On Evil and Computational Creativity

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Abstract. This work introduces one swarm intelligence algorithm, Stochastic Diffusion Search – mimicking the foraging behaviour of one species of ants, *Leptothorax acervorum* and one physiological mechanism – imitating the behaviour of Human Immunodeficiency Virus. The aim is to outline a novel integration strategy deploying the search capabilities of the swarm intelligence algorithm and the destructive power of the digital virus. The swarm intelligence algorithm determines the colour attribute of the dynamic areas of interest within the input image, and the digital virus modifies the state of the input image, creating the projection of 'evil' over time (evil is hereby used as both an extension to freedom and a destructive force). This paper touches upon the concept of evil in the context of creativity in general, and computational creativity in particular. It concludes by exploring the creativity of the hybrid system in the light of the philosophical concept of evil.

1 Introduction

In the last few decades, investigating the behaviour of social animals and social insects has brought to life several new metaheuristics in the context of collective intelligence. Natural examples of collective or swarm intelligence that exhibit a form of social interaction are, among others, fish schooling, birds flocking, ant colonies in nesting and foraging, bacterial growth, animal herding and brood sorting.

Various aspects of producing artistic works through the use of swarm intelligence techniques have already been explored. A-Life (Artificial Life), where the boundary between biology and artificial intelligence is blurred [17], inspired many artists and researchers in computer graphics to investigate this area. Among the direct responses to A-Life are some works by Karl Sims (e.g. [24]). In an earlier work, Harold Cohen used techniques of artificial intelligence to produce art and developed a computer program, AARON, which created drawings as well as paintings [18].

Following other works in the field of swarm paintings ([4, 21, 27]) and ant colony paintings ([13, 20]), the output images presented here – created by a swarm intelligence algorithm and a digital virus – are used as a platform to explore whether or not the system has the potential to exhibit computational creativity. One of the chief goals here is to use the visual examples given to initiate a discussion on the role of destruction in computational creativity.

In this paper, the swarm intelligence algorithm used is explained first, and subsequently the physiological mechanism of the virus is briefly presented. Afterwards, some details are given on the way the swarm intelligence algorithm and the virus mechanism are hybridised; the behaviour of the virus in the system is contextualised and the process through which the hybrid system contributes to creating artistic works is explained. A discussion on creativity in general and the philosophical concept of evil will then follow. Whether the hybrid system exhibits computationally creativity is explored next. Finally, suggestions for possible future research can be found at the end, along with the conclusion.

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2 Stochastic Diffusion Search

This section introduces Stochastic Diffusion Search (SDS) [5, 1], a multi-agent global search and optimisation algorithm which is based on simple interaction of agents. This algorithm is inspired by one species of ants, *Leptothorax acervorum*, where a 'tandem calling' mechanism (i.e. one-to-one communication) is used: the forager ant finds the food location and recruits a single ant upon its return to the nest, physically publicising the location of the food [19]). In SDS, direct one-to-one communication (which is similar to tandem calling recruitment) is utilised.

SDS introduces a probabilistic approach for solving best-fit pattern recognition and matching problems. As a multi-agent population-based global search and optimisation algorithm, SDS is a distributed mode of computation utilising interaction between simple agents.

Unlike many nature inspired search algorithms, SDS has a strong mathematical framework, which describes the behaviour of the algorithm by investigating its resource allocation, convergence to global optimum, robustness and minimal convergence criteria and linear time complexity.

2.1 SDS Architecture

The SDS algorithm commences a search or optimisation by initialising its population. In any SDS search, each agent maintains a hypothesis, h, defining a possible problem solution. After initialisation, two phases are followed (see Algorithm 1):

Algorithm 1 SDS Algorithm

```
Initialising agents()
While (stopping condition is not met)
   Testing hypotheses()
   Diffusion hypotheses()
End While
```

In the test phase, SDS checks whether the agent hypothesis is successful or not by performing a partial hypothesis evaluation which returns a boolean value (e.g. active or inactive). Later in the iteration, contingent on the precise recruitment strategy employed, successful hypotheses diffuse across the population; this way, information on potentially good solutions spreads throughout the entire population of agents.

