CoChI BSc topics 2023

RepliCHI

Supervisors: Eve Hoggan and Henrik Korsgaard

Human-computer Interaction has a series of classical experiments, where MacKenzie's Fitts' law studies are best known [1, 2]. These studies still act as the foundation for research and design in understanding input, interaction, perception, multi-modality and much more. However, recent work within HCI have shown that a significant number of studies suffer from poor reporting standards, gender and age bias, and potentially an over-reliance on students as participants [e.g. 4, 5].

In this project, students will select one or two classical experiments from HCI. They will examine the literature and develop experiments aiming at replicating the classical work. This involves designing and developing the software for the experiments [see 3] and conduct the experiments with different groups of participants. For instance, how does computer science students compare to other groups (different age groups, educational backgrounds, ethnicity etc.).

There are multiple opportunities for shaping and defining the project, from identifying and selecting a particular experiment, to implementation choices, experimental design, demography etc. This could also be developing an experimental setup that support conducting the experiment in different settings and locations. Students will have an opportunity to train their analytical skills in designing evaluations and laboratory studies, implement classical experiments and practice running experiments.

References

[1] MacKenzie, I. S. (1995). Movement time prediction in human-computer interfaces. In Readings in human–computer interaction (pp. 483-493). Morgan Kaufmann.
http://www.yorku.ca/mack/GI92.html

[2] Soukoreff, R. W., & MacKenzie, I. S. (2004). Towards a standard for pointing device evaluation: Perspectives on 27 years of Fitts' law research in HCI. International Journal of Human-Computer Studies, 61, 751-789. doi:10.1016/j.ijhcs.2004.09.001 http://www.yorku.ca/mack/ijhcs2004.html

[3] MacKenzie, I. S (accessed 2022): Fitts' Law Software,
http://www.yorku.ca/mack/FittsLawSoftware/

[4] Caine, K. (2016, May). Local standards for sample size at CHI. In Proceedings of the 2016 CHI conference on human factors in computing systems (pp. 981-992).

[5] Offenwanger, A., Milligan, A. J., Chang, M., Bullard, J., & Yoon, D. (2021, May). Diagnosing bias in the gender representation of HCI research participants: how it happens and where we are. In Proceedings of the 2021 CHI Conference on Human Factors in Computing Systems (pp. 1-18).

Human-Data Interaction with Public Data

Supervisor: Henrik Korsgaard

Denmark and EU are taking a leading role in making public data available on open data platforms [1]. Today, there are a plethora of open data platforms and data sets available, e.g., on businesses (https://datacvr.virk.dk/), weather (https://www.dmi.dk/frie-data/), public transport (https://help.rejseplanen.dk/hc/da/articles/214174465-Rejseplanens-API), legislation (https://www.ft.dk/da/dokumenter/aabne_data), energy (https://forsyningsdataportal.dk/dataoversigt) and much more. This has the potential to support a more transparent society and foster innovation. Human-Data Interaction (HDI) is a subarea within Human-Computer Interaction (HCI) that focus on multiple aspects of how data is generated, collected, analysed, represented and used in interactive applications and services [2].

There are multiple ways students can approach this project depending on methodology, interest and ambition:

- Empirical projects: Study how existing users of open data use the data (tools, processes, collaboration, challenges). This could be understanding how journalists, housing organisations, utility and energy consumption.
- Theoretical projects: Select fitting theoretical framework from HCI and explore its application within HDI using analysis and interactive demonstrations. This could be how instrumental interaction [3] could inform HDI.
- (Participatory) Design projects: Collaborate with existing and new user groups in designing tools and applications based on data (journalists, organisations, individuals etc.). This can be novel ways of working with data, representations, data-driven applications, situated data visualisations etc.
- Software development: Appropriate existing techniques for data exploration, wrangling, analyses, collaboration etc. to a particular data platform. This could be visual programming or exploration, descriptive statistics, utilisation of feedback/feed forward strategies, information foraging, NLP/NLIDP techniques etc.

