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IMPRNT: A CROSS-PLATFORM MOBILE APPLICATION FOR PERSONALITY-BASED PET ADOPTION

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ABSTRACT

Imprnt: A cross-platform mobile application for personality-based pet adoption. Sigmund, Kinsley, 2021. Capstone Paper, University of North Carolina Wilmington.

Every year hundreds of thousands of shelter dogs are euthanized after failing to imprint on potential owners, oftentimes due to no fault of their own. To help address this issue, this capstone project implements Imprnt, an iOS and Android mobile application providing personality-based pet adoption that matches prospective adopters with compatible dogs in need of homes. Imprnt is implemented in approximately 5800 lines of Dart code using the Flutter cross-platform development framework and is supported by Firebase cloud services. Imprnt provides questionnaires to assess both Adopter and Dog personality profiles. Imprnt calculates a similarity score using a modified Simple Matching Coefficient algorithm to recommend Dog matches to Adopters. Imprnt's additional functions include secure login and registration, profile management, rescue organization contact, and viewing all dogs available for adoption with various filters including location-based queries. Adopters are presented with matches tailored to their personality profile and rescue organizations can register and manage their dogs while also browsing dogs from other organizations. Imprnt was deployed on the Apple and Google Play stores and tested by 30 beta testers, 25 of whom completed an anonymous feedback survey. Of the survey respondents, 92% claimed they would use Imprnt frequently and 96% felt Imprnt was easy to use. The feedback identified areas for improvement such as expanding dog profiles to include more personality information, support of accessibility features, and condensed questionnaires in collaboration with established rescue organizations. Future performance enhancements include exploring more efficient implementations of the matching algorithm and caching match results.

ACKNOWLEDGEMENTS

I would like to express my greatest appreciation for Dr. Lucas Layman and his mentorship in mobile application development over the past three years, laying the foundation on which I was able build and complete this capstone project. I feel extremely blessed to have had the opportunity to work alongside him in the development of UNCW's first mobile application, Coastal Eco Explorer.

I would like to thank my friends, family, and colleagues who have supported me through every step of this journey.

DEDICATION

Imprnt, and the countless hours that went into making it a success, are dedicated to my two greatest inspirations and guardian angels, my Grammy Jackie Sigmund and cousin Layla Sigmund. Both of these outstanding women were powered by love and helping others.

Imprnt was inspired by my personal rescue dog, Josie.

CHAPTER 1: INTRODUCTION

An estimated 68% of reported households in the US were pet owners according to the 2017-2018 American Pet Products Association (APPA) Survey [1]. A reported 3.3 million dogs enter animal shelters in the US every year, and, sadly, approximately 20% of shelter dogs are euthanized each year despite 80% of those dogs being healthy and adoptable [1]. Overpopulation is one of the main reasons for euthanasia in animal shelters, as many animal shelters are under-resourced and cannot humanely care for each shelter dog for the remainder of their natural lives [2]. The goal of every animal shelter and animal adoption agency is to place their pets in a loving, safe home.

This capstone introduces Imprnt, a mobile application that helps to match potential adopters with dogs using intelligent matching. The goal is to help potential adopters find compatible pets and adopt them out of shelters. Imprnt is a mobile application to help reach the maximum number of users (the average US citizen spends around three hours per day on their mobile devices [3]) and to facilitate easy and accurate posting of dog information by rescue organizations. Imprnt calculates a match between prospective adopters and available dogs based on their respective personalities, wants, and needs to produce a more compatible and lasting home lifestyle after adoption. A match based on personality traits provides Adopters with more information than an online photo or brief visit to the shelter. A cute dog may come with needs or quirks that are overlooked and can lead to a dog being returned for subsequent re-adoption. Conversely, the ugliest dog may have the perfect personality for an adopter who may overlook the dog based on appearance alone. Imprnt provides users with matches they may not expect but that can lead to a more compatible relationship.

This capstone project consists of a cross-platform mobile application implemented using the Flutter framework to provide a modern user interface and personality-based matching algorithm. Adopters make accounts in the app, set up their profile, and take the Adopter questionnaire. Rescue organizations and pet adoption agencies register for an account in the app, create dog profiles for their organization, and fill out a questionnaire for each registered dog. Upon completion of the Adopter questionnaire, Imprnt suggests Dogs to the Adopter using a matching algorithm based on the Simple Matching Coefficient [4] with the questionnaire response as input.

An early prototype of Imprnt was created in Fall 2019 called FETCH! Your Pet in as a CSC 450 Software Engineering project at UNCW. FETCH! Your Pet was developed using Android Studio and simulated both Adopter and Dog account creation, quizzes, and the matching process using fictional test data. While this project was a useful prototype, significant work was required to re-design Imprnt's underlying functionality, to implement a better matching algorithm, and to deploy to the app stores. Imprnt is a completely new implementation using the Flutter cross-development framework to reach users on both iOS and Android platforms. Information is stored and managed using Google’s Firebase cloud services.

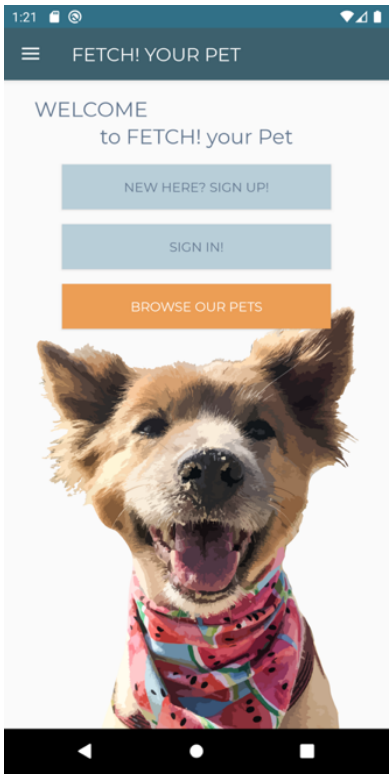
The remainder of this document is organized as follows: Chapter 2 describes the FETCH! Your Pet prototype, related work on adopter and dog personality matching, and a review of similarity measures. Chapter 3 describes Imprnt's implementation and features including the matching algorithm. Chapter 4 discusses user feedback and lessons learned and Chapter 5 provide a summary and future work.

CHAPTER 2: BACKGROUND AND RELATED WORK

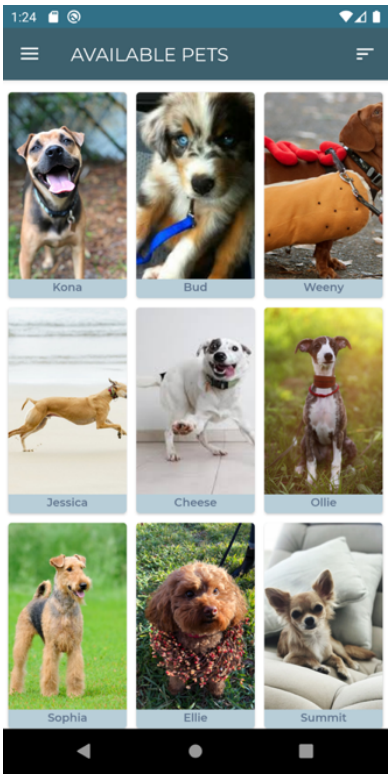
2.1 "FETCH! Your Pet" Prototype

“FETCH! Your Pet” was Imprnt’s predecessor, the first trial at implementing a dog and adopter personality matching mobile application. This project was written in Android Studio as part of a team project in UNCW's CSC 450 Software Engineering class in Fall 2019. Both adopters and rescue organizations could create accounts. Adopters could take an adopter quiz. Rescue organizations could register dogs on their profile and take their dog quiz. After taking the adopter quiz, FETCH! Your Pet would calculate a similarity and present the user with dogs it found that were the most similar to the adopter. The user could swipe through these matches and designate them as a favorite or remove them from their matches list. The user could also view the entire collection of dogs in the database, tap them to learn more, and favorite them if desired. Screenshots from the prototype can be found in Figure 1.

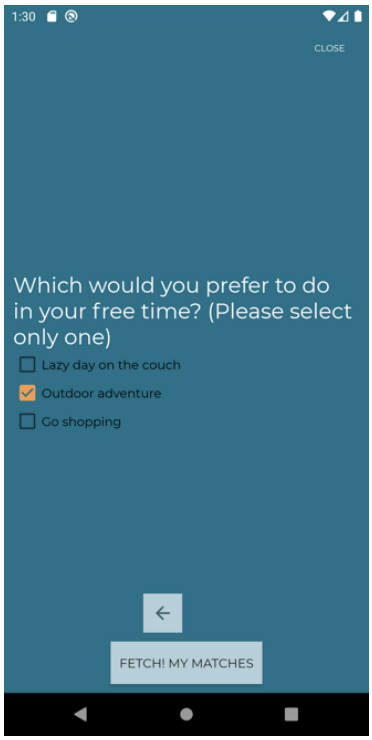
While a useful prototype, FETCH! Your Pet lacked the research on factors of human-dog compatibility and appropriate matching algorithms. The adopter and dog quizzes were created with minimal analysis on whether these questions would result in a compatible relationship between the adopter and their matched dog. Cosine similarity [4] was chosen as FETCH! Your Pet’s matching algorithm with minimal analysis of whether it was appropriate.



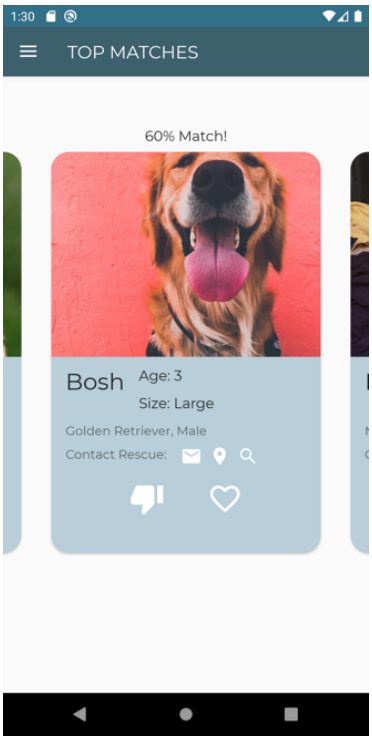
a. FETCH! Your Pet Landing Screen



b. FETCH! Your Pet View Available Dogs



c. FETCH! Your Pet Adopter Quiz



d. FETCH! Your Pet View Matches

Figure 1. FETCH! Your Pet Screenshots

Imprnt is a new implementation that improves upon the lessons learned from the FETCH! Your Pet prototype. Imprnt incorporates research on existing systems with a similar core concept, but improves upon those systems in multiple ways. Imprnt's Adopter and Dog Questionnaires are crafted based on dog-human compatibility research from literature (discussed in Section 2.3). Imprnt includes a matching algorithm better suited to the features of the compatibility questionnaires (discussed in Section 2.4). Finally, and most significantly, Imprnt has been re-designed and re-implemented as a cross-platform and cloud-based mobile application to reach and support more users on both iOS and Android platforms. Imprnt has been deployed on both the Google Play and App Stores to a pool of beta testers to gain user feedback.

2.2 Pet Adoption Applications

There are many pet adoption applications that help users search for available dogs, but very few are based on adopter-pet personality matching. Two of the main adopter-pet personality matching applications are PawsLikeMe [5] and the ASPCA's Meet Your Match [6]. PawsLikeMe (https://pawslikeme.com/) was published in 2015 and features a survey that analyzes four canine personality quadrants that align with human personalities to help match adopters with animals [5]. The PawsLikeMe site does not explain how the quadrants were chosen, but states the cofounders have experience working with animals, technology, and behavior science [7]. The four quadrants are: physical and mental energy levels, ability to concentrate on a task, level of confidence and security, and level of independence with values ranging from "high" to "low" in each quadrant [8]. The PawsLikeMe matching algorithm was tested by 3000 users for 6 months. The first public trials achieved over a ninety one percent matching accuracy [5]. The PawsLikeMe application is similar to the core concept of Imprnt, but

PawsLikeMe is a website whereas Imprnt is a mobile application designed for use on smartphones.

The ASPCA's Meet Your Match (https://www.aspcameetyourmatch.org/) uses their "Canine-ality Assessment" to match adopters with a color that represents a personality group of dogs. Green signifies that the adopter would do well with dogs who enjoy being physically and mentally engaged [6]. Orange represents adopters who would mesh well with the average dog who enjoys regular interaction and attention [6]. Purple signifies adopters who would work best with an easy-going, laid back dog [6]. Instead of matching users with dogs upon completion of the survey, users print their results and take them into the ASPCA shelters in order to meet dogs that fall into that color category [6]. Meet Your Match limits users to dogs that are within the ASPCA system and within a fixed radius of travel. Imprnt incorporates a filtering option to see dogs within a specified radius but does not require the user to visit a shelter to contact the rescue organization, many of whom may use foster homes and not have a central location.

Imprnt proposes several improvements over these existing applications. First, Imprnt is a mobile application to help reach users in their most common computing environment – their smartphones. Unlike the ASPCA application, Imprnt presents adopters with potential matches instead of having to physically bring results into the shelters to meet dogs. The portability of Imprnt leads to more accurate and truthful dog information: rescue organizations can take photos of their adoptable dogs and answer their dog questionnaire while interacting with the dog in real time instead of recording notes and transferring them to a computer.

2.3 Dog-Human Compatibility

Dogs are widely referred to as "man's best friend." The dog-human relationship is one that has been studied qualitatively across various fields with findings showing the emotional and

physical benefits of dog ownership [9]. Dotson and Hyatt suggest that pet owners believe that they both give and receive love and affection from their animals in a “relationship of mutualism” [9]. Studies also show that pet owners experience reduced stress, blood pressure, cholesterol and triglyceride levels, and depression by being more physically active and social than those who are not pet owners [10].

Dotson and Hyatt studied 749 dog owners focusing on the owner’s interactions with their dogs using a survey containing 57 items on a five-point Likert scale [9]. Dotson and Hyatt's analysis of this survey resulted in seven dimensions of the dog-companion experience: symbiotic relationship, extension of self, anthropomorphism, activity, boundaries, specialty purchases, and willingness to adapt.

