David E. Bernal Neira [iD]

Website: bernalde.github.io
Email: dbernaln@purdue.edu
LinkedIn: bernalde
GitHub: github.com/bernalde
ORCID: 0000-0002-8308-5016

RESEARCH INTERESTS

- Special interest in optimization applications in Chemical Engineering and Process Systems Engineering such as Process Intensification and Energy Systems Optimal Process Synthesis, Design, Operation, and Control.
- Quantum Algorithms for Combinatorial Optimization, with emphasis in Chemical Engineering applications.
- Development and evaluation of novel hardware algorithms for optimization and chemistry.
- Theory and applications of Decision-making Optimization, Machine Learning, and Artificial Intelligence.
- Discrete-Continuous Nonlinear Optimization Solution Algorithms, Theory, and Software.

EDUCATION

Carnegie Mellon University   Pittsburgh, PA, USA
Ph.D. in Chemical Engineering, Advisor: Prof. Ignacio E. Grossmann, GPA: 3.92/4.00   2017–2021

Universidad de los Andes   Bogotá, Colombia
B.S. in Physics, GPA: 4.62/5.00   2011–2018

M.S. in Chemical Engineering, GPA: 4.73/5.00   2014–2016

B.S. in Chemical Engineering with Honors - Cum Laude, GPA: 4.62/5.00   2010–2014

EXPERIENCE

NASA - Universities Space Research Association (USRA)   Mountain View, CA, USA
Research Scientist at NASA Quantum and Artificial Intelligence Laboratory (QuAIL)   2021-Current

Associate Scientist at USRA Research Institute of Advanced Computer Science (RIACS)   2021-Current

- Study and design of optimization algorithms that exploit quantum computing for science and engineering

Ph.D. Intern as part of Feynman Quantum Academy NASA QuAIL and USRA RIACS   Summer 2019

- Development and Implementation of Computational Algebraic Geometry and Integer Programming based compiler for Quantum Annealing problem embedding

Carnegie Mellon University – Department of Chemical Engineering   Pittsburgh, PA, USA
Visiting Research Scholar   2021-Current

- Management of Grossmann Research Group meetings
- Maintenance of Mixed-Integer Nonlinear and Generalized Disjunctive Programming Library minlp.org

Ph.D. Student   2017-2021

- Algorithm development and study for optimization problems with application in chemical, process, and energy systems engineering
- Algorithm development for Mixed-Integer Nonlinear Programming and Generalized Disjunctive Programming
- Study of short-term quantum computing techniques for combinatorial optimization

Visiting Research Scholar   Summer 2015

- Implementation of Mixed-Integer Nonlinear Programming (MINLP) heuristic algorithms in solver DICOPT

ExxonMobil Engineering and Research Company   Clinton, NJ, USA
Ph.D. Intern at Corporate Strategic Research Division   Summer 2020

- Evaluation of quantum computing for solving optimization problems relevant to logistics in oil & gas

Ph.D. Intern at the Process Technology Department   Summer 2018

- Development, implementation, and deployment of a combined heat and power plant with carbon capture technologies optimal operation model

Universidad de los Andes – Department of Chemical Engineering   Bogotá, Colombia
Graduate Teaching and Research Assistant   2014-2016

- Researcher in the Process and Products Design Group and the Processes Optimization Group

Bayer Technology Services   Leverkusen, Germany
Undergraduate Intern   Spring 2013

- Modeling and automatic implementation of dynamic flooding in distillation columns, and thermodynamic and electrolytic effects in HCl water absorption for acid absorption columns simulation

TEACHING

Carnegie Mellon University   Pittsburgh, PA, USA
Course Instructor in the Tepper School of Business and Electrical and Computers Engineering   Fall 2021

- 47-779 / 47-785 Quantum Integer Programming and Quantum Machine Learning graduate course

Course Instructor in the Tepper School of Business   Fall 2020

- 47-779 Quantum Integer Programming graduate course

Graduate Teaching Assistant in the Chemical Engineering Department

- 06-421 Chemical Process Systems Design undergraduate course.   Fall 2017, Fall 2018
  - *Mark Dennis Karl Outstanding Teaching Assistant Award*
- 06-720 Advanced Process Systems Engineering graduate course   Spring 2018
- 06-805 Special Topics in Chemical Engineering – Disjunctive Programming graduate course   Spring 2018

Universidad de los Andes   Bogotá, Colombia
Graduate Recitation Leader in the Chemical Engineering Department   2014–2016

- IQUI3040 Chemical Process Optimization   2015-2016
- IQUI2021 Phase and Chemical Equilibrium   2014

Undergraduate Teaching Assistant and Grader   2010–2014

- IQUI3001 Separation Processes and IQUI3040 Chemical Process Optimization in the Chemical Engineering Department
- FISI1518 Physics 1, FISI1528 Physics 2, and FISI2540 Thermodynamics in the Physics Department
- MATE1203 Differential Calculus and MATE2301 Differential Equations in the Mathematics Department

Teaching-related Training

- Future Faculty Program - CMU Eberly Center for Teaching Excellence and Educational Innovation   2019–2022
- Teaching Effectiveness Colloquium - Institute for Operations Research and Management Science   2020

MENTORING

NASA - Universities Space Research Association   Mountain View, CA, USA
Feynmann Quantum Academy   2021-2023

- Robin Brown
- Phillip Kerger
- Pratik Sathe

- Dan Zhao
- Diana Chamaki
- Christopher Um

Carnegie Mellon University   Pittsburgh, PA, USA
M.Sc. students Research   2018-2020

- Yunshan Liu
- Haokun Yang

Undergraduate students Honors Research   2018-2020

- Felicity Gong
- Rahul Joglekar
- Saeed Syed
- Zhifei Yuliu

Universidad de los Andes   Bogotá, Colombia
Undergraduate students Thesis   2015-2016

- Paola Cristancho
- Hugo Cuellar

Journal Publications

[J1] L. Su, **D. E. Bernal**, I. E. Grossmann, and L. Tang, "Modeling for integrated refinery planning with crude-oil scheduling", *Chemical Engineering Research and Design*, vol. 192, pp. 141–157, 2023. DOI: 10.1016/j.cherd.2023.02.008.