2.2 Standard SDS and Passive Recruitment

In standard SDS (as used in this paper), *passive recruitment mode* is employed. In this mode, if the agent is inactive, a second agent is randomly selected for diffusion. If the second agent is active, its hypothesis is communicated (*diffused*) to the inactive one; otherwise there is no flow of information between agents and a completely new hypothesis is generated for the first inactive agent at random instead (see Algorithm 2).

Algorithm 2 Passive Recruitment Mode

```
For ag = 1 to No_of_agents
   If (ag is not active)
      r_ag = pick a random agent()
      If (r_ag is active)
         ag.setHypothesis(r_ag.getHypothesis())
      Else
         ag.setHypothesis(randomHypothsis())
      End If/Else
   End If
End For
```

3 Physiological Mechanism

The progression of Human Immunodeficiency Virus (HIV) infection to Acquired Immune Deficiency Syndrome (AIDS) involves two distinct phases, from the initial phase of acute infection to the development of an opportunistic disease.

When entering the body, the virus causes an acute infection, mainly targeting the white blood cells responsible for defending the body [16]. These cells mount an attack to destroy the virus on its entrance; however, the virus conceals itself by inserting its genetic into the cells and using their material to replicate inside them, eventually destroying them.

The process causes a high depletion of T-cells over a period of time that can last up to 10-12 years [15]. This ultimately leads in ineffective, cell-mediated and humoral responses to HIV resulting to a chronic phase of infection, which is characterized by persistent immune activation and progressive decline of the naïve and memory T-cells. The continuously active immune system loses its defending cells and turns inefficient. In other words, during the chronic phase of the illness, the system loses its ability to fight and the patient will be prone to opportunistic diseases[3].

4 Hybrid Swarm Algorithm and Virus Mechanism

This section details the process through which the swarm intelligence algorithm is coupled with digital virus to create a visual piece based on an input image.

As stated in the earlier sections, each SDS agent has two components: the status and the hypothesis. The status is a boolean value, and the hypothesis is the (x, y) coordinate pointing to the colour attribute (i.e. RGB values) of a particular pixel within the search space (input image).

The physiological mechanism of the virus is loosely borrowed in this work and it offers three distinctive features that are incorporated in the hybrid system:

- identifying the white blood cells
- destroying the cells
- spreading of the virus throughout the system

These three features are integrated in the hybrid system as detailed below:

- Following the analogy of the virus identifying the white blood cells, the brightest colour within the image is identified and the coordinate of the relevant pixel is recorded (see Fig. 1)
- The located pixel is set as the model or goal for SDS.
- SDS agents are initialised throughout the search space
- SDS iterates n times through the test and diffusion phases ($n = 100$)
  - During the test phase, the colour of the pixel where each agent resides is compared against that of the identified brightest pixel; if the RGB distance between the two colours is less than the distance threshold, $d_t = 5$, the agent is set active, otherwise it is set inactive
  - In the diffusion phase, as in standard SDS, each inactive agent randomly picks another one. If the randomly selected agent is active, the inactive agent adopts the (x, y) coordinate of the active agent (with a Gaussian random distance, $\sigma = 5$). However, if the selected agent is inactive, the selecting agent generates a random (x, y) coordinate from the search space.
- After n iterations of test and diffusion phases, the average colour of the agents is calculated and then visualised on the output canvas on the right side of each snapshot (see Fig. 2).
- The pixel with the brightest colour and the pixels where the active agents are residing are removed from the input image (i.e. the digital virus destroys the identified 'white' cells/pixels).

This process is repeated until all the pixels from the input image are removed and the output image is complete. In other words, this process gives rise to the destruction of the entire pixels of the input image and creates a visualisation that, while non-identical to the original image, still representative of it.

The initial number of agents is 10; this number (representing the number of digital virus) increases with the ratio of 0.1 after each $1,000$ full system iterations (SDS cycle and physiological mechanism).

