

Growing Intelligent Agents for the Delivery of Knowledge: A Structure

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Abstract

Johansen (Johansen 1997) has described a knowledge agent as "a type of intelligent agent that deals in knowledge, in the way of keeping, querying, distributing it or communicating it whether as a primary or secondary function". A number of insights underlie this conceptualization. A knowledge agent is an entity, describable on the knowledge level, that has a behavior that can reasonably be called intelligent including the ability to communicate intelligently. A further step can be taken to recognize that knowledge is actionable information. In fact, most information that is actionable is open to alternative actions. To have an understanding of the consequences of the several outcomes is for the agent to possess wisdom. Knowledge agents, as described, may be found in classrooms or designed for the Internet. They may be humans or computer programs. The paper will explore the processes of discovery and learning as exemplified in these two domains.

"To conceive of knowledge as a collection of information seems to rob the concept of all of its life... Knowledge resides in the user and not in the collection. It is how the user reacts to a collection of information that matters." -- Churchman (1971, p. 10).

"New knowledge? No problem: man will carry it!" (Kooistra, 1997b)

Introduction: academic values

In the Western world it is felt by a lot of faculty and staff (and students too) that the "computerization" of the university's educational systems is a threat to traditional academic values. Others feel that the use of computers for educational ends adds to their competence. In the latter case, there exists disagreement on the extent to which the computer should be integrated into the educational system. However, dead against computerization or not, it is evident that something serious is happening to the academic values, or to formulate it better: to the activities by which the academic values are processed.

By changing the subject: academic values into '*activities by which academic values are processed*' we do not intent to change the problem. Academic is a term that goes back to the Hellenic civilization. The story is that Plato bought a plot to found his philosophical school. This piece of land was named after the hero *Akademios*. One could say that ever since science means that we are *on the land of the hero Akedemos*. Figurative spoken. The value of being on this land has not changed. It says: 'be philosophical, act like an hero, be critical, search fundamentally, be distrustful to the issues of the day, because this is the only medicine you have got. Man is carrying knowledge. It is like carrying a virus. It is hiding itself within the living system. Even though you know it is there, you cannot feel it. Knowledge has the same characteristics. So be philosophical! See it as a challenge to live with it. Knowledge is changing but the academic challenges stay the same (Wetfil, 1998).

Activities as an outcome of challenges

What are the activities we are talking about? Again a story, though a less figurative one. The advent of writing at the beginning of the Christian era and the dissemination of writing by printing at the end of the Middle Ages created a new set of challenges (Chanowski, 1999). These challenges led to the systematic development of four academic activities: searching, analyzing, evaluating and concluding / applying. This methodology appears in many forms. For present purposes each may be characterized quite simply. Searching may be viewed as collecting the data necessary for to describe the matters of interest. Analyzing may be viewed as stating the model or parsing the terms contained in the collected data to produce information (of course, there are multiple possible models and multiple ways to parse). Evaluating may be identified as considering the information derived from the data in relation to previously known information and its related actions thereby adding the information to the knowledge base. Finally, concluding / applying considers the options in light of their scientific, social and moral consequences.

And note the point we make. We call the four activities the outcome of the challenges that were putted forward by the act of writing as such. These activities (searching, analyzing, evaluating and concluding / applying) of which we think that they are human qualities *pur sang* happen to be just part of a culture and an era. It is the culture of transforming our ignorance into signs/symbols, storing these symbols in/on paper and creating procedures to get the stored material out of the paper again (without loose of information). This transaction is done in a ultimate try to 'better' this knowledge. We take the symbols out of the paper, we juggle them in the air in search for new configurations and put these back again in their paper home: knowledge not stored in paper becomes ignorance again, is less resistant against time / looses its information quickly (Kooistra, 1997a).

Academic values *paper* values?

