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Reassuring Electronic Commerce Mechanism based on User Evaluation Controlling

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Abstract

In this paper, we show theoretical properties and mechanism design based on information disclosure incentives. Normally, in existing electronic commerce, user evaluation system in electronic commerce provides rough attributes of evaluation scoring given by buyers who finished all trading procedures. Also, related work in user evaluations are assumed simple situations and conditions when they analyze and discuss the effects of evaluations. In this paper, we describe the detailed evaluation factors and new evaluation mechanism when users choose items in the trade. Also, we characterize the theoretical effects using our proposed mechanism in the user evaluation. In our proposed mechanism, sellers can provide some additional evaluation attributes to help buyers’ decision-making on items selection to purchase. The electronic commerce manager adds extra points based on the amount of information disclosure and credit history of sellers.

Keywords: evaluation system, e-commerce, incentive design, incomplete information, asymmetric information.

1. Introduction

In recent years, as the Internet and computers are widely used, electronic commerce enables user to negotiate with multiple methods \cite{1,2}. As one of the negotiation methods, auction research is popular to allocate tasks, resources, and rewards to autonomous multi-agents. \cite{3}. A lot of theoretical contributions have been published, and also some have been focusing on the practical method and systems \cite{4}. Auction mechanism design research is also popular as one of agent-based decision support systems, that is, agents bid in an auction instead of buyers \cite{5,6}. Matsuo et al. proposed a new mechanism to reduce an incentive of untruthful bidding with theoretical analysis on trading in volume discount-based auctions \cite{7}. In this contribution, the mechanism is employed Vickrey-Clarke-Groves mechanism, which is regarded as one of most important theoretical work in auction research \cite{8}. The mechanism is applied into volume discount mechanism and it reduces a chance of free riding with adjusting payment amount. Namely, if an agent contributes to decrease a price of an item buying a lot of items at once, he/she get a large utility rather than doing free riding. In actual e-commerce sites, buyers normally check the evaluation point in order to make better decision.

For example, Yahoo! Auctions managed by Yahoo.com employs a five-rating and comment based evaluation system. Buyer/seller evaluates trading partner with each other \cite{12}.

In this few years, researches regarding trader’s evaluation are becoming popular to make validity and reliability in evaluation systems. The contribution of evaluation mechanism researches can be applied to automatic trading support.

Kobayashi et al. proposed an effective evaluation model to evaluate users using trading relationship and its network. Online auction sites are regarded as network structures and confidential relationship is evaluated by the strength of network connected with each user. Also, Kobayashi et al conducted an experiment and analyzed the effectiveness of their proposed evaluation method, which is applied from web-page evaluation algorithm \cite{9}.

Usui pointed out that evaluation system gives a certain effect of market revitalization \cite{11}. The market size becomes bigger, if the evaluation system is provided in the market. One of well-known auction sites eBay.com employs multiple attribute-based evaluation mechanism to enable users get useful information. The attributes include delivery speed, communication with buyer, and so on \cite{22}.

However, in these system, the evaluation between users are not objective and the trade makes an symmetric information problem like that the amount of information in which buyer has are less than the information in which seller has. Thus, in this paper, we propose a new mechanism design that is implemented into the evaluation system in electronic commerce. The contributions of our research are including to make a safe and secure e-commerce environment, reliable society in e-commerce, and to give a theory of mechanism design in evaluation system.

2. Preliminary Discussions

2.1 Incomplete Information

In the Internet-based auction, buyers view items information and sellers information based on only displayed information on the web browser. Buyers cannot perfectly know the actual information by the Internet until they receive purchased items. These situations put out incomplete information, such as every existing electronic commerce web site. On another hand, in an e-marketplace, differences of quantity and quality of information
between sellers and buyers are huge issue for them. These situations put the problem on asymmetric information. Web-based marketplace has more asymmetric information than actual marketplaces.

In the actual marketplaces, buyers can view items from multiple aspects, sometimes touch and pick up them. Thus, they make sure the material, quality, size, and several other information. On the other hands, when users try to buy items on the electronic marketplace, they cannot touch and pick up items.

Further, they just look at some pictures taken by sellers. Some sellers are good faith and honesty, but others may hide a scuff on the item and do not provide adverse information. It makes unfair trades. It is very important for buyers to be filled the gap of information between them and sellers. When there are above unfair issues on the trades, buyers sometimes fail their decision making to select items. This means that buyers’ utilities are decreased by unfair information provision.

2.2 Existing User Evaluation Systems

Yahoo! [12], Rakuten [13] and Bidders [14] are popular Internet auction sites in Japan. In their system, users can input their evaluation including total/synthetic evaluation and evaluation by free description.

Users can know the latest result of evaluation and make decision by viewing whether trading partner is active or not.

Seller may gain evaluation score by many trades with same person, such as his/her friend. However, in a lot of e-auction systems, when a seller trades with same buyer, total score is not reflected after second trade. Namely, only new trades with different traders can be reflected in the total score.

Buyer may deliberately give a bad/poor evaluation for sellers. In existing e-auction systems, a pair of seller and buyer evaluates by mutual evaluation. Thus, each trader takes care on evaluation.

Although existing evaluation systems have these features, buyers can never perfect information about sellers and items with incomplete and asymmetric information. A lot of causes of criminal acts are set up by these problems on information.

3 E-Commerce Site Properties and the Proposed Concept

In the electronic commerce, there three key agents exist. (1) sellers prepare items to sell; buyers choose items and buy; trading system providers provide the e-commerce page trading system, and user evaluation system. Normally, sellers can make and modify the information about the items information, sales information and shipping information on the allocated electronic commerce webpage. However, they cannot set up and change the user evaluation system and attributes in which buyers give score. Figure 1 shows the simple example of properties of electronic commerce website from a seller. The key point of our proposed issue is providing an environment where the seller can decide the number of evaluation attributes and its number. Because there are plenty sorts of items in the electronic commerce website, the evaluation factors and their quantities should not fixed like the existing electronic commerce sites. For example, the evaluation attributes are not same between fresh meat and personal computers. The former includes the evaluation attributes like as freshness, product location, and so on. On the other hands, computers have the evaluation attributes like computer specs, brand, and some other attributes that are different from agricultural product.

Figure 1: Electronic Commerce Properties

Figure 2: Key concept of the proposed mechanism

However, if the sort of attributes and its number can be changed by a seller, some serpent sellers may provide unnatural and unfair evaluation attributes. In order to avoid these situations, in our proposed mechanism, electronic commerce manager controls the seller total score by monitoring the number of evaluation attributes in which the seller set up, shown in the Figure 2. And also, it controls the total score by monitoring the number of most recent successful trade, which is the number of positive rating given by the buyers. Roughly, we can know the sellers may not have an inventive to give small number of evaluation attributes. Generally, the synthetic score is computed by the average of scores on each evaluation attributes. Thus, the seller has an incentive to give a lot of information if the electronic commerce manager gives an extra-point based on number of information disclosure. And also, the seller has an incentive to trade carefully if the electronic commerce manager gives extra-points on the number of recent successful trades.
4. Evaluation Mechanism
4.1. Conditions and Protocols
This section describes some conditions of the evaluation system and a mechanism employed by the system. We show some conditions and a protocol of the evaluation system. Let \( N = \{s_1, \ldots, s_m, b_1, b_2, \ldots, b_n\} \) be a set of buyers and sellers of the electronic commerce, where each \( s_j \) shows a seller and each \( b_i \) shows a buyer, and \( A = \{a_1, \ldots, a_k\} \) be a set of agents, which adjust the mechanism at each and calculate the evaluation. Hence, there are \( N \cup A \) players in the electronic commerce. The evaluation system has a set of evaluation items denoted by \( E = \{e_1, \ldots, e_j\} \), each item’s upper \( u_e(\in \mathbb{N}) \) and lower bound \( l_e(\in \mathbb{N}) \) and a calculation method for computing the evaluation.