5 Discussion on Creativity

This section presents a discussion on whether the hybrid swarm algorithm and the physiological mechanism have the potential to exhibit 'computational creativity' in what they visualise and/or in the way they interact. It also investigates whether inducing 'evil' in such system has any impact on its creativity. First, the role of freedom on art and creativity is discussed and then the link between freedom and evil (as a destructive force) is explored.

5.1 On Freedom and Art

For many years, there have been discussions on the relationship between art, creativity and freedom, a debate that is elegantly encapsulated in the famous German prose by Ludwig Hevesi, situated at the entrance of the Secession Building in Vienna:

> *"Der Zeit ihre Kunst*
> *Der Kunst ihre Freiheit"*

[3] Thanks to Dr Ahmed Aber, from the Department of Cardiovascular Sciences, University of Leicester Royal Infirmary, Leicester, UK for his contribution to this part of the paper.

Figure 2. The Hybrid Swarm Intelligence and Evil System. The images are recorded after every $5,000$ full system iterations. The top-left image is the first and the bottom-right image is the last displayed snapshot of the system.

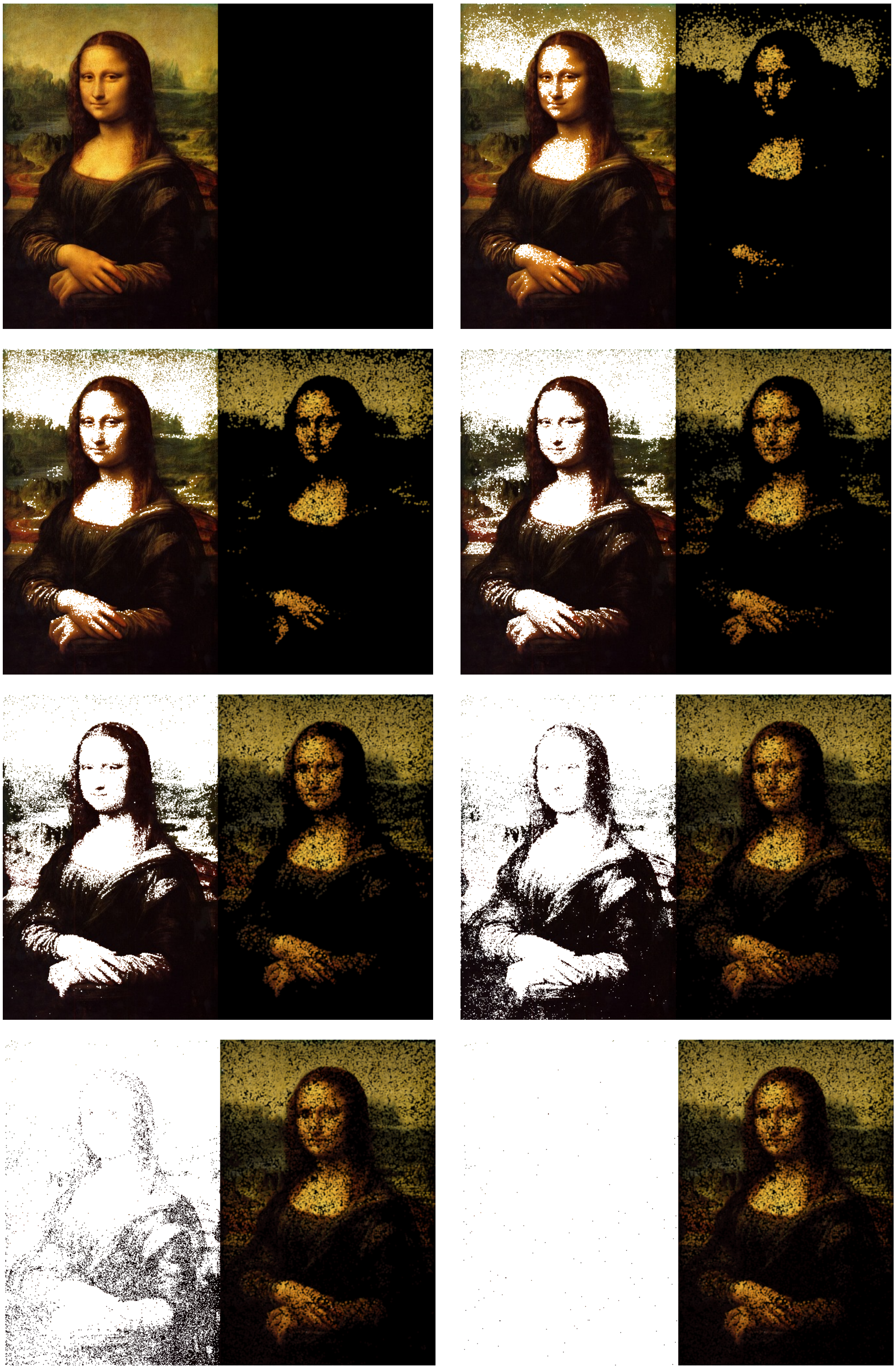
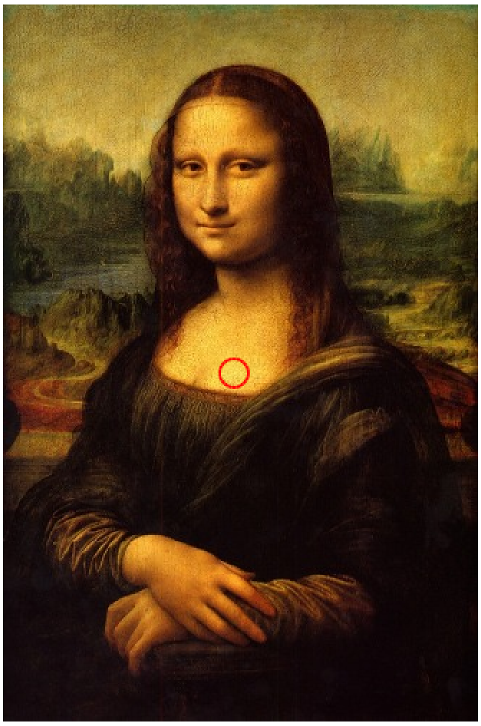


