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Research article

The Cat's Meow – Feline Translations

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Abstract
Modern trends of posthumanism are increasingly changing the relationship between humans, animals and machines. Technology can become an intermediary in the communication between people and pets. The possibility of using artificial intelligence without needing to recover the ontology and semantics of the feline language, allows one to use it for the „translation" of cats' talk. A necessary condition for this is the presence of a language. As with other languages in the multilingual environment, testing the results is difficult, as one can only rely on circumstantial evidence to judge the correctness of the translation. Here, particular attention is paid to the work of the application that renders human speech into feline, as well as the effectiveness and reliability of, for example, *MeowTalk* to translate from feline into human language. To this end, 143 cats were studied aged 3 to 8 years, of which 30 were female. Of these 143 cats, 74% appeared to respond to the sounds generated by the app. During the experiment, the application translated the cats' meowing in different ways, for example, "I'm on the hunt," "My love, I'm here," and "Let me relax." Inversely, the pets were interested in the sounds made by the app. This suggests that cats perceive these sounds as real cat "language." As a result, it was concluded that the application is partly functional, but it remains an open question whether it can serve as a true translator from feline language. Nevertheless, there is reason to believe that technologies can become real intermediaries in the communication of people and animals.

Keywords: Feline language; Cats' talk; Cat translations; Translation; Animal; Cat; Language; Human-cat

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Research article

Кошачье Мяу – Перевод с кошачьего

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Аннотация

Современные течения постгуманизма все больше меняют отношения человека, животного и машины. Возможности использования искусственного интеллекта без непосредственного обучения правилам, позволяет применять его для перевода с кошачьего. Необходимым условие для этого является наличие языка. Однако тестирование результатов также затруднено, так как мы модем полагаться только на косвенные свидетельства корректности перевода. Особое внимание уделяется работе как приложения, переводящего человеческую речь на кошачий, так и эффективности приложения “MeowTalk” для определения надежности перевода с кошачьего на человеческий язык. Мы провели исследования на 143 кошках в возрасте от 3 до 8 лет, из которых 30 особей были самками. Из них 74% кошек пришли на звуки приложения. В ходе проведения эксперимента приложение переводило мяуканье котов по-разному, например, “Я на охоте”, “Любовь моя, я здесь”, “Дай мне расслабиться”. Домашние животные были заинтересованы в звуках, издаваемых приложением. Что свидетельствует о том, что кошки могут воспринимать эти звуки как настоящую кошачью “речь”. В результате было установлено, что приложение отчасти функционально, но данном этапе еще не может служить полноценным переводчиком с кошачьего. Тем не менее существует потенциал развития технологий, которые могут стать реальными посредниками в коммуникации людей и животных.

Ключевые слова: Кошачий язык; Речь кошки; Перевод кошачьего; Перевод; Животные; Кошка; Язык; Кошка-человек

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INTRODUCTION

Modern discussions of posthumanism are increasingly concerned with the changing relationship between humans, animals, and machine (Mustola, 2021). The rejection of anthropocentrism "opens up new and exciting opportunities for the study of non-human lives" (Fox, 2006). Instone (1998) writes that all beings are connected in a series of overlapping "networks" or "networks" of activity (p. 453). These interwoven lives make up a so-called "materialistic semiotics" where "all sorts of fragments and fragments – bodies, cars and buildings, as well as texts – are linked together in an attempt to restore order" (Bingham, 1996, p. 643).

Nevertheless, such fascinating philosophical thoughts do not provide a foundation for the everyday interaction of human and non-human entities. And few studies go beyond suggestive metaphors to properly flesh out what a modern politics of socionatural hybridity is all about (Castree, 2003).

Technology has become part of the life of pets: There are smart food feeders, smart toys, lockable doors for cats with electronic tags, smart pet houses, fully automated dog and cat toilets, and so on. All these technologies primarily create convenience for people, but one of the most interesting areas of technological development seeks to improve the communication between pets and humans.