The first dimension focuses on the mutually beneficial bond between the dog and human [9]. The symbiotic relationship includes the human who feels emotional and physical benefits by having the dog around, and the dog who is in turn being nurtured and cared for by the human. Both parties benefit from the relationship [9]. The second dimension, called the “Dog-Oriented Self Concept,” views the dog as an extension of the human self or the human’s best friend [9]. In this dimension, humans can seem more reclusive and enjoy spending time with their dog more than other people but are more inclined to interact with others who accept the dog as an extension of its owner [9]. The third dimension, anthropomorphism, describes a dog who is viewed as more of a person and less as an animal, much like a part of the family or a surrogate child [9]. The fourth dimension focuses on activity levels and the feeling of youthfulness as a result of becoming more physically active [9]. The fifth dimension describes the boundaries between the dog and human, such as letting the dog sleep in the bed or lounge on the couch [9]. The sixth dimension involves the willingness of the human to make specialty purchases such as

toys, bandanas, treats, veterinary expenses, doggy day care, etc. [9]. The seventh dimension highlights a human's willingness to adapt to the day-to-day life of having a dog [9]. These seven dimensions are measurable and lay a foundation to understanding what makes a human and their dog compatible.

2.3.1 Imprnt's Adopter and Dog Personality Questionnaires

Based upon the quadrant scheme of PawsLikeMe and the study by Dotson and Hyatt, Imprnt assesses users and dogs in five areas: Willingness, Activity, Boundaries, Affection, and Appearance. Willingness measures how open an adopter is to making changes in their lifestyle, for example spending extra money on vet bills for a dog who may have special medical concerns. From the dog perspective, Willingness measures how much adaptation is needed from the user, for example, if they have any medical conditions that may lead to increased vet bills or if they need advanced training. Activity measures the activity level of the dog and adopter between highly active and not active at all. Boundaries measures things such as how well-behaved the adopter wants their dog to be or how involved they want the dog in their daily activities such as sleeping in the bed or hanging out on the couch. Affection measures how much love and attention an adopter may want from a dog and how much love and attention the dog is willing to show or requires. Appearance measures things such as how much shedding an adopter may be able to tolerate, size of the dog, etc. Each section includes three to five questions. Each question and answer of the Imprnt Adopter Questionnaire matches with a corresponding question and answer from the Imprnt Dog Questionnaire as seen in Table *1* below. Many of these questions were inspired by both PawsLikeMe (PLM) [8] and the research by Dotson & Hyatt (DH) [9]. The value of each question is stored in parallel arrays representing the Adopter personality and the Dog personality to be consumed by the matching algorithm.

Table 1. Imprnt Adopter and Dog Questionnaires

Imprnt Adopter Questionnaire	Inspiration	Imprnt Dog Questionnaire
Willingness Dimension		***Willingness Dimension***
Are you willing to take on extra expenses for health-related concerns? Yes, no, neutral	DH	Does this dog require extra expenses for health-related concerns? Yes, no
Are you willing to take on extra expenses for training or behavior modification? Yes, no, neutral	DH	Does this dog require extra expenses for training or behavior modification? Yes, no
Are you willing to put time and energy into training and working on specific behaviors with your dog? Yes or no		Does this dog require extra time and energy for training or working on specific behaviors? Yes or no
Activity Dimension		***Activity Dimension***
Do you have access to a fenced in area for off leash exercise? Yes or no		Would this dog benefit best from access to a fenced area for exercise? Yes or no
I like to go for walks or runs outside. Agree or disagree	PLM	Does this dog enjoy leashed walks or runs outside? Yes or no
My friends or family describe me as someone who is active. Agree or disagree	PLM	Would you describe this dog as more active or more relaxed? Active or relaxed
I prefer going on an outdoor adventure over lounging around the house. Agree or disagree	PLM	Does this dog prefer going on an outdoor adventure or lounging around? Lounging or adventure
Boundaries Dimension		***Boundaries Dimension***
I will allow my dog to hangout on the furniture. Agree or disagree	DH	Does this dog like to hangout on the furniture? Yes or no
I want my dog to respect my authority and follow my direction. Agree or disagree	PLM	Does this dog appear to be trainable and respect a human's authority? Yes or no
I want my dog to sleep in the same room/bed as me. Agree or disagree	DH	Does this dog like to sleep close to humans (in the same room or on the bed)? Yes or no
I want to be able to leave my dog out and trust that he/she will behave while I am away. Agree, disagree, neutral	PLM/DH	Can this dog be trusted to roam free in a room/house unsupervised? Yes or no

Affection Dimension		***Affection Dimension***
I want my dog to be excited to see me when I come home. Agree or disagree		Does this dog get excited to see its person/people? Yes or no
I don't mind a dog who will cover me in kisses. Agree or disagree	PLM	Does this dog like to give kisses? Yes or no
I want my dog to enjoy all the pets, belly rubs and head scratchies. Agree or disagree	PLM	Does this dog enjoy all the pets, belly rubs and head scratchies? Yes or no
I want my dog to cuddle with me. Agree or disagree	PLM	Does this dog like to cuddle or snuggle up next to you? Yes or no
I want my dog to stay close to me the majority of the time. Agree or disagree	DH	Does this dog like to be close to you or follow you around? Yes or no
Appearance Dimension		***Appearance Dimension***
Do you prefer a smaller (<40lbs) or larger (40lbs+) dog? Larger, smaller		Is this dog smaller (<40lbs) or larger (40lbs+)? Larger, smaller
What level of shedding are you comfortable with? More shedding, less shedding	PLM	How much does this dog shed? More shedding, less shedding
Do you prefer short hair or long hair dogs? Shorter or longer		Does this dog have a short or long coat? Shorter or longer
I want to take my dog to socialize with other humans. Agree, disagree, neutral	PLM	Does this dog socialize well with other people the majority of the time? Yes or no
I want to take my dog to socialize with other dogs. Agree, disagree, neutral	PLM	Does this dog socialize well with other dogs the majority of the time? Yes or no

2.4 Measures of Similarity

The core computational issue of Imprnt is how to match an adopter with potential dogs. Imprnt Adopter and Dog Questionnaire responses (or personalities) are stored as one-dimensional arrays. Imprnt's matching algorithm compares an adopter's personality and performs a calculation against dog personalities to determine which dogs are the most similar to the results

from the adopter questionnaire. Many measures exist to calculate similarity or distance between n-dimensional vectors, including Euclidean distance, cosine similarity, the Jaccard coefficient, and the Simple Matching Coefficient. Each measure consumes two vectors as its input and produces a similarity score.

For this section, a shortened questionnaire example is used to demonstrate how the similarity calculations work.

1. Willingness Dimension:

   Are you willing to take on extra expenses for health-related concerns?

   Answers: Yes (1), No (0), No preference (*)

2. Activity Dimension

   I prefer an outdoor adventure over lounging on the couch.

   Answers: Agree (1) or Disagree (0)

3. Boundaries Dimension:

   I want my dog to sleep in the same room/bed as me.

   Answers: Agree (1) or Disagree (0)

4. Affection Dimension:

   I want my dog to enjoy all the pets, belly rubs and head scratchies.

   Answers: Agree (1) or Disagree (0)

5. Appearance Dimension:

   What size dog do you prefer?

   Answers: Larger 40lbs+ (1), Smaller < 40lbs (0)

For our example, let us say this Adopter is willing to take on financial expenses, prefers outdoor adventures over lounging on the couch, wants a dog who will sleep in their bedroom, wants a dog who enjoys all the pets, and prefers larger dogs. Each answer is given a numerical value and the Adopter's results will be stored as a vector of those values: (1,1,1,1,1). We define Dog1 to be the opposite of the Adopter requiring no extra medical expenses, prefers lounging around, does

not want to sleep close to the humans, does not enjoy being pet, and is a smaller dog resulting in the vector (0,0,0,0,0). Dog2 will be the same as the Adopter results, meaning they should be considered perfect matches: (1,1,1,1,1). Dog3 will be similar in the sense that he requires extra expenses for medical concerns, prefers lounging on the couch, enjoys sleeping in the same bed, enjoys pets and belly rubs, but is a small dog resulting in the vector (1,0,1,1,0).

The FETCH! Your Pet prototype used cosine similarity. Cosine similarity computes the similarity between two vectors by measuring the angle between the two vectors in n-dimensional space [4]. Cosine similarity is calculated as the dot product of the two vectors divided by the length of the vectors, as seen in the formula below [11]:

$$\mathrm{CSIM}(\mathrm{A},\mathrm{B}) = \frac{\mathrm{A}\cdot\mathrm{B}}{\|\mathrm{A}\|\times\|\mathrm{B}\|} = \frac{\sum_{\mathrm{i}=1}^{\mathrm{n}}\mathrm{A_i}\times\mathrm{B_i}}{\sqrt{\sum_{\mathrm{i}=1}^{\mathrm{n}}\mathrm{A_i^2}}\times\sqrt{\sum_{\mathrm{i}=1}^{\mathrm{n}}\mathrm{B_i^2}}}$$

Cosine similarity produces a score between -1 (perfectly dissimilar) and 1 (perfectly similar). This metric is often used to determine the similarity between two documents with word frequency vectors [4]. To demonstrate this formula, we will calculate the Cosine similarity between the Adopter and Dog2, which was defined as perfectly similar.

$$\mathrm{CSIM}(\mathrm{Adopter},\mathrm{Dog2}) = \mathrm{CSIM}\big((1,1,1,1,1),(1,1,1,1,1)\big) = \frac{\sum_{\mathrm{i}=1}^{\mathrm{n}}\mathrm{A_i}\times\mathrm{B_i}}{\sqrt{\sum_{\mathrm{i}=1}^{\mathrm{n}}\mathrm{A_i^2}}\times\sqrt{\sum_{\mathrm{i}=1}^{\mathrm{n}}\mathrm{B_i^2}}}$$

$$= \frac{1\cdot1+1\cdot1+1\cdot1+1\cdot1+1\cdot1}{\sqrt{1^2+1^2+1^2+1^2+1^2}\times\sqrt{1^2+1^2+1^2+1^2+1^2}}$$

$$= \frac{1+1+1+1+1}{\sqrt{5}\times\sqrt{5}} = \frac{5}{5} = 1.0$$

As expected, the Adopter and Dog2 show a perfect similarity score of 1.0. Let us examine the similarity between the Adopter and Dog3 who we made somewhat similar by having some matching answers and some differing answers.

$$\text{CSIM}(\text{Adopter}, \text{Dog3}) = \text{CSIM}\big((1,1,1,1,1),(1,0,1,1,0)\big) = \frac{\sum_{i=1}^{n} A_i \times B_i}{\sqrt{\sum_{i=1}^{n} A_i^2} \times \sqrt{\sum_{i=1}^{n} B_i^2}}$$

$$= \frac{1\cdot 1 + 1\cdot 0 + 1\cdot 1 + 1\cdot 1 + 1\cdot 0}{\sqrt{1^2 + 1^2 + 1^2 + 1^2 + 1^2} \times \sqrt{1^2 + 0^2 + 1^2 + 1^2 + 0^2}}$$

$$= \frac{1 + 0 + 1 + 1 + 0}{\sqrt{5} \times \sqrt{3}} = \frac{3}{3.873} = 0.7745967$$

The similarity between the Adopter and Dog3 results in more similar than dissimilar, which aligns with logical reasoning. However, imagine the Adopter vector is (1,1,1,1,1) and the dog vector is (2,2,2,2,2). Logical reasoning sees these two vectors as different, however cosine similarity yields:

$$\text{CSIM}(\text{Adopter}, \text{Dog1}) = \text{CSIM}\big((1,1,1,1,1),(2,2,2,2,2)\big) = \frac{\sum_{i=1}^{n} A_i \times B_i}{\sqrt{\sum_{i=1}^{n} A_i^2} \times \sqrt{\sum_{i=1}^{n} B_i^2}}$$

$$= \frac{1\cdot 2 + 1\cdot 2 + 1\cdot 2 + 1\cdot 2 + 1\cdot 2}{\sqrt{1^2 + 1^2 + 1^2 + 1^2 + 1^2} \times \sqrt{2^2 + 2^2 + 2^2 + 2^2 + 2^2}}$$

$$= \frac{2 + 2 + 2 + 2 + 2}{\sqrt{5} \times \sqrt{20}} = \frac{10}{2.236 \times 4.47213595} = 0.999 \approx 1.0$$

Roughly perfectly similar vectors contrary to logical reasoning. This is because cosine similarity works better to determine if a dimension is present or not rather than determining the difference in magnitude between values within a dimension [12]. Cosine similarity also does not weight dimensions, such as if the Activity dimension were more important than another.

Whereas cosine similarity measures the angle between vectors, Euclidean distance measures how far apart they are in n-dimensional space [4] using the formula [13]:

$$\boldsymbol{d(p,q) = \sqrt{(p_1 - q_1)^2 + (p_2 - q_2)^2 + \ldots + (p_n - q_n)^2}}$$

Lower Euclidean distance is equivalent to higher similarity, with perfect similarity being a Euclidean distance of 0. The advantage of Euclidean distance over cosine similarity is that it

does take into consideration the magnitude of values. Recall the cosine similarity between Adopter (1,1,1,1,1) and Dog (2,2,2,2,2), who has no matching answers but received a cosine similarity of almost perfectly similar calculated above. Let us look at the Euclidean distance between these two vectors.

$$\boldsymbol{d(Adopter, Dog) = d\big((1,1,1,1,1),(2,2,2,2,2)\big)}$$

$$\boldsymbol{= \sqrt{(1-2)^2 + (1-2)^2 + (1-2)^2 + (1-2)^2 + (1-2)^2}}$$

$$\boldsymbol{= \sqrt{(-1)^2 + (-1)^2 + (-1)^2 + (-1)^2 + (-1)^2} = \sqrt{5} = 2.236}$$

In contrast with the cosine similarity, we are presented with a result that better aligns with logical reasoning in the sense that they are not perfectly similar. Euclidean distance does not work well for vectors of varying lengths, but because the Imprnt questionnaires are a fixed length, Euclidean distance provides a more accurate similarity metric. However, the Imprnt questionnaire does not use ranges of values in each dimension, and thus Euclidean distance may not be most appropriate or simplest approach.