[J2] **D. E. Bernal**, "Coherent simulation with thousands of qubits", *Nature Physics*, 2022. DOI: 10.1038/s41567-022-01772-z.

[J3] **D. E. Bernal**, A. Ajagekar, S. M. Harwood, S. T. Stober, D. Trenev, and F. You, "Perspectives of Quantum Computing for Chemical Engineering", *AIChE Journal*, e17651, 2022. DOI: 10.1002/aic.17651.

[J4] **D. E. Bernal**, Z. Peng, J. Kronqvist, and I. E. Grossmann, "Alternative regularizations for Outer-Approximation algorithms for convex MINLP", *Journal of Global Optimization*, pp. 1–36, 2022.

[J5] R. Quintero, **D. E. Bernal**, T. Terlaky, and L. F. Zuluaga, "Characterization of QUBO reformulations for the maximum k-colorable subgraph problem", *Quantum Information Processing*, vol. 21, no. 3, pp. 1–36, 2022. DOI: 10.1007/s11128-022-03421-z.

[J6] Q. Chen, E. S. Johnson, **D. E. Bernal**, R. Valentin, S. Kale, J. Bates, J. D. Siirola, and I. E. Grossmann, "Pyomo. GDP: an ecosystem for logic based modeling and optimization development", *Optimization and Engineering*, pp. 1–36, 2021. DOI: 10.1007/s11081-021-09601-7.

[J7] S. Harwood, C. Gambella, D. Trenev, A. Simonetto, **D. E. Bernal**, and D. Greenberg, "Formulating and Solving Routing Problems on Quantum Computers", *IEEE Transactions on Quantum Engineering*, 2021. DOI: 10.1109/TQE.2021.3049230.

[J8] D. A. Liñán, **D. E. Bernal**, J. M. Gómez, and L. A. Ricardez-Sandoval, "Optimal synthesis and design of catalytic distillation columns: A rate-based modeling approach", *Chemical Engineering Science*, vol. 231, p. 116 294, 2021. DOI: 10.1016/j.ces.2020.116294.

[J9] H. A. Pedrozo, S. R. Reartes, **D. E. Bernal**, A. Vecchietti, M. S. Díaz, and I. E. Grossmann, "Hybrid model generation for superstructure optimization with Generalized Disjunctive Programming", *Computers & Chemical Engineering*, vol. 154, p. 107 473, 2021. DOI: 10.1016/j.compchemeng.2021.107473.

[J10] **D. E. Bernal**, S. Vigerske, F. Trespalacios, and I. E. Grossmann, "Improving the performance of DICOPT in convex MINLP problems using a feasibility pump", *Optimization Methods and Software*, vol. 35, no. 1, pp. 171–190, 2020. DOI: 10.1080/10556788.2019.1641498.

[J11]   T. J. Ikonen, H. Mostafaei, Y. Ye, **D. E. Bernal**, I. E. Grossmann, and I. Harjunkoski, "Large-scale selective maintenance optimization using bathtub-shaped failure rates", *Computers & Chemical Engineering*, vol. 139, p. 106 876, 2020. DOI: 10.1016/j.compchemeng.2020.106876.

[J12]   J. Kronqvist, **D. E. Bernal**, and I. E. Grossmann, "Using regularization and second order information in outer approximation for convex MINLP", *Mathematical Programming*, vol. 180, no. 1, pp. 285–310, 2020. DOI: 10.1007/s10107-018-1356-3.

[J13]   C. Li, **D. E. Bernal**, K. C. Furman, M. A. Duran, and I. E. Grossmann, "Sample average approximation for stochastic nonconvex mixed integer nonlinear programming via outer-approximation", *Optimization and Engineering*, pp. 1–29, 2020. DOI: 10.1007/s11081-020-09563-2.

[J14]   D. A. Liñán, **D. E. Bernal**, L. A. Ricardez-Sandoval, and J. M. Gómez, "Optimal design of superstructures for placing units and streams with multiple and ordered available locations. Part I: A new mathematical framework", *Computers & Chemical Engineering*, p. 106 794, 2020. DOI: 10.1016/j.compchemeng.2020.106794.

[J15]   D. A. Liñán, **D. E. Bernal**, L. A. Ricardez-Sandoval, and J. M. Gómez, "Optimal design of superstructures for placing units and streams with multiple and ordered available locations. Part II: Rigorous design of catalytic distillation columns", *Computers & Chemical Engineering*, p. 106 845, 2020. DOI: 10.1016/j.compchemeng.2020.106845.

[J16]   H. Yang, **D. E. Bernal**, R. E. Franzoi, F. G. Engineer, K. Kwon, S. Lee, and I. E. Grossmann, "Integration of Crude-Oil Scheduling and Refinery Planning by Lagrangean Decomposition", *Computers & Chemical Engineering*, p. 106 812, 2020. DOI: 10.1016/j.compchemeng.2020.106812.

