Spatial analysis of stray animal management in Daejeon City

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Abstract

This paper analyses data on stray animals collected by the city of Daejeon—the fifth largest city in South Korea. The analysis uses deep learning modelling techniques to identify patterns in data. I intend to identify patterns in data that can help improve the management of animals in Daejeon, to propose policies to prevent the irresponsible behaviour of animal owners and to identify additional requirements for the improvement of animal care in Korea.

Keywords: Spatial modelling, Stray animal management, Deep learning.

Disclaimer: Please note that my work is at present preliminary and as such incomplete, as I am awaiting the complete dataset. However, I'm familiar with the problem and data through volunteering with animal rescue groups in South Korea for the past eight years. I should receive the remaining data by the end of March 2017.

1. Introduction

This paper analyses data on stray animals collected by the city of Daejeon—the fifth largest city in South Korea. Daejeon city has about 1.5 million inhabitants, and according to rough estimates around 27% of households have a pet. This suggests there has been an almost 200% increase in pet ownership over the last 20 years. With the increasing popularity of pet ownership in Korea, cities need to cope with an increasing number of lost and stray animals. Stray animals in Daejeon city are managed by the Daejeon City Animal Center, a city-funded facility that collects stray animals within the city limits. Animals are collected, held for the time period specified by law (10 days) and subsequently either returned to their original owner or offered for adoption. Unlike many other similar facilities in Korea, this shelter often keeps animals beyond the holding period, which greatly increases the chances of their survival. However, animals can still be euthanized under certain circumstances, such as being in bad health or testing positive for contagious diseases, or in cases when they cannot be quarantined due to overcrowding. The goal of this study is to identify any patterns in data that can help improve the management of animals in Daejeon, highlight the need for new policies to prevent the irresponsible behaviour of animal owners and identify additional requirements for the improvement of animal care.

1. Data

The data used in this analysis was collected by the city of Daejeon and covers the period between January 2016 and March 2017. There have been 4,907 observations thus far. Data can be obtained upon request, subject to approval from the Daejeon City Council. The vast majority of animals collected are dogs (about 65%) and cats, but occasionally there are other species, which make up less than 1%. My sample so far includes one miniature pig, one donkey, two iguanas, three hamsters, five rabbits and seven birds (chickens and other exotic species). Due to the limited number of observations, these will not be included in my analysis.

Each animal's species, breed, sex, age, date and place of collection is recorded, along with its health status (test results for frequent diseases, other information; symptoms like diarrhea, vomiting, lack of appetite, state of coat, and presence of ear or eye disease) and status (on hold, returned to owner, adopted, euthanized or died of natural causes, which covers cases when the animal is found dead, dies as a result of a car accident or dies due to disease while in the care of the Animal Center). This status is updated approximately once a week, or when there is a significant change in health while the animal is in the care of the Animal Center. It is possible to obtain the GPS coordinates of the location from which the animal was collected.

Other data used in this study identifies the attributes of each of the five districts of Daejeon city (*-gu* in Korean; meaning a city district): Daedeok-gu, Dong-gu (East District), Jung-gu (Central District), Seo-gu (West District) and Yuseong-gu and their respective neighbourhoods (*-dong* in Korean; the smallest level of urban government to have its own office and staff). These attributes include the population and zoning type of the area in which each animal was found: residential, industrial, agricultural, highway or commercial. Finally, the information on veterinary hospitals in the city has been collected to determine whether animals came from underserved neighbourhoods in the city.

2. Method

This section will be finalized once I receive the complete dataset at the end of March 2017, but I have several proposals on how to approach the problem. There are two aspects of data that I will take advantage of in my analysis. First, the spatial aspect, which is the GPS location of where the animal was collected, and second, the temporal aspect, or the health history that is updated from the day of collection until final status is reached. Plotting the complete dataset is unlikely to be helpful in uncovering new patterns. Such a map posted in the City Hall office shows several clusters around residential areas, which is hardly surprising. These are areas well recognized and patrolled by employees collecting stray animals in Daejeon. In fact, the officials recognize that there may not be much to learn from it. However, from my volunteer work I believe there is sufficient anecdotal evidence about people abandoning animals in certain city neighbourhoods, and so I would like to investigate these claims as I believe there is a better way of interpreting this data: to plot specific groups of animals stratified by several factors: health on arrival, health in one week, health in two weeks, health in three weeks, and test results (if available) in each time period, whether the animal was picked up by the original owner within holding time period, and so on. Stratification by health status could reveal important information because most diseases are preventable through

vaccination, so the absence of vaccination implies suboptimal care (and is more likely if the animal was abandoned). On the other hand, if the animal was simply lost, it would be clear in the data because the owner picked it up from the shelter.

The Animal Center performs three tests routinely: two for dogs (canine distemper, parvovirus) and one for cats (feline parvovirus: FPV). All three diseases are highly infectious and can be fatal. Young and unvaccinated animals are at the greatest risk of contracting these diseases. Additionally, after the possibility of other diseases is eliminated, dogs are tested for coronavirus. Further information about each disease is presented in Table 1 below.

Canine distemper	• incubation period: about 7 days • symptoms: malaise, depression and a high body temperature • the virus does not survive easily in the environment and it is killed by most disinfectants • transmitted from animal to animal by aerosol
Canine Parvovirus	• incubation period: about 7-14 days • the most common form of the disease is the intestinal form known as enteritis • symptoms: vomiting (often severe), diarrhea, dehydration, dark or bloody feces, and in severe cases, fever and lowered white blood cell counts • the disease progresses very rapidly and death can occur as early as two days after the onset of the disease • transmitted primarily by the fecal-oral route (including through exposure to objects/clothing/hands contaminated with virus from feces) • the virus is known to survive in the environment and on inanimate objects - such as clothing, food pans, and cage floors – for up to 2 years in the right conditions
Coronavirus	• incubation period: one to three days • symptoms: diarrhea, vomiting, and anorexia • infected dogs spread the virus for six to nine days, but sometimes for six months following infection • highly contagious and is spread through the feces of infected dogs
Feline panleukopenia virus (FPV)	• incubation period: less than 14 days • symptoms: vomiting, diarrhea, and can cause sudden death in cats • transmitted primarily by the fecal-oral route (including through exposure to objects/clothing/hands contaminated with virus from feces) • the virus is very durable and can persist in the environment for months or even years unless inactivated by an effective disinfectant. • kittens are at highest risk for this disease, and adult cats with current vaccinations are at very low risk

Table 1: Diseases tested in the Daejeon City Animal Center.

All three diseases share a relatively short incubation period, and vulnerability increases significantly without vaccination. These facts can actually help my analysis because understanding when an animal contracted the disease (tested positive) can help me determine whether it was properly cared for, simply lost (likely vaccinated) or not properly cared for and abandoned.

3. Study design

I plan to use deep learning and spatial statistics techniques to answer the following questions:

1) Which animals were lost and which were dumped? Are there any predictors that help differentiate the two cases?
2) Are there any areas where animals are frequently not vaccinated?
3) Are there any areas where owners abandon animals?
4) How far are the areas where animals were found from the areas where they originally lived (as judged by returned animals)? How do attributes of these animals differ from those that were not picked up (likely dumped)?
5) What is a social cost of irresponsible pet ownership?

4. References

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