We consider single seller and single buyer case for showing our protocol. First of all, the seller \( s \) chooses a set of appropriate evaluation items \( E' \subseteq E \) for an own selling goods. Second the buyer \( b \) is able to evaluate the seller \( s \) and input it to the evaluation system when the buyer \( b \) took the goods. Also the evaluation system puts on among time from a transaction termination time to giving scores for each evaluation item by the buyer \( b \). The buyer \( b \) scores to each evaluation item \( e_i \) given by the seller \( s \) among the value from upper \( u_e \) to lower bound \( l_e \), subjectively, that is, whether each evaluation item \( e_i \) influence to make a decision of purchasing in evaluation phase. In this phase, the evaluation system gives a weight to each evaluation item \( e_i \), which shows believability of the item. The weight is calculated by an average score of every past buyers’ evaluation scores.

4.2. Evaluation Mechanism
Our objective of making an evaluation mechanism is to have an incentive for the seller to open more correct information of his/herself. The mechanism employs credit history method for not only providing useful subjective information to the buyers but also providing some objective information like a transaction result. The credit history is, generally, a credit record institution for credit card users of USA. The credit history works the following scheme:
- When the credit card user uses the credit card continuously or does not fall behind in his/her payment, the credit history point is increasing.
- When the credit card user falls his/her payment or does not use his/her credit card continuously, the credit history point is decreasing.

Our mechanism uses this scheme, and we describe our mechanism as follows.

[Mechanism 1] Each seller \( s_j \) is given his/her evaluation by each agent \( a_i \) and buyer \( b_i \).

[Mechanism 2] The buyer \( b_i \) is able to report an impression of the goods compared with before purchasing and after receiving the goods. Also the buyer is able to report a difference between a process written on the webpage and actual process.

[Mechanism 3] The interval of purchasing time and evaluation reporting time is able to influence the seller \( s_j \)’s rating, particularly, it is able to influence the evaluation of transportation time.

[Mechanism 4] The agent \( a_i \) gives some additional evaluation points to the seller \( s_j \) by number of evaluation items indicated by the seller \( s_j \).

[Mechanism 5] The system is able to give some weight for separating evaluation items between important and not in the transaction before the buyer \( b_i \) scores the evaluation.

[Mechanism 6] The system evaluates some similar evaluation items, which is not specify in this trading, depending on the case of trading.

[Mechanism 7] The agent \( a_i \) adjusts the evaluation point by using credit history.

[Mechanism 8] The agent \( a_i \) calculates a total evaluation point of the seller \( s_j \).

5. Efficiency of the Mechanism
We evaluate our above mechanisms’ efficiency by some computational experiences, simulations and incentive analyses. In this section we show some fundamental observations. [Mechanism 1] in our mechanism is able to control that the seller \( s_j \) increases own total evaluation value by making fictional buyer, where every buyers and sellers do not know how to calculate the total evaluation value. [Mechanism 2] requires a fairness to the buyer’s evaluation. In the existing electronic commerce, the buyer report ambiguous evaluation, the evaluation is not fair unless the impression of the seller is not same among the buyers. [Mechanism 3] controls a reliability of the evaluation items. If the buyer scores to the evaluation items after a long time, then the impression of the purchased goods is decreasing. Hence, the evaluation system employs the [Mechanism 3] as a penalty for delaying evaluation of the buyer. [Mechanism 4] works for the sellers to encourage opening information. It means the evaluation system has an incentive that the seller provides more evaluation items to the buyers, when the system announces the additional point is given by the number of opening information. Also if the administrator of the electronic commerce evaluates the number of evaluation items is too many for the buyer, the system restricts the evaluation items such that it satisfies a maximum total additional point. This mechanism has an another advantage. The most hopeful seller’s strategy of increasing his/her point is to increase the evaluation items and to improve his/her weak point. This mechanism has a function that the seller try to improve his/her weak point in this mean. [Mechanism 5] is able to eliminate idle evaluation items for the selling goods. For example, if the seller choices “Is this goods fresh?” as one of evaluation item in the sale category, the goods is already categorized “Sale”, therefore the seller’s choice is idle evaluation in this case. This problem is able to be solved by the buyer put a weight on the important evaluation item. [Mechanism 6] controls that the seller choices a lot of redundant evaluation items for increasing his/her
evaluation value. For example, suppose that the seller describes some foreign countries on the introduction of the goods and this goods is actually made by a foreign country. Then the two evaluation items “Does the introduction accord with actual goods?” and “Is the goods made by domestic?” are redundant. [Mechanism 7] means that the system evaluates the seller who gets a positive point continuously. That is an evaluation of continuously application. We consider that the total point of the seller is only calculated by the average value given by the buyers. Even if the seller is evaluated by negative evaluation after he/she got many positive evaluation, the high level positive evaluation lacquers the negative evaluation. This mechanism requires that a high level seller try to trade maturely. It means that the mechanism provides a negative incentive for false trading. [Mechanism 8] try not to occur a disadvantage for the sellers by the agent changes the total evaluation value with respect to each market character by using some control value. We have been confirmed that the ratio of successful trading is changed significantly by types of buyers in the experience which verifies the effectiveness of decision making of purchasing by considering the evaluation value of the seller.

6. Efficiency of the Mechanism

6.1. Information Disclosure Evaluation from Electronic Commerce Manager

Our proposed model is based on number of disclosure of information. Multiple attributes to evaluate are prepared and a seller selects attributes based on his/her strengths. If he/she is good at packing, he/she can choose the "Package" as the evaluated attribute. On the other hand, if he/she does not want to disclose his weakness, he/she can omit the attribute to be evaluated. To design a desirable mechanism in evaluation, we set a control value based on number of information disclosure. When a seller changes five attributes from four attributes to be evaluated, the system gives an incentive points to the seller. Namely, if the seller discloses more attributes, the incentive points are given in proportion. Thus, he/she sets up a lot of attributes to get many incentive points. And also, incomplete information reduce from the shopping site. However, if he/she does so, he/she needs to be careful in each activity on a trade. If a seller provides an item’s information by pictures and explanation, a risk on trade is decreased [20][21].

6.2. Evaluation from the System by Cumulative Extra Point

Here, we define an experience value based on the cumulative number of trades for each seller. In existing evaluation systems, the score/rating of evaluation is calculated simple cumulative trading experience. For example, when a seller has 30 positive rating without any negative rating and he/she gets a positive rating in a subsequent trade, his/her score becomes 31 rating. However, we propose an appreciate model for outstanding sellers. The outline of the model is that the system gives an extra point for a seller who continues a lot of trading without negative rating from buyers. On the other hands, once he/she gets a negative point, the cumulative number goes back to the start. For example, when a seller has cumulative 100 positive rating without any negative rating and he/she gets a positive rating in a subsequent trade, the system give some extra score automatically. Thus, the marketplace positions outstanding sellers apart from the rest.

7 Experiments

We conducted experiments to measure our proposed model. When the system changed the evaluation depending on the number of evaluation attributes, we searched the market conditions where buyer can have dealings with confidence. In the market conditions, we configured (1) Buyer takes precedence elements in dealing, (2) Buyer has an impression to concern the evaluation for seller when buyer looks at multiple attributes, (3) About the number of each buyer type defined by (1) and (2). In the definition of (1), the experiments assumed three buyer types including price-oriented (PO), evaluation-oriented (EO), and neutral buyers (N) in the marketplace. Price-oriented buyers prefer low price item rather than rating of evaluation to decide a seller to trade. Evaluation-oriented buyers have a trend to choose sellers with rating of evaluation rather than item’s price. Neutral buyers have both above features. In the definition of (2), we set that buyer has a good impression on the specific number of evaluation attributes and gives seller higher one level rating. In the definition of (3), we investigated how many there are buyer types defined because we didn’t know it exist in actual marketplace.

