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Advanced Analytics in Mining Engineering

Details

- 13 Sessions
- 13 Modules
- 100 Hours

CONTACT US

100 Creek St., Brisbane City, QLD 4000, Australia

info@soofastaei-educations.com

www.soofastaei-educations.com

0061 422 125 935

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PROGRAM OVERVIEW

Data analytics is no longer a luxury but viewed as a necessity for an industry generating trillions of dollars every year. There are many phases of the mining process where data analytics can be put to practical use. The mining industry is increasingly using advanced analytics (AA)and artificial intelligence (AI) applications tooptimize processes, enhance decision-making, derive value from data, and improve safety.

Five key application areas in mining – where high operational costs and business value are created – are ore extraction, mining and handling mined materials, grinding materials in preparation for processing, separating and concentrating the usable components into saleable products, and mined material transferring. While there are many benefits to AA implementation in the mining industry, it is still a very new applied science, and there is much work that needs to go into a successful application. During the AA in Mining Engineering course, attendances will learn the AA and AI application opportunities in the mine value chain, from exploration to marketing.

The 4th industrial revolution is the 21st-century convergence of digital, physical, and biotechnologies driving an unrelenting acceleration of human progress. Advances in computing power, AI, the internet of things (IoT), and machine learning (ML) enable mining companies to speed growth and create exceptional experiences in different operational areas. The technology of the 4th revolution is inseparably tied to the vast amounts of data needed to train AI algorithms and other critical forms of modern technology. The need for data has led to exponential growth in gathering it, and AA has gained massive momentum in the industrial mining sector.

The main objectives of this course are presenting the scientific concepts and providing industrial case studies for different applications of AA in mining, which can be grouped into three main areas:

- **Descriptive Analytics:** Its function is to describe, diagnose, and discover what trends and patterns occur in a given process, thanks to the real-time study of historical data.
- **Predictive Analytics:** Based on more advanced mathematical methods that include statistical analyses, data mining, predictive models, and ML, among others. Its function consists of predicting events that can occur in the future, thanks to developing a predictive model.
- **Prescriptive analytics:** Its function consists of defining the actions to obtain the best results in a process. It relies on predictive models, scenario simulations, localized rules, and technical optimization to transform data and recommend obtaining the desired result. This level of analytics is greater and more robust. It uses complex event processing, neural networks, heuristic learning, and "ML," among others.

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KEY BENEFITS

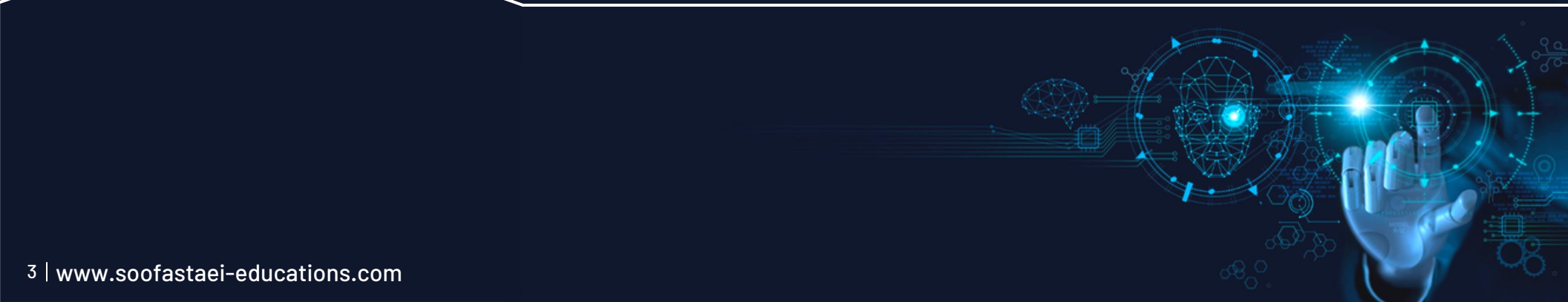
The Program is aimed at providing:

- Deep understanding about the modern mining operation;
- Develop knowledge and skills in analyzing data to inform investment decisions;
- Enhance your critical and analytical skills;
- Identify where and how to apply advanced data analytics in mining industry;
- Business problems with data-driven decision-making;
- Explanation of how data is used for recruiting and performance evaluation;
- Evaluating the potential opportunities to increase the mining operation performance; and
- Finding the clear relationship between the all-mining activities.