Language has traditionally been considered the basis of identity that separates humans and animals (Fox, 2006). Nevertheless, recent studies indicate that many animal species may have some kind of "linguistics" that does not share all the features of human language, but can still be very rich and complex (Kershenbaum, 2017). Humans and animals living together master common forms of communication, which depend on various factors, including the type of animal. In this study, we will turn to one of the most popular pets, namely cats. For communication, it can use visual, tactile, and olfactory signals, but voice (auditory, acoustic) language is one of the most important. Their vocal repertoire is more complex than that of many other mammals, it is also characterized by an "infinite wide variety of sounds and patterns" (Moelk, 1944). Susanna Schötz (2020) believes that a deeper study of the vocal component of cat-human communication can improve our interspecific communication.

There is a fairly long history of studying cat language (Brown et al., 1978; Moelk, 1944; Nicastro & Owen, 2003; Owens et al., 2017; Schötz, 2017; Yeon et al., 2011), however, digital technologies of the last decade have made it possible to move forward in identifying the meaning of meowing – for much the same reason that the digital translation of human languages has also improved.

The association of animals, people, and machines contributes to the creation of close networks of interaction. Digital solutions aimed at animals are already being created today. There are means of communication connecting pets and their owners, digital games designed for animals (Bylieva et al., 2020; Hirsky-Douglas and Lucero, 2019; Rossi et al., 2016). Even a robot vacuum cleaner can be used to communicate with a pet left at home. There are computer games with a species-appropriate interface (Noz & An, 2011) and apps for building of interactive connection between a person and a deaf cat (Zhang et al., 2021). Today, there are dozens of games for mobile devices designed for cats, where the pet catches a mouse, a fish, a ball etc. moving across the screen with its paw

(fig. 1), some of them even have a multiplayer mode. There are games that allow a person to play with a cat.

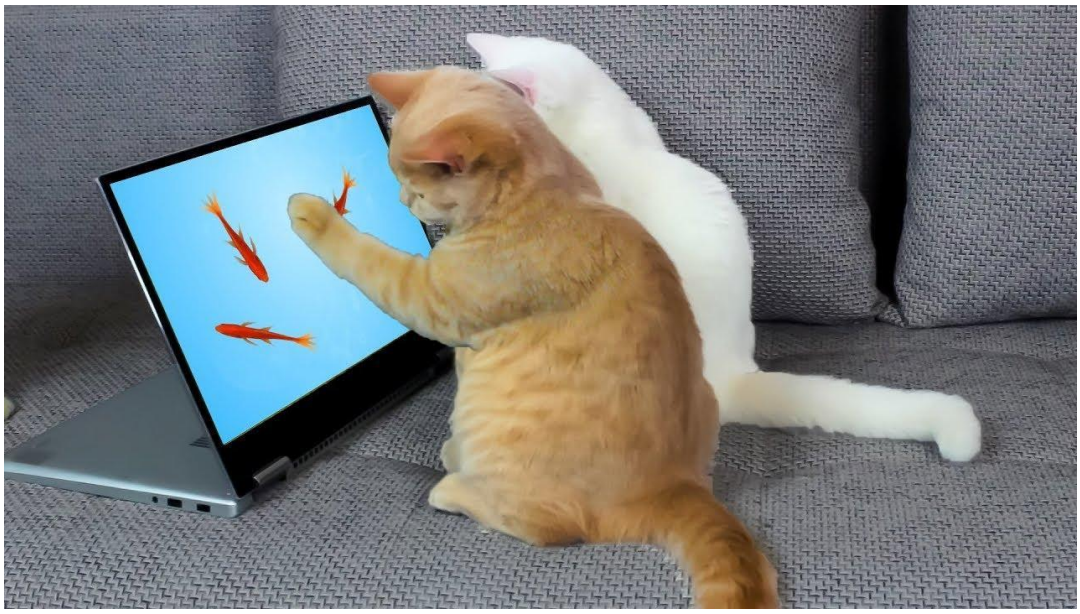

Figure 1. Cats play a game on a tablet (My Funny Cats, 2018)

COMMUNICATION WITH CATS

According to official data, 33.7 million domestic cats are kept in the homes of Russians. That is, there is one cat for four people. In Russia, the highest indicator in Europe of the number of apartments or houses in which there is at least one cat – it reaches 54% (Abrashkina, 2020). Of course, all owners independently build up communication patterns with their pet, but, of course, they might want to make facilitate this process.

