"FiRE will help identify rare cells involved in cancer drug resistance"

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By : Rahul Koul - January 12, 2019

Detection of rare cells is an important problem because some of the critical tumor and diseases conform to rare cell types only. It is difficult to detect them because they are very small in number in the human body. Despite low abundance, rare cell populations play an important role in determining the progression/development of diseases like cancer, mediating immune responses, angiogenesis in cancer and other diseases, etc.

Traditionally, a truly rare cell type can only be found by profiling several thousands of cells, which takes a lot of time. While technological advances over the past years have enabled us to perform ultra high-throughput single-cell experiments, scalable methods for rare cell detection are nearly non-existent.

Now Dr Debarka Sengupta's team at the Indraprastha Institute of Information Technology (IIIT) New Delhi has designed FiRE (Finder of Rare Entities), a software solution that can detect rare cell types at a very fast speed. Sengupta lab led by Dr Debarka is one of the leading research groups in the field of single-cell genomics. His collaboration with Prof Jayadeva's group at IIT Delhi led to this work, which they used to discover a new cell type in

mouse brain. Aashi Jindal and Prashant Gupta, PH.D. students from IIT Delhi steered the study for nearly a year before it got published. Availability of such a solution can have a significant impact on the faster discovery of these cells, thereby enabling effective diagnosis.

Sengupta lab has published FiRE, an ultra-fast anomaly detection algorithm for big data. The algorithm helped discover a new cell type in mouse brain. This work tops the list of high-impact-factor computational biology publications by Indian authors.

In an exclusive interaction with the BioVoice, Dr Debarka Sengupta, Assistant Professor, Computational Biology at IIIT-Delhi explains the novelty and significance of the software solution for detecting rare cells developed by his team. Read on:

Please tell us the idea and motivation behind your novel research work? Were there any challenges?

Recent technological advances have enabled the production of large-scale single-cell expression data. However, currently, there is no computational method to discover rare cells from such voluminous data. We developed the first of its kind rare cell detection algorithm (FiRE) for ultra-large single cell expression data. This paved the way for the discovery of a rare subtype of pars tuber cells in the brain, which is linked to pituitary development. This can also be used in finding rare cancer cells which are resistant to drugs.

The biggest challenge was statistical algorithms because for finding rare entities these were unbearably slow. So, to overcome this challenge, we have used a novel hashing technique that helps find out rare cells in a fraction of seconds.

When did the project begun, what was the time duration and how much was the funding support? Are you looking at patenting the algorithm?

The project began almost a year ago as part of an ongoing collaboration between Jayadeva's lab at IIT Delhi and Sengupta lab at IIIT Delhi. As Debarka Sengupta is an INSPIRE faculty awardee, the project was primarily funded by his INSPIRE project grant given by DST. Regarding the IPR, we have already applied for getting patent against FiRE algorithm in India. We are also planning to protect this Software Solution in overseas countries as well.

Dr Debarka Sengupta (3rd from left) with his team. Dr Sengupta received his Ph.D. in Computer Sc. and Engineering from Jadavpur University. Afterwards, he spent two and half years as a postdoctoral research fellow at the Genome Institute of Singapore. Before joining IIIT-D he spent a short sting at Machine Intelligence Unit of Indian Statistical Institute as a INSPIRE faculty. Debarka started his professional career as a software engineer working for Infosys and then IBM.

What is the long-term significance of Finder of Rare Entities (FiRE) algorithm?

The algorithm will help scientists leverage large-scale single-cell experiments for finding previously unobserved cell types. It has already helped us study heterogeneity in dendritic cells in human blood beside the discovery of the new brain cell type. It will help identify rare cells involved in cancer drug resistance etc. In fact, the same algorithm can be used for detecting rare particles from large hadron collider based experiments.

What is the current status of the project and where is it headed to? Is it possible to commercialize it by collaboration with industry?

The project is the post-development stage, and we are working with companies abroad to commercialize it. It has already topped the list of high-impact-factor computational biology publications by Indian authors.

How did the collaboration with Prof Jaydeva's Lab help the research work? Please explain the context of joint efforts?

Sengupta lab is a pioneer in building machine learning and big data algorithms for big biological data whereas Jayadeva Group is known for their expertise in the machine learning community. We have co-developed this unique software solution using our vast experience in solving academic and industrial problems.

How do you view the computational biology/bioinformatics trends in India and globally?

India is still lagging in computational biology research. To the best of my knowledge, this is so far the first computational biology paper published by all Indian authors in a Nature series journal. This will definitely boost our global prestige and inspire young researchers to study more this rare subject.