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Abstract

It has been suggested that small and medium enterprises (SMEs) are similar to large organisations. But there seems to be a sustained lack of resources for implementing intelligent applications in the small business sector. This paper reviews methodologies for developing intelligent applications for SMEs. It also addresses the issues associated with these methodologies and proposes modalities for improvement.

Keywords: Intelligent Applications, Neural Networks, and SMEs

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INVESTIGATING CURRENT METHODOLOGIES USED IN DEVELOPING NEURAL NETWORK INTELLIGENT APPLICATIONS FOR SMES.

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ABSTRACT

It has been suggested that small and medium enterprises (SMEs) are similar to large organisations. But there seems to be a sustained lack of resources for implementing intelligent applications in the small business sector. This paper reviews methodologies for developing intelligent applications for SMEs. It also addresses the issues associated with these methodologies and proposes modalities for improvement.

KEYWORDS

Intelligent Applications, Neural Networks, and SMEs

1.0 INTRODUCTION

The art of competition is a core factor in determining the success or failure rate of businesses today. Increasingly, SMEs have to devise new strategies to manage threats from local as well as global competitors. This has lead to smaller firms contemplating new markets for continued success.

Most SMEs provide at least 90% of gross domestic product (GDP) (Duarte, 2004; Sarosa and Zowghi, 2003) of their respective countries and as a result it is imperative that such businesses continue to do so if they are to avail

their economies. For smaller businesses to continue to grow they must adopt technology and in so doing these organisations will need to identify what types of technology best fits the strategic objectives of individual small firms.

According to Duarte (2004) SMEs are small enterprises that consist of between 10-99 employees and medium sized if there are between 100-499 employees. Sarosa and Zowghi (2003) consider Indonesian SMEs as "all business organisations who possess assets less than US$ 1 Million (excluding land and building) and have annual sales turnover less than US$ 5 Million" (SMIDEC, 1998 cited in Sarosa and Zowghi, 2003). This suggests that there are no traditional SMEs today, however a business is considered small and or medium depending on its locale, sales (annual), total assets and even culture (initial or created due to environmental changes).

Information Technology (I.T.) adoption in SMEs is somewhat harder to determine as most will not have access to information nor the resources that have become a functional requirement for larger businesses. This makes learning in smaller firms harder, as there is no capacity to learn which has to be considered when the designated risks are taken into consideration.

This paper is the result of a research question and as such is an attempt in discovering the validity of the question. Section one gives a brief introduction. Section two summarises some literature reviewed on SME methodologies. Section three introduces neural networks whereas section four shows results followed by a conclusion in section five.

2. A REVIEW OF SME METHODOLOGIES

A small business is similar to any other business in that there has to be an approach that allows management to plan for the future. To this effect, an approach has to be administered that can ensure that smaller businesses are at least meeting their operational targets.

In an attempt to design a proposal for enhancing total quality management (TQM) in smaller businesses, Fernandez et al (2006) examines the usage of knowledge by small and medium enterprises. In doing so, the authors demonstrate an in-depth understanding about the problems small businesses

are currently facing with rewards to adapting relevant technology in a predefined sector but the article does not truly suggest any approach. It could be considered of a review more than a novel approach to developing a strategy for business operation. However, Fernandez et al, does suggest indirectly that SMEs do need advice in administering technology, which is supported by Morgan et al (2005). There has been an emphasised need for creating advisors for incorporating information and communications technology in small businesses (Morgan et al, 2005 and Al-Quirim, 2006).

As a result of this, the authors attempt to track the stages of accreditation involved in becoming ICT advisors as well as in deducing how such personnel can aid SMEs to adapt ICT. Morgan et al, 2005, focuses immensely on ICT advisors and not so much on the small business, which suggests that for a small business to succeed in any implementation of technology then their should be a qualified practitioner who has been trained and has obtained the required standard which could make he or she more suitable to give suggestions and advice to smaller organisations.

Unlike Morgan et al, Majocchi et al (2005) examines the relationships between size, experience and the firm's ability to export its goods and services. This kind of approach ensures that there is a positive interaction between the age of firm and the length of operability in a continued area of operation are used to determine some of these relationships. Therefore, the methodology of this piece of research revolved around two hypotheses. (1a). Firm size is positively related to export intensity. (1b). The relationship between the relative change in size and export intensity is non-linear and decreasing. (2). The relationship between export intensity and age of the firm is positive.