The discussion about the threat of the 'academic values' has everything to do with revolutionary changes in the nature of the knowledge systems in use. Now and again a knowledge system is pushing away another. This kind of changes did (or does) not go smoothly since they have an impact on the way the truth (best possible knowledge) is produced by the system. So the art of writing pushed away the narrative knowledge - and still does in primitive societies. Lyotard mentions the activities (i.c. narrative values) as used by the Cashinahua storyteller...`a storyteller always begins his narration with a fixed formula: "Here is the story of - , as I've always heard it told. I will tell it to you in my turn. Listen." And he brings it to a close with another also invariable formula: "Here ends the story of -. The man who has told it to you is - (Cashinahua name), or to the Whites - (Spanish or Portuguese name)' (Lyotard, 1984, p 20). The activities that are processing the truth are clear: the narrator's claim to competence for telling the story is the fact that he has heard it himself and the current narrate gains potential access to the same authority simply by listening. So the truth is in (the) man. By the way this sort of remembering the membership by telling and listening created a very well developed long term memory - sustained by skills like rhythm and rhyme .

Internet communications technology will importantly impact all phases of the four-phase methodology of writing outlined above. In the short term the danger lies in an overemphasis on the faster/better/cheaper search capability while ignoring the additional phases required to support action or, more importantly, the fundamental nature of the changes that have taken place. The new technology will not only speed up the current methodology (Kooistra, 1991) but also affect the truth system i.e. the way the current methodology is organizing its legitimization. As the Cashinahua storyteller is floating on his special values, so searching, analyzing, evaluating and concluding are the mechanisms with which a modern scientist can tell his story (note that 'modern' does not mean 'up to date' but is referring to the modern era). The modern scientist begins his paper with a fixed formula too: "Here is my paper - , I've written it as I have always seen papers written. I used the academic skills to get the truth out of the papers I read and after that I putted it (the truth) back in my paper using these skills again" Signed - (a name and an address)'.

Digital methodology

Nowadays information and communication technology (ICT) is asking for a digital methodology. Which are the activities in the case of such a methodology? Our first assumption is that these ICT activities (ICT-values) are processing again the 'old' academic values. Secondly we assume that the activities will inextricably bound up with the belief in the benefit of participation. Being connected by ICT means that solving a problem, developing a set of action plans or taking a decision cannot be done in isolation. There is not any longer the possibility to do

things on your own. It's the way the ICT system works. Whereas the paper methodology meant that you had to sit down, write the knowledge into the paper and send it to a journal, the ICT methodology means that one has to put questions and ideas on the internet and ask for the filling up, for complements. The paper sources and the *networks of paper-presenting scientists* as they existed during the 20^e era, *will vanish*. Anonymous and unfinished material (data) will go round ready to get a push by someone as a ball in the pinball machine. So participation means that the inwards directed interface of writing has to be followed up by an outward oriented ICT-methodology which could handle the idea of (the situation of) being connected the digital way, a methodology which has its own pragmatics which will process people into a new system. The consequence of the ICT methodology is that one is persistent at an address (being @) in a process of growing intelligence. One is (part of) a Growing Intelligent Agent: a Gi@ ..

Knowledge agent: system and structure

The Gi@ is derived from the idea of a knowledge agent as coined by Johansen (Johansen, 1997). We will go into the basic notions of the knowledge agent here and then try to make the jump into the idea of the Gi@.

Before the advent of the current ICT technologies, writing and a paper driven exchange process drove inquiry. The process was well known and emulated in the best of classrooms. Quizzes, tests, and exams were substituted when the numbers would not allow emulation of the real process. The acceleration of the information flow has produced what amounts to a global "rumor" experiment of the kind so often tested in the introductory psychology classroom. The experiment is exemplified by the Clinton impeachment proceedings. Its continuation can be expected to produce more of the same kind of results as the classroom events unless we take seriously the nature of the new process.

Johansen describes a knowledge agent as follows: 'A knowledge agent: a type of intelligent agent that deals in knowledge, in the way of keeping, querying, distributing and communicating it whether as a primary or secondary function.' (Johansen 1997). Johansen follows the four-phase methodology: keeping, querying, distributing and communicating that covers the four activities mentioned above as the academic activities.

