AI CERTs™

AI+ Mining (2 Days)

Program Detailed Curriculum

Executive Summary

The AI+ Mining course explores how artificial intelligence is transforming the mining industry. It covers AI fundamentals, machine learning, and deep learning applications in exploration, operations, predictive maintenance, and workforce development. The course emphasizes ethical AI, regulatory compliance, and AI-powered AR/VR training for workforce upskilling. It also highlights strategic decision-making, risk management, and supply chain optimization. Real-world case studies from leaders like Vale and Anglo-American illustrate practical AI benefits. This course prepares mining professionals to harness AI for safer, more efficient, and sustainable mining operations in today's competitive landscape.

Course Prerequisites

- Basic understanding of mining industry operations and terminology
- Familiarity with fundamental concepts of data analytics and statistics
- No prior coding experience required (coding templates provided)
- Prior exposure to GIS, geospatial data, or industrial automation is a plus but not mandatory
- Recommended: Prior exposure to GIS, geospatial data, or industrial automation is a plus but not mandatory

Module 1

Introduction to AI in Mining

1.1 Overview of AI, ML & Deep Learning in Mining

- **Artificial Intelligence (AI):** Discover what AI is, its core goals, and how AI technologies revolutionize mineral exploration, extraction, and processing in mining.
- **Evolution of AI in Mining:** Explore the historical development of AI in mining, highlighting key technological milestones and industry adoption from the 1990s to today.
- **Difference Between AI, Machine Learning (ML), and Deep Learning (DL):** Discuss and differentiate AI, ML, and DL concepts, understanding their unique roles and applications in mining analytics and automation.
- **How AI learns from mining data and makes predictions:** Learn about supervised, unsupervised, and reinforcement learning techniques and how AI models analyze mining data to predict equipment failures and optimize operations.
- **AI-powered automation vs. traditional automation in mining:** Discover the advantages of AI-driven automation over traditional systems, including adaptability, predictive capabilities, and enhanced decision-making in mining workflows.

1.2 Use Cases

- **AI-powered automated decision-making in mining:** Discuss how AI systems use sensor and equipment data to autonomously make operational decisions, reducing downtime and improving resource management.
- **Deep Learning for Geospatial Analysis;** Learn how deep learning techniques process satellite and geospatial data to identify mineral deposits and optimize exploration strategies.

1.5 Activity: Group Discussion – How is AI changing the mining industry

Engage in collaborative discussions to critically analyze AI's evolving role and its broad impacts on mining productivity, safety, and sustainability.

Module 2

Machine Learning & Deep Learning for Mining

2.1 Introduction to ML & Deep Learning

- **How ML models learn from data in mining applications:** Discover how machine learning models extract patterns from mining datasets to improve exploration accuracy and operational efficiency.
- **Supervised vs. Unsupervised Learning for Mining Applications:** Discuss the differences between supervised and unsupervised learning and their distinct uses in mining data classification and anomaly detection.

2.2 Use Cases

- **Use Case 1: Machine Learning for Mineral Targeting:** Learn how AI analyzes geospatial and geochemical data using ML models to identify promising mineral deposits efficiently.
- **Use Case 2: Deep Learning in Mining Safety:** Discover how deep learning algorithms detect hazards in real-time underground mining operations, enhancing worker safety.

2.3 Case Study: AI-Powered Geophysical Analysis: Explore a real-world example of how ML models improve mineral-rich zone detection, optimizing exploration success and reducing costs.

2.4 Hands-On Exercise: Engage in practical exercises building ML models for exploration analysis and equipment monitoring, applying theory to real mining challenges.

2.5 Activity: Group Discussion – Will AI Replace Traditional Geologists and Mining Engineers: Discuss and debate AI's impact on traditional mining roles, exploring collaboration opportunities and future workforce evolution.

Module 3

AI in Mineral Exploration & Resource Modeling

3.1 AI for Smart Exploration & Orebody Modeling

- **Introduction to AI in Mineral Exploration:** Discover AI's foundational role in identifying mineral deposits through advanced data processing and geophysical analysis.

