Are We Really Standing on the Shoulders of Giants?

Raghava Mutharaju and Pavan Kapanipathi

Wright State University, OH, USA.
mutharaju.2@wright.edu, pavan@knoesis.org

1 Introduction

I have not failed. I have found 10,000 ways that won't work.
–Thomas A. Edison

About 3000 designs for bulbs were tested between 1878 and 1880 before the first light bulb was invented in Edison's lab. The tests include experiments with several materials for filaments such as cotton, linen thread, and wood splints that are reported in his first patent. However, months later the material that was proven to be successful was carbonized bamboo filament that could last for more than 1200 hours [1]. This story portrays the significant effort in analyzing the failures of each of the materials to experiment with new ones. This is the basic principle of science, where researchers examine what went wrong to get things right. In the above light bulb story, what most of us remember is that Thomas A. Edison invented light bulb in the year 1879. Success stories generally overshadow the failures that lead to it and failures are often not well documented.

This misconception of ignoring failures and highlighting only the success stories permeated into the publication of research results. In the research world, where publications are one of the main methods of disseminating work, discussion of failures is often neglected. Research by its very nature involves risk and is prone to failures. So there will likely be more failures than success stories. This makes it all the more important to share and discuss the negative results in an unbiased and open-minded environment so that others do not end up with similar dead ends. In order to have such an environment, there needs to be a change in the way negative results are perceived by the community. Steps need to be taken in order to have this gradual change.

We argue that negative results should also be considered as a research contribution and state the benefits in such a case. We also indicate the possible next steps that can be taken in order for negative results to get their due.

2 Impact of Overrating Success and Ignoring Failures

"Publish or Perish" is a deeply rooted paradigm in the research domain. In conjunction with this, the common perception of success over failures in research

publications has introduced the *"fear of failure"* in researchers. The exact opposite emotion is required to perform high impact and high quality research. This fear of failure has in turn led to a chain of problems that include:

- **Selective publishing of results:** Due to the pressure of publishing positive results, researchers opt to select a part of the results that supports their hypothesis and ignore the negative results. This is not only a problem in the data driven areas of computer science research, but also a significant challenge in other areas of research such as medicine and psychology [2].
- **Irreproducibility:** Researchers find it hard to reproduce the results of a published paper either due to the lack of information or as a consequence of selectively published results. This research hence would have no value and can be considered as waste of time and effort for the authors and the researchers who intend to reproduce the results.
- **Wastage of research funds:** United States federal government spent around $30 billion dollars in 2013 for basic scientific research [4]. Sequestration has already cut down the funds that is allocated for research purposes. Irreproducible and selectively published research eat up a part of these funds that can be better utilized for quality research that also includes negative results.
- **Reinventing the wheel of negative results:** Research extends the state-of-the-art and helps in the advancement of knowledge. However it is not uncommon that the proposed solution to a problem does not work as well as expected. It could very well be that this solution was already tried and tested by other researchers in the field but has not been published. Significant time, effort and funds are consumed in the process of reinventing this wheel of negative results.

3 Encouraging Negative Results

Positive results are helpful in determining what to do and how to do; whereas negative results are useful to know what not to do. Furthermore, negative results can help in mitigating the limitations introduced in Section 2. Although having a workshop on negative and inconclusive results is a good start, more needs to be done in order to integrate discussion of negative results into the mainstream. Here we list some possible steps that can be taken in this regard.

3.1 Negative Results are a Contribution

A submission to the research track of conferences such as ISWC and ESWC will be evaluated based on its contribution to the state-of-the-art. For a submission to be determined as a research contribution, it should not depend on the type of results obtained in the work. Irrespective of whether the results are positive or negative, the quality of the work should be determined based on appropriate review criteria. We need a different set of review criteria for assessing the quality of negative results. Existing review criteria are more in favor of positive results.

On the other hand, encouraging the submission of negative results opens up the possibility of conference submissions over flooded with negative results since generally there are more dead ends than positive results in research. Strict metrics for judging the *quality* of negative results should be put in place. Following criteria can be used to determine the quality of negative results.

1. **Quality of proposed solution:** Sometimes the most obvious solution to a problem need not be the most efficient or suitable. Since the solution is quite obvious, this is a potential pitfall for researchers to go through the same route and hit a dead end. Although determining how *obvious* a proposed solution (that lead to negative result) is subjective, experienced researchers (reviewers) should have a fair idea about the obviousness of a proposed solution. So the more obvious a solution is, higher is the quality of negative result that was a consequence of the proposed solution.
2. **Scale of failure:** A failure on larger scale should be avoided. So higher is the amount of time, effort and funds that were invested into the proposed approach that lead to the negative result, higher is the quality of negative result.
3. **Lessons learned:** The primary purpose of publishing negative results is to describe the lessons that were learned from the proposed approach. The quality of negative results depends on the number and the quality of lessons learned.
4. **Impact on related work:** Discussion of the following question will be helpful to the community: "Given that a particular approach gave negative results for a particular problem, is it also the case that this approach gives negative results to related problems or similar problems in other domains?"

Furthermore, in order to assess the impact of these negative results it would be important for researchers to come up with a criteria that translates to the number of researchers who can avoid taking the dead end path (Reinventing the Wheel of Negative Results) or learning from "what went wrong".

Long term impact of this encouragement and in turn the utility of negative results overtime can be checked by using citations of papers published. More citations would mean that several other researchers in the community were able to make use of the lessons learned from the approach that lead to negative results.

3.2 Open Reviews

Quality of reviews at conferences has consistently been a topic of debate. Since modern researchers are prone to accept positive results, conferences open to negative results must consider having an open review system (e.g. Semantic Web Journal [3]). This not only encourages accountability of reviewers but also provides an open grounds for discussion on the value of negative results if they are ignored by the reviewers. This transparency would reduce the "fear of failure" among researchers.

3.3 Open Datasets and Code

One of the problems in the chain introduced by "fear of failure" is the issue with verifiability. Since most researchers position their research towards positive results, trust on the results has become abundant and there is a lack of verifiability. Hence transparent research (where ever possible[1]) should be encouraged. Open source code and open datasets of negative results can be strongly verified in order to assess the impact of the results and its reproducibility for the paper acceptance. On the other hand, this should also be encouraged for positive results. In general, this approach would hopefully alleviate the irreproducibility and verifiability problems induced by the fear of failure.

3.4 Flexible Funding agencies

Funding agencies play an important role in setting the direction of research. If they specify that negative results in the funded projects will also be encouraged (say, for example, by ensuring publication at a top conference, which in turn is related to the previous discussion) then that would give researchers greater freedom in pursuing risky topics as well as the confidence to publish the negative results.

4 Conclusion

Negative results are as important as positive results since they help researchers from wasting their time, effort, and money on approaches that did not give positive results to others. The *Publish or Perish* approach with the *Fear of Failure* (success overshadowing failures) has lead to a chain of problems that can be addressed by recognizing negative results also as a contribution. In doing so, we can learn from the negative results and truly say that failures are the stepping stones to success. This in turn would enable us to see much further since we can stand on the shoulders of giants (other researchers). Right now, we are on a shaky ground since we are unwilling to learn from other's failures.

References

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[1] Some organizations are restricted due to their non disclosure policies.