Opinion

Bioinformatics progress in Iran: an interview

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1- Please present us a summarized background about yourself.

I am a Ph.D. in biotechnology at university of Tehran. In fact, I just finished my M.Sc. in this program. Then, I studied Bioinformatics at the Max Planck Institute for Molecular Genetics in Berlin. After finishing my doctoral studies, I returned to Iran.

2- Would you please tell us about your research interests and achievements?

Well, my research interest is mainly focused on the analysis on the metabolic networks. Metabolism is one of the most important parts of the cell biochemical machinery. Actually, metabolism is directly related to the state of the cell, for example, whether it is healthy or diseased. Therefore, if you understand metabolism you may understand the mechanism of certain diseases. For instance, at the moment there is a major focus on the metabolism of cancer cells. It is believed that if you want to restrict the growth of cancer cells, the best option would be to attack the cancerous metabolism, which is considerably different from the metabolism of normal cells. So, if you can block, specifically, the metabolism of cancer cells and not normal cells, you can actually move toward curing cancer.

3- How is the status of educational and research condition in your field of interests in Iran compared to the developed countries?

I would say my research interest is related to computational biology and systems biology. Computational biology includes very

different fields like molecular modeling, protein structure analysis and protein-drug interactions.

My current research focus is on systems biology, which is basically about the analysis of molecular networks. For example, in a metabolic network, we take into account how every metabolite is linked to other metabolites, and how each reaction converts a certain set of reactants to another set of products. In systems biology, you typically get this network structure as the input, and then, predict whether the network can perform a certain task.

Analysis of such networks needs a totally different field of science, namely systems science, which presents a holistic view of the system. That is, the components of a system might not be important, but the interaction between them can be the most important thing and can determine the system-level behavior.

Systems biology is the current trend in the last 20 years, with an increasing number of researchers are involved in the field and several journals are devoted to this topics. Unfortunately, I would say systems biology in Iran is currently only a name, with no strong roots. It is not developed, I think, because this field of science is very interdisciplinary. That is, it requires computer science, physics, biology, and mathematics and so on, all combined together with a holistic view. We do not have this kind of inter and transdisciplinary training in Iran. Furthermore, scientific research groups basically are focused on highly-specialized practical problems like developing a cure to a certain disease.

4- What we should do to improve our level of education and research in Iran?

I would say the system should be revised completely. At the moment you just have specialized teachings. For example, suppose that, as a lecturer, you want to teach mathematics. So, you present your lectures based on a certain predefined book. In the best situation you also have tutorials, and you solve some problems for the student. Then, at the end, the students are supposed to be able to reproduce the solution of the known problems in the final exam. In descriptive fields like biology the situation is much worse, because the students are supposed to only memorize all and every single point written in the textbooks or in the lecture notes. So, I would argue that creativity of a student is not stimulated in the situation. So, an average student does not deeply understand the topic of the study, as they just memorize the details in order to get good grades. When they grow up and they become

scientist, they don't have creativity yet. So our average researcher tries to "mimic" the research that is done in their field to publish papers. As long as it works, which means that there are some papers, nobody would complain about it. It is always possible to do outmoded research on less-important topics and get it published in inferior journals, and the research evaluation system still believes that you are doing research. If you go to prestigious high impact factor journals, it is not possible to just mimic and repeat the previously published experiments. Having creativity is a must. You have to introduce original questions. But this ability is not developed in our students from the very first years of their education.

5- How do you see the trend in field of bioinformatics in the next ten years in the world?

In the next ten years, I would expect a rapid expansion of bioinformatics. In the last ten or fifteen years, the main problem in molecular biology was to produce big data or molecular "omics" data. But now, we have tons of data, most of which are publicly available. So, you have to go through them and try to understand their meaning and uncover the link between these data and the underlying biochemical mechanisms. Now, the point is that you have to extract knowledge from the available unprocessed data. The raw data is not interpretable until you understand the links between the details of the data. For this, you need automatic tools to go through this kind of huge data, for example the gene expression data, and extract the valuable information that interprets the data, for example explains a complex disease mechanism.

I guess we do not need much more experimental tests at the moment. After having appropriate mechanistic models, a limited set of experiments, if any, might be necessary to understand the ambiguous parts of the mechanism.

6- What is your vision about the position of Iran in the bioinformatics in next years?