Depending on the project, students will have the opportunity to develop their skills within user research and participatory design, understanding challenges in working with open data, API design and usability, information visualisation and data-driven application design.

References

[1] European Open Data Ranking https://data.europa.eu/en/dashboard/2021

[2] Victorelli, E. Z., Dos Reis, J. C., Hornung, H., & Prado, A. B. (2020). Understanding human-data interaction: Literature review and recommendations for design. *International Journal of Human-Computer Studies*, *134*, 13-32.

[3] Beaudouin-Lafon, M. (2000, April). Instrumental interaction: an interaction model for designing post-WIMP user interfaces. In *Proceedings of the SIGCHI conference on Human factors in computing systems* (pp. 446-453).

Family stories, sharing of family trees and data quality, physically and/or through online platforms like MyHeritage

Supervisors: Susanne Bødker and Henrik Korsgaard

Several services offer ways for people to trace their family history and family trees. MyHeritage [1] is one example where users can sign up, create, explore, visualize, share and develop their family tree. This often leads to discovering new ancestors, overlaps between the family tree of others and new aspects to their family history. This also includes searching for information and dealing with the (lack of quality and conflicting information when managing their family trees.

Perhaps without knowing it, using these services become a kind of data work [2], human-data interaction [3] or casual information visualization [4] (depending on framing). The services all adopt the GEDCOM [5] data format and common tools and visualizations around this. Hence, understanding the particular aspects of genealogy as an example of HDI/casual infovis can inform how citizens approach data in other areas of life.

The project can take on multiple directions depending on the interests and focus developed by the students:

- Empirical work could examine how users of MyHeritage or amateur genealogist [6] engage with and share records, data, visualizations and more in their search and hobby.
- Participatory design activities could be used to examine alternative redesigns, tools, representations and applications on top of GEDCOM or other resources within the practice.

References

[1] https://www.myheritage.dk/

[2] https://en.wikipedia.org/wiki/GEDCOM

[3] Møller, N. H., Bossen, C., Pine, K. H., Nielsen, T. R., & Neff, G. (2020). Who does the work of data?. *Interactions*, *27*(3), 52-55.

[4] Victorelli, E. Z., Dos Reis, J. C., Hornung, H., & Prado, A. B. (2020). Understanding human-data interaction: Literature review and recommendations for design. *International Journal of Human-Computer Studies*, *134*, 13-32.

[5] Pousman, Z., Stasko, J., & Mateas, M. (2007). Casual information visualization: Depictions of data in everyday life. *IEEE transactions on visualization and computer graphics*, *13*(6), 1145-1152.

[6] https://www.aakb.dk/nyheder/lokalhistorie/slaegtsforskning-for-begyndere-saadan-kommer-du-i-gang-med-slaegtsforskning

Shared traces in collaborative virtual activities.

Choosing a specific collaborative activity that happens virtually (either on-line or through a specific shared technology) this project works with traces of activity, analytically and constructively. Based on principles from the CIO project [1] the aim is to identify a collaborative activity and explore the possibilities of augmenting this through traces. The process includes developing design suggestions and prototypes to better support traces, using the CIO principles. Through this project the students will show that they have mastered methodologies, theories and concepts in Human Computer Interaction. The students will plan and carry out the project and apply the results in the relevant contexts. The students will apply and reflect on the methodologies used to analyze and solve academic questions and issues. In the project the students will relay and communicate academic questions and issues, collaborating constructively on a scientific basis to solve subject-related issues.

