Brand Name (To Do): An Interactive and Collaborative Drawing Platform to Engage the Autism Spectrum in Art and Language Learning using Artificial Intelligence

Xuanxi Kuang[1] and Yu Sun[2]

[1]University High school, 4771 Campus Drive, Irvine, CA 92612
[2]California State Polytechnic University, Pomona,
CA, 91768, Irvine, CA 92620

ABSTRACT

Special communities specific to Autism Spectrum disorder face difficulties both socially and communicably [1]. Autism spectrum disorder will affect their expression and response to society, and they'll have a hard time learning and following complex directions [2]. This paper proposes software to promote one's collaborative skills and drawing skills with interaction with the AI system. At the same time, it also tries to raise awareness of the special group in our society. As an open platform, each individual will have opportunities to work with other users to cooperate, and they'll have a chance to learn drawing step by step from drawing that is contributed by more than 15 million players around the world. They can decorate the object with a color adjective to enhance their sense of beauty. In order to test the usability of the software, we did two experiments to test the accuracy of the graph and color combination. The result shows this software achieves a high accuracy on color input and obtains a correct graph from the input.

KEYWORDS

Interactive, Artificial intelligent, Self learning process.

1. INTRODUCTION

Autism spectrum disorder (ASD) is a developmental disability that affects their response to the environment not only behaviorally, but also socially and communicatively [3]. Autism children may have difficulty with meaning and understanding what others are trying to express–they might misunderstand others. Communication might be a question for them, and they may have problems with developing languages and arranging words for others [4]. This project is designed for a special community–specific to autistic teens and kids who need a platform to practice their collaborative skills and who are trying to learn to draw on their own. I believe that capitalizing on each child's interest will be effective in promoting positive behavioral growth. Collaboration using art and composition between each individual not only will improve their aesthetic ability to surroundings, but also improve their communication skill [5]. The project includes a stick figure which they can design by using a different color. Even if they don't like the random figure, they still can refresh until they find the one they like. The project also Included step-by-step learning, coloring, and collaboration for them to improve their language skill with others. It will be a great platform for special kids who need someone to talk to, practice their social skills, or purely just

want to learn drawing. A platform is one of the resources and tools to express their feeling and their opinion in this world. At the same time, this project raises the attention on supporting autistic children's education and provides more opportunities to learn for the special groups [6].

Some of the AI techniques and systems that have been proposed to interact with Autism kids. For example, The app Emotion Charades allows the AI to monitor a person's facial reaction with the corresponding emoji, and check the sign for anxiety when needed [7]. The AI interactive techniques are also proposed to provide opportunities for the Autism group to draw. However, most of the drawing apps miss the part of teaching. Their implementations are also limited. Most of the teaching process is taking the form of either human-to-human interaction through watching a video and taking a class from the internet, or console games that provide opportunities for them to draw based on the picture given. Without the internet, the learning resources will be limited. For example, The doodle Buddy App provides opportunities for children to draw, write, and upload photos. It is an interactive app that opens up space for creativity, but it misses the learning drawing technique process which is essential for children to obtain knowledge. The second practical problem is that some users might find it hard to understand the design of the website and app. Autism might have difficulties following along with the games and drawing process due to the disabilities of response to the information on the website or app. Either the website has too many instructions, the language is too hard, or the guideline is too vague can all affect their cooperation and interaction with the AI systems. Distracting advertisements on the App and website may also become a hidden problem for the ability to concentrate. For many autistic children, experiencing overwhelm and overloading the information might lead to a lack of focus. But more Autism usually tends to increase the ability to focus especially when they're exploring their interest.

In this paper, we follow the same line of research by using AI to generate different images. By using the Quickdraw database to create a variety of pictures based on the object [8]. To create a Graphic user interface, we import Tkinter as one of the frameworks built within Python [9]. Also, use spacy as one of the Language processing systems. Our goal is to build a simple interactive platform to provide opportunities for children to learn how to draw and collaborate with others. Our method is inspired by one of my volunteer experiences. By tutoring an autistic girl whose mindset changes so fast that leads up to misunderstanding and problems with communication. So this program provides a resource that demonstrates how to draw step by step by themselves, so they can draw the images in their mind. There are some good features of the drawing programs. First, the quickdraw database provides a variety of image resources from everywhere around the earth to meet the demand. Second, By providing the option of redraw and slow mode, children are easier to follow the step-by-step drawing. Third, By separating nouns and adjectives, the user can add different color arrangements to the drawing. Therefore, we believe that a good platform with simple instruction and showing a teaching step is a tool for children who are trying to obtain art knowledge.