WHO SHOULD ATTEND THIS PROGRAM?

This course is designed for all C-level / President / Vice President / Director / Head / Manager of:

- Mine Management
- Change Management
- Technology Transformation
- Business Management
- Organization Development
- Organization Transformation
- Project Management
- Business Strategy
- Business Transformation and Marketing Management



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Agenda

Module 1:
Advanced Analytics and Exploration

Due to the decrease in commodity prices in a constantly dynamic environment, there has been a constant urge to maximize benefits and attain value from limited resources. Traditional empirical and numerical simulation techniques have failed to provide comprehensive, optimized solutions in little time. Coupled with the immense volumes of data generated daily, a solution to tackle industry challenges became imminent. Various expert opinion fraught with bias has posed extra challenges to obtain timely, cost-effective solutions. Data Analytics has provided substantial contributions to several sectors. This module reviews various AA and ML applications in mining exploration. This module will cover the following topics:

- Introduction to Exploration;
- Geological Features and Genetic Models of Mineral Deposits;
- Minerals Prospecting and Exploration;
- Geophysics Prospecting; and
- Geochemical Prospecting.

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Module 2:
Advanced Analytics and Deposit Assessment

One of the essential subjects in the mining value chain is the deposit assessment. This module introduces deposit assessment in mining, a summary of geological data collection, geologic interpretation, modeling, and representation. Moreover, this module discusses the sample preparation and assaying process, ore-body sampling, and metallurgical testing. Furthermore, other subjects, including mineral resource estimation, valuation of mineral properties, mineral property feasibility studies, and cost estimation for underground and surface mines, are discussed in this module. This module will cover the following topics:

- Introduction to Deposit Assessment;
- Geological Data Collection;
- Geologic Interpretation, Modelling, and Representation;
- Sample Preparation and Assaying;
- Ore-Body Sampling and Metallurgical Testing;
- Mineral Resource Estimation;
- Valuation of Mineral Properties;
- Mineral Property Feasibility Studies;
- Cost Estimating for Underground Mines; and
- Cost Estimating for Surface Mines.

Module 3:
Advanced Analytics and Mine Management

The unprecedented demand for natural resources drives mining companies to strive for step-change in the efficiency and optimization of their business processes. AA techniques are being applied in other industries to enable significant improvements in both strategic and operational business processes by optimizing decision making. Today, decisions are usually locally optimized but do not achieve optimum capability for the value chain. Although mining operations now collect more information than ever before, it is difficult to bring all this information to bear to make better decisions. This module looks at how these AA techniques can be applied to the fundamental challenges mine management faces. This module will cover some critical subjects in mine management, such as mine economics, management, low, employee relations and training, and finally, a global perspective on mining legislation. This module will cover the following topics:

- Introduction to Mine Management;
- Mine Economics, Management, and Law;
- Economic Principles for Decision Making;
- Management, Employee Relations, and Training; and
- A Global Perspective on Mining Legislation.

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Module 4: Advanced Analytics and Mining Method Selection

The mining method selection is one of the most crucial decisions in the design stage of mine that mining engineers have to make. Selecting a mining method for mineral resources is entirely dependent on the resource's uncertain geometrical and geological characteristics. The unique characteristics of each mineral resource must be taken into account to select the suitable mining method for the extraction of a particular resource so that the utilized method would have the maximum technical-operational congruence with the geological and geometrical conditions of the mineral resource. To make the right decision on mining method selection, all effective criteria related to the problem should be considered. Increasing the number of evaluation criteria in the decision-making problem makes the problem more complex, and the rightness of the decision increases. Therefore, there is a need for alternative methods to consider all known criteria related to surface and underground mining methods selection in the decision-making process. The sensitivity of this decision has led to different solutions introduced by different researchers. AA has been introduced as one of the practical tools to select the mining method. This module provides a comprehensive investigation of the use of AA to compare the underground and surface mining methods. This module can open a new door in Infront of mining engineers and managers to make better decisions to select the mining method. This module will cover the following topics:

- Introduction to Mining Method Selection;
- Evaluation of Mining Methods and Systems;
- Mining Methods Classification System;
- Selection Process for Hard-Rock Mining;
- Selection Process for Underground Soft-Rock Mining;
- Comparison of Underground Mining Methods; and
- Comparison of Surface Mining Methods.

