



AN OVERVIEW OF

NYM'S CLINICAL
LANGUAGE
UNDERSTANDING (CLU)
TECHNOLOGY

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Overview

Nym's Clinical Language Understanding (CLU) technology is a new approach to understanding patient medical charts.¹ The Nym CLU engine captures the narrative of the medical chart and creates a reconstruction of the patient's visit by identifying the logical relations among the various linguistic elements of the chart. From this complete understanding of a patient's visit, Nym assigns the accurate medical codes to the chart for hospital reimbursement.

This paper describes the mechanics of Nym's breakthrough CLU technology and demonstrates how healthcare providers, Revenue Cycle Management companies, and other stakeholders can benefit from this novel technology.

History of Language Understanding

Interest in machine understanding of language began in the mid-1900s with early attempts to achieve machine translation using the renowned Turing test which demonstrated a machine's ability to understand intellectual behavior. In the early 1950s, the new field of modern generative linguistics was born, which influenced the cognitive sciences and led to the development of machine natural language processing (NLP). Among the various approaches in this area was that of theoretical linguist Noam Chomsky, whose work in those years revolutionized linguistics further by claiming that machine models should be expected to recognize grammatically correct or incorrect sentences, just as people do intuitively.

In the decade following the invention of NLP, the NLP field split into two main branches: a rule-based approach focused on syntax, and a statistical approach aimed at probabilistic language understanding. Ultimately, the probabilistic approach proved more versatile and became more commonly accepted than the rule-based approach, with applications in such areas as machine translation, speech recognition, sentiment extraction, and understanding of expressed intent and meaning.

¹The terms *medical chart*, *medical record*, and *health record* are used somewhat interchangeably to describe the systematic documentation of a single patient's medical history and care across time.

In the 1960s, Natural Language Understanding (NLU) emerged as a subfield of NLP focusing on the capabilities of machine-human interaction using rule-based and statistical approaches. NLU is aimed at analyzing machine reading comprehension. It addresses challenges in ambiguity resolution and discourse modeling, and detects logical relationships between objects described in a passage of text. To enable text understanding, many NLU approaches use knowledge graphs, known as ontologies, to map linguistic entities with real-world concepts and events.

Nym has leveraged these advances in linguistic theory and syntactic complexity to develop a new form of NLU designed specifically for understanding clinical language. By combining computational linguistics with clinical knowledge, the Nym CLU technology has created the first effective solution for machines to understand the narrative of a patient chart.

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The Linguistic Problem in Medical Charts

Successful understanding of patient healthcare records has applications in areas spanning the medical industry - from legal teams representing healthcare facilities, to reimbursement and billing services, and to the medical research field. Until today, generating this complete and accurate story of a patient visit could only be achieved through manual chart review.

Historically, machine-based understanding of clinical language and accurate interpretation of charts has been limited primarily due to the linguistic challenge presented in medical charts. Information in medical charts, such as diagnoses, medical procedures, and past patient history, is recorded in both structured and unstructured formats, with unstructured free text often written in shorthand style. Domain-specific context is required to understand the medical terminology, to accurately interpret each section of the patient's chart, and to combine the applicable information into a cohesive patient narrative.

Applying NLU to Medical Charts

Numerous NLU technologies aimed at understanding medical charts have emerged in recent years with the specific focus on optimizing the medical coding and billing processes. There are over 250,000 medical coders in the United States dedicated to reviewing medical charts and assigning the applicable reimbursement codes that are then sent to insurance providers for payment. It takes a medical coder on average 6-10 minutes to review and code a single chart -- a time-intensive and costly process for healthcare facilities. Manual coding is also subject to human errors, which could lead to significant expenditures of time and effort in cases that are rejected or denied by the payer.

While statistics-based methods that generate probability distributions of potential outcomes work well for certain applications, such as analyzing social media posts or news feeds, they are less effective in the medical field that requires deterministic, accurate, and reliable results. In addition, NLP solutions for

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improving efficiency and accuracy in medical coding, such as Computer Assisted Coding (CAC), provide only an approximate understanding of the full narrative and still require manual validation of suggested results. These solutions mostly use the “bag-of-words” model in which grammar and the order of the words are not taken into consideration for understanding the sentence meaning. For example, misunderstanding the phrase “not” in the following sentence could have disastrous consequences: “The patient does not seem to display signs of liver failure.” These statistical models offer limited transparency, as they are typically unable to provide detailed reasoning as to why the specific results, in this example medical codes, were generated.

Contrary to the statistical model of understanding and coding medical charts, Nym has taken a different approach which focuses on a complete understanding of the text, not only the relationships among words in a sentence. The Nym CLU technology, coupled with Nym’s medical ontologies, integrates complex computational linguistics with knowledge graphs to understand the complete chart narrative. The Nym coding engine applies this understanding to assign accurate medical codes to the patient chart. This process provides full transparency into how a chart was interpreted, and, subsequently how accurate coding was applied to the chart based on this interpretation. A transparent audit trail is automatically generated for full visibility into the chart comprehension and coding process.

