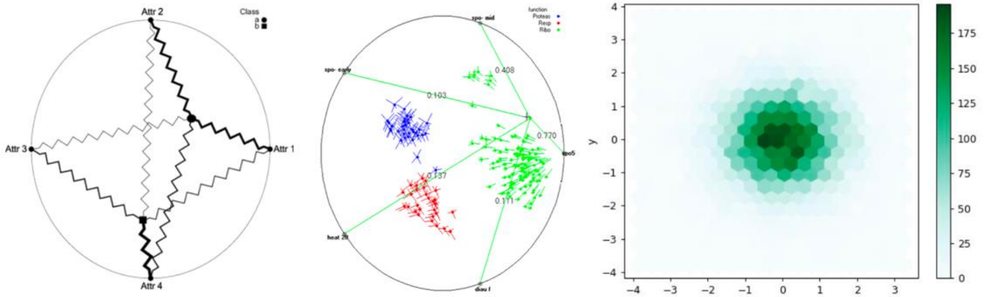
Binned RadViz Visualization

Hans-Jörg Schulz hjschulz@cs.au.dk



Left: The principle behind the data placement in RadViz. Middle: A dataset with 5 attributes being shown in RadViz, nicely bringing out the three inherent clusters. Right: An example of a hexagonal binned scatterplot.

RadViz is a visualization technique for mapping multivariate, quantitative data onto a 2D display space. It uses a physics-based approach based on spring forces that attract data points in the plane to anchor points at the boundary of the drawing space. All variants of RadViz tend to clutter by placing potentially thousands of data points in a very small drawing space.

Your task is to investigate the use of binning techniques to show where the density of data points is higher and where it is lower.

Research questions to answer would be: Which tiling/spatial subdivision to use for a Binned RadViz plot? How to interact with a Binned RadViz plot? (e.g., how to select a region of interest, as the usual rectangular selection is not a good match for the circular drawing space and the radial placement) Can the developed solution be generalized to also work for Star Coordinates and its improved versions like Enhanced Star Coordinates or iStar (i*), which use a similar placement?

Interaction Techniques for the Triangular Model

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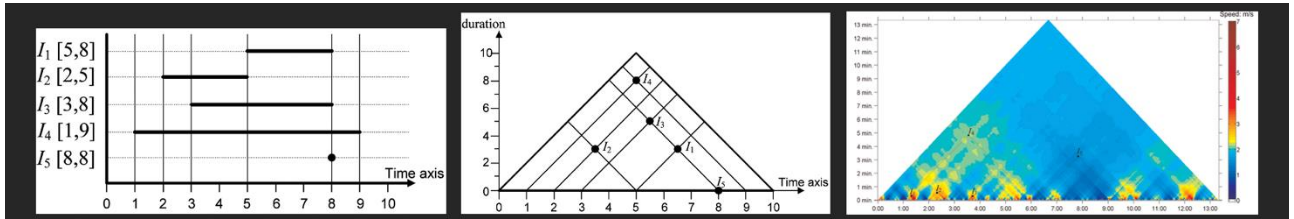
The Triangular Model is a visualization technique for showing many time intervals at once. Unlike GANTT charts, they reduce the time interval into a mere point that is placed in a triangular drawing space. Extensions for the Triangular Model, e.g. for continuous time series or uncertain time intervals, exist. Yet, dedicated interaction techniques for the Triangular Model are not researched at all. Your task is to investigate some first interactions for the Triangular Model - such as triangular brushing or collapsing/expanding.

Research questions to answer would be: Which of the standard interactions - like zooming, panning, selecting - would need to be specifically adjusted to the triangular data placement of the Triangular Model? Which could be added to specifically support the triangular query operations described in the literature? How do the interaction techniques you propose translate to the Continuous Triangular Model?



Left: GANTT chart showing five time intervals including one event - i.e., an interval of duration 0. Middle: Triangular Model visualization of the same five time intervals. Right: Example of a Continuous Triangular Model showing intervals of activity (yellow/red) and inactivity (green/blue) of a soccer player over a 13 minute period.