Figure 1. Input image, where the area of the pixel with the brightest colour is highlighted.



("To Time its Art; To Art its Freedom")

Which, centuries after, resonates with an earlier observation from Aristotle [11] emphasising the importance of freedom (here, having "a tincture of madness") in presenting a creative act.

> *"There was never a genius without a tincture of madness."*

More recently, Boden [7] argues that creativity has an ambiguous relationship with freedom:

> *"A style is a (culturally favoured) space of structural possibilities: not a painting, but a way of painting. Or a way of sculpting, or of composing fugues .. [] .. It's partly because of these [thinking] styles that creativity has an ambiguous relationship with freedom."*

Amongst definitions that have been given to creativity (around sixty, as stated by Taylor [26]) several explore 'combinational creativity', which is defined as *"the generation of unfamiliar combinations of familiar ideas"* [6]. This is a category we suggest the presented outputs best fit in.

Considering the many factors constituting the evaluation of what is deemed creative raises core issues regarding how humans evaluate creativity, their aesthetic capacity and, potentially, that of other animals (as exhibited in, for example, mate-selection). Galanter [12] suggests that perhaps the 'computational equivalent' of a bird or an insect (e.g. in evaluating mate selection) is all that is required for computational aesthetic evaluation:

> *"This provides some hope for those who would follow a psychological path to computational aesthetic evaluation, because creatures with simpler brains than man practice mate selection."*

In this context, as suggested in [10], the tastes of the individual in male bowerbirds are made visible when they gather collections of bones, glass, pebbles, shells, fruit, plastic and metal scraps from their environment, which they then arrange to attract females [8]:

> *"They perform a mating dance within a specially prepared display court. The characteristics of an individual's dance or artefact display are specific to the species, but also to the capabilities and, apparently, the tastes of the individual."*

However, the question of whether *'mate selection behaviour in animals implies making a judgement analogous to aesthetic judgement in humans'* is perhaps (pace Nagel's famous discussion 'What is it like to be a bat? '[22]) a fundamentally unanswerable question.