Mechanics of the Nym Technology

The Nym CLU technology’s linguistic rule-based approach uses structured maps of human knowledge for identifying key elements in the text of a medical record. The engine reconstructs the clinical narrative of the patient chart by analyzing each textual component to understand linguistic intent and resolve context and word ambiguity.

Details of each step in this process are outlined below.

Step 1: Analyze Sentence Structure

The Nym engine analyzes each sentence in the patient chart, breaking it down into individual syntactic parts. A parse tree and a semantic representation are created showing hierarchical relations to understand the structure and logic of the sentence. Nym identifies and flags any incomplete or ambiguous sentences, describing the specific reasons for its inability to linguistically understand the sentence. These charts are sent back to the healthcare facility for manual coding and review to determine areas for improved clinical documentation.

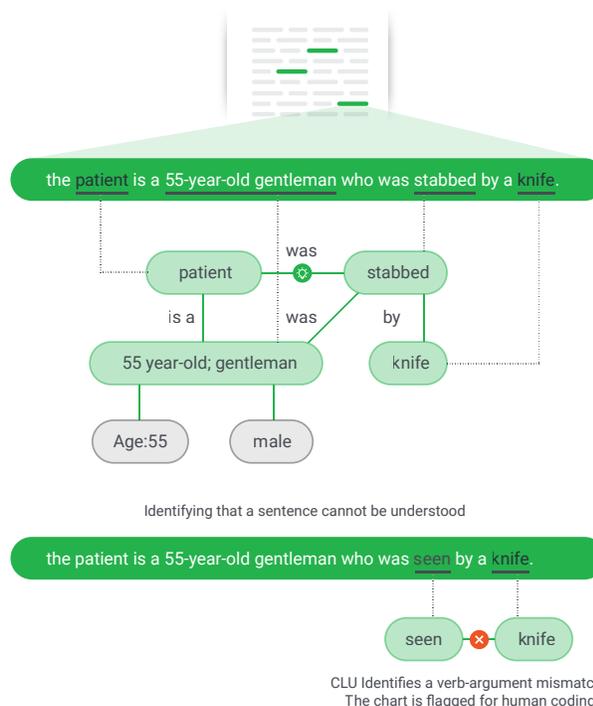


Figure 1: Diagram illustrating sentence structure analysis

Step 2: Reconstruct Medical Narrative

The Nym engine combines meanings and medical logic with knowledge graphs (or 'ontologies') to create a logical explanation of the structure and the relationships between the sentences of the medical narrative.

References such as pronouns (e.g., I, my, he, his) and definite articles (e.g., the), as well as objective or subjective speech, tenses, or negated issues are identified and marked.

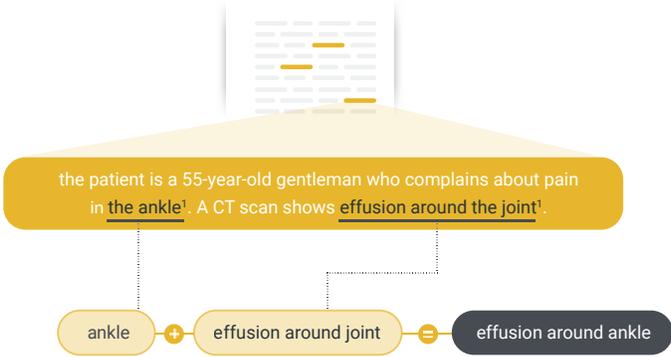


Figure 2: Diagram illustrating medical narrative reconstruction

Step 3: Extract Insights

To understand the context of the narrative, the Nym engine searches through the medical narrative and extracts meaningful insights from the text about active speakers, locations, and anatomy by correlating information to knowledge graphs. Extracted insights are converted into a list; parts-of-speech are tagged as subjective or objective and marked as negated if needed; and assessed and classified according to confidence level. For example, in the sentence: "The patient denies any previous trauma to the leg", the Nym engine would detect the negated subjective speech.

