Big Data Analytics Meets Internet of Things: Paradigm Shift in Bio--logistics

Rationale: The demand of **temperature** and **time sensitive** shipping service are growing exponentially. The technology has clearly not kept pace with the demand and realities in the ground. For example, a report compiled by Pharma presented in the 3rd biologistics conference 2015, identifies that "inefficiencies in the process lead to seven out of ten trials being delayed or cancelled, at a cost of $1.1 million in daily prescription revenues," please see page 5 of the report [1]. Instead of investing to develop an in--house supply chain, industry trend is to rely on shipment services such as FedEx. FedEx has been serving its users through a number of X--services:

-- FedEx custom critical, which provides temperature control, records humidity, light exposure, etc. throughout the shipping.
-- Healthcare Shared Network – Cold Chain LTL transportation, reports the temperature every half an hour.
-- FedEx Temperature control solution, uses liquid nitrogen that can keep constant temperature for 10 days. Provides temperature monitoring. FedEx Priority Alert for time critical and temperature sensitive packaging offers re--icing options such as dry ice replenishment or gel pack conditioning and also makes effort to deliver shipment on time. The SenseAware technology which logs all the data in the shipment package and that can be used later to check whether the package encountered any unusual condition.

CargoSense supply chain solution which enables a number of environmental factors a package might be exposed to – temperature, humidity, light, shock, etc. and provides analytics for collaboration among the stakeholders. Predictable and timely delivery that maintains desired environment (such as temperature and exposure to light) and specific requirements (such as no shock, etc.) seem to be the most important concerns for bio--logistics. It is clear that biologistics has been using data analytics and web--services to deliver products. Given the multi--factorial and heterogenous nature of data profile and requirements, it seems feasible to combine ideas from big data analytics (BDA) and Internet of Things (IoT) to design more efficient and scalable bio--logistics supply chain.

Aim: We propose to perform feasibility study on how to combine concepts from big data analytics to design optimal packaging and flexible routes. This study will consider publicly available data produced by bio--logistic infrastructures/companies to create data profile that include weather data, customer requirements and other domain specific factors. Big Data Analytics will learn the representations (optimal route with alternates (should there be any need to change) and provide real--time update through IoT for changes in delivery routes/maintain shipping requirements. In particular:

1. Big data analytics will learn the flexible routes by considering the destination, the designated route, historical data, weather forecast among other factors and will optimize the use of coolant. It will also enable optimal routing strategy that would also suggest alternatives to ensure timely delivery while maintaining the customer requirements from source to the destination.
2. We will adopt best practices from the Internet of Things (IoT) to ensure real--time update to improve tracability (for the customer and the shipper) as simpler visualization to enable timely decision making or adapt strategy that will ensure timely delivery.

There might be a few other avenues of using big data – considering the risk tolerance of the users and types of biomaterials, we can categorize the packages into optimal clusters or predetermined classes. **We intend to do feasibility study of the idea on a publicly available supply chain data, gather information and techniques that are suitable for the profile of the big data in biologistic and requirements from customer. If successful, we plan to do pilot study with**
Shipping companies like FedEx/ UPS to test our ideas on a more realistic setup.
Adopting Tensor Flow for Big Data Analytics and Internet of Things for Biologistics

Since 2011, The Google Brain project has been exploring the use of very--large--scale deep neural networks, both for research as well as product development. Over the time the Google team has developed set of deep learning tools and architecture to for Big Data analytics. A number of tools (such as DistBelief -- first--generation scalable distributed training and inference system [7] for unsupervised learning;; language representation [3], models for image classification and object detection [4], video classification [5], speech recognition [6]) were developed the team and used for Google Search [2], advertising products, Google Photos [8], Google Maps and StreetView [9], Google Translate [10], YouTube, and many others. The Pi Dr. Yeasin has been using this suit of technologies to characterize emotions, learn models non--verbal communications and provide assistive technology solutions to people who are blind or visually impaired. The PI's interdisciplinary research background and interest is driving motivation to study the cross road where big data analytics meets the Internet of Things in Biologistics.

Reference:

1. CLINICAL TRIAL OUTSOURCING, Industry Report Compiled by Pharma for the BioLogistics Conference
2. Jack Clark. Google turning its lucrative web search over to AI machines, 2015. www.bloomberg.com/news/articles/2015-10-26/googleturning-its-lucrative-web-searchover-to-ai-machines.
3. Tomas Mikolov, Kai Chen, Greg Corrado, and Jeffrey Dean. Efficient estimation of word representations in vector space. In International Conference on Learning Representations: Workshops Track, 2013. arxiv.org/abs/1301.3781.
4. Christian Szegedy, Wei Liu, Yangqing Jia, Pierre Sermanet, Scott Reed, Dragomir Anguelov, Dumitru Erhan, Vincent Vanhoucke, and Andrew Rabinovich. Going deeper with convolutions. In CVPR'2015, 2015. arxiv.org/abs/1409.4842.
5. Andrej Karpathy, George Toderici, Sachin Shetty, Tommy Leung, Rahul Sukthankar, and Li FeiFei. Large-scale video classification with convolutional neural networks. In Computer Vision and Pattern Recognition (CVPR), 2014 IEEE Conference on, pages 1725–1732. IEEE, 2014. research.google.com/pubs/archive/42455.pdf.
6. Matthew D. Zeiler, Marc'Aurelio Ranzato, Rajat Monga, Mark Mao, Ke Yang, Quoc Le, Patrick Nguyen, Andrew Senior, Vincent Vanhoucke, Jeff Dean, and Geoffrey E. Hinton. On rectified linear units for speech processing. In ICASSP, 2013. research.google.com/pubs/archive/40811.pdf.
7. Jeffrey Dean, Gregory S. Corrado, Rajat Monga, Kai Chen, Matthieu Devin, Quoc V. Le, Mark Z. Mao, Marc'Aurelio Ranzato, Andrew Senior, Paul Tucker, 17 Ke Yang, and Andrew Y. Ng. Large scale distributed deep networks. In NIPS, 2012. Google Research PDF.

8. Chuck Rosenberg. Improving Photo Search: A step across the semantic gap, 2013. googleresearch.blogspot.com/2013/06/improvingphoto-search-step-across.html.
9. Ian J. Goodfellow, Yaroslav Bulatov, Julian Ibarz, Sacha Arnoud, and Vinay Shet. Multidigit number recognition from Street View imagery using deep convolutional neural networks. In International Conference on Learning Representations, 2014. arxiv.org/pdf/1312.6082.
10. Otavio Good. How Google Translate squeezes deep learning onto a phone, 2015. googleresearch.blogspot.com/2015/07/how-googletranslate-squeezes-deep.html.