AI 4 Science Discovery Network+

AI4SD Interview with Dr Frank Langbein
09/12/2021
Online Interview

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Humans-of-AI4SD:Interview-31

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Title	AI4SD Interview with Dr Frank Langbein
Interviewer	MP: Michelle Pauli - MichellePauli Ltd
Interviewee	FL: Dr Frank Langbein - Cardiff University
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2 Biography

Figure 1: Dr Frank Langbein

Frank Langbein: 'This might be a dangerous statement, but there really isn't too much publishers do'

Dr Frank Langbein is a senior lecturer in Computer Science at Cardiff University, where he is a member of the Visual Computing Research Section. He co-leads the Qyber\black international research network in quantum control, which arose from the Quantum Technologies and Engineering research priority area at Cardiff University, and the Healthcare Technologies Research Group at the School of Computer Science and Informatics.

In this Humans of AI4SD interview he discusses his life in data, the barriers to data sharing and the role of funders.

3 Interview

MP: What's been your path to where you are today?

FL: I was always interested in science. I guess it started with me taking the TV apart and seeing how it worked, or starting very early on with computers. Those interests determined the direction I ended up going. I was always more interested in the deeper theories though, so I started in Germany with a combined undergraduate and Master's degree in mathematics, which gave me a solid grounding in theory and helped me later to think about computer science and physics.

From there, I ended up doing a PhD in computer science in Cardiff. A colleague told me about a PhD position in an area in which I was interested: geometric modelling. I'd never been to Wales before, and I was travelling when they were holding interviews, so I actually ended up doing the interview on a payphone in a car park! During my PhD, I mainly worked on reverse engineering geometric models, understanding structures and then finding patterns. At the time, I found that fairly interesting, but there was always an interest in physics and control topics. At the same time, all of these quantum control concepts began coming up, which were outliers at the time. I was interested in what you can do with quantum systems. I still do some geometry now, but work mostly in the area of quantum control.

So I got here by having a broad background in maths. Although there's much to learn with computer science and programming, it came quickly to me. From my maths background, I could get into other disciplines and try to understand them in mathematical terms in order to work on them.

MP: What challenges have you found doing interdisciplinary work?

FL: Most of the work is still separated by discipline. For example, if you have a paper that doesn't fit into any one of them, it can get randomly assigned to a discipline, and you can't be sure how much knowledge a reviewer will have about it. That remains a problem, but we still need interdisciplinarity. It doesn't make sense to stick in one area and, for instance, develop abstract maths that may or may not have applications. If you look at things in relation to application, you might get new ideas or directions. But there's the same thing from the side of the application, where someone might say, "No, I don't need this maths context." That's not better either.

So there are certainly problems with people being able to understand the broader concepts across many subjects, because many people in academia are far too stuck in specific disciplines. But maybe it's because I get bored quickly, it is more fun to switch between subjects.

MP: Do you think interdisciplinarity needs to be encouraged earlier on?

FL: Certainly — it should be encouraged from the very beginning. Don't just say "I'll start as a computer scientist, and then I'll only look at computer science without thinking about anything else." It makes sense to broaden your interests at that stage, because you have the time to look at all these other subjects.

For my first degree, I looked at maths and computer science, and I kind of smuggled in physics too because it wasn't a default option! Having that cross-disciplinary view helped an awful lot, otherwise I would have got stuck in pure maths. There's lots of interesting stuff in that area, but it doesn't interest me on its own. The earlier people see that there are multiple directions and understand the different languages the better, because the more senior you become, the less time you have to do this work.

MP: What project are you working on at the moment?

FL: We're currently looking at controlling quantum systems. So, a device — a biological or engineered system, which dominantly follows the laws of quantum dynamics — we're looking at how to steer them towards what we want them to do. We're trying to get a quantum system to dance to our tune, except that the tune is an amplitude modulation, not a frequency modulation, so we can't listen to the signals in the usual way.

The initial idea comes from chemistry, with the notion that we can steer chemical synthesis to produce molecules which would be hard to synthesise naturally. Those are the origins, and there has been some progress in that area but it's still very difficult.

We've also been looking in the direction of quantum computing and communication, which has taken us into healthcare and MRI machines. It might sound quite strange, but it's not that different. There are some different dynamics and some different physics, but a lot of the basic methods, the theory and techniques we use, are awfully similar. The issue with MRI machines and quantum computers is that they do not scale. One or two qubits is fine, but with a 128 qubit machine, it collapses and doesn't give us what's called the quantum advantage. The scalability of this method to larger systems is where it becomes more interesting, but more difficult. Whether that's more qubits or more complicated molecules, you have the same problem, which is that the controls become too complex. You almost need another quantum computer to solve the problem of the quantum computer you already have!

