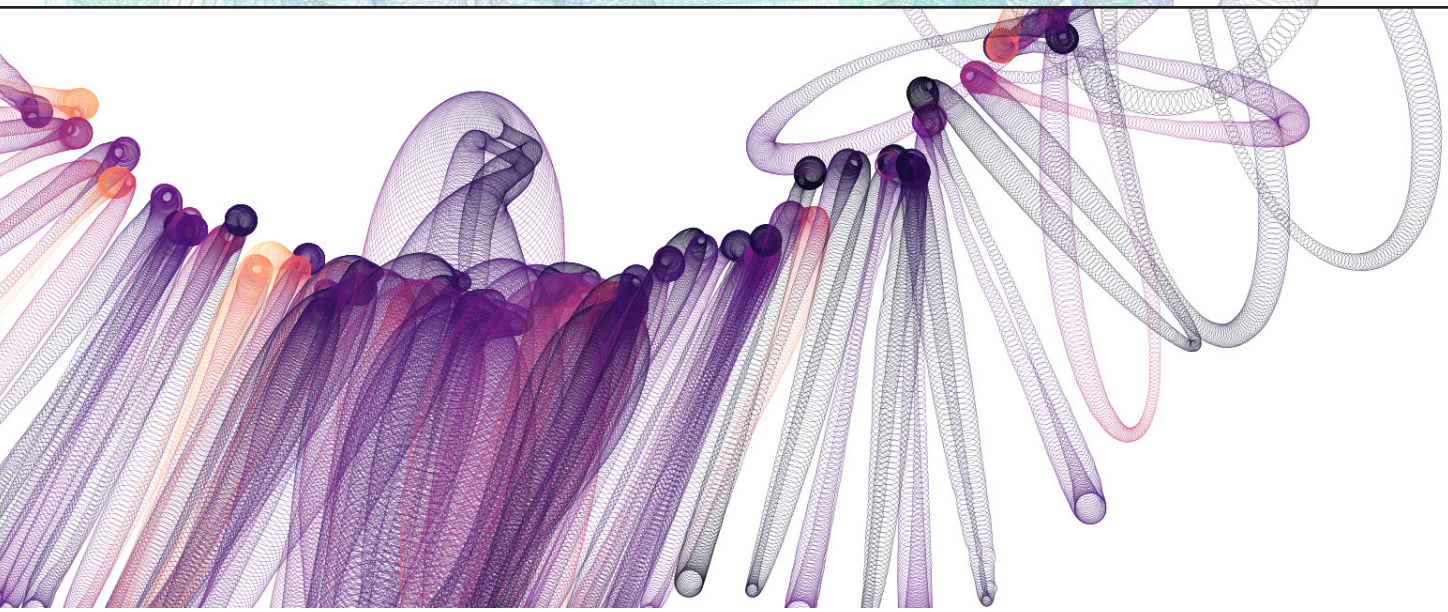


DataMorph

Translating Structured Data into AI-Driven Parametric Art

PGT 60a Reflective Research Report
Samantha Mharie | MSc Data Science and AI in Creative Industries
Norwich University of the Arts, UK, May 2026.

Based on the project:
<https://sammikins31.github.io/DataMorph/>



$$P_{art}(k) = P_{base}(k) + Signal_{csv}(k) \cdot \delta$$

DATA-MORPHED BIRD

EQUATION (DATA-SYNTHESIZED) — DEPRESSION QOF PREVALENCE - 12 CSV

$$X(k) = \sin^{12}\left(\frac{\pi k}{20000}\right) \left[\frac{1}{2} \cos^{14}\left(\frac{35.0000\pi k}{10000}\right) \sin\left(\frac{8.1706\pi k}{10000}\right) + \frac{1}{6} \sin^{20}\left(\frac{35.0000\pi k}{10000}\right) + \frac{3k}{20000} + \cos^6\left(\frac{35.0000\pi k}{10000}\right) \sin\left(\frac{\pi}{2} \left(\frac{k-10000}{10000}\right)^7 - \frac{\pi}{5}\right) \right]$$
$$Y(k) = -\frac{9}{4} \cos^6\left(\frac{35.0000\pi k}{10000}\right) \cos\left(\frac{\pi}{2} \left(\frac{k-10000}{10000}\right)^7 - \frac{\pi}{5}\right) \left[\frac{2}{3} + \sin^4\left(\frac{\pi k}{20000}\right) \sin^4\left(\frac{8\pi k}{20000}\right) \right] + \frac{3}{4} \cos^{10}\left(\frac{3\pi(k-10000)}{100000}\right) \cos^{10}\left(\frac{9\pi(k-10000)}{100000}\right) \cos^{10}\left(\frac{36\pi(k-10000)}{100000}\right) + 0.7 \left(\frac{k-10000}{10000}\right)^2$$
$$R(k) = \sin^{10}\left(\frac{\pi k}{20000}\right) \left[\frac{1}{4} \cos^{10}\left(\frac{35.0000\pi k}{10000}\right) \frac{25\pi}{32} + \frac{1}{20} \cos^2\left(\frac{35.0000\pi k}{10000}\right) + \frac{1}{30} \left(\frac{3}{2} - \cos^2\left(\frac{62\pi k}{10000}\right)\right) \right]$$

