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From Data Silos to Data Science

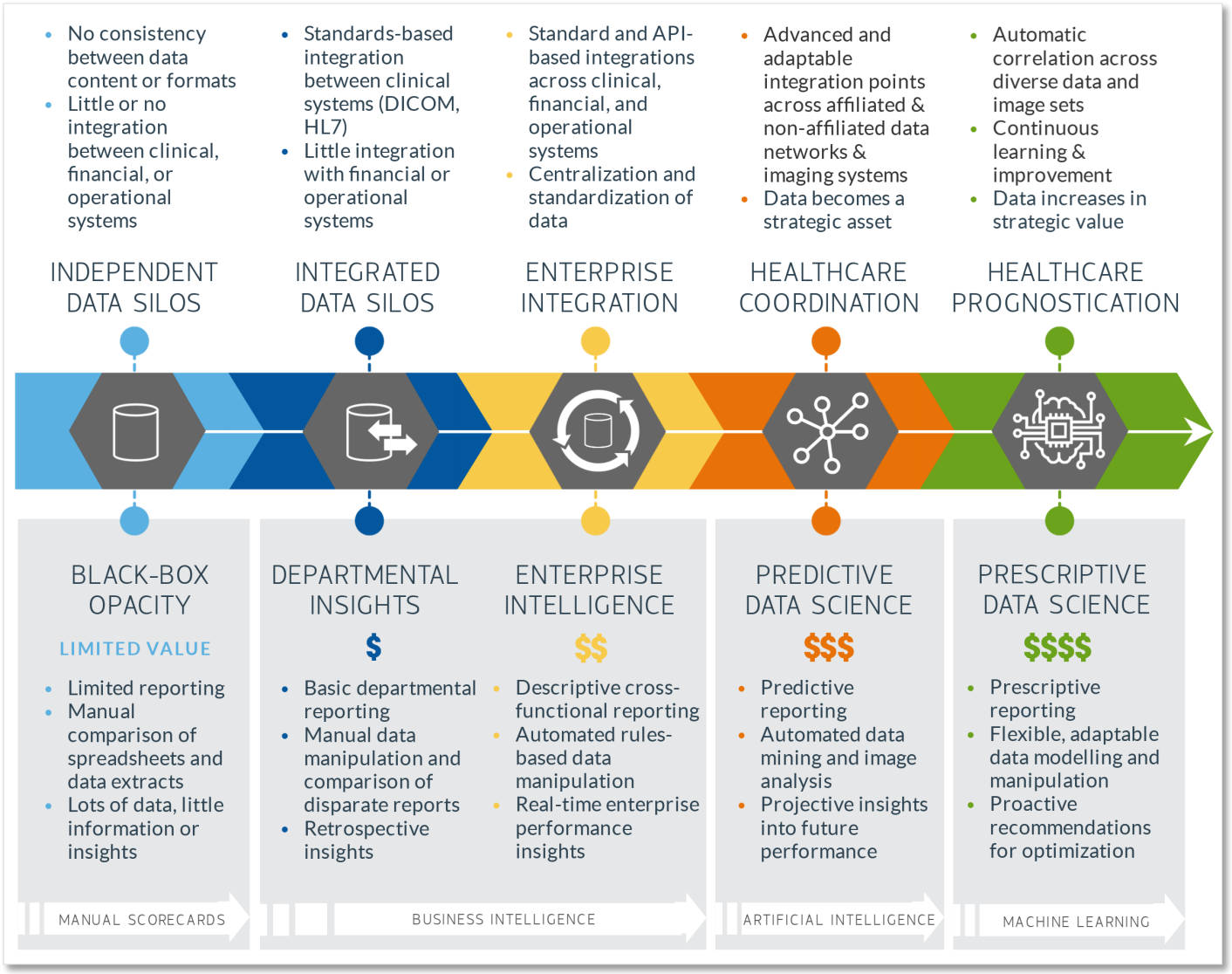
Unlocking the Strategic Value of Medical Imaging Data

From Data Silos to Data Science

Without question, the way imaging data has been collected and managed since the early days of digital radiology and cardiology has advanced significantly. As more and more data was generated and collected, and applications advanced in their ability to glean meaningful insights from it, the science of business intelligence evolved into the new frontier that is now known as data science – a discipline that has emerged to make sense of the vast stores of 'big data' that is now available across the medical imaging continuum (see Figure 1). This data represents a treasure trove of information that is of significant strategic value to healthcare organizations, academics, scientists, and the population at large which, until recently, has been untapped due to structure, format, and interoperability challenges.