7.1. Survey

We surveyed fifty-seven peoples in order to set parameters in our experiments. We asked two questions.

**Question (1):** Which do you prefer buying the item in e-commerce, products low prices, height of seller’s rating or both low price and high evaluation?

**Question (2):** When there are various sellers disclosing some evaluation attributes between one to ten, how many evaluation attributes are you desirable?

Table 1 shows the questionnaire result regarding buyer’s preference in online market. From questioner’s answer in the question (1), most of them are interested in a feature both low price items and high evaluation sellers. And there is a little questioner who makes a point of only high evaluation of seller. Table 2 shows the questionnaire result regarding buyer’s impression about number of evaluation attributes. From questioner’s answer in the question (2), many questioners wish the evaluation attributes is around five. Result in the question (2) looks like normal probability distribution between one and ten. We involved the distribution of each buyer type gotten by the above result into the experiments.

<table>
<thead>
<tr>
<th>Table 1: Questionnaire Result (1)</th>
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<tbody>
<tr>
<td><strong>Question (1)</strong></td>
</tr>
<tr>
<td>Priority</td>
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<tr>
<td>Totals Num.</td>
</tr>
</tbody>
</table>

**Table 2:**

<table>
<thead>
<tr>
<th><strong>Mechanism</strong></th>
<th><strong>Definition</strong></th>
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</thead>
<tbody>
<tr>
<td>7</td>
<td>Buyer takes precedence elements in dealing.</td>
</tr>
<tr>
<td>8</td>
<td>Buyer has an impression to concern the evaluation for seller when buyer looks at multiple attributes.</td>
</tr>
</tbody>
</table>

**Table 3:**

<table>
<thead>
<tr>
<th><strong>Mechanism</strong></th>
<th><strong>Definition</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Buyer takes precedence elements in dealing.</td>
</tr>
<tr>
<td>2</td>
<td>Buyer has an impression to concern the evaluation for seller when buyer looks at multiple attributes.</td>
</tr>
<tr>
<td>3</td>
<td>About the number of each buyer type defined by (1) and (2).</td>
</tr>
</tbody>
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**Table 4:**

<table>
<thead>
<tr>
<th><strong>Mechanism</strong></th>
<th><strong>Definition</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>Buyer takes precedence elements in dealing.</td>
</tr>
<tr>
<td>6</td>
<td>Buyer has an impression to concern the evaluation for seller when buyer looks at multiple attributes.</td>
</tr>
<tr>
<td>7</td>
<td>About the number of each buyer type defined by (1) and (2).</td>
</tr>
</tbody>
</table>
7.2. Setting

In the marketplace, rating of evaluation is rated through 1 to 5 of integers. Item’s price is assumed between $400 and $600 chosen by a normal distribution on distribution value 50. The average of price of sold items is $500. We assume three types of preferences in which buyers have. First, if buyer has the preference about price of item, the threshold of decision-making $D_p$ is shown as equation (1). If $P_s$ is larger than the equation, buyer trades with a seller who deals in at the lowest price out of candidates.

$$D_p: p - \frac{e}{10}$$

Second, if buyer has the preference about seller’s evaluation, the threshold of decision-making $D_e$ is shown as equation (2). If $E_s$ is larger than the equation, buyer trades with a seller who deals in at the highest rating out of candidates.

$$D_e: \frac{500 - p}{10} + e$$

Third, if buyer is neutral for price and seller’s evaluation, the threshold of decision-making $D_n$ is shown as equation (3). If $E_s/3 - P_s/500$ is larger than the equation, buyer trades with a seller who deals in at the highest value (than threshold value) out of candidates.

$$D_n: e + \frac{p}{3} + \frac{P_s}{500}$$

$p$ indicates item’s price and $e$ indicates rating of evaluation. $P_s$ indicates item’s price shown by seller. $E_s$ indicates seller’s rating of evaluation. In the setting of experiments, four types of trends of evaluation are assumed with number of evaluated attributes. The number of evaluated attributes is between 1 and 10. We assume four types of about evaluation given for seller. The following is detail of each evaluation type.

(A) Average of evaluation value monotonically increases when the number of evaluated attributes increase.

(B) When the number of evaluated attributes increases, the average of evaluation value exponentially increases.

(C) When the number of evaluated attributes increases, the average of evaluation value increases with marginal decreasing.

(D) When the number of evaluated attributes is around 5, it tends for buyers to give high rating like normal distribution.

Table 3 shows types of evaluation used in experiments. These evaluation types include both the rating given by buyer and the extra point from number of evaluation attributes.

Depending on characteristics of buyers, some of them give a low rate of evaluation when a seller provides a lot of evaluation attributes because evaluating activities are not simple and make buyers bother to fill out the form. We are considering such situation in our simulation.

Table 4 is a setting of 4 cases of experiments. Buyer’s preferences are shown as PO, EO, and N. PO indicates the buyer’s preference in which he/she has a price-oriented preference. EO indicates the preference in which he/she has a evaluation-oriented preference. N indicates a neutral buyer who has a preference both price and evaluation. In cases 1 and 2, we assume there is same number of types of buyers in the market. In cases 3 and 4, the rates of buyer’s preferences are respectively used from our survey result shown in Table 1. EP indicates the condition where the number of attributes effect buyer’s input to evaluate. When EP=0, number of evaluation attributes are not effected in an evaluation by buyers. When EP=1, some buyers give high rate when the number of attribute to be evaluated is same as their preferences shown in Table 3.

For example, when a buyer prefers that the number of attributes is 6, he/she give a high rate if the trader provides 6 attributes to be evaluated. In the experiment, we assume that buyer gives 1 additional rate in such case. Result of experiments shows the average of rate of successful trade in 1,000 trials. We assume that there are three hundred potential buyers and one hundred potential sellers to trade.

Table 2: Questionnaire Result (2)

<table>
<thead>
<tr>
<th>Attributes #</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
</tr>
</thead>
<tbody>
<tr>
<td>Totals Num.</td>
<td>3</td>
<td>0</td>
<td>5</td>
<td>5</td>
<td>20</td>
<td>10</td>
<td>3</td>
<td>5</td>
<td>0</td>
<td>6</td>
</tr>
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</table>

Table 3: Type of Evaluation

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
</tr>
</thead>
<tbody>
<tr>
<td>Case 1</td>
<td>.31</td>
<td>.32</td>
<td>.35</td>
<td>.38</td>
<td>.43</td>
<td>.46</td>
<td>.50</td>
<td>.53</td>
<td>.56</td>
<td>.58</td>
</tr>
<tr>
<td>Case 2</td>
<td>.31</td>
<td>.32</td>
<td>.36</td>
<td>.42</td>
<td>.49</td>
<td>.50</td>
<td>.51</td>
<td>.53</td>
<td>.56</td>
<td>.59</td>
</tr>
<tr>
<td>Case 3</td>
<td>.30</td>
<td>.33</td>
<td>.35</td>
<td>.37</td>
<td>.41</td>
<td>.43</td>
<td>.46</td>
<td>.48</td>
<td>.49</td>
<td>.49</td>
</tr>
<tr>
<td>Case 4</td>
<td>.30</td>
<td>.33</td>
<td>.36</td>
<td>.41</td>
<td>.47</td>
<td>.45</td>
<td>.47</td>
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<td>.49</td>
<td>.50</td>
</tr>
</tbody>
</table>

Table 4: Experiment Setting

<table>
<thead>
<tr>
<th>Experiments (A), (B), (C), and (D)</th>
<th>Number of Buyer’s type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Experiments Case1: PO=100, EO=100, N=100, EP=0</td>
<td></td>
</tr>
<tr>
<td>Case2: PO=100, EO=100, N=100, EP=1</td>
<td></td>
</tr>
<tr>
<td>Case3: PO=69, EO=21, N=210, EP=0</td>
<td></td>
</tr>
<tr>
<td>Case4: PO=69, EO=21, N=210, EP=1</td>
<td></td>
</tr>
</tbody>
</table>

7.3.1. Experiment (A)

In this experiment, the type (A) in 1 is used as buyers trend. Table 5 shows the result of experiment on a setting of Experiment (A) in Table 4. When the evaluation given by buyers and the system is high, the successful trade rate is also high in the marketplace. When the each buyer type exists respectively the same rate, the transaction success rate is flat in the number of each evaluation attribute. On the other hands, when we employ a condition of cases 3
7.3.2. Experiment (B)
In this experiment, the type (B) in 1 is used as buyers trend. Table 6 shows the result of experiment on a setting of Experiment (B) in Table 4. When the average of evaluation given by buyers and the system is 4 or less, effects of the impression value are low. In case 4, the rate of successful trade is a little lower than other cases. Namely, the best strategy for sellers is to provide a lot of attributes to be evaluated. When there are same ratios of buyers types, the effect is quite high when the number of attribute is 6.