In two application scenarios, we demonstrate how the quickdraw database can be used as an effective database that contains various resources, and the Language processing system can be an effective tool to identify color using the difference between nouns and adjectives. First, we show the usefulness of the quickdraw database corresponding to our Algorithm that an AI system can reorganize user input and find a random graph from more than a million resources [10]. As the result of the experiment demonstrates, the project displays a highly accurate graph from the input. Quickdraw database not only provides massive graph resources from the world but also provides the straw-by-straw step that is easy for the user to follow up on the process of drawing. The algorithm efficiently analyzes the input into the graph and then sends it back to the back-end server. Second, we use Spacy as our Language processing system to provide an additional color option for the user. Its main function is to recognize color within the user input. It is effective on

the basic color which can be separated with nouns and adjectives. With the coloring option, the user can interact with different color options and try out different color arrangements in the graph. Our result shows within the basic 10 colors arrangement, the accuracy of the color can be up to 90%. So the system can provide high usability on the interaction with the color and more possibility.

The rest of the paper is organized as follows: Section 2 gives the details on the challenges that we met during the experiment and designing the sample; Section 3 focuses on the details of our solutions corresponding to the challenges that we mentioned in Section 2; Section 4 presents the relevant details about the experiment we did, following by presenting the related work in Section 5. Finally, Section 6 gives the concluding remarks, as well as pointing out the future work of this project.

2. CHALLENGES

In order to build the project, a few challenges have been identified as follows.

2.1. Satisfaction from user

One of the challenges is to ensure customer satisfaction. During the process of building the platform, we need to take into account the quality of the program from an Autistic child's perspective. In order to build friendly user software, it is necessary to have simple instructions and an easy to follow interface. Complex interfaces and guidelines that are too vague might engender discomfort and loss of cooperation and interaction. The overload of information might also lead to emotional stress. Bad quality safeguards within a software may cause dissatisfaction from the user, and if the application didn't work as users expect, it may lead to a credibility decrease. So ensuring customer satisfaction is one of the important challenges when building the program.

2.2. Usability of the program

Due to the consideration that this is an interactive program that opens up space for the creation of a special group, the usability of the program is an essential part to consider. The usefulness of a product is important to society, and the product meets the expectation of the designer. In Which program should be designed easy for users to perform an assigned task without confusion. The product needs to ensure its functions, as well as possibilities to raise the value of the product, can be hard to operate. if a product does not have good usability, the level of dissatisfaction with the product will increase as well as complaints from the user. Higher usability will engender learning quicker and retain knowledge longer, which reduces the training costs and time users spend on learning. In order to generate a user-friendly product, usability must be taken into consideration during the construction process.

2.3. Limitation of the software

Software with no limitation can create a barrier for the user to access the resource. When a software product doesn't fit with the user's computer system, the computer will be unable to perform the assigned task that the code's trying to do. This is also the biggest challenge in which different users have a variety of computer systems. We need to consider the user's situation, and we can't meet all users' computer capabilities, and the access to the resource will be limited as well. That's also one of my problems, my original computer didn't have the capabilities to support me to finish my project, and that forced me to change a computer for my code work. If

the software has a large limitation, that will cause the usability to decrease and the feedback of dissatisfaction from the user will increase.
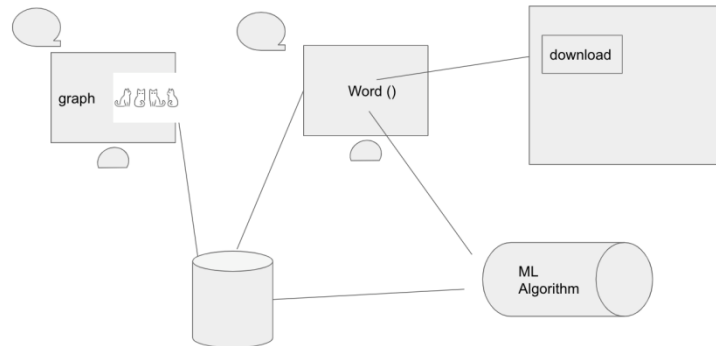
3. SOLUTION

