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Machine Intelligence can guide Pet Dog Health Pre-Diagnosis for Casual Owner: A Neural Network Approach

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Abstract

In this paper, we developed a health pre-diagnosis system with ART2 neural network for Pet dog health monitoring. This system is for the pet owner who does not have deep knowledge on the pet diseases nor computer technology. The standardized database of symptoms/diseases associations is constructed from textbooks and the user simply gives the most unusual symptom that is found from the dog and then the communication between the user and the system refines and expands the input symptoms through queries. Then an unsupervised ART2 learning system checks the similarity between input and stored diseases with confidence and generates three most probable diseases as output. The system has incremental learning ability and learning by experience ability thus appropriately changes the database over time even without user's database update. In spite of the fact that the system is ad-hoc in nature, the system's performance is verified by veterinarian as adequate and it can stimulate the owner's attention on the dog's abnormality in time such that appropriate professional treatment is given in its early stage.

Keywords: *pet dog, health diagnosis, ART2, symptom-disease association, unsupervised learning*

1. Introduction

In recent days, dogs are not just working animals living around human beings but are almost family members of their owners - living in the same house, always touching with each other. There are pet shops and veterinarians to take care of these new kinds of non-human family members. In particular people who feel disconnected from society tend to substitute social contacts by pets, including supportive anthropomorphic traits ("humanization" of non-human beings) [1]. For health care point of view, however, those pet-attached people may have emotional loss from pet dog's disease or sudden death and also there has been an increasing risk of transmission of microorganisms between humans and their dogs [2].

Usually a pet dog gives a sign to its owner by expressing unusual behavior or by the change of its body when its health is at risk or having a disease. However, without deep knowledge about the pet dog's disease, owners tend to neglect such signs but only depend on the regular check by veterinarians only to make the situation worse.

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Our motivation of this research is thus to develop a pet dog health pre-diagnosis/monitoring system with artificial intelligence that can be easily checked by dog owners without deep knowledge of computer technology or dog diseases. The proposed system in this paper requires dog owner's only symptoms they found from their pets then the system answers some number of most probable diseases pets may have with computed confidence rate. Technologically, like many existing health diagnosis system for human beings [3, 4], the system requires a database for symptom-disease associations and the inference system from that database with given symptoms recognized by pet owners. There exist few known studies in this part of research but a recent study also look at the feasibility of neural network application to recognize the lameness of dogs [5]. However, when the system like [5] targets single disease recognition, the accuracy of its predictability is the main issue as a pre-diagnosis but our goal is to develop a system capable of giving ad-hoc pre-diagnosis for as many standardized dog diseases as possible.

Thus, in this paper, we explain our database collecting procedure and propose an intelligent diagnosis generating method based on ART2 [6], a type of unsupervised learning artificial neural network.

2. Intelligent Pet Dog Health Pre-Diagnosis System

2.1. Disease-Symptom Data Collection

For the pet dogs' disease-symptom data, we used two books [7, 8] by veterinarian's recommendation to obtain 180 representative symptoms of 105 frequently found diseases with respect to 13 body parts that those symptoms occur - whole body, head, abdomen, leg, hip, eye, nose, mouth, ear, hair, skin, temper, and excretion. Those symptoms are associated with diseases and verified by veterinarians. Some representative symptoms associated with a certain disease also creates other queries to user for further considerations.

2.2. Database Construction

Obtained symptoms and corresponding diseases are associated with different strength that will be learned by our ART2 learning engine. Our database consists of three main tables.

- Disease (ID, DiseaseCode, SymptomCode, Description)
- Symptom (SymptomID, BodyPart, Description)
- LearnedResult (ClusterID, InputNeuron, Strength)

SymptomCode of Disease table may contain multiple SymptomIDs of Symptom table. Since usually a disease has multiple symptoms. The learning result table stores the connection strength after learning between disease and symptom as shown arrows in Figure 1.

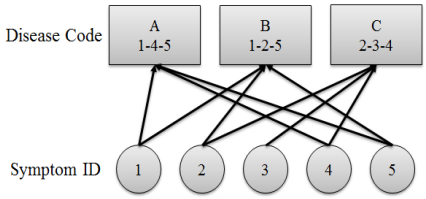

Figure 1. Symptom-disease association

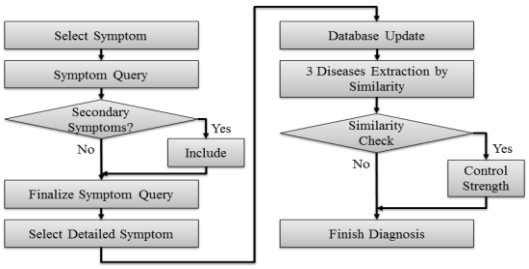

Figure 2. Overall procedure of proposed system

2.3. Overall Procedure

The system starts with asking representative symptoms currently a dog suffers from the user. This symptom input procedure is carefully designed to minimize misleading input. First, the system asks the most obvious symptom that the owner can observe barring the possibility of misleading excessive input. With that most obvious symptom, the system generates related symptoms and asks user if the owner's dog shows that symptom.

