From Reading to Writing: Building Blocks of HCI Research

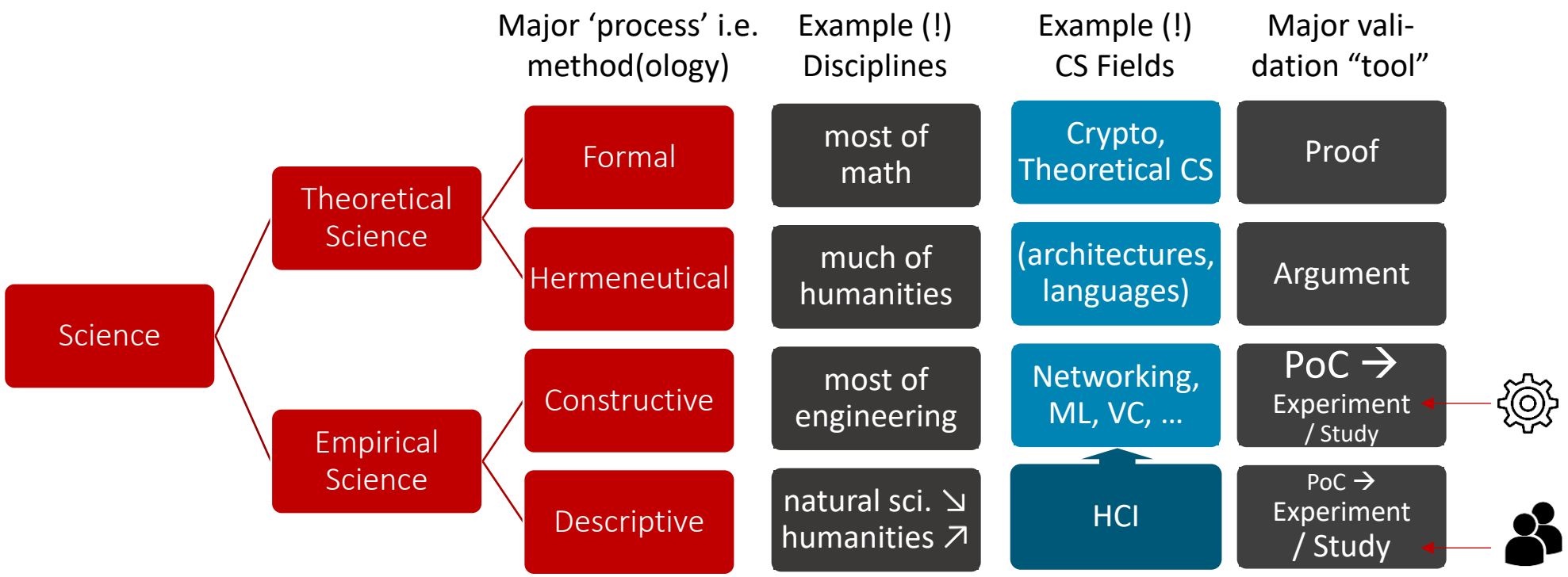
Seminar Generative AI for Interactive Systems

Ashwin Ram, Martin Schmitz, Jürgen Steimle

Slides based on Hands-On HCI Lecture 2024 / TU Darmstadt

HCI @ Scientific Fields / Methodologies

Disclaimer: no agreed-upon classification exists --- yet **every scientist is doing it!**



HCI is *unique* in computer science (informatics) w.r.t. scientific methodology

Three Approaches to HCI Research

Research Approaches

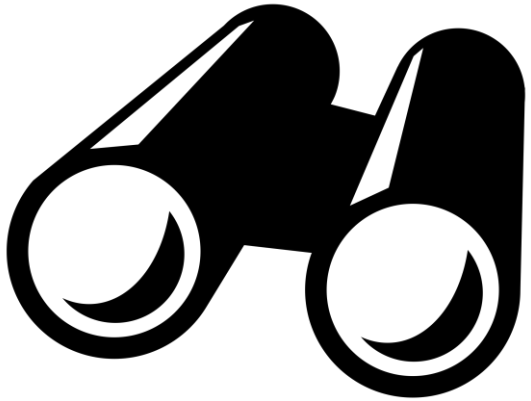
Literature Review

How to read papers

Writing Related Work

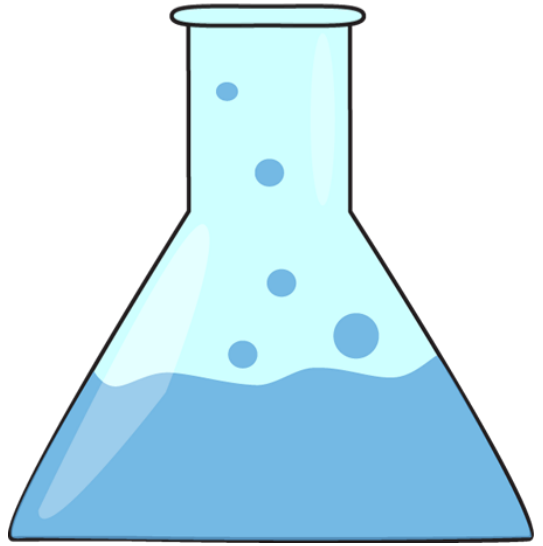
Writing Research Questions

Three approaches to HCI Research



Ethnography
(Look)

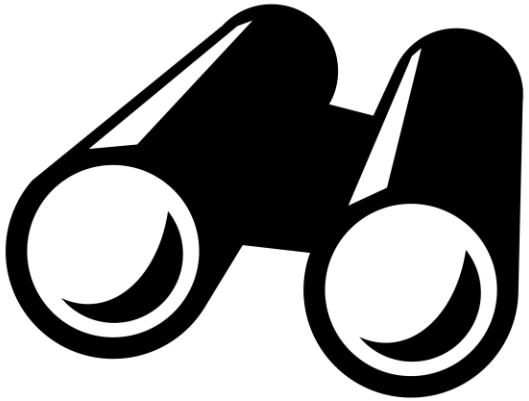
Engineering and Design
(Make)

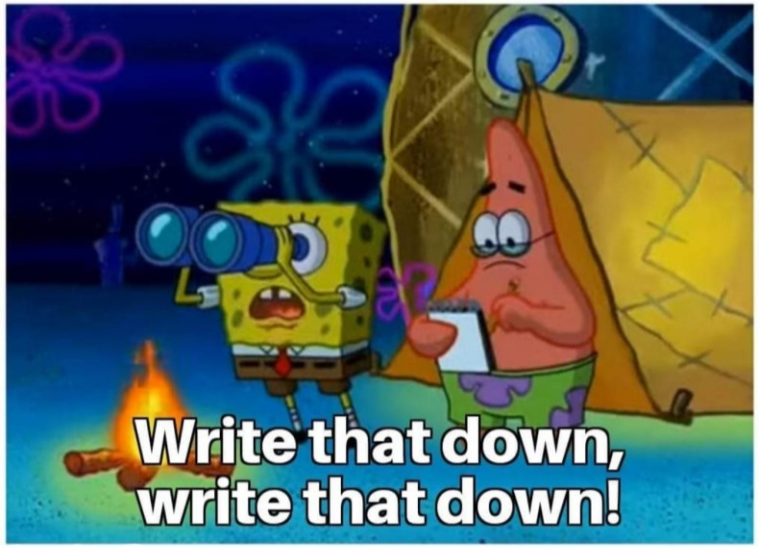


Empirical science
(Test)