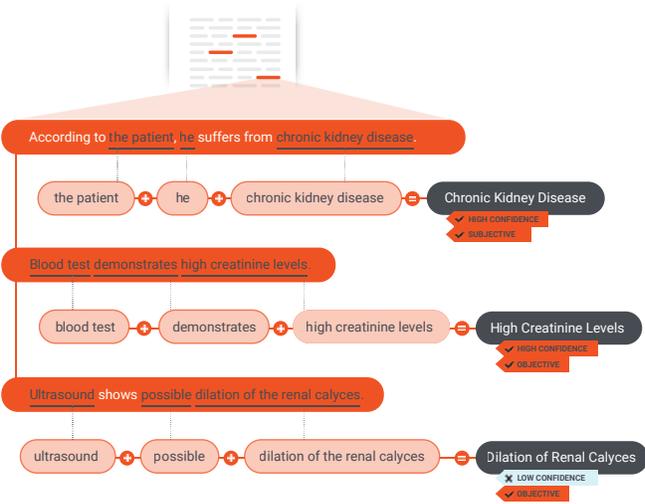


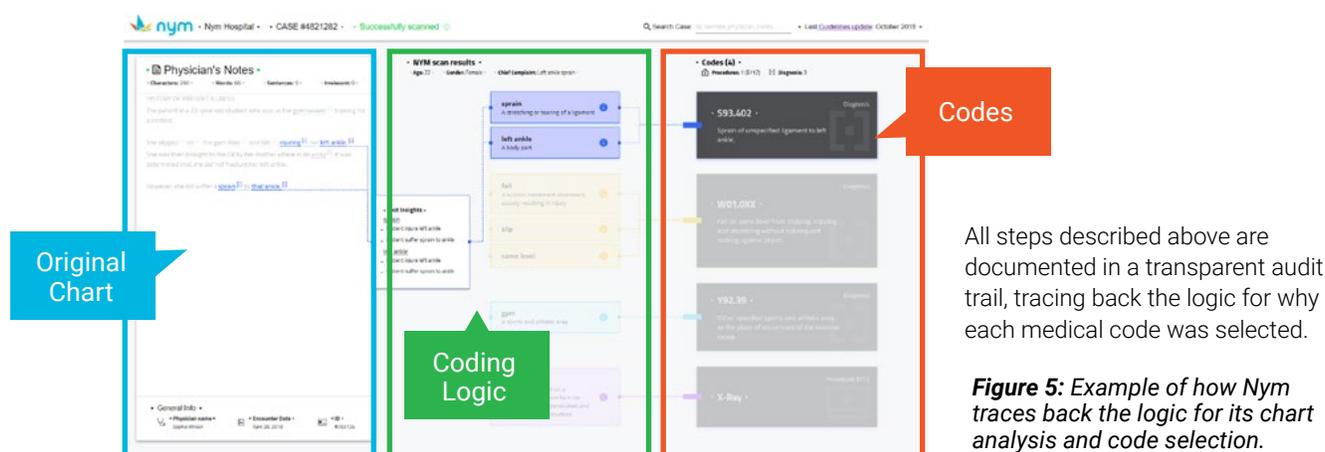
Figure 3: Diagram illustrating insight extraction

Step 4: Assign Medical Codes

The engine reviews the insights collected about the narrative and maps them to the knowledge graph to identify relevant diagnoses and medical procedures in the patient chart. It then automatically applies the relevant codes based on coding guidelines.



Figure 4: Diagram illustrating medical code assignment



Impact of Autonomous Coding

Leveraging the Nym CLU engine and autonomous coding solution provides high value to healthcare organizations and revenue cycle management companies, specifically in the following areas:

- **Accurate medical coding:** Nym achieves a high coding accuracy rate. The Nym engine codes only the charts that it fully understands. The remaining charts are returned to the customer for completion or amendment by manual coders. Charts Nym cannot fully understand are returned with recommendations for how medical professionals can improve their clinical documentation for successful coding, both within that specific chart and for future charts. The percentage of coded records is continuously increasing as Nym's linguistic technology advances and as its medical knowledge expands.
- **Reduces A/R (Accounts Receivable) time:** By integrating a fully-automated medical coding process that increases efficiency and accelerates payment cycles, hospitals get reimbursed on average 3-4 days earlier.
- **Maximizes audit readiness:** Nym generates a detailed audit trail explaining why the specific codes were assigned to the patient chart. Audit trails are automatically generated which allows for immediate chart audit readiness.
- **Assures continuous compliance:** Nym's transparent audit trail provides full coding reasoning which serves as an invaluable tool for validation and appeals, while also minimizing legal risk and the chance of fraud investigation.
- **Accelerates denial handling:** Nym's high accuracy minimizes rejections and denials due to coding errors, and the Nym's complete audit trail enables efficient denial management with no human coder interaction required.
- **Cuts operational costs:** Nym's fully-autonomous coding engine requires no human intervention, reducing operational costs as fewer coders and coding educators are required.

About Nym Health

Nym Health is a medical-coding software provider for healthcare organizations focused on streamlining healthcare processes. Nym's Clinical Language Understanding (CLU) autonomous coding solution, the company's first product, allows clinical charts to be processed autonomously, efficiently, and accurately without human involvement. The Nym CLU coding engine provides fully transparent medical coding. The company aspires to enable new ways of processing clinical language with its breakthrough technology.

For inquiries about partnering with Nym please contact: <https://nym.health/contact-us/>