7.3.3. Experiment (C)
In this experiment, the type (C) in 1 is used as buyers trend. Table 7 shows the result of experiment on a setting of Experiment (C) in Table 4. The successful trade is high on the number of evaluation attributes between 1 and 5. On the other hands, in cases 3 and 4, the number of successful trade is a little low. This means that seller’s best strategy is to provide 1-4 attributes to be evaluated. Only this result shows seller should not provide evaluation attributes more than 6.

7.3.4. Experiment (D)
In this experiment, the type (D) in 1 is used as buyers trend. Table 8 shows the result of experiment on a setting of Experiment (D) in Table 4. In the Cases 1 and 2, successful trades are the highest between 5 and 6. Considering actual tradings, seller’s best strategy is to prepare attributes between 5 and 6 to be evaluated.

8. Discussions
8.1. Mechanism Features
From our mechanism design, it has the following two theoretical features.

[Theorem 1] In the situation where electronic commerce managers can control the seller’s evaluated total score based on the number of evaluation attributes, the seller does not have an incentive to give an unfair information about items and himself/herself.

[Theorem 2] In the situation where electronic commerce manager can control the seller’s evaluated total score based on the number of recent positive scores, the seller does not have an incentive to make a fraud in the limited situations.

In the [Theorem 2], if the seller makes a collusion with some colleagues, it is not easy to keep the desirable conditions. This issue is included in our future work.

8.2. Related Work
Researches on the evaluation system in online auction system are very popular and a lot of contributions are published [16]. Kobayashi analyzed the evaluation mechanism on the Internet auctions by considering as a network structure, that is, the relationship is constructed between buyers and sellers [15]. The contribution proposes a new evaluation model of network structure instead of the evaluation on trades by sellers and buyers. Further, in the contribution [16], he implemented the evaluation system with the evaluation algorithm of web page. It also analyzed through the experiments to make sure of effectiveness. Ming analyzed the evaluation method of online auction to take in exponential smoothing[17]. It analyzed to avoid the cheating because a bad evaluation wields large impact on seller’s evaluation to give a lot of weight the last evaluation. It is a large effect to have a lot of weight when seller resort to cheating for buyer in trade. Ito analyzed the Internet auction protocol to permit the Pareto efficient distribution[19]. It shows that the protocol can admeasure according to goods quality made a honest declaration by specialist when there are a lot of asymmetric information and some specialist in the Internet auction.

9. Conclusion
In this paper, we designed an evaluation model in which sellers become to have an incentive to disclose a lot of information of item and themselves. Except for the situation where buyers do not want to evaluate a lot of attributes, seller can get high successful trade if he/she provides 4 ore more attributes. By using our proposed method, users evaluate more precisely sellers because our proposed method provides concrete criteria to be evaluated. Our model is based on multiple attribute evaluation including evaluation from buyer and system. System gives extra point based on the number of evaluation attributes set by sellers. Even though a seller is good at packaging, the system discounts the rating as a penalty when he/she chooses only one attribute "packaging" as detailed rating. Because our model makes an effect to promote information disclosure,
10. References

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The Supporting System for the First Process of PBL

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Abstract
PBL (project-based learning) in the field of medical education has been introduced earlier. These learning methods have proven to be effective in improving problem-solving abilities. Recently, this method has been applied in many university fields other than medical education, such as economics, literature, engineering, and science. This learning method is highly dependent on the expertise and experience of the professor, resulting in a broadening of the content and methods of PBL. This broadening has generated a difference in what a PBL student learns and how well they learn it. This research develops a support system for PBL and aims to solve some of the problems of PBL.

Keywords: Problem Based Learning, Project Based Learning, Title of Research, Research Plan Document

1. Introduction
Learning techniques are widely researched and are popular methods for enhancing the quality of education (Colomo-Palacios, 2010; Engeström, 2007; Howard, 2002; Saito, 1994; Soto-Acosta, 2010; Walker, 2009). Some have begun to feel that university education has become unsatisfactory in Japan because the content of what students learn at a university does not correspond to the requirements of society. For instance, the ability to request from the student is a problem solving skill in the enterprise that develops the information processing system in a certain investigation from the skill of the computer technology from which communications skills etc. are contained.

Problem based learning (PBL) is a learning method that was developed to improve problem solving skills (Doppelt, 2003). In Europe and America, this learning method was initially introduced in the field of medicine. It has since been widely introduced into other fields such as business administration, sociology, etc.

In PBL, a problem is given to students by their teacher. Then, students determine a method to solve the problem. Next, they simulate or execute the solution. This process allows students to experience the problem solving process, which builds students’ problem solving skills. Additionally, the process of organizing a project and executing is called project-based learning (PBL). It is expressed by the abbreviation named PBL as which ‘Problem Based Learning’ and ‘Project Based Learning’ are the same. Because of their similarities, hereafter, PBL is used to refer to both learning approaches.

At the university in Japan, PBL has been introduced into the curriculum, but it is generally limited to the fields of medicine, nursing science, and engineering. There are many reasons that it is not implemented in more fields. One such reason is because teachers who implement PBL have an increased workload because PBL requires students to be more aggressive in their approach to problem solving; thus, teachers must stimulate such aggressiveness in their students. Due to the relative dearth of PBL in universities, we have developed a system that may provide a solution. This was achieved by using this system to address the issue. The results of this process allowed us to introduce standardized content that should assist teachers who wish to implement PBL.

2. PBL
2.1 About PBL
Ikeda defined PBL as ‘an educational technique by the few people group practiced by the learner while accompanying the work of reflected repetition.’ PBL is the acronym of problem based learning (Fukuda, 2002; Helle, 2006). PBL is often adopted in curricula associated with medicine, odontology, nursing science, environmental science, law, and engineering. Ikeda said, ‘As for problem-based learning and project-based learning, two PBL has much in common in the point that the process of a concrete problem of restructuring of the insight, the observation, the conversation, the negotiation, reflection, and learning is seen in learning the few people group’ (2010).

In PBL, first, a teacher introduces a problem to their students. Next, the teacher has the students determine a method that can be used as a solution. Finally, the teacher has the students execute the solution and evaluate the results. At the university in Japan, such a learning method has not been actively introduced outside of the fields of medicine, nursing science, and engineering. Reasons for not expanding the field described in 2.3.

2.2 The Process of PBL
We have been doing PBL for one year now (Macias-Guara, 2006). In Japan, PBL is implemented one year before a student graduates and is called ‘graduation research’. Students perform research activities over the course of the year and present the results of their research at the end of the period. The results of the students’ research are evaluated, and students can graduate if they receive a good evaluation. In this paper, we describe our research of the system that supports ‘graduation research’. The process of graduation research is roughly as follows.

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I. Deciding the title of the research: The teacher and the student discuss the content of the research.

II. Making the research plan: First, it is necessary to examine the research plan before research activities are started. The result of the examination is filled in by the format ‘research plan document’.

III. Execution of research: The experiment, investigation, and production advance according to the approved research plan document. The outcomes of the research are kept in a portfolio.

