SAGE3 for Interactive Collaborative Visualization, Analysis, and Storytelling

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ABSTRACT

SAGE3, the newest and most advanced generation of the Smart Amplified Group Environment, is an open-source software designed to facilitate collaboration among scientists, researchers, students, and professionals across various fields. This tutorial aims to introduce attendees to the capabilities of SAGE3, demonstrating its ability to enhance collaboration and productivity in diverse settings, from co-located office collaboration to remote collaboration to both at once, with diverse displays, from personal laptops to large-scale display walls. Participants will learn how to effectively use SAGE3 for brainstorming, data analysis, and presentation purposes, as well as installation of private collaboration servers and development of custom applications.

CCS CONCEPTS

• **Human-centered computing** → **Collaborative and social computing systems and tools**; *Open source software*; *Visualization systems and tools*; **Interactive systems and tools**.

KEYWORDS

Large Displays, Space to Think, Collaboration, Visualization, Data Science, Data Analysis, Computational Narratives

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1 TUTORIAL JUSTIFICATION

With the rise in remote and hybrid work due to the COVID-19 pandemic, the need to enable more flexible forms of collaboration has increased significantly. SAGE3 helps address this issue by enabling seamless synchronous and asynchronous collaboration with colleagues regardless of whether they are co-located in an office, distributed outside the office working remotely, or both.

2 WHAT IS SAGE3?

SAGE3 (the Smart Amplified Group Environment) is open source software that enables scientists, researchers and students to collaborate with their colleagues in front of everything from laptops to scalable tiled display walls, sharing information, documents and digital media data, particularly large-scale visualizations and animations, to make discoveries, reach agreement, and make decisions with greater speed, accuracy, comprehensiveness and confidence.

SAGE development began in 2004 at the University of Illinois at Chicago. The current version, SAGE3 beta, was released in November 2022 with the first official version to be released in summer 2023. SAGE3 is being developed from a collaboration between the Laboratory for Advanced Visualization & Applications at the University of Hawaii at Manoa, the Electronic Visualization Laboratory at the University of Illinois at Chicago, and Virginia Tech.

SAGE3 enables users to collaboratively upload content from their computers directly onto a shared canvas and manipulate and edit it, whereas SAGE1 and 2 were primarily intended to support large high resolution display walls [5]. SAGE3 users can also share multiple desktop computer screens simultaneously to SAGE3's shared boards. SAGE3 allows users to brainstorm with text and images, create no-code dashboards for visualizing live data, build large data analytics boards with spatially positioned Python code cells, create charts using natural language, and give presentations/teach classes coordinating a wide variety of content.

In our experience using SAGE3, we have found that it enables more interactive meetings in which participants can seamlessly engage with and add relevant materials to ongoing discussions [4] as well as enabling the benefits of Space to Think [1]. Through this tutorial, we hope to enable others to experience the same benefits we have found.

The previous versions of SAGE have been used by over 4000 users at 800 sites worldwide, including national laboratories, universities, companies and government agencies.

SAGE3's code can be found at the following Github Link:

- https://github.com/SAGE-3/next

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SAGE3 is available for download at the following website:

- https://sage3.sagecommons.org/

3 WHAT KINDS OF ATTENDEES WOULD BENEFIT FROM THIS TUTORIAL?

- This tutorial will benefit educators, IT managers, researchers, knowledge workers, visualization experts, artists, educators as well as students.

4 WHY IS THIS TUTORIAL USEFUL FOR ATTENDEES?

- The tutorial will teach users to collaborate in an information-rich way, at home, on travel or in front of a large display wall at work using SAGE3.
- It will teach them productivity-enhancing usage patterns that best leverage SAGE3's special capabilities.
- It will teach them how to use SAGE3's spacial computational notebooks for collaborative data science coding.
- It will teach them how to install SAGE3 servers should they be interested in installing their own private collaboration servers.
- It will introduce them to developing their own custom applications.

5 LEARNING OBJECTIVES

After participating in this session, attendees should know how to:

- Share, manipulate, organize and collaborate over content in SAGE3.
- Work with SAGE3 in a variety of usage scenarios that include brainstorming, presentation and data analysis and visualization.
- Develop spatialized computational notebooks using SAGE-Cells, computational notebook cells moveable in 2D space and based on works by Harden et al. [2, 3].

