# Sifting Strands

## Winter and Spring 2022

Oskar Elek, lead artist, researcher at the University of California in Santa Cruz
Weston Mossman, musician, independent artist in Santa Cruz
Angus G. Forbes, mentor, professor at the University of California in Santa Cruz

## ABSTRACT

Sifting Strands is an interdisciplinary art project which arose from a wider scientific collaboration between computational researchers and astrophysicists. Sifting Sands brings bio-inspired patterns rooted in optimal transport networks into the aesthetic visual realm. Through it we explore how compter-generated art and live audience can collaborate in the creative act. The core of this work is a generalized simulation of Physarum polycephalum which meaningfully reacts to music, video and scene depth information. The resulting computational graph is implemented in Touch Designer and has been adapted to live performances and interactive installations. Universally, our works bring their audience together by creating a mingling space around the computational artifact.

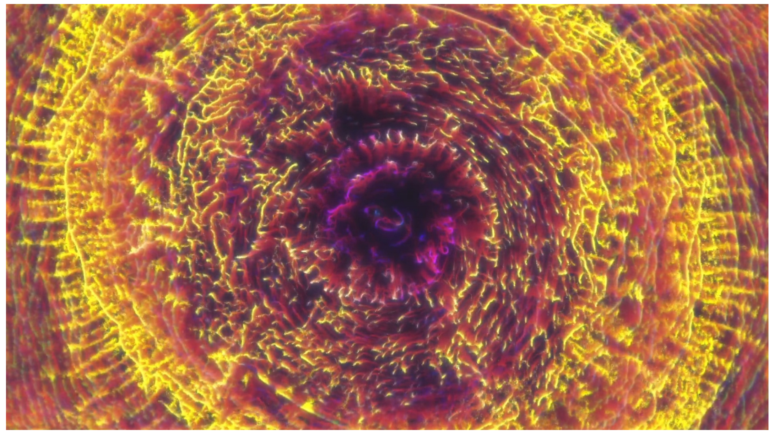
## FORMAT

digital simulation, projection mapping, physical media

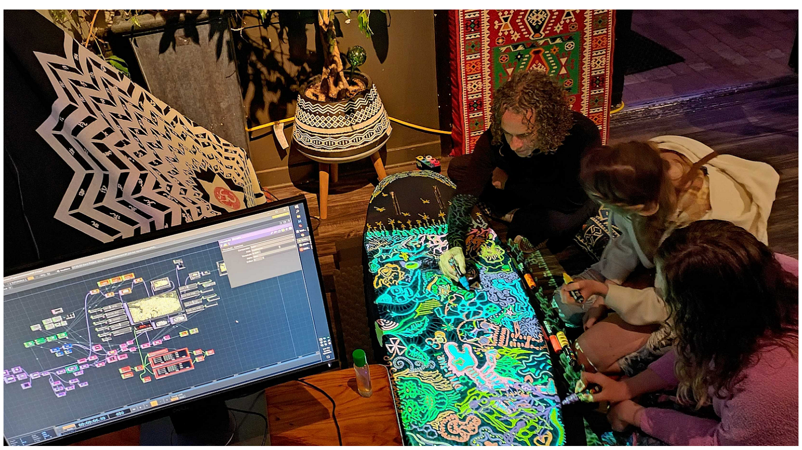
## OVERVIEW

*Sifting Strands* is an interdisciplinary art project which arose from a wider collaboration between astrophysicists and computational researchers at the University of California in Santa Cruz.

The core technical component is the MCPM algorithm which builds on a computational model of *Physarum polycephalum* slime mold [Jones 2010]. We have used MCPM and an interactive visualization system we built around it under the name *Polyphorm* to collaborate with astronomers in the effort to develop a functional model of the cosmic web [Elek2022a]. With the use of the MCPM methodology, we built the first accurate density map of the cosmic web, detected the contributions of intergalactic medium to the signal from a fast radio burst, explored novel 3D printing designs, developed a physically realistic visualization of volumetric slime mold networks, and explored language embedding models [Elek2022b].



This work proposes an interactive performance that transforms the MCPM algorithm to a more expressive formulation that is also music and video reactive. Our simulation responds to acoustic transients by spatial distortions of the simulation domain, and uses the video capture input as an additional signaling modality to steer the agents. The resulting generative patterns have a mesmerizing organic, fractal nature. Further technical details are provided in a latter section and illustrated by the supplemental materials.



We have performed different adaptations of this work within a series of collaborative spaces in Santa Cruz, California titled *Liminal Space*. In one adaptation, the simulation reacts to the live performed music as well as the video recording of the room and the resulting visuals are projected on the wall. In another adaptation we projected the simulation onto a surfboard which the participants could draw on, which created a feedback loop dialogue between the people and the simulation. The resulting drawings are unique to their authors, yet consistently mesh together thanks to the simulation dynamically adapting to people's work.

Through these performances we have explored how compter generated art and live audience can collaborate in the creative act. People appreciated the opportunity to participate in the performances, whether is be through drawing, modulating the controls of the generative system in real time, or simply having stimulating conversations about the nature of this work and connections between different aspects of the world which it points to. For us as researchers this has been a unique opportunity to get feedback on our work and spread knowledge of complex systems through the performance as a unique outreach activity. We believe this work in its own way demonstrates that artistic exploration and scientific research can inform each other, and participatory artistic presentations can make scientific research more accessible and interesting to the general public, with the added benefit of strengthening local art communities.

## MINGLING SPACES

We understand a 'mingling space' as a holding space for creative emergence. The participants of a mingling space bring their own diverse identities and impose them on the physical and virtual artifacts contained in the space. In contrast to prescriptive presentations of art, the artifacts in a mingling space are subject to reinterpretation and in turn are co-created by the participating audience.