Perceptually-Aware Foveated Rendering in VR

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Achieving photorealistic VR rendering is challenging because it requires high-resolution displays running at 90–120 Hz. Foveated rendering reduces computational load by rendering in high detail only at the gaze center and lowering resolution in the periphery. However, current systems typically use fixed, symmetric high-quality regions for both eyes, ignoring user-specific visual behavior and asymmetries. This praoject investigates adaptive foveated rendering that dynamically adjusts to a user's gaze and perceptual traits to improve both efficiency and visual quality.

Main goal: Evaluate the feasibility of adaptive foveated rendering through analysis of real-time gaze data.

Methodology

- Develop a VR scene (Unity or Unreal) with integrated eye tracking to record gaze under controlled stimuli.
- Process gaze data offline to extract fixation patterns and inter-eye differences.
- Propose an adaptive foveal model that modulates region shape and per-eye quality.
- Implement a prototype applying these findings to test perceptual and performance improvements.
- Perform statistical evaluation of gaze behavior and perceptual asymmetries.
- User Study: Compare standard vs. adaptive foveated rendering through subjective feedback on image quality and noticeability.

Stable VR360 Outpainting

Stefanie Zollmann stefanie.zollmann@cs.au.dk

Most video today is captured with standard monocular cameras (like smartphones), which produce “flat” footage lacking the depth and peripheral information needed for VR. This project aims to bridge that gap by developing a system that converts regular monocular videos into immersive 360° VR experiences. The core challenge is generating the missing visual data—both extending the field of view and inferring 3D geometry from limited input.

The main goal is to research, implement, and evaluate a system that expands monocular videos for full VR rendering.

Proposed Methodology

Monocular Depth Estimation: Use a state-of-the-art model (e.g., MiDaS, ZoeDepth) to produce per-frame depth maps. These maps describe scene geometry and are essential for realistic 3D rendering.

Generative Outpainting: Expand video frames using generative models (Stable Diffusion) to fill unseen regions. Depth information will guide synthesis to ensure geometric consistency. Temporal consistency across frames will also be addressed.

VR Integration: Combine expanded frames and depth maps, projecting them onto a 3D mesh (like a sphere or cylinder) for immersive viewing in VR.

Evaluation Quantitative: Assess the accuracy of depth estimation and the realism of outpainted regions using benchmark metrics.

Qualitative: Evaluate visual plausibility, temporal stability (no flickering), and overall immersion in the final VR experience.

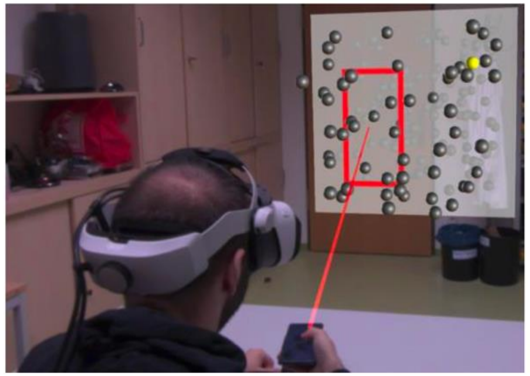
Comparing Plane-Based 3D Selection Techniques in Augmented Reality

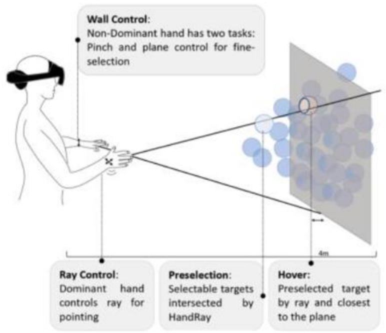
Sebastian Hubenschmid (ssh@cs.au.dk) and Niklas Elmqvist

Object selection in 3D space is a fundamental task in immersive 3D environments, such as augmented reality. While current approaches employ hand gestures or spatial controllers, they lack precision and can quickly tire out users. Research has shown the benefits of using a user-controllable 2D plane to aid in 3D selection, e.g. using gaze interaction. In this context hybrid user interfaces, which integrate 2D devices such as smartphones with AR environments, could more accurately control the plane and select points in 3D space.

