

Biologically Inspired Music, Sound, Art and Design, EvoMUSART 2012

Biologically Inspired Music, Sound, Art and Design, EvoMUSART 2012 virtual worlds. We present a dance performed by avatars in a virtual world, where a computational ecosystem provides a mechanism driving the actions and movements of the avatars. First, we discuss the background and motivations, and describe the performance. Then, we describe the technical aspects of the algorithm driving the choreographic movements. Finally we discuss its critical aspects and contextualise the work with regards to dance practice and evolutionary art history. In the process of this discussion, we emphasise the advantages of the AI model of computational ecosystems for the animation of non-player-characters.

Biologically Inspired Music, Sound, Art and Design, EvoMUSART 2012 multi-objective evaluation of aesthetics, with the goal of automatically evolving aesthetically pleasing images. This paper investigates the application of similar models of aesthetics towards the evolution of 3-dimensional structures. We extend existing models of aesthetics used for image evaluation to the 3D realm, by considering quantifiable properties of surface geometry. Analyses used include entropy, complexity, deviation from normality,  $1/f$  noise, and symmetry. A new 3D L-system implementation promotes accurate analyses of surface features, as well as productive rule sets when used with genetic programming. Multi-objective evaluation reconciles multiple aesthetic criteria. Experiments resulted in the generation of many models that satisfied multiple criteria. A human survey was conducted, and survey takers showed a clear preference for high-fitness highly-evolved models over low-fitness unevolved ones. This research shows that aesthetic evolution of 3D structures is a promising new research area for evolutionary art.

Biologically Inspired Music, Sound, Art and Design, EvoMUSART 2012 This paper describes an evolutionary design tool that enables the architect to directly interact with the encoding of designs they find aesthetically pleasing. Broadening interaction beyond simple evaluation increases the amount of feedback and bias a user can apply to the search. Increased feedback will have the effect of directing the algorithm to more fruitful areas of the search space. We conduct user trials on an interface for making localised changes to an individual and evaluate if it is capable of directing search. Examination of the locality of changes made by the users provides an insight into how they explore the search space.

Biologically Inspired Music, Sound, Art and Design, EvoMUSART 2012 images, and how these can be interpreted as describing the placement of objects in a scene for generative painting projects. Building the library to contain only markedly distinct images necessitated a machine learning approach, whereby two decision trees were derived to predict visual similarity in pairs of images. The first tree uses genotypical information to predict before image generation whether two images will be too similar. The second tree uses phenotypical information, namely how pairs of images differ when segmented using various distance thresholds. Taken together, the trees are highly effective at quickly predicting when two images are similar, and we used this in an evolutionary search where non-unique individuals are pruned, to build up the library. We show how the pruning approach can be used alongside a fitness function to increase the yield of images with certain properties, such as low/high colour variety, symmetry and contrast.

Biologically Inspired Music, Sound, Art and Design, EvoMUSART 2012 the use of Scalable Vector Graphics as a genotype representation in evolutionary art. In previous work we investigated the feasibility of SVG as a genetic representation for evolutionary art, and found that the representation was very flexible, but that the potential visual output was somewhat limited by the simplicity of our genetic operators. In this paper we extend on this work, and introduce various new, more expressive genetic operators for SVG. We show that SVG is a flexible and powerful representation for evolutionary art, and that the potential visual output is only limited by the design of the genetic operators. With the genetic operators that we describe in this paper, we are able to evolve art that is visually similar to screen printing art and pop art.

Biologically Inspired Music, Sound, Art and Design, EvoMUSART 2012 exploitation, because users are typically more interested in evolving a collection of diverse images than converging to a single ‘optimal’ image. However, maintaining diversity is a difficult task. In this paper we investigate various techniques to promote population diversity in evolutionary art. We introduce customised mutation and crossover operators that perform a local search to diversify individuals and evaluate the effect of these operators on population diversity. We also investigate alternatives for the fitness crowding operator in NSGA-II; we use a genotype and a phenotype distance function to calculate the crowding distance and investigate their effect on population diversity.

Biologically Inspired Music, Sound, Art and Design, EvoMUSART 2012 as individuals within a population, and that the audible evolution of populations over time are of musical interest. The

system additionally uses genetic algorithms to generate high level musical aspects that control how the population is presented, and how it may be combined with other populations. These algorithms feature fitness functions that adapt based upon context: specifically, by using an analysis of the evolving population, the fitness functions adjust their constituent parameters in selecting strong individuals.