Advanced data science technologies are now able to achieve true clinical interoperability and leverage this data to uncover deep, targeted insights into all aspects of imaging workflow performance. Understanding the true value of this information and the role data science can play in realizing its full potential requires an appreciation of the evolution of imaging data collection and analysis.

Figure 1: The Evolution of Data Science



Integrating the Enterprise: Connecting Data Silos

The earliest imaging systems existed as largely independent information silos, servicing specific workflow needs within imaging departments (i.e. Hospital and Radiology Information Systems (HIS, RIS) for patient registration and scheduling, Picture Archiving and Communication Systems (PACS)/Cardiovascular PACS (CPACS) for medical imaging, recorded dictation and transcriptionists for reporting, etc.) with little to no interoperability between systems. As industry standards and profiles evolved in their maturity, so too did the level of integration that was possible.

The emergence of combined systems such as RIS/PACS for radiology and Cardiovascular Imaging and Information Systems (CVIS) for Cardiology are examples where disparate data types (i.e. DICOM, HL7, XML) were brought together in a meaningful way to support basic analytics within imaging departments. However, the level of integration at this stage was limited to basic connection between largely independent systems, and therefore challenges persisted regarding bespoke data formats and structures, data management practices, and limited integration points. To gain even departmental insights typically required manual abstraction and correlation of data, and there was little ability to traverse systems or data formats and subsequently very little, if any, automated reporting available.

Most Healthcare organizations lie in the early stages of the AI Data Readiness Scale, between connected data silos and true enterprise integration.

Broadening Horizons: The Emergence of Enterprise Imaging Informatics

The introduction of Enterprise Imaging (EI), fueled by industry organizations like IHE and HIMSS/SIIM, further tore down information silos by defining advanced integration profiles that would enable data collection across disparate imaging systems and departments. Widespread data consolidation, a common theme in EI projects, provided not only cost savings through economies of scale, but also enabled enterprise analytics by forming large-scale data warehouses that were equipped to handle the diverse array of data formats and provided a variety of standard and non-standard methods for data inspection to enable cross-functional analysis of information generated across radiology, cardiology, and other image-generating departments.

However, more often than not data needed to be standardized to conform to the prescribed formats and models required by enterprise analytics applications, which once again introduced cumbersome and often manual processes related to developing standardized values and building matrices to cleanse and normalize ‘dirty’ data.

A Bright Future: The Value of Data Science in Medical Imaging

Medical imaging management is evolving once again, thanks to the introduction of advanced business intelligence, artificial intelligence, and machine learning technologies. At this point data significantly increases in value, becoming a strategic asset as it pivots from being retrospective of past occurrences to becoming descriptive of current events, predictive of future trends and performance, and informing prescriptive recommendations for how clinical and operational resources can be optimally deployed to achieve the highest quality outcomes at the lowest possible cost. To truly understand the impact data science can have within healthcare, it is necessary to demystify the various technologies that are involved: Business Intelligence (BI), Artificial Intelligence (AI), and Machine Learning (ML).

Business Intelligence

Business Intelligence (BI) in the medical imaging realm refers to the cross-functional analysis and correlation of clinical, operational, and financial key performance indicators (KPIs) to derive clinically and operationally relevant insights into workflow efficiency, quality of outcomes, and resource utilization that can be used to inform practice improvement initiatives. Advanced BI algorithms are able to process information from a variety of scheduling, ordering, image, and information capturing devices in real-time, and provide access to descriptive performance insights using flexible mediums such as custom dashboards, on-demand or scheduled reporting, and even live alerts for critical events.

