CarMa

SEPTEMBER 2021

Foreword

CarMa is SDC's biannual flagship magazine, which is primarily aimed at guiding undergraduate students of all disciplines towards choosing suitable careers after graduation. The first issue was published in 2017, and since then, there have been 5 subsequent issues. The magazine focuses on providing valuable information to undergraduate students and insights into various career prospects such as internships and jobs in academia and industry.

It features several interesting articles on career building, internship experiences, opportunities in different fields, etc. In particular, a staple and popular article is "Alumni Accounts", which features conversations of the SDC with IISERB alumni, in which they share their experiences at IISER Bhopal and how it has helped them shape their careers. This edition of the magazine also features several exciting and informative articles for the greater benefit of the students.

On a personal front, it has been a very pleasant and rewarding experience for me working with the SDC these past two years. We hope that our association will continue into the future as we strive to extend the best opportunities and guidance to our aspiring students.

Dr. Kashyap Rajeevsarathy

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Entrepreneurship in Science

People who become entrepreneurs generally have two qualities - they are curious and they are daring - and well, scientists are exactly that. Science entrepreneurship is a major source of scientific advancement as well as a mechanism for gaining personal wealth. Some view it as a good thing that will drive new scientific discoveries while some worry about its effect on the pursuit of pure science. Either way, science entrepreneurship is here to stay.

Entrepreneurship in science is typically born in one of two ways. Sometimes a business venture comes into being when a scientist makes a discovery that could be made into something marketable. The other alternative is when someone recognizes a market need and builds a venture to exploit that opening. In the latter, the individual usually has some exposure to science, either through association with scientists or a previous job in a related industry, which allows them to identify opportunities to start profitable ventures. However, they are not the scientists who will be discovering or inventing the technology.

A paper by Shreefal Mehta (hyperlink) terms the former type of entrepreneur as a 'technopreneur' and the latter as a 'market perceiver'. "The technopreneur brings an internal approach to the new venture (a

technology push), whereas the market perceiver uses an external path (a market pull) to technological entrepreneurship. The former model can be viewed as a hammer hunting for a nail (a technology looking for an appropriate market need), whereas the latter is akin to a nail sticking up. As distinct as these two approaches are, there is clearly some mix of the two that occurs in startup processes, as presented in the case studies here and in other recent studies of this phenomenon, which can be summed up as 'hammer-nail co-development.'"

Venture stage	Market perceiver	Technopreneur
Recognize opportunity	**HAS:** A comprehensive knowledge of markets. Clear definition of product characteristics that are needed. **NEEDS:** To find appropriate technology to meet the market's specific needs.	**HAS:** A solid understanding of and expertise in specific, well-characterized technology. Established credibility with peers, investors and customers (academic researchers, biotechs or big pharma). **NEEDS:** To confirm that there is a market for the product. To define product characteristics.
Secure IP[a] rights	**HAS:** A clear understanding of the market application, so IP claims can be formulated easily. **NEEDS:** To comprehensively harvest IP portfolio.	**HAS:** A strong position to easily license his/her own invention from the university into the startup. **NEEDS:** To erase any perceived conflict of interest that may arise by being on both sides of license negotiation, as academic inventor and employee and company executive. An understanding of future IP needs; the inventor often overestimates the novelty of the invention and breadth of patent protection.
Fund team and build company	**HAS:** Business credibility in creating sound commercialization and business plan with clear market needs. **NEEDS:** To carefully evaluate timeline for technology development, balancing the attraction of large markets with a plan for growth as technology matures. Strong history of experience to overcome credibility gap if technology is licensed in without inventor participation.	**HAS:** Strength in early phases of company, where main efforts are on research and most of the personnel are technically oriented. Credibility with investors due to technical expertise. **NEEDS:** To manage investors' questions in business and commercial areas. To learn how to manage nonscientists.
Develop technology to product	**HAS:** An external perspective that brings a strong product-focus to the development process. Focus on scaling up production to commercial manufacturing levels, market acceptance and regulatory acceptance. **NEEDS:** Understanding of the transition from R&D to commercial manufacture—to manage technopreneur's expectations.	**NEEDS:** Experience of commercial product development, particularly issues in scaling up. Unbiased perspective to evaluate the technology's realistic potential versus its elegance.
Survive	**HAS:** Sensitivity to the needs of the business and finances so as to strategize and manage IP assets astutely.	**NEEDS:** To understand that his or her appropriate position within growing company may not be at the helm, but in a specific technical leadership position, such as CTO, CSO or on the Scientific Advisory Board.
Market	**HAS:** Ability to deliver the market potential message to multiple stakeholders on their terms, put a commercial team in place and strike appropriate business partnerships.	**NEEDS:** To shift focus from developing technology to building a strong commercial team speedily and efficiently.

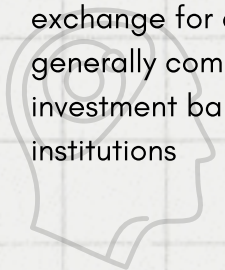
Here, we will focus on the first type of science entrepreneurship. Universities play a large role in cultivating science entrepreneurship. They can provide a playground for potential entrepreneurs in multiple ways. They can encourage participation of students in pre-existing startups that the university is associated with and can cultivate student entrepreneurship through entrepreneurship education. Oftentimes, startups are kicked off from work happening in a university.

When a scientist is looking to start a business venture from a novel discovery, they must first file a disclosure through

the university office and begin discussions with the technology transfer or licensing officer at the university about commercializing the discovery. They will have to write a small business innovation research grant to fund the startup activities, find other interested scientists or business associates to work as collaborators, and license the discovery from the university.

After this, the individual has two choices. They may continue in their university position while developing the company on the side, or leave the academic position (either permanently or temporarily on a leave of absence) to focus on actively pursuing the commercialization of his or her discovery. In the latter case, funding comes from personal funds or angel investors (1) and venture capitalists (2). The venture is launched, typically focused on products, with a business model of forming a fully integrated company.

1- also known as a private investor, seed investor or angel funder, they are wealthy individuals who provide funding for a startup, often in exchange for an ownership stake in the company
2 - a private equity investor that provides capital to startup companies and small businesses exhibiting high long-term growth potential in exchange for an equity stake. Venture capital generally comes from well-off investors, investment banks, and any other financial institutions



New discoveries from university research can lead to the development of many new products that benefit the public. In fact, in the knowledge economy, scientific research and the technological innovation it brings play a big role in the nation's productivity growth.

University spin-offs are also common. These are companies that take and build on technological inventions developed from university research that are likely to remain unexploited otherwise.

New discoveries from university research can lead to the development of many new products that benefit the public. In fact, in the knowledge economy (3), scientific research and the technological innovation it brings play a big role in the nation's productivity growth. However, new products and processes do not come fully formed right from the basic research done in the universities.

3 - a system of consumption and production that is based on the ability to capitalize on scientific discoveries and basic and applied research

They require development, capital, manufacturing capability, and marketing. This is where University Technology Transfer comes in.

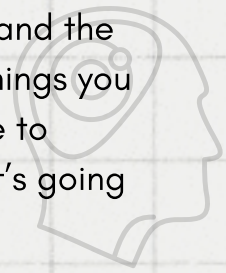
Many universities have Technology Transfer Offices (TTOs) that help researchers in identifying research with potential for commercialization, in acquiring forms of Intellectual Property, and they facilitate licensing.

Universities use the process of technology transfer to push scientific findings to further development and commercialization. Many of the most successful university-industry interactions are based on the education and training of students who have the knowledge and skills to meet industry needs or on relationships that faculty members have developed with particular companies. Many universities have Technology Transfer Offices (TTOs) that help researchers in identifying research with potential for commercialization, in acquiring forms of Intellectual Property, and they facilitate licensing. They also help create awareness about the importance of technology transfer. It is important for students and new scientists to know about the potential of entrepreneurship so that they can consider it an option if it were to present an opportunity.

But turning a novel idea into a business venture is neither easy nor simple. Only around 10% of new entrepreneurs manage to establish a new firm within 1-2 years while the rest fail either due to the lack of a sound business model or due to the realization that their idea itself won't work out. So, there are some important things to keep in mind while trying to build a startup.

Only around 10% of new entrepreneurs manage to establish a new firm within 1-2 years while the rest fail either due to the lack of a sound business model or due to the realization that their idea itself won't work out.

One of the most important traits to learn to become a successful entrepreneur is *self-knowledge* - knowing your own strengths and weaknesses. You should be confident and be humble - have the confidence that you can do it, and the humility to understand all the things you don't know and where you have to create a group around you that's going



to complement your ideas and purposes. There are so many resources nowadays that you can be aware of concepts and processes by reading books and by simply looking around online. Yet you cannot possibly know everything. In an academic career, you have to impress on an individual level and build your own academic track record.

