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ВИКОРИСТАННЯ ШТУЧНОГО ІНТЕЛЕКТУ В ДІАГНОСТИЦІ ПСИХОЛОГІЧНОГО СТАНУ

Метою цього дослідження є огляд існуючих способів діагностики розладів психічного здоров'я (зокрема, депресії та посттравматичного стресового розладу). Пропонується зануритися в різні літературні джерела на цю тему, включаючи дослідження, які вже проводилися в цій галузі. Для розуміння актуальності питання дане дослідження також включатиме серію інтерв'ю та опитувань з психотерапевтами, психіатрами, та психологами з різним досвідом, щоб отримати уявлення про їхні погляди на потенційне застосування штучного інтелекту в діагностиці психічного здоров'я а також дізнатися про процес діагностики і лікування пацієнтів. Сучасні умови створюють нові тенденції в розвитку аналізу психологічного стану людей, варто розуміти ефективність існуючих методів, враження практикуючих спеціалістів наскільки теперішні умови змінюють підходи до аналізу психологічного стану людини і пошук ідей як штучний інтелект може спростити їх роботу і покращити результати. Результати цього дослідження нададуть огляд теми, та підтвердять чи спростують можливості використання технологій штучного інтелекту для спрощення процесу діагностики, також створено набір критеріїв, які можна використовувати для оцінки ефективності різних методів штучного інтелекту в діагностиці психічного здоров'я. Це може включати різні кількісні показники, пов'язані з точністю, ефективністю та етичними міркуваннями. Додатковим результатом могло б стати краще розуміння потенційних переваг і недоліків використання штучного інтелекту в цьому контексті, що могло б стати основою для майбутніх досліджень і розробок у цій галузі. Зрештою, це дослідження має на меті зробити внесок у поточну дискусію про те, як технології штучного інтелекту можна використовувати для покращення і спрощення діагностики психічного стану здоров'я та процесу лікування.

Ключові слова: депресія, психометрія, машинне навчання, шаблони програмної інженерії, штучний інтелект, психотерапія, посттравматичний стресовий розлад.

USING ARTIFICIAL INTELLIGENCE IN MENTAL HEALTH DIAGNOSIS

The purpose of this study is to review existing ways of diagnosing mental health disorders (specifically depression and post-traumatic stress disorder). We will dive deeper into the literature about the topic, including studies already conducted in this area and their results. To understand how up-to-date this question is, the research will also involve a series of interviews and surveys with psychotherapists, psychologists, and other mental health professionals with various years of experience to gain insights about their views on the potential applications of artificial intelligence in mental health diagnostics and learn more about the existing process of diagnosing different mental health issues. Modern conditions create new trends in the development of the analysis of the psychological state of people, and it is worth understanding the effectiveness of existing methods, the impressions of practicing specialists to what extent current conditions change approaches to the analysis of the psychological state of a person and the search for ideas on how artificial intelligence can simplify their work and improve results. The findings of this study will provide an overview of the topic and give the proof or disproof of the concept of using the artificial intelligence methods for the diagnostic process and speeding up the treatment process. Besides, the study could provide a set of criteria that can be used to evaluate the effectiveness of different methods of artificial intelligence for these purposes. This could include metrics related to the accuracy, efficiency, and ethical considerations. An additional outcome could be a better understanding of the potential benefits and drawbacks of using artificial intelligence in this context, which could inform future researchers and developers in this field. Ultimately, this study aims to contribute to the ongoing conversation about how technology can be used to improve mental health care and outcomes.

Key words: Depression, Psychometrics, Machine Learning, Software Engineering Patterns, Artificial Intelligence, Psychotherapy, Post-traumatic stress disorder.

Introduction. The natural variability of the mental state and susceptibility to various destabilizing influences limits the effectiveness of traditional methods of analyzing a person's mental state.

According to WHO's World mental health report [1], which was published in June 2022, only for the last year, based on their report, depression and anxiety as the most common disorders rose 25%, bringing the total number of people living with a mental disorder to nearly 1 billion people.

For example, in 2017, depression was diagnosed for 3.4% (Table 1) of the global population [3].

