09291 Abstracts Collection
Computational Creativity : An Interdisciplinary Approach
— Dagstuhl Seminar —

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Abstract. From 13th to 17th July 2009, the Dagstuhl Seminar 09291 "Computational Creativity : An Interdisciplinary Approach" was held in Schloss Dagstuhl – Leibniz Center for Informatics. During the seminar, several participants presented their current research, and ongoing work and open problems were discussed. Abstracts of the presentations given during the seminar as well as abstracts of seminar results and ideas are put together in this paper. The first section describes the seminar topics and goals in general. Links to extended abstracts or full papers are provided, if available.

Keywords. Computational creativity, music, art, artificial life, artificial intelligence, ecosystems, culture

09291 Summary – Computational Creativity: an interdisciplinary approach

This document outlines the proposal for the Dagstuhl seminar 09291 on computational creativity.

Keywords: Computational creativity

Joint work of: McCormack, Jon; D'Inverno, Mark; Boden, Margaret

Full Paper: http://drops.dagstuhl.de/opus/volltexte/2009/2209

Computational Creativity: an interdisciplinary approach: Seminar Programme and Speakers

This document provides an introduction to the seminar and includes a programme for the week, speaker biographies and a list of key references.

Keywords: Computational creativity

Joint work of: McCormack, Jon

Computational Creativity through a Gap

Iris Asaf (University College London, GB)

A significant aspect of creativity is its elusive mystery. Unlike pure novelty or pure originality and adaptability, creative ideas have an aura of something which is unanticipated, yet, in a way not completely surprising, but providing insight into familiar ideas. This position paper wishes to focus on this mysterious aspect of creativity and discusses uncertainty and the creative gap as aspects that are part of creative thinking processes in generative art and design. This paper argues that a significant part of the mechanism underlying a creative process using generative methods is a cognitive gap or dissonance between the human mind of the designer or artist and its otherness, the non human computer expressivity. What is re-established through this gap is a feedback process between the designer and the computer or its algorithmic expressivity that serves as an autonomous agent. This process of feedback can at a certain point give rise to some new insight, and thus enables the generative design or artistic process to become creative.

Keywords: Uncertainty, creativity, gap, generative design and art

Full Paper: http://drops.dagstuhl.de/opus/volltexte/2009/2201

TANGIBLE REPRESENTATIONS AND MODES OF CREATIVE ENGAGEMENT

Rodney Berry (National Univ. of Singapore, SG)

Tangible interfaces are finding their way into various areas of creative activity, particularly in the creation of music. Tangible representations of musical information, together with their graphical counterparts, play an important role in increasingly complex representational systems. This paper explores the relationships between these representations in the context of various modes of compositional (and by extension, creative) engagement adopted by composers in their working process.

Keywords: Computational creativity

Full Paper: http://drops.dagstuhl.de/opus/volltexte/2009/2208

Live Algorithms

Tim Blackwell (University of London, GB)

A Live Algorithm takes part in improvised, collaborative performance, sharing the same modes of communication and expression as its partners. The device enjoys the same constraints and freedoms as its human associates. A live algorithm would be expected to imitate, develop ideas and, at times, to contribute novelty and surprise, to experiment and take risks, and to assume leadership. Other performers experience the live algorithm as if it were a human, with a sense of validity and belief. Although designing a live algorithm with the ability to imitate and develop shared ideas is already a formidable undertaking, the additional requirement of innovation is an even harder research challenge.

We suggest that it is the ability to innovate that distinguishes autonomy from automation and randomness and postulate that novelty and surprise can be explained as an emergent phenomenon. To this end, most current live algorithm research focusses on certain open dynamic systems which model some aspects of a natural system in which emergence is known to occur. Some differences between people and dynamical systems are immediately evident, however. Memory enables performers to revisit past actions and understand relationships; evaluation, followed by learning, leads to improvement; a social context provides encouragement and criticism and a cultural context imparts meaning via a web of shared experience. But dynamical systems can be augmented with memory using a counterpart to the environment-mediated stigmergetic interaction between insects. We speculate if a live algorithm culture could be also created, and if this is the missing ingredient.