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Module 5: Advanced Analytics and Rock Breaking

Rock breaking processes, including drilling and blasting, are the most economical techniques to achieve rock fragmentation in mines and quarries. The main objective of these processes is to realize the fragmentation in the desired size, keeping up with the constraints of ground vibration, air overpressure, flying rocks, and stability. Analytics can help several considerations by providing a better understanding of the process. An AA solution can help in faster decision-making and manage the data generated throughout the rock-breaking process in mining. Additionally, data generated during the drilling and blasting operations can be stored in a central database, which can be used later. The power of AA can be used to evaluate the data, identify key performance variables, implement changes, and appraise the outcome. This presents an incredible opportunity to leverage the data generated during the rock-breaking process to achieve improvements in terms of cost and fragmentation. This module discusses the role of AA in mechanical rock breaking, drilling, and blasting. This module will cover the following topics:

- Introduction to Rock Breaking;
- Mechanical Rock Breaking;
- Blast hole Drilling; and
- Explosives and Blasting.

Module 6: Advanced Analytics and Ground Mechanics

AA is the autonomous or semi-autonomous examination of data or content using sophisticated techniques and tools, typically beyond traditional business intelligence (BI), to discover deeper insights, make predictions, or generate recommendations. AA techniques include data/text mining, ML, pattern matching, forecasting, visualization, semantic analysis, sentiment analysis, network, and cluster analysis, multivariate statistics, graph analysis, simulation, complex event processing, neural networks. AA is a powerful tool in the field of ground mechanics. This module presents the application of AA in hard and soft rock ground control, surface mine subsidence, tailing impoundments and dams, waste piles, and dumps. The following topics will be discussed in this module:

- Introduction to Ground Mechanics;
- Soil Mechanics;
- Slope Stability;
- Rock Mechanics;
- Geotechnical Instrumentation;
- Hard-Rock Ground Control;
- Soft-Rock Ground Control;
- Mine Subsidence;
- Tailings Impoundments and Dams; and
- Waste Piles and Dumps.

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Module 7:
Advanced Analytics and Infrastructure and Services

Mine asset owners and industry professionals hold a tremendous amount of data on the condition, maintenance, and operation of infrastructure and services, and this data can be used to improve their capital - planning decisions significantly. Although infrastructure and services players in mining increasingly use AA, this industry still lags behind others, such as retail, financial services, and automotive, in embracing AA comprehensively across the mining project life cycle. As a result, many mine asset owners experience weaker capital productivity than what we see in other sectors, as they are making significant decisions based primarily on qualitative rather than quantitative factors. Incorporating AA into the capital- mine planning phase can radically improve the ability of mine owners to make decisions based on the expected performance of their existing infrastructure and services. It can also help mine owners and operators generate deeper insights and value on maintenance versus replacement decisions and asset-longevity trends. This module provides the technical information we need to use AA in mining infrastructure and services. The following topics will be discussed in this module:

- Introduction to Infrastructure and Services;
- Electric Power Distribution and Utilization;
- Compressed Air;
- Mine Communications, Monitoring, and Control;
- Mine Surveying;
- Dewatering Surface Operations;
- Dewatering Underground Operations;
- Physical Asset Management; and
- Mine Infrastructure Maintenance.

