Context Information Based FOREX Services

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Abstract. Context-aware computing is one of the key research issues in smart business applications, IoT paradigm and it is evident that it is successful in understanding the data sensed from trading environment. The success of trading depends on providing the proper personalized services to the trader based on his current context. The challenge here is to design and develop a context aware model which extracts meaningful information from raw data generated from underlying physical world. When there exists right information at right time it is possible to make effective decisions. This paper, proposes a C-IOB (Context-Information, Observation, Belief) hierarchical graphical structure model which signifies a causal relationship between low level context and high level context to reason about the customer and vendor context based beliefs. The proposed model provides accurate service with minimum computation and also reduces solution search space since the context information of a business entity is synthesized in the form of beliefs. Our research findings indicate the importance of the context based belief model in developing innovative Forex applications.

Keywords: Forex · Context · Customer · Trader · Belief · Service Transaction

1 Introduction

A Forex environment deals with the business prospects of an economy in which activities like currency exchange, Traveler's cheque purchase, and other financial services takes place to meet the current needs of traveler's and traders. In this environment, exchange of bulk information takes place to meet the growing needs of customers/vendors. Since the Forex domain is highly dynamic as the new business need of an individual appears, there is a need to develop more accurate realistic context aware models. The challenge here, is to design an approach to analyze the context information of an entity (e.g., trader, transaction, currency, location) and provide timely information or service. Hence, the Forex applications are to be designed and developed to understand the current context to enhance the business experience of a customer.

Context awareness in Forex is about capturing a wide range of context attributes (e.g., location, exchange rate, social status, peak hours, etc.) of an

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entity to better understand the business task and the kind of context aware service. It is important that a service must be offered based on a specific context because the kind of service is different according to the context of the user [1]. Hence, the services are provided by efficiently utilizing the context of user [2]. The aim of context aware computing is to extract and infer the context of an entity to provide intelligent Forex services. The context aware Forex applications have to be developed which effectively utilize the context information to adapt their behavior according to the needs of Forex business participant (e.g., customer, vendor, broker etc.). To extend context-aware applications into more cognitive domains includes observing the behaviors of customer environment, business processes, application processes, social events and even emotional and physical states of the customer/vendor.

The Foreign exchange market is the most liquid financial and largest market in the world. Forex is a part of global financial market and is used to invest in other countries, buying or selling of foreign currencies or even to buy foreign products. Forex traders (dealer, broker) are incessantly negotiating prices one among the others to succeed in the market. By building a broad integrated view of context information (physical, system, application and social) the services provided will be better able to meet the needs and aspirations of customers. The work [3,4] discusses the importance of deducing beliefs about a business entity (e.g., customer, vendor) which are primitive in most theories of decision making so that business applications can use these beliefs to develop intelligent user interfaces.

The proposed Context-Information, Observation and Belief (C-IOB) model [3,4] collects the relevant context information, forms observations which are further deduced to beliefs. It has the capability to adapt to real time situations of business needs, thereby enhancing the business customer satisfaction. The context based beliefs capture the relationships between alternative representation of the same type of context information to address multiple situations in Forex environment and they are primitive in most theories of decision making to provide intelligent Forex services. Our research findings indicate the importance of the proposed method in reducing data flow and solution search space in deriving higher level context. The C-IOB model can be further expanded to develop Smart business, e-Healthcare, Smart village and Tourist applications.

The rest of the paper is organized as follows. In Sect. 2, we briefly describe some of works related to context aware systems, Sect. 3, describes the formal representation of C-IOB model. In Sect. 4, we describe the categories of context information with examples and Sect. 5 discusses the application of C-IOB model to Forex system. Section 7, presents simulation environment and results and lastly the conclusion.

2 Related Works

Many researchers highlight the importance of context awareness in the development of context aware systems. A context-aware application is one which

adapts its behavior to a continuously changing environment. These are some of the context aware works developed in real time applications for providing context aware services. The relationship between context awareness and user preferences/interests is exploited to adapt and provide the personalized services in [5]. [6] highlights the importance of context modeling (representation of user, the environment and the access mechanism) as the basis to provide personalization within mobile web search. An implementation of wearable system [7] learns context-dependent (location, activity, physiology) personal preferences by identifying individual user states in context-aware mobile phone. The work in [8] proposes a context based foreign exchange system in adhoc environment in which a resource capable node acts as a context manager to select a suitable vendor based on current context.