In this project, you will conduct an experiment to compare different input modalities (e.g., gaze+pinch, touch interaction from a spatially-aware smartphone) for selecting objects in 3D space.

You will create a study prototype using (e.g., Apple Vision Pro, Samsung Galaxy XR, or Meta Quest 3), conduct a lab experiment with real users, and analyze the resulting data to gather insights into the techniques you've developed.





Generative Parametric Design: Bridging LLMs and 3D Manufacturing

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Traditional product design is slow. A brainstormed idea must be manually modeled in CAD, checked for printability, and iterated upon—a process that can take hours or days. We are skipping the manual design phase entirely.

The Vision: We want to create the foundation for a "Star Trek Replicator" that instantly translates human intention into a physically realizable 3D object. You will design a system where a user simply describes the product they need, and the system automatically generates a guaranteed 3D-printable CAD file moments later.

The Goal: To link a state-of-the-art LLM to a code-based parametric CAD engine.

Task 1: Intent Capture and Parameter Extraction (The LLM Interface) Integrating with a powerful LLM (via API) to receive a user's prompt (e.g., "Design a remote control with 8 buttons and a wrist strap hole").

Task 2: Parametric Model Logic: Developing the Python-based logic for a chosen product family (e.g., Custom Enclosures or Ergonomic Handles). Implementing a parametric CAD script. This script uses the LLM's parameters as inputs to define the geometry.

Task 3: System Integration and Output: This module connects the AI brain to the manufacturing tool.

Keywords: Generative AI, LLM, Parametric Modeling, Computational Design, 3D Printing, Python, Rapid

Flexible, Soft, Skin-Mounted E-Ink Displays

Supervisors: Michael Wessely au723384@uni.au.dk, Himani Deshpande

Smartwatches are bulky and distracting for simple glanceable information, while stickers or skin markings are static, non-private, and not reusable. There is a need for display technologies that are softer, more subtle, and more integrated into the body.

The Vision: This project explores thin, flexible E-ink displays that sit directly on the skin, bend and stretch naturally with movement, and maintain simple information with zero power until updated — enabling lightweight, everyday wearable interaction.

The Goal: To prototype a stretchable segment-based E-ink display that adheres comfortably to the skin and can be updated using a user-defined layout. Students will develop the fabrication, electronics, and interface that make personalized on-skin displays functional and practical for daily use.

Task 1: Fabrication & Display Design

Task 2: Hardware Control

Task 3: Software & User Interface

Keywords: Wearable Computing, Flexible Displays, Embedded Systems, Human-Computer Interaction, E-Ink, Design Tools

Exploration Of Interaction Techniques In XR

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As computing expands beyond traditional screens, this project explores new ways of interacting with digital content through technologies such as extended reality (XR), wearables, and spatial interfaces. The focus is on designing and evaluating interaction techniques—using gestures, gaze, voice, or handheld devices—to create more natural and immersive user experiences in 3D or mixed-reality environments. This can be for general-purpose use for potentially all XR devices, but also interface explorations for specific use cases and applications (even games!).

Students will prototype and test interactive systems using platforms like Unity and head- mounted displays (e.g., Meta Quest 2, 3, Pro). Depending on interests, the project can emphasize design, development, or user evaluation, aiming to contribute novel insights into the future of human–computer interaction. Specific topics will be defined based on student interests and supervisor discussions. The project offers flexibility for both technical (implementation-focused) and design-oriented (interaction-focused) approaches.

Potential example directions and inspirations from recent years:

- https://dl.acm.org/doi/pdf/10.1145/3654777.3676331, https://www.youtube.com/watch?v=uhUhTfBfaXw
- https://dl.acm.org/doi/10.1145/3654777.3676446, https://www.youtube.com/watch?v=MZtRpPndSAo
- https://eprints.lancs.ac.uk/id/eprint/223408/1/CGA_24_Design_Principles_2_.pdf

How can Mixed Reality blend different spaces for collaboration?

Jens Emil Grønbæk – jensemil@cs.au.dk

We need better tools for doing work together over distance! New Mixed Reality headsets (such as Meta Quest 3 and Apple Vision Pro) enable collaboration experiences that combine elements from the virtual and the real world to provide a “blended” space. This provides new exciting opportunities. For instance, users can be in different rooms and sit at their individual tables, move physically around, and draw on their individual whiteboards, while seeing each other’s avatars embedded in their own physical environment as if they were sitting at the same table, or drawing on the same whiteboard.

