INTELLIGENT DYNAMIC ENQUIRY METHODOLOGY FOR INNOVATION TECHNOLOGY

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Abstract

The explicit objective of this study is to develop a methodological approach based on identification of online community members' needs towards the specification phase in Agent-Oriented Software Engineering. *Intelligent Dynamic Enquiry* (IDE) methodology is based on the Dynamic Enquiry. The implicit objective is to design a tailored Agent-Oriented System based on members' proposals to promote participation in online dialogue. The suggested frameworks bridge a theoretical gap regarding a methodology for patterns recognition as well as online communities. Active Readers On the Web (AROW) definition for users and a division between *e*nformatic, pseudo- *e*nergetic and *e*nergetic communities, as well as blended and online communities seemed to be needed. '*Spiral Identification of Information Locus in Online Discussion*' (SILOD) portrays the raised stages and structure properties revealed by IDE. The tailored system would enhance creativity, online dialogue and save significant time for newcomers' introduction and engagement in virtual communities.

Key Words
online communities, AOSE specification methodology

1. Introduction

After Rheingold's book *The Virtual Community*[1] in the 1990s, the idea of simulating a community was as popular as ever. OnLine, Electronic Discussion Group (EDG)[2] are two well known dialogue-based definitions. Communities of practice[3] supported both approaches. Is it something new or we are just reinventing the wheel? Fox[4] and Jones[5] do not share the enthusiasm. Fox thinks that communities of practice are actually imagined communities, whereas Jones prefers the term *network metaphors* and imply the importance of blended activities[6], the idea of online and offline communities. The distinction between the two is going to be referred as *blended communities* for off and online co-operation, and *online communities* for online interaction.

The threshold experience[7] is the line between feeling part of a community and feeling that one is outside looking in. Some of the members act as invisible observers and never seem to cross the threshold. Sproul and Faraj[8] refer to an 80% of lurking. Preece found that the average percentage of lurkers is between 46% and 82%[9]. However, little research has been done on newcomers and observers regarding their engagement in the group. Additionally, most of the research is based on posing a question or hypothesis and then collecting and analyzing data - quantitative or qualitative - designed to answer the question or test the hypothesis. This approach limits and frames the results significantly regarding users' needs. As the value of an online artefact is determined within the context of the activity in which it is used[10] recent research emphasized the importance of new knowledge production in creative domains. Innovation Technology follows Information Technology. There are studies in dialogical sequences constructions for artificial agents[11] and creative intelligent systems[12].

2. Reality Inversion & Synergy

A theoretical approach seemed to be needed due to inadequate framework for online interactions. In "*reality inversion*"[13] online members' activity and the communication system are integrated elements. Ideas and comments are usually examined through interactions on common interests and focused on the message instead of the messenger. Morioka cited in Aoki[14] describes this kind of use as "*ishiki tsushin*" (conscious communication). According to Morioka, it is the communication for the purpose of social interaction itself, which is distinguished from "*joho tsushin*" (information communication). As such, a difference is suggested between *e*nformatic (information-based), pseudo-*e*nergetic and *e*nergetic communities. Members in *e*nformatic communities usually send mare information and there is a great deal of lurking there, since the motivation for participation is the use of information. Pseudo-*e*nergetic members follow the system and moderators' suggestions. *E*nergetic communities enable members' engagement with the process of changing the

environment of participation i.e. the interface, the used strategies and policy.

