Integration of Sentiment Analysis into Customer Relational Model: The Importance of Feature Ontology and Synonym

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Abstract

Online business or Electronic Commerce (EC) is getting popular among customers today, as a result large number of product reviews have been posted online by the customers. This information is very valuable not only for prospective customers to make decision on buying product but also for companies to gather information of customers’ satisfaction about their products. Opinion mining is used to capture customer reviews and separated this review into subjective expressions (sentiment word) and objective expressions (no sentiment word). This paper proposes a novel, multi-dimensional model for opinion mining, which integrates customers’ characteristics and their opinion about any products. The model captures subjective expression from product reviews and transfers to fact table before representing in multi-dimensions named as customers, products, time and location. Data warehouse techniques such as OLAP and Data Cubes were used to analyze opinionated sentences. A comprehensive way to calculate customers’ orientation on products’ features and attributes are presented in this paper.

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Keywords: opinion mining; sentiment analysis; feature ontology; structured data; unstructured data; subjective expression; polarity;

1. Introduction

Finding new market segments and keeping current customers with company are two most important tasks that companies need from analysis of customers’ behavior and characteristics.

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Customer analysis is the most important analysis needed by company in solving the issues. Customer analysis is an analysis of customer activities and characteristics in doing transaction with company [1]. A large amount of data regarding the customers’ purchasing patterns is needed to ensure the accuracy of customer analysis result. Structured data from Customer Relationship Management (CRM) is used to solve this issue.

The emergence of online business has change the way of customer buys a product and the product reviews posted by customers also can influence a potential customer in making a decision whether to buy a product or not. Product review is an unstructured data and it is impossible to integrate with structured data from CRM to implement customer analysis. 80 percent of data in companies is unstructured data such as web pages, text comments, e-mails, and images [2-4]. Another problem is every product review has expression sentences either subjective or objective and maybe both [5]. Subjective expression means a sentence contain at least a sentiment word. Data pre-processing is used to overcome these two problems, even though data pre-processing is a challenging task due to different formats and schemas employed for data storage. Data pre-processing task is important to ensure efficiency and effectiveness of customer analysis in supporting company to make accurate decision on producing new product based on customers’ satisfactory.

In this paper, we perform customer analysis based on unstructured (customer comments) and structured (CRM) data to generate a more accurate result than using only one of it. Multiple data dimension such as customer dimension, product dimension, date dimension and opinion dimension are used to classify the data. We use concept hierarchy to extract each dimension in helping to understand the semantic meanings underlying the data. For example, the concept hierarchy for phone number: Country Code – State Code – Area Code – Customer Number.

Customer expression on particular product covers many issues about products. Comments by customers may be about general product as a whole, or may be more towards technical/specific issues; some of the comments are positive or negative and some of the comments may be neutral.

In this article, we present a new approach to integrate customer’s opinionated comments into a traditional CRM model. Firstly, our model identifies the entities and opinion descriptors from customer’s comments. Then these entities are mapped to the corresponding concepts based on the product concept hierarchy and formally represent in a fact table. Association rule mining technique is used to find the relationship among the tables. In addition, ontology of product feature and synonym for each level of ontology also created in this research to capture more accurate product features.

We organized the remainder of this paper as follows. Section 2 mentions the related work on CRM, ontology and opinion mining. Section 3 describes about our model. The evaluation of our model is discussed in Section 4. Section 5 show result and discussion between our model and baselines. Last section is about future works and conclusion.

2. Related Work

In business, customers are the biggest asset that company must take care of. Many businesses today have their own Customer Relationship Management (CRM) unit or department to concentrate on making good relationship with current customers and finding new customers. CRM is a strategy for company to build, manage and strengthen the relationship with customers [6], [7]. Meanwhile, Rainardi [1] describes CRM as collecting customers contact and managing them through communication. Most of the companies use database management system to manage their relation with customers [8]. The main task of current CRM is to improve customers’ satisfaction by understanding the customers’ behaviors by analyzing customers’ shopping patterns, sales record and promotion record [8-9]. From definition above, the main CRM’s task is to analyze customers’ purchasing patterns only, which data is collected from CRM system (structured data). As we mentioned earlier, structured data only cover 20 percent of company, so analyzing with only one fifth of data does not produce an accurate result. Our model is developed to solve this problem by using both data from CRM and customers’ comments (unstructured data) to generate more accurate result.