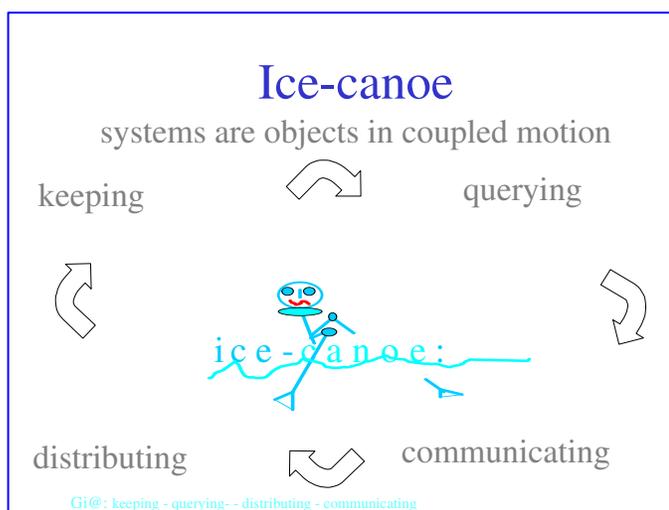
Johansen points generally in the direction of the kinds of changes that are needed. That is, he distinguishes all other agent processes from a process in which the agent investigates (queries), develops the information (communicates), distributes the results to a network and stores away the results for future use. Growing an intelligent agent demands that a process be devised that the agent uses to sort and sift among the items (data) found in a message in order to make the required identifications (information) and finally to connect actions to options (knowledge).

The ice-canoe

Johansen does not go far enough. Some reflection will suggest that the agent is engaged in a social process. To get an expansion to the idea of Johansen we put it into the frame of Hough's 10 injunctions or steps for describing the basic elements of any complex living system (Hough, 1975, 1999). The central idea in Hough's description of living systems is that growth creates form, that form means structure and structure at its turn limits growth.

We can understand the four activities (keeping, querying, distributing and communicating) as part of a hierarchy of systems. They are subsystems of a larger system. The larger system in this case is *the production of survival knowledge* by an agent. The agent can operate at different levels (group, class, staff) and within different area's (neighborhood, nation, institute, university, etc.) The process of the production of survival is part of a supra system: the living system (Hough & Day, 1999). The key to the understanding of the system of the production of survival knowledge (and to the subsystems of keeping, querying, distributing and communicating) is that the structure of these systems is at the same time *means AND outcome* of social practices (economies, technologies, social security practices, etc.). This means / outcome mechanism is what we call an ice-canoe (Kooistra, 1989). The story of the ice-canoe is as elementary as illustrative: once an artist built a canoe out of the material ice, he launched it in a pond and paddled around till his boat melted / vanished into its original state: the

Figure 1: Ice-canoe



water. Survival knowledge is an ice-canoe. It is made of the same material we try to sail on. Knowledge is frozen ignorance. Only with a lot of energy (social

constructions, education and technology) we can succeed to keep our knowledge in freeze. At the same time this is not the state we really want it should have. It is the water we are after, we want our knowledge running. The subsystems of keeping, querying, distributing and communicating are subsystems connected to the system of survival knowledge. They are interdependent in their effort to(un)freeze (parts of) the canoe - keeping the knowledge floating and solid at the same time.

New pragmatics

Speaking about an outward oriented ICT-methodology which could handle the idea of (the situation of) being connected the digital way (*being @*) means looking to the changes that will be executed to the structure of the ice-canoe. What changes are processed by ICT to the subsystems of keeping, querying, communicating and distributing? This means research into the coupled motion of the production of survival knowledge and its subsystems. Under the influence of ICT keeping, querying, communicating and distributing (did) get new pragmatics which at their turn are effecting and processing the larger system. We will try to spot the characteristics of the subsystems and their 'effects' in order to say more about the process of growing of intelligence being @.