As an entrepreneur, knowing how to collaborate, strategically assemble a team, and understand team dynamics is extremely important; so, learning to have a team attitude is crucial. Moreover, in case of an unforeseen obstacle or failure, a strong, creative team can get back up, learn from the failure, come up with a new idea, and make the next version much better.

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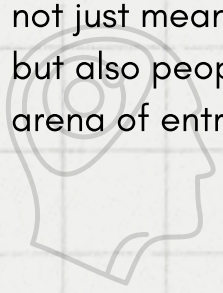
After having a good team, another aspect to focus on is mentors. This does not just mean high-profile professors but also people who have explored the arena of entrepreneurship before.



You must also be willing to listen and learn from them.

While there is great value created by fostering science-based ventures, these companies can tend to take longer to reduce technology risk and require larger amounts of investment capital to scale.

In case of an unforeseen obstacle or failure, a strong, creative team can get back up, learn from the failure, come up with a new idea, and make the next version much better.

All startups will face technology risk, market risk and operational risk. Technology risk means the challenge of building the product, market risk is the risk of being relevant to consumers – whether or not anyone cares once you build it – and operational risk is related to access to talent. Generally, a science-based venture would tend to have a much higher technology risk, and while access to capital will always be challenging, it is more available to companies that have already addressed

their fundamental technical risk. The biggest gap that exists today is the funding for the research that will lead to bridging university labs and the marketplace. But the impact of this funding on the communities that foster them will be long-lived.

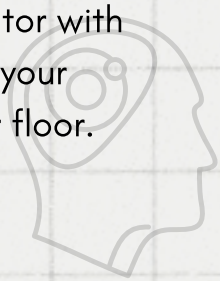
But these smaller ventures have their own advantages. They use capital differently. Their innovative thinking is better. There is a greater zeal to do the killer experiment without politics getting in the way. Ultimately, the whole team owns and has to ensure the survival of a young organization by appropriately betting on the best ideas. That dynamic is what leads to the success stories.

At their core, entrepreneurs and scientists both create and test hypotheses and develop solutions to problems. The challenges faced are paralleled in both career paths, and scientists can adopt aspects of entrepreneurial thinking in their own work.

Even if you aren't interested in building a startup, having an entrepreneurial mindset can be handy for a scientist. At their core, entrepreneurs and scientists both create and test hypotheses and develop solutions to problems. The challenges faced are also paralleled in both career paths, and scientists can adopt some aspects of entrepreneurial thinking in their own work.

In business, a value proposition is a short sentence that encompasses three main points: what the product/service is, who the target customers are, and the value the business will provide to these customers. This helps communicate the value of a company to its customers and investors. Scientists, of course, do not have customers but they can use the framework to describe their research, whom it affects, and the impact of their findings when communicating with colleagues and stakeholders.

Another technique in business is an elevator pitch - a short (approximately 30 seconds) description of a business in plain language. It aims to pique the interest of your audience while conveying the key components of your value proposition. The name comes from a scenario of being in an elevator with someone and trying to explain your business before you reach your floor. Scientists can use the elevator



pitch for communicating their research and its importance while networking at conferences and other forums to market their skills and promote their work.

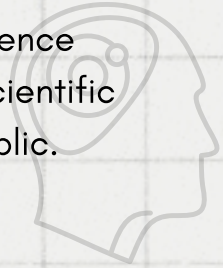
Most scientific research requires significant amounts of funding, crowdfunding platforms can be used to fund smaller-scale experiments, purchase a new piece of equipment, etc

Crowdsourcing is the method of completing a substantial task by using the combined effort of many people working on smaller, individual tasks and is also common to both parties. For example, entrepreneurs use hackathons, where a group of computer developers (who may even get recruited) come together for a weekend to create an application and scientists use it to compile large amounts of data over vast geographic areas, which they otherwise could not accomplish on their own (like Ebird, a website that lets birders and citizen scientists all over the world list species they have spotted with photographs and locations).

We also have crowdfunding, the practice of funding a project or venture by raising small amounts of money from many individuals, often via the internet.

This is very popular for entrepreneurs but is a fairly new tool in the scientific community. Experiment and SciFund are examples of online crowdfunding platforms specifically for scientific research. While most scientific research requires significant amounts of funding, crowdfunding platforms can be used to fund smaller-scale experiments, purchase a new piece of equipment, or cover travel costs to a conference or research site.

Crowdfunding involves promotion on social media - another tool that is becoming greatly helpful to both entrepreneurs and scientists. Entrepreneurs use social media platforms to spread the word about their business to targeted markets. Similarly, scientists use social media to promote their research among peers, stakeholders, and the public. Scientists can use themed hashtags to stimulate dialogue (e.g., #ActualLivingScientist and #ILookLikeAnEngineer). These tools also can also help promote science communication and improve scientific literacy among the general public.



Though they may appear very different from the surface, science and entrepreneurship have a lot of common ground. These common skills can be used to improve yourself as an academician or can help you adjust to an entrepreneurial career. As science entrepreneurship helps drive scientific thinking and innovation to the market and ultimately to the people and success stories become more heard of, it is safe to say that entrepreneurship in science is slowly making its way into emerging as a potent career for young students with creative minds.

Sampurna Roychoudhury

References:
https://www.nature.com/articles/bioent831
https://www.sciencemag.org/custom-publishing/webinars/money-matters-science-entrepreneurship
https://link.springer.com/article/10.1007/s11365-019-00623-3
https://armoneyandpolitics.com/importance-science-entrepreneurship/
https://wyss.harvard.edu/news/the-key-to-successful-entrepreneurship-in-the-life-sciences/
http://blog.cdnsciencepub.com/science-and-entrepreneurship-different-careers-common-ground/

Author's Note

Every individual has a fire within them that comes out in different ways for different people. When this fire is expressed as an ambition to bring something new into the world, it mustn't be ignored no matter how unconventional it may seem. Armed with the proper skill-set, stepping into the world of entrepreneurship may bring you and your ideas to great heights. So go for it, don't let your dreams be dreams

Effects of the Covid-19 on R & D

The COVID-19 outbreak proved to be a challenging situation for individuals in every professional sphere. Apart from amplifying people's anxieties about the uncertainty of the imminent future and putting quite everything to a standstill, this pandemic taught us how to bounce back into action with an altered protocol of general affairs. The research works of people in the scientific community were disrupted with concerns regarding the time delay, career prospects, research funding and restricted access to labs. Yet, in such difficult times, scientists and researchers around the globe came to the forefront and played a major role in analysing the virus's characteristics and providing solutions for its mitigation.

In this interview, Mr Hemant Kulkarni talks about the inevitable impact of the COVID-19 pandemic on the R & D industry, the challenges it posed for the scientific community, and their response to such an unprecedented outbreak.

Mr Hemant Kulkarni is a versatile scientist with over 20 years of experience, currently working at the Council of Scientific & Industrial Research (CSIR), New Delhi.

What is your field of expertise and how did COVID affect your work?

I have done my studies in the field of Biotechnology and Biomedical Engineering before moving to Consulting and Project Finance. Currently, I am part of the Technology Management Directorate at CSIR that looks after the management of industry-linked projects and programmes. Also, the other part of my portfolio includes activities that support researchers and institutions to organise and participate in scientific events.

Do you think there was a giant leap for the scientific community due to the current state?

COVID-19 has brought about a paradigm shift world over, both in terms of areas of research and the way it is carried out. Since early 2020, the pandemic necessitated re-evaluating priority areas and focusing on the development of products and solutions for the COVID-19 mitigation being faced by the country. These included both pre-and post-covid management, rapid diagnostics for COVID-19, setting up of makeshift hospitals, oxygen-enrichment units, vaccines and medicines etc.

The entire machinery of various scientific departments, universities, health sectors, and industry worked together as one team to develop and deploy solutions in a very short time which was unprecedented. This experience has primed the research community to be prepared for emergencies and work in a virtual mode which was uncommon. Other areas that saw a big leap include - large scale networking in rather a massive mode, use of AI, data mining, analytics and other IT tools.

Various scientific departments, universities, health sectors, and industry worked together as one team to develop and deploy solutions in a very short time which was unprecedented.

One major aspect of these unprecedented outbreaks that we should realise is the suddenness of the unknown challenges it throws out.

Many things are novel and unpredictable for us since we do not know how a population might get affected, how long the issue will sustain, or how it will affect different communities with different genetic makeups.

So basically, to theorise about any entity or its effects, we must have long term data. This was missing considerably in the case of SARS-CoV-2. We had limited theses from various laboratories based on which we had to - and did make - progress. So, this makes this situation more of an *opportunity* for the scientific community than a giant leap. Today we have the COVID-19 pandemic, but something entirely different might come up in the future.

Lockdown necessitated the use of online tools, automation of processes for all possible spheres of research activities.