Keywords: Live algorithms, emergence, innovation, autonomy

Full Paper: http://drops.dagstuhl.de/opus/volltexte/2009/2221

Mind as Machine (extract) and THE CREATIVE MIND: MYTHS AND MECHANISMS (extract)

Margaret Boden (University of Sussex - Brighton, GB)

- Extract from the book MIND AS MACHINE (2006) OUP.
- Extract from the 2nd edition of THE CREATIVE MIND: MYTHS AND MECHANISMS (2004).

Keywords: Computational creativity

Full Paper: http://drops.dagstuhl.de/opus/volltexte/2009/2211

Full Paper: http://drops.dagstuhl.de/opus/volltexte/2009/2211

Against Individual Creativity

Oliver Bown (Monash University - Clayton, AU)

In this paper I discuss reasons for viewing creativity more as a social process than as an individual act. These reasons include the subjectivity of evaluation in attributing creativity, the potentially arbitrary relationship between individuals and creativity at the cultural level, the importance of the capacity for preserving cultural information over and above the capacity to innovate, the role of objects, institutions and interaction in sparking creativity, and the social constructedness of creative domains. I discuss these ideas and consider the consequences of this way of thinking for research into computational creativity. I argue that realising the goals of computational creativity depends on integrating research on creative agents with social technologies.

Keywords: Creativity, culture

Full Paper: http://drops.dagstuhl.de/opus/volltexte/2009/2205

Creative Agency: A Clearer Goal for Artificial Life in the Arts

Oliver Bown (Monash University - Clayton, AU)

One of the goals of artificial life in the arts is to develop systems that exhibit creativity. We argue that creativity *per se* is a confusing goal for artificial life systems because of the complexity of the relationship between the system, its designers and users, and the creative domain. We analyse this confusion in terms of factors affecting individual human motivation in the arts, and the methods used to measure the success of artificial creative systems. We argue that an attempt to understand *creative agency* as a common thread in nature, human culture, human individuals and computational systems is a necessary step towards a better understanding of computational creativity. We define creative agency with respect to existing theories of creativity and consider human creative agency in terms of human evolution. We then propose how creative agency can be used to analyse the creativity of computational systems in artistic domains.

Keywords: Creativity, agency

Full Paper: http://drops.dagstuhl.de/opus/volltexte/2009/2216

Computational Artistic Creativity and its Evaluation

David Brown (Worcester Polytechnic Institute, US)

For artistic creativity, in comparison to design creativity, requirements may not exist, and constraints on the artifact (the artistic 'product') are usually looser or absent.

Many computational creativity systems produce artistic artifacts, but such results can be judged in a variety of ways: by a variety of artistic standards or by the perceiver's "taste", for example.

There is less chance of a generated artifact being judged in a single, clear and concrete fashion, so the standards may be softer and perhaps easier to satisfy: certainly harder to make computational. With regard to taste, Boden (1994) quotes, "I don't know anything about art, but I know what I like". If this were true in general, then there would be as many tests of the creativity of an artifact as there are people!

Keywords: Evaluation, design creativity, artistic creativity, novelty, resolution, style, function

Full Paper: http://drops.dagstuhl.de/opus/volltexte/2009/2220

Notes from the Discussion Group on "Evaluation"

David Brown (Worcester Polytechnic Institute, US)

Group Members:

Harold Cohen, Maggie Boden, Dave Brown, Paul Brown, Oliver Deussen, Philip Galanter.

These notes represent approximately what was discussed by the group members over a period of several hours over two days. There has been some attempt to organize the material, but little attempt to expand it to make it coherent – we rambled, so do the notes. The notes, and this report, were recorded, organized, and elaborated into this form by Dave Brown.

Keywords: Evaluation, art, artistic, creativity

Full Paper: http://drops.dagstuhl.de/opus/volltexte/2009/2212

Autonomy, Signature and Creativity

Paul Brown (paul brown - art < > technology - Brisbane, AU)

One of the key themes that emerged from the formal investigations of art and aesthetics during the 20th century was that of the autonomous artwork. The goal of an artwork that was not just self-referential but also self-creating found renewed vigour in the work of the systems and conceptual artists and especially those who were early adopters of the then-new technology of artificial intelligence (AI).

