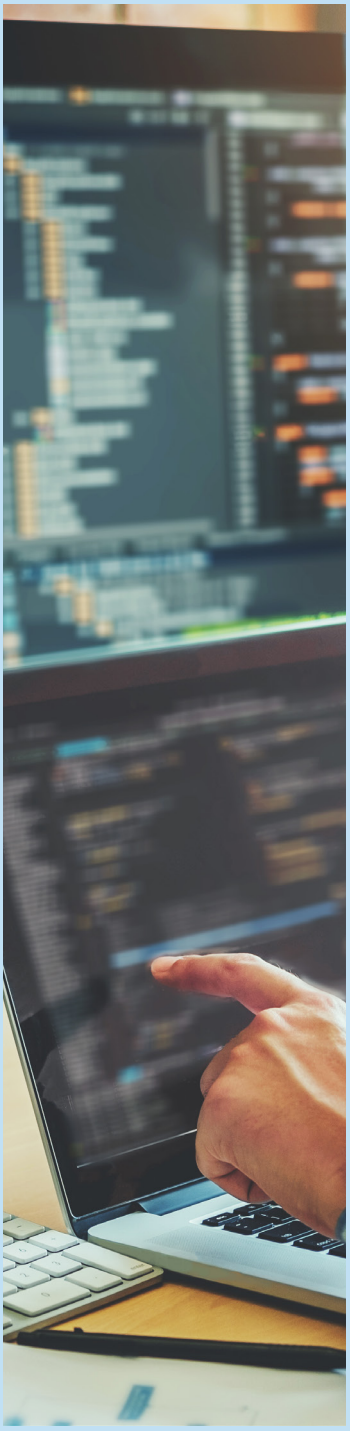
VIEW POINT



THE TRANSFORMATIVE POWER OF AI IN SPATIAL DATA

Abstract

Data is a key asset that decides the course of an organization's digital transformation initiatives. Spatial data, in particular, is crucial in transformation initiatives across industries especially in logistics, utilities, and telecommunications. Against this context, this paper explores how the advent of artificial intelligence and machine learning into the GIS domain is transforming data management, improving the consistency of data quality, and increasing the efficiency and simplicity of business operations.

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The challenges of figuring out GIS data

GIS systems are storehouses of geospatial data, relying on a wide range of structured and unstructured map-related data, with significant attention paid to accuracy and precision. In order to gain a complete picture, GIS systems rely on varied data sources, that include satellite images and aerial photographs using light detection and ranging (LiDAR) and earth sensor systems, and location coordinates. They also include more rudimentary sources such as paper maps, sketches, schematics, measurements, and survey data.

The manual, labor-intensive process of reading any of these data sources can lead to inaccuracies because of the challenges involved in interpreting complex geometry diagrams, that involve engineering drawings and schematics, annotations, text, contours, and metadata. While image recognition technologies such as optical character recognition/ raster to vector (OCR/R2V), object detection, and data & feature extraction can help automatically read these images, they still require significant human supervision to ensure quality in conversion, migration, correction, and cleansing.

Bringing in the levers of technology

While the adoption of artificial intelligence (AI), machine learning (ML), and automation brings in efficiencies in data management, a few housekeeping actions are necessary to truly reap the benefits of becoming data-driven. Depending on the organization, these actions could mean eliminating certain legacy technologies, transitioning from outdated process models and practices, changing outsourcing methodologies, as well as upskilling on digital technologies.

Leveraging AI in GIS comes with its own set of challenges. For example, deep learning can handle data sources based on spectral and spatial resolution. However, in the case of similar data, the technology can overfit a model thereby impacting its performance. The diversity in data sets is another challenge to consider while deciding to adopt AI.

To overcome some of these challenges, a new scientific discipline, which is a combination of AI/ML and GIS, has slowly emerged as a preferred option. Also known as geospatial artificial intelligence (geoAI), it combines innovations in spatial science, AI/ML, data mining, and high-performance computing that is capable of extracting knowledge from spatial big data. Presently, this combination of GIS + AI is among the most interesting emergent technologies in the data applications in the government and private sector enterprises.