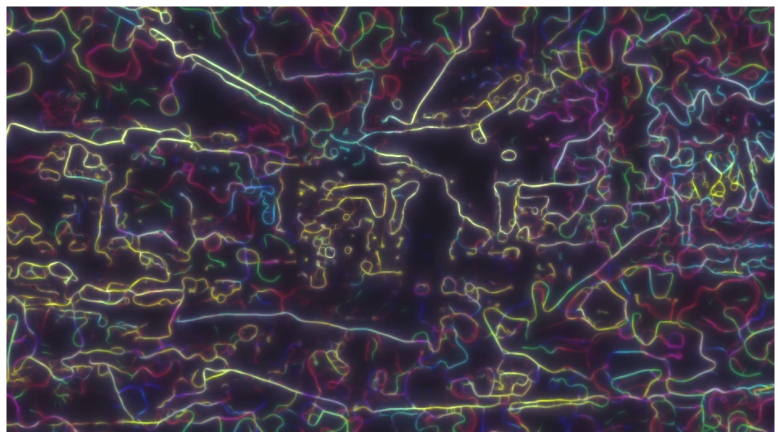
Our works have been performed in such a setting named *Liminal Space*: an ongoing series of events in Santa Cruz, California. These events transform both the indoor and the outdoor open spaces of a coffeeshop into performance grounds, including a musical and dance stages, installations, exhibits, even food and rest areas. This gives local artists an opportunity to share their work with other artists and the audience, leading to open conversations, exchange of ideas, and new collaborations.

Our contribution to the *Mingling Spaces* theme of VISAP 2022 includes a live performance and an interactive installation:

- The performance will be an audiovisual show with pre-mixed music and live generated visuals. Rather than a traditional stage/auditorium configuration, we will perform to a standing audience. People are free to walk around, chat, but also come up to the performers and temporarily take control of the generative visuals or play their own instrument.

- The installation will be built around the visual simulation. Its main inputs will be the ambient audio, as well as the optical and depth images from a Kinect device. The patterns of simulated organism will respond to these stimuli in a way inspired by the elusiveness of the model organism, i.e., slime mold. Sudden changes of motion and ambient acoustic noise will disrupt and 'startle' the simulation, breaking its patterns and causing its agents to disperse.

In both of the above components, we place emphasis on the audience participation. In the performance, the audience will not be strongly separated from the performers. We will encourage mingling and experimentation with the set. In the case of the installation, its participants will be led to figure out the mechanisms in which the simulation responds to their behavior. This will be nontrivial enough, and thus promising interesting conversations and references to the participants own work or experiences in general.



## TECHNICAL DETAILS

Our visual simulation is based on a custom variant of the Monte Carlo Physarum Machine algorithm [Elek2022a] which builds on earlier work on slime mold simulation [Jones2010]. We further implement custom rules that increase the diversity and the environmental responsiveness of patterns the algorithm is able to generate.

The simulation implements a massively parallel multi-agent system. Millions of particle-like agents navigate the simulation domain in the search for 'biomarker' emitted by the agents themselves, as well as a number of possible additional sources. These sources can be data points, which we make use of in our scientific work [Elek2022b]. They can also be signals from external devices, such as an RGB camera or a Kinect depth camera. These signals are variably interpreted as sources of the virtual biomarker, attracting the agents to a configurable degree and creating a stylized, patterned rendition of the performance space and its residents.

The simulation further reacts to transients extracted from the input audio. We separate them into three frequency bands and use this to distort the simulation domain: pulsing for low transients, rotation for mids, and twitching for high transients. Rather than impacting the motion of the agents themselves, these distortions are applied to the underlying marker field. This ensures a smooth, continuous response to the input audio, avoiding abrupt changes that would be visually distracting for the audience.

Our simulation is implemented as a Touch Designer graph and relies on compute shaders. It runs on a single PC equipped with an NVIDIA Titan X GPU, reaching a stable performance of 60 Hz at the 1080p resolution with 2 million agents. We will make the compute graph publicly available after the performance and exhibition take place.

## TECHNICAL REQUIREMENTS

The performance will require a projector and a projection screen, a Windows PC with a decent GPU and a display, and a speaker system. We will bring our own specific peripherals: cameras, MIDI board. We will configure the PC and the software environment we need.

The installation will use the same PC and software environment as the performance. For display we can use the projector as well, or alternatively a large flat screen. We will supply the necessary peripherals: cameras, Kinect, microphone.

## ADDITIONAL MATERIALS

A reel showing different visual outputs from the live performance is available here:
https://elek.pub/projects/Sifting-Strands/reel.mp4

An edited video from the live performance is available here:
https://www.instagram.com/tv/CbViXdzgNFR/

An annotated interactive pictorial of the scientific background of this project is available here:
https://elek.pub/projects/Rhizome-Cosmology/

Further details about this work and the related projects are available here:
http://elek.pub/creative.html

## ACKNOWLEDGEMENTS

This project has been supported by an incubator fellowship of the Open Source Program Office UC Santa Cruz that is funded by the Alfred P. Sloan Foundation (G-2021-16957).

## REFERENCES

Elek O, Burchett JN, Prochaska JX, Forbes AG. *Monte Carlo Physarum Machine: Characteristics of Pattern Formation in Continuous Stochastic Transport Networks*, MIT Artificial Life, **2022**

Elek O, Burchett J, Forbes AG. *Rhizome Cosmology*, **2022**
https://elek.pub/projects/Rhizome-Cosmology/

Jones J. *Characteristics of Pattern Formation and Evolution in Approximations of Physarum Transport Networks*, MIT Artificial Life, **2010**