Supervisors: Susanne Bødker and Eve Hoggan

References

[1] Mirzel Avdic, Susanne Bødker, and Ida Larsen-Ledet. 2021. Two Cases for Traces: A Theoretical Framing of Mediated Joint Activity. Proc. ACM Hum.-Comput. Interact. 5, CSCW1, Article 190 (April 2021), 28 pages. https://doi.org/10.1145/3449289

Applications for re-programmable high-resolution textures on physical objects using photochromic dyes

Advisor: Michael Wessely. Michael.wessely@cs.au.dk. www.michaelwessely.com

Programmable matter that can change its physical properties (color, shape, density) promises a future in which objects will re-configure themselves according to a user's needs. One aspect of programmable matter is color, which would allow objects to change their appearance repeatedly. For instance, in clothing, accessories could be altered to match the main outfit and textiles could be recolored for different events on the same day.

https://youtu.be/fEdN1VciJx0

We developed several methods for reprogramming objects with multiple colors and at high resolution [1], high speed [2], and even 3D printable reprogrammable objects [3] that will be available for you at the CoCHI lab. The goal of this bachelor thesis is to find new application areas for reprogrammable materials. I outline below one application scenario that is possible to pursue within a bachelor thesis. A thesis can focus on one or multiple elements of this application scenario but can also study a different scenario.

Many users apply nail polish to get colorful nails with sometimes highly detailed textures on them. Using photochromic nail polishes, users could reprogram their nails daily with new designs and textures without having to reapply the nail polish repeatedly.

Developing a nail reprogramming system involves multiple steps:

- Development of reprogramming device using mini projectors
- UI development of a nail application system
- Material Exploration for photochromic nail polish
- Light exposure optimization method
- Fingernail detection using a camera system

This project requires maker skills and/or computer graphics/optimization skills. Interest in design is useful. Drop me a mail to know more about this project.

[1] Yuhua Jin, Isabel Qamar, Michael Wessely, Aradhana Adhikari, Katarina Bulovic, Parinya Punpongsanon, and Stefanie Mueller. 2019. Photo-Chromeleon: Re-Programmable Multi-Color Textures Using Photochromic Dyes. UIST '19. https://doi.org/10.1145/3332165.3347905

[2] Michael Wessely, Yuhua Jin, Cattalyya Nuengsigkapian, Aleksei Kashapov, Isabel P. S. Qamar, Dzmitry Tsetserukou, and Stefanie Mueller. 2021. ChromoUpdate: Fast Design Iteration of

Photochromic Color Textures Using Grayscale Previews and Local Color Updates. CHI '21. https://doi.org/10.1145/3411764.3445391

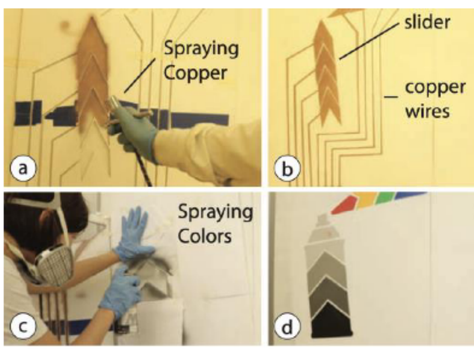
[3] Isabel P. S. Qamar, Sabina W Chen, Dimitri Tskhovrebadze, Paolo Boni, Faraz Faruqi, Michael Wessely, and Stefanie Mueller. 2022. ChromoPrint: A Multi-Color 3D Printer Based on a Reprogrammable Photochromic Resin. CHI EA '22. https://doi.org/10.1145/3491101.3519784

Fabricating large-scale user interfaces in architecture

Advisor: Michael Wessely. Michael.wessely@cs.au.dk. www.michaelwessely.com

We explore how to make large-scale user interfaces using spraying as the fabrication method. Unlike many existing techniques, such as 3D printing, screen printing or inkjet printing, spraying is not bound to a specific volume and as often demonstrated by graffiti artwork, can create output that covers entire walls and even building facades. By using sprayable inks such as conductive copper ink, or light-emitting phosphor ink, we demonstrated that it is possible to create touch buttons, sliders, proximity sensors and electroluminescent displays on large surfaces such as the walls of a room or on furniture [1].

https://youtu.be/UXzyFbqGYOU



The goal of this project is to extend the current state-of-the-art to computer-controlled spraying drones. The first step is to mount a spraying system on a drone that can apply functional inks (or colors) on entire buildings. The drone can be controlled by a computer system where a user can digitally design the appearance and the function of the building/wall, and the drone will automatically spray the designs.