Figure 1. Overview of the solution

1) Customer Front End GUI (Python Thinker)
   a) User could input the words
   b) User could receive the graph
   c) User could interact with other users (The step)
2) Backend Server (Python Flask)
   a) Server to provide service to receive the word data stable
   b) Server to host AI algorithm to generate the graph
   c) Server to send the graph back to users
3) Algorithm (Python ML)
   a) Algorithm to generate pictures from words
4) Demo Web (Html CSS Javascript)
   a) Provide the demo and path where users could download the app

This project mainly serves for the Autism group to interact with AI drawing systems which include step by step learning, coloring, and collaborating for them to improve their language skill with others. The project includes four main components. Consumer Front End GUI, Backend server, Algorithm, and Demo Web. Customer Front End GUI is written in Python Tkinter which provides a user interface where the user could input the words, receive the graph, and interact with other users.GUI is one type of computer graphics technology, which generally consists of graphical controls such as windows, drop-down menus, or dialog boxes. The user interacts with the machine by clicking the menu bar, button, or pop-up dialog box. Customer Front End GUI connected to a Backend server that is mainly provided by Python Flask. This main function is to host the AL algorithm to generate the graph, receive the word data stable, and send the graph back to users. It is mainly used for server operation and maintenance management, database management, and interfaces (private interfaces) used to connect the front and back end. The third part of the components is the Algorithm composed of Python ML, and its function is to generate pictures from words. In this part of the component, Computer learns and stimulates the unordered data to its own knowledge and reorganizes the data that send from the user to a piece of useful information that ultimately finds the corresponding graph. The last part of the main component is the Demo Website written by Html CSS Javascript, which provides the demo and path where users could download the app.

Customer Front End GUI (140)

Customer Front End GUI connected to the backend servers. It is the platform that users would usually see when they run the program. It allows the user to input the words through the windows system provided, receive the graph from the Algorithm, and interact with others. The program's graphical user interface provides a basic window for displaying graphs, several buttons for different uses, and dialog boxes to type in their thoughts. Users can interact with the AI by clicking the button or sending the input words. Tkinter is one of the GUI toolkits that python usually provides. After installing python, you can directly use Tkinter without installing it separately. As a Python GUI tool, Tkinter has good cross-platform support and supports Windows, Mac, etc. It inherits the basic features of Python's concise syntax and high coding efficiency for beginners to learn.

Backend End (110)

The backend server is connected by the Customer front end GUI and supports delivering the data to the Algorithm. It provides a data stable platform that could receive the words from the user, consists of a host AL algorithm to generate the graph, and is able to send the graph back to the users (Customer Front) system. The feature is primarily provided by Python Flask, which is a framework implemented by Python that allows users to quickly implement web services using Python Language. Its main function focuses on the management of maintenance, database, and interfaces. It controls the content of input words and interacts with the database to process the corresponding input.

Algorithm (97)

The algorithm is connected by the Backend server that is supposed to translate the input word into pictures and then send them back to the server. The algorithm is one branch of an AI system that learns from the user input and reorganizes the unordered data into a piece of useful information then sends it back to the backend. It allows users to provide a computer algorithm large amounts of data drawn from the quickdraw database, and then analyze the data from the database in order to make a data-driven decision-- specifically drawing the graph from the database and then sending it back to the Backend.

Demo Web (Html CSS Javascript)

