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Technology Transfer: Lessons Learned from Taghreed System

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Complete List of Authors:	Magdy, Amr; University of California Riverside Foundation, Computer Science and Engineering Mokbel, Mohamed; University of Minnesota Twin Cities, Computer Science and Engineering
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Responses to reviewer comments:

We thank the reviewer for all the valuable comments. We are responding to them one by one as follows.

- *"The manuscript describes an interesting case study of software technology transfer and lessons learned."*
  Response 1: We thank the reviewer for appreciating our work to transfer research into practical technology.

- "*The case does not involve geospatial software per se, but implies that lessons learned are applicable to the geospatial domain.*"
  Response 2: Thank you for your comment. The presented system, Taghreed, is primarily motivated by analyzing geospatial content of microblogs data. We modified the abstract to highlight this fact. So, the whole case is centered around a geospatial software. It might be also the case that the reviewer means that the discussed lessons are not specific to geospatial software and could be applicable to any type of software technology transfer. In fact, we are not in the position either to agree or disagree with argument for a main reason: our sole experience in technology transfer was with Taghreed system and the rest of our experience is academic research, so generalization is hard for us in this context. That is why the entry is designed as a set of specific lessons to Taghreed case and not a generalized entry. However, it was obvious to us, as we pointed out in the revised manuscript, that the geospatial aspect of Taghreed was a key aspect in motivating industrial partners to incubate it. So, the geospatial aspect is implicitly embedded as a general motivating aspect due to the importance and popularity of geospatial applications. We highlighted this in the revised manuscript.

- "*The manuscript is not, however, a primer on technology transfer in the geospatial context or any other for that matter. For the GIS&T BoK, I expected an entry comparable to Wikipedia's treatment of technology transfer (https://en.wikipedia.org/wii/Technology_transfer), but situated in the geospatial industry context. In such an entry, lessons learned could be a section of the entry, but should not be the whole story."*
  Response 3: Thank you for clarifying the point. However, as we mentioned in *Response 2*, our philosophy in writing this entry is not intended to be a generalized entry like Wikipedia articles. We believe that this is beyond our scope as academic researchers who went through a single technology transfer experience and beyond the scope of GIS&T BoK that is targeted to certain audience. However, we are highlighting the lessons learned from the perspective of academic researchers to be useful for the audience of GIS&T BoK. If this audience prefer more of a generic knowledge about this process, then there should much more content in other sources, and we believe that GIS&T BoK is not the place to have this generic knowledge as it is not a business-oriented publication.

- "*Apart from that concern, I have two other issues with the manuscript. The first sentence in the (line 50, p. 1) states "Technology transfer is an ultimate goal for research projects that address real world problems and contribute to computing platform." In my university experience, that was typically not the case. In academic contexts (and in some disciplines more than others) where research publication is the coin of the realm, software technology prototypes and proofs of concept may be ends in themselves. Furthermore, professional GIS software engineers with whom I now work claim that they've learned almost nothing useful from university research. (True or false, such statements belie an attitude not conducive to technology transfer projects.)*"

Response 4: Thank you for your comment. We agree with your point and we have modified the revised manuscript to reflect this and to be more specific that some of the research projects that include system-oriented research might be candidates for such technology transfer process, but this does not imply it is an academic goal or included in the academic evaluation. So, we fully agree with your point and we reflected that in our revised version.

- "*A core issue cited beginning on line 60 of p. 3 is the observation that "There is much concern over the increased emphasis of citation counts instead of research impact. This discourages large systems projects, end-to-end tool building, and sharing of large datasets." This issue deserves greater attention, in my opinion.*"
Response 5: Thank you for acknowledging this. We fully agree with your point and we are addressing this in our research and trying to spread the culture to have more large systems come from the academic groups that are spending major efforts in developing new cutting-edge technology.

- "*Finally, the manuscript's references include no works on technology transfer per se.*"
Response 6: As we elaborated, we are discussing lessons that are directly related to our technology transfer experience rather than a generalized version for of the discussion. That is why the manuscript does not include references on technology transfer, which would be more suitable for a business-oriented publication.