Practically speaking

Let's look at a few practical applications of the intersection - geoAI in managing geospatial data and maintaining data quality.

Due to the rise of location-based systems and cloud technology, spatial data has increased exponentially, making the management of such data a challenge. A smart option when it comes to tackling big data, even spatial big data, is to incorporate AI technology. AI/ML enables organizations to unlock the potential of data and delivers massive disruptions in geospatial data management. For example, the earth observation industry is transforming the way it functions by adopting AI to manage the humongous volume of data produced, including open data.

There are several aspects involved in managing spatial data, as shown in the image below, but with AI/ML driving each of these, organizations can benefit from best-of-breed methods that enable end systems to behave intelligently, simply, and efficiently.

Data Workflow Orchestration	Analytics/ Data Change Analysis	Image tagging/ object detection	Computer vision model
Information Retrieval and gathering	OCR/ Data Extracts	RPA/Bots	Validation / Attribute Selection
Business rules and automation	What If Analysis	Predicative Analytics	High Personalization
Operational & Business analytics	Statistical Modelling	NLP	Ontological Model

Fig 1: Incorporating AI/ML in data management

A common challenge in manually managing large volumes of data is having to deal with inaccuracies, incompleteness, long processing times, and operational inefficiencies. AI, on the other hand, allows organizations to transition from cumbersome, error-prone, and time-consuming activities, thereby increasing productivity. AI can process structured data such as geometries and vectors as well as unstructured data containing location entities by leveraging deep learning which processes data at a scale that supersedes human performance.

Another area where AI delivers value is object detection which is used in locating and identifying assets, including anamoly detection, and feature extraction. Object detection is critical in GIS as it involves finding objects in satellite images or aerial photographs and plotting their location on a map. With AI, auto-extraction capabilities can improve drastically from 5% to 80% while maintaining high levels of accuracy. An application for this technique includes building training data sets involving thousands of annotated images for ML which leads to the development of solutions such as driverless cars, robot-based machine landing, and smarter cargo movement.

