Aalto University

ELEC-E7861

Lecture 11: Scientific Writing

2021
Antti Oulasvirta
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Schedule

Jan 14: Introduction
Jan 21: Computational modeling
Jan 28: Analytical methods
Feb 4: User research
Feb 11: Literature review
Feb 18: Research strategy
Feb 25: No meeting
Mar 4: Research planning
Mar 11: Guest lecture
Mar 18: Modeling clinic
Mar 25: No meeting
Apr 1: Modeling clinic
April 8: Scientific writing
Apr 15: Scientific presentation
Independent study period
May 14: Submission of paper (PDF)
May 15: Dress rehearsal
May 16: Final presentations

A warm up question

- ***What aspect of writing have you struggled with in this course?***

Status with research

Anything you want to bring up?

If you get stuck:

1) Consult yourself, talk with a peer
2) Consult your coach
3) Email Antti

Preparation for this lecture

1. Pen and paper: Checklist of things you can improve
2. Your current manuscript

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Scientific Writing

Q: Why do we learn to write in this course?

Writing communicates your work

Writing makes it scrutinable by others

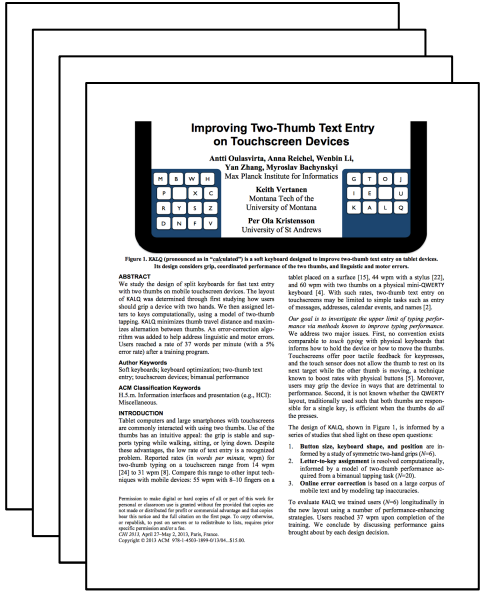
Writing is research

Writing is a skill

- You can develop it
- It is deceptively easy to read a well-written paper

Writing also teaches you how to read

Writing in HCI poses some special requirements



Improving Two-Thumb Text Entry on Touchscreen Devices

Antti Oulasvirta, Anna Reichel, Wenbin Li, Yan Zhang, Myroslav Bachynskyi
Max Planck Institute for Informatics

Keith Vertanen
Montana Tech of the University of Montana

Per Ola Kristensson
University of St Andrews

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The design of KALQ, shown in Figure 1, is informed by a series of studies that shed light on these open questions:

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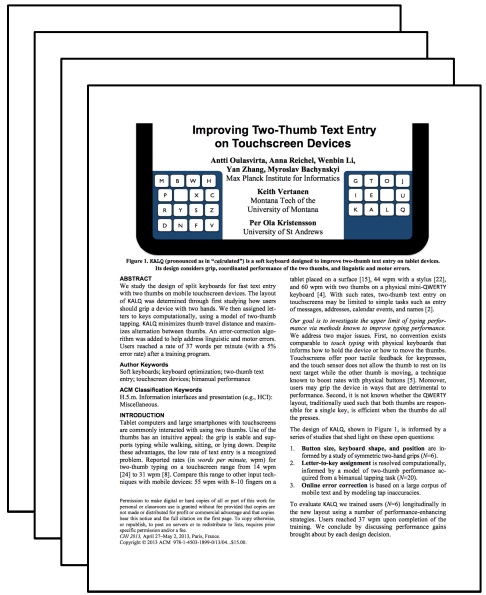
To evaluate KALQ we trained users (N=6) longitudinally in the new layout using a number of performance-enhancing strategies. Users reached 37 wpm upon completion of the training. We conclude by discussing performance gains brought about by each design decision.

Learning objectives

1. **Understand scientific writing**
   - Beyond “reporting”
   - Communication, argumentation, appeal
2. **Understand basic structures and techniques *in an HCI paper***
3. **Enhance the value of your research**
4. **Learn tips and avoid common pitfalls**



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CHI 2013, April 27-May 2, 2013, Paris, France.
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Evaluation form for your coach

Usefulness of outcomes (1 – 5)

"These results make a significant contribution toward solving the original problem"

Validity of methodology (1 – 5)

"The methodology followed is valid. I have high confidence in the obtained results."

Process (1 – 5)

"I am happy with how the research project was managed by the student."