NAMA [9] considers the context, user profile with preferences to discover current needs and thereby providing personalized services to the user. A context-aware telecommunication service platform (CaTSP) [10] is developed to provide more intelligent personalization services according to user behavior, history, preference and current ambient environment. A multiagent framework [11] considers different contexts like location, device and user information to support personalized shopping-assistance service and multimedia selection service on wireless networks. A prototype system is implemented [12] to provide the personalized shopping services using context history. The paper [13] discusses the importance of using psychological characteristics of user for personalized recommendation in tourist guiding system. [14] proposes a novel context-aware service selection approach using Fuzzy analysis and it uses active context(user's devices, bandwidth of network, location, preferences) and passive context (weather and time) for service selection.

[15] discusses a common conceptual layered architecture for modern context-aware applications to improve extensibility and reusability of system. The situation of the user [2] is modeled through three dimensional space and the space describes the set of possible service access situations and in which identity, access position and time represent the three axis of the situation space. The context considered in [16] plays the role of filtering mechanism, thereby allowing the transmission of relevant data to the required device thus saving bandwidth and reducing query processing time. The paper [17] presents in depth classification of context information and proposes context information modelling technique using fuzzy set theory to incorporate the imprecise sensed context in IoT environment.

Although there have been several efforts to develop context aware applications, the process of acquiring knowledge using cognitive factors, establishing relationships between alternative representations of the same context is not focused. Therefore, it is essential that smart business applications have to be designed to reason about complex situations by deriving higher level context information for intelligent decision making and also to deal with large variety of contex information and uncertainity issues.

3 Formal Representation of C-IOB Model

The context based belief modeling (CBM) problem for context aware service is formalized as a triple

$$\text{CBM} = \langle \text{CI}, \text{O}, \text{B} \rangle \tag{1}$$

1. $\text{CI} = \{\text{C}_{\text{py}}, \text{C}_{\text{sy}}, \text{C}_{\text{ap}}, \text{C}_{\text{sc}}\}$, where C_{py}, C_{sy}, C_{ap}, C_{sc} represents set of physical, system, application and social environment context information of a business entity respectively.
2. $\text{O} = \{\text{ob}_1, \text{ob}_2, \ldots, \text{ob}_{\text{L}}\}$, where $\text{ob}_{\text{k}}(1 \leq \text{k} \leq \text{L})$ is a set of observations formulated by summarizing the context information of an entity (e.g., person, place, thing or object) in a particular environment.
3. $\text{B} = \{\text{bf}_1, \text{bf}_2, \ldots, \text{bf}_{\text{M}}\}$, where $\text{bf}_{\text{j}}(1 \leq \text{j} \leq \text{M})$ is a set of beliefs deduced based on set of observations.

The knowledge is extracted by using intuitive theory to model real world information by cause-effect relationship. The role of intuitive theories in learning and reasoning has been most prominently studied in the context of causal cognition [18]. The C-IOB model is a causal graphical model in which the context information, observation and beliefs are represented by nodes and they are connected by arrows, indicating the direction of causal dependencies from *context information* to *observations* and *observations* to *beliefs*. In the following section, we give the definition of context information, observation and belief.

Context Information: The context information refers to the perception and characterization of current state of a business entity (e.g., customer, vendor, place, transaction). The context information (e.g., business time, festival time etc.) plays significant role and can be utilized in several ways by business applications to model complex situations.

Observation: An observation is formulated by identifying the relevant context information of an entity. Observation enhances the prediction capability by continuously learning and receiving the knowledge of the physical world through perception for example *browsing for exchange rate, sending e-mail, looking for discount* etc.