This procedure is done twice (taking another representative symptom as input) to be more accurately gathering symptom information.

Then the system accesses the learning result table to select three most probable diseases that is already learned. The overall system procedure is as shown in Figure 2.

2.4. ART2 Learning System

The key of our diagnosis system is its learning engine based on ART2 [6] that is a self-organizing neural network presented as the solution for the plasticity-stability problem without suffering from the local minima problem [9]. Its characteristic can be summarized as follows.

1) ART2 is a self-organizing pattern clustering structure by competitive learning.
2) It is a stable and adaptable neural network with incremental learning ability, that is, new learning procedure does not affect already existing clusters.
3) No local minima problem.
4) It is learnable with binary input and analogue input.

The change of connection strength is the average of all input patterns thus it is uniformly distributed to all clusters.

In this paper, we only consider active neurons defined as at least one of the two - input neuron or connection strength - is non-zero to avoid this problem. Thus, unrelated symptoms that are given from the user are treated as noises so that they have no effect in learning.

The ART2 algorithm applied to our system is as shown in Figure 3.

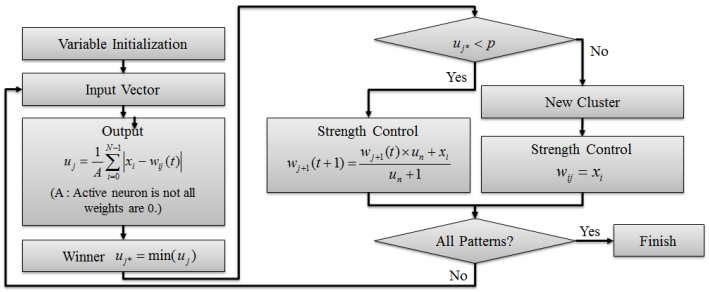

Figure 3. ART2 learning algorithm

3. Experiment and Analysis

An IBM compatible PC with Intel Pentium IV 3 GHz CPU and 512M RAM is used with JDK 6.0 and Oracle 9.2.0.1.0 are used in implementation and the system is available for on-line environment. As described earlier, our database contains 105 different diseases, 180 different representative symptoms associated with 13 different body parts of a dog.

Figure 4 demonstrates an example of such information-giving consultation snapshot.

In order to avoid misleading user input symptoms, the system has query process to refine the search. Thus, the user firstly gives a most obvious symptoms then the system reacts with showing related symptoms so that user can select observed symptoms more accurately and this procedure is done twice to minimize the risk of lack of available information. An example of such query process screen is as shown in Figure 5. In Figure 5, the user selects "hair" and "lost its shine" as the most obvious abnormality and then the system answers with possible symptoms related to some diseases that have such symptom so that the user can choose his/her dog's case.

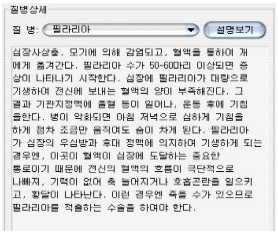

Figure 4. Extracted disease explanation

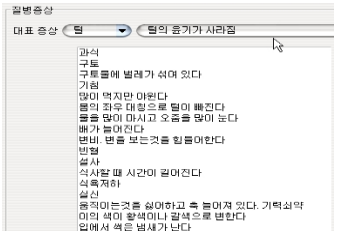

Figure 5. Example query with "lost hair shining"

Figure 6 shows an example of final display of three most probable diseases with confidence level. In this particular example, the user selected "dirty eye edges due to tears and dirty hair around the nose" and "always wet eye" as detailed symptoms and the result shown in Figure 6 is galactorrhea (50%), corneitis (25%), and external otitis (11%).

However, this result may be misled by very particular symptom of "dirty eye edges due to tears and dirty hair around the nose" that filters a lot of other candidate diseases. Thus, the system asks secondary representative symptoms to expand the search space. In this particular example, when the user adds "faint image on the retina", other symptoms related to different diseases came out. In the detailed symptom input phase, the user selects "lame", "frequently lost toys", "bumped to obstacles like furniture's", "foggy comea" in addition to previous three detailed symptoms, the system gives more confident result as shown in Figure 7.

Figure 6. Final diagnosis example

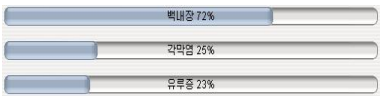

Figure 7. Diagnosis with secondary symptom

The refined result shows cataract as the most probable with 72% confidence followed by corneitis(25%) and galactorrhea(23%).

The proposed system also provides incremental learning feature thus with enough diagnosis experiences with ART2 the learned information evolves over time that is not provided in the previous study [10].

