Computational Pokémon character design

Computational Creativity
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2021 – 2022

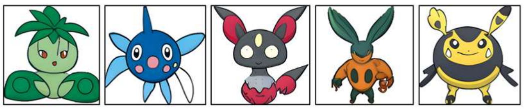

Figure 1 Fake Pokémon, generated by the system presented in this paper.

***Abstract* — We propose a creative system that attempts to replicate the process a human goes through when designing characters. The system takes as input a concept in the form of text and searches for inspiration on the web. Based on its findings, the system generates a Pokémon and gives meaning to the creature by assigning it a made-up name. We evaluate the system's creativity using Simon Colton's notion of the creative tripod and conclude that the system is capable of being creative.**

***Index Terms* — Character design, Computational creativity, Generative system**

1 Introduction

Character design is the process of brainstorming, sketching, outlining, drawing with as end goal to obtain a fictional character [1]. However, when coming up with new character designs, there is more that goes into the process than creating a well-drawn figure. Good characters should tell a story; they have a personality and they bring a certain atmosphere or vibe to them [2]. A well-known example are Pokémon.

Pokémon are imaginary creatures that appear in many different colours, shapes, and sizes. Pokémon always have one or two types associated with them such as fire, electric and dark. Masuda, the director of the Pokémon design team, says the following: "When designing Pokémon, not just from a graphic design perspective, there must be a reason for why it looks the way it does, and you have to think about why it might live in the Pokémon world." [3].

According to a designer known for his contributions in Pokémon character design, the process of creating a new character can be split up into the following three phases: concept definition, sketching, and execution [4].

Concept definition

In the first phase, designers start from a concept or an idea and try to understand the meaning of the concept. It is important that the creature tries to convey a message of how it feels, in what environment it lives, etc.

Sketching

In this phase designers give a physical embodiment to the concept and explore possible designs on how to represent those ideas in the form of sketches.

Execution

In the execution phase multiple sketches are combined into a single final rendering. Lastly, colours and shadings are added to the final design.

There are some rules that define what a Pokémon can and cannot be. According to an article Pokémon must always be living creatures [3]. For example, a Pokémon can be a pile of thrash, but it is made alive by for example giving it eyes, hands, and a mouth. In Figure 2 we can see the Pokémon Trubbish, which was inspired by a thrash bag.

Figure 2: Image of the Pokémon Trubbish

Pokémon also have some distinctive design characteristics. For instance, they always have black contour lines. Their base form usually has a cute appearance. As Pokémon evolve, the receive a more complex design. It is a common that the designers take inspiration from the real world (e.g.: animals, or objects).

In this paper we present a creative system that generates Pokémon-like characters. It will go through a similar thought process as humans do when creating new characters. The system takes as input a concept in the form of text. The output of the system is an image and name of a non-existing Pokémon. The system also provides a degree of transparency in the decision process it went through to obtain its artifact.

If we place the system in terms of the creative systems framework [5], we assume the universe to consist of all possible character designs. The conceptual space can then be defined as the universe minus all concepts that do not obey the constraints of what it means to be a Pokémon.

In section 2, we position the system within existing related work. Section 3 covers the components the creative system in depth. Lastly, section 4 discusses how the system's creativity is evaluated.

2 Background

For a system to be deemed creative it must exhibit certain behaviours. An example of a creative system is DARCI, which produces images that match a list of adjectives it is given. Although DARCI's images are not related to Pokémon, it is similar in other ways. Just like our system, DARCI also generates an image and it can reflect on its work by labelling it with an adjective. Instead of associating an adjective to an image, our system can associate a type with the Pokémon it generates. DARCI's creativity is evaluated using Colton's notion of the tripod. According to Colton's creative tripod, a creative system must exhibit three behaviours: skill, imagination, and appreciation. Skill refers to the fact that system's artifacts must be recognizable as members of the intended domain. Imagination means that the system's artifacts must be both authentic and they may not be the result of random processes. Lastly, for appreciation, a system must have a means to evaluate its own work. We will later demonstrate how our system possesses these criteria as well.

In the field of computer-generated imagery, multiple papers have been written regarding Pokémon. The papers cover ways to either generate new Pokémon or adapt existing ones. One instance uses computational intelligence to learn how a Pokémon's type influences its colours and shapes [6]. This information is then used by an evolutionary algorithm to create new Pokémon sprites.

In a different paper, work was done to generate gameplay art assets using transfer learning [7]. The presented system is based on variational autoencoders and Generative Adversarial Networks (GAN). Given the sprite of a Pokémon and a type, the system produces a modified version such that the characteristics would correspond to the new type it is given. For example, if we provide their system with an electric Pokémon and request a fire Pokémon, their system will transform the original image into a fire Pokémon. Although the idea sounds promising, a lot of work must be done to obtain production ready results.

Lastly, The website nokemon generates 3D images of fake Pokémon [8]. It obtains the most promising results available so far.

The three existing methods for generating Pokémon-themed artwork as discussed above all have the same objective: to create new Pokémon sprites. However, they differ in the way they create their artifacts. Everything is done using one single model that tries to generate an appealing piece of artwork. Still, the newly generated characters, do not tell a story. There is no indication on where the system found its inspiration or what the basis was for its creation. In the following sections we discuss how our system attempts to resolve this.

Generative Adversarial Networks (GANs) have shown promising results for computationally generating images. However, recently, transformers language models have gained attention for their use in text to image generation. Although they were originally meant for real-time text/speech translation, researchers have found ways to apply these techniques for generating visuals as well [9]. Two transformer models that have achieved great results in text-to-image generation are DALL-E and ruDALL-E.

DALL-E is not publicly available, but ruDALL-E is. The 1.3B parameter pretrained neural network takes as input a Russian sentence and generates an image.

Shonenkov et al. have presented a paper on finetuning the ruDALL-E pretrained model using an emoji dataset [10]. Via finetuning, the authors keep the generalization ability of the pre-trained model, while changing the generated images to become emojis instead. We use this idea to obtain Pokémon images instead.