The approach administered by Majocchi et al (2005) is vital, as the current practices of an organisation must be considered before any attempt is made to deploy technology. Therefore, a strategic plan of action must be implemented. As to the manner and timing of such implementation, it may be solely dependent on the organisation and the management goals of such organisations. Frizelle (2001) gives an insight into the strategic interventions that should apply in over twenty SMEs. This he does by carefully demonstrating an approach that each small business could administer to allocate and or administer focus.

Even though the technological emphasis of Frizelle (2001) is somewhat restricted, the author does give an insight into the core functions of organisations seeking a strategic focus to implement a decision tool. It appears that the decision support tool is being deployed as a matchmaker for any SME under examination whereby the system seems to provide a link between what aspects each business would like to strengthen and or develop with that of market requirements. In this manner decisions can only be made through five key stages (a) Business Analysis (b) Strategy Development (c) Market Focus (d) Strategic Direction (e) Action Planning. Decisions of this nature are also supported in the development of decision-making tools suggested in research conducted by Scoutter and Whyte (2005), and Lawson et al (2006), respectively.

The findings presented by Frizelle (2001) conclusively imply that all SMEs examined have three distinct disadvantages. These disadvantages do not have much supporting evidence outside of the fact that such companies formally sought "outside help" as stipulated by the author (pg.6). These disadvantages are as follows:

1: SMEs only plan when faced with changes or such unplanned for crisis.

2: SMEs are similar to large enterprises and as such their approach to business and the range of enterprises they associate in.

3: SMEs do not understand their markets of operation.

In light of this, Scoutter and Whyte, (2005) introduces a category-mapping tool that can be used to aid knowledge management in a large organisation. It essentially performs the following tasks: it aids management to collate data that is nonsensical (in its present form) into a more organised and easily accessible form from which information can be established whereas, Lawson et al (2006) demonstrates the implementation of a novel project selection tool harnessed in a small engineering firm. The authors conducted an initial assessment of the firm, which allowed them to identify the relevance of this technique in the SME sector. Having conducted a field study (in a small engineering company) it is still unclear if such an approach could aid the small business sector, as this organisation is individually managed and the literature suggests that only one field study was conducted and as such there is no conclusive evidence to suggest that

such a technique would ensure that similar organisations could use such a tool to monitor and control the activities of each department (novel as it is). What this article does indirectly is to identify a major problem that most small businesses tend to share and that is lack of financial resources that tend to undermine the capability of some small firms embracing and channelling technological advantages.

The literature reviewed also suggests that there is a overwhelming need for the learning of technology to be used as a platform for delivery management training for small businesses. This also suggests that continuity in small businesses has to focus on the environment in which the stated business operates. Therefore, how management perceives the area of business operation currently and the category of business continuity has to be considered in light of the changes external to the business (Lohrke, et al, 2006).

Environmental changes cannot always be planned for but an organisation needs to be prepared at least for changes in business operation. This type of change happens mostly when competitors enter a businesses current market of operation. Lohrke et al (2006) introduces two novel approaches in detecting such competition, the behavioural theory of a firm (BTOF) and the threat rigidity thesis respectively. The behavioural theory of a firm focuses on the locale of the business and the operating trends the business normally practices but the threat rigidity thesis is dissimilar to the BTOF. It focuses more to the point of firm performance and firm strategy. This basically suggests that if a firm proposes a strategy that enhances the business acumen and or performance goals of such organisations, then it means decision-making is justified as a direct result of the strategy-performance relationship. It however, also suggests that such an ideology will not allow for management to deploy a totally new approach but rather ensuring that management commits to familiar strategies as opposed to disregarding a tried and tested approach that could be now failing the business (this is in disagreement with the BTOF as proposed).