The FETCH! Your Pet prototype used cosine similarity, which is more appropriate when comparing the presence or absence of dimension. Euclidean distance is useful when the vector values are in a range. However, Imprnt's questionnaires use binary encoding (1 or 0) of response values. There are four cases when comparing binary responses, A and B: both A and B respond with the value 1 ($\boldsymbol{f_{11}}$), when A has value 0 and B has value 1 ($\boldsymbol{f_{01}}$), when A has value 1 and B has value 0 ($\boldsymbol{f_{10}}$), or when both have value 0 ($\boldsymbol{f_{00}}$). Often a value of 1 signifies that an attribute is present and 0 would signify the absence of that attribute [4]. Imprnt's survey is encoded with binary values but will not signify the presence or absence of that attribute. Instead, a value of 1 and value of 0 are of equal importance denoting opposite aspects of a dimension.

The Jaccard coefficient computes the similarity of two vectors by counting unique items present in both vectors (the intersection) and then dividing by the total number of non-zero attributes in the vectors (the union) [4]. This is shown in the formula below [4]:

$$\boldsymbol{JSIM(A,B) = \frac{f_{11}}{f_{11} + f_{10} + f_{01}}}$$

The Jaccard coefficient produces a score between 0 and 1, 0 being dissimilar and 1 being the most similar. To demonstrate this formula, we will calculate the Jaccard coefficient between the Adopter and Dog1, which was defined a dissimilar.

$$JSIM(Adopter, Dog1) = JSIM((1,1,1,1,1), (0,0,0,0,0) = \frac{0}{5} = 0.0$$

As expected, the Jaccard similarity between the Adopter and Dog1 who we made the opposite of the Adopter resulted in a score of 0, meaning they were perfectly dissimilar. Let us take a look at the similarity between the Adopter and Dog3 who we made somewhat similar by having some matching answers and some differing answers.

$$\text{JSIM}(\text{Adopter}, \text{Dog3}) = \text{JSIM}((1,1,1,1,1), (1,0,1,1,0)) = \frac{3}{5} = 0.6$$

Adopter and Dog3 are shown as in between similar and dissimilar. However, notice from the formula, Jaccard similarity does not take into consideration where both Adopter and Dog would have value 0, which technically would be a 0 to 0 match between the two. This poses a problem because attributes that are a 0 to 0 match would not be considered with the Jaccard coefficient. Jaccard was originally intended to capture the similarity of sets, where the primary concern is presence or absence of an item.

Simple Matching Coefficient (SMC) is a metric similar to the Jaccard coefficient but useful for matching vectors with binary responses that includes where both values may be 0 (f_{00}) [4]. A match would be considered if corresponding Adopter and Dog profile values are

both 0 or both 1. SMC is defined as the total number of matching indexes divided by the total number of attributes, seen in the formula below [4].

$$\mathrm{SMC}(\mathrm{A}, \mathrm{B}) = \frac{\mathrm{f}_{11} + \mathrm{f}_{00}}{\mathrm{f}_{11} + \mathrm{f}_{10} + \mathrm{f}_{01} + \mathrm{f}_{00}}$$

Consider Adopter and Dog3:

$$\mathrm{SMC}(\mathrm{Adopter}, \mathrm{Dog3}) = \mathrm{SMC}((1,1,1,1,1), (1,0,1,1,0)) = \frac{3}{5} = 0.6$$

The calculation is equivalent to the Jaccard coefficient between the two, which was calculated above. However, consider an Adopter2 vector with (0,0,0,0,0). This indicates the Adopter is not willing to take on extra medical expenses, prefers lounging on the couch, does not want a dog who will sleep in the same room or bed, does not want a dog who enjoys a lot of attention and petting, and prefers a smaller dog under 40lbs. Dog3 with vector (1,0,1,1,0) requires extra medical expenses, prefers lounging on the couch, wants to sleep in the same room/bed as their person, enjoys attention and pets, and is a smaller dog under 40lbs.

$$\mathrm{SMC}(\mathrm{Adopter2}, \mathrm{Dog3}) = \mathrm{SMC}\big((0,0,0,0,0), (1,0,1,1,0)\big) = 2/5$$

$$\mathrm{JSIM}(\mathrm{Adopter2}, \mathrm{Dog3}) = \mathrm{JSIM}\big((0,0,0,0,0), (1,0,1,1,0)\big) = 0/5$$

The SMC calculation captures the similarity between Adopter2 and Dog3, whereas Jaccard does not. The key difference between SMC and Jaccard coefficient is the inclusion of dimensions where both have the value of 0, thus providing a more logical result since the binary values in Imprnt's surveys are not representing the presence or absence of an attribute but are instead used to match equal values.

Imprnt implements the SMC similarity score with a modification. There are questions in the Adopter Questionnaire where the user may be neutral for a given question, for example, if they do not have a preference over smaller or larger dogs. By introducing a third value option for

these cases the wildcard value * could take the form of a logical OR where a * for the Adopter profile would consider both the smaller (0) and larger (1) dogs. The included OR feature incorporated into the SMC is the basis of Imprnt's matching of adopters and dogs.

CHAPTER 3: METHODOLOGY

The Software Development Life Cycle includes requirement gathering and analysis, system design, implementation, testing, deployment, and maintenance [14]. Some of the requirements, analysis, and design are introduced in the Related Work section and are based on my previous experience with the FETCH! Your Pet prototype. This section discusses the Imprnt implementation, the Imprnt Matching Algorithm, a cost analysis, testing, and deployment.

3.1 Implementation

This section discusses Imprnt's architecture and data schema. Imprnt is implemented in Flutter and utilizes Google Firebase as its backend, leveraging its Cloud Firestore, Cloud Functions, Authentication, and Cloud Storage products (Figure 2).

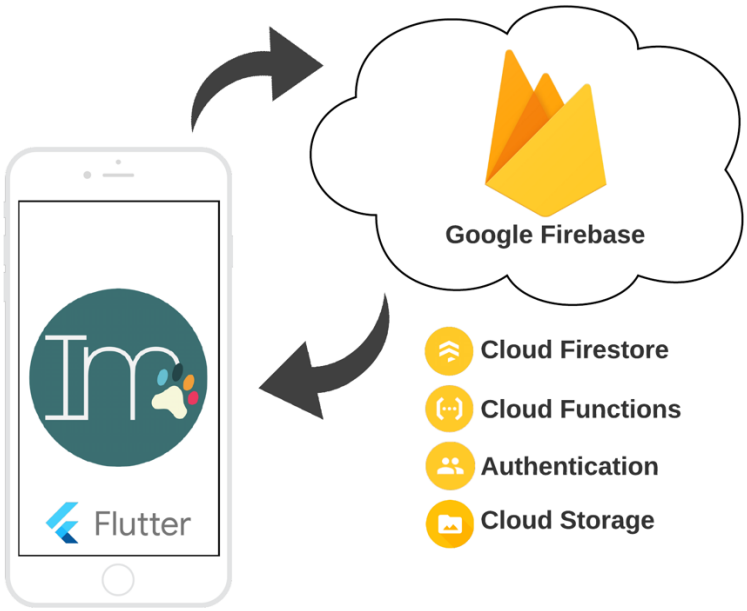


Figure 2. Imprnt Architecture

Flutter is Google's open source, cross-platform Software Development Kit (SDK) written in the Dart programming language for creating both Android and iOS apps from a single codebase [15]. Flutter integrates native platform differences such as icons, fonts, navigation, and

provides native performance and experience for both Android and iOS users. Flutter powers many apps, including Realtor.com, The New York Times, and Google Assistant [15]. Flutter is newer than its top cross-platform competitor, React Native, but has better support for native platform rendering that improves performance and reduces the need for third-party libraries [16]. I chose Flutter over React Native because I have previous experience developing in Flutter and wanted to focus on implementing features instead of learning a new language and environment.

Google's Firebase is a cloud services platform that supports application development [17]. Firebase as a backend service provides functionality for authentication, database management, and storage that seamlessly scales on their cloud platform [17]. All of these features can be implemented in a Flutter mobile application with a few lines of code, freeing the developer to focus on the core application logic. Imprnt uses four Firebase services described below: Cloud Firestore, Cloud Storage, Authentication, and Cloud Functions.

Imprnt's data is stored in the Cloud Firestore, a NoSQL document database that allows its users to easily store, sync, and retrieve data in almost real-time across Android, iOS, and web applications [18]. NoSQL is often referred to as "not only SQL" or non-relational, and it stores data differently than traditional relational databases. In Cloud Firestore, data is stored as a JSON (JavaScript Object Notation) tree with collections that can have any number of documents [18]. Firestore also supports applications when they go offline by providing locally cached data and saving queries made while offline for when connectivity is restored [18]. Firestore libraries exist to easily integrate into Flutter applications. Imprnt's Firestore data schema is shown in Figure 3.

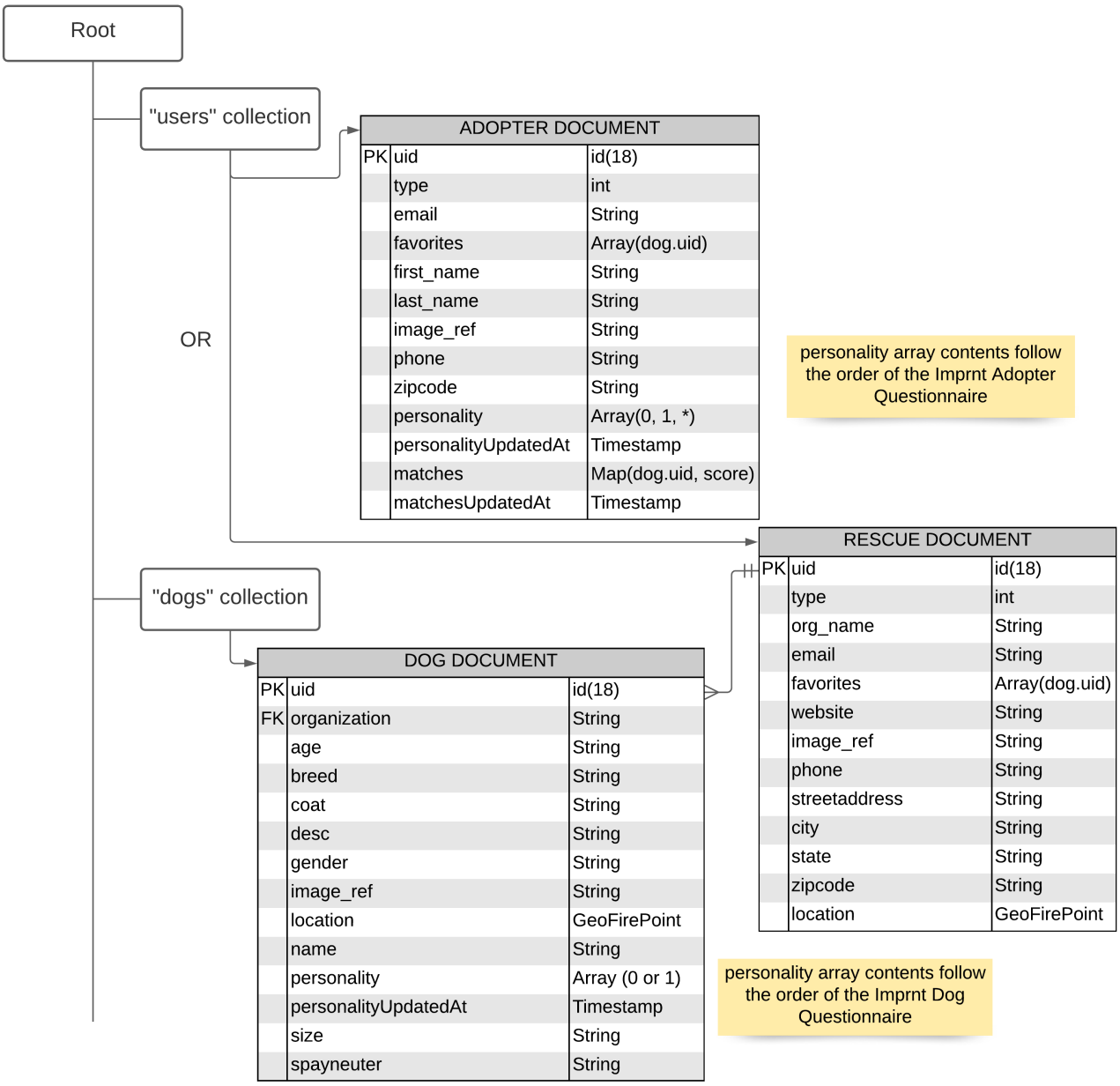


Figure 3. Imprnt Firestore Data Schema

Cloud Storage provides cloud-based file storage and is used to store user and dog profile images, which are referenced in the Firestore schema and downloaded into the app for display. Cloud Functions hosts Imprnt's matching algorithm and integrates with Flutter and Cloud Firestore—the algorithm and these integrations are discussed in detail in Section 3.3. Firebase Authentication handles Imprnt's secure login, sign up, and user management. Firebase

Authentication provides secure user management and access control [19] and requires only around ten lines of code to be integrated into a Flutter app. All of the Firebase features have pricing models that are usage-based. Section 3.4 provides a cost analysis of Imprnt Firebase features; the free tiers of the Firebase services are adequate for Imprnt testing.

3.2 Functionality Walkthrough

This section provides walkthrough narratives from both the adopter and rescue organization perspectives accompanied by screenshots of all implemented functionality.

3.2.1 Point of Entry

When a new user launches Imprnt for the first time, they are presented with a screen prompting them to review an End-User License Agreement (EULA) before being able to use the app, shown below in Figure 4 (left image). The EULA terms limit what a user can do with an app such as reverse engineering or reproducing the app. If no user is currently authenticated, Imprnt opens to a sign-in screen that includes text fields for an email and password, a button to learn more about Imprnt, and a button to sign up (Figure 4, center image). The learn more button triggers a pop up that includes a brief description about what Imprnt is with a link to an information website (https://imprntfeedback.wixsite.com/imprnt) and other technical information including mandatory licenses for third-party libraries used in the app (Figure 4, right image).

