

# INTRODUCTION

ALEXANDER SEREBRENIK

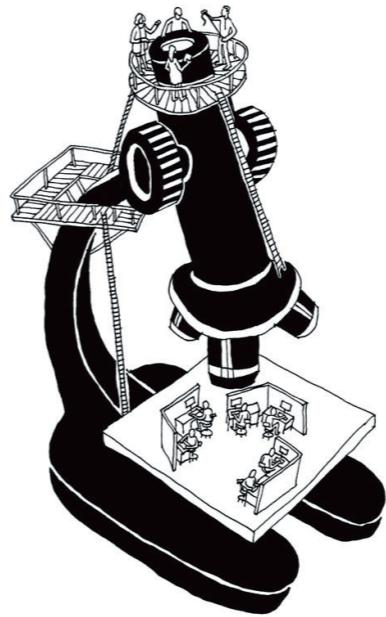


Illustration by Tom Dunne.  
American Scientist 99(6):466, 2011

# **ADMINISTRATION**

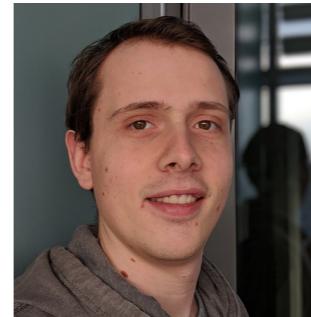
5 ECTS = 140 h  
28h lectures/workshops  
1.5h exam  
110h homework

Tuesday 13:30-15:15  
Thursday 8:45-10:30  
Auditorium 13  
Check [mytimetable.tue.nl](http://mytimetable.tue.nl)

No classes on  
December 26, 28  
January 2, 4



prof. dr. Alexander Serebrenik  
(he/him)  
[a.serebrenik@tue.nl](mailto:a.serebrenik@tue.nl)



ir. Nathan Cassee  
(he/him)  
[n.w.cassee@tue.nl](mailto:n.w.cassee@tue.nl)

We will try to stay on campus if it is possible, but we will move on-line if needed

## **AFTER TAKING THIS CLASS, YOU SHOULD BE ABLE TO**

- independently **design** and **execute** a sound empirical study in Software Engineering given a state-of-the-art dataset.
- **evaluate** empirical studies in Software Engineering using tools accepted in the field, and identify **threats to validity**.
- describe the results of empirical studies to **practitioners** not familiar with academic research.
- **comprehend** the research methods used for empirical studies in Software Engineering

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These are the new learning goals but they do not agree with OSIRIS, not sure what to do here



We have two kinds of meetings: lectures and workshops. Most of the class meeting will be lectures, but we also have three workshops where you will work

# ASSESSMENT

- **Assignments:**

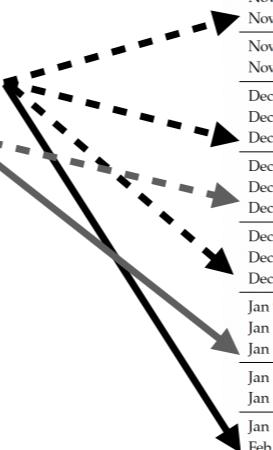
- Design a study (4 students) **70%**
- Describe a study (individual) **30%**
- **5 or more to pass the course**

- **Exam**

- January 23, 9:00-12:00
- **5 or more to pass the course**

- **Final**

- Assignments \* 0.7 + Exam \* 0.3,  
if Assignments  $\geq 5$  and Exam  $\geq 5$
- $\min(5, \text{Assignments} * 0.7 + \text{Exam} * 0.3)$ , otherwise



When	What	Topic
Nov 14 13:30	Lecture	Introduction to Empiricism and Rationalism
Nov 16 08:45	Lecture	Research Questions and Research Strategies
Nov 21 13:30	Guest-Lecture	Adyen
Nov 21 14:30	Lecture	Design Science
Nov 23 08:45	Lecture	Sampling
Nov 24 23:59	Deadline	1st deadline for Design a study
Nov 28 13:30	Lecture	Interviews & Surveys
Nov 30 08:45	Workshop	How to read an empirical paper
Dec 5 13:30	Lecture	Mining Software Repositories I
Dec 7 08:45	Workshop	Mining Software Repositories
Dec 8 23:59	Deadline	2ND deadline for Design a study
Dec 12 13:30	Lecture	Quantitative Analysis
Dec 14 08:45	Lecture	Qualitative Analysis
Dec 15 23:59	Deadline	1st deadline for Describe a study
Dec 19 13:30	Coffee-hour	Feedback and assignment Q&A session
Dec 21 08:45	Lecture	Advanced Repository Mining
Dec 22 23:59	Deadline	3RD deadline for Design a study
Jan 9 13:30	Coffee-hour	Feedback and assignment Q&A session
Jan 11 08:45	Lecture	Threats to Validity
Jan 12 23:59	Deadline	2ND deadline for Describe a Study
Jan 16 13:30	Workshop	Recap & Threats & Trustworthiness
Jan 18 08:45	No lecture	
Jan 23 09:00	Exam	Final examination
Feb 2 23:59	Deadline	Final deadline for Design a study
Apr 9 18:00	Exam	Resit