[J17]   J. Kronqvist, **D. E. Bernal**, A. Lundell, and I. E. Grossmann, "A review and comparison of solvers for convex MINLP", *Optimization and Engineering*, vol. 20, no. 2, pp. 397–455, 2019. DOI: 10.1007/s11081-018-9411-8.

[J18]   J. Kronqvist, **D. E. Bernal**, A. Lundell, and T. Westerlund, "A center-cut algorithm for quickly obtaining feasible solutions and solving convex MINLP problems", *Computers & Chemical Engineering*, vol. 122, pp. 105–113, 2019. DOI: 10.1016/j.compchemeng.2018.06.019.

[J19]   C. L. Lara, **D. E. Bernal**, C. Li, and I. E. Grossmann, "Global optimization algorithm for multi-period design and planning of centralized and distributed manufacturing networks", *Computers & Chemical Engineering*, vol. 127, pp. 295–310, 2019. DOI: 10.1016/j.compchemeng.2019.05.022.

[J20]   **D. E. Bernal**, C. Carrillo-Diaz, J. M. Gómez, and L. A. Ricardez-Sandoval, "Simultaneous design and control of catalytic distillation columns using comprehensive rigorous dynamic models", *Industrial & Engineering Chemistry Research*, vol. 57, no. 7, pp. 2587–2608, 2018. DOI: 10.1021/acs.iecr.7b04205.

[J21]   L. Su, L. Tang, **D. E. Bernal**, and I. E. Grossmann, "Improved quadratic cuts for convex mixed-integer nonlinear programs", *Computers & Chemical Engineering*, vol. 109, pp. 77–95, 2018, ISSN: 0098-1354. DOI: 10.1016/j.compchemeng.2017.10.011.

[J22]   L. Leisman, M. P. Haynes, S. Janowiecki, G. Hallenbeck, G. Józsa, R. Giovanelli, E. A. Adams, **D. E. Bernal**, J. M. Cannon, W. F. Janesh, *et al.*, "(Almost) Dark Galaxies in the ALFALFA Survey: Isolated H i-bearing Ultra-diffuse Galaxies", *The Astrophysical Journal*, vol. 842, no. 2, p. 133, 2017. DOI: 10.3847/1538-4357/aa7575.

Articles Preprints, in Progress, or Under Review

[S1]   **D. E. Bernal**, H. Alghassi, R. Dridi, S. Tayur, and I. E. Grossmann, "Evaluating the Quantum inspired Graver Based Algorithm for Integer Nonlinear Programs", In preparation.

[S2]   **D. E. Bernal**, Z. Peng, C. Li, K. Furman, and I. E. Grossmann, "Implementing Global Outer-Approximation for nonconvex MINLP", In preparation.

[S3]   W. Chaimanowong, **D. E. Bernal**, and F. Cisternas, "Optimizing Product Influence of Shelf Display", Submitted for publication. Available here., 2023.

[S4]   P. A. Kerger, **D. E. Bernal**, Z. Gonzalez Izquierdo, and E. G. Rieffel, "Asymptotically Faster Quantum Distributed Algorithms for Approximate Steiner Trees and Directed Minimum Spanning Trees", Submitted for publication. Available here., 2023.

[S5]   T. Lubinski, C. Coffrin, C. McGeoch, P. Sathe, J. Apanavicius, and **D. E. Bernal**, "Optimization applications as quantum performance benchmarks", Submitted for publication. Available here., 2023.

[S6] P. Maciel Xavier, P. Ripper, T. Andrade, J. Dias Garcia, N. Maculan, and **D. E. Bernal**, "QUBO.jl: A Julia Ecosystem for Quadratic Unconstrained Binary Optimization", Submitted for publication. Available here., 2023.

[S7] R. Brown, **D. E. Bernal**, D. Venturelli, and M. Pavone, "Copositive programming for mixed-binary quadratic optimization via ising solvers", Submitted for publication. Available here., 2022.

[S8] **D. E. Bernal** and I. E. Grossmann, "Convex Mixed-Integer Nonlinear Programs Derived from Generalized Disjunctive Programming using Cones", Submitted for publication. Available here., 2021.

[S9] **D. E. Bernal**, S. Tayur, and D. Venturelli, "Quantum Integer Programming (QuIP) 47-779: Lecture Notes", Available here., 2020.

Conference Proceedings

[P1] **D. E. Bernal**, Y. Liu, M. L. Bynum, C. D. Laird, J. D. Siirola, and I. E. Grossmann, "Advances in generalized disjunctive and mixed-integer nonlinear programming algorithms and software for superstructure optimization", in *Computer Aided Chemical Engineering*, vol. 49, **(PSE2021+)**, Elsevier, 2022, pp. 1285–1290.

[P2] **D. E. Bernal**, D. Ovalle, D. A. Liñán, L. A. Ricardez-Sandoval, J. M. Gómez, and I. E. Grossmann, "Process superstructure optimization through discrete steepest descent optimization: A gdp analysis and applications in process intensification", in *Computer Aided Chemical Engineering*, vol. 49, **(PSE2021+)**, Elsevier, 2022, pp. 1279–1284.