Scientists counted eighteen different shades of cat meow with different intensity, with different pitch of voice, tone, duration, and timbre (Tavernier et al., 2020). Dennis C. Turner claims that meowing can be used by the cat in order to express food or attention seeking, illness, stress, loneliness, aging, or need to breed (Turner, 2017). Elena Filippova (2006) writes that some cats even appear to utter “human” words – ma-ma (mother), y-mi-rai (die), mne (me). Whether these words relate to their meaning is, of course, an open question, but one thing is certain: there are cats who like to talk, and there are cats who won’t open their mouths. This depends in part on the natural volubility of the cat, that is, on its breed. Siamese cats are very talkative. “Woolen” cats are less talkative, they prefer to talk by purring. Of course, no cat can understand abstract concepts (Filippova, 2006).

Communication with cats is possible with eyes. “As a person who studies animal behavior and as a cat owner, I am glad that I have the opportunity to show that cats and people can communicate in this way”, the psychologist McComb (1988) reported. Cats often close their eyes, blinking slowly. This is a bit like people squinting their eyes and smiling, suggesting that the cat is relaxed and happy. Cat owners often attempt to copy this expression when communicating with cats.

The study of communication with cats is an open and controversial area of research. Kitaygorodaya and Rozanova (1999) analyze conversations with animals from the point of view of genres of speech. They believe that the communication with animals implements different genres depending on the type of communication: the monological genre of prescriptive and appellative speech (prohibition, reprimand, etc.).

Excellent summaries of cat–cat communication through olfactory, auditory, visual and tactile channels are already available in Bradshaw (1992), Bradshaw and Cameron-Beaumont (2000) and Bradshaw (2018). Cats employ vocalizations much more frequently when humans are present than when together with conspecifics, probably reflecting a learning process. Generally, meows are typical attention-seeking vocalizations in interspecific settings and higher pitched (more pleasant) than the equivalent vocalization in feral cats and the wild ancestor of the domestic cat (Yeon et al., 2011). Meows and purring can be varied by the cat in different situations and interpreted differently by human listeners (Turner & Bateson, 2014). In food-soliciting situations elements of meow-like vocalizations are found within the purr and humans can detect the difference. Bradshaw et al. (2012) suggest that this purring may function as a 'manipulative' contact- and caresoliciting signal possibly encouraged by the positive response of the owner. Humphrey et al. (2020) found that 40% of the participants in their study identified the correct contexts of recorded meow vocalizations of their own cats at a level greater than that predicted by chance.

TECHNOLOGIES OF TRANSLATING FROM FELINE

Non-human language translation

Despite the commonness of communication with pets, the question of the technology of translation of feline language refers us to popular science fiction literature. In many literary works there is a translator device which, having listened to incomprehensible sounds made by aliens, begins to translate them into human language. In some cases, for plausibility, the help of people who fixed some initial concepts was needed. However, in reality (as opposed to fantastic literature) there has never been a technology that translates from a non-human language.

The use of artificial intelligence technologies today has improved the quality of machine translation, it has become possible to "translate" text into program code, into visual images, and other forms. However, there is a fundamental difference to working with translations of natural languages and other sign systems used by humans: With these we know for sure that they are meaningful sign systems, we know how they work, and we can test the result obtained by an AI system for correctness. In the case of a non-human language, there are difficulties with all three indicated components:

- we are not sure whether we are really dealing with a language as we understand it,
- we have no idea about the principles underlying this sign system (if it is a language in the first place),
- we cannot get feedback on the adequacy of the "translation."

