emtelliPro™ for Imaging AI Quality Assurance

emtelligent®
MEDICAL NLP

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As medical imaging artificial intelligence (AI) vendors bring new diagnostic models to market, imaging organizations adopting these tools want to know: how accurate are they compared to our radiologists? emtelligent's emtelliPro NLP platform can easily be deployed as part of these AI systems to answer this question, reassuring users of the accuracy, efficacy, and value of this new technology.

BACKGROUND

Many vendors are now offering AI software to augment the ability of medical imaging professionals to diagnose disease on medical imaging studies. These models take advantage of the latest techniques in deep learning to make highly-accurate AI models that are in many cases claimed to exceed the performance of humans in diagnosing conditions on medical imaging studies.

But these models may have been trained on specific patient populations, on equipment from certain vendors, or using different imaging protocols than those used at a particular imaging site. Similar to adopting any new medical technology, imaging customers have legitimate questions about system accuracy - most importantly, they'd like to know how these models are performing 'in the wild', dealing with often imperfect real-world images acquired at their institutions.

> AI models are highly variable in how they're trained, which makes it difficult to create a standardized way to measure accuracy and performance. With NLP, radiologists' final reads can be automatically compared to AI's interpretation to determine concordance or discordance – regardless of the data, equipment, or imaging protocols used.

This is where emtelligent's NLP platform, emtelliPro, can help. emtelliPro analyzes every sentence in medical reports, coding identified medical concepts against multiple ontologies, and detecting assertions about these concepts, such as where a radiologist says a condition is present or absent, or has some uncertainty about a diagnosis. It also identifies many relations in text, such as qualifier adjectives (e.g. 'mild', 'moderate', 'severe'), measurements, experiencers, and follow-up recommendations, to name a few. In this case, emtelliPro can be used to classify the radiologist's final read, such as whether the radiologist and AI model's interpretation were concordant or discordant, for example shown in the table below.

CONCORDANCE TABLE

Study ID	AI Model Output	Radiologist			Rad/AI Discrepancy Status
		Concept Identified	Polarity	Sentence	
11111111	positive	intraparenchymal hemorrhage	positive	Large intraparenchymal hemorrhage in the left parietal lobe.	Concordant
22222222	positive	subarachnoid blood	positive	Possible small amount of subarachnoid blood lying over the right frontal convexity.	Concordant
33333333	negative	thalamic hemorrhages	positive	Stable appearance of bilateral thalamic hemorrhages.	Discordant
44444444	positive	subarachnoid hemorrhage	negative	No evidence of hemorrhage.	Discordant

By using emtelliPro to automatically process radiology reports and classify them for the presence or absence of the disease conditions detected by a vendor's AI models, real-world sensitivity and specificity data about the performance of the AI models can be constructed based on the end-user's data. This can be used to prove the accuracy of these AI systems, or help define problem areas where the models or imaging protocols may be in need of tuning.

A DIFFICULT PROBLEM

To people unfamiliar with some of the complexities in medical imaging, it may seem easy to create a document classifier. Many deep learning tutorials are available online that show people familiar with programming how to download a deep learning toolkit, and with a small amount of training data, create what appears to be an accurate document classifier. It may seem easy to use this approach to come up with a system for QA purposes, but this approach ignores the real-world complexities of medical imaging reports, and does not account for the benefits of using a true medical imaging platform like emtelliPro.

REAL WORLD PROBLEMS

A user may want to create a document classifier to detect the presence or absence of intracranial hemorrhage, which would be used to compare AI model performance to the radiologist's final read on head CT scans. But the intersection of language and biology is incredibly complex, making this an almost Sisyphean task without a huge amount of training data and human annotators.

First, radiologists don't list all absent conditions on imaging reports; in the case where the indication for the report asked them to evaluate for hemorrhage, the dictating radiologist may indicate that hemorrhage was absent, but more likely, if it is absent, they may just say 'normal head CT scan', or indicate the presence of some other diagnosis -- in other words, the report may not say anything about the presence or absence of hemorrhage.

For patients with known hemorrhage receiving follow-up scans, the report may often contain indications that hemorrhage is both present and absent. These reports usually say something like, "Stable right thalamic hemorrhage with no new hemorrhage".

Descriptors regarding changes in the brain related to prior episodes of hemorrhage are also common - sentences like "Stable chronic changes related to remote hemorrhage in the right hemisphere" are frequently used. These are difficult to parse because even though no hemorrhage is actually present, the word 'hemorrhage' is present, which is confusing for simple document classifier models.

There may also be other conditions related to hemorrhage which are important such as 'hemorrhagic transformation', conditions that are similar to but are not hemorrhage like hemorrhagic metastases, or types of hemorrhage not often detected by imaging AI models such as petechial hemorrhage.

Creating a highly-accurate document classifier to deal with all of these very common but complex cases is no easy task. It would take months of work and tens of thousands of reports annotated by domain experts just to come up with a single classification model that would still have limited accuracy. In addition, even with a model like this, an AI vendor would need the classification to be explainable to properly validate any AI model. Standard methods in document classification for explanation use attention to pick the words and phrases that are the reason for the output label, but these attention-based explanations are often misleading and do not provide sufficient clinical information compared to the use of clinical NLP.