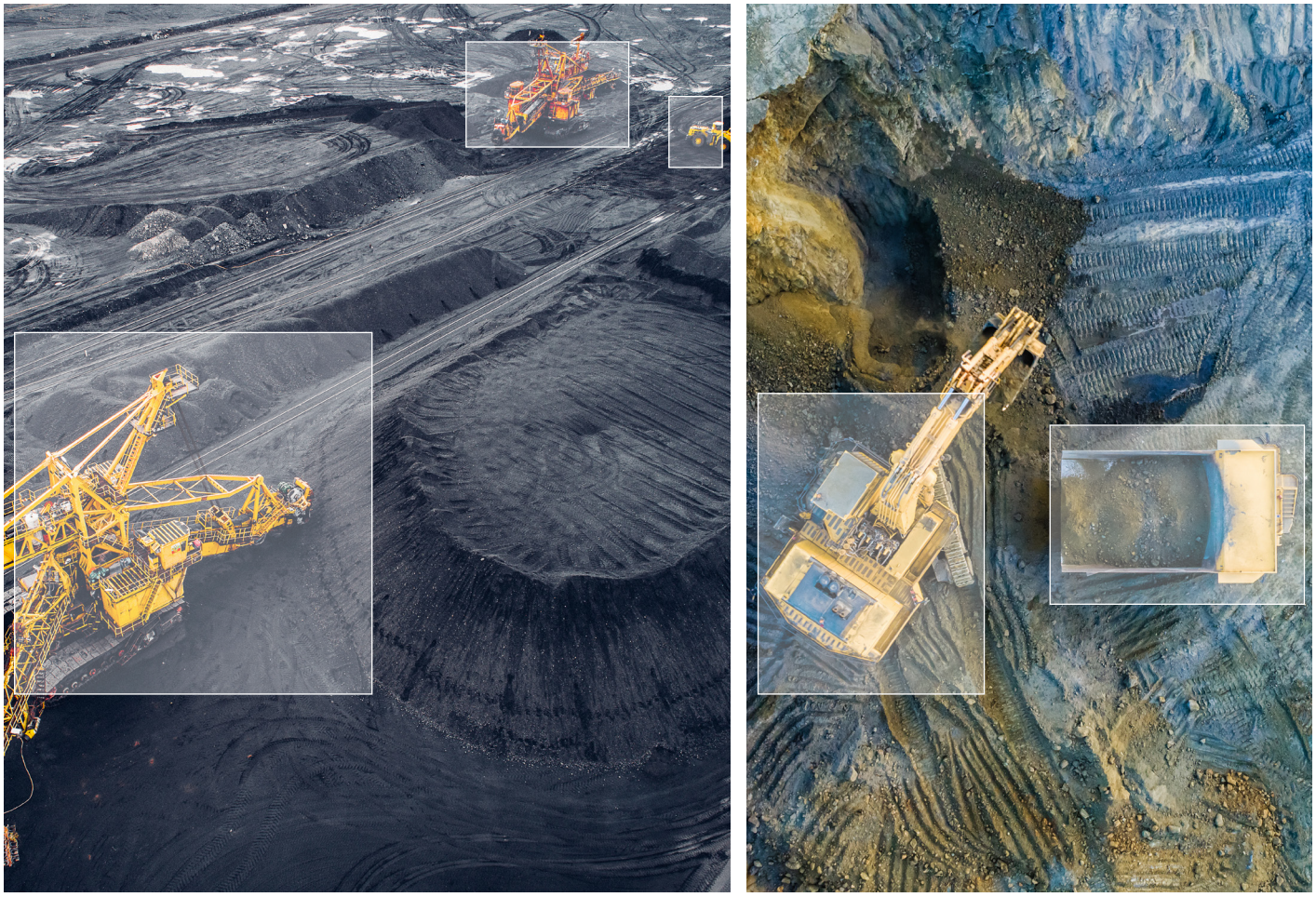


Fig 2: Creating training datasets for ML by annotating images

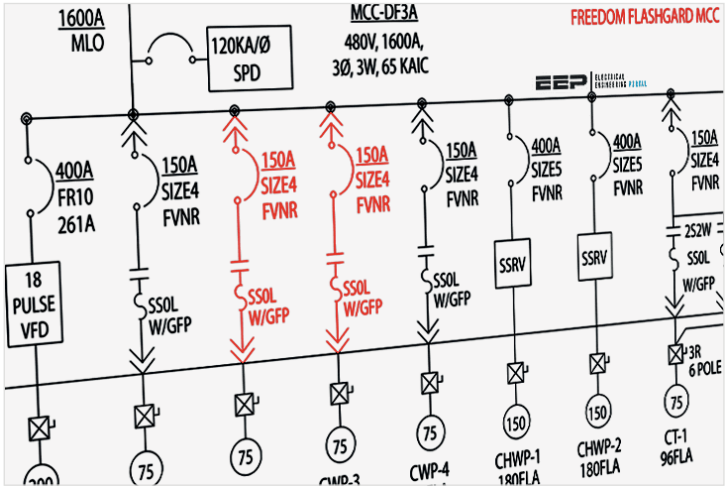
The advantage of leveraging AI in GIS is that it enables organizations to adapt to change and provides a competitive edge while maintaining compliance with regulations.

Impact of AI in data quality

For data to be considered valuable, it needs to be of the highest quality. This is one reason why considerable attention is paid to data quality and standards as inaccuracies and errors can cause huge disruptions. When it comes to geospatial data, it needs to be precise, complete, relevant, and timely. This makes maintaining the consistency of GIS data a labor-intensive, rudimentary, and repeated activity. The challenge of maintaining quality is compounded by the increase in data generated, the increasing numbers of users accessing the internet, as well as a lack of skilled human resources.

An ML model can be trained to review source data or transaction data based on a predefined data model and produce a desirable result with reduced human intervention. For instance, GIS data specialists in utility industries can use ML to detect and apply algorithms to highlight a missing valve type that needs to be added when assessing the diameter of connecting pipes.

