Report Outline

I. Abstract: When looking for a dog to adopt, there is no automated method to match potential owner preferences to appropriate dog breeds. Currently potential owners need to go to the internet and try to manually find a breed that will meet specific needs of an individual or a family. It is often difficult to find a breed if there are multiple criteria and constraints. To address this need to meet multiple, sometimes conflicting, requirements of finding a matching breed of dog to adopt, we propose an ontology-based solution that ultimately forms the basis of a recommender of dog breeds to households, given some specific characteristics of the homeowner, their home, family, and personal preferences. The proposed ontology-supported application recommends dog breeds to households given some specific characteristics of the homeowners like home size, activity level, child friendliness. Additionally, the recommendation will provide a list of other potential dog breeds that may suit the family's needs, to account for any potential subjective factors like cuteness.

II. Introduction/Motivation: In recent years, dogs have become popular family members across households in America. They represent companionship, loyalty, and are often irresistibly cute. With the popularity of pet dogs comes an increase in the amount of dogs available for adoption, whether through a breed, pet store, or shelter. Presently, there is a cycle of dogs being adopted, returned, and sent to a shelter, where they may potentially have a deadline for re-adoption before they get put down. As such, it is important that dogs that are adopted are being sent to their forever-homes. By creating an ontology that best matches a household to specific breeds such that both parties have all of their needs met, we hope to lower the amount of dogs that are sent into the shelter cycle.

III. Use case - summary and pointer to your online use case:
    A. *Website Version:* https://dog-breed-ontology--rpi-ontology-engineering.netlify.app/oe2022/dog-breed-ontology/usecase
    B. *Google Drive Version:* OE_10_DogBreedOntology_UseCase_Clean.docx

IV. Technical Approach:
    A. *Use Case and competency questions:* We started this project by first coming up with ideas for a use case and potential competency questions/uses for the topic. From there, we had decided on one topic and refined our use case to be achievable but challenging in the timespan of the semester. We had also filled

out the use-case template, which required activity diagrams, architecture diagrams, usage scenarios, and other pieces of descriptive information in order to ensure that our idea had been well fleshed out. From there, we had further developed our competency questions to capture a larger variety of question types.

B. *Terms list*: After developing our use-case and competency questions, we had developed a preliminary terms list: this was a list of vocabulary that we would later use to build our initial concept model, which we had later translated to our ontology. This included the definition, the source, the usage notes, labels, and anything else that could be useful to have documented.

C. *Concept model description:* We had built our concept model on the existing vocabulary that we had built. We structured our model such that we could model our breeds with characteristics while re-using as much from other ontologies as possible in order to avoid re-creating many aspects (such as location, provenance, party structure, etc). We currently have a model that has a characteristic profile and a physical profile to model the different potential aspects of a breed that may impact a user and modeled other factors about a dog in our ontology to make logistical sense (for example, we have coat type class that has specific type classes like rough coat type or curly coat type). On the other side of our conceptual model, we have information about the potential adopter, including factors like their residence space and location, their members, and other characteristics that might impact the needs of a given dog breed. Our most updated conceptual model can be found below.

   Link to most recent concept model:
   Website Version:
   https://dog-breed-ontology--rpi-ontology-engineering.netlify.app/oe2022/dog-breed-ontology/ontology#conceptual-model
   Google Drive Version:
   OE_10_DogBreedOntology_ConceptualModel_Clean.pptx

D. *Ontology:* We had built our ontology to just model the existing conceptual model described above. Throughout the weeks of updating our ontology, we have strived to include more libraries for re-usage, add provenance, add more logic to improve our reasoning, and constantly restructured our existing model in attempts to model our ontology in the way that works the most efficiently.

   Link to ontology:
   Website Version:

https://dog-breed-ontology--rpi-ontology-engineering.netlify.app/oe2022/dog-breed-ontology/ontology#ontologies
Google Drive Version (Main):
OE_11_DogBreedOntology.rdf

E. *Individuals:* Our individuals file utilizes information web scraping in order to create instances that will allow us to prove that our competency questions can be answered utilizing reasoning from our ontology. It imports our main ontology in order to incorporate all of our base logic, but includes more specific information in order to keep these two things separate.

Google Drive Version (Individuals):
OE_11_DogBreedOntology_Individuals.rdf

V. Related Work - you can fill this in later

VI. Evaluation: The evaluation of our ontology-recommender system is based upon its ability to provide answers to our primary competency questions:

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

- Sample answer: Goldendoodle
- 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.
- 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 good with children, friendly, and has a high energy level. Using this information, the system will query for breeds that are hypoallergenic, good with children, high amounts of energy, friendly, and very active. Finally, the system sorts based on popularity, producing the top 10 results, with the top result being a Goldendoodle. 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 neighbors 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 Cattledog
- 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. From here, the system knows to narrow down for a larger, athletic dog with a loud bark. 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 intelligence 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 Cattledog.

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

- Sample answer: Mediocre fit, greyhounds are not cat friendly
- 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, dog friendly, and affectionate towards family. It compares these characteristics with those of a greyhound, and finds that all characteristics match except being cat friendly.

(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. Since no precise restrictions are specified the size of the dog is not restricted. 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. Additionally, while the system cannot quantify 'cuteness,' it will prioritize 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 apartment friendly dogs and sort by popularity.

VII. Discussion

A. Value of Semantics: Semantics were incredibly important to our project because it allowed us to properly create classifications for different characteristics that may only be semi-related. For example, we have defined apartment friendliness to be breeds that have low barking, high stranger friendliness, and a small to medium size. While these characteristics don't specifically make a breed the best for an apartment, these qualities are important for a dog that will be living in a small space, which generally makes them fairly good candidates for this scenario. Semantics have allowed us to define this in our ontology such that these characteristics are connected, resulting in the search for apartment friendly breeds to bring up a list of dogs that have all of these qualifications. We use semantics throughout the entirety of our ontology for this type of logical specification.

B. *Project Website:* Our project can be found at the following website https://dog-breed-ontology--rpi-ontology-engineering.netlify.app/oe2022/dog-breed-ontology/

C. *Limitations:* Many of the limitations within our project involved the limited scope that we created in order to ensure we'd have a working project within our semester time frame. The parts of the project that have been scoped are discussed within the "Future Work" section of this report;

VIII. Future Work:

When more research has been done on the topic, we would hope that some future work would take into account how different coat types and length potentially affect the level of hypoallergenic that a breed has. Provided we have the information, this implementation could appear as another restriction or could require a re-work

of our existing framework in order to have hypoallergenic status represented as a numeric value that suggests a dog is more or less likely to cause allergies.

Another area that could be explored during future work would be the inclusion of non-US breeds and/or common mixed breeds. We had initially intended on including common mixed breeds, but later came to realize that these breeds lack the same extensive research that we get with US-recognized breeds from some of our sources, including the American Kennel Club.

IX. Conclusion:

At the time of creating this outline, we can confidently say that we have represented our ontology in traditional RDF language through the usage of Protege and some web scraping. We are confident in our ability to return relevant dog breeds for simpler requests that rely on qualities like apartment-friendliness, child-friendliness, and other specific breeds that we had created.

X. References

"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