Aarhus
University
Department of Computer Science

Ubiquitous Computing and Interaction Research Group

[UBI-A] Better Communication Cues in Video Conferencing Systems

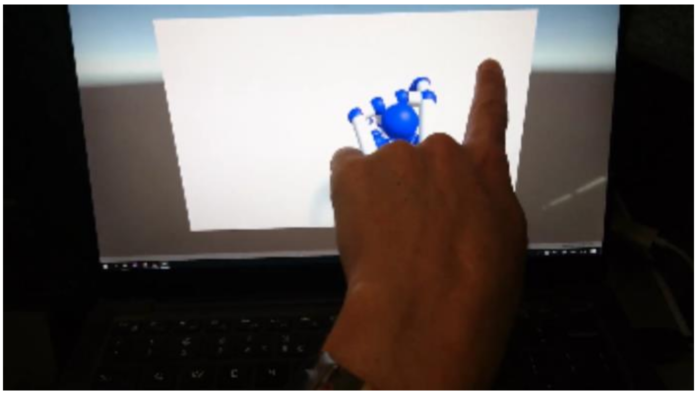
(Hans W. Gellersen – hwg@cs.au.dk, Jens Emil Grønbæk – jensemil@cs.au.dk)

Much of our collaborative work today is mediated by video conferencing tools. The tools today enable meeting participants to share their screen and point at the content with their mouse cursors to support the communication. However, video communication inhibits other non-verbal cues that we normally rely on when sharing the same physical space. For instance, in Zoom or Skype, you cannot see where people are looking, and people cannot naturally point to screen content using their hands. This often results in ineffective collaboration.

You will have the opportunity to extend the work on an existing research prototype designed to support flexible video conferencing. The prototype system is called MirrorBlender. The system already has the infrastructure for video conferencing using WebRTC, which you then do not have to implement from scratch. See video of the MirrorBlender prototype and concept here:
https://www.dropbox.com/s/u1i2aesvmtciwa6/MirrorBlender_CHI2021_FinalDraft.mp4?dl=0 (research on MirrorBlender is currently under peer review. Please, do not distribute this video!) MirrorBlender is a What-You-See-Is-What-I-See interface that supports blending, repositioning, and resizing mirrors. Mirrors are shared video feeds of people and screens. Meeting participants can leverage their mirrored images for gestures, like pointing on the screen content.

You can choose between two subprojects that extend MirrorBlender by addressing different issues of remote communication. You are expected to build a prototype in one of these subprojects and evaluate the system and interaction techniques that you build with users in a controlled setting.

[UBI-A1] Hand tracking for screen pointing in video conferencing systems



Currently, in MirrorBlender (see video link above), users have to point in mid-air in the camera field-of-view for remote participants to see where they are pointing, and they cannot point directly on the screen content, as the hands are outside the camera field-of-view. In this subproject, you develop a prototype with a laptop and a hand tracking sensor (a Leap Motion device) to enable pointing on the screen content during video conferencing. The goal of the project is to enable pointing to screen content with virtual hands. The project involves the following steps:

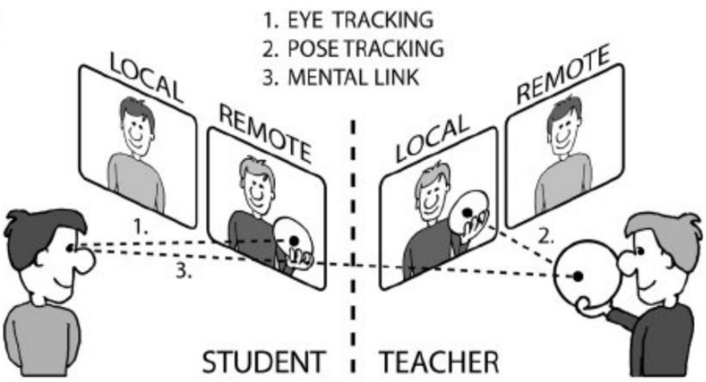
Developing a calibration method based on prior methods (e.g., see reference below). Once the space in front of the screen is tracked, the hands can be visualized outside the web camera's field-of-view, showing not only a person's 'talking head' video, but also the virtual hands extending from a person's real body in the video feed. The challenge here is to create a visualization of the hand that clearly communicates who is pointing where. Different virtual representations of hands and arms should be explored to find a good solution for the visualization. Beyond using the hands for communication cues, they can further be used as a means for interaction input, such as selecting and moving items on the screen via mid-air above-the-surface gestures (for interaction e.g., zoom by spreading fingers, pinching gesture, or communication e.g., highlighting/marking things with drawings). This enables new types of direct manipulation techniques designed to support communication with the hands.