Querying

Querying means to face the heart of the problem that knowledge is means as well as outcome of social practice. The material one has to use to query is of the same kind as the material one has to query. So one uses a frame of thoughts (a theory) that is doomed to melt down into its original state (ignorance?) - paddling as hard as one can to reach the other side. Here the idea of the ice-canoe shows its depth full of nightmares: how to de-construct the output of our knowledge-system without drowning? The French philosopher and psychoanalyst Jacques Lacan speaks in this sense of *alienation*. Knowledge is alienation. Lacan uses language as an example (model) to illustrate what is happening. Speaking a language means that one has to cross the border from the 'I' (first person) to the '(s)he' position (third person). Though the 'I' is speaking, another person always will hear the '(s)he' who is talking. And not only another person will hear the (s)he. The 'I' itself is split up by speech: *when I speak I know that you hear him!* (Lacan, 1968). Using a structure (language, knowledge) means alienation: the splitting of a person into two worlds: the 'I' that is personal and the (s)he that can be shared with other (s)he's. If one wants to communicate with another one has to use a system that belongs to *no-body* in the most literally sense of that word. In term of the ice-canoe: the 'I' uses the '(s)he' to cross the water. Deconstructing (querying) means going back to the 'I' position. Its the classical position where chaos, death and passion are ruling (the waves of emotions). Querying as a subsystem means that the intelligent agent can activate the 'I' position in order to set the whole system in to a growing state.

Communicating

The distance between ourselves (the first person) and the world (the third person) is intrinsic to our consciousness and by that neither avoidable nor repairable (Klukhuhn 1995). So by way of compensation we use information and communication systems (language, social systems, ICT). A provocative theory should be that we are losing connection from the very point that we started to think, to talk or to get knowledge. The more we know the more we lose of our original togetherness: from being just a cloud of spirits we become more and more like boxes full of knowledge, separated and using all kinds of systems to remember our original state. So knowing about (the pragmatics of) the structure of the system we are using to communicate is most important. We have to @lose the system before we lose any grip on who we are. Note that @lose means that we 'copyright' the structures of communication. This because we need a 'no-body' system: a system that everybody can use without gaining power over other person's. Here the discussion about the freedom on the Internet fits. By making appointments about the structure (@lose the system) we slow it down / get room to organize things but lose also (some) freedom (compare: mathematics). So we are always speaking in the dark and if somebody answers we have to face the pragmatics of the interface we use (Wetfil, 1998). As a subsystem to the intelligent agent communication means processing the right environment for the message it gets: if the querying goes into the 'I' position the communication should go into 'an understanding the chaos position': music, poetry, visual art, etc.

Distributing

It is neither smart nor efficient to store the data the way you collect it nor the way you think you are going to use it again. Our life is like a movie. Daily we go through time in a linear way where we use 'data' which was stored long ago and under quite different circumstances (memories). So we are completing our daily feelings. Takes of one moment are used by us on quite different moments (later) in time. This makes clear that the distribution of knowledge is not the same as education. Education means re-storing the knowledge to the program which has to expose its moral dimensions. We are aliens in our knowledge, we try to @lose the system before we lose any grip (using ICT at this moment) and have to restore our (here and there) stored memories in a linear model to make sense. Computer science does know a lot of this storing systems. Here the subsystem can be seen as a provider of all kinds of memories. The effect of growing is produced by alternate the different memories which are available for the same 'I' position.

Keeping

There is no knowledge like survival knowledge. It is not difficult to understand where this querying, communicating and distributing game has to end. Parents are dying sooner. They have to hurry to tell their kids how to survive. That is the iron law since people get their first knowledge. Here the idea of survival knowledge fits. Survival is the start of the development of the systems that try to

keep the knowledge available in spite of individual dying. In this race we invented institutions. Institutions are social systems that die later: Universities live longer than their students! Then in our times the digital methodology starts its useful work: addresses have eternal life: they are always available to their users. Not any longer one has to be a member of a 'social' (third person/ nobody) system. Jan's survival is arranged at an address: . The relation to the system as a whole is that keeping can select the possibilities for better survival knowledge out off the stream of chaos, poetry and reshaked memory: the system alters its 'statistic' view by making other statistics in which survival is defined more 'human': using more what human have to know (more than what subjects have to).

From the knowledge agent into the Gi@

If one wants to look in the mirror the basic notions are clear: face alienation and get your refill (querying), close connection by knowing the pragmatics of your interfaces (communicating), re-store morality in your program using the movie approach: what you see/observe is not the same as what you remember (distributing) and try to describe how your survival was successful (keeping). This is called wisdom?