Module 8: Advanced Analytics and Surface Extraction

Many existing surface mines are maturing, resulting in the extraction of lower ore grades and longer haul distances from the mine face; ore-body-replacement rates are in decline, and new surface mine-development times are increasing. The mining industry has shifted its focus to improving productivity by "sweating" existing assets, but this strategy will go only so far. Despite the industry's booms and busts, the nature of surface mining has stayed the same for decades. Achieving a breakthrough in productivity performance demands rethinking how mining works. The potential to achieve such a breakthrough is now coming within the industry's reach through digital and technology innovations that could transform key aspects of mining. This module will focus on the role of AA in surface mining operations, including open-pit planning and design, mechanical extraction, loading, hauling, equipment selection, and maintenance. The following topics will be discussed in this module:

- Introduction to Surface Mining;
- Open-Pit Planning and Design;
- Mechanical Extraction, Loading, and Hauling;
- Selection and Sizing of Excavating, Loading, and Hauling Equipment;
- In-Pit Crushing; Design, Construction, and Maintenance of Haul Roads;
- Strip Mining; and Highwall Mining.

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Module 9: Advanced Analytics and Underground Development and Extraction

The potential of using AA in underground mines is now coming within the industry's reach through digital and technology innovations that could transform key aspects of the mining industry. This module describes several digital technologies that have long been in the works and are now available and affordable enough to become operational at scale across the mining industry. The applications of AA in underground mining include building a more comprehensive understanding of the resource base, optimizing material and equipment flow, improving anticipation of failures, increasing mechanization through automation, and monitoring performance in real-time. This module also presents the role of AA in underground equipment selection and sizing, underground horizontal and inclined development methods, construction, and underground ore movement. The following topics will be discussed in this module:

- Introduction to Underground Mining;
- Hard-Rock Equipment Selection and Sizing;
- Soft-Rock Equipment Selection and Sizing;
- Underground Horizontal and Inclined Development Methods;
- Construction of Underground Openings and Related Infrastructure; and
- Underground Ore Movement.

Module 10: Advanced Analytics and Mineral Processing

Mineral processing plants are one of the most data-rich parts of any mining operation. Historically, process analysis and optimization have been undertaken by skilled operators and metallurgists experienced in monitoring fluctuations in behavior. However, this relies heavily on highly skilled people with sufficient experience in operation to interpret results. Data from individual unit operations are often used in this process to support hypotheses, but the capability to use integrated data sets from across the operations has not been available. The development of AA techniques, deep learning, ML, and AI now means that the tools are available in mineral processing to better use the data. In recent years advances have been made in the development and implementation of tools such as Digital Twins, and today we will explore how those can be used to drive genuine improvements. This module presents the application of AA in crushing, milling, grinding, classification by screens and cyclones, gravity concentration and medium-heavy separation, froth flotation, magnetic and electrostatic separation, and dewatering. The following topics will be discussed in this module:

- Introduction to Mineral Processing;
- Crushing, Milling, and Grinding;
- Classification by Screens and Cyclones;
- Gravity Concentration and Medium Heavy Separation;
- Froth Flotation;
- Magnetic and Electrostatic Separation; and
- Dewatering.

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Module 11: Advanced Analytics and Material Transportation

Environmental impacts of mining can occur at local, regional, and global scales through direct and indirect mining practices. Impacts can result in erosion, sinkholes, loss of biodiversity, soil contamination, groundwater, and surface water by the chemicals emitted from mining processes. These processes also impact the atmosphere from the emissions of carbon, which affect the quality of human health and biodiversity. Some mining methods may have such significant environmental and public health effects that mining companies in some countries must follow strict environmental and rehabilitation codes to ensure that the mined area returns to its original state. The mining industry's impact on the environment has been a public concern, with a growing appreciation of the natural environment and increasing awareness of the possible harmful effects that the industry's activities can cause. The industry and government have responded with several initiatives and regulations to protect and manage the environmental effects of mining activities. The extractive nature of mining operations creates various impacts on the environment before, during, and after mining operations. The extent and nature of impacts can range from minimal to significant, depending on various factors associated with each mine. These factors include the characteristic of the ore body, the type of technology and extraction methods used in mining and the on-site processing of minerals, and the sensitivity of the local environment. The environmental impacts of mining, although significant, are generally confined to local areas. Apart from the direct physical impacts of extractive activities, air, land, and water contamination may also result. However, mining in isolation may not be the mainland use those upsets ecological systems, as environmental effects are cumulative, and other past activities or events may have contributed to these effects. This chapter discusses the significant environmental impacts of mineral mining, such as wastes and the rate of resource use (where the supply of minerals depends on the rate of resource use, which is affected by the economic life of mineral deposits and the rate at which new reserves are discovered). This chapter also summarizes environmental management initiatives, such as using AA to reduce the negative impacts of mining operations on the environment. The following topics will be discussed in this module:

- Introduction to Material Transportation; and
- Locomotive and Rail Ways and Material Shipment.