Related Literature:

- Benko et al. 2009 "Enhancing input on and above the interactive surface with muscle sensing". Proc of ACM ITS. doi: https://doi.org/10.1145/1731903.1731924
- Feuchtner & Müller 2017 "Extending the Body for Interaction with Reality". Proc. of CHI. doi: https://doi.org/10.1145/3025453.3025689
- Calibration method: https://www.youtube.com/watch?v=7p0-9pBV6BM ("Where you point is what you get: Spatial mapping for touchless experiences with Leap Motion")

[UBI-A2] Eye tracking for sharing attention in video conferencing systems

MirrorBlender (along with any of the commercial video conferencing systems) lacks support for feedback on shared attention, meaning there are no awareness cues for where remote participants are looking on their respective screens.



In this subproject, you will extend MirrorBlender with communication cues and interaction techniques based on eye tracking (from a Tobii Pro eye tracker). The goal of the implemented techniques is to support more effective communication around screen content in video conferences. Eye tracking can here be used for implementing communication/awareness cues as well as interaction techniques. For instance, your own video feed could follow where your eyes look, allowing others to subtly follow where you are looking as you speak. Or to avoid clutter in the view, when many people are present in the meeting, the video feed that most participants look at, could become more opaque while other feeds fade into the background.

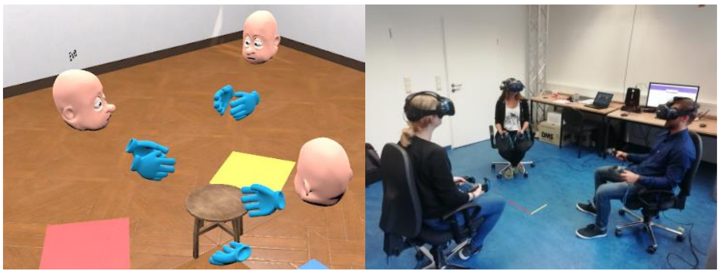
Related Literature:

- Barakonyi et al. 2007 "Cascading Hand and Eye Movement for Augmented Reality Videoconferencing". Proc. of 3DUI. doi: https://doi.org/10.1109/3DUI.2007.340777
- Gupta et al. 2016 "Do You See What I See? The Effect of Gaze Tracking on Task Space Remote Collaboration". IEEE TVCG. doi: http://doi.org/10.1109/TVCG.2016.2593778
- Tanriverdi & Jacob 2000 "Interacting with eye movements in virtual environments". Proc. of CHI. doi: https://doi.org/10.1145/332040.332443

[UBI-B] Multimodality in Virtual Reality Collaboration (Ken Pfeuffer – ken@cs.au.dk, Jens Emil Grønbæk – jensemil@cs.au.dk, Eve Hoggan – eve.hoggan@cs.au.dk)

Enter VR! This project investigates how human conversation in Virtual Reality (VR) can be designed with and is affected by the inclusion of non-verbal cues. In VR, most current social applications do not support a range of non-verbal cues, e.g., user's body, eye movement, hand movement, finger tracking, or face/mouth expressions. Instead, an often-static looking avatar is employed. But what makes a virtual conversation natural? Are all modalities necessary or would a partial coverage be sufficient? How do different user representations affect our social interaction?

To investigate these questions, the main goal is to develop a multi-user multi-modal VR prototype. This includes using at least 2 headsets and synchronizing them in one virtual scene over the network. For example, implementation in Unity and using a modern VR device such as the Vive Pro or Oculus Quest 2. It is possible to develop this in a local lab space where two users sit next to each other. Optionally, users may be remotely located. Further potential tasks and follow-up projects include a comparison of multi-user conversations with different support of modalities, to assess their impact on the user experience, immersion, and "naturalness".



Related Literature:

- Auda et al. 2021. "I'm in Control! Transferring Object Ownership Between Remote Users with Haptic Props in VR". In Proc. of SUI '21, https://www.dropbox.com/s/ka63cr52tvvvmfd/_SUI_2021.pdf?dl=0

[UBI-C] Understanding haptics and touch in (remote) physical Mixed Reality (Ken Pfeuffer – ken@cs.au.dk, Jens Emil Grønbæk – jensemil@cs.au.dk, Eve Hoggan – eve.hoggan@cs.au.dk)

Enter MR! This project explores how physicality can aid collaboration in Mixed Reality. Current VR devices allow remote collaboration but are completely virtual - without info on the physical environments. This includes objects users may have (pen, drinks, etc.), the people themselves in remote collaboration (body, head, hands, gaze, ...), and the environment (e.g., table, chair, ...). By supporting such physical aspects, remote collaboration could in principle become more tangible and natural, as if sitting side by side.