INTRODUCTION

In this project, I investigate how structured datasets can be transformed into generative visual systems through the integration of artificial intelligence, statistical modelling, and parametric mathematics. My practice is situated within data-driven computational creativity, with a focus on reconfiguring data beyond analytical representation into dynamic, visually expressive systems.

DataMorph explores how CSV datasets can be operationalised as generative substrates for mathematical systems that produce interactive visual behaviours. Rather than treating data as static numerical artefacts, I position it as an active material capable of shaping spatial organisation, temporal dynamics, and emergent visual structures through computational transformation.

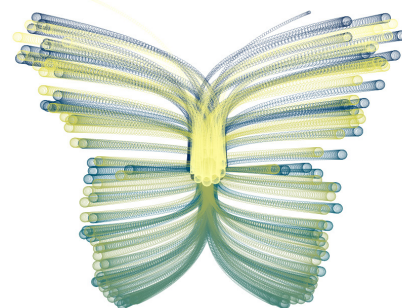
This research is informed by a sustained interdisciplinary academic trajectory, which has shaped both my technical competencies and conceptual framing. My background includes BTEC Interactive Media, a BA (Hons) in Illustration, a Level 5 Diploma in Creative Computing, and my current MSc in Data Science and AI in Creative Industries. Across these stages, my practice has progressively transitioned from visual communication and narrative construction towards interaction design, and ultimately toward computational, data-driven generative systems.

This progression is critical to the epistemological framing of the project. Illustration established foundational principles of composition, semiotics, and visual hierarchy; interactive media introduced experiential and user-centred systems; creative computing developed algorithmic reasoning and coordinate-based generative frameworks; and my current MSc studies formalise machine learning, statistical inference, and artificial intelligence as computational systems of abstraction and transformation.

The research question guiding this work is:

How can artificial intelligence, PCA-based data analysis, and parametric mathematical systems transform structured datasets into interactive generative visual systems?

This project contributes to computational aesthetics, explainable AI, and data-driven visualisation by proposing a hybrid system that prioritises interpretability while preserving generative flexibility.



CONTEXTUAL BACKGROUND AND INFLUENCES

A significant influence on *DataMorph* is the work of Hamid Naderi Yeganeh, whose mathematical visualisation systems have been widely documented in both academic and public-facing mathematical communication platforms, including the American Mathematical Society (American Mathematical Society, 2024) and Scientific American (Scientific American, 2017). I was first introduced to his mathematical and algorithmic artworks during my Creative Computing diploma, where I developed generative experiments using polar and Cartesian coordinate systems.

This marked a critical shift in my understanding of visual production - from representational drawing to rule-based computational generation.

Yeganeh's work demonstrates how complex visual forms can be constructed entirely through mathematical systems, including trigonometric functions, iterative computation, and geometric transformations. Rather than drawing images directly, his methodology encodes visual structure into equations capable of producing emergent forms such as birds, flowers, and abstract geometries through computation alone. This approach reframes image-making as procedural logic rather than manual representation.

This directly aligns with findings in mathematical visualisation research, where deterministic rule-based systems are shown to generate emergent visual complexity without explicit representational intent (Jaakola, 2022).

Similarly, work in algorithmic aesthetics demonstrates that mathematical structures can produce visually and conceptually coherent artefacts through formal rule systems rather than symbolic depiction (Ibrahim, 2022).

In addition, research on mathematical art exhibitions highlights how computational form generation can operate at the intersection of aesthetics and formal systems (Nimuthumana & Mahasinghe, 2025).

Together, these perspectives inform my methodological position: visualisation is not a passive representation of data, but an active transformation of mathematical structure into perceptual experience.

RESEARCH PROBLEMS, INSIGHTS, AND TECHNIQUES

Problems in AI-Driven Visualisation

Contemporary AI-driven visualisation systems exhibit three primary limitations.