The theoretical and computer science perspectives help us to ask what the limits are. What is the fundamental limitation for building a device? If we build amplifiers, for example, we know there are certain trade-offs between noise and performance. In the quantum domain, however, we have no idea where the limits are. With the work we've done so far, we've seen some of the limits you see in classical control, but we also see cases where the classical limitations do not hold anymore. The more classical a system becomes, the more robust it is, meaning it's easier to scale, but then you lose all the quantum advantages. Any engineer will tell you that devices have limits, they're not infinitely robust. The challenge with quantum technologies and quantum engineering is not only building the devices, but understanding what you can do with them. If I push a certain thing far, what breaks elsewhere? What kind of compromise and balance do I need in order to have a valid technology that can be reasonably manufactured in large numbers? With quantum computing, it'll take us a long time to sort that out.

MP: What has surprised you in your research?

FL: We started off thinking that there was something we wanted to demonstrate: here is a system that is not fully controllable and here are where the things don't work. But the surprise was that the system then started to work. We realised you can't implement everything on a system, but then some of the things we had set out to implement were easier - more robustly - realisable.

We were also surprised to get results which violated fundamental limitations in classical robust control. In classical robust control there is an offset between performance and the robustness of a system, that there's a balance between the two, and they can't be both pushed to their limits. In robust quantum control there are cases where performance and robustness are optimal at the same time.

So there's still hope in that area that there will be things that can be made to work in quantum control. It's just a huge challenge where we need to work out all of the details. For now, it's just theory.

MP: Where are we with open science at the moment?

FL: I find open science to be in a confused spot right now. I started off in the free software community, where the idea is that software should be released freely: I should have the sources to the solution, I should be able to modify it and release it freely. I'd like to see the same thing in science — it was never a question for me. If I produce the results, I should release them and everyone should be able to access them, and they can take it forward. As long as they reference me, it's perfectly fine.

If it's used commercially, I don't care too much, but I get angry when it becomes exploited: if, for example, someone tries to protect it so that no one else can use their modifications. I get a bit angry because other people have put in the work, they've given it to you for free, and then you do some trivial modifications or give it a nice user interface, protect it, and then make lots of money from it. That means no one can access the work that's actually been done elsewhere. It makes sense to pay for a service if I don't have to sit down manually and do it myself, but if I want to do that, I should not need to depend on a company. That's the problem with some of the software developments: the exploitation on the commercial side.

For me, that's generalisable to science: your paper should be available, at least the pre-print. They shouldn't be behind paywalls. With some of the open access you need to pay for the publication so that other people don't have to pay. If I have a grant for that, then I don't care, but why should I pay for it myself when I could just as easily put it on an archive and say it's available? In physics in particular, if you put it on the arxiv (arxiv.org), people find it. Journals should be making content available for free. I do the editing for free, I do refereeing for free; after that, the paper's pretty much directly publishable, it just gets made a little prettier. If you compare the cost of archiving on something like arxiv.org, which you don't have to pay for yourself, with journal publication fees it's really cheap per paper.

But I don't see how we go from the current system to open science, where people can freely share results and build on others' results. It's something that the open source community has already largely solved, but it doesn't involve the powerful publishers.

MP: What could the open science community learn from the open source community?

FL: They could learn not to bother with publications. There needs to be far more focus on making things available and distributable. Attribution is an important part of this, but that's kind of there anyway; if you look at source repositories like GitHub, it's clear to see what you've contributed to it. And it works fairly cheaply. There's still a cost, but these systems are cheap enough that users mostly get to use it for free, and you only need to pay a bit more for more services. Getting a single paper out in a high-impact journal would be enough to get a subscription on GitHub for at least a year, and there I can release even more research. The costs currently aren't justified.

This might be a dangerous statement to make, but there really isn't too much publishers do, from my perspective. There are examples of communities that have just said, "Let's start a journal, put it on a server, and we can referee it." I have my "favourite" high-impact publishers, but many of their papers aren't even that good. It's stuff we already know which gets published ten times over. The hard work is being done elsewhere.

It would also be fairer, because right now the grant system determines who can get the publications. If someone tries to come in from a completely different direction, if they have new ideas but don't have a grant, it's more difficult for them to find a place for publication.

MP: What advice would you give to early career researchers in your area?

FL: I would say find your own area. Don't worry too much about what other people are doing. Find your own interest, but don't limit yourself too narrowly to one specific field. There's always other areas where you can learn from, and where you can transfer what you've been doing. Learn about what's being done in those areas, it might be relevant somewhere in your field. Just because you don't know anything about it doesn't mean you can't learn it. Find people in that area, talk to them. That might be the best option for learning, instead of just reading up on it. A combination of reading and talking to people usually works fairly well, and I find it more fun.