3. Active Readers On the Web (AROW)

Group-generated text created by the active members of an Online Community, follows the notion of open-source software, creative copying and public copyright and suggests an open-ended and thus creative environment. The dialogue as a social interactive medium in online discussion and information sharing is actually the only medium that conveys the meaning of the interactive sequences and contributes to constructive learning. Bakhtin[15] emphasised the dialogical construction of meaning as a basic characteristic of all communication. Meaning cannot be transmitted from one to the other, but *is constructed* between the speaker and the listener, the writer and the reader. It is the reciprocity and the active engagement with the ideas of others that changes an action into interaction, the monologic into dialogic and multilogic processes. The selection of particular clusters of text that convey the subjective parts of meaning is a dynamic, cognitive process in which the interpreter 'foregrounds' certain elements of the display and 'backgrounds' the others[16]. If there is a way of separating the useful from the useless information in a group-generated text (text mining and information extraction) then the selection and construction of the meaning will be a result of internal reciprocity going beyond the person who provided the information (creative copying). The importance of this selected data has been stressed from all vicarious learning researches regarding the re-useable learning material and learning objects[17] although without considering the process of the selection itself[18]. As such, Active Reading on the Web reflects itself as the result of common knowledge; text mining serves as the waste of this interaction.

There is a wider point of viewing Active Readers On the Web in online communities since *all* members need to ground their initial knowledge by reflecting on both other members' behaviour and themselves simultaneously. Based on the number of messages in online learning courses, Oriogun[19] introduced Low (1), Medium (2) and High (3) Levels of Engagement of the users starting with one message as the lowest participation. AROWs do not participate at all. As such, the addition of Potential Level of Engagement (0), would complete Oriogun's scale.

4. Intelligent Dynamic Enquiry

The suggested methodological approach in this study extends the Dynamic Enquiry (DE) concept in intelligent systems. DE is anchored in London and McMillen's work[20] on a community development project. DE is headed to result in a successful intervention based on: the design of "what would be studied", the process of inquiry or "how the information would be collected", the interpretation of data, or "how they would make sense of what they discovered".

IDE, same as DE, heads towards the articulation of a collective reality that encompasses individual views, problems, underlying causes of the problems and solutions suggested by the members of an online community. IDE works towards a dynamic structure, a hierarchical clustering, non-stationary data learning and the parameter of self-adjustment especially when data are related to time on the internet. Since we are seeking to inform design, the recognition of patterns should have been coherent and systemized. IDE suggests the completion of questionnaires in phases from dual groups. The flexible nature of the research design from unstructured to semi-structured and to structured questionnaires leads to the systemization of the results and the construction of a skeleton towards the very structured nature of a machine. Both the inductive (looking for patterns and associations) and deductive (propositions reached hypothetically) approaches occurred due to the complex nature of a research as induction and deduction are involved at different stages. Inductive approach emphasized the critical importance of respondents' own interpretations in complex processes. Half of the subjects participating in the previous phase join new subjects in the next. Asymmetry ensures that the functionality of previous suggestions can be checked and extended. The quest ends when forked constructions stop. IDE facilitates extractions of hidden structures from the data towards clustering techniques. As such, it is difficult for the members of the online community to categorize the results for the phases as in dynamic enquiry. At this point the role of the researcher is crucial with all the implications that come from the non-objective third party approach of the researcher. The general purpose and goals is the first step of the Phase I. The next phases will build up as she members determine the: (i) actions for the system's environment; (ii) shared data sources for text mining and important information identification and (iii) identification of roles between users and between users and the systems. Accordingly, IDE could work towards the specification stage in intelligent systems by revealing the:

- users involvement
- patterns recognition strategies for data mining and identification of agents' roles
- meaningful shared data sources
- simplicity in the construction
- functionality of the system
- goals and actions that are determining the system's environment
- re-use of solutions and experiences using roles
- mapping of the framework for the agents' roles
- the number and the types of the agents
- iterative interaction of the agents

5. The study

At the following study the subjects filled questionnaires in three phases and managed to provide a structure for both engagement and the interface regarding an online community.

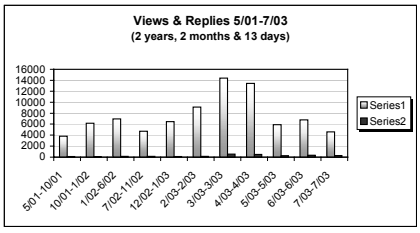
5.1 The subjects

Thirteen participants grouped in 3 teams based on their active/inactive behaviour. The criteria of the selection were their age and the absence of previous knowledge regarding conflict resolution for asymmetry and their ability for self explanation. The age range in the forum was 9 to 50 years old. As such, the selection of the subjects was from 16 to 48 years old and came from Canada, India, Ellas and U.K.