Ethnography

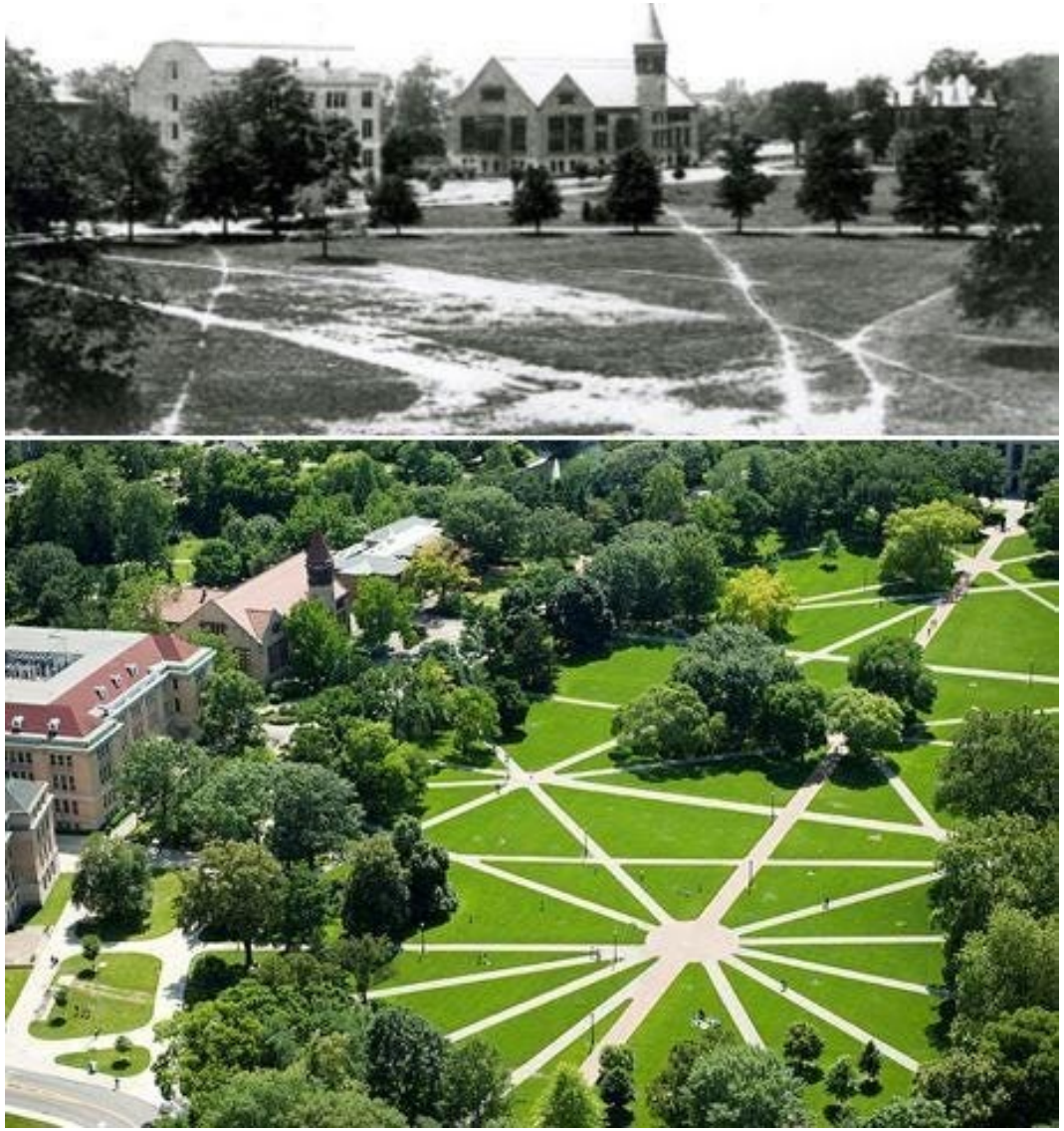
- **Collect** data with different methods, e.g.:
  - Observation
  - Interview
- **Code** data and find patterns in it
- **Create theories** that explain the data
- Try to attack the theories by **gathering more data**
  - Leads to stronger theories





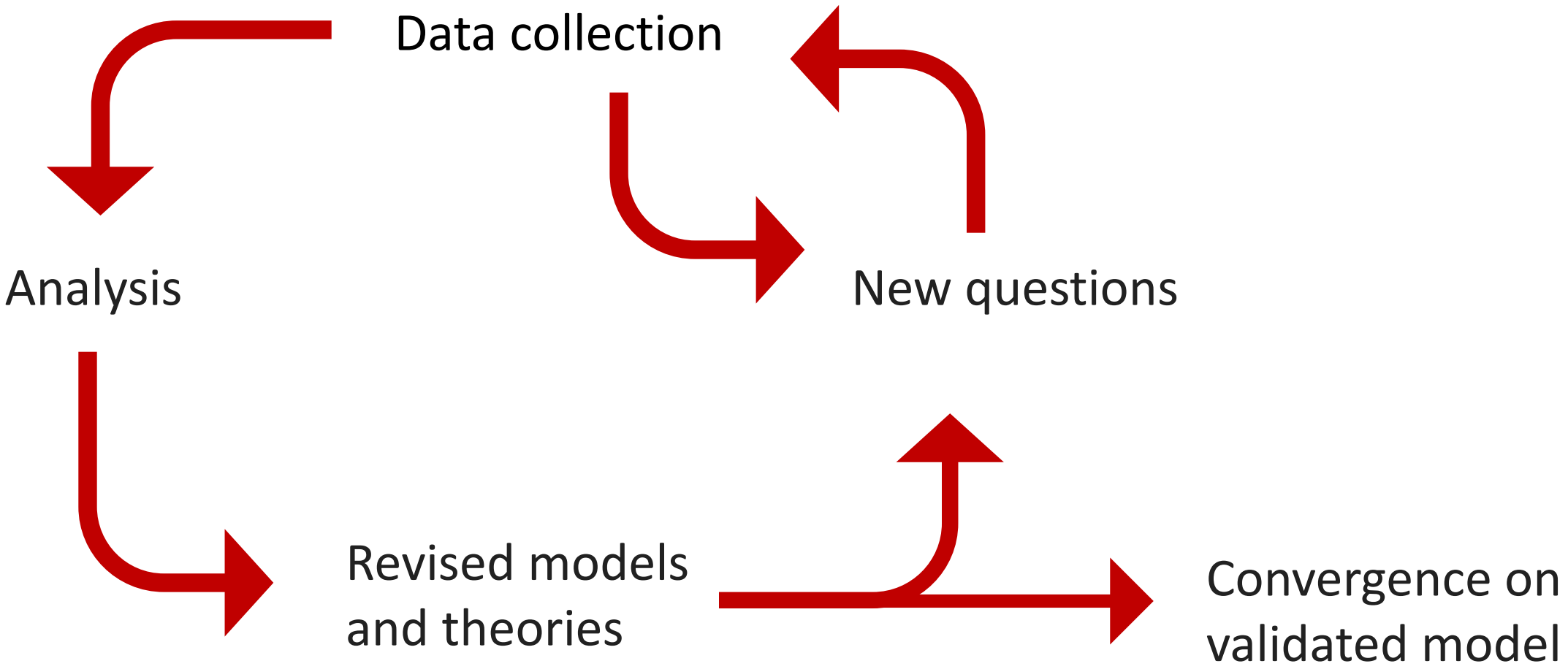
Data collection

- Methods: Observation, interview, participation, logging
- Format: Field notes, video, audio, log files
- Triangulation: use multiple data sources to support an interpretation that increases the confidence of your conclusion
- From different participants
- From different types of data, e.g., observations, interviews, logs



https://miro.medium.com/v2/resize:fit:640/format:webp/0*IpuCnOIO3XE1Gwxz.jpg

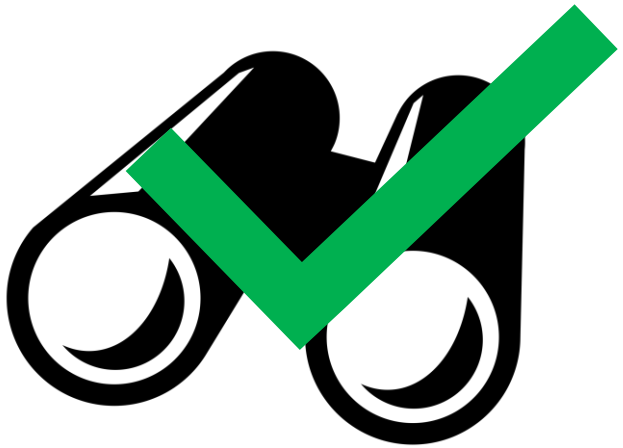
The iterative process of ethnographic research



Example

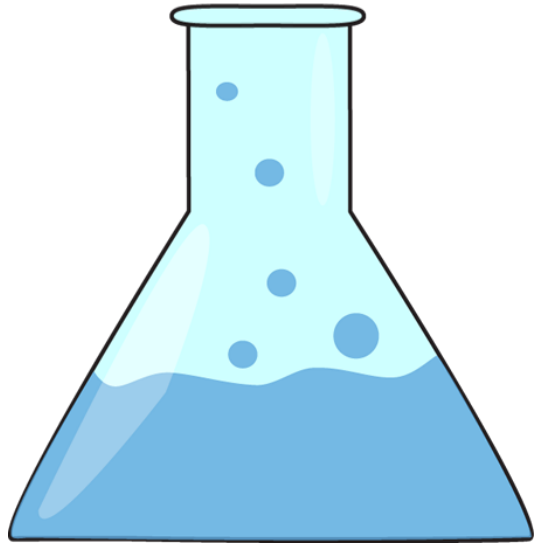
Source and full video: https://www.youtube.com/watch?v=osN2CmmGooM