While Mixed Reality has exciting prospects, there are still many open challenges for future research.
How can Mixed Reality interfaces incorporate elements such as furniture and walls from multiple users’ physical spaces?
How can such physical elements be mapped to each other, when users’ physical rooms are dissimilar?

In this project, you will explore and develop this design space of possibilities for blending spaces. The outcome will be a set of prototypes that demonstrate new techniques for blending spaces, with considerations for how to scale to multiple users and spaces. These can be evaluated with pairs of users to study their collaborative benefits and limitations.

Read relevant literature and watch videos here: https://jensemil.dk/research/

Mixed Reality Whiteboard Collaboration

Jens Emil Grønbæk – jensemil@cs.au.dk

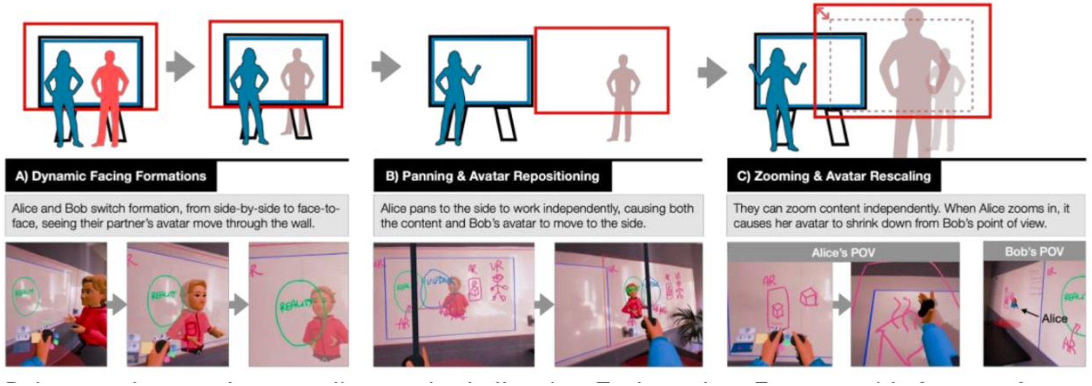
Being creative together over distance is challenging. Imagine being able to break out of your 2D Zoom window, and instead meet remotely in 3D with your friend or colleague around your own physical whiteboard, where you can freely sketch and place both physical and digital objects (such as documents, post-it notes, or even 3D models) while you generate ideas together.

In this project, you will explore how to use Mixed Reality headsets (such as Meta Quest 3/Pro and Apple Vision Pro) to enable remote creative collaboration around real whiteboards.

Examples include:

- Ink: Virtual ink could be interactive and animated to support ideation
- Beyond ink: Multimedia content (e.g. video playback, 3D models) could be integrated
- Using AI: Generative AI could be integrated as a sketching tool, combining LLMs with multimodal input from speech and sketches, etc.

Read relevant literature and watch videos here:
https://jensemil.dk/research



Multimodal Physical Computing Interfaces for Mobile Hybrid Meetings

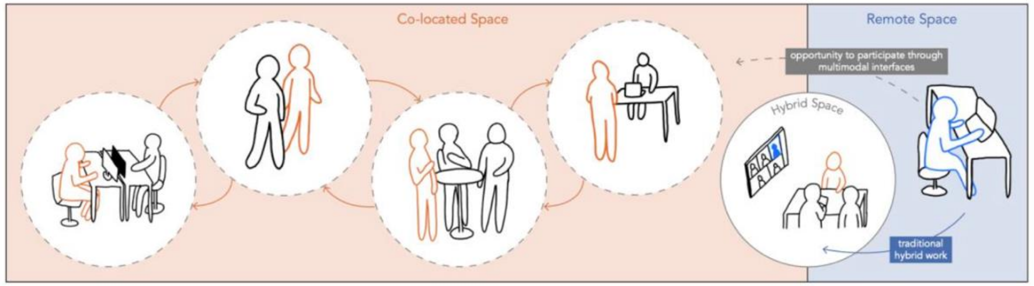
Jens Emil Grønbæk – jensemil@cs.au.dk, and Eve Hoggan