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Module 12: Advanced Analytics and Health and Safety

The mining industry has a reputation for being a risky business, with health risks that are varied and often quite serious, and miners need to protect themselves accordingly. Nevertheless, mining does not have to be unsafe. With the introduction of strict safety legislation and protocol and advances in safety equipment, the industry has seen its fatality rate drop over time. Although the goal of zero harm has not yet been achieved, it remains the standard that mining companies continue to strive towards. Understanding and being aware of the environment is the first step to preventing illness or injury in the mining workplace. Some common health risks to watch out for in the mining industry include coal dust, noise, whole-body vibration, UV exposure, musculoskeletal disorders, thermal stress, and chemical hazards. The mining industry has made significant improvements in health and safety over the last decade, reducing fatalities and serious injuries. However, the mining industry still has one of the highest rates of fatalities of any industry. AA and auditing the work procedures can dramatically help the mining companies to improve safety and decrease the incidents rates in the mine sites. Predictive models can use historical datasets to predict new accidents, injuries, and fatalities. Optimization models can provide practical suggestions to change the procedures and decrease human and machine errors to increase safety. Moreover, AI algorithms can help managers make better decisions in this field. The following topics will be discussed in this module:

- Introduction to Mining Health and Safety;
- Mine Ventilation;
- Health and Medical Issues in Global Mining;
- Gas and Dust Control;
- Heat, Humidity, and Air Conditioning;
- Radiation Control; and
- Noise Hazards and Controls.

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Module 13: Advanced Analytics and Environment

Environmental impacts of mining can occur at local, regional, and global scales through direct and indirect mining practices. Impacts can result in erosion, sinkholes, loss of biodiversity, soil contamination, groundwater, and surface water by the chemicals emitted from mining processes. These processes also impact the atmosphere from the emissions of carbon, which affect the quality of human health and biodiversity. Some mining methods may have such significant environmental and public health effects that mining companies in some countries must follow strict environmental and rehabilitation codes to ensure that the mined area returns to its original state. The mining industry's impact on the environment has been a public concern, with a growing appreciation of the natural environment and increasing awareness of the possible harmful effects that the industry's activities can cause. The industry and government have responded with several initiatives and regulations to protect and manage the environmental effects of mining activities. The extractive nature of mining operations creates various impacts on the environment before, during, and after mining operations. The extent and nature of impacts can range from minimal to significant, depending on various factors associated with each mine. These factors include the characteristic of the ore body, the type of technology and extraction methods used in mining and the on-site processing of minerals, and the sensitivity of the local environment. The environmental impacts of mining, although significant, are generally confined to local areas. Apart from the direct physical impacts of extractive activities, air, land, and water contamination may also result. However, mining in isolation may not be the mainland use those upsets ecological systems, as environmental effects are cumulative, and other past activities or events may have contributed to these effects. This chapter discusses the significant environmental impacts of mineral mining, such as wastes and the rate of resource use (where the supply of minerals depends on the rate of resource use, which is affected by the economic life of mineral deposits and the rate at which new reserves are discovered). This chapter also summarizes environmental management initiatives, such as using AA to reduce the negative impacts of mining operations on the environment. The following topics will be discussed in this module:

- Introduction to Mine Sites Environmental Considerations;
- Impacts and Control of Blasting; Water and Sediment Control Systems;
- Mitigating Acid Rock Drainage;
- Waste Disposal and Contamination Management; and
- Closure Planning.

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Soofastaei-Educations is an influential global training organization that delivers specialized world-class short- and long-term educational programs.

This organization is a part of Soofastaei Institute, which provides technical business solutions, publications, and educational services in the field of advanced applied analytics and AI in different for different industries.

The Soofastaei Educations works directly with the prestigious universities and giant industrial companies to train the new generation of students and experts for the digitalized future industries.

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