Three approaches to HCI Research



Ethnography
(Look)

Engineering and Design
(Make)



Empirical science
(Test)

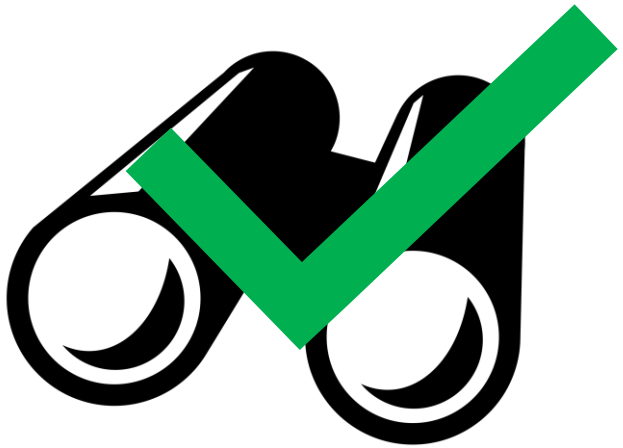
Engineering & Design

- Objective: solve a problem with a **solution that works**
- Key attributes:
  - Compelling target
  - Solve a concrete, compelling problem with demonstrated need
  - Solve a set of problems using a unifying set of principles
  - Explore how people will interact with computers in the future
- Technical challenge
  - Requires novel, non-trivial algorithms, or configuration of components
- Deployed when possible
  - System is deployed, intended benefits and unexpected outcomes documented

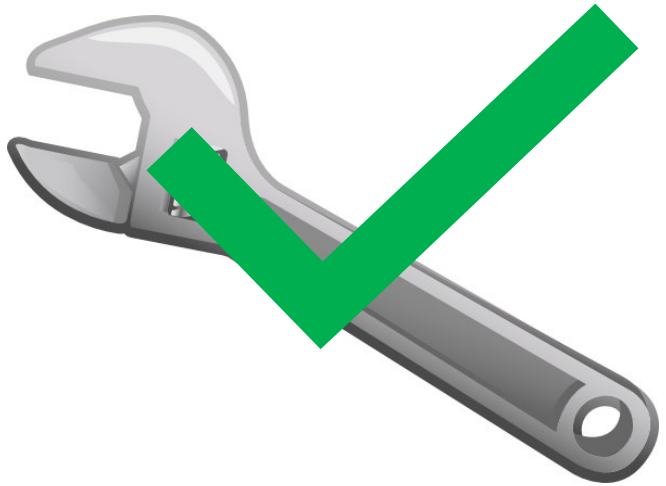
Example

Source: https://www.youtube.com/watch?v=g3XPUdW9Ryg

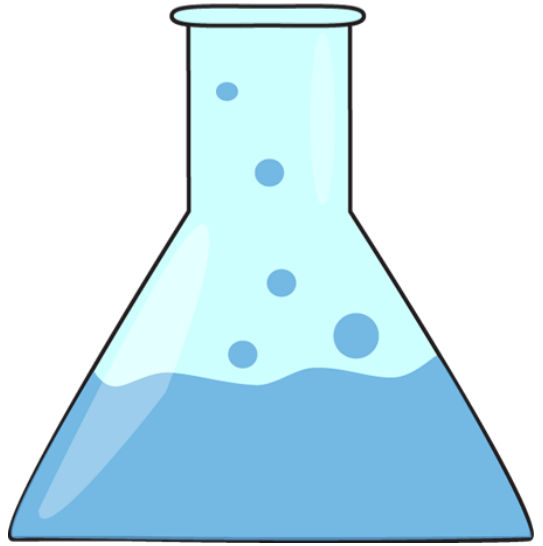
Three approaches to HCI Research



Ethnography
(Look)



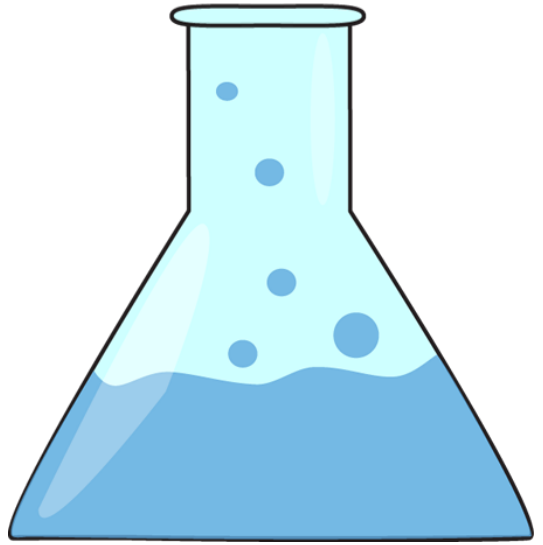
Engineering and Design
(Make)



Empirical science
(Test)