Alongside research on generating Pokémon sprites, accomplishments have also been made in generating plausible Pokémon names. Geissler et al. present a paper to generate Pokémon names [11]. Many existing Pokémon names are a combination of two existing words that describe some of its characteristics. Let's take the name Snorlax as an example, which is a blending between the words Snoring and relax. Names are made from a list of eight input words. The input words are split up into syllables and multiple plausible names are obtained by mixing syllables of different words. A linear model that is trained on existing Pokémon names selects the best plausible name. The system we propose incorporates this technique in one of its components.

3 Description of creative system

Proper character design shows more than just an appealing picture. There is a story behind the character; a way to see the character as a living thing. Also, character designers usually do not start from nothing. They take inspiration from other things and thus start from a concept or an idea. The system we propose will try to simulate this behaviour.

Figure 4 presents the process the system goes through to obtain its artifacts. We discuss each component below.

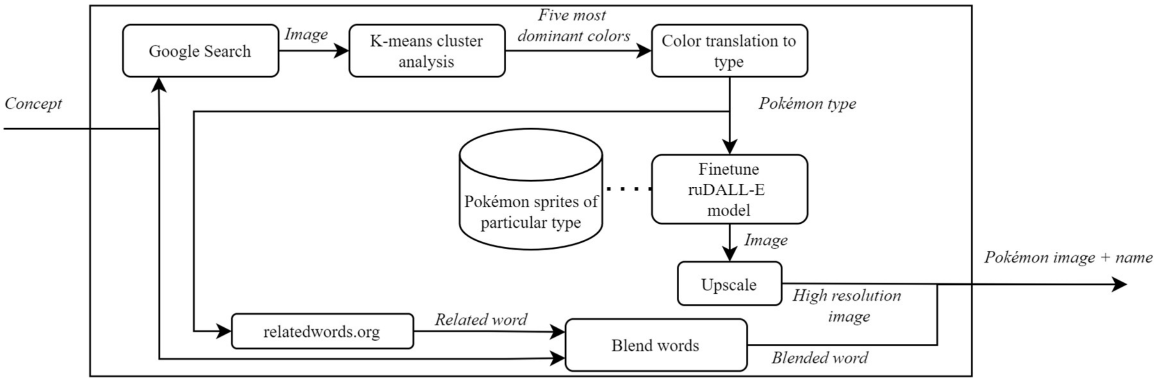

Figure 3 High level overview of the different components

The components of the system can be split up into three categories: 1) Take inspiration from the web, 2) Draw the image, and lastly, 3) come up with a name. The components are split up in this manner to emphasize the process a human would go through when designing a character.

3.1 Inspiration from the web (Concept idea to Pokémon type)

The goal of the inspiration process is to map a concept idea to a Pokémon type. The type the system decides on, will later become the type of the Pokémon it will generate. The system simulates taking inspiration from the web by searching for the concept in Google Images. It randomly selects one of the images it finds and uses this image as a starting point. Via a 5-means cluster analysis, the five most dominant colours are extracted from the image.

Pokémon types can be associated to a particular colour. The electric type, is associated to the colour yellow, fire is associated to the colour red, etc. The table below displays to which colour types are associated. From the five dominant colours obtained earlier, similarity is checked to the colours associated to a particular type. The type that best matches one of the five dominant colours is selected. The similarity between colours is calculated via the Euclidean distance function using the RGB representation of these colours. For simplicity the system is limited to the following types: Water, Fire, Electric, Grass and Dark.

Pokémon type	Associated hexadecimal colour
Water	#6390F0
Fire	#EE8130
Grass	#7AC74C
Electric	#F7D02C
Dark	#705746

Table 1 Associated colours to Pokémon types. Only the types that are supported by the system are shown.

3.2 Draw the image

The artworks are generated using a transformer model. In the inspiration phase the type of the Pokémon was obtained. To create Pokémon designs that correspond to the characteristics of the requested type, the neural network is trained solely on the Pokémon of that particular type. The images used were obtained from a publicly available dataset of Pokémon images [12]. The dataset consists of over 1000 images. This corresponds to roughly eighty images per Pokémon type.

We investigated multiple techniques for generating images, including multiple GAN architectures. Due to the limited size of the dataset (roughly eighty images per Pokémon type), training models from scratch did not give meaningful results. Instead, we finetuned the pretrained model 'ruDALL-E' [13] on Pokémon images. The method is based on Shonenkov et al.'s paper on finetuning the ruDALL-E model with the purpose of generating emojis as discussed earlier. By freezing the feedforward and self-attention layers in the pretrained transformer model allows for the pretrained model to keep "knowledge about the world", while adjusting the style to generate Pokémon images. We trained five models, one for every Pokémon type, each model was trained for 3000 iterations. Generated images are then upscaled using a publicly available AI-based upscaler API [13].

It is worth mentioning that a different approach to generate these images is also plausible. The website nokemon generates 3D images of "Fake Pokémon" mentioned earlier. Although the images are promising and incorporating this system would severely simplify this project, the system offers no control, nor transparency of the data it was trained on.

3.3 Come up with a name

As mentioned earlier, it is not enough for the system to draw an appealing character. There must be a story behind the character, it should have a meaning or a way to make people bond with the it. We attempt to recreate this feeling by giving the Pokémon a name that is specific to its characteristics.

The name is composed based on two concepts: 1) the original concept-idea that was given as input to the user and 2) the Pokémon type the system choose earlier. The name is obtained by blending two keywords together. We explain the blending process more in detail later. To obtain the two keywords that that must be blended, again an inspiration process is initiated. The system "gets inspired" by the Pokémon type it choose earlier. The system randomly selects a word out of a list of words related the original Pokémon type. A public API is used [14]. Blending the related word, combined with the original concept-idea results in a personalized name that is related to the Pokémon's characteristics.

