Curiosity in Motion: Independent Research Portfolio

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1) What is Quantum Computing and How Can It Help Us?

The reason I researched quantum computing was because it kept showing up at the edge of every "future tech" list and it felt like the one domain where math and physics had built a tool we barely knew how to use yet. At its core, quantum computing replaces classical "bits" with qubits: objects that can exist in superposition and become entangled with others. Hence, the idea of why it's labeled under "quantum". Those two features enable algorithms that explore large solution spaces in epic ways. That's a neat idea, however, the practical points matter: quantum devices are particularly well-suited to simulation of quantum systems (molecules and materials), certain optimization problems, and specialized sampling tasks. They do not, however, meaningfully speed up all everyday computations necessarily.

Reading technical reviews and company roadmaps taught me to separate the headline from the engineering. 'Quantum advantage' is not a single milestone; it is task-dependent. The Reviews of Modern Physics survey on quantum computational chemistry shows how molecular simulation maps naturally onto quantum hardware but also emphasizes the current limits: noise, short coherence times, and the need for error correction. Industry groups (IBM, Google, academic labs) publish steady progress—new architectures, error-mitigation techniques, and demonstrators of quantum simulation—but the road to fault-tolerant, general-purpose quantum computing is still long and expensive.

Thus, my final conclusion as of right now follows that of a practical and modest perspective. Quantum computing is more than just "cutting-edge" for targeted scientific problems— chemistry, materials science, or some classes of optimization—and will likely integrate into hybrid classical-quantum workflows. However, we are nowhere near the rather sci-fi concepts we believe in, including that Quantum Computing is the simple technological solution to help us better resolve all problems.

I can connect to one useful concept that goes for anything in terms of development, be it technological, scientific, medicinal, political, economical, financial, etc. I realize that it's important to understand where the power actually lies and what impacts it can fundamentally and realistically make. I understand that pure hype and inaccurate information provides us with false hopes or understanding. Quantum computing is truly magnificent, but has a long way to go and is nowhere near where the media expresses it to be.

Sources (MLA):

IBM. "What Is Quantum Computing?" IBM, https://www.ibm.com/think/topics/quantum-computing. Accessed 30 Oct. 2025.

McArdle, Sam, et al. "Quantum computational chemistry." Reviews of Modern Physics, vol. 92, 2020, https://link.aps.org/doi/10.1103/RevModPhys.92.015003. Accessed 30 Oct. 2025.

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2) Can Quantum Computing Be Accessible to the General Public Easily?

My previous research consisted of my claim that I have a balanced perspective towards Quantum Computing. Consequently, researching its accessibility and feasibility proved to be a no-brainer step. I approached accessibility as a layered problem: knowledge, tooling, and hardware constraints. On the knowledge side, learners now have access to excellent free materials, IBM's Qiskit tutorials and learning tracks are a great example, which lower entry barriers for programmers and students. On the tooling side, cloud platforms already let hobbyists run small circuits or high-fidelity simulators. Those two layers mean the public can experiment and learn, which is essential for democratization.

However, hardware remains the neck-pain after awakening from the wrong position from sleeping.. Meaningful quantum workloads (the ones that can beat classical methods for real problems) demand many low-noise qubits and error corrections. There is no surprise to note that it is neither cheap nor easy to engineer. Here's my own synthesis to make sense of it: its feasibility and accessibility will follow the similar pattern of the cloud-technologies arc for data storage and discovery of streaming—researchers first, then specialized cloud services, then higher-level APIs that hide quantum complexity. If I am realistic, most citizens will encounter quantum benefits indirectly (through improved drug discovery, materials, or optimization-as-a-service) rather than owning personal-use quantum devices.

Therefore, I have no definite answer as to if Quantum Computing can be accessible to the general public easily. However, I believe that if not directly, the public will benefit from the flourishments of advancement in medicine, pharmacy, etc that it can help with.