IV. Evaluation and conclusion that analyzes the research result: When the research is completed, the outcome of an experiment and the results of the survey obtained by the research work are analyzed and evaluated. Those results are given official approval if they are acceptable to the teacher.

V. Presentation of the results: Finally, students present their results orally and submit a paper on their research.

The process described above is divided into three parts: the first process, the middle process, and the final process. In this paper, we refer to steps I and II as the first process. Steps III and IV comprise the middle process. Finally, step V constitutes the final process. Students simulate a lot of problem solving methods generated in society via PBL. They take implement problem examination, investigation experiments, etc., to gather information and create a plan for their solution. Students can acquire effective methods and skill for solving problem through PBL. In addition, students are exposed to new knowledge that they have not yet used in problem solving. This method differs from one-way learning via lectures, and it can help students learn solutions to the possible problems they may encounter in real world situations. Therefore, the PBL involved in graduation research is an effective study method to teach students problem solving.

2.3 The Problems of PBL

Ikeda has stated that the following problems exist in PBL (Ikeda, 2010).

(1) It is impossible for students to progress through PBL with only a teacher’s guidance. Support from a tutor or other assistance is necessary outside of the classroom (It often consolidates labour in PBL).

(2) PBL is often performed in learner groups, which decreases the pressure on individual learners to contribute. Therefore, it is difficult to expect a homogeneous learning effect in learner groups.

(3) The effect of a learner’s sense of values and cultural context on the formation and management of group learning is unknown (the development of a high-quality tutorial is a pressing need).

In addition, the following problems also exist if PBL is limited to ‘graduation research’.

(1) The content of a teacher’s guidance varies according to their specialized field and experience.

(2) Students begin their graduation research during job hunting season in Japan. Therefore, students may not be able to concentrate on their graduation research in the most effective manner.

(3) Students often delay the research planning process because they have no knowledge of planning or management methods for graduation research projects.

In particular, low-quality work during the research plan process often causes a delay in beginning the research and requires many corrections to set students on the right path.

3. The Support System for PBL

In PBL, a deciding on a title and a making a research plan document during the initial stage of the process are important (Frank, 2003; Paniagua-Martín, 2010). This process requires a great deal of work and time and is a difficult intellectual endeavour for both the teacher and the student. However, if this process is not done accurately and fast, delays to the overall schedule of the PBL and decreases in the quality of learning can occur. For instance, delays may occur in making a research plan document because the research title has not been decided. Furthermore, in the middle processes, the investigation and the experiment can be delayed because the research plan document has not been completed.

Polite support for the students is especially necessary in the first stage of PBL. Then, the content of the learning support that the teacher and the tutor provide is stored in the knowledge base of the system. Furthermore, a mechanism that students can use to answer questions using the system is necessary. The process should be similar to that of a teacher asking a question of a student.

3.1 The Outline of the Support System for PBL

We developed a system that supports the student in the first process of PBL (deciding a title and creating a research plan document), and have tried the introduction (Fukuda, 2010; Lee, 2004; Liu, 2002). An explanation of the system is as follows. This system is composed of two modules, which support the ‘decision of the title of the research’ and ‘creation of the research plan’ steps, respectively. In the module that supports ‘decision of the title of the research’, it becomes a mechanism to which the original bill of the title is automatically displayed by questioning on the term that composes the title of the system, and connecting the content that the student answered it. A database that includes the structure of the research plan is prepared beforehand. In the module that supports ‘the creation of the research plan’, the question is generated from the database in the student, and the student makes the content of the data base buried by answering the question. When the content of the database where this answer is buried is output, the draft of the plan is made. The plan without the omission fall of the item that composes the plan can be smoothly made by this method. Moreover, we think that this process also helps the student better understand the structure of the research plan document.

In summary, we developed a support system for PBL to solve the above-mentioned problems. This system is
composed of two modules: ‘the support module for deciding the title of a project’ and ‘the support module for creating a research plan’.

3.2 The Support Module for Deciding the Title of a Project

3.2.1 Deciding the Title of a Project

In the graduation research, a research title is decided using one of the following three processes.

1) Mutual consent: The student discusses possible titles with the teacher. They discuss the possibilities until both agree on a final title.

2) Teacher initiation: A title prepared by the teacher is shown to the student. The student then decides whether or not to use it as a final title.

3) Student initiation: The student prepares a title and shows it to the teacher. The teacher’s approval is obtained, and the title is assumed to be the final decision.

The first method seems to be the most preferable because it encourages the student’s autonomy and motivation. However, teachers’ specialized fields differ in an integrated faculty that consists of various specialized fields. Furthermore, teachers’ instructional methods also differ. Moreover, students’ intentions vary and they have different levels of knowledge.

3.2.2 Deciding the Title of a Project through Instruction

This support system decides the research title using a conversational method. First, we focus on the terms that make up the research title. These terms are assumed to be a parameter of the title sentence. Because the student inputs these parameters while talking with the system, the title can be made in this system. It is a method of the teacher and the student’s proofreading the made title sentence, and completing the title. These following four parameters are used by the system.

1) The field in which the student is interested.
2) The more detailed field.
3) The standpoint of the research (example: Manager, Researcher, and User, etc.)
4) The viewpoint of the research (example: Cost, ethics, and custom, etc.)

The role of this module is to support students attempting to decide the title of their project. In this module, a title is decided upon according to the following procedures. Figure 3 displays items such as ‘interesting field’, ‘words related to the field’, ‘aspects concerning the related words’, ‘viewpoint’ and ‘standpoint concerning the related word’. The student makes a selection from the possible choices displayed on the screen. In other words, the student inputs an answer to the questions and chooses the desired parameters. When the student answers all of the questions, the answers (the parameters) are connected and the system displays the combination, which may serve as a hint for creating a research title. The following is an outline of the questions displayed by the system.

1) What field interests you? : The student selects the field of research that interest them (e.g. health, food, sports, psychology, etc.).
2) What interests you in this field? : The student further narrows their research focus in the previously selected field.
3) The student selects the most interesting word related to their chosen field. : In this step, the students can choose from about 1,000 words from a previously constructed ‘corpus database’ of about 12 million words. This database was established by the National Institute for Japanese Language.
4) The student selects a standpoint from 400 relating words. : ‘Standpoint’ refers to the person or organization related to the research theme (e.g. manager, consumer, researcher, engineer, professor, etc.)
5) Which aspect do you want to research? : The student chooses from various aspects such as cost, securing talent, and sales expansion.
6) What method do you want to research? : The students select the desired method they wish to research (e.g. research, development, consideration, investigation, comparison, experiment, trial, evaluation, verification, etc.)

Finally, the module connects each answer selected by the student. Next, the research paper database is referenced using the parameters input in the title decision process. Papers on topics that are similar to the students’ chosen
interests are retrieved from the database. About 13 million research papers are stored in this database, which was established by the Japanese National Institute of Informatics. Finally, the student decides their title by proofreading incomplete sentences.

3.3 Deciding the Title of a Project
This module supports the creation of a research plan that examines the purpose, meaning, method, and evaluation of the research according to the chosen title. The research plan provides a clear description of the background, purpose, procedure, and schedule of the research. In the current study, we developed this module to support the creation of a research plan document. Additionally, successful implementation of this module will standardize the graduation research.

This module satisfies the following two points.
1) The purpose, meaning, method, and evaluation of graduate research should be clearly stated.
2) The student should have a structural understanding of the plan of the graduation research.

This module presents the previously stored question from the database in sentence form. The student inputs their answer to the question as in the ‘Answer input’ field (see Figure 5). The ‘Intention of the question’ is displayed under the question sentence. The purpose of this display is to support the student while they perform enter data into the ‘Answer input’ field.