Customers’ comments about product are invaluable asset in business today. Companies can evaluate their customers’ satisfaction by analyzing comments from customers. Comment is an unstructured data, so it can’t merge directly with CRM’s to generate any customer analysis. Ontology and opinion mining especially feature extraction can solve this issue. Ontology has many different definitions but many agree that it represents concept of the real world. Almeida and Barbosa [10] cite ontology as a hierarchical structure based on concepts and relations.
Meanwhile, other researchers define ontology as a meaningful symbols or components that support the representation of specific views in Information System (IS) [11-12]. In opinion mining, ontology is a term that can share knowledge, exchange information and minimize ambiguity [13]. Somprasertsri and Lalitrojwong use ontology to differentiate term of product features base on level of product’s structure name [14]. Our model uses ontology to group product into four levels as product name, product feature, product attribute, and product instance. For every single term of ontology we integrate it with product feature synonym file from thesaurus.com’s website.

The difference between opinion mining and information retrieval is format of data; subjective data is involved with opinion mining while factual data works with information retrieval [15]. Opinion mining is classified into three different levels as sentence, document and feature. Opinion mining at sentence level is to identify opinionated sentence and then classify into positive, negative or neutral. While opinion mining at document level is to identify a whole review either positive, negative or neutral. In our research, we do not discuss these two levels because we are only interested on feature. Main tasks on opinion mining at feature level are to identify and to extract object features from users’ comments, and then determine opinion from the comment as positive, negative or neutral. After that, opinion summary is produced as final result. One of the popular techniques in this area is using the frequent feature proposed by Hu and Liu [16] and this technique is improved by Popescu and Etzioni [17] with introduction of part-of-relations that removed the frequent noun which is not a feature. Other techniques for identification of opinion orientation are supervised pattern learning by Liu [18] and lexicon based approach by Ding, Liu, and Yu [19].

Our model uses ontology and synonym on product and product feature to group the product features, than we use combination of frequent noun (adjective and adverb) and polarity lexicon to capture pair product features and opinionated noun. For summarization of opinionated we use seven levels polarity to calculate the product orientation. Detail about our model will be discussed in next section.

3. Opinion Integration Model

The hardest tasks for company in competing with their competitors are producing new products that satisfy customers’ needs and retaining loyalty of their customers. Customer analysis is one aspect that company need to implement in their business plan to get one step ahead of their competitors. We produced a new model to overcome this problem by using CRM to obtain the customer information such as customer background, loyalty programmed and pattern of customer transaction. These data then integrated with customers’ comments on a particular product to find the summary of opinion orientation on the product itself as shown in Fig. 1.

![Fig. 1. Our Sentiment Analysis Model](image)

Data source (customer’s comment) is extracted into nouns and sentiment words by using the ETL (Extraction, Transformation, and Loading) process. In data source file, part of speech (POS) tagging is used to pre-process the data (customer’s review) and produced another text file which has data such as product name, customer information, date, and pairs of entity descriptor based on our business model that involved our main tables such
as product, customer, opinion, and time [20-21]. The output from pre-processed data is the main inputs to the transformation part, where the extracted nouns will be matched with feature ontology (FO) to understand the features that customer want to review [21]. In our model, the polarity of extracted sentiment words will be calculated. A pair of feature and polarity is inserted into fact comment with related dimension keys. The output of this matching process then loaded to the data warehouse.

3.1. Feature Ontology (FO) and Opinion Sentence (OS)

We define FO and OS based on A as a set of attributes of all products for an enterprise and C as a set of customers as follows [20]:

**Definition 1** Feature Ontology (FO): A Feature Ontology $FO = <A, R>$, is a combination of a set attributes $a$ and their relations in producing feature ontology, and we can say that $(a_1, a_2) \in R$, if attribute $a_1$ is more general concept than $a_2$, or $a_2$ is more specific than $a_1$. Based on this definition, we can say that feature ontology is very specific and detail concepts because it defines a sequence of mappings from a set of low-level concepts to higher-level.

**Definition 2** Opinion Sentence (OS): An Opinion Sentence $OS = \{(f_1, s_1), \ldots, (f_m, s_m)\}$ is based on the pairs of feature pairs, where $f$ and $s$ are representing a set of feature-sentiment pairs.