The way words are blended is based on the paper written by Geissler et al. mentioned earlier [11]. Using the Natural Language Tool Kit (NLTK) words are split up into syllables. A list of new words is created by mixing syllables of different combinations. For example, given the words "starfish" and "yellow", one of the mixed words could be 'star-low". A ranking of names is done using a linear classifier, trained on Pokémon names.

The name with the highest ranking is selected as the name of the newly defined Pokémon.

4 Evaluation of creativity

To prove that our system is creative, we work in a similar way to how Norton et al. have evaluated DARCI [15]. DARCI's creativity is evaluated by taking inspiration from Colton's notion of the creative tripod [16]. Colton states that for a system to be creative, it must exhibit three behaviours: skill, imagination, and appreciation.

Skill

For a system to be deemed skilful, it must create artifacts that can be recognized as members of the intended domain. In the case of the Pokémon creator, this means that the characters it creates, should be plausible Pokémon designs with a suitable name. The system also shows skill by trying to replicate the same inspiration process a human could go through, when designing characters.

Imagination

For a system to express imagination, Norton et al. claim that the system's artifacts must be authentic and they may not be the result of random processes. The Pokémon creator exhibits this behaviour by making up images and names that do not yet exist.

Appreciation

Lastly, to argue for appreciation, a system must have a means to reflect on its own work. The Pokémon creator learns to appreciate its creations by associating a type to the images it generates. It also shows appreciation for its work by coming up with an appropriate name for the Pokémon.

Computational creative systems can be evaluated from at least four different perspectives [17]. For the evaluation of our system, we consider two perspectives; evaluation of the product as a system's output, and evaluation of the process as the way it operates. Similar to DARCI's evaluation process, we distinguish between internal evaluation (= appreciation) and external evaluation. In the following sections we evaluate the system externally.

Each behaviour (skill, imagination, appreciation) of Colton's tripod is evaluated. Just like in DARCI's evaluation process skill and imagination are evaluated together because the behaviours have some overlap. Appreciation is evaluated separately.

4.1 Evaluation of appreciation

During the finetuning process, the system learns to show appreciation for its artifacts, by learning the type of the Pokémon it creates. Later, the system shows appreciation for its creations by assigning them a relevant name.

The system's appreciation is evaluated by first testing how well it can distinguish different Pokémon types. How the system associates types to its images is evaluated by two experts in Pokémon. Each expert has more than 1000 hours of experience in Pokémon. Experts were each given twenty-five generated images. Participants were asked to label the types of Pokémon. Performance of appreciation is assessed by counting the ratio of correct associations, made by the system. The system makes a correct association when the experts obtain the same findings. The results will be further discussed in section 4.3.

Measuring how well the system assigns made-up names to its creatures is not as easily calculated. This is because there exist multiple plausible names for a Pokémon. It is true that the system generates a personal name that is based on the characteristics of the Pokémon, but this name could just as well be the name of another Pokémon. For this reason, we cannot use the same strategy we used to assess how well the system associates Pokémon types to images. Instead, the quality of the made-up names is evaluated without considering whether it is a good fit for the image. This is done in section 4.2., as part of the system's evaluation of skill and imagination.

4.2 Evaluation of skill and imagination

Although, Ritchie's criteria for evaluation of creative systems [18] are great for evaluating a product as the artifacts it produces, we have opted for a survey instead. By asking questions, both about the system's artifacts and its process allows for evaluation of the system in terms of its product, but also in terms of the process the system goes through.

Five Pokémon were generated by the system with the purpose of evaluation. No cherry picking was done. The system generated one Pokémon for every supported type: water, fire, grass, electric and dark.

Thirty participants with prior knowledge of Pokémon volunteered to rate the creative system. The survey was performed digitally over the period of one week. Each participant was assigned to one Pokémon that the system created. The assignment was done based on the participant's IP-address. This way we could make sure each participant could only rate one single Pokémon.

Participants were given the name and image of one Pokémon. They were also given the inspiration process the system went through to obtain this artifact. An example of what was presented in the survey is available in the appendix. Participants were not explicitly told that the Pokémon were generated by a machine to prevent bias.

Participants were given six statements. For each statement they were asked whether they agreed or disagreed with the claim. The six statements were the following:

1. I like the Pokémon.
2. I believe the image is starting to look like Pokémon.
3. I believe the image is a plausible Pokémon.
4. I can empathize with the Pokémon.
5. I have never seen a Pokémon similar to this one.
6. I believe the steps the system goes through to obtain its Pokémon designs [image + name] are similar to how a human would perform character design.

The statements were designed to cover different aspects of evaluation. Statements one to five review the quality of the systems' artifact, while statement six reviews its process. Within the questions related to the artifact's evaluation, questions one to four evaluate the system's skill, conform to the creative tripod, while statement five reviews authenticity.

The skill-level of the system could be evaluated differently by asking participants to compare two images. One image would be an existing Pokémon and the second image would be made up by the system. Participants would be asked to mark which Pokémon they believe is real and which one is generated by the system. We did not opt for this approach because this would risk potential biases in case the participant has prior knowledge of existing Pokémon.

4.3 Effectiveness of surveys and results

To assure the responses from the survey are meaningful, there must be some level of agreement between the different raters. For the experiment done by the two experts, we measure inter-rater reliability via Cohen's kappa. For the survey that reflects on the system's skill and imagination, Fleiss' kappa is used. The statistical measure is an extension of Cohen's kappa and allows for measuring agreement of more than two raters.

Appreciation

We first discuss the results from the experiment done by the two experts. Two domain-experts were each asked to label twenty-five Pokémon with a Pokémon type. The raters' labels were compared to those made by the system. In 20 out 25 instances, rater 1 marked the images the same as the system. Rater 2 labelled 19 out of 25 instances correctly. This corresponds to an average score of 78%.

