A CORUÑA, SPAIN · 1-5 September
SPLC 2025

NC STATE UNIVERSITY

THE FUTURE OF SOFTWARE ENGINEERING IS IN YOUR HANDS

AND I BELIEVE IN YOU!

I truly do!

Wesley K. G. Assunção
https://wesleyklewerton.github.io/
@wesleyklewerton

ABOUT ME

Associate Professor
NCSU (2023-now)

Senior Researcher
JKU Linz (2021-2023)

Assistant/Associate Professor
UTFPR-Toledo (2013-2021)

Ph.D. in Computer Science (2017)
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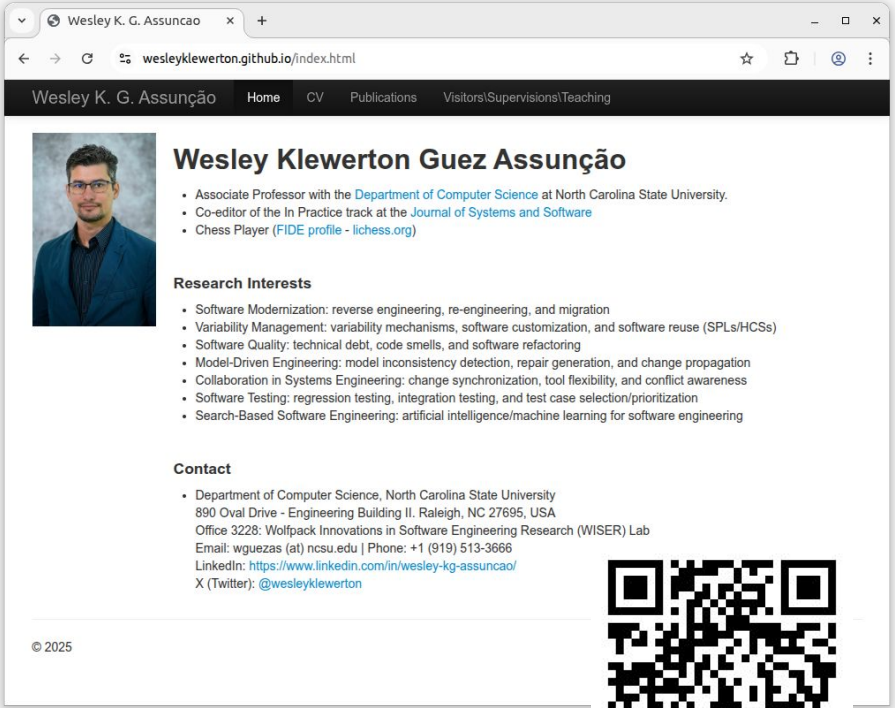
B.Sc. in Information Systems (2006)



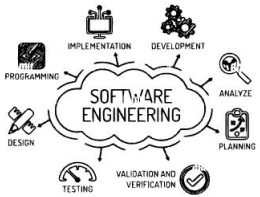
SW ENG AT NC STATE

NC STATE

Home Contact

Software Engineering at NCSU

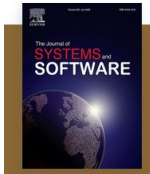
Accelerate your SE career, in industry, in research.



JSSS IN-PRACTICE

ScienceDirect

Journals & Books



Journal of Systems and Software

Supports open access

8.6 CiteScore

3.7 Impact Factor

In Practice Editors

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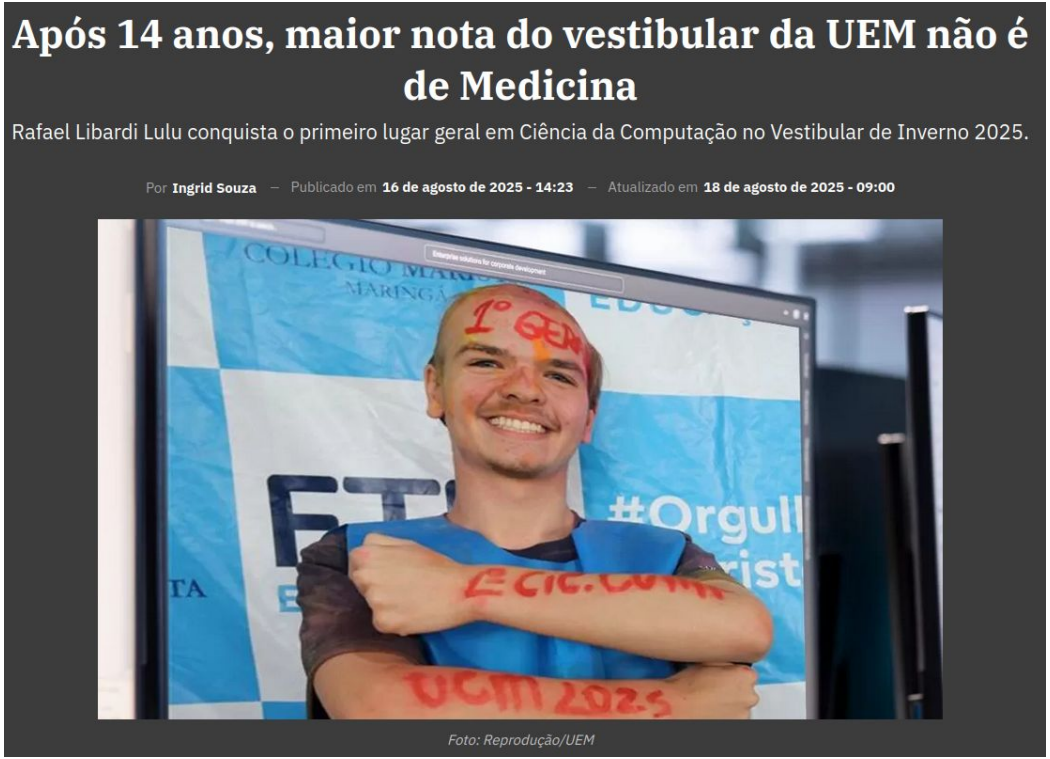
https://www.mendezfe.org/the-new-in-practice-track-of-jss/

