I. Use Case Description	
Use Case Name	*Find a Friend*
Use Case Identifier	
Source	
Point of Contact	*Ashley Choi, choia5@rpi.edu* *Danielle Villa, villad4@rpi.edu* *Debjani Ray-Majumder, raymad@rpi.edu*
Creation / Revision Date	12/2/2022
Associated Documents	

II. Use Case Summary	
Goal	*The goal of this ontology is to recommend a dog breed based on the specifications of a particular household*
Requirements	*The system must be able to differentiate between different breeds and their characteristics, as listed below:* *Breed Group, minimum height (once fully grown), maximum height, minimum weight, maximum weight, minimum expected lifespan, maximum expected lifespan, colors, markings, minimum price range, maximum price range, coat length, coat type, popularity ranking by year and organization, training purpose, intelligence, trainability, friendliness with strangers, friendliness with children, friendliness with cats, adaptability, watchdog ability, playfulness, health issue susceptibility, exercise needs, mental stimulation needs, barking level, drooling level, grooming level, and shedding level.* *The system must return a list of all dog breeds and their basic characteristics.*
Scope	*This application can only recommend dog breeds and will not recommend any breeds of other animals. This ontology should evaluate breeds using the following characteristics: height, weight, grooming frequency, shedding, energy, trainability, demeanour, hypoallergenic status.*
Priority	
Stakeholders	*Households looking to adopt a dog, dog breeders, shelters, pet stores, dogs*
Description	*This application recommends dog breeds to households given some specific characteristics of the homeowner based on a list of specifications: type of residence, including availability of indoor and outdoor space, number of individuals (along with factors about these individuals including allergies, exercise level, number of available interactable hours, and number of hours in the residence), and whether or not the family has children. Additionally, the recommendation would provide a list of other potential dog breeds that may suit the family's needs to account for any potential subjective factors like cuteness.*
Actors / Interfaces	*Customer/Seeking dog – This person will directly benefit from the ontology as it will help them find the dog that best suits their condition.* *Breeders – This actor will use the ontology to better determine households that are a good fit for the limited number of puppies per litter. They will also be more aware of what their specific breeds need and better take care of their litters prior to selling them.* *Pet Stores – This actor will benefit from being able to stock their stores with more dog breeds that fit the description of a large proportion of people in their local area. They will also benefit as owners who are more*

	aware of the needs of their dog will both purchase more dogs and purchase more supplies to properly meet the needs of the dog. *Shelters – This actor could benefit from knowing which dog breeds benefit in each type of home, allowing for the potential of transferring them to an area where there are more people that can provide them a suitable home. They will benefit if more users utilize this ontology as it will decrease the amount of dogs in shelters as a result of the new owners not being able to meet the needs of the dog.* *Dogs – This actor will benefit from this ontology as more people getting dogs will be aware of their needs and hopefully chose to provide them*
Pre-conditions	*The customer is aware of their family's size, age, housing situation, allergies, and overall level of fitness.* *The ontology must have a knowledge base with all information about all recognized dog breeds.*
Post-conditions	*The ontology will provide many different types of dog breeds, differentiated by their various height, weight, grooming frequency, shedding, energy, trainability, demeanour, and hypoallergenic status.* *The ontology will implement the following constraints as follows:* *Hard constraints:* *Allergies, the breed's exercise needs.* *If the user potentially has kids, friendliness with kids.* *If the user potentially has cats, friendliness with cats.* *If the user potentially has other dogs, friendliness with dogs.* *If the user lives in an apartment, potential breed/size restrictions, friendliness with strangers, and low barking.* *If the user requires a breed for a specific purpose, trainability and purpose.* *Soft constraints:* *User preferences, coat type, coat length, budget* *The application will then close.*
Triggers	*A household, looking to adopt/buy a dog but unsure of what breed, launches the application, inputs their information, and requests recommendations.*
Performance Requirements	
Assumptions	*We assume that people opening the application are looking to get a dog and not another type of pet.* *Dog breed assumptions:* *Having children -> breed should be good with kids, friendly, energetic, and less independent as kids will likely want to spend time with a more dependent dog* *Apartment/Small House -> breed should be of small height/weight,low amounts of barking, calm temperament, and friendly with strangers* *Student/Full-Time Employee -> breed should be more independent* *Having other pets -> breed should be friendly with other dogs or different pet species* *Student/Low Budget -> Breed should have fewer expensive health issues*

	and a lower requirement for expensive food/toys *Enjoys walking/hiking/exercise -> breed should be energetic and have high exercise needs* *Service dog/seeing eye dog/etc. -> breed should have high levels of trainability as they will likely be used for a task*
Open Issues	