Belief: The beliefs are deduced based on the observations. It is a descriptive thought that a person has about something and the people acquire beliefs through continuous learning. The notion of belief is considered as an informational attitude obtained from the history of experiences like observations. The beliefs generated are dynamic in nature and theses beliefs vary with the same context. Some of the beliefs about an entity are *competitive trader, trustworthy vendor, day trader, mini Forex trader* etc. The logical operators (AND ($\wedge$), OR($\vee$), NOT ($\neg$) are applied over formulated observations to construct predicates and some of the examples of belief deduction are given below.

1. Day-Customer $\Leftarrow$ High-end-Device $\wedge$ Analyzing-Market $\wedge$ Buying-and-Selling-Quickly

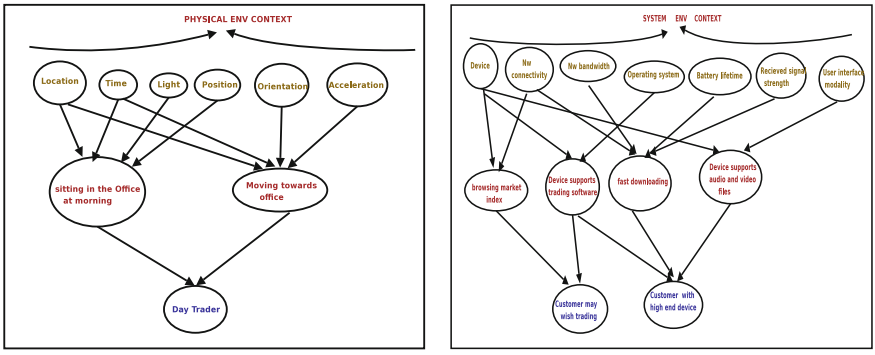
2. Reliable-Vendor $\Leftarrow$ Provides-high-Quality-news $\vee$ Offers-Competitive-Spreads $\vee$ Offers-Optimum-Leverage
3. Neuroticism-customer $\Leftarrow$ Feeling-Depressed $\wedge$ More-Conscious

We categorize and present four types of context information with examples in the following section.

4 Context Information Types

The broad classification of context information is required, as future IoT/Pervasive computing have to deal with heterogeneous applications and services. The *context information* is defined as the constantly changing status of *physical*, *system*, *application* and *social* environment, when a business entity is executing Forex transactions.

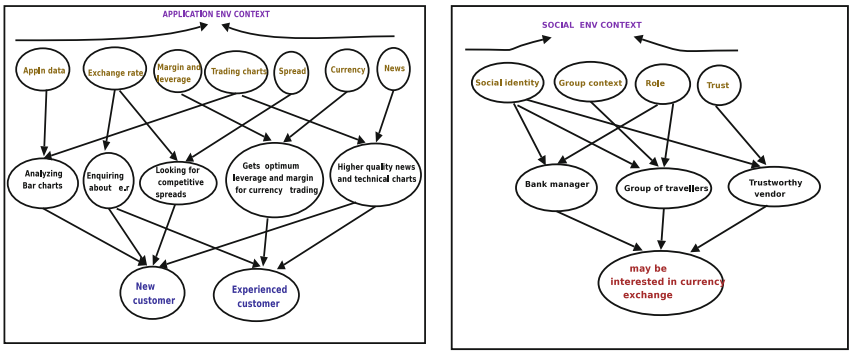
- *Physical environment context information*: It uniquely interprets and characterizes the context space of a physical entity (e.g., buyer, seller, place, dealer). Ex: *peak hours, business time, location of transaction, orientation of device,* etc.
- *System context information:* The system context information deals with computing aspects and finds its significance for the optimization of services in the heterogeneous environment. The system context includes the information about *device-type, battery power, memory, device-usage-history, device-interface and device-modality* of a Forex dealer. Figure 1(a) and (b) shows the examples of belief deduction by utilizing physical and system environment context information.
- *Application context information:* It describes the information related to specific application type and for example, in Forex applications it represents the information about *type of transaction, exchange rate, currency symbol, leverage ratio*and *currency spread*.



