SAIMM
THE SOUTHERN AFRICAN INSTITUTE OF MINING AND METALLURGY

DATA ANALYSIS AND MACHINE LEARNING IN METALS PROCESSING 2024

WORKSHOP

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MISTY HILLS CONFERENCE CENTRE
JOHANNESBURG, SOUTH AFRICA

Many metallurgical processes generate more data, often of good quality, than plant engineers or researchers can digest. Various data analysis and machine learning tools are now readily available to help turn the data into knowledge. This workshop will illustrate the use of some of these techniques.

Part 1

In the first part of the workshop, examples of metallurgical applications will be shared. These include quantifying the refining reactions during ladle metallurgy, correlating metal deposition with process conditions in additive manufacturing, and identifying features in micrographs. The illustrated techniques range from multiple linear regression to random forest models, automated machine learning, and computer vision.

In all cases, fundamental process principles – or 'domain knowledge' – is essential. One way to embed process principles is to calculate 'features' – intermediate variables that capture process information in a nonlinear manner. An example is calculating the mass transfer coefficient for ladle metallurgy from the sulfur analyses of samples taken at different times. The use of Shapley values to rank the most important variables used by machine-learned models will be demonstrated.

Part 2

You will practice visualization and analysis of a dataset by using the statistical package R (see below for download instructions). The dataset relates to several hundred heats of electric arc furnace (EAF) data. Your task will be to look for the process variables that have a strong effect on electricity consumption in EAF steelmaking.

R is available for free. Download R from https://cran.r-project.org/ (available for Windows, macOS and Linux).

Start the package "RStudio", then choose "Tools" – "Install packages" and add the following packages: dplyr; ggplot2; ggthemes; and gridExtra

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Petrus Christiaan (Chris) Pistorius is POSCO Professor and Co-Director of the Center for Iron and Steelmaking Research in the Department of Materials Science and Engineering at Carnegie Mellon University. His research focuses on pyrometallurgy and solidification. Previously he was an associate professor (1991-1996) and professor (1997-2008) in the Department of Materials Science and Metallurgical Engineering, University of Pretoria, South Africa, and served as the head of that department from May 2002 to June 2008. Chris has a Master's degree in Metallurgical Engineering from the University of Pretoria, and a PhD from the University of Cambridge, United Kingdom.

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