Speaking about knowledge agents this way (the more abstract and sophisticated way) we can see the following system: *data*, in an oversimplified view, consists of syntactic and semantic entities. In a syntactic sense, objects, processes and the relationships among them are the grammatical contents of the messages that pass among agents. In a semantic sense, the words used to describe objects, processes and relationships may possess semantic relationships of synonymy and contiguity. Data is interpreted by an agent and thus becomes *information*. Interpretation includes the identification of key objects, processes and relationships, whether explicit or implicit in the message. *Knowledge* is information that is learned by the agent, related to the options open to the agent and becomes part of its reasoning resources. As a result of the interpretation, the agent may retain knowledge of the objects, processes, relationships and actions identified and the semantics peculiar to the entity's descriptions. That knowledge may be delivered as data to another agent that repeats the parsing process and thereby learns from it. Finally, after the fashion of the Oracle at Delphi, the agent may reach associative conclusions that are not logically evident. Such is the nature of *wisdom*.

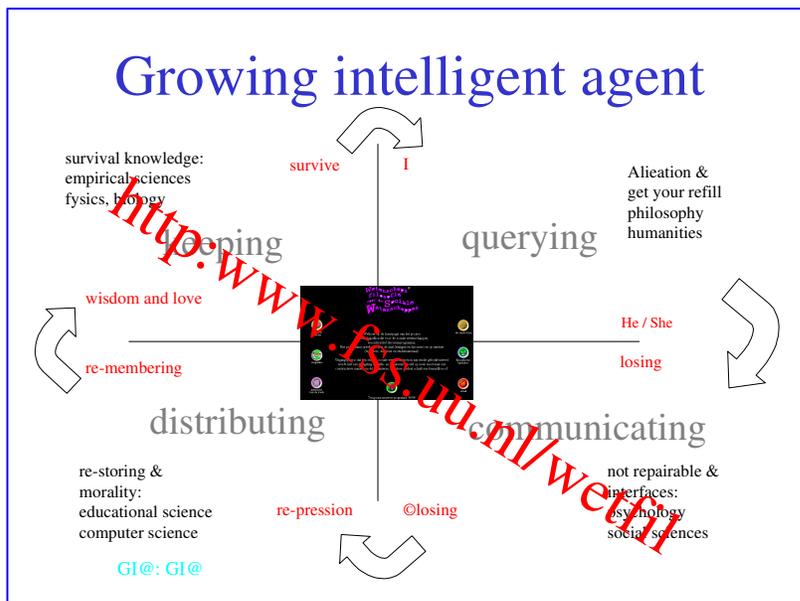
Knowledge is at once the means and outcome of social practice. Internet communications technologies have expanded the stage to the point where it is cross-cultural and global. Here lies a true problem of participation and connection. How can an agent participate in such a way that it maintains and improves its connections while blizzard of data obscures its view of the terrain? This problem can be better mastered by modeling the knowledge agents evolution of understanding through the four states outlined above: *data*, *information*, *knowledge*, and *wisdom*. By identifying the unique interdependence

of the researcher and the knowledge agent as understanding evolves, we can better define the requirements of an effective knowledge agent.

The internet: anonymity, confidence and fuzziness

Below we offer an example (model) of 'being @'. (figure 2). It is the wetfil-site as it is used in the Netherlands (<http://www.fss.uu.nl/wetfil>). Wetfil is the Dutch abbreviation of philosophy of science.