Even though a firms size and length of operability has to be considered (Majocchi et al, 2005), before decisions can be made about technological change, there must also be advisors (technologists) that are available to liaise with managers or owners of such smaller businesses in order to ensure that the best suited technology is deployed in each business (Al-

Quirim, 2006 and Morgan et al, 2005). Oyelaran-Oyeyinka and Kaushalesh (2006) provide detailed insights into the ideas put forward by Al-Quirim and Morgan et al respectively. They examine the effects of firm locale, environment and technology in a cross section of three countries. The literature suggests that most Nigerian and Ugandan SMEs tend to adapt standalone technology that is only being used to address particular job roles as opposed to Indian firms that chiefly incorporate the internet and its associated techniques that are essential in order to learn how to do set tasks. Supporting evidence to the rewards of learning new technologies is given but there are no suggestions as to how technologically naïve firms in Uganda and Nigeria especially could incorporate technology usage in SMEs. To this effect, for such firms to become truly learning organisations then the organisation has to administer some sort of in-house training and or overseas association in order to benefit from the learning of new technologies culture (Carr, 2005 and Majocchi et al, 2005).

Wang et al (2005) addresses some of the problems that small and medium enterprises are currently experiencing in the manufacturing industries. The authors have developed an agent-based architecture for Virtual Computer Integrated Manufacturing (VCIM). The system developed appears to be more efficient as opposed to those developed in catering to other SMEs in manufacturing industries (Turkyilmaz et al, 2006). The authors are suggesting such architecture would ensure that SMEs in the manufactured industries are more equipped to schedule and deal with customer requests in a more efficient manner.

The need for technology is overwhelming but the need to incorporate the most suited technology is even greater. Therefore, technology adaptation will often be the best approach for SMEs functioning in predefined sectors. Sectors such as manufacturing have an apparent need for intelligent types of technology. Al-Quirim (2006) demonstrates the rewards and shortcomings in adopting mobile and wireless technologies (MWT) for SMEs. He elaborates further on the significance of MWTs in that most if not all businesses will complete globally and as such a small business today might become a larger small business tomorrow, i.e.. The areas of operation will grow and the emphasis to compete on a global platform will herald the usage of MWTs. Thus it is crucial for these enterprises to adopt and or implement some type of MWT in the imminent future of the business because of the ease of use of such systems as opposed to traditionally wired

systems. However, Huin et al (2003) looks at knowledge base tools for planning of enterprise resources in Southeast Asian economies. As a result of which a hybrid methodology has been proposed that if adapted may be used to store existing knowledge. This would allow for two separate artificial intelligence techniques to be combined. Namely cased based reasoning and neural networks.

Even though Al-Quirim (2006) is suggesting that MWTs can lead to innovation if adaptation takes place incrementally but within a controlled manner. The literature does suggest that firm operation is mostly dependent on belief systems incurred from the culture of the organisation as well as the current area of firms operation. All of which suggest that this literature (Al-Quirim, 2006) is mostly concerned with adapting an approach that is untried, making the research somewhat novel in the authors attention and focus to the operability of most smaller firms. As such, firms, which have expertise and cost usage have to be depreciated consequently organisations will need to adapt not only the cheapest form and or types of technology but also one that is flexible, portable and ubiquitous (Huin et al, 2003).

Any intelligent application proposed will have to reduce the need to acquire new knowledge but more importantly it will have to extract information from existing knowledge databases (Huin et al, 2003). In light of this, developments such as Kuo et al (2002) may have to focus on some form of a hybrid methodology. These types of technology could be sued for intelligent forecasting as from a sales point a view any business (SMEs included) will need to make a profit and the technology to be created or adapted should be able to ensure more than negligible increases in productivity.

This does mean also that the advent of technology in SMEs needs to be relevant to the business needs and not just a passing façade. Intelligent applications should only be deployed if they are to be regarded as strengths in favour of the business as they are so many statistical approaches that can be administered such as regression models (Kou, et al, 2002). McMahon (2000) and Turkyilmaz et al (2006) attempts to achieve pathways of achievement for SMEs in the manufacturing sector through quality management with the latter focusing on a neural network tool but it is the work conducted by Naserreddin and Mollagashemi (1999) that demonstrates how much technology truly has to be relevant to the goals of

a small business. They focus on creating a methodology for building and examining reverse simulation metamodels by incorporating the goals and cultures of the business.