III. Usage Scenarios

A young couple without children is looking for a medium-sized dog. They live in an apartment with a large backyard in Seattle, Washington. One person has a dog allergy and is not very active, but has a job where they can work at home. The other person is in the office from 9-5, but is interested in running and takes hikes. Due to busy schedules, the apartment will not be cleaned often.The recommender system, as such, will look for small to medium dogs that are hypoallergenic, good with strangers, low level of barking, does not require constant physical activity, and has a low grooming and drooling level. The system will incorporate hard constraints on the dog allergy, activeness, as it is incredibly important to some breeds to get enough exercise, low level of barking, and smaller size, as many apartments will have breed and size restrictions, which can later be edited by the user if this is not the case. Soft constraints of the family's preferences, the medium sized dog, good with strangers, as it is not guaranteed that the dog will be in constant company of strangers, and the low amounts of drooling and grooming, will be taken into consideration.

A large family consisting of 3 kids is looking for a dog. They live in a very large house with a large front yard. The kids are ages 6, 9, and 15. Their house is in Stamford, Connecticut. There is always someone at home, and there are known allergies. Additionally, the parents are looking to provide a pet that will both entertain their kids and provide a sense of responsibility. They have a pet cat.The system will look for dogs that enjoy a regular amount of exercise, is good with children, has a medium coat to handle the variety of weather in Stamford, Connecticut, enjoys attention, and is good with cats. The hard constraints that the system will put in place include being good with children and being good with cats. Soft constraints will include having a medium coat, requiring a regular amount of exercise, and enjoying attention.

A young person looking to work as a dog trainer is looking for a new challenge to take on. They live in an area with lots of backyard and local trails for hiking trips. They are hoping to adopt and foster as many dogs as possible, hoping for this first dog to be a good leader for the rest. They currently work a remote job. They have a garden in the backyard that they regularly maintain. The recommender system will look for dogs that have low trainability values, enjoy lots of exercise, and get along well with other dogs. The hard constraints for this would be getting along with other dogs. The soft constraints will include the owners preferences, including low trainability and high amounts of exercise.

An older person is looking for a new life companion. They were hoping to create a social media page for their new dog as it would give them an excuse to keep in touch with their children and grandchildren. They live alone in a small apartment, but they would like a lively dog. They live on retirement with a very low influx of money. The system will prioritize dogs that are popular, small, low levels of barking, good with strangers, energetic, and generally have a low amount of health issues. Hard constraints include a small size and low levels of barking. Soft constraints include being good with strangers, as it is not guaranteed the dog will be exposed to strangers often, low amounts of health issues, as health issues cannot always be accurately predicted, and energetic, as these are more preferences of the user.

A family with small kids are looking for a dog to help around their farm in Texas. They live in a large farm house with a lot of land and expect a breed that can act as a herding dog. There are no known allergies and are willing to exercise the dog as much as needed. The recommender system will look for dogs that can perform the herding purpose with high trainability levels, high exercise levels, and good with kids. The hard constraints for this dog would be high herding ability and good with kids with soft constraints of high

trainability and exercise levels.

A group of 4 college students is looking to adopt a dog. They live in an apartment and want a dog to take on their weekend adventures. Their apartment complex has a small yard garden. The system will infer that the household has a low budget and a low amount of available time due to their student status, thus requiring a dog with a cheaper purchase cost and more independence. Additionally, the system will infer that the dog should have low to medium exercise needs, small to medium size, low amounts of barking, and good with strangers due to their apartment conditions. Thus, the system will recommend dogs that are cheaper to purchase, more independent, have low to moderate exercise needs, have small to medium size, low amounts of barking, and friendliness with strangers. The hard constraints will be independence and low amounts of barking while soft constraints will consist of low to moderate exercise needs, small to medium size, friendliness with strangers, and a lower cost to purchase.