Overall grade (1 – 5)

Free comments

Scientific Writing for HCI

Scope: HCI papers

~~**grammar, style, scientific writing in general**~~

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Objectives for Writing in HCI

Four objectives for writing

Communication

- Get your reader to 1) attend to your point, 2) understand it, and 3) be able to act upon it

Scrutinability and replicability

- After reading this, will I be able to understand how you exactly did it and replicate it?

Follows tradition

- Follows the tradition in HCI in paper writing

Appeal

- Am I convinced that you have done this according to the highest standards of quality? Does this work excite me?

Grading: Demonstrate your acquired competences in…

1. Formulation of research problems
2. User research methods
3. Representations of user research data
4. Understanding the design space and tasks
5. Computational approaches
6. Research planning
7. Research strategy
8. Empirical methods
9. Data analysis and visualization
10. Scientific reporting and presentations

Typical fallacies in student writing

Complicated writing

- Too many things are said. → Focus on one main problem

Chronological writing

- Reporting things in the order they occurred → Scientific argumentation is more important

Argumentative flow broken

- Sections don't flow well from one to another
- Argumentative elements missing

Depersonalized writing

- Not clear what the student did → Explicate your own contribution

Inefficient writing

- Lots of space is wasted for less important points →Dedicate space according to importance

”The CHI Style”

CHI 2021

Making Waves, Combining Strengths

Type: Late Breaking Paper at CHI

Minimum length 6 pages - excluding Appendices and References. Maximum 10 apges

"A Late-Breaking Work submission is a concise report of recent findings or other types of innovative or thought-provoking work relevant to the CHI community. Late-Breaking Work submissions represent work that has not reached a level of completion or maturity that would warrant the full refereed selection process.

Appropriate submissions should make a contribution to the body of HCI knowledge, whether realized or promised. [..] Examples of work sought by this submission category include: emergent technologies, designs, empirical findings or theoretical contributions, preliminary studies, and ongoing work."

CHI author guidelines

1. Making a Significant Contribution
2. Offering Benefit to the Reader
3. Ensuring Results are Valid
4. Gaining Credit for Originality
5. Replicability
6. Describing the Work Clearly and Concisely

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First page, Abstract, & Introduction

It’s simple

You can follow a template

- It pays attention to the description of the **practical** problem and **research** problem

Use the beginning to communicate the main points

What interests readers is
not what interests authors

Principae.be Het Pand

Abstract: What's in it?

Topic and problem

Motivation

- "Who cares about this problem and why?"

Inadequacy of existing solutions

- "Why could we not solve this straight away?"

Research problem

Your core concept/method/solution/knowledge

- "How did you solve this? Why does it work?"

Evidence for the solution

- "Why should I believe this?"

Benefit or "gain in problem-solving capacity"

- "So what?"

Example: Spotlights (CHI’16)

How to construct a *Nature* summary paragraph

Annotated example taken from *Nature* 435, 114–118 (5 May 2005).

One or two sentences providing a **basic introduction** to the field, comprehensible to a scientist in any discipline.

Two to three sentences of **more detailed background**, comprehensible to scientists in related disciplines.

One sentence clearly stating the **general problem** being addressed by this particular study.

One sentence summarizing the main result (with the words "**here we show**" or their equivalent).

Two or three sentences explaining what the **main result** reveals in direct comparison to what was thought to be the case previously, or how the main result adds to previous knowledge.

One or two sentences to put the results into a more **general context**.

Two or three sentences to provide a **broader perspective**, readily comprehensible to a scientist in any discipline, may be included in the first paragraph if the editor considers that the accessibility of the paper is significantly enhanced by their inclusion. Under these circumstances, the length of the paragraph can be up to 300 words. (This example is 190 words without the final section, and 250 words with it).

