Computer Technology Review article – Cognitive Computing is Turning Precision Medicine into a Reality

In his 2015 State of the Union Address, President Obama launched a Precision Medicine Initiative – but a year later only about 15% of hospitals use Predictive Analytics and practicing Precision Medicine continues to be out of reach for most medical professionals. So what is Precision Medicine and what is needed for it to be practiced at the point-of-care and at scale?

"Precision medicine will enable healthcare providers to tailor treatment and prevention strategies to people's unique characteristics, including their genome sequence, microbiome composition, health history, lifestyle, and diet. To get there, we need to incorporate many different types of data, from metabolomics (the chemicals in the body at a certain point in time), the microbiome (the collection of microorganisms in or on the body), and data about the patient collected by health care providers and the patients themselves. Success will require that health data is portable, that it can be easily shared between providers, researchers, and most importantly, patients and research participants." (Source: The White House Precision Medicine Initiative.)

Linking Healthcare Data is Complex

The complex nature of health data makes sharing data between patients, providers and researchers a tall order. To practice

Precision Medicine broadly on all patients, a medical facility would need to seamlessly link their internal data to external knowledge bases such as drug interaction databases, the Gene Ontology, PubMed, disease databases and incorporate data from other health networks, medical centers, research institutes and public data sets, which could encompass thousands of studies, millions of patients and billions of bits of data.

But it doesn't stop there. Data from IoMT (Internet of Medical Things) also needs to be analyzed. This can include all the sensor data available in the ICU, data from devices monitoring heart rate, infusion pumps and commercial or medical grade wearables, which needs to be abstracted and linked to other time stamped data. Then let's not forget the financial aspect of patient care. Every healthcare system is required to link to billing codes (ICD9 and ICD10), which are used in standard EMR databases.

Linking of data from all types of data sources Gartner refers to as the 'Information of Everything.' "Information has always existed everywhere, but has often been isolated, incomplete, unavailable or unintelligible. Advances in semantic tools such as graph databases as well as other emerging data classification and information analysis techniques will bring meaning to the often chaotic deluge of information." (Source: *Gartner Identifies the Top 10 Strategic Technology Trends for 2016*, Oct 6, 2015)

Linking data is very useful in understanding relationships between data. But the real value is realized when analyzing the connections in the linked data. Here again, traditional relational technologies fall short – making it impossible to:

- Answer questions across internal, external and public data simultaneously
- Answer questions that were not anticipated in advance
- Add new internal, external and public data sources in minutes

Enter Semantics and Cognitive Computing

To overcome the complex data linking and analyzing challenge – Semantics and Cognitive Computing offers a leap forward.

First, applying a semantic model to complex Big Data makes it simple to combine unstructured data with structured data and internal data with external (including public) data – to fuel real-time analysis, predictive analytics and deep learning. Integrating databases is virtually effortless, since the data can remain in its original databases and database designers do not have to create a schema up front. In order to forward Precision Medicine, this capability is particularly valuable since healthcare organizations need to tap into the growing number of public datasets to enrich their analytics.

Second, Cognitive computing systems make context computable by identifying and extracting context features such as time, location, task, history or profile to present an information set that is appropriate for an individual or for a dependent application engaged in a specific process at a specific time and place. Cognitive Computing can provide machine-aided serendipity by wading through massive collections of diverse information to find patterns and then apply those patterns to respond to the needs of the moment.

Using Cognitive Computing for Precision Medicine can make it possible to:

- Practice **Precision Medicine** by answering questions about treatments/medicine for sub-populations such as kids, older adults, women and different ethnicities.
- Practice **Personalized Medicine** by mapping genomic data with individual patient electronic medical records.
- Answer questions for treatments/medicine for **Rare Diseases**, which has been cost-prohibited in the past due to small sample sets.

Semantic Data Lake for Healthcare

Recently, considerable strides have been made toward Precision Medicine with a collaborative effort between Montefiore Health System (the leading Accountable Care Organization in the U.S) Franz, Intel, Cloudera and Cisco in the creation of the Semantic Data Lake (SDL) for Healthcare. The SDL for Healthcare is an effort spearheaded by Dr. Parsa Mirhaji, MD. PhD., Director of Clinical Research Informatics at Einstein College of Medicine and Montefiore Health System for constructing longitudinally integrated, semantically enriched, scalable and secured analytics infrastructure necessary for next generation learning healthcare systems, and Precision Medicine.

The SDL enables modelers, data scientists and application developers to leverage complex information, biomedical knowledge-bases and ontologies, as well as the linked open data (LOD) for predictive modeling, care management, population and community health management, health systems research, and clinical and translational research.

“The Semantic Data Lake for Healthcare will help us to connect the dots to better understand the determinants of outcome, cost, and patient satisfaction in a complex ecosystem in which patients and clinicians interact with each other, with the delivery of care system, and with the research enterprise,” said Dr. Parsa Mirhaji MD. PhD., Director of Clinical Research Informatics at Einstein College of Medicine and Montefiore Health System. (Source: AllegroGraph Certification on Cloudera Enterprise Creates a Semantic Graph Data Platform for Hadoop Feb 8, 2016)

“The SDL embodies Montefiore’s incremental and measured approach towards Cognitive Computing in healthcare,” said Dr. Mirhaji. “Our ability to conduct real-time analysis over new combinations of data, to compare results across multiple analyses, and to engage patients, practitioners and researchers as equal partners in big-data analytics and decision support will fuel discoveries, significantly improve

efficiencies, personalize care and ultimately save lives." (Source: AllegroGraph Certification on Cloudera Enterprise Creates a Semantic Graph Data Platform for Hadoop Feb 8, 2016)

The pressure of federal mandates from the Affordable Care Act and a growing aging population are key forces driving the urgency for Precision Medicine. But recent advances in Cognitive Computing and Semantics will help make Precision Medicine a reality, save the lives of people with rare diseases and improve the overall state of healthcare in 2016 and beyond.

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