To investigate these issues, the main goal is to develop a system in VR where physical objects in the environment are tracked and integrated in the VR scene. This is, e.g., possible by using markers placed on objects that are tracked by a motion tracking system. Implementation can for instance be conducted in Unity, and prototyping in a given VR headset. Further tasks can include, e.g., to investigate how these objects can be synchronised to remote users, e.g., through virtual representations, potentially over the network. A further potential task is an evaluation with users, that assesses the pros and cons of adding physicality to remote collaboration.

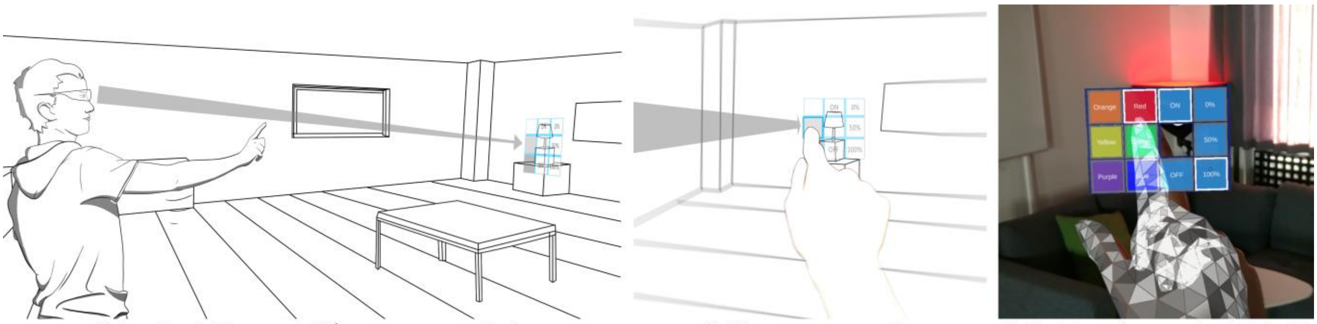
Related Literature:

- Auda et al. 2021. "I'm in Control! Transferring Object Ownership Between Remote Users with Haptic Props in VR". In Proc. of SUI '21, https://www.dropbox.com/s/ka63cr52tvvvmfd/_SUI_2021.pdf?dl=0

[UBI-D] Eye Based Interaction in Augmented Reality (Ken Pfeuffer – ken@cs.au.dk, Jens Emil Grønbæk – jensemil@cs.au.dk, Hans W. Gellersen – hwg@cs.au.dk)

Enter AR! Future Augmented Reality (AR) smart glasses may replace our phones, raising many new design challenges such as how users interact without traditional mouse, keyboard, and touchscreen. In this project, we investigate how we can design the UI of AR devices using novel spatial sensing capabilities. Especially, how freehand gestures and eye tracking can be fused to provide novel types of interactions. Hand gestures alone support only a constrained limited range, however can be extended by using the eyes to point at objects of interest.

For example, we started to explore the interaction concept in the Figure below. The user invokes selection commands by aligning the index finger exactly in line with the object they look at (A-B). It can e.g. be useful to interact with context menus situated in the world using the HoloLens 2 (C).



A) Eye-Hand Alignment (3rd person perspective) B) 1st person perspective C) Prototype for a context UI in AR

The potential group of students will explore further explorations in this space. Students will learn and develop skills in 3D programming by using the Unity platform. They will also gain experience with design, implementation, and evaluation with using head mounted devices (e.g., Vive Pro, Hololens 2, Oculus Quest 2). Example use cases include:

Continuous input: How can a user drag & drop an object by using their eyes and hands? E.g., continuous input in the form of a line or other shape? Project tasks involve 1) design of techniques that allow continuous input with eye and hands, 2) implementation of those techniques in prototypes, and 3) user testing to get insights into their usability.

Eye-refocus interaction: Humans can instantly refocus their eyes between large distances –for example between a far-away restaurant, and the close-by hand. Could we exploit this, e.g., to transfer information across distance? In this project, students will learn how to explore a completely new interaction concept. Tasks include investigating how well such eye refocus can be tracked, and how it can be exploited for interaction with interfaces in AR.