Planning is a useful asset when administered in any type of business provides competitive advantage. Hence a small business must unearth information and ensure that it is made available to management, as this planning process can also be helpful in technology adaptation. Even though the collection of information is harder for small businesses as stipulated in the literature surveyed there is an apparent that it is a functional requirement in most SMEs currently (McMahon, 2000). One key concept that has arisen from literature surveyed is the opportunity landscape (cited in Savioz and Blum, 2002). The opportunity landscape can only be used as a planning tool when relevant literature has to be searched and a member of staff known as a gatekeeper decides what information is relevant to the present or future needs of the organisation before such information is then stored unto a knowledge base.

Businesses have to learn how best to compete in order to succeed. For this reason if for no other, organisations must continue to innovate (Mulligan et al, 2005) as such an issue appears to be problematic in Irish SMEs. They argue further that SMEs should not be blamed for pitfalls associated with implementing the management of innovation, as the techniques being deployed currently do not fit the smaller business. Thus, suggesting that there is a lack of available knowledge and resources that could aid in developing any type of innovation strategy for the small firm.

Even though many larger firms have been participating in outsourcing to smaller firms, the advent of technology has not been imprinted on the culture of such businesses. Innovation as we now perceive to be is a competitive advantage tool if harnessed effectively can aid in the fruitful alignment of an organisations core competencies in a predefined sector. Performance of an SME must be examined if we are to truly address their relevant capabilities in managing innovation (Phillips et al, 2000). Therefore, for innovation to produce such companies will have to delegate responsibilities that maybe the key in ensuring that knowledge and or skill is continually being developed. (Mulligan et al. 2005) proposes a research methodology that revolves around the scorecard technique as created by Cormican (2003) (cited in Mulligan et al.2005) which is also supported in

Carr (2005) and Morgan et al (2005). This methodology allows for the researcher to discover a problem and review relevant literature before hypotheses are shaped and case analysis (feasibility study). Having conducted this four-tier approach a scorecard is developed based on the deductions made and then it is validated in the form of analysis of scores.

There is an emphasised need for smaller organisations to create means of mutual existences with other businesses. In so doing, there is a clear vision of operation for such businesses as there is an opportunity to maximise on any areas of interest for the organisation (Phillips et al, 2000). This also ensures that SMEs are better positioned to tap into the technological advances that may better suit its area of operation, as well as in identifying how to enhance the skills of its employees via links with educational institutions alongside similar types of businesses. All of which could provide the difference in an SME sustaining growth or lagging behind in its area of operation. More importantly, it could provide freethinking and freedom of idea expressions as members of smaller organisations are being supported in how they shape and express not only ideas but also opportunities that can become future products and or services.

3.0 THE CASE FOR NEURAL NETWORKS

The application areas of SMEs can be considered as widening in that the areas of intelligent applications must be dependent on the organisation and the types of knowledge that are currently being harnessed. Nonetheless neural networks are tools that if used wisely will boost the decision-making capabilities of any organisation.

3.1 EXAMINING NEURAL NETWORKS.

Artificial Neural Networks (or neural networks) are systems that tend to mimic the human brain. The underlying principle is somewhat similar to the brain connectors in that neural networks are made up of four basic structures known as dendrites, soma, axon and synapses.