Firstly, “*black-box*”¹ architectures in neural generative models obscure interpretability. While diffusion-based systems can generate visually compelling outputs, they do not provide transparent mappings between input data and output structure. This limits their use in analytical or scientific contexts.

Secondly, computational sustainability is a growing concern. Large-scale generative systems require significant computational resources, raising questions around environmental impact and scalability.

Thirdly, there is a persistent divergence between aesthetic optimisation and data fidelity, where visual appeal is often prioritised over faithful representation of underlying data structures.

These issues highlight a fundamental tension in current generative systems: the trade-off between visual complexity and interpretability.

Research Insights

Recent interdisciplinary research suggests a movement towards hybrid systems that combine machine learning with deterministic computational models (Wu et al., 2021). These approaches aim to balance interpretability with generative expressiveness.

Recent work in generative visual analytics also explores interactive AI-assisted design environments that support rapid prototyping and iterative visual exploration. Ding and Chan (2024) propose a framework in which generative AI is embedded directly into visual analytics pipelines, enabling users to iteratively refine and curate visual outputs through AI-assisted interaction. This reinforces the shift toward hybrid systems where machine intelligence operates as a co-design mechanism rather than a standalone generator.

Furthermore, research on human–AI co-creativity (Epstein et al., 2023) positions AI not as an autonomous creator, but as a collaborative interpretive system that supports human decision-making within generative workflows.

A key gap identified across this literature is the absence of unified systems that integrate interpretability, efficiency, and generative flexibility within a deterministic computational framework.

Research Techniques and Critical Evaluation

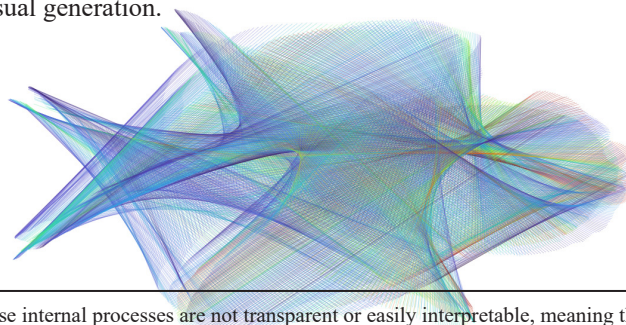
The primary analytical technique used in this project is Principal Component Analysis (PCA), a statistical method for dimensionality reduction (Jaakola, 2022). PCA extracts dominant variance structures from high-dimensional datasets and projects them into a lower-dimensional latent space.

Within DataMorph, PCA functions not simply as compression, but as a behavioural abstraction layer that translates statistical structure into generative control signals.

However, PCA is inherently limited by its linear assumptions, reducing sensitivity to nonlinear relationships within complex datasets. Despite this limitation, it is computationally stable, interpretable, and highly suitable for parametric mapping.

In contrast, algorithmic generative systems in mathematical art demonstrate alternative rule-based approaches that prioritise structural determinism over statistical inference (Nimuthumana & Mahasinghe, 2025). These systems highlight the potential of formal mathematical construction as a generative method in its own right.

By combining PCA with parametric modelling, DataMorph establishes a hybrid framework that bridges statistical abstraction and deterministic visual generation.



¹ A “black box” refers to a system whose internal processes are not transparent or easily interpretable, meaning the relationship between input and output cannot be clearly traced or explained.

METHODOLOGY AND SYSTEM DESIGN

DataMorph is implemented as a browser-based system that transforms CSV datasets into interactive generative visual outputs.

The system follows this pipeline:

Dataset ingestion → **PCA signal extraction** → **parameter mapping** → **parametric synthesis** → **generative rendering**

Data Processing

The system uses a client-side computational environment via Pyodide, enabling Python execution directly in the browser.

Data preprocessing includes:

- CSV ingestion and parsing
- Normalisation of numerical values
- Interpolation of missing values
- Removal of categorical variables for PCA compatibility

This ensures that datasets are structurally optimised for statistical transformation while maintaining computational efficiency.

Dimensionality Reduction

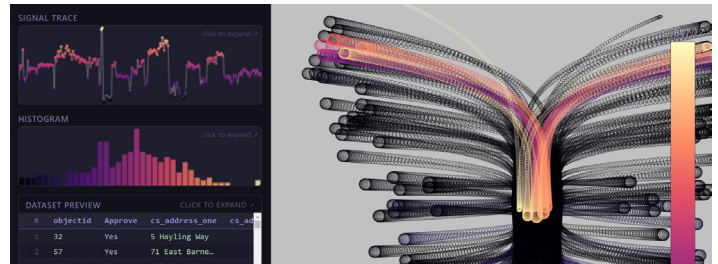
PCA reduces multidimensional datasets into a single dominant variance signal. This signal acts as the primary generative driver of the system.

