HUMAN JUDGMENT IN DIAGNOSING PROBLEM BEHAVIOR IN HORSES

USING KNOWLEDGE-BASED SYSTEM APPLICATION

by

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(Under the Direction of Robert P. Mahan)

ABSTRACT

Judgment and decision making happens in everyday lives. However, the information used in making judgment is seldom perfect and contains a degree of error. The relationship between variables, cues and information bits in the environment tend to lead to other things occurring with different likelihood. This thesis focuses on the process of human judgment based on Brunswick's theory and the Lens Model in diagnosing behavior problems in horses using knowledge-based system application. The development of the system using LPA Win-Prolog in predicting behavior problem in horses can help increase the awareness of users in noticing certain cues and signals from the environment as well as increase the accuracy of judgment. It is hoped that with the development of the system and focusing on behavior problems in horses, it can educate people on the importance of noticing cues to the welfare of animals.

INDEX WORDS: Human Judgment, Brunswick's Lens Model, Horse Behavior Problems, Knowledge-Based System, LPA Win- Prolog

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CHAPTER 1

INTRODUCTION

Everybody is faced with making judgments and solving problems in everyday life. Some situations would require little cognitive resources while in other situations a lot of resources are needed in order to help make the correct decision, especially in a complex environment when faced with multiple cues and information. Judgment analysis is a theory based on cognitive psychology and is still one of the most interesting areas of research and study. It is one of the methods in assessing how a decision maker forms a judgment when faced with lots of information at hand (Cooksey, 1996).

The theory is based on the work of Egon Brunswick, who viewed the decision maker as being embedded in an ecology (environment) from which he receives cues as to the true state of things (Brunswick, 1956). These cues are probabilistically related to the actual state of events. Brunswick's original theory has been extended into many judgment domains including meteorological forecasting (Stewart et al, 1989), social welfare judgments (Dagleish, 1988), the understanding of risk judgment (Bushell & Dagleish, 1993), and medical decision-making (Wigton, 1988). The theory has been used as a reference in many theoretical studies to model the way certain minds work, for example to model criminal preference in computer crime (Gunderson & Brown, 2001). The focus of research in this study will be based on the development of a knowledge-based system in predicting behavior problems of horses in order to provide suitable treatment, given

cues and signals from the horse, and the environment perceived by the user (the horse owner or handler). It is hoped that with the development of the system and the focused on behavior problems in horses, the study can educate and increase awareness in people on the importance of noticing cues to the welfare of animals.

1.1 Purpose of the Study

The aim of this study is to develop a knowledge-based system to help increase accuracy of judgment in predicting sudden changes in horse behavior. Based on the input given by the user, the system can output the type of behavioral problems associated with the horse which includes bad habits such as kicking, biting and halter pulling and vices (undesirable habits in horses typically exhibit in the stable environment) so that proper treatment of these behavior problems can be suggested to the user. Information from the environment such as poor stable condition, the behavior towards other horses and handlers as well as the visual signals given by the horse is interrelated with each other contributing to the sudden changes in its behavior.

Another aim of the study is to model the way the horse handler makes judgment by interpreting the way he communicates with the system and compare it to Brunswick's Lens Model of human judgment. By using the system, the user can increase his awareness of the behavior changes and accurately predict the right behavioral problems and treatment. Indirectly, the system can help owners or handlers learn to be sensitive to the cues surrounding them, with regards to the animals in their care. The system can also help in identifying certain cues that are either mistakenly perceived by the user (noise or

wrong attribute) or not seen (missing values or attributes) but are there in the environment. However, the system will be based on information concerning general behavior problems that are found in equine literature and therefore might not be covering all behaviors shown by horses. The system will be written in LPA Win-Prolog to build an efficient declarative knowledge-base and to develop procedural control and user interface. The system design will be explained further in chapter 4 and 5.

1.2 Theoretical Foundations of Judgment Analysis

Humans make judgments all the time. However the information used to make judgments is seldom perfectly indicative of the decisions to be made. The judgments made under constraints and in complex environments (e.g. medical decision-making (Wigton, 1988), meteorological forecasting (Stewart et al, 1989)) and added with stress such as decisions made during management of emergencies (Kowalski-Trakofler et al, 2003), will contain some degree of error. This is because things that are perceived in the environment and processed in the heads may not be exactly the same as things in the real world. There will be discrepancies and this will lead to error in judgments. In order to reduce this error, the judgment process needs to be understood so that a system based on this process can be built to aid judgment. The relationship between variables, cues and information bits in the environment are probabilistic; things will tend to co-occur or lead to other things occurring with different likelihoods. Humans usually act with a sense of purpose or act in order to accomplish things that will benefit them. Therefore they act with some intention in mind and respond towards the stimulus coming from the environments. The

organism and the ecology should therefore receive equal emphasis in psychological research since both plays a role in determining the accuracy of certain situations (Cooksey, 1996).

This is where Brunswick's theory comes into play, he pointed out that the importance of the "stimulus" or "input" or environmental conditions of an experiment have to be taken into consideration rather than just stressing on the subject's side. In 1939 Brunswick offered a specific example of what he meant by "uncertainty" in the environment in his study of rats ("Probability as a Determiner of Rat Behavior"). He argued in the first paragraph: "In the natural environment of a living being, cues, means or pathways to a goal are usually neither absolutely reliable nor absolutely wrong. In most cases there is, objectively speaking, no perfect certainty that this or that will, or will not lead to a certain end, but only a higher or lesser degree of probability" (Hammond, 1998). Therefore, the proximal cues process in the head is never perfectly reliable or valid indicators of the real/actual state of affairs (distal criteria). Proximal cues will tend to be related to each other to the extent that different events in the ecology give rise to similar arrays of cues. So cues are entangled and partially redundant with respect to each other and with respect to the information each gives about distal criteria and can be represented as uncertainty (the amount of valid information in the environment that is useful). Ecological validity indicates potential utility of proximal cues (for accurately representing reality). There is also uncertainty within the organism with respect towards how to use cues/information to guide best response (functional outcome). In all, the same concept thus applies to environment (ecological validity) and organism (utilization validity) and how well proximal cues (perception) are used to represent reality and how

well significance or importance is weighted to those proximal cues (information bits) (Cooksey, 1996).

Hammond (1996) took Brunswick's theory that is based on perception and adapted it to human judgment and decision-making. He draws upon the Lens Model as a mathematical representation of how proximal cues are related to psychological responses and how information is considered and weighted before arriving at a judgment or decision. The Lens Model will be discussed more in the next section (1.3). However there is one more decision making model that needs to be pointed out, and that is Cognitive Continuum Theory (CCT) which is a type of naturalistic decision making (Hammond and Brehmer, 1973). According to this theory, there are two poles of thought or process judgment that fall on a continuum, either on the analytic side or intuitive side of cognitive process. The task characteristics drive this different cognition, for example lots of information that tends to be unrelated and easily distinguishable will trigger analytic cognition (slow, effortful and methodical). Humans tend to use analytical cognitive process when solving abstract math problems. In the case of complex information, where the information tends to be related to each other and difficult to distinguish, it will prompt them to use the other side of the cognitive continuum theory, which is intuition, or the intuitive side of cognitive processes (Allard et al, 2003).

Therefore, based on the knowledge of behavior problems of horses and the CCT, the owner or handler who perceives multiple arrays of cues might use more intuitive process than analytical process. This is because the proximal cues that the owner and handler perceive and process are redundant to each other and often relate to different situations or behavior problems. The next chapter (Chapter 2) will explain more on the

types of proximal cues given by the environment (the horse and the environment surrounding it) and also the different behavior problems related to them.

1.3 Lens Model

As mentioned in section 1.2, the judgment process can be represented by the Lens Model (Cooksey, 1996). An example is explained in Gunderson & Brown's (2001) paper on predicting computer crime and the behavior model of a criminal. They explained using a simple example of estimating the distance to a child's building block, lying on a table. Based on the Lens Model, the actual distance to the block is an environmental (distal) variable (ye). The onlooker has a series of observable (proximal) cues (ci) relating to this distal variable, such as the size of the retinal representation of the block, the differences of the image in the right and left eyes, and the blurring of the image. These cues have a correlation to the actual state (Ecological Validity). The subject then weighs the cues and uses a function of these weighted cues to make a judgment as to the true state (ys). This cue weighting has a correlation to the relationship of the cues to the actual state (Cue Utilization Validity). The actual achievement (performance) in the judgment task can be used to update the weights placed on the cues in future judgment tasks (Gunderson & Brown, 2001). This model is shown graphically in Figure 1.1.

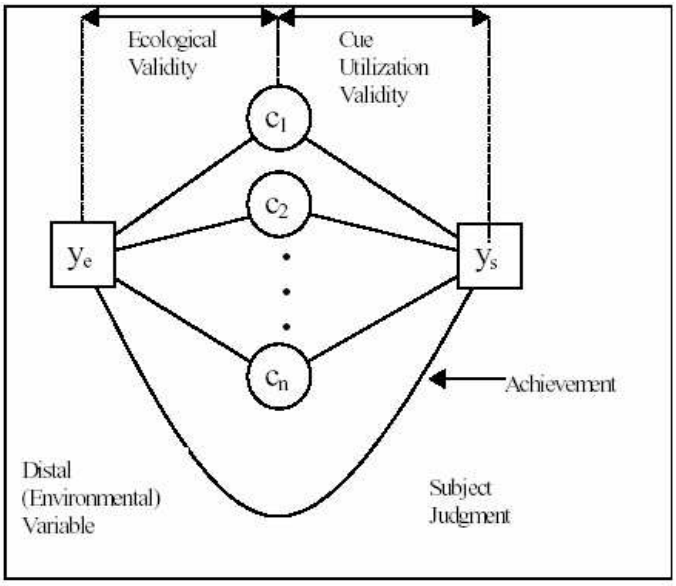


Figure1.1: Lens Model (sources from (Gunderson & Brown, 2001))

Now applying the Lens Model concept to the research area in this thesis that is identifying behavior problems in horses, consider a horse showing sudden changes in behavior such as kicking. The observer (handler or owner) has to predict what type of behavior problems the horse is displaying and why, in order to prevent the behavior from getting worse and to provide treatment where needed. The sudden change in behavior of the horse is the environmental (distal) variable (ye). The owner or handler has a series of observable (proximal) cues (ci) relating to this distal variable, such as the condition of the barn where the animal is placed, the posture of the horse, the facial expression, and noise that the animal makes when displaying this behavior, etc. Again the ecological validity as well as the cue utilization validity needs to be considered. This is because the owner or handler weighs the cues and uses a function of these weighted cues to make a judgment of the true state (ys). The actual achievement (performance) in the judgment task can be used to update the weights placed on the cues in future judgment tasks. Therefore the

owner or handler will be able to increase the accuracy of predicting behavior problems in horses the next time he is faced with the same cues and situation (Gunderson & Brown, 2001).

1.4 Scope of the Project

The scope of the thesis will be on how owners or handlers predict or judge general behavior problems exhibited by horses, particularly domesticated horses. Based on readings on equine behaviors the same visual cues perceived by the observer can contribute towards different types of behaviors. However, treatment and management of each behavioral problem is different. Therefore the more accurate the judgment made by the observer compared to actual behavior of the horse, the more efficient the treatment will be. The knowledge-based system developed for this area will help the owners to increase the accuracy of judgment and further increase awareness of cues or signs given by the horse, stressing the importance of the visual cues that are perceived every day.

1.5 Values of the Study

Most researches on equine studies are focused towards diagnosing illness and corresponding treatment, however, this thesis is more directed towards the behavioral signals or cues given by the horse indicating some displeasure that it is experiencing. This is because it is very difficult to identify specific behavior problems in a horse since there are a lot of factors to take into consideration and each horse is itself different in

personality and traits. Since a horse is good in communicating through visual cues and signals (Aronson & Dodman, 2003), these signs together with signs from the environment should provide adequate information in relying problems faced by the horse to the owners or handlers. Based on the projects offered by Frontiers for Veterinary Medicine, The Welfare of Animals in 2000, a lot of studies done on horses are now focusing on behavioral signs.

One example of the project is done by Allison Brendell from the Washington State University, College of Veterinary Medicine. She is doing a survey of behavioral signs of abuse in the Arabian horse show circuit. She is working on developing an objective method for identifying potential abused horses by observing their exhibited behaviors in the show ring. Recognizing the prevalence of these behaviors in particular events could aid in changing or enforcing rules regarding the abuse of Arabian show horses. Additionally, she hoped that her research would educate the show veterinarians and judges about the behaviors they should be aware of and therefore increase the awareness of better treatment towards these horses.

It is therefore part of the aim of this study to help increase the knowledge and awareness of the owners and handlers of behavioral signals of horses, especially during the development of the study in Sarawak, Malaysia where hopefully, using the system will help train the handlers in making judgments based on the surrounding environment rather than just concentrating on the facial expression of the horse to predict the animal's behavior.

1.6 Related System

Although many expert systems have been developed for different applications, few focused on the area of predicting behavior problems in horses and human judgment. However, there are examples of systems that focus on human judgment in clinical settings using AI (Artificial Intelligence) applications such as JANNET (Judgment Analysis via Neural NETwork) done by Bruins & Cooksey (2000). The study was done in order to gain information on how dental clinicians weigh certain dental and radiotherapy conditions as important indicators for extraction of teeth in patients with head and neck cancer.

Another example is more towards applying expert system for educational and training purposes such as Anesoft, an expert system for canine anesthesia (Deng, 2000) and a medical expert system developed for veterinary students fused with a physiological simulator so that they can practice emergency medicine without endangering the lives of real animals (Schlachter 2004). But no expert system for predicting behavior problems in horses was found in the literature.

1.7 Limitations of the Study

There are several limitations to the study because it is only focusing on the general behavior problems shown by domesticated horses. Therefore the system might not capture all types of behaviors seen in horses. The system does not take into account the type or breed of the horse as well as the medical and personal history of the horse. This is

because the study is focusing on what type of visual cues the observer stresses on and how he weighs the importance of the cues that he perceive. The knowledge or data based for this system is from secondary resources such as the Internet, Journal of Veterinary Medicine and also information from an experienced horse handler in Sarawak Equestrian and Turf Club as well as other equine literature on behavior.