- **How AI is Transforming Mineral Exploration and Orebody Modeling:** Explore the innovative AI techniques improving exploration efficiency and orebody characterization.
- **AI-Powered Geophysical and Geochemical Data Analysis for Deposit Identification:** Learn to apply AI for analyzing complex geophysical and geochemical datasets to pinpoint new mineral targets.
- **How Machine Learning (ML) Improves Mineral Prediction Accuracy:** Discuss how ML algorithms refine prediction models, reducing uncertainty and enhancing discovery rates.
- **AI-Driven Geostatistical Modeling and Anomaly Detection for New Deposits:** Explore AI-enabled geostatistical approaches to detect anomalies indicating potential mineralization zones.
- **3D Orebody Modeling: AI-Powered Block Modeling, Reserve Estimation, and Deposit Visualization:** Learn how AI supports 3D modeling techniques for accurate reserve estimation and effective visualization.
- **Challenges of AI-Driven Exploration & Future Potential:** Discuss current limitations and emerging opportunities for AI integration in mineral exploration.

3.2 Use-Cases

- **AI-Powered Exploration & Discovery – Barrick Gold's AI-Powered Mineral Targeting:** Discover how Barrick Gold leverages AI to enhance mineral targeting and discovery success.
- **AI in Orebody Modeling – Automating Block Modeling:** Learn how AI automates complex block modeling tasks, improving accuracy and reducing manual effort.

3.4 Hands-On Exercises: Engage in practical AI-assisted geological analysis and ML model building for mineral targeting using industry tools.

3.5 Activity: Group Discussion – Present an AI-powered Exploration Plan to a Mining Board Collaborate to develop and present strategic AI-driven exploration plans, fostering critical thinking and applied knowledge.

3.6 Case Study: Analyze an AI implementation in gold resource estimation that optimizes drilling and enhances operational efficiency.

Module 4

AI for Equipment Automation & Fleet Optimization

4.1 AI in Autonomous Vehicles & Robotics

- **Introduction to AI in Autonomous Mining Equipment:** Discover core AI technologies enabling vehicle autonomy, including computer vision, reinforcement learning, and IoT sensor integration.
- **How AI Enables Self-Driving Haul Trucks, Autonomous Drills, and Robotic Mining Machines:** Explore AI's role in navigation, task automation, and real-time decision-making for autonomous mining machinery.
- **Key AI Technologies: Computer Vision, Reinforcement Learning, IoT Sensors, Digital Twins:** Understand how these technologies combine to optimize equipment performance and predictive maintenance.
- **AI-powered Decision-Making for Fleet Dispatch and Haulage Optimization:** Learn how AI dynamically schedules fleet operations for maximum productivity and minimal delays.

- **AI in Robotic Excavation, Drilling, and Material Transportation:** Explore AI applications in automating repetitive mining tasks, improving precision and safety.
- **The Role of AI in Underground Mining Automation for Safety and Efficiency:** Discover AI solutions enhancing underground mining safety through remote operation and hazard detection.
- **Challenges and Limitations of AI-Driven Automation in Mining:** Discuss technical, environmental, and operational challenges facing AI adoption in mining automation.

4.2 Use Cases

- **AI-powered Autonomous Haulage – AI Optimizing Truck Routing (BHP's AI-powered Self-driving Trucks):** Explore BHP's autonomous haulage system that optimizes routes to reduce fuel use and increase haulage efficiency.
- **Reinforcement Learning for Fleet Management – AI Optimizing Haul Truck Movements:** Learn how AI reinforcement learning algorithms optimize fleet movements based on real-time conditions.

Module 5

AI in Predictive Maintenance & Asset Management

5.1 AI in Equipment Health Monitoring

- **How AI Transforms Predictive Maintenance in Mining Operations:** Explore AI's shift from reactive to predictive maintenance, reducing downtime and improving operational efficiency through real-time analytics.
- **The Role of IoT Sensors and Real-Time Data Collection for Machine Health Analysis:** Discover how IoT sensors capture vital machine data enabling AI models to detect anomalies and forecast failures early.
- **Supervised Learning vs. Anomaly Detection in Predictive Maintenance:** Discuss different AI learning approaches to predict known faults and detect novel equipment anomalies in mining operations.
- **The Role of AI in Vibration, Temperature, and Pressure Monitoring for Heavy Machinery:** Understand how AI analyzes critical equipment parameters to identify early signs of wear and prevent failures.
- **The Role of AI in Reducing Unscheduled Downtime Through AI-Driven Proactive Maintenance:** Learn how AI-powered maintenance minimizes unexpected breakdowns, optimizing resource use and improving safety.