Discussion on creativity and the conditions which make a particular work creative have generated heated debates amongst scientists and philosophers for years [23]; for a theoretical review on 'conditions of creativity', the 'systems' view of creativity, cognitive approaches, etc see [25]. Although this article does not aim to resolve any of these issues (or even suggest that the presented work strongly fits and endorses the category of the 'computationally creative realm'), it presents an investigation of the performance of a novel hybrid swarm intelligence and physiological painting system. Works of this nature have previously been viewed through the philosophical lens of Deleuze, offering new insights on the putative creativity, autonomy and authorship of the resulting system [3].

5.2 Computational Creativity of the 'Evil' System

As stated by James [14], the more we learn about certain concepts, the harder they become to define. The concept of evil is no exception, and despite all the attempts, its definition remains incomplete and incomprehensive; Wittgenstein [28, 29], while acknowledging that language is an indispensable tool, argues that what can be said in words is finite and necessarily approximate.

Therefore, in this work, we focus on one out of many definitions of evil, paying particular attention to evil as an extension to freedom or, put differently, evil surfacing with the excessive use of the underlying freedom. Richard Worsley argues that evil is a consequence of human freedom; he states that human evil is a matter of choice, but a destructive choice: a 'destructiveness of imperfection or excess' [30] (p.144).

This section raises a question about the 'creativity' of the manifestations of evil. In 'Anger, Madness, and the Daimonic: The Psychological Genesis of Violence, Evil, and Creativity' [9], the link between evil and creativity is discussed in detail; furthermore, a link is made between repressing anger (defined as a form of evil) and repressing creativity:

> *"Our culture requires that we repress most of our anger, and, therefore, we are repressing most of our creativity".*

In the example presented in this paper if the destructive or 'evil' power of the system (represented through the radius of the digital virus) is increased, it allows the digital virus to inflict a greater impact on the input image; as a result, the generated image has less resemblance to the original image.

As shown in Fig. 3, if there exists a gradual increase in the destructive nature of the digital virus, the output images exhibit a gradual distance from an (almost) identical representations (e.g. Fig. 3 top images) of the input image towards different yet recognisable representations (e.g. Fig. 3 middle images); and then with further increase in the 'dose of evil' the output images illustrate increasing lose of fidelity towards the original image (e.g. Fig. 3 bottom images).

When more 'evil' (or destructive power) is applied, the hybrid painting system soon begins to deviate from the original image. For this reason, excessively increasing the 'dose of evil' results in a very poor – low fidelity – interpretation of the original image. In contrast, if the digital virus 'moderately' impacts the input image as it spreads on the canvas, the generated image maintains a recognisable fidelity to the input. It can be seen that by simply extending a basic physiological mechanism (i.e. inducing more destructive force) it fails to demonstrate that more 'creative images' would be produced.

A question is raised here as to how to control the extent of evil, which is perhaps where the 'creativity' lies, and the area where the computer needs to be in control in order to demonstrate the sought after computational 'creativity'. What can be stated now is that controlling the dose of evil or freedom (or the '*tincture of madness*') exhibited by the hybrid system is crucial to the resultant work.

6 Conclusion

In this paper, we have discussed the potential of the hybrid system in exhibiting (weak) computational creativity[4]. The work described herein uses a swarm intelligence technique (Stochastic Diffusion Search) along with a physiological mechanism (Human Immunodeficiency Virus) as tools to explore the impact of 'evil' – as an extended form of freedom and a destructive force – in creating artworks; as such, the role of destruction in creativity is briefly discussed. This work has shown the influence of the 'dose of evil' (or the impact of digital destruction) on the output of the collaborative system. We emphasised on the significant of controlling the intensity of destruction on the emergent creativity, and presented a discussion on how these concepts are mapped onto the hybrid system.

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Figure 3. Increasing the 'dose of evil' and its impact on the system. The images are recorded after every $5,000$ full system iterations.