In order to create a technology that can translate the sounds produced by cats, at least we need to be convinced on the first point: that a cat really possesses an aural language. An alternative to the language hypothesis might be that the sounds have no meaning, that they simply serve to attract attention and express emotions that are not endowed with meaning, that they are kind of singing or senseless copying of sounds. The difference between emotional sounds and words will be that in the first case, it doesn't matter which sounds are used, the important thing is the volume, timbre, intonation, and in the second, regardless of the method of enunciation, the meaning is preserved. That is, in order to create translation technology, one needs to be sure that cats have a certain symbolic system that associates meanings to certain sound signals. An interesting feature of cats' meowing is that adult cats rarely use meows to communicate with one another, but more often to interact with people (Brown, 1993; Vigne et al., 2004). This speaks in favor of considering their meows a language if one assumes that cats have already taken the first step to switch to a vocal language familiar to humans.

Despite the fixation of various sound parameters, current research on cat meowing is far from providing valid hypotheses about the construction of feline language (Saito et al., 2019). This fact would completely undermine any attempt to create a translation technology, if "dictionaries" were still used today for machine translation. However, modern translation technologies use machine learning, which does not require people to transfer the rules for working with data to the machine. Artificial intelligence, having received a dataset, will itself build hypotheses about correspondences and will produce results, regardless of whether the people who set the task understand how the results are obtained. The weakest point of translating from feline with the help of AI is the need for a database in which there should be translation examples. Of course, such a database can be created, but the accuracy of the translation now depends entirely on whether the owners are able to intuitively understand animals. Nevertheless, the use of AI allows you to remove from the development of technology the stage that requires specialists to understand the construction of cat grammar.

The third difficulty lies in evaluating the performance of the translation technology. How can one evaluate the correctness of the translation from and into feline language? To check the adequacy of translations from feline, one must again rely on the owners' assessment of how the non-verbal cat's behavior corresponds to the translation. In this situation, both human empathy and animal characteristics can influence the results.

In our experiment the *MeowTalk* application was tested. Before the experiment, the owners of their pets had to install this application on their smartphones and register their pets in it, whose meowing will be translated in the future. To receive the translation, the owners had to hold a special button on the screen to record their pet's meowing, and after processing, the application has to translate the meowing into one of eleven statements: Let me in; Let me out; I am angry; Leave me alone; I'm going to attack; Hello there; I'm hunting; I'm in love; Mommy; I'm in pain; I'm resting. In parallel with this, a video was recorded so that a smartphone with the *MeowTalk* application running was visible in the field of view, making it possible to observe the behaviour of the animal as it hears sounds from the smartphone. This behaviour can also be analyzed to further explore the translation process.

As for translating into feline, it is possible to try to translate a phrase that should cause a reaction, and see if it happens. In this study, the translation into feline of the phrase "Go eat" was tested. The study involved 143 cats aged 3 to 8 years, of which 30 cats were female. All cats were domestic, and the owners were familiar with the rules and procedures for conducting our research, and agreed to the publication of these experiments. On the first day, we checked whether the cat could understand human speech, for this, we asked owners to record a video in which they would call their pet to a bowl of food with the phrase "Go eat" to see the cat's reaction: whether it would respond to the call or ignore it. On the second day, it was decided to use the application *Human-to-Cat Translator* which would call the cat by sounding out its feline rendition of „Go eat."

Cat translation applications

Although you can find dozens of cat translators in the app store, most of them are a joke that randomly selects sounds from a library of cat sounds. But there are some applications that are actually doing sound analysis. The application *Human-to-Cat Translator* performs audio analysis on the voice and issues carefully crafted meows according to human input, it also includes a 16-meow soundboard for instant access to common cat calls. An analysis of the reviews indicates that although for some cat it doesn't work at all, there are positive results.[1] It is clear that the reaction of cats to the translation made by the application can be a reaction to the sound or anything else, and be a coincidence. At the same time, the positive reviews and owners' reports are reason enough to study the phenomenon.

The most advanced application of this kind is *MeowTalk* which also received mixed reviews but some of them quite positive.[2] It was developed by Javierz, a former Amazon engineer who worked on the Alexa voice assistant. The application works on the principle of machine learning, that is, an AI-system was initially exposed to tens of thousands of different examples allowing the neural net to learn to recognize the sounds made by cats. Users can mark unidentified sounds and thereby continue AI training and improving the operation of the application.