The last main component of the project is the Demo Website written in HTML. Its main function is to provide a platform where users can access the resource. On the Website, Users will be able to download the app, check our slogan, and the necessary procedure required for downloading. This platform will open wide and be easy to follow for everyone. It contains the link of the project, download option, server's description, possible video, and images of the project that allow users to access.

```
37   def draw(data):
38       global xcoordinate
39       if data['stroke'] == 'slow':
40           drawing = qd.get_drawing(data['noun'], data['doodleNumber'])
41           adj = data['adj'].split(' ')
42           for stroke in drawing.strokes:
43               strokecolor = adj[random.randint(0, len(adj) - 1)]
44               for i in range(len(stroke) - 1):
45                   canvas.create_line(
46                       (stroke[i][0] + xcoordinate, stroke[i][1], stroke[i + 1][0] + xcoordinate, stroke[i + 1][1]),
47                       fill=strokecolor, width=4)
48                   time.sleep(0.2)
49
50                   root.update()
51           xcoordinate += 300
52       elif data['stroke'] == 'animate':
53           drawing = qd.get_drawing(data['noun'], data['doodleNumber'])
54           adj = data['adj'].split()
55
56           for stroke in drawing.strokes:
57               strokecolor = adj[random.randint(0, len(adj) - 1)]
58               for i in range(len(stroke) - 1):
59                   canvas.create_line(
60                       (stroke[i][0] + xcoordinate, stroke[i][1], stroke[i + 1][0] + xcoordinate, stroke[i + 1][1]),
61                       fill=strokecolor, width=4)
```

Figure 2. Screenshot of code 1

This section of the code was for specifying to the computer how to draw an image As the user is given a certain input data. It is a section of front-end code that allows us to insert input content through the code. The data that the user types in, for example, color information, object information, slow mode, or regular animations presenting can come from either the user or the back-end servers which the AI will analyze the information and user's data and then transfer to the front end. The If statement is provided for adjusting the speed of the straw, either slow or regular speed, providing a more convenient way for users if they can't follow up the normal speed. And the slow speed is 0.2 seconds between each stroke.

4. EXPERIMENT

4.1. Experiment 1

Experiment 1 is related to the words and interaction with graphs. As we introduce that the project should be able to generate graphs from the user input words. We want to make sure that our algorithm is functional which translates the inputs into a graph and then sends them back to the server. As mentioned before, usability is an essential part to consider when doing experiments. One of the goals is to test the graph and layout of the program user-friendly and easy to operate. With the idea in mind, we built up an experiment that was designed to test the accuracy of the graph with different easy input words.

For the experiment, we randomly choose 20 different objects from our daily life as predicted user input to test the accuracy of the graph. The result of the experiment is user input can correctly correspond to the graph that shows up. But because the Quickdraw database is an open, free database where more than 15 million people can contribute, the quality of the graph can be varied. Some of the graphs' shapes are vague compared to what the object really is. For example, some of the panda graphs look like a bear, and the stick figure of the helicopter can't be recognized. Compared to the complex animal and architecture, simple shaped objects can be well present, for example, moon and star. Overall more than 85% of the graph's shape can be recognized. And it shows an above-average for usability that the system works properly.
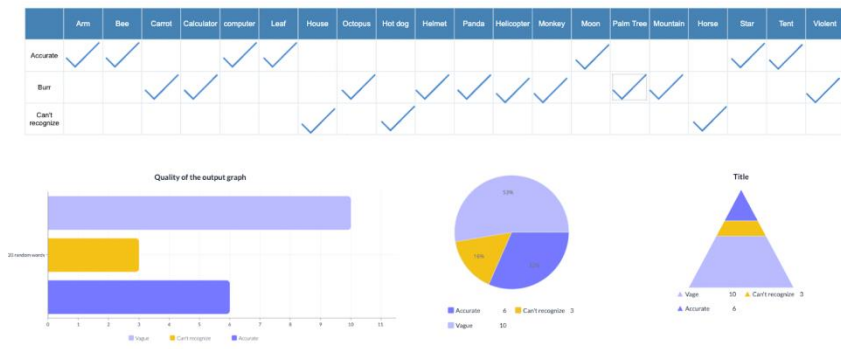
	Arm	Bee	Carrot	Calculator	computer	Leaf	House	Octopus	Hot dog	Helmet	Panda	Helicopter	Monkey	Moon	Palm Tree	Mountain	Horse	Star	Tent	Violent
Accurate	✓	✓			✓	✓								✓				✓	✓	
Burr			✓					✓	✓	✓	✓		✓			✓				✓
Can't recognize							✓		✓						✓					