The system connects these answer sentences and outputs them as syntax and as a text file. These are both displayed on the screen. The student proofreads the sentence and the text file using the text editor. Next, the student submits the result to the teacher as a research plan document. However, even if it suddenly questions the student on background and purpose’ that is the component of the research plan, it is difficult at once to answer the student. Then, the component was subdivided further, and the student's answer was facilitated by the method of displaying a detailed question sentence. Table 1 shows some example question groups and the corresponding breakdown of the questions.

In summary, the student edits the research plan and submits a draft of the research plan document to the teacher. The research plan is generated as a database, which is composed of chapters such as ‘Background and purpose’, ‘Research method’, ‘Experiment and result of the survey’, and ‘Summary’.

Table 1. Question prompts used for the background section of the research plan document

<table>
<thead>
<tr>
<th>Question group</th>
<th>Question</th>
<th>Intention of question</th>
</tr>
</thead>
</table>

Figure 3. Screen depicting the theme (title) decision process

Figure 4. The operations involved in the creation of a research plan

Figure 5. The screen for the making of a research plan (e.g. Introduction)
4. The Trial of the Support System for PBL

This section described the trial implementation of the support system.

4.1 The Trial Method

In the first process of PBL with this support system, ten students were chosen to participate for a period of three months. Next, we evaluated the effectiveness of the introduction of this system and searched for any operational issues.

The method we used to evaluate this system was to compare the research plan documents of two groups of students—Groups A and B. Group A used the support system, and Group B did not. In the trial, the evaluation that put the point of 0 or more of 5.0 or less in each chapter of the research plan was done.

4.2 The Result of Trial

Group A scored higher in the general evaluation of the research plan document upon completion of the examination. In addition, the evaluation totals for each chapter could be used as comparable results. The evaluation results tested using Wilcoxon rank-sum test. This test is a non-parametric statistical hypothesis test for cases where two related samples or repeated measurements are measured in a single sample. It can be used as an alternative to the paired t-test when the population cannot be assumed to be normally distributed. The following can be said as a result.

1) There is the difference in the overall evaluation averages of Groups A and B. ‘There is no difference in both groups’ was used as null hypothesis. As a result, the difference in the mean value of the entire evaluation for Group A was 0.333 higher than Group B (p = 0.017, p < 0.05). Therefore, the null hypothesis was dismissed. Consequently, it can be said that there is a difference in the evaluations of ‘Method’ for Groups A and B. Therefore, the evaluation of the group that used the system was high overall for each section.

<table>
<thead>
<tr>
<th>Group</th>
<th>Evaluation of the students’ research plan made by students</th>
<th>Average</th>
<th>STD (p)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group A</td>
<td>4.00</td>
<td>3.90</td>
<td>3.80</td>
</tr>
</tbody>
</table>

6. Conclusion

The following observations are based on the results of the examination of the system. (1) This system improved user efficiency in the first process of graduation research. The research plan document made with this system is standardized, and the time required to complete the first process was able to be shortened. (2) The student users gained a better understanding of how to make a research plan document through their experience with the system. The composition was learnt because it had input it repeating the reply for the question on each chapter of which the student composed the plan many times. Therefore, we feel that improvements in efficiency and work standardization during the first process of graduation research can be achieved as a result of using the support system.

There are other benefits which can be gained using this system; that is, students gain more than just an improvement to their productivity in the first process. By using this system, students can structurally understand the whole project by advancing through each component stage (e.g. background, purpose, research method, methods of analysis, etc) and interacting with the system. Furthermore, we think that students are able to develop so-called ‘metacognition’ by using the system. However, the following problems occurred during the trial: (1) The students felt that the questions were vague and subject to a relatively large range of answers; (2) Some titles that students chose had a many examples of previous research; and (3) When students began to think about the title, they use plain language and avoid difficult academic language. Therefore, even if there is a title such as newspaper articles.

As described in Figure 1, we are taught to search a database of student papers. However, students not only about database search page a little. If only there was not only see the first page of search results. Moreover, after the research on the system was executed, we found new problems that occurred during the stage of the final process where the student presents their research results. (1) Several
students who referred generated the review of the research title at the stage that had entered the middle process. We think that this was due to a lack of attention to the title by student or the teacher during the first stage process. (2) It was possible to do fast, and the item to which the content leaked, too was few in making the research plan according to the use of this system. However, a gap was generated in the schedule for progressing and the planning the research work. This is likely to have occurred because of lack of effort (e.g. being vague when the student settles on the schedule of the plan).

The two problems mentioned above indicate that the students and the teachers sufficiently discuss the process. In the process of creating the research plan document, the teacher generally confirms whether a student understands the situation clearly. The advantage of this support system is that the time required for the student and the teacher to discuss the project was greatly diminished. Therefore, it seems that this system caused teachers to become lax in their confirmation of the content of the student’s plans. The student can make an ordered plan by using this system, but even if the student does not examine the content of the plan closely, they can still make a plan.

The teacher thought that the content completed for the research plan document was formatted in an orderly fashion. It might be necessary for teachers and students to sufficiently discuss and confirm the research plan documents in the future. Furthermore, we should implement a new check item. There were criticisms that students’ imaginations were limited by the method used to answer questions in the system. However, unsuitable words or words that do not correspond with the elements in the research may cause confusion if students are allowed to create titles without guidelines. Therefore, teachers should spend a lot of time and persuade the student for what the student has submitted. Therefore, we do not welcome such a method in graduation research.

References


A New Forecasting Model based on Genetic Algorithm, SMS and Concordance

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Abstract
In this paper, we propose a new fusion approach to predict Stock Market index based on Statistical Semi-metric Spaces (SMS), Concordance and Genetic Algorithm (GA). The developed model can be used for the in depth analysis of the stock market. Different measures of concordances such as Kendall’s Tau, Gini’s Mean Difference, Spearman’s Rho, and a weak interpretation of Concordance are used to search for the pattern in the past that look similar to the present. The Genetic Algorithm is used to match the past trend to present trend as close as possible. The Genetic Program estimates what will happen next based on what had happened next. The concept is validated using financial time series data, S&P 500 and NASDAQ Indices as the sample data sets. The forecasted result is then compared with a conventional forecasting method.

Keywords: Stock Market Forecasting, Genetic Algorithm, Statistical Semi-metric Spaces, Concordance, Kendall’s Tau, Gini’s Mean Difference, Spearman’s Rho.

1. Introduction

This paper proposes and implements a new fusion approach based on Statistical Semi-metric Spaces, Concordance and Genetic Algorithm to predict time series in short term in the same or another time series. These generic trends in the time series are identified by the measures of concordance such as the Kendall’s Tau, Gini’s Mean Difference, Spearman’s Rho, and a weak interpretation of Concordance. This paper validates the concept using Financial Time Series data as the sample data set. We apply this method to forecast S&P 500 and NASDAQ Indices.

Stock Market forecasting is considered as one of the most challenging tasks in present financial world. So a lot of attention has been made to analyze and forecast future values and behavior of financial time series. Many factors interact in stock market including business cycles, interest rates, monitory policies, general economic conditions, traders’ expectations, political events, etc. According to academic investigations, movements in market prices are not random. Rather they behave in a highly non-linear, dynamic manner [10]. The ability to predict direction and correct values of the future stock market values is the most important factor in financial market to make money. These days because of online trading, stock market has become one of the hot targets where anyone can earn profits. So forecasting the correct value and behavior of stock market has become the area of interest. However, because of the high volatility of the underlying laws behind the financial time series, it is not any easy task to build such a forecasting model [11]. Numbers of forecasting techniques have been proposed so far with their own merits and limitations. Especially the conventional statistical techniques are constrained with the underlying seasonality, non-stationary and other factors [11].

2. Previous Approaches to Forecasting

There have been many ways in which the prediction of time series has been proposed, such as extrapolation, linear prediction etc. Some existing models are ARIMA, Box-Jenkins Model, and ARMA etc. Generally there exist two classes of methods of prediction; Parametric Methods and Non-Parametric Methods [1]. The time series data may be stationary or non-stationary as well as seasonal or non-seasonal.