ABOUT THIS TALK

IT IS A GREAT TIME TO DO RESEARCH IN SE

State University of Maringá, Brazil:

- **936 vacancies** for registered candidates.
- **9,045 candidates** participated in the exams.
- Candidate with the overall **highest score was for Comp Science.**



Após 14 anos, maior nota do vestibular da UEM não é de Medicina

Rafael Libardi Lulu conquista o primeiro lugar geral em Ciência da Computação no Vestibular de Inverno 2025.

Por **Ingrid Souza** – Publicado em **16 de agosto de 2025 - 14:23** – Atualizado em **18 de agosto de 2025 - 09:00**

Foto: Reprodução/UEM

ABOUT THIS TALK

- **Software engineering** has been a crucial discipline in our modern world
- To achieve this state, we depended on **talented, smart, and creative** people
- The **PhD degree** is the highest academic degree for educating people
- Demands from society and new technologies **create new, and uncover old, challenges**
- Current PhD students will be in charge of **creating and taming such new technologies** for the benefit of society in the future

- We need to discuss what the **expectations, responsibilities, benefit, and barriers** are faced by a PhD student.
- I share **my experiences** as a developer, PhD student, post-doc researcher, and professor
- This talk aims to **inspire and guide students** as they navigate their PhD studies

WHAT DO I HAVE TO SAY?

Silvia Vergilio

Roberto Lopez-Herrejon

Alessandro Garcia

Alexander Egyed

Many Collaborators

Community Service

Gabriela

Ana Carla

Luciano

Willian

Daniel

Delfina

Marcel

Vinicius

Lawrence

Kevin

Hui Sun

Biruk

+ Undergrads and MSc

WHAT IS A PHD?

WHAT IS A PHD?

Google AI Overview:

"*A PhD, or Doctor of Philosophy, is the **highest academic degree** awarded by universities. It signifies that the recipient has achieved a **high level of expertise** in a specific field and has made an **original contribution to knowledge** through **independent research**. While often associated with academia and research, PhDs are also pursued by those seeking **careers in various sectors**.*"

…it is an award to **an expert** who has proven their **scientific worth** and *not to someone who stayed in a tolerant group for long enough*

EMBO *reports*

editorial

What is a PhD?

This might seem like an unusual topic, as most scientists seem to know exactly what a PhD is and for what it stands. But on closer inspection, a PhD has as many meanings as there are educational systems. It is not—and has never been—a single, well-defined qualification. As research practices and funding change, the situation becomes even more confused, with consequences for the quality of both scientific training and research.

I received my PhD from a British university. After three years of research, I submitted a three-centimetre-thick thesis that addressed a specific problem. Being awarded my doctorate meant that I knew my topic, I understood enzymology, I could work with proteins and I was able to navigate the complexities of enzyme kinetics. I was not qualified for the title until I was able to demonstrate all these things. In essence, my PhD showed that I developed from a dependent student into an independent scientist.

and others are variations of these. In Germany, it is necessary to spend up to two years on a diploma degree before moving on to a PhD. Many other countries require their PhD students to teach undergraduates. In some systems, the final examination is a mere formality with an inevitably positive outcome; in others, it is a rigorous cross-examination by jury.