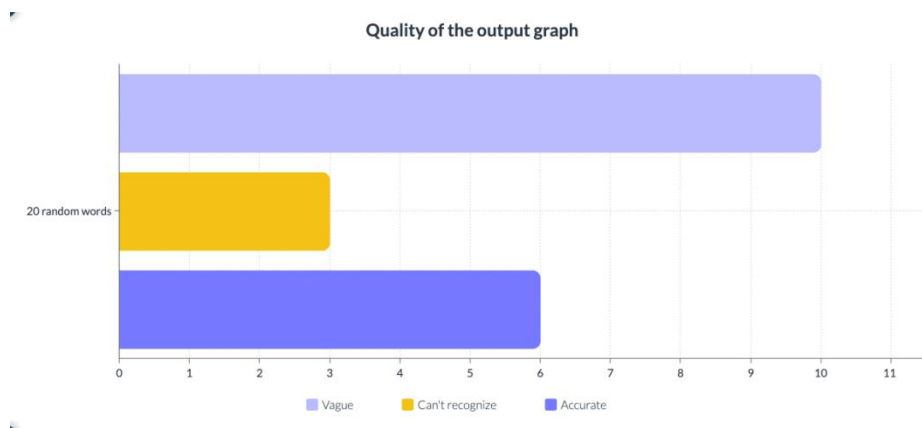Figure 3. Data of experiment 1

Figure 4. Quality of the output graph

4.2. Experiment 2

The second experiment is related to the interaction with color. Color provides more possibility with the engagement from the user that will raise user satisfaction with the app. We want to make sure that our Language processing system identifies the typing adjective as color and then fills our graph corresponding to it. Users can play around with different color combinations and enjoy it. We build an experiment based on our idea to test the accuracy of one color of the graph and the accuracy of the multi-color graph. To have enough samples, we test 10 different objects for some of the available color options.

For the experiment, we focus on one object: Panda to test the different colors available. Since our language process system separates different words as nouns and adjectives, some of the colors can't be recognized as an adjective. We test the basic daily 10 colors: red, blue, yellow, brown, purple, white, green, orange, and gray. The result shows that 90% of the graph can correspond to the input color. We also test on multi-colors with combinations, for example, red yellow, and yellow-brown. Find out if the single color is accurate with the graph, the color combination will also be accurate. Data demonstrate that more than 70% of the two color inputs are accurate, and 20% of the combinations only display one of the colors among the choices. Good to know that only 10% of the combined amount to 10 trails that none of the colors appear. Overall, users can test basic color combinations on the object, and there will be a high possibility to display the correct basic color.
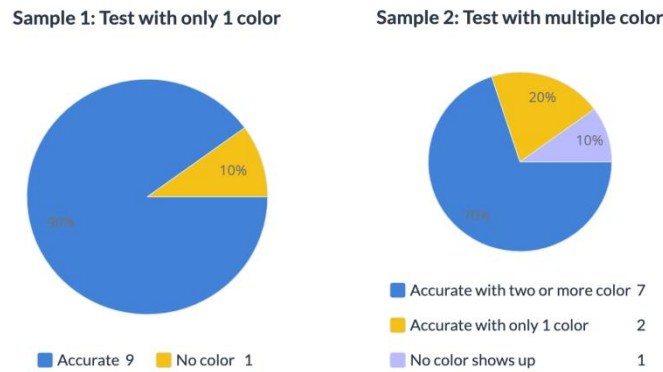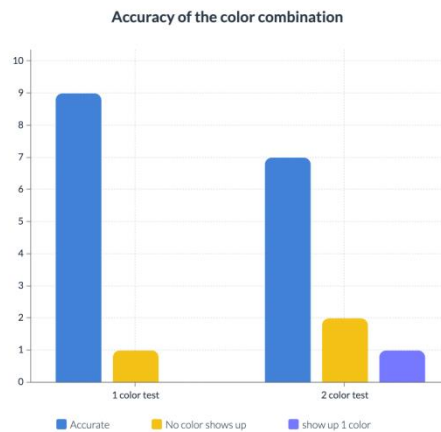
Figure 5. Sample of experiment 2

Figure 6. Accuracy of the color combination

The result of the two experiments provides the usability of the software that it obtains high accuracy on the color combination and words. Since the database obtains more than a million graphs, the quality of the graph might vary. The appearance of the software is designed to be easy for the user to complete the interaction without confusion. High accuracy of color meets the expectation of the customer satisfaction that they can decorate the graph. The algorithm works properly to analyze user input and then send back the graph to the user. The high accuracy of the image demonstrates software can provide a stable platform for users who are trying to interact with the AI system. From the result of both experiments, Algorithm is functional to translate the input into a graph, and most of the common colors in the Language processing system can be identified as an adjective to decorate the graph.