Table 1

Stats on mental disorders share in global population in 2017

Disorder	Share of global population with disorder (difference across countries)	Number of people with disorder	Share of males:females with disorder
Any mental health disorder	10.7%	792 million	9.3% males 11.9% females
Depression	3.4% (2-6%)	264 million	2.7% males 4.1% females
Anxiety disorder	3.8% (2.5-7%)	284 million	2.8% males 4.7% females
Bipolar Disorder	0.6% (0.3-1.2%)	46 million	0.55% males 0.65% females
Eating disorders (clinical anorexia & bulimia)	0.2% (0.1-1%)	16 million	0.13% males 0.29% females
Schizophrenia	0.3%(0.2-0.4%)	20 million	0.26% males 0.25% females
Any mental or substance use disorder	13% (11-18%)	970 million	12.6% males 13.3% females
Alcohol use disorder	1.4%(0.5-5%)	107 million	2% males 0.8% females
Drug use disorder (excluding alcohol)	0.9% (0.4-3.5%)	71 million	1.3% males 0.6% females

Moreover, as WHO mentioned, those numbers are growing faster from year to year, and in 2023, for example, in Ukraine, it is up to 6.3% (Fig. 1). [2]

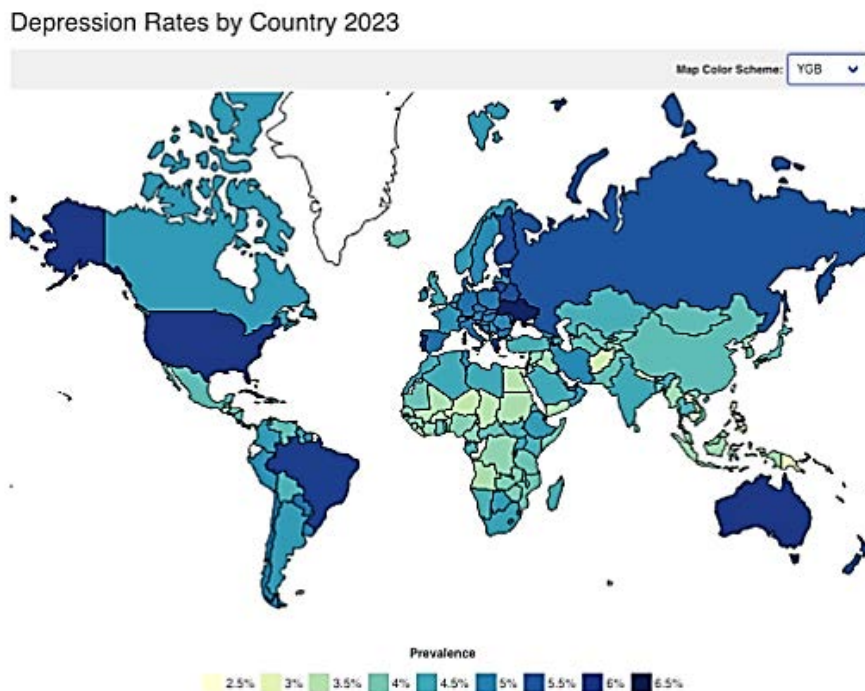


Fig. 1. Diagram of Depression Rates by Country in 2023

Another common mental health issue that has been shared around the globe for the last couple of years is PTSD. Armed conflicts worldwide grew in 2021 (Alert2021! Report, 2021 [4]). In 2022 the full-scale war started in Ukraine, and all these armed conflicts have caused many people that suffer from PTSD. It should be mentioned that PTSD usually is a delayed disorder. Psychotherapists explain that the symptoms could be shown six months after trauma. But in 2021, NeuRA Foundation shared an article [5] that shows that around 3.9% of the global population could have PTSD by the end of the year. And now, in 2023, because of the full-scale war in Ukraine and other military conflicts around the globe, different research agencies expect to grow to 5.6%.

In addition, access to mental health care varies greatly depending on the country. Some countries have more resources and funding allocated to mental health care than others. For example, in countries with lower income, based on the WHO's report from June 2022 [1], there may be long wait times to see a mental health professional or limited options for treatment. Mental health care may be more readily available and affordable in more developed countries. These disparities can significantly impact individuals' ability to receive the care they need.

At the same time, the number of people seeking medical treatment is growing, and some of them, as explained earlier, can't afford it. Therefore, the study of new methods that could speed up the diagnostic process, find new ways to make early diagnostic is relevant.