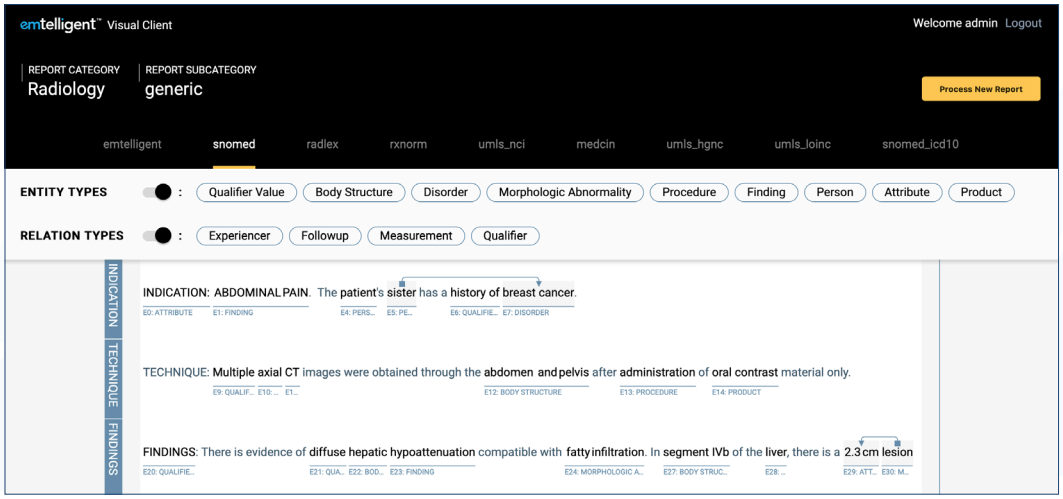
BENEFITS OF CLINICAL NLP

In addition to the complexities that would make obtaining high accuracy from a document-level classifier difficult, there are additional benefits for using a clinical NLP system that truly understands complex medical text for this task.

The emtelliPro architecture processes documents into structured data and while not mandatory, the output is usually stored in a relational database. This gives AI vendors a persistent data store about the content of these reports; they can use this information for secondary diagnosis identification or use cases not originally contemplated at the time of the original processing.

Another benefit is that emtelliPro will link any mentions of the many types and subtypes of pathology to concepts from ontologies like SNOMED and RadLex. In the example above, this means that AI vendors not only can identify that hemorrhage was present or absent, they can identify what specific type of hemorrhage was present (e.g. intraventricular hemorrhage, intraparenchymal hemorrhage, etc.). This information can then be used for more detailed QA, analytics, or further model refinement. It can also be used to specifically exclude subtypes of pathology (e.g. petechical hemorrhage, which are very small hemorrhages often seen after a stroke) so as to truly reflect the intended accuracy of their AI models.

EMTELLIPRO VISUAL CLIENT



The emtelliPro Visual Client provides a graphical view of NLP output for individual reports, helping developers to better understand the entities, assertions, and relations identified during processing

emtelliPro's ability to extract relations such as measurements or qualifiers (e.g. 'small', 'moderate', 'large') can also be used by AI vendors to enhance QA - for example by excluding subcentimeter foci of hemorrhage from classification - or to further tune models using this data. These features of emtelliPro can also be used in cohort identification, to create unique batches of training data based on pathology features.

The main benefit is that emtelliPro's output is explainable. It outputs which ontology concepts are identified with their spans in the text and their negation and uncertainty status. Analysts and data scientists using this output can see exactly why a document was classified as positive or negative for pathology, and rapidly fine-tune results without needing to build a new model.

EASY INTEGRATION

emtelliPro has been designed from its inception for ease of integration with other vendors. It can be deployed on bare-metal or as a virtual machine inside of an imaging center's network, or calls to its API can be made via emtelligent's cloud-based servers. Sending data to emtelliPro is as easy as making an API call using our client software or vendors can also create their own client using our API specification or our Python or Java SDKs. Our SDKs and client also contain everything needed to take emtelliPro's structured data output and store it in an emtelliPro database, a relational database schema that can be used as a persistent data store that takes advantage of the power of relational database management systems to intelligently filter, search, sort, and aggregate the NLP data.

emtelliPro has been designed from its inception for ease of integration. Using our client software, customers can be up and running in under an hour – and our team of data science specialists are there to help accelerate data integrations and application development.

Using our client software, customers can be up and running in under an hour, and our extensive documentation on the emtelliPro database schema can be used to get up and running with complex SQL queries very quickly. emtelligent also has an team of clinical and data science specialists to help customers easily and rapidly create the applications that they want today.

LEARN MORE

To learn more about how your AI company can make model generation easier and more accurate and how to provide the QA tools your customers are asking for, visit our website: www.emtelligent.com or contact us at info@emtelligent.com.

ABOUT EMTELLIGENT

Based in Vancouver, British Columbia, emtelligent is focused on making the jobs of healthcare professionals easier and their patients' lives better. Built by medical experts, for medical experts emtelligent's Deep Learning NLP engine and collection of clinical and search tools automate and simplify data collection and analysis across clinical systems, specialties, and patient populations to uncover meaningful insights from within complex, unstructured medical data. By partnering with health networks, medical imaging facilities, research institutions, payer organizations, and technology innovators emtelligent helps to increase safety, boost operational efficiency, and elevate quality of care for providers and patients across North America. The emtelliPro engine is available now, and our team of medical and NLP experts are on-hand to consult regarding your medical data needs.

Schedule a demonstration at www.emtelligent.com or call 1-877-GO-EMTEL (1-877-463-6835) today.

Make the emtelligent Choice

emtelligent's advanced NLP engine transforms difficult-to-use, narrative medical text into valuable and actionable insights.

Enable innovation. Improve competitiveness. Drive performance.