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Innovative perspectives in the design of intelligent artwork classification algorithms: tools for better human-machine integration

The present research explores an innovative perspective in the design of algorithms for classifying pictorial artworks according to their art style. Avoiding some of the human-machine integration issues associated with machine learning algorithm design, ℓ-SHE is an algorithm based on logical representation and qualitative concepts which in addition to successfully recognizing and classifying the art style of paintings, it works with semantic information, generates explanations of which reasonings have been followed for the classification results, and can easily be trained using relatively small databases.

The use of intelligent algorithms for classifying paintings into different art styles is a widespread subject of investigation in artificial intelligence. Most of the research on this topic uses automatic learning techniques, that is, machine learning techniques where algorithms are designed using neural networks, deep learning, or support vector machines. This kind of technique offers good results, with around 75% of success, but they come with some inconveniences. Often these algorithms do not work using units or operations that are predefined by their designers, which

generates **situations in which is virtually impossible to do an explicit track of the reasonings that lead to a certain discrimination result.** In addition, these systems need training with large databases that require a big load of previous information processing work.

The investigation here presented has been carried out by researchers from the Universitat Autònoma de Barcelona, the Artificial Intelligence Research Institute (CSIC), the Barcelona Graduate School of Mathematics, and the Bremen Spatial Cognition Center (University of Bremen). With the objective of avoiding these previous issues and exploring a human-machine integration perspective, **the authors have designed a painting art style classification algorithm based on logical representation and color qualitative concepts**. The result is ℓ-SHE (ℓogical Style painting classifier based on Horn clauses and Explanations), an algorithm in which the working units and the operations have “human-sized” semantic and representative contents that allow interpretations and explanations of its classification results, just needing a relatively simple training.

The selected art styles for this experiment are the Baroque, Impressionism, and Post-Impressionism styles. Following experts evaluations that defend that there are typical color traits for each style, and using a qualitative color model—based on a color reference system that has been calibrated according to human abilities for differentiating color hue, saturation, and lightness—, the authors have defined the fuzzy color notions that are most representative of each style. **ℓ-SHE’s design is based on three evaluated Horn clauses** (formulas defined in a propositional language expanded with rational constants), each representing a style. According to this proposal’s definitions, it is considered, for example, that Baroque paintings are composed of a combination of color frequencies with little lightness or with an abundance of dark colors, and also with high contrast between dark and light colors, while it is characteristic of the Post-Impressionism to present a high frequency of vivid and warm colors, etc.

Once ℓ-SHE has been calibrated using the QArt-Dataset (with 90 paintings), the obtained classification results do not exceed the best algorithms created with automatic learning techniques, given that the best version of ℓ-SHE has 73.3% success for the QArt-Dataset and 60.2% success for the Painting-91-BIP database (with 256 paintings). Notwithstanding, **this research is pointing to a new perspective in algorithm design,** one which is not the optimal one in terms of classificatory success, but which can present satisfactory results, and in which interaction, and explanatory feedback win terrain as key factors.

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