Literature review and problem statement. Many articles explaining the process cover the mental health diagnostic process. Mental health diagnosis is a complex process with many different variables the therapist should rely on. Besides, it has numerous ways to work with patients.

The mental health diagnostic process involves a comprehensive evaluation of a patient's mental state, including their symptoms, medical history, and personal background [6]. Mental health professionals typically interview patients to gather information about their experiences and any symptoms they may be experiencing. They may also use standardized questionnaires or assessments to help diagnose specific mental health disorders.

Additionally, imaging studies, such as MRI or CT scans, may be used to rule out other conditions that could be causing the patient's symptoms.

These interviews and medical data are good starting points to make an early diagnosis of mental health diseases. However, it's mostly processing with manual human work, while this data could be good starting points for different artificial intelligence models that could speed up the process.

At the same time, we need a valid proof of concept that AI could be helpful at some tasks with mental health diagnostics.

The aim and objectives of the study. The aim of this study is to find the most common problems psychotherapists, psychiatrists, and psychologists struggle within mental health diagnostic processes, and find how AI could be helpful for them. To accomplish the aim, the following tasks have been set:

- Determine the main tasks professionals do within the diagnostic of mental health diseases;
- To form a structure of diagnostic process for two of the most important and common mental health diseases in Ukraine (PTSD and depression);
- Look for different studies and methods already developed for mental diseases diagnostic;
- Find a proof of concept that AI can be helpful in psychotherapy and mental health diagnostic process.

The study materials and methods. While searching for different materials about the usage of AI within psychotherapy - could easily be found the first insight about it. The chatterbot, Eliza [8], is a 1960s natural language processing program created to simulate conversations and give users an illusion of understanding. It is a very important and successful experiment, followed by several other bots. However, such software aimed to mimetic a psychologist interacting with a patient and was never supposed to perform recommendations about a patient's problems. It was during the 1980s that many reports were published describing the support of computers for clinical use [9; 10; 11]

These papers proved that logic-based AI could be used as an approach to computerized therapy, particularly to brief cognitive and behavioral therapies. By then, automatic theorem proving and deduction systems were not mature enough to support such applications, which may explain the lack of publishing concerning this theme over the following years.

In 2019, de Mello, F. L., & de Souza, S. A. published a study that explains when a psychotherapist tries to map and understand the phenomenon that generates a conflict in a patient with depression or other mental health issues [12], there is an attempt to project the theoretical concepts of psychotherapy on the specific situation presented by the individual.

The projection of these concepts into the real world is the reification operation of Knowledge Geometry, a process of inference whose resources are analogies and isomorphism. By identifying the modus operandi and the functional pattern of the family (or conjugal system), it becomes possible to intervene and propose new alternatives to the system. This calls attention to the option to deconstruct the addictive mechanisms of feedback and maintenance that prevent the system from admitting new experiences and learnings, thus hampering its development or the resolution of the conflict in question.

In AI, this situation is known as Case-Based Reasoning (Figure 2) and is usually modeled by first-order logic. What this means is when the psychotherapist tries to identify and understand how the patient’s individual symptom is connected to the broader interactional system, that is, how the particular situation is related to the general scenario, it represents the intuition operation of Knowledge Geometry.

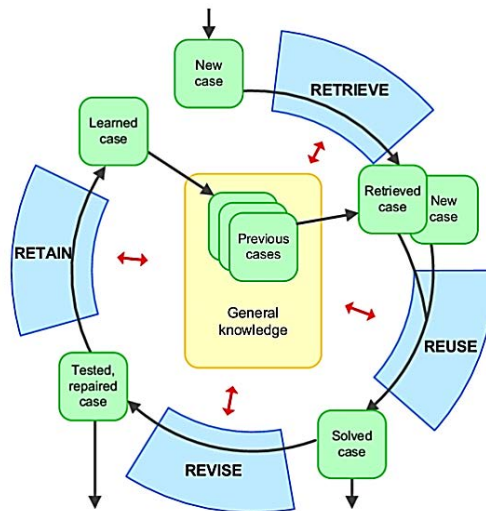


Fig. 2. Case-Based Reasoning

From this point of view, de Mello and de Souza said the patient manifests symptomatology projected onto the family or conjugal system. In other words, the particular phenomenon is used to support understanding a broader pattern.

