SceneLoom: Communicating Data with Scene Context

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1 Introduction

In data-driven storytelling contexts such as data journalism and data videos, data visualizations are often presented alongside real-world imagery to support narrative context. However, these visualizations and contextual images typically remain separated, limiting their combined narrative expressiveness and engagement. Achieving this is challenging due to the need for fine-grained alignment and creative ideation. To address this, we present SceneLoom, a Vision-Language Model (VLM)-powered system that facilitates the coordination of data visualization with real-world imagery based on narrative intents.

2 Methods

Data visualizations and real-world scenes differ fundamentally in information type, perception modes, and communicative goals. This divergence creates tensions in their coordination:

*(1) **semantic gaps** between abstract data encoding and concrete scene semantics,*

*(2) **perceptual competition** when visual channels overlap.*

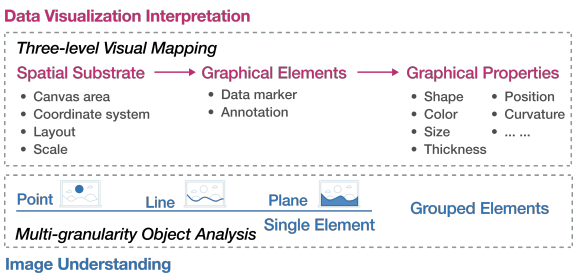


Fig.1 Visual components in data visualization and real-world images.

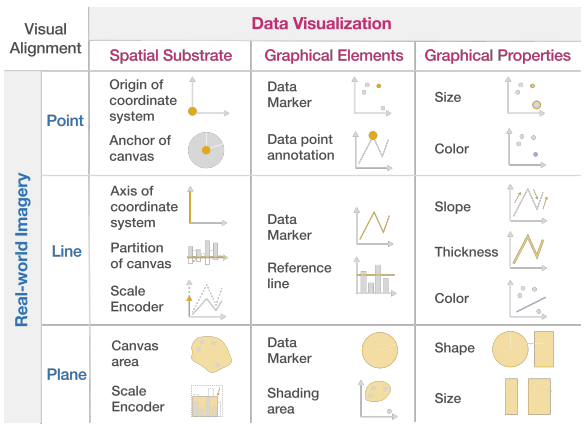


Fig.2 Design space for visual alignment between data visualization and real-world imagery.

Formative Study

To address these issues, we conducted a formative study to analyze design components in data visualizations and real-world scenes, and to derive coordination relationships from both visual and semantic perspectives.

Conducted a corpus analysis of data videos

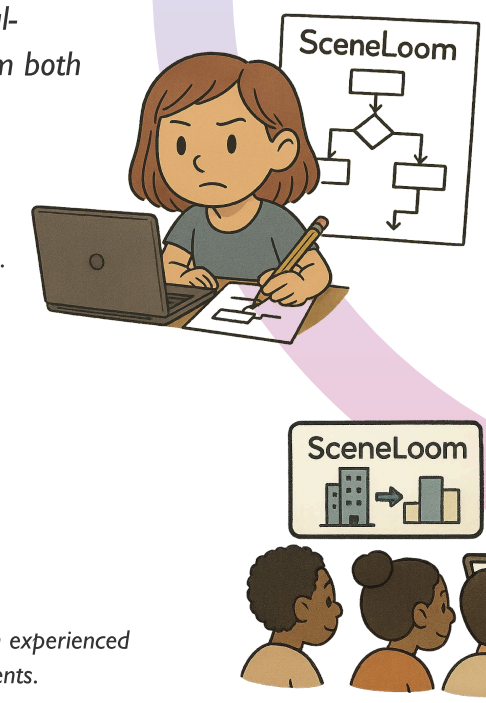
We collected 54 data videos that integrate visualizations with real-world imagery, identifying recurring patterns and common coordination strategies.

Derived a multi-dimensional design space

Based on this analysis, we identified key visual and semantic components from both data visualizations and real-world scenes (Fig. 1) and organized them into a design space structured along two main dimensions: visual alignment, which ensures spatial and perceptual consistency (Fig. 2), and semantic coherence, which maintains meaningful links between data content and scene context.

Validated the design space through expert interviews

To validate the design space, we conducted semi-structured interviews with experienced practitioners, whose feedback confirmed its relevance and guided refinements.



How to coordinate data visualization and real-world scene?