Unlike conventional statistical pipelines, this reduction is conceptualised as a translation layer between data structure and perceptual behaviour.

Parametric System Design

The PCA signal is mapped into trigonometric and parametric systems controlling:

- Spatial deformation
- Oscillation frequency
- Particle dynamics
- Rotational systems
- Density modulation



Mathematical constructs are defined explicitly through equations, ensuring deterministic reproducibility.

Further developments in generative computational design include interactive evolutionary and optimisation-based approaches. Ma and Zhang (2026) demonstrate how interactive genetic algorithms can be used to evolve digital media art patterns through user-guided selection mechanisms. This supports the broader methodological positioning of *DataMorph*, where structured mathematical and algorithmic systems can be dynamically shaped through constrained interaction loops.

Interaction Model

User interaction is implemented through constrained natural language inputs.

Rather than directly generating outputs, AI functions as a selection mechanism that determines parametric configurations. This reframes AI as an interpretive routing system rather than a generative engine.

TECHNICAL IMPLEMENTATION

The system is built using HTML, JavaScript, and Python via Pyodide, enabling fully client-side computation.

Features include:

- Dataset upload
- PCA computation
- Parametric rendering
- Interactive canvas visualisation
- MathJax mathematical overlays
- Export functionality (PNG, JPG, SVG)

This architecture aligns with edge-based computational design principles by removing server dependency and enabling distributed accessibility.

REFLECTION ON AI AND CREATIVE PRACTICE

This project significantly reconfigured my understanding of artificial intelligence in creative systems. Initially, AI was conceptualised as an autonomous generative mechanism. Through development, it became clear that AI is more effectively understood as a mediating computational layer between data structure and visual expression.

Within *DataMorph*, AI is not used for image generation but for statistical abstraction through PCA. This reframes datasets as dynamic systems capable of producing structured visual behaviour rather than static representations.

Research in algorithmic aesthetics supports this reframing by demonstrating how formal mathematical systems can generate expressive outputs without reliance on neural inference (Ibrahim, 2022). However, limitations remain. PCA reduces multidimensional complexity into a single axis, resulting in loss of secondary structure. Additionally, rule-based interaction constrains emergent generative behaviour.

Despite this, the system demonstrates an alternative paradigm: transparent, deterministic, and interpretable computational creativity.

DATA VISUALISATION BEYOND TRADITIONAL METHODS

Traditional visualisation systems prioritise clarity, hierarchy, and analytical communication. However, they often fail to represent temporal, behavioural, or experiential qualities of data.

DataMorph extends beyond these limitations by treating datasets as behavioural systems:

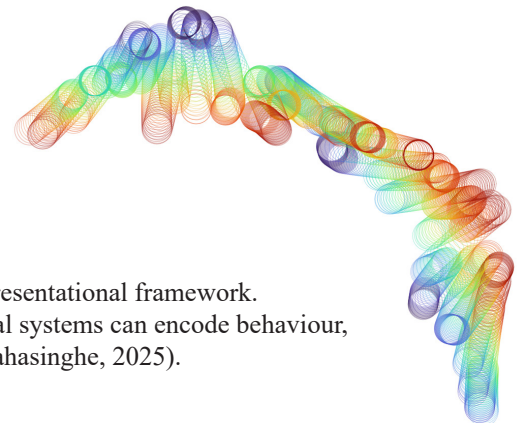
High variance → instability and motion complexity

Repetition → symmetry and structural coherence

Dense datasets → geometric complexity

Smooth datasets → fluid motion behaviour

This reframes data visualisation as an experiential system rather than a static representational framework. Research in computational art supports this shift, demonstrating that mathematical systems can encode behaviour, structure, and aesthetic form simultaneously (Jaakola, 2022; Nimuthumana & Mahasinghe, 2025).



INDUSTRY RELEVANCE

DataMorph operates within a growing industrial shift towards interpretable, hybrid AI systems that integrate machine learning, deterministic modelling, and real-time generative visualisation.

In AI-assisted visual analytics, research highlights increasing demand for systems that maintain transparency between data input and visual output while still enabling generative flexibility (Wu et al., 2021). This is particularly relevant in sectors such as scientific visualisation, financial modelling, and data journalism, where interpretability is critical.