A key problem is that of signature: at what point can we claim that an artwork has its own distinct signature? My own work in this area began in the 1960's with an early, and in retrospect, naive assumption. At that time art was still based on the concept of engagement with the materiality of the medium.

I suggested that using a symbolic language to initiate a process would distance me far enough from the output of that process for it to have the potential of developing its own intrinsic qualities including a unique signature. By the 1990s it had become obvious that this approach had failed. Complementary research in many fields had demonstrated that the signatures of life were robust and strongly relativistic. The myriad bonds that define a signature are embedded in even the simplest symbol system and any attempt to create autonomy by formal construction is unlikely to succeed.

During this same period a group of biologically inspired computational methods were revisited after several decades of neglect; evolutionary, adaptive and learning systems suggested a 'bottom up' approach to the problem. If it's not possible to design an autonomous agency then can we instead make a system that evolves, learns for itself and eventually has the potential of displaying autonomy as an emergent property?

The DrawBots project is an attempt to apply these computational methods to the problem of artistic autonomy. It is an example of a strong art-science collaboration where all the disciplines involved have a significant investment in the project and its themes.

Keywords: Computational creativity, autonomous art, signature

Full Paper: http://drops.dagstuhl.de/opus/volltexte/2009/2204

Strategies for creating new informational primitives in minds and machines

Peter A. Cariani (Harvard Medical School - Boston, US)

Open-endedness is an important goal for designing systems that can autonomously find new and expected solutions to combinatorically-complex and ill-defined problems. Classically, issues of open-ended generation of novelty in the universe have come under the rubric of the problem of emergence. We distinguish two modes of creating novelty: combinatoric (new combinations of existing primitives , 'resultants') and creative (new primitives, 'emergents'). Although combinatoric systems may differ in numbers of possible combinations, their set of possibilities is closed. Creative systems, on the other hand, have open-sets of possibilities because of the partial- or ill-defined nature of the space of possible primitives. The two conceptions provide two modes for describing and understanding change and creativity: as the unfolding consequences of fixed combinatorial rules on bounded sets of pre-defined primitives or as new processes and interactions that come into play over time to define new primitives.

We face several related problems. We want to know how to recognize creative novelty when it occurs (the methodological problem), we want to understand the creative process in humans and other systems (the scientific problem) such that creativity in human-machine collaborations can be facilitated and that creativity in autonomous devices can be usefully enabled (the design problem).

The methodological problem can be solved by the 'emergence-relative-to-a-model' approach in which an observer forms a model of the behavior of a system. Novelty and creativity are inherently in the eye of the observer, i.e. relative to some model that specifies possible alternatives. If the behavior changes, but it can still be predicted/tracked in terms of the basic categories/state set of the model, one has combinatorial creativity. If it changes, but requires new categories/observables/states for the observer to regain predictability, then one has emergent creativity (creation of new primitives).

We argue that pure computation by itself can generate new combinations of symbol primitives, but, absent states or processes that are hidden from the observer, it cannot autonomously generate new primitives. Breakout strategies are therefore required. In order for a computational system to transcend the limitations of its own primitive symbol set, it must be coupled to some other non-symbolic, material system. In order to increase its effective dimensionality, it can couple to the world outside its internal symbol-states by three means:

1. via human-machine interactions (facilitate novel insights in humans, use humans to create new primitives that expand systems, develop tools for creativity),
2. via sensors and effectors on an external world (epistemically-autonomous evolutionary robots), and
3. via internal analog dynamics (adaptive self-organization in mixed analog-digital devices or biological brains).

When a computational system is augmented and opened up in these ways, it is transformed from a formal system that is informationally isolated from its surrounds to one that is self-organizing, self-complexifying, and in informational interaction with its surrounds.