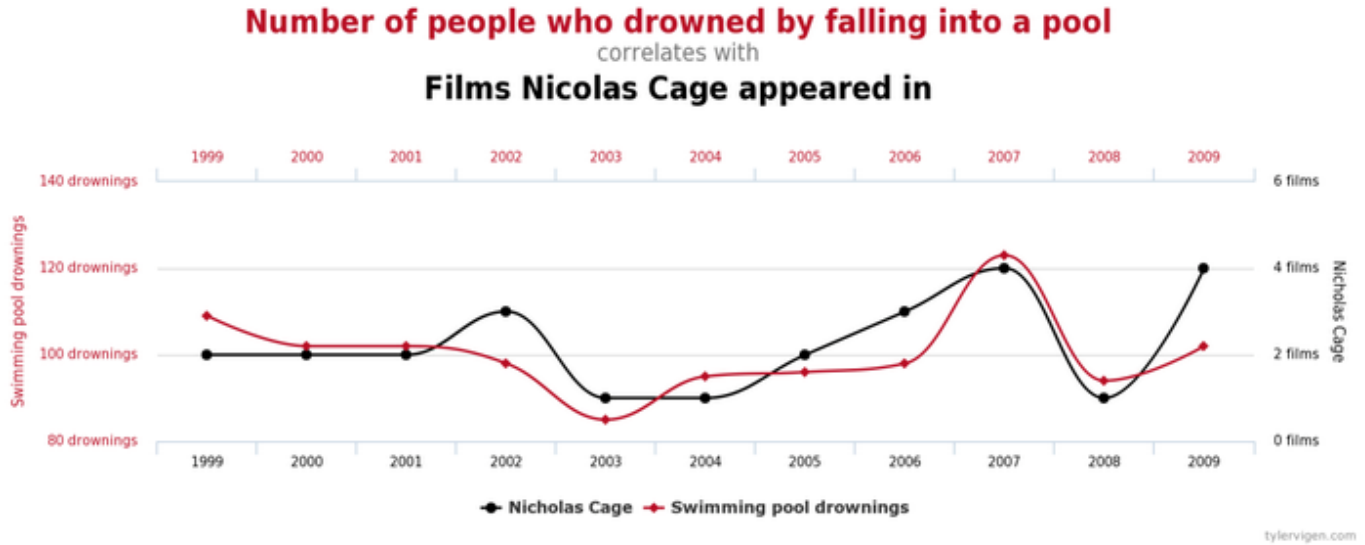
Empirical approach

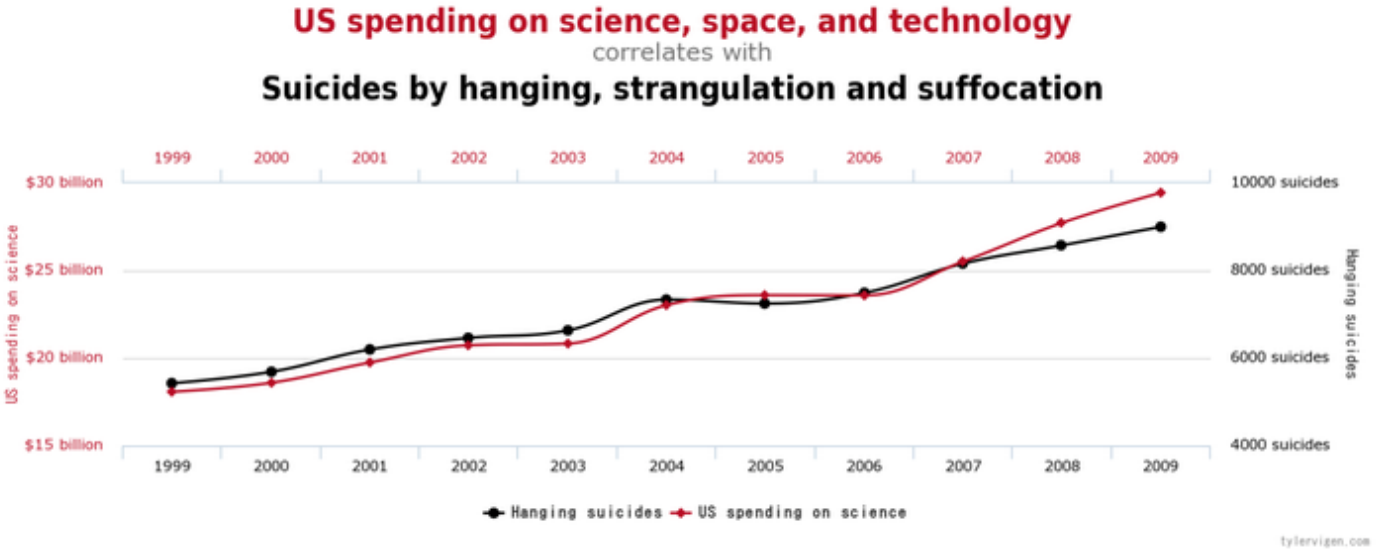
- Begin with casual or informal observation
- Usually comes from **personal experience** that catches your attention or raises questions in your mind
- Example: “Cloth has an affordance of pinching. Could this be useful for interaction design?”



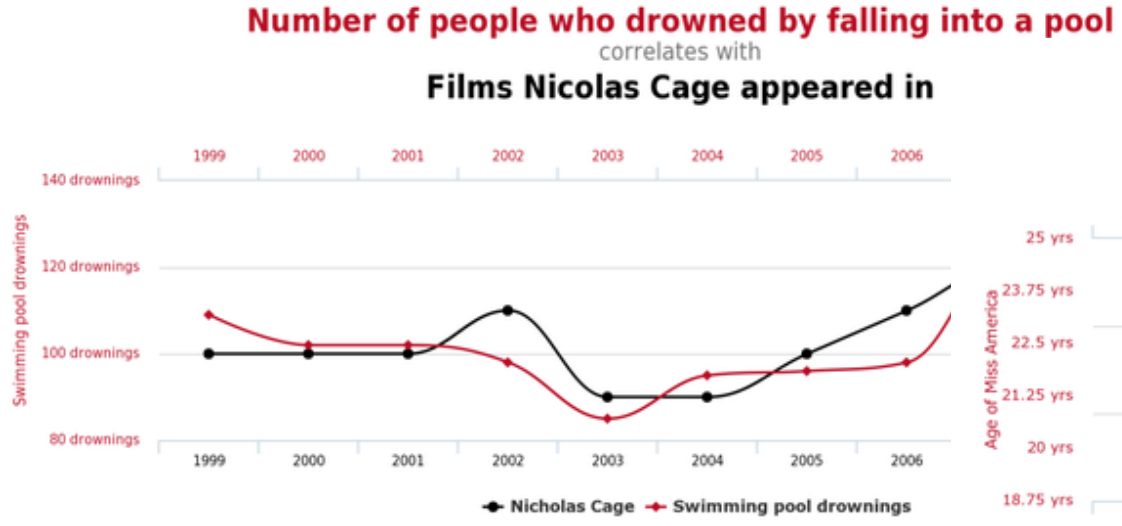
Planned Observation

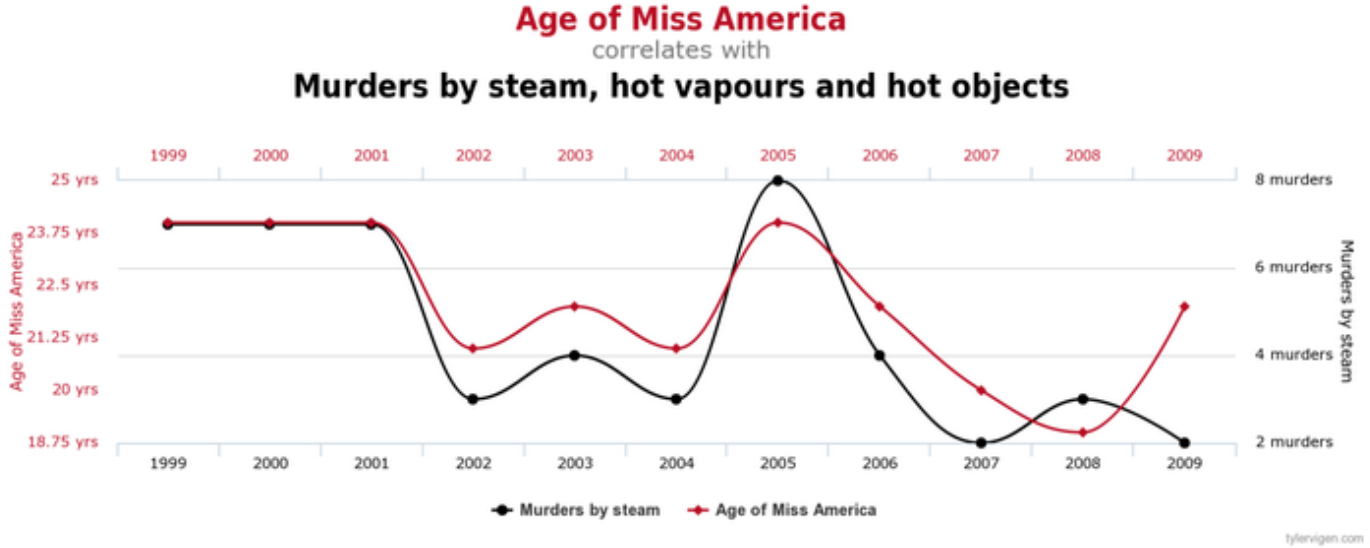
- Collect data to support, refute, or refine the original hypothesis
- Three strategies
  - **Descriptive research**: X happens
    - Focus on the current state of each individual variable
    - It finds the *what/when/where*, not the *why/how*
  - **Relational research**: X and Y happen together
    - Measure two or more variables that exist naturally from each participant
  - **Experimental research**: X causes Y
    - Manipulate one or more variables and observe their effects to other variables

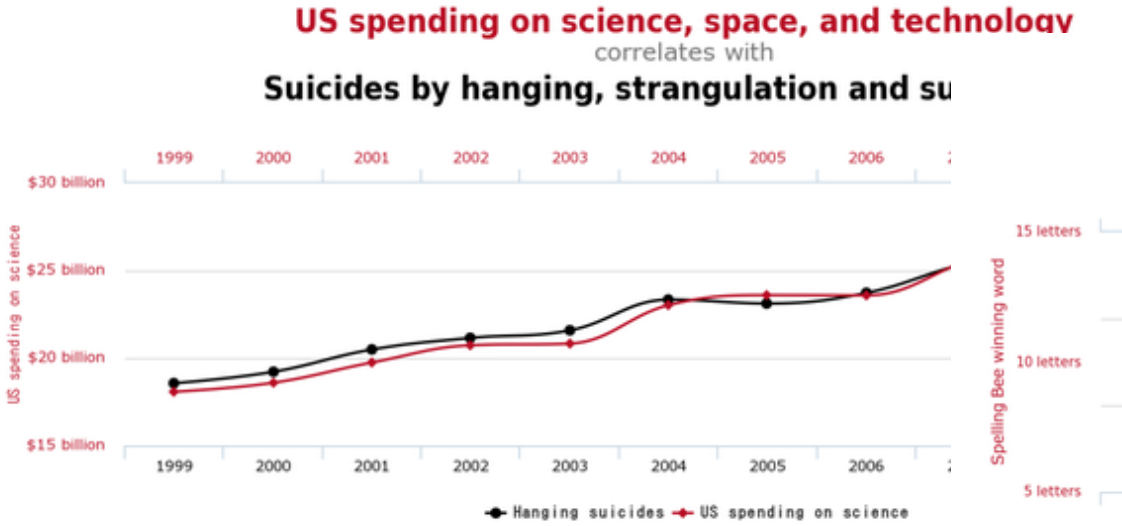




https://bigthink.com/health/data-connects-nicholas-cage-movies-to-drownings-wait-what/