During cell division, mitotic spindles are assembled by microtubule-based motor proteins[1,2]. The bipolar organization of spindles is essential for proper segregation of chromosomes, and requires plus-end-directed homotetrameric motor proteins of the widely conserved kinesin-5 (BimC) family[3]. Hypotheses for bipolar spindle formation include the 'push–pull mitotic muscle' model, in which kinesin-5 and opposing motor proteins act between overlapping microtubules[2,4,5]. However, the precise roles of kinesin-5 during this process are unknown. Here we show that the vertebrate kinesin-5 Eg5 drives the sliding of microtubules depending on their relative orientation. We found in controlled *in vitro* assays that Eg5 has the remarkable capability of simultaneously moving at ~20 nm s^{-1} towards the plus-ends of each of the two microtubules it crosslinks. For anti-parallel microtubules, this results in relative sliding at ~40 nm s^{-1}, comparable to spindle pole separation rates *in vivo*[6]. Furthermore, we found that Eg5 can tether microtubule plus-ends, suggesting an additional microtubule-binding mode for Eg5. Our results demonstrate how members of the kinesin-5 family are likely to function in mitosis, pushing apart interpolar microtubules as well as recruiting microtubules into bundles that are subsequently polarized by relative sliding. We anticipate our assay to be a starting point for more sophisticated *in vitro* models of mitotic spindles. For example, the individual and combined action of multiple mitotic motors could be tested, including minus-end-directed motors opposing Eg5 motility. Furthermore, Eg5 inhibition is a major target of anti-cancer drug development, and a well-defined and quantitative assay for motor function will be relevant for such developments.

Spotlights, a paper at CHI 2016

The paper contributes a novel technique that can improve user performance in skim reading. Users typically use a continuous-rate-based scrolling technique to skim works such as longer Web pages, e-books, and PDF files. However, visual attention is compromised at higher scrolling rates because of motion blur and extraneous objects with overly brief exposure times. In response, we present Spotlights. It complements the regular continuous technique at high speeds (2–20 pages/s). We present a novel design rule informed by theories of the human visual system for dynamically selecting objects and placing them on transparent overlays on top of the viewer. This improves the quality of visual processing at high scrolling rates by 1) limiting the number of objects, 2) ensuring minimal processing time per object, and 3) keeping objects static to avoid motion blur and facilitate gaze deployment. Comprehension levels for long documents were comparable with those in continuous-rate-based scrolling, but Spotlights showed significantly better scrolling speed, gaze deployment, recall, lookup performance, and user-rated comprehension.

Example

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Topic statement

Problem statement

Contribution statement

Benefit statement

Evidence statement

Introduction: Objectives

PROBLEM

What is the problem in terms of design / engineering / scientific knowledge?

MOTIVATION

What do we lose when the problem remains unsolved? What should we achieve?

INADEQUACY OF EXISTING SOLUTIONS

What have previous solutions achieved / failed to achieve?

YOUR SOLUTION/RESULT

How does it improve over state-of-the-art?

EVIDENCE FOR THE SOLUTION

What evidence decreases uncertainty over the your solution's capability?

CONTRIBUTION & BENEFIT

What is known now that was not known before

How is the reader now better able to solve the original problem?

Introduction: Exercise (8 mins)

PROBLEM

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EVIDENCE

What evidence decreases uncertainty over the your solution's capability?

CONTRIBUTION & BENEFIT

What new knowledge is produced?

How is the reader now better able to solve the original problem?

1. Two-person rooms in Zoom
2. Provide your paper to the pair
3. Circle these elements from the Introduction
   - Do you find them?
   - Are they well expressed?
4. Report back after 8 mins