1.8 Structure of the Thesis

The structure of the thesis would be to lay out the goal or purpose of the study, the theory, background and literature behind the study in Chapter 1. While Chapter 2 will explain in detail the area in which this theory will be compared to the actual model in how humans make judgment based on Brunswick's Lens Model. In this chapter, all the information gathered about common types of the horse behavior problems, its cues and signals that the owner or handler perceived from the environment and the animal itself, possible treatment and solutions and other information that can be used for the data base or knowledge-base in the system that will be developed is further explore.

Chapter 3 then will be focusing on the research methodology where it contains explanation about the layout of the design and study, how the subject is chosen, the software and equipments and evaluation of the system. As for chapter 4 and chapter 5, they are more towards explaining the overall system design from the conceptualization until the user interface design. However the study is more focused towards the inference engine rather than the user interface design.

Chapter 6 is the result and discussion chapter in which the result from the evaluation and usage of the system will be used as a conclusion on how the user, in this case the owner or the trainer/handler of the horse, makes judgments on what type of behavioral problems the horse is displaying. The model of judgment made by the user will be compared to the Brunswick's Lens Model, which is found to be the same in the sense that according to the Lens Model, the environment and the perceiver have to play an active role in the judgment process. Lastly, the overall conclusion of the study will also be discussed in this chapter. It will include limitation or problems related to the study, as well as the comparison between the models. Further studies and other areas of focus are also suggested.

CHAPTER 2

BEHAVIOR PROBLEMS OF HORSES

It is important for horse owners to recognize the signs of a normal and healthy horse (Sestric & Coates-Markle, 1996). An awareness of normal signs of health for individual horses will allow the horse owner and its veterinarian to determine the best care for the horse. In the wild, the horse is subjected to many natural strains including extreme weather conditions and the frequent lack of food and water. This horse has evolved as a free roaming and free grazing herbivore. The domesticated horse, however, is subjected to the confinement of the stall and life in the pastures, its owner's feeding schedule (often twice per day) and usually is dependent on its owner for regular exercise (Zeitler-Feicht, 2003). In the whole schema of things involved in domestic horse temperament and behavior, the critical factors are their management, environment, and particularly their interaction with people. Therefore, to be able to have a better assessment of the horse's health, one has to be familiar with the horse's natural environment and lifestyle. One of the most obvious health signs of a horse is told by looking at its behavior. Every horse has a different personality and variable behavior. It is not uncommon for sequential owners or trainers of a particular horse to describe it quite differently. Even within the same time period, a horse can show very different attributes depending on the people or environment around it. However, a horse should be very consistent in its overall behavioral patterns. Any abrupt changes to the behavior should be an indication of a

problem. This is because most horses are good in behavior. Any horse however can become rebellious with improper care or handling (Hill, 2000) or when it feels threatened and at unease with its environment.

2.1 Visual and Environmental Cues

A horse is likely to communicate feelings and dislike towards a human by showing expressions such as anger by kicking or biting, fear by walking away, anxiety or depression or stress by not eating or not showing interest in anything. This shows that a horse is superbly equipped for visual communication, which is probably the primary mode for expressing feelings (Aronson & Dodman, 2003). The first clue to noticing these expressions would be from the animal's posture. In most situations, either both the head and tail will be up or down. For example, with increasing excitement, both head and tail tend to become higher. A submissive horse has a lowered head and tail and seems to be trying to go further down towards the ground. A somewhat elevated head with a tucked or partially raised tail may accompany a defensive threat. However, a sleepy horse, a horse that is excited to check out its new environment and a horse that is trotting would show the same signals as dropping the head and tail indicating that context is also an important factor in judging posture and attributing it to the animal's behavior (Aronson & Dodman, 2003).

Another important visual cue is by looking at a horse's facial expression, particularly the movements of its ears, mouth and nose. There are 13 pairs of muscles adjusting the position of each ear and ten pairs moving the nostrils, mouth and lips. The

aggressive horse's ears are laid back against its head, pushed flat against the skull. Its eyes will be wide open and generally focused on the object of aggression. The horse's nostrils will also be flared drawing in air in case it is called upon to take further action, and its mouth tends to be open as if it intends to bite, the front teeth will also be seen. If a bite or its threat is being made, the head will drop and become extended, giving the neck a snake like appearance. A submissive horse's ears tend to spread out to the side or are held backwards but not pinned against the head. The tail can also signals a horse's intentions, if a horse is slashing its tail forcefully from side to side, or even more dramatically up and down, there is a good chance it will kick or lash out.

Other signals would be the way the horse orients its body. If the animal turns its quarters towards the object of attention, or pushes at it with the shoulder, it would indicate either a dominant display or mild aggression. A horse will start biting and kicking as aggressive display intensifies (Aronson & Dodman, 2003).

The environment where the horse spends much of its time would also contribute towards giving the owners or handlers signals or cues in understanding why the horse is displaying behavior problems such as kicking. Some horses develop this behavior in a new environment out of fear. Other animals develop it due to the lack of routine in the handling/handler of the horse such as with a new mucker. Another example would be that the horse is too accustomed to being in a herd of horses or barn such that if it is left alone in the stable, the animal might develop a bad habit called barn sour or herd bound caused by separation from buddies or the barn. In this case, the horse would balk and scream so that it can rush back to the herd or barn.

2.2 Common Behavior Problems

Behavior problems in horses can take many forms. Entire books and careers have been devoted to detailing horse behavior problems and suggested solutions (McDonnell, 2002). Many problems are the result of failure to become accustomed to domesticated life such as natural fear and escape tendencies. Other problems are the result of failure to suppress a natural instinct behavior that is incompatible with domestic behavior requirements. For example, the natural instinct to graze grass or nibble, if the horse has this natural urge even if it is confined in the stall, it will lead to stall biting or cribbing. Another example would be the innate behavior to kick, which is undesirable in the domesticated horse.

In the wild, horses react to predators in one of two ways: by fleeing, or if they feel trapped, by threatening and kicking. On the ranch or stable, domesticated horses may try this same maneuver on their human handlers if they don't want a person near them or they sense fear, danger, imminent pain or territorial compromise. Some behavioral problems resulted from failure to learn new, non-natural behaviors that most horses can learn. Other problems represent learning as an undesirable behavior for the horse, such as getting into a trailer for transportation. Certain horses have developed certain behavioral traits based on either their early experiences with the dam or during training. Horses are most affected by their handling experiences when young, but even aged horses can be affected by how they are handled.

This is where proper handling and good management is essential in maintaining good behavior in horses. Horses need to have enough exercise and turn out as well as a

good diet of essential nutrients. Lack of exercise and dietary imbalances (over or under nourished) will lead to boredom, fatigue and result in the horse displaying behaviors such as weaving or pacing, pawing, stall kicking, wind sucking, wood chewing or even coprophagia or pica (eating his own feces). These behaviors are called vices, which are defined as undesirable habits that a horse exhibits in the stable environment, and are generally caused by confinement, overfeeding, and stress (Cherry Hill, 2000, Zeitler_Feicht, 2003)

On the other hand, bad habits are undesirable behaviors in response to human handling and are generally caused by rushed or improper training, uncertainty, insecurity, or resentment (Cherry Hill, 2002). A resentful horse is uncooperative and resistant. This can be caused by fear, disrespect, fatigue, and things that may confuse and occasionally create high spirits in the horse. Examples of bad habits are rearing, halter pulling, or tail wringing. The following few examples however, represent the most common questions and cases concerning general behavior problems in equine behavior clinic (McDonnell, 2002).

Biting and nipping are normal greeting behaviors for colts and stallions. However a horse bite is very painful even when it wants to be playful. Sometimes they bite in response to sharp pain. The next example of abnormal behavior is called head shyness. It is a term used to describe hyper-reactivity or sensitivity about the head generally or specifically to the mouth, ears or eyes. Rough handling, beating, or physical pain can be the cause of the problem. Loading a horse into a trailer is probably the most common simple problem that a horse owner would face sooner or later. A horse may be afraid to enter a confined space that moves and rattles.

With respect to vices and bad habits, cribbing, weaving, head shaking, and self-mutilation are sometimes called stereotypies, which are the most common and frustrating behavior problems of horses. Stereotypies are repetitive, highly stylized, seemingly functionless motor responses and sequences. They occur in all captive, wild and domestic species. The classic equine stereotypies are listed in Figure 2.1 below.

ORAL	LOCOMOTOR	SELF-MUTILATION
Cribbing, ***tongue-movements,*** ***lip-movements***	Head movements, weaving, pacing, stall walking, kicking, digging	Self-biting, wall kicking, lunging into objects.

Table 2.1: Equine Stereotypies (source: McDonnell (2002) Understanding Horse Behavior)

In addition to all these classic stereotypies, horses can develop a wide variety of other repetitive movements such as banging a bucket or jiggling a door, which would be classified as stereotypical (McDonnell, 2002).

Lastly, some behaviors are actually related to signs or behavioral cues indicating stress, pain or even a medical condition. Head shaking is a condition where a horse flips his head in a reaction to sunlight, wind, movement, stress, etc. The horse can display mild annoyance to the sensations, or may exhibit sheer and extreme pain. Behavioral cues show that the horse will strike its nose with the forelegs because of the biting or burning sensation. Others may rub their noses on anything they could find. This behavior can also include extreme nose blowing, snorting, and coughing. Other head shaking symptoms can

be found in the appendix. If a horse is behaving as mentioned above, owners should quickly get their vet for medical attention. Other pain related behavior is when the horse is showing the following behavioral statement which includes evading contact during grooming, pinning its ears or biting during saddling, sinking, bucking or rearing during mounting and etc. Again if these behaviors are noticed, the first thing that the owner or handler could do is to examine the possible cause of soreness such as checking the horse's history or finding clues from the environment. If during the riding session these behaviors become more obvious and intensify, check the saddle fit and riding techniques. Ill-fitting saddles are often a cause of back pain. After making the correct judgment that the horse has a sore back or back pain and making the necessary adjustments, call the vet for an evaluation and treatment plan if the pain still persists (Vanessa Craft).

2.3 Identify Related Signals to Bad Behaviors and Vices

All the above behaviors have in some ways common cues or signals that are related with each other and each have their own contribution or weight towards the outcome. Most behaviors are either related with fear, aggression, and pain, how the horse is handled (communication with humans), the environment, turnout, eating patterns, and appearance among others. The horse owner or handler therefore needs to be able to judge accurately whether the signals and cues that are seen in the environment are related with the change in behaviors that are exhibited by the horse. When the owner or handler understands the horse's behavior and why and how these behaviors are triggered, then most of the problems can be prevented and cured. Some of the examples of visual clues,

environmental clues, and causes of certain behavioral problems are shown in a table at the appendix section.

2.4 Treatment and Solutions

Most of the bad habits and vices are preventable, that is with proper management and training, most of them can be avoided. Examples of treatments of equine behavioral problems are behavior modification, horse psychology, training, attitude adjustment, and conditioning or just management changes. For instance, it is usually difficult to identify and/or eliminate a particular stressful aspect of a domestic environment responsible for a particular bad habit or behavior problem. Nonetheless, most horse owners and managers would like to try to reduce or eliminate such behavior.

Changes in management that most likely to result in reducing bad habits and horse behavior problems by adopting physical or social environmental manipulation or nutritional changes in the direction of more roughage and less concentrated feeds. Owners or handlers need to monitor their horse's eating patterns and watch the horse's appearance every day. It is important to observe the horse eating patterns are in relation to its schedule. A horse that refuses to eat or drink is a cause for concern. This behavior combined with other unusual behaviors such as difficulty in urinating or eliminating feces, is a significant cause for concern as well. With careful planning, diligent efforts, and monitoring, some habits can be permanently changed therefore preventing any illness concern. Another example of a treatment for deterring or correcting biting and nipping behavior is by smacking the horse on the lips with as much force with gloved hands. Also

stopping hand feeding, that can promote nipping. However if a behavior does not change and keeps getting worse, further examination by the vet is essential in determining the actual cause, which might be due to physical problems.

There are certainly behavior problems that are simply behavior problems, however sometimes there is a primary or secondary physical component that should be addressed and monitored. For example, a young stallion that had nipped a handler, was corrected, and now is head-shy might sound like a simple behavior problem. But the horse should be checked for any possible physical reason for head-shyness such as looking at its ears, eyes, teeth and sinuses for any damage or sensitivity. The pain may have developed coincidentally with the punishment for nipping or the animal may be inadvertently be injured by the punishment. Therefore the key questions that the owner or handler should consider when examining their horses are:

1) Could this be principally a behavior problem that has adverse effects on the physical health?
2) Is this principally a physical health problem causing a change in behavior?
3) Could this be a learned behavior?
4) How does the behavior vary with environment, season, work schedule, diet, and etc?

However, not all treatments will work according to plan. If everything has been done, yet yielding little success in deterring habits such as a treat to kick, always seek professional help. According to Cherry Hill (2000), an author on horse behavior and horse information, vices, bad habits and other behavioral problems are best approached in a step-by step manner:

1) Understand horse behavior and needs
2) Identify and describe the vice or bad habits
3) Determine the cause(s)
4) Make management changes (facilities, exercises, nutrition, conditioning, grooming)
5) Implement appropriate training practices
6) Consider remedial training practices
7) Consider medical and surgical solutions

Therefore after considering all the steps above, the owner or handler can use this knowledge and information to make a better judgment in dealing with the horse's behavior. As mentioned earlier, the subject of horse behavior is difficult and complex to explain and judge. This is because all the information, cues, and signals either from the environment or from the horse are connected with one another and depend on the amount of importance put into the signals. The owner and handler have to consider or eliminate other aspects as well that will lead to behavior problems such as physical pain, so that appropriate treatment can be given immediately.

2.5 An example of a case study

A yearling Thoroughbred is seen constantly circumnavigating its stall. This is causing an uneven wear pattern on its hooves. However, when the horse is outside it is very happy and quite content. Does this horse show behavioral problems? Can the horse be stopped from doing this?

(Excerpt from NetPets: www.netpets.com retrieved July 30, 2004)

Although some of the behavioral problems described in this chapter do not seem serious enough to be of concern and are only related with the horse's natural urge such as nipping, grazing, kicking, and walking among others, however, sooner or later it will have a bad impact on the horse as well as the environment surrounding it.

