Attributing Creative Agency: Are we doing it right?

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Abstract

When contemplating the creativity of computational systems, a host of factors have been taken into consideration, many of which people have attempted to measure or otherwise operationalise: novelty, value, P-creativity versus H-creativity, exploration versus transformation, the subjective evaluation and contextualisation of the artefact, and so on. Whilst of equal importance, the systematic and rigorous attribution of creative agency to different actors in the production of a specific output has been given less attention. It is common to make the simplifying assumption that the most direct contributor to an artefact is that artefact's sole author, but arguably this is never the case: all human creativity occurs in the context of networks of mutual influence, including a cumulative pool of knowledge.

This paper looks at how we might better formalise creative authorship such that for any artefact, a set of agents could be precisely attributed with their relative contributions to the existence of that entity. It asks only what the nature of this formalisation should be, and concludes that a more critical approach is needed to the creative agency of human actors, and thus the expected creative agency of machines.

I draw on two critical notions that can inform a methodology for the ascription of creative origins in computational creativity: becoming, and the agency of networks of interaction.

I look at a example from both historical human creativity and computation creativity, to consider how we can break down creative agency and ascribe it to different sources. Practical implications are dicsussed.

Introduction

In contemplating creativity, we are comfortable with taking at face value statements such as "Ludwig van Beethoven composed Beethoven's Fifth Symphony" or "Leonardo da Vinci painted the Mona Lisa". At the same time, we are well aware that such attributions are rough at the edges when scrutinised. Creativity does not occur in a vacuum. All creators are subject to influence from their culture or environment, and other forces at play in the creative process include chance, the influencing of opinions such as value attribution, the emergence of outcomes through collective action, and the need to consider the potentially active role played by passive objects, as discussed most famously by Latour (1996) and Clark (2003), but with recently renewed interest by Malafouris (2007), Miller (2010) and Ingold (2007).

Longstanding theories of creativity have successfully managed these apparently conflicting perspectives, most notably the work of Simonton (2003) and Csikszentmihalyi (1999). In both cases, creativity is properly understood as a process that operates at a macro level (sometimes described as a network or systems level). For Csikszentmihalyi the macro perspective is critical because the process of creativity involves the interaction between heterogenous groups of participants, and for Simonton it is because creativity is best modelled as a stochastic process across a population, which cannot be properly understood when looking at single instances.

However, it has been difficult to translate such knowledge into practical methods for evaluation in computational creativity, which despite its strong acknowledgement of such theories does not successfully draw on this macro-level perspective in evaluating individual systems. In this paper I present this challenge in terms of recurring misconception that evaluation can be performed on isolated individuals, i.e., at a micro-level, which I refer to as the "islands of creativity" view. Drawing on literature from creativity research, philosophy and the social sciences, I consider how a macro-level view of creativity can work in the applied task evaluating computationally creative systems.

I suggest that a critical step is to recognise how the objects of evaluation are dynamic, in flux, and have boundaries that shift at different stages in their history, as they interact with other people and things.

I propose a "dynamic analysis" of any system, which details (i) the fluid and temporary boundaries between entities, and when these aggregations act as agents, (ii) when and where influence occurs, (iii) what constitutes an output. Such an analysis, it is proposed, could help us better attribute creative agency in the evaluation of computationally creative systems, by clarifying how novelty and value are determined (by whom) and what influences feed into the creative system at different times.

Simonton's macro-creativity model

Simonton, for example (Simonton, 2003), showed through quantitative analysis of scientific achievements that the arrival of creative breakthroughs was sufficiently unpredictable as to be effectively random. This does not mean to say that a member of the population chosen at random might make an advance in quantum physics. Naturally, strategies for creative success involve becoming expert in a field, focusing on problems, working hard, knowing what to look for, and so on. Indeed, Simonton showed that success was proportional to activity: the more active you were in a field the more likely you were to produce creative outcomes, but equally the more likely you were to produce uncreative ones. What remained stable was the rate of success, measured as the ratio between successful output and total output.