Although the application is based on machine learning, which was used for voice assistants, it could not be used directly for cat language, since, unlike human language,

[1] For example "It WORKS! I love this app so so so so sooooo much! My cat is my best friend and she listened and hit the screen, and ALSO meowed back, this is AMAZING!!! As humans we force cats to learn our languages but we need to be less ignorant and learn the cat's languages as well, because it might be hard for them to communicate with us, since they are not bilingual;" "It's amazing! First I was trying to get my cat and kitten to listen and I looked for an app and I downloaded this app as soon as I tried it I said in the microphone come here baby you are the best and she came up to me and started purring I couldn't believe it and I've been using this app ever since I would definitely recommend this app if you are a cat lover."

[2] "Surprisingly, it works. The program captures a barely noticeable intonation in the meow, and correctly conveys the mood of the cat, by 90 percent. You can listen to the story and make sure that there is still a difference between 'hello,' 'I'm looking for love,' 'what's going on?' etc. When I leave the kitchen without feeding him for the 5th time in a day, the cat is quietly indignant, the program writes 'I'm not doing so good.' I failed to meow in such a way as to deceive the program such that it would confuse me with a cat."

cat language does not have a dictionary. It should be mentioned that Alexa's capabilities include meow recognition, but in a very primitive way: She can note that a cat is meowing and issues a random meow in response. Alexa's developers do not seem to believe that cat language is more than just a random collection of sounds.

MeowTalk combines three layers of analysis for the voice of cats: first, there is the determination of the cat's language (based on a Google data science model the application knows that this sound is a meow); second, a general model that provides the app's initial cat vocabulary and associated actions; and third, a highly specific model which is trained for each cat.

The application is user-friendly, similar to the Shazam-app which identifies musical tracks. At the touch of a button, the decryptor is activated, and users are offered the probable translation of the meow, with which they can agree or request another option.

Even if cats do not have a shared language, the application might render unique meows as an understandable phrase if the owners upload unique pet's meows that robustly correspond to certain situations, for example, of the cat saying „food" at feeding time, or „let me out" at the door. At least 5-10 examples are required for each new "word". Using machine learning, the MeowTalk app learns to translate the cat's unique sound, paying attention to cats' specific vocalizations and intentions.

A number of applications have also been developed that can translate human language into feline and cat language into human language. Their aim is to remove the language barrier between the pet and its owner. Also there is a prototype of a collar that will translate any meows sounds to human speech and also can send a message to the smartphone if the cat is outside.

Feedback on translation

The results of the experiments inviting cats to „Go eat!" showed that 93% of the total number of cats respond to the human voice on the first day. More precisely, 86.7% came on the first call, 6.3% responded to a second call, and 7% did not come at all. On the second day, when using an app that translated „Go eat!" into a meow, 74.13% of the total number of cats responded to it. Of these, 64.3% came on the first call, 9.8% on a second call, and 25.9% did not respond at all.

The application allows us to try to understand this language. Since the application analyzes the "speech" of animals through sound, it is very important to consider how differently cats enunciate. For an analysis of the sounds uttered by cats, we collected video materials and sound wave patterns of audio tracks which we received from animal owners. To demonstrate the result of the translation, let's take a detailed look at some examples of where the application appeared to work. The task was to record cat sounds on a video. After analyzing the video, the features of their conversation and literal interpretation were identified.

"Let me relax![3]"

During the making of the video which shows Leon the cat, sound was recorded in parallel using the "MeowTalk" application. It translated the cat's loud meowing as: "Let me relax!" His phrase appeared to be a response to excessive attention from the owner and was a desire for privacy.

The sound wave generated by the beacon of this cat has the maximum amplitude of all the presented oscillations. This indicates that the cat has a high tone of meowing. If we decompose the recording of a given cat's meowing into extremely small time intervals $d\tau$, then it will also be possible to observe that the presented sound is high-frequency. The results of the decryption and translation are presented in fig. 2 and 3.