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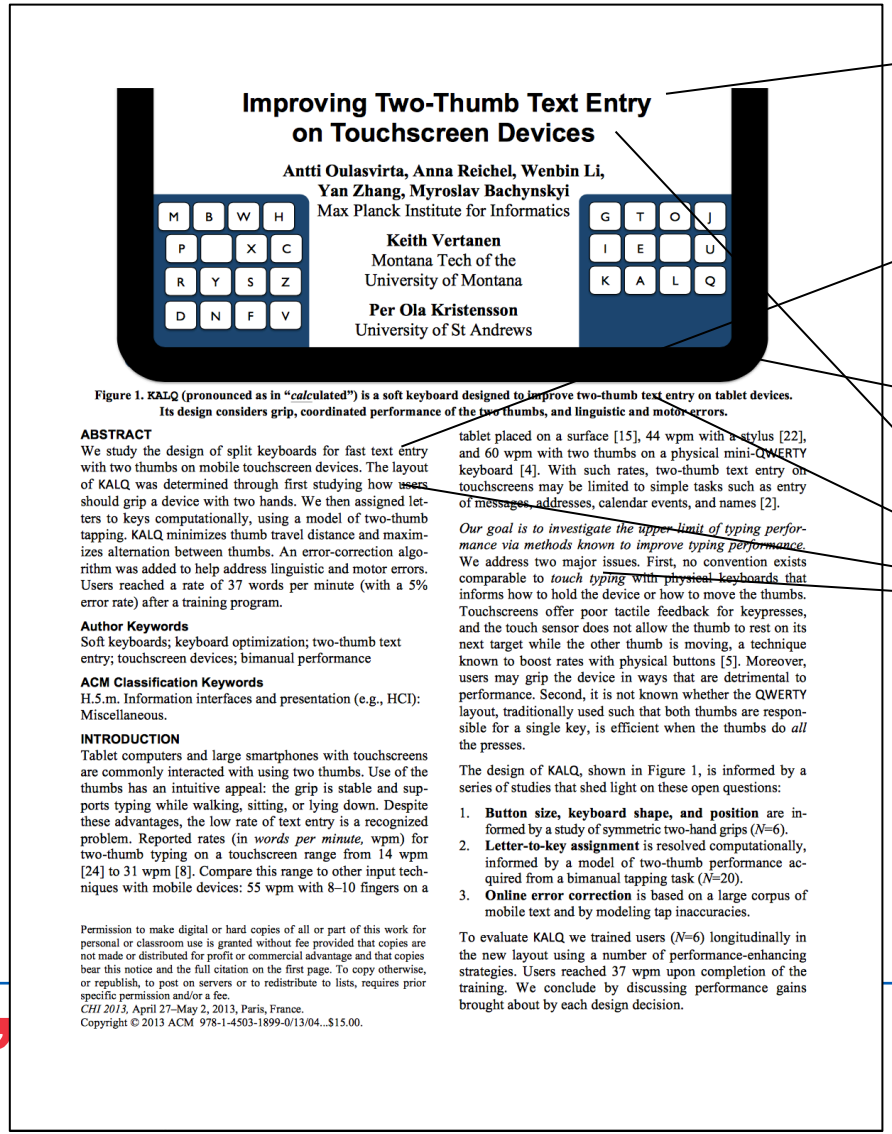
Communicating structure & argument



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CHI 2013, April 27–May 2, 2013, Paris, France.

Title communicates the topic, objective or outcome of your work

Abstract provides an overview of the whole argument and contribution

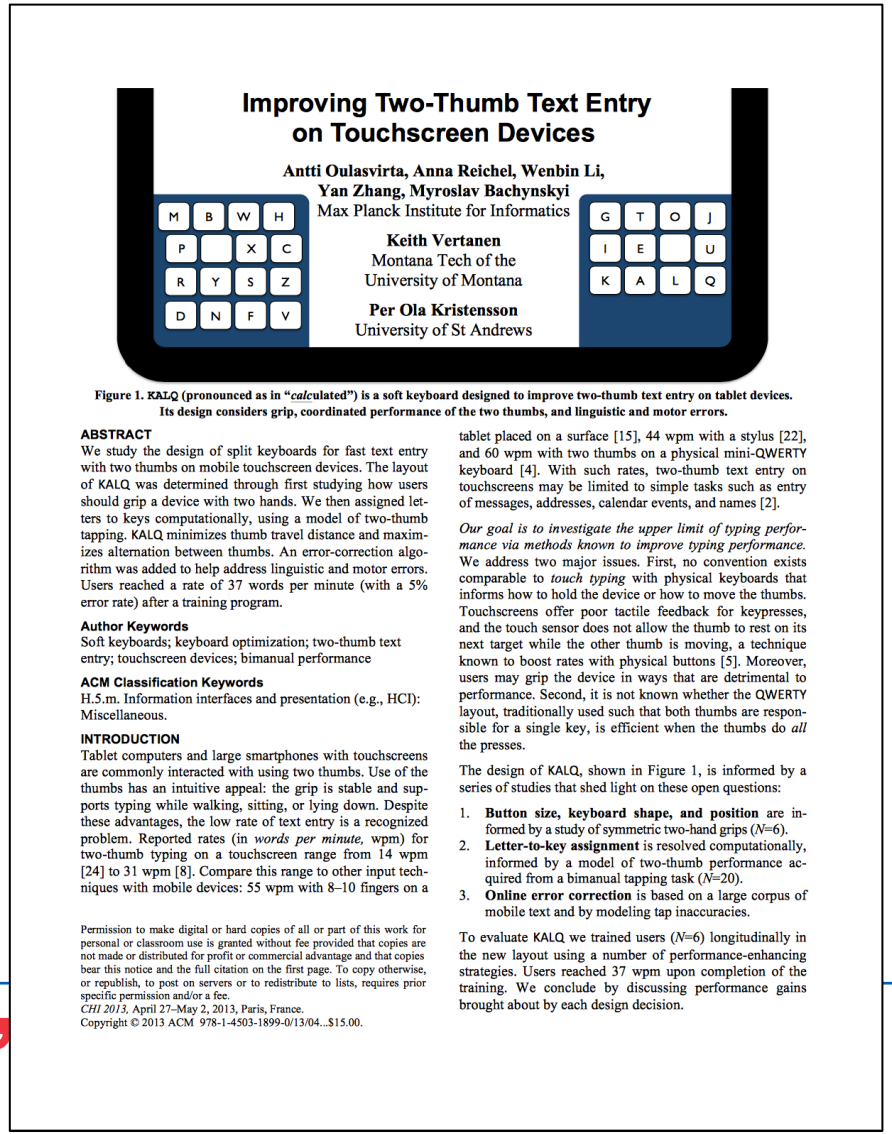
Figure 1 (teaser; optional) shows the main outcome or approach