Sources (MLA):

IBM Quantum. "Tutorials." IBM Quantum Documentation, https://quantum.cloud.ibm.com/docs/tutorials. Accessed 30 Oct. 2025.

IBM Quantum. "Learn Quantum Computing." IBM Quantum Learning, https://quantum.cloud.ibm.com/learning. Accessed 30 Oct. 2025.

3) AI Pros and Cons and AI Ethics

Truly, AI is the connective tissue for many of my other interests, so this research felt like a must.

The upside is unfathomably enormous: algorithmic pattern recognition amplifies human capacity for diagnosis, design, and productivity. From healthcare diagnostics to accelerating research cycles, the benefits are truly real and truly repeatable.

The downside is not just technical. In fact, it's political and social, and all that relates to those topics. Models trained on biased data can automate unfair outcomes. Powerful companies can concentrate capabilities and influence. In addition, opacity in large models creates accountability gaps.

Policy frameworks like UNESCO's Recommendation on the Ethics of Artificial Intelligence and the OECD AI Principles helped me organize the ethical landscape. They emphasize human rights, transparency, accountability, and inclusive governance. My reading convinced me that technical teams need governance partners. Tools for fairness, explainability, and auditability are important, but governance (legal frameworks, oversight, public input) is what scales responsibility across deployment contexts.

Practically, my takeaway is a design principle: integrate ethics into the engineering lifecycle. For projects I'd build or join, that means audit logs, human-in-the-loop safety checks, and cross-disciplinary review panels. These design choices that make ethical commitments operational, not rhetorical.

Sources (MLA):

UNESCO. "Recommendation on the Ethics of Artificial Intelligence." UNESCO, 2021, https://www.unesco.org/en/articles/recommendation-ethics-artificial-intelligence. Accessed 30 Oct. 2025.

Organisation for Economic Co-operation and Development (OECD). "AI Principles." OECD, May 2019, https://www.oecd.org/en/topics/sub-issues/ai-principles.html. Accessed 30 Oct. 2025.

Mehrabi, N., et al. "A Survey on Bias and Fairness in Machine Learning." arXiv, 2019, https://arxiv.org/pdf/1908.09635. Accessed 30 Oct. 2025.

4) Usefulness, Applications, Development of Biotechnology

Based on my previous research, it goes without saying that “Biotechnology” would be positively impacted by things like Quantum Computing and/or AI. In fact, “Biotechnology” turned out to be the most immediately consequential field I researched. The combination of molecular biology, computational design, and scalable manufacturing (think mRNA platforms, CRISPR editing, and protein design) creates a pipeline from concept to therapy at speeds that would have seemed pretty much impossible even a decade ago. My reading of Nature reviews and translational medicine articles emphasized both capability and caveats: breakthroughs are fast, but moving from bench to clinic requires rigorous translational infrastructure.

I paid special attention to mRNA vaccines because they are a clear, recent success story with broader engineering lessons: modular design, rapid prototyping, and the leverage of lipid nanoparticle delivery. CRISPR and base-editing trials show therapeutic promise but also hint at delivery and off-target risk issues. The interdisciplinary demand—computational biologists, wet-lab scientists, regulators, and ethicists—means biotechnology is as much an organizational challenge as it is a scientific one.

For my future interests, that suggests two paths: learn laboratory techniques and computational design, and study regulatory and ethical frameworks that govern clinical translation. The field’s promise is enormous, but stewardship and equitable access are part of the responsibility.

Sources (MLA):

Chaudhary, N., et al. “mRNA vaccines for infectious diseases: principles, delivery and clinical translation.” Nature Reviews Drug Discovery, 2021, https://www.nature.com/articles/s41573-021-00283-5. Accessed 30 Oct. 2025.

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Morrison, B. W. “Biotechnology and Translational Medicine.” PMC, 2016, https://pmc.ncbi.nlm.nih.gov/articles/PMC5351330/. Accessed 30 Oct. 2025.