Users must enter their email and password used to create their Imprnt account. These credentials are validated by Firebase Authentication. If any error occurs when Firebase attempts to authenticate the user, a pop up will appear at the bottom of the screen signaling the issue to the user. For example, if they entered the wrong email address or password, an error will be displayed that reads, “Wrong email/password combination.” If the user forgets their password, they have the option to reset it with the “Forgot password?” button. If Firebase detects that the

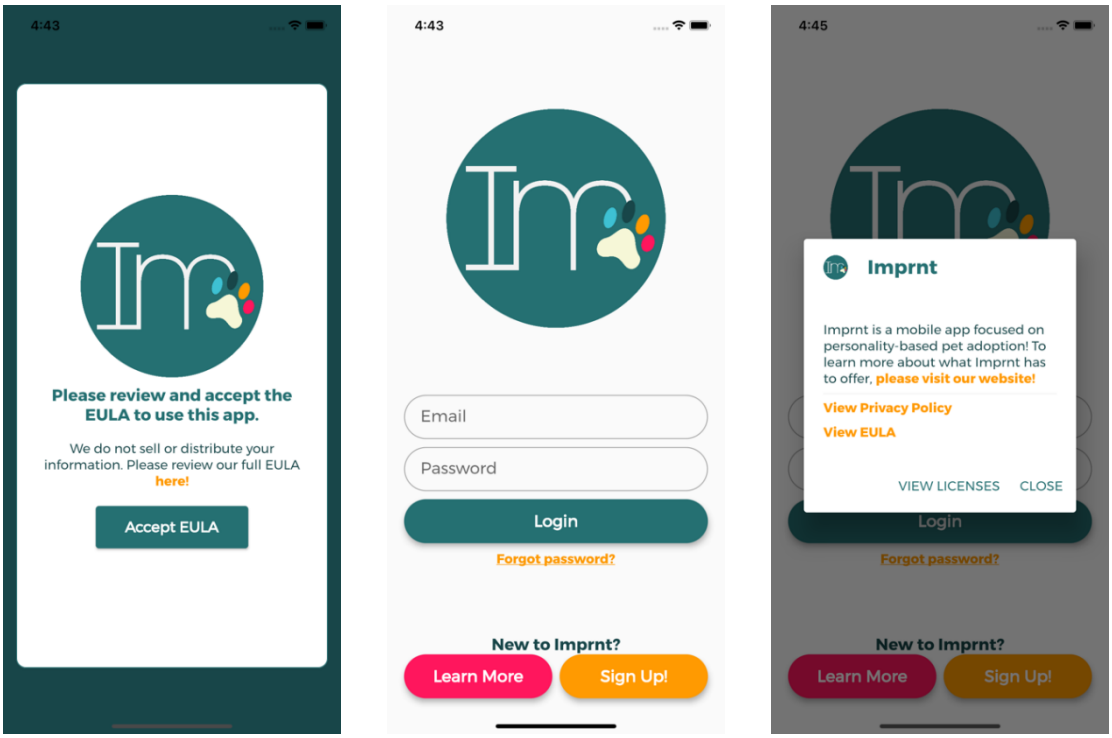


Figure 4. Imprnt Point of Entry Screenshots

email in the email text field is already a registered user with Imprnt, an email is sent from Firebase with a link to reset their password. The sign-up button prompts the user for which type of account they are interested in registering as and redirects accordingly.

3.2.2 Adopter Narrative

First time adopters are required to register for an Imprnt account. The Imprnt adopter registration screen (Figure *5*, left image). This information is used to establishes their adopter profile in the Imprnt database. Pressing the "Sign up!" button first provides form validation to ensure all provided information meets the set restrictions, for example, a five-digit ZIP code. Form validation errors are indicated on screen with a pink underline and error information. If the user provided a profile image, it is uploaded to Cloud Storage with the filename set as that user's Unique Identifier (*uid*). The *uid* is provided by Firebase Authentication and is a mechanism for uniquely identifying users within an application. A new unique document is created in Imprnt's Firestore "users"

collection (Figure 3) to hold the user's data, including a reference to the profile image in Cloud Storage.

New adopters are redirected to the Imprnt Adopter Questionnaire after completing registration. In contrast to the FETCH! Your Pet experience, this immediate redirect encourages new adopters to take the Imprnt Adopter Questionnaire before browsing available animals and provides clear navigation for the next intended action. An alert dialog containing information on the questionnaire's contents and goal is shown. Imprnt presents mutually exclusive answer choices in contrast to the prototype (Figure *5*, center image). An answer must be chosen before being able to proceed to the next question. A linear progress indicator is featured to show users where in the questionnaire they are. If the user is not ready to take the questionnaire, they can exit out of the screen by pressing the "EXIT" button at the top of the screen. This will trigger an

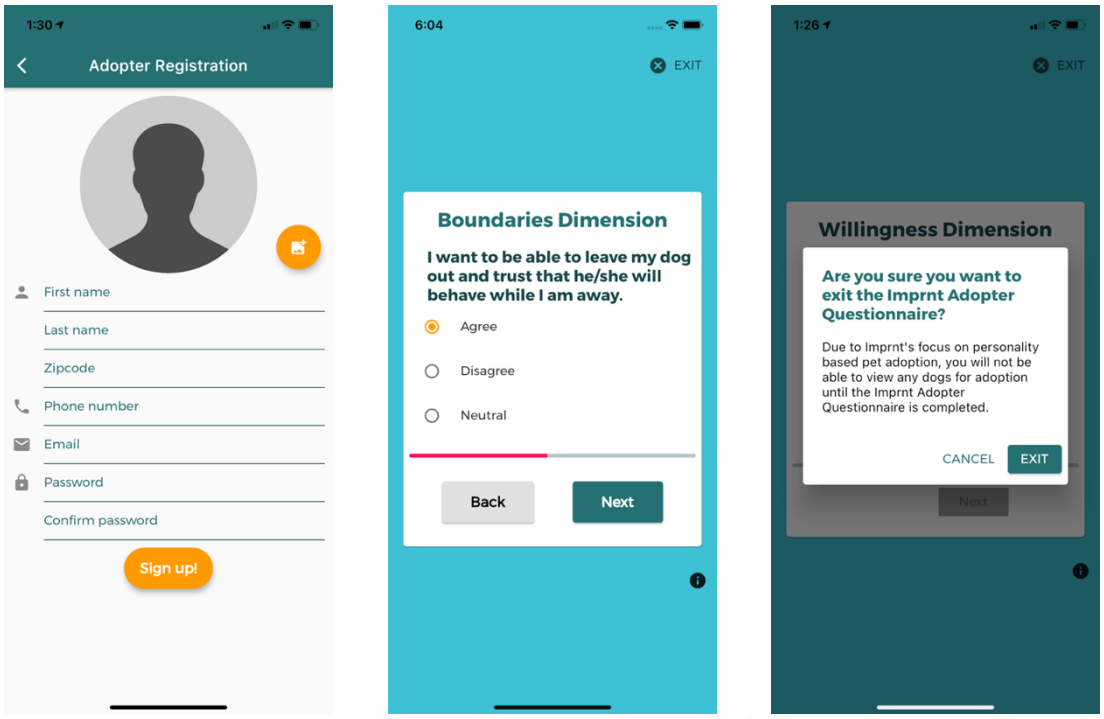


Figure 5. Imprnt Adopter Registration and Questionnaire

alert dialog to confirm the user wants to exit and provides a warning that they will not be able to access some of Imprnt's features until they complete the questionnaire (Figure *5*, right image).

Completion of the Imprnt Adopter Questionnaire stores the results in the user's Firestore document under the field "personality" as a one-dimensional array with the value of each selected answer choice (1, 0, or * as described in Section 2.4). The field "personalityUpdatedAt" is also updated with a timestamp of when the questionnaire was submitted—this becomes important for Imprnt's matching algorithm discussed in Section 3.3. Completion of the questionnaire directs the user to explore their matches. The user is shown their Adopter dashboard after completing the questionnaire and after subsequent logins (Figure 6, left image). The dashboard includes previews of three matches and three dogs from Imprnt's full database. If the user does not have any matches yet, an error shows prompting to calculate the user's matches now, this opens the matches screen.

Any time "Matches" is pressed in the bottom app navigation bar or the matches screen is opened, the Imprnt matching algorithm is invoked as a Firebase Cloud Function (described in Section 3.3) and a loading screen is displayed. The invoked cloud function returns the user's top 10 matches as a list and presents them to the user in a carousel (Figure 6, middle image). Users can dismiss a match (pink thumbs down), which removes that dog from the user's current matches. "Favoriting" a dog (blue thumbs up) stores the dog in a favorites list on the user's account. Users can click the match card to view the full dog profile. Imprnt shows an on-screen visual cue when users have reached the end of their list of matches (Figure 6, right image), a feature that FETCH! Your Pet lacked. Adopters can update their questionnaire responses via the button on this screen. Their previous answers are already applied to each question of the

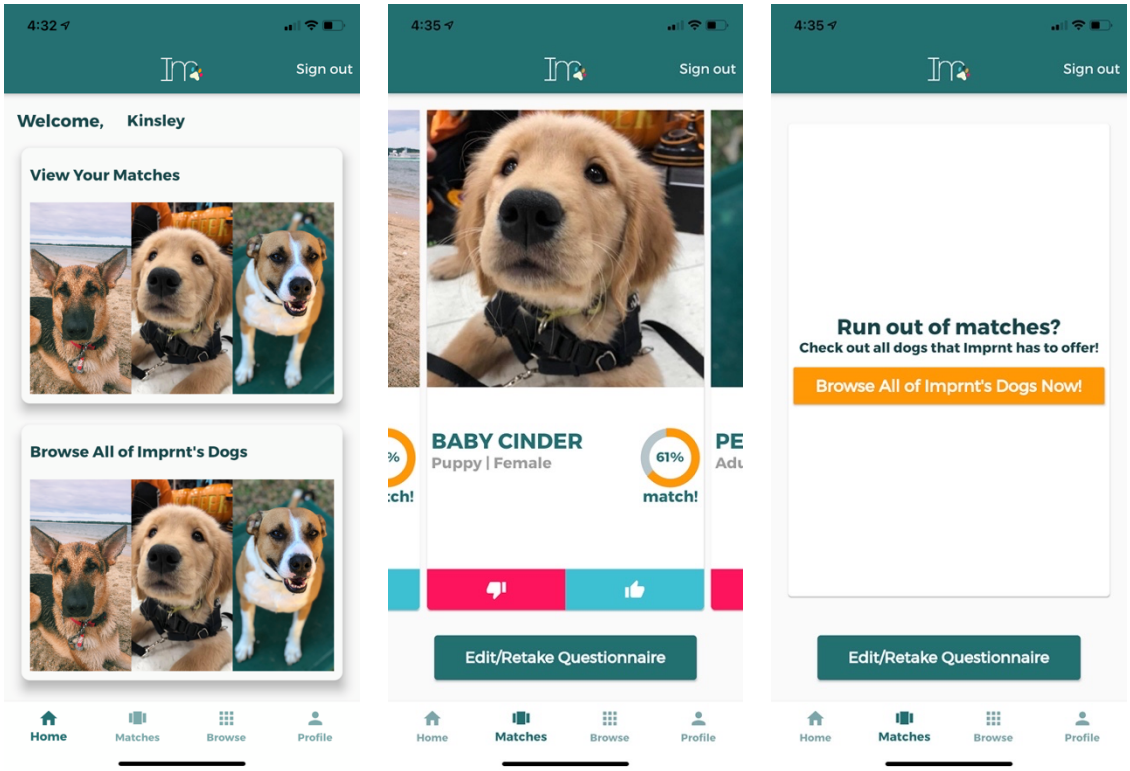


Figure 6. Imprnt Dashboard and Matches

questionnaire, and they can update as they deem necessary. Updating their questionnaire saves the new results and updates the "personalityUpdatedAt" timestamp on their Firestore document.

Browsing all available dogs (Figure 7, left image) provides a collection view of every dog in the database. This functionality is only available if the user has completed the Imprnt Adopter Questionnaire, otherwise they will see an error prompting them to take the questionnaire (Figure 7, right image). Whereas FETCH! Your Pet included various sorting functionalities, Imprnt adds filtering functionality based on location proximity asking for the user's current location, age, size, coat length, gender, spay/neuter status, and user-indicated favorites. Sort and filtering functionality is accessible by clicking the orange floating action button (FAB) in the lower right corner of the browse screen. If the user has enabled location permissions, Imprnt defaults to querying dogs within a 50-mile radius of the user's location. Selecting any of the filter options displays further options for each category of filtering (Figure 7, center image).

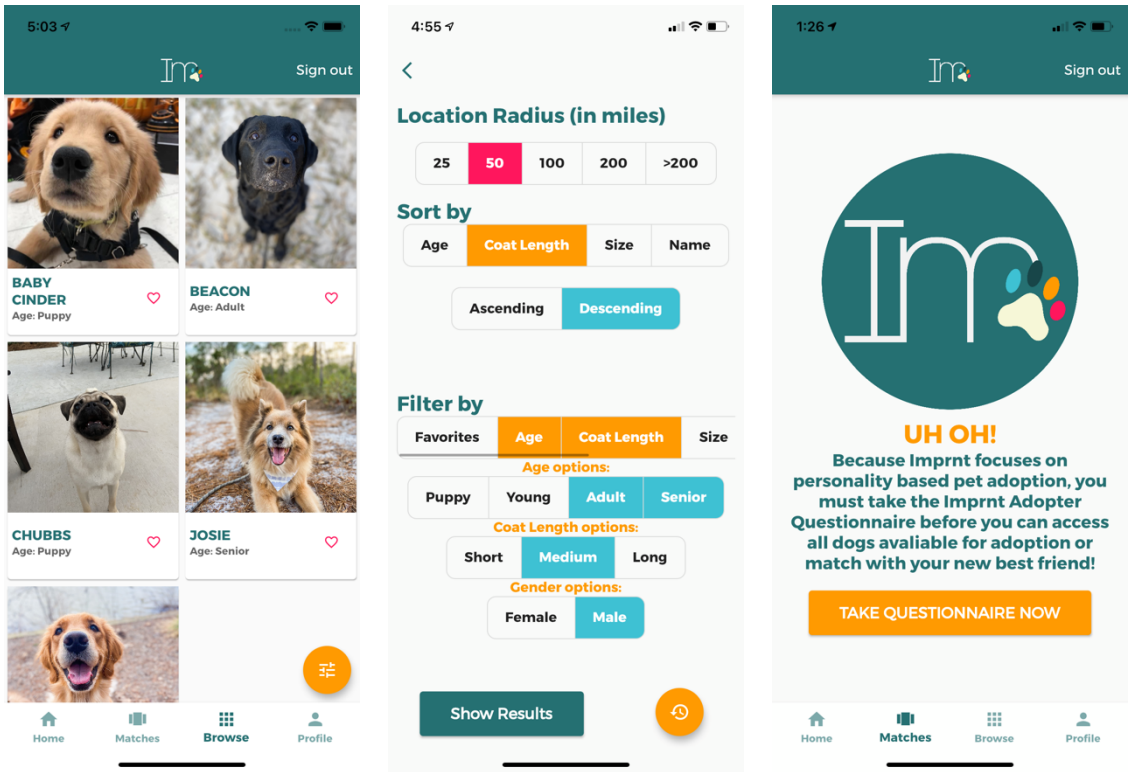


Figure 7. Imprnt Browse Collection

The orange FAB on the sort and filter options screen will reset the form. Clicking "Show Results" saves the user's sort and filter options and the dogs are locally sorted, filtered, then displayed to the user.