5. RELATED WORK

Golinski Pawel's project CoPainter: Interactive AI drawing experience applies the google quickdraw database and aims to provide more educational activity [11]. The activity is based on the Sketch-RNN model interactive provided by Google, so some of the intelligent-- either robots or abstract entities --can cooperate with users that ask the user to draw a painting of some object. Its main contribution is porting the Sketch RNN web app experience to Qt. Similar to my program, it uses the google quickdraw database for educational use. It is very similar to the

Quickdraw application. The main difference between CoPainter and my program is that CoPainter ask the user to draw in order to interact with AI, but my program is used to type in the input object they want to gain, so the AI can analyze the code in order to find an image that corresponds with the input.

Adam Moren and Thomas Indrais's project is similar to the Telestration game that makes the game based on doodle classification using a convolutional Neural network [12]. Its project was also inspired by the google quickdraw databases that allow users to interact with one of the AI players. The main methods the project used are Jupyter (Python) through Google Colab, and the client structure runs through JavaScript. Similar to the Telestration project, my project also uses quickdraw databases and is able to interact with AI. It is a good program for Telestration Games.

The project: From Quickdraw To story Generation System for Kids' Robot is aim to be a model for robots that accompany children to group up [13]. This project is inspired by the Google Quickdraw game that children would be able to interact with input information, and short stories based on image input. It used Multitask Transformer Network to generate the sentence based on the information from the quickdraw database, and it also used OpenAI Generative Pre-Training Model to generate stories based on the content of the sentence. The idea behind this project is really good and fun that the child would be able to draw a narrative story based on simple lines. Similar to this project, my project also uses AI interactive with the Quickdraw database, but this project transfers the input from the image to the sentence and then narrows it down into a story. It uses two different networks to generate sentences.

6. CONCLUSIONS

People who have ASD will face difficulties in understanding and communicating with others. This program is aimed to create a platform for the special community to practice collaborative skills and learn drawing from their own. The interaction between each individual will improve their communication skill and their aesthetic ability. The project is focused on a straw-by-straw process drawing and coloring program for those who want to learn simple stick figures on their own. This platform also is one of the available resources to raise awareness about supporting autistic groups. This program is composed of four main parts: Consumer Front End GUI(Python Thinker), Back end Server(Python Flask), Algorithm(Python ML), and Demo website(Html Css Javascript) [14]. The front end provides a place for the user to input the words and receive the graph. It is connected to the backend server which receives the words from the user, hosts an AI algorithm to generate the graph, and sends the graph back to the users. The algorithm uses Python ML which analyzes the input words into a picture from the database. We did two basic experiments to ensure the accuracy of the graph and color system works properly. The first experiment gives us 85% readable graphs from the quickdraw database [15]. Prove that the system can draw the corresponding word from the database. The second experiment aims to test the proper color combination on 10 major colors, and the result shows that when the user only puts 1 color, the accuracy of the color can be as high as 90%, and when the user input 2 color, the accuracy for the combination of color can reach to 70%. The system shows steady usability for the user and easy to-run system so as to improve customer experience while using it.

There are limitations on the availability of the different computer systems. The current application requires a Mac OS 11 or later. which will limit the user's practicability that not every user will be able to use it. This method requires a higher computer software standard which might decrease the practicality. The optimization might be applied to the beauty part of the program since the current program system only provides the necessary function mode, without any coloring and decoration. The accuracy of the quality of the image might also need to be

optimized due to the data of drawing can contain more than a thousand choices. The coloring system of the image can also be enhanced and optimized to provide more accuracy and open up more choices for users.

Some of the possibilities of solving the quality of the image might be writing a section of code that provides a reporting system for the user so each individual has the ability to report the quality of the drawing image. Based on the popularity of the image, the system will automatically generate and recommend the "good" image to the user so as to avoid some poor drawings. The coloring system enhancement might be more viable. The limitation of computer software systems might change a different method that is available for fitting different systems and computers.

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