We discuss classes of adaptive and self-modifying cybernetic evolutionary robotic devices in terms of combinatoric and creative novelty and in terms of new functionalities that are created (new syntactic states, new semantic observables & actions, new pragmatic goals). If adaptive sensors and effectors are internalized in the form of signal generators and receivers, it is possible to think of neural networks in these terms. What this view of biological brains might look like is sketched out. Adaptively-tuned neuronal assemblies would conceivably function as internal sensors and signal generators, such that new signal types could be produced (i.e. new concepts). Emergence of new signal types would increase the effective dimensionality of internal signal spaces over time in an apparently open-ended manner.

Keywords: Computational creativity, emergence, neural networks, neural timing nets

Full Paper: http://drops.dagstuhl.de/opus/volltexte/2009/2192

Notes on the demonstration of the formation of a new "symbol"

Peter A. Cariani (Harvard Medical School - Boston, US)

This is a writeup of our group project, which was to demonstrate by means of a game, how two human actors can come to agreement on the semantic meanings of an arbitrary set of signs.

Keywords: Sign, symbol, meaning, meaning creation

Full Paper: http://drops.dagstuhl.de/opus/volltexte/2009/2203

The Art of Self-Assembly: the Self-Assemby of Art

Harold Cohen (UC San Diego, US)

AARON is a semi-autonomous art-making program that has been under continuous development for nearly forty years. This paper discusses the origins and development of two critical features in it's most version; a coloring algorithm and an algorithmic shape generator. It concludes that for the foreseeable future, "computational creativity" does not so much describe the creative capabilities of a computer program as the nature of the collaborative relationship between program and programmer.

Keywords: Computational creativity

Full Paper: http://drops.dagstuhl.de/opus/volltexte/2009/2202

Seven Catchy Phrases for Computational Creativity Research

Simon Colton (Imperial College London, GB)

I understand that simulating creative processes by computer can enhance our understanding of creativity in humans. I also understand that there is more need than ever for software to help people to be more efficient in creative jobs. And I know that computational creativity research can be of great value in both these areas.

However, I'm really only interested in the intellectual challenge of enabling nuts and bolts machines - bits and bytes computers - to create artefacts of real cultural value to society. Such behaviour used to be thought of as divinely inspired, no less than a gift from the Gods. This is why it is a worthy challenge for me to bet my career against. Building a truly computationally creative machine is as much a societal as a technical challenge, and it will need computational creativity researchers to come together in consensus about certain aspects of

their field. To this end, I have written here seven phrases around which we could rally (or about which we could debate - which may also be healthy). I present the ideas from which the phrases emerged with little argumentation, in the tradition of a position paper. They are drawn from twelve years of immersion in the field of computational creativity during which I've written an automated mathematician (HR) and an automated painter (The Painting Fool), and they have created artefacts which I believe are of real value to society.

Keywords: Computational creativity

Full Paper: http://drops.dagstuhl.de/opus/volltexte/2009/2194

Ideas and Tools in Material Space - an extended spatial model of creativity

Palle Dahlstedt (IT University of Göteborg, SE)

In this paper I propose a spatial framework for thinking about creative processes, both actual and computer modeled, which combines the conceptual dimensions of a work with the implications of the artistic tools we are using and the material in which the work is created. The paper is not about the novelty aspect of creativity, and not (so much) about the social and cultural aspects. It concentrates on what goes on in the mind of an artist during the birth and development of an artwork in an iterated interplay between concept and material form. It is primarily based on experience from sound, music and visual art, but I believe the ideas are applicable to many other domains, and could possibly form the basis of computational models of creativity.

Keywords: Creativity, computational creativity, topology, spatial model

Full Paper: http://drops.dagstuhl.de/opus/volltexte/2009/2198

Improbable Creativity

Alan Dorin (Monash University - Clayton, AU)

We begin with a number of basic facts about creativity and a brief history of the idea. These provide criteria that any definition of the term should meet and help guide us to a new definition of creativity. This definition is independent of cultural appropriateness or the perceived value of creative objects, ideas which have encumbered previous investigations.

We briefly defend our definition against some plausible objections and then explore the ways in which this new definition differs from alternative views, by improving upon them.

Keywords: Creativity, mechanism, creative evolution, complexity, representation

Joint work of: Dorin, Alan; Korb, Kevin B.