5.2 Procedure

There was no contact between the researchers and the participants. Data was taken from the subjects every week for about a month in order to identify the progress and its stages. They should have taken the notes while they were on the online community. This was due to avoid post-event rationalization. Seven participants who did not have any contact with the previous 6 subjects filled in the new questionnaires in Phase II and both a quantitative and a qualitative analysis were conducted. Only 2 subjects continued in Phase III since they sent at least one message.

6. Results



The online forum was investigated from the 5th of October 2001 until on the 23rd of July, 2003 and had 2 moderators. 346 members sent 2,850 messages. The figure compares views and replies, the life range of the community and its activity, as well as the connection with time and historical events. The overall replies were 2,850 whereas the views 82,452.

6.1 Quantitative Results

According to the findings there were 97% views and only 3% messages in the overall activity. The invasion in Iraq started on the 20th of March. The reflection on the war is obvious due to the increased number of messages in March and April. The average number of messages sent was 8,02 messages (number 8 was used) per member.

Half of the average number of messages defines the middle staring point of the division i.e. 4 messages is the 2/4 of 8. Up to ¼ of the messages (1-3) indicates Low Level of Engagement. Up to 2/4 of the messages (4-6) indicates Medium Level of Engagement and more than the ¾ of the messages (6+) indicate High Level of Engagement. In figure 5 there is a 57% Low Level of Engagement, 18% Medium and a surprisingly 25% of High Level of Engagement. 54,9% of messages came out from the 25% of the members, 11,3% out from the 18%, and 7,2% out of 57% number of members. There is a counter analogous connection between the messages and the members.

6.2 Qualitative Results

The qualitative results were the following:

1 Real problems are reflected in the virtual world.
2 Overall initial decisions on reading a message were based mostly on the topic. The AROWs used to read the messages according to (i) the date of the message sent, (ii) the number of messages and (iii) the person who sent the message. Keywords as identified in the context (80%) and familiar words (20%) were the attractors of their eyes. There was no identified pattern regarding the order they were identifying the information loci.
3 Reasons for visiting the online forum: 90% replied that this is in order to (i) use the information and (ii) learn. Secondly, they liked to (iii) add, (iv) resolve or (v) conclude their own meaning on the subject, whereas one member referred to (vi) curiosity.
4 Criteria for the messages were based on: (i) members' clarification and (ii) view of innovative approaches of the subject. Secondly, they actively read messages because they wanted to (iii) integrate and (iv) promote their views with other people's approaches, (v) find their own innovative views.
5 The next steps were to think, reflect and respond. The reasons were to add something different and interesting, to clarify and state their own views, to open a new topic and to contradict someone with opposite views. The replies were according to the title of the topic.
6 They used to review and visit the same messages mostly to clarify their own views and better understand the point of the person.
7 The obstacles for finding the needed meaning were the irrelevant title, the quantity of the messages, the poor quality of the message, the irrelevant responses and the interface.
8 Time was very significant for the subjects. They needed 4 hours on average for familiarization.
9 All members said that they didn't develop any feelings but they were open. However, after the second week of

the study they were judging the active members and 2 out of 13 (15,3%) developed empathy with a couple of active participants.

10 Two members who replied that they developed feelings for the other participants were the ones who decided to actively participate in the discussion.

11 The basic obstacles were mostly technical: (i) the irrelevant title of the message (70%), (ii) the quantity of topics and the numerous postings (20%), the unfamiliar interface and getting to the actual lists of messages (10%).