Baihan Lin, Guillermo Cecchi, and Djallel Bouneffouf [13] published that each therapy session has its own pipeline of how in communication between the therapist and the patient therapists (Figure 3) can diagnose the different mental health issues in earlier steps.

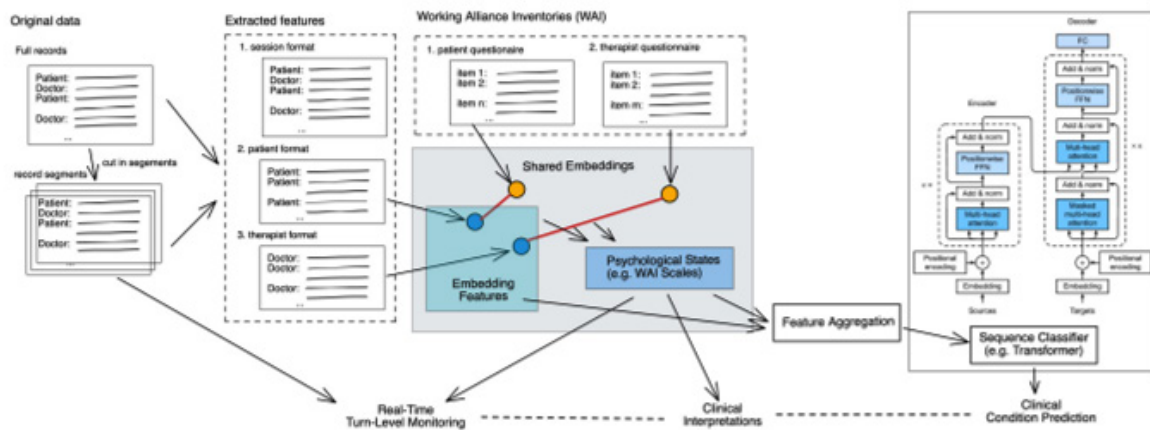


Fig. 3. Communication pipeline between therapist and a patient

Based on this pipeline, they proposed a Working Alliance Transformer (WAT), a classification model that utilized an inference module that informed the downstream classifier where the current state is with respect to the therapeutic trajectory or landscape in the psychotherapy treatment of the patient. The algorithm they proposed outlined the classification process. After the classification is done, they also added an analytical feature that allows an algorithm to do not only classification but other downstream tasks such as predictive modeling and real-time analytics.

Then, following the model architecture introduced above in the Figure, they evaluated three classifier backbones. Classical transformer model: for the multi-head attention module, they set the number of heads to be 4 and the dimension of the hidden layer to be 64. The dropout rates for the positional encoding layer and the transformer

blocks are both set to 0.5. The second sequence classifier is a single-layer Long Short-Term Memory (LSTM) network with 64 neurons. And the last one is a single-layer Recurrent Neural Network (RNN) with 64 neurons.

As a result, they ran 50,000 iterations of training. They improved the classification accuracy of mental health diseases from 26% to 32%. To make it possible, they used a dataset with highly imbalance clinical conditions (495 anxiety sessions, 373 depression sessions, 71 schizophrenia sessions, and 12 suicidal sessions). They mentioned that if they directly train models on this dataset, the classifier will likely be highly biased towards the majority class. To correct this imbalance issue, the sampling technique was used. Instead of going through the entire training data in epochs, they trained the models in sampling iterations. In each iteration, a class was randomly chosen, and then a random sample of one session from the class pool. Before they sampled the sessions, they splitted the dataset into 20/80 as a test set and a training set. It showed a great result during the training process.

In contrast to previous authors, there are some concerns about what we can reach with AI in psychotherapy. Anna Melnik, Konstantyn Marchenko, and their colleagues [14] argue that it could be decomposed easily. They tell us that there are different risks in this process.

For example, they assume that the absolute reliability of computer systems and the results of information processes that run in them can not be guaranteed. So, the main problems with introducing artificial intelligence in computer systems are the inability to predict all real situations and program the machine's behavior adequately to them, lack of reliability, and software errors. The research task is to identify critical areas where such mistakes and failures are unacceptable.

The input on which artificial intelligence is taught may be incorrect. Melnik and Marchenko are questioning their developers' way of thinking and values, as they are not always familiar with psychology, sociology, and other humanities. These shortcomings during the use of artificial intelligence systems have led to many incidents, including fatal ones.

