

BACKGROUND

A chatbot is an artificial intelligence software designed to perform a series of tasks on its own and without the help of a human. Being. They can interact via text or voice interface with a human user in natural language chatbots that can help inform a user or help them fulfill a task. From an architectural point of view, there are two types of chatbots; one functions based on a set of rules, and the other more advanced version uses machine learning:

Types of ChatBots: Rules-based chatbots

Rules-based chatbots are limited to responding to pre-defined commands and are not efficient in answering questions that do not match their programmed rules. They are created using a rule-based approach such as AIML (Artificial Intelligence Markup Language).

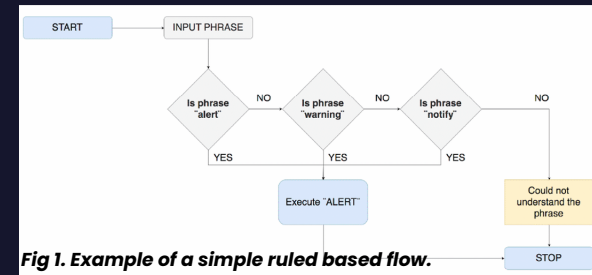


Fig 1. Example of a simple ruled based flow.

However, writing rules for different scenarios is time-consuming and impossible to cover every possibility. This bots can handle simple queries but struggle with complex ones.

Machine learning-based chatbots, "Self learn-able bots"

They process and understand natural language, acting in a more human way, getting smarter by learning from conversations. These bots can be of two types:

<p>Retrieval based models are trained on a set of questions and their possible answers, and can find the most relevant answer for a given question. The chatbots can range in complexity from simple rules to complex machine learning algorithms. Additionally, there are no issues with language or grammar since the answers are predetermined.</p>	<p>Generative models can generate answers and are better at handling complex and unseen queries. However, they need to take spelling and grammar into account, making them more prone to errors. Language translation models can be used to create generative models, but they need to be trained precisely to perform well.</p>
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BUILDING CHATBOTS-ANATOMY OF A CHATBOT

Sensory Layer
 Helps the BoT interact with external world. In a multi modal way, a BoT can interact with humans via: Social chat messengers, Web based chat, SMS, Email and voice input.

Endpoint Orchestration Layer

Orchestration layer synchronizes BoT's inward and outward communications. Across various channels such as social, web etc.

Natural Language Processing (NLP) Core

The natural text, words are "understood" by Bot. By sheer power of AI. NLP Core helps to interpret the conversational streams coming BoT's way.

- Off-the-shelf cloud services Fast. Easy. Leverage the best of AI research done for years. (Ex. Microsoft LUIS).
- Tailor-made NLP block — For performance greedy applications, "tailor-made" is often the way to go. (Ex. Python NaturalLanguage Tool Kit (NLTK)).

Machine Learning (ML) Block

Thanks to ML block, BoTs often become smart with more usage, interactions, and user data. The internal ML model gets trained with the usage and ambience data, and starts operating 'smart' over a period of time. Ability to predict user's need at right time and suggesting him right options.

Business Logic Core

This is where BoT's core functionality logic resides.

API Brokerage Layer

Helps the BoT consume services using cloud API. This helps to augment more functionality to a BoT's core capability. For example: A scheduling bot's API Brokerage Layer helps to connect to external scheduling software.

BUILDING CHATBOTS-CHOOSING THE RIGHT BOT

The first step to choosing the best chatbot type is to assess your needs. If you want an informative bot for patients, maybe the best option is a simple rule-based chatbot with response buttons and a defined question hierarchy; however, if you want to develop a bot for standardized reports, do you need to have advanced AI, ML, and NLP capabilities to get better results.

INTEGRATING CHABOTS IN RADIOLOGY WORKFLOW

The possibilities of implementation of the bots in the different stages of the radiology workflow are endless, it is enough to explore each simple or complex task to find an empty space that can be occupied by this technology. These are some examples:

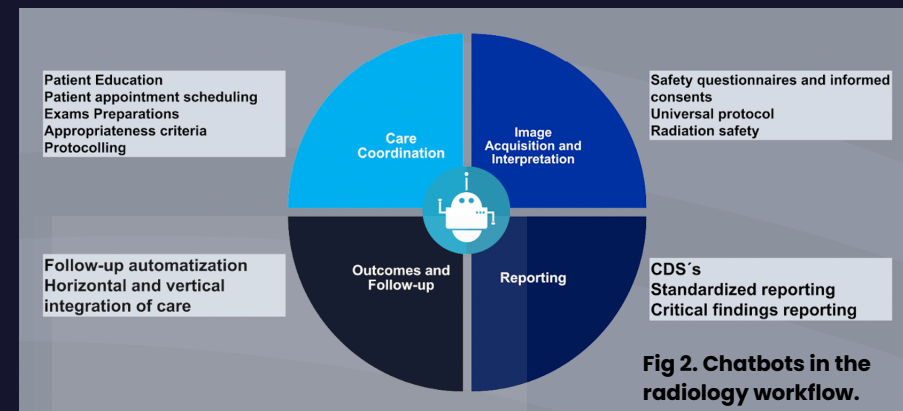


Fig 2. Chatbots in the radiology workflow.