Full Paper: http://drops.dagstuhl.de/opus/volltexte/2009/2214

Words on the Creativity and Cognition Studios contribution

Ernest Edmonds (Univ. of Technology - Sydney, AU)

This is a statement from the catalogue of a recent exhibition in which UTS's Creativity and Cognition Studios was represented by two of its members. It briefly encapsulates the concept and philosophy of the group.

Keywords: Computation, Art, Design, Experimentation, Human Factors

Extended Abstract: http://drops.dagstuhl.de/opus/volltexte/2009/2199

Statement

Ernest Edmonds (Univ. of Technology - Sydney, AU)

This is a statement about computation and my art practice.

Keywords: Art computation

Full Paper: http://drops.dagstuhl.de/opus/volltexte/2009/2218

Thoughts on Computational Creativity

Philip Galanter (Texas A&M University, US)

There is a close relationship between computational creativity in the arts and generative art. Prior work is summarized here as to how complexity theory can serve as a theoretical context for generative art. This is extended to show how complexity theory can also illuminate discussions regarding computational creativity.

Another prior proposal is also summarized. It suggests that a world-view called 'complexism' can reconcile the current differences between the modern culture of science and the postmodern culture of the humanities. This line is also extended to considerations regarding computational creativity. Particular attention is extended here to the issues of authorship, progress, and aesthetic measurement in computational creativity.

Finally, under artistic license, I discuss some very speculative ideas regarding computational creativity that I explore in my current artwork.

Keywords: Generative art, complexity, complexism, computational creativity, modernism, postmodernism, art, art theory, computer art

Full Paper: http://drops.dagstuhl.de/opus/volltexte/2009/2193

In Praise of Evolution and Opacity

Inman Harvey (University of Sussex - Brighton, GB)

The perspective I bring to questions of creativity in man and machine reflects my background in evolutionary robotics, which I consider an exercise in philosophy of mind, trying to understand the relationship between Behaviour and Mechanism. I have a suitcase full of philosophical premises and assumptions; some of these are common, some will be identifiable as associated with a Dynamical Systems approach to cognitive science, also influenced by Varela; and some will seem plain perverse.

Keywords: Computational creativity

Full Paper: http://drops.dagstuhl.de/opus/volltexte/2009/2196

Notes on group discussion: Stimulating creative flow through computational feedback

Daniel Jones and others (Goldsmiths, University of London, GB)

This report summarises the discussion and experimental work produced by the authors at the 2009 symposium *Computational Creativity: An Interdisciplinary Approach*, Dagstuhl Leibniz-Zentrum für Informatik. It outlines the motivation for using computational techniques to stimulate human creativity, briefly summarising its historical context and predecessors, and describes two software studies produced by the group as base-line exemplars of these ideas.

Keywords: Computational creativity

Full Paper: http://drops.dagstuhl.de/opus/volltexte/2009/2223

Casually Evolving Creative Technology Systems

Matthew R. Lewis (Ohio State University, US)

This position paper will describe the early stages of a development effort in which an interactive evolutionary design approach is being applied to the domain of technology-based system development, in a new media art and design context. These systems connect different technologies and techniques in order to process and transform data of one type into another. For example, location data might be used to select a relevant network information feed, the text of which drives geometry generation, which in turn could be sent to a 3D printer that would

produce a sculpture. While the flexibility of this problem domain is idiosyncratic to our interdisciplinary new media environment, the target physical context for using a creativity support tool, and the context's effect on creative output is rather the primary research focus. The goal is to explore the possibilities of what might be termed 'casual design', analogous to the 'casual gaming' genre in which games are played by anyone, where ever they might find a few spare minutes, rather than requiring significant time and hardware commitments.