What was the standard approach followed by the researchers worldwide since there was a period of lockdown resulting in the loss of time?
If we look at the scientific activities - like the implementation of research projects, conferences, panel meetings, collaborations and experimentations - they mostly happen in a physical environment. People need to move from one lab to another to carry out various experiments, analyse data and collaborate with others. Lockdown necessitated the use of online tools, automation of processes for all possible spheres of research activities. Physical interactions, movement of scientists across labs, barring a few exceptions, came to a standstill. This created an opportunity for the IT sector which quickly developed various useful platforms with virtual communication/documentation tools for collaboration and provided analytics tools on a massive scale that were not heard of earlier. These greatly facilitated networking amongst the research fraternity. One could connect with anyone else, thereby contributing to the ease of doing research.

There was a disruption in the research works of the scientific community, where hands-on experimentations are essential. How did the scientists and researchers cope with that?
Unprecedented times call for out-of-the-box thinking and solutions. This pandemic saw the emergence and execution of innovative ideas and tools for collaboration and communication, including the use of social media. All the work shifted to a virtual mode, and that became the basis for the general working of all scientists.
Since the priority in every aspect was to combat the COVID-19, whatever projects were addressing the pandemic got a boost. Apart from

being worried about the completion of projects and carrying out their previous research, there were concerns about job security, meeting deadlines, etc.

Did the COVID-19 affect the previously ongoing projects? How did the scientists reorient their work with regard to this?

Majorly, yes. As we know, a majority of the funding for research projects comes from the government. During the pandemic, governments worldwide had to allocate a significant amount of funds towards the COVID-19 mitigation measures, for example, testing, vaccinations, medical infrastructure, awareness, etc. This was very well supported by researchers who reoriented their research to aid the COVID-19-related work.

At CSIR, for instance, many of us were involved in providing support to the ongoing COVID-19 projects in different forms such as networking, communication/outreach, providing an interface for the stakeholders, such as line ministries, municipal corporations. The point is, all worked as a team; the team had to reorient itself and refocus its priorities to COVID-19 concerning areas.

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Can there be any comparison of the effects of the COVID-19 pandemic on the scientific works in India and other countries?

On broader terms- no. COVID-19 has hit everyone and all spheres of activities- economic or social- equally and hard. The countries that implemented the mitigation measures early were better off, while others faced greater and grievous challenges. I must add here, India's research work and advancements in science in these recent times were really fruitful. We executed impactful steps and imposed various measures because of which the spread of COVID-19 could be contained.

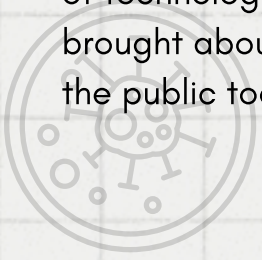
To tackle this pandemic, how did the advancement of technology help?

Due to the current times, the rapid advancement in technology was a game-changer. The invention of digital and molecular surveillance assisted the scientists to analyse the variants, mutations and responses of the SARS-CoV-2.

It helped in the study of how the virus could change its domain and how it impacted the population. Then, the development and analysis of novel drugs as well as repurposed drugs and their target mechanism could be evaluated.

The need for online platforms to serve as a medium of communication led to a spurt in the use of various online tools.

So, technology facilitated the chemistry field like drug discovery and modification of repurposed drugs to combat the COVID-19. Basically, the IT sector enabled us with sensors, AI and other technologies useful for screening, surveillance and diagnostics during this crisis. There was also a growth in the development and production of hospital assistive devices and PPEs, such as ventilators, oxygen-enrichment units, testing kits, etc.
The IT-enabled interventions in production processes, supply chain and logistics systems were more efficient due to technology. Furthermore, the introduction of technology-driven surveillance systems brought about a behavioural change in the public too.



Sustainable development and care for the environment became even more relevant in these times and hence, the use of technology was expanded to manage, reuse, and recycle the waste due to the pandemic.

The technology sector was already expanding, but did this pandemic give an extra boost to it?
Indeed, it happens to be so. Apart from communication and educational platforms, the technology in the medical field advanced significantly within a short period. Rapid diagnostic technologies improved as well. The need for online platforms to serve as a medium of communication led to a spurt in the use of various online tools. Even for diagnostics, different technologies came into the picture. For instance, we have introduced FELUDA, NGS - based systems that are rapid diagnostic tests for COVID-19 detection. Almost all strategies to curb the COVID-19 transmission and monitor the spread in an area had a technology-driven approach. So, in every sphere of our lives, technology has had an effect. As stated earlier, the manufacturing of hospital assistive devices and units requires components and skill sets that are available in our country, so, obviously, it got a boost. These kinds of technological interventions led to a massive jump in this sector.

Has this pandemic transformed India's scientific landscape, thereby strengthening it?

Yes, this pandemic has reinvigorated India's scientific landscape such that, in the current scenario, the research works and outputs of the COVID-19 related projects in India were overwhelming. But at the same time, it has critically affected and left behind certain other areas which require an equal boost for India to become 'aatmnirbhar' (self-reliant) and be at par with the leading nations. As is evident, many areas that were not associated with the COVID-19 have taken a beating to the extent that the earlier projects that were undertaken and progressing were put on hold or could not be implemented due to the uncertainty of lockdown periods. Similarly, many development projects in various industries could not be undertaken at that moment as the market was not ripe.

So, to answer your question- yes, we have gotten ahead now more than before. But, sustainability and holistic progress of other areas while adopting the 'aatmnirbhar' outlook are also important.

Is there any positive change in the public view of science?

Yes, there was a positive change in the public view since this is a matter of concern for everybody. I think people have become more aware - out of compulsion in a moment of need.

But having said that, this kind of awareness has not reached every nook and corner. For instance, we still find people without masks in various regions aggregating in large numbers and disregarding other protocols. So, the awareness is sporadic. When people are engrossed with the discoveries of this virus, they follow the protocols and act responsibly. But say, after a few months, by human tendency, they want some respite and hence, go out while ignoring the guidelines issued by authorities.

People have become more aware - out of compulsion in a moment of need.

Since there's a contributing factor of fright and panic, people want a lucid solution, an understanding of whether they will be affected anyway and the medication technologies that will be needed.

This is where the main concern of the Indian government and other concerned institutes lies. And, due to this, we don't exactly know when the third wave will hit. Thus, as responsible people, we should ensure that we stick to those minimum necessary protocols, or else we will not be able to contain the disease entirely soon.

The critical impact of COVID-19 on every apparently stable system was evident. Every person in the population had to face the drastic consequences of this pandemic in some way or the other. Though everything else came to a standstill, science kept advancing. A significant period of essential time ebbed away for researchers due to lockdown periods and various restrictions, leading to disruption in their research projects. Several organisational processes and global collaborative projects were hampered due to the pandemic - making many things for the people uncertain.

Also, the mitigation of the COVID-19 pandemic was a challenging task. Yet, the cumulative efforts of scientists from different fields to tackle this pandemic, despite their antecedent projects and protocol restrictions, proved the perseverance and consistency of the scientific community.

The invention and accessibility of rapid diagnostics tests and various repurposed drugs gave way to a new era of medical advancements. The wide use of technological tools, for example - AI, to alleviate the pandemic's effects and various platforms for communication brought about a virtual revolution, making many things quick and accessible to all. But moreover, this pandemic brought about a sense of preparedness for such situations in the future.

There was also the realisation of an urgent need to support various research areas. In this crisis, India emerged to be a major global contributor in many scientific areas, and the advancement in science and technology was applaudable.

Indeed, the skillset in India is a great asset to the nation and needs to be recognised and supported more. Among the chaos the novel coronavirus brought about, it also spiked the interest of the general public in science and research So, preventing such biological catastrophes is not only in the hands of the scientific community and the governing institutions but is also the public's onus.

Poorva Kumari

Author's Note

It is said, "It's the challenges that shape one's purpose." And, in my opinion, this is truly relevant for the scientific community. They prove time and again what it takes to serve not only humans but also humankind, however difficult or unconducive the situation might be. This interview with Mr Hemant Kulkarni was an extraordinary experience for me, and his humility and incisiveness was a significant factor that led to such a great interview. I gained valuable insight into the working of industries and science as a whole, and I hope you - the readers - did too.

Reading Project: A Dialogue

We are science students - exploring, searching, and researching along our way to answer a seemingly simple question, 'How does this happen?'. Yet, despite its elementary nature, answering this question might take you a whole lifetime (or even more than that!). No one becomes a scientist in a day, (GitHub lingo incoming!) it requires you to 'commit' to yourself every single day, 'push' your boundaries, and 'merge' all of it in your 'repository' of knowledge in volume as well as depth. So to accomplish this, why not start early?

Reading Projects have been instrumental in catalyzing the process of learning. Being beginner-friendly, they are a superb way to start your research journey before getting your hands dirty with lab work. To provide a first-hand view on reading projects, we interviewed one of our fellow seniors,

Mr. Raibat Sarker, discussing his experiences, learnings, and outcomes during his two reading projects, Winter-2017 and Summer-2018.