A family just came into a pet store looking to get a new dog, and the store owner wants to help them find a dog that would work well with their lives. The parents said that they hadn't done any research yet since they wanted their kids to pick a dog they like, but that they weren't worried because they already had a dog and a cat. The store owner is worried that the dog the children pick will not get along with the other animals. The parents also said that there were no known allergies and that they had a large backyard for the dogs and kids to play in.

IV. Basic Flow of Events

Basic / Normal Flow of Events			
Step	**Actor (Person)**	**Actor (System)**	**Description**
1	User		Launches application
2	User		Inputs information regarding household characteristics
3		System	Creates assumptions about household characteristics and returns to use
4	User		Adjusts assumptions/characteristics
5	User		Requests breed recommendations
6		System	Queries knowledge base and ranks potential dog breeds
7		System	Returns rankings,dog breed characteristics, corresponding dog breed characteristics, and source for dog breed information
8	User		Receives and analyses returned results
9	User		Is satisfied with results and finds a pet store/breeder/shelter to adopt the dog

Description: This is the basic flow for a standard usage of the recommender. The user, a person looking to adopt a dog, will log into the application and input their household information. The application will make assumptions based on the household characteristics and wait for confirmation from the user to edit/confirm necessary breed characteristics. The application will then query its knowledge base and return a ranked list of breeds that fit the needs of the user, the breed/user characteristics that match, and the sources of the breed characteristic.

V. Alternate Flow of Events

Alternate Flow of Events #1			
Step	**Actor (Person)**	**Actor (System)**	**Description**

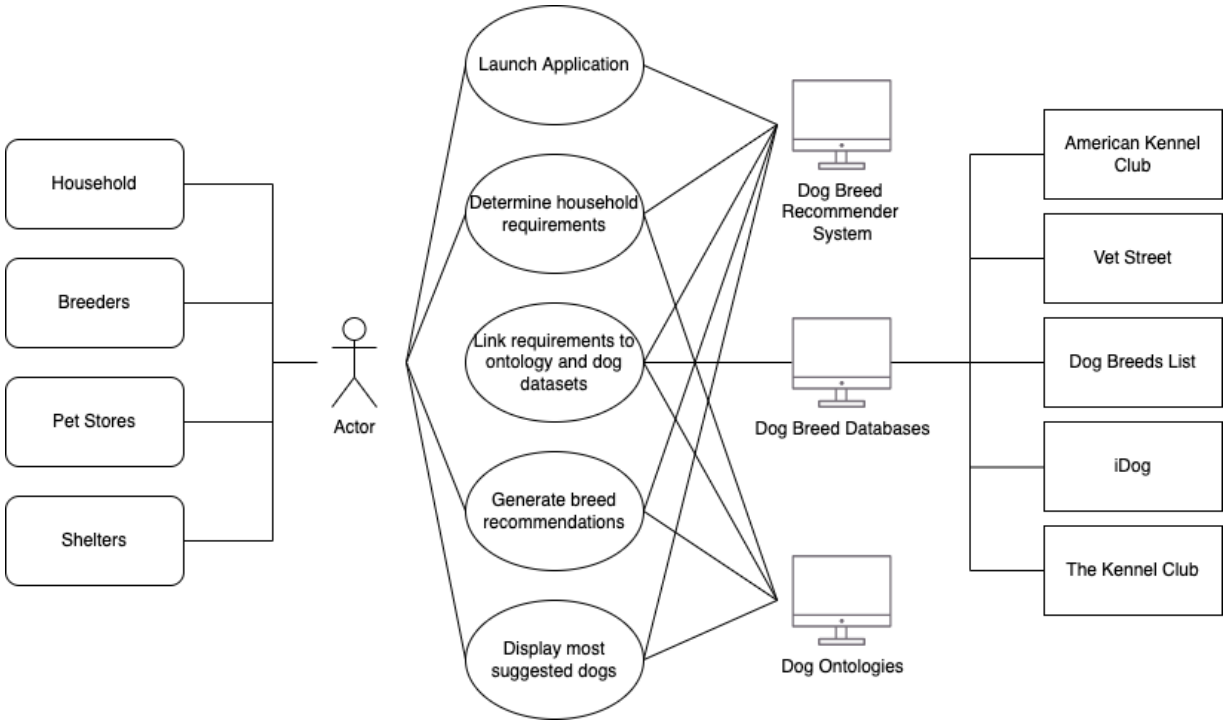
1	User	System	Proceeds with steps 1-9 of basic flow
2	User		Is unsatisfied with existing results because top rated breed is not cute
3	User		Indicates to the system to not include the previously-suggested breed in its recommendations
4	User		Requests new breed recommendations
5	User	System	Return to step 6 of Basic Flow