Using Cohen's kappa, a kappa score of 0.65 was obtained. This score corresponds to a substantial agreement between the two raters. We can thus accept the results obtained from the raters and claim that the system does indeed possess a form of appreciation.

Skill and imagination

We now discuss the results of the second survey. Participants were given six statements. For each statement they were asked to discuss whether they agreed or disagreed. Since each rater was assigned to one out of five Pokémon, we measured agreement between raters for each Pokémon individually. The kappa scores are displayed in the table below.

Pokémon to rate	# raters	Kappa score
1 – Fire	10	0.28
2 – Electric	6	0.29
3 – Dark	9	0.26
4 – Grass	2	0
5 – Water	3	0.1
Agreement between all raters	30	0.13

Table 2 Inter-rater reliability per Pokémon. The first five rows display the inter-rater reliability between raters who were assigned the same Pokémon. The last row shows inter-rater reliability without taking into account which Pokémon the rater evaluated.

From the table shown above we note a fair degree of agreement for the raters who evaluated fire, electric, or dark Pokémon. There is slight to no agreement between raters of the grass or water type Pokémon. We believe this is caused by the small number of raters in these two groups. From the table we also observe that the total agreement for all thirty raters small. This may be caused due the inconsistencies in quality between the generated Pokémon.

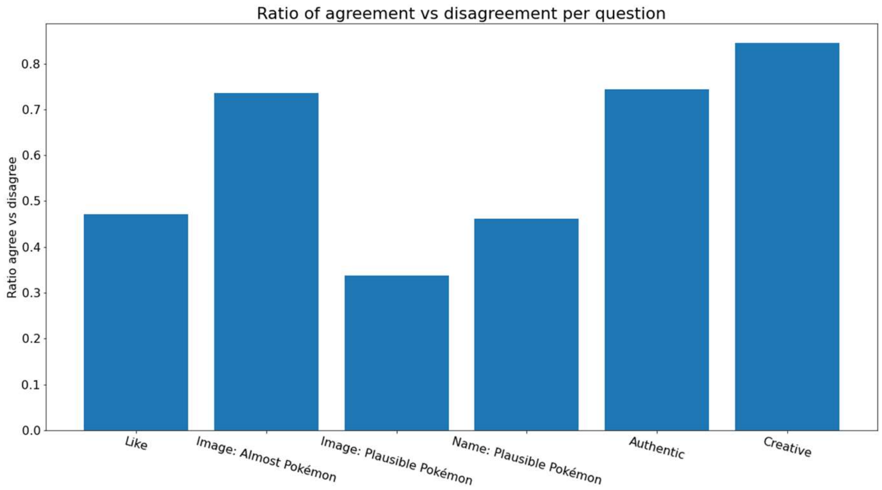

Figure 4 Average score per statement

The graph in figure 4 displays the average score per question. We note that most raters (84%) believe that the system exhibits some form of creativity. 74% have never seen a similar Pokémon (authentic). Although merely 34% think the image could be a real Pokémon, we observe much higher confidence when raters are asked whether the image is starting to look like a Pokémon. 47% of the raters like the Pokémon. Lastly, we note that 46% of participants believe the made-up name could be a plausible Pokémon name. From these results, we can conclude that the majority of generated images are not yet ready for production, but they are heading in the right direction.

Table 3 displays the average score per Pokémon, assessed by the raters. High variability can be observed in the answers of Q3 between different groups. This statement tested whether the image is a plausible Pokémon. While most raters disagree with this statement, 80% of participants who evaluated the fire Pokémon agreed. This indicates that the system can generate images that come close to imitating real Pokémon images. However, it is still inconsistent in doing so. Note that we cannot claim that the system is better at generating Pokémon of a particular type compared to another type, simply because only one Pokémon was evaluated for each type.

Pokémon of specific type	Q1	Q2	Q3	Q4	Q5	Q6
Water	0.3	1.0	0.3	1.0	0.3	0.3
Electric	0.5	0.5	0.3	0.2	1.0	1.0
Fire	0.8	0.9	0.8	0.2	0.5	1.0
Grass	0.5	0.5	0.0	0.5	1.0	1.0
Dark	0.2	0.8	0.2	0.4	0.8	0.8

Table 3 Average rating per question. The numbers Q1 to Q6 correspond to the six statements discussed in section 4.2., the scores can range from 0 to 1. A high value corresponds to all raters agreeing for a particular question.

As we observed earlier, most participants ought the system to be creative. We also observed that the system's artifacts are authentic and start to look like Pokémon. From these findings, we conclude that results are acceptable to claim that the system exhibits skill and imagination. Since the system exhibits the three behaviours, required by the creative tripod, we may conclude that the system is indeed creative.

5 Discussion and future work

The current system we propose tries to imitate aspects of the human character design process. When coming up with a name, there is a clear transparency from which concepts the made-up name originates. However, in the case of generated images, this is not as trivial. The produced outputs of our finetuned ruDALL-E models are the final renderings of the Pokémon. When humans perform character design, they do not draw a single final rendering in one session. They start from shapes, draw sketches, and colour their best sketch, which becomes the final rendering. The system we propose does not yet have this behaviour. We have put some initial steps towards achieving this goal by splitting the image generation into two parts: firstly, sketching and secondly colouring, as an attempt to get closer to imitating the human character design process. We finetuned the ruDALL-E pre-trained model on sketches of Pokémon. The dataset of Pokémon sketches was obtained by applying the XDoG filter to the original data discussed earlier. Liu et al. apply this technique in the auto-painter tool [19]. We tried multiple techniques for colouring the sketches and although some techniques showed promising results, the coloured images did not have the typical Pokémon style. We investigated three techniques: style-transfer by NVIDIA, a publicly available auto colour API that was trained on anime images and training a conditional GAN. The appendix displays the results of generated sketches and some of their coloured variants as well.