However, a weakness of this argument is that it assumes that AI will do the whole work instead of the psychotherapists. The AI could use data and suggestions from the therapists. They could review the data before the learning process, and it could speed up the process to highlight the most valuable findings in the diagnostic to help therapists find the correct treatment for the patients. In the future, it could also cover some parts of their job. 37% of interviewed therapists described the possibility of transferring part of the diagnostic job to the AI assistant.

In support of this point, Chao, Y., Wu, C., Lai, Y., Hsu, H., Cheng, Y., Wu, H., Huang, S., & Chen, W. (2022) [15] displays that they worked in collaboration with a therapist to run different tests on the effectiveness of existing methods. They have shown that only 35.71% correctly indicated the diagnoses represented by the test equations.

If you can test the effectiveness of existing methods with collaboration with therapists and real data from their clients, we can also use it to create a more effective expert system for therapists on what diagnosis a person could have.

To learn more about depression and PTSD diagnosis, it seems necessary to learn it from professionals themselves.

For this study, numerous anonymous interviews and surveys were conducted with psychotherapists, psychologists, and psychiatrists from Ukraine to gather more information about the process behind the diagnosis. In interviews participated professionals with various years of experience (up to 16 years of practice). There mostly were open questions to gather more explanations of psychological terms and to use them as criteria in future research.

Based on their answers, we found that to assume that a person has depression, a therapist should learn more about the person's: current mood state, how well and for how long the person sleeps, the amount of day-to-day stress, and the problems with focusing on the task. Most of these questions use quantitative numbers to understand the level of depression the person might have. A similar process applied to PTSD.

Besides in these interviews, we gathered their experience on what changes in a person's behavior and emotional state are the first symptoms of depression or PTSD. Mostly they highlighted and focused on: feeling hopeless and helpless, anxious or worried, suicidal thoughts and thoughts of harming themselves as psychological symptoms, and loss of libido, lack of energy, and unexpected aches and pains as physical symptoms of depression. Or nightmares, flashbacks, and physical sensations for PTSD.

Also, they explained how often these symptoms usually repeat. For this question, responses were splited in almost halves that a person should start therapy when symptoms are repeating every day or a couple of days in a week. The other half explained that even if such symptoms repeat themselves at least once in a month, it is better to start reaching for psychological support and help from professionals.

In addition to that, it was helpful to learn when usually first symptoms could be shown. For PTSD, most professionalssaythatthefirstsymptoms could be visible in a period between 4 weeks to 6 months after the traumatic event happened. For depression, it has a progression and could be visible after a month of traumatic event happened. That information uncovers the primary flags that mental health professionals look for when diagnosing these

conditions and gain insight into the time and effort it takes to understand a person's mental profile and create a personalized healing plan.

As a final touch, after the interviews, we gathered information about how they analyze the level of depression or PTSD. Usually, therapists run different screening tests, but based on their experience, since the number of traumatic events has grown due to the war in Ukraine, these tests started to show less efficiency and personal sessions work more effectively for complexity analysis. In addition, each of these tasks, even running tests, is time-consuming. Analyzing them is even more time-consuming. Based on the survey, 43% of the therapists admit that today they should always rewatch the whole case independently to ensure they are making the correct diagnosis.

The main problems in these tests right now that professionals are struggling with a phenomenon that the amount of symptoms is growing, and those tests do not cover all of them. Some of these symptoms could be the same for different mental diseases. Analyzing data from screening tests is time-consuming and could be not efficient. Screening tests are less personal than a conversation, so people might cheat in them because they are afraid of being "not normal." Besides, to make them effective, they should be regular, on a daily or weekly basis, to track progression.

To cover all questions that tests cannot cover, they often ask for individual medical data such as hormone level, sleep records, and other biomedical data. Analysis of these data is even more time-consuming than analysis of tests. They also mentioned that sometimes people's interactions with strangers in social media could be a small hint into their progress in healing from mental disease, so some of them also check patients' social media.

Once a diagnosis has been made, the mental health professional will work with the patient to develop a treatment plan that may include therapy, medication, or a combination of those. All of these depend on the level of depression or PTSD.