Against this background of different systems, new aspects have arisen that are moulding the PhD into a different entity to what it was. For example, the concept that a student must carry out an individual piece of research seems outdated. Most publications list many authors, each of whom contributed to the overall content of the paper. In fact, scientific research increasingly demands teamwork, and the PhD system must adapt accordingly; indeed, an important lesson for a young scientist is to learn how to work in a team. But if the thesis is a cooperative effort, then it becomes even more difficult to judge the

achievement. But if we collectively become unconcerned about what a PhD is, then we have little basis for expecting the pre-doc students in our laboratories to go through the diligent work that ultimately enables experiments to work and provides robust results. The 'three years and out' mentality concentrates on time and investment rather than quality, and runs the risk of producing substandard scientists.

Thus, there might be real consequences for research if we lower the standards for earning a PhD. Perhaps one of the reasons behind the success of the US research system is the quality and structure of their PhD training. Maybe one reason why European countries produce such a high number of papers of more moderate quality is the frequent requirement for a defined number of first-author publications to complete a PhD. Perhaps the concept of writing a thesis on the basis of a well-defined body of work is so foreign to today's students that they prefer the easier route of collating a

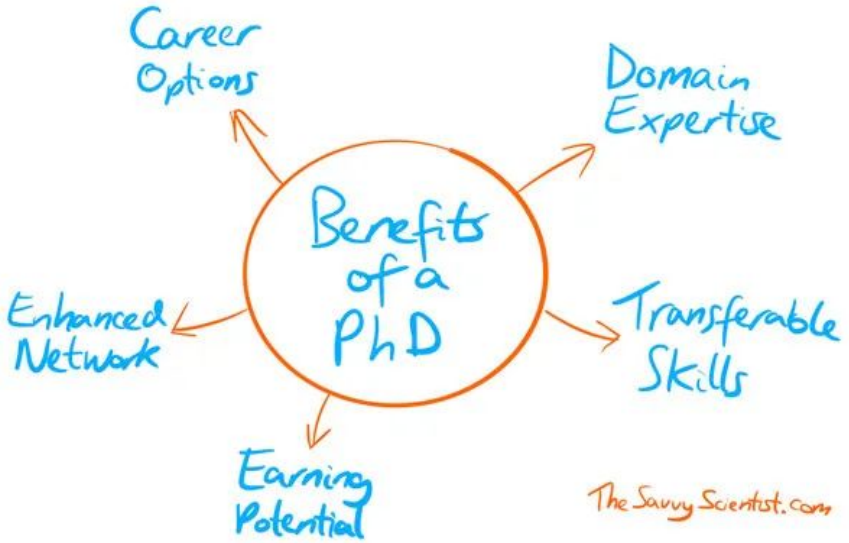
WHAT IS THE MAIN OUTPUT OF A PHD?

One of the most knowledgeable people in a topic of study in the world.

A talented, smart, and creative person

THE JOURNEY

IT IS NOT AN EASY JOURNEY...



...BUT IT HAS BENEFITS

WHAT IS A PREREQUISITE FOR A SUCCESSFUL PHD?

Being healthy!
Physically and Mentally

We are athletes of knowledge

Food, Exercises, Breaks,*
Sleep, Friends, Fun

* Nonstooping work is not productive!

THE LIFE OF A PHD

Before

- What has motivated you?
- What were your expectations?
- What are society expectations?
- What do you think are your supervisor expectations?

During

- What do you consider to be a successful PhD?
- What are your expectations?
- What are your responsibilities?
- What are the benefits?
- What are the barriers?

After

- Working in academia?
- Working in the industry?

What is your long-term plan?

DOS AND DON'TS

THERE IS NO RECIPE ON HOW TO DO A PHD

- Depends on the **topic** of your research
- Depends on the **country, university, department, research group** you are
- Depends on **your time** and **discipline**
- Depends on **your supervisor time**
- **Research** work VS. **Engineering** work

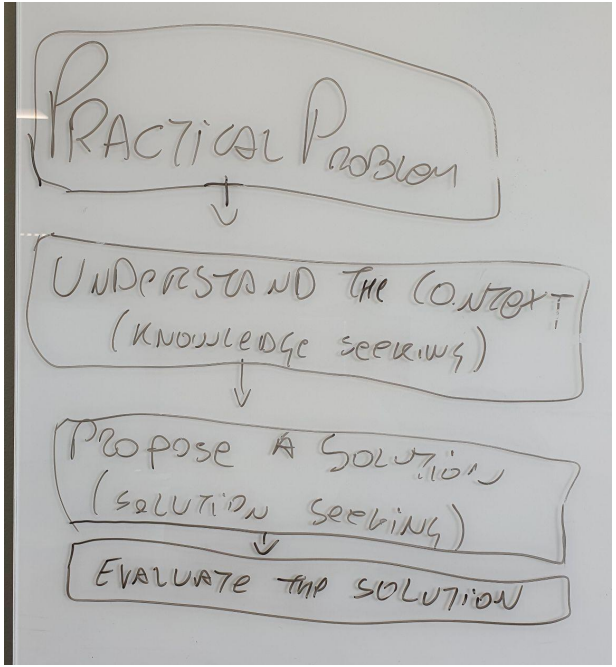
RESEARCH TOPICS

- Your PhD depend on the topic of your research
  a. Research "hype" topics (e.g., Artificial Intelligence)
  b. New research topics (e.g., software modernization)
  c. Well-established topics (e.g., software refactoring)
  d. Fundamental topics (e.g., software variability)