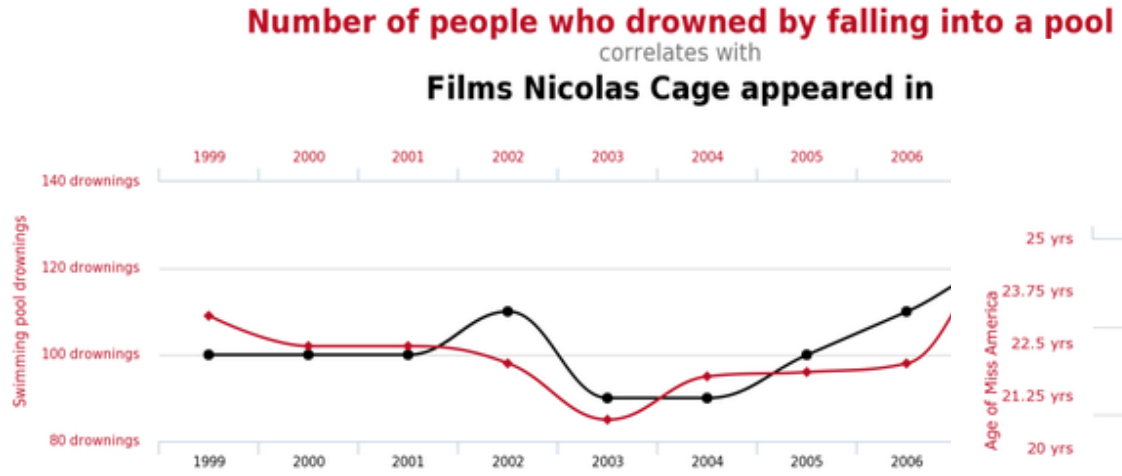


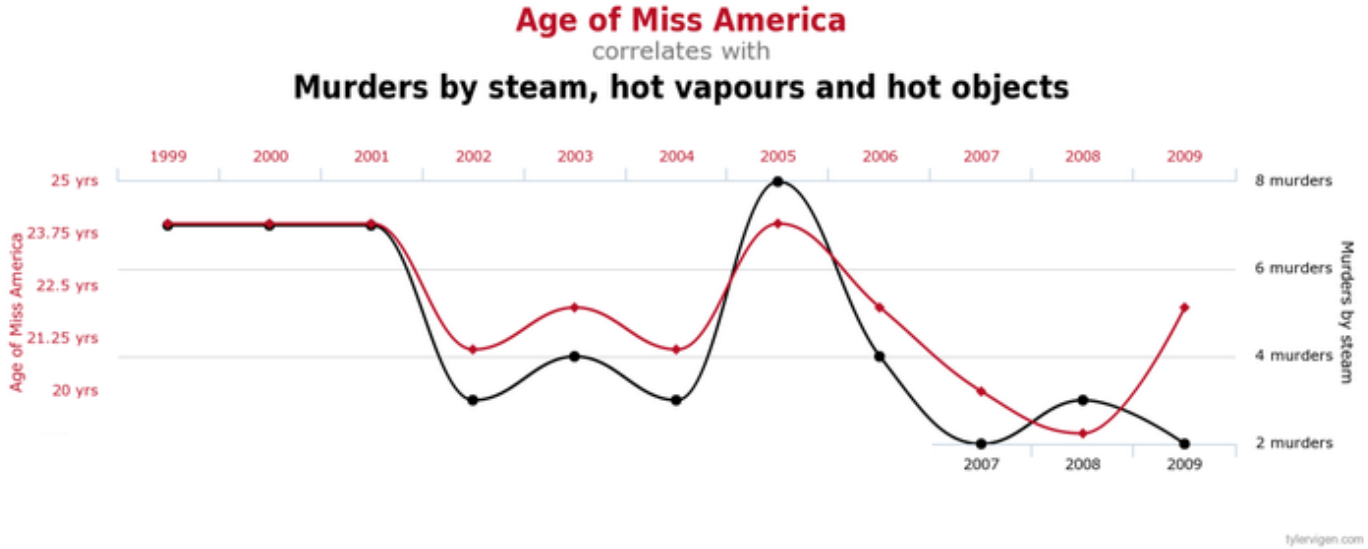


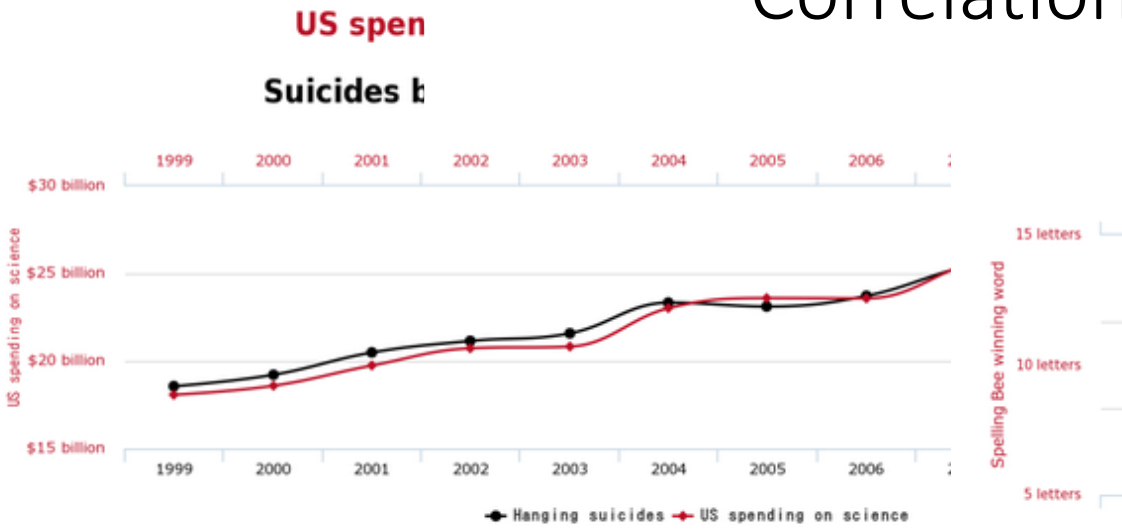


https://bigthink.com/health/data-connects-nicholas-cage-movies-to-drownings-wait-what/

Correlation vs Causation







https://bigthink.com/health/data-connects-nicholas-cage-movies-to-drownings-wait-what/

Seven research contribution types

- Theoretical contribution
- Methodological contribution
- Survey contribution
- Empirical contribution
- Opinion contribution

- **Artefact contribution**
- **Dataset contribution**

Wobbrock, J. O., & Kientz, J. A. (2016). Research contributions in human- computer interaction. interactions, 23(3), 38-44.

Artefact contributions encompass…

- New systems
- Architectures
- Tools
- Toolkits
- Techniques
- Sketches
- Mockups
- Envisionments

Artefact contributions

- Creation of interactive artefacts is at the core of HCI Architectures
- Facilitate new insights / Help envisioning new futures
- New knowledge is embedded in and manifested by artefacts
- Evaluated based on type of artefact
  - Often accompanied by empirical studies (not always!)

Dataset contributions

- New and useful dataset beneficial for the research community Architectures
- Typically includes an analysis of the characteristics of the dataset Techniques
- Often accompany benchmark tests, new tools or methodological contributions
- Judged favourably based on the extent to which they supply the research community with a useful and representative corpus against which to test and measure

https://www.uio.no/studier/emner/matnat/ifi/IN2020/h22/timeplan/02-hci-methods.pdf