5.2 Use Cases

- **AI-Driven Predictive Maintenance – How AI Detects Faults Before Failure (Anglo American's AI Asset Management)**
  Explore how Anglo American uses AI to analyze real-time sensor data, predict equipment faults before failure, and schedule timely maintenance, reducing downtime and repair costs.
- **Case Study: Predictive Maintenance Using AI in Mining Fleet Management – Case of AI-Driven Wear Prediction for Haul Trucks at Anglo American**
  Analyze a real-world example where AI models predict wear on haul trucks, enabling condition-based maintenance that optimizes fleet availability and extends equipment lifespan.

5.3 Case Study: AI in Predictive Equipment Failure – Reducing Unplanned Downtime in Mining Operations

Analyze Anglo American's successful AI-driven predictive maintenance program reducing downtime and maintenance costs.

5.4 Hands-On Exercise: AI for Equipment Monitoring – AI-Powered Sensor Data Analysis Using Orange Data Mining: Engage with AI tools like Orange Data Mining to build predictive models using mining equipment sensor data.

5.6 Activity: Group Discussion - "Should AI Decide When Machines Need Maintenance?": Debate the pros and cons of AI making maintenance decisions, balancing efficiency and human oversight.

Module 6

AI for Environmental Compliance & Sustainability

6.1 AI-Powered Environmental Monitoring

- **AI in Real-Time Air Quality Monitoring – How AI Detects Pollutants in Mining Regions:** Learn how AI detects pollutants and forecasts air quality to ensure mining operations meet environmental standards.
- **AI for Water Resource Management – AI-Powered Solutions for Tailings Dam Monitoring:** Explore AI-powered tailings dam monitoring for early failure detection and sustainable water use.
- **AI in Soil Contamination Analysis – Using AI to Detect Heavy Metal Pollution in Mining Sites:** Understand AI applications detecting heavy metal pollution, enabling targeted remediation in mining sites.
- **AI in Emission Reduction – Optimizing Carbon Footprint Reduction in Mining Operations:** Examine AI strategies optimizing energy use, reducing carbon footprints, and supporting sustainability goals.

6.2 Use Cases: Review AI-driven projects by Vale and BHP for dam safety and water quality monitoring improving environmental compliance.

6.3 Case Study: Analyze Rio Tinto's AI-enabled sustainability initiatives optimizing water recycling, energy consumption, and emissions control.

6.4 Hands-On Exercises: Practice AI-based environmental risk assessment using satellite data and Google Earth Engine.

6.5 Activity: Group Exercise: Collaborate on designing AI-powered sustainability plans to reduce emissions and protect biodiversity in mining.

Module 7

AI for Workforce Transformation & Ethical AI

7.1 Ethical AI, Workforce Augmentation & AI Regulations

- **AI-driven workforce augmentation:** Discover how AI collaborates with workers, enhancing productivity and decision-making without replacing jobs.
- **Ethical considerations in AI adoption:** Discuss transparency, accountability, and bias prevention to ensure fair and responsible AI use.

- **AI and Workforce Reskilling:** Explore AI-powered personalized training transforming mining job skills and workforce adaptability.
- **Fair AI in Mining:** Learn how AI supports ethical hiring and enforces safety compliance fairly and transparently.
- **AI in AR and VR Training Simulators:** Discover immersive AI-driven AR/VR technologies revolutionizing underground mining safety training.

7.2 Use Cases: Explore practical AI implementations enhancing worker safety monitoring and VR training effectiveness.

7.3 Case Study: Analyze Anglo-American's success in using AI-powered VR training for workforce reskilling.

7.4 Hands-On Exercises: Engage with AI simulation tools for hazard detection and immersive safety training modules.

Module 8

AI in Mining Strategy & Implementation

8.1 AI-Driven Decision-Making in Mining

- **AI's role in high-level strategic decision-making:** Explore AI's predictive insights empowering business growth and competitive advantage.
- **How AI improves production forecasting:** Discover AI's techniques for demand prediction, supply chain risk mitigation, and pricing trend analysis.
- **AI in mining finance & risk management:** Discuss AI's applications in budget planning, fraud detection, and investment risk analysis.
- **AI for Regulatory Compliance & Legal Risk Assessment:** Learn how AI automates compliance, monitors legal risks, and supports transparent operations.

8.2 Use Cases: Explore AI applications in supply chain optimization and commodity price forecasting.

8.3 Case Study: Vale's AI-Driven Supply Chain Optimization Strategy: Analyze Vale's AI adoption that reduced costs by 30% and improved logistics efficiency.