Mr. Raibat Sarker is currently a 5th year Majors student in the Dept. of Chemistry. To name a few of his achievements, he is a recipient of the prestigious DAAD-WISE Virtuell Akademie Fellowship, DAAD-WISE Summer Fellowship, KVPY Fellowship, and was also a part of the award-winning i-GEM - 2020 team of IISERB.

What actually is a Reading Project?

In a reading project, you basically have to read a lot. It also depends on the background you already have; if you are new to some topic, you might have to dig a little deeper. The mentor provides you with books, reference materials, research papers, review papers, etc. Every mentor likes to start with the basics - you might be given standard textbooks to read first for the first two weeks, and then move to review papers, and when you are quite familiar with the concepts, you might choose a specific topic to research or read upon. At the end of it, you have to submit a report or sometimes a presentation for whatever you have learned.

How did you apply for these projects?

In 2017, I was in my first year and didn't know many professors, so I approached one of our professors in the Dept. of Biology, Dr. Neetu Kalra. I told her that I was interested in studying Cancer and described my background in it and she agreed to supervise me over a reading project. Similarly, for the second one, I approached Dr. Abhijit Patra, a professor in the Dept. of Chemistry.

You might be given standard textbooks to read for the first two weeks, then move to review papers, and when you are quite familiar, you might choose a specific topic to research or read upon. At the end of it, you have to submit a report or a presentation for whatever you have learned.

Can you talk about your experience during those projects?

The experiences for both of them were nice in their own ways. I did my first project remotely from my home, in which I learned about Cancer. Being my first project, it gave me a lot of exposure to very new things like reading a paper, report writing, etc. I used to ask my doubts over email, as we didn't have G-Meet in 2017. For the second one, in which I studied Spectroscopy, I stayed on campus for it, so it was a bit more interactive. I used to go to Dr. Patra's lab and talk to Ph.D. students there - they were very helpful. He also had a few other students with me doing a project under him, so we interacted with each other, exchanged ideas, shared views over a certain topic. Every week we had discussion sessions and sometimes he would ask us to prepare

a 'chalk-talk', in which we were asked to explain a concept to everyone. It was a very productive activity which led to quite interesting insights sometimes.

How did you keep a track of your learnings?

For the first project, I used to maintain a notebook to jot down all the learnings, doubts, etc. And for the second one, Sir himself gave us a notebook and told us to fill it completely by the end of the project. It (a notebook) is instrumental in keeping a track of your learnings and also helps you pick up your thoughts quickly from where you left the other day.

What was your approach to reading a research paper?

It is firstly very important to understand the research question that the paper is trying to answer. Then try to understand the background behind the question and look for why the question is important to science or society. When you get a basic understanding of the question, you can move to the procedure, methodologies or whatever experiments they did during the research and then finally read the results and discussions.

You might have encountered several terms which were completely irrelevant to you while you read a research paper, so how did you tackle that problem?

There will always be some terms in the paper which you won't understand, whether you be a 1st-year, 5th-year, or a Ph.D. student, and it is very crucial to understand them properly. I tried to understand such terms by myself by referring to some relevant texts or online material. I also asked my doubts to Ph.D. students in my mentor's lab, and they were very helpful in resolving them. And when I had a big conceptual query, I would go to my mentor. Also, it is a nice experience to discuss the problem with your fellow batchmates since these discussions are very productive sometimes.

I used to maintain a notebook to jot down all the learnings, doubts, etc.

A notebook is instrumental in keeping a track of your learnings and also helps you pick up your thoughts quickly from where you left the other day.

What roles did your concerned mentors play in your project?

As a newbie in research, I got to learn a lot from both my mentors, whether it was how to read a research paper, understanding a new concept, making and presenting a presentation, and whatnot. Discussions were very interesting, they carried the thought forward and it actually gives you an idea of how to think of a single problem from multiple perspectives, which sometimes leads to some even more intriguing questions.

These projects helped to know what the topics entailed and what the different avenues in that field were, which helped me a lot while choosing my research area.

Having done many internships and projects along your way, how did these first-year projects help you in building a base for your further studies?

In the first year, I was exploring stuff. In my case, I wasn't completely sure about what topic I would pursue my research in but had decided on Chemistry as my Major. These projects were quite exploratory for me; I got to know what the topics entailed and what the different avenues in that field were, which helped me a lot while choosing my research area. And it's always better to have a theoretical background before you get your hands dirty with labs. And for IISERB students, you get an idea of what kind of research is going on in the respective labs, which might help you make an informed decision for your MS Thesis.

The output is not always positive. You might get to know an area where you don't want to research, but you do get to learn a lot in it. You can also do a reading project on your own anytime, but having support from a professor always helps.

What suggestion would you give to students who are willing to do a reading project?

My suggestion would be to take up a project, no matter the pandemic situation. Most of the professors are now adapted to online meetings and learning, and you might also have gotten acquainted with going virtual. So professors will be willing to give you projects and guide you.

You will learn new things, concepts and you might also get your original research question. We don't know the situation in the future, but try to make the most out of the available resources.

Would you suggest doing it during the semester?

In a semester with six theory courses, I would rather not. It becomes a bit hectic to manage all the academics and project stuff, especially in online sem. It also depends on the individual, how much they can grasp from both, so it's finally up to you. But you won't know your limits unless you try them out. Go ahead.

We thank Mr. Raibat Sarker for taking out time for this interview and sharing valuable insights. We hope that this interview served its purpose of highlighting the importance of reading projects, giving you a sneak-peek, and most importantly motivating you to take up one yourself! So what are you waiting for, get started with planning your reading project because 'Winter is coming!' (but first, do check out the other articles in this magazine!)

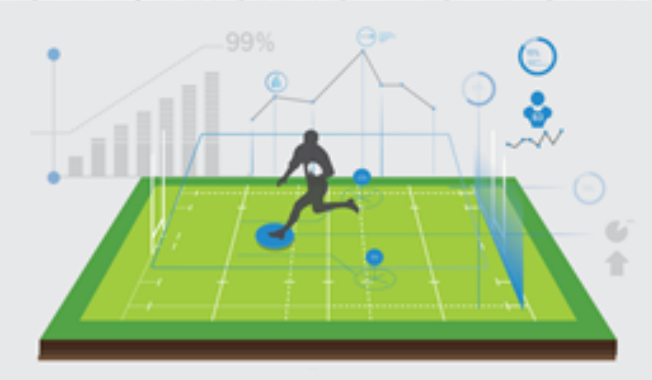
Hardik Kuralkar

Author's Note

Master Oogway once said, "The panda will never fulfill his destiny, nor you yours, until you let go of the illusion of control.", which, if you think deeply enough, is completely irrelevant here. What's relevant is that you should never refrain from exploring a field you like, and opportunities like reading projects will prove beneficial in deciding your career path.

The World of Sports Analytics!

Finding the next Sporting Superstar?



Welcome to the world of Sports Analytics! Do you watch your favourite sports teams and players through an analytical lens pondering on the "Why's" and "How's" after each match? Well, then, this is the place to transform your passion into a career. The practice of using analysis in sports has been around for decades. But recent advances in Data Science and Machine learning have found applications in the sports ecosystem, thus providing beneficial insights to teams and players.

Basically, Sports Analytics uses mathematical and statistical principles coupled with data analysis techniques to analyze various components of the sports industry. These components include player performance in a team and as an individual, recruitment, scouting, tactical analysis, business performance, and more.

The Inception :

To begin with, the term "sports analytics" was popularized in mainstream sports culture following the release of the 2011 movie Moneyball. This movie tells the true story of the 2002 Oakland Athletics manager Billy Beane (played by Brad Pitt), who uses sports analytics to build a successful team with a limited budget. They used specific metrics to acquire undervalued players and make the best use of their talents.

Since then, more and more teams are being receptive to the idea of using data to enhance their performance. Teams and players are willing to receive as much information as possible to gain a competitive edge over their opponents, and nowadays, strategic decisions are no longer taken just based on the "gut feeling" or past traditions.

Before looking at making careers in this field, let us look at a broad classification of areas in sports where analytics is used.

1. Scouting and Team building (finding a perfect fit based on budget, age, style of play, etc.) :

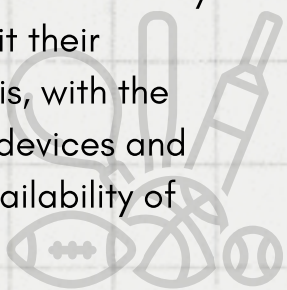
Using data analytics in the early stages of scouting casts a wider net while searching for players, especially by exposing clubs to different leagues and markets which they wouldn't have looked at traditionally. Analysts can perform machine learning techniques such as clustering and statistical analysis based on several essential attributes for players fitting into the team's style and philosophy. These clusters will help identify players having lower financial value but similar impact and skill compared to the popular targets.