Prototype System

Building on these insights, we developed SceneLoom, a prototype system that applies the coordination strategies through a structured workflow, as illustrated in Fig. 3.

Designed a data preparation module *SceneLoom takes narrative text, structured data, and real-world images as input. It extracts narrative features, generates candidate visualizations, and filters segmented image elements for design coordination.*

Structured a visual perception stage *We introduced a specification format to encode visual and semantic properties of both data visualizations and image elements, supporting consistent interpretation by VLMs.*

Developed a reasoning and mapping process *The core coordination process is guided by four design considerations: spatial organization, shape similarity, layout consistency, and semantic binding.*

- *To ensure accurate alignment, SceneLoom supports both data-level (e.g., filtering and sorting) and view-level (e.g., translation and rotation) adjustments of the visualization while preserving image content.*
- *The system invokes tools via structured prompts to automate these operations and align design components with image elements.*
- *Finally, it evaluates design outcomes based on data accuracy, visual clarity, and attention salience to support user refinement.*

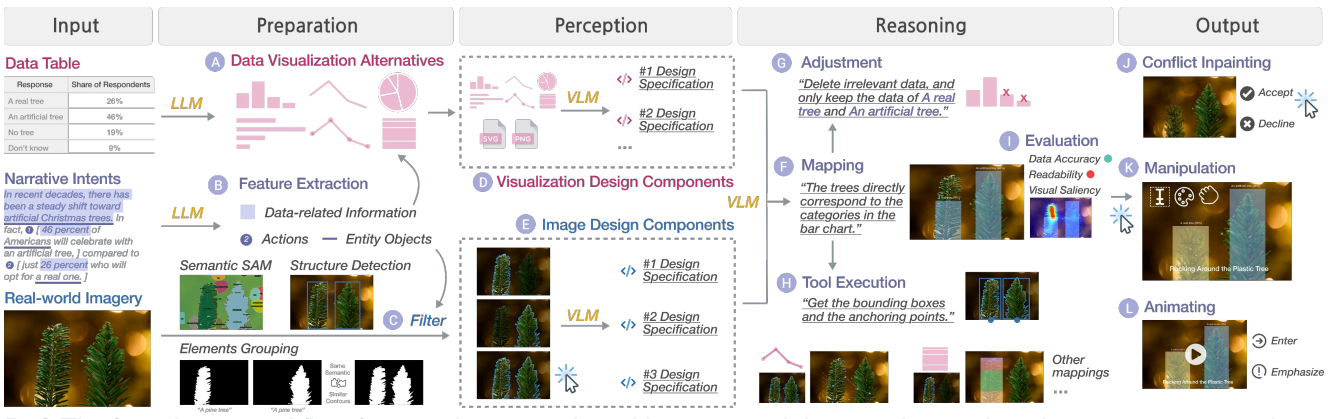


Fig.3 The SceneLoom workflow for coordinating real-world imagery and data visualization based on narrative intent. It consists of five stages: Input, Preparation, Perception, Reasoning, and Output.

3 Evaluation

To demonstrate SceneLoom's expressive potential, we compiled selected design outcomes created by participants.

We also conducted a user study with 10 participants from various domains to evaluate SceneLoom's usability and creative support. As shown in Fig. 4, the system received strong scores in both usability and creativity support, with participants highlighting its guidance, design diversity, and integration of narrative and visual elements. SceneLoom effectively aided ideation, helped externalize and refine designs, and encouraged exploration beyond habitual patterns. While some failure cases revealed limitations in image complexity handling and narrative matching, participants generally found the system engaging and helpful for both concept generation and design iteration.

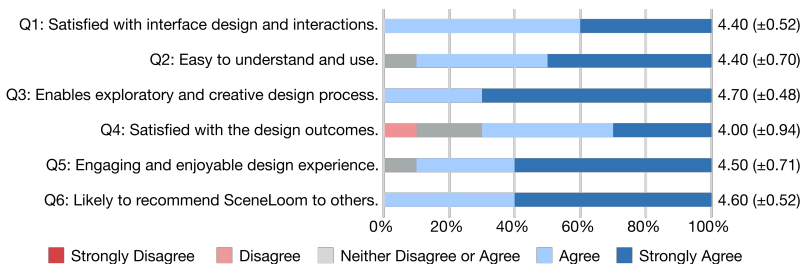


Fig.4 Detailed subjective questions and corresponding user rating results. A 5-point Likert scale was employed to quantify user satisfaction, where a score of 5 represents strong agreement.