Figure 2. Sound wave characterizing the cat's phrase "Let me relax"

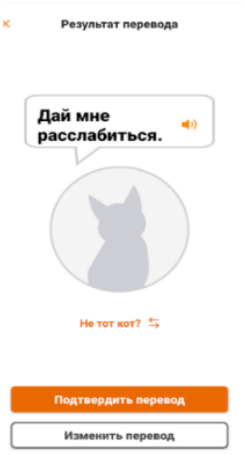

Figure 3. "Let me relax"

The other cat is eating, at this time the owner touches the cat by the tail, moves the bowl with food, and strokes her back. The reaction of the cat can be observed in Figure 4. The cat does not like it, she constantly jerks her head, obviously does not want

[3] https://youtu.be/4_YKjR6PoUQ

Figure 4. The cat is dissatisfied with the actions of the owner

the owner to interfere with her eating. She meows. and the app translates her meowing as “let me relax.” In this situation, it appears obvious that the translation is correct since the cat's demand coincides with its reaction to the actions of the owner.

Hunting and love

The owner comes into the kitchen and sees how the cat is trying to climb on the table where the food is. The owner uses the app to ask the cat what she is doing. The cat meows in response, and the app translates her meowing as follows: “I'm on the hunt.” In this example, there is no reason to believe that the application is not working correctly, because the cat „gave an answer“ that completely coincides with her actions.

In the same video, one can see how the owner approached her second pet, and the cat began to caress her feet. She looks into the face of the owner and begins to purr and meow. At that moment, the app interpreted her meowing as “Hello. I want to be loved.” The application translated the pet's meowing exactly as one would expect in this situation: The cat wanted affection, demanding to be petted.

In another video[4] a cat named Zhora was filmed in close-up, walking along a dark corridor and meowing. The app interpreted her meowing as: “My love, I'm here!”. The result of the audio decoding is shown in fig. 5 and fig. 6. Thanks to the translation the viewers perceive a longing in the voice, attributing the desire to find a soul mate.

Figure 5. Sound wave characterizing the phrase “My love, I am here.”

[4] https://youtu.be/sjcqfoHpfsA

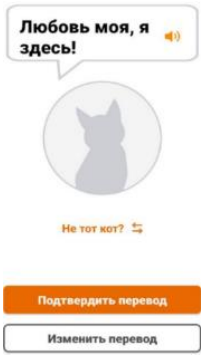

Figure 6. "My love, I am here!"

In one more video[5] the cat Misha examines and sniffs a jacket with interest. At the same time, he meowed loudly and for a long time. The person who experimented brought the phone with the application. The translator interpreted the animal's voice as "I'm looking for someone special!", which can be interpreted as the intention of the cat to find the owner of the jacket or another cat who owns the smell left on the jacket. The result of the audio decoding is shown in fig. 7 and fig. 8. The application with a high degree of probability correctly determined Misha's intention.

Figure 7. Sound wave characterizing the phrase "I'm looking for someone special".

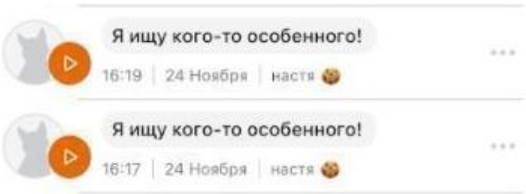

Figure 8. "I'm looking for someone special"

The sounds of the meowing cats Leon (Miaou), Tisha (Nyarv), Zhora (Rrnyau), Misha (Mmryau) have low amplitudes of oscillations, therefore, these voices of cats are quiet and characterized as low-frequency.

In another video[6] the cat Anesa is sitting in front of the owner holding a bowl. During this process, audio was recorded with the *MeowTalk* application. The app translated Anesa's quiet meowing as: "My love, I'm here!" The transcript of the recording is presented in fig. 10 and fig. 11. Then the owner gives Anesa a bowl of food. It would appear that the cat understands that she is being teased, and therefore says that she is here and wants to eat.

[5] https://youtu.be/N21AND5dUKo
[6] https://youtu.be/-haGd-jlZ0k

It is worth noting separately the final oscillation in the recording of the cat meowing Anesa. It is characterized by a sharp increase in amplitude. This phenomenon can lead to resonance of sound waves, that is, there is a coincidence of some external frequency of the wave with the frequency of the waves created by the cat's vocal cords. If the coincidence of these frequencies occurs at a level caught by the human ear, then you can hear not the usual meowing, but some distorted sound, in certain cases similar to familiar words.