(a) Physical Environment (b) System Environment

Fig. 1. Belief deduction using physical and system context information

– *Social context information:* It describes information related to social aspects of an entity (e.g., dealer, social network) who is connected to global network of Internet of Things. Social identity is based on *nature of work*, such as *traveler* or *visitor*, economic status as *poor* or *rich*person, education level as *educated* or *uneducated.* Example of belief deduction by utilizing application and social context information is given in Fig. 2(a) and (b).



(a) Application Environment (b) Social Environment

Fig. 2. Belief deduction using application and social context information

5 Application of C-IOB Model to Forex System

5.1 Context Based Forex Transactions

Each transaction represent a set of interactions or activities involved between business parties like customers and vendors for buying or selling of currency at particular location and time. Let A = $\{a_1, a_2, .., a_n\}$ represents the number of activities or actions initiated (e.g., *browsing for bar charts, downloading market analysis chart, downloading currency statement and so on).* Some of the examples of transactions are given in Table 1.

Table 1. Context based Forex transactions

Transaction	Description
T_1	Request for foreign currency buying based on specific time
T_2	Request for foreign currency exchange rate at particular location and time
T_3	Request for market analysis information during business hours
T_4	Request for Traveler's cheque purchase rate at particular time
T_5	Request for Traveler's cheque selling rate at particular time
T_6	Enquiring about foreign currency exchange rate during peak hours
T_7	Importing goods at specific location by currency exchange

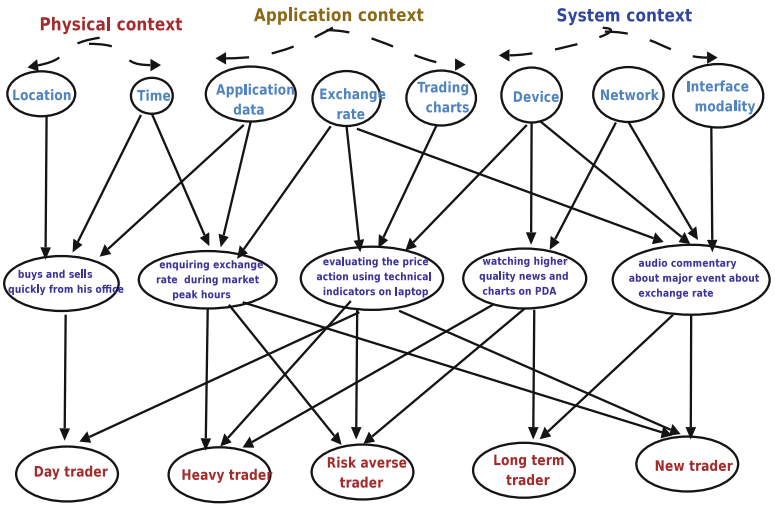


Fig. 3. Example of Causal C-IOB model

5.2 Example of C-IOB Model

Whenever a customer requests for a service the current context information is acquired using CI-Constructs [3] to retrieve the context information from the multi-way datastructure. The thing/object used to acquire context information is given in Table 2. The beliefs are deduced by making suitable combination of four types of context information. An example of C-IOB model based on causal concept for establishing Forex transaction/service is given in Fig. 3.

Table 2. Acquisition of context information

Thing for data acquisition	Acquired context information
System clock	Time is 10 a.m
Proximity sensor, GPS receiver (Passive Infrared Sensors or Capacitive sensors)	Near shopping mall
Logical sensors (operating system, APIs)	PDA, Wi-Fi network
Access point, logical sensors (operating system APIs)	Bandwidth
Age, education, profession	Elder person, M.B.A, Trader
Login/password	Bank manager/new customer
Calendar information	Social event
User feedback/rating	Trustworthiness of vendor

5.3 C-IOB Model Evaluation

The three different causal structures of C-IOB model is shown in Fig. 4. The first structure shows the deduction of beliefs based on Ten context parameters chosen from four environments. The other two structures gives the modification in the deduced belief because of absence of certain context parameters. Therefore, we can address and interpret multiple situations in Forex by extracting specific context in the form of beliefs and thereby we can conclude that certain/relevant context parameters are always required to provide the personalized Forex services. Some of examples of customer context based beliefs and the specific services are given in Table 3.