Outlined below are the several elements to enable this project. One or multiple of those can be a bachelor thesis.

- Engineering Spraying System on a computer-controlled drone
- Tracking system for a drone
- Computational Model for Wind Compensation in the flight trajectory of a drone
- UI for designing large-scale user interfaces
- Material Exploration for spraying smart materials (e.g., sprayable solar cells, electroluminescent displays)
- User study with architects and city planners for applications of large interfaces at building-scale for the future of smart cities

This project requires maker skills and/or computer graphics/optimization skills. Drop me a mail to know more about this project.

[1] Michael Wessely, Ticha Sethapakdi, Carlos Castillo, Jackson C. Snowden, Ollie Hanton, Isabel P. S. Qamar, Mike Fraser, Anne Roudaut, and Stefanie Mueller. 2020. Sprayable User Interfaces: Prototyping Large-Scale Interactive Surfaces with Sensors and Displays. CHI '20. https://doi.org/10.1145/3313831.3376249

Haptic textures in 3D printing

Advisor: Michael Wessely. Michael.wessely@cs.au.dk. www.michaelwessely.com

3D printing enabled a wide range of users to create highly detailed geometries without expert knowledge in crafting and design. However, the materials that can be 3D printed are still limited to plastic-like substrates but fail to print other materials such as metal, glass, wood, or stone.

The goal of this project is to develop a novel 3D printing technique that creates objects that are printed with standard filament such as PLA but create the haptic experience of wood, stone, or glass when users touch them. The key idea is to create microstructures on the surfaces of 3D prints that change the way they feel. To enable printers to create such microstructures, this project explores the utilization of vibration during the printing process. By letting the printer nozzle vibrate during printing in a computer-controlled way, it might be possible to create microstructures on the final print that alter the way the objects feel.

Some Inspiration: https://youtu.be/1JjaqKUUMMw

Below I outline several steps where each can be a bachelor thesis.

- Modifying a 3D printer to support vibration of the printing platform the printer nozzle
- Computational Model to simulate effect the of vibration on 3D printed objects
- Study and development of a metric to define the similarity of a printed surface texture to real-world materials
- Material Exploration on 3D printable filaments with varying heat-transfer rates and studying the combination of surface roughness and heat transfer on the perceived material characteristics

This project requires maker skills and/or computer graphics/optimization skills. Experience in haptics is useful. Drop me a mail to know more about this project.

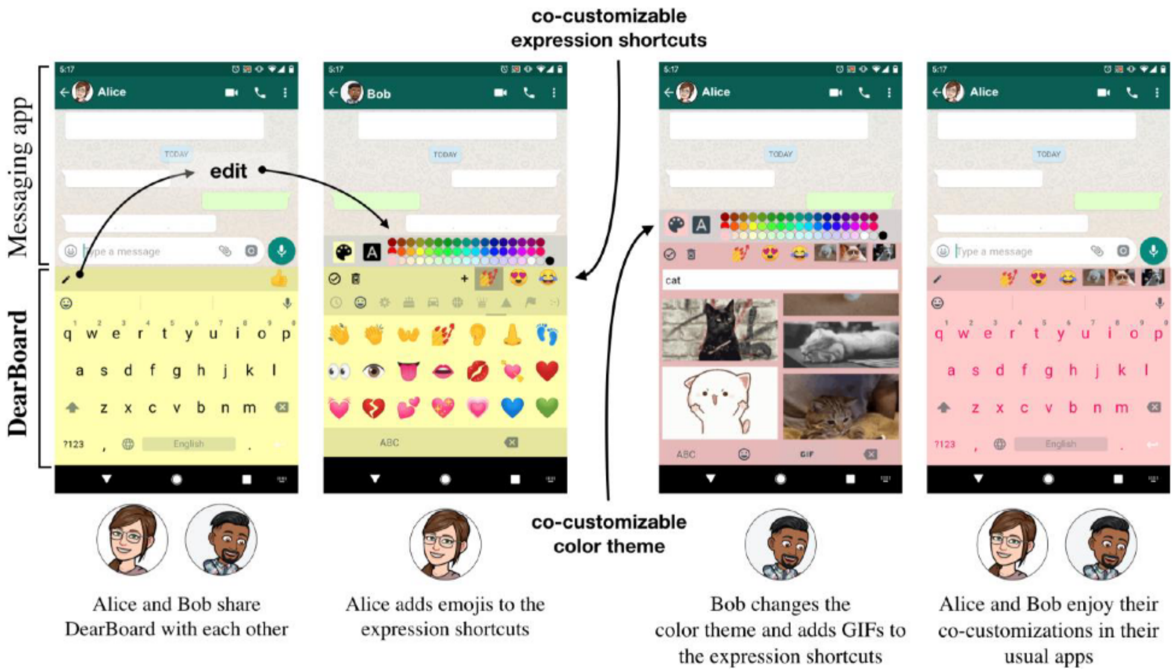
Collaborative customizations for messaging apps