From this perspective, in computational creativity what we might describe as strictly micro level focus – privileging the creative agency of individual creators without considering how these agents interact with each other and with other elements in the world – is a detrimental but seductive simplification, which is often assumed to be reasonable where in fact it is problematic. Simonton's micro-level view of creativity tallies with his macro-level view: at the micro-level an individual iterates through many trial-and-error attempts at a solution, understood in creativity research through cognitive processes such as incubation. This trial and error is the best that can be done in an unknown search space; there aren't reliable analytical or inductive approaches available to the kinds of problems that we would define as creative, because the problem spaces are unknown – at least, in the case of Boden's 'transformational' creativity (Boden, 1990). Thus we may imagine a population of individuals searching for solutions to the same problem, working at the same rate. When one individual discovers the solution, in Simonton's view, we should not leap to the conclusion that there is anything fundamentally different about the creative process used by that individual. Simonton also draws on evidence from 'simultaneous scientific discoveries' to support this view, arguing that the common occurrence of such discoveries is due to the fact that it is the discovery context, and not the creative ability of the discoverer, that is key to the arrival of the discovery.

Such work is widely acknowledge in computational creativity research, but this macro-level thinking remains largely absent in the methods that we apply to the evaluation of computationally creative systems.

The "islands of creativity" problem

Such approaches have been successfully applied in the context of studies of traditional human (i.e., not computational) creativity. But in computational creativity, although we frequently pay homage to these macro theories, we have yet to find a way to incorporate them into a working methodology in the complex area of evaluation. I suggest that a significant obstacle to computational creativity evaluation lies in the idea of "islands of creativity", the idea that creativity is situated in specific systems (mostly humans, now also computers), without any fluidity between these systems and the rest of the world:

Definition: *The "islands of creativity" problem in creativity is the misuse of the simplifying view that individual human actors (or individual computer actors) are sole originators of specific creative artefacts. It conflicts with the more holistic view that stochastic and network macro processes involving interactions between heterogeneous elements underlie the big picture of creative production.*

Is this view actually a misconception, and what have been the implications of holding it? Would our approach to evaluation benefit from avoiding it, and shifting towards thinking about creation occurring through the relationships between entities? I will argue that looking at creativity only by reference to the human cognitive capacity for creativity continues to be problematic for computational creativity, not least because the kinds of computational systems that will do creative things in the near future may not do them in particularly human-like ways. Rejecting the "islands of creativity" problem is a necessary part of stepping away from a human-centric frame.

Specifically, the embrace of an alternative, macro-level theoretical framework may enable two important contributions to computational creativity: (i) in the way we understand what we mean by human cultural activities such as art and music. There is a tendency to trivialise such questions in pursuit of simple computable targets, whereas these areas of activity are some of the most ethnographically rich that humans exhibit, so as to be far from easily reducible; and (ii) by providing practical methods to help us attribute creative agency properly when asking questions of the form "did system x do something creative?"

Defining creative production in terms of interaction

In the words of Heraclitus, via Nietzsche, "the whole flows as a river", the river's evident dynamism, by which it is constantly in a state of re-creation in the movement of water, is an apt way to understand those less obviously fluid things in our environment: "being is an empty fiction" (Nietzsche, 1998). We tend to take the consistency of objects at face value, but for practical, not only philosophical, reasons it can be preferable to view things not as entities that have the property of *being*; instead their existence is in constant re-creation, captured through the notion of 'becoming'. Viewing things without this frame of dynamism, as neat bounded entities, may be a practical way of simplifying and understanding the world in the everyday, but risks missing the myriad ways in which entities transform, influence each other, have porous boundaries and fuse and fissure. Such thinking has been applied successfully in the social sciences, and may be helpful in thinking about evaluation in computational creativity, particularly in how we frame the notion of a creative agent.

Creative agents

Theorists have embraced the idea of fluidity in the context of social systems, which are more evidently fluid, using a network interaction approach, most famously the actor network approach of Latour (1996) and Law (1992) and the extended mind theory of Clark (2003). More recently, Malafouris (2007) makes a terse argument for the abandonment of the human as a privileged category of agency. For Malafouris, much as for Clark, if a blind man can be said to 'see' with his stick, then the physical matter of the stick is exactly to the blind man what the optic nerve is to the sighted. For as long as the blind man is using the stick, we can designate a transient entity of the form blind-man+stick which is in some sense capable of sight. Importantly, the stick is part of that unit, not apart form it. The man does not see with the stick; the man+stick sees.