5) Can It Be Possible to Ever Rid Bias, Especially in AI?

I may have a generally positive outlook on AI, but there obviously lies its dark sides. So, I asked the blunt and cliche question: can bias be fully removed from AI systems? The short answer I found in the literature is no. Bias is a structural feature that originates in measurement choices, historical inequalities, data collection practices, and socio-economic systems. Humans are, without doubt, biased creatures. As developers of AI and providing access to published information that WE published (as biased beings), Ai is only bound to have biases. Algorithms reflect and sometimes amplify those biases. One could never be more wrong than to blame the programmers and other scientists for this, for it is truly nothing but a mirror of human systems.

Technical work—reweighting, fairness constraints, counterfactual approaches, and adversarial debiasing—can mitigate many harms in specific contexts. However, academic surveys and real-world case studies (like the COMPAS recidivism controversy) show why technical fixes alone are insufficient. The sustainable approach combines rigorous technical methods with institutional change: diverse teams, continuous auditing, legal remedies, and public oversight.

Practically, my research convinced me to reframe goals: aim for transparency, measurable harm reduction, and accountability rather than chasing neutrality. That is a defensible, and an honest standard to present in my portfolio and it’s the one I’d use as a guideline in any AI project I lead.

Sources (MLA):

Mehrabi, N., et al. “A Survey on Bias and Fairness in Machine Learning.” arXiv, 2019, https://arxiv.org/pdf/1908.09635. Accessed 30 Oct. 2025.

Angwin, J., et al. “Machine Bias.” ProPublica, 23 May 2016, https://www.propublica.org/article/machine-bias-risk-assessments-in-criminal-sentencing. Accessed 30 Oct. 2025.

6) Why Would EQ (Emotional Intelligence) Be More Important Than Pure IQ?

“What’s your IQ” is a cliche question asked throughout the generations since its inception in 1905 by French psychologist Alfred Binet. What about the significance of “EQ” or “Emotional Intelligence”? I went into emotional intelligence research skeptical that it could outrank IQ in value. The evidence pushed me to a subtler claim: while IQ measures problem-solving and abstract reasoning, EQ measures interpersonal skills—self-awareness, empathy, social regulation—that are extremely critical for leadership, teamwork, and sustained project delivery. Reviews in organizational psychology show consistent correlations between EQ and leadership effectiveness across contexts.

In practice, teams execute ideas, not individuals. Brilliant technical solutions require buy-in, coordination, and conflict management to scale. That is why I treat EQ as a multiplier: it amplifies intellectual gifts by improving collaboration. For my own development priorities, that means deliberately practicing communication, feedback, and perspective-taking skills alongside technical study.

For admissions and interviews, I frame this as a commitment to holistic preparation: I can code, but I also work on being the kind of teammate and leader who makes the code matter.

Sources (MLA):

Coronado-Maldonado, I., et al. “Emotional intelligence, leadership, and work teams: A hybrid literature review.” Frontiers in Psychology, 2023, https://pmc.ncbi.nlm.nih.gov/articles/PMC10543214/. Accessed 30 Oct. 2025.

7) Is It Better to Be Objective-Oriented or Explore Subjectiveness?

This question proved philosophical and pragmatic. Objectivity is the backbone of reproducible science and engineering: it gives us tools to verify claims and build reliable systems. Subjectivity, however, captures context, values, and meaning—elements essential for ethics, design, and human-centered problems. The literature on mixed methods research shows how objective and subjective approaches complement each other.

I learned to think in modes: adopt objective, measurable methods when precision and verification matter; use subjective, interpretive methods when exploring values, user experiences, or cultural phenomena. That cognitive flexibility is a practical skill—an intellectual toolkit for deciding which method the problem requires.

In my portfolio I present this as methodological maturity. Admissions officers want students who can choose appropriately between rigor and nuance; demonstrating both is more persuasive than claiming one is uniformly superior.