3.2. Opinion Extraction (OE)

The extraction of customer review is a very hard task because we need to produce the review in structured data’s format. One of the solutions to solve this problem is by using the POS tag from natural language processing (NLP). Our model captures noun that was divided into three parts as noun, adverb, and adjective. Noun means attribute that can describes the feature of a product, while adverb and adjective are used to express the opinion of the customers to the features. The support function $\sup(n)$ is used to capture only frequent nouns because all the entities or features are noun. In this paper we show the latest version of support function which is updated from our previous works [20-21]. We define support function as follow:

$$\sup(n) = \frac{tf(n)}{tn}$$

where $tf(n)$ is the number of appearances of $n$ in a sentence and $tn$ is total noun appearance in a sentence. This support function produces a lot of extracted nouns that related to either product or feature. As a result, the maximum and minimum threshold for frequency of noun is introduces to only capture the frequent nouns that follow these rules. Therefore we define frequent nouns as follow:

$$\min sup \leq \sup(n) \leq \max sup, \sup(n) \geq \max sup$$

where $df(n)/tf(n) < tr/tn$, with $df(n)$ is the document frequency, $tf$ is noun frequency, $tr$ is total review, and $tn$ is total noun appearance. The minimum support $\min sup$ and maximum support $\max sup$ are empirical random. Both of minimum support $\min sup$ and maximum support $\max sup$ are parameter, where defaults value for $\min sup$ is 1% of total nouns appearances and default value for $\max sup$ is 10% of total nouns appearances. Every noun with the closest adjective and adverb in term of distance with product feature will be saved in the output file together with the structured data from the CRM because these types of data words will represent the sentiment of comments. Then, each frequent noun will be mapped with the feature ontology. As a result, four cases of mapping between feature and product attribute are generated. Those four cases are: exact match, partial match, association rules, and no match. For no match our model will ignore it. Our previous articles discussed detail about this part [20-21]. The output of mapping attributes to the feature ontology is a list of features. These features together with the closet sentiment words will be associated to find the customer’s opinion about specific product features before calculation of sentiment word’s polarity can be made.
3.3. Opinion Integration

One of our focuses in this research is producing conclusion of customer’s orientation from comments based on opinion group of customer \( (ogc) \) [20-21]. After integrating related data into data warehouse, many cubes were created to calculate and analyze the orientation of customer based on the product and product features. These cubes then used to find out the orientation \( o \) based on product features for a group of customer \( g \) to a category of products \( c \) as follows [20-21].

\[
o(g, c) = \begin{cases} 
\text{positive, if } ogc(g, c) > 0 \\
\text{negative, if } ogc(g, c) < 0 \\
\text{neutral, otherwise}
\end{cases} 
\]

The Eq. (1) shows three different orientation based on calculation of \( o(g,c) \), which positive orientation if \( ogc(g,c) \) greater than zero, negative if it less than zero, and neutral if neither of it in previous rules. Furthermore, the Eq. (2) shows the calculation for \( ogc(g,c) \) as follows.

\[
ogc(g, c) = \sum_{z=-3}^{3} (z \times \text{polarity}(c, g, z))
\]

Eq. (2) shows polarity is the total support of the comments for the sentiment value \( z \), the group of customer \( g \), and category of product \( c \). Further improvement has be done on polarity \( (c,g,z) \) as mentioned by Yaakub et al. [21]. This revived formula created to improve result of \( ogc(g,c) \) especially in capturing words that representing features or attributes of product based on ontology level.

4. Evaluation

In this research we focus on two different tasks. First is finding the sentiment from the customers’ comments based on the product’s features, and secondly is to give summary of product’s feature based on customers’ opinion orientation. We used ontology and synonym to define product features, while JAVA is the main tool to develop the model, and Microsoft SQL Server 2008 R2 for developing the data warehouse. We have set objectives for evaluation based on three perspectives:-

- Identification of Opinion Sentences, which evaluated by Recall \( (R) \) and Precision \( (P) \).
- Identification of Opinion Orientation, which evaluated by \( F_1 \) measurement.
- The ability of model to give conclusion about product based on customer’s comment (orientation), it’s hard to find other researchers do any evaluation in this area.

