[CP-04-005] Geospatial Technology Transfer Opportunities, and a Case Study of the Taghreed System

Abstract

The technology transfer process moves research ideas from preliminary stages in research labs and universities to industrial products and startup companies. Such transfers significantly contribute to producing new computing platforms, services, and geospatial data products based on state-of-the-art research. To put technology transfer in perspective, this entry highlights key lessons learned through the process of transferring the Taghreed System from a research and development (R&D) lab to an industrial product. Taghreed is 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.

Keywords: business incubation, industry, microblogs, research, social media, technology transfer

Author & citation

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Explanation

1. Definitions

- **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.

- **Business incubation**: a process of helping preliminary technologies to be transferred into a young business through providing financial and technical support.
- **Business incubator**: a company or an entity that provides financial and technical support to create startup companies out of preliminary technologies.
- **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.
- **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.

2. Overview of Geospatial Technology Transfers

Technology transfer is a process to transfer research ideas from their preliminary and developmental stages in research labs and universities to industrial products and startup companies. There is increasing interest across federal agencies, academic institutions, and individual researchers in transferring research discoveries into commercially viable software, services, and products as broader impacts of research including economic development and to help support further research. These commercialization activities are referred to as academic entrepreneurship and commercialization (Perkmann et al. 2013). While each technology transfer is unique based on differences in technological implementations, individuals, institutions, and markets, the process of technology transfer has a similar set of steps. To help researchers navigate the legal, ethical, and commercial ramifications involved in technology transfer, most research institutions have an office of technology transfer and commercialization designated to help researchers with these steps.

Broadly speaking, the steps of technology transfer include invention disclosure, evaluation for commercial potential, patenting and protection of intellectual property, marketing, licensing, and commercialization, such as this step-by-step guide provided for its faculty by the University of Minnesota (https://drive.google.com/file/d/0B7644h9N2vLcUUVwaFB0ZTMyQkE/view). For most institutions the first step is invention disclosure, which begins the conversation with a technology transfer and commercialization unit. Technology transfer offices generally have experts that can help researchers think through the advantages and disadvantages of technology transfer. The next step is evaluating the commercial potential for a technology. This crucial step examines whether there is a commercial market. If not, then the process ends here. If there is commercial potential, then the next step is protecting intellectual property, and one of the most common ways is to apply for a patent or through copyright. The following step involves licensing the product. In many cases, researchers do not own the intellectual property, the institution does. So the institution needs to license the technology to a company through a license agreement. At this point the technology can be commercialized to generate revenue.

Within GIS&T there are several classes of technologies and services that could be candidates for technology transfer.

- Geospatial software. Licensing and distributing a software package is the most obvious example of technology transfer. The software (or algorithms) can optionally be protected by one or more patents. Esri is the leading GIS&T commercial example of licensing and selling GIS software.
- Geospatial (web) services. Instead of licensing and distributing software, it is possible for researchers to license access to their software through a web service. The Texas A&M Geocoder is an excellent example of making geospatial research and geospatial software capabilities available as a service (in this case geocoding addresses) (http://geoservices.tamu.edu/Services/Geocode/).
- Geospatial platforms. Beyond a single service, it is possible to license a GIS&T web-based platform that offers a variety of capabilities including analytics, modeling, and/or visualization. An example of this is BigKnowledge, which offers the BoKMap platform (https://www.bigknowledge.net/).
- Geospatial (expert) services. GIS&T expertise can have just as much commercial potential as a GIS&T technology. In certain cases, releasing software under an open-source software license and commercializing the expertise and support for the software can be commercially successful. This example is referred to as the ‘Enterprise Support’ model (https://drive.google.com/file/d/0B4UVTqmHDXguUEFqQUgtN2gxckk/view).
- Geospatial data. Many GIS&T researchers may not realize that the data they produce have commercial value. In this case the data is licensed, but the software/technology remains privately held by the researcher (or commercial company).

Technology transfer requires investment to get a technology from discovery to commercial success. The US has several programs spanning across federal agencies to improve this innovation process including the the Small Business Innovation Research program (SBIR), Small Business Technology Transfer program (SBTT), and the National Science Foundation's Innovation Corps program (I-Corps) (e.g., National Academies of Sciences, Engineering, and Medicine, 2020 and 2016). These programs can provide initial resources to start-up ventures. However, there is a well-known “Valley of death” for young ventures which occurs at the crucial stage when the initial support from these programs expires, but the venture has not yet gained new investors or sufficient revenue to be self-sustaining (see Figure 2-4 in National Academies of Sciences, Engineering, and Medicine (2020)). Technology transfer and commercialization offices can help researchers explore various options and opportunities for commercializing their research. Some institutions offer incubator services including space, seed capital, and legal support for early ventures to explore whether licensing agreements, joint partnerships, or launching a start-up company is a promising avenue for technology transfer. There are a variety of combinations and opportunities in technology transfer. The following case study provides a concrete example of commercializing a patented software system and lessons learned from the technology transfer process.

3. The Taghreed System Case Study

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 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 was built up relatively quickly and has held an early agreement with Twitter to have this data in its geographic region. In this article, we highlight key lessons that were learned through the process of transferring Taghreed from a research and development (R&D) lab to an industrial incubation.

3.1 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, leading to 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 expanded 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.