Based on it, we can assume that people need to start reaching for mental support and help from professionals as early as possible, and therapists recommend making it in person instead of online screening. However, at the same time, based on the Institute of Psychology, in their Public Attitudes Toward Guided Internet-Based Therapies: Web-Based Survey Study in 2018 [7], we know that nowadays, almost 60% of people first will try to find answers to their problems around the web or social media, instead asking help from psychotherapists directly.

As people are afraid of seeking help directly, and the diagnostic process starts to become even harder from day to day, we can think of ways how using AI could speed up the diagnostic process and maybe improve existing methods and their efficiency, and make the lives of people easier. For example, with AI, we can focus on speeding up the analysis process of test data, improving tests, and making it regular to make a picture clearer for therapists and let them focus on patients instead of creating a report based on all data. Also, it seems possible to analyze biomedical data and notify people about possible mental diseases they could have to motivate them to reach for help or at least consult with professionals.

It is also interesting how therapists analyze their patients' social media for some hints on the healing progress. Analyzing social media with AI is not new, but it could be helpful to focus it on tracking possible mental diseases.

Results of the research. In the previous section, a list of possible options to improve the diagnostic process was reviewed. Mainly it's speeding up the classification job, improving the accuracy of existing tests, and focusing on highlighting the possibility of symptoms of the patient.

For example, as was mentioned in the first section of this study, therapists outlined that for diagnosis of PTSD, there could be a delay between the first symptoms showing up and the situation that causes it, around 6 months.

The Nov 2020 Ann-Maria Bucur study from the University of Bucharest showed that they could find the first symptoms before a person asked for help from a therapist based on what they post on social media [16]. From the interviews arranged with therapists, it shows that almost half of the therapists review the social media of their patients as a part of the "first interaction" with the patient. It helps them to understand the patients better. But, based on this study, while using the app with such an algorithm, if a therapist has a link to a social-media profile, the algorithm can gather the information from the person's social posts and create a profile with possible symptoms a person might have to ask the therapist to pay attention to them.

In close work with therapists and with training a model similar to what Baihan Lin, Djallel Bouneffouf, and Guillermo Cecch did in their research with analysis of sessions between therapists and patients, we could also analyze tests and even go further and make a chatbot, for businesses for example to track the regularly mental state of their employees, or for therapists to ask about mental health on a regular basis their patients, we can gather more up to date information about each patient and algorithm could classify those patients who might need a different or adjusted treatment program based on their answers. As mentioned earlier, regular state tracking is the key to better understanding a patient's needs and making treatment more efficient.

Also, the same algorithm could be adjusted or reworked to work with biomedical data (heart rates, sleep tracking, hormones level) to gather even more information on patients' states. And improve results they reached even more.

Discuss the results. After the research, a second round of interviews was conducted with professionals to ask them about their thoughts on how their work could be simplified or even improved with AI. Only 13% of them at the beginning said that AI could help them, on a barely minimal level, speed up the process of gathering data. After we reviewed those findings together, more than 30% of therapists agreed that AI could actually speed up their work on analysis data if it could create an effective report for each patient they have. It is still around 70% of skeptical people, but that is because they have yet to work in pairs with any tools that could do this job.

Conclusion. These abstracts show that psychology can find support for specific tasks in computation. From this perspective, AI can play a role as an add-on resource for therapeutic work in addition to those that already exist.

The different tools could speed up the process of gathering information about the patients, and it could be a separate application or an option to gather this data through chat-bots and social media.

But when the data is gathered, the correct AI model could classify the data, find patterns and create a list of possible diseases for each patient with a full picture of possible or existing symptoms that could also speed up finding the correct treatment for each patient.

Besides, with enough data set, it seems possible to create a recommendation system for those people who do not want to reach for direct help from therapists at the beginning and suggest different options before they are ready to make their life easier. The same recommendation system could also help therapists to focus on real tasks while working closely on solving mental health issues each person could feel. In this case, we can focus on these tasks to solve:

- Search for new data sources that can be used to analyze a person's mental state. Combine them with existing ones.
- Development of an algorithm based on the means of artificial intelligence, which can predict the mental state of a person or groups of people and create a list of recommendations for a person and psychotherapists
- Also, start working on correct models to analyze different biomedical data to help therapists fill gaps in knowledge about the patient's state and adjust the treatment process.

Those studies also prove that the future of diagnosis could relate to the new technologies to make diagnostics affordable and faster with the help of Artificial Intelligence

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