As a relevant example, I recall an excerpt from one of the TechTalks on sports analytics organized by the Computing and Networking Council of IISER Bhopal (CNC). In this talk, the speaker, Mr. Arvind Sivdas, spoke about how their team worked with Chennai Super Kings to plan the recruitment strategy before the 2018 IPL auctions. They targeted more experienced players who were in the later stages of their career (hence, not the costliest picks in the auction), such as Shane Watson and Ambati Rayadu, who went on to play crucial roles in CSK's title-winning 2018 season.

Teams and players are willing to receive as much information as possible to gain a competitive edge over their opponents, and nowadays, strategic decisions are no longer taken just based on the "gut feeling" or past traditions.

2. Performance analysis and Pre-match Tactical planning :

Performance analysis and planning include going through video footage of the opponent's past matches to identify patterns of play and exploit their weaknesses. Apart from this, with the vast increase in wearable devices and sensors, there is a large availability of



data from GPS tracking - positional data - as well as health and fitness data. Analysts use this to assist the coaches in optimizing training sessions and creating individual player plans. Although the coach and players make the final choices, data analysts provide them valuable insights, thus enabling a more informed decision.

Not only did the results convince him that he is an integral part of the team, he used this data to leverage a new and improved salary at Manchester City based on his report.

A recent interesting example of analysts influencing player decisions is that of Kevin de Bruyne, currently one of the world's best attacking midfielders in football. Before agreeing to a new four-year contract extension with Manchester City earlier this year, De Bruyne commissioned a data analytics company (Analytics FC) to produce a report analyzing his past, present, and projected future contribution as well as importance in the team. Not only did the results convince him that he is an integral part of the team, he used this data to leverage a new and improved salary at Manchester City based on his worth to the club from the report. Analytics FC founder Jeremy Steele said, "This is the first time a player has hired us to work directly on their behalf. It is an evolution in football, I believe." This example displays the growing importance of analytics in sports and how even players are now realizing the same.

Changing the way we perceive the game :

Apart from the already existing applications in this field, sports analytics is ever-expanding, catalyzed by the development of new AI, ML techniques, computer vision research, and more. Sports analytics is not just restricted to on-field and off-field commercial applications. On the contrary, several academicians from relevant backgrounds are conducting cutting-edge research and discovering novel ideas that change how we perceive the game. To get a flavour of the research happening in sports analytics, check out some of the abstracts from this link.

Now, for a firsthand view of research in this field, I have invited my dear friend and batchmate from IISERB, Praharsh Nanavati, who had presented his idea of "Bowling Partnerships in Cricket" in the Poster presentation at Azim Premji University in Dec 2019. He shall briefly share with us the thought process behind this idea and the analysis techniques he used. So, over to you Praharsh!

A Deeper Dive - Extraa Innings with Praharsh

Bowling partnerships haven't been formally investigated in depth like batting partnerships. Commentators sometimes anecdotally observe that a bowler being economical (saving runs) leads the batsmen to attack the other bowler resulting in them making errors and giving away wickets. This raises the question of whether two bowlers are more effective as a pair with each other, whether that be in saving runs or taking wickets.

A bowler pair consists of two bowlers bowling alternate overs during a match. Deciding which bowler should bowl from which end and when is a crucial decision taken by the captain. Such decisions depend upon a number of complex factors including pitch conditions and assessing the competitor team's strengths and weaknesses.
Therefore a bowling pair can be deemed effective if the pair together saves more runs and/or takes more wickets.

This could happen in three ways:

(i) both the bowlers have improved economies
(ii) both the bowlers take more wickets
(iii) one of them has an improved economy while the other gets more wickets.

Ball-by-ball data was acquired from cricsheet.org which consisted of 2,034 ODIs, 634 Test matches and 1,432 T20Is. We define the number of wickets taken per over as the hitrate of a bowler. To analyse an individual bowler's economy as well as hitrate, we plotted the runs conceded per over and checked if these distributions were normal which wasn't the case. Since the falling of a wicket is a rare event, the distribution of wickets per over for each bowler is not normal either.

We compare two sets for calculating bowlerships.
Set A is the set of overs bowled by the bowler with a specific bowler and the set B consists of overs he bowled with all other bowler partners. Since the data is not normal, we conduct the following 3 tests using the non-parametric Mann-Whitney U test. Mann-Whitney U test is a nonparametric test in statistics. It tests

the null hypothesis that P(X>Y) = P(Y>X) where X,Y values are randomly selected from the population. (Here, H0 is the null hypothesis of the tests)

1. “greater” test:
H0: Individual Economy better than or same as the Bowlership Economy.
2. “two-sided” test:
H0: Individual Economy is same as the Bowlership Economy.
3. “less” test:
H0: Individual Economy is worse or same as the Bowlership Economy.

Similar tests can be conducted for hitrates too.

Based on the results of these three tests, a weighted directed graph can be constructed and analysed which may greatly help in Team Selection and Attack planning.

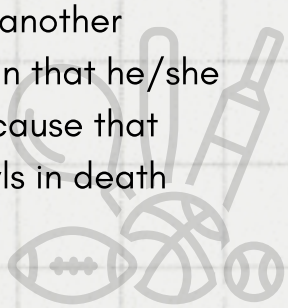
Our results showed that in tests, Jacques Kallis performed well with all other bowler partners. This shows that he is not very dependent on his partner as he has many outgoing edges in the graph. Ravichandran Ashwin too has many outgoing edges implying that he brings out the best in his bowler partners. This is also a very attractive trait. This work can be extended in various directions and shall be exciting to observe!

Thank you!

Careers in Sports Analytics :

Now that we have a fair share of knowledge about what happens in sports analytics, let us look at how can one go about making a career in it :

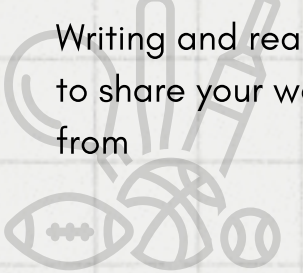
> *A deep understanding of your sport and a keen interest in it*
Sports analytics is as much about the sport as it is about its analysis. Observing each game, identifying patterns, and making sense of "why would the player perform this action in that particular situation?" are key points to keep in mind. Having a contextual understanding of the data before jumping to conclusions is a great asset. For example, in cricket, if a bowler has a higher economy rate than another bowler, that need not mean that he/she is worse. Maybe it was because that bowler predominantly bowls in death overs.



> Technical Skills for Success
Getting well acquainted with any statistical software such as R programming or Python coupled with knowledge of relevant libraries and models used in sports analytics can be a good starting point. Also, based on their requirements, people use software such as Tableau for visualization and SQL for database management.

>*Start applying instead of waiting to learn everything*
There are various skills to learn and master, as mentioned above, but, having said that, you need not wait to learn everything before getting started. Start now! You can begin by analyzing your favourite team, players, or whatever interests you. Apply what you know, and keep learning more gradually.

> *Put your work out there and create good stories*
In an upcoming field like sports analytics, there is no well-defined path to tread on. Writing and reading blogs is a great way to share your work, getting inspiration from the stuff already out there, and connecting/collaborating with like-minded people. A platform such as Medium could be a great place to explore this. Put your work out there and weave it into good stories, receive feedback, and communicate.



You need not wait to learn everything before getting started. Start now! You can begin by analyzing your favourite team, players, or whatever interests you. Apply what you know, and keep learning more gradually.

> *Sports Analytics is not a degree.*
(Though, that isn't very true nowadays! Online platforms e.g. Coursera offers a specialization course in Sports Analytics by University of Michigan)
Yet, there is no particular degree or course that makes you fully equipped for a job in sports analytics. It comes from regular practice of applying your knowledge and performing analysis using whatever techniques you are acquainted with. People in this field come from various academic backgrounds, from Computer Science and Economics all the way up to Physics and Chemistry. With the relevant knowledge and a keen interest to learn, one can pursue Sports Analytics irrespective of their degree.

> *Applying for a Job in Sports analytics*

If the work you publish is consistently good, seniors from analytics companies could reach out to you. Alternatively, you can look for openings at various sports teams and clubs as more teams have begun to hire data analysts and realize their importance. Apart from that, you can work in media, broadcasting companies, consultancy spaces, or even become a freelance journalist.

Challenges and Conclusion :

We are all fans of the sport, and sports analytics provides different ways to perceive the game and understand it better. Careerwise, it is quite a competitive field with its own challenges, such as limited job openings. But challenges bring opportunities, and sports analytics is an excellent opportunity to merge your passion with your profession. As more and more teams try to gain a competitive edge with data analytics, these are exciting times for everyone. So come on people, get ready to revolutionize the sports ecosystem by harnessing the power of data!