Artificial Intelligence

AI is the ability for computers to emulate human reasoning by perceiving and interpreting diverse and unstructured information. When applied to medical imaging, AI enables analysis of the vast amount of data being generated across the imaging continuum including but not limited to electronic medical records (EMRs), ordering and imaging systems (RIS/PACS/CVIS), financial systems, and a variety of other information or image capturing devices and systems. Advanced image analysis, statistical analysis, and natural language processing algorithms are designed to process and correlate this information at a rate and level of accuracy that far exceeds the abilities that teams of dedicated human resources could accomplish. AI leverages this data to automatically detect clinical, operational, and financial points of interest from diagnostic orders, images, reports, and operational and financial KPIs, thus providing valuable insights into diagnostic findings, treatment alternatives, and workflow efficiencies in real-time. As well, AI can be used to deliver predictive analytics, which have the ability to forecast future performance, resource requirements and imaging appropriateness criteria based upon a statistical analysis of historic data patterns and can be used to inform continuous improvement initiatives.

Machine Learning

Machine Learning (ML) is an application of AI that allows a system to effectively learn for itself and automatically improve its algorithms using cognitive processes that are formed upon training and experience – and not explicitly programmed. The implications of this technology in healthcare are significant. ML has the ability to deliver prescriptive analytics, which not only predict what might happen but also provide actionable recommendations to mitigate or optimize the forecasted outcomes. For instance, ML can learn from differing ordering practices and associated diagnostic outcomes to determine ideal imaging and other diagnostic protocols based upon specific patient symptoms and disease profiles. As well, ML can develop actionable recommendations to optimize workflow and resource utilization and reduce turnaround times and cost based upon individual, departmental, and enterprise-wide KPIs. From a broader clinical perspective, ML can profile patients' clinical history, socioeconomic situation, and genetic makeup to not only predict future diseases or conditions, but also suggest proactive steps to mitigate their risk or severity. As well, ML can learn from various patient outcomes to determine the optimal treatment options for specific patients and conditions.

Unlock the Value of Data Science

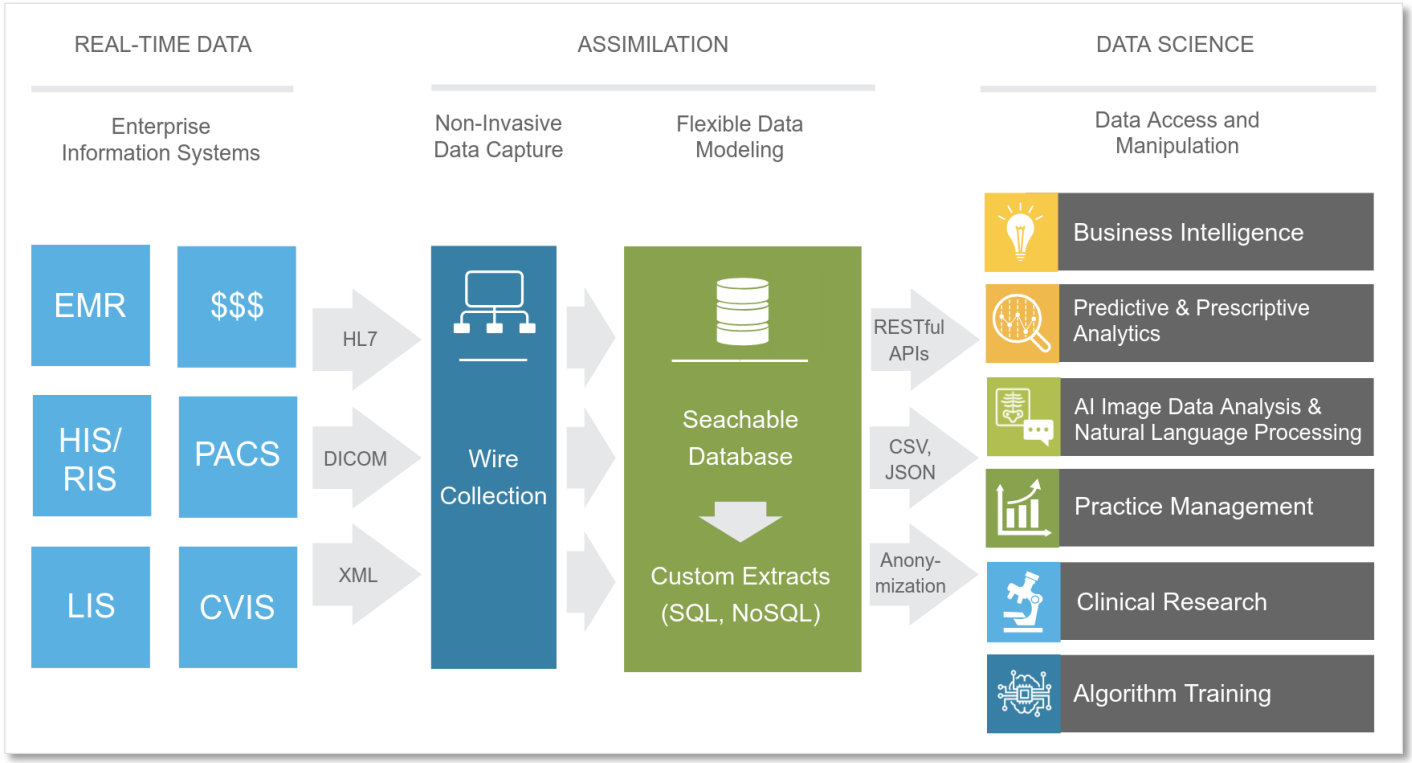
The benefits of integrating AI and ML into medical imaging are too numerous to list, which begs the question – why aren't more organizations actively leveraging these technologies to improve their clinical and business operations and outcomes? The answer is, at its core, quite simple – data.