Similarly, he argues, as a potter shapes clay on a wheel, one cannot successfully draw neat lines of causality that show the potter's hands influencing the clay, and not vice versa. The potter is responsive to the clay, and in her adaptivity, allows causality to flow back in the opposite direction from clay to action. The right way to understand the resulting creation of a pot, Malafouris posits, must not presume potter as agent and wheel and clay as other, but to conceive of a unity in interaction between them.

In his words:

> "If human agency *is* then material agency *is*, there is no way that human and material agency can be disentangled. Or else, *while agency and intentionality may not be properties of things, they are not properties of humans either: they are the properties of material engagement, that is, of the grey zone where brain, body and culture conflate*." (original emphasis). (Malafouris, 2007, p. 22).

The purpose of this thought experiment is to preempt and thus interrogate the implied objection: "surely we can see that the potter is the active, intelligent agent in this interaction, whilst the wheel and clay are passive non-agents, there to be operated or shaped". This presents a problem: although it seems mistaken to start to talk of the agency or intentionality of clay and mechanical wheels, how else can we handle the fact that the resulting pot owes its form to clay and wheels, and not merely to a single human actor?

I understand Malafouris as saying here, as with the blind-man and his stick, that it would be more correct to say that the temporary interaction of potter+wheel+clay is responsible for the creation of the pot, than to say that the potter created the pot using the wheel and the clay. Although apparently a trivial distinction, the question of agency has been shifted in a way that significantly transforms discussions of creative authorship in computational creativity, and equally resolves the "islands of creativity" problem. This is a more palatable option than talking about the agency of inanimate objects, and is particularly apt in the context of machines, for which the perception of agency might slide easily up and down a scale. It also takes care of collaborative action between individuals, whether in a clearly bounded working unit such as a band, or a fluid genre movement.

Turning to computational creativity, we see that attention to this detail concerning the existence of bounded agents is generally overlooked. In major mathematical and logical formulations such as those of Ritchie (2007) and Wiggins (2006), understandably, this would be a complex step. Here the focus is more on artefacts anyway. In other work where the focus is on the individual and the process of production, there is still little in terms of acknowledging the fluid boundaries between components of a creative system.

Dividing individuals

Further to this, thinking from philosophy of mind, AI, evolutionary psychology, anthropology, and other disciplines, has in different ways converged on a notion that human agents, equally, should not be viewed as unitary in action, but consist of networks of interaction themselves. This thinking can be found in Minsky's society of mind (Minsky, 1988), Baars' global workspace theory (Baars, 2005), Barkow, Cosmides and Tooby's (Barkow, Cosmides, and Tooby, 1992) multi-domain model of the evolved mind, and many psychological accounts that reveal conflicting drives and processes and dedicated channels of activity. In anthropological theory we have the notion of the 'dividual' (Marriott, 1976). This concept was initially specific to an ethnographic analysis of how South Asians viewed personhood, but it may also describe Western conceptions if we admit them to have more variability:

> "Single actors are not thought in South Asia to be 'individual', that is, indivisible, bounded units, as they are in much of Western social and psychological theory, as well as in common sense. Instead, it appears that persons are generally thought by South Asians to be 'dividual' or divisible. To exist, dividual persons absorb heterogeneous material influences. They must also give out from themselves particles of their own coded substances, essences, residues, or other active influences that may then reproduce in others something of the nature of the persons in whom they have originated . . . What goes on between actors are the same connected processes of mixing and separation that go on within actors."

(Marriott, 1976, p. 111)

Although framed in terms of a distinction between Indian and Western perspectives, it is fair to say that in all world views there is some freedom to flip between different conceptions of personhood and individuality. It is common to talk about feeling like you are 'defined' by your family or friends or the objects you possess. We are also familiar with the idea expressed at the end of the quote, that two people can 'think together', for example through brainstorming, and that this is in some way isomorphic to the same process happening within an individual.

In our computationally creative systems, this fluidity is more evident. A piece of software is itself an assemblage of subsystems and may communicate beyond its nominal boundaries to form supersystems, including with humans. We should expect that in some cases it is clear that agency is more strongly associated with a specific subsystem than with others, whereas in other cases, agency takes the form of interaction between subsystems or the system and its environment.