Current technology limits co-located participants' ability to move around and remote participants' ability to be included and stay engaged [1, 2]. In this project, you will be able to contribute to our ongoing research by developing Multimodal Physical Computing Interfaces, aimed at enhancing engagement and mobility for both remote and co-located participants in hybrid meetings. Potential project directions could be (but are not limited to):

Gesture and voice integration: to allow remote participants to follow or center on specific speakers or locations in real-time.

Haptic feedback: to support coordination and spontaneous interaction between remote and co-located participants.

Spatial audio: to enable better spatial awareness, allowing remote users to sense and respond to on-site participant movements.



Related Literature:

[1] Bjørn, et al. 2024. Achieving Symmetry in Synchronous Interaction in Hybrid Work is Impossible. ACM TOCHI. https://doi.org/10.1145/3648617

[2] Mu, et al. 2024. Whispering Through Walls: Towards Inclusive Backchannel Communication in Hybrid Meetings. In Proceedings of CHI '24. https://doi.org/10.1145/3613904.3642419

Understanding Robot Appearance Preference

Majken Kirkegård Rasmussen and Eléni Economidou Contact: mkirkegaard@cc.au.dk

The landscape of social robotics is largely characterised by cute aesthetics, as exemplified by robots such as Pepper, Jibo, Kuri, and Buddy which all in different ways showcase the prevalent adoption of cute baby-like characteristics such as large eyes, small chins, and rounded facial features and limbs. The challenge with these studies is that they only focus on the 3 dominant robot appearance categories: anthropomorphic (human-like), zoomorphic (animal-like) and technical (machine-like), while neglecting the much less explored category of artefact-inspired robots.

Research questions:

- Are robots evaluated differently depending on whether they are evaluated as general designs (for others), as opposed to designs placed into the user's own home?
- How do different robot design morphologies (artefact-inspired, human-inspired, animal-inspired, or technical/machine-inspired) influence users’ acceptance and willingness to integrate robots into their homes?

The project can be realised in many different ways, for example:

- Qualitative and/or quantitative user study comparing different existing robot morphologies
- Design-based user study, designing robot concepts to explore different design elements, such as altering the shape or materiality of the robot design to create a visual set of data to be used in a qualitative or quantitative user study.

Virtual Tourism or Google Streetview on Steroids

(Bachelor / Master)

- Research questions:
  - Can we live stream 2D and 3D information to remote viewers to enable live immersive Virtual Tourism experience: Feeling like being there without going there
- Project description:
  - Prototype and test interactive systems that stream panoramic video streams into head-mounted displays (e.g., Meta Quest 2, 3) using Unity as a platform. Depending on interests, the project can emphasize design, development, or user evaluation to explore the future of Virtual Tourism. Specific topics will be defined based on student interests and discussions with their supervisor.
- Skills involved: Unity, C++/C#, Insta360 panoramic cameras, WebRTC streaming,
- Contact: Tobias Langlotz (tobias.langlotz@cs.au.dk) or check by my office :)

Smart sunglasses

(Bachelor / 10 ECTS Project / Master)

Existing Prototype (off)

Existing Prototype (on)

- Research questions:
  - Can we build computer-controlled sunglasses that allow us to control the brightness of the environment on a very fine level?
- Project description:
  - Prototype novel sunglasses that can be adjusted (darkened) on a per-pixel level (not just for sun protection :). Depending on interests, the project can explore different directions and applications and specifics will be defined based on student interests and discussions with their supervisor.
- Skills involved: 3D prototyping, Arduino, C++/C#/Python
- Contact: Tobias Langlotz (tobias.langlotz@cs.au.dk) or check by my office :)

Designing Tools for Cryptography Education

Mille Skovhus Lunding, Marianne Graves Petersen
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In an increasingly digital world, privacy, security, and identity are central to public debate, with major discussions focusing on issues such as chat control and age verification. To truly understand what is at stake, we need to educate children and youth to understand how cryptography works, so that they have real agency in the technology development of the future. This project aims to investigate how we can design tools to educate children and youth to understand and reflect on how cryptography can be used to create trust between people and digital systems.