Description: This is an alternate use case for if the user is not satisfied with the results of the recommender. Specifically, if the user is not satisfied with the cuteness of the top recommendations.

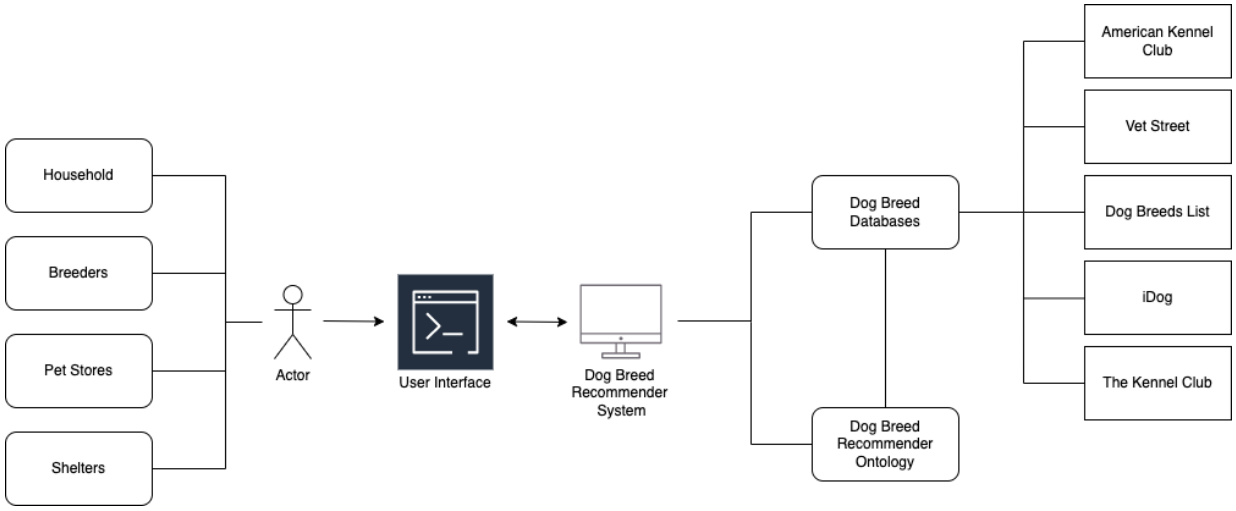
VI. Use Case and Activity Diagram(s)

Provide the primary use case diagram, including actors, and a high-level activity diagram to show the flow of primary events that include/surround the use case. Subordinate diagrams that map the flow for each usage scenario should be included as appropriate