For evaluation, a comprehensive list of features in the reviews were extracted as the opinion of the customer and identified as positive and negative based on the scales developed in previous works by Yaakub et al. [21]. All of these are read and evaluated by human beings.

Dataset used in this research is collected from Minqin Hu and Bing Liu’s project [17]. This dataset contain 1000 reviews of Nokia 6610 from amazon.com. We deleted original tagging to get the raw data, and then we processed again the needed raw data to produce a new list of tagging data. 500 data items are used as training data to mine the patterns. Ontology and synonym were used for product feature and for opinion orientation we used lexicon of orientation from Hu and Liu [17]. We improve this lexicon by using synonym for every term in database. Seven level polarity systems [20-21] are used for every word in lexicon based on Wordnet system. This important in calculating the orientation based on Eq. 2.

Baseline models for this research are developed by Minqin Hu and Bing Liu [17]. Hu and Liu’s technique started with crawling the reviews before put them in review database. Part of Speech tag or POS is used to isolate the reviews into categories. By using association mining, they identified the features by finding frequent nouns or noun
phrases. Then, adjective words used to identify the infrequent features. After that, they identified the opinion sentence based on the adjective word that is close to the feature word before producing the review summary.

5. Result and Discussion

We used recall, precision, and F1 score to evaluate performance of our model. Table 1 below shows the result of our model and five baseline models developed by Minqin Hu and Bing Liu [17].

| Model                          | Recall (r) | Precision (p) | F1 Score |
|--------------------------------|------------|---------------|----------|
| Proposed Technique (PT)        | 0.855      | 0.924         | 0.888    |
| Opinion Sentence Extraction    | 0.675      | 0.815         | 0.7384   |
| Frequent Feature               | 0.731      | 0.563         | 0.6361   |
| Compactness Pruning            | 0.716      | 0.676         | 0.6954   |
| P-support Pruning              | 0.716      | 0.828         | 0.7679   |
| Infrequent Feature             | 0.761      | 0.718         | 0.7389   |

Our model shows significant improvement when compared with the best baseline model in all three aspects precision, recall, F1 score. The best result for baseline model in recall (Infrequent Feature) is 0.761, while ours is 0.855 or almost 12 percent improvement. Moreover, compared with the best result in precision (P-support Pruning), our model shows about 11 % = ((0.924-0.828)/0.828) improvement. The improvement for F1 score is more impressive with more than 15 percent improvement compared with P-support Pruning model, as the baseline model best result.

The result proved that our model with combination of ontology and synonym technique is better than all baseline models because the ability of our model to detect both frequent features and infrequent features in product’s comments.

By using results above, we built a report based on ogc formula as shown in eq. (2). This report can show a potential customer about orientation of every feature in a particular product that can be used by customer to make a better decision on buying the product. Fig. 2 shows that the customers were not happy with connectivity in general but happy with WiFi reception in specific.

6. Conclusion

This new architecture of CRM is combination of customer’s personal record, product record and feedback from customers regarding the particular product that they have already used. Our testing and evaluation showed better result compared with our baselines with the recall 0.855, the precision 0.924, and the F1 score 0.888.

Currently, our model is developed to cater only for one product with ontology. Our next target in the future is to develop a model with ontology that can be used for multiple products.
References