Sources (MLA):

Horsten, L. “Philosophy of Mathematics.” Stanford Encyclopedia of Philosophy, https://plato.stanford.edu/entries/philosophy-mathematics/. Accessed 30 Oct. 2025.

ERIC. “Mixed-Methods Research: A Discussion on its Types.” ED611786, https://files.eric.ed.gov/fulltext/ED611786.pdf. Accessed 30 Oct. 2025.

8) Regardless of Beliefs, Has Religion Generally Brought Better Order to Humankind?

I treated religion as a social institution that produces norms, networks, and public goods. Historical and sociological evidence suggests religion can increase social capital and civic engagement—Putnam's Bowling Alone and Pew Research's comparative studies are instructive here—but the effects are conditional. Religion has organized charitable institutions, education, and mutual aid in many societies; it has also been mobilized for exclusion or violent conflict in other contexts.

The balanced conclusion is conditional: religion has contributed to social order and cohesion where it fosters inclusive norms and civil engagement; it has caused harm when intertwined with extractive political projects or when it excludes dissenting voices. The relevant policy implication is that civil institutions—religious or secular—must be judged by their openness, accountability, and contribution to public goods.

For my personal reflection, that means valuing the functional role of institutions while holding them accountable to human-rights standards. That balance is practical, historically grounded, and defensible in an application context.

Sources (MLA):

Pew Research Center. "Religion's Relationship to Happiness, Civic Engagement, and Health Around the World." Pew Research Center, 31 Jan. 2019, https://www.pewresearch.org/religion/2019/01/31/religions-relationship-to-happiness-civic-engagement-and-health-around-the-world/. Accessed 30 Oct. 2025.

Putnam, Robert D. Bowling Alone: The Collapse and Revival of American Community. Simon & Schuster, 2000.

9) Why Can't Perfect Circles Really Exist?

This question led me to think about the difference between mathematical ideal and physical instantiation. In Euclidean geometry, a circle is a perfect abstract object defined by an exact locus of points equidistant from a center. But any physical object is made of atoms and subject to thermal motion, measurement noise, and quantum uncertainty. A physical circle can be an excellent approximation, but not an ontologically perfect instance.

Practical engineering shows that our approximations are more than sufficient for human purposes: machining tolerances and manufacturing processes produce shapes precise to the limits we need. Philosophically, though, the impossibility of perfect instantiation illustrates the gap between abstract models and embodied reality—an idea that matters across physics, engineering, and epistemology.

For my portfolio's philosophical piece, this was a neat way to show interdisciplinary thinking: I connected a simple geometric intuition to physics and the philosophy of mathematics, and used it to demonstrate how idealized models guide but do not replace empirical work.

Sources (MLA):

Carnegie Mellon University News. "Do Perfect Circles Exist?" 13 Mar. 2019, https://www.cmu.edu/news/stories/archives/2019/march/pi-day.html. Accessed 30 Oct. 2025.

Horsten, L. "Philosophy of Mathematics." Stanford Encyclopedia of Philosophy, https://plato.stanford.edu/entries/philosophy-mathematics/. Accessed 30 Oct. 2025.

10) Were Numbers/Math Discovered or Invented?

This is the oldest meta-question in the book: are mathematical structures discovered (Platonic realism) or invented (formalism/fictionalism)? Historical work shows humans invented numeral systems, notations, and symbols as tools. Yet mathematical structures—symmetry groups, prime relationships, solutions to differential equations—appear in nature in ways that suggest there is something being discovered about the world.

My synthesis is pluralist: math is both invented and discovered. Human cultures invent notations and frameworks; those frameworks, when rigorous, reveal structures that are objective in the sense that independent observers can verify their consequences. That pragmatic pluralism fits how mathematicians and applied scientists actually work: they create axioms and then discover what follows.

For my intellectual trajectory, this conclusion supports two habits: respect for formal rigor and openness to the sense of discovery that motivates deep inquiry. That combination is exactly the posture I want to bring to college research.

Sources (MLA):

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