7. Discussion

IDE was intended to reveal constructions towards the system that needs to be improved. In our case modifications and changes were towards intelligent systems. '*Spiral Identification of Information Locus in Online Discussion*' (SILOD) portrays stages and properties for information seeking and information identification processes. The researcher decided that it is the most suitable approach for the specification stage in AOSE. As such, the SILOD AOSE approach might support a heterogeneous agent system incorporating collaborative, interface, mobile, information/internet, and agents' applications.

7.1 *E*nformatic – SILOD Phase I

(i) *initial contact* with the discussion forum; a tracking option of the system will reveal the inactive members automatically and an agent will try to initiate them in the discussion after a specific period of time encouraging them to participate in the community. An agent welcomes the user and asks for personal information creating a profile of the person. When a new member signs in, a profile is useful to be constructed and a photo to appear. The profile will be saved in a database, available to the users and the moderator. This is due to the fact that empathy and consequently communication, and easier to be triggered towards someone who is familiar. As such, a new member's area is needed. When there is no action, the agent could create and sustain the common interest, by sending messages in random order: challenge the members, create opposite (even false) views, 'kick' people on a personal level. The studies[6] showed that the most common reason that brings people together, opens and sustains a dialogue as well as creates empathy is a crisis. The moderator and the agent cannot create a crisis but they can bring problems from the real world by being connected to a community news web page.

(ii) *identification of keywords:* an agent would be able to find the relative information from the database. The semantic approach via the agent will save time and function as a search option being able to find words, other people's profiles, answer questions and search for specific phrases. News is useful to be available.

(iii) *identification of keyword locus context* and

(iv) *identification of information loci* indicate the simultaneous and interconnected processes between information loci. After searching, the different information loci will appear on the interface with the word or the phrase highlighted. The identification of the keyword locus context and then the next identification of a different one etc are interconnected. The information loci carry the subjective meaningful material for each member.

(v) *comparison and critical view between the information loci* could give the users the framework to work further than the information given. Users read the meaningful for them messages, toward the decryption of the meanings, basic beliefs, information, presented solutions similar or challenging their own framework. The clusters of the identified information could be presented in a spatial way instead a narrowed down one on a different window. This means that the user will be able to move the e-loci clusters around the window and put them together or separate them by just drugging and dropping them. The use of second generation communication tools like a wiki, collaborative web logs (blogs) or/and a notepad as well as saving the information in a wider network instead of a single computer would be helpful for the users towards collaborative organization and maintenance of their ideas.

7.2 Pseudo-*e*nergetic – SILOD Phase II

Active Engagement, according to the results of the study, seemed to be decided by the users in order to present a synopsis of the meanings, to state something, to lead the discussion on a different level or to add a new approach. This is the most crucial stage since the users will cross the red line of the Potential Engagement and send their first message. It is the stage that will encourage or discourage the members to continue their search, activate their willingness to interact or stop. This is where An agent might provide an additional force to the member in order to 'push' him/her into the discussion. A presentation of an issue, a statement, launching and directing a discussion on a different level or comment might be the intention of the agent. If we think in numbers we have 3 responding activities:

(i) the positive response (R+) describes a member's opinion in order to promote, to clarify, to present a meaningful information or to integrate new points of view;
(ii) the negative response (R^-) describes an opposition, a challenge, the opening of the discussion on a different level or the addition of a new approach; and
(iii) the neutral response (R) that describes the inactivity of the member.

The agent would help them to use the gathered knowledge creatively responding in three ways: (R+) positive; (R^-) negative and (R) neutral. It would ask the user to actually

articulate what s/he would like to do helping him/her in a 3D spiral development of the meaning. As such, the discussion cannot only revolve around a message as in a thread but has a non-linear character and a 3D spiral evolution of the meaning.

7.3 *E*nergetic – SILOD Phase III

Interactive engagement refers to the members' ability to suggest to the agents changes via Online Dynamic Enquiry regarding the policy and the system as such.

