also seams to motivate. Carving out the scientific delta might lead to more acceptance from the scientific community evaluating the research result during a review process for publication.
In the last section of the survey, we asked for scientific questions the researcher ask themselves while working scientifically. We did receive 135 questions, in which we were able to identify six categories. For each of this categories we have verbalised a affiliated question. The initial four principles where covered in the collected questions, but only two of them where addressed frequently.

Significance (25.2%) : 34 questions refer to Significance, which ends in the question: "*Why is my work interesting for others?*".

Related Work (20.0%) : 27 questions refer to Related Work, we found a wide range of formulation reaching from available conferences to basic knowledge to other approaches and there shortcomings. Our question here is twofold, representing the two types of innovation introduced earlier: "*Are there approaches available for this problem?*" (product innovation) and "*Have the existing solutions shortcomings we can address?*" (process innovation).

Problem Classification (17.0%) : 23 questions refer to the Problem Classification, which ends up in the question: "*What is the problem?*".

Evaluation (14.1%) : 19 questions refer to the Evaluation and emerged the question: "*How can we validate the results?*".

Innovation (9.6%) : 13 questions refer to the Innovation adding up to the question: "*What is the scientific contribution?*".

Resources (5.9%) : 8 questions refer to resources ending in the question: "*How can the work scheduled correctly to the given resources?*".

In order to give a complete overview over the collected data, we were able to assign 1 (0.7%) question to the scientific principle Clearness and 3 (2.2%) to Traceability. Furthermore, we were not able to assign 7 (5.2%) questions to any of the introduced categories.

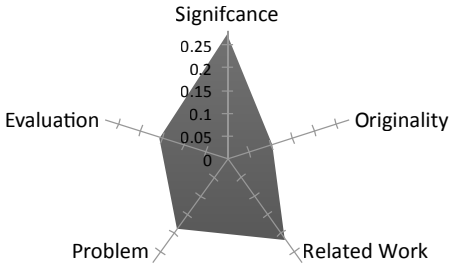

Fig. 4 Relation between the identified research categories and the available resources.

Figure 4 illustrates the six categories and emphasise the area of conflict between them (in terms of the available resources) in a multi-dimensional model. Here the number of time a scientific question is asked is generalised to the amount of time spend to answer the question. Because of the practical derivation of application papers and project work, a use case might be evident, which simplifies finding a method of evaluation and some significance to the underlying research question. With only 9.6% of all questions the principle Innovation seams the least important to researchers. Referencing our beginning statement, we conclude that by answering the questions listed above researcher support the identification of an significant and innovative research delta with regard to the SotA. Eventually concluding in to a research question, which could lead to a higher acceptance in a academic community. This on the one hand fosters practical research papers and on the other, motivate researchers.

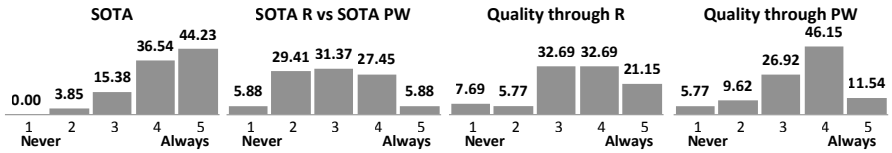

Fig. 5 (1) Amount of SotA in PW (M = 4, MD = 1.14); (2) Difference between the SotA analysis during R and during PW (M = 3, MD = 1.15); (3) Quality gain in R applying PW (M = 4, MD = 1.2) (4) Quality gain in PW applying R (M = 4, MD = 1.32)

However, in the survey we asked also about the difference between SotA analysis during project work and during research. Figure 5 illustrates the results and shows that the SotA analysis done in research is about the same as in project work. Taking the data presented in Figure 6 into account, it seams that most researchers experience a quality increase by applying research methods in project work. At the same time, the researchers perceive embedded research methods as time consuming. This leads to the conclusion, that more time is necessary when research is embedded in project work, while seeing research as an additional task opposing to the project work.

4 Discussing Guidelines

Through our survey, we were able to identify six categories of questions and to objectify one question for each category. Furthermore we have ranked them through the gained insights from the survey. Consequently, we are able to confirm a major part of the author guidelines presented by *Hirsch et al.* [7] and further extend it with two new questions that an application oriented paper (and probably others too) should answer to emerge a research question from project work:

- Why is my work interesting for others?

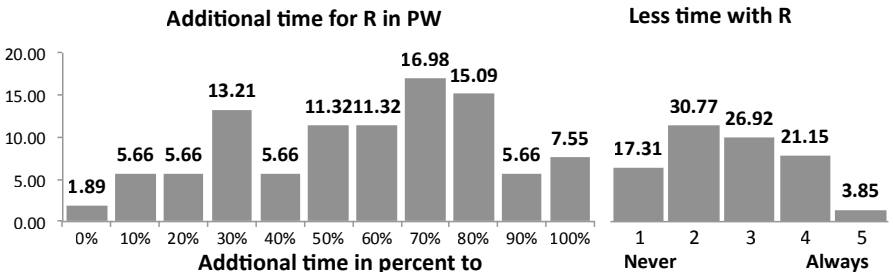

Fig. 6 (1) Time saved with R in PW (M = 3, MD = 1.24); (2) Increasing amount of time required when applying R in PW (M = 70%, MD = 28%)

- What is the scientific contribution?
- Are there still approaches available for this problem? Have the existing solutions shortcomings we can address?
- What is the problem?
- How can we validate the results?
- How can the work be scheduled correctly to the given resources?

By answering these questions researcher support the identification of an significant and innovative research delta to the SotA and with that on the one hand foster practical research papers and on the other, motivate researchers. As we did not receive a significant amount of questions regarding the Traceability and and Clearness, these two aspects are missing.

5 Conclusion

In this paper, we present the results of a survey regarding the discrepancy between research and project work and the motivation for writing application papers. Overall, 54 researchers answered our questionnaire. The analysis of the questionnaire showed that researcher can gain experience from projects for their research work and emphasises the importance of finding a research question to publish the results of more practical work. Here, we were able to identify six different categories of questions, which we ranked through the gained insights of the survey. Furthermore, we verbalised questions for each category to objectify and extend the author guidelines presented by *Hirsch et al.* [7]. By answering these questions researcher support the identification of an significant and innovative research delta to the SotA and with that, on the one hand foster practical research papers and on the other, motivate researchers. Enabling more insight into the matter, future conferences could classify application papers submitted to evaluate if missing quality might be the reason for a lesser acceptance rate. Furthermore with agents being just one approach, the amount

of application papers accepted in other domains should be studied to determine if this is a domain specific problem.

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