From the excerpt mentioned, the owner noticed visual clues from the horse such as walking constantly in the stall, a wearing pattern on its hooves, and appearing to be happy when released outside. From these clues or signals the owner can make judgments based on his experiences and knowledge that the horse is displaying a certain type of behavior problem called stall walking. Stall walking is commonly thought as a problem brought on by boredom. However, evidence has shown that this behavior is caused more by confinement, lack of interaction with other horses, and lack of grazing (Katherine Houpt). These two behaviors are basic to horses, and it is when they are deprived of this basic equine need that stall walking and weaving generally show up. These behaviors generally do no harm to the horse. However, the horse may excessively wear the floor of the stall or may wear its shoes or hooves abnormally. The behavior may in the end affect its performance. Therefore after identifying the behavior problem from the clues provided by the horse and the environment, what the owner can do to prevent further problems is to release the horse to pasture more frequently, keep the horse in the company of other horses and to offer the horse more than one kind of roughage. Adding a companion animal such as a goat or a pony may also help.

It is not easy to take a horse to a veterinarian or to call professional help in a time of need. Even if medications that could treat obsessive, compulsive behavior such as stall walking were available, the cost or price would be astronomically expensive. That is why

upon observation of changes in behavior that could have an impact on the overall being of the horse and the environment, what the owner or handler should do is to identify what actually triggered the behaviors by relating them to the visual and environmental cues that the owner saw. Judgment has to be made relating to the behavioral problem and only then treatment can be given (refer to 2.4). This will not cost as much as calling the vet when the owner can prevent or control the behavior in the first place. However, not all owners or handlers can make the correct judgment about the actual behavioral problem. This is because the owner or handler might misinterpret the cues given by the horse or they might only stress on certain cues rather than others thus making inaccurate conclusions which will lead to non effective treatment. Therefore this study will help increase the probability of making correct judgments by owners and to train them to be better at identifying signals related to behaviors.

CHAPTER 3

RESEARCH METHODOLOGY

This chapter describes the framework of the study, which was run after the completion of the system design and development of the Knowledge-Based Horse Diagnosis System (HDS). During the first stage of the study, diagnosis training and learning tasks on types of horse behaviors were identified and designed. The training and learning tasks were developed to focus on the causes, visual cues and environmental cues leading to certain problem behaviours. The tasks were also designed to be in a correct manner or sequence. The types of horse behaviors are presented during the training and learning stages in the Knowledge-Based Horse Diagnosis System. The design and development of the system will be discussed in chapter 4 and 5 as well as the software LPA Win-Prolog language that is used in writing the system.

3.1 Subjects

The study is carried out on a clustered and stratified sample of 10 subjects who are recruited randomly. The subjects have limited experience and exposure to the horse training environment. Therefore, a preliminary training is provided to all the subjects and all of them have to go through a usability questionnaire. An ideal sample for this study is a horse trainer from Sarawak Equestrian and Turf Club, Malaysia. The reason being that horse trainers are continually exposed to these kinds of behaviour in horses.

3.2 Location

The study is conducted at Sarawak Equestrian and Turf Club, Malaysia which creates an authentic environment for the subjects to perform the training while learning the types of horse behavior problems and treatments using HDS.

3.3 Materials

3.3.1 Preparatory Materials

Questionnaires are prepared before the experiment and are used to test the usability of HDS. The answers are based on the Likert Scale which is an ordinal scale measurement, that is assigned by numerical values (Table 3.1) so that the subjects would not feel bored and stressed when answering the related questions (Wiersma, 1991). HDS is tested on (a) user reaction toward the system, (b) capability of the system, (c) feedback on the system, (d) user interface, and (e) general questions on system usability.

Table 3.1: Likert Scale

Category	**Degree of Agreement**
1	Strongly Agree
2	Agree
3	Neutral
4	Disagree
5	Strongly Disagree

3.3.2 Experimental Material

Writing pads and pens are made available to all participants, in addition to the items listed in Section 3.3.1.

3.4 Equipments

This study is equipped with a computer notebook (Toshiba, Satellite 2450-A742) installed with the HDS which is made available during the experiment. All the equipment was used for data collection.

3.5 Procedures

3.5.1 Preparatory Procedures

The training and learning task is designed to focus on types of horse behavior problems and treatments, specifically on the causes, visual cues and environmental cues that need to be understood in the correct manners. Causes, visual cues and environmental cues are selected as training and learning methods. Then, the design is developed as HDS with LPA Win-Prolog language (Chapter 5).

The designed questionnaires are sent for a pilot test with a group of five trainees from Sarawak Equestrian and Turf Club, Malaysia. The pilot test is used to validate the materials before the real usability test is conducted. Moreover, this pilot test is able to

identify and clarify misunderstandings, ambiguities, or inadequate items in the questionnaire before running the experiment.

3.5.2 Experimental Procedures

The experiment is conducted on one subject per session basis. First, the subject is briefed about the objectives of this research and consent to participate was obtained. Second, the subject is provided with instructions and demonstrations about how to use and explore the HDS system, as the preliminary training. Assistance/explanation is readily provided if the subject has any difficulty during the training. Third, the subject is allowed to test the controls, navigate, and experience the system for about 5 minutes before the actual experiment.

Then, the subject is given a maximum of 20 minutes to perform learning and training. Observation is carried out simultaneously. The subject is given a writing pad and pen for notes and sketches, thus enabling easier and clearer explanation by the subject. The information is crucial and enlightening in answering the thesis question of 'what information was needed to perform learning'. Later, the subject has to fill in the questionnaire within 20 minutes.

3.6 Data Collection

All data, including performance tests, questionnaires and transcripts, or work sheets (if any) are kept confidential and stored in special files with anonymous filenames. The data

corresponds to the knowledge used for the computer accessory maintenance tasks. This research is conducted to go through the notes and other records as soon as possible after each evaluation session. The researcher's personal opinions are highlighted and separated from what had happened when reviewing the notes and other records. This helps the researcher to understand what had transpired and led the researcher to make good interpretations. The recorded data is the subjects' description and explanation about 'what', 'why', and 'how' the subjects perceived the learning environments. They are later transcribed for verbatim, and subsequently pruned, and segmented into statements. The verbal reports produced by the subjects are examined, critiqued, considered, explored, synthesized, and analyzed. Transcripts are checked for correctness by re-running the protocols. Corrected transcripts are coded and the data is developed. The data is read and then proof read by the researcher.

This chapter describes the research methodology used in the study. It presents the framework of experimental procedures, methodologies, and data collection of the study. The empirical study is run after the completion of the system design and development of Knowledge-Based Horse Diagnosis System (HDS).

CHAPTER 4

SYSTEM DESIGN

This chapter describes the system design of the Knowledge-Based Horse Diagnosis System (HDS). The system design presented training and learning materials of horse behavior with a conceptual design that led to the architectural flow of the training and learning environment.

4.1 Task Analysis

Task analysis is an important aspect of the user interface design, insuring that the end product is usable and practical. Dix et al. (1993) is in favor of suggesting the way to make a new task more efficient is by supporting the task with a goal. From here, HDS is designed to learn about and train types of horse behavior problems. On the other hand, this system is designed by recognizing and analyzing from the perspective of the end-user and not from the point of view of those who do not necessarily use the system. Figure 4.1 shows the task selection that subjects should undertake when using the system. This phase is completed before proceeding to the design phase in order to identify the possible action and the selection of devices for the appropriate tasks. By predicting the steps the users should take, the system can be designed to meet users' requirements and expectations.

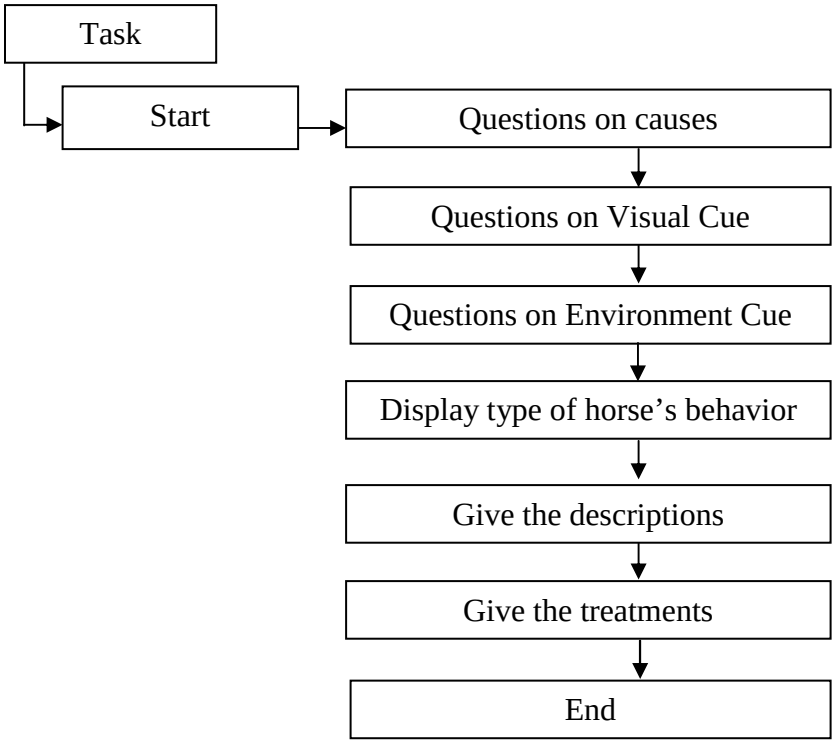


Figure 4.1: Task Selection

4.2 Project Design

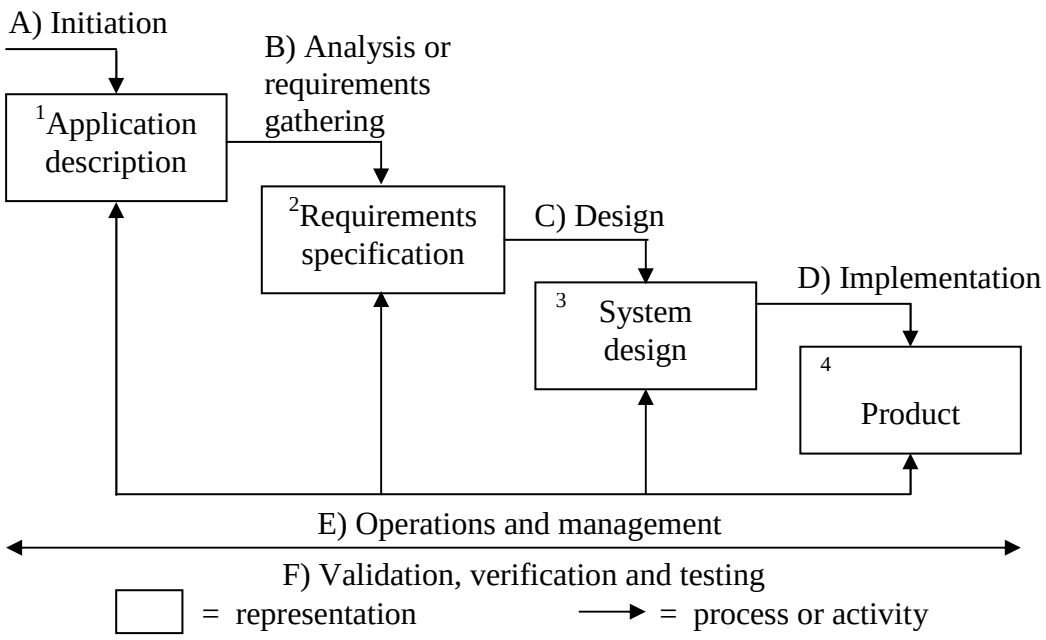


Figure 4.2: The Traditional "Waterfall" Model of System Development

(Source: Preece et al., 1994)

Table 4.1: The “Waterfall” Method

Phase	**Process**
Initial	Have clearer ideas on the objectives of the study undertaken and past research papers are also reviewed.
Analysis or requirements gathering	Features and functions of HDS are sketched, defined and identified before designing the system. The relevant information on the types of behavior problems, software and hardware requirement is gathered.
Designing	Conceptual framework is designed and data that is related to the learning material is collected. After designing the layout of the system, the selection criteria for user interface design are tackled for appropriate task.
Implementation	The sketch layout of user interface is implemented on the system.
Operations and management	These processes involve running the system, enhancing the performance and correcting any system errors after revising the implementation. The specification requirement of the project should be meet by then.
Validation, verification and testing	The feedbacks from testing are gathered and evaluated to validate and verify the interactivity and user-friendly interface of the system.

The typical framework for the system life cycle in HDS is based on the Waterfall Model. The explanation in Table 4.1 and Figure 4.2 summarizes the phases involved in the development of this system. The purpose of using this model is to make sure that every action is taken during the design and development of the system according to the right sequence and with the aim that the project is well designed and organized.

4.3 Conceptual Design

Preece et al. (1994) claimed that conceptual design is part of the system design, and is concerned with questions about what is required. It can simply be defined as the way users view the system and the task (Dix et al., 1993). The system developed in this study focused on the desired data or information to be designed as the training and learning materials. The causes, visual cues and environmental cues are presented in a structured flow so that the subjects easily understand the types of horse behaviors and treatments in HDS. The design of this system is used to understand the horse behaviors and treatments in a way where the subjects won't feel bored and stressed when using the system. The interactive and user-friendly criteria are also considered during the designing stage to make the feature more interesting. The aim is to help subjects learn and train more effectively when using the system.

4.4 System Architecture

HDS was designed with the progression of conceptual design that refined the systems' architecture. Of course, the conceptual design was essential to stabilize the architecture of

HDS. Throughout design iterations, the design of HDS was expended into system architecture to ensure that it supported training and learning for types of horse behavior and treatments. The training and learning environment was purposely designed in such a way that subjects could understand the causes, visual cues and environmental cues of each type of behavior and treatment in order to diagnose the horse's behavior in the right way. Furthermore, they could automatically undertake their training and learning in a controlled manner by practicing and applying the skills.