Biologically Inspired Music, Sound, Art and Design, EvoMUSART 2012 systems. Among the tags usually employed for classifying music, genre is a prominent one. This paper presents an ensemble of classifiers that uses a hybrid genetic fuzzy approach. By using a set of Fuzzy Rule Based Systems automatically tuned by means of a Genetic Algorithm, and structured in two layers, the system is capable of correctly classifying classical and jazz samples randomly chosen from a wide set of authors and styles. The ensemble is built on top of a previously developed method that profits from non-precise information by using Fuzzy Systems. The inherently ambiguous information frequently related to music genre is properly managed by a Fuzzy Rule Based System that focuses on random samples extracted from the audio to be analysed. A set of these Fuzzy Rule Based Systems are then applied simultaneously to a number of samples, and the final system is in charge of processing the partial information obtained by each of the Fuzzy Rule Based System. The experimental setup and results take into account harmonic principles and their relationship with the specific genre considered. The system is capable of providing good classification accuracy by using an extremely narrow set of features.

Birdsongs Biologically Inspired Music, Sound, Art and Design, EvoMUSART 2012 an ecological network of sonic agents whose interaction is self-organised into an open complex system of similar cognitive characteristics, at the same time that it continuously generates original acoustic data. This work presents a preliminary study on the development of an evolutionary algorithm for the generation of an artificial soundscape of bird songs. This computational environment is created by genetic operators that dynamically generate sequences of control parameters for computational models of bird songs, given by the physical model of a syrinx. This system is capable of emulating a wide range of realistic birdsongs and generating with them a network of bird calls. The result here presented is an artificial evolutionary soundscape that is also interactive, as it can receive external data, such as from instant text messages like the ones from the micro-blog Twitter, and map them as the genotype of new individuals belonging to a dynamic population of artificial bird songs.

Biologically Inspired Music, Sound, Art and Design, EvoMUSART 2012 robots. We describe the primitive assembly language that we designed to use for the genome for a drawing robot in order to facilitate controller evolution, as well as the corresponding structure and execution of the decision tree phenotype it supports. Our controllers are modelled after controllers that have been evolved for video games such as Mario Bros. We present some preliminary examples of evolved controller robot drawings.

Collaborative Search Biologically Inspired Music, Sound, Art and Design, EvoMUSART 2012 technique that uses human input to make subjective decisions on potential problem solutions. But humans are slow and get bored and tired easily, limiting the usefulness of IEAs. Here we describe our system which works toward overcoming these problems, The Approximate User (TAU), and also a simulated user as a means to test IEAs. With TAU, as the user interacts with the IEA a model of the user's preferences is constructed and continually refined and this model is what is used as the fitness function to drive evolutionary search. The resulting system is a step toward our longer term goal of building a human-computer collaborative search system. In comparing the TAU IEA against a basic IEA it is found that TAU is 2.5 times faster and 15 times more reliable at producing near optimal results.

Used? Biologically Inspired Music, Sound, Art and Design, EvoMUSART 2012 taxonomy is presented of the ways in which fitness is used in such systems, with two dimensions: what the fitness function is applied to, and the basis by which the function is constructed. Papers from a large collection are classified using this taxonomy. The paper then discusses a number of ideas that have not be used for fitness evaluation in evolutionary art and which might be valuable in future developments: memory, scaffolding, connotation and web search.

finding aesthetic measures for sound Biologically Inspired Music, Sound, Art and Design, EvoMUSART 2012 modelling human conception of sound is a challenging task and has motivated several research works. It is not only targeted to the creation of automatic music composers and raters, but also reinforces the research for a deeper understanding of human noesis. The aim of this work is twofold: first, it proposes an Interactive Evolution system that uses Genetic Programming to evolve simple 8-bit melodies. The results obtained by subjective tests indicate that evolution is driven towards more user-preferable sounds. In turn, by monitoring features of the melodies in different evolution stages,

indications are provided that some sound features may subsume information about aesthetic criteria. The results are promising and signify that further study of aesthetic preference through Interactive Evolution may accelerate the progress towards defining aesthetic measures for sound and music.