Related Literature:

- Pfeuffer et al. 2017. "Gaze + pinch interaction in virtual reality". In Proc. of SUI '17. https://doi.org/10.1145/3131277.3132180, https://youtu.be/NzLrZSF8aDM

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Bachelor Projects

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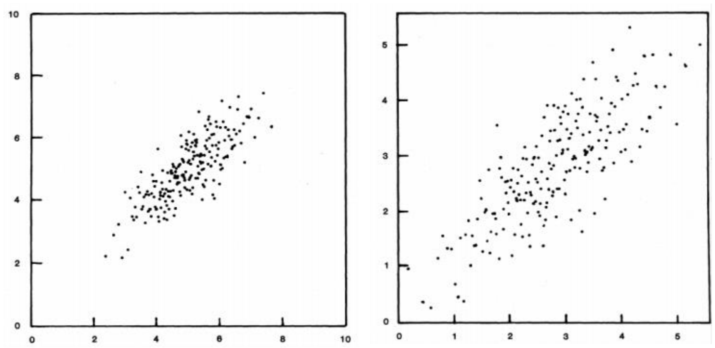
[UBI-E] Reproducible Data Visualization through Embedded Metadata in PNG Images

(Hans-Jörg Schulz – hjschulz@cs.au.dk)

Given any data visualization one can find on the web, all of these "end results of a visualization process" beg the questions whether the underlying data was not tampered with or whether the visualization technique was not deliberately parametrized so that unwanted details are hidden. Take for example the two charts shown on the side: the left one exhibits a rather clear positive correlation between x and y, whereas the right one shows a point cloud that is more dispersed. Yet, the right chart is actually just a zoomed-in version of the left! How can we thus trust a visualization? In a first step, it is your task to explore how metadata about the underlying dataset and the visualization procedure can be generated for a visualization and embedded as "ancillary chunks" in the resulting PNG file. In a second step, you are tasked to extend a standard PNG parser / viewer to read and verify these metadata to ensure that the given PNG image is indeed the result of the specified data + visualization process. In a last step, the possibility of using this metadata for visualization retargeting is to be explored. This would allow, for example, zooming out to see if the authors have not cropped important data points from the figure.



Related Literature:

- Dai et al. 2018 "Chart decoder: Generating textual and numeric information from chart images automatically" Journal of Visual Languages & Computing. doi: https://doi.org/10.1016/j.jvlc.2018.08.005
- Poco & Heer 2017 "Reverse-Engineering Visualizations: Recovering Visual Encodings from Chart Images" Computer Graphics Forum. doi: https://doi.org/10.1111/cgf.13193
- Jung et al. 2017 "ChartSense: Interactive data extraction from chart images" Proc. of CHI. doi: https://doi.org/10.1145/3025453.3025957
- Siegel et al. 2016 "FigureSeer: Parsing result-figures in research papers" Proc. of European Conference on Computer Vision. doi: https://doi.org/10.1007/978-3-319-46478-7_41

[UBI-F] Organic Charts – Nature-inspired Rendering for Data Visualization

(Hans-Jörg Schulz – hjschulz@cs.au.dk)

In data visualization, in particular in visual presentation scenarios, different rendering styles can be used to give otherwise common charts or diagrams a unique look & feel. The field of visualization knows a number rendering styles, such as sketchy rendering, impasto rendering, or watercolor rendering (see below).

Your task in this project is to invent and implement an organic rendering style for selected charts (preferably implicit tree diagrams) that gives a chart an organic – i.e., "amoebic" or "cellular" – look & feel that can be parametrized in its distortion of the underlying chart in a smooth manner from clear-cut & straight to amorphous & blobby. You can find some inspiration for that in the related literature.

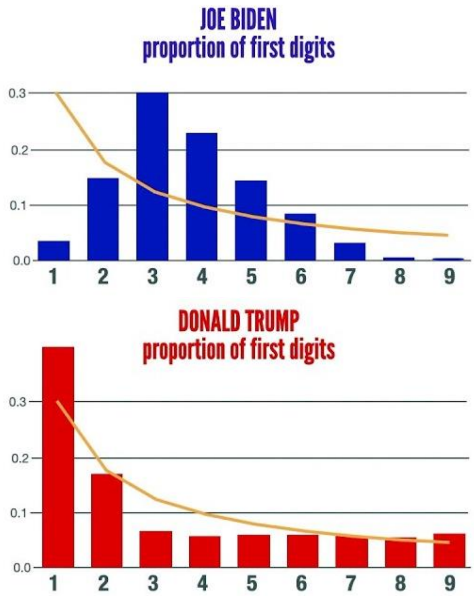
Related Literature:

- Görtler et al. 2018 “Bubble Treemaps for Uncertainty Visualization”, IEEE TVCG. doi: https://doi.org/10.1109/TVCG.2017.2743959
- Collins et al. 2009 “Bubble Sets: Revealing Set Relations with Isocontours over Existing Visualizations”, IEEE TVCG. doi: https://doi.org/10.1109/TVCG.2009.122
- Hlawatsch et al. 2014 “Bubble hierarchies”. Proc. of Workshop on Computational Aesthetics. doi: https://doi.org/10.1145/2630099.2630107

[UBI-G] A Visual Analytics Tool to Identify Data Tampering

(Hans-Jörg Schulz – hjschulz@cs.au.dk)

Numerical data that is collected in an unbiased and even way exhibits certain distributions across its digits. This is known as Benford’s Law and it is a simple way to detect potential data tampering, but often tricky to make sense of its results. I.e., if the distribution of digits deviates from Benford’s Law, finding out why is not necessarily straightforward. It may for example be that the data simply does not fulfill the preconditions for applying Benford’s Law – as is the case with election data. Other tests that can be employed in a similar vein are Zipf’s Law and the Pareto Distribution. It is your task to combine these tests in a sensible manner in a “Data Checker Tool” that allows to run them on a numerical dataset, while at the same time warning the user if these tests are not applicable. The outcomes of these tests are then to be visually displayed. In a next step, you are to extend your concept and tool to accommodate for streaming data – e.g., for sensor data streams to automatically detect not fraud, but malfunction of the sensors. Finally, you are tasked to apply your data checker tool to some openly available datasets, such as the “Skatteoplysninger for selskaber 2014-2018” (https://skat.dk/skat.aspx?oid=2167688) or the daily/weekly numbers of COVID infections across Europe (https://www.ecdc.europa.eu/en/covid-19-pandemic), and a suitable data stream (e.g., bitcoin transaction data).

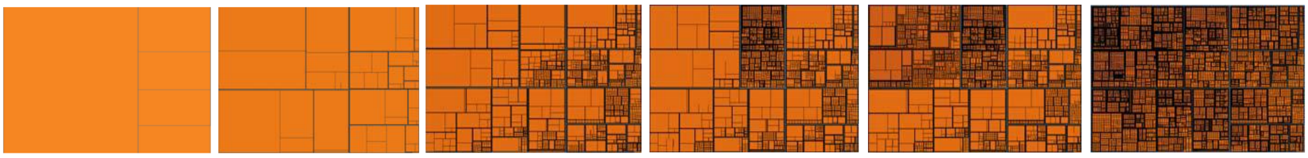


Related Literature:

- Parker 2020 “Why do Biden's votes not follow Benford's Law?” url: https://www.youtube.com/watch?v=etx0k1nLn78
- Geyer & Williamson 2004 “Detecting Fraud in Data Sets Using Benford's Law” Communications in Statistics - Simulation and Computation. doi: https://doi.org/10.1081/SAC-120028442
- Whyman et al. 2016 “Intuitive considerations clarifying the origin and applicability of the Benford law” Results in Physics. doi: https://doi.org/10.1016/j.rinp.2015.11.010
- Goodman 2016 “The promises and pitfalls of Benford's law” Significance. doi: https://doi.org/10.1111/j.1740-9713.2016.00919.x
- Tao 2009 “Benford’s law, Zipf’s law, and the Pareto distribution” url: https://terrytao.wordpress.com/2009/07/03/benfords-law-zipfs-law-and-the-pareto-distribution/

[UBI-H] Progressive Visualization Techniques (Hans-Jörg Schulz – hjschulz@cs.au.dk)

Progressive Visualization is a chart drawing paradigm, where not all data is shown at once – possibly after a lengthy layout computation – but instead added bit by bit to a chart so that it "evolves" from a rough sketch to the final polished visualization. A few progressive visualizations techniques are already known, such as Progressive Treemaps, Progressive Parallel Coordinates, or Progressive Scatterplots / Dotmaps. Yet for a variety of other charts, it is still open how to integrate such a progressive visualization paradigm with them and their usual layout algorithms. In this project, it is your task to fill some of these gaps and to propose – e.g., Progressive Line Charts, Progressive Area Charts, Progressive Chord Diagrams, Progressive Icicle Plots / Sunbursts, Progressive Venn Diagrams, Progressive Tag Clouds, or Progressive Cartograms.