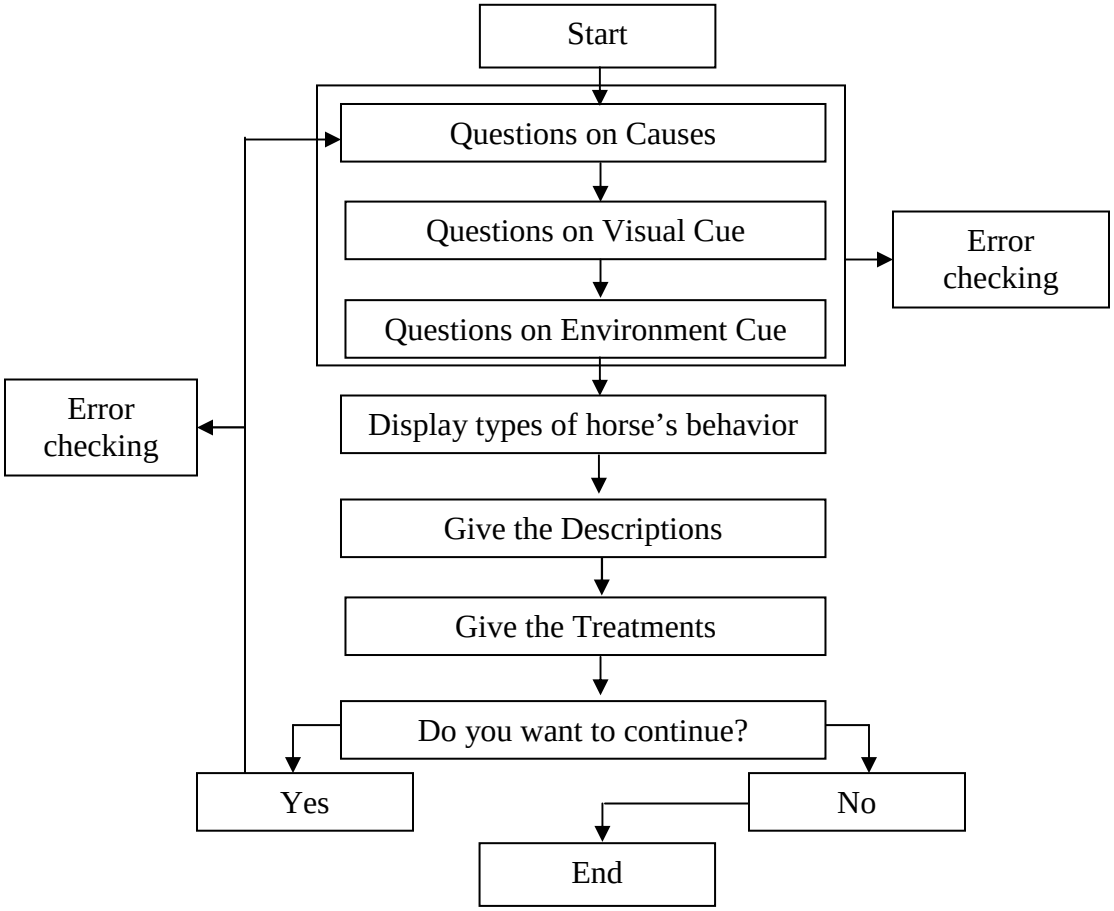


Figure 4.3: The Functional Flows of HDS

The training and learning system was designed in such a way that the subject could easily understand and follow the steps (Figure 4.3). The system starts with asking questions related to the causes that affect the horse behavior. If one of the causes is not related to the types of behavior, the system will trace the possibility of other behaviors. If this is found, then the system will ask the next questions related to visual cues and environmental cues. Sometimes, users might key in the wrong characters for YES or NO. Error checking will take place in the system for any input information and keep the previous data in the temporary memory until the user keys in the right character of YES or NO. Once the system matches all the questions concerning the causes, visual cues and environmental cues with the data in the system, the system will then display the type of behavior problems and suggested treatments. The subject could repeat the procedure by just keying in 'YES' after the system asks, "Do you want to continue?"

This chapter has provided some aspects that influenced the HDS design in general; the design issues related to the architecture of the systems, and interactive learning contents that are needed. Design recommendations for interactive training and learning materials are also included in the chapter.

CHAPTER 5

SYSTEM DEVELOPMENT

This chapter describes the implementation of Knowledge-Based Horse Diagnosis System (HDS), which began with system specification, functional and non-functional requirements. LPA Win-Prolog programming language was used in the development of the system that consists of a database of facts and logical relationships (rules). The rules describe the relationships, which hold for the given application. The system will interact with the user, asking questions to establish information that is needed to execute the rules.

5.1 System Specification

The HDS performed horse behavior analysis; causes, visual cues and environmental cues to develop skills and knowledge for the users. Most system developers were emphasized on the importance of knowledge-based diagnosis system as a medium.

5.1.1 Functional Requirements

The functional requirements of HDS were to (a) capture and analyze the horse's behavior, (b) scan the facts and logical relationships (rules) of horse behavior, (c) locate and identify the causes, visual cues, and environmental cues, and (d) interact with users

using Natural Language Processing (NLP) with PROLOG. It was important to capture the requirements accurately before starting the system development. Otherwise there would be a lot of changes and delays that led to problematic development.

5.1.2 Non-functional Requirements

HDS used a simple user interface to display the information. When HDS identified a possible type of horse behavior, the system would present descriptions and treatments of the horse on the screen in such a way so that the users could observe it straight away. For example, when the type of horse behavior was identified, the typical behavior descriptions and treatments would appear on the computer screen. The user could view different type of horse behavior problems, descriptions, and treatments for the horse.

5.2 Software for Development of HDS

5.2.1 Platform

HDS is an open system that could run both MS Windows 2000 and MS Windows XP platforms. Hence, the platform dependency was not a factor. The development of HDS took place on a personal computer with Intel Centrino Mobile 1.0GHz, 256MB RAM, 2GB hard disk space, 32MB graphics card on MS Windows XP. It allowed the HDS to acquire sufficient data for diagnosis analysis. LPA Win-Prolog was the programming

language used to develop the HDS. The following sections briefly offer an informative reference to programming languages used.

5.2.2 Programming Language

LPA Win-Prolog Programming.

Prolog is a language, which is completely different from other languages normally used in the programming of computers. The programming languages BASIC, C and PASCAL are languages which use, as their main technique in programming, a method of splitting a problem into discrete steps and obeying those steps in sequential order. That is, the programming language exactly mimics the way in which a digital computer obeys the programmed commands. Each machine instruction is a discrete step giving an exact order to the computer and the computer carries the instruction out exactly. Each instruction is obeyed and the actions are irrevocable. The computer stores information in its memory overwriting the previous contents. These kinds of languages are called algorithmic languages. An algorithm is a mathematical procedure, which enables a problem to be solved by a finite number of steps. Algorithmic languages are those languages, which are designed to provide solutions by expecting a problem to be divided into a number of discrete steps. Prolog is not considered to be an algorithmic language.

The name Prolog comes from **Pro**gramming in **Log**ic. Prolog is not in fact considered to be a true logic programming language but it is definitely a great step in the right direction towards producing a logic programming language. Prolog is a very attractive language for professionals in the area of Knowledge Engineering and Artificial

Intelligence and is increasingly used in practice. Indeed it has been used in over 1000 real world applications and its use continues to increase. Examples of real world applications of Prolog include:

- Environmental Modeling
- Sales Modeling
- Fungus Identification
- Image Recognition
- Fire Officer Training
- Management Consultancy
- Trade and Industry
- Shift Allocation
- Payrolls

A description of these applications can be found in the LPA-Prolog home page at:

http://www.lpa.co.uk/

Writing programs in Prolog is completely different from writing programs in algorithmic languages. The programmer must be more concerned with the problem to be solved rather than finding the means to break the solution down into small steps which can be programmed. Prolog makes the representation of the solution much easier, allowing one to concentrate on solving the problem rather than coding the solution.

Prolog contains a number of features not found in the normal programming languages, which make Prolog very powerful in the logic style of programming. These features include:

- A powerful search and backtracking inference mechanism,
- A powerful built-in ‘pattern matching’ mechanism,
- A simple but sophisticated data structure with the ability to manipulate the data structure.

There is also a uniformity of Program and Data. In Prolog the data and the program are in fact just two different ways of looking at the Prolog objects. Items can be freely created and deleted in a uniform database. Thus as there is no distinction between program and data, Prolog has the ability to change its program whilst that program is running. There are no pointers, assignments, or “go_to” statements in Prolog. Recursion is also a very natural programming technique in Prolog.

Another important aspect of Prolog is that it is related to a logic called predicate calculus. This gives Prolog a number of distinct properties that it inherits from logic and gives it better foundations than other conventional programming languages. One of the properties is that it is a declarative language. This allows one to develop a program by concentrating on “what” needs to be done instead of “how” it is done. It can also allow a program to be understood without the need to follow through its dynamic execution. However, the true power of Prolog comes not from any single feature, but from the result of having these features combined.

5.3 Horse Diagnosis System

5.3.1 Objectives

The system is using NLP in diagnosing type of horse behaviors in order to help ordinary users. It is about how to make computers (system) understand human languages such as English and any other language in this world. Furthermore, it allows human being to be able to use their native languages to put information into the system rather than resorting to artificial language such as C or Prolog. So, to process the information conveyed by human language, more powerful ways to represent and use knowledge are needed. In order to do this, the system has to have a tokenization, template and simple parser.

5.3.2 Methodology

Since developing the system based on NLP is not easy, the expert system module is implemented in the system instead. It works even though not exactly fulfilling the needs. Prolog is a suitable language as it is more to English and it is easy to understand rather than using other programming languages such as C or C++ or Visual Basic.

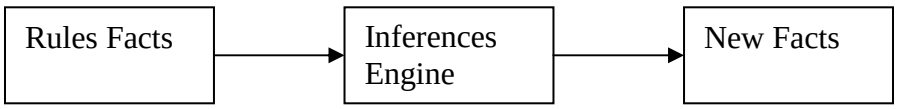
Backward chaining rule based system is used where the goal of variable is identified. The inference engine searches sequentially through the knowledge-base for the first rule with that goal variable in its conclusion. When the inference engine finds such a rule, it examines the premise of one of the rule. Three possibilities will occur: -

1. If the premise evaluates to true, then the goal variable is set equal to the value specified in the rule and the search stops.

2. If the premise evaluates to false, then the inference engine resumes its sequential search for another rule with the given goal variable in its conclusion.
3. If the premise cannot evaluate because the value of a variable is unknown, then the inference engine begins a new search with this variable as a sub-goal.

Once this sub-goal is determined, the inference engine resumes its evaluation of the former rule's premise. This search continues in a recursive fashion until the search for the initial goal variable is found. If there are no rules for the goal variable or all the rules evaluate to false, then the goal variable is concluded as known. If there are no rules for a sub-goal variable, then the knowledge-base is usually encoded so that the inference engine asks the user directly for a value of the sub-goal variable.

Backward chaining is the basic theorem-proving aspect of Prolog. This means that the Prolog system starts with what has to be proven and attempts to build a proof tree for it. But, since Prolog is a complete programming language, the inference engine can be coded with forward chaining method as well. An inference engine is simply a program that can manipulate a known set of facts and rules to produce (infer) new facts. In practice, Prolog turns out to be a highly suitable language for writing inference engines.



5.4 Testing and Debugging

Testing was carried out to view the results and functionality implemented at each stage. It was also done to analyze the system. When errors and inconsistencies occurred, they

were investigated and corrected. The reworked application would again be tested for any new errors and checked whether the original errors were eradicated. Debugging facilities is available with LPA Win-Prolog and was used to code other errors.

5.5 System Development

5.5.1 Explanations on how the program runs

A Prolog program can be made to explain its own reasoning in a very straightforward manner. These are the database about the type of horse behavior problems and the details. It could be consider as a sub-goals listing, in Prolog.

```
/*-----------rules to identify types of horse behavior problems----------------*/

horse(balking):-
 fear,
 heavy_hand,
 stubbornness,
 extreme_fatigue.

horse('barn sour herd bound'):-
 check,
 separation_from_buddies_or_barn.

horse(biting):-
 check,
 greed,
 playfulness_or_resentment,
 investigate_things_with_mouth,
 often_hand_feeding_treats,
 pain_or_fear,
 aggression,
 menuask('visual cues',['mime bite','a head swing','neck extended and slightly opened mouth or nipping','directed towards the adversary''s forelegs,head,shoulder or chest']).
```

```
horse('bolting when turned loose'):-
 check,
 poor_handling,
 anxious_to_exercise_or_join_other_horses.

--- etc.
```

At first, this program must be compiled. The name of the file is <horse>. A welcome menu will appear. Then, users have to follow another step to gain more information. User need to type <main>. Next, users will be asked to answer the questions for the causes, visual cues, and environmental cues. Users would type the word either <yes> or <no>. The memory in Prolog would read what data the users have already keyed in.

```
:- nl,nl,nl,write('Horse Diagnosis System'),nl,
write('by'),nl,
write('Kartini Abdul Ghani'),nl,nl,
 write('*********************************'),nl,
write('* Please type "main." to start *'),nl,
 write('*********************************'),nl,nl,nl,nl.

main:- diagnosis.

diagnosis:-
 retractall(known(_,_)),
 horse(X),
 nl,write('The horse is just '), write(X),write('.'),nl,nl,
 write('****************'),nl,
write('* Description: *'),nl,
 write('****************'),nl,nl,
description(X),
 write('**************'),nl,
 write('* Treatment: *'),nl,
 write('**************'),nl,nl,
 treatment(X),
 continue.
```

```
diagnosis:-
 nl,write('I cannot identify the behavior! Please seek for professional advice!'),nl,nl,
 continue.

continue:-
 write('Do you want to continue? (yes. or no.)'),nl,
 read(ANSW),
 determine(ANSW),
 change(ANSW),
 main.
continue:-
 nl,nl,nl,write('Thank you very much for using this system!'),nl,nl,nl.
```

Each time the selection comes out as the display, it would take five spaces from the left margin.

```
determine(ANSW):-
 member(ANSW,[y,yes,yup,ya,n,no,nop,nope]),!.

determine(ANSW):-
 nl,write('You are giving an answer that I do not recognize'),nl,
 write('Please answer yes. or no.!'),nl,nl,
 continue1.

change(ANSW):-
 member(ANSW,[y,yes,yup,ya]).

change1(ANSW):-
 member(ANSW,[n,no,nop,nope]).

continue1:-
 write('Do you want to continue? (yes. or no.)'),nl,
 read(ANSW),
 determine(ANSW),
 change(ANSW),
 main.

determine1(ANSW,A,Z):-
 member(ANSW,[y,yes,yup,ya,n,no,nop,nope]),
 asserta(known(ANSW,A)),
 Z=ANSW,!.
```

```
determine1(ANSW,A,Z):-
 nl,write('You are giving an answer that I do not recognize'),nl,
 write('Please answer yes. or no.!'),nl,nl,
 ask1(A,Z).

determine2(ANSW,A,Menu,Z):-
 member(ANSW,[y,yes,yup,ya,n,no,nop,nope]),
 asserta(known(ANSW,A)), Z=ANSW,!.
determine2(ANSW,A,Menu,Z):-
 nl,write('You are giving an answer that I do not recognize'),nl,
 write('Please answer yes. or no.!'),nl,nl,
 menuask1(A,Menu,Z).
```

These are the data that are being kept in the memory. It means, Prolog would use pattern recognition in order to detect the same pattern in the system. To allow the recognition process to occur, both queries and facts in the database must have the same information (number of arguments).

