Predictive Geometallurgy and Geostatistics Lab
Queen's University

Annual report 2019

This report summarizes the ongoing research of the Predictive Geometallurgy and Geostatistics Laboratory at Queen's University in Kingston, Ontario, Canada.

The lab currently includes 7 graduate students:

- Sebastian Avalos, Ph.D. student
- Maria Bolgkoranou, Ph.D. student
- David Casson, Ph.D. student
- Ilkay Cevik, M.A.Sc. student
- Joshua (Eddie) Kofman, M.A.Sc. student
- William Midkiff, M.A.Sc. student
- Alvaro Riquelme, Ph.D. student

Three faculty collaborate with the lab, supporting the research and co-advising students:

- Willy Kracht, Adjunct Professor – The Robert M. Buchan Department of Mining (Queen's University) and Associate Professor – Department of Mining Engineering (U. de Chile)
- Gema Olivo, Professor – Department of Geological Sciences and Geological Engineering (Queen's University)
- Oscar Rielo, Senior Program Coordinator – The Robert M. Buchan Department of Mining (Queen's University)

Thirteen contributions provide a view of the broad scope of the lab, which is to develop predictive models from the exploration to the production stage of mining operations, integrating issues related to uncertainty quantification and uncertainty management. The papers include original research, reviews and tutorials in topics related to geostatistics, geometallurgy, machine learning and deep learning applied to predictive modeling in mining.

We welcome industrial and academic collaboration. If interested, please send a note to julian.ortiz@queensu.ca.

Julian M. Ortiz
Associate Professor, The Robert M. Buchan Department of Mining
Director, Predictive Geometallurgy and Geostatistics Lab
Queen's University

August 2019

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Journal and Conference Publications

Publications in peer-reviewed journals and international conferences are listed below for the period 2018-2019. These are not included in this report, since the copyright belongs to the corresponding publishers, but can be requested for personal use or research purposes directly to julian.ortiz@queensu.ca.

Journal papers

1. Gutierrez R, Ortiz JM (2019) ***Sequential Indicator Simulation with Locally Varying Anisotropy – Simulating Mineralized Units in a Porphyry Copper Deposit***, Journal of Mining Engineering and Research, 1(1): 1-7. https://doi.org/10.35624/jminer2019.01.01

2. Pamparana G, Kracht W, Haas J, Ortiz JM, Nowak W, Palma-Behnke R (2019) ***Studying the integration of solar energy into the operation of a semi-autogenous grinding mill. Part I: framework, model development and effect of solar irradiance forecasting***, Minerals Engineering, 137: 68-77. https://doi.org/10.1016/j.mineng.2019.03.017

3. Pamparana G, Kracht W, Haas J, Ortiz JM, Nowak W, Palma-Behnke R (2019) ***Studying the integration of solar energy into the operation of a semi-autogenous grinding mill. Part II: effect of ore hardness variability and geometallurgical modeling and management***, Minerals Engineering, 137: 53-67. https://doi.org/10.1016/j.mineng.2019.03.016

4. Santibañez F, Silva JF, Ortiz JM (2019) ***Sampling Strategies for Uncertainty Reduction in Categorical Random Fields: Formulation, Mathematical Analysis and Application to Multiple-Point Simulations***, Mathematical Geosciences, 51: 579-624. https://doi.org/10.1007/s11004-018-09777-2

5. Garrido M, Ortiz JM, Villaseca F, Kracht W, Townley B, Miranda R (2019) ***Change of support using non-additive variables with Gibbs Sampler: Application to metallurgical recovery of sulphide ores***, Computers & Geosciences, 122: 68-76. https://doi.org/10.1016/j.cageo.2018.10.002

6. Nelis G, Ortiz JM, Morales N (2018) ***Antithetic Random Fields applied to Mine Planning under Uncertainty***, Computers & Geosciences, 121: 23-29. https://doi.org/10.1016/j.cageo.2018.09.003

7. Peredo OF, Baeza D, Ortiz JM, Herrero JR (2018) ***A path-level exact parallelization strategy for sequential simulation***, Computers & Geosciences, 110: 10-22. https://doi.org/10.1016/j.cageo.2017.09.011

Conference papers

1. Avalos S, Kracht W, Ortiz JM (2019) ***Forecasting SAG mil energy consumption using Gated Recurrent Units***, COM-Copper 2019, Proceedings of the 58th Annual Conference of Metallurgists (COM), hosting the 10th International Copper Conference 2019, Vancouver, BC, August 18-21, 2019, paper 574722, 13p.

2. Pamparana G, Kracht W, Ortiz JM, Haas J (2019) ***Understanding the Effect of Ore Hardness Variability on the Integration of Solar Energy into the Operation of a Semi-Autogenous Grinding Mill***, COM-

Copper 2019, Proceedings of the 58th Annual Conference of Metallurgists (COM), hosting the 10th International Copper Conference 2019, Vancouver, BC, August 18-21, 2019, paper 590145, 10p.

3. Riquelme A, Ortiz JM (2019) ***Uncertainty assessment in an arbitrary volume without the use of geostatistical simulation***, Geomin-Mineplanning 2019, Proceedings of the 6th International Conference on Geology and Mine Planning, Santiago, Chile, August 7-9, 2019, Campos E and Morales N (eds.), Gecamin, 8 p.

4. Bolgkoranou M, Ortiz JM (2019) ***Multivariate geostatistical simulation of compositional data using Principal Component Analysis – Application to a Nickel laterite deposit***, Mining Goes Digital, Proceedings of the 39th International Symposium Application of Computers and Operations Research in the Mineral Industry (APCOM 2019), Wroclaw, Poland, 4-6 June 2019, Mueller, C. et al. (eds.), CRC Press, 76-85.

5. Nelis G, Ortiz JM, Morales N (2019) ***Performance assessment of antithetic random fields in a stochastic mine planning model***, Mining Goes Digital, Proceedings of the 39th International Symposium Application of Computers and Operations Research in the Mineral Industry (APCOM 2019), Wroclaw, Poland, 4-6 June 2019, Mueller, C. et al. (eds.), CRC Press, 300-308.

6. Avalos S, Ortiz JM (2019) ***Recursive Convolutional Neural Networks in a Multiple-Points Statistics Framework***, Mining Goes Digital, Proceedings of the 39th International Symposium Application of Computers and Operations Research in the Mineral Industry (APCOM 2019), Wroclaw, Poland, 4-6 June 2019, Mueller, C. et al. (eds.), CRC Press, 168-176.

7. Avalos S, Ortiz JM (2019) **Geological modelling using a recursive convolutional neural networks approach**, CIM 2019 Convention, 8 p. https://arxiv.org/abs/1904.12190

8. Garrido M, Sepulveda E, Ortiz JM, Navarro F, Townley B (2018) ***A methodology for the simulation of synthetic geometallurgical block models of porphyry ore bodies***, Geomet 2018 – 5th International Seminar on Geometallurgy, November 28-30, 2018, Santiago, Chile, 10 p.

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