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# A Novel Algorithm for Breed-Specific Climate Understanding for Dog Safety

Final Report for CSCI 5939 - Internship

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## Preface & Acknowledgement

For three months from May 2019 till August 2019, I did an internship at Pupptech Inc, a software company which has products for dog safety in the USA. Pupptech Inc. distributes different products Puppcomm, K9 Weathervane & BSCUIT to their customer having the vision of dog safety. This internship project is a part of my 5-year Ph.D. program which I conduct at the University of Colorado Denver, USA.

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## List of Abbreviations

**BSCUIT**                      Breed Specific Climate Understanding Information Technology

## List of Breeds

Affenpinscher  
Airedale Terrier  
Akita  
Alaskan Malamute  
American Bulldog  
American Bully (Standard)  
American Eskimo Dog (Miniature)  
American Eskimo Dog (Standard)  
American Pit Bull Terrier  
American Staffordshire Terrier  
Australian Cattle Dog (Heeler)  
Australian Kelpie  
Australian Shepherd  
Australian Terrier  
Barbet  
Basenji  
Basset Hound  
Beagle  
Beauceron  
Bedlington Terrier  
Belgian Malinois  
Belgian Tervuren  
Bernese Mountain Dog  
Bichon Frise  
Black and Tan Coonhound  
Bloodhound  
Bluetick Coonhound  
Boerboel  
Border Collie  
Border Terrier  
Borzoi  
Boston Terrier  
Bouvier des Flandres  
Boxer  
Boykin Spaniel  
Bracco Italiano  
Briard  
Brittany  
Brussels Griffon  
Bull Terrier (Miniature)  
Bulldog  
Bullmastiff  
Cairn Terrier  
Cane Corso  
Cardigan Welsh Corgi  
Catahoula Leopard Dog  
Caucasian Shepherd (Ovcharka)  
Cavalier King Charles Spaniel  
Chesapeake Bay Retriever  
Chihuahua (Apple-headed)  
Chihuahua (Long hair)  
Chihuahua (Smooth)  
Chinese Crested  
Chinese Shar-Pei  
Chinook  
Chow Chow  
Clumber Spaniel  
Cocker Spaniel (American)  
Cocker Spaniel (English)  
Collie  
Coton De Tulear  
Dachshund  
Dalmatian  
Doberman Pinscher  
Dogo Argentino  
Dogue de Bordeaux  
Dutch Shepherd  
English Mastiff  
English Setter  
English Shepherd  
English Springer Spaniel  
English Toy Spaniel  
English Toy Terrier  
Entlebucher Mountain dog  
Eurasier  
Field Spaniel  
Finnish Lapphund  
Finnish Spitz  
Flat Coat Retriever  
French Bulldog  
German Pinscher  
German Shepherd  
German Shorthaired Pointer  
Giant Schnauzer  
Glen of Imaal Terrier  
Golden Retriever

Gordon Setter	Presa Canario
Great Dane	Pug
Great Pyrenees	Puli
Greyhound	Pumi
Harrier	Rat Terrier
Havanese	Redbone Coonhound
Irish Setter	Rhodesian Ridgeback
Irish Terrier	Rottweiler
Irish Wolfhound	Russian Toy Terrier
Italian Greyhound	Saint Bernard
Japanese Chin	Saluki
Japanese Spitz	Samoyed
Keeshond	Schipperke
Kerry Blue Terrier	Scottish Deerhound
Komondor	Scottish Terrier
Kooikerhondje	Shar-Pei
Kuvasz	Shetland Sheepdog (Sheltie)
Labrador Retriever	Shiba Inu
Lagotto Romagnolo	Shih Tzu
Lancashire Heeler	Shiloh Shepherd
Leonberger	Siberian Husky
Lhasa Apso	Silky Terrier
Maltese	Smooth Fox Terrier
Miniature American Shepherd	Soft Coated Wheaten Terrier
Miniature Pinscher	Spanish Water Dog
Miniature Schnauzer	Spinone Italiano
Neapolitan Mastiff	Staffordshire Bull Terrier
Newfoundland	Standard Schnauzer
Norfolk Terrier	Swedish Vallhund
Norwich Terrier	Thai Ridgeback
Nova Scotia Duck Tolling Retriever	Tibetan Mastiff
Old English Sheepdog	Tibetan Spaniel
Olde English Bulldogge	Tibetan Terrier
Papillon	Toy Fox Terrier
Parson Russell Terrier	Treeing Walker Coonhound
Patterdale Terrier	Vizsla
Pekingese	Weimaraner
Pembroke Welsh Corgi	Welsh Springer Spaniel
Pharaoh Hound	West Highland White Terrier
Plott	Whippet
Pointer (English)	White Shepherd
Pomeranian	Wire Hair Fox Terrier
Poodle (Miniature)	Wirehaired Pointing Griffon
Poodle (Standard)	Xoloitzcuintli
Poodle (Toy)	Yorkshire Terrier
Portuguese Water Dog	