A rule can be defined in search of a goal, for example asking a question such as what is the cause of the horse behavior. ‘Assert’ is used so that the questions will not be asked again if the operation fails. When the instructions fail, the 'retract' is used to perform a backward search in the previous information to see whether those queries could be satisfied or not.

Cut (!) is use to control the Prolog program when the backward search action is performed. It means the system does not have to do the backward search again even though the operation fails.

```
/*----------------------start checking rules----------------------*/

check:-
 known(X,_),
 change(X),!, fail.

check:-
 known(X,_), change1(X).
```

```
check1:-
 known(X,'extreme fatigue'),
 change(X),!,fail.

check1:-
 known(X,stubbornness),
 change(X),!,fail.

check1:-
 known(X,'heavy hand'),
 change(X),!,fail.

check1:-
 known(X,fear),
 change(X).

check3:-
 known(X,'bad habit'),
 change(X),!,fail.

--- etc.
```

"askable" is used to keep track of the questions that can be asked, and askable(causes) is retracted when the question is answered. "ask" is responsible for getting information from the user, and remembering the user's response. If the program does not already know the answer to a question it will ask the user. It will then assert the answer. "ask" only deals with simple yes or no answers. A "yes" is the only yes value. Any other response is considered as "no". It recognizes two cases of knowledge:

1) The attribute-value is known to be true,

2) The attribute-value is known to be false.

```
ask(Attribute):-
 known(X, Attribute),        % succeed if we know its true
 change(X),
 !.                          % and don't look any further
```

```
ask(Attribute):-                % fail if we know it's false
 known(X, Attribute),
 change1(X),
 !, fail.

ask(Attribute):-                % fail if we know it's false
 known(_, Attribute),
 !, fail.

ask(A):-
 write(A),                      % if we get here, we need to ask.
 write('?(yes or no): '),
 read(Y),
 determine1(Y,A,Z),             % get the answer
 %asserta(known(Y,A)),          % remember it so we don't ask again.
 change(Z).                     % succeed or fail based on answer.


ask1(Attribute,Z):-
 known(X, Attribute),           % succeed if we know it's true
 change(X),
 !.                             % and don't look any further

ask1(Attribute,Z):-             % fail if we know it's false
 known(X, Attribute),
 change1(X),
 !, fail.

ask1(Attribute,Z):-             % fail if we know it's false
 known(_, Attribute),
 !, fail.

ask1(A,Z):-
 write(A),                      % if we get here, we need to ask.
 write('?(yes or no): '),
 read(Z),
 determine1(Z,A,Z1),            % get the answer
 %asserta(known(Z,A)),          % remember it so we don't ask again.
 change(Z1).
```

"menuask" has the same function as “ask”. The difference is that it gives the user a list of menu rather than a single question about causes. Therefore, it is basically functions as "ask" except for the menu.

```
menuask(Cues,Menu):-
 known(X, Cues),
 change(X),
 !.
menuask(Cues,Menu):-
 known(X, Cues),
 change1(X),!, fail.

menuask(Cues,Menu):-
 known(_, Cues),!, fail.

menuask(Cues,Menu):-
 nl,write('Does this '),write(Cues),write(' exist?'),nl,
 display_menu(Menu),
 write('Answer(yes or no)'),
 read(ANSWER),
 determine2(ANSWER,Cues,Menu,Z),
 %asserta(known(ANSWER,Cues)),
 change(Z).

menuask1(Cues,Menu,Z):-
 known(X, Cues),
 change(X),!.

menuask1(Cues,Menu,Z):-
 known(X, Cues),
 change1(X),
 !, fail.

menuask1(Cues,Menu,Z):-
 known(_, Cues),
 !, fail.

menuask1(Cues,Menu,Z):-
 nl,write('Does this '),write(Cues),write(' exist?'),nl,
 display_menu(Menu),
 write('Answer(yes or no)'),
 read(Z),
 determine2(Z,Cues,Menu,Z1),
 %asserta(known(Z,Cues)),
 change(Z1).

display_menu(Menu):-
 disp_menu(1,Menu),!.          % makes sure we fail on backtracking
```

```
disp_menu(_,[]).
disp_menu(N,[Item|Rest]):-          % recursively write the head of
 write(N),write(':'),write(Item),nl,  % the list and disp_menu the tail
 NN is N+1,
 disp_menu(NN,Rest).
```

5.5.2 Example of input and output

```
Horse Diagnosis System
by
Kartini Abdul Ghani
*********************************
* Please type "main." to start *
*********************************

# 0.02 seconds to consult horse 28 august 2004 b.pl [c:\my documents\win-prolog 4\]
| ?- main.
fear?(yes or no): |: yes.
heavy hand?(yes or no): |: yes.
stubbornness?(yes or no): |: yes.
extreme fatigue?(yes or no): |: yes.

The horse is just balking.
*****************
* Description: *
*****************
Refusal to go forward often followed by violent temper if rider insists.

***************
* Treatment: *
***************

1.curable.
2.review forward work with in-hand & lounging
3.turn horse's head to un track left or right
4.strong driving aids with no conflicting restraining aids(no pull on bit)
5.do not try to force horse forward by pulling

Do you want to continue? (yes. or no.)
|: wrong.

You are giving an answer that I do not recognize
Please answer yes. or no.!
```

Do you want to continue? (yes. or no.)
|: yes.
fear?(yes or no): |: yes.
heavy hand?(yes or no): |: mo.

You are giving an answer that I do not recognize
Please answer yes. or no.!

heavy hand?(yes or no): |: yes.
stubbornness?(yes or no): |: yes.
extreme fatigue?(yes or no): |: yes.

The horse is just balking.

****
* Description: *
****

Refusal to go forward often followed by violent temper if rider insists.

****
* Treatment: *
****

1.curable.
2.review forward work with in-hand & lounging
3.turn horse's head to un track left or right
4.strong driving aids with no conflicting restraining aids(no pull on bit)
5.do not try to force horse forward by pulling

Do you want to continue? (yes. or no.)
|: yes.
fear?(yes or no): |: no.
separation from buddies or barn?(yes or no): |: yes.

The horse is just barn sour or herd bound.
****
* Description: *
****
balking, rearing, swinging around, screaming and then rushing back to the barn or herd.

****
* Treatment: *
****
1.curable but stubborn cases require professional help.
2.a confident, capable trainer that insists to the leave the barn(herd) and then positively reinforces the horse's good behaviour so the horse develops confidence.
3.the lessons GO and WHOA must both be reviewed.

Do you want to continue? (yes. or no.)
|yes.
fear?(yes or no): |: yes.
heavy hand?(yes or no): |: no.
resentment?(yes or no): |: yes.
disrespect?(yes or no): |: yes.
bad habit?(yes or no): |: yes.

Does this visual cues exist?
1:shows his back end
Answer(yes or no)|: yes.

Does this environmental cues exist?
1:new environment
2:new handler or mucker
Answer(yes or no)|: yes.

The horse is just cannot catch.
****
* Description: *
****
avoids humans with halter and lead.

****
* Treatment: *
****
1.curable.
2.take time to properly train, use walk-down method in small area first, progress to larger.
3.remove other horses from pasture; treats on ground, never punish horse once caught.
Do you want to continue? (yes. or no.)
|: no.

Thank you very much for using this system!

5.5 Strengths of the System

The HDS is a very attractive system. Users are able to go back to the main environment and avoid themselves from getting lost when they are using the system. Basically, the system is to train users who have some experience with horses or those without experience or knowledge in types of horse behavior problems. They can learn the types of horse behavior problems and treatments from the HDS system. The system can control the training and learning environment of the user such as giving instructions to prevent them from getting lost when they are using the system. The HDS system is also able to retrieve information successfully. A few limitations have been found in the system and are further discussed in chapter 6.

This chapter covers the development of the HDS and the selection of hardware and software. This chapter is concerned with the implementation of the application design. It includes how the algorithms were adapted in developing the application and the subsequent changes to the design provided in Chapter 4. There are also examples of code that were used in the application for various methods employed. This chapter provided the strategy in implementing the specification of the application as well as listing the strengths of the HDS.

CHAPTER 6

DISCUSSION AND CONCLUSION

In this chapter, the findings of the study will be discussed with relations to the development of the knowledge-based system. The process of how the horse handler makes judgment when facing with a sudden change in horse behavior is also discussed as well as the problems and limitations faced in the study. Conclusion and suggestion for further and future work will be mentioned at the end of the chapter.

6.1 Findings of the study

Based on the observation of the interaction between the user and HDS during the usability-testing period, it seems that the user is more concerned with answering the questions right rather than focusing on which cue is more relevant in the scenario that he have in mind with regards to recent behavior problems that he faced. This is because the user would keep on repeating the same answer until a behavior can be diagnosed and if the conclusion cannot be found they will try again with different answer or just guess. Another explanation might be on the structure of the questions in which the user only has to answer yes or no for each questions. The way the questions is structured might encourage the user to go either way, therefore, promote guessing. However, most of the participants agreed that the system help in providing additional awareness in noticing

cues or gathering other important information from the environment especially when making judgment in diagnosing behavior problems in horses. This is because horse handlers usually focus only on certain overt behaviors of the horse such as the facial expression especially ears, eyes, head and tail when making judgment on the horse behavior rather than to look at other cues such as the surrounding environment. This is true in the sense that a horse is equipped for visual communication to express his feelings by looking at his posture, facial expression, and orientation of his body (Aronson & Dodman, 2003).

Based on the users' feedback and with regards to increasing accuracy of judgment, if certain cues were taken into consideration, judgment made in determining the causes of changes in behavior will be more accurate. This is because, the system helps educate the users in which cues to notice and therefore help to increase the accuracy when making these judgment especially if the same situation occurs and if the user keep on practicing using the system. By using the system, it helps the owners or handlers in increasing the probability of making correct judgment and training them to be better at identifying signals related to certain behavior so that proper treatment can be given.

As mentioned previously, one of the cues that the users always look for is the facial expression of the horse. This is what Brunswick is trying to stress on which is the importance of the "stimulus" or "input" or environmental conditions of a situation rather than just stressing on the subject's view or opinion (Hammond, 1998). The way the users communicate while interacting with the system is that they are more into visualizing what the horse is expressing while answering the questions. The first question that the system

ask is about fear, and the user will visualized either the horse ears is pinning against its head or its eyes are bright and wide open, or even the position of the head and tail of the horse is taken into consideration when trying to answer the question. Consider an example where the horse is displaying a certain behavior (Ye). The user visualize all the cues relating to that behavior such as fear, extreme fatigue, screaming and rushing back to the barn (cue utilization validity) and uses these cues to answer the question in HDS (Ys). The system then diagnoses a behavior and provides treatment suggestions based on the answers given (performance or judgment made). In this case the horse is displaying either balking or barn sour, a habit commonly happen when the horse is separated from his buddies or barn. However, if the system cannot find a conclusion or diagnose, then the system will prompt the user to try again encouraging him to be more precise on the cues (achievement).

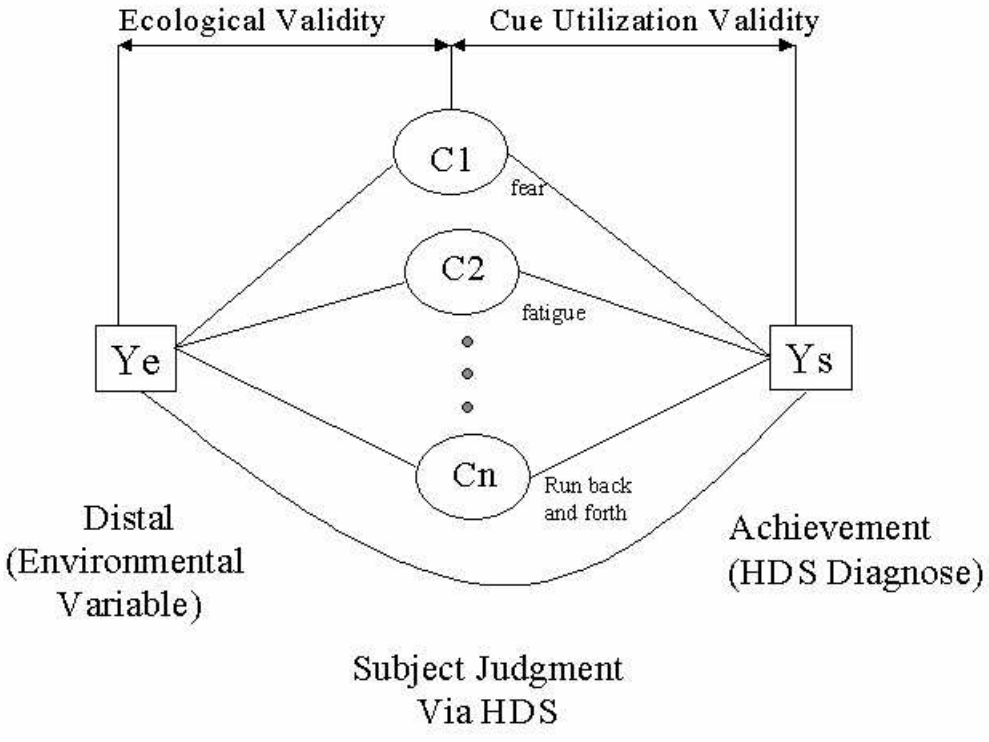


Figure 6.1: Lens Model in HDS

Another cognitive process that can be found from the observation of users interacting with this system is whether their cognitive process is more geared towards using their intuition rather than going through analytical processes. According to the Cognitive Continuum Theory, humans are prone to use the intuitive side of cognitive processes when they are faced to solve problems containing complex information where the information tends to be related to each other and difficult to distinguish (Allard et al, 2003). Therefore, based on the domain (problem behavior in horses) and that certain cues contribute towards different problem behavior, the user should be going through an intuitive cognitive process. However, based on the observation of the HDS, it is not sure whether the user is going through which processes. Again, the way the HDS questions is structured might be one of the reason since the steps the user choose in solving a problem could not be monitored since the questions or steps to diagnose a behavior are already predefined.