An evolutionary framework

As others have discussed (Dawkins and Krebs, 1978; Boyd and Richerson, 1985; Aunger, 2000; Shennan, 2002), Darwinian evolutionary theory provides a good template, recognising in natural evolution exactly that agency lies in 'processes of interaction' rather than in specific entities (Nietzsche was also heavily inspired by Darwin). It is interesting to contemplate the non-human creativity of evolution in contrast to what we typically think of when considering human creativity. Given a specific organism and asking, "what created that organism?" we see very clearly that such an act of creation can only be understood as a continuous process of interaction between organisms and their environment, and amongst individual organisms. We cannot pin our form on the creativity of our parents, nor even on our entire ancestral history. This view naturally takes into account the the many interesting cases of coevolution, runaway sexual selection, niche construction and, in humans, gene-culture coevolution which produce things through diverse forms of interaction.

When we talk of function in such systems we are actually referring to teleofunctions (Sperber, 2007), specifically, functions that serve their own existence. This is in contrast to the functions of things we build, which are imposed upon them and are external to the existence of the thing. But cultural traits and artefacts can and often do have teleofunctions too and can come about in ways that are more or less similar to evolutionary processes occurring at a cultural level. Sperber (Sperber, 2007) discusses the interesting case of the perception of suntanning. Furthermore, machines that learn or evolve can have teleofunctions by virtue of the fact that their goals can be adaptive, but mostly, today, are built with regular functions.

Dynamic analysis of fluidity in creative systems

Our earliest efforts at building machines that create have resulted in superlatively weak creative agents when held up against human beings, as would be expected. But the contemporary language of creativity is geared towards the superlative creativity of humans. It does not do well at describing the simple forms of computational creativity we are developing today. For this reason, an "islands of creativity" view, that works for humans, needs to be replaced by a more fluid conception of creativity that will work equally well for computational systems. By comparison, a view of this process of production based on networks of interaction between elements (whether brain, body and culture, as Malafouris suggests (Malafouris, 2007), or some other active ingredients) makes less of a conceptual meal of that scenario.

Even if these various perspectives may be technically true, is it any use to try to use them to rethink evaluation in computational creativity? It would be counterproductive to take clearly delineated elements and blur them into a loosely defined muddle of interaction purely for the sake of being more accurate. A danger with adopting this perspective is that useable categories disappear to dust. Evoking a Beethoven-piano-stave-pen-church-king-orchestra-etc.-etc. network complex to explain the creation of the Fifth Symphony may not have any practical value and if so, should not be pursued. But as part of a wider investigation into how qualitative, situated human science methods can contribute to the understanding of evaluation in computational creativity (Bown, 2014, 2012; McCormack et al., 2014), I believe that it will be necessary to take on the "islands of creativity" problem by introducing such thinking to form a method of "dynamic analysis" of creative systems.

As a first step in a dynamic analysis approach, we would need to look at where we have pre-emptively identified creative agents. Mostly, these will be either individual people, or the computational systems we have built. For each presumed agent, we should investigate what assumptions we hold about their boundedness, their autonomy (any cases in which we say the system did something "on its own") and the origins or their actions. We can also investigate where different systems might be seen to unite in co-action or break down into interacting components, and we can look at how each system is influenced to change its state or structure over time. In each case, this will be a temporal process where different system boundaries are recognised over time. In the case of many computationally creative systems, the full analysis of such a process would include the role of the system developer, observing outcomes and iterating their design in order to improve it (what Colton, Pease, and Ritchie (2001) refer to as "fine tuning"). We may also find that the process is so widely distributed across elements that such descriptions take on a more statistical nature, as we have seen in both Simonton's theories (Simonton, 2003), and in Darwinian evolutionary thinking. In this case, it should be fine to attribute some degree of creativity to a macro-level stochastic process itself.

Through the examples below it is proposed that a simple but effective way to dynamically analyse creative events is through simple dot-point timelines that discuss sequences of events, the influence of systems on each other, and the potential coupling of systems. This is relatively crude, but may have the potential to feed ultimately into more formal frameworks such as that of Wiggins (2006).

Application

Without adopting a strong cultural Darwinism – which is contrary to what I would argue for, and what Sperber's article (Sperber, 2007) emphatically argues against – it follows from all of the above that every creative act should be framed in terms of processes of interaction. The issue still remains of showing that this is practically useful. I consider the following instances and how such an approach serves to clarify the creative agency.