Redundancy: The same thing is said many times but increasing level of detail

A'

REDUNDANCY

Expressing your work



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Use ***clear statements and active voice ("we", "I")*** *to describe recognizable elements of your research*

"Our goal is to …"

"The design of X is informed by …"

"To evaluate X, we …"

"We cast the problem of … as …"

~~"Our design process consists of…"~~

Use figures & tables to convey the story

Example: How we type (CHI'16)

MAIN TOPIC AND PROBLEM

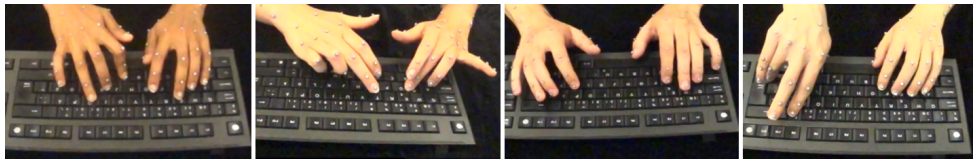


Figure 1. Four users showing different typing behaviours involving different numbers of fingers and movement strategies. This paper reports typing rates, gaze and movement strategies for everyday typists, including both professionally trained and self-taught typists. We explain how untrained typists are able to type at very high rates, which were previously attributed only to the touch typing system that enforces the use of all 10 fingers.

Phenomenon or Measure	M	SD	Ref
Background Factors: *Studies were usually conducted with professionally trained and employed typists.*			[5, 13, 23, 29]
Participants touch typing (%)	100	0	
Weekly amount of typing (h)	11	19	[23]
Performance: *Average inter-key interval (IKI) is a fraction of typical choice-reaction times (e.g. 560 ms). The typing rate is slowed for random letter sequences.*			[23]
Words per minute	75	9.7	[13]
IKI easy prose (ms)	140	–	[29]
IKI random strings (ms)	326	–	[29]
Hand- and finger alternation: *Letter pairs (bigrams) typed by fingers of different hands is 30–60 ms faster than those typed by the same hand.*			[24]
Bigrams typed by:			
Hand alternation (%)	48	–	[5]
- IKI (ms)	155	43	[23]
Finger alternation (%)	34	–	[25]
- IKI (ms)	194	45	[23]
Same finger (%)	4.6	–	[5]
- IKI (ms)	223	41	[23]
Letter repetition (%)	n/a	–	
- IKI (ms)	176	26	[23]

Table 1. Well established phenomena and their corresponding measures based on prior studies of professional touch typists. Exact values are selected from the referenced papers and may vary in other studies.

PREVIOUS WORK

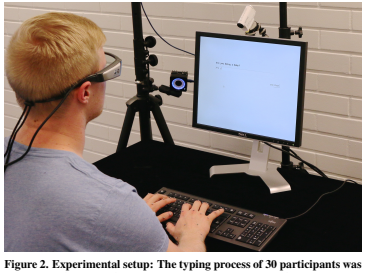


Figure 2. Experimental setup: The typing process of 30 participants was captured using a motion capture system and eye tracking glasses. In addition, keypress timings were logged and a reference video recorded.

SETUP

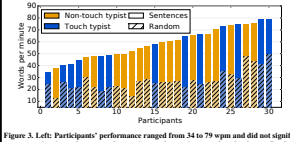


Figure 3. Left: Participants' performance ranged from 34 to 79 wpm and did not significantly differ between touch- and non-touch typists. Right: The percentage loss in performance when typing random strings was found to be smaller for typists of high skill, trained or untrained.