6.2 Problems and limitations

One of the problems faced in this study is the domain area itself (horse behavior problems) which involves a large number of cues, signals, and conditions from the environment that can contribute towards certain behavior changes. All these cues are interrelated and have their own proportionate or weight-age to the outcome or change in behavior. Therefore, owners or horse handlers have difficult time in identifying which signals are more prevalent than others. It is fairly common for horse owners or veterinarians to face frustrating scenarios where it is very difficult to recognize or

diagnose horse behavior problems. It is easy to say that the horse is perfectly fine physically and conclude that the problem is purely management related or behavioral. However, when the secondary behavioral problems quickly build up, it further complicates the interpretation of the problem behavior. Then, the subtle physical root cause goes undiagnosed even by the best veterinary evaluations. There are a lot of things that an owner or horse handler need to know before diagnose can be made. A lot of questions need to be answered especially in details the situational and behavioral response when a change in behavior happens.

Another problem is getting information from an expert to contribute towards the development of the system especially to be put in the knowledge-based of the system. Only one horse handler information or experience from Sarawak Equestrian Club was acquired in addition to information from secondary resources such as books on horse behavior and the internet during the development of the system. Therefore, the information gathered might be limited and needs to be updated and refurbished with more information. There are however advantages and weakness in acquiring information from one single expert (Awad, 1996). Another limitation to the research is with regards to the subjects. The subjects chosen for the research came from the same Equestrian Club making the conclusion only applicable to that set of subjects and can not be generalized to other horse handlers elsewhere.

The system can only be used for general horse behavior. It does not include any medical records, any types/or description of the horse or specific to certain type of horses. If this information can be added in the system, HDS will be more informative and useful

as a system that can keep medical records and history of the horse as well. It can also use these records to come up with solution based on previous knowledge and experiences.

Few limitations have been found in the system. The display in the HDS system is not clear enough although this system used a projector as a computer screen. In addition to that, subjects have to concentrate and pay more attention to the screen when reading the questions and responding answers to the system. Furthermore, the subjects found that the HDS system is not accurate during their training and learning. This might delay and slow down the speed of the learning process.

The users also have to be very careful when using the system in order to avoid errors and be lost in the system. Some users have suggested that the system should add more interactivity criteria in it. The message appeared is too small and hard to read from the computer screen. In order to avoid these weakness or limitations, the characters used in the system is controlled and tested from time to time during the development stage.

There is one weakness that can not be catered which is the natural needs in NLP, for example the grammar of the sentences. This system is more akin to prolog system than focusing on the NLP, which is what the system supposed to do. It is difficult to include all the files together like the file of tokenization, template systems, parser, morphology and semantic interpretation even though these are correct.

6.3 Conclusion

In conclusion, the development of HDS with reference to Brunswick's theory of judgment and the Lens Model are aids to decision making in the sense that it promotes

awareness of the users to cues that is seen as less important and therefore help to increase accuracy of diagnosing behavioral problems of horses as well as providing appropriate treatment. HDS can also be utilized as an educational tool when use in practice and can be taken anywhere since it is portable.

6.4 Future Work

More studies can be done using artificial intelligence application in human judgment area especially using neural network such as back propagation or machine learning techniques such as clustering or even fuzzy logic to define or include the importance of probability or percentage of importance of each of the cues that contribute towards certain change in behavior or situations.

Graphical user interface using LPA prolog window can be implemented to provide more clear and easy to use visual interaction. Windows can prompt users to provide more information on the horse such as the horse's personal and medical history, and other description of the horse that might also contribute towards making judgment and therefore use this information to come up with better diagnosis and decision.

Especially in Malaysia horse show or horse race is now being introduced and becoming one of the common sports. This is to encourage Malaysian people to participate in other active sports and also as a show of high standard of living of Malaysian people since only elite or high-income people can involve themselves with expensive animal such as the horse. KL Grand Prix International Horse Show has been organized twice to encourage investors or foreign tourists to visit the country as well as expose Malaysia to

international sports. Therefore, the ability of the organizers to detect an abusive treatment towards the competing horses can help make the sports more attractive to animal lovers. By creating a system incorporating HDS to horse racing or horse show domain, the participants as well as the judges can increase their awareness on how to interpret any abusive treatment towards the competing horses as well as aiding them in diagnosing any sudden changes in behavior during the competition.

REFERENCES

Aronson, L. (n.d.). *Aggression in Horses*. Retrieved July 30, 2004 from http://petplace.netscape.com/articles/artShow.asp?artID=2868

Aronson, L (n.d.). *Fear in Horses.* Retrieved July 30, 2004 from http://petplace.netscape.com/articles/artShow.asp?artID=3150

Awad, E. M. (1996). *Building expert systems: principals, procedures, and applications.* West Publishing Company

Brehmer, B., (1988). The development of social judgment theory. In B. Brehmer & C. R. B. Joyce (Eds.), *Human judgment: The SJT view* (pp. 13-40). North Holland: Elsevier Science Publishers.

Bruins, H.H., and Cooksey R.W., (2000). *JANNET, a neural network approach to judgment analysis* [Electronic version]. Retrieved January 21, 2003, from www.library.uu.nl/digiarchief/dip/diss/1966871/c4.pdf

Brunswik, E., (1956). *Perception and the Representative Design of Psychological Experiments.* Berkeley, CA: University of California Press.

Bushell, H, and Dalgleish, L.I., (1993). "Assessment of Risk by Employees in Hazardous Workplaces", *Safety Science Monitor*, 3.

Carpenter L. (n.d.). *Coprophagia.* Retrieved July 30, 2004 from http://petplace.netscape.com/Netscape/nsArtShow.asp?artID=251

Cooksey, R.W., (1996). *Judgment Analysis: Theory, Methods, and Applications.* San Diego , CA: Academic Press.

Craft V. (1999). *Treating your horse's back pain.* Retrieved 25 July, 2004 from http://www.equisearch.com/magazines/Equus/backpain_treating-070803/

Craft V. (1999). *Your horse's back pain.* Retrieved 25 July, 2004 from http://www.equisearch.com/magazines/Equus/backpain-070803/

Dagleish, L.I., (1988). "Decision making in Child Abuse Cases: Appication of Social Judgment Theory and Signal Detection Theory", in *Human Judgment: The SJT View, Advances In Psychology*, Vol. 54, Amsterdam, The Netherlands: Elsevier Science Publishers.

Dix, A., Abowd, G. & Beale, R., (1998). *Human-Computer Interaction*. New York: Prentice Hall.

Fraser, F. F., (1992). *The Behavior of the Horse.* Wallingford, UK: CAB International.

Gill, W., Meadows D.G., and Neel J.B., (n.d.). *Understanding Horse Behavior.* University of Tennessee Agricultural Extension Services. [Electronic version]. Retrieved August 1, 2004 from www.utextension.utk.edu/publications/pbfiles/PB1654.pdf

Gunderson L.F. & Brown D.E., (2001). Using Derived Preferences to Predict the Targets of Computer Crime in the *Proceedings of the 2001 IEEE Workshop on Information Assurance and Security*, 5-6 June, pp. 279-284.

Hammond, K. R., & Brehmer, B. (1973). Quasi-rationality and distrust: Implications for international conflict. In L. Rappoport & D. Summers (Eds.), *Human judgment and social interactions.* New York: Holt, Rineholt, & Winston.

Hammond, K. R. (1996). *Human Judgment and Social Policy: Irreducible Uncertainty, Inevitable Error, Unavoidable Injustice.* New York: Oxford University Press.

Hammond K.R. (1998). *Representative Design.* [Electronic version]. Retrieved August 2, 2004 from http://www.albany.edu/cpr/brunswik/notes/essay3.html

Hammond, K.R., and T.R. Stewart, eds. (2001). *The Essential Brunswick: Beginnings, Explications, Applications*. New York: Oxford University Press.

Harper, F., and Spitzfaden, D., (1994). “Stereotypies in Horses: A new look at old vices.” *Horse Express* Vol. 13, No 4. University of Tennessee Agricultural Extension Services.

Headshaking Syndrome (Capstar). (n.d.). Retrieved 25 July, 2004 from http://www.headshaking.com/syndrome.htm

Hill C. (2000). *When good horses do bad things.* Retrieved July 30, 2004 from http://www.horsekeeping.com/horse_behavior/When_Good_Horses.htm

Hill C. (2000). *Vices in horses.* Retrieved July 30, 2004 from http://www.horsekeeping.com

Hill C. (2002). *Bad habits in horses.* Retrieved July 30, 2004 from http://www.horsekeeping.com

Houpt K. (n.d). *Stall Walking.* Retrieved July 30, 2004 from http://www.netpets.com/horses/reference/gencare/stall.html

Jadwin L. (1999). Headshaking in horses: A resource page. *The equine practitioners*, 1997, pp 1-5. Retrieved July 30, 2004 from http://www.jadwin.net/horse

Johnson P. (n.d.). *Headshaking.* Retrieved July 30, 2004 from http://petplace.compuserve.com/articles/artShow.asp?artID=3381

Kowalski-Trakofler, K.M., Vaught, C. and Scharf, T., (2003). "Judgment and decision making under stress: an overview for emergency managers", *Int. J. Emergency Management,* Vol. 1, No. 3, pp.278-289.

Martocchio, J. J., Webster, J., & Baker, C. R., (1993). Decision-making in management information systems research: The utility of policy capturing methodology. *Behavioral and Information Technology, 12*, 238-248.

McDonnell S., (2002). *Understanding Horse Behavior, Your Guide to Horse Health Care and Management.* Eclipse Press

Preece, J., Rogers, Y., Benyon, D., Holland, S. & Carey, T. (1994). *Human-Computer Interaction*. England: Addison-Wesley.

Proctor, R. W., & Dutta, A. (1995). *Skill acquisition and human performance*. Thousand Oaks, CA: Sage.

Sestric & Coates-Markle (1996). *Keeping your horse healthy*. Oregon State University Extension Service. [Electronic version] Retrieved December 15, 2003 from http://eesc.orst.edu/agcomwebfile/edmat/ec1472.pdf

Stewart, T. R. (1988). Judgment analysis: Procedures. In B. Brehmer & C. R. B. Joyce (Eds.), *Human judgment: The SJT view* (pp. 41-74). North Holland: Elsevier Science Publishers.

Stewart, T.R., Moninger, W.R., Grassia, J., Brady, R.H., and Merrem, F.H., (1989). "Analysis of Expert Judgment in a Hail Forecasting Experiment". *Weather and Forecasting*, 4, pp. 24-34.

Sweat R. (n.d.). *How to curb your horse's urge to kick.* Retrieved July 30, 2004 from http://petplace.netscape.com/articles/artShow.asp?artID=785

Understanding Cribbing and Wind Sucking (n.d.). Retrieved 30 July, 2004 from http://petplace.netscape.com/articles/artShow.asp?artID=260

Van Riel, Allard C.R., (2003). "Effectiveness and Scope of Decision Making Styles", Effective Decision Making in the *High Tech Service Innovation Process*, Doctoral Dissertation, Maastricht University, Maastricht, Datawyse/Maastricht University Press.

Wiersma, W. (1991). *Research Methods in Education*. Fifth Edition. Boston: Allyn and Bacon.

Wigton, R.S., (1988). “Applications of Judgment Analysis and cognitive Feedback to Medicine” in *Human Judgment: The SJT View, Advances In Psychology*, Vol. 54, Amsterdam, The Netherlands: Elsevier Science Publishers.

Xingfeng Deng, (2000). *ANESOFT: An Expert System for Canine Anesthesia.* Master Thesis, University of Georgia.

Yunxiu Xu (2002). *K9er (canine emergency room): a veterinary practice simulator based on the integration of an expert system and a physiological simulation.* Master Thesis, University of Georgia.

Zeitler- Feicht M. H. (2003). *Horse Behavior Explained- Origins, treatment, and prevention of problems.* Manson Publishing.

APPENDIX A

HORSE BEHAVIOR PROBLEMS

Appendix A contained charts of “Bad Habits” and “Vices” from www.horsekeeping.com.