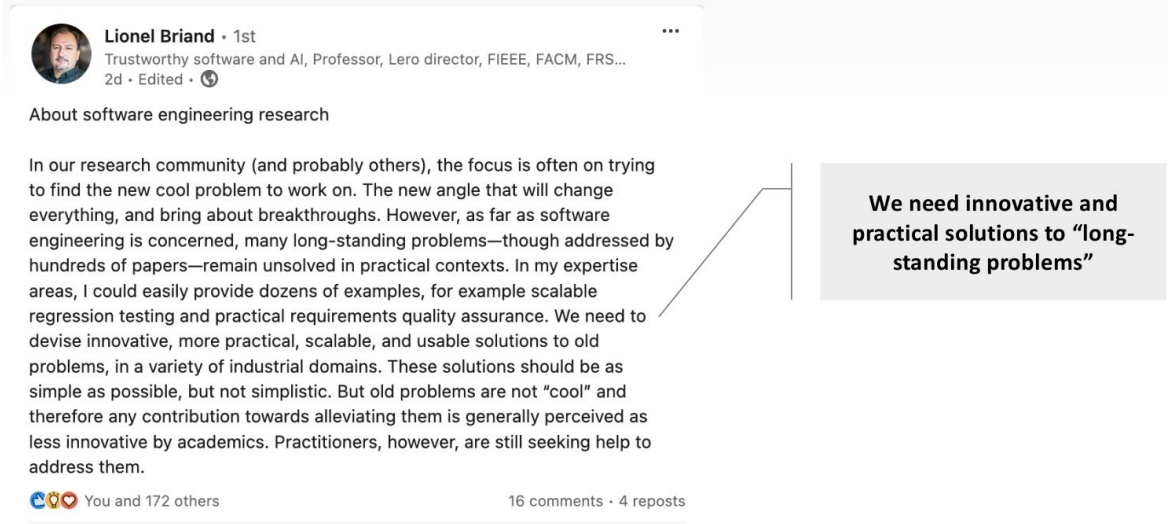
- Don't focus on finding a problem that fits your solution

WHAT ARE COMMON STEPS OF RESEARCH?

- Identify a practical, relevant, fundamental problem
- Conduct empirical research to understand the context
- Propose a solution to the problem
- Evaluate the solution
- Communicate your results to the community



IDENTIFY A RELEVANT PROBLEM



Lionel Briand · 1st
Trustworthy software and AI, Professor, Lero director, FIEEE, FACM, FRS...
2d · Edited ·

About software engineering research

In our research community (and probably others), the focus is often on trying to find the new cool problem to work on. The new angle that will change everything, and bring about breakthroughs. However, as far as software engineering is concerned, many long-standing problems—though addressed by hundreds of papers—remain unsolved in practical contexts. In my expertise areas, I could easily provide dozens of examples, for example scalable regression testing and practical requirements quality assurance. We need to devise innovative, more practical, scalable, and usable solutions to old problems, in a variety of industrial domains. These solutions should be as simple as possible, but not simplistic. But old problems are not "cool" and therefore any contribution towards alleviating them is generally perceived as less innovative by academics. Practitioners, however, are still seeking help to address them.