[P3] **D. E. Bernal**, K. E. Booth, R. Dridi, H. Alghassi, S. Tayur, and D. Venturelli, "Integer programming techniques for minor-embedding in quantum annealers", in *International Conference on Integration of Constraint Programming, Artificial Intelligence, and Operations Research*, **(CPAIOR2020)**, Springer, 2020, pp. 112–129. DOI: 10.1007/978-3-030-58942-4_8.

[P4] **D. E. Bernal**, Q. Chen, F. Gong, and I. E. Grossmann, "Mixed-Integer Nonlinear Decomposition Toolbox for Pyomo (MindtPy)", in *13th International Symposium on Process Systems Engineering (PSE 2018)*, ser. Computer Aided Chemical Engineering, vol. 44, **(PSE2018)**, Elsevier, 2018, pp. 895–900. DOI: 10.1016/B978-0-444-64241-7.50144-0.

[P5] L. Su, L. Tang, **D. E. Bernal**, I. E. Grossmann, and B. Wang, "Integrated scheduling of on-line blending and distribution of oil products in refinery operation", in *13th International Symposium on Process Systems Engineering (PSE 2018)*, ser. Computer Aided Chemical Engineering, vol. 44, **(PSE2018)**, Elsevier, 2018, pp. 1213–1218. DOI: 10.1016/B978-0-444-64241-7.50197-X.

Conference Presentations

1. **Bernal, D.E.**, Brown, R.A., Venturelli, D., Pavone, M. "Hybrid Classical-Quantum Algorithms for Mixed-Integer Optimization", *SIAM OP23*.

2. **Bernal, D.E.** "Discrete nonlinear optimization: Modeling and solutions via novel hardware and decomposition algorithms", *2023 Quantum Computing Applications in Chemical and Biochemical Engineering Workshop*.

3. **Bernal, D.E.**, Kerger, P., Rieffel, E.G., "Quantum Distributed Algorithms for Approximate Steiner Trees and Directed Minimum Spanning Trees", *2023 American Physics Society (APS) March Meeting*.

4. Sathe, P., Lubinski, T., Coffrin, C., Apanavicius, J., McGeoch, C., **Bernal, D.E.** "Characteristics of Optimization Applications as Quantum Performance Benchmarks", *2023 APS March Meeting*.

5. Quintero, R.A., **Bernal, D.E.**, Terlaki, T., Zuluaga, L., "Characterization of QUBO reformulations for the maximum k-colorable subgraph problem", *XXI Latin-Iberoamerican Conference on Operations Research (CLAIO) 2022*.

6. **Bernal, D.E.** "Perspectives on Quantum Computing for Chemical Engineering: A joint view from Academia and Industry", *2022 American Institute of Chemical Engineering (AIChE) Meeting*.

7. **Bernal, D.E.**, Venturelli, D., Wudarski, F.A., Rieffel, E.G. "Benchmarking the Operation of Quantum Heuristics and Ising Machines: Scoring Parameter Setting Strategies on Real World Optimization Applications", *2022 Institute for Operations Research and Management Sciences (INFORMS) Meeting*.

8. Brown, R.A., **Bernal, D.E.**, Venturelli, D., Pavone, M. "Copositive Optimization via Ising Solvers", *2022 INFORMS Meeting*.

9. Rieffel, E., Kerger, P., **Bernal, D.E.**. "Quantum, quantum-classical hybrid, and distributed quantum algorithms for problems in operations research", *Workshop on Quantum Computing and Operations Research.*

10. **Bernal, D.E.**, Brown, R.A., Venturelli, D., Pavone, M. "Mixed-Binary Quadratic Programming via Convex Copositive Optimization and Ising Solvers", *7th International Conference on Continuous Optimization (ICCOPT) 2022.*

11. Brown, R.A., **Bernal, D.E.**, Sahasrabudhe, A., Loot, A., Venturelli, D., Pavone, M. "Copositive optimization via Ising solvers", *24th International Conference on the Integration of Constraint Programming, Artificial Intelligence, and Operations Research (CPAIOR) 2022*, Video.

12. **Bernal, D.E.** "Perspectives on Quantum Computing for Chemical Engineering: A joint view from Academia and Industry", *2022 Quantum Computing Applications in Chemical and Biochemical Engineering Workshop.*

    - Prize for best talk at the workshop

13. **Bernal, D.E.**, Venturelli, D., Wudarski, F.A., Rieffel, E.G. "Benchmarking the Operation of Quantum Heuristics and Ising Machines: Scoring Parameter Setting Strategies on Real World Optimization Applications", *2022 APS March Meeting.*

14. **Bernal, D.E.**, Peng, Z., Kronqvist, J., Grossmann, I.E. "Alternative Regularization Schemes in Outer-Approximation Algorithms for Convex MINLP", *2021 AIChE Meeting.*

15. **Bernal, D.E.**, Ovalle, D., Liñán, D., Gómez, J.M., Ricardez-Sandoval, L., Grossmann, I.E. "Discrete-Steepest Descent: A Solution Method for Process Synthesis Generalized Disjunctive Programs", *2021 AIChE Meeting.*

16. Pedrozo, A., Rodriguez, S.B., **Bernal, D.E.**, Vechietti, A., Diaz, M.S., Grossmann, I.E. "Optimal Synthesis and Heat Integration Using Generalized Disjunctive Programming with Hybrid Models", *2021 AIChE Meeting.*

17. **Bernal, D.E.**, Grossmann, I.E. "Easily Solvable Convex Mixed-Integer Nonlinear Programs Derived from Generalized Disjunctive Programming using Cones", *2021 INFORMS Meeting.*

