RODRIGO ADOLFO REYES FEREGRINO

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EDUCATION

Honours Bachelor of Science with Professional Experience Year (PEY), University of Toronto
Expected graduation June 2026

- Double major: Computer Science and Chemistry | Minor: Philosophy
- **Graduate-level coursework:** Introduction to Quantum Algorithms (CSC2332), Deep Learning and Neural Networks (CSC413)
- **Additional relevant coursework:** Enriched Linear Algebra I, Enriched Data Structures, Algorithm Design & Analysis, Introduction to Computational Chemistry, Structural Biochemistry, Introduction to Medicinal Chemistry and Molecular Recognition.

PUBLICATIONS & MANUSCRIPTS

In Preparation:

- Uvarov, A., **Reyes Feregrino, R.A.**, Wang, L., Zeng, T., and Izmaylov, A.F. "Sampling Quantum Diagonalization from Quantum SENiority-based Subspace Expansion (Q-SENSE) States." *Manuscript in preparation.* (2025)
- Bhogal, J.†, **Reyes Feregrino, R.A.**†, Gupta, P.†, Mathur, A.†, et al. "PHORAGER: Engineering the Future of Phage Therapy Through AI-Driven Host Retargeting." *Manuscript in preparation.* (2025)
†Equal contribution.

RESEARCH EXPERIENCE

Undergraduate Researcher: Quantum and Computational Chemistry August 2025 - Present
Chemical Physics Theory Group (Izmaylov Lab), University of Toronto *Toronto, Canada*

- Co-developed Sampling-based Quantum Diagonalization (SQD) method using Q-SENSE (Quantum SENiority Subspace Expansion) ansätze for NISQ-era electronic structure calculations, creating first practical pipeline leveraging seniority-structured states.
- Designed numerical experiments linking seniority control to sampling efficiency, and demonstrating systematic ansatz engineering optimized for SQD eigenvalue discovery.
- Contributed theoretical insights connecting SQD, Q-SENSE, Adaptive Variational Optimization (AVO), and selected configuration interaction (CI) methods.

Undergraduate Researcher & Dry Lab Lead, iGEM Toronto March 2022 - Present
University of Toronto *Toronto, Canada*

- Lead computational modeling division for University of Toronto's synthetic biology research team, participating in the International Genetically Engineered Machine (iGEM) competition.
- **2025 – Phage Engineering:** Engineered bacteriophage receptor-binding proteins using AI-driven design integrating ESM3 generative models, Boltz-2 structure prediction, and MCMC optimization with simulated annealing to navigate protein fitness landscapes. Developed open-source platform reducing phage screening time from months to days. PHORAGER: Engineering the Future of Phage Therapy Through AI-Driven Host Retargeting
- **2024 – Plasmid Generation:** Developed machine learning pipeline for generating biologically viable, de novo plasmid sequences. Trained Mamba2-based generative model from scratch on 137,000+ plasmid sequences with feature optimization for origins of replication (ORIs). Created largest open-source toolkit for plasmid foundation models. Plasmid.AI: an intelligent platform to write new life
- **2023 – Metabolic Engineering:** Applied genome-scale metabolic models and linear optimization (Flux Balance Analysis, FSEOF algorithm) to predict genetic modifications enhancing bacterial metabolic network efficiency. A comprehensive solution to harness landfill gas emissions

Undergraduate Researcher: Quantum Computing May 2024 - Present
University of Toronto (Supervisor: Prof. Nathan Wiebe) *Toronto, Canada*

- Investigate mathematical foundations of quantum simulation for chemical systems, including product formulas (Trotter-Suzuki approximations, truncated Taylor series) and block-encoding methods (Linear Combination of Unitaries, Qubitization).