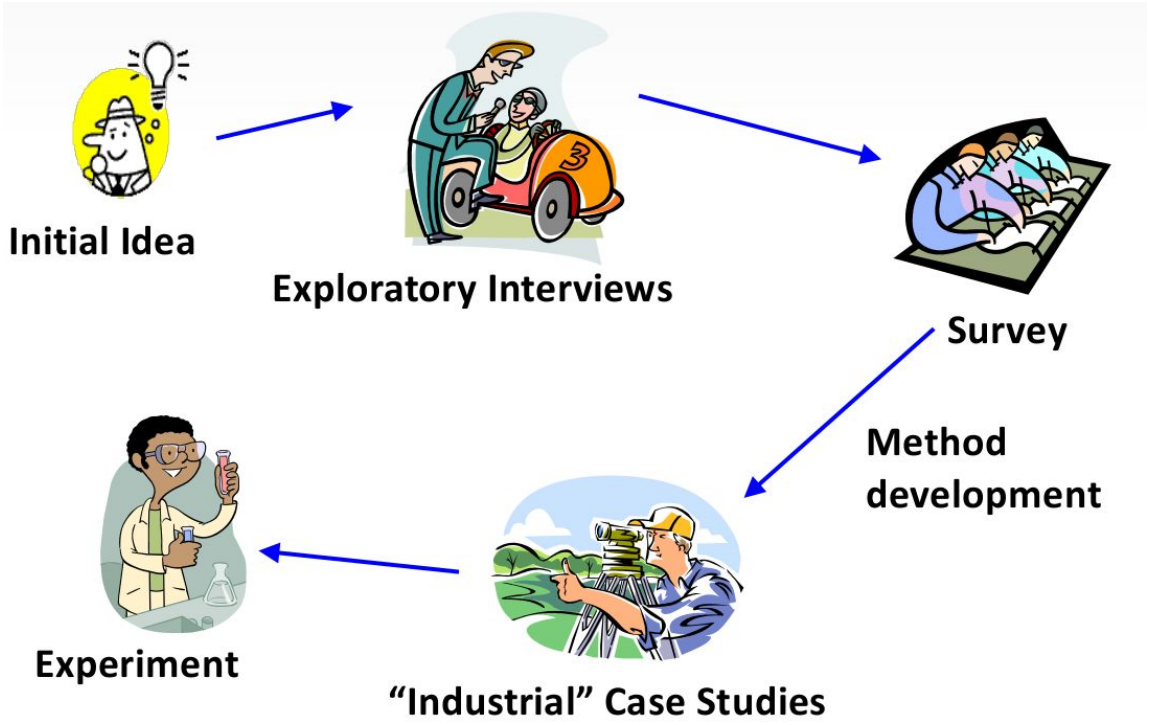
You and 172 others 16 comments · 4 reposts

We need innovative and practical solutions to "long-standing problems"

"Don't pick a problem that's too broad or too abstract. Find a manageable issue that's impactful and solvable within the scope of your PhD."

It is important to participate in conferences, workshops, and read papers in the field. Connecting with the community can help you identify relevant problems and trends.

EMPIRICAL RESEARCH (KNOWLEDGE-SEEKING)



PROPOSE A SOLUTION (SOLUTION-SEEKING)

- How do we reduce software development cost?
- How do we make better software?
- How do we make software developers happier?
- How do we use new pieces of information to solve problems?
- How solutions in other fields can be applied in our problems?
- Who is benefiting from our solution?

EVALUATE THE SOLUTION

- How do we reduce software development cost?
- How do we make better software?
- How do we make software developers happier?
- How do we use new pieces of information to solve problems?
- How solutions in other fields can be applied in our problems?
- Who is benefiting from our solution?

Academia

What metrics to use in the evaluation?

Controlled Experiments
Phenomena studied in a lab set up to mimic reality, often using students.

Design science research
Research that invents a new purposeful artefact to address a type of problem and evaluates its utility for solving problems of that type"

Field Experiments
Phenomena studied in their "real" environment using practitioners

Survey Research
Phenomena studied by probing reality "from a safe distance" using questionnaires or interviews

Case study research
Phenomena studied in context using open ended interviews and questionnaires

Action Research
Phenomena studied through intervention, observation and reflection

COMMUNICATE YOUR RESULTS

- Ideas must be tested and improved. Collaborative work, creative and iterative, rather than the traditional research silos and sequential pipelines.

- What exact benefits stakeholders may have from your work?
  a. Practitioners, Tool builders, Researchers, Educators, End-users, Society in general

- Developing communication skill is essential!
  a. Writing
  b. Presentations

How to write a paper by Tim Menzies

Here's my paper template (may not work for you)

The take away

(A) remove biased labels; and (B) rebalance internal distributions such that they are equal based on class and sensitive attributes

http: //tiny.cc/ advice22

Title,abstract: Important! This is how you attract reviewers.

1. Many people Do something

2. There is a problem

3. Because of some novel/unique perspective, we might have a fix (which no one else has tried before)

4. What we did

Research questions (very quick summary of results)

5. List of contributions

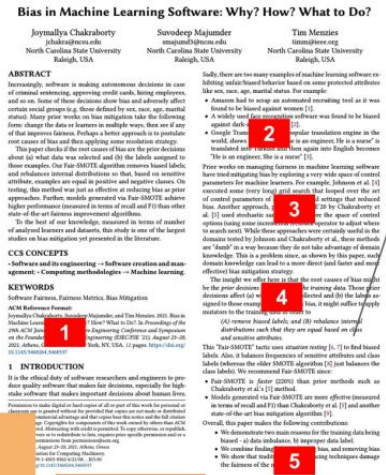
6. CYA: Caveats, limitations, expectation management,

Page2 groovy graphic

Related work: respect and disrespect the past

The throw
In summary, prior work suffered from: (1) Some methods only find bias, without trying to fix it; (2) Some methods for fixing bias have an undesired side effect: leaner performance was degraded.