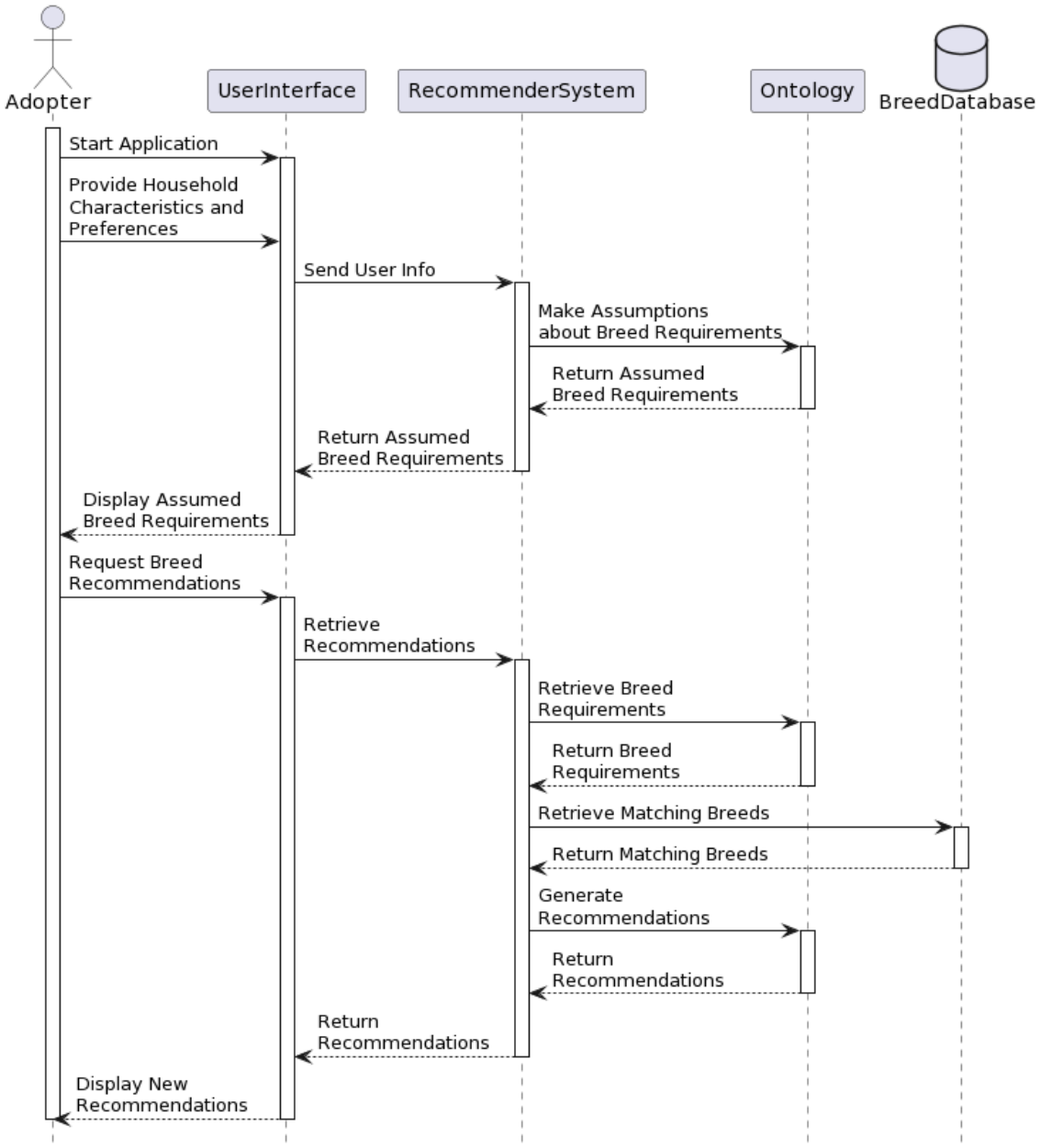
Use Case Diagram



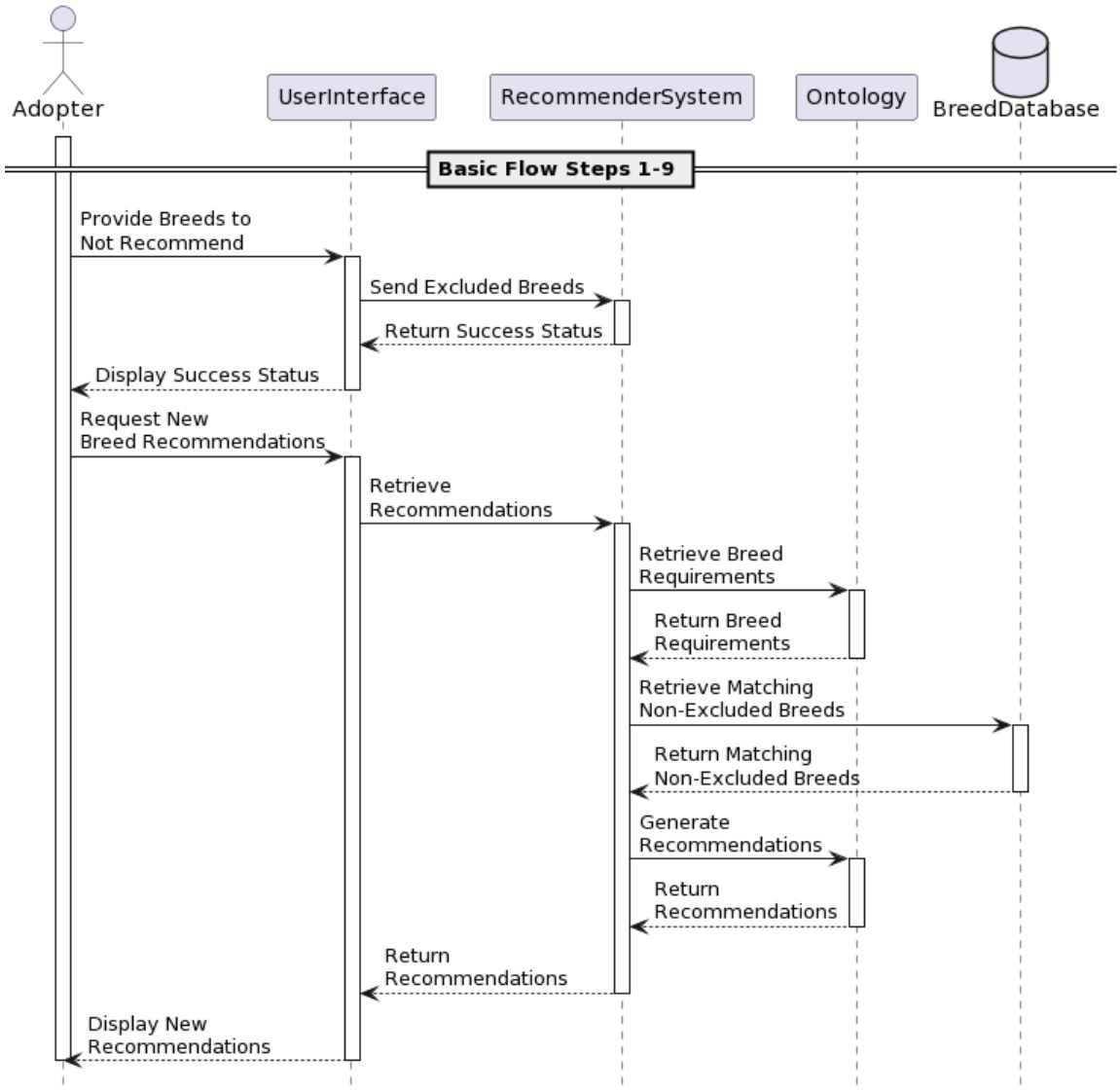
Architecture Diagram



Activity Diagram - Basic Flow



Activity Diagram - Alternate Flow #1



VII. Competency Questions

Competency questions that were prioritised are bolded

These results are examples based on a small selection of breeds and a minimum necessary characteristic value of 0.5. Changing this value or searching over a every possible breed may provide other answers.

1. **What dog breed would meet the needs of a large family with allergies in a large home?**

   Sample answer: Labrador Retriever
   Terms used: dog, breed, family, residence, indoor space, house, family, person, allergies
   Semantic process involved: Simple lookup to find suitable breeds, reasoning to check for constraints
   Usage scenario covered: A large family consisting of 3 kids is looking for a dog.
   Description and ontology use:

   Ontology process: The system first infers that the family requires a hypoallergenic dog. It next must infer from the large family that there are children. Thus, it requires a breed that is safe around

children and has a high energy level. Using this information, the system will query for breeds that are hypoallergenic, safe for children, and playful. Finally, the system sorts based on popularity, producing the top 10 results, with the top result being a labrador retriever. Users may request for more results if unhappy with the first. Alternatively, they may also re-do the ontology and readjust some of the initial assumptions made.

2. What dog breeds are good for students living in apartments?

   Sample answer: Japanese Chin
   Terms used: dog, breed, person, number of available hours, residence, indoor space, apartment
   Semantic process involved: Simple lookup to find suitable breeds, reasoning to check constraints
   Usage scenario covered: A group of 4 college students is looking to adopt a dog.