18. Quintero, R.A., **Bernal, D.E.**, Terlaki, T., Zuluaga, L., "Characterization of QUBO reformulations for the maximum k-colorable subgraph problem", *2021 INFORMS Meeting.*

19. **Bernal, D.E.**, Peng, Z., Kronqvist, J., Grossmann, I.E. "Regularization in Decomposition Methods for Global Optimization of Mixed-Integer Nonlinear Programming", *2021 Society for Industrial and Applied Mathematics (SIAM) Conference on Optimization.*

20. **Bernal, D.E.**, Peng, Z., Kronqvist, J., Grossmann, I.E. "Regularization in Decomposition Methods for Global Optimization of Mixed-Integer Nonlinear Programming", *31st European Conference on Operational Research (EURO) 2021.*

21. Li, C., Grossmann, I.E., **Bernal, D.E.**, Furman, K., "Sample Average Approximation for Stochastic Nonconvex Mixed Integer Nonlinear Programming via Outer Approximation", *31st EURO 2021.*

22. Quintero, R.A., **Bernal, D.E.**, Terlaki, T., Zuluaga, L., "Characterization of QUBO reformulations for the maximum k-colorable subgraph problem", *31st EURO 2021.*

23. **Bernal, D.E.** "Modern Computational Approaches to Nonlinear Discrete Optimization and Their Application to Process Systems Engineering", *2020 AIChE Meeting.*

    - Meet the Faculty & Post-Doc Candidates Poster Session

24. **Bernal, D.E.**, Grossmann, I.E. "Use of Quantum Computing to Solve Optimization Problems in Process Systems Engineering", *2020 AIChE Meeting.*

    - Computing and Systems Technology Division Directors' Student Award Finalist

25. Li, C., **Bernal, D.E.**, Grossmann, I.E., Furman, K., "Sample Average Approximation for Stochastic Nonconvex Mixed Integer Nonlinear Programming via Outer Approximation", *2020 AIChE Meeting.*

26. Chen, Q., **Bernal, D.E.**, Johnson, E., Valentin, R., Kale, S., Bates, J., Siirola, J.D., Grossmann, I.E. "Pyomo.GDP: An Ecosystem for Logic-Based Modeling and Optimization Development", *2020 AIChE Meeting.*

27. Chen, Q., Liu Y., Seastream G., **Bernal, D.E.**, Siirola, J.D., Grossmann, I.E. "Pyosyn Graph: New Representation and Systematic Generation of Process Superstructures", *2020 AIChE Meeting.*

28. **Bernal, D.E.**, Kronqvist, J., Lundell, A., Grossmann, I.E. "A Review And Comparison Of Solvers For Convex MINLP", *2020 INFORMS Meeting.*

29. Li, C., **Bernal, D.E.**, Grossmann, I.E., Furman, K., "Sample Average Approximation for Stochastic Nonconvex Mixed Integer Nonlinear Programming via Outer Approximation", *2020 INFORMS Meeting.*

30. **Bernal, D.E.**, Booth, K.E.C., Dridi, R., Alghassi, H., Tayur, S., Venturelli, D. "Integer Programming techniques for minor-embedding in quantum annealers", *Constraint Programming, Artificial Intelligence, Operations Research CPAIOR 2020.*

31. **Bernal, D.E.**, Grossmann, I.E. "Easily Solvable Convex Mixed-Integer Nonlinear Programs Derived from Generalized Disjunctive Programming using Cones", *2019 AIChE Meeting.*

32. Chen, Q., Kale, S., Bates, J., Romeo, V., **Bernal, D.E.**, Bynum, M., Siirola, J.D., Grossmann, I.E. "Pyosyn: A Collaborative Ecosystem for Process Design Advancement", *2019 AIChE Meeting.*

33. **Bernal, D.E.**, Valentin, R., Chen, Q., Grossmann, I.E. "Mixed-integer Nonlinear Decomposition Toolbox for Pyomo MindtPy", *2019 INFORMS Meeting.*

34. Chen, Q., Valentin, R., Kale, S., Bates, J., **Bernal, D.E.**, Bynum, M.L., Siirola, J., Grossmann, I.E. "Advances in Pyomo.GDP: an Ecosystem For Nonlinear Disjunctive Programming Modeling and Optimization Development", *2019 INFORMS Meeting.*

35. **Bernal, D.E.**, Su, L., Tang, L., Grossmann, I.E. "Quadratic Cut Decomposition Method for Convex Mixed-Integer Nonlinear Programs", *2018 AIChE Meeting.*

36. Yang, H., **Bernal, D.E.**, Grossmann, I.E. "Integration of Crude-Oil Scheduling and Refinery Planning By Lagrangean Decomposition Approach", *2018 AIChE Meeting.*

    - Best submission in the Refining and Petrochemical Plant Modeling and Operations Improvement Session

37. **Bernal, D.E.**, Gong, F., Chen, Q., Grossmann, I.E. "Mixed-integer Nonlinear Decomposition Toolbox for Pyomo", *2018 INFORMS Meeting.*

38. **Bernal, D.E.**, Kronqvist, J., Lundell, A., Westerlund, T., Grossmann, I.E. "A Center Cut Algorithm for Quickly Obtaining Feasible Solutions and Solving Convex Mixed Integer Nonlinear Programs", *2018 INFORMS Meeting.*

39. Yang, H., **Bernal, D.E.**, Grossmann, I.E. "Integration of Crude-Oil Scheduling and Refinery Planning By Lagrangean Decomposition Approach", *2018 INFORMS Meeting.*