Furthermore, generative AI research identifies a shift from static dashboards towards interactive, adaptive visual systems (Ye et al., 2024). *DataMorph* aligns with this transition by converting datasets into dynamic behavioural systems rather than static charts.

In creative industries, human–AI co-creativity frameworks (Epstein et al., 2023) are reshaping workflows in motion design, interactive media, and generative branding. Within this context, AI is increasingly positioned as a collaborative design tool rather than an autonomous creator.

From a career perspective, this project directly supports roles such as:

- Computational Designer
- Generative Systems Developer
- Data Visualisation Specialist
- AI Interaction Designer
- Creative Technologist

These roles reflect a growing demand for hybrid practitioners capable of integrating statistical modelling, machine learning, and generative visual systems within applied production environments.

WHO WOULD USE THE TOOL?

DataMorph is designed for a specialist but interdisciplinary target audience working at the intersection of data, computation, and visual design. The primary users are data visualisation specialists and information designers, who are responsible for translating complex datasets into meaningful visual forms.

Within this context, the system offers an alternative to conventional dashboard-based tools, enabling exploratory, non-linear representations of structured data where patterns are expressed through behavioural and parametric visual systems rather than static charts. This makes it particularly relevant in environments where interpretability and narrative-driven data communication are as important as analytical accuracy, such as data journalism, research communication, and investigative analytics.

A second key user group includes creative technologists, computational designers, and generative systems designers, particularly those working in digital studios, interactive media labs, and experimental design practices. For these users, *DataMorph* functions as both a prototyping environment and a generative framework, allowing datasets to directly influence motion systems, spatial behaviours, and interactive visual structures.

In professional contexts such as motion graphics, generative branding, experiential installations, and real-time audiovisual systems, the tool supports the development of data-driven creative outputs where statistical structure is embedded into visual behaviour.

The system is also relevant to data scientists and machine learning practitioners working in exploratory data analysis (EDA) and interpretive modelling, particularly within applied research, AI product development, and data science teams in technology companies. In these contexts, *DataMorph* can function as a complementary visual reasoning layer, enabling users to identify latent structures, variance patterns, and behavioural relationships within datasets that may not be immediately visible through conventional statistical summaries or tabular visualisation methods. This positions the system as a bridge between quantitative analysis and perceptual interpretation, supporting more intuitive forms of data exploration.

In addition, *DataMorph* has clear applications for UX researchers, AI interaction designers, and product designers working within generative AI and data-driven interface design teams. These practitioners are increasingly responsible for designing systems where users interact with complex underlying data models through simplified or abstracted interfaces. Within this context, the tool demonstrates how structured datasets can be translated into responsive visual systems, informing the design of future AI-powered creative tools and adaptive user interfaces.

I also believe that the system is highly applicable within higher education and research-led learning environments, particularly in disciplines such as data science, artificial intelligence, computational design, digital media, and creative computing. Here, students and researchers can use *DataMorph* as an experiential learning platform to develop intuitive understanding of statistical and mathematical concepts including Principal Component Analysis (PCA), variance distribution, dimensionality reduction, and parametric modelling.

By converting abstract computational processes into visible and interactive behaviours, the system supports embodied learning and strengthens conceptual understanding across technical and creative disciplines.

TECHNICAL LEARNING AND DEVELOPMENT INSIGHTS

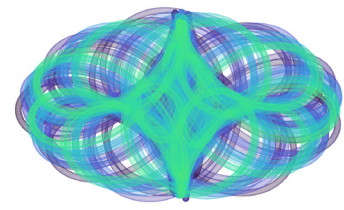
Throughout the development of *DataMorph* final outcome in making it WebGL², several key technical insights emerged that significantly shaped the final implementation of the system.

One of the primary discoveries was the use of Pyodide to bridge Python-based data processing with a browser-native environment. This enabled the execution of Python code directly within HTML and JavaScript, effectively allowing computational processes such as data parsing and PCA to run client-side without requiring a backend server. This approach was essential in translating traditional Python-based data science workflows into a web-based interactive system.

Another important learning outcome was the integration of MathJax for rendering mathematical expressions within the browser. This was necessary to accurately display equations, symbols, and structured mathematical notation within the interface. MathJax was implemented within the equation display system (eqMath inside the eqBox container), enabling dynamic and readable visualisation of parametric equations generated by the system.

These technical decisions highlight a key shift in my development approach: from traditional computational scripting environments towards browser-based, modular, and interactive systems that combine data science, mathematics, and visual rendering in real time.