## Introduction

Dog Safety is now one of the concern issues in the USA. The term “*dog safety*” includes weather effect related to the breed-specific dog. Some dogs need special consideration in terms of their age, breed, weight etc. The importance of such an issue is focused on an article by *Patrick Kruse*, the founder and R&D director of Bend, Oregon–based dog gear brand Ruffwear. He said that securing a dog is kind of like buying a fire extinguisher. Most of us don’t plan on testing a dog safety harness, but if one’s ever does, it really becomes apparent that having a dog restrained is a good thing [1].

In our research, we conduct a study on over 170 different breeds in USA and what happened to them on temperature changes. We construct **BSCUIT** algorithm to solve such issue. **BSCUIT** refers to *Breed Specific Climate Understanding Information Technology*. The main objective of this algorithm is to make a personalized decision for dogs. The algorithm considers several characteristics of a dog to determine the comfort range for that dog. In this study, we also visualize the output of BSCUIT using another application named **K9 Weathervane**. This application is also used as a test application for our BSCUIT algorithm.

## Problem Statement

Every year, hundreds of pets die from heat exhaustion because they are left in parked vehicles without any monitoring system. The excuse: "Oh, it will just be a few minutes while I go into the store," or "But I cracked the windows...". These excuses don't amount to much if your pet becomes seriously ill or dies from being left in a vehicle.

The temperature inside a vehicle can rise almost  $20^{\circ} F$  in just *10 minutes*. In 20 minutes, it can rise almost  $30^{\circ} F$ ...and the longer you wait, the higher it goes. At 60 minutes, the temperature in your vehicle can be more than 40 degrees higher than the outside temperature. Even on a 70-degree day, that's 110 degrees inside your vehicle! It refers that a vehicle can quickly reach a temperature that puts a pet at risk of serious illness and even death, even on a day that doesn't seem hot to the owner. And cracking the windows makes no difference.

Elapsed time	Outside Air Temperature (F)					
	70	75	80	85	90	95
0 minutes	70	75	80	85	90	95
10 minutes	89	94	99	104	109	114
20 minutes	99	104	109	114	119	124
30 minutes	104	109	114	119	124	129
40 minutes	108	113	118	123	128	133
50 minutes	111	116	121	126	131	136
60 minutes	113	118	123	128	133	138
> 1 hour	115	120	125	130	135	140

*Table 1: Estimated vehicle interior air temperature v. elapsed time*

A study showed that the interior temperature of vehicles parked in outside temperatures ranging from 72 to 96° F rose steadily as time increased [2]. Another research found that the temperatures in a dark sedan as well as a light gray minivan parked on a hot, but partly cloudy day, exceeded 125°F within 20 minutes [3].

## Research Objectives

Based on the observation that stated in the problem statement, the main research objective of this study is to make a monitoring system that allows the dog owner to track his/her dog in the car. The additional goal is to get the breed-specific temperature for dog safety.