Related Work:

- Rosenbaum et al. 2009 "Progressive Presentation of Large Hierarchies Using Treemaps" in "Advances in Visual Computing", Springer. doi: https://doi.org/10.1007/978-3-642-10520-3_7
- Rosenbaum et al. 2012 "Progressive parallel coordinates". Proc. of IEEE PacificVis. doi: https://doi.org/10.1109/PacificVis.2012.6183570
- Huron et al. 2013 "Visual sedimentation", IEEE TVCG. doi: https://doi.org/10.1109/TVCG.2013.227
- Angelini & Santucci 2013 "Modeling Incremental Visualizations", Proc. of EuroVA. doi: http://doi.org/10.2312/PE.EuroVAST.EuroVA13.013-017

[UBI-I] Evaluating parallelization frameworks for progressive visualization (Marius Hogräfer – mhograefer@cs.au.dk & Hans-Jörg Schulz – hjschulz@cs.au.dk)

In progressive visual analytics (PVA), the goal is to visualize early, incomplete results of long-running analytical computations, instead of having to wait for minutes, hours or even days before seeing a result. This means that we get a look at our data faster and can therefore also detect interesting patterns or errors. In both cases, we can potentially avoid waiting for the result while doing nothing, making the whole analytics process more efficient and the user experience more fluent.

A common way to achieve this progressiveness is splitting up the data into smaller chunks, running computations on these chunks one after the other, and then visualizing these intermediate results. Since PVA is rather recent research field, however, there currently is no tool support for this kind of workflow, where a result is refined over time. There are however many different approaches of parallelizing analytic computations.

The goal of this Bachelor project is to evaluate existing parallelization frameworks for their applicability for progressive computations. Your task will be to implement a progressive computation using a couple of these frameworks and then assess, how they perform in terms of how well they integrate with existing data science frameworks (such as R and scikit-learn for Python), their computational performance, and their ease-of-use (in terms of overall setup, lines of code, etc.). We will provide to you a basic event-based visualization pipeline, in

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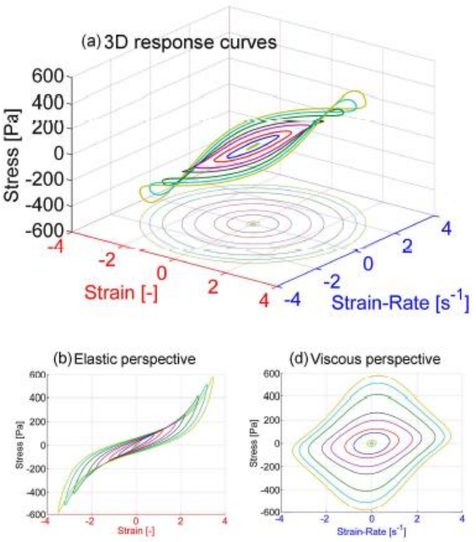
which you can test these frameworks. This pipeline consists of a MySQL database on one end and a web-based visualization on the other. Here is a list of potential frameworks that you may choose to evaluate:

- C++20's coroutines: https://en.cppreference.com/w/cpp/language/coroutines
- Intel's Thread Building Blocks https://software.intel.com/content/www/us/en/develop/tools/threading-building-blocks.html
- Go's goroutines: https://golang.org
- Go for Apache Beam: https://beam.apache.org/documentation/sdks/go/
- Dask for Python: https://dask.org, https://github.com/dask/dask

[UBI-J] Better Lissajour curves for the food sciences (Hans-Jörg Schulz – hjschulz@cs.au.dk)

Lissajour curves are used in material sciences to show the relation between the stress imposed on a material and the resulting strain of that material. Depending on the shape of the resulting curves, one can determine the elastic, viscous, or viscoelastic nature of the material. Current state-of-the-art tools (e.g., MITlaos) are able to generate these plots in a static way, without any interactivity, filtering or querying mechanisms. Additional information, particularly w.r.t. the material's response to various forms of oscillatory stress (e.g., different frequencies with which the stress is applied) is hard to gauge from these plots alone. Comparison between plots is tricky.



Your task will be to make these curves more useful – in particular for their interactive analysis – through combining these curves with suitable interactivity, as well as with linked views that show additional aspects of the data, which are not captured by these rather simple curves. This will be done in close collaboration with researchers from AU's Dept. of Food Science, who will be using your resulting visualization software for their research.