2.1 Parametric Approach

The parametric approach assumes that we can predict the outcome of a time series data based on certain parameters on which the time series is dependent upon. The first stage of such approach typically involves the identification of the parameters on which the data depends. Then, a function or a set of functions on these parameters are constructed. The measures of parameters are collected from the data and are then used in the set of functions to predict the value of the series.

The parametric approaches are classified into two types based on the types of functions that are used for prediction. They are linear parametric approach and non-linear parametric approach. Linear parametric approach emphasizes that the function or the set of functions defined on the parameters be linear whereas the non-linear parametric approach emphasizes that these functions be non-linear.

Various other approaches are also taken for prediction of time series in economics such as Auto Regressive Moving Average, ARMA, Auto Regressive Integrated Moving Average ARIMA and the Seasonal ARIMA [1]. The ARMA method involves two parts, Auto Regression and the
Moving Average, that is, it takes into consideration the regression models of data and also the moving average for analyzing the time series data. The ARIMA method is a generalization of the ARMA model and is obtained by integrating the ARMA model. The data series for ARIMA should be stationary, means it should have constant mean, variance and autocorrelation through time. So the series first needs to be differenced until it becomes stationary.

2.2 Non-Parametric Approach

In Non-Parametric approach, we assume that the data is independent of any other parameters. Some of the Non-Parametric methods that are in use are Multivariate Local Polynomial Regression, Functional Coefficient Autoregressive Model, Adaptive Functional Coefficient Autoregressive Model and the Additive Autoregressive Model [3]. Since the behavior of the varieties decays exponentially with increase in the amount of past data, one of the proposed ways is to convert a multi-dimensional problem into one-dimensional problem by incorporating a single trajectory in the model [9].

Another non-parametric approach is the use of perceptrons or neural networks [5]. There are many ways to implement such approach. The predictive perceptron model or neural network is created and the historical data is fed as input to the neural network for training. Once the neural network completes the training stage, it can then be used for prediction. Several methods include, conversion of input data into a symbolic representation with grammatical inference in recurrent neural networks to aid the extraction of knowledge from the network in the form of a deterministic finite state automaton [6], preprocessing of input data into Embedded Phase-Space Vectors using delay co-ordinates [7], using special types of networks called Dynamic System Imitator which have been proved to model dynamic complex data. Another method of prediction involves choosing of the training dataset that closely resembles the time series in the “Correlation Dimension”. In some cases, there are separate neural nets that are used to find undetected regularities in the input dataset [5]. Another way of prediction is to apply a neural network to fuzzy time series prediction using bivariate models to improve forecasting [8].

The advantage of such a system over the parametric approach is that it is very robust, as it can adapt and respond to structural changes. The disadvantage of such an approach is that it can be very data intensive to get fully trained and cannot be used for any data set that is not huge [4].

3. Proposed Fusion Model

The daily changes for market are well fitted by non-Gaussian stable probability density, which is essentially symmetric with location parameter zero. The time evolution of the standard deviation of the daily change of stock market follows power law [13]. The Box-Jenkins model requires data to be stationary. Then seasonality has to be checked. Once stationarity and seasonality is addressed, then only identification of order of the autoregressive and moving average terms takes place. Same is true with ARIMA model also. Because of these complexities, we come across with model that uses concordance that does not require making the data stationary and also check the stationary. The correlation immune to whether the biased or unbiased versions for estimation of the variance are used, concordance is not. So it is better to use concordance [2].

We develop a forecasting method based on Statistical Semi-Metric Space and Concordance. In this section, we present the underlying theory. In the proposed fusion model, a function is developed based on Statistical Semi-Metric Space and Concordance then the Genetic Algorithm is used to find out the optimal initial parameters. Finally the fusion model finds out a number of alternative data items from the historical data that has the similar trend as of present day. Since the past data is huge, we want to limit the past data so as to compare with the present using mathematical concordance.

Concordance is the measure of agreement among raters. Given the rating/ranking \( X < x_1, x_2, \ldots > \) and \( Y < y_1, y_2, \ldots > \) given by two judges say, then two pairs of rankings \( (x_i, y_i) \) and \( (x_j, y_j) \) are said to be concordant if \( (x_i - x_j)(y_i - y_j) > 0 \). But for this model, we have used the weak concordance. As a measure of concordance for items that is calculated based on the varying successive values of a series, we define weak concordance. For all values in between, increasing value of \( W \) indicates increasing concordance.

Weak Concordance is defined as

\[
C_w = \frac{\sum \delta_i}{(n-1)};
\]

Where \( \delta_i \) is defined as

\[
\delta_i = \begin{cases} 
1, & \text{if } (x_i - x_{i-1})(y_i - y_{i-1}) > 0 \\
-1, & \text{otherwise}
\end{cases}
\]

Based on the pair of points \( p: p < p_1, p_2, \ldots, p_n > \) and \( q: q < q_1, q_2, \ldots, q_n > \), we first find out the concordance. We use a version of Weak Concordance \( C \) to define a similarity measure. The Similarity Measure of two
datasets \( p < p_1, p_2, \ldots, p_n \) and \( q < q_1, q_2, \ldots, q_n \) is the strength of agreement between the two datasets \( p \) and \( q \). It can be obtained by modifying the function \( \delta_i \) in Weak Concordance \( w \) as

\[
\mu(p, q) = \frac{\sum \delta_i}{n - 1}; \quad \text{Where,}
\]

\[
\delta_i = \begin{cases} 
1, & \text{if } (x_i - x_{i-1})(y_i - y_{i-1}) > 0 \\
0, & \text{otherwise}
\end{cases}
\]

The function \( \delta \) creates the “patterns” from the datasets. Here, \( \mu \) calculates the percentage of match between the successive values of the series based on whether the present value has risen or fallen in both the data sets over the previous value or not. The value of \( \mu \) ranges from 0 to 1 where 0 indicates no match between rankings and 1 indicates high match between rankings. For all values in between, value of \( \mu \) indicates increasing match.

It can be noted that the Similarity Measure \( \mu \) is a weak interpretation of the Kendall’s Tau, because \( \mu = 1 \) when \( \tau = 1 \) but \( \tau \neq 1 \) when \( \mu = 1 \). We know that two pairs of rankings are concordant if

\[
(x_i - x_j)(y_i - y_j) > 0, \quad \text{Means}
\]

\[
\text{sign}(x_i - x_j) = \text{sign}(y_i - y_j)
\]

If \( \tau = 1 \), then for all \( i \) and \( j \), the above condition holds true. If we impose the condition \( j = i + 1 \), then we get \( \mu \) which is also equal to 1. Therefore, if \( \tau = 1 \), then \( \mu = 1 \).

As we discussed earlier, the past data is huge, we want to limit the past data so as to compare with the present using mathematical concordance. The weak Tau, Gini, and Rho concordances of all the possible past segments are compared over a short period of time. This will come out with all the lengths and positions for high concordances. Higher the concordances and longer the matches, indicate better matches. A high concordance means that the trend is likely to continue, so we can use the past data to predict the future. To make the prediction as accurate as possible, we search the mathematical equation which in this case is derived using Statistical Semi-Metric Space.

According to [12], \( \mathcal{R} \) a set of points is a statistical semi-metric space if with each pair of point \( p \) and \( q \) of the space \( \mathcal{R} \) a real function \( F(x; p, q) \) is associated satisfying the following conditions:

1. \( F(x; p, q) = 0 \) for \( x \leq 0 \) and \( \lim_{x \to \infty} F(x; p, q) = 1 \).
2. \( F(x; p, q) \) is a non-decreasing function of \( x \) and continuous to the left.
3. \( F(x; p, q) = F(x; q, p) \) for any pair of points \( p \) and \( q \).
4. \( F(x; p, p) = 1 \) for any \( x > 0 \).