40. Su, L., Tang, L., **Bernal, D.E.**, Grossmann, I.E., Wang, B. "Integrated Scheduling of On-Line Blending and Distribution of Oil Products in Refinery Operation", *13th International Symposium on Process Systems Engineering PSE 2018*

41. Kronqvist, J., **Bernal, D.E.**, Grossmann, I.E. "A Level-Based Quadratic Outer-Approximation Algorithm for convex MINLP", *2017 AIChE Meeting.*

42. **Bernal, D.E.**, Gomez, J.M. "Optimal design and control of a catalytic distillation column. Case study: Ethyl tert-butyl ether (ETBE) synthesis column", *2016 AIChE Meeting.*

43. **Bernal, D.E.**, Vigerske, S., Trespalacios, F., Grossmann, I.E. "Feasibility pump for solving convex MINLP problems with DICOPT", *2016 AIChE Meeting.*

Theses

[T1]   **D. E. Bernal**, "Modern Computational Approaches to Nonlinear Discrete Optimization and Applications in Process Systems Engineering.", Ph.D. Thesis available here, Ph.D. dissertation, Carnegie Mellon University, 2021.

[T2]   **D. E. Bernal**, *Optimal design and control of a catalytic distillation column. Case study: Ethyl tert-butyl ether (ETBE) synthesis column.* M.Sc. Thesis available here, 2017.

[T3]   **D. E. Bernal**, *Bounding the tangential velocities of Andromeda's satellite galaxies using nonlinear programming.* B.S. Thesis available (in Spanish) here, 2016.

[T4]   **D. E. Bernal**, *Comparative study of the simulation methods of the extractive distillation system for the dehydration of ethanol using glycerol as a solvent.* B.S. Thesis available (in Spanish) here, 2014.

Awards and Honors

- Best talk award at Quantum Computing Applications in Chemical and Biochemical Engineering Workshop 2022
  American Institute of Chemical Engineers and Technical University of Denmark

- Finalist for AIChE CAST Directors' Student Presentation Awards 2020
  Computing & Systems Technology Division (CAST) - American Institute of Chemical Engineers

- Mark Dennis Karl Outstanding Teaching Assistant Award 2019
  Chemical Engineering Department - Carnegie Mellon University

- Cum Laude in Chemical Engineering 2014
  Universidad de los Andes

- Valedictorian 2009
  Gimnasio Británico

- First place in the Colombian Physics Olympiad, Superior level 2007
  Universidad Antonio Nariño

Fellowships and Scholarships

- NSF Supplement Award 2038247 Enabling Quantum Computing Platform access with Amazon Web Services 2020
  NSF Proposal "GOALI: Optimal Design and Operation of Reliable Process Systems." 1705372

- Travel Award to attend CRM/DIMACS Workshop on Mixed-Integer Nonlinear Programming 2019
  Centre de recherches mathématiques and Center for Discrete Mathematics and Theoretical Computer Science

- Feynman Quantum Academy - Internship Program 2019
  University Space Research Association (USRA), NASA Quantum and Artificial Intelligence Laboratory

- NSF Travel Award 1838086 2018
  NSF Proposal "GOALI: Optimal Design and Operation of Reliable Process Systems." 1705372

- Travel Award to attend COIN fORgery workshop 2019
  Institute for Mathematics and its Applications and Computational Infrastructure for Operations Research

- Travel Award to attend Dagstuhl seminar on Mixed-Integer Nonlinear Optimization 2018
  NSF Support Grant for Junior Researchers CNS-1257011 and Schloss Dagstuhl Leibniz'Zentrum für Informatik

- Undergraduate Research Fellow in Astrophysics SURF Cornell-UniAndes 2016
  Cornell University and Universidad de los Andes

- Fellowship for Master of Science Degree in Chemical Engineering 2014
  Chemical Engineering Department, Universidad de los Andes

- Fellowship for Ph.D. in Chemical Engineering 2014
  Center of Advanced Decision-making (CAPD), Chemical Engineering Department, Carnegie Mellon University

- Young Engineers Scholarship for International Exchange at Otto-von-Guericke Universität 2012
  German Academic Exchange Service (DAAD), Colombian Science National System (COLCIENCIAS), and Universidad de los Andes

- Alberto Magno Scholarship to Academic Excellence 2009
  Universidad de los Andes

Invited Seminars and Lectures

- Overview Seminar: Discrete nonlinear optimization: Modeling and solutions via novel hardware and decomposition algorithms - Learning from Both Sides Linear and Nonlinear Mixed-Integer Optimization, Institut Mittag-Leffler, Stockholm, Sweden July 2023

- Seminar: Discrete nonlinear optimization: Modeling and solutions via novel hardware and decomposition algorithms - Power Systems Lab, Department of Information Technology and Electrical Engineering, ETH, Zürich, Switzerland Feb. 2023

- Seminar: Perspectives on Quantum Computing for Chemical Engineering: A joint view from Academia and Industry - Sargent Centre of Process Systems Engineering, Imperial College London, London, UK   Feb. 2023

- Seminar: Perspectives on Quantum Computing for Chemical Engineering: A joint view from Academia and Industry - CODES Research Group Meeting, University of West Virginia, Morgantown, VA, USA   Feb. 2023

- Lecture: Discrete nonlinear optimization: Modeling and solutions via novel hardware and decomposition algorithms - 5th Grid Science Winter School - Los Alamos National Laboratory, Santa Fe, NM, USA   Jan. 2023