   Ontology process: Since the adopter is a student, the system can infer that they likely have little free time and a small budget. Since they live in an apartment, the system can infer that any pet must be apartment friendly and not annoy any neighbours by being loud or aggressive. Using this information, the system can query for breeds with low activity needs, low health problems (since those are expensive), are apartment friendly, bark less, and are less likely to be aggressive towards strangers. The system will sort by popularity and return the top 10 results, with the top 1 results being a Japanese Chin. If the user wishes to create a hard constraint on the estimated level of expense, they can specify this as a hard constraint after the initial breed requirements are displayed.

3. What dog breeds are good for a farm environment in Texas?

   Sample answer: Australian Cattle Dog
   Terms used: dog, breed, residence, outdoor space, yard, trainability, purpose
   Semantic process involved: Simply look up to find suitable breeds, reasoning to check constraints
   Usage scenario covered:A family with small kids are looking for a dog to help around their farm in Texas

   Ontology process: Since the dog will be on the farm, the system will first infer that they will be around other animals. The system will also know to find dogs that are capable of being trained to perform tasks, like herding other animals, and a dog that is likely to get along with other animals. From here, the system knows to narrow down for an athletic, trainable dog that is animal friendly. Additionally, with the owner living in Texas, the dog will need to be able to withstand lots of heat in addition to lots of exercise. Using this information, the system will query for breeds with high tolerance for other farm animals, high activity levels, high trainability and a light fur coat. The system will sort by popularity and return the top 10 results, with the top 1 results being an australian cattle dog.

4. **Is a greyhound a good breed for a large family with multiple pets, including cats and other dogs?**

   Sample answer: No
   Terms used: dog, breed, family, cat friendliness, child friendliness
   Semantic process involved: Look up suitable breeds, reasoning to check constraints, check constraints against listed breed
   Usage scenario covered: A large family consisting of 3 kids is looking for a dog; A family just came into a pet store looking to get a new dog

   Ontology process: Since the adopter is a large family, the ontology assumes that there are children in the household and that an affectionate dog would be preferred. Since there are other pets in the household, any breed should not be aggressive towards cats or dogs. Using this information, the system would match this adopter with a breed that is cat friendly, child friendly, and dog friendly.

It compares these characteristics with those of a greyhound, and finds that all characteristics match except being cat friendly, so it returns that it is not a good fit.

5. **What is a cute dog breed that can do well in an apartment that doesn't get cleaned very often?**

   Sample answer: Poodle
   Terms used: dog, breed, residence, indoor space, apartment, drooling level, grooming level, ranking,
   Semantic process involved: Look up suitable breeds, reasoning to check constraints
   Usage scenario covered: A young couple without children is looking for a medium-sized dog.

   Ontology process: Since the dog will live in an apartment, it should be apartment friendly. This means that the dog should not be too big, not aggressive towards strangers, and not bark frequently. If the home is not cleaned frequently, the system can assume that any dog shouldn't shed much to prevent shed hair from building up in the home and not drool much for similar reasons. Additionally, while the system cannot quantify 'cuteness,' it will prioritise popular dogs under the assumption that more popular dogs will be better liked by the average person, accounting for subjective characteristics that the system cannot quantify. The system will then query for low shedding, low drooling, apartment friendly dogs and sort by popularity.

VIII. Resources

Knowledge Bases, Repositories, or other Data Sources

Data	Type	Characteristics	Description	Owner	Source	Access Policies & Usage
AKC (American Kennel Club) Dataset	Remote	Web-based	Dataset containing the following data points about 277 breeds recognized by the AKC	AKC	https://www.akc.org/dog-breeds/	Free for personal/Non-commercial usage
VetStreet	Remote	Web-based	Dataset containing information about dog breeds from vetstreet	VetStreet	http://www.vetstreet.com/dogs/breeds	Free for personal/non-commercial usage
Dog Breeds List	Remote	Web-based	Contains characteristics per breed, popularity, and standard price range	Dog Breeds List	https://www.dogbreedslist.info/	Free for personal/non-commercial usage
The Kennel Club UK	Remote	Web-based	Dataset containing data points about 222 breeds, with some info specific to the UK	The Kennel Club	https://www.thekennelclub.org.uk/search/breeds-a-to-z/	Free for academic use