6 VENUE REQUIREMENTS

- Wifi for everyone in the room.
- Ideally 2 projectors with a projector for each wall plugged into a PC that we will bring.
- Room mic that can feed into a Zoom session that will run from our PC.

7 TUTORIAL ATTENDEES

- Laptop of their own that will let them install their own copy of SAGE3.
- No programming experience is necessary, although experience with Python is helpful.

8 TUTORIAL SCHEDULE

To achieve our learning objectives and impact the VIS community, we are proposing a half-day tutorial with the following schedule:

- Welcoming Introduction to SAGE3 & Installing the software (5 minutes)
- Working with SAGE3: An Introduction (10 minutes)
- Interactive multi-site SAGE3 work session (50 minutes)
  - Collaborative Brainstorming (10 minutes)
  - Collaborative Data Analysis with SAGE Cells and No-code Dashboards (30 minutes)
  - Collaborative Presentation / Interactive Posters (10 minutes)
- Discussion and Q&A (20 minutes)
- Wrap-Up and Survey Invitation (5 minutes)

The tutorial begins with a welcome from the presenters, explanation of the tutorial format, introduction of the presenters, and a brief session for help installing the SAGE3 software on attendees' laptops. Then we will introduce one of the main differences between SAGE3 and prior SAGE work: the ability to navigate the space provided on both a large display and one's personal laptop. In addition, we will go over some of the main features of SAGE3 that attendees will get to use and gain experience with. After this introduction of SAGE3, we will give participants the opportunity to practice using SAGE3 in groups with data that they are interested in; we will have some datasets available for any group that needs a starter dataset. This section will be divided into 3 parts: brainstorming, analysis, and presentation. The brainstorming part will give participants a chance to discuss the data they would like to analyze and the methods they would like to experiment with using SAGE3. The analysis part will involve the participants using SAGE3 applications, especially SAGE Cells and ChartSAGE, to analyze their data. Finally, the presentation part will give each group of participants a chance to present what they did with SAGE3 and how they organized their work in the space provided. After the work session, we will open the floor for a discussion and questions period. Finally, we will end the tutorial thanking everyone for attending and inviting participants to fill out a survey to gauge their learning, perceptions of the usefulness of SAGE3, and their hopes for future developments.

9 HANDLING A HYBRID FORMAT

Since SAGE3 can be used in both a co-located and distributed format at the same time, virtual participants can download SAGE3 in advance and participate on a SAGE board during activities remotely. Combined with using Zoom to broadcast the tutorial presentation, this enables a seamless integration of work from both virtual/remote and in-person participants.

10 ORGANIZER BACKGROUNDS

Nurit Kirshenbaum is an Junior Researcher at the University of Hawaii-Mānoa (UHM) and a CRA Computer Innovation Fellow at LAVA (Laboratory for Advanced Visualization & Applications). She specializes in Human-Computer Interaction and Tangible User Interfaces (TUI) such as ProjecTable - a physicalization system using a tangible model augmented with digital data. She is the User Experience designer of SAGE3- NSF's flagship middleware for working in data-rich immersive environments.

Roderick Tabalba is a Ph.D. student in Computer Science under Jason Leigh at University of Hawaii at Manoa. His current research interests are in Natural Language Processing, Data Visualization, and human-AI collaboration. He is a developer on the SAGE3 project and has primarily been working on enabling creating data visualizations using Natural Language Processing techniques. He received

his Master's in Computer Science from the University of Hawaii at Manoa in 2022.

Jesse Harden is a Ph.D. student in Computer Science & Applications under Chris North at Virginia Tech. His current research is on the intersection of Data Science and Human-Computer Interaction, with a focus on computational notebooks and the use of 2D space. He conducts this research as part of the Smart Amplified Group Environments (SAGE) multi-university research group. He received his Master's in Data and Information Management from Radford University in 2019.

Jason Leigh is a Professor of Computer Science at the University of Hawaii at Manoa and director of the Laboratory for Advanced Visualizations and Applications, and co-director of the Hawaii Data Science Institute, and director emeritus of the Electronic Visualization Laboratory at the University of Illinois, Chicago. He is the founder and is the lead of the SAGE projects.

Chris North is a Professor of Computer Science at Virginia Tech and Associate Director of the Sanghani Center for AI and Data Analytics. His research and education agenda seeks to enable human-AI interaction in visual analytics, immersive analytics, and data science, including novel interactive visual interfaces for computational notebooks.

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