For the rest of this paper, we explore a solution that finds root causes of bias, and directly implement mitigation of those causes (resulting in less bias and better performance than seen in prior work).


Bias in Machine Learning Software: Why? How? What to Do?

Joymallya Chakraborty, Suvodeep Majumder, Tim Menzies

ABSTRACT

arXiv:2105.12195v3 [cs.LG] 9 Jul 2021

1 INTRODUCTION

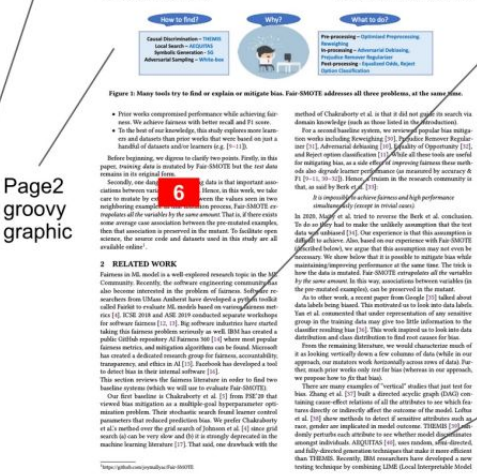


Figure 1: Many tools try to find or explain or mitigate bias. Fair-SMOTE addresses all three problems, at the same time.

2 RELATED WORK

Writing Good Software Engineering Research Papers

Minitutorial

Mary Shaw
Carnegie Mellon University
mary.shaw@cs.cmu.edu

Abstract

Software engineering researchers solve problems of several different kinds. To do so, they produce several different kinds of results, and they should develop appropriate evidence to validate these results. They often

- What concrete evidence shows that your result satisfies your claim?

If you answer these questions clearly, you'll probably communicate your
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Draft Guidelines for My Students on Writing Software Engineering Research Papers

Mark Harman
University College London, UK

ABSTRACT

Here are some tips for academic writing in Software Engineering papers. They may not be suitable for all papers, but they are likely to apply to any you co-author with me. When I comment on your work I may refer to the principles named here so that I can be more productive. Since this document is *not* a software engineering paper itself, do not expect me to follow my own tips. For example, this abstract contains only 1 Zeller Number, and it is not a 'key number that quantifies the primary findings of the paper'.

1. PATTERNS

Favour precision: Referees hate vague statements. Rather than saying "several programs crashed" say "3 of the 17 programs crashed". Do not write things like 'this usually works'. Rather, you need to define what is meant by 'working' (so that others could also investigate) and give numbers. Precision does not require a point estimate; where the value is uncertain, try to bound it with a range. For example, in place of "the computation took roughly 2 seconds" say "the

Zellerise your abstract: Via Gordon Fraser, I learned of Andreas Zeller's principle that an abstract should contain numbers; the key numbers that quantify the primary findings of the paper. I called the process of adding such numbers *'Zellerisation'* in recognition of him. Zellerisation is not always appropriate for every paper, but it often is and even in cases where you decline to use the numbers you obtain in the abstract, the process of thinking about them is helpful. You will be surprised how effective it is. I believe that the process of deciding on the Zeller numbers helps us to focus our minds on the main findings and messages of the work.

Précis and précis again: Good writing is succinct, particularly the abstract. Act on this observation continually.

Titles matter: Think carefully about your title. Be ready to change it if you can find a better one. A good title is memorable (thereby increasing citations, discussion and conversational mentions). It also is the first 'abstract' of your paper that the referee will read; do not make it catchy at the price of irritating or confusing the referee.

Notes On Writing Effective Empirical Software Engineering Papers: An Opinionated Primer

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DOI: 10.1145/ 3743095.3743100
https://doi.org/10.1145/3743095.3743100

1. INTRODUCTION

While mastered by some, good scientific writing practices within Empirical Software Engineering (ESE) research appear to be seldom discussed and documented. Despite this, these practices are implicit or even explicit evaluation criteria of typical software engineering conferences and journals. In this pragmatic, educational-first document, we want to provide guidance to those who may feel overwhelmed or confused by writing ESE papers, but also those more experienced who still might find an opinionated collection of writing advice useful. The primary audience we had in mind for this paper were our own BSc, MSc, and PhD students, but also students of others.

If you have made it this far, you probably do not need much convincing why good scientific writing is important, but let us briefly cover it anyway. Most people will (hopefully) agree that it is even more important to conduct rigorous research. However, if you cannot communicate your research properly, it is at best not living up to its potential and, at worst, useless. Additionally, good scientific writing makes it easier for reviewers to identify solid research, and it may convince them that decent research is "good enough" to be accepted. Bad scientific writing, on the other hand, may demotivate or even anger your reviewers, making acceptance less likely. It may give the impression of incompetence, sloppiness, or laziness, all of which you definitely want to avoid. Ideally, reviewers should focus much more on the research than

2. A TYPICAL ESE PAPER STRUCTURE

While ESE papers can vary in their structure, most usually contain – with potentially different names and order – the following sections. For more information on the content of each section, please refer to Section 3.