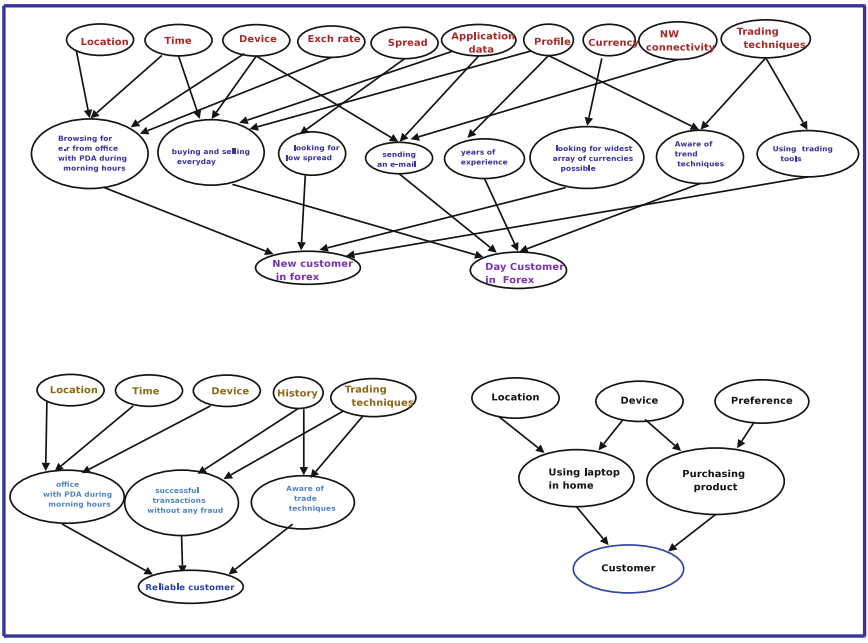


Fig. 4. Alternative structures of C-IOB model

Table 3. Customer context based beliefs and services

Beliefs	Services
Day customer	Providing proper Forex trading startegy
Low currency buyer	Mini account broker service
Customer	Import and export of both goods and services

6 Simulation and Results

6.1 Simulation Environment

The simulation environment is established by considering 550 customers and 100 Forex vendors who are involved in Forex currency buying, selling, traveler's cheque purchase and other transactions. The context information from four environments is collected, for 500 customers who are frequent travelers, novice customers, who wish to exchange currency based on their need. The proposed model has been simulated on hybrid wireless network as shown in Fig. 5. It consists of Samsung grand Smartphone and Mobilephone connected to Linksys access point with 802.11n connectivity and a Laptop with wireless connectivity. The system is very much consistent and competitive to realistic mobile environments. The laptop is used as vendor device, the mobilephone and smartphone are used as customer devices.

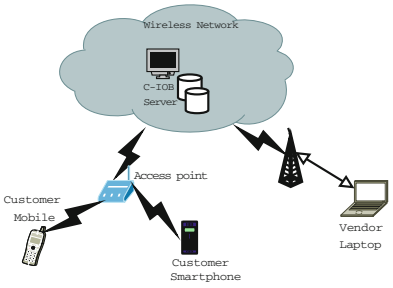


Fig. 5. Hybrid wireless network

The simulation is carried out to test several Forex transactions. The database is created for 1000 customers, 100 vendors and are characterized by their *identity, name, address, phone number, profession and economic status*. The context environment is varied by changing the parameters such as location, time, currency type, exchange rate, spread and so on. When customer device sends a request for a transaction/service, the current context information is acquired, using menu driven programs [3]. The C-IOB server formulates a set of observations, which are further deduced into beliefs and the simulation exhaustively tests the working of C-IOB model under distinct environments.