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For this assignment there will be a total of four deadlines, the four deadlines will build up, and for each subsequent deadline we expect a more complete version of your report. The first three deadlines are not mandatory. For these deadlines we will only give feedback on your work to help you improve your report. The fourth deadline is mandatory and will be graded.

# ASSESSMENT

[Check the syllabus!](#)

- **Assignments:**

- Design a Study (4 students) **70%**
- Describe a Study (individual) **30%**
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- **Exam**

● Exam date: 21-0-00 10:00

Groups (20)

▶ Design a study 1

0 / 4 students

▶ Design a study 2

0 / 4 students

▶ Design a study 3

0 / 4 students

▶ Design a study 4

0 / 4 students



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Please register!

## **TEAMWORK MIGHT BE CHALLENGING**

- **Communicate**

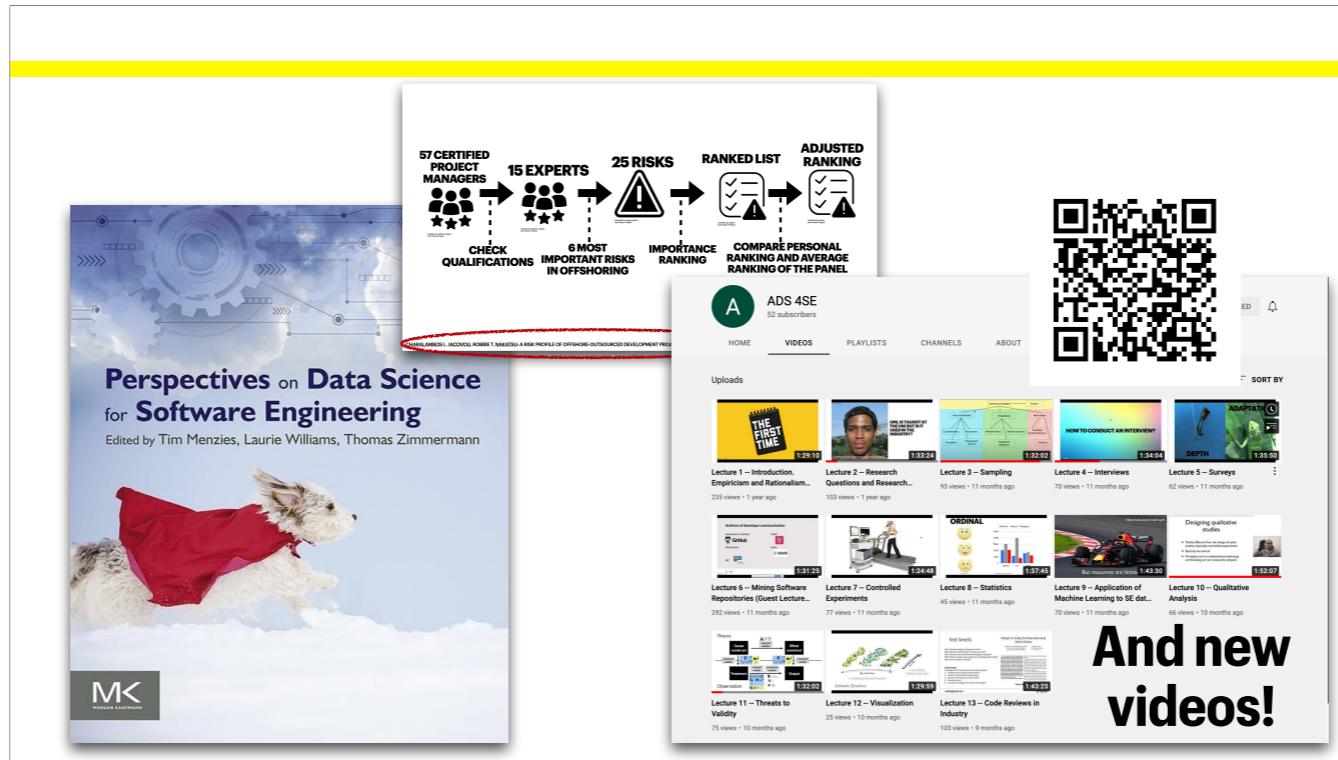
- Talk to each other and listen to each other
- Be mindful of different working styles
- Make clear and explicit agreements upfront
- Let us know *before the submission* if the things do not work out