8. Definition of the system

IDE has an organic, creative nature that helps the researcher to go beyond her/his expectations. The need for automation of tasks, the semantic search on the dynamic environment of the Internet and the specific SILOD approach for participation activation indicate the need for a multi-agent system. The researcher decided upon the best available solution and this was AOSE.

9. Agent-Oriented Systems Methodology

Formal AOSE (Agent-Oriented Systems Engineering) methods play 3 basic roles in software engineering[21]: (a) specification of the system; (b) directly programming systems and (c) verification of the system. Two characteristics are valuable for Agent Oriented Software Engineering: (i) Architectural Independence (different paradigms and architectures must be accommodated naturally) and (ii) Robustness and Scalability (supporting dynamic social interactions between agents and the system). Additionally, we propose (iii) the user mobility for user modeling support as another characteristic for a methodology implemented on the Internet. The suggested methodology should be capable of handling the following aspects: (i) the beliefs that agents have, regarding a dynamic environment (reactivity within the Internet, other agents and the user); (ii) the goals that agents try to achieve (exhibition of goal directed and reactive behaviour); (iii) the actions that agents perform and the effects of these actions and (iv) the ongoing interaction that agents have between them and the environment (social ability). Sociability and Reactivity**Error! Bookmark not defined.** are suggested to be the most important features for agents' interactions as well as the feature of mobility which allows the agents to change their execution environment. IDE now needs a comparative study on the characteristics in AOSE methodology in order to find the most suitable approach towards a multi-agent system situated on the internet. The methodological propositions are Gaia Methodology[22], Prometheus[23] developed by M.I.T. and BRAIN[24] by the University of Modena.

10. Conclusion

Users' modifications as discovered with IDE in an open system could extend researcher's expectations. IDE might be able to reveal the needs of a system as well as identify the specifications and characteristics of new theoretical approaches related to the subject of the research. In our study, constructions for members' activation for data mining as connected to data quality, strategy, roles, a centralized policy, using agents and accelerate members' participation in online communities via SILOD were divulged. As such, IDE is able to lead to suggestions identification and Innovation Technology, Technology that will formulate inventions. More research should be done on a non-linear methodology, ways for patterns recognition for system identification in order to decide more objectively for the best available solution towards a system. Turing[25] in 1950 suggested that machine evolution depends on heredity material as up to date technology, mutation as changes and natural selection as judgment of the users. The combination of the three will lead to the Innovation Technology.

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References

[1] Rheingold, H., *The Virtual Community: Homesteading on the Electronic Frontier* (Reading, MA: Addison-Wesley, 1993).

[2] Berge, Z.L. & Collins, M.P., Perceptions of e-moderators about their roles and functions in moderating electronic mailing lists. *Distance Education: An International Journal,* 21(1), 2000, 81-100.

[3] Lave, J. & Wenger, E., *Situated Learning: Legitimate Peripheral Participation* (Cambridge: Cambridge University Press, 1991).

[4] Fox, S., Networks and Communities: An Actor-Network Critique of ideas on Community and Implications for Networked Learning. In Banks, S., Goodyear, P., Hodgson, V. and McConnell, D., *Networked Learning 2002: A research based Conf on e-learning in Higher Education and Lifelong Learning*, Sheffield: University of Sheffield, 2002, 110-118.

[5] Jones, C., Networks and Learning: communities, practices and the metaphor of networks, *Proc. ALT-C 2003 Conf. On Communities of Practice*, Sheffield, 2003, 234-248.

[6] Lambropoulos, N., Co-operation towards Change: ICT Projects in Education, *Proc. HEGB 2003 Conf. On ICT & Diaspora*, London, 2003, In Press.

[7] Wegerif, R. *The Social Dimension of Asynchronous Learning Networks.* available on line http://www.aln.org/alnweb/journal/vol2_issue1/wegerif.htm last accessed 14.02.01.

[8] Sproull, L. & Farj, S., Atheïm, Sex, And Databases: The Net As a Social Technology. In Sara Kiesler (Ed.), *Culture Of The Internet* (Mahwah, NJ: Lawrence Erlbaum Associates, 1997) 35-51.