The Violin

In a recent article (Nia et al., 2015) evidence was given to support the theory that the shape of sound holes in violins emerged through an essentially evolutionary process whereby apprentices copied their masters' designs with random variation, and those designs with louder sounds, due to the shape of the holes on the body of the violin, were over time more successful. The winning design, the familiar f-shape that we know today, maximises the ratio between the perimeter of the hole and its size, providing greater amplification of the sound, whilst providing a pleasing visual appearance. Who designed the violin as we know it today? If the above account is correct we could answer as we would with the design of organisms in the biological world, that there is no one designer, and there are not really any designers in the sense of psychological creative discovery. The design came about through a macro-level process. Indeed, we could go so far as to say that the design of the optimised sound holes was not due in any way to a human creative capacity, although, difficulty arises when we ask whether a given luthier's new design was actually a conscious improvement, or a random variation that turned out to be successful. As with Simonton (2003), we may be mistaken in attributing creativity to the individual mind instead of to the broader cultural process.

The creative process, as described by Nia et al. (2015), might look something like the following if represented as a dynamic analysis timeline:

1. An existing design is copied and modified in ways that do not explicitly attempt to optimise sound amplification
2. Given time, the louder designs make more money, and these workshops grow and reproduce whilst the workshops responsible for the quieter designs diminish.

Paul Hession / Arne Eigenfeldt Live at Cafe Oto

At a recent concert of live algorithms[1], drummer Paul Hession and flautist/saxophonist Finn Peters performed with a number of live algorithms. I consider the performance between Paul Hession and Arne Eigenfeldt's (Eigenfeldt, 2014) system[2] (a discussion of the factors underlying such concerts can be found in Bown et al. (2013)). Clearly, as an improvised duet, the interaction between the two participants is critical to understanding the creative output. Musical improvisation is possibly the most unambiguous case of a process of interaction underlying a creative result. But over a longer timescale we can consider Eigenfeldt's development of the system, and his interaction with Hession during rehearsal as part of the creative process. It has been proposed in various ways (e.g., McLean and Wiggins, 2010), that creative software development involves a cycle of interaction between developer and software, and we can see this as directly analogous to the case of the potter described by Malafouris, with the same arguments applying. Such notions have also been discussed in the case of Cohen's work with AARON (McCorduck, 1990).

A full picture of the development of the outcome might look something like the following. Through discussions with many live algorithm developers, this seems typical, and really it is just a specific case of what any musicians do in preparing for a collaborative performance:

1. Designer takes on project, listens to recordings of Musician in order to approach design of System;
2. Designer iteratively develops System;
3. Designer, System and Musician rehearse;
4. System and Musician perform.

[1] Cafe Oto, London, June 29th 2014, as part of the New Interfaces for Musical Expression 2014 Conference.

[2] https://www.youtube.com/watch?v=vL6Jty5hOFc

In this we can look at the moments where there is influence. Of interest, in Stage 1, the musician has influence on the System. In Stage 2, the system has influence on the designer, and in Stage 3 the System has influence on the musician, influencing how they might choose to perform. Under Malafouris' framework, these interactions, no matter how consciously or authoritatively the subject of the influence is receiving this input, imply that boundaries between these entities are fluid, or porous. We should be aware that that design of the system contains iterative, hence albeit minutely autopoietic, development, and the final form of both system and musician are the result of a longer-term interaction.

Still, does this matter? It is not burningly evident that it does. But it provides a more complete analysis than if we say that a system, all of a sudden, stands alone as an autonomous agent and 'produces' things. A rich qualitative description takes account of the actual pathways that lead to something being produced.

Conclusion

In this paper I consider what is still, despite its long standing in social sciences, quite a radical approach to thinking about attributing creative agency. This view removes the privilege of the human actor, making place for the idea of humans and other actors forming temporary networks of interaction that produce things. It does not unfortunately offer us a powerful analytical framework that makes agency attribution easy or formulaic, but asks us to avoid making mistaken and simple agency attributions, whether to humans or to creative machines.

References

Aunger, R. 2000. *Darwinizing Culture*. New York: Oxford University Press.

Baars, B. J. 2005. Global workspace theory of consciousness: toward a cognitive neuroscience of human experience. *Progress in brain research* 150:45–53.

Barkow, J. H.; Cosmides, L.; and Tooby, J. 1992. *The Adapted Mind: Evolutionary Psychology and the Generation of Culture*. New York: OUP.