[1] Rainardi, V., Building a Data Warehouse with Examples in SQL Server, Apress, New York, 2008.
[2] Sukumaran, S., and Sureka, A., Integrating Structured and Unstructured Data using Text Tagging and Annotation, Business Intelligent Journal, 2006; 11(2):8-17.
[3] Baars, H., and Kemper, G. H., Management Support with Structured and Unstructured Data – an Integrated Business Intelligence Framework, Information System Management, 2008; 25(2):132-148.
[4] Losee, M. R., Browsing Mixed Structured and Unstructured Data, Information Processing and Management, 2006; Vol.42: 440-452.
[5] Mishra, N., and Jha, K. C., Classification of Opinion Mining Techniques, International Journal of Computer Applications, 2012; 56(13):1-6.
[6] Tsiptsis, K., and Chorianopoulos, A., Data Mining Techniques in CRM: Inside Segmentation, Wiley. 2010.
[7] Winer, S. R., A Framework for Customer Relationship Management, California Management Review, 2001;43(4):89-105.
[8] Anderson, J. L., Jolly, L. D., and Fairhurst, A. E., Customer Relationship Management: A Content Analysis of Retail Trade Journals, Journal of Retailing and Consumer Services, 2007; Vol.14: 394-399.
[9] Mithas, S., Krishnan, M. S., and Fornell, C., Why do the Customer Relationship Management Applications Affect Customer Satisfaction?, Journal of Marketing, 2005; Vol. 69:201-209.
[10] Almeida, M. B., And Barbosa, R. R., Ontologies in Knowledge Management Support: A Case Study, Journal of the American Society for Information Science and Technology, 2009; 60(10):2032-2047.
[11] Fonseca, F. T., The Double Role of Ontologies in Information Science Research, Journal of the American Society for Information Science and Technology, 2007; 58(6):786-793.
[12] Guarini, N., Formal Ontology in Information Systems, In Proceedings of FOIS’ 98, Trento, Italy, 1998, p. 3-15.
[13] Xue, Y., Wang, C., Ghennawi, H. H., and Shen, W., A Tree Similarity Measuring Method and Its Application to Ontology Comparison, Journal of Universal Computer Science, 2009; 15(9):1766-1781.
[14] Sompsertsri, G., and Lalitrojwong, Mining Feature-Opinion in Online Customer Reviews for Opinion Summarization, Journal of Universal Computer Science, 2010; 16(6):938-955.
[15] Mishra, N., and Jha, C. K., Classification of Opinion Mining Techniques, International Journal of Computer Applications, 2012. 56(13):1-6.
[16] Pecos, A. M., and Etzioni, O., Extracting Product Features and Opinions from Reviews, In Proc. Conf. Human Language Technology and Empirical Methods in Natural Language Processing, Vancouver, British Columbia, 2005, p. 339-346.
[17] Hu, M., and Liu, B., Mining and Summarizing Customer Reviews, Proceedings of the ACM SIGKDD Conference on Knowledge Discovery and Data Mining (KDD), 2004, p. 168-177.
[18] Liu, B., and Cheng, J., Opinion Observer: Analyzing and Comparing Opinions on the Web, Proceeding of WWW, 2005. p. 342-351.
[19] Ding, X., Liu, B., and Yu, P. S., A Holistic Lexicon-based Approach to Opinion Mining, Proceedings of the Conference on Web Search and Data Mining (WSDM), New York, 2008. p. 231-240.
[20] Yaakub, M. R., Yuefeng, L., and Yanming, F., Integration of Opinion into Customer Analysis Model, In Guerrero, J. (Ed.) Proceedings of the 2011 IEEE International Conference on e-Business Engineering, IEEE Computer Society Conference Publishing Services, Beijing, China, 2011. p. 90-95.
[21] Yaakub, M. R., Yuefeng, L., Algarni, A., and Peng, B., Integration of Opinion Customer Analysis Model, International Conference on Web Intelligence, Macau. 2012.
PREFACE

This volume of Procedia Technology comprises a collection of 174 research papers that were accepted for presentation at the International Conference of Electrical Engineering and Electronics and Informatics (ICEEI 2013), which was held on June 24-25, 2013, in the town of Bangi, Selangor, Malaysia. This conference is an international event organized by University Kebangsaan Malaysia, in collaboration with the Institut Teknologi Bandung (ITB) Indonesia with the purpose of establishing an open forum for exchanging ideas and discussing recent progress in all fields of electrical engineering and informatics. In addition to 24 technical sessions devoted to the presentation of the papers presented in this volume, the technical program of the conference included a research exhibition, and 3 keynote talks delivered by the following distinguished speakers:

• Prof. Peter Haddawy, Director of the United Nations University International
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• Prof. Dr. Ir. Benhard Sitohang, Professor at the Data & Software Engineering – Research Group School of Electrical Engineering and Informatics (STEI) Institut Teknologi Bandung
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The papers in this volume address a variety of problems that triggered to new ideas and research directions in the fast emerging areas of Informatics and Electrical Engineering, Information System and Multimedia Technology, Data, Software and Computer Engineering. They were selected out of a total of 235 manuscripts that were submitted for review by authors from 7 different countries. The review of this amount of papers would not have been possible without the help of fellow researchers that kindly agreed to serve on the conference’s technical program committee. In this respect, we are deeply thankful to:

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On behalf of the organizing committee of ICEEI 2013, we thank all TPC members and reviewers for their hard work. Likewise, we thank the authors for submitting their papers to the conference. This volume of Procedia Technology would have never materialized without their contributions.