Rahul Krishnakumar

Footnotes :

1] clustering: It is a machine learning technique that is used for grouping data points into different clusters, such that each cluster contains similar data points.

2] weighted directed graph: A directed graph is made up of a set of vertices connected by directed edges known as arcs.

Author's Note :

Sports Analytics is a developing field with increasing importance. I am nowhere near being knowledgeable enough to give advice in this field! But I would say as students, we can start by exploring it as a new way to perceive the sports we love . So I would conclude by saying, "Try Sports Analytics, you will either make a career in it, or at least enjoy the sport a bit more!"

References :

Moneyball and Soccer - Leading with People Analytics
How Sports Analytics is Changing the Game | Latentview
NumPy
What is Sports Analytics?
Sports analytics - Wikipedia
The role of a Performance Analyst in Sports
How Analytics FC helped De Bruyne negotiate new Man City deal
How to Get into Sports Analytics in India
Getting into Sports Analytics. I've been working almost a year and a... | by Sam Gregory
2019, Bowlership, Praharsh Nanavati, SURC-Azim Premji University, 5th-7th December 2019, Bangalore

A Path Sparking Curiosity - Biophysics

Biophysics is an interdisciplinary field of science that bridges the gap between two very distinct branches of science and gives us answers to some of the most important questions about life.

Biology is the study of life in all of its variety and complexity. It explains how organisms obtain their food, how they communicate, perceive their environment, and reproduce. On the other hand, Physics seeks out mathematical laws of nature and makes detailed predictions about the forces that drive idealized systems.
Biophysics is critical to understand the mechanics of molecular functioning and the complex systems in our body.

It explains what happens in nature by applying the principles of physics to biological processes.

Following is an interview of **Dr. R. Mahalakshmi**, a Professor in the Department of Biological Sciences at IISER Bhopal. She primarily works on molecular experimental biophysics.

Can you explain your research in biophysics briefly?

Proteins have many important functions from preserving the genetic composition to the metabolism of any organism. Genetic material holds importance because it is transferred from an organism to its progeny. Conservation of an organism's attributes is possible by the very presence of genetic proteins. The other aspect of metabolism is the key to life because whatever we eat is converted to energy by this process. The energy to perform even the most basic tasks for any organism is obtained by metabolism which is done by proteins.

Proteins have many important functions from preserving the genetic composition to the metabolism of any organism. We look into how proteins fold and what decides their structure at the atomic level. So this is a more curiosity-driven work but has direct implications in health and medicine.

Proteins, which are one of the four major biomolecules, play a vital role in maintaining these two aspects of an organism's functioning. By definition, proteins are workhorses of a cell i.e. they do what is required to keep the cell running and functioning.

For a protein to function, it needs to have different yet specific shapes to recognize different molecules. For proteins to take a specific shape, it needs to fold in a particular manner. This is what we are interested in finding out about. We look into how proteins fold and what decides their structure at the atomic level. So this is a more curiosity-driven work but has direct implications in health and medicine.

Were you intrigued by the mystery that biophysics holds right from when you were a student or did it catch up with you later? What made you choose to have a career in this path?

This is a question that I'm frequently asked. As a student, I used to hate biology. Growing up, I aspired to be a pilot in the Indian Air Force and it was my dream to fly the Sukhoi fighter plane. Unfortunately, my glasses got in the way of my childhood dream. That is when I began concentrating on other things. Mathematics and Physics were my next favourites, which is why I considered becoming an astrophysicist.

The contents began to change with the transition from school to college . It began to broaden my horizons and Biology stopped being just about learning about organ systems. I was introduced to several topics of molecular mechanisms of biology that I had never heard of before.

After I finished 10th grade, I had the option of studying either pure science (Physics, Chemistry, Botany, Zoology) or Commerce with History. Some aspects of history didn't arouse my curiosity enough to consider the subject anymore (I had a hard time remembering all the minor details!) Therefore, taking up pure science was pretty much an obvious choice for me since I could do well in Physics and could somehow manage with Biology. However, that course did not offer Mathematics as a subject. In my 11th standard, I had a fantastic set of teachers who helped me develop an interest in Biology. The contents began to change with the transition from school to college . It began to broaden my horizons and Biology stopped being just about learning about organ systems. I was introduced to several topics of molecular mechanisms of biology that I had never heard of before.

When I was later offered an opportunity to switch to Mathematics in another course, I immediately declined since by then I had grown to appreciate what biology had to offer. After my 12th standard, everyone around me urged me to study medicine but my parents were very supportive of my decision to get a bachelor's degree in Biochemistry. I really enjoyed studying the topics in it.

Seeing Biophysics as an option there brought back the flood of my childhood memories of Mathematics and Physics.

After my B.Sc. I was accepted to the IISc for an integrated Ph.D. program. In IISc there were 5 departments to choose from, for my Ph.D. Seeing Biophysics as an option there brought back the flood of my childhood memories of Mathematics and Physics. I took it as an opportunity to go back to Mathematics and Physics. That is how I ended up taking Biophysics for my Ph.D. and I have not looked back since then!

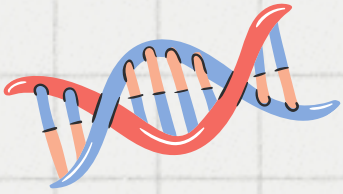
What topics did you initially work on after your master's and during your Ph.D.?

I worked on a lot of research topics . In my Integrated Ph.D. study, my master's thesis was based on peptides. To explain further, I looked into how amino acids, which are the building blocks for proteins, can be connected to each other, and based on our understanding of allowed and disallowed connections in proteins, whether tweaking a small part of it could change the entire peptide's structure. I enjoyed this work on "biomolecule design" a lot. Throughout my Ph.D., I continued to work on this project to design specific structures, and also look into how aromatic amino acids interact with each other in these designed peptides. I studied peptide chemistry for my master's and doctoral degrees along with which I studied ion channels using electrophysiology. I did some computational work as well. I also worked on RNA biology.

I looked into how amino acids, which are the building blocks for proteins, can be connected to each other, and based on our understanding of allowed and disallowed connections in proteins, whether tweaking a small part of it could change the entire peptide's structure.

How much of physics and how much of biology is involved? Is one dominant over the other or do both of them contribute equally?

Let us consider some cases here. If you choose to work on protein structures and try to modify them according to your requirements, that is more biology and less physics.



On the other hand, when you do experiments like single-molecule atomic force microscopic studies or something like optical tweezers, they involve a lot more physics. Here the molecule is just the subject of interest. When you try to find out how the proteins fold using atomic microscopy it qualifies more as physics. There can be studies where just 1% of biology is involved with the rest being physics or the other way around, but it still qualifies as biophysics. So, it ultimately depends on you and what aspects you decide to work on. It is a personal choice. My research, for example, is approximately 75% biology and 25% physics.

What is the difference between working in biophysics rather than just biology?

Since I've primarily worked in biophysics, I don't believe it's appropriate for me to comment on this, as I have never really explored general biology. As far as I know, since biophysics is a part of general biology, they overlap with each other. For instance, in our laboratory, we perform experiments that are based on biophysics, as well as some on cellular or mainstream biology. In layman terms, I think it might simply boil down to how many equations and spectra you include in your experiment that makes it qualify as biophysics. If you are exploring microscopic images of the cell with little mathematical aspects, it would probably qualify as mainstream biology since it doesn't require that many mathematical aspects.

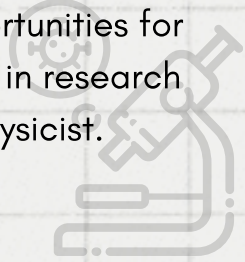
Since biophysics is a part of general biology, they overlap with each other. For instance, in our laboratory, we perform experiments that are based on biophysics, as well as some on cellular or mainstream biology. In layman terms, I think it might simply boil down to how many equations and spectra you include in your experiment that makes it qualify as biophysics.

What are some real-life applications of the field other than academia?

There are a lot of applications of biophysics. For instance, all drugs have to undergo a wide range of testing before they are approved for use by the general public. Many of these processes use the principles of biophysics. It would involve a chemist who would conjure it up, and a biologist who would test it in mice models, chimp models, and eventually on humans. In between these processes, the role of biophysicist comes through.

A biophysicist finds out the specific part of a cell where the drug acts. It involves procuring the results of how a certain chemical acts on a protein; how this protein goes on to affect the cell and therefore the body of the organism. It involves locating the binding site of the protein and then modifying the chemicals in the drug to bind better with this specific protein of interest, while also ensuring that it doesn't bind elsewhere.