Dendrite is used to accept inputs before the soma processes inputs and the axon turns the processed inputs into outputs whereas synapses are the electrochemical contacts between neurons.
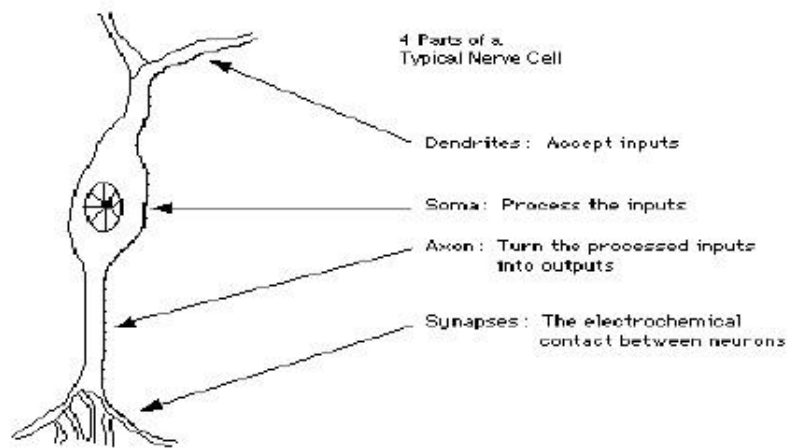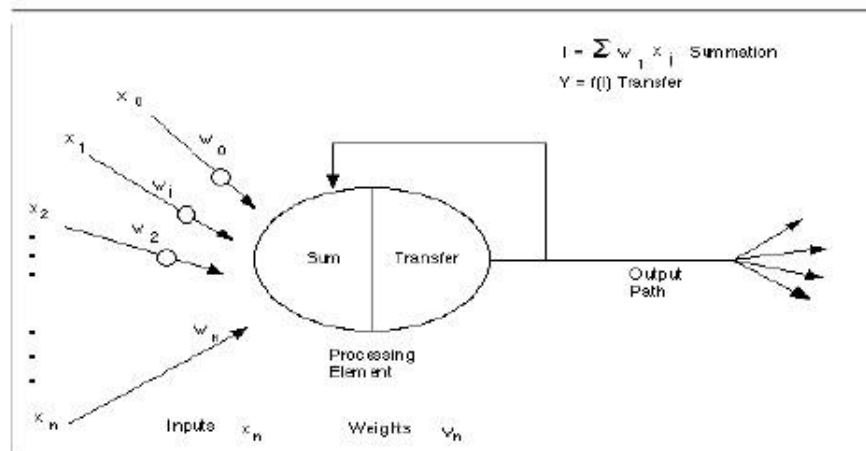
Fig 1. A neuron in its biological form. (Anderson and McNeil, 1992)

3.2 ALTERNATE NEURAL FORMATS

Because of the nature of the biological neuron and the need to create a system that closely resembles a biological neuron then an artificial neuron often takes the form of Figure 2 below. Inputs to the neuron in Fig.2 below are represented by Xn and are multiplied by Wn (number of weights). These products are summed and fed via a transfer function in order to generate an output.

Figure 2 below shows an artificial neuron (Anderson and McNeil, 1992).

$$I = \Sigma \, w_i \, x_i \quad \text{Summation}$$
$$Y = f(I) \quad \text{Transfer}$$

Sum | Transfer

Output Path

Processing Element

Inputs x_n Weights v_n

3.3 TRAINING NEURAL NETS

Small and Medium Enterprises cannot afford to deploy technology at the cost often available to larger enterprises. Therefore these organisations will often attempt to adapt more than create. This is one of the major similarities between neural networks and SMEs. For a neural network to be considered as an intelligent application such networks must first be trained on data that is necessary to the businesses current areas of practice. So, as the literature so far suggested that SMEs might need to become learning organisations and in effect also incorporating the usage of ICT advisors to ensure that current members of staff understand the significance of the technology to be implemented a neural network also has to become familiar with the needs of the business that such techniques when be used to aid.

Training in neural networks normally takes the form of either being supervised or unsupervised. Supervised training consists of providing the network with a desired output, which can either take the form of manually tuning the weight or by providing desired outputs. This is somewhat similar to how management in a small business may identify an approach for moving the business forward and in effect staff may need to learn a new technique in order to perform they designated job role as the business objectives change the job roles may change accordingly.

Unsupervised training can only occur if the network has to determine outputs from inputs without any form of grading or tuning of weights. This is somewhat similar to employees conducting their job roles without a senior member of staff telling them what has to be done. This could mean that management would gain insight only into problems based on performance and how such performance affects the goals of the business and in effect productivity.

3.4 TYPES OF NEURAL NETWORKS

There are an abundance of neural network techniques available currently but they can be largely categorised in four major sections. These major sections are classification; data association; data conceptualisation and data filtering (prediction or forecasting).

3.4.1 ANALYSIS OF NEURAL NETS

Data association types of neural networks are similar to classifying types in that both are used to input data and or values to determine classification. However with data association, the ability for the network to detect noise is made possible. Examples of data association networks are the Hopfield and Hamming networks, the Boltzmann machine and the Spation-temporal Pattern recognition whereas some examples of classifying networks the learning vector quantization, probabilistic neural networks and counter propagation respectively.

Data filtering networks are used to eradicate noise (in common with data association and classification) whereas prediction networks use inputs to determine outputs. Some examples of these types of networks are back propagation, high order neural networks and self-organizing maps into back propagation. Data conceptualisation conversely allows for data grouping to take place. This means that inputs to such networks are analysed in order to determine how to group relationships may be inferred. In a network such as this, relationships would be based on past experiences as associated within the designated inputs. Examples of this network will adaptive resonance networks and the self-organising map.