The main objective above can be decomposed to 3 smaller objectives:

- **Objective 1:** Building an algorithm for breed-specific climate understanding for dog safety.
- **Objective 2:** Modelling an API for BSCUIT algorithm for public use.
- **Objective 3:** Building an application on top of BSCUIT algorithm named K9 Weathervane Which will provide safety factor with visualization for dogs.

## Technical Descriptions

This section describes the concept and architecture of **BSCUIT** and **K9 Weathervane** application, as well as the motivation of transforming from dog safety research to an application that enhances the security of dogs in the car. An important part of developing these applications is taking dog owner recommendations to make a better application.

This section is organized as follows: *subsection 2.1* describes BSCUIT algorithm and its API details. *Subsection 2.2* explains the concept of visualization of BSCUIT algorithm and develops K9 Weathervane application.

### Service: BSCUIT

This subsection will describe the BSCUIT algorithm. BSCUIT refers to **Breed Specific Climate Understanding Information Technology**. The main objective of this algorithm is to make a personalized decision for dogs as factor of dog safety. The algorithm considers several characteristics of a dog to determine the comfort range for the dog. In this research, dog information on over 170 breeds are taken to design the algorithm.

Parameters	Questions
Brachycephalic	What's the shape of your dog's face?
Coat	How thick is your dog's coat?
Overweight	Is your dog overweight?
Toy Breed	Is your dog a toy breed?
Age	How old is your dog?

*Table 2: BSCUIT parameters and questions*



The algorithm is developed based on some parameters. These parameters consider several characteristics of your dog to determine the comfort range for your dog. These parameters are shown in table 2.



*Figure 1: BSCUIT parameters & its visualization*

For example, Susan is a dog breed (yorkie) and we want to determine the dog safety score for this dog. The algorithm takes all the inputs related to BSCUIT parameters.

Parameters for Susan	Answers for Susan
Brachycephalic	Yes
Coat	Standard Coat
Overweight	9 lbs
Toy Breed	Yes
Age	8 years

*Table 3: Parameters for Susan*

Based on these parameters, BSCUIT algorithm will determine Susan’s comfort range. The recommendation is given below.

Susan is an upper middle-aged Yorkie that might be overweight, so BSCUIT has determined that she has a fairly narrow range of temperatures in which she is most comfortable. Susan also faces a higher risk of being exposed to temperatures outside of her comfort range.



Susan (Yorkie)



Susan’s Comfort Range

*Figure 2: Personalized comfort range for Susan (Yorkie)*

After developing the algorithm, I also develop **BSCUIT API**. During this development, I make sure the security and user-friendly user interface to the customer. To get output of BSCUIT API application, I developed a backend application to generate a secured API token for the customer and ensure its usability for a time period. The REST API gives the user access to all BSCUIT's data including breed database, BSCUIT parameters, and the BSCUIT algorithm which outputs environmental risk factors and warnings for a dog in any conditions. With the API, a user could add breed selection dropdowns to your app or build an app that outputs comfort ranges and provides recommendations for the optimum environmental conditions for any dogs. The output of this task is hosted on <https://bscuit.pupptech.com/>.

### Service: K9 Weathervane

**K9 Weathervane** is developed to visualize the smarter weather decisions for dogs. The primary objective of this project is to make the world's first weather app designed specially to help their customer to understand how the weather outside might impact the safety of their dog. In this application, I integrate forecasting daily and weekly weather to help their customer to plan time with their dog. To do this, I applied BSCUIT algorithm along with weather data to forecast the safety score which determines the safety level of a dog. The additional dependency forecast API is taken from a 3rd party client **Dark Sky Weather** to show weather information.

The goal of this application is as follows:

1. **Weather forecasts:** Daily and weekly (coming soon) weather forecasts to help you and your dog plan your time outside together.
2. **Weather risk assessment:** The K9 Weathervane provides suggestions on what times during the day, if any, are the safest to venture outside with your dog.