Supervisors: Carla Griggio (carla@cs.au.dk / carlagriggio.com) and Susanne Bødker

This project invites students to think of creative designs and implementations that explore the concept of "co-customizations" (collaborative customizations) applied to messaging apps, allowing two or more users to negotiate the functionality and settings that shape their conversations.

Messaging apps are part of our everyday communication with friends, family, and colleagues, and the available functionality of each app shapes the way we communicate with others. For example, the possibility of adding custom stickers and emojis allows us to express themselves in more personal ways than with default emojis and sticker packs [1]; we may be more open and relaxed about what we write when messages disappear after they are read (e.g., as in Snapchat) and more careful about how we phrase things when messages persist indefinitely (e.g., as in Slack); and status indicators such as "typing…", "online", or read receipts can foster a sense of "co-presence" but also interfere with privacy, depending on who we are chatting with [2]. Such functionality and customizations have great influence over how we relate to others online, however, they are not designed with relationships in mind. Customizations generally apply at the "individual user" level [1], e.g., if WhatsApp users disable read receipts, they do so for all their contacts. When two users have different settings, the app decides for them which setting applies as the "lowest common denominator" (e.g., if a WhatsApp user with read receipts chats with another one without them, the feature is disabled for both). This project seeks to grant more power to users and their contacts in deciding how their conversations are mediated, turning fixed functionality and individual-user settings into collaborative customizations.

Dearboard [3] is an example of a project applying co-customizations to messaging. In this figure, a keyboard allows two users to collaboratively change its color theme and a toolbar of shortcuts to emojis and GIFs according to what best fits ***their*** relationship.



For this project, the students will propose their own idea related to co-customizations and set a plan to address one or more of the following challenges:

- Design: what kind of new interface designs and interaction techniques can help two or more users negotiate customization possibilities and agree on one? How to let users re-use past co-customizations?
- Programming/engineering: what kind of code abstractions and OOP design patterns could help turning ***any*** interface element and app setting a co-customization? If two users are changing a co-customization at the same time, how to prevent/manage customization conflicts?
- Empirical: how do co-customizations affect online communication for diverse types of relationships? What kind of logging mechanisms and user studies could help answer this question?

The above challenges and ideas are intended as inspiration, and students are welcome to pitch their own. Students interested in implementing a working prototype can develop a reduced version of a messaging app from scratch or modify an open-source messaging client (e.g., Signal, Telegram, Element).

References

[1] Carla F. Griggio, Joanna McGrenere, and Wendy E. Mackay. 2019. Customizations and Expression Breakdowns in Ecosystems of Communication Apps. Proc. ACM Hum.-Comput. Interact. 3, CSCW, Article 26 (November 2019), 26 pages. https://doi.org/10.1145/3359128

[2] Midas Nouwens, Carla F. Griggio, and Wendy E. Mackay. 2017. "WhatsApp is for family; Messenger is for friends": Communication Places in App Ecosystems. In Proceedings of the 2017 CHI Conference on Human Factors in Computing Systems (CHI '17). Association for Computing Machinery, New York, NY, USA, 727–735. https://doi.org/10.1145/3025453.3025484