Literature Review

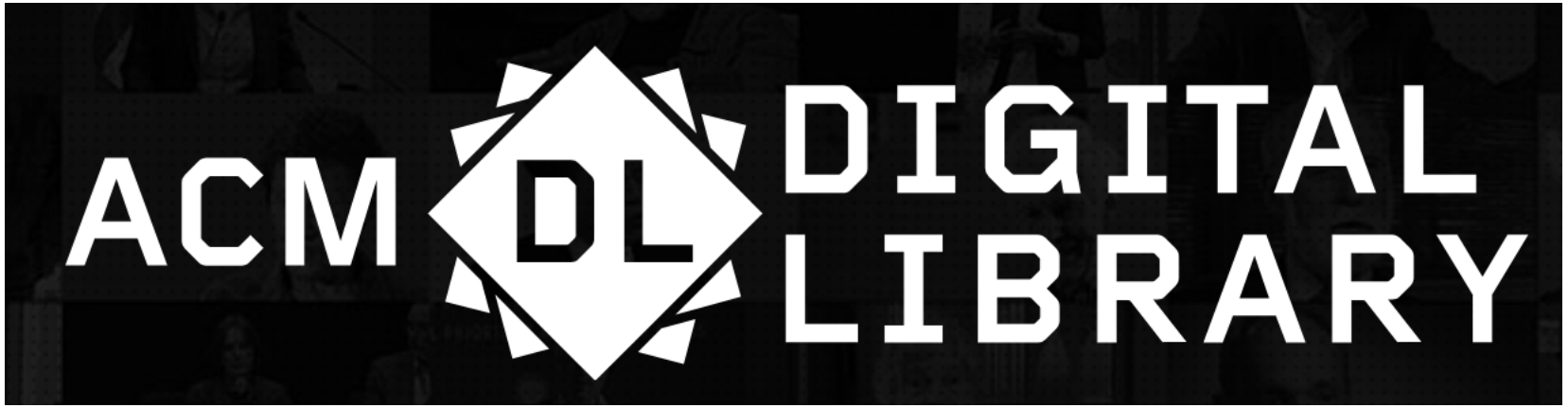
Research Approaches | **Literature Review** | How to read papers | Writing Related Work | Writing Research Questions

Literature Review

- Where and how to look for related work?
- Where and how to store your search results?
- How to integrate the references in your paper?

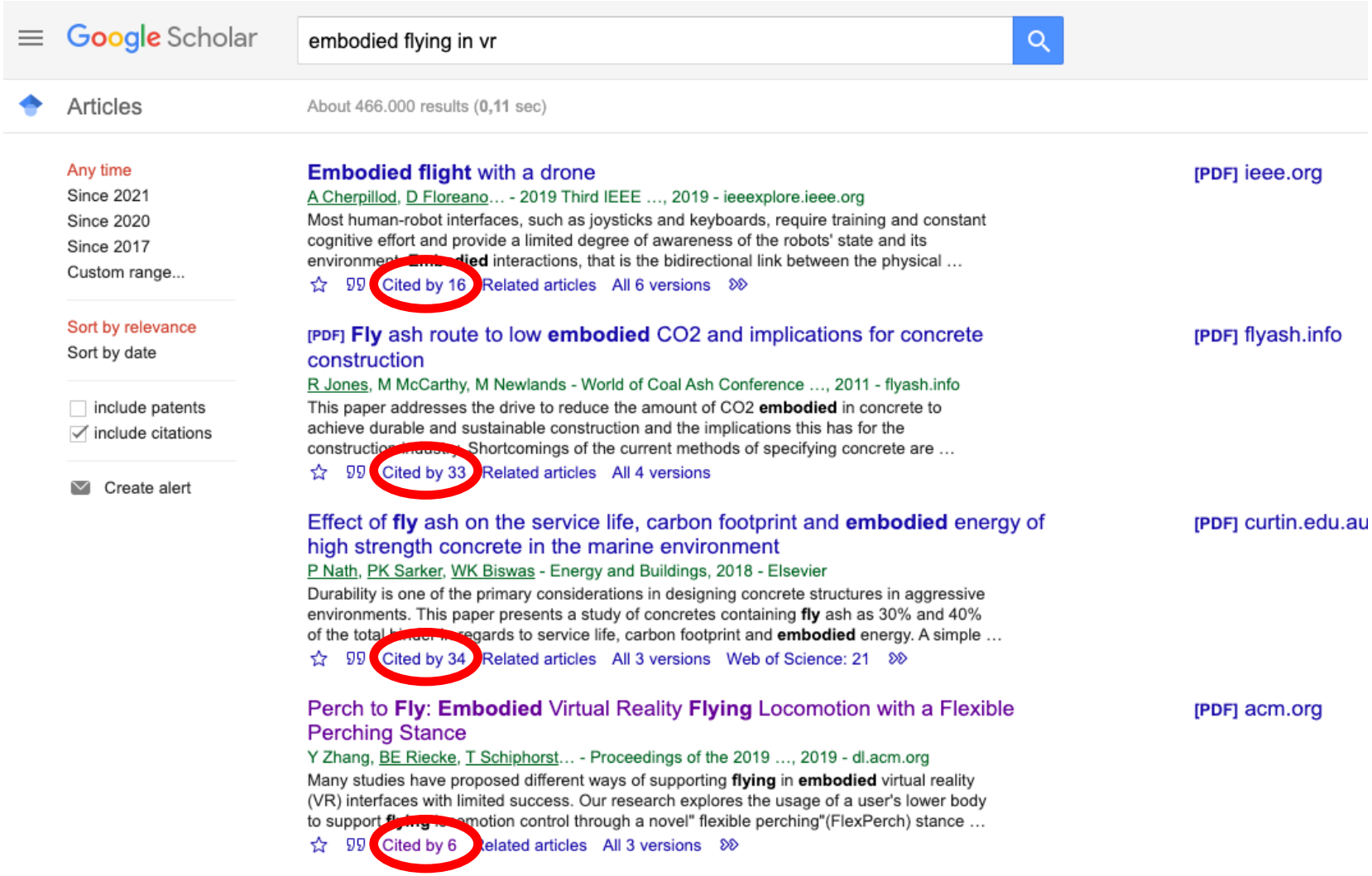
Where to look for related work?

- Google Scholar: https://scholar.google.com
- ACM Digital Library: https://dl.acm.org



How to look for related work?

- Check who cites relevant work



How to look for related work?

- Check list of references and related work section

Perch to Fly: Embodied Virtual Reality Flying Locomotion with a Flexible Perching Stance *

Yaying Zhang, Bernhard E. Riecke, Thecla Schiphorst, Carman Neustaedter
School of Interactive Arts and Technology, Simon Fraser University, Surrey, Canada
{yayingz, ber1, schiphorst, carman}@sfu.ca

RELATED WORK

3D Locomotion Technique Studies

Embodied VR flying locomotion, is a kind of **3D locomotion**. There are three primary goals of 3D locomotion: exploration, search and maneuvering [7], [8]. In exploration, a user locomotes to gather information in the environment, or just locomotes for fun in a joyful or stimulating VE. Search is when the user has a specific target to locate in the VE. Maneuvering refers to a precise perspective control over a target. This may happen when the user observes an object at a different angle, in order to gain more knowledge of it. Each of these three goals may require different techniques to be most effective [8].

REFERENCES

[1] D. A. Bowman, D. Koller, and L. F. Hodges, "Travel in immersive virtual environments: an evaluation of viewpoint motion control techniques," in Virtual Reality Annual International Symposium, 1997., IEEE 1997, 1997, pp. 45–52, 215.

[2] H. Iwata, "Walking about virtual environments on an infinite floor," in Proceedings IEEE Virtual Reality (Cat. No. 99CB36316), 1999, pp. 286–293.

[3] M. Usoh et al., "Walking ≫ Walking-in-place ≫ Flying, in Virtual Environments," in Proceedings of the 26th Annual Conference on Computer Graphics and Interactive Techniques, New York, NY, USA, 1999, pp. 359–364.

[4] X. Tong, D. Gromala, B. E. Riecke, C. D. Shaw, T. Loughin, and M. Karamnejad, "Usability Comparisons of Head-Mounted vs. Immersive Desktop Displays for Pain Management in Virtual Reality," presented at the ICME (submitted), 2014.

[5] Limbic Life, "Limbic Chair." [Online]. Available: https://www.limbic-life.com/limbic-chair-custom/. [Accessed: 01-Apr-2019].

[6] A. Field and G. Hole, How to Design and Report Experiments. SAGE, 2002.

[7] D. S. Tan, G. G. Robertson, and M. Czerwinski, "Exploring 3D Navigation: Combining Speed-coupled Flying with Orbiting," in Proceedings of the SIGCHI Conference on Human Factors in Computing Systems, New York, NY, USA, 2001, pp. 418–425.

[16] A. Kitson, A. M. Hashemian, E. Stepanova, E. Kruijff, and B. E. Riecke, "Comparing leaning-based motion cueing interfaces for virtual reality locomotion," in 2017 IEEE Symposium on 3D User Interfaces (3DUI), 2017, pp. 73–82.

[17] A. M. Hashemian and B. E. Riecke, "Leaning-Based 360° Interfaces: Investigating Virtual Reality Navigation Interfaces with Leaning-Based-Translation and Full-Rotation," in Virtual, Augmented and Mixed Reality, 2017, pp. 15–32.