B: PROLOG DOCUMENTATION

```
% This is a sample of a diagnosis expert system for identification
% of certain kinds of horse's sick.

% This type of expert system can easily use Prolog's built in inferencing
% system.  While trying to satisfy the goal "horse" it tries to satisfy
% various subgoals, some of which will ask for information from the
% user.

% "diagnosis" is the high level goal that starts the program.  The
% predicate "known/2" is used to remember answers to questions, so it
% is cleared at the beginning of the run.

% The end of the code lists those attribute which need
% to be asked for, and defines the predicate "ask" and "menuask"
% which are used to get information from the user, and remember it.

:- nl,nl,nl,write('Horse Diagnosis System'),nl,
write('by'),nl,
write('Kartini Abdul Ghani'),nl,nl,
 write('*********************************'),nl,
write('* Please type "main." to start *'),nl,
 write('*********************************'),nl,nl,nl,nl.

main:- diagnosis.

diagnosis:-
 retractall(known(_,_)),
 horse(X),
 nl,write('The horse is just '), write(X),write('.'),nl,nl,
 write('*****************'),nl,
write('* Description: *'),nl,
 write('*****************'),nl,nl,
description(X),
 write('***************'),nl,
 write('* Treatment: *'),nl,
 write('***************'),nl,nl,
 treatment(X),
 continue.
```

```
diagnosis:-
 nl,write('I cannot indentify the behavior! Please seek for professional advice!'),nl,nl,
 continue.

continue:-
 write('Do you want to continue? (yes. or no.)'),nl,
 read(ANSW),
 determine(ANSW),
 change(ANSW),
 main.

continue:-
 nl,nl,nl,write('Thank you very much for using this system!'),nl,nl,nl.

determine(ANSW):-
 member(ANSW,[y,yes,yup,ya,n,no,nop,nope]),!.

determine(ANSW):-
 nl,write('You are giving the answer that I do not recognise'),nl,
 write('Please answer yes. or no.!'),nl,nl,
 continue1.

change(ANSW):-
 member(ANSW,[y,yes,yup,ya]).

change1(ANSW):-
 member(ANSW,[n,no,nop,nope]).

continue1:-
 write('Do you want to continue? (yes. or no.)'),nl,
 read(ANSW),
 determine(ANSW),
 change(ANSW),
 main.

determine1(ANSW,A,Z):-
 member(ANSW,[y,yes,yup,ya,n,no,nop,nope]),
 asserta(known(ANSW,A)),
 Z=ANSW,!.

determine1(ANSW,A,Z):-
 nl,write('You are giving the answer that I do not recognise'),nl,
 write('Please answer yes. or no.!'),nl,nl,
 ask1(A,Z).
```

```
determine2(ANSW,A,Menu,Z):-
 member(ANSW,[y,yes,yup,ya,n,no,nop,nope]),
 asserta(known(ANSW,A)),
 Z=ANSW,!.

determine2(ANSW,A,Menu,Z):-
 nl,write('You are giving the answer that I do not recognise'),nl,
 write('Please answer yes. or no.!'),nl,nl,
 menuask1(A,Menu,Z).

/*------------------start description-------------------------*/

description(balking):-
 write('Refusal to go forward often followed by'),nl,
 write('violent temper if rider insists.'),nl,nl.

description('barn sour herd bound'):-
 write('balking,rearing,swinging around, screaming'),nl,
 write('and then rushing back to the barn or herd.'),nl,nl.

description(biting):-
 write('nibbling with lips or grabbing with teeth'),nl,
 write('especially young horses.'),nl,nl.

description('bolting when turned loose'):-
 write('wheels away suddenly before halter is'),nl,
 write('fully removed.'),nl,nl.

description(bucking):-
 write('arching the back,lowering the head,kicking'),nl,
 write('with hind or leaping.'),nl,nl.

description('cannot catch'):-
 write('avoids humans with halter and lead.'),nl,nl.

description('cannot handle feet'):-
 write('swaying,leaning,rearing,jerking foot away,'),nl,
 write('kicking,striking.'),nl,nl.

description('halter pulling'):-
 write('rearing or setting back when tied,often'),nl,
 write('until something breaks or horse falls'),nl,
 write('and/or hangs by halter.'),nl,nl.

description('head shy'):-
 write('moves head away during grooming,bridling,'),nl,
```

```
 write('clipping,vet work.'),nl,nl.
description(jigging):-
 write('short,stilted walk or jog with hollow'),nl,
 write('back and high head.'),nl,nl.

description(kicking):-
 write('lashing back at a person with one or both'),nl,
 write('hind legs,also "cow kicking" which is'),nl,
 write('lashing out to the side.'),nl,nl.

description(rearing):-
 write('standing on hind legs when led or ridden,'),nl,
 write('sometimes falling over backwards'),nl,nl.

description('running away or bolting'):-
 write('galloping out of control.'),nl,nl.

description(shyinh):-
 write('spooking at real or imagined sights,sound,'),nl,
 write('or occurrences.'),nl,nl.

description(striking):-
 write('taking a swipe at a person with a front leg.'),nl,nl.

description(stumbling):-
 write('losing balance or catching the toe on the'),nl,
 write('ground and missing a beat or falling.'),nl,nl.

description('tail wringing'):-
 write('switching and/or rotating tail in an irritated'),nl,
 write('or angry fashion.'),nl,nl.

description('coprophagia or pica'):-
 write('the practice of eating feces.'),nl,nl.

description(cribbing):-
 write('colic,poor keeper(prefers mind drugs over food'),nl,
 write('anchoring of incisors on edge(post, stall ledge)'),nl,
 write('arching neck,gulping air.'),nl,nl.

description('wind sucking'):-
 write('emits grunting sound.'),nl,nl.

description(pawing):-
 write('gids holes;tips over feeders and waterers;'),nl,
 write('gets leg caught in fence;wears hooves away,'),nl,
```

```
write('loses shoes;most often young horses.'),nl,nl.
description('self mutilation'):-
 write('bite flanks,front legs,chest,scrotal area'),nl,
 write('with squealing,pawing,and kicking out.'),nl,nl.

description('stall kicking'):-
 write('smashing stall walls and doors with hind hooves'),nl,
 write('resulting in facilities damage and hoof and leg injuries.'),nl,nl.

description('tail rubbing'):-
 write('rhythmically swaying the rear against a'),nl,
 write('fence or stall wall.'),nl,nl.

description('weaving or pacing'):-
 write('swaying back and forth often by stall door or pen gate'),nl,
 write('repeatedly walking a path back and forth.'),nl,nl.

description('wood chewing'):-
 write('gnawing of wood fences,feeders,stall walls,'),nl,
 write('up to three pounds of wood per day.'),nl,nl.

description(headshaking):-
 write('uncontrollable urge to shake or toss the'),nl,
 write('head up and down,left or right,or in circles.'),nl,nl.

/*-------------------------start treatment----------------------*/

treatment(balking):-
 write('1.curable.'),nl,
 write('2.review forward work with in-hand & longeing'),nl,
 write('3.turn horse''s head to untrack left or right'),nl,
 write('4.strong driving aids with no conflicting restraining aids(no pull on bit)'),nl,
 write('5.do not try to force horse forward by pulling'),nl,nl.

treatment('barn sour herd bound'):-
 write('1.curable but stubborn cases require professional.'),nl,
 write('2.a confident, capable trainer that insists the'),nl,
 write('  leave the barn(herd) and then positively reinforces'),nl,
 write('  the horse''s good behaviour so horse develops confidence.'),nl,
 write('3.the lessons GO and WHOA must both be reviewed.'),nl,nl.

treatment(biting):-
 write('1.curable.handle lips,muzzle & nostrils regularly'),nl,
 write('  in a business-like way;when horse nips,tug on'),nl,
 write('  nose chain,then resume as if nothing happened.'),nl,nl.
treatment('bolting when turned loose'):-
```

```
 write('1.curable but dangarous as horse often kicks as he wheels away.'),nl,
 write('2.use treats on ground before you remove halter;use rope around the neck.'),nl,nl.

treatment(bucking):-
 write('1.monitor feed and exercise;proper progressive training;check tack fit.'),nl,nl.

treatment('cannot catch'):-
 write('1.curable.'),nl,
 write('2.take time to properly train,use walk-down method in'),nl,
 write('  small area first,progress to larger.'),nl,
 write('3.remove other horses from pasture;treats on ground,'),nl,
 write('  never punish horse once caught.'),nl,nl.

treatment('cannot handle feet'):-
 write('1.cureble but persistent cases require professional.'),nl,
 write('2.through,systematic conditioning and restraint lessons:'),nl,
 write('  pick up foot,hold in both flexed & extended positions'),nl,
 write('  for several minutes while cleaning,grooming,rubbing leg,'),nl,
 write('  coronary band,bulbs etc.'),nl,nl.

treatment('halter pulling'):-
 write('1.can be curable but very dangerous and incurable in'),nl,
 write('  some chronic cases which require professional'),nl,
 write('2.might use stiff bristled broom on the rump or'),nl,
 write('  wither rope on advice of professional.'),nl,nl.

treatment('head shy'):-
 write('1.curable.'),nl,
 write('2.first eliminate medical reasons such as ear,tongue,lip or dental problems.'),nl,
 write('3.start from square one with handling;after horse allows touching,then teach'),nl,
 write('  him to put head down.'),nl,nl.

treatment(jigging):-
 write('1.curable.'),nl,
 write('2.check tack fit,use aids properly including'),nl,
 write('  use of pressure/release(half halt) to bring'),nl,
 write('  horse to walk or use strong driving aids to'),nl,
 write('  push horse into active trot.'),nl,nl.

treatment(kicking):-
 write('1.might be curable but serious cases are very dangarous and require'),nl,
 write('  professional to use remedial restraint methods.'),nl,
 write('2.request advise from veterinary behaviorist.'),nl,
 write('3.remove the horse to a different social group or'),nl,
 write('  turn him out alone.'),nl,nl.
```

```
treatment(rearing):-
 write('1.can be curable but is a very dangarous habit that might'),nl,
 write('  be impossible to cure even by professional.'),nl,
 write('2.check to be sure no mouth or back problems.'),nl,
 write('3.review going forward in-hand with a whip and review longeing.'),nl,nl.

treatment('running away or bolting'):-
 write('1.might be curable but very dangarous as when'),nl,
 write('  horse panics,can run into traffic,over cliff,'),nl,
 write('  through fence,etc.'),nl,
 write('2.remedy is to pull(with pressure and release)'),nl,
 write('  the horse into a large circle,gradually decressing the size.'),nl,nl.

treatment(shying):-
 write('1.generally curable.'),nl,
 write('2.put horse on aids and guide and control his'),nl,
 write('  movement with driving and restraining aids.'),nl,nl.

treatment(striking):-
 write('1.curable but very dangarous especially if coupled'),nl,
 write('  with rearing as person''s head could be struck.'),nl,
 write('2.review head handling(mouth,nostrils,ears);head down'),nl,
 write('  lesson;and through body handling and sacking out.'),nl,nl.

treatment(stumbling):-
 write('1.curable.'),nl,
 write('2.have hoof balance assessed,check breakover,ride horse'),nl,
 write('  horse with more weight on the hindquarters(collect),'),nl,
 write('  conditioning horse properly.'),nl,nl.

treatment('tail wringing'):-
 write('1.may not be curable once established.'),nl,
 write('2.proper saddle fit,rider lessons,massage and others'),nl,
 write('  medical therapy.'),nl,
 write('3.proper warm-up & progressive,achievable training demands.'),nl,nl.

treatment('coprophagia or pica'):-
 write('1.curable;have the diet evaluated by the vet.'),nl,
 write('2.solve inadequate nutricain and inadequate exercises'),nl,
 write('  by managing the homestead effectively.'),nl,nl.

treatment(cribbing):-
 write('1.make cribbing less enjoyable,remove crib-friendly'),nl,
 write('  objects from the stall.'),nl,
 write('2.cribbing strap prevents contaction of neck muscles;'),nl,
 write('  also available with clamps,spikes,electric shock.'),nl,
```

```
 write('3.possible future pharmacological treatment.'),nl,
 write('4.keep your horse occupied,turn him out more or for longer'),nl,
 write('  periods to allow him additional opportunities to exercise.'),nl,
 write('5.provide stall toys.'),nl,
 write('6.last resort:surgery possible Muzzle can be used in some situations.'),nl,nl.

treatment('wind sucking'):-
 write('1.keep your horse occupied,turn him out more or for'),nl,
 write('  longer periods to allow him additional opportunities'),nl,
 write('  to exercise.'),nl,
 write('2.provide stall toys.'),nl,nl.

treatment(pawing):-
 write('1.curable.'),nl,
 write('2.provide exercise,diversion,do not use ground feeders'),nl,
 write('  and waterers, use rubber mats,do not reinforce by feeding.'),nl,
 write('3.formal restraint lessons.'),nl,nl.

treatment('self mutilation'):-
 write('1.manageable or might be curable.'),nl,nl.

treatment('stall kicking'):-
 write('1.can be curable depending on how long-standing the habit.'),nl,
 write('2.increase exercise,change neighbors,pad stall walls or hooves'),nl,
 write('3.use kicking chains or kicking shoe.'),nl,
 write('4.do not reinforce by feeding.'),nl,nl.

treatment('tail rubbing'):-
 write('1.manageable with grooming,cleaning sheath and udder,'),nl,
 write('  deworming,other medical treatments.'),nl,
 write('2.for chronic habit,use electric fence.'),nl,nl.

treatment('weaving or pacing'):-
 write('1.manageable.'),nl,
 write('2.turn out where he can see other horses.'),nl,
 write('3.use specially fitted stall door for weaver.'),nl,nl.

treatment('wood chewing'):-
 write('1.manageable.'),nl,
 write('2.increase roughage in diet.'),nl,
 write('3.decrease palatability of wood.'),nl,
 write('4.increase exercise & activity.'),nl,
 write('5.more time out on pasture.'),nl,nl.
```

```
/*----------------------start checking rules----------------------*/

check:-
 known(X,_),
 change(X),!,
 fail.

check:-
 known(X,_),
 change1(X).

check1:-
 known(X,'extreme fatigue'),
 change(X),!,fail.

check1:-
 known(X,stubbornness),
 change(X),!,fail.

check1:-
 known(X,'heavy hand'),
 change(X),!,fail.

check1:-
 known(X,fear),
 change(X).

check3:-
 known(X,'bad habit'),
 change(X),!,fail.

check3:-
 known(X,disrespect),
 change(X),!,fail.

check3:-
 known(X,resentment),
 change(X),!,fail.

check3:-
 known(X,fear),
 change(X).

check4:-
 known(X,'a response to collected work'),
 change(X),!,fail.
```

```
check4:-
 known(X,'associated with balking'),
 change(X),!,fail.

check4:-
 known(X,'does not think he must go forward or is afraid to go forward into contact with
bid'),
 change(X),!,fail.

check4:-
 known(X,'rough handling'),
 change(X),!,fail.

check4:-
 known(X,fear),
 change(X).

check_boredom1:-
 known(X,'lack of exercise'),
 change(X),!,fail.

check_boredom1:-
 known(X,'dietary imbalance'),
 change(X),!,fail.

check_boredom1:-
 known(X,boredom),
 change(X).

check_boredom2:-
 known(X,'a way of managing his innate desire to nibble'),
 change(X),!,fail.

check_boredom2:-
 known(X,'endorphins are released during the behaviour'),