Figure 9. Anesa is waiting for food

Figure 10. Sound wave characterizing the phrase “My love, I am here!”

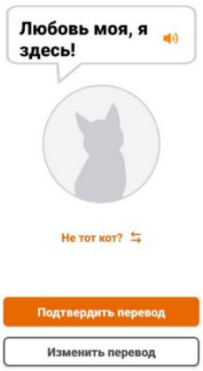

Figure 11. ”My love, I’m here!”

The cat Asya rushes from side to side, she is alarmed by something. The owner set up the application to translate the meowing and asked the cat to say something. Asya replied, “I'm chasing something.” Indeed, the actions of the pet seem to justify this interpretation. After all, the cat is definitely not sitting still, she pulls the blanket on the bed with her paws, and turns her head, from which it can be concluded that she is looking for something.

Sometimes the app translated human speech and cats' meowing not correctly enough. For example, in test number 24 a cat named Pushok is sleeping on his couch, and the owner starts waking the animal. At this moment, the cat meows and the app translates the sound of meowing as “I'm on the hunt!”. The translation does not correspond to the

current situation, because Fluff was asleep, and not going to hunt. Or in test number 25, the owner of a cat named Katya calls her pet to eat using the translator *MeowTalk*, but the animal does not show any reaction. The experiment lasts about 10 minutes, and Katya never comes. But at the voice of the owner, the pet came running almost immediately. That is, Katya wanted to eat, but the application could not convey to her the meaning of the owner's words. This shows that the animal did not understand the translation of the application.

DISCUSSION AND CONCLUSION

Translation from feline language still seem more like a whimsical experiment or joke, and along with technologies aimed at actually analyzing cat language, there are a lot of unserious translators with random meows (including Amazon's virtual assistant Alexa). Perhaps, technologically mediated communication with animals is a promising area of development. At the very least, it testifies to an expanded notion of a multilingual world which we navigate with digital tools.

Several translations, which the owners of the animals considered accurate, suggest that digital technologies can actually contribute to the establishment of communication, although this is not sufficiently proven or developed as of today. The pets were interested in the unexpected sounds made by the app. This suggests at least that cats perceive these sounds as genuine cat meowing.

The *MeowTalk* application performed well on some occasions, not so well on others. Overall, it remains evident that cats respond better to normal human speech than to machine translation into feline talk. This is probably because this is a more familiar way of communicating for cats.

In all the experiments distortions could arise since the animals were confronted and confounded by new situations. For example, a cat who sees a camera pointed at her will experience awkwardness, fear or confusion, which may cause the whole experiment to fail. Due to conducting experiments at home, it is impossible to unambiguously exclude the influence of various noises on the final result of translation. The animal's voice can also influence the result, for example, the application can more accurately translate the intentions of cats with a larger amplitude of meowing and the voices of cats whose it is louder. Another important factor influencing the accuracy of successful translation is the distance of the microphone from the pet, as with increasing distance between the recording device and the object of translation, the clarity of recognition deteriorates.

The results of the study show that the application that translates human speech into feline speech works to some extent. But there is no proof of its reliability. It is in any cases impossible to determine exactly whether the translation coincides with the intentions of cats. Thus cats often come to eat on other cues than the translator app's meow or the call by human voice.

The mixed results obtained from application testing is not discouraging. Even if the experiments are not conclusive, the indicate possible directions for further work. Translation errors themselves are also normal, just remember the history of trial and error in machine translation. Any inaccuracy of the translation can always be explained by the

fact that the technology is not sufficiently developed at the moment. Increasing the number of tests and edits contributes to learning and improving the work of AI and the application.

The positive results are encouraging in terms of creating a technical intermediary in communication with animals. If we can claim that a feline spoken language exists and we can use AI to translate it, then further improvement of the system will only be a matter of collecting the most complete and correct database possible – deliberately including cats and other pets in our conception of a multilingual world.

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