Clicking on any dog card opens a dog profile screen with all of their information (Figure 8, left image). Once an adopter has found a dog they are interested in adopting, they will be able to contact the corresponding rescue organization for further details by clicking the orange FAB in the lower right corner of the dog's profile. This FAB opens their rescue's contact information (Figure 8, center image). Each of these options are interactive: clicking the phone number opens the device's phone populated with the rescue's phone number, clicking their email opens the device's email and prepopulates an email template (Figure 8, right image), clicking the address opens that location in Google maps, and clicking the website launches the website in a browser. Imprnt does not handle

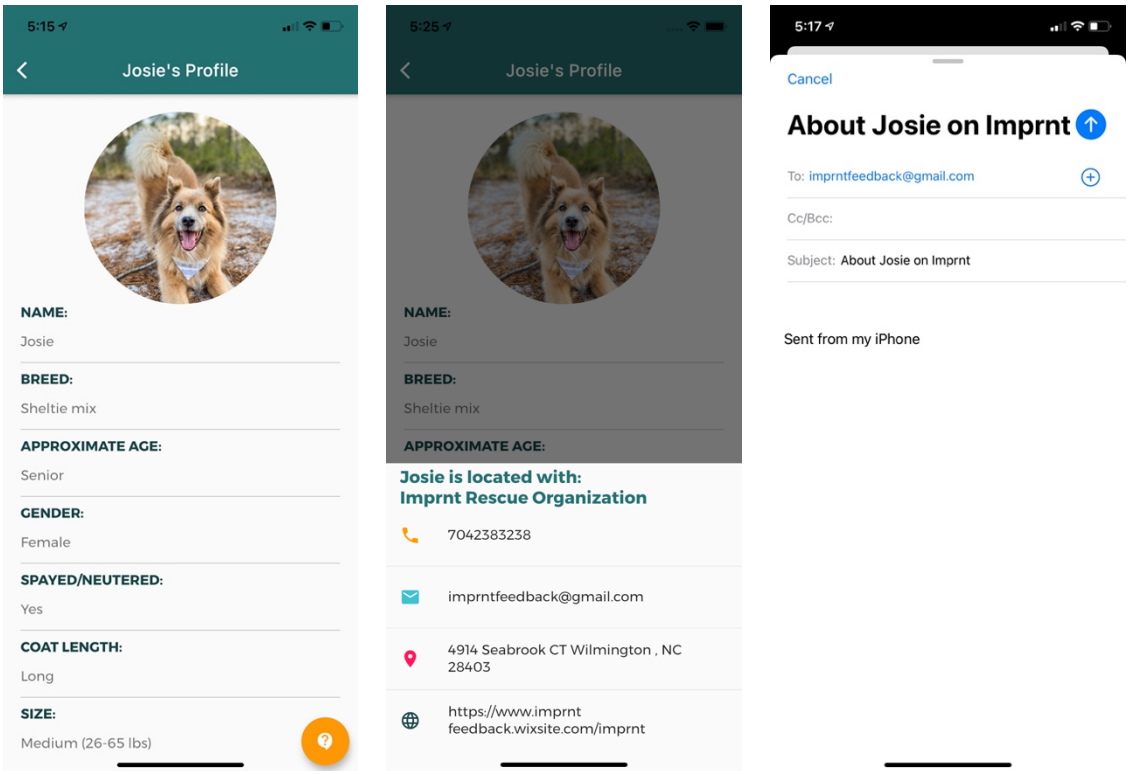


Figure 8. Imprnt Dog Profiles

the actual adoption application beyond being an initial point of contact; many rescue organizations have their own applications and unique adoption processes.

Adopters can update their profile information by selecting “Profile” from the bottom app navigation bar and clicking the orange edit FAB in the lower right corner (Figure 9, left image). Clicking this FAB makes all the form fields editable, if any information is changed the “SAVE” button becomes active and the updated information will be updated on the user’s Firestore document (Figure 9, center image). For sensitive information such as email or password, users will be asked to verify their current password before being able to update (Figure 9, right image). Form validation also occurs here, and errors are indicated with a red underlined text field followed by the violated validation rule. If the user fails to provide the correct current password, their sensitive information (email or password) will not be updated, and an error message will be

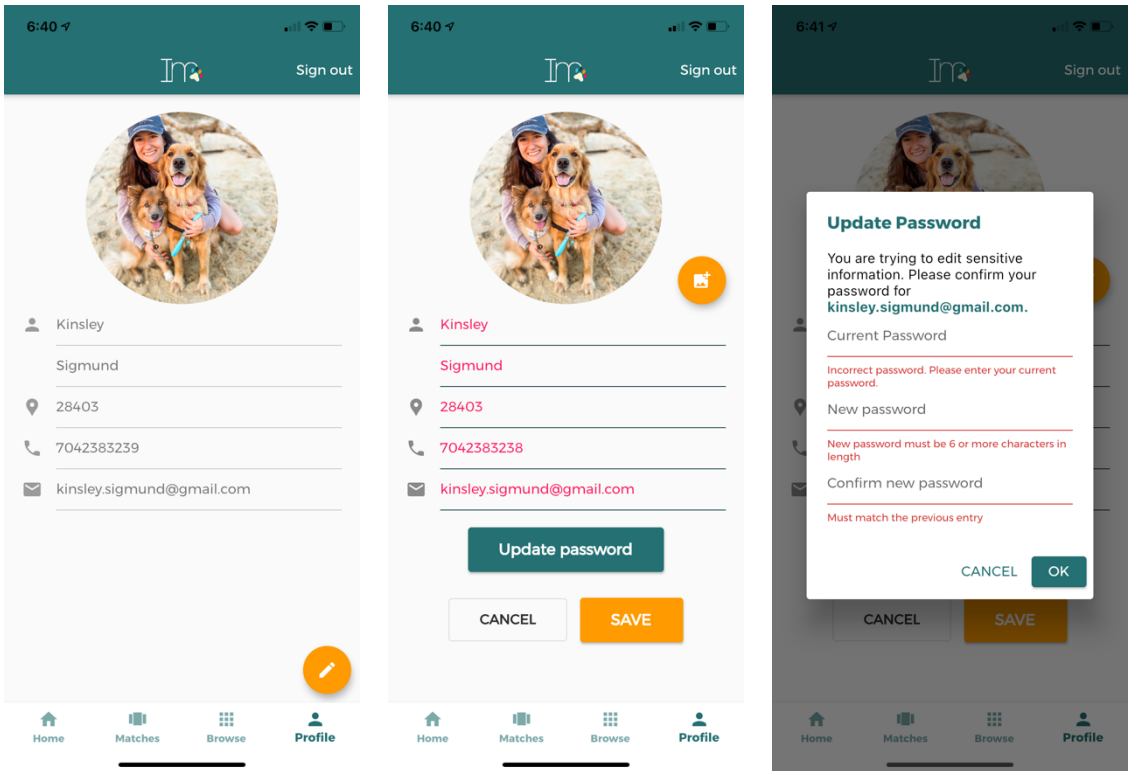


Figure 9. Imprnt Adopter Profile

displayed to the user indicating that they must confirm their identity before proceeding in updating that information. The user's authenticated state persists across app closing, but if at any point they wish to sign out they can do so by clicking "Sign out" from the top app bar from anywhere within the main screens (Home, Matches, Browse, Profile). This will sign the user out of their authenticated state and return them to the Login screen.

3.2.3 Rescue Organization Narrative

Rescue organizations also register for an Imprnt account. Rescue organization registration is like adopter registration but with different fields to support contact information (Figure *10*, left image). A disclaimer on this page states that information such as the rescue's phone number, email address, physical address, and website will all be visible to users of the app. Upon completing registration, new rescues are redirected to

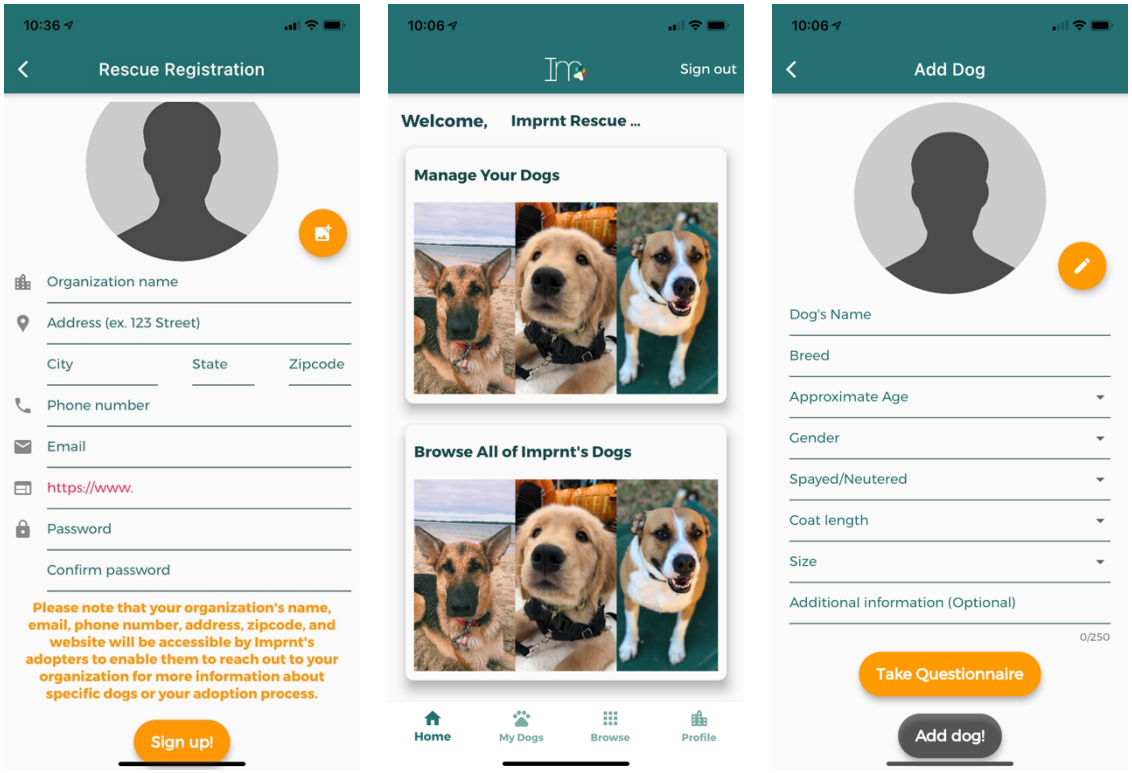


Figure 10. Imprnt Rescue Registration, Dashboard, and Dog Registration

their rescue dashboard which features a preview of their registered dogs and a preview of all dogs in the Impnt database (Figure *10*, center image).

Rescue organizations can view, edit, and register dogs by clicking “My Dogs” from the bottom navigation bar. To register a dog, they click the orange plus FAB in the lower right corner. Rescues will fill out information for the dog within the dog registration page (Figure *11*, right image). Imprnt includes a feature to access the device’s camera to capture an image of the dog in real time in addition to uploading a preexisting image from the device. Before a rescue can submit a dog’s registration, they must complete the Imprnt Dog Questionnaire, which can be accessed by clicking the “Take Questionnaire” button. The Imprnt Dog Questionnaire looks and functions like the Imprnt Adopter Questionnaire, however the questions are for the dog’s perspective. Until the questionnaire is completed, the “Add Dog” button will be inactive. If the rescue tries to add the dog before the questionnaire is taken for that dog, an error will pop up to

remind them to take the questionnaire. The focus of Imprnt is personality-based pet adoption, there should not be any dogs within the app without a registered personality. Once all information is filled out and the rescue presses “Add dog!”, the dog's information is saved in the dog's Firestore document and, if applicable, the image of the dog is saved to Cloud Storage. To provide a link between the dog and their registering organization, each dog's Firestore document (Figure 3) has an “organization” field containing the *uid* of their registering rescue organization.

To filter dogs by location radius, each dog document also has a “location” field containing a geohash and geopoint (latitude and longitude) value created with the GeoFlutterFire plugin [20]. GeoFlutterFire is an add-on to the Cloud Firestore library that provides functionality to store and query location data with a geohash string [20]. Geohashing is an algorithm for encoding location as a string that represents a rectangular cell and has the property that the closer the geopoints, the more similar their geohashes [21]. A dog’s location is derived from the rescue organization’s supplied address and the use of a geocoding service that returns the resolved latitude and longitude given an address string. Any time a Dog document is created or updated, the location field is updated with the geopoint and geohash supplied by GeoFlutterFire’s GeoFirePoint object. GeoFirePoint calculates its geohash given a latitude and longitude. By including these geolocation packages, dogs can now be queried and filtered by a surrounding location radius when browsing the entire Imprnt collection.