We wish to briefly discuss the possibility of a feedback loop. As we mentioned earlier, the size of the training dataset is limited due to number of Pokémon that currently exist. We suggest that part of the generated images could be reused in the training process to obtain a better neural network.

6 Conclusion

We have presented a system that incorporates aspects of character design similar to the process a human would go through. This was done by allowing the system to simulate taking inspiration. The generated artifacts were Pokémon creatures, that were inspired based on images it found on the web. The system also tried to give meaning to the character by coming up with a personalised name that is based on the characteristics of the Pokémon. We evaluated the system's creativity using Colton's creative tripod.

The system's appreciation was evaluated by two Pokémon experts who each rated how well the system associated a type to an image. We observed that on average 76% of the generated images from the system image to type associations were in line with those of the experts. We evaluated systems skill and imagination with a six question survey survey, done by thirty participants. We observed that the system's artifacts were believed to be authentic, while also images were starting to look like real Pokémon. Raters also believed the system's process to be creative. Since the system exhibits the three behaviours, required by the creative tripod, we concluded that the system is indeed creative

7 References

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8 Appendix

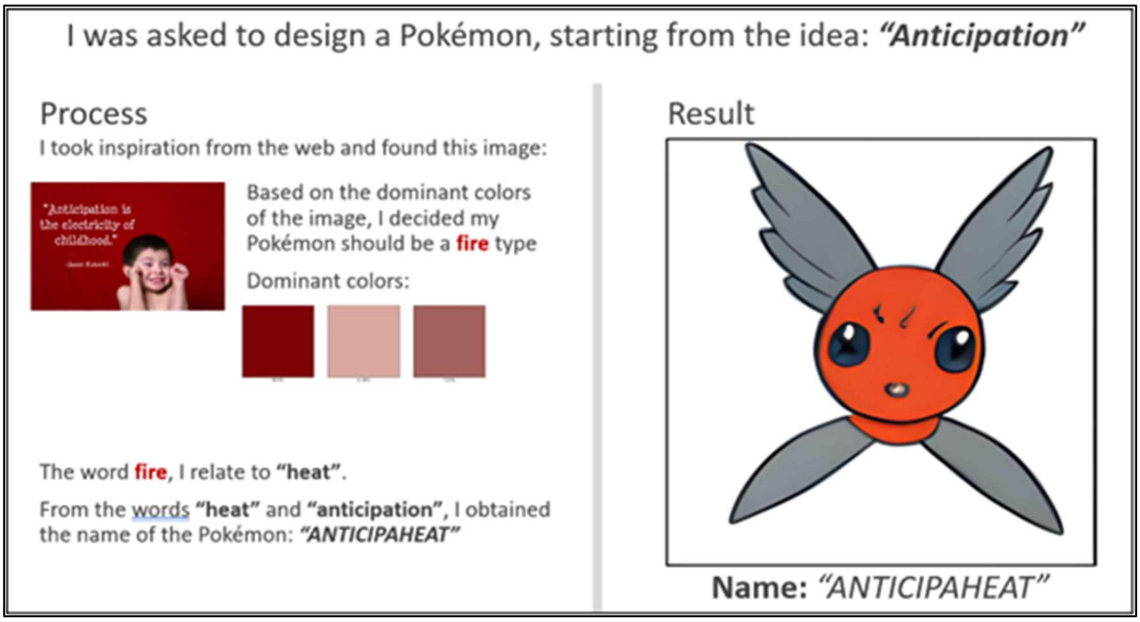

Figure 5 Example evaluation form

Figure 6 Dark type Pokémon, generated by the finetuned ruDALL-E model

Figure 7 Fire type Pokémon, generated by the finetuned ruDALL-E model

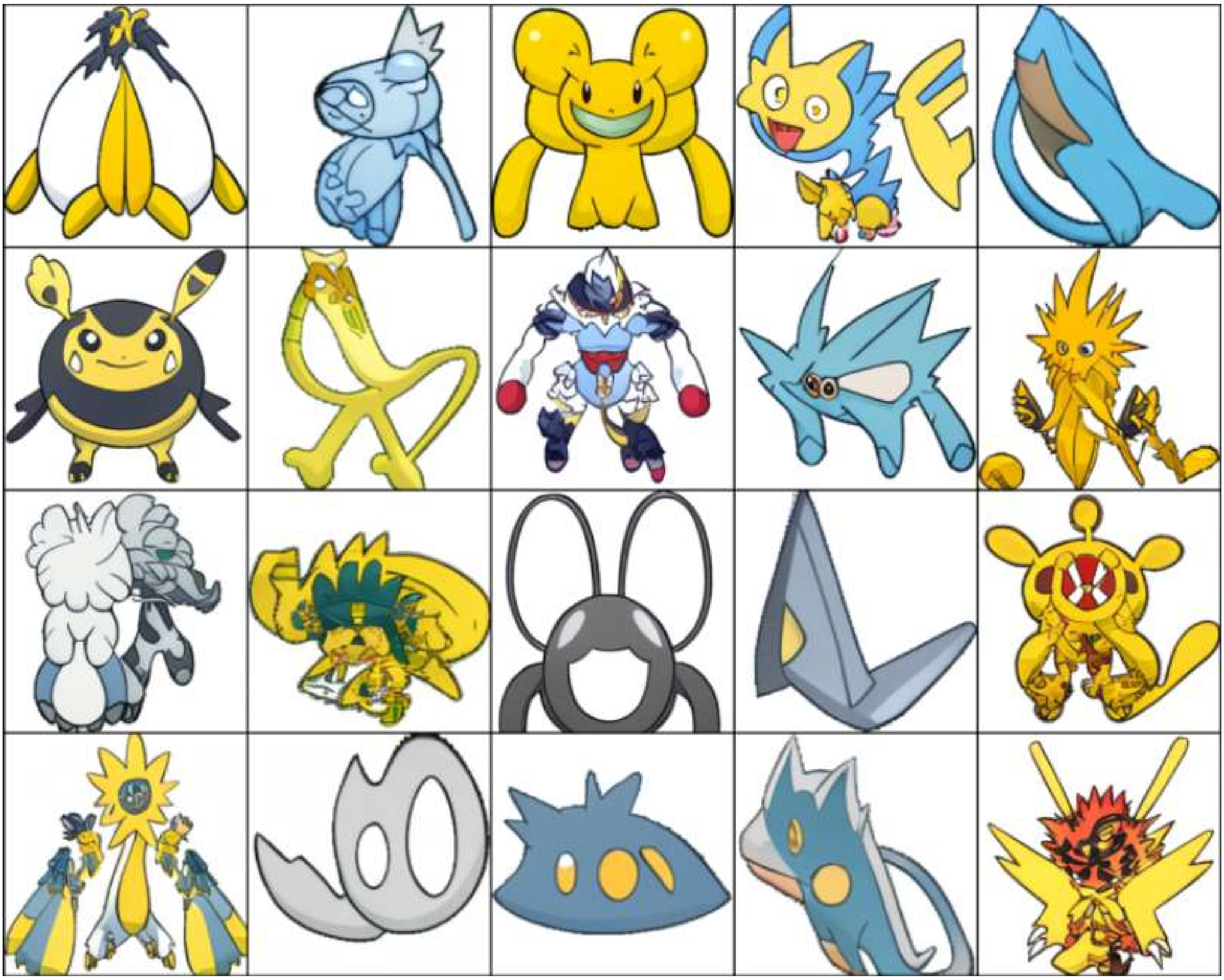

Figure 8 Electric type Pokémon, generated by the finetuned ruDALL-E model

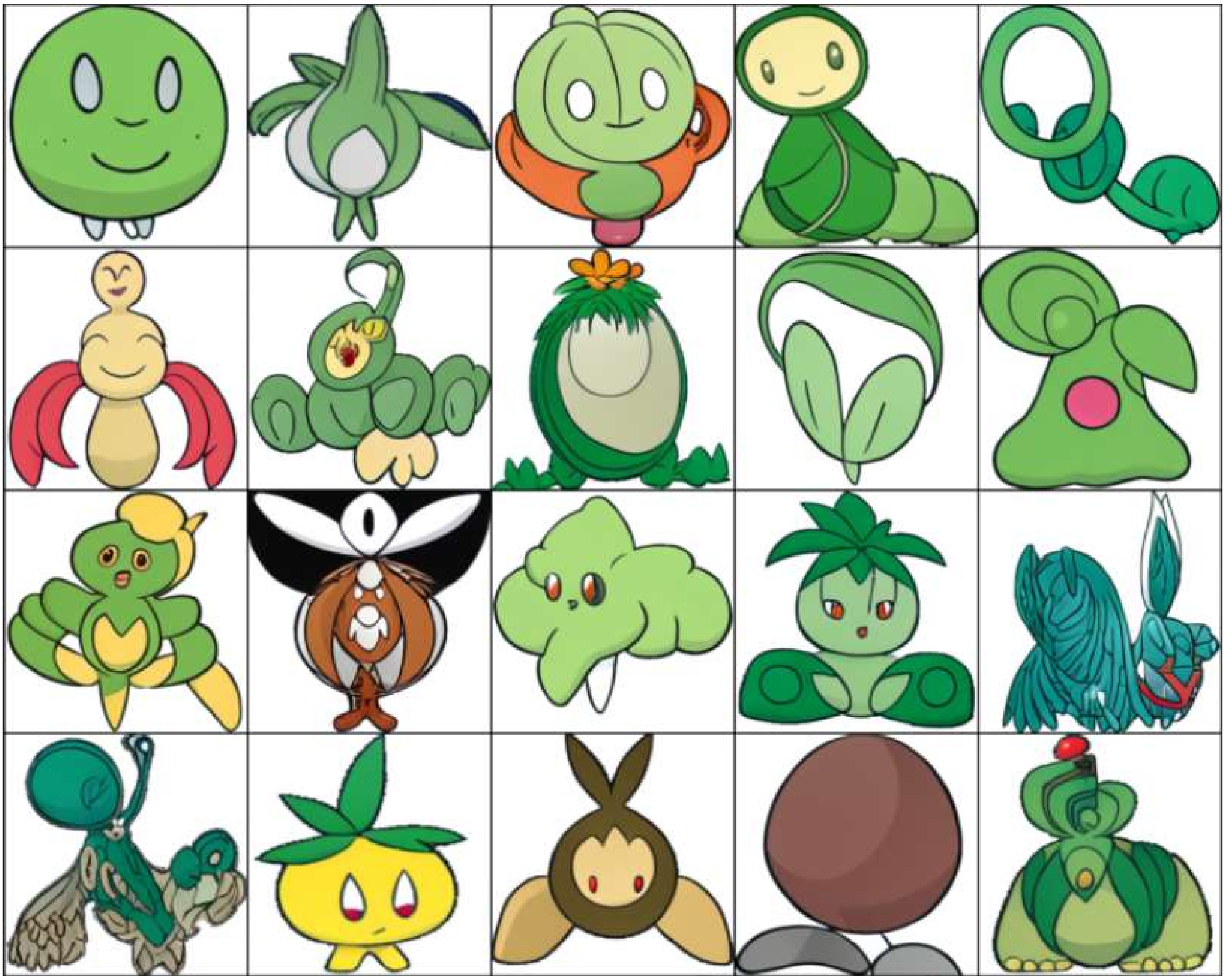

Figure 9 Grass type Pokémon, generated by the finetuned ruDALL-E model