CHABOTS RUNNING IN OUR IMAGING SERVICES

COORDINATION OF CARE - ER CHATBOT FOR THORACIC IMAGING

Starting in 2020, the Protecting Access to Medicare Act (PAMA) mandates that referring providers consult ACR appropriate use criteria before ordering advanced diagnostic imaging services for Medicare patients. To assess the efficacy of this requirement, a chatbot model has been developed that utilizes the ACR criteria for thoracic pathology. The chatbot asks physicians basic questions about the patient's clinical scenario and recommends the most appropriate imaging study based on the criteria. The aim is to improve the quality of care and reduce hospital costs by minimizing repeated and unnecessary explorations in the emergency department.

- Impact Measurements:**
- Rate of inappropriate ED patient exams
 - Repeat rate for ED exams
 - CDS-prompted order modification
 - Savings from canceled or modified outpatient orders
 - Overall CDS utilization
 - Savings from canceled or modified inpatient and ED orders

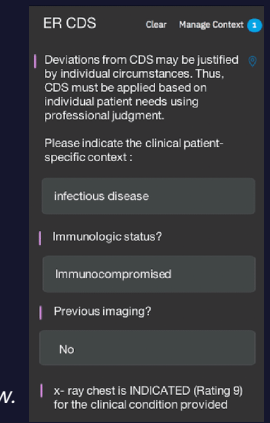
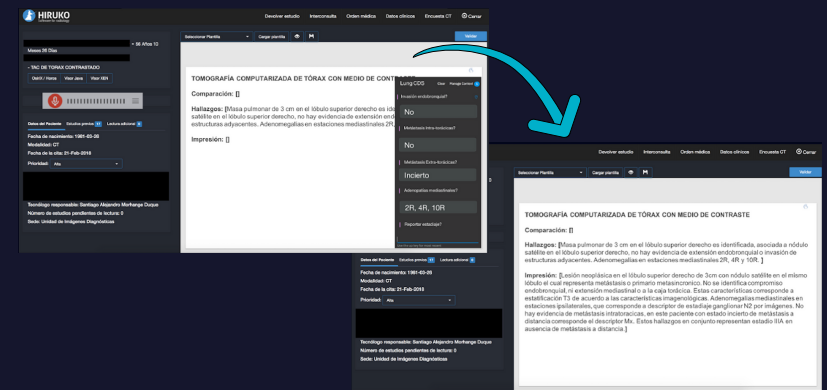


Fig 3. ER chatbot for Thoracic Imaging - deployment view.

IMAGE ACQUISITION AND INTERPRETATION - CHATBOT FOR STANDARDIZED REPORTING FOR LUNG CANCER STAGING

The Universal Protocol was created to ensure that patients were accurately identified and procedures correctly scheduled and performed. A model was developed for standardized report in lung cancer, the radiologist follows an established reading pattern and responds to the bot the questions that lead to the production of a complete standardized report adjusted to The eighth edition TNM stage classification for lung cancer.



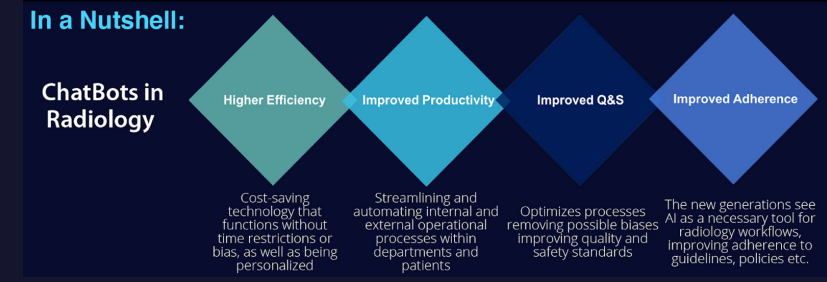
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IMAGE ACQUISITION AND INTERPRETATION - CHATBOT AS CLINICAL DECISION SUPPORT TOOL ON THYROID NODULE ASSESSMENT

We developed a chatbot using machine learning to improve adherence to the ACR Thyroid Imaging Reporting and Data System (ACR TI-RADS) for assessing thyroid nodules found on ultrasound. ACR TI-RADS helps standardize reporting and management of thyroid nodules. After implementing the chatbot, the ACR TI-RADS concordance was significantly higher in cases where the chatbot was used (104 out of 110 or 95%) compared to cases where it was not used (70 out of 110 or 63.63%, P = .008). The chatbot simplifies the evaluation process by asking a few questions and producing a paragraph with a clear management recommendation for the radiologist to add to the report.

TR1 Benign 0 points - Cancer Risk <2%	No FNA
TR2 Not suspicious for malignancy 2 points - Cancer Risk <2%	No FNA
TR3 Mildly suspicious for malignancy 3 points - Cancer Risk 5%	FNA if ≥ 2.5 cm Follow if ≥ 1.5 cm
TR4 Moderately suspicious for malignancy 4 to 6 points - Cancer Risk 5%-20%	FNA if ≥ 1.5 cm Follow if ≥ 1 cm
TR5 Highly suspicious for malignancy 7 points or more - Cancer Risk >20%	FNA if ≥ 1 cm Follow if ≥ 0.5 cm

Fig 4. ACR TIRADS Categories.



CONCLUSIONS:
 Chatbots are software based on artificial intelligence of easy implementation that can fulfill important tasks in each of the stages of the radiology workflow, generating a positive impact in order to improve the quality and safety of our services.

References

Storey, M. A., & Zagalsky, A. (2016, November). Disrupting developer productivity one bot at a time. In Proceedings of the 2016 24th ACM SIGSOFT International Symposium on Foundations of Software Engineering (pp. 928-931). ACM

Disclosure

The authors have no relevant financial or nonfinancial relationships to disclose. Comments: andres.vasquez@ideas-foundation.org