AI and ML require vast amounts of data from which to glean insights and form decisions, and unfortunately most data-gathering systems in the healthcare universe today suffer from a variety of inhibiting limitations related to insufficient integration points, rigid data models, and restrictive data format support. Because of these limitations, even if a system is able to natively support AI or ML applications, centralization and some level of standardization of the data to be utilized is often required – which ultimately means expensive, time consuming, and risky migration projects that are often too cost inhibitive for most organizations to undertake.

The solution? A flexible data management platform for Medical Imaging that is designed to overcome these limitations and create the foundational framework for BI, AI, and ML across the enterprise. Bialogics' Diagnostic Imaging Management and Analytics Exchange (DImax) AI-Ready Business Intelligence Platform offers a framework that unleashes the insights hidden in for both free-text and structured data enabling faster and more accurate analysis. A unique and non-invasive data science engine, DImax passively collects clinical, operational, and financial imaging data as it is sent between disparate systems and departments; correlates, organizes and prepares it for data mining and analysis; and delivers clinically and operationally relevant insights for practice improvement and clinical research, and supports ongoing AI/ML algorithm training and development (see Figure 2).

Your ability to realize the full benefits of Artificial Intelligence and Machine Learning is only as good as your data foundation.

Figure 2: Bialogics AI-Ready Business Intelligence Platform

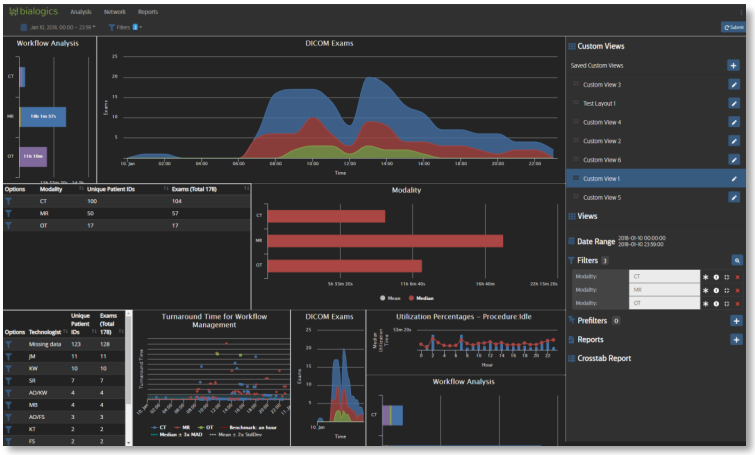


Achieving True Clinical Interoperability

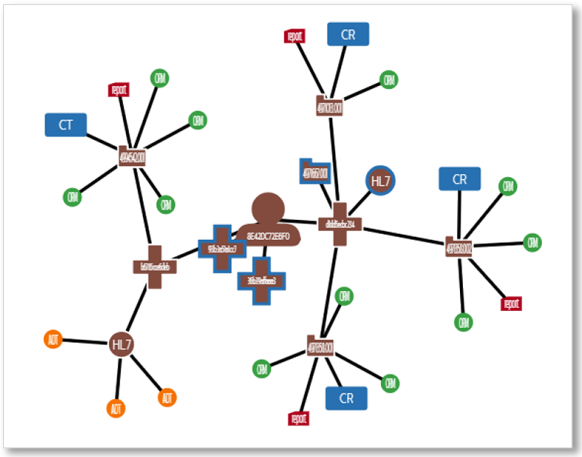