Personally, I am not very much optimistic about it, because the trend is not improving at the moment. We actually did not recognize bioinformatics as an interdisciplinary field. Typically, biology students do not have bioinformatics in their studies. In the best situation, they may have bioinformatics as a selective courses. So, the majority of biology students never really understand what bioinformatics dose for them. When they start research, they are not very familiar with the logic behind the tools. Biologists, in general, use certain tools, like BLAST, for doing research, almost always with the default parameter setting. Biology

researchers are rarely trained to understand and adjust the tools for their application.

Unfortunately, the situation is not better in the computer science side. The average computer science students do not really encounter biology in their studies. Biology and computer science are dealt with as two completely separate things. So, the problems continues, as the science policy makers do not really believe that inherently interdisciplinary fields like bioinformatics are necessary, not only as independent fields of study, but also to train biology students with transdisciplinary insight.

7- What activities should be done in order to bring the informatics finding and researches to play a role in economic and industrial fields?

At the very first, you have to understand the potential of informatics, and then you can simply convince the corresponding industry or research institute about their usefulness. At the moment, health science is becoming more and more dependent on informatics. For example just consider remote surgery. In remote surgery you have robots that are linked to doctor and the operation can be done from a long distance. So, In this case, electronics and computer science play very important roles in telemedicine. On the other hand, artificial intelligence has recently proven to be very useful for diagnostics. If one is not familiar with the importance of these advances in medical sciences, it is natural to question the importance, and even the relevance, of computer science for medical student. Just like now. You may have a look at the medicine, dentistry or pharmacy curriculums to believe that computer science is absolutely avoided there. In contrast, there is increasing investments on medical informatics worldwide. So, if we really understand the trend, we would immediately realize that informatics and computational biology are relevant for treating health issues.

8- In order to make a good progress; how much money should be injected in science in Iran or a similar country?

If you consider only classical basic research, you may probably need computers for doing simulations and or things like this. But if you really like to have infrastructures for doing research and for developing new techniques, you certainly need much more. You may, for example, need high-performance computing architecture. Full-time computer and theoretical scientists are also to be hired and paid. In conclusion, there must be some kind of defined policy or national program that considers these subjects as a national priority and then spend money on it.

For seriously developing computational biology, not only we need to train researchers in multidisciplinary fields like bioinformatics, but also it is necessary to integrate mathematical and computational material into biomedical and biological studies.

For doing such a nationwide program, we certainly need a specific budget. In basic science we typically rely on the governmental funds, but in general, there must be some science-based start-ups that find new ways to develop technologies that practically result in making money and providing new services. This might be related to diagnostics, to developing cures for diseases, to public health and so on. So, basically, application of computers in biology and medicine can, directly or indirectly, result in wealth creation. In conclusion, both you need governmental funding to support basic sciences, you can also rely on the investment of private sector to develop new technologies.

9- Where that money should come from?

Well, as far as I know, it basically the same. Part of the money comes from the governmental fund. While the private sector has its own investments, the government supports fundamental research, which might be far from being applied yet. The private sector is mostly focused on the new technologies and new drugs that can be directly used in clinic, and I would say, the private sector is really active in the developed countries. The entrepreneurs have realized that science can make money, but it does not mean that the governmental support is nonexistent.

10- What are the present templates for the source and amount (%GDP) of research money in the developing countries?

Apart from the private sector, even the governmental investments can immediately be converted to money. Just suppose that vaccination in a country is not effectively done. So, what will happen? The public health situation may worsen in a few years, and then, the government has to pay much more money to help the affected people. In order to prevent this, it is much easier to spend on vaccination. I would say that funding this kind of research, especially in basic science, can be more or less like an investment. It is wrong, and I would say insulting, to consider it as just wasting public money on nonsense.

11- What is your recommendation to bioinformatics students?

Bioinformatics students should recognize their situation to their world. Today, we have

a huge amount of publically available data that are yet to be analyzed. There is a big gap between the analyzed and well-understood data and the raw data. A bioinformatics researcher can play an important role in fixing this gap. They should consider the importance of their field and really focus on interdisciplinary education, to be effective both on the biomedical side and the computational side. On the other hand, I strongly recommend biology and medical students not to remain simple bioinformatics end users. I invite them to push themselves to learn more about the mathematics and computer science behind algorithms. On the other hand, I urge the informatics students to study the language and the methodology of biology and biomedicine. In conclusion, I invite them to pay attention to the biology.