The Fig. 6 shows the Context Selection Index (CSI) when business participant is either customer, vendor, broker or banker. For a *customer* the physical and social context information is important, because of his frequent change in location and in addition influenced by friends or family in Forex transaction. For a *vendor* and *banker* the percentage of application and social context information contributes more. Lastly, the percentage of social context information is high in belief deduction for a broker as he has to establish a transaction between buyer

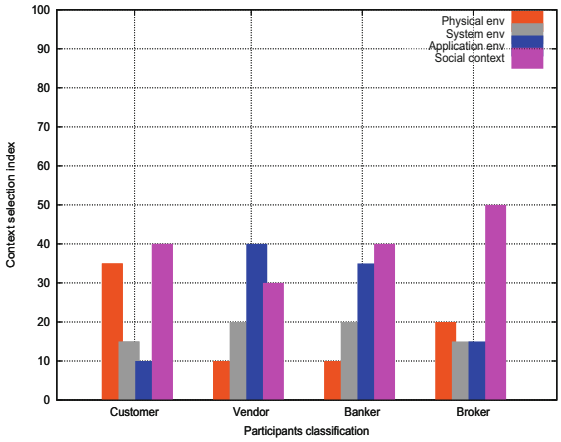


Fig. 6. The CSI of four business participants

Table 4. Context weights chart

Business traders	w_1	w_2	w_3	w_4
Customer	0.33	0.15	0.11	0.41
Vendor	0.11	0.21	0.37	0.31
Banker	0.10	0.21	0.33	0.36
Broker	0.22	0.14	0.15	0.49

and seller by connecting through social network. The context weights chart for business traders are given in Table 4.

The percentage of context information is calculated based on the following formula.

$$\gamma_i = \frac{m_3 \star w_i}{\sum m_3 \star w_i} \tag{2}$$

where, $\gamma_i \mid \mathrm{i} = \{1 = \text{physical}, 2 = \text{system}, 3 = \text{application}, 4 = \text{social}\}$, represents the percentage of context information, m_3 is the number of input context parameters used in belief formation and w_i is the weight associated with each environment and $\sum_{i=1}^{4} w_i = 1$. Therefore *Context Selection Index* assists in designing innovative systems.

The average processing time of context based transaction is given by

$$T_{pt} = N\ (T_{acq}) + T_{of} + T_{bf} + T_{se} \tag{3}$$

where, 'N' represents the number of context parameters used in belief deduction and description of these parameters is given in Table 5.

The graph shown in Fig. 7 gives processing time with variation in number of customer requests. The average processing time for executing a particular Forex

Table 5. Context aware transaction time parameters

Symbol	Description
T_{acq}	Context acquisition time
T_{of}	Observation formulation time
T_{bf}	Belief formulation time
T_{se}	Transaction selection and execution time

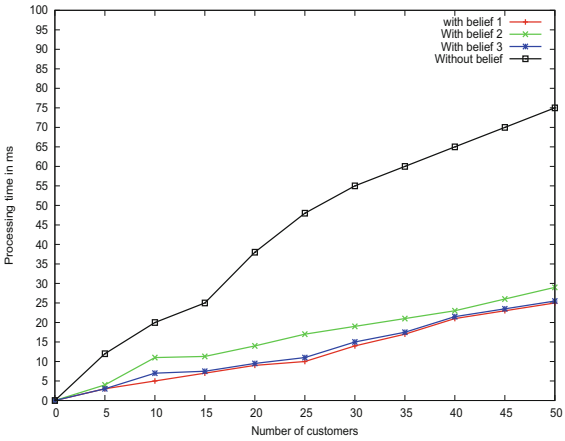


Fig. 7. Processing time vs number of customer requests

transaction is less with belief based request compared to context unaware approach, since the traditional request takes more time in searching the information about the vendor, place and also peak hours.

7 Conclusion

In this paper, we have proposed C-IOB model based on cause-effect relationship by extracting the specific context information of a business entity. The proposed model provides accurate context-aware services and has the capability to adapt to real time situations of business needs by deducing beliefs based on observations, thereby enhancing the customer satisfaction. The simulation results have shown that the time to execute Forex transactions is less with context based beliefs. In our future work, we incorporate qualitative and credible reasoning techniques to address the issues related to imprecise or uncertain context information to make the future computing paradigm more realistic towards real world implementation. As a result, it is possible to obtain more accurate decisions and provide intelligent or new services to the trader.

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