[18] L. R. Harris et al., "Simulating Self-Motion I: Cues for the Perception of Motion," Virtual Real., vol. 6, no. 2, pp. 75–85, Sep. 2002.

[19] R. L. Page, "Brief History of Flight Simulation," SimTecT 2000 Proc., pp. 11–17, 2000.

[20] N. Hays, "Nobody Walks in VR - They All Fly," IEEE Comput. Graph. Appl., vol. 13, no. 3, p. 85, May 1993.

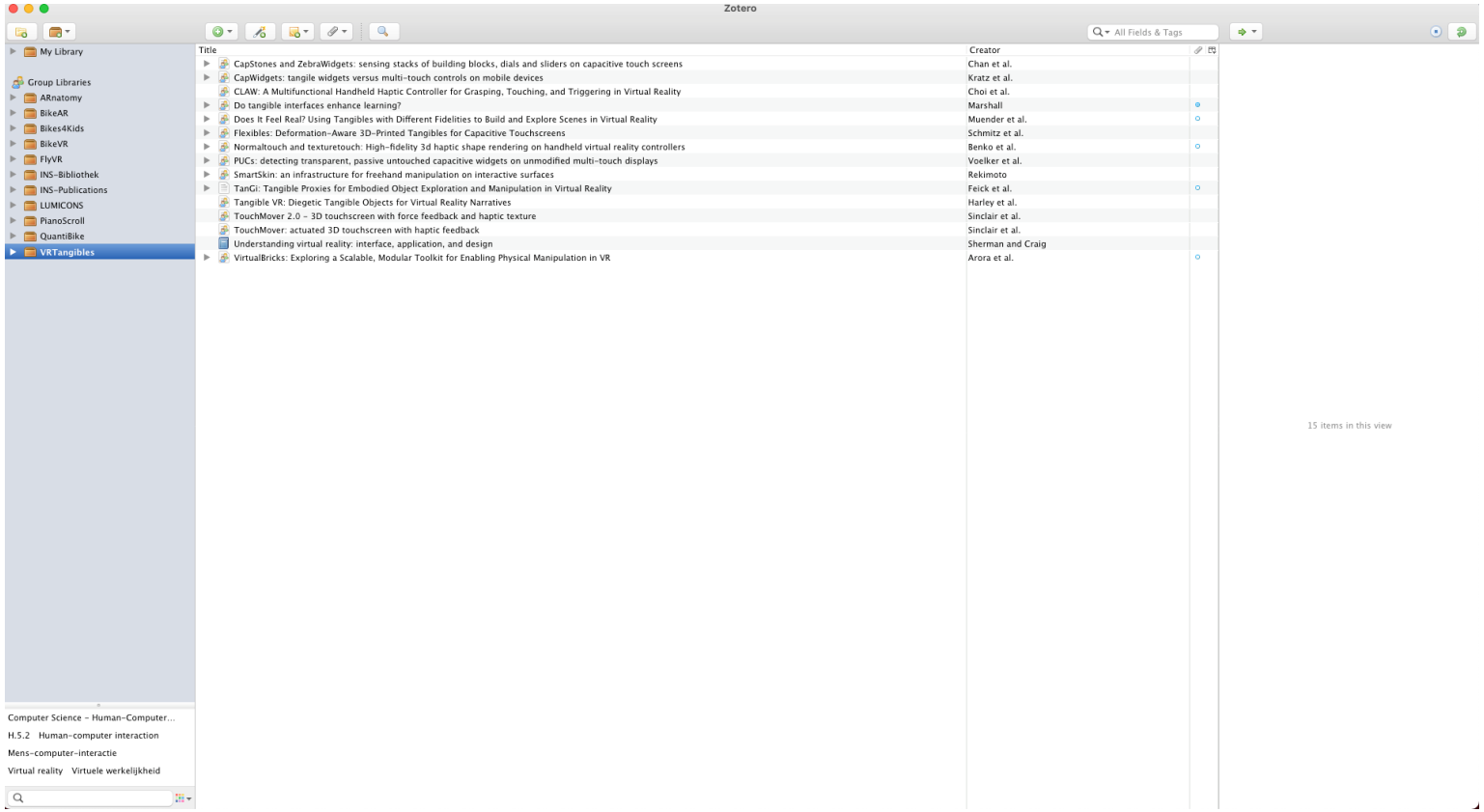
[21] C. Ware and S. Osborne, "Exploration and Virtual Camera Control in Virtual Three Dimensional Environments," in Proceedings of the 1990 Symposium on Interactive 3D Graphics, New York, NY, USA, 1990, pp. 175–183.

[22] R. Pausch, T. Burnette, D. Brockway, and M. E. Weiblen, "Navigation and Locomotion in Virtual Worlds via Flight into Hand-held Miniatures," in Proceedings of the 22Nd Annual Conference on Computer Graphics and Interactive Techniques, New York, NY, USA, 1995, pp. 399–400.

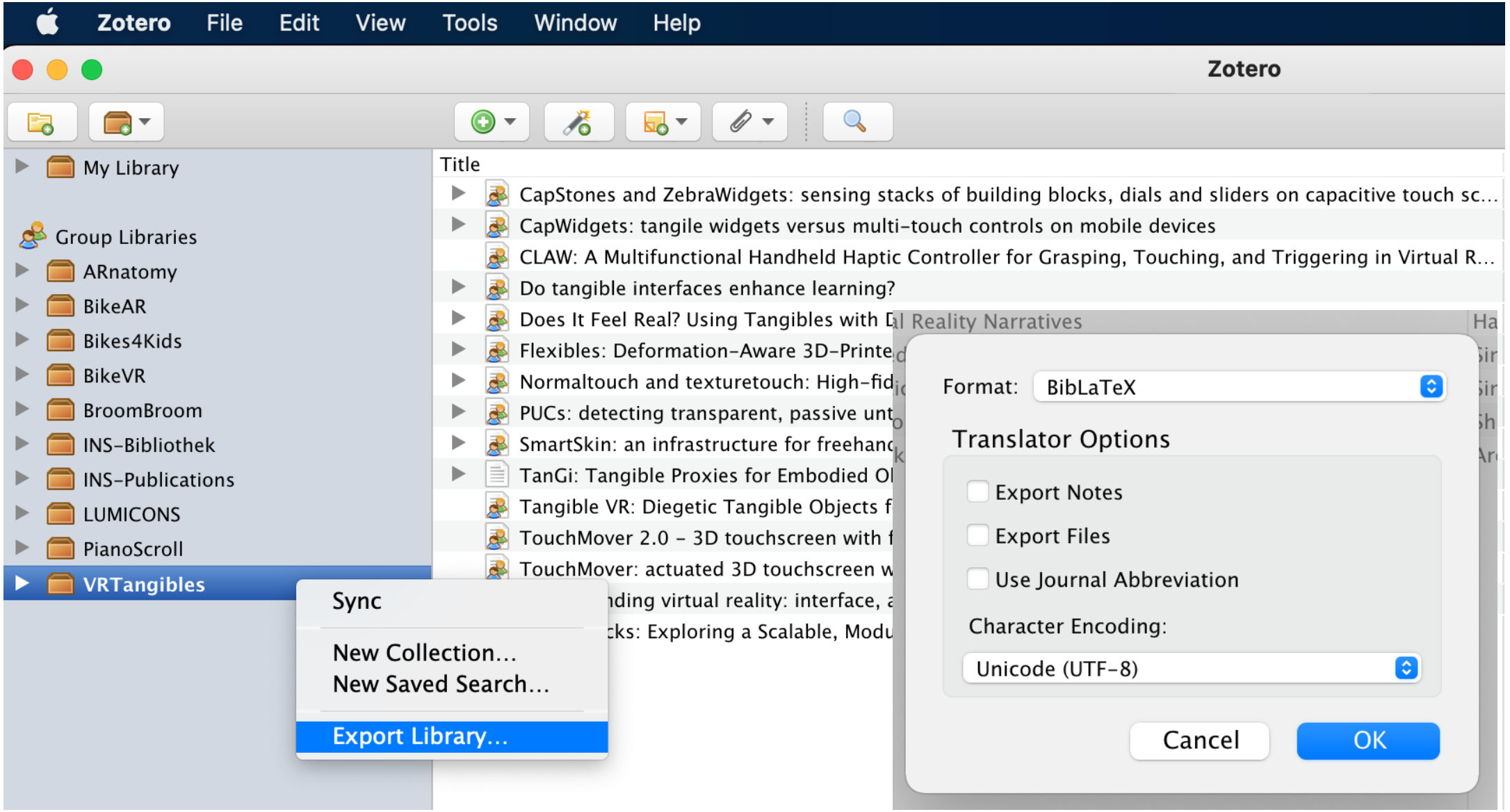
[23] J. D. Mackinlay, S. K. Card, and G. G. Robertson, "Rapid Controlled Movement Through a Virtual 3D Workspace,"

Where and how to store your search results?