- Seminar: Perspectives on Quantum Computing for Chemical Engineering: A joint view from Academia and Industry - Sustainable Process Systems Engineering Lab, Institute of Chemical and Bioengineering, ETH, Zürich, Switzerland Dec. 2022

- Seminar: Perspectives on Quantum Computing for Chemical Engineering: A joint view from Academia and Industry - Department of Chemical Engineering, McMaster University, Hamilton, ON, Canada   Oct. 2022

- Seminar: Exploiting and Benchmarking Ising Solvers - Quantum Pittsburgh (QPitt) Meetup, Pittsburgh, PA, USA Oct. 2022

- Seminar: Introduction to Quantum Computing and Perspectives of Quantum Computing for Chemical Engineering - Quantum Pittsburgh (QPitt) Meetup, Pittsburgh, PA, USA   Jun. 2022

- Plenary Moderator and Panelist: Future of Quantum Computing in Optimization - 2022 CORS/INFORMS International Conference, Vancouver, Canada   Jun. 2022

- Seminar: Quantum Computing and Modern Computational Optimization Approaches to Process Systems Engineering - Laboratoire d'Informatique de Paris Nord, Paris, France   Apr. 2022

- Seminar: Quantum Computing and Modern Computational Optimization Approaches to Process Systems Engineering (in Spanish) - Universidad de los Andes, Bogotá, Colombia   Jan. 2022

- Seminar: Modern Computational Approaches to Nonlinear Discrete Optimization and Process Systems Engineering (in Spanish) - Universidad Nacional de Colombia, Bogotá, Colombia   Dec. 2021

- Plenary: Modern Computational Approaches to Nonlinear Discrete Optimization and Process Systems Engineering (in Spanish) - Argentinian Symposium on Industrial Computing and Operations Research, Argentina Video   Aug. 2021

- Quantum Computing for Discrete Nonlinear Optimization. Graver Augmented Multiseed Algorithm - Mixed-Integer Nonlinear Programming Virtual Workshop, Computational Optimization Group, Imperial College, London, UK Video   Jun. 2021

- Invited Lecture for Modeling and Optimization Group, PSR, Rio de Janeiro, Brazil   Apr. 2021

- Seminar: Modern Computational Approaches to Nonlinear Discrete Optimization - Quantum Computing and Mathematical Optimization, Real World Optimization meeting, Gesellschaft für Operations Research and German Aerospace Center, Germany   Mar. 2021

- Seminar: Modern Computational Approaches to Nonlinear Discrete Optimization and Applications in Process Systems Engineering - Group for Applied Mathematical Modeling and Analytics, Industrial Engineering Department, University at Buffalo, NY, USA   Mar. 2021

- Seminar: Modern Computational Approaches to Nonlinear Discrete Optimization (in Spanish) - Chemical Engineering Department, Universidad de Salamanca, Salamanca, Spain   Jan. 2021

- Invited Lecture for Modeling and Optimization Journal Club: Quantum Computing for Optimization - Modeling and Optimization, Amazon, Seattle, WA, USA   Jan. 2021

- Invited Lecture for 17-617 Programming Quantum Computers: Quantum Annealing and Ising Model Computation - Institute for Software Research, Carnegie Mellon University, Pittsburgh, PA, USA   Dec. 2020

- Seminar: Modern Computational Approaches to Nonlinear Discrete Optimization and their Application to Process Systems Engineering - Chemical Engineering Future Faculty Series   Dec. 2020

- Seminar: Modern Computational Approaches to Nonlinear Discrete Optimization and their Application to Process Systems Engineering - Discrete Optimization Talks (DOT) Video   Dec. 2020

- Invited Distinguished Speaker: Modern computational approaches to nonlinear discrete optimization - Department of Chemical and Biological Engineering, University of Wisconsin-Madison, Madison, WI, USA   Nov. 2020
- Invited Lecture for ID5840 Quantum Integer Programming – Department of Electrical Engineering, Indian Institute of Technology, Madras, India   Oct. 2020
- Invited Lecture for 06-720 Advanced Process Systems Engineering: Constraint Programming - Chemical Engineering Department, Carnegie Mellon University, Pittsburgh, PA, USA   Feb. 2020
- Short Course: Mixed-Integer and Disjunctive Optimization Theory, Software, and Algorithms - Institute of Industrial & Systems Engineering, Northeastern University, Shenyang, China   April 2019
- Invited Lecture for 47-830 Integer Programming: Valid inequalities for Mixed-Integer Programming - Tepper School of Business, Carnegie Mellon University, Pittsburgh, PA, USA   Feb. 2019
- Seminar: Incorporating Quadratic Approximations in the Outer-Approximation Method for Convex MINLP - Universidad Nacional del Litoral, Santa Fé, Argentina   Aug. 2018
- Software Wokshop: Mathematical Programming in Python/Pyomo - Instituto de Desarrollo y Diseño INGAR CONICET-Universidad Tecnológica Nacional, Santa Fé, Argentina   Aug. 2018

Incorporating Quadratic Approximations in the Outer-Approximation Method for Convex MINLP - Designing and Implementing Algorithms for Mixed-Integer Nonlinear Optimization, Dagstuhl Seminar 18081, Dagstuhl, Germany   Feb. 2018