(a) Before

(b) After

Figure 8. Flea allergic dermatitis extracted

Figure 8 (a) and (b) demonstrate the change of confidence over time with diagnosis experiences. Two results have the same input query as "Excessive scratching with biting or licking its skin" and four other symptoms. In Figure 8 (a), flea allergic dermatitis is the most probable one with fairly high confidence (72%) thus the result affects connection strengths between related symptoms and the disease. Not just one more diagnosis but significantly many same diagnoses reinforce the confidence over time and one can find the higher confidence level of the same diagnosis in Figure 8 (b).

However, this system is not a completely accurate diagnosis system but rather an ad-hoc pre-diagnostic system that stimulates dog owner's attention. This diagnosis depends on a simple description of layman (owner)'s observation of pet dog's abnormality. There are many cases that the same disease has different symptoms over the progress of the disease or simply individual differences among dogs. Thus, the main role of this system is not to lose the timing of treatment if the owner sees highly confident disease diagnosis through this system.

4. Conclusion

In this paper, we introduce a pet dog health pre-diagnosis system using artificial intelligence technique. While there are increasing number of pet dogs living with human beings, owners do not have enough knowledge about the pet dog diseases thus frequently they lose the timing of appropriate treatments. In our system, it has standardized symptoms-diseases associations as the form of database and a self-organizing neural network ART2 technology is used to infer most probable diseases with respect to the input symptoms the owner gives.

One of the key functions of this system is query type input generation from the pet owner so that the owner can observe his/her dog from most obvious abnormality to detailed description. This input generation is performed twice to minimize misleading input.

ART2 learning procedure checks the similarity of various diseases from user input and generates three most probable diseases to be displayed.

This system also has the incremental learning ability so that the association strengths are changed over time and additional input diseases/symptoms in real time based on the ART2 algorithm's adaptability and stability.

In this experiment, 105 diseases and 180 related symptoms on 13 different pet dog's body parts are considered and the data collection is done from two common textbooks with field expert's guidance. The testing result was also verified by the veterinarian.

However, the role of this system is not replacing veterinarian's diagnosis but stimulating owner's attention to pet dog's abnormality in nature. There are several similar diseases with very similar symptoms that an ad-hoc observation cannot see the difference. Also, some diseases have different symptoms with respect to the progress of the disease. In those cases, veterinarian's care is "must".

This paradigm is also applicable to other pets like cats but the prerequisite of such intelligent pre-diagnosis system is to have reliable disease-symptoms database like we have in this paper. This system can also be developed under mobile platform easily and more clinical research with veterinarian can make this system to be more serious.

References

[1] N. Epley, A. Waytz, S. Akalis and J. T. Cacioppo, "When we need a human: Motivational determinants of anthropomorphism", Social Cognition, vol. 26, no. 2, (**2008**), pp. 143-155.
[2] L. H. Wieler, C. Ewers, S. Guenther, B. Walther and A. Lübke-Becker, "Methicillin-resistant staphylococci (MRS) and extended-spectrum beta-lactamases (ESBL)-producing Enterobacteriaceae in companion animals: Nosocomial infections as one reason for the rising prevalence of these potential zoonotic pathogens in clinical samples", International journal of medical microbiology, vol. 301, no. 8, (**2011**), pp. 635-641.
[3] G. B. Buchanan, "SHORTLIFFE, Edward H. Rule Based Expert Systems: The Mycin Experiments of the Stanford Heuristic Programming Project (The Addison-Wesley series in artificial intelligence)", Addison-Wesley Longman Publishing Co., Inc., **(1984)**.
[4] S. Begum, *et al.*, "Case-based reasoning systems in the health sciences: a survey of recent trends and developments", IEEE Transactions on Systems, Man, and Cybernetics, Part C: Applications and Reviews, vol. 41, no. 4, (**2011**), pp. 421-434.
[5] M. Kaijima, T. L. Foutz, R. W. McClendon and S. C. Budsberg, "Diagnosis of lameness in dogs by use of artificial neural networks and ground reaction forces obtained during gait analysis", American Journal of Veterinary Research, vol. 73, no. 7, (**2012**), pp. 973-978.
[6] G. Graef and C. Schaefer, "Application of art2 networks and self-organizing maps to collaborative filtering", In Hypermedia: Openness, Structural Awareness, and Adaptivity, Springer Berlin Heidelberg, (**2002**), pp. 296-309.
[7] N. Kugure, "Knowledge of Pet Dog Disease and Taming", Yuwon Print Ltd., (**2001**).
[8] Y. Dateuchi, "Pet Dog Diseases and Treatments", Haseo Print Ltd., (**2001**).
[9] G. A. Carpenter and S. Grossberg, "ART2: self-organization of stable category recognition for analog input patterns", OPTICS, vol. 26, no. 23, (**1997**), pp. 4919-4930.
[10] K. B. Kim, D. H. Song and Y. W. Woo, "Ad-hoc Pet Dog Healthcare Diagnosing System using Machine Intelligence", Proceedings of International Workshop (Bioscience and Medical Research 2013), vol. 33, (**2013**) December 11-13, pp. 16-19; Jeju Island, Korea.

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