PARTICIPANTS

Measure	Touch M	Touch SD	Non-Touch M	Non-Touch SD	M.-W. Stat.	U	p
Background							
Reported strategy (%)	43.33	–	56.66	–	–		
Years touch typing	16.96	9.66	–	–	–		
Age	33.00	9.15	28.82	7.59	○	75	0.07
Comp. experience (y)	21.69	7.73	16.38	3.95	○	64	0.053
Weekly typing (h)	47.15	20.63	44.56	18.39	○	98	0.44
Performance							
WPM	57.83	15.25	58.93	10.82	○	103	0.38
- Random	27.43	8.73	27.02	8.46	○	96	0.28
Avg. IKI (ms)	176.39	44.31	168.91	33.22	○	103	0.38
- Random (ms)	382.31	122.56	399.36	133.70	○	100	0.34
Error rate (%)	0.76	0.62	0.47	0.42	○	82	0.13
- Random (%)	0.98	0.86	0.72	1.08	●	60	0.02
Efficiency	0.88	0.03	0.89	0.04	○	100	0.34
Eye gaze							
Gaze shift	0.92	0.99	1.20	0.94	●	96	0.03
Visual attention	0.20	0.27	0.41	0.33	●	85	<0.01
Motion Analysis							
#Fingers used	8.54	1.08	6.24	0.94	●	16	<0.01
- Left hand	4.46	0.63	3.47	0.70	●	37	<0.01
- Right hand	4.08	0.73	2.76	0.73	●	23	<0.01
Keys per finger	3.64	0.74	5.65	1.51	●	16	<0.01
- pres. by both hands	1.15	1.17	4.41	2.35	●	24	<0.01
Hand alternation (%)	46.50	0.61	48.26	2.35	●	50	<0.01
- IKI (ms)	150.64	31.78	141.28	32.53	○	90	0.2
Finger alternation (%)	35.94	6.08	26.42	10.76	●	44	<0.01
- IKI (ms)	161.61	31.66	161.10	41.38	○	99	0.32
Same finger (%)	11.05	5.88	18.67	9.87	●	50	<0.01
- IKI (ms)	194.90	26.60	202.75	34.24	○	98	0.31
Letter repetition (%)	6.71	0.10	6.68	0.12	○	91	0.2
- IKI (ms)	159.30	25.36	145.16	12.59	○	72	0.06
Hand alt. benefit (ms)	16.96	15.83	28.72	23.48	○	82	0.12
Entropy	0.26	0.18	0.38	0.20	●	71	0.047
Global mov. left (cm)	0.02	0.06	0.01	0.01	○	110	0.50
Global mov. right (cm)	1.05	0.80	0.81	0.38	○	104	0.40
Dist. to next key (cm)	1.94	0.41	2.41	0.59	●	60	0.02

● : Significant difference ○ : No significant difference

Table 2. Overview of results, comparing touch- and non-touch typists. Statistical significance is tested at the 5% level using the Mann-Whitney signed rank test and reported in the last two columns.

RESULTS OVERVIEW

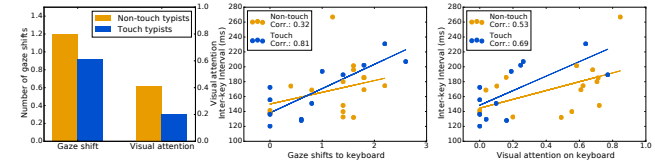
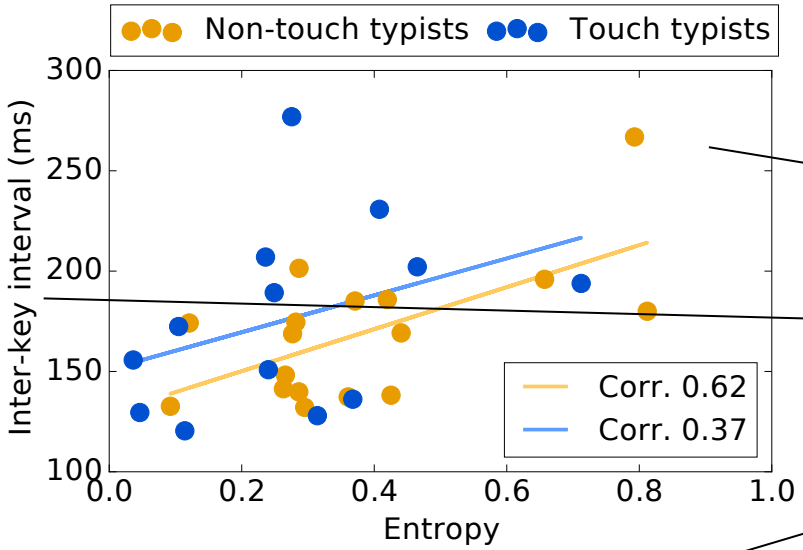


Figure 4. Characteristics of eye gaze during text input. Left: Touch typists spent less time looking at the keyboard (visual attention) and required less gaze shift. Right: Gaze switches and visual attention correlate with the average inter-key interval, increasing as performance gets slower.