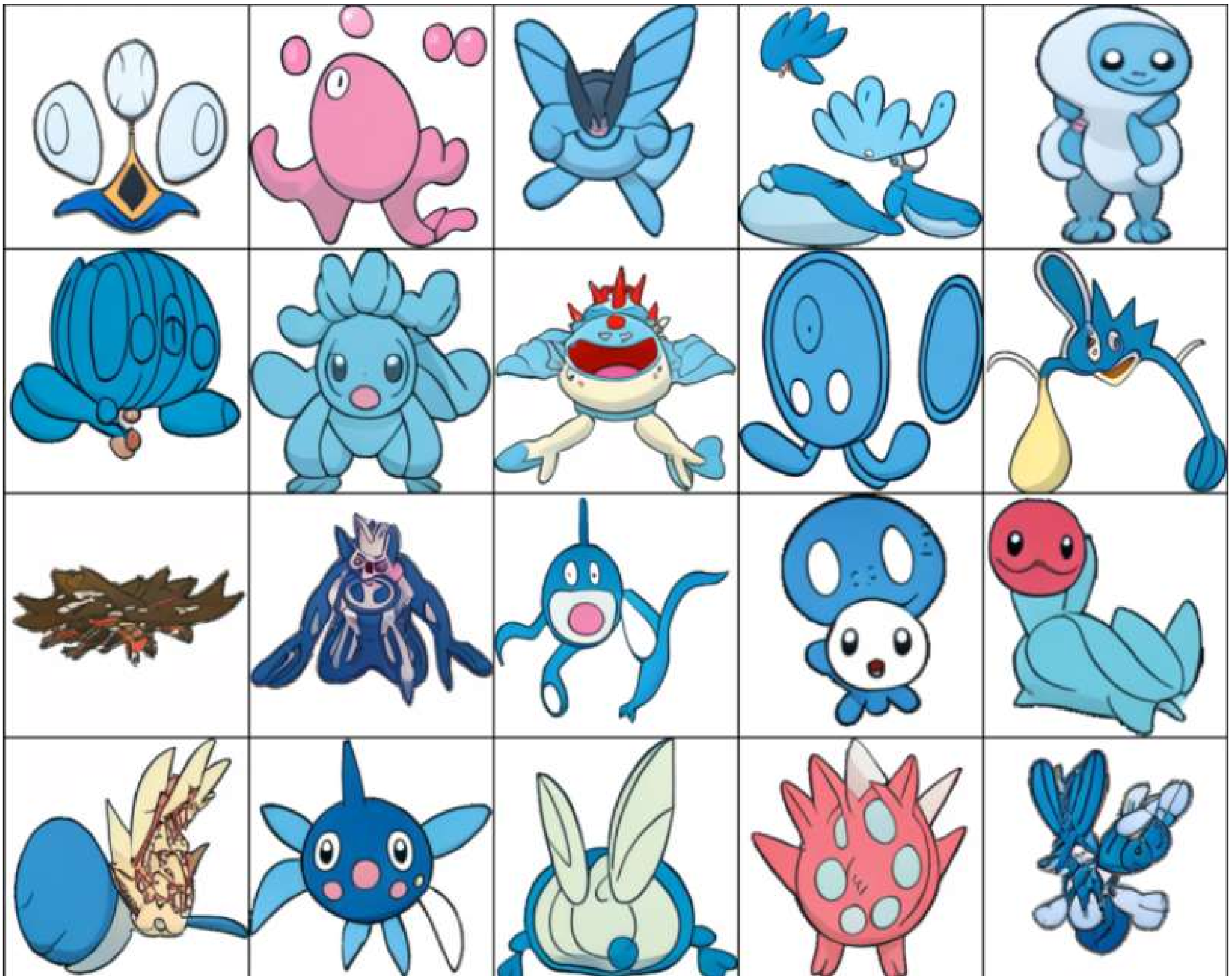

Figure 10 Water type Pokémon, generated by the finetuned ruDALL-E model

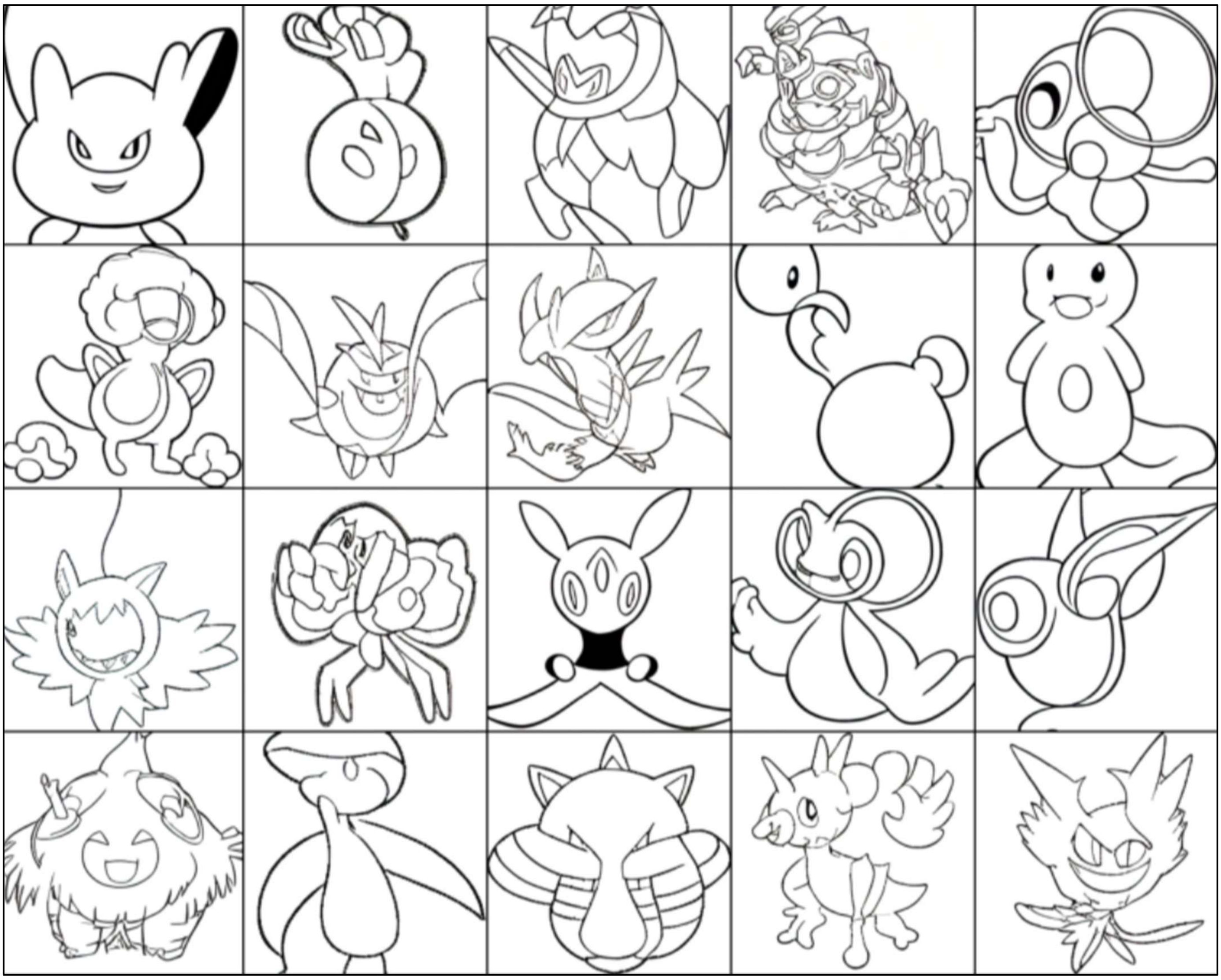

Figure 11 Pokémon generated by the finetuned ruDALL-E model using dataset of Pokémon sketches

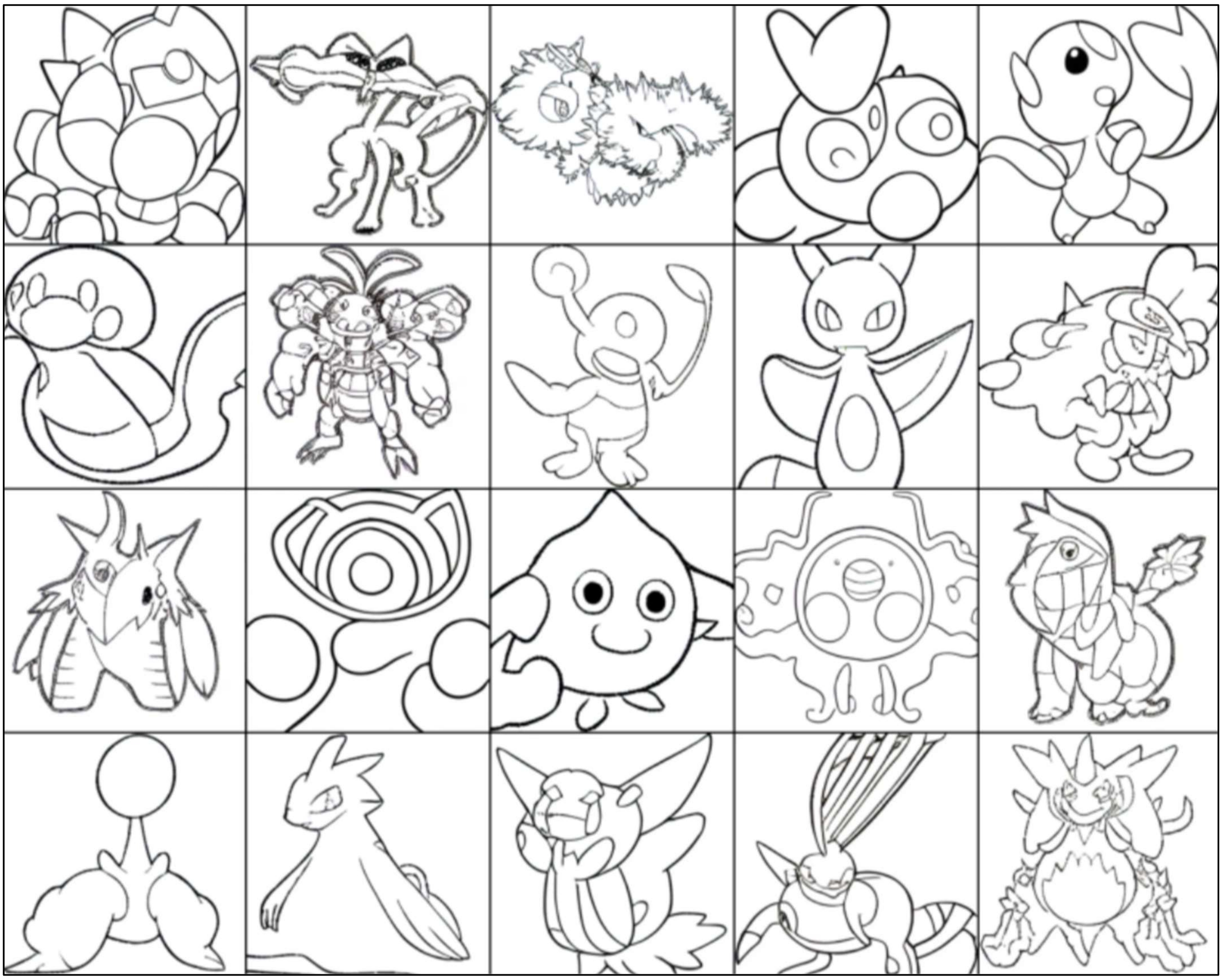

Figure 12 Pokémon generated by the finetuned ruDALL-E model using dataset of Pokémon sketches

Figure 13 Sketches that were coloured in using different computational techniques. The first two images were coloured in using Petalica [20]*. The third image was coloured in via style transfer* [21]*. The requested style was the image of an existing Pokémon.*