- **Take responsibility**

- Describe who has done what
- Whether everyone has contributed equally

# 2IMP40 AND OTHER COURSES

- **Prerequisites:** no formal prerequisites. We do expect knowledge of **basic statistics**, readiness to **read scientific papers**, familiarity with **modern software development**, interest in software engineering **research**
  - GitHub, code review, p-value, DevOps, Wilcoxon test, ...
- **Software engineering:**
  - 2IMP25 Software evolution (Q3). 2IMP40 focuses on methods that can be applied to study different software engineering phenomena incl. software evolution. 2IMP25 focuses on the insights and techniques designed to study software evolution.
  - 2IMP00 Seminar Software Engineering & Technology (Q2/Q4)
- **Master project - if you like the topics discussed in the course reach out to Nathan and me!**

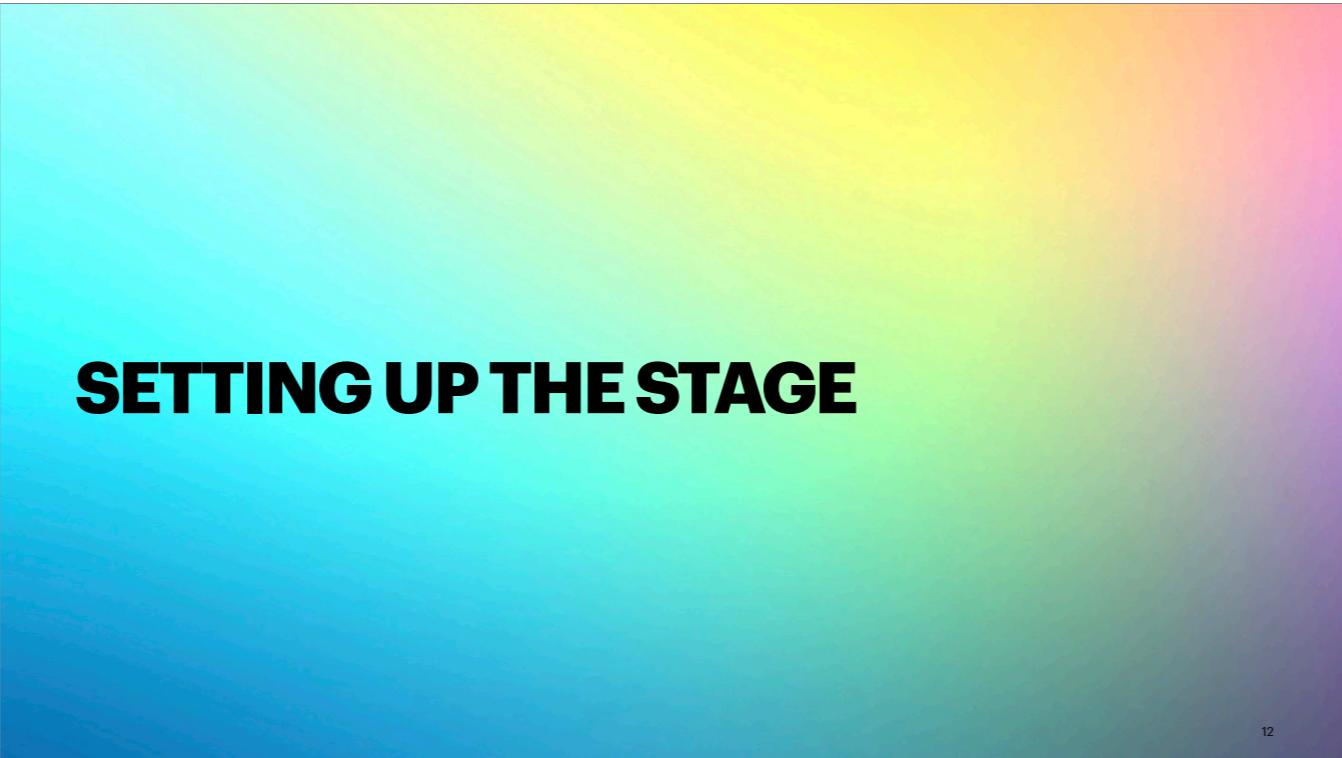


The videos of the 2020/2021 edition are on YouTube [https://www.youtube.com/channel/UCUeRK8nJKyj\\_i\\_Yz81eHa8g/](https://www.youtube.com/channel/UCUeRK8nJKyj_i_Yz81eHa8g/) playlists This being said (a) several lectures have been adjusted in 2021/2022 or will be adjusted in 2022/2023, and these lectures are not/will not be recorded, and (b) in addition to lectures we will organise several workshops - while we are not going to check for presence, the participation in the workshops will help you to work on the assignments. There will be no new recordings in 2022/2023.