Any of the rescue’s dogs can be edited by clicking on their profile on either the “My Dogs” screen or the “Browse” screen. If a rescue is viewing a dog profile from a different organization, the FAB in the lower right corner shows contact information for the other organization and does not allow them to edit (Figure 11, left image). Any dogs that are registered to their organization may be edited by clicking the orange edit FAB from the lower left corner of

the dog profile (Figure 11, center image). From here the organization can edit the profile image, any profile information, retake the Imprnt Dog Questionnaire, or completely delete the dog from the app (Figure 11, right image). If the Imprnt Dog Questionnaire is edited, the results are updated in the dog's "personality" field and the "personalityUpdatedAt" field is also updated with a timestamp of when the results were submitted. This timestamp is important for the Imprnt Matching Algorithm explained in Section 3.3.

Rescues have the same browsing, favoriting, filtering, and sorting functionality as explained in the Adopter narrative. Rescue organizations can also edit their profile in a similar way as described in the Adopter narrative. The only notable difference being the updated "location" field if their address is updated.

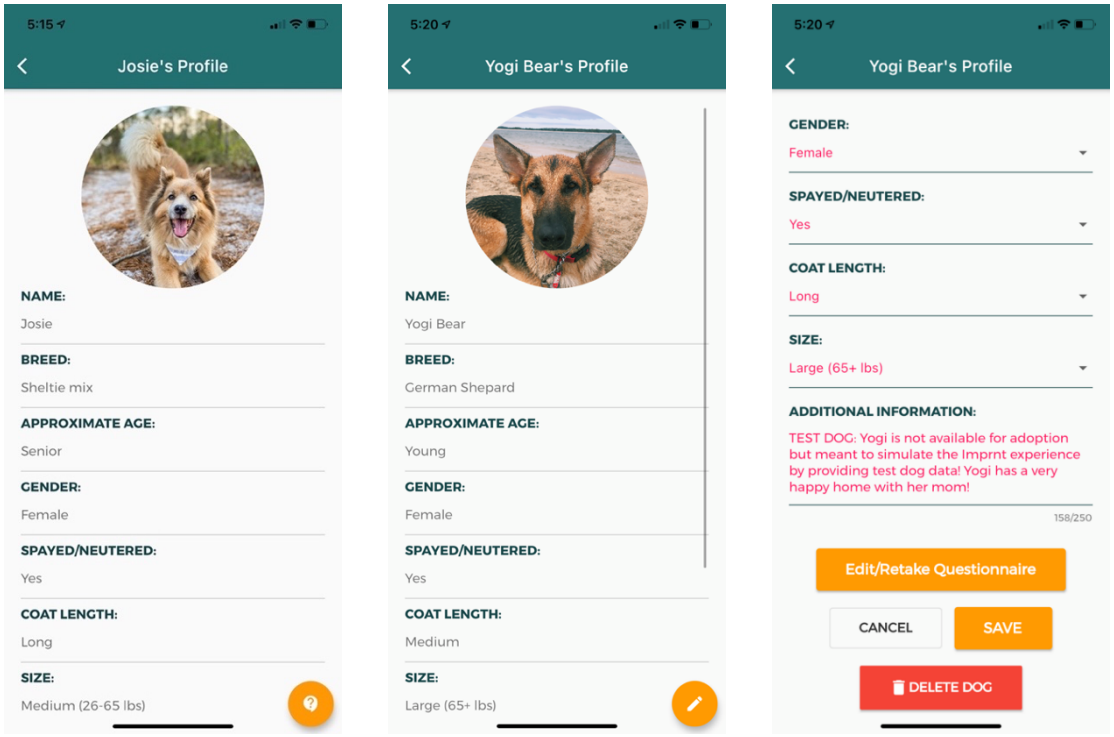


Figure 11. Imprnt Manage Rescue's Dogs

3.3 Imprnt Matching Algorithm

The core functionality of Imprnt is calculating and displaying matches for adopters who have taken the Imprnt Adopter Questionnaire. A sequence diagram for the matching process is shown in Figure 12.

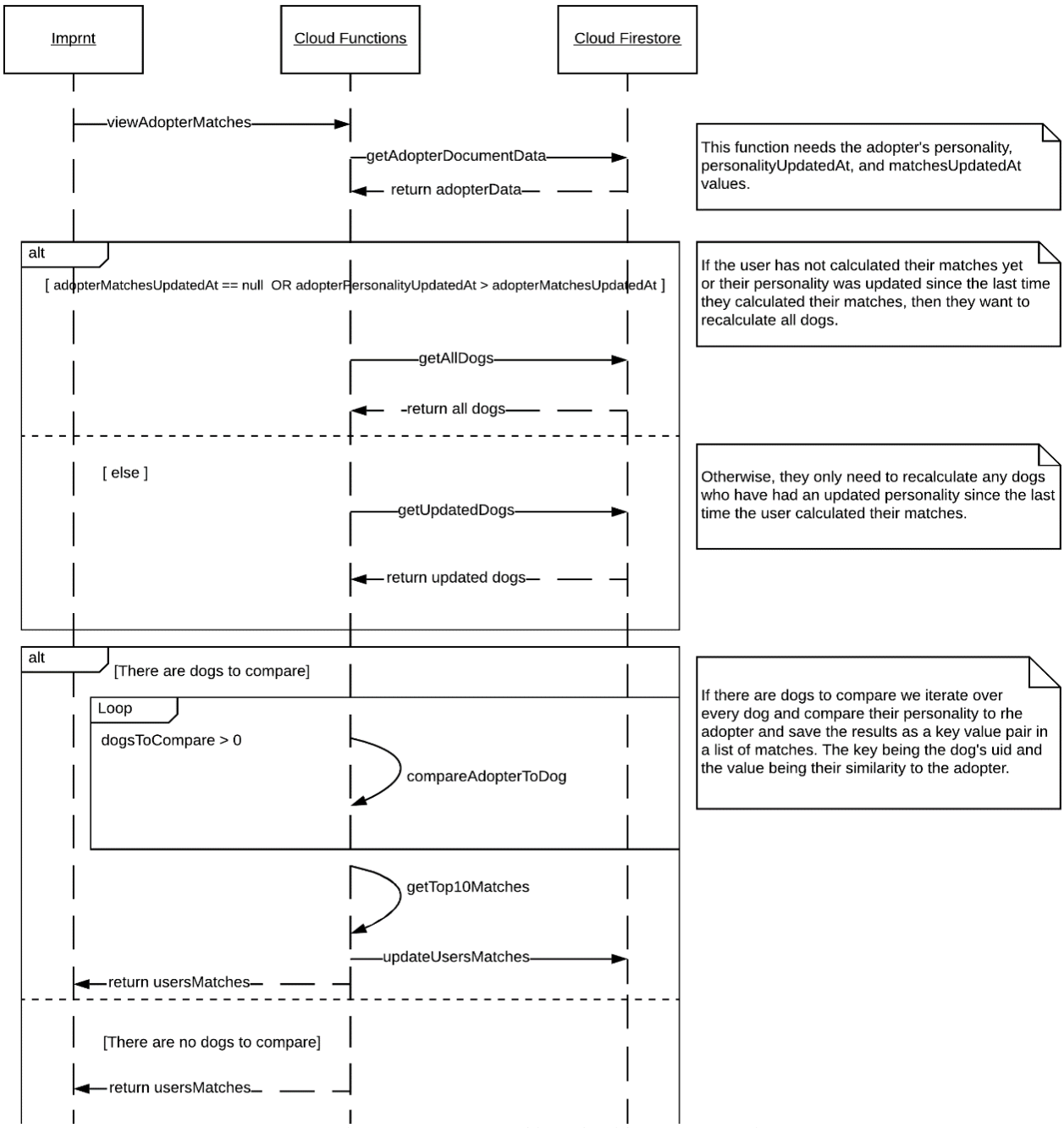


Figure 12. Imprnt Matching Algorithm Sequence Diagram

Imprnt's matching algorithm is an invokable Cloud Function. The first part of the algorithm determines which dogs will be evaluated. Imprnt will evaluate all dogs in the system when the user first requests their matches or if the user has updated their Adopter questionnaire since last calculating matches. Otherwise, Imprnt only evaluates the dogs whose personality has been updated since the last time the user calculated their matches. If neither Dog questionnaires nor the Adopter's questionnaire have been updated since the last match calculation, the previous calculated matches list is returned to the user.

The Cloud Function computes the Simple Matching Coefficient described in Section 2.4 between each dog's questionnaire and the adopter's questionnaire. The Cloud Function sorts the list of calculated similarities and keeps the top ten highest scores. These matches are stored on the Adopter's Firestore document and their "matchesUpdatedAt" field is updated with a timestamp of when the new matches were calculated. The list of ten matches is returned to the Imprnt app and displayed to the user. Ten was chosen with consideration to storage and computational processing time since the list is cached on the Adopter's Firestore document. At present, only the top ten matches are cached, but adopters have the option to view all dogs in the database. Future work will refactor the matching algorithm and data schema to support larger match set sizes (see Section 4.2).

3.4 Cloud Service Costs

Firebase uses a “pay as you go” cost model, including a free tier that is billed monthly [22]. Table 2 shows the Firebase service costs and the costs incurred during Imprnt's beta test.

Table 2. Firebase Billing Metrics

Firebase Service	Free Tier	Pay As You Go (includes free tier)	Imprnt Beta Test (April 1-April 10)
Cloud Firestore			
• Data Stored	1 GiB total	$0.18/GiB	0.0003 GB
• Document Reads	50K/day	$0.06/100K	0.32K/day avg
• Document Writes	20K/day	$0.18/100K	0.0064K/day avg
• Document Deletes	20K/day	$0.02/100K	0
Cloud Functions			
• Invocations	2M/month	$0.40/million	0.00039M/mo. avg
• GB-seconds	400K/month	$0.000000463/100ms	N/A
• CPU-seconds	200K/month	$0.0000100/sec	N/A
• Cloud Build minutes	120min/day	$0.003/min	N/A
• Outbound Networking	5GB/month	$0.12/GB	N/A
Authentication	Free	Free	
Cloud Storage			
• GB stored	5 GB	$0.026/GB	0.4996 GiB
• GB downloaded	1 GB/day	$0.12/GB	0.08199 GiB/day
• Upload operations	20K/day	$0.05/10k	0
• Download operations	50K/day	$0.004/10k	0.0323K/day avg

** N/A indicates that Firebase does not provide summary information.*

Between April 1 and April 10, the Imprnt beta test included 32 users and 9 test dogs. Over this period, Cloud Storage stored 499.6 MB of data and serviced 323 requests with a total download throughput of 819.9 MB. Cloud Functions logged 133 invocations of the Imprnt Matching Algorithm. The beta test identified a performance issue: the Cloud Firestore showed 3,200 document reads, which was unusually high only nine test dog documents. A refactored method has yielded a 25% reduction in the number of reads, but the number is still high and will be the subject of future performance improvements.

3.5 Testing and Deployment

Extensive exploratory tests were conducted throughout Imprnt’s development. Imprnt was deployed on the Google Play Store and Apple’s App Store for beta testing after

implementation. Both the Google and Apple Developer programs require developer registration and a fee to test their platforms. Each platform allows for either private or public alpha/beta testing. For this project, I utilized private beta testing wherein I invited specific users to download the prerelease version of Imprnt. The invitees were colleagues, friends, relatives, and personal contacts from rescue organizations. Private internal release for Google Play allows 100 testers, only requiring the packaged app and a written description of release notes for testers. Imprnt went through Apple's beta app review before external testers could access the app. The review process can take up to 48 hours for each new build requiring written app description and test details, a link to a privacy policy, publisher contact information, and login information for Apple's reviewers to gain access to core functionality. Apple rejected Imprnt twice before it was approved for beta testing (see lesson learned in Section 4.2.2). Each approved build is active for 90 days and can be accessed by up to 10,000 testers. Opening Imprnt as a beta before a full release on the app stores allows the opportunity to receive feedback from real users, make improvements before a full release, and catch any bugs that may have been missed during developmental testing. Gathering feedback from real users is essential to Imprnt's success and effectiveness. Both stores require a store presence including logos, promotional materials, screenshots from various resolutions, contact information, written descriptions, and extensive reviews before release to the general public.

CHAPTER 4: FEEDBACK AND LESSONS LEARNED

Imprnt was deployed to several beta testers in early April 2021 for testing and feedback. This section describes that process, and also reflects on lessons learned during the course of Imprnt's development.

4.1 Imprnt Feedback Survey

To gather feedback on Imprnt, I created an anonymous survey for testers to take after exploring the app using UNCW's SelectSurvey tool. This section provides analysis of the survey results.

4.1.1 Survey Contents and the System Usability Scale (SUS)

The survey includes the ten-item System Usability Scale questionnaire [23]. The System Usability Scale is intuitive, can be used on smaller sample sizes with reliable results, and has demonstrated validity in differentiating between a usable and unusable system [23]. I also asked the testers optional open-ended questions for improving Imprnt. A full list of Imprnt's feedback survey is shown in Table 3.

Table 3 Imprnt Feedback Survey

Question	Response Type
System Usability Survey (SUS) - Required	Likert Scale
I think that I would like to use Imprnt frequently.	Strongly Agree – Strongly Disagree
I found Imprnt unnecessarily complex.	Strongly Agree – Strongly Disagree
I thought Imprnt was easy to use.	Strongly Agree – Strongly Disagree
I think that I would need the support of a technical person to be able to use Imprnt.	Strongly Agree – Strongly Disagree
I found the various functions in the Imprnt app were well integrated.	Strongly Agree – Strongly Disagree

I thought there was too much inconsistency in the Imprnt app.	Strongly Agree – Strongly Disagree
I would imagine that most people would learn to use Imprnt very quickly.	Strongly Agree – Strongly Disagree
I found the Imprnt app very cumbersome to use.	Strongly Agree – Strongly Disagree
I felt very confident using Imprnt.	Strongly Agree – Strongly Disagree
I needed to learn a lot of things before I could get going with the Imprnt app.	Strongly Agree – Strongly Disagree
Imprnt Specific - Optional	
What type of Imprnt user did you register as?	Adopter/Rescue Organization
Was there any information you felt was missing from the Imprnt dog profiles that would help you in taking next steps of the adoption process? Was there any information you felt was unnecessary or could be removed from the Imprnt dog profiles?	Open ended
Would you consider using the Imprnt app next time you are looking to adopt a pet?	Yes/No
Please explain why or why not for the previous question!	Open ended
Did you experience any weird or unexpected behaviors when interacting with Imprnt? If so, please describe them or list any room for improvements!	Open ended

4.1.2 Quantitative and Qualitative Analysis

Imprnt's prerelease test included 30 invited users: four Android users and 26 iOS users. Twenty-five testers responded to the Imprnt Feedback Survey. The complete quantitative results and qualitative responses are provided in Appendix A. Respondents agreed or strongly agreed that they would like to use Imprnt frequently (92%), that Imprnt was easy to use (92%), that they imagine most people would learn to use Imprnt very quickly (92%), that they felt confident using Imprnt (88%), and that they did not think they would need to learn a lot of things before being able to use Imprnt (100%). Respondents disagreed or strongly disagreed that Imprnt was unnecessarily complex (88%), that they would need the support of a technical person to use

Imprnt (96%), that they felt there was too much inconsistency within the app (92%), and that Imprnt was cumbersome to use (96%).