4.0 RESULTS OF LITERATURE SURVEYED

Current methodologies being administered in the SME sector of business operations have been examined in this paper. It does not attempt to create an intelligent application but more importantly to determine the need for such types of applications in the small business sector. The research conducted so far has suggested that irrespective of the methodologies used to develop intelligent application for SMEs currently there are four stages that are considered in developing technology for smaller businesses. These phases are the planning of technology, model conceptualisation, data collection and data analysis.

4.1 TECHNOLOGY PLANNING

Technology planning has to be of most importance when considering designing or adapting any system. This has to be relevant as small businesses cannot afford to misuse money as such literature reviewing or rather technology planning allows the manager or owner of the business to identify what types of technology are being used in similar small business markets and how this influx of technology has aided competitors (or even worked against them). This may also determine if a small business will adapt or attempt to liaise with a more established business in order to create a mutual understanding for acquiring and procuring relevant data.

4.2 MODEL CONCEPTUALISATION

The problems facing most SMEs are not dissimilar to those faced by larger organisations because it may be wise to determine if another organisation has faced similar problems in order to assess the best ways to achieve model development. This stage will give managers or decision makers an idea of the pitfalls to circumvent if a model is to become authentic.

4.3 DATA COLLECTION IN SMEs

As mentioned above (in section 4.1) information sourcing is crucial as from information the SMEs can learn the latest types of technology being used in various businesses but also they could identify a newer area of operation.

This will therefore identify problems smaller businesses are currently experiencing or could experience in the future.

The literature examined so far has suggested that data collection for most SMEs tend to take the form of questionnaires and surveys. This has been used to identify the problems and associated techniques to deploy for larger firms by technologists. But this stage has to have greater precedence in examining the current needs in smaller organisations. Most small businesses do not understand intelligent applications and a survey or questionnaires does not capture the lack of knowledge always. Therefore it may be a better approach to actually conduct more case studies and actually work with the SMEs for a specified time frame in order to better determine how data is collected.

4.4 DATA ANALYSIS OF SMES

At this stage collected surveys and questionnaires are examined in order to determine what problems organisations are experiencing. This is the point at which most SMEs are faltering and in effect this is where SMEs require some form of intelligent application that can provide decision making capabilities.

Examination of collected surveys and questionnaires are traditionally good ways in identifying problems or opportunities for change in some organisations. But this does not always hold true in smaller organisations. This apparently could be as a result of limited resources, size, structure, assets or even culture as discussed in the preceding literature to date. But data collection and analysis has to be conducted simultaneously as this will give the researcher and or technologist the opportunity to learn about the habits (culture) of the business and as such any conclusions to be drawn can better determine if the business would be better suited to an intelligent application such as that of a neural network.

5.0 CONCLUSIONS

Even though the literature investigated has suggested that SMEs are somewhat similar to larger organisations there are indeed many limitations. Some of the major limitations found are as follows:

a) SMEs do not plan unless they are focused to do so.

b) An average SME has a limited cash flow, which means intelligent applications may never be deployed.

c) There are no funds for training staff, which suggests that any advent of technology maybe undermined even if advisors are to be brought in for training purposes.

d) There are often no clearly defined goals or business objectives as management largely constitutes one party only.

Irrespective of the limitations within the SME context, their needs to be modalities for improving them which means that smaller firms would only benefit from such approaches providing that they are created taking into consideration where the business currently operates, where the business wants to go, and what types of financial packages such firms may have at their current or forecasted disposal. The literature examined have suggested a few intelligent applications that can be modified (taking into consideration the former) such as the Al-Qirim (2006), Huin et al (2003), Kuo et al (2002) and Lawson et al, (2005).

This paper has been essentially a literature survey of current methods used in developing or adapting technology for SMEs with a larger emphasis on neural networks. Therefore, the research will have to be expanded on in order to deduce if there could be a central type of methodology that can be incorporated in the adoption or creation of intelligent applications for small businesses. In addition, an assessment of neural networks has to be undertaken if the research can be used to justify neural network usage in developing an intelligent application in the future.

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