 change(X),!,fail.

check_boredom2:-
 known(X,boredom),
 change(X).

check_boredom3:-
 known(X,'hing strung or stressed horse'),
 change(X),!,fail.
```

```
check_boredom3:-
 known(X,'excess feed'),
 change(X),!,fail.

check_boredom3:-
 known(X,'confinement'),
 change(X),!,fail.

check_boredom3:-
 known(X,boredom),
 change(X).

check_boredom4:-
 known(X, teething),
 change(X),!,fail.

check_boredom4:-
 known(X,'lack of corse roughage in diet'),
 change(X),!,fail.

check_boredom4:-
 known(X,boredom),
 change(X).

check_hing:-
 known(X,'hing strung or stressed horse'),
 change(X),!,fail.

check_hing:-
 known(X,'hing strung or stressed horse'),
 change1(X).

/*-----------rules to indentifying the sick---------------*/

horse(balking):-
 fear,
 heavy_hand,
 stubbornness,
 extreme_fatigue.

horse('barn sour herd bound'):-
 check,
 separition_from_buddies_or_barn.
```

```
horse(biting):-
 check,
 greed,
 playfulness_or_resentment,
 investigate_things_with_mouth,
 often_hand_feeding_treats,
 pain_or_fear,
 aggression,
 menuask('visual cues',['mime bite','a head swing','neck extended and slighty opened
mouth or nipping','directed towards the adversary''s forelegs,head,shoulder or chest']).

horse('bolting when turned loose'):-
 check,
 poor_handling,
 anxious_to_exercise_or_join_other_horses.

horse(bucking):-
 check,
 high_spirits,
 get_rid_of_rider_or_tack,
 sensitive_or_sore_back,
 reaction_to_legs_or_spurs,
 menuask('visual cues',['arching the back','lowering the head','kicking with hind or
leaping']).

horse('cannot catch'):-
 check1,
 fear,
 resentment,
 disrespect,
 bad_habit,
 menuask('visual cues',['shows his back end']),
 menuask('environmental cues',['new environment','new handler or mucker']).

horse('cannot handling feet'):-
 check,
 insufficient_or_improper_training,
 horse_has_not_learned_to_cooperate,
 balance_on_3_legs,
 take_pressure_and_movement_of_farrier_work,
 menuask('visual cues',['swaying',leaning,rearing,'jerking foot away',kicking,striking]).

horse('halter pulling'):-
 check,
 rushed,
 poor_halter_training,
```

```
using_weak_equipment_or_unsafe_facilities_so_horse_get_free_by_breaking_something
, often_horse_was_tied_by_bridle_reins_and_broke_free.

horse('head shy'):-
 check,
 initially_rough_handling_or_insufficient_conditioning,
 painful_ears_or_mouth_problem,
 menuask('visual cues',['moves head away']).

horse(jigging):-
 check,
 poor_training_attempt_at_collection,
 horse_not_trained_to_aids,
 too_strong_bridle_aids,
 sore_back,
 menuask('visual cues',['short,stilted walk','jog with hollow back','high head']).

horse(kicking):-
 check,
 initially_reflex_to_touching_legs,
 fear_of_rough_handling_or_to_get_rid_of_a_treat_or_unwanted_nuisance,
 menuask('visual cues',['turn his rump toward you,while pinning his ears at the same
time','vigorous tail switching accompanied by lifting one or both legs and extending both
hind feet out behind','high pitch squels','sore muscles','signs of depression','lose
weight','being "sour"','kicking other horses']),
 menuask('environmental cues',['environmental stress','chronic pain','over training']).

horse(rearing):-
 check1,
 check3,
 fear,
 rough_handling,

does_not_think_he_must_go_forward_or_is_afraid_to_go_forward_into_contact_with_bi
d,
 associated_with_balking,
 a_response_to_collected_work,
 menuask('visual cues',['standing on hind legs when led or ridden','sometimes falling over
backwards']).

horse('running away or bolting'):-
 check1,
 check3,
 check4,
 fear,
 panic,
```

```
 flight_response,
 lack_of_training_to_aids,
 overfeeding,
 under_exercise,
 pain_from_poor_fitting_tack,
 menuask('visual cues',['galloping out of control']).

horse(shying):-
 check,
 fear_of_object_or_trainer_reaction_to_horse_behaviour,
 poor_vision,
 head_being_forcibly_held_so_horse_cannot_see,
 playful_habit.

horse(striking):-
 check,
 reaction_to_clipping,
 first_use_of_chain_or_twitch,
 restraint_of_head,
 dental_work.

horse(stumbling):-
 check,
 weakness,
 lack_of_coordination,
 lack_of_condition,
 young,
 lazy,
 long_toe_or_low_heel,
 delayed_breakover_of_hooves,
 horse_ridden_on_forehand,
 poor_footing.

horse('tail wringing'):-
 check,
 sore_back_from_poor_fitting_tack,
 poorly_balanced_rider,
 injury,
 rushed_training.

horse('coprophagia or pica'):-
 check,
 boredom,
 dietary_imbalance,
 lack_of_exercise,
 menuask('visual cues',['eating feces']).
```

```
horse(cribbing):-
 check_boredom1,
 boredom,
 endorphins_are_released_during_the_behaviour,
 a_way_of_managing_his_innate_desire_to_nibble,
 menuask('visual cues',['anchor upper front teeth onto the stall door','partition or
post','tenses up his neck and facial muscle','retracts his larynx,gulps down air','result
in:excessice wear of the incisor teeth','overdevelopment or enlargement of the neck
muscle and poor performance']),
 menuask('environmental cues',['damage to the barn or stall']).

horse('weaving or pacing'):-
 check_boredom1,
 check_boredom2,
 boredom,
 confinement,
 excess_feed,
 hing_strung_or_stressed_horse,
 menuask('visual cues',['swaying back and forth often by stall door or pen
gate','repeatedly walking a path back and forth']).

horse(pawing):-
 check_boredom1,
 check_boredom2,
 check_hing,
 boredom,
 confinement,
 excess_feed.

horse('self mutilation'):-
 check,
 onset_2_years,
 primarily_stallions,
 can_be_triggered_by_confinement,
 lack_of_exercise_or_sexual_fustration.

horse('stall kicking'):-
 check,
 confinement,
 does_not_like_neighbor,
 gets_attention,
 menuask('environmental cues',['facilities damaged']).
```

```
horse('tail rubbing'):-
 check,
 initially_dirty_udder_sheath_or_tail,
 shedding_hq,
 pinworms,
 ticks_and_other_external_parasites_or_skin_conditions,
 menuask('visual cues',['rhythmically swaying the rear against a fence or stall wall']).

horse('wood chewing'):-
 check_boredom1,
 check_boredom2,
 check_boredom3,
 boredom,
 lack_of_corse_roughage_in_diet,
 teething,
 menuask('visual cues',['chewing wood']).

horse(headshaking):-
 check,
 allergy,
 menuask('visual cues',['nose rubbing','a watery ocular and nasal discharge','low head
carriage','sneezing','snorting','head pressing','pressing the muzzle into the ground']),
 menuask('environmental cues',['seasonal change','bright sunlight','warm and humid
days','wind blows into affected horse''s face']).

horse('wind sucking'):-
 check_boredom1,
 check_boredom2,
 check_boredom3,
 check_boredom4,
 boredom.

fear:-ask(fear).
heavy_hand:-ask('heavy hand').
stubbornness:-ask(stubbornness).
extreme_fatigue:-ask('extreme fatigue').
balking:-ask(balking).
separition_from_buddies_or_barn:-ask('separition from buddies or barn').
greed:-ask(greed).
playfulness_or_resentment:-ask('playfulness or resentment').
investigate_things_with_mouth:-ask('investigate things with mouth').
often_hand_feeding_treats:-ask('feeding treats').
pain_or_fear:-ask('pain or fear').
aggression:-ask(aggression).
poor_handling:-ask('poor handling').
```

```
anxious_to_exercise_or_join_other_horses:-ask('anxious to exercise or join other
horses').
high_spirits:-ask('high spirits').
get_rid_of_rider_or_tack:-ask('get rid of rider or tack').
sensitive_or_sore_back:-ask('sensitive or sore back').
reaction_to_legs_or_spurs:-ask('reaction to legs or spurs').
resentment:-ask(resentment).
disrespect:-ask(disrespect).
bad_habit:-ask('bad habit').
insufficient_or_improper_training:-ask('insufficient or improper training').
horse_has_not_learned_to_cooperate:-ask('horse has not learned to cooperate').
balance_on_3_legs:-ask('balance on 3 legs').
take_pressure_and_movement_of_farrier_work:-ask('take pressure and movement of
farrier work').
rushed:-ask(rushed).
poor_halter_training:-ask('poor halter training').
using_weak_equipment_or_unsafe_facilities_so_horse_get_free_by_breaking_something
:-ask('using weak equipment or unsafe facilities so horse get free by breaking
something').
often_horse_was_tied_by_bridle_reins_and_broke_free:-ask('often horse was tied by
bridle reins and broke free').
initially_rough_handling_or_insufficient_conditioning:-ask('initially rough handling or
insufficient conditioning').
painful_ears_or_mouth_problem:-ask('painful ears or mouth problem').
poor_training_attempt_at_collection:-ask('poor training attempt at collection').
horse_not_trained_to_aids:-ask('horse not trained to aids').
too_strong_bridle_aids:-ask('too strong bridle aids').
sore_back:-ask('sore back').
initially_reflex_to_touching_legs:-ask('initially reflex to touching legs').
fear_of_rough_handling_or_to_get_rid_of_a_treat_or_unwanted_nuisance:-ask('fear of
rough handling or to get rid of a treat or unwanted nuisance').
rough_handling:-ask('rough handling').
does_not_think_he_must_go_forward_or_is_afraid_to_go_forward_into_contact_with_bi
d:-ask('does not think he must go forward or is afraid to go forward into contact with
bid').
associated_with_balking:-ask('associated with balking').
a_response_to_collected_work:-ask('a response to collected work').
panic:-ask(panic).
flight_response:-ask('flight response').
lack_of_training_to_aids:-ask('lack of training to aids').
overfeeding:-ask(overfeeding).
under_exercise:-ask('under exercise').
pain_from_poor_fitting_tack:-ask('pain from poor fitting tack').
fear_of_object_or_trainer_reaction_to_horse_behaviour:-ask('fear of object or trainer
reaction to horse behaviour').
poor_vision:-ask('poor vision').
```

```
head_being_forcibly_held_so_horse_cannot_see:-ask('head being forcibly held so horse cannot see').
playful_habit:-ask('playful habit').
reaction_to_clipping:-ask('reaction to clipping').
first_use_of_chain_or_twitch:-ask('first use of chain or twitch').
restraint_of_head:-ask('restraint of head').
dental_work:-ask('dental work').
weakness:-ask(weakness).
lack_of_coordination:-ask('lack of coordination').
lack_of_condition:-ask('lack of condition').
young:-ask(young).
lazy:-ask(lazy).
long_toe_or_low_heel:-ask('long toe or low heel').
delayed_breakover_of_hooves:-ask('delayed breakover of hooves').
horse_ridden_on_forehand:-ask('horse ridden on forehand').
poor_footing:-ask('poor footing').
sore_back_from_poor_fitting_tack:-ask('sore back from poor fitting tack').
poorly_balanced_rider:-ask('poorly balanced rider').
injury:-ask(injury).
rushed_training:-ask('rushed training').
dietary_imbalance:-ask('dietary imbalance').
boredom:-ask(boredom).
lack_of_exercise:-ask('lack of exercise').
endorphins_are_released_during_the_behaviour:-ask('endorphins are released during the behaviour').
a_way_of_managing_his_innate_desire_to_nibble:-ask('a way of managing his innate desire to nibble').
confinement:-ask(confinement).
excess_feed:-ask(excess_feed).
onset_2_years:-ask('onset 2 years').
primarily_stallions:-ask('primarily stallions').
can_be_triggered_by_confinement:-ask('can be triggered by confinement').
lack_of_exercise_or_sexual_fustration:-ask('lack of exercise or sexual fustration').
does_not_like_neighbor:-ask('does not like neighbor').
gets_attention:-ask('gets attention').
initially_dirty_udder_sheath_or_tail:-ask('initially dirty udder sheath or tail').
shedding_hq:-ask('shedding HQ').
pinworms:-ask(pinworms).
ticks_and_other_external_parasites_or_skin_conditions:-ask(' ticks and other external parasites or skin conditions').
hing_strung_or_stressed_horse:-ask('hing strung or stressed horse').
lack_of_corse_roughage_in_diet:-ask('lack of corse roughage in diet').
teething:-ask(teething).
allergy:-ask(allergy).
```

```
/*----------------------ask & menuask function--------------------*/
% "ask" is responsible for getting information from the user, and remembering
% the users response.  If it doesn't already know the answer to a question
% it will ask the user.  It then asserts the answer.  It recognizes two
% cases of knowledge: 1) the attribute-value is known to be true,
%                     2) the attribute-value is known to be false.

% "ask" only deals with simple yes or no answers.  a "yes" is the only
% yes value.  any other response is considered a "no".


ask(Attribute):-
 known(X, Attribute),          % succeed if we know its true
 change(X),
 !.                            % and dont look any further

ask(Attribute):-               % fail if we know its false
 known(X, Attribute),
 change1(X),
 !, fail.

ask(Attribute):-               % fail if we know its false
 known(_, Attribute),
 !, fail.

ask(A):-
 write(A),                     % if we get here, we need to ask.
 write('?(yes or no): '),
 read(Y),
 determine1(Y,A,Z),                  % get the answer
 %asserta(known(Y,A)),               % remember it so we dont ask again.
 change(Z).                          % succeed or fail based on answer.


ask1(Attribute,Z):-
 known(X, Attribute),          % succeed if we know its true
 change(X),
 !.                            % and dont look any further

ask1(Attribute,Z):-            % fail if we know its false
 known(X, Attribute),
 change1(X),
 !, fail.
```

```
ask1(Attribute,Z):-             % fail if we know its false
 known(_, Attribute),
 !, fail.
ask1(A,Z):-
 write(A),                      % if we get here, we need to ask.
 write('?(yes or no): '),
 read(Z),
 determine1(Z,A,Z1),                % get the answer
 %asserta(known(Z,A)),               % remember it so we dont ask again.
 change(Z1).


% "menuask" is like ask, only it gives the user a list of menu
% rather than a single causes. It is basically function as "ask"

menuask(Cues,Menu):-
 known(X, Cues),
 change(X),
 !.

menuask(Cues,Menu):-
 known(X, Cues),
 change1(X),
 !, fail.

menuask(Cues,Menu):-
 known(_, Cues),
 !, fail.

menuask(Cues,Menu):-
 nl,write('Does this '),write(Cues),write(' exist?'),nl,
 display_menu(Menu),
 write('Answer(yes or no)'),
 read(ANSWER),
 determine2(ANSWER,Cues,Menu,Z),
 %asserta(known(ANSWER,Cues)),
 change(Z).

menuask1(Cues,Menu,Z):-
 known(X, Cues),
 change(X),
 !.
menuask1(Cues,Menu,Z):-
 known(X, Cues),
 change1(X),
 !, fail.
```

```
menuask1(Cues,Menu,Z):-
 known(_, Cues),
 !, fail.

menuask1(Cues,Menu,Z):-
 nl,write('Does this '),write(Cues),write(' exist?'),nl,
 display_menu(Menu),
 write('Answer(yes or no)'),
 read(Z),
 determine2(Z,Cues,Menu,Z1),
 %asserta(known(Z,Cues)),
 change(Z1).

display_menu(Menu):-
 disp_menu(1,Menu),!.                    % make sure we fail on backtracking

disp_menu(_,[]).
disp_menu(N,[Item|Rest]):-               % recursively write the head of
 write(N),write(':'),write(Item),nl,      % the list and disp_menu the tail
 NN is N+1,
 disp_menu(NN,Rest).
```