With this project you could look into how we can make cryptography tangible for students to understand basic concepts of Travel Layer Security (TLS), or you can explore how we can teach children about specific privacy preserving cryptographic techniques, such as Multi-party Computation (MPC), Zero-knowledge Proofs (ZKP), that can have a huge potential to shape our digital future.

The project combines elements of human-computer interaction, interaction design, and cryptography. You will gain experience with interface design, prototype development, and user evaluation while contributing to our understanding of how we can design tools to support modern cryptography education. ‘Technologies’ might include creating un-plugged materials, web-development, and micro:bits.

This bachelor project takes place within the context of the Interdisciplinary Center for Computational Thinking & Design (https://cctd.au.dk/) at AU.

Tools, Activities and Resources for Education about Generative AI

Marianne Graves Petersen, Luke Connelly luke@cs.au.dk

Generative AI has quickly become very prominent in classrooms. However, both teachers and students alike lack opportunities and tools to learn about how they work, so that they can actively and informedly decide how they would like to use them.

With this project, the aim would be to explore this design space and research questions such as “How can we design tools, activities, and resources which support AI literacy?”, through designing one or multiple tools, activities, and/or resources. We can provide some inspiration activities which can be used as a starting point on the topic of natural language processing, and share our experiences with participatory design with teachers and students - though alternate approaches and design methods are welcome and encouraged!

You will be working with e.g. the following research challenges:

AI literacy - what should people know about AI?

User interface design for different interaction techniques and modalities

Methods for providing meaningful feedback

Implementation of interactive prototypes

User testing with students or other learners

This project takes place within the context of the Interdisciplinary Center for Computational Thinking & Design (https://cctd.au.dk/) at AU.

Building Playful Educational Tools to Introduce Young People to Computer Science

Marianne Graves Petersen, Maja Dybboe dybboe@cs.au.dk (Maja)

This bachelor project takes place within the context of the Interdisciplinary Center for Computational Thinking & Design (https://cctd.au.dk/) at AU.

Children are growing up in an ever increasingly digital world where communication, entertainment and even money exist within a mythical computer universe, where having a conversation with your computer is a very normal thing. The technological development is fast paced, and the underlying technologies are often very complex, making it almost impossible for teachers with little technological experience to keep up. At the same time, almost all children go through general education, no matter their future aspirations, meaning a classroom will have a very wide range of ways knowledge is best obtained. A solution for these challenges is to design educational tools that utilise play and exploration and allow the students to make sense of complex topics through experimentation and constructive play.

The aim of this project is to design a novel digital educational tool, either monitor based or a tangible technology, with the aim of exposing an area of computer science, such as programming, sorting algorithms or cryptography to a young audience. The tool should emphasise play and exploration, allowing children, either in groups or alone, to experiment with the topic and gain meaning through this exploration. The tool should further be designed for a specific age group and be evaluated with this age group at the end of the project.

The project can be realised using technologies such as co-tinker and micro:bits if relevant.

Practical experiments with a Design Satire Card Deck

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Tech satire is flourishing on the internet and in popular culture, eliciting weaknesses and fiascos in modern technology. Tech satire is not only fun, but also useful for our understanding of technology, as IT-professionals contributing to future IT-solutions.

Using satire in the design of interactive technologies has been an element in critical design (Djajadiningrat et al 2000, Dunne 1999) and funology (Blythe et al 2005), but it can be taken a step further. To make a satirical approach in IT-development more accessible for designers we are developing the Design Satire Card Deck, a tool, designers at large can use to support lateral and critical thinking in interaction design. We base this approach on existing works on inspiration cards etc. in interaction design (e.g. Halskov et al. 2006, Lucero et al. 2010).

In this bachelor project, the students will plan and execute an empirical investigation into the usefulness of such design satire cards. The aim is to find one or more teams of design professionals to use the cards in the context of design projects. The specific focus of the project report will be developed in collaboration with the supervisor.