- **Abstract:** a concise and precise summary of the whole paper that covers the key points of all major sections (think of it as an executive summary for researchers);
- **Introduction:** the general context of the study, the motivation for the study, *i.e.*, the importance of the problem to be solved, an outline of the solution / observations, the main contributions of the study (sometimes combined with the main results), and potentially the intended readers;
- **Background:** provides not widely known information required to understand the study (if necessary), *e.g.*, important foundational concepts;
- **Related Work:** a discussion of the related work, used to position the study in its academic and / or industrial context (what is new / different?), ideally with a summary at the end;
- **Approach:** if the paper is primarily about a design contribution, then this sections provides a description of the pro-

RESEARCH DIRECTIONS

SOME CHALLENGES IN VARIABILITY

- **Scalability of Variability Models**
  a. Managing thousands of features and configurations in large Product Lines
  b. Efficient reasoning over large feature models is still difficult
- **Automation of Variability Management**
  a. Automated tools for generating, validating, and maintaining variability models are still lacking
  b. Integrating variability into CI/CD pipelines remains a challenge (e.g., non-intrusive tools?)
- **Variability in AI-Based Systems**
  a. Handling non-deterministic variability due to machine learning components (e.g., different models or datasets)
  b. Feature models for AI-enabled systems are often incomplete or ambiguous
- **Runtime Variability & Dynamic Reconfiguration**
  a. Systems that adapt at runtime must manage variability efficiently without service disruption.
  b. Formal guarantees for dynamically adaptive systems are often hard to define and verify.

SOME CHALLENGES IN REUSE

- **Context-Aware Reuse**
  a. Selecting the right component requires understanding the context in which it was originally developed
  b. Lack of metadata and documentation limits effective reuse
  c. Reuse beyond the code (feedback from industry)
- **Component Interoperability**
  a. Components often have hidden assumptions that break integration
  b. Dealing with legacy code and APIs in modern architectures is hard
- **Reuse in ML and Data-Centric Systems**
  a. Reusing trained models, datasets, and pipelines introduces versioning, data quality, and legal issues.
  b. Provenance and explainability of reused components are critical in high-stakes domains.
- **Cost-Benefit Analysis of Reuse**
  a. There's insufficient empirical data on long-term ROI of reuse strategies.
  b. Tooling to evaluate reuse potential (and effort) is still immature.

SOME CHALLENGES IN CONFIGURATION

- **Configuration Validation and Testing**
  a. Testing all possible configurations is infeasible (combinatorial explosion)
  b. Finding minimal yet representative test sets (combinatorial interaction testing)
- **Misconfiguration Detection and Debugging**
  a. Misconfigurations are a major source of production failures
  b. Detecting root causes of misconfigurations in complex systems (e.g., cloud or containerized environments) remains hard
- **User-Centric Configuration Tools**
  a. Many configuration tools are too technical for end-users or domain experts
  b. There is a need for more intuitive UIs and recommendation systems
- **Security and Privacy in Configuration**
  a. Improper configurations can expose sensitive systems
  b. Tools that proactively detect and warn about insecure configurations are limited

CROSS-CUTTING CHALLENGES

- **Traceability**
  a. Maintaining traceability between requirements, features, components, and configurations is complex and often manual.
- **Evolving Systems**
  a. Variability and configuration models must evolve with the system, and ensuring backward compatibility is non-trivial (evolution in space and time).
- **Tool Integration**
  a. Tools for variability, reuse, and configuration often operate in silos; better integration is needed across the DevOps toolchain (e.g., non-intrusive).
- **Explainability**
  a. Developers and stakeholders need understandable justifications for why a particular configuration or reusable component was selected.
- **Human-aspects**
  a. How do developers feel about dealing with variable code?

EMERGING DIRECTIONS

- Variability management in Cyber-Physical Systems (CPS), IoT, and other emerging technologies.
- AI-assisted reuse and configuration, using LLMs to recommend features or detect errors.
- Variability in infrastructure-as-code (IaC) and cloud environments (e.g., Terraform, Kubernetes).
- Ethical reuse, ensuring that reused components respect licensing, attribution, and bias considerations.

PIECES OF ADVICE

THERE IS ALWAYS AN OPPORTUNITY TO LEARN

- You learn with your supervisors
- You learn with your collaborators
- You learn with your students

- Be alert and take the initiative to:
  a. Read what is new in your field
  b. Talk to people in conferences
  c. See different perspectives

- In academia we have the benefit of being with amazing people

KNOW YOUR COMMUNITY

- Who are the people working in your topic/field of study?
- What do they do (i.e., known for)?
- Where do these people meet?
- How do they work?
- How did they build their career?