SERVICE

Peer Reviewing Activities

- Associate Editor - Frontiers in Chemical Engineering, Computational Methods in Chemical Engineering   2023
- Computers & Chemical Engineering   2020–2023
- Optimization Letters   2021–2022
- Nature Physics   2022
- Quantum Information Processing   2022
- Operational Research   2022
- Frontiers of Sustainability   2022
- IEEE Conference on Decision and Control   2022
- Optimization & Engineering   2019–2021
- Journal of Optimization Theory and Applications   2021
- Quantum Machine Intelligence   2021
- Current Opinion in Chemical Engineering 2021
- Mathematical Programming   2020
- Journal of Global Optimization   2019–2021
- Chemical Engineering Journal   2019
- American Control Conference   2020

Membership in Professional Societies

- American Institute of Chemical Engineering (AIChE)   2014–Current
- Institute for Operations Research and Management Science (INFORMS)   2017–Current
- American Physics Society (APS)   2021–Current
- Society for Industrial and Applied Mathematics (SIAM)   2020–Current
- Pittsburgh Quantum Institute (PQI)   2019–Current
- Organizer of mini-symposium for Quantum Computing in Optimization - SIAM OP meeting   2023

- Scientific Committee member for the Workshop of Quantum Computing for Chemical and Biochemical Engineering Applications - AIChE and DTU   2023
- Session chair at Workshop of Quantum Computing for Chemical and Biochemical Engineering Applications session on Emerging QC Applications for Engineers   2023
- Session chair at APS March Meeting session on Quantum Network Algorithms and Analysis   2023
- Session chair at INFORMS Annual Meeting session on Hybrid Quantum-Classical methods for Optimization and Sampling   2022
- Panelist for Workshop on Quantum Computing and Operations Research   2022
- Sorting of talks for the Division of Quantum Information at the American Physics Society (APS) March Meeting 2021
- Jury for the best undergraduate graduation project at Universidad de los Andes Chemical Engineering Department 2021
- Jury for the best poster in the Chemical Engineering division for the forum for Latin American chemistry community conference LatinXChemE   2021
- Moderator on discussion about Decomposition techniques for Mixed-Integer Nonlinear Programming at MINLP Virtual Workshop   2021
- Session chair at INFORMS Annual Meeting session on Integer Programming   2021
- CMU Chemical Engineering LatinX and Hispanics Graduate Student Recruiting Session Organizer   2021
- SHPE Annual Meeting CMU College of Engineering Graduate Student Recruiting Volunteer   2020
- Liaison of the CMU Quantum Computing group for the Pittsburgh Quantum Institute (PQI)   2019–2021
- Representative of Chemical Engineering in the CMU INFORMS student chapter   2017–2021
- Conference chair and organizer of YinzOR Student Conference   2017
- Session chair at INFORMS Annual Meeting session on Pyomo   2019

Membership in Student Organizations at Carnegie Mellon University
  - Latino Graduate Student Association (LGSA)
  - Society of Hispanic Professional Engineers (SHPE) chapter
  - Spanish And Latin Association (SALSA)
  - INFORMS Student Chapter

Software Products

- **MindtPy** (Developer): Open-source decomposition toolkit for Mixed-Integer Nonlinear Programming
- **Stochastic-Benchmark** (Developer): Open-source benchmarking tool for stochastic optimization solvers
- **toQUBO.jl** (Originator): Open-source library for reformulation of Mathematical Programs into Quadratic Unconstrained Binary Optimization in Julia
- **QUBOTools.jl** (Originator): Open-source Tools for Quadratic Unconstrained Binary Optimization models analysis in Julia
- **QUBODrivers.jl** (Originator): Interface for classical and quantum annealing solvers in Julia
- **GDPLib** (Contributor): Open-source library of Generalized Disjunctive Programming models in Pyomo
- **GDPOpt** (Contributor): Open-source solver for Generalized Disjunctive Programming in Pyomo
- **DICOPT** (Contributor): Commercial solver for Mixed-Integer Nonlinear Programming in GAMS

Complementary Courses

Carnegie Mellon University	Pittsburgh, PA, USA
10-716 Advanced Machine Learning, Theory and Methods	Spring 2019
10-703 Deep Reinforcement Learning and Control	Fall 2019
CAPD Conceptual Design and Optimization Modeling	Summer 2015

	Universidad de los Andes		Bogotá, Colombia

Universidad de los Andes   Bogotá, Colombia
IIND-4101 Advanced Optimization   2014

Universidad Nacional de Colombia   Bogotá, Colombia
Advanced Separation Processes   2014

Max Planck Institute for Dynamics of Complex Technical Systems   Magdeburg, Germany
5.24 Innovative Concepts in Integrated Reactors   2012

Goethe-Institut   Göttingen, Germany
Intensive technical German Course   2012

SKILLS

- **Programming Languages:** Python, C, FORTRAN, C++, Julia
- **Experience with algebraic modeling language for optimization:** GAMS, Pyomo, AIMMS, JuMP.
- **Software Proficiency:** MATLAB, Aspen Plus, Aspen HYSYS, UniSim Design.

LANGUAGES

	Comprehension		Speaking		Written Expression
	Listening	Reading	Oral Interaction	Oral Expression	
Spanish	Native Speaker				
English	C2	C2	C1	C1	C1
	TOEFL 115/120				
German	C1	C1	C1	B2	B2
	Test DaF 4.5/5				
French	A2	A2	A2	A2	A1
	Test Delf A2 74.5/100				

Level A1/A2 Basic User – B1/B2 Independent User – C1/C2 Proficient User
Common European Framework of Reference for Languages