One of the biggest challenges facing medical imaging data scientists today is gaining access to data from assorted imaging and information systems that have varying levels of interoperability across the enterprise. While many systems have achieved some level of technical interoperability, ranging from basic standards-based interfaces to advanced Application Programming Interface (API) integrations, few have achieved true clinical interoperability, which involves assimilating relevant data points across to deliver timely insights and recommendations to the person and place where they can be most easily acted upon and presented in a way that can be easily accessed and interpreted.

For complete clinical interoperability, DImax supports DICOM/DICOMweb, HL7/FHIR, and XML protocols and provides a comprehensive set of APIs for advanced integrations. Data received from EMR, RIS, PACS, CVIS, voice dictation, and financial systems are transformed into a live feed of harmonized information that provides a view into real-time performance and informs AI and ML applications such as image data analysis, natural language processing, and predictive and prescriptive analytics.

These insights can be accessed through DImax's simple and intuitive user interface, which captures and displays over 100 relevant KPIs. Highly configurable, users can easily create their own personalized views using flexible drill-down variables to gain visibility into in-depth, targeted metrics that can be easily integrated into clinical or administrative workflows. As well, using synonym-matching algorithms driven by Natural Language Processing and an integrated RadLex library for increased precision, DImax's highly accurate report module allows users to efficiently mine structured and unstructured data in real-time to generate ad-hoc or scheduled reports that support practice improvement, quality assurance programs, and return-on-investment (ROI) monitoring.



A personalized DImax dashboard showing real-time KPIs relevant to imaging demand, modality utilization, workflow performance, and turnaround times, etc.



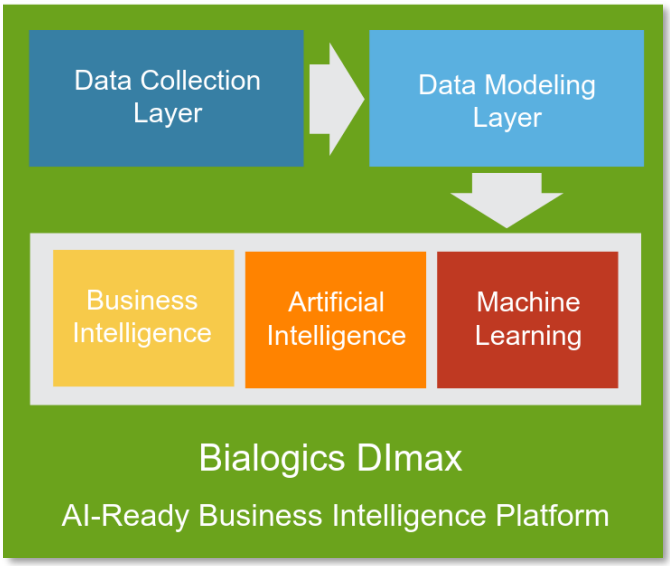
The live DImax map provides dynamic visualization of patient imaging visits, encounters, exams, and results.