Visually, to understand the Dog Safety Factor, we introduce gage concept. The gage is a graphical representation of the current dog safety factor for your dog. The colors increase in intensity as current conditions move away from your dog's zone of maximum comfort. We classified this gage into 2 different weather conditions as given in **figure 3**.



Hot weather



Cold weather

*Figure 3: Graphical dog safety factor gage*

The safety factor number indicates the level of risk that current conditions pose for your dog. The details meaning of those factors are given below.

Safety Score	Verbal Meaning
5C	Potentially life-threatening conditions. Avoid prolonged outdoor activity.
4C	Dangerous weather conditions. Use caution and pay attention.
3C	Potentially unsafe depending on the breed. Keep an eye on your pet outside.
2C	Risk is unlikely. Have fun outside but be careful.
1	No evidence of risk. Have fun outside!
2H	Risk is unlikely. Have fun outside but be careful.
3H	Potentially unsafe depending on the breed. Keep an eye on your pet outside.
4H	Dangerous weather conditions. Use caution and pay attention.
5H	Potentially life-threatening conditions. Avoid prolonged outdoor activity.

Table 4: Detailed meanings of dog safety score

Recently, for test purpose, the application is hosted online at <https://weather.pupptech.com/>.

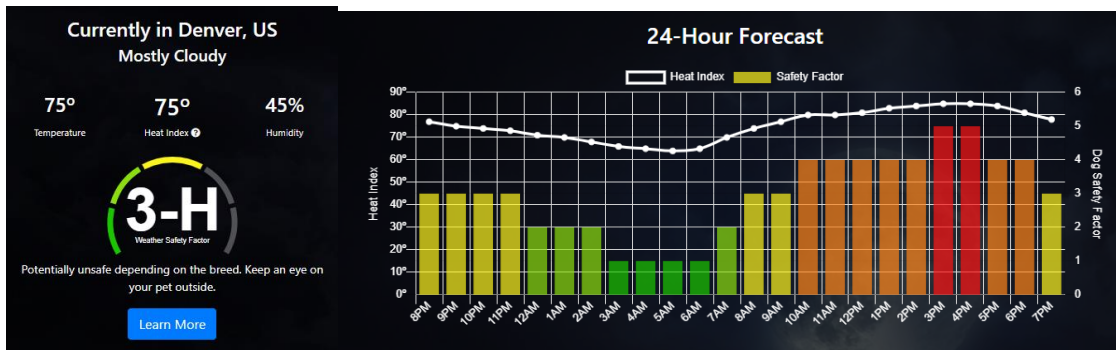


Table 5: Dog safety factor with weather data visualization

## Conclusion

Each year, dogs become sick after being left unattended in motor vehicles. The combination of a hot summer sun or cold and carelessness can have devastating consequences. To solve this issue, a monitoring service is very important to the dog owner. The **BSCUIT** and **K9 Weathervane** application will allow dog owners to monitor his/her dogs even being left unattended in motor vehicles. The application will send a notification to the dog owner about the dog situation. With Nationwide 4G LTE wireless communication and a built-in strap, the PuppComm with BSCUIT and K9 Weathervane can be attached nearly anywhere in your vehicle, on your dog’s crate, or wherever your dog’s environment happens to be. The PuppTech Application is made simple, easy-to-use, and available on both iOS and Android smartphones. It’s dog owner hub for checking on the dog’s environment, receiving alerts, updating dog profile information, and watching the PuppComm’s usage timer. The application receives real-time information from a PuppComm via the cloud. This is how a monitoring system will prevent the unwanted situation with dogs.

## Reference

- [1] Wes Siler, We Need to Talk About Keeping Dogs Safe in Cars, Outsideonline Article Series, July 2018.
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- [3] Gibbs, L.I., Lawrence, D.W. and Kohn, M.A., 1995. Heat exposure in an enclosed automobile. *Journal of the Louisiana State Medical Society*, 147(12), pp.545-546.