Art Biologically Inspired Music, Sound, Art and Design, EvoMUSART 2012 judgements in an evolutionary art system. We evolve genetic art with our evolutionary art system, BioEAS, by using genetic programming and an aesthetic learning model. The model is built by learning both phenotype and genotype features, which we extracted from internal evolutionary images and external real world paintings, which could lead to more interesting paths. By learning aesthetic judgment and applying the knowledge to evolve aesthetical images, the model helps user to automate the process of evolutionary process. Several independent experimental results show that our system is efficient to reduce user fatigue in evolving art.

Biologically Inspired Music, Sound, Art and Design, EvoMUSART 2012 a musical space and the metaphor of composition as the musical expression of a travelling experience in that space. A Progressive Percussion Graph is a directed graph where each node is associated with a particular percussion rhythm and each connection corresponds to a rhythmic progression, generated through optimization processes, from one percussion rhythm to another, respecting the connection's direction. We have explored different optimization techniques and different path-finding algorithms resulting in a rich and diverse musical output.

Biologically Inspired Music, Sound, Art and Design, EvoMUSART 2012 timbre distinguish between five musical instruments. Using only simple arithmetic and Boolean operators with 95 features as terminals, a program is developed that can classify 300 unseen samples with an accuracy of 94percent. The experiment is then run again using only 14 of the most often chosen features. Limiting the features in this way raised the best classification to 94.3percent and the average accuracy from 68.2percent to 75.67percent. This demonstrates that not only can GP be used to create a classifier but it can be used to determine the best features to choose for accurate musical instrument classification, giving an insight into timbre.

Biologically Inspired Music, Sound, Art and Design, EvoMUSART 2012 Assignment, Face Detection engine is explored. The framework is instantiated using an off-the-shelf face detection system and a general purpose, expression-based, genetic programming engine. By default, the classifier returns a binary output, which is inadequate to guide evolution. By retrieving information provided by intermediate results of the classification task, it became possible to develop a suitable fitness function. The experimental results show the ability of the system to evolve images that are classified as faces. A subjective analysis also reveals the unexpected nature and artistic potential of the evolved images.

Biologically Inspired Music, Sound, Art and Design, EvoMUSART 2012 representation is based on graph grammars, a fascinating and powerful formalism in which sub-graphs, nodes and edges are iteratively rewritten by rules analogous to those of context-free grammars and shape grammars. The nodes of the resulting derived graph are labelled with Euclidean coordinates: therefore the graph fully represents a 3D beam design. Results from user-guided runs are reported, demonstrating the flexibility of the representation. Comparison with results using an alternative graph representation demonstrates that the graph grammar search space is rich in appealing, organised designs. A set of numerical graph features are defined in an attempt to computationally distinguish between good and bad areas of the search space, leading to the definition of a computational fitness function and non-interactive runs.

Swarm Optimisation Biologically Inspired Music, Sound, Art and Design, EvoMUSART 2012 optimisation task if the classifiers of all possible polyphonic combinations could be learnt beforehand. However, it is impractical to learn all possible classification models in real life due to the exponential explosion of all possible polyphonic combinations. Here, we describe a novel polyphonic transcription approach that applies a hybrid of the Particle Swarm Optimisation (PSO) and the Tone-model techniques. This hybrid approach exploits the strengths from both the heuristic-search and the model based approaches. In our work, only the monophonic Tone-models of all pitches are learnt and employed to calculate the first pass output of polyphonic transcription, which is then refined in the second pass by PSO. The experimental results show that the proposed hybrid approach outperform the competing Non-negative Matrix Factorisation (NMF) approach. This paper presents and discusses the design and the experimental results of this novel approach.

Biologically Inspired Music, Sound, Art and Design, EvoMUSART 2012 reinforcement learning, adaptive resonance theory new concepts and ideas, is a significant challenge. Machine learning models make advances in this direction but are typically limited to reproducing already known material.

Self-motivated reinforcement learning models present new possibilities in computational creativity, conceptually mimicking human learning to enable automated discovery of interesting or surprising patterns. This work describes a musical intrinsically motivated reinforcement learning model, built on adaptive resonance theory algorithms, towards the goal of producing humanly valuable creative music. The capabilities of the prototype system are examined through a series of short, promising compositions, revealing an extreme sensitivity to feature selection and parameter settings, and the need for further development of hierarchical models.