² WebGL is a JavaScript API that enables rendering interactive 2D and 3D graphics directly in the browser using the device's GPU, allowing high-performance visualisation without additional plugins.



Purpose

This project aims to merge artificial intelligence, data science, and creative visualisation to generate algorithmic, data-driven art from structured datasets. It explores how datasets can be translated into mathematical equations that drive visual patterns, making complex data more tangible, interpretable, and engaging.

The system enables users to explore data creatively through interactive animations and generative designs without requiring expertise in programming or mathematics. It also establishes a flexible and reusable AI-driven framework capable of adapting to different datasets, prompts, and artistic styles.

Overall, the project promotes a bridge between analytical thinking and artistic expression, demonstrating how data can function as a generative medium for creative output.

DataMorph contributes to Sustainable Development Goals (United Nations, 2015), particularly SDG 4, SDG 9, and SDG 12, through its focus on accessible computational systems, responsible computation, and educational visualisation frameworks.

SDG 9: Industry, Innovation and Infrastructure

SDG 9 is reflected in the project through the development of lightweight, browser-native computational systems. By utilising Pyodide for client-side processing, it reduces dependency on cloud infrastructure and promotes decentralised access to generative tools.

This aligns with AI-driven visual analytics research (Wu et al., 2021), which emphasises scalable and efficient computational infrastructures. The system demonstrates an alternative model of AI deployment focused on accessibility and modularity.

SDG 12: Responsible Consumption and Production

The system reduces computational overhead by replacing energy-intensive neural generation with deterministic mathematical modelling.

Unlike diffusion-based systems, *DataMorph* avoids repeated training cycles and stochastic sampling, thereby reducing energy consumption and computational waste.

Mathematical systems in computational art demonstrate that complex visual outputs can be achieved through formal rule structures without reliance on high-resource neural architectures (Mannone, 2018).

Future development includes, WebGL acceleration, adaptive resolution rendering and energy-aware computation strategies.

SDG 4: Quality Education

DataMorph enhances conceptual accessibility by visualising statistical and mathematical processes interactively. Research in STEAM-based education demonstrates that integrating computational systems with creative practice improves understanding of abstract concepts (Jaakola, 2022). Similarly, mathematical visualisation research shows that computational art can function as an educational bridge between technical and creative disciplines (Nimuthumana & Mahasinghe, 2025).

The system supports learning in data science, AI systems, mathematical modelling and computational design.

Future Sustainability Trajectory

Future development focuses on improving computational efficiency and educational accessibility.

Potential directions include:

- Multi-dimensional PCA systems
- Hybrid generative equation learning
- WebGL-based optimisation
- Audio-reactive generative systems
- Edge-computing deployment models

These developments aim to enhance both sustainability and generative richness while maintaining interpretability.

CRITICAL EVALUATION

A key strength of *DataMorph* lies in its ability to establish a transparent and traceable computational pipeline from dataset ingestion through to final generative output. Unlike contemporary neural generative systems, which often operate as opaque “black-box” models, this system maintains full interpretability across all transformation stages.

Each visual output is directly traceable to structured statistical operations (PCA), deterministic mathematical mappings, and parametric equation systems. This aligns with wider discourse in algorithmic aesthetics, where rule-based generative systems are valued for their formal clarity and structural legibility (Ibrahim, 2022; Mannone, 2018).

This interpretability is particularly significant when considered in relation to current debates in AI-driven visualisation. Research highlights a growing concern that generative AI systems prioritise perceptual realism over analytical transparency, resulting in outputs that are visually compelling but structurally untraceable (Wu et al., 2021). In contrast, *DataMorph* deliberately reverses this prioritisation by foregrounding explainability and structural causality over purely aesthetic optimisation. This positions the system within a critical counter-movement to black-box generative AI, where visibility of process is treated as equally important as visual outcome.

However, this design decision introduces inherent constraints. The use of PCA as the primary dimensionality reduction technique imposes a linear abstraction layer over inherently complex, multidimensional datasets. As a result, secondary variance relationships and nonlinear structures are reduced or lost during transformation. While PCA provides computational stability and interpretability, its statistical simplicity limits the richness of representational depth that more complex machine learning models might capture. This trade-off reflects a broader methodological tension identified in computational visualisation research: the balance between interpretability and expressive capacity (Wu et al., 2021). Similarly, the reliance on deterministic parametric systems introduces a controlled but constrained form of generative behaviour. While this ensures reproducibility and mathematical clarity, it limits emergent unpredictability often associated with stochastic or neural generative models.