Keywords: Computational creativity

Full Paper: http://drops.dagstuhl.de/opus/volltexte/2009/2195

Creative Ecosystems

Jon McCormack (Monash University - Clayton, AU)

This paper addresses problems in computational creative discovery, either autonomous or in synergetic tandem with humans. A computer program generates output as a combination of base primitives whose interpretation must lie outside the program itself. Concepts of combinatoric and creative emergence are analysed in relation to creative outputs being novel and appropriate combinations of base primitives, with the conclusion that the choice of the generative process that builds and combines the primitives is of high importance. The generalised concept of an artificial ecosystem, which adapts concepts and processes from a biological ecosystem at a metaphoric level, is an appropriate generative system for creative discovery. The fundamental properties of artificial ecosystems are discussed and examples given in two different creative problem domains. Systems are implemented as pure simulation, and where the ecosystem concept is expanded to include real environments and people as ecosystem components, offer an alternative to the 'software tool' approach of conventional creative software.

Keywords: Computational creativity

Full Paper: http://drops.dagstuhl.de/opus/volltexte/2009/2206

Embodied creativity

Alex McLean (University of London, GB)

By taking the view of embodied cognition summarised here, we may define embodied creative search, where sensory-motor faculties are used to navigate a geometric space, in direct metaphor to a search through a physical space. In this view, creative computation requires concepts to be represented in a manner at least sympathetic with the way humans perceive, act and introspect.

Keywords: Creativity, embodied cognition, conceptual space

Full Paper: http://drops.dagstuhl.de/opus/volltexte/2009/2217

Musical Creativity on the Conceptual Level

Alex McLean (University of London, GB)

The theory of conceptual spaces, a geometrical form of knowledge representation introduced by Gärdenfors (2000), is examined in the context of the general creative systems framework introduced by Wiggins (2006a, b). The representation of musical rhythm and timbre on the conceptual level is then discussed, together with software allowing human users to explore such spaces. We report observations relevant for future work towards creative systems operating in conceptual spaces.

Keywords: Creative systems framework, conceptual space, geometrical representation, music

Joint work of: McLean, Alex; Forth, Jamie; Wiggins, Geraint

See also: Forth, J., Mclean, A., and Wiggins, G. (2008). Musical creativity on the conceptual level. In proceedings of IJWCC 2008.

Words, movement and timbre

Alex McLean (University of London, GB)

Phonetic symbols describe movements of the vocal tract, tongue and lips, and are combined into complex movements forming the words of language. In music, vocables are words that describe musical sounds, by relating vocal movements to articulations of a musical instrument. We posit that vocable words allow the composers and listeners to engage closely with dimensions of timbre, and that vocables could see greater use in electronic music interfaces. A preliminary system for controlling percussive physical modeling synthesis with textual words is introduced, with particular application in expressive specification of timbre during computer music performances.

Keywords: Vocable synthesis, timbre

Joint work of: McLean, Alex; Geraint Wiggins

See also: Mclean, A. and Wiggins, G. (2009). Words, movement and timbre. In Proceedings of NIME 2009.

Artificial Life meets Computational Creativity

Barry McMullin (Dublin City University, IE)

I review the history of work in Artificial Life on problems related to the open-ended, creative, evolutionary growth of complexity in computational worlds.

This is then put into the context of evolutionary epistemology and human creativity.

Keywords: Artificial life, complexity, computational creativity

Full Paper: http://drops.dagstuhl.de/opus/volltexte/2009/2200

My Ten Minutes

Gordon Monro (Monash University - Caulfield, AU)

I am a PhD student in Art, planning an artificial life art project involving camouflage, mimicry, and models of the perceptual mechanisms of predators. The slides outline my proposed project and also indicate what I hope to learn by attending this seminar.

Keywords: Perception, camouflage, mimicry, artificial life art

Humans Create, Occasionally. Computers Operate, Always. Self-Evident & Trivial

This essay is a bit of a grumble. I will try to be subjectively trivial. Not exactly scientific. Some important names will be mentioned. If some readers enjoy reading this, it's enough from my standpoint. The title exactly says what I want to say. The essay is only longer.

Keywords: Trivial creativity, historic creativity, generative art, generative aesthetics

Full Paper: http://drops.dagstuhl.de/opus/volltexte/2009/2215

Creativity or Virtuosity?