Technology Transfer: Lessons Learned from Taghreed System

Amr Magdy[1,2]

[1]Department of Computer Science and Engineering
[2]Center for Geospatial Sciences
University of California, Riverside
amr@cs.ucr.edu

Mohamed F. Mokbel[3]

[3]Department of Computer Science and Engineering
University of Minnesota – Twin Cities
mokbel@umn.edu

Abstract

Technology transfer is a process to transfer research ideas from preliminary stages in research labs and universities to industrial products and startup companies. Such a transfer significantly contributes to producing new computing platforms out of state-of-the-art research ideas. Our research has produced Taghreed; a system that supports scalable **geospatial** data analysis on social media microblogs data. **Taghreed is primarily motivated by the large percentage of mobile microblogs users, over 80%, which has led to greater availability of geospatial content in microblogs beyond anytime in the digital data history**. Taghreed has been commercialized and is powering a startup company that provides social media analytics based on full Twitter data archive. This entry highlights key lessons that are learned through the process of transferring Taghreed from a research and development (R&D) lab to an industrial product.

Keywords and Related Topics: Technology transfer, Social media, microblogs, business incubation, CP-10 - Social Media Analytics, CV-36 - Geovisual Analytics

Definitions

(1) Software technology transfer: a process of transferring software technologies, such as technical ideas, software modules, and system prototypes, from their preliminary stages in research labs and universities to software products in industrial and startup companies.

(2) Business incubation: a process of helping preliminary technologies to be transferred into a young business through providing financial and technical support.

(3) Business incubator: a company or an entity that provides financial and technical support to create startup companies out of preliminary technologies.

(4) Industrial partners: a team of business managers and software engineers who are responsible for incubating the transferred technology on the industrial side through all the process stages.

(5) Microblogs: Micro-length posts of user-generated data that is posted on the world wide web, such as tweets, comments on news websites and social media, location check-in's, and online reviews. Microblogs **are dominated with** textual, spatial, are temporal **content**, **in addition to** other attributes **such as user information and language information**.

Body

Research projects that involve system-oriented research are strong candidates for technology transfer to play direct role in addressing real world problems and contribute to computing platforms. Our research has produced Taghreed (Magdy et. al. 2014); a system that provides scalable spatial, temporal, and textual data analysis for microblogs data, i.e., micro-length user-generated data such as tweets, comments, likes, and reviews. Taghreed has been patented (Mokbel and Ahmed 2015) and commercialized by a business incubator to establish a startup company that provides social media analytics reports to a wide variety of customers. **A major motivating aspect for commercializing Taghreed was the capability to analyze geospatial content in microblogs effectively and at scale, which was missing in all state-of-the-art big data management systems that are built for general query workloads**. The startup company profile has been built up relatively quickly and hold an agreement with Twitter so it has access to all Twitter data as the first company to have this data in its geographic region. In this article, we highlight key lessons that are learned through the process of transferring Taghreed from a research and development (R&D) lab to an industrial incubation.

Lesson 1: Simplicity first

In our experience with commercializing Taghreed, simplicity was a key aspect in several stages. First, starting with a simple and to the point idea was very important in effective engagement with the industrial partners, and hence developing a complete solution that provides an end-to-end analytics system. The idea started with developing scalable indexing and query processing for high velocity and large volume microblogs. Then, along the way, the team recognized the dire need for other modules, such as natural language processing and visualization, and the system has been gradually developed to be a complete solution over time. The simple start was key in getting the incubation rolling. Second, simplicity in designing the different system modules was very important for being incubated by industrial partners. In industrial systems, each module is embedded in a multi-layered software system for design modularity, fault tolerance, durability, and maintainability. These layers add significant overhead in runtime to the module performance compared to experimental results that are obtained from research code bases. Thus, modules with complicated algorithms and techniques are less likely to scale in industrial systems. In addition, complicated modules need increasingly significant efforts in development and maintenance. For these reasons, software engineering managers are more reluctant to incubate complicated algorithms to ensure both scalable performance and quick development cycles.

Lesson 2: Iterative feedback is key

Technology transfer is a process that involves two teams with different mind sets, researchers and industrial partners. Thus, effective and continual communication between members of the two teams is key in achieving successful results. In our experience of commercializing Taghreed, getting feedback from our industrial partners in an iterative way was key in advancing major steps toward a successful incubation. In fact, in a prior incubation attempt, lack of iterative feedback has led to a major waste of time and resources, which ended up being a failing attempt. This failing experience started with meeting the industrial partners and setting broad goals for the system functionality and use cases. Then, an engineering team in the R&D lab has prototyped all system components for approximately nine months without any feedback from the industrial partners. In the following meeting with the industrial partners, it was obvious that the system prototype that has been developed over the past nine months has different limitations on their side in terms of performance and functionality. Part of their different expectations were emerging business use cases that have evolved over the past year and were not reflected in the developed prototype. The meeting has ended up being a termination meeting for the incubation attempt due to the significant time and resources that are needed to fix these problems. This experience was key in the following attempts to always consider iterative feedback from the industrial partners to ensure meeting their evolving expectations in both system performance and functionality. In our successful incubation attempt, we have first approached the industrial partners with the key system ideas and business use cases. Then, we have built a whole system prototype skeleton that includes only the key components and other utility components, without optimizing any individual component. Thereafter, we kept optimizing each component individually and adding new components as needed. In each step, we were holding meetings with the industrial partners to synchronize the existing progress, the system performance, and the following steps. This has ensured a synchronized view along the way to the point of delivering the system prototype to the startup company team.