The function \( F(x; p, q) \) can be interpreted as the probability distribution function of the distance \( p \) and \( q \); i.e., for any value \( x \), \( F(x; p, q) \) denotes the probability that the distance of \( p \) and \( q \) is less than \( x \). In all that follows a distribution function will mean a function of a real variable \( x \) which satisfies conditions 1 and 2.

Based on the Statistical Semi-Metric Space, we have developed a probability distribution function of distance \( p \) and \( q \) which is given by

\[
F(x) = f(x) (1 - C_{pq}) \quad \text{where,}
\]

\[
f(x) = \begin{cases} 
0, & \text{if } x \leq 0 \\
x, & \text{if } 0 < x < \frac{1}{1 - C_{pq}} \\
1 - \frac{1}{1 - C_{pq}}, & \text{if } x \geq \frac{1}{1 - C_{pq}}
\end{cases}
\]

To make the prediction as accurate as possible, we search the mathematical equation \( g(x) \) to map the past data to the future data to select which section of the past to use based on the concordances. The genetic program will then search for an equation such that

\[
\forall k, g(p_k) \approx F_{k+n}
\]

where \( k \) is a day in the past and \( n \) is the offset, in days.

Specifically, we want to minimize \( \sum (g(p_k) - F_{k+n})^2 \) for all \( k \) by choosing the best possible function \( g(x) \). The square makes larger differences matter much more than smaller differences. The function \( g(x) \) will get us close, but it will not be perfect. So we measure the error \( e_k \) for each term and subtract that error to get a better function. By extrapolating that error and using known values from the past, we can guess values that have not happened yet. This is done through genetic programming.

### 3.1 Forecasting Methodology

Here we have provided the algorithm we have used for forecasting. The algorithm constitutes of two parts. First part is for the main Program and the second part is for the Genetic Program.
3.1.1 Algorithm for Main Program

1. Get stock data for all stocks we want to test.

2. Search for the pattern in the past that look very similar to the present pattern using Kendall’s Tau, Gini’s Mean Difference and Spearman’s Rho as probabilistic distance measure.

3. Find the highest recorded Tau concordance among of all matches.

4. Use Genetic Program to match the past trend to present trend as close as possible. Use this program to estimate what will happen next “now” based on what happened next “then”.

5. Repeat Steps 3 and 4 with Gini and Rho Concordances.

3.1.2 Algorithm for Genetic Program

1. Generate a population of random Polynomials.

2. Compute a “fitness” of each polynomial, defined by \[ \sum_{k=1}^{l} (g(p_k) - f_k)^2 \] where \( g \) is the genetic polynomial, \( p \) is the past data, \( f \) is the present data, and \( l \) is the length of the section found by the concordance measures.

3. Sort the polynomials according to their fitness. Then replace the lower half of the population through breeding and mutating the upper half, along with adding new random individuals.

4. Repeat Steps 2 and 3 until a sufficiently low fitness is attained.

3.2 Flow Chart

\[\text{Start}\]

- Get the Historic Stock Data

- Search past similar pattern using distance measures

- Take the highest concordance among all matches

- Generate population of random Polynomials

- Compute fitness of each polynomial

- Sort the polynomial based on fitness

\[\text{Sufficient fitness attained}\]

\[\text{Yes}\]

- Genetic Algorithm

\[\text{No}\]

- \[\text{End}\]

Figure 1: Flow Chart of proposed fusion Model
4. Experiments and Results

4.1 Test Data

For the efficacy of the proposed method, we have used stock index values for S&P 500 and NASDAQ from Yahoo Finance (www.finance.yahoo.com). Table 1 shows the information of the training and test datasets. We have used 102 sequential test data.

<table>
<thead>
<tr>
<th>Stock Index</th>
<th>Training Data</th>
<th>Test Data</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>From To</td>
<td>From To</td>
</tr>
</tbody>
</table>

Table 1: Training and test data information

4.2 Experimental Setup

The data set is selected based on the best Tau, Rho and Gini. In most of the cases, the values obtained from these three parameters are same. So we can take any of them to select the predictor data set. But if there is significant difference in those values, then we have to select three different data sets based on them which will give us three different predictions. However, the predicted values do not differ much. In our experiments, we have predicted values for 102 business days. However, we can predict for more days but the accuracy level will deteriorate as the forecasting horizon increases. This means lesser the forecasting horizon, better the forecasting values. These values are compared to the closing index values of respective business days and differences are measured to find the accuracy. Then the result is compared to the value we get from ARIMA model to find out which model is better.

4.3 Performance Metric

The performance of the proposed model is measured in terms of Mean Absolute Percentage Error (MAPE). Mean Absolute Percentage Error is calculated as

$$ MAPE = \frac{1}{n} \sum_{i=1}^{n} \frac{|a_i - p_i|}{a_i} \times 100\% $$

where,
- $a_i$ actual stock index value on day $i$
- $p_i$ predicted stock index value on day $i$
- $n$ total number of test data sequences

4.4 Result

The result obtained from this model is compared with ARIMA model to show this method is better than existing model. In order to do this, parameters required for ARIMA model are obtained based on Akaike Information Criterion (AIC) and Bayesian Information Criterion (BIC). Then the values are predicted using ARIMA model.

The experimental values are obtained and comparisons of actual and forecasted values with ARIMA model from 1-31-2011 to 6-24-2011 for both S&P 500 and NASDAQ data are done. The comparison of 102 days data is shown graphically in figure 2 and figure 3 for S&P 500 and NASDAQ indices respectively.

In figure 2 and 3, blue color represents the actual index values, red color represents the predicted index values and green color represents the ARIMA values. From the experiments, we can see that the direction of prediction is accurate in all experiments and the predicted values are closer to the actual values than the values obtained from ARIMA.

<table>
<thead>
<tr>
<th>Stock Index</th>
<th>Mean Absolute Percentage Error (MAPE) for 102 sequential test dataset</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Proposed Model</td>
</tr>
<tr>
<td>S&amp;P 500</td>
<td>1.051447</td>
</tr>
<tr>
<td>NASDAQ</td>
<td>1.246452</td>
</tr>
</tbody>
</table>

Table 2: Performance improvement of proposed model and forecasting accuracy comparison with ARIMA

Table 2 shows mean absolute percentage error for the proposed model and ARIMA model for both stock indices for 102 business days. The MAPE for the proposed model is pretty lower compared to that of ARIMA model in both the cases. This means the performance of proposed model is better than ARIMA model.
5. Conclusion and Further Works

In this paper we proposed a new time series forecasting tool that combines SMS, concordance and Genetic Algorithm. The result shows Absolute Percentage Error (APE) of the proposed model is less than that of ARIMA in both the cases. Mean Absolute Percentage Error (MAPE) are calculated for both S&P 500 and NASDAQ data sets. The result shows the error for proposed model comes out to be less than that of ARIMA.
Model. So we can conclude that the forecasting ability of the proposed model is better (based on experimental results) than that of ARIMA Model. The proposed model can also be used without any test of seasonality of the data. From the experimental results, the performance of this forecasting tool is reasonably accurate not only in direction but also in values as well. The error is less compared to that of traditional ARIMA model keeping in mind that the forecasting direction is absolutely same as that of final values. There is a lot of scope for future work in this proposed model tough. Currently we are working on adding up some more influence parameters on this model so that the forecasting would be more accurate.

6. References


Mathematical Modeling and Simulation, Risk Analysis, Stock Market Forecasting, and Computer Architecture. As a professor, his major contributions related to DoD projects include G050 system implementation and ABDR support system (ABDRSS) implementation. The G050 system is a major analysis tool used by weapon system managers and government contractors at Tinker and at other ALCs. The ABDRSS was used by the ABDR team at Tinker ALC. As part of summer research supported by Center for Aircraft and Systems/Support Infrastructure (CASI), he conducted research in WUC-NSN-Part number cross-reference, failure mode data collection for indentured parts, and AFMC form 173 automation.

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