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## RESEARCH ARTICLE

# Analyzing and discussing primary creative traits of a robotic artist



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Received 11 June 2016; accepted 26 July 2016

### KEYWORDS

Cognitive architecture;  
Computational creativity;  
Humanoid robot

### Abstract

We present a robot aimed at producing a collage formed by a mix of photomontage and digital collage. The artwork is created after a visual and verbal interaction with a human user. The proposed system, through a cognitive architecture, allows the robot to manage the three different phases of the real-time artwork process: (i) taking inspiration from information captured during the postural and verbal interaction with the human user and from the analysis of his/her social web items; (ii) performing a creative process to obtain a model of the artwork; (iii) executing the creative collage composition and providing a significant title. The paper explains, primarily, how the creativity traits of the robot are implemented in the proposed architecture: how ideas are generated through an elaboration that is modulated by affective influences; how the personality and the artistic behavior are modeled by learning and guided by external evaluations; the motivation and the confidence evolution as a function of successes or failures.

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## Introduction

In 1961, Rhodes (1961) discussed in a famous article some basilar principles of creativity, proposing the relevant strands that have influenced and inspired researchers on this topic. Rhodes, analyzing the human creativity, individuated the four strands that are well-known as the big Ps: people, processes, press, products. Nowadays, the scientific field dealing with creativity is huge and variegated, and it

also comprises the artificial branch named computational creativity (Colton, Pease, & Charnley, 2011; Wiggins, 2006). Our approach to artificial creativity, in the present work, has various points of contact with Rhodes analysis. The artificial creative agent has to exhibit cognitive capabilities that are typical of a human being, such as personality, habits, attitudes, and so on. The production of an artwork is the result of a creative act that depends on the experience and expertise of the artist and that it is strongly influenced by motivation, emotions, learning and communicative capabilities.

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Products are the tangible outcomes of ideas and they are characterized by the media of expression, by the emotional impact on the subject who experiences the artwork, and by their intrinsic value (e.g. aesthetic, utility, and so on).

In recent years, robotic systems are available at a reduced cost and with increased performances allowing cognitive researchers to experiment their developed models in embodied artificial agents and exploring different artistic domains such as dance, music, drama, painting. On the other hand, robotic researchers have the possibility to test the robots social behaviors in the real environment while they interact with humans by means of suitable artificial cognitive architectures (CAs). We think that a CA is mandatory to establish a meaningful connection between robots and humans to express a concept or transmit a message.

The quality of the artistic creation can be bound to the assessable bunch of meaning that is possible associate to an artistic piece (Pound, 1934). In this paper we consider the creation of an artwork as a collage whose meaning can be obtained with the proper composition of elementary items.

While some skillful aspects may be undertaken by the computer, the intent that deals with the creation of the artefact and its related meaning depends on the developer who drives the process; this is one of the reason why systems undertaking creative tasks might be perceived as not being creative (Krzeczkowska, El-Hage, Colton, & Clark, 2010). A system that creates an output endowed with an intent has been proposed by Krzeczkowska et al. (2010) and Cook and Colton (2011). The system searches for news articles in order to find information that is related with a given concept, then, a set of images are selected and they are properly put together in a collage by exploiting services of image retrieval and image processing.

Similarities and analogies play also a key role in the generation of new ideas that is at the basis of creative processes (Indurkha & Ogawa, 2012; Stojanov & Indurkha, 2013). In the specific case of collage creation, they are fundamental for the selection of the items to compose. An agent, interacting with the environment, stores in its memory the most salient aspects of its perceptions. The stored concepts can be recalled when the agent experiences something similar, also if the new experience involves different sensing quantities.

In this paper, the humanoid starts the collage creation, it informally takes inspiration, from a verbal interaction with a human user and from the collection of web items that she/he has published on his social network profile. The inspiration phase is strongly influenced by the semantic associations between the humanoid perceptions and the elements of the creative language of the artist. In particular the symbols of the artistic language used by the collagist are pictorial elements that are stored in its long term memory and can be used to compose the collage. The inspiration is characterized by evoking pictorial elements which are considered similar to the information acquired from the user through a dialog. The dialog also triggers an emotional empathy in the robot, that influences its artwork. The artist composes, in an original manner, the "basic terms" of its artistic language, painting them with palettes that are related to the emotions that have been detected during the interaction with the user. When the collage is

completed, the robot creates a title for the artwork through an analysis of the concepts arising during the dialog phase.

The paper is structured as follows: the first section describes how the cognitive architecture supports the creative process and the inspiration phase; then we describe the artwork creation process and finally, in the last section we show some experiments.

## Cognitive architecture supporting collage creation

The creative behavior of the digital artist is modeled through a cognitive architecture depicted in Fig. 1. The digital artist is embodied into the humanoid robot NAO Aldebaran. The NAO is able to draw very simple geometric shapes and to interact with the user by means of a natural language dialog implemented by a chatbot. The collage allows the robot to summarize and express ideas about the people it interacts with and to compose a set of selected pictorial items. This technique allows the robot to expand its limited physical capabilities and to produce a more elaborated artistic result.

The creation of the artwork is based on two phases, an *inspiration* phase, where the robot processes the sensory inputs and as consequence it selects from its LTM the elements and the most adequate styles to use for the artwork creation, and an *execution* phase where the robot physically draws the artistic work.

The inspiration phase is based on the interaction with people, in agreement with the hypothesis that human creativity only makes sense when placed in the context of rich social interactions as shown by Csikszentmihalyi (1988) and Sawyer (2008, 1999).

In this first phase, the robot is endowed with some set of basilar sketches and artistic styles, which constitutes its basic repertoire. The repertoire can be extended with other pictorial elements provided by the user during its interaction with the robot (for example giving some image published into its social network profile). The items (sketches, artistic styles, and images provided by the user) stored in the robot knowledge base constitute the basic "terms" of its artistic language. All the natural language descriptions of the artistic repertoire are mapped into a semantic space, built through the well known Latent Semantic Analysis (LSA) approach, that is well founded for both cognitive (Landauer, Foltz, & Laham, 1998) and statistical (Pilato & Vassallo, 2015) aspects. The use of a semantic space allows the digital artist to enrich its creation with associative/intuitive capabilities. This is a key point, since association and intuition are two peculiar features of human beings in general and artists in particular. In the proposed architecture what the user says is mapped in the semantic space. This information triggers the activation of some basic items of the artistic repertoire of the robot, according to a semantic similarity measure. This representation allows the robot to choose those terms that best fit user profile (or loosely speaking his/her personality).

The recognition of human emotions through a text analysis, influences also the creative process of the robot. In particular, by means of an introspective process, the robot is able to associate a specific color palette to the perceived

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