Francois Pachet (Sony CSL - Paris, FR)

Position:

Creativity or Virtuosity? Instead of looking at creativity upfront, I propose to look at another facet of human behavior: virtuosity. I propose a definition of temporal virtuosity which consists in the ability of creating sequences with specific properties, which are often contradictory, thereby resulting in what can be seen as a "difficult problem". I propose algorithms for generating such sequences, and I will illustrate their use for the generation of controllable virtuoso Bebop improvisation.

Experiments involving musicians, children ... and birds will be described and compared.

Papers:

- Pachet, F. Enhancing Individual Creativity with Interactive Musical Reflective Systems. In Deliege, I. and Wiggins, G., editor, Musical Creativity: Multidisciplinary Research in Theory And Practice, Psychology Press. 2006
- Pachet, F The future of content is in ourselves. ACM Journal of Computers in Entertainment, 6(3), 2008

All papers at: http://www.csl.sony.fr

Keywords: Computational creativity

Simulating Morphogenesis

Benjamin Porter (Monash University - Clayton, AU)

I am a graduate student at Monash University. My research is in the domain of computer graphics, where I am attempting to grow organic three dimensional forms using models inspired by real biological development. The presented animation demonstrated the simulated development of a virtual organism reminiscent of a starfish or sea urchin. As in a real developing organism the cells of the virtual organism divide and communicate, adding more complexity to the initially simple form. The behaviour of the cells result in the development of limbs, giving rise to the starfish-like appearance of the final organisms.

Keywords: Morphogenesis 3D modelling

Full Paper: http://drops.dagstuhl.de/opus/volltexte/2009/2210

Artificial Creative Systems: Completing the Creative Cycle

Rob Saunders (University of Sydney, AU)

Human creativity is personally, socially and culturally situated: creative individuals work within environments rich in personal experiences, social relationships and cultural knowledge. Computational models of creative processes typically neglect some or all of these aspects of human creativity. How can we hope to capture this richness in computational models of creativity? This paper introduces recent work at the Design Lab where we are attempting to develop a model of artificial creative systems that can combine important aspects at personal, social and cultural levels.

Keywords: Creative systems, culture, language games, interest, curiosity

Full Paper: http://drops.dagstuhl.de/opus/volltexte/2009/2213

Driven by Compression Progress: A Simple Principle Explains Essential Aspects of Subjective Beauty, Novelty, Surprise, Interestingness, Attention, Curiosity, Creativity, Art, Science, Music, Jokes.

Juergen Schmidhuber (IDSIA - Lugano, CH)

I argue that data becomes temporarily interesting by itself to some self-improving, but computationally limited, subjective observer once he learns to predict or compress the data in a better way, thus making it subjectively simpler and more "beautiful." Curiosity is the desire to create or discover more non-random, non-arbitrary, regular data that is novel and surprising not in the traditional sense of Boltzmann and Shannon but in the sense that it allows for compression progress because its regularity was not yet known. This drive maximizes interestingness, the first derivative of subjective beauty or compressibility, that is, the steepness of the learning curve. It motivates exploring infants, pure mathematicians, composers, artists, dancers, comedians, yourself, and (since 1990) artificial systems.

Compare overview sites with previous papers (1990-2009) on the formal theory of subjective beauty and creativity:
http://www.idsia.ch/~juergen/interest.html and
http://www.idsia.ch/~juergen/beauty.html

Keywords: Subjective Beauty, Surprise, Interestingness, Curiosity, Creativity, Art, Science, Music, Jokes

Full Paper: http://drops.dagstuhl.de/opus/volltexte/2009/2197

Full Paper:
http://www.idsia.ch/~juergen/driven2009.pdf

See also: Journal of SICE 48(1), 21-32, 2009. Also: Proc. ABIALS, 2009. KES 2008 keynote. ALT 2007 / DS 2007 joint invited lecture.

A Creative Dance: Symbols, Action and the Bringing Forth of Meaning

Tim Taylor (Timberpost Ltd - Edinburgh, GB)

In our attempts to understand the evolution of biological, cognitive and cultural systems, critical questions arise concerning the origin of meaning. I argue that the key to success in attempts to create computational systems that exhibit the same capacities as their natural counterparts to evolve new and creative ways of interacting with their environment, beyond that which is simply 'programmed into' the system from the start, lies in answering these questions.