- Developed comprehensive quantum simulation framework combining qDRIFT time evolution with quantum phase estimation (QPE) for Hamiltonian eigenvalue estimation, implementing both QFT-based and Kitaev's iterative QPE algorithms
- Designed zero-noise extrapolation protocol using Chebyshev node sampling to eliminate systematic $O(t^2)$ qDRIFT errors, approaching Heisenberg-limited precision scaling
- Implemented optimized parameter sweep framework with function caching, parallelized execution (joblib/loky), and automatic run resumption—enabling large-scale exploration of algorithm performance across 1000+ parameter configurations

INDUSTRY RESEARCH EXPERIENCE

Bioinformatics Software Developer May 2025 - September 2025
Roche - Sequencing by Expansion (SBX) Technology R&D *Mississauga, Canada*

- Developed computational infrastructure for evaluating performance metrics of Roche's novel SBX nanopore sequencing platform, enabling systematic benchmarking of read quality, throughput, and accuracy across experimental conditions.
- Designed and implemented a **bioinformatics data pipeline** for processing time-series sequencing performance data, facilitating longitudinal analysis of algorithm improvements and platform optimization.

Bioinformatician May 2024 - April 2025
Sanofi - Analytical Sciences R&D *Toronto, Canada*

- Improved existing high-throughput genomics pipelines in Python and C++ processing 4.5B+ DNA reads per batch, implementing alignment algorithms and Bayesian inference methods for viral minority variant detection.
- Developed novel heuristics to distinguish biological mutations from RT-PCR and sequencing artifacts via strand-bias correction and read-position mismatch-distribution analysis, reducing false positives by 15%.
- Created graph-based algorithms using k-mer spectrum analysis and local sequence alignment to detect and quantify cross-sample contamination events arising from barcode misassignment and library preparation artifacts.
- Deployed optimized multi-threaded workflows on hybrid cloud cluster for large-scale genomic analyses.

TEACHING EXPERIENCE

Teaching Assistant September 2024 - Ongoing
University of Toronto *Mississauga, Canada*

- Lead tutorials, grade exams, and help design course content for both the mathematics and computer science department.
- TA for: CSC373 (Algorithm Design and Analysis) MAT135 (Differential Calculus), and CSC363 (Computational Complexity and Computabiliy)

TECHNICAL SKILLS

Programming Languages: Python (expert), Java, C, C++

Scientific Computing & ML: NumPy, SciPy, Pandas, Scikit-learn, PyTorch, RDKit, Biopython, COBRApy, Qiskit

Computational Chemistry: Autodock, HADDOCK3, OpenBabel, Spartan, PySCF, OpenFermion

Development Tools: Git, Docker, Conda, Unix/Linux, AWS

Languages: Spanish (native), English (C2), German (C1)

SOFTWARE & OPEN-SOURCE TOOLS

PHORAGER — GitHub

- Open-source platform for AI-driven phage receptor-binding protein engineering (ESM3, Boltz-2, MCMC)

qDRIFT-QPE Extrapolation Framework — GitHub

- Comprehensive quantum simulation framework combining qDRIFT time evolution with quantum phase estimation, featuring Chebyshev node sampling, zero-noise extrapolation, and parallelized parameter sweeps

Plasmid.AI — GitHub

- Largest open-source toolkit for plasmid foundation models; Mamba2-based generative model trained on 137K+ sequences

COBRA-FSEOF — GitHub

- Python implementation of FSEOF algorithm for bacterial strain design using constraint-based metabolic modeling

AWARDS & HONORS

- **iGEM Competition:** 4× Gold Medal (2022-2025), 2× Best Model Award (2023-2024), Best Therapeutics Project (2025), Best Entrepreneurship Award (2024), plus nominations for Best Foundational Advance, Best Wiki, Best Integrated Human Practices, Best Presentation
- Summer Undergraduate Data Science (SUDS) Research Scholarship, University of Toronto (CAD $7,200, 2024) - Fully funded research position at Lunenfeld-Tanenbaum Research Institute; declined due to concurrent commitment at Sanofi. Program details
- University of Toronto Entrance Scholarship (2021)