Another instance where the benefits of ML is tangible is when a field-level update needs to be made. Let's consider transmission engineering data requiring field-level updates in the enterprise GIS data with information on insert, update, and delete marked on a drawing. If the update is processed manually, a reconciliation of all entries is needed as the manual process is ineffective and prone to error. However, an image scanning ML model can be trained to scan information on the drawing within hours and produce a report showing the frequency of delta updates. The AI technology can then automatically update the master database using this information, ensuring that data is not lost while drastically reducing the effort involved.



Source PDF

AI/ML

Grade	Radius	Perimeter	
1.5KW	315M	N 12380	E 12208
4.7KW	150M	N 12085	
3.2KW	205M		
3.2KW	129M		
1.6KW	83M		

Metadata (Json)

Fig 3: Illustration of auto extraction of source data to error-free output

Similarly, yet another valuable application of AI in GIS is related to data cleansing and improvement where through the use of AI, the task of eliminating erroneous data is simplified. AI can also be leveraged to maintain and store historical GIS utility data.

Therefore, the transformative impact of the disruptive technologies of AI and ML can be seen in several data processes and quality aspects of spatial data management, as depicted in the image below.

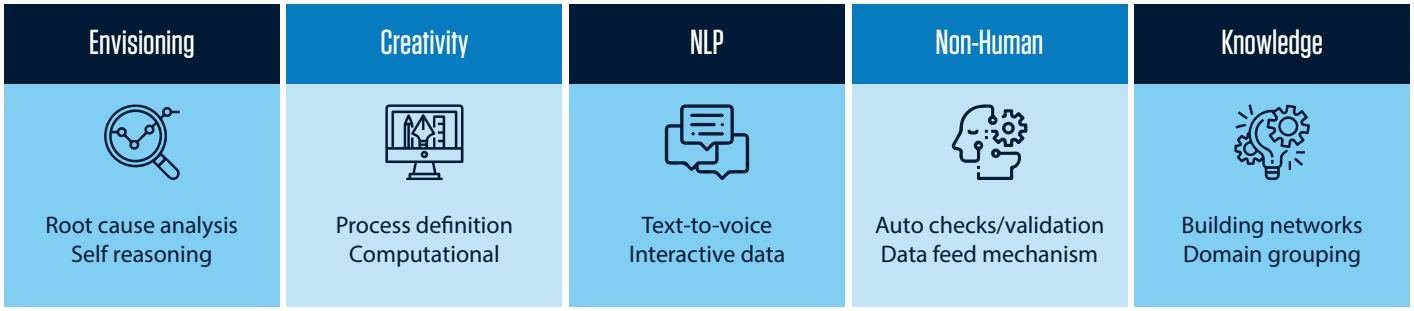


Fig 4: Benefits of AI/ML in Data Management and Quality

The way forward for AI in GIS

A vast majority of data around us is geospatial in nature, especially cosnidering the wide-variety of data sources such as sensors, location-tagged social media posts, satellite images, and other location-based applications. In order to process and make sense of this ever-increasing quantum of GIS data, major advancements must be made in AI technology and in its application in GIS. AI and ML are already ushering in a technological revolution that is helping organizations offer innovative solutions to real-world problems. As more and more organizations adopt geospatial artificial intelligence, intelligent solutions to these problems are only bound to increase. With the accelerated technology progress and diffusion of new business innovations, these will also bring about tectonic shifts in society. Surely, the GIS + AI space promises to be an interesting one to watch.

About the Author

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Dr. Pradeep leads the GIS data practice in Infosys BPM. He has close to 22 years of experience in the field of GIS, telecom OSS/BSS, mobility and telematics domain, and is involved in the consulting, solution architecture, program/project management, portfolio management for Indian and overseas clients (US/Middle-East). In Infosys BPM, he is responsible for leading the GTM strategy, presales, consulting, COE accountabilities - creating/owning business modeling/framework and contribution to all lines of GIS business/new wins.

Pradeep holds a Doctorate Degree in Disaster Management (landslides prediction) using GIS/remote sensing and has done his post-graduation in Applied Geology.

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