WAIVS: An Intelligent Interface for Visual Stylometry Using Semantic Workflows

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ABSTRACT

In this paper, we present initial work towards creating an intelligent interface that can act as an open access laboratory for visual stylometry called WAIVS, Workflows for Analysis of Images and Visual Stylometry. WAIVS allows scholars, students, and other interested parties to explore the nature of artistic style using cutting-edge research methods in visual stylometry. We create semantic workflows for this interface using various computer vision algorithms that not only facilitate artistically significant analyses but also impose intelligent semantic constraints on complex analyses. In the interface, we combine these workflows with a manually-curated dataset for analysis of artistic style based on either the school of art or the medium.

CCS CONCEPTS

• **Applied computing** → *Fine arts*; • **Information systems** → Mashups; • **Human-centered computing** → User models;

KEYWORDS

Visual Stylometry, Semantic Workflows, Artistic Style

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1 INTRODUCTION

Visual stylometry combines research and methods from art history, computer science, and cognitive science to help quantify the style of an artist [1, 3]. Research in this field employs image analysis algorithms to study key aspects of artistic style. Instead of relying only on what our senses perceive, we can use artistically relevant computational features and methods to quantify and compare aspects of artistic style over the course of the career of an individual artist, among artists who share in a common artistic style, and across different schools of art.

We have developed a digital image analysis interface for studying paintings that does not require computing or mathematical expertise. This framework, called Workflows for Analysis of Images and Visual Stylometry (WAIVS), allows students and researchers in many disciplines, even those without significant computer skills, to analyze artworks in order to conduct research as well as for art appreciation and analysis.

WAIVS can additionally be used as a pedagogical tool to promote computational literacy and data analytic skills among humanities students, to introduce students in STEM fields to research in art and the humanities, to explore the nature of artistic style and its role in our understanding of artwork, and to help researchers in cognitive science understand how viewers perceptually categorize, recognize, and otherwise engage with artworks.

2 INTERFACE DESIGN PRINCIPLES

The prototype for our intelligent interface, WAIVS (Workflows for Analysis of Images and Visual Stylometry), can act as an open access laboratory for visual stylometry. An example WAIVS analysis is shown in Figure 1. We derived design principles based both on artistically relevant principles, as explained in Section 1, and on the results of a user study workshop.

These design principles are to: Present artistically meaningful algorithms for image analysis: as noted in the user study workshop feedback, researchers and students alike were interested in practical applications, without underlying details of the algorithms, for applications like curatorial research, condition reporting of fine arts, and the ability to analyze images to experiment with styles and for inspiration; Use an artistically-relevant dataset of sample images that can aid the study of artistic style in particular rather

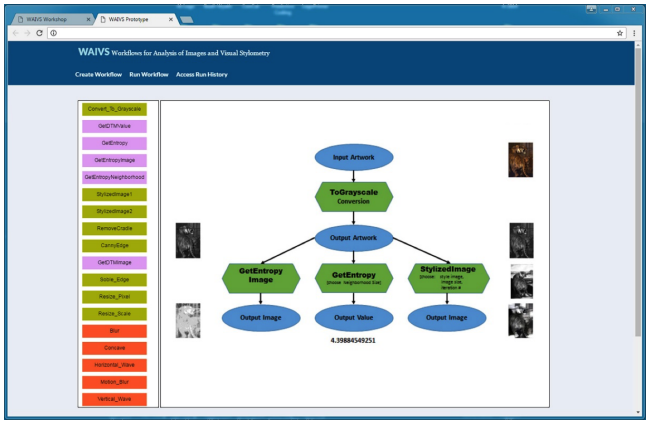

Figure 1: The main WAIVS prototype based on user feedback from the user study workshop.

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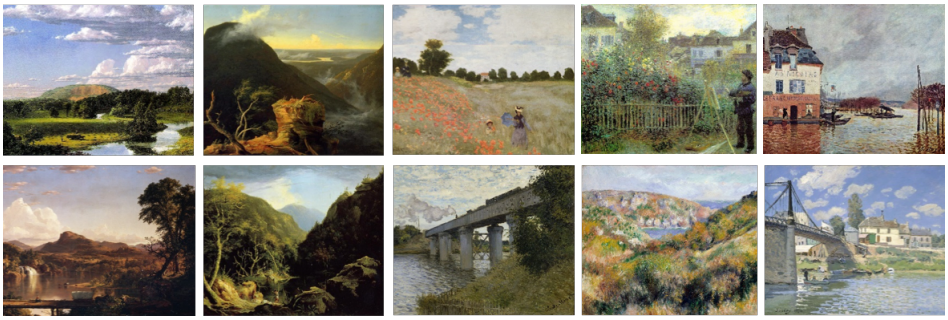

Figure 2: Sample images from the curated dataset

than general art or image analyses; Provide an intelligent interface that can guide humanities researchers and students in conducting complex, compound analyses. The interface needs to guide them in knowing what are valid algorithmic combinations as well as providing a clean, usable interface that's free of computational jargon.

Although many computational techniques have proven to be effective in visual stylometry, there is a significant hurdle to introducing them as a general research tool in the humanities: using these techniques requires expertise in the field-specific computational tools and applications of machine learning algorithms, skills which humanities scholars typically lack. Artists and art historians without such expertise, or access to relevant experts like computer scientists, simply could not use these advanced computational tools to help tame the analysis of their collections. In addition, there is a lack of computational tools that incorporate and specifically implement many of the techniques utilized by philosophers, cognitive scientists, and art historians.

WAIVS is designed around the idea of scientific workflows [5] to help democratize access to advanced computational tools and the leading research tools in visual stylometry. Scientific workflows allow users to build complex applications in the same way they would draw a flowchart, dragging objects representing data sets and image analysis procedures onto the workspace and drawing links between them. Researchers and students can simply drag these graphical boxes without needing to know the implementation details of the underlying machine learning algorithms.

WAIVS allows users to assemble complex combinations of algorithms so that humanities researchers can just run them on any images of interest without needing to create or install complex software to perform experiments. Once the user designs the workflow, they can simply click the run button to execute the program and conduct the analysis. WAIVS uses the WINGS semantic workflow engine to develop and run workflows [2, 4].This allows us to represent the semantic constraints of the algorithms and uses them to ensure their correct use by non-experts.

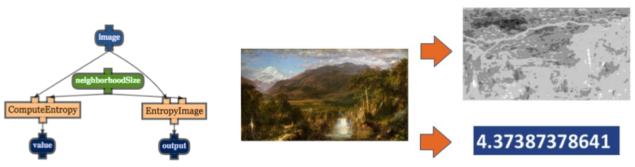

Figure 3: Workflow for calculating entropy: A workflow that generates an entropy value and an entropy image Church's The Heart of the Andes (1859)

For example, a user can easily run the workflow with different images, and can explore how the results differ with different neighborhood sizes. If a user tries to run a workflow with a neighborhood size that is too large, the semantic constraints will generate a warning and suggest that a smaller size be used. Users can easily add new steps to the workflow by dropping new components into the canvas.

We have implemented a broad range of image analysis algorithms currently employed in the visual stylometry literature (e.g., Discrete Tonal Analysis, Entropy Measure, Convolutional Neural Networks, Contourlets, Blurs, Brush-Stroke Analysis, etc.) as scientific workflows. WAIVS includes not just these algorithms but also current image-analysis algorithms employed in computer vision and vision science more generally [2, 4].

The WINGS engine also uses artificial intelligence planning techniques and semantic web languages to capture expert knowledge about setting up the parameters that control the image analysis algorithms, so that users can get recommendations of parameter settings to create valid workflows that work best with their data.

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