The papers presented in this conference is an effort to highlight the state of the art and discuss the issues and opportunities on new research directions that can help develop new ideas for the betterment of society. The ultimate goal of ICEEI 2013 was to disseminate the findings of research activities that contribute to advance the state of the art in the conference’s areas of interest.

Therefore, we sincerely hope that the concepts, techniques and results presented in the 174 papers that we have selected are useful to the reader.

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Theme: Nurturing Research Collaborations

Dear Prof/Dr/Mr/Mrs,

The 4th International Conference on Electrical Engineering and Informatics (ICEEI2013) will be held in Universiti Kebangsaan Malaysia (UKM), Malaysia on 24 - 25 June, 2013. This conference is an international event organized by Faculty of Information Science and Technology, UKM, Malaysia, co-organized with the School of Electrical Engineering and Informatics, Institut Teknologi Bandung (ITB) Indonesia, together with Faculty of Engineering and Built Environment, UKM, Malaysia. The purpose of this conference is to provide a forum for researchers, scientists and engineers from all over the world to exchange ideas and discuss recent progress in all fields of electrical engineering and informatics from basic science to practical applications. The organizing committee cordially invites you to participate in the conference.

We welcome academicians, scientists, professionals, undergraduate and graduate students to submit qualified and state-of-art research papers in all aspects of electrical engineering and informatics from basic science to practical applications. The paper may contain theory and review, experiments, simulation and modelling, as well as applications. The conference scopes are Power Engineering, Telecommunication, Control Engineering, Information Technology, Electronics, Informatics, Data Base and Software Engineering, Biomedical Engineering and Computer Engineering. Original papers are welcomed on the following areas, but not limited to:

- Animation Systems
- Antenna and Propagation
- Audit, Security and Governance
- Bioinformatics and Telemedicine
- Biomaterials, Tissue Engineering and Drug Delivery System
- Biomechanics and Rehabilitation Engineering
- Biomedical Imaging and Image Processing
- Biomedical Instrumentation
- Broadcasting Technology
- Communication Systems
- Computer Architecture Design
- Computer Vision and Robotics
- Control Theory and Application
- Data Mining
- Database and programming
- Digital Right Management
- Electrical Machines, Power Electronic & Industry Application
- Electromagnetic Compatibility
- Fundamental and Education
- High Voltage Engineering and Insulation Technologies
- Image Processing
• Industrial Electronics
• Information Systems
• Information Technology Application
• Intelligent System
• IT Management and Assurance
• Knowledge Management
• Learning Systems
• Multimedia Services and Applications
• Network Management and Security
• Operating Systems
• Parallel and Distributed Computing
• Pervasive Computing and Network
• Power System and Energy
• Quantum Information Science
• Radar and its Application
• Real-Time and Embedded Systems
• Satellite Communication
• Sensors and Telemetry System
• Signal Processing in Communication
• Software Engineering
• VLSI and IC Design
• Wireless and Mobile Communication

Publication

All accepted papers will be considered to publish in Journal on Electrical Engineering and Informatics, ITB (indexed by Scopus, Index Copernicus (ICV 2010 = 6.18), Scholary Google, DOAJ, EBSCO, ProQuest) and Asia-Pacific Journal of Information Technology and Multimedia (APJITM), FTSM (indexed by Waset, Eprint, Research Gate, Google Scholar, World academic union, EBSCO HOST connection and IEEE Xplore Digital Library).

Important Dates

| Event                                | Date               |
|--------------------------------------|--------------------|
| Submission of Full Paper             | 15 February 2013   |
| Notification                         | 15 March 2013      |
| Submission of Camera-Ready Paper     | 15 April 2013      |
| Registration of Early Birds          | before 15 May 2013 |
| Normal Registration Date             | 15 May 2013        |
| Conference Date                      | 24-25 June 2013    |
Contact us

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Do kindly circulate this Call for Papers to your colleagues who may be interested to participate.