Twenty-one of reported respondents registered as an Imprnt adopter and one registered as a rescue organization. Feedback from both perspectives was positive. Many adopters mentioned the desire to see more in-depth information on the dog profiles. The "Additional information" section of the current profiles was meant to encompass any additional information rescues felt relevant to include, however several adopters expressed the interest to see standardized areas such as medical considerations, temperament around other animals and children, and adoption requirements. A dog's temperament around other dogs is part of the questionnaire, but this information is not visible on the profile. The responding rescue organization also suggested more information for the dogs, including medical information, support for videos of the dogs, and a personality tag (such as "Cuddle bug"). The rescue organization also suggested allowing a link to the adoption application and condensing the dog questionnaire.

One hundred percent of respondents were interested in using Imprnt next time they wanted to adopt a pet. Most adopters claim the app was easy to use, visually pleasing, and user friendly. One responder noted that they felt the presentation of matches helped make the adoption process less overwhelming by narrowing presented options. Some users expressed interest in more information regarding the matching process itself and how matching percentage is calculated. The rescue feedback also loved the idea and user interface while highlighting the importance of the location-based queries as their dogs may be housed in foster homes. I think it would be beneficial to add an option for an additional address for dogs who reside with fosters to provide an accurate location of the dog instead of only tagging based on the rescue's location.

No app crashes or serious bugs surfaced during Imprnt's prerelease test. Adopters suggested some areas for improvement such as providing on-screen feedback for what happens when they thumbs-up/thumbs-down a match, presenting the user with matches right after completing the questionnaire, and making call to action buttons a dominant color. All these suggestions were implemented after analyzing feedback. One complaint was that the sort and filter conditions are reset each time the "Browse" page is loaded, which required users to keep changing their location radius to view dogs (since all test dogs were in Wilmington and beta testers were outside the 200-mile radius).

4.2 Lessons Learned

In this section, I reflect on a few challenges that arose during Imprnt's implementation and how I addressed these issues.

4.2.1 Firestore Triggers, Cloud Functions, and Cloud Pricing

Imprnt's core functionality is calculating and displaying matches for adopters who have taken the Imprnt Adopter Questionnaire. Imprnt must track calculated matches, which proved to be a non-trivial problem. Imprnt's matching algorithm is hosted as a Firebase Cloud Function. The initial approach to this function was to calculate the similarity between the Adopter and every dog any time an Adopter's personality was updated. This was first implemented in the form of an onUpdate trigger on the Adopter Firestore document. I then implemented a second function that was an onUpdate trigger for the Dog document: any time a dog personality was updated, their similarity was calculated against every Adopter in the Imprnt database and the Adopter's matches was updated accordingly. The strategy created an infinite trigger loop because every time the Dog onUpdate trigger was initialized, it would calculate the similarity and update the Adopter's saved matches, thus triggering the Adopter onUpdate trigger.

Cloud Functions are billed based on the number of function invocations, meaning this infinite trigger loop would be costly. I was fortunate to catch this looping while testing the functions locally using the Cloud Functions emulator. This approach failed because Firebase does not allow limiting triggers to a single field: the trigger is on the entire document. Ideally, the match update algorithm would trigger only when the "personality" field was changed, but the trigger fired when any field of the entire document was changed, so updating the "matches" field or favoriting/un-favoriting a dog would initialize the trigger again.

To avoid the trigger loop, I changed the algorithm so that matches are now calculated on demand when an Adopter clicks the "Matches" button from the bottom app navigation bar. I also cache the user's top ten matches stored on their Firestore document and include timestamps for when personalities and matches are updated to determine which dogs' similarities need to be re-calculated. While this solution works, the best strategy for caching and computing similarity scores to minimize computational overhead while retaining match accuracy is an area for further research. A two-dimensional matrix that tracks the scores between every adopter and every dog and can be updated in a row-wise or column-wise fashion would likely yield the best performance, but Cloud Firestore does not support two-dimensional arrays.

4.2.2 Testing Different Build Modes

Flutter allows developers to compile and run apps in three different modes:

- *Debug mode* is for development and enables real-time synchronization of code changes with the running application.
- *Profile mode* is used for analyzing performance and includes additional instrumentation to measure the timings and resource costs.

- *Release mode* is used once the app is ready to be published and hides certain error information and minimizes the app's size for distribution to devices.

I tested my app in debug mode throughout development. I packaged my app in release mode and submitted to both the Google Play store and App Store. When Apple's testers tried running Imprnt during their required beta app review, Imprnt simply displayed a grey screen, and the Apple reviewers rejected my first build because nothing worked. This grey screen issue was a common issue in the Flutter online community and I was advised to run my app in debug mode on various screen sizes and ensure no render errors were logged. Upon running on the smallest iPhone size, I found one render error where text was not fitting correctly on the smaller screen and I was able to fix, repackage, and redeploy. This corrected the issue and Apple approved the app for test release.

While I learned throughout my studies the importance of testing, this experience taught me the importance of testing mobile apps on various screen sizes and in release mode before distributing to my users. However, testing on every screen size is complex and expensive because Apple and Android have a plethora of devices. Android and Apple provide virtual device simulators to digitally test various devices instead of having to physically acquire multiple devices for each platform, but each simulator takes multiple gigabytes of disk space and significant time to launch, build, run, and test the app. I try to test on the smallest, largest, and an average sized device for each platform as a personal rule of thumb. I also now test all builds in release mode within my development environment and from both app stores before alerting my testers or submitting for review.

4.2.3 Accessibility in Programming

One of Imprnt's beta testers reported being unable to click the “Next”, “Back”, and “Submit” buttons during the Adopter Questionnaire, and as consequence of not completing the questionnaire, the user was unable to view matches or browse. Imprnt presents an error and call to action to complete the questionnaire if the user has failed to complete it (Figure 13). They were unable to see the button call to action within the error, essentially barring them from being able to complete any functionality within Imprnt. After troubleshooting with the user, I discovered that their device’s Accessibility settings were set to larger text to help with poor eyesight. Images of her device with the increased text are shown in Figure 13 (left and center images) followed by a screenshot capturing what the error looks like without the increased text size (right image).

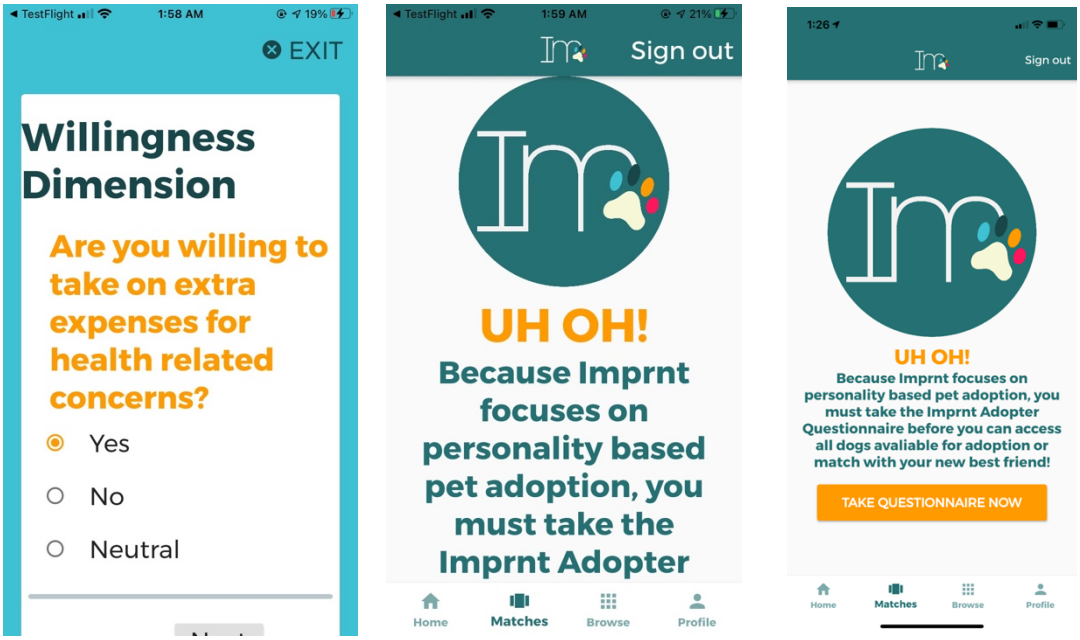


Figure 13.Imprnt’s Accessibility Error

This feedback raised an important issue that was not covered in my undergraduate studies, but that I have recently been learning about through my internship: the importance of

programming for accessibility. Software should be accessible to a wide range of users regardless of any physical, visual, or auditory limitations. Accessibility should be thought of beforehand and baked into development instead of being a secondhand consideration after deploying to users. Flutter provides helpful documentation including a checklist and some areas of focus to take into consideration before deployment [24]. Flutter recommends testing with the device's text set to the largest setting to resolve this specifically mentioned issue, but Imprnt would benefit from an accessibility audit to ensure its compliance with screen readers, visual contrast ratio guidelines, and scale factors. Imprnt would be legally required to meet accessibility requirements according to Section 508 of the Rehabilitation Act if it were to receive federal funding at any point [25].

CHAPTER 5: SUMMARY AND FUTURE WORK

This report describes Imprnt, a cross-platform mobile application that provides personality-based pet adoption. Imprnt's mission is to decrease the number of dogs euthanized in shelters by matching prospective adopters with compatible dogs in need of a home. Imprnt uses questionnaires based on research on human-dog compatibility from Dotson & Hyatt [9] and PawsLikeMe [8] to assess adopter and dog personalities. The basis of Imprnt's matching algorithm is a modified Simple Matching Coefficient calculated between adopter and dog questionnaires [4]. Imprnt is implemented as a cross-platform mobile application with the Flutter framework to support users on both Android and iOS and supported by Firebase cloud services. Imprnt was deployed to the Google Play Store and Apple App Store to a pool of prerelease test users who provided feedback via an anonymous survey. The feedback was positive with 100% of respondents claiming they would use Imprnt in the future when considering pet adoption. Suggestions for improvement include more personality information shown on the dog profiles, better support for large text scaling, and a condensed questionnaire.

I was able to address some user feedback before the close of this project. I plan to do an accessibility audit and address any necessary changes to make Imprnt accessible to all users who share Imprnt's mission to help dogs. Beyond the scope of this capstone, I will solicit more feedback from rescue organizations. I hope to motivate rescue organizations to participate by showing them the Imprnt app and positive survey results, which show that 100% of Imprnt's test Adopters are interested in using the app to facilitate pet adoption. The next step for Imprnt is another round of testing implementing additional rescue specific feedback and including more data from real rescue dogs. Imprnt will then be ready for production. Future work for Imprnt includes:

- Solicit further feedback from rescue organizations and include real dog data
- Condense questionnaires in collaboration with existing rescue organizations
- Enhance performance by decreasing read operations with browse queries and explore more efficient storage options for storing matches
- Improve accessibility compliance
- Research privacy issues in regard to storing personal information

My hope is that Imprnt will become an impactful aid in the fight to reduce euthanasia rates by promoting successful, permanent adoptions of shelter dogs to loving homes.

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APPENDIX A. Imprnt User Feedback Survey Results

Imprnt User Feedback Survey

Respondents: 25 displayed, 25 total **Status:** Open

Launched Date: 03/29/2021 **Closed Date:** 04/24/2021

1. I think that I would like to use Imprnt frequently.

	Response Total	Response Percent	Points	Avg
Strongly Agree	10	40%	n/a	n/a
Agree	13	52%	n/a	n/a
Neutral	2	8%	n/a	n/a
Disagree	0	0%	n/a	n/a
Strongly Disagree	0	0%	n/a	n/a
Total Respondents	25	100%		

2. I found Imprnt unnecessarily complex.

	Response Total	Response Percent	Points	Avg
Strongly Agree	1	4%	n/a	n/a
Agree	0	0%	n/a	n/a
Neutral	2	8%	n/a	n/a
Disagree	6	24%	n/a	n/a
Strongly Disagree	16	64%	n/a	n/a
Total Respondents	25	100%		

3. I thought Imprnt was easy to use.

	Response Total	Response Percent	Points	Avg
Strongly Agree	16	64%	n/a	n/a
Agree	7	28%	n/a	n/a
Neutral	2	8%	n/a	n/a
Disagree	0	0%	n/a	n/a
Strongly Disagree	0	0%	n/a	n/a
Total Respondents	25	100%		

4. I think that I would need the support of a technical person to be able to use Imprnt.

	Response Total	Response Percent	Points	Avg
Strongly Agree	0	0%	n/a	n/a
Agree	1	4%	n/a	n/a
Neutral	0	0%	n/a	n/a
Disagree	4	16%	n/a	n/a
Strongly Disagree	20	80%	n/a	n/a
Total Respondents	25	100%		

5. I found the various functions in the Imprnt app were well integrated.

	Response Total	Response Percent	Points	Avg
Strongly Agree	10	40%	n/a	n/a
Agree	13	52%	n/a	n/a
Neutral	1	4%	n/a	n/a
Disagree	1	4%	n/a	n/a
Strongly Disagree	0	0%	n/a	n/a
Total Respondents	25	100%		

6. I thought there was too much inconsistency in the Imprnt app.

	Response Total	Response Percent	Points	Avg
Strongly Agree	0	0%	n/a	n/a
Agree	0	0%	n/a	n/a
Neutral	2	8%	n/a	n/a
Disagree	11	44%	n/a	n/a
Strongly Disagree	12	48%	n/a	n/a
Total Respondents	25	100%		

7. I would imagine that most people would learn to use Imprnt very quickly.

	Response Total	Response Percent	Points	Avg
Strongly Agree	18	72%	n/a	n/a
Agree	5	20%	n/a	n/a
Neutral	1	4%	n/a	n/a
Disagree	1	4%	n/a	n/a
Strongly Disagree	0	0%	n/a	n/a
Total Respondents	25	100%		

8. I found the Imprnt app very cumbersome to use.

	Response Total	Response Percent	Points	Avg
Strongly Agree	0	0%	n/a	n/a
Agree	1	4%	n/a	n/a
Neutral	0	0%	n/a	n/a
Disagree	9	36%	n/a	n/a
Strongly Disagree	15	60%	n/a	n/a
Total Respondents	25	100%		

9. I felt very confident using Imprnt.

	Response Total	Response Percent	Points	Avg
Strongly Agree	15	60%	n/a	n/a
Agree	7	28%	n/a	n/a
Neutral	3	12%	n/a	n/a
Disagree	0	0%	n/a	n/a
Strongly Disagree	0	0%	n/a	n/a
Total Respondents	25	100%		

10. I needed to learn a lot of things before I could get going with the Imprnt app.

	Response Total	Response Percent	Points	Avg
Strongly Agree	0	0%	n/a	n/a
Agree	0	0%	n/a	n/a
Neutral	0	0%	n/a	n/a
Disagree	7	28%	n/a	n/a
Strongly Disagree	18	72%	n/a	n/a
Total Respondents	25	100%		

11. What type of Imprnt user did you register as?

	Response Total	Response Percent	Points	Avg
Adopter	21	95%	n/a	n/a
Rescue Organization	1	5%	n/a	n/a
Total Respondents	22	100%		
(skipped this question)	3			

12. Was there any information you felt was missing from the Imprnt dog profiles that would help you in taking next steps of the adoption process? Was there any information you felt was unnecessary or could be removed from the Imprnt dog profiles?