[3] Carla F. Griggio, Arissa J. Sato, Wendy E. Mackay, and Koji Yatani. 2021. Mediating Intimacy with DearBoard: a Co-Customizable Keyboard for Everyday Messaging. In Proceedings of the 2021 CHI Conference on Human Factors in Computing Systems (CHI '21). Association for Computing Machinery, New York, NY, USA, Article 342, 1–16. https://doi.org/10.1145/3411764.3445757

Magnetic Haptic Feedback

Supervisor: Eve Hoggan

Traditionally, haptic feedback is presented using vibrotactile motors. However, these are noisy and somewhat limited in terms of design parameters. In this project, students will explore the possibilities of creating distinguishable haptic feedback using magnets.

This project requires extremely good prototyping skills (electronics and 3D printing) and will also involve psychophysical user studies.

Declarative programming of interaction in computational notebooks

Supervisor: Clemens Nylandsted Klokmose

Computational notebooks such as Jupyter Notebook or Observable have become popular tools in data science and for programming that involves data processing or visualisation. Many notebook systems support embedding interactive widgets of various kinds, e.g., to embed an interactive map inside a notebook. Developing widgets typically require external tools such as an integrated development environment (IDE) where the programmer programs up against the API of the notebook system. Programming small interactive components inside the notebook itself is often relatively limited, not possible at all, or requires extensive knowledge of event handling and software architecture. We have developed a declarative programming model for specifying interactive behaviour in Web applications called Varv. Varv works like CSS just for specifying interactive behavior.

In the project, the students will experiment with how Varv can be used in the context of computational notebooks, build a prototype, and design a small user study to evaluate its feasibility. The students will work with and are expected to have experience with Web technology (JavaScript, HTML, CSS). The prototypes will be built on top of Webstrates (webstrates.net) using the Codestrates v2 framework (https://codestrates.projects.cavi.au.dk). Both of which are technologies developed in the CoCHI group.

Interactive and collaborative JavaScript exercises in CoTinker

Supervisor: Clemens Nylandsted Klokmose

CoTinker is an experimental platform for creating learning activities around computational thinking developed at Aarhus University. CoTinker provides a web-based interface where students collaboratively can solve exercises and document their results. Our first prototype of a learning activity in CoTinker revolves around agent-based modelling (ABM). Students are presented with an interactive simulation of a biological phenomenon and are gradually asked to explain the phenomena that are modelled and solve various programming related tasks. CoTinker supports collaborative control of the progression of assignments, distribution of control across laptops and mobile phones, collaborative editing of code, and control of what code to expose to students for editing based on the given exercise.

The project will explore how CoTinker can be used to design learning activities around JavaScript programming. The students will develop one or more learning activities in CoTinker and design and conduct an empirical study to compare the use of CoTinker with a conventional assignment design. The students are expected to have experience with Web technology (HTML, CSS, and JavaScript).

Violations of personal digital sovereignty

Supervisor: Clemens Nylandsted Klokmose and Carla Griggio

Human-computer interaction (HCI) research should be concerned that the current design of software and modern digital infrastructures challenge personal digital sovereignty. Personal digital sovereignty consists of an individual's independence, autonomy, and control in their relationship with data, software, and hardware:

- Independence means not needing to rely on others and is challenged when, for example, users are unable to make changes to their software without the (global) market demanding similar changes.
- Autonomy means the freedom to self-direct and is challenged when, for example, users are forced to update their software at the schedule of the developer.
- Control means the proactive power to determine how to achieve one's goals and is challenged when, for example, users are unable to combine multiple applications in new ways to interoperate on the same data.

In this project, the students will pick a profession (electronic musicians, patent clerks, communication consultants, architects, teachers, medical doctors...) and document when the participants' personal digital sovereignty is violated and what aspect of the software they use are a cause of this. Methods can include qualitative interviews, cultural probes, future workshops, and more. Based on the results of this study, students will suggest what aspects of the studied software should change and how so that it grants greater independence, autonomy and control.