Multimodal Declarative NetLogo Simulations

Supervised by: Clemens Nylandsted Klokmose and Line Have Musaeus

This project explores how large language models can help students learn programming and systems thinking by turning multimodal descriptions—text, sound, and images—into working NetLogo simulations (https://ccl.northwestern.edu/netlogo/). Building on the Webstrates platform (https://webstrates.net) and integrating elements from MODA (https://moda.education/), the project enables learners to describe a simulation declaratively, for example by writing a short scenario, recording a sound to represent an event, or providing an image to define an environment. The system then translates these inputs into an executable model that can be run and explored.

The work will focus on building and experimenting with a lightweight proof-of-concept that connects a language model to Webstrates (https://webstrates.net/) and integrates NetLogo (https://ccl.northwestern.edu/netlogo/) or MODA (https://moda.education/) as the simulation engine. The system will interpret multimodal inputs—text, sound, and images—as declarative model descriptions that can be transformed into runnable simulations. The student will explore how these different forms of expression can shape the resulting models and document examples that highlight both the potential and the limitations of this approach to learning computational modeling.

This project suits students interested in computing education, interaction design, and AI-assisted creativity. It combines lightweight system development with exploratory evaluation and contributes to ongoing work in CoTinker on generative tools for accessible, expressive forms of programming.

Generative Interfaces for AI-Augmented Meeting Histories

Clemens Nylandsted Klokmose & Jens Emil Grønbæk

This project explores how AI can help people understand, reflect on, and improve collaboration during and after meetings. When meetings are recorded as data—such as transcripts, spatial layouts, and notes—AI can find patterns and create new visual or interactive ways of showing what is happening. The goal is to experiment with how large language models can turn this data into meaningful overviews and small interactive elements that provide feedback and feedforward in real time.

The project builds on an existing experimental system that already records and structures meeting histories. The student will design and prototype new ways of interacting with this data in a Webstrates-based environment (https://webstrates.net/). This might include small widgets that highlight key discussion topics, track engagement, or suggest follow-up actions while the meeting is still in progress. Afterward, the same system can help participants explore how the meeting unfolded and what was decided.

This project is well suited for students interested in human–AI interaction, interface design, and experimental systems development. It combines creative prototyping with technical implementation and contributes to understanding how AI can make collaboration more visible, adaptive, and supportive in everyday meeting practices.

Accessibility in Dashboards

Vaishali Dhanoa and Niklas Elmqvist
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Making data visualizations accessible to blind and low-vision (BLV) users has been an active area of research for many years [1][6]. Recent advances in multimodal large language models (MLLMs), particularly vision-language models, offer promising new opportunities for improving accessibility. While prior work [2][3] has primarily focused on making individual charts accessible, there remains a significant gap in supporting complex, multi-view visualizations such as interactive dashboards. How can dashboards be made accessible to the BLV users? We have two potential directions:

Data physicalization: Tactile displays / Can dashboards be converted to tactile displays that can be synced with their digital counterparts?

Multimodal AI interaction: How could we leverage AI in the dashboard exploration process for BLV users?

A key part of this research will be to evaluate whether any of the above approaches enhance understanding, usability, and adoption of dashboards among BLV users.

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Monitoring Agency in Data Visualization Process

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The question of whether AI possesses agency has been debated among researchers [1]. With the growing integration of AI agents across the data visualization pipeline, these agents are gaining increasing levels of autonomy. Based on the data, these agents can already help users identify potential areas of interest, suggest suitable visualizations, and even present findings to users through narrative summaries. Although end users are generally assumed to remain at the center of these computational and decision-making processes, empirical research on how users actually interact with AI tools and use these agents in the data visualization process remains underexplored [3]. Depending on users' understanding of the system, their domain and visualization expertise, and their level of trust in AI, they may either overly rely on the system or restrict its role to that of a simple rule-based assistant. To address these dynamics, we plan to design an AI-assisted interface that monitors user interactions during data exploration and provides feedback when users either grant excessive agency to the AI and drift from their initial analytical goals or overly constrain the AI, effectively reducing it to a rule-based system. User evaluation is also expected to illustrate how AI agency is negotiated and exercised throughout the data visualization process.

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