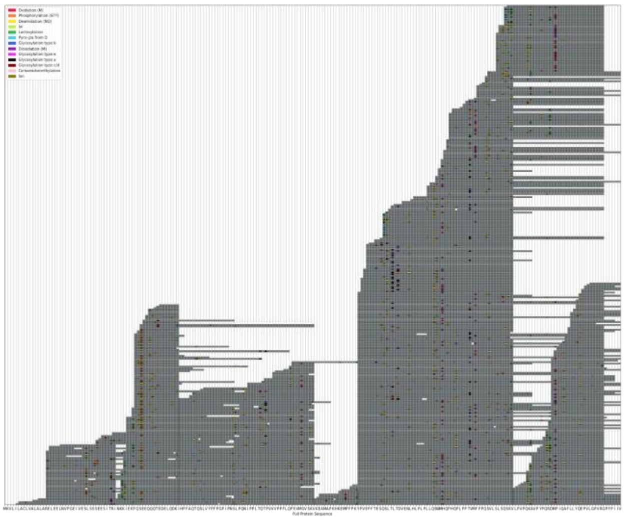
Related Literature:

- Ewoldt et al. 2010 "Large amplitude oscillatory shear of pseudoplastic and elastoviscoplastic materials". In Rheologica Acta vol.49, pp.191–212. https://doi.org/10.1007/s00397-009-0403-7
- Klein et al. 2007 "Separation of the Nonlinear Oscillatory Response into a Superposition of Linear, Strain Hardening, Strain Softening, and Wall Slip Response". In Macromolecules vol.40, pp.4250–4259. https://doi.org/10.1021/ma062441u
- Schreuders et al. 2021 "Small and large oscillatory shear properties of concentrated proteins". In Food Hydrocolloids vol.110. https://doi.org/10.1016/j.foodhyd.2020.106172
- MITlaos software. http://web.mit.edu/nnf/research/phenomena/mit_laos.html

[UBI-K] Statistical Visualization for Mass Spectrometry Data

(Hans-Jörg Schulz – hjschulz@cs.au.dk)

Modern Mass Spectrometry yields a vast amount of data. Not all of which are statistically significant. That doesn't mean, though, they are not of interest. Current tools like the Perseus software platform can be used to compute a range of statistics on Mass Spectrometry data to provide insight into each data item's relevance. Yet, its output is not shown in a visual-interactive way, so that the domain experts themselves could take a look at what parts of the data exhibit which levels of relevance and determine, for example, suitable cut-off thresholds for the data.



Your task in this project will be to close that gap by computing suitable statistical results over Mass Spectrometry data and making it available in a visual-interactive form. This can mean to either display the results of the statistical analysis directly, but also to indirectly take the statistics into account when displaying the Mass Spectrometry data itself – e.g., for scaling or color-coding the data. This way, we may be able to reduce the visual clutter that results from showing all resulting data with the same importance, for example by de-emphasizing the data that are of lesser statistical significance and emphasizing those that are of more significance.

This project will be done in close collaboration with researchers from AU's Dept. of Food Science, who will be using your resulting visualization software for their research.

Related Literature:

- Choi et al. 2014 "MSstats: an R package for statistical analysis of quantitative mass spectrometry-based proteomic experiments". In Bioinformatics Vol.30, pp.2524–2526, https://doi.org/10.1093/bioinformatics/btu305
- Hall et al. 2016 "Formalizing Emphasis in Information Visualization", In Computer Graphics Forum Vol.35, pp.717.737, https://doi.org/10.1111/cgf.12936
- Perseus software platform: https://maxquant.net/perseus/

[UBI-L] Reinventing Books' Table of Contents in a visual-interactive form

(Hans-Jörg Schulz – hjschulz@cs.au.dk)

Even in the age of e-books, we still rely on very simplistic forms to provide tables of contents to the readers. This is usually in the form of an indented list, potentially with clickable entries that take the reader directly to the indicated position in the book.

Your task in this project is to reinvent the Table of Contents (ToC) to bring it up to speed with the 21st century. There are different directions in which this can be taken. For example, you could explore adaptive ToCs that change their appearance and level of detail depending on screen size or depending on the relevance of a book's section w.r.t. a search term or keyword given by the reader. You could also try to replace it entirely with a suitable interactive visualization of the book's contents and its structure. Or even combine both with each other. This project is very exploratory and open ended. You are tasked to try out as many possible ideas you may have and to user test the 2-3 most promising variants in the end.

[UBI-M] Seamless music streaming room to room (Niels Olof Bouvin – bouvin@cs.au.dk)

This project explores network communication, mobile and server development, personal presence, identity, and preference, as well as collaborative spaces, and integration with and data mining of streaming services. The goal is to develop one of two scenarios, both involving music.