RESULTS DETAIL

A"

Clear Visual Design of Figures



(a) Entropy

Clear colors

Clear axis-labels

Large, readable font

Clear labeling

Use figures and tables to support quick absorption of your main message.

You can skim the paper just by looking at them

Informative Headers

Use brief, recognizable section/subsection headers

CLUSTERING OF MOVEMENT STRATEGIES

To identify similarities among typists, we performed hierarchical clustering on the finger-to-key mappings of each user. Clustering in this space groups users with similar mappings, revealing the *input strategies* used by multiple users. As described above, we found notable differences in behaviour between the left and right hands — the right hand has higher global movement, while the left hand typically has more active fingers, independent of the handedness of the participant. Given these differences, we decided to cluster the finger-to-key mappings for each hand separately to uncover subtle within-hand effects that might be masked in a joint analysis.

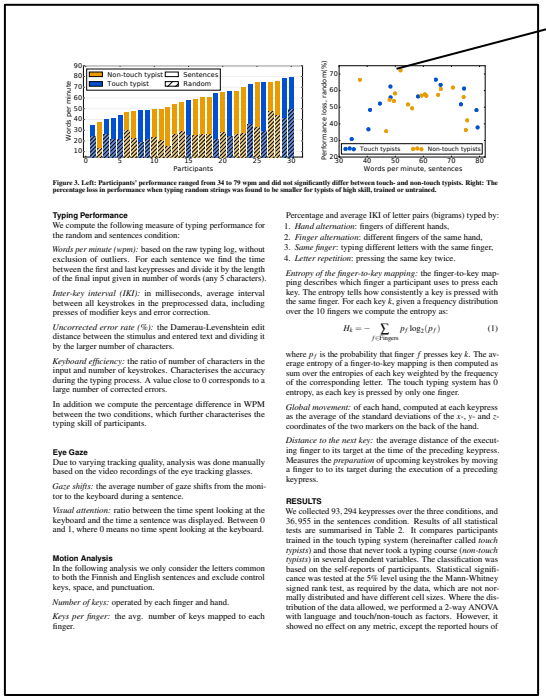
Input Data and Clustering Method

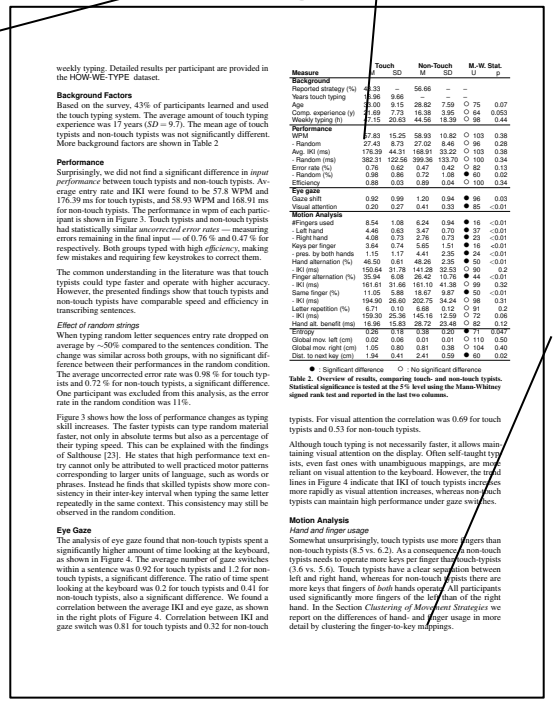
For each user, the feature vector consisted of 10 entries per key, giving the proportion of total presses by each finger. We performed Hierarchical Clustering [16] since it is powerful, flexible and makes no assumptions about the distribution of the data. We used a Euclidean distance measure and Ward's linkage criterion [33] to create compact clusters with minimum internal variance.

“Paper gestalt”

Paper gestalt refers to the visual flow and layout of elements.

Figures and tables on top / bottom





No orphans / widows

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Middle part

Approach & Results

OVERVIEW OF APPROACH
This section describes your approach to solving the problem. It describes only the highest-level choices and justifies them if needed. Most of this content will come from your research plan and research strategy (latter part of the course). This section is optional. Suggested length: 2-4 paragraphs.