The nature of the problem is laid bare when we consider the origin and evolution of life. A fundamental question is this: how is it possible for organisms,

that follow their own goals and behave according to their own rules, to emerge in a world governed by the laws of physics and chemistry? More generally, how can agents and agency emerge in a system governed by universal laws? And even once our agents have emerged, how can the evolutionary process produce new agents that interact with their environment through previously unexploited modalities?

In this paper I describe work on a novel modelling approach which aims to solve these problems and thereby allow us to produce artificial evolutionary systems with greatly improved creative evolutionary potential. This perspective sees organisms as entities whose phenotypes are embedded within an environment viewed as a dynamical system, and whose genotypes interact with the environment by specifying constraints upon its dynamics, thereby generating the phenotypes. That is, the abiotic environment has its own dynamics and self-organisational properties; genotypes act to 'sculpt' these pre-existing dynamics by supplying constraints. From this point of view, the most important distinction is not between organisms and their abiotic environment, but rather between the environment as a whole (including organism phenotypes) and organism genotypes.

Elsewhere I have presented initial results from a model based upon this perspective, and demonstrated simple examples of the evolution of new sensors and effectors, and of genome-regulated self-stablising behaviour. Going further, we can generalise this perspective; in so doing, we may find useful connections and analogies between biological, cognitive and cultural systems, and thereby gain a better understanding of how creativity may be instilled into artificial systems.

The generalised picture describes a situation in which the constraints of the system initiate dynamics, and the dynamics may feed back to affect (select or modify) the constraints. In a situation such as this, the system may exhibit behaviour which cannot be explained purely by the laws of dynamics, but only with reference to the particular history through which the system has evolved from its initial to current state. This mutual interaction (or 'creative dance') thereby brings forth novel forms of behaviour, the meaning of which can only be understood by considering how the dance itself has evolved over time.

This general description could be applied to a variety of other systems, including the development of human cognitive processes, and the development of human cultural traditions, institutions and artefacts. Consideration of the extent to which such analogies hold between these very different systems, and the commonalities and differences between them, will surely lead to a much deeper understanding of the generative causes of novelty and creativity, and the origin of meaning, in natural systems. And such understanding will suggest ways in which we may create artificial systems with a much deeper capacity for creativity than exhibited by previous attempts.

Keywords: Computational creativity, origin of meaning, artifical life, evolution, biosemiotics

Full Paper: http://drops.dagstuhl.de/opus/volltexte/2009/2207

Self-redundancy in Music

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Where a structural analysis can be produced for a musical artefact, variants of the artefact can often be obtained by 'inverting' the analysis, in much the same way we produce novel sentences from a grammar. The paper describes use of information theory for purposes of deriving structural analyses of sequences, and shows how the method can be used with musical data, for purposes of generating novel musical patterns.

Keywords: Empirical music, cognitive informatics, information theory

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Creative Computers, Improvisation and Intimacy

Michael Young (University of London, GB)

Autonomous musical machine partners, 'live algorithms', are able to collaborate with human improvisers on an equal footing. Adaptability can be a significant factor in human/machine interaction in this context. Intimacy is an additional factor; intimacy might be achieved if human and machine performers can adapt to each other and learn from one another. Previously associated in computer music with ideas of embodiment and HCI, 'intimacy' as more widely understood, refers to the interpersonal process enjoyed between individuals, in which personal self-disclosure finds validation through a partner's response. Real intimacies are learned over time, not designed, and are based upon an evident reciprocity and emergent mutuality. In the context of musical expression, a social – rather than a biological/technological – discourse can be applied to live algorithms with a capacity for learning. This possibility is explored with reference to the author's various improvisation/composition systems including *au(or)a*, *piano_prosthesis*, and *oboe_prosthesis*.

Keywords: Computational creativity, improvisation, intimacy, composition, live algorithm, neural network, computer music, adaptation

Full Paper: http://drops.dagstuhl.de/opus/volltexte/2009/2222