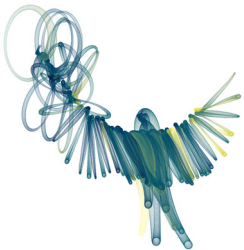
In contrast, research into mathematical and algorithmic art demonstrates that rule-based systems can still produce visually rich and conceptually complex outputs, but only within the boundaries of their defined parameter space (Nimuthumana & Mahasinghe, 2025; Jaakola, 2022).

DataMorph therefore operates within a structured generative envelope, where creativity emerges from parameter interaction rather than autonomous model inference.

Another limitation lies in the interaction model. By constraining natural language input into system-level parameter selection rather than direct generative control, the system prioritises interpretive routing over expressive freedom.

While this reinforces transparency and system stability, it reduces the possibility of open-ended emergent behaviours typically associated with co-creative AI systems (Epstein et al., 2023). This reflects a deliberate design choice: AI is positioned as a structuring and mediating mechanism rather than an autonomous creative agent.

However, this also means that user interaction is partially constrained by the predefined parametric architecture of the



User and Peer Feedback

Informal peer evaluation conducted during development provided valuable insight into both the usability and conceptual reception of the system. Feedback highlighted the accessibility and originality of the project, particularly its integration of public-facing computational systems, generative visual outputs, and interactive data transformation workflows.

Rabi Syed, an MSc Creative Computing student, noted that:

“It’s really good to see the code being published to the public and accessible for everyone to see. I feel that the UX needs improving like having the dataset uploaded or choosing samples first flowing into the prompt palette details and making the generate pattern button stick out more. It’s a minor thing but overall it’s really impressive and most of all cool.”

This feedback reinforced the importance of interaction flow and interface hierarchy within computational creative systems, particularly regarding onboarding and usability clarity. Future development could improve this through a more guided workflow structure, clearer dataset onboarding, and stronger visual emphasis on key interaction controls such as the generation interface.

Similarly, Jack Gallant, an upcoming MMath Mathematics student, observed that:

“I like the website as a whole. I think it was difficult for me to interpret the result when uploading a dataset that didn't have many points, I tried it with a different dataset with more data points and I can see the result much more clearly, the artwork output looks beautiful! I look forward to seeing it being developed more!”

This highlighted an important system limitation regarding low-density datasets and the dependency of PCA-driven outputs on sufficient variance structures for visual complexity. Future iterations of the system could address this issue through adaptive preprocessing techniques, minimum dataset guidance, or alternative dimensionality reduction methods capable of preserving more meaningful variation within smaller datasets.

Evelin Flámis, an MA Animation student and former Creative Computing collaborator, commented that:

“The tool looks really good. I looked for a CSV file and it gave it a prompt. It gave some interesting patterns. I find it interesting how the different prompts give these patterns. I think it is definitely something a creative scientist would use or someone who is interested in art science.”

This feedback reinforced the interdisciplinary positioning of *DataMorph* between computational creativity, scientific visualisation, and artistic experimentation. The responses also demonstrated that the project engaged audiences from multiple disciplinary backgrounds, including creative computing, mathematics, and animation. This is significant because the system intentionally operates between analytical and aesthetic domains rather than existing solely within either scientific visualisation or digital art practice.

Collectively, these responses suggest that while the system demonstrates strong conceptual engagement and visual effectiveness, future iterations would benefit from improvements in interface design, dataset guidance, and interaction clarity. Feedback surrounding onboarding and dataset selection indicates that user understanding is partially dependent on familiarity with structured data and statistical behaviour. This highlights an important challenge within explainable computational systems: transparency alone does not necessarily guarantee accessibility.

The feedback also revealed a tension between interpretability and creative freedom. While users responded positively to the transparency and deterministic logic of the system, some observations suggested a desire for more exploratory and unpredictable generative behaviour. This reinforces wider debates within computational creativity regarding whether structured, interpretable systems can achieve the same degree of perceived emergence as stochastic neural models.

At the same time, the responses support the broader research argument that transparent, interpretable generative systems can remain engaging and creatively expressive without relying on opaque neural generation models. Participants frequently interpreted the visible relationship between data transformation and visual output as a conceptual strength rather than a limitation.

From a computational perspective, the system performs efficiently due to its browser-native architecture and avoidance of heavy neural inference pipelines. By using Pyodide for client-side computation, *DataMorph* reduces dependency on external servers and large-scale GPU processing. This contributes positively to computational sustainability but also limits scalability for more complex dataset transformations or higher-dimensional modelling tasks.