- Zotero: https://www.zotero.org
- Mendeley: https://www.mendeley.com



How to integrate the references in your paper?



How to Read a Scientific Publication

Research Approaches | Literature Review | **How to read papers** | Writing Related Work | Writing Research Questions

How to read a scientific paper?

- Read the title, determine your interest
- Skim the paper and identify its structure
  - For empirical research, IMRD structure is popular: Abstract, Introduction, Methods, Results, and Discussion
- Read abstract: motivation, research problem, methodology, some results & conclusion
- Jump to figures: identify experiments and results
- At each point you decide whether to continue, store it for later, or discard it

- See: ‘How to Read a Scientific Article’ (Purugganan & Hewitt 2004) for more details

How to read a scientific paper?

- Introduction
  - Purpose: create interest, clarify the domain, “shortest path to the problem”
  - Common knowledge statement (broad)
  - What is known about the topic
  - What is not known
  - What question the authors asked and answered (specific)
- Related work
  - Similar work and base knowledge
  - Clarifies delta to existing works

How to read a scientific paper?

- Methods
  - What experiments were done
  - What variables were considered
- Results (objective)
  - Statements of what was found (from observation & data analysis), and reference to the data in figures and tables
- Discussion
  - Show how results (don’t) answer your question
  - Identify unexpected findings

Ask yourself questions while reading

- What specific problem does this research address? Why is it important?
- Is the method used a good one? The best one?
- What are the specific findings? Am I able to summarize them in short?
- Are the findings supported by persuasive evidence?
- Is there an alternative interpretation of the data that the author did not address?
- How are the findings unique/new/unusual or supportive of other work?
- How do these results relate to the work I am interested in?

Example: Title and Abstract

HeadReach: Using Head Tracking to Increase Reachability on Mobile Touch Devices

ABSTRACT

People often operate their smartphones with only one hand, using just their thumb for touch input. With today's larger smartphones, this leads to a reachability issue: Users can no longer comfortably touch everywhere on the screen without changing their grip. We investigate using the head tracking in modern smartphones to address this reachability issue. We developed three interaction techniques, *pure head (PH)*, *head + touch (HT)*, and *head area + touch (HA),* to select targets beyond the reach of one's thumb. In two user studies, we found that selecting targets using HT and HA had higher success rates than the default direct touch (DT) while standing (by about 9%) and walking (by about 12%), while being moderately slower. HT and HA were also faster than one of the best techniques, BezelCursor (BC) (by about 20% while standing and 6% while walking), while having the same success rate.

Paper: https://hci.rwth-aachen.de/publications/voelker2020b.pdf

Writing Related Work

Research Approaches | Literature Review | How to read papers | **Writing Related Work** | Writing Research Questions

Related work

- Builds a full picture of the state-of-the-art
- There is no bad or useless work done before
- Identify main pillars of the previous work
- Be clear and specific where your research will advance the state-of-the-art

Example: Related wo

2 RELATED WORK

Previous research has investigated the representation of navigational cues using visual, auditory and tactile displays and showed advantages and disadvantages for each of these feedback types. For example, in the automotive domain visual displays provide detailed information, but often distract drivers from the main task of driving and monitoring the road situation [16]. To supplement visual displays, auditory feedback is often used, but can be difficult to hear in noisy environments. Finally, tactile displays have a limited design space to represent detailed navigation information, even though they do not overwhelm visual or auditory channels. In this section, we focus on prior work that has examined different navigation methods for cyclists.

Vibrotactile navigation. Tactile feedback on a bicycle has been primarily used to convey navigational cues. For example, Tacticycle [24, 25] explored vibrotactile navigational cues on the handlebar for exploratory bicycle trips. Further empirical investigation by Bial et al. [3] has shown that the tactile signals on the hands can be recognized 87.4% of the time under the driving condition. Commercial products, such as SmartGrips[2], have leveraged this finding to represent turn-by-turn navigation for cyclists through vibrotactile grips. These handlebar grips vibrate on the side a cyclist is supposed to turn.

In addition to vibrotactile feedback on a bicycle, researchers have also explored on-body vibrotactile cues for navigation. Similarly to handlebar vibration, Steltenpohl and Bouwer [29], Tsukada et al. [32] and Ferscha et al. [12] have utilized a vibrotactile belt around a waist to convey eight directional cues. In particular, Steltenpohl and Bouwer [29] showed that their Vibrobelt was successful in guiding the cyclists though unfamiliar routes. However, cyclists were better at navigating using the visual system. They were also better at recalling the route and showed a higher contextual understanding. Since vibrotactile feedback was shown to be an effective method for conveying spatial information for adult cyclists, we aim to investigate its suitability for child cyclists.

Light-based navigation. Various commercial systems have explored on-bicycle visual navigation systems. For example, Smarthalo[3] utilized LEDs in a circular configuration on a bicycle's handlebar to encode direction and distance. Another product called Hammerhead[4] used directional LEDs in the middle of a handlebar to indicate turn-by-turn navigational signals. However, since both these systems are commercial products, they lack an empirical evaluation of their effectiveness.

Helmets are one of the most commonly used [15] cycling accessories and are also mandatory in many countries [19]. Researchers have used helmets to show visual information to riders. Tseng et al. [31] investigated a peripheral LED-based navigation system through an LED-strip on the front side of a helmet above the eyes. They showed that riders could use the system for navigation without introducing additional distractions. Since visual feedback above the cyclists' eye is independent of head movement and utilizes peripheral vision [31], we aim to investigate the suitability of such a visual navigation aid for child cyclists.

Auditory navigation. Auditory navigation has been widely used in car navigation systems, such as Garmin, TomTom and StreetMate. One of the main advantages of auditory navigation is the ability of a driver to focus on the road and receive navigation instructions via the auditory channel in addition to a visual display. For cyclists, auditory feedback has been typically used for pedalling training systems where cyclists have to maintain a constant speed for sport performance [23]. There are not many empirically tested systems exploring navigational cues via auditory feedback for child cyclists. In our work, we explore how auditory cues integrated in a helmet can be used to facilitate navigation for child cyclists.

We are encouraged by recent work [21] that has shown the applicability of multimodal feedback to present warnings to avoid car-to-cyclists collisions, specifically for child cyclists. They found that multimodal feedback drastically reduced the number of accidents in the simulated environment. In our paper however, the overarching goal is to support child cyclists with a simple, non-distracting and understandable navigation system, using different unimodal signals.

Scope of the SOTA

Pillar 1

Summary and a research gap

Pillar 2

Pillar 3

Writing Research Questions

Research Approaches | Literature Review | How to read papers | Writing Related Work | **Writing Research Questions**

Writing Research Questions

Research question:

A statement that describes or explains **a relationship between or among variables** and is a proposal to be tested.

Therefore, need to identify **variables** and **research question** for your observation.

What are variables?

Characteristics or conditions that change or have different values for different individuals.

Writing Research Questions

Questions Should Have Complex Answers (not just yes/no)

Bad: Does owning a pet improve quality of life for older people?

Good: In what ways does owning a pet improve quality of life for older people?

Good Research Questions Need Focus (not too generalized)

Bad: Does medication help alleviate attention deficit hyperactivity disorder (ADHD) symptoms? And do kids need more exercise?

Good: How effective are the various types of medication in treating elementary students with ADHD?

Questions Should Be Specific and Precise

Bad: How do artificial sweeteners affect people?

Good: How does aspartame affect elderly women older than 70 who suffer from migraines?

Research Question Checklist

- ❑ Is it an open-ended question?
- ❑ Is it appropriate in scope? Focused and narrow enough for your project or paper?
- ❑ Does it suggest factors that can be measured?
- ❑ Is it relevant to my audience?
- ❑ Is answering the question manageable, and can I find and access enough documents, statistics, or persons to provide information to develop and support my ideas?
- ❑ Is the topic of interest to me?

Summary

- Three approaches to HCI research
  - Ethnography
  - Engineering
  - Empirical science
- Seven types of HCI contributions
- Literature review
- How to read a scientific publication
- How to write related work
- How to write research questions