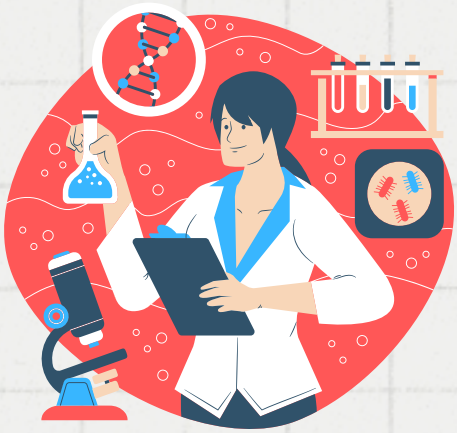
There are excellent job opportunities for someone who wants to work in research and development as a biophysicist.



Professionals in R&D study the structures of the model drugs and refine them in response to the large-scale trial outcomes.

Is there any particular advice that you would like to give to students who wish to pursue a career in biophysics?

My advice would not be restricted to biophysics alone; it doesn't even have to be science. My advice is: do what you love. Enjoy your work or find a way to appreciate what you get. It might happen in life that you won't get what you want at all times, so learn to make your peace with that and move on. Biophysicists in particular would need to possess a strong sense of curiosity, and they must be open to all kinds of possibilities.



An acronym I use repeatedly in my laboratory is - **WYSIWYG** - "What you see is what you get".

An acronym I use repeatedly in my laboratory is – WYSIWYG – "What you see is what you get". We approach every experiment with an open mind. This, in my opinion, is the beauty of biophysics, you don't need to speculate anything. Whatever you get from the experiment is your answer.

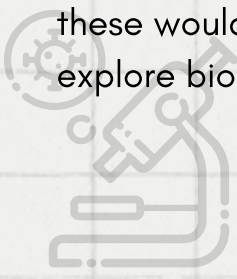
We approach every experiment with an open mind, and we don't carry our assumptions about the outcome. We let the protein tell us how it folds and functions because many times we get unexpected results. Biophysics is a very vast field. It provides you with answers to every question you ask. It is entirely up to you whether to accept the results or not, so acceptance of your results is also very crucial. This, in my opinion, is the beauty of biophysics, you don't need to speculate anything. Whatever you get from the experiment is your answer.

How can students find the best career opportunities? It could be internships, reading projects, or jobs.

I would say that it is a combination of what they enjoy and what opportunities they get. My advice would be to find something that gives you hands-on experience because the more involved we are, the more we learn. You should choose to do anything where you learn rather than staying idle; choose someplace where you can learn about what you like, and where you can be creative. Science thrives on creativity and innovation.

Many institutions offer a degree in biophysics, but biophysics as such is a multidisciplinary field. For example, you can find biophysics in structural biology, stem cell biology, as well as astronomy. There is both an Indian Biophysical society and an International Biophysical Society. They bring together a large number of people who work on biophysics and hold annual meetings to discuss everyone's work, as well as various aspects of biophysics.

Applying to work as a research assistant with a professor who specializes in the field of your interests from either of these would also be a good way to explore biophysics.



Despite all of his accomplishments, Prof. Padmanaban Balaram was never hesitant to say "I don't know ". This, I believe, is what leads him to learn about what he doesn't know and has made him one of the greatest scientists India has ever produced, and everyone should strive to instill this in themselves.

Is there something you would like to add or tell the readers about?

I always share what I learned by observing my Ph.D. supervisor, Prof. Padmanaban Balaram. He was the director of the Indian Institute of Science for two successive terms. Despite all of his accomplishments, he was never hesitant to say "I don't know ".

This, I believe, is what leads him to learn about what he doesn't know and has made him one of the greatest scientists India has ever produced, and everyone should strive to instill this in themselves.

"Do what you feel in your heart to be right- for you'll be criticized anyway. You'll be damned if you do, and damned if you don't."

Acknowledging the fact that you have some limitations is the only way you come close to perfecting things.

I use a lot of quotes so, I will just leave you with one by Eleanor Roosevelt which goes "Do what you feel in your heart to be right- for you'll be criticized anyway. You'll be damned if you do, and damned if you don't."

Maya Katti

Author's Note

I first came across Dr. R Mahalakshmi while taking a look at the list of professors in the biological science department at IISER Bhopal. Her research topics seemed unconventional and interested me a lot. She was punctual and cheerful as I visualized her to be. During the interview what pleased me the most was her efforts to make me comfortable. It was a wonderful, insightful experience for me to talk to her.

Leaving the Nest

Life Abroad as a PhD student

After finishing their final years of college, students often find themselves in a dilemma: whether to stay here or go abroad to pursue their higher education. It's a valid concern since there are many factors to consider.

Following is an interview of **Dr Arnab Rudra**, an assistant professor in IISER Bhopal, whose research areas are String Theory and Quantum Field Theory. He completed his bachelor's from the University of Calcutta, then proceeded to do his master's and PhD from the University of Cambridge, UK.

What helped you decide to go abroad?

I used to go to Harishchandra Research Institute for summer and winter projects when I was in the last two years of my undergraduate study. My mentor was Prof. Rajesh Gopakumar, who is currently the director of the International Centre for Theoretical Sciences. I also had the

opportunity to work with Prof. Ashoke Sen. When I paid a visit to HRI during my third-year vacation, a PhD student (Arunabha Saha) there told me about a Cambridge course called Part III Mathematical Tripos and encouraged me to apply. I asked Mahan Maharaj (my mentor during my time at Belur Ramakrishna Mission) and Rajesh for suggestions. Both of them were extremely helpful and made sure that I applied. I received it, along with a Trinity College Cambridge fellowship (Ramanujan Studentship). It was just too fantastic an offer to pass up. Fortunately, I did not have to plan much in my case; my teachers guided me in this direction. I had a clear choice: if I got in, I'd go there; if not, I'd go to HRI and finish my PhD there.

I watched a video series called Elegant Universe in Class 11; I liked it a lot, not because I understood it, but because it sounded like something I should try.

After completing your MS, how did you choose your topic for your PhD thesis?

That has a strange backstory. I watched a video series called Elegant Universe in Class 11; I liked it a lot, not because I understood it, but because it sounded like something I should try. That was my first exposure to the field of string theory. When I started my undergrad, I read a wonderful book called A First Course in String Theory, published by Cambridge University Press, based on an undergraduate course on String theory at MIT. It's not a difficult book to read; anyone in their sophomore year should be able to do it. After that, I went to HRI and met all these incredible physicists, who significantly influenced my decision to pursue string theory as a career.

What role did your guide play in your PhD thesis?

Speaking of my PhD supervisor (Michael Green), he helped me a lot. I'm not sure I could have done it without such a great supervisor. He is a superb scientist who has published excellent articles. He gave me a lot of time and never discouraged me from asking questions; he would answer any queries I had, despite how inconsequential it might sound. He also taught me how to do physics. Physics isn't only about memorising facts and reading books; it's about asking questions and seeking answers. More significantly, he is a wonderful human being who has always treated me with compassion. I am very fortunate to have had him as my supervisor.

How different is the research culture and work ethic between here and abroad?

Well, I certainly can't make any judgments based on my one-year experience as a lecturer in this country. But I can certainly draw a contrast between my time as a student in India and Cambridge. The most significant difference I saw there was that asking questions wasn't discouraged. In my school and college years, I noticed that asking questions was frowned upon. People did not always respond appropriately when asked a question. Secondly, I had encountered very few people in my school and college years who were willing to acknowledge that they didn't know something.

In India, our society fixates a lot on how much a person knows; not knowing is seen as undesirable and is despised in many places. I noticed in Cambridge that not knowing is normal because it is the first step towards learning something new; you can discuss the problem with everyone else in the process and know more. My supervisor used to come into my office and say, "I'm confused about this. Could you help me out here?" I was initially perplexed about what was going on because I witnessed someone openly admit that he didn't know for the first time in my life. On top of that, he's asking for advice from someone junior to him. When it comes to science, this mentality is crucial. I encountered it briefly when I interacted with Dr Sen or Dr Gopakumar. However these were the exceptions rather than the rule. The rules were similar to what I had to deal with in school and college, which was the suppression of speech. So that was a significant change for me, and it helped me get to where I am now.

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How different are the experimental facilities?

Since my field was theoretical physics, I didn't have much exposure to the experimental facilities. However, based on what I have heard, the financial situation there is far better than here, which is not surprising given India's status as a developing country. Secondly, I believe that equipment and science necessitate a distinct level of

engineering. Vibration-free labs and other peripherals are sometimes required to conduct highly accurate research. Since the infrastructure for creating such labs is far less developed in India, it may be challenging to get accurate results at times. But, as I previously stated, India is a third-world country with a lot of space for growth.

The word 'hello' is a lovely one. You may say hello and strike up a conversation with anyone. 'Hello' has no connotations of deference or respect; it is simply a nice way to begin a discussion.

What are the things that you like the most about studying abroad?

I'd say the word 'Hello.' The word 'hello' is a lovely one. You may say hello and strike up a conversation with anyone. In Hindi or Bengali, I don't believe there is a word for hello; it's either 'Namaste' or 'Nomoshkar', both very formal. 'Hello' has no connotations of deference or respect; it is simply a nice way to begin a discussion. When I crossed paths with someone in the UK for the first time, they said hi, and that was the end of it. There was no discussion, just a simple "hi."