Total Respondents	**20**
(skipped this question)	5

13. Would you consider using the Imprnt app next time you are looking to adopt a pet?

	Response Total	Response Percent	Points	Avg
Yes	22	100%	n/a	n/a
No	0	0%	n/a	n/a
Total Respondents	22			
(skipped this question)	3			

14. Please explain why or why not for the previous question!

Total Respondents	**21**
(skipped this question)	4

15. Did you experience any weird or unexpected behaviors when interacting with Imprnt? If so, please describe them or list any room for improvements! Imprnt is a work in progress :)

Total Respondents	**19**
(skipped this question)	6

12. Was there any information you felt was missing from the Imprnt dog profiles that would help you in taking next steps of the adoption process? Was there any information you felt was unnecessary or could be removed from the Imprnt dog profiles?

No, the profile looks good.
No but I would like to see my top match presented first!
No the level of information was great
If the dogs were truly up for adoption (which I understand they were test profiles so this doesn't apply) it would definitely be helpful to list next steps for potential adopters, such as a link to the rescue's application or the rescue's email.
Behavior status and energy levels would be nice to be included in their profiles!
I think some of the only two question choices in the questionnaire should be 3 to keep it consistent amongst all the questions, like the do i want to leave them out and be okay without destroying anything. I am neautral on this as I keep them kenneled but I think I had to put disagree, I don't remember exactly. Nothing specific comes to mind that I thought was unnecessary. Possibly just confused on the one that said do I want them to be excited when I come home, I wasn't sure if that meant I wanted them to be jumping on me or just be chill.
Instead of using "young, adult, senior" I would put their actual age, if you know it! or approx age. Then under additional information talking about their temperament/personality, good with other dogs or no, energy level, health concerns, etc. I wouldn't remove any info!
I felt like it would be good to add if the dog was good with other dogs and kids if that information is known. Of course it could be added under additional information when they are not test dogs. I did not feel there was any unnecessary information!!!
You asked a lot of behavioral questions then put a percentage but didn't include anything about their personality on their profile
I think medical needs could be added, but I guess the rescue organization could put that in additional info. I'm trying to rescue a dog right now, and I've been running into issues with certain dogs requiring a fenced in backyard or not allowing an adopter who lives in an apartment. You could add a section about adopter requirements to make that info clear to potential adopters. You could also think about adding a question about your ideal breed or what specific kind of dog you're looking for.
Thought all the info was needed and helpful. Hit the main points I look for when attempting to find dogs in the area that would work well in my home environment. The only thing I would add is dog breed as a filter option. I have seen that on other search engines for local rescue animals.
Opportunity to list pet temperaments, exposure to children, cats and other dogs would be great, especially if there is desire to support fosters down the line :)
I think that a temperament tag could prove useful. Whether a dog is shy outgoing etc.. This may be something that is listed behind the scenes but I didn't see it in the profiles, except for in the additional comments section on one.
Maybe you'd add this, but under additional information like a "about me" section for the dog, like good with other dogs, good with children, needs to be only pet, needs a lot of exercise, etc.
NA
A glossary for what age range young, adult and senior are for the pups. I liked the profiles that had more information like how Josie had notes about her temperament. More consistent infor about each dog would be helpful in the notes so you have an idea of what the app tells you.since it's supposed to find you a good fit, having info on level of exercise/activity, a section on health info, training, gets along with other animals and then additional information would be helpful. I like the ease and "tinder" UI but if I were looking for a dog to fit my lifestyle I'm not sure the information provided on the sample profiles hit that mark for me. I also would have preferred the results to be in level of match. My first result was like a 61% match and as I scrolled through I had 70 and 80% matches. It would be nice if this were updated and maybe something telling me what wasn't a good match.
The dog profiles and questionnaire all seemed to be geared toward active dogs and owners. I think having questions that better describe a dogs personality outside of whether or not they are active is important. An option for a basic quiz and maybe a more in depth one about specific behaviors such as house training or dogs with kids

would be nice touch. But the overall dog profiles seemed very well put together and to contain the information that is needed before meeting a dog.
Descriptions of dogs behaviors and general breed characteristics is helpful when seeking to adopt a dog. Energy levels of dogs is also important to share - and any history that is known of the dogs back story including medical conditions Adoption fees, where would pet be adopted from
Percentages of matching dogs do not change even after reversing all answers in questionnaire
I think it would be helpful to include in the pet's bio if they are good with kids, cats, or dogs. A lot of people are adding on a pet to a family, so this is a common question we get from prospects. I also find the wording on "approximate age" confusing when there isn't a space to list an approx. age. Some people are very interested in approx. ages before adopting. Suggest rephrasing to something like "age range" or make a rich text field so users can fill in an age. Also think it would be really neat to be able to include videos, if possible. Sometimes videos do a better job at showing the animal's personality. I'd also consider adding a couple more fields for medical needs (sometimes a medically-dependent dog is a deal-breaker and saves us a lot of time if they know upfront); adoption fee (again, sometimes $ is a dealbreaker) ; and maybe personalities field where uses can select all the personalities that apply (for ex, Snuggle Bug, Laid Back, Loves to Play, etc.) < - that might also be a good space to include if the animal is good with cats/dogs/kids. Not sure how possible it is, but a small thing that is a little funky is the picture of the human in the image upload circle that says upload your dog, but really not a big deal at all. I am confused what the point of the questionnaire is, where did all of my answers go? I also recommend condensing the questionnaire to maybe 10 main questions. Some of the questions seemed a bit redundant or not applicable (ie; does this animal respect authority & seem trainable), rescues would never adopt out an animal that is deemed "dangerous" or "untrainable" and there are a few questions that I think would always receive a "yes" and may not be needed. I'd be happy to offer my opinions of questions, if you're interested :) Also last thing -- suggest including a field for rescues to link to their adoption applications & also a way to tell which pet is with which rescue. I think someday in the future, it'd be really cool to expand this to cats. But I totally get baby steps ;)

14. Please explain why or why not for the previous question!

easy to use and saves time looking through information vs on normal adoption websites!
Reason is because the imprnt profile shows the dog image as well as the dog details: name, breed, approximate age, gender etc.
It caters to my specific wants and seems like it would give me a lot of good options for dogs that would work well in my home.
Yes! I think it's a great way to gain knowledge on what kind of dog breed and behavior you would match the best with as opposed to the overwhelming choices when you just walk into a shelter
It's a good way to see dogs that fit your personality!
It's a very easy to use app and I find it helpful when looking for the right pup!
It's a user friendly app that takes into account your lifestyle and the adoptable dog's to ensure you would be a good fit. It makes your process of finding the right dog for you easier as you would have a base level undeestanding of what you are looking for!
I think it's a really easy way to see the pets up for adoption without having to physically go to a location first. It makes it very convenient and I think more pets would get adopted that way if people have easy access to seeing & learning about them
I think I would definitely use this app, as well as recommended it to friends!!! The idea of having 'matches' based on specific questions really will tell you all need to know about the dog. So many people are quick to go after breeds for looks or whatever reasons, and get upset they are are missing certain qualities. This app is such a good idea for both rescue organizations and people adopting to increase knowledge for the people who are adopting, and for the adopters to really know what kind of dog they want! The app was super easy to navigate and play around on and would be suitable for all ages!! When I got my dog, I really had no clue what I was looking for including personality, shedding, size, and everything in between. This app easily lays it out for you and would be beneficial for a first time dog owner and even an experienced dog owner!!! Overall great app, super easy to use, and I would use this again and recommend to others!!!
You can only see so much about the personality of a pet with one visit

This is way easier and more fun to use than adoption websites! I find myself constantly on various adoption websites, scrolling through the dogs, but the websites are usually harder to navigate. This app is easy because I wouldn't need to go to all the different websites, all the dogs are right here on one app!
It's simple. Also you to only look at dogs that would be a good fit for your lifestyle. Narrows down your options to keep everything easy and not overwhelming.
The app is incredibly user friendly, familiar, and has a structure that flows intuitively, and simplifies a process that is otherwise pretty complicated, many shelters, adoption centers, etc have outdated and clunky websites.
It is a great concept. It streamlines the process of finding a pet the suits your needs or personality.
Love it. although it only matched me and peyton a 71% and I feel that we are 100%. Beamer was an 80%
The ability to filter dogs based on preferences would make searching for new dog easier than having to reach out to different rescues and ask about specific dogs
I think the app is easy but without more info about each dog, I probably would use this as a starting point and then probably switch to another method of zeroing in on an adoptable pets.
It is a great concept and has the potential to be a fantastic tool for potential dog parents. The interface was extremely user friendly. Obviously some work needs to be done to the questions and actual content but the construction of the app was fantastic. The graphic design was also very friendly and inviting.
The concept is interesting - it's hard to tell with such little test data if the matching is accurate.
I believe I would once I was confident in the matching percentages.
I thought the UI was very clean and really liked that it automatically pulls in animals based on my location. That is a big pain point for a rescue like ours, since our fosters are literally scattered across the state. Overall, I really like the design and idea behind this. Making it easier for people to find their forever pal (esp. rescues like ours that doesn't have a facility) has always been a struggle.

15. Did you experience any weird or unexpected behaviors when interacting with Imprnt?

I think neutral options should be added to some of the questions asked on the imprnt app for the adoption of a dog.
I wanted it to give me my matches right after taking the quiz!
I have my text on my phone larger than most so when I went through the survey, the next buttons did not appear because my text is too large. When I exited out of the quiz, I could not hit the button to take it again because the text was too large to display it all on screen. When I made my text size small on the accessibility part of settings, I was able to access those buttons!
N/A
My liked dogs should have their own section on the home page so I can easily find them and narrow my search down
this is probably user error, but after the personality test it said "uh oh you have no matches" and then if I clicked on the button below where I were to view the dogs anyway, then it said I was actually a match for them
The only thing I noticed was that when I went to create an account, after typing my information in, when I went to create it, it said there was already an account with that email and then refreshed to the home page logged into the account I had just created. I wasn't sure if it was because I was sent an email link to register or not, but other than that, the app was great!!!!
Nope, it was great!
Everything worked smoothly and had no glitches or issues from start to finish.
After thumbs upping or thumbs downing a pet, their image seemed to disappear without indication of what action was performed, but of course those pets were locatable in the matches page.
I tried for a little while to see if anything would act up if the user did anything out of the ordinary. Continuously clicking things, swapping between profiles quickly things of that nature and nothing broke. One thing that I did notice is that when you click matches it seems like its making calculations each time the button is clicked. This might just be because of the load time, but it seems to me that it should only check for new matches if the user requests it to do so. Example: store previous matches and have a button to check for new matches. Also not really a problem but more a QOL thing. I found myself trying to swipe between menus when the only way to navigate

was to click them individually. So, the ability to swipe between menus could be useful but touch sensitivity might become an issue. It would open up the possibility of accidently swiping between menus. So, it has its pros and cons.
nope
I am >200 miles from the nearest dogs and whenever I go to 'browse' I need to select that option again
Nope
Just what I repeated in the previous questions about maybe a simple and a complex quiz for people to choose from. Similar to how people will take skincare or hair care quizzes and if they know more they can take the complex quiz, but for expected behavior for the dog and level of commitment to training the potential owner would bring to the table. Otherwise, fantastic app :)
I generated no matches & also displayed matches. I also wouldn't use red font unless it's an error. Consider making the action button the dominant color on screens that have next and cancel - wouldn't use red on the next button Make error messages clear.
When using the Home button and clicking on Browse all Imprnt Dogs, the app briefly showed pictures of dogs but then brough up a screen stating no dogs within 50 miles. This occurred each time even after changing distance to >200 miles.
I think the login page is a little busy. When typing in password I think there needs to be more space between the keyboard and the password text field (not sure how much control you have over that). Also might look nice if you added some space between the text and the buttons on the bottom of the login page. Also, I got an error message when clicking forgot password, not sure if this functionality was meant to work or not for the test.
I didn't realize you needed to complete the questionnaire after you put in details of the dog. I got excited and went straight to the questionnaire, filled it out, went back filled in the dog details and then tried to upload and it said I needed to fill out the questionnaire. When I clicked back into the questionnaire it appeared to have refreshed.