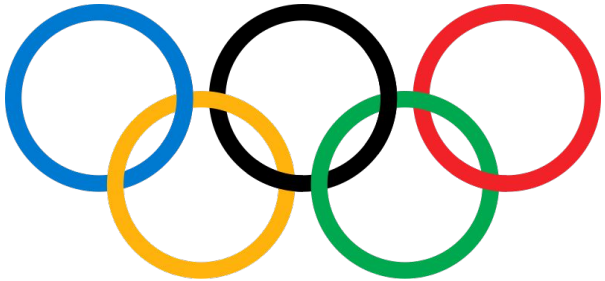
- You need good discussions about your work
- You need a committee for your defense
- You may need reference letters in the future
- You will need a job after your PhD :-)

- Google Scholar alerts, Social media !?

Help the others!

CONTRIBUTION VS. PUBLICATION

- I like to think of doing research is like sports
  a. Conferences are our Olympic Games
  b. Most of the work is done before the competition
  c. There are no medals for everyone…
     …but we are the best versions of ourselves



- Focus on making contribution
- You should try to be better each day, in comparison to the previous one
  a. How different will you be after finish your PhD
- The medals will eventually come :-)

PIECES OF ADVICE

- 1: Now that you've finished your PhD, if you could go back in time and give yourself advice for yourself, what would it be?
- 2: What were the most difficult challenges for you during your PhD?
- 3: What advice would you give to other people currently pursuing a PhD?

1. Focus on **constant progress** and don't get discouraged by the first rejections.

2. Work on problems that don't seem relevant [not in the hype]. You **only realize its relevance after a long time**.

3. Avoid comparing yourself to colleagues at the institute or outside in terms of publications or awards, and **focus on moving forward in your topic**.

PIECES OF ADVICE

- 1: Now that you've finished your PhD, if you could go back in time and give yourself advice for yourself, what would it be?
- 2: What were the most difficult challenges for you during your PhD?
- 3: What advice would you give to other people currently pursuing a PhD?

1. Have a **clear view** of what is a PhD, and **why to do a PhD**.

2. So what's most challenging is **doing a PhD and working at the same time.**

3. I think the main suggestion would be to not care so much about conference reviews. Not everyone knows how to value the work of others, and **each study is important** within its field and context. Do what you find interesting and **contribute to science** in the way that's possible within your situation.

PIECES OF ADVICE

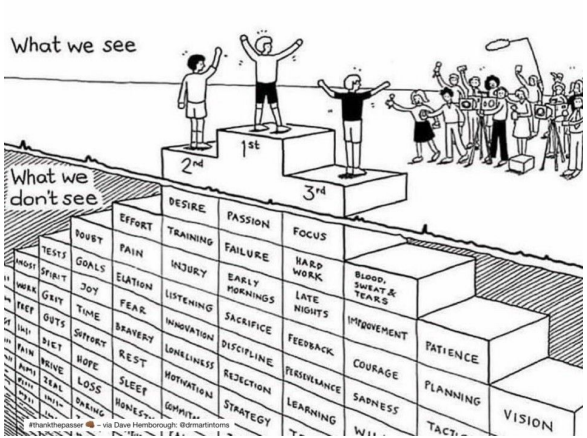
1. It takes patience, calm, and a **long-term vision** to build well-founded and well-constructed research. Also, be clear about **why you're pursuing a PhD**; otherwise, you'll give up at the first hurdle. It will require a lot of **time and energy**, so be clear about what you'd like to do in your professional career, aligning it with your family, spouse, children, etc.

2. The hardest part for me was **controlling the anxiety** of wanting to see my PhD finished so I could pursue my dreams and plans. Overcoming **paper rejections** is very difficult. But with maturity, I understood that going through the **process is what makes us researchers**, and accepting article rejections as a way to learn and improve. We really need to go through this to be ready for our thesis defense.

3. Think about why you're pursuing your PhD and the **things you'll gain from it in the future**, because this thought motivates you to continue with the process every day. And **taking breaks is essential**, because we're not robots.

CONCLUSION

- It is not easy to be on world-leading expert in a field of research
- You must have your motivation, goals, and long-term plan clear
- Finding the recipe that works better for you is part of the journey
- Focus on making contributions. Society has so many problems…
- Communicate your work and know your community
- Try to improve every day, the medals will come!



TAKE HOME MESSAGE

+ The Future of Software Engineering (and society) is in your hands.
+ I (trully) believe in you…
  …but you should believe too :-)
+ PhD is the journey, not the destination.
+ Enjoy the journey too!

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NC STATE UNIVERSITY

THE FUTURE OF SOFTWARE ENGINEERING IS IN YOUR HANDS

AND I BELIEVE IN YOU!

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