**PLEASE TELL US WHAT YOU THINK**



Both Nathan and I will do our best to make this course interesting for you. Please do not wait till the end of the course to provide us feedback.



# **SETTING UP THE STAGE**

# EVIDENCE NEEDED: REALITY CHECK

How can I find bugs in my code?

Use our new testing environment!

But I need to retrain all my teams!

How can I improve my requirements?

Use a controlled language!

But I cannot express what I want!

How can I reduce the resources needed for testing?

Use model checking!

I need training! It takes too long! Models do not capture what I need!

## REASONING/INTUITION A PRIORI ≠ OBSERVATION

ALESSIO FERRARI. EMPIRICAL METHODS IN SOFTWARE ENGINEERING. LECTURE 1.1 - INTRODUCTION [HTTPS://WWW.YOUTUBE.COM/WATCH?V=EQNSQKNj3B&LIST=PLSKM4VZCJV-P3FFJYMU2OHLTJER9BJLO](https://www.youtube.com/watch?v=EQNSQKNj3B&list=PLSKM4VZCJV-P3FFJYMU2OHLTJER9BJLO)

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Lots of good intentions

Typical consultancy scenario

# EMPIRICISM

- εμπειρία (Greek) - experience
  - observation is the only source of knowledge
  - reasoning or intuition can be source of belief or conjecture
- in software engineering
  - researchers describe how software is being developed
  - to suggest best practices
    - how to develop better software (product)
    - how to develop software better (process)

PAUL RALPH. THE TWO PARADIGMS OF SOFTWARE DEVELOPMENT RESEARCH. SCIENCE OF COMPUTER PROGRAMMING 156 (2018) 68-89

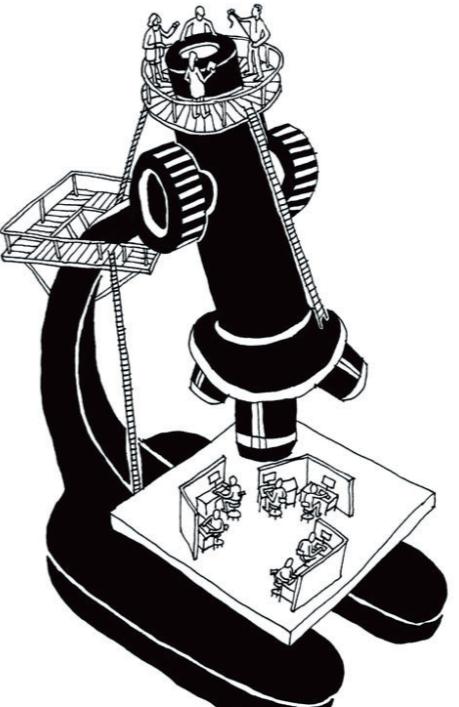
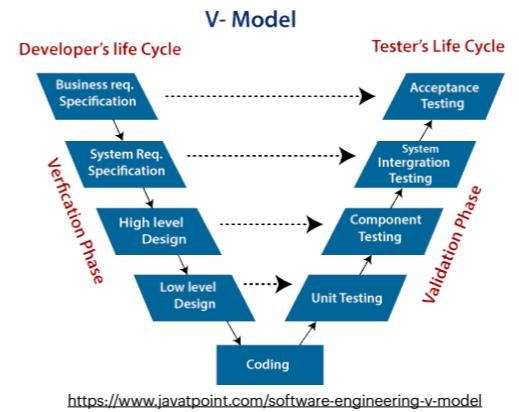


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Empirical research is the structured way of obtaining evidence  
should vs is

# RATIONALISM

- ratio (Latin) - reason
  - knowledge can be obtained by intuition and reasoning
  - for some rationalists knowledge can also be obtained by observation
    - but this knowledge is inferior to the one obtained by intuition and reasoning
- in software engineering
  - design methods and guidelines how to develop software
  - prescriptive