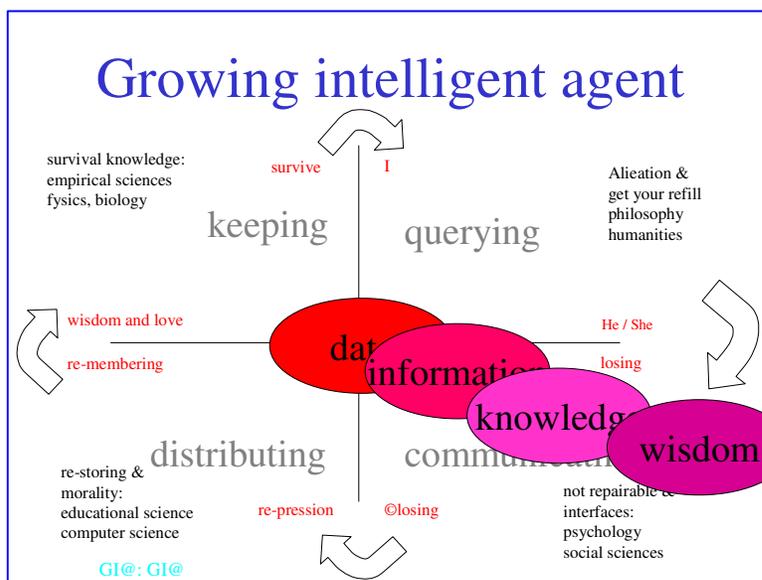
Figure 2



The site represents the idea of the ice-canoe: structures (knowledge) is as well means as outcome of social practices. The practice in this case is being @ the land of *Academos* the digital way. There has been different themes to discuss till now. As there were: *The third culture: consciousness and the α , β and γ sciences* (1996/1997); *The feasible student* (1997/1998) and *Speaking in the Dark: the pragmatics of the use of the Internet for processing knowledge* (1998/1999). The use of ICT- methodology means processing other 'facts', means another concept (system) of truth. What the value of knowledge under condition of ICT using ICT as condition? Students are discussing the impact of ICT on the value system of science und the condition of the use of ICT. Here we have tried to let a knowledge agent grow into a Gi@. Which are the activities processing the new academic values under the condition of ICT. There are three concepts that are of great importance we learned. There is (the combination of) *anonymity, confidence and fuzziness*. Jurgen Habermas, though arguing against everything that makes the postmodern feeling (post-modern = being @)) speaks of confidence that is needed to let us be as communicative as possible. Communication needs that one can be confidential to gain the required quality and paradoxical enough therefore a certain anonymity in a social system is

needed. Our GI@'s are a mix of these two: confidence and anonymity. For (social) science there is still a lot to gain on this point. So is the advent of the special lines for kids to get help (in the seventies) based on this two elements. Complete new worlds came knowable here and were scientifically unlocked. Anonymity and confidence thrive in fuzziness. It is this triangle which gives the Gi@ its power to grow. Not here (but in the future) we will go into these three elements and publish about their playing leapfrog using the digital methodology of being @. Below we give the structure of a Gi@ (figure 3).

Figure 3



Bibliography

Churchman C.W. (1971) The design of inquiring systems, basic concepts of systems and organization. New York [etc.], Basic Books

Chanowski, M.M. <http://www.medialab.nl/default.asp>

Habermas, J. (1981) Theorie des kommunikativen Handelns. Frankfurt aM: Suhrkamp

Hough, R. R. (1975) A Paradigm for the Application of a General Theory of Systems. In: General Systems and Organization Theory: Methodological Aspects. Arlyn.J.Melcher, editor Kent State University Press.

Hough, R.R. and B.A. Day (1999) Addressing the Social Dimension: An Application of Systems Thinking. In: Exploring Human Nature, New Society Press (in press).

Hough, R. : <http://www.edict.com>

Hough, T. : <http://www.edict.com>

Johansen (1997): <http://www.ifi.ntnu.no/grupper/ai/fredj-masters.html>

Klukhuhn, A. (1995) Een inleiding tot de 21^e eeuw: sterf oude wereld. Amsterdam: Arbeiderspers

Kooistra, J. (1993) Speeding-up knowledge. In: Glanville, R. ed. Problems of Support, Survival and Culture. Amsterdam (Thesis) 1993. ISSN 0167 9901

Kooistra, J. (1997b) Socialisatie en Identiteit in Postmodern Perspectief. In: Kooistra, J. & I. van Mourik, Leefvormen, Identiteit en Socialisatie, Utrecht: Lemma

Kooistra, J (1996) <http://www.fss.uu.nl/wetfil>

Lacan, J. (1968) Écrits, Paris: Éditions du Sueil

Liotard, J-F. (1984) The Postmodern Condition: A report on knowledge. Manchester: Manchester Univ. Press.

Wetfil, 1998: see <http://www.fss.uu.nl/wetfil> (1998/1999: Praten in het Donker)