A Data Modeling Chameleon

There are countless medical imaging use-cases for AI and ML, and as such data needs vary significantly between algorithms. Moreover, there is a large and steadily increasing number of AI and ML vendors offering these aforementioned algorithms, and unfortunately, as no standard has yet been defined for the format of AI and ML data, each vendor has its own unique requirements regarding the underlying data model structure and format. To-date this has been a significant inhibitor to both the development and training of new algorithms, as well as the integration of AI and ML into clinical practice.

DImax overcomes this challenge by providing flexible data mapping to ensure consistent translation and appropriate utilization of information across diverse systems with differing standards and formats. This allows data to be stored in its native format, preserving its original integrity while meeting the bespoke needs of consuming AI or ML algorithms. DImax's highly performant searchable database allows AI and ML algorithms to mine structured and unstructured data in real-time while optionally standardizing and cleansing search results on-the-fly.

For systems that require locally-sourced data DImax can generate custom database extracts that adhere to target systems' unique data model requirements and are pre-populated with the data required for AI and ML training, analytics, or clinical research purposes. DImax supports a number of extract formats, including, CSV, and JSON and which can be easily imported into 3rd party systems using a direct ODBC connection, AVRO (a data serialization framework), or Restful APIs. DImax also provides the option to anonymize and de-identify PHI for any extracted data, using a secure salted-hash method to ensure complete privacy.



DImax is an advanced analytics framework that combines a fully interoperable and non-invasive data collection layer with adaptable data modeling tools to fuel BI, AI, and ML applications.

Future-Proof Your Data Management Strategy

There's no doubt about it, data has value. The more an organization is able to collect and structure in a meaningful way, the better positioned it will be for current and future data analysis initiatives. Fueled by data, business intelligence, artificial intelligence, and machine learning technologies have the potential to deliver significant and immediate clinically and operationally relevant insights.

Why wait? Bialogics' Diagnostic Imaging Management and Exchange (DImax)

platform can be quickly easily integrated into your existing infrastructure so you can start your data collection efforts immediately. Whether you're a private clinic large hospital system, or Accountable Care Organization (ACO), it is imperative that you start your data collection efforts today in order to prepare your organization for future data science use cases.

DImax helps diverse healthcare organizations sharpen their focus on key initiatives that will deliver the greatest return on investment. Let DImax prepare you for the future of medical imaging data while delivering an immediate impact on your organization's clinical, operational, and fiscal performance (see Figure 3) through advanced business intelligence analytics that unlock the value potential of your organization's biggest strategic asset – your imaging data.

> *"[Don't just] prepare for AI or machine learning. You want to prepare for what's going to come down the road and it's not just AI. It's advanced IT, big data, analytics, and AI. You want to prepare your IT infrastructure to be able to consume all these things." – Dr. Paul Chang, MD*[1]
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> [1]*HealthImaging.com 2019, 'Check the PACS, radiology isn't fully prepared for AI'*

Figure 3: DImax Use Cases and Benefits

About Bialogics

We provide fully interoperable and innovative data transformation solutions for healthcare provider organizations and industry vendors that enable informed business decisions, greater workflow efficiencies, and improved patient outcomes. Developed in collaboration with industry partners and healthcare clients we set out to build a true vendor agnostic platform for Medical Imaging Administrators and Physicians, incorporating a comprehensive tool-set to measure and improve patient access to diagnostic imaging, procedural appropriateness, Turn-Around-Times, and operational costs and efficiencies. The pursuit of our vision has resulted in a unique data engine designed to support business intelligence, AI, and Machine Learning applications. – simple, cost-effective, and powerful.

Contact Us

For more information on DImax, our AI Ready Business Intelligence Platform, or BIAmart, our DataMart for Clinical Analytics, and IDEA Integrated Data Engine for Analytics, visit our website at www.bialogics.com or to arrange a demonstration connect with us through email at info@bialogics.com.