External Ontologies, Vocabularies, or other Model Services

Resource	Language	Description	Owner	Source	Describes/Uses	Access Policies & Usage
SKOS	RDF/OWL	A W3C recommendation designed for classification schemes, taxonomies, subject-heading systems, or any other type of structured controlled vocabulary	W3C	https://www.w3.org/TR/2008/WD-skos-reference-20080829/skos.html	Used for sharing and linking knowledge organization via the semantic web	Free for non-commercial use
Language, Countries, and Code (LCC)	RDF/OWL	Represents countries and country subdivisions, as well as individuals of all US states	Object Management Group Inc.	https://www.omg.org/spec/LCC/Countries/CountryRepresentation/	Used for adding different US states to account for climate	Free for non-commercial use
The Provenance Ontology (PROV-O)	RDF/OWL	Provides a model of tracking provenance throughout a system	W3C	https://www.w3.org/ns/prov#	Used for adding provenance to our breed information	Free for non-commercial use
OMG Ratings	RDF/OWL	Provides a model for organization to provide ratings and rankings	OMG	https://www.omg.org/spec/Commons/Ratings/	Used to add popularity rankings to our breeds	Free for non-commercial use

Other Resources, Service, or Triggers *(e.g., event notification services, application services, etc.)*

Resource	Type	Description	Owner	Source	Access Policies & Usage

IX. References and Bibliography

List all reference documents – policy documents, regulations, standards, de-facto standards, glossaries,

dictionaries and thesauri, taxonomies, and any other reference materials considered relevant to the use case

"Answer These 5 Questions to Find the Right Dog For You." The American Kennel Club. https://www.akc.org/expert-advice/lifestyle/answer-5-questions-find-right-dog/.

Babineau, J R. “Understanding the IECC's New Climate Zone Map.” Johns Manville, Berkshire Hathaway, 17 Mar. 2021, https://www.jm.com/en/blog/2021/march/understanding-the-iecc-s-new-climate-zone-map/.

"Dictionary by Merriam-Webster: America's most-trusted online dictionary." Merriam-Webster Dictionary. https://www.merriam-webster.com.

“Dog Breed Information Ultimate Resource: Listing of All Dog Breeds.” Vetstreet, http://www.vetstreet.com/dogs/breeds.

“Dog Breeds - Types of Dogs.” American Kennel Club, https://www.akc.org/dog-breeds/.

“Dog Breeds .” Dogbreedslist.info, https://www.dogbreedslist.info/.

"iDog." China National Center for Bioinformation: National Genomics Data Center. https://ngdc.cncb.ac.cn/idog/breed/getAllBreed.action

K.E. Holland, "Acquiring a pet dog: A review of factors affecting the decision-making of prospective dog owners," Animals, vol. 9, no. 124, Mar. 2019 , doi: 10.3390/ani9040124

Kendall, Elisa F., and Deborah L. McGuinness. Ontology Engineering. Morgan & Claypool Publishers, 2019.

"Oxford English Dictionary." Oxford Dictionary. https://www.oed.com/.

“SKOS Simple Knowledge Organization System RDF Schema.” W3C. https://www.w3.org/TR/2008/WD-skos-reference-20080829/skos.html

X. Notes

See the related work section of the website for other ontologies classifying pets or animals in general.

Every source provides different information on each breed, though some traits overlap. This means that every breed should have at least 2 characteristic profiles to cover every trait that we need for most reasoning (since the AKC doesn’t have all of them). Due to the OWA not having a value doesn’t mean it’s zero, but it does mean that the breed can’t be classified as anything requiring that value. Because of this, only 1 profile needs to have the required characteristic for classification, though this may be misleading if different sources give contradictory values (see results from query 3 on the website for an example of this).

Because we track provenance of profiles and rankings through object properties rather than just annotations, we should be able to reason with them. We have a way to deal with multiple organisations providing data for profiles (they’re all treated equally) but it’s unclear how this would apply to rankings. Maybe it's worth looking into for future work.