METHOD/PROTOTYPE/MODELING/...
This section describes the core of your research work, whether it is an empirical study (method), design (prototype), or model (modeling). Subsections should follow the conventions of the corresponding paper type. Suggested length: 20-40% of total paper length.

RESULTS/EVALUATION
This section describes the obtained results or evaluation of the final result. Again, subsections should follow the conventions of the corresponding paper type. Suggested length: 20-40% of total paper length.

Specific to the type of work

See assignments from first weeks where we identified example papers for you.

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Ending

Discussion & Conclusion

DISCUSSION

This section discusses how well you achieved the original objectives. It should first summarize the main outcome. It should then assess its pros and cons. Discuss benefits to practitioners. Finally, it should discuss limitations. Limitations can be phrased as challenges for future work. Be clear about what you learned. Suggested length: 2-4 paragraphs.

CONCLUSION

A one paragraph summary of what you conclude based on the study. This should go beyond what was said in the beginning.

“Hourglass structure”

A paper starts with broad ambitions, narrows down to the particularities of its study, only to become back to the broadest issues in the end

Big themes

Your actual work

Big themes

Other goals

Balanced sections

- Do not need to be equally long, but ensure there is a balance between the importance of a section and its length

Use Appendices for materials that are not necessary for your argumentation

- This does not count for total page count

Find 2-3 well-written papers and learn from them

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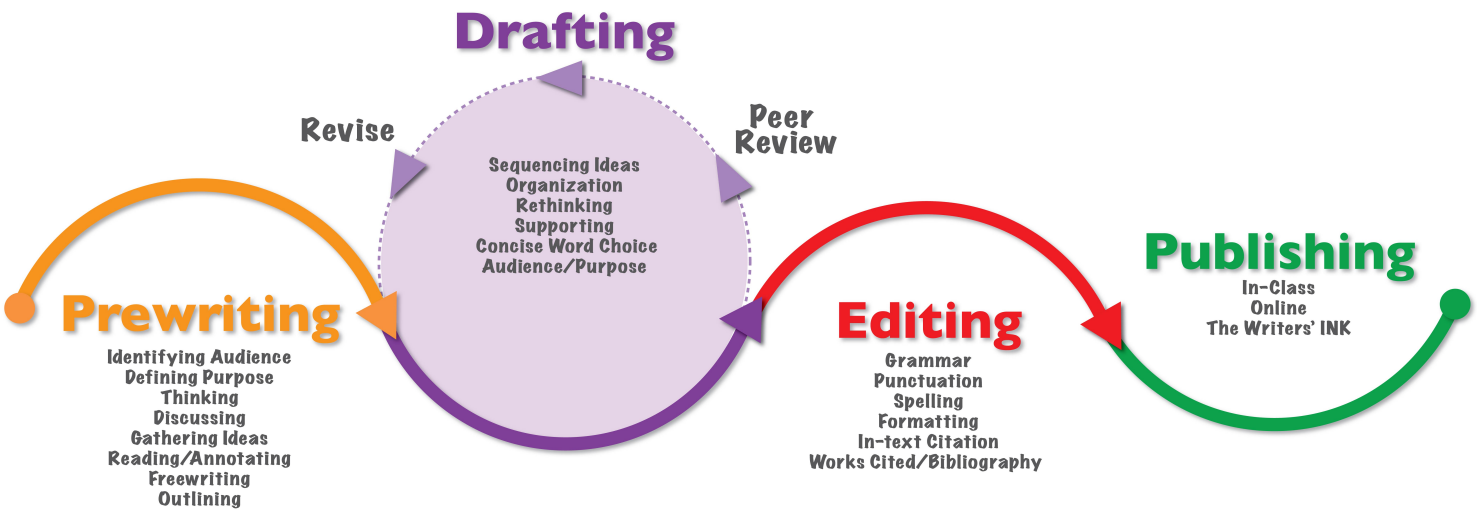
Process

Process writing

“There is no perfect writing, only perfect rewriting”



http://www.bcsc.k12.in.us/cms/lib/IN01000842/Centricity/Domain/1072/Writing-Process_05-219rszm.jpg

Tips

Write daily

Set explicit goals for writing outcomes

- E.g., “Tomorrow I’ll write Method”

Accept imperfection & and embrace iteration

- Do not expect high quality writing during the first pass

Allow enough time for polishing, getting feedback etc.

Aim at having first full version of your manuscript ready 1 week before the deadline

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Assignment 11

Assignment 11

I will send 5 points to focus on in this round

Based on the lecture

Upload PDF by Wed 14 March