3.2 Lesson 2: Iterative feedback is key

Technology transfer is a process that involves two teams with different mind sets: researchers and industrial partners. Hence, 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 led to a major waste of time and resources, eventually contributing to a failed attempt. This failure 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 spent 9 months prototyping all system components without any feedback from the industrial partners. In the subsequent meeting with the industrial partners, it was obvious that the system prototype that had just been developed had different limitations on their side in terms of performance and functionality. Part of their different expectations were emerging business use cases that had evolved during the intervening months and were not reflected in the developed prototype. The meeting became a termination meeting for the incubation attempt due to the significant time and resources that would have been needed to fix the problems.

This type of experience exemplifies the importance of iterative feedback from the industrial partners to ensure that their evolving expectations in both system performance and functionality are met. In our eventual successful incubation attempt, we first approached the industrial partners with the key system ideas and business use cases. Then, we built a whole system prototype skeleton that included 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. During each step, we held meetings with the industrial partners to synchronize the existing progress, the system performance, and the next steps. This ensured a synchronized view towards the point of delivering the system prototype to the startup company team.

3.3 Lesson 3: Value the Business Case

Approaching industrial partners is significantly 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 and potential customers. For example, a researcher might provide a novel idea that enables highly scalable indexing and querying for new sources of data that can be used in societal applications. On the research side, this would be enough to motivate the activity and pursue the novel technical contributions. However, on the industrial side, if the proposer has not justified the contributions of the new technology to a profitable business case, it is considered as an interesting research idea with no business impact. In fact, in our first attempt to commercialize Taghreed, the feedback we received was very different from what we had expected. We had introduced our system as a highly scalable system for indexing and querying fast and large data but had neglected to show a concrete end-to-end story about how such a technology would contribute to generating profits or new revenue. Focusing only on the technical aspects of our innovation made the business value of our technology unclear and contributed to the initial failed incubation attempt. In later attempts, clearly describing the potential for customers and the profitable value of providing business reports, based on social media data and user-generated content, were always included. Only then would we go into the details of how our technology would make that happen in a scalable way to digest all existing data with commodity hardware equipment. This way of approaching industrial managers was much more effective for assessing the research contribution for industrial incubation.

3.4 Lesson 4: Reliable prototyping

Research ideas often have questionable applicability in the business world due to the persistent differences and gaps between typical research environments and the real world of available resources, access to data, lack of interaction with customers, etc. For the Taghreed incubation, once we had started to make the business case with our industrial partners, providing a reliable and well-engineered system prototype was key to progressing further in the negotiation process. In the case of Taghreed, the R&D lab had an engineering team that collaborated with us researchers to provide a reliable system prototype. The prototype was able to demonstrate very good performances and fault tolerances when being tested during real operations, i.e., digesting large scale datasets and producing real business reports based on user-generated data. The prototype showed scalability of the core research ideas as well as the practicality of employing them in real production to meet business needs. Having a demonstrably successful prototype was key for us to build trust with the industrial partners as they considered dedicating resources to incubating our research ideas with more confidence.

3.5 Lesson 5: Novelty is differently perceived

The concept of novelty is differently perceived by industrial partners as compared to the research community. Software engineers generally appreciate systems contributions more than the research community. These cultural differences have been recognized in the data management research community. For example, in the Beckman report on Database Research (Abadi et. al. 2016), the community challenges specify 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 did not underestimate or undervalue 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 industrial partners, so that contributions that are highly valued are not underestimated or go unappreciated.

3.6 Lesson 6: Real-time content matters

The Taghreed system deals with deals with data from microblogs, which by nature is very time-sensitive as users are posting a lot of real-time content. Thus it was key that our industrial partners appreciated the capacity of our technology to update query results based on recently posted content, a technical achievement that might have seemed trivial to the industrial partners but was actually very challenging to execute well. It became one of the most important points to explain with potential industrial collaborators due to its potential for impact on the business case. Other existing systems were not able to cope with such high update rate efficiently. Thus, this feature in Taghreed provided a high value-add research contribution to the business case. Being able to clearly explain these types of differentiators is key, especially when the technical details may be complex but the functions and capabilities are highly valuable ones to the final products or solutions.

References

Abadi, D., Agrawal, R., Ailamaki, A., Balazinska, M., Bernstein, P. A., Carey, M. J., . . . Widom, J. (2016). The Beckman Report on Database Research. In Communications of the ACM 49(2): 92-99.

Magdy, A., Alarabi, L., Al-Harthi, S., Musleh, M., Ghanem,T., Ghani, S., & Mokbel, M. (2014). Taghreed: A System for Querying, Analyzing, and Visualizing Geotagged Microblogs. SIGSPATIAL '14: Proceedings of the 22nd ACM SIGSPATIAL International Conference on Advances in Geographic Information Systems, pp 163-172.

Mokbel, M. and Ahmed, A. M. (2015). System and Method for Microblogs Data Management. U.S. Patent and Trademark Office on August 31, 2015. US Patent US20160070754A1.

NASEM, National Academies of Sciences, Engineering, and Medicine. (2016). STTR: An Assessment of the Small Business Technology Transfer Program. Washington, DC: The National Academies Press.

NASEM, National Academies of Sciences, Engineering, and Medicine. (2020). Review of the SBIR and STTR Programs at the Department of Energy. Washington, DC: The National Academies Press.

Perkmann, M., Tartari, V., McKelvey, M., Autio, E., Broström, A., D'Este, P., ... & Krabel, S. (2013). Academic engagement and commercialisation: A review of the literature on university–industry relations. Research Policy, 42(2), 423-442.