Overall, the critical evaluation of *DataMorph* reveals a deliberate set of design trade-offs. The system privileges interpretability, determinism, and computational efficiency over stochastic complexity and deep generative variability. Rather than positioning these entirely as limitations, they should be understood as intentional epistemological constraints that define the conceptual identity of the project.

In this sense, *DataMorph* contributes to a broader discourse in computational creativity that questions whether transparency and generative richness must necessarily be mutually exclusive, or whether hybrid systems can negotiate a productive balance between the two.



CONCLUSION

This project demonstrates how structured datasets can be transformed into generative visual systems through a hybrid integration of artificial intelligence, machine learning, statistical abstraction, and parametric mathematical modelling.

Across its development, *DataMorph* has functioned not only as a technical system but also as a critical investigation into how data, computation, and visual expression can be reconfigured into a unified generative framework.

By positioning artificial intelligence as an interpretive transformation layer rather than an autonomous generative agent, the project challenges dominant paradigms in contemporary AI-driven visualisation.

Instead of treating AI as a mechanism for direct content production, it is reframed as a mediating computational structure that translates between statistical data and perceptual form. This aligns with emerging research in human-AI co-creativity, where intelligence is understood as distributed across systems rather than centralised within a single generative model (Epstein et al., 2023).

The integration of Principal Component Analysis (PCA) and parametric mathematical systems further reinforces this hybrid methodology. PCA operates as a statistical abstraction layer that reduces high-dimensional datasets into interpretable latent structures, while parametric equations translate these structures into controlled, deterministic visual behaviours. This dual-system approach enables *DataMorph* to occupy a space between analytical rigour and generative expression, demonstrating that computationally constrained systems can still produce visually complex and aesthetically rich outcomes without reliance on large-scale neural architectures.

Beyond its technical contribution, the project advances a broader conceptual argument: that data should be understood not only as an analytical resource but as a generative material capable of producing spatial, temporal, and behavioural systems. This perspective aligns with research in computational aesthetics and algorithmic art, which demonstrates that mathematical structures can function simultaneously as representational and expressive systems (Ibrahim, 2022; Mannone, 2017). Within this framing, *DataMorph* positions data as an active creative medium rather than a passive input for visualisation.

From a reflective standpoint, this project represents a consolidation of my interdisciplinary academic and creative trajectory. My background spans BTEC Interactive Media, a BA (Hons) in Illustration, a Level 5 Diploma in Creative Computing, and my current MSc in Data Science and AI in Creative Industries. Across these stages, my practice has progressively shifted from visual and conceptual design approaches towards computational, data-driven, and algorithmic systems of creation. This progression has enabled the integration of visual communication principles from illustration, interaction design methodologies from interactive media, and algorithmic thinking from creative computing into a unified computational framework.

DataMorph therefore operates as a synthesis of these intersecting disciplines, demonstrating an applied convergence between creative practice and technical data science. It reflects a transition from producing visual artefacts to designing generative systems, where abstract data structures are translated into interpretable, rule-based visual behaviours. In this sense, the project evidences not only technical competency in machine learning and mathematical modelling, but also a broader capacity for interdisciplinary synthesis, where creative and analytical approaches are treated as interdependent components of a single generative system.

Within wider research contexts, the project contributes to ongoing developments in explainable AI, computational aesthetics, and data-driven visualisation.

It aligns with emerging approaches that advocate for hybrid AI systems capable of balancing interpretability with generative capability (Wu et al., 2021), while also engaging with broader conceptualisations of data as an expressive medium (Brown University, 2023). By embedding these principles into a functioning system, *DataMorph* moves beyond theoretical discourse and demonstrates a practical implementation of these evolving paradigms.

Ultimately, *DataMorph* establishes a framework in which transparency, mathematical structure, and generative design coexist within a single computational system. While acknowledging the limitations imposed by linear dimensionality reduction and deterministic modelling, the project demonstrates that meaningful visual complexity can emerge from constrained, interpretable systems. This positions the work within a broader field of computational creativity that seeks to redefine the relationship between data, intelligence, and visual expression.

In conclusion, *DataMorph* contributes to a rethinking of generative visual systems by demonstrating that computational transparency and creative complexity are not opposing forces, but can instead be integrated through carefully designed hybrid architectures. It proposes a model of AI-assisted visualisation that prioritises interpretability, sustainability, and conceptual clarity, while still enabling rich generative outcomes. As such, the project functions both as a technical system and as a critical reflection on the future of data-driven creative practice.

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