Lesson 3: Motivate for a business case

Approaching industrial partners is way different from approaching the research community. Unlike the research community, novelty is not the key motivation for admiring a certain idea for industrial incubation. Instead, the idea must contribute to a viable business case that has potential customers to be incubated. For example, a researcher might be providing a novel idea that enables highly scalable indexing and querying for new sources of data that is used in societal applications. On the research side, this would be enough to motivate an interesting problem to tackle and show novel technical contributions. However, on the industrial side, if the proposer is not justifying the new technology as a potential contributor to a profitable business case, it is considered as an interesting research idea that does not have any business impact. In fact, in our first attempt to commercialize Taghreed, we got a feedback that is very different from what we expected at the time. The main reason was the way we introduced our system as a highly scalable system for indexing and querying fast and large data without showing a concrete end-to-end story about how such a technology would be contributing to making profit. Focusing on the technical aspects of our innovation made the business value of our technology questionable and ended up being a failed incubation attempt. In later attempts, it was key to motivate for potential customers and the profitable value of providing business reports based on social media data and user-generated content. Then, we go into the details of how our technology can make this happen in a scalable way to digest all existing data with commodity hardware equipment. This way of approaching industrial managers was much more impactful for considering the research contribution for industrial incubation.

Lesson 4: Reliable prototyping is the second key step

Research ideas are in many cases questionable for applicability in real situations due to the differences between research environments and real world in terms of available resources, access to real data, lack of interaction with real customers, etc. Therefore, it was very important for Taghreed incubation, once the business case got along with the industrial partners, to provide a reliable and well-engineered system prototype to progress further in the incubation process. In the case of Taghreed, the R&D lab had an engineering team that contributed with researchers to provide a reliable system prototype. The prototype was able to show very good performance and fault tolerance when being in real operations, i.e., digesting large scale datasets and producing real business reports based on user-generated data. This prototype has shown scalability of the core research ideas and practicality of employing them in real production to meet the business needs. This was key in building trust with the industrial partners to put dedicated resources for incubating our research ideas with high confidence in their technical solidity.

Lesson 5: Novelty is differently perceived

The concept of novelty is differently perceived by industrial partners compared to the research community. Software engineers generally appreciate systems contributions more than the research community. Such a culture is actually recognized in the data management research community several years ago. In the Beckman report on Database Research (Abadi et. al. 2016), it is stated clearly under the community challenges in the research culture that "*There is much concern over the increased emphasis of citation counts instead of research impact. This discourages large systems projects, end-to-end tool building, and sharing of large datasets, since this work usually takes longer than solving point problems. Program committees that value technical depth on narrow topics over the potential for real impact are partly to blame. It is unclear how to change this culture. However, to pursue the big data agenda effectively, the field needs to return to a state where fewer publications per researcher per time unit is the norm, and where large systems projects, end-to-end tool sets, and data sharing are more highly valued.*" On the contrary, in our experience with Taghreed, the industrial partners are not underestimating novelty in engineering index structures, for example, to make it simpler to access or easier to maintain. Such a notable difference is important to consider while communicating with the industrial partners not to underestimate a contribution that is highly valued or vice versa.

Lesson 6: Real-time content matter

Taghreed system is dealing with microblogs data, which is by nature very timely data where users are posting a lot of real-time content. As a result, it was a corner stone in convincing industrial partners with the significance of our technology to consider real-time content analysis to update query results based on recently posted content. This was one of the most challenging tasks technically due to the distinguished nature of user-generated content compared to traditional streaming data. However, it was one of the most important points raised with potential industrial collaborators due to its impact on the business case. Existing systems were not able to cope up with such high update rate efficiently. Thus, this feature in Taghreed provided the essence of a research contribution that adds a value to the business case.

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Learning Objectives

- Describe the technology transfer process.
- Discuss major challenges at the different stages of the technology transfer process.
- Distinguish major differences while communicating research ideas with the research community and industrial incubators.
- Identify major additions to a successful research idea to contribute to a technology transfer process.
- Point out major success keys of Taghreed system in the technology transfer process.