James Amidei
August 28, 2024
Assignment #1 - Quantum Workforce Analysis

a.) I think all of the activities they included were expected. However, I was surprised to see that they made a conscious choice to not include machine learning. I have to say, I don't know if I really agree with their justification for excluding it; that it is a skill that's not connected to any specific job or degree. I feel like by that same reasoning they could've made the choice to exclude many of the skills we are going to learn in this course, since there's overlap between the computer science, electrical engineering, and physics degree programs.

b.) The first methodological limitation is that they are unable to provide specific numbers about the number of positions that are currently filled or make projections as to the growth of the number of those same positions in the future, due to the qualitative focus of this study. They go on to claim that this is also one of the strengths of the study since companies are more likely to respond due to them not having to give up possibly sensitive, "strategic information". On this point, I think I agree with the authors. Any data that a quantitative analysis would return would be so contextual that it may not be useful in as little as a year or two from the studies completion. One reason for this is that it would likely start from the assumption that the economy, government policy, or both will not experience any major changes in the coming years. This is to say, that job growth projections are something that needs to be constantly updated, and thus would make this analysis more locked into the place and time it was conducted. Meanwhile, the qualitative analysis is able to provide an insight into the nascent U.S. quantum industry's practices and desired skill sets, which are to things with seemingly much more staying power than specific jobs numbers.

The second limitation they mention is in the selection of companies, as well as individuals at each company. While the authors were able to remove their own bias in the selection process by relying on responses from the QED-C, the snowball sampling (asking respondents to recommend other's they think may be willing to contribute) may have led to an intra company bias, meaning that the individuals or groups interviewed in each respective company may not represent the company as a whole. Ultimately, this is probably something that couldn't be avoided given the scope of the study. In order to mitigate this potential source of bias, the authors would've likely had to expend significantly more effort on each individual company, thus limiting the scope from the quantum industry as a whole, to only a couple of facets. This of course would've meant the authors would need to more directly select which companies to focus on, opening the study up to their own biases based on their selections.

The final limitation mentioned wad based on the fact that the authors themselves are professional physicists, meaning that the study itself may have more a bias towards physics than other fields which could find a home in the quantum industry. For me, I think this bias is no big deal, but it does also hurt the study's ability to provide a more holistic picture. In order to mitigate this, it may have been prudent for the authors to team up with professionals across several different fields in science and engineering.

c.) From this "Skills needed for the job" section, I think the skills that immediately drew my interest were those under the "quantum information theorist" and "application researcher" categories.

What drew my interest for the theorist section was the how you take a knowledge of quantum algorithms and figure out how to implement them on systems. In general, I love researching and trying to understand the theory behind different topics in physics, and this seems like a role that would require you to have as close to a "complete" understanding of the systems you work with as possible. Additionally, I find the field of information science to be incredibly fascinating on the whole, and working to improve and streamline quantum information systems has a wide range of potential applications. Insofar as my current skills, I won't feign to be anywhere close to the level of understanding I would need for this role. But a guy can dream.

What drew my interest to the "application researcher" role was how it also places an importance on understanding the theory behind the systems you work with, with extra emphasis on how they can map onto real world problems. Additionally, this seems to have a much lower barrier of entry, since you are not expected to solve problems that have never been solved before. They specially mention that workers in this role need a bachelor's degree as minimum, which together with the other skills they mentioned (coding, linear algebra, etc.) seems like it could be fairly accessible if one were to go out of their way to specially curate a few special skills in their undergraduate education.

d.) In S.II, the categories for Ph.D. and bachelor's in physics. I thought the conversation under the Ph.D. section was fairly illuminating as to the actual, "in demand" skills these companies are most aggressively looking for. While it is entirely possible to go into the quantum industry with a bachelor's degree, you still need a level of specialization that you are more likely to get with some graduate school experience. Additionally, when you come into the industry with a Ph.D., you are doing so in part as a manager; as someone who is expected to understand how to manage a research project and deliver results, as much as someone who has a very deep knowledge of some niche topics. The conversation under the bachelor's section placed an emphasis how workers coming into the industry with just their bachelor's in physics are often in engineering roles. Additionally, they explained how their data does not account for the specific experience of individual employees, who may have gained the necessary skills for their role through "on-the-job" experience, and how this experience may bring a worker with just a bachelor's degree to the level of knowledge and independence as a Ph.D. While this does seem possible, I wonder how likely this will be in the future, since I would imagine the vast majority of companies would prefer to hire someone with a Ph.D.'s level of experience outright, rather than train someone over years and years.

Insofar as how my own experience maps on to that outlined in the physics section (i.e. a knowledge of quantum physics, experience delivering on research, etc.), I would not say that I am exactly prepared. However, I could see after finishing my bachelor's how I would be well on my way to being able to claim those skills.

e.) For any type of theorist role in a quantum technologies company, it seems pretty open and shut that a Ph.D. is a requirement. This is not unexpected, but it does mean I am personally quite far from having the skill set/credentials required for such a role. For an application researcher, this again seems like a more accessible role, where I am much closer to having the relevant skill set, with a good bit of my undergraduate research being in computation physics already.

f.) Insofar as skills I feel like I have a basic grasp of, almost everything listed under "Traditional Quantum Theory" is something I feel relatively good about. I would say that the biggest weaknesses I have fell under the "Quantum Information Theory" and "Hardware for Quantum Information" sections. In particular, the bits about circuit design, encryption algorithms, and everything that was not highlighted in grey under “Hardware for Quantum Information”. All of these skills seem like things you would gather as you work through a Ph.D. with an focus on Quantum Information. I think this drives home the near necessity of having a Ph.D. if your goal is to go into this field as a physicist.