People spontaneously talking, greeting one another is not something I observe to be very common in India.

The second word is "thank you."All of us have people working in our houses and workplaces, yet we never thank them. It's not just about saying the word; it's about appreciating everyone's efforts; there's no such thing as superiority or inferiority in the workplace. Because of my background, I happen to be a professor. However, it doesn't imply that the individuals who scrub the floor don't deserve respect, which I believe I discovered more in the west. I found Indian society to be a place obsessed with how much people know. If someone doesn't know that much in terms of certificates or degrees, they aren't valued that much as a human being. That's one thing that bothers me a lot.

The general atmosphere there aided me greatly; I would describe it as a highly exhilarating vibe I still miss. You could go around bumping into people and start talking about physics beautifully without giving a second thought to how they might assess you. That gave me a huge mental lift, which helped me overcome a few minor setbacks along the way; I would have had a nervous breakdown if the surroundings had not been so pleasant.

Before moving to the United Kingdom, I ate rice at least twice a day , which became once a day towards the end of the first year. I can now spend months without having rice or dal. Thai, Chinese, Mexican and other continental cuisines can keep me going for months.

How did you adjust to the huge change when you first moved to the UK?

I had to. To be honest, I had never spoken English before coming to the United Kingdom. I grew up in a Bengali-speaking family, attended a Bengali-medium school, and spoke Bengali in college. Even the three mentors I spoke about: Rajesh Gopakumar, Ashoke Sen, and Mahan Maharaj, all speak Bengali; the first time I had to verbalise in English was during conversations in the UK. So that was a tremendous shock to me, but I chose to go there to pursue my dreams, so I had to adjust to the shift despite the odds. I had no right to complain because it was my own choice; all I had to do was back myself up, do my job, and return with dignity *(laughs)*.

Food was also a big change for me. Before moving to the United Kingdom, I ate rice at least twice a day , which became once a day towards the end of the first year. I can now spend months without having rice or dal. Thai food, Mexican food, Chinese food, and other continental cuisines can keep me going for months. I ate the cuisine of whichever country I was in, and I believe this is quite important since it exposes you to diverse cultures.

Have you considered going abroad again for career related reasons?

Not yet. I'm pleased with the students I've received, as well as the institute's support. To be honest, the most essential part is your pupils and how they challenge you daily ; it's an immense joy if they challenge you to take yourself to a new level. I've only taught two courses till now. I had three MS thesis students last year and have five this year.They've all been fantastic in my brief experience. I don't regret or second-guess this decision because of the academic opportunities it has provided to me. If it changes in the future, I'll have to reconsider, but till then, fingers crossed*(laughs)*.

You said so many amazing things about studying abroad. Despite all these, why did you choose to come back after completing your PhD?

To begin with, many individuals in India are doing science much ahead of what I am doing right now in my field; for example, Prof. Ashoke Sen, Prof Rajesh Gopakumar, Prof Spenta Wadia, Prof Sunil Mukhi, Prof Sandip Trivedi, Prof Justin David, Prof. Shiraz Minwalla, and Prof. Aninda Sinha, to mention a few excellent string theorists. I believe that if they can return to India and do such an amazing job, so can I. In that respect, I don't think I have made any scientific sacrifices to return.

Secondly, as a high school student, I aspired to study at IISER. The IISERs were coming up in 2007, which was also the year I began my undergraduate studies. Unfortunately, I didn't make it to the IISERs that year; therefore, I didn't get an opportunity to study here. Since then, I've had a soft spot for the IISERs, because the concept of students developing a research mindset from their very first year and doing great things appealed to me as a very challenging and enjoyable thing. In that regard, I've always wanted to work in an IISER.

In my opinion, if you're a string theorist, you should only travel outside of India if the locations there are better than India. At the time when I was applying for jobs, I don't think I would've gotten a job anywhere that was significantly better than somewhere in India, so that wasn't a big motivator for me; however, I did miss being in India - the food, the people - so I thought why not go back to my roots, and here I am!

I've had a soft spot for the IISERs, because the concept of students developing a research mindset from their very first year and doing great things appealed to me as a very challenging and enjoyable thing.

What would you advise our readers about going abroad?

First and foremost, the choice to travel overseas should be made only based on scientific interests. If you know what science you want to pursue, make sure you go somewhere, which is better than where you're getting a chance to study in India.

Secondly, it's important to put in efforts to go abroad to some extent, but don't devote all your resources and energy to it; more important is to keep an open mind from your initial years itself and work hard

to become a good researcher. I believe that in the IISER system, by the fifth year, you can become an excellent researcher and do considerably good work in your final year thesis.

If you do so, I believe it will benefit your life and increase your chances of studying somewhere worthwhile outside. I recommend studying in groups for your final year for whichever exam you are preparing for, be it GRE or TOEFL. Learning with others has the advantage of exposing your limitations because when you try to explain them to others, you realise what you don't comprehend. Teaching is an important activity because it allows you to put yourself to the test. Seniority or ego should not be an issue if you can teach your friend or if he is teaching you, and I believe it is an effective learning technique.

I'll urge people to think about, "Why do you want to go abroad?" since it's a very crucial issue to consider. There will be a lot of hiccups on the road at first; only having a clear idea about what you want can help you conquer that barrier; else, you could get so upset that you might give up science altogether.

What advice would you give the students who have set their minds already on going abroad?

Make a strong strategy and decide how you'll achieve it. Applying abroad is quite expensive, and there's no point in spending that money unless you have a clear plan to execute it. Also, passing the GRE or TOEFL isn't enough to go overseas; you'll need an admirable Letter of Recommendation (LOR), Statement of
Purpose and research experience, among other things.

When you're thinking about applying abroad, some of these things matter a lot, so work in that direction. I'll urge people to think, "Why do you want to go abroad?" since it's a very crucial issue to consider. There will be a lot of hiccups on the road at first: mental setbacks, dietary changes, and so on; only having a clear idea about what you want can help you conquer those barrier; else, you could get so upset that you might give up science altogether. Many who went abroad to study at prominent universities like Princeton, MIT, or Harvard to pursue further education have experienced this: it's just that the people around you are so bright that you get intimidated by their knowledge and begin believing that you aren't good enough for science.

As a consequence, you might end up quitting science. In that case, emotional strength and maturity are required to accept that you are not the smartest person in the room. Most people around you will likely be more intelligent than you, and one must have the fortitude and capacity to deal with that. They shouldn't give up on the first setback. If they believe that's likely to happen to them, they should reconsider travelling overseas. Even colleges ask for these when they request your LOR since they understand how crucial these are.

You're away from your culture and eating habits, which might be challenging to adjust to at times. Learning should be an enjoyable experience, and there might be hurdles to overcome. But at the end of the day, when you see your efforts bear fruit, nothing will make you happier.

Barishan Das

Author's Note

It's crucial to keep an open mind from the very beginning itself, and not stay fixated on going overseas for the glamour etc. since there are a lot at stake. In my opinion, there should be a fair weightage of pros and cons before any decision is made. Till then, keep exploring :D.

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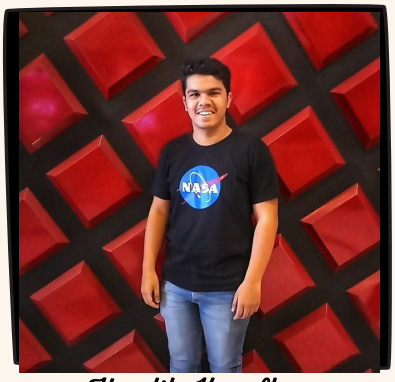

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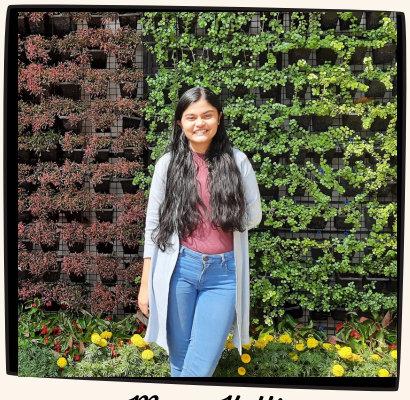

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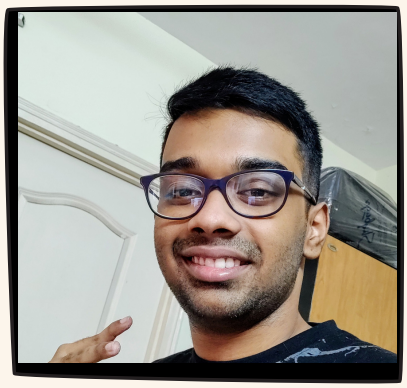

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