[UBI-M1] A home with speakers in each room

As the user comes home, their music transitions seamlessly from their phone (or other music player) to the loudspeakers in the home. As the user moves from room, their music follows them, so that it is not playing where they are not. If the home is not a single residency, the system keeps track of where the inhabitants are and adjusts the playback accordingly. The music is of course always in sync throughout the home. If there are multiple people, the system can combine their playlists and personal preferences into a shared playlist. Guests can be granted temporary access to affect the playlist.

[UBI-M2] A public place with one speaker and a communal playlist

There is one speaker system and thus only one playlist. The people present can make suggestions to the playlist, and others can in return vote or influence what is going to played next. People who have demonstrated good taste according to the room (upvoted songs) are given higher weight and influence. If no-one is voting, the system automatically plays music that matches the collective taste of those present.

Both projects involve developing a sensor platform that can reliably detect presence through, e.g., Bluetooth LE beacons, ultrasound sensors, or camera input. The sensed data is used to create a context sensitive system combined with what can be gathered from the users' online music profiles. Finally, the playback requires synchronization across different devices. From a concrete scenario, students will gain experience and understanding of Ubiquitous Computing fundamentals as well as advanced topics, distributed programming, and Web integration with existing services.

[UBI-N] Designing to support Hybrid collaborative work
(Marianne Graves Petersen – mgraves@cs.au.dk, Jens Emil Grønbæk – jensemil@cs.au.dk)

During the pandemic, we witnessed a major uptake of remote and hybrid collaboration supported by videoconferencing systems. Even though decades of research into e.g. mediaspaces have informed the design of the systems we live with today, there are still many unresolved issues, both in research and practice e.g. establishing shared references to objects, establishing eye contact, negotiating floor control etc. The complexity of these challenges increase tremendously when we transition from purely remote collaboration (where no-one are co-present) to designing for hybrid collaboration (where some people are co-present and others are remote).
This situation poses additional challenges in terms of establishing symmetry between the opportunities for co-present people and remote people to engage in the collaboration.

This project will investigate how we can design interactive environments in order to support hybrid collaboration. This involves conducting empirical studies of the challenges of current practices, drawing upon theoretical insights to inform analyses and design, (this could be in terms of proxemics, f-formations, spatial literacy) and finally developing and evaluating innovative interactive systems, which points ahead toward future techniques, principles opportunities for supporting hybrid collaboration. Emphasis can be placed in different ways between these activities and on the type of design solutions to explore (e.g. Cross-device interaction, interactive interiors etc.)

Related Literature:

- Saatci et al. 2019. "Hybrid Meetings in the Modern Workplace: Stories of Success and Failure". In Proc. of CRIWG+CollabTech 2019. https://doi.org/10.1007/978-3-030-28011-6_4
- Grønbæk et al. 2021. "MirrorBlender: Supporting Hybrid Meetings with a Malleable Video-Conferencing System" In Proc. of ACM CHI 2021. https://doi.org/10.1145/3411764.3445698

[UBI-O] Aesthetics of appearance and interaction in domestic healthcare devices

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Home healthcare devices and services (e.g., blood pressure and glucose monitors, thermometers, fertility and allergy trackers) are getting more and more popular in monitoring, documenting, diagnosing, prevention, treatment, allevition of disease and rehabilitation of illness. This project aims to map out the existing aesthetic appearance, interaction, material choices as well as overall design style that is used in the domestic healthcare devices through benchmarking of the existing devices and research prototypes in certain domestic healthcare technology area. Based on the findings, the project should explore alternative aesthetic appearances and materials and make physical mockups. Project should also investigate user perceptions to both existing and designed alternative mockups to build understanding of user preferences of both the existing domestic healthcare devices and designed mockups. This project requires understanding of the design styles and product semantics as well as good command on physical model making with various materials (e.g., wood, plastic, textiles). The outcome of the project should be user-based design recommendations for the product and interaction design of a specific domestic healthcare device area.

Note that this project will be carried out in cooperation with the Socio-technical Design Group at the Department of Communication and Culture.

Related Work:

- Bitterman et al. 2019 “Home healthcare devices. Challenge of CPAP design for effective home treatment”. In The Design Journal, 22:sup1, pp.669-681, https://doi.org/10.1080/14606925.2019.1595446
- Homewood et al. 2019 “Ovum: Designing for Fertility Tracking as a Shared and Domestic Experience”. In Proc. of DIS '19. pp.553–565. https://doi.org/10.1145/3322276.3323692
- Pakanen et al. 2021. “Crafting a Leather Self-tracking Device for Pollen Allergies”. In Proc. of TEI ’21. https://doi.org/10.1145/3430524.3446072