[9] Preece, J., *Online Communities: Designing Usability, Supporting Sociability* (Chichester, UK: John Wiley & Sons, 2000).

[10] Ryder, M. *Spinning Webs of Significance: Considering anonymous communities in activity systems* http://carbon.cudenver.edu/~mryder/iscrat_99.html last accessed 18.09.03.

[11] Ravenscroft, A., & Pilkington, R. M., Investigation by design: developing dialogue models to support reasoning and conceptual change. *International Journal of Artificial Intelligence in Education: Part I of the Special Issue on Analysing Educational Dialogue Analysis*, 11(3), 2000, 273-299.

[12] Manouselis, N. & Sampson, D. Agent-based E-learning Course Recommendation: Matching Learner Characteristics with Content Attributes, *International Journal of Computers and Applications*, 25(1), 2003, 50-64.

Shibata, S. & Hori, K., An information management system with facility to support long-term creative thinking, *New Generation Computing*, 21(1), 2003, 23-36.

[13] Gibson, W. (1984) *Neuromancer*. New York: Ace Books

[14] Aoki, K., Virtual Communities in Japan http://www.vcn.bc.ca/sig/comm-nets/aoki.txt

[15] Bahktin, M. *The Dialogic Imagination: Four essays of M. M. Bahktin*, (trans. Caryl Emerson and Michael Holquist, Austin: University of Texas Press, 1981).

[16] Dysthe, O., The Multivoiced Classroom. Interaction of Writing and Classroom Discourse, *Written Communication*, 13, 1996, 385-425.

Nystrand, M., Social interactionism versus social constructionism: Bakhtin, Rommetveit, and the semiotics of written text. In. A. H. Wold *The dialogical alternative. Towards a Theory of Language and Mind* (Oslo: Scandinavian University Press) 157 - 173.

[17] Boyle, T., Design principles for authoring dynamic, reusable learning objects, *Australian Journal of Educational Technology*, 19(1), 2003, 46-58.

[18] *The Vicarious Learner Projects,* Online Version of Paper: http://www.hcrc.ed.ac.uk/gal/vicar/index.html

[19] Oriogun P. K, Content Analysis of Online Interrater Reliability using the Transcript Reliability Cleaning Percentage. *Proc CD-ROM, ICEIS 2003*, *5th International Conf. on Enterprise Information Systems*, France: Angers, 4, 2003, 296-307.

[20] London, A. & McMillen, M.C., Developing Social Issues: Organisation Development in a Multicultural Community, *The Journal of Applied Behavioural Science*, 28(3), 1992, 445-460.

[21] Wooldridge, M. and Ciancarini, P. Agent-Oriented SoftwareEngineering: The State of the Art. In *Agent-Oriented Software Engineering*, Ciancarini, P. and Wooldridge, M. (Eds), Springer-Verlag Lecture Notes in AI Volume 1957, 2001.

[22] Wooldridge, M., Jennings, N.R., Kinny, D., The Gaia Methodology for Agent-Oriented Analysis and Design. *Journal of Autonomous Agents and Multi-Agent Systems,* 3(3), 2000, 285-312.

[23] Winikoff, M., Padgham, L. and J. Harland, Simplifying the development of intelligent agents. In M. Stumptner, D. Corbett, and M. Brooks, *AI2001: Advances in Artificial Intelligence. 14th Australian Joint Conference on Artificial Intelligence*. Springer, LNAI 2256, 2001, 555–568.

[24] Cabri, G., Leonardi, L. & Zambonelli, F., Implementing Role-based Interactions for Internet Agents, *3rd IEEE Symposium on Applications and the Internet*, Melbourne, IEEE CS Press, 2003.

[25] Turing, A., Computing Machinery and Intelligence, *Mind*, 59(236), 1950, 433-460. Available at www.abelard.org/turpap/turpap.htm by permission of Oxford University Press.