Boden, M. 1990. *The Creative Mind*. George Weidenfeld and Nicholson Ltd.

Bown, O.; Eigenfeldt, A.; Martin, A.; Carey, B.; and Pasquier, P. 2013. The musical metacreation weekend: challenges arising from the live presentation of musically metacreative systems. In *Proceedings of the musical metacreation workshop, AIIDE conference, Boston*.

Bown, O. 2012. Generative and adaptive creativity. In McCormack, J., and d'Inverno, M., eds., *Computers and Creativity.* Berlin: Springer. 361–381.

Bown, O. 2014. Empirically grounding the evaluation of creative systems: incorporating interaction design. In *Proceedings of the Fifth International Conference on Computational Creativity*.

Boyd, R., and Richerson, P. J. 1985. *Culture and the Evolutionary Process*. Chicago, IL, US: University of Chicago Press.

Clark, A. 2003. *Natural-Born Cyborgs: Minds, Technologies, and the Future of Human Intelligence*. Oxford University Press.

Colton, S.; Pease, A.; and Ritchie, G. 2001. The effect of input knowledge on creativity. *Technical Reports of the Navy Center for Applied Research in Artificial Intelligence*.

Csikszentmihalyi, M. 1999. Implications of a systems perspective for the study of creativity. In Sternberg, R. J., ed., *The Handbook of Creativity*. New York: Cambridge University Press. 313–335.

Dawkins, R., and Krebs, J. R. 1978. Animal signals: Information or manipulation? In Krebs, J. R., and Davies, N. B., eds., *Behavioural Ecology: An Evolutionary Approach*. Sinauer Associates. 282–309.

Eigenfeldt, A. 2014. Generating structure–towards large-scale formal generation. In *Tenth Artificial Intelligence and Interactive Digital Entertainment Conference*.

Ingold, T. 2007. Materials against materiality. *Archaeological dialogues* 14(01):1–16.

Latour, B. 1996. On actor-network theory: a few clarifications. *Soziale welt* 369–381.

Law, J. 1992. Notes on the theory of the actor network: Ordering, strategy and heterogeneity. Published online at www.lancs.ac.uk/fass/sociology/papers/law-notes-on-ant.pdf.

Malafouris, L. 2007. At the potter's wheel: An argument for material agency.

Marriott, M. 1976. *Hindu transactions: Diversity without dualism*. University of Chicago, Committee on Southern Asian Studies.

McCorduck, P. 1990. *AARON's Code: Meta-Art, Artificial Intelligence, and the Work of Harold Cohen*. W. H. Freeman and Co.

McCormack, J.; Bown, O.; Dorin, A.; McCabe, J.; Monro, G.; and Whitelaw, M. 2014. Ten questions concerning generative computer art. *Leonardo* 47(2):135–141.

McLean, A., and Wiggins, G. A. 2010. Bricolage programming in the creative arts. In *22nd Annual Psychology of Programming Interest Group*.

Miller, D. 2010. *Stuff*. Polity.

Minsky, M. 1988. *Society of mind*. Simon and Schuster.

Nia, H. T.; Jain, A. D.; Liu, Y.; Alam, M.-R.; Barnas, R.; and Makris, N. C. 2015. The evolution of air resonance power efficiency in the violin and its ancestors. *Proceedings of the Royal Society of London A: Mathematical, Physical and Engineering Sciences* 471(2175).

Nietzsche, F. 1998. *Twilight of the Idols*. Oxford University Press.

Ritchie, G. 2007. Some empirical criteria for attributing creativity to a computer program. *Minds and Machines* 17(1):67–99.

Shennan, S. 2002. *Genes, Memes and Human History*. Thames and Hudson, London.

Simonton, D. K. 2003. Scientific creativity as constrained stochastic behavior: the integration of product, person, and process perspectives. *Psychological bulletin* 129(4):475.

Sperber, D. 2007. Seedless grapes: Nature and culture. In Margolis, E., and Laurence, S., eds., *Creations of the Mind: Theories of Artefacts and Their Representation*. Oxford University Press. chapter 7.

Wiggins, G. A. 2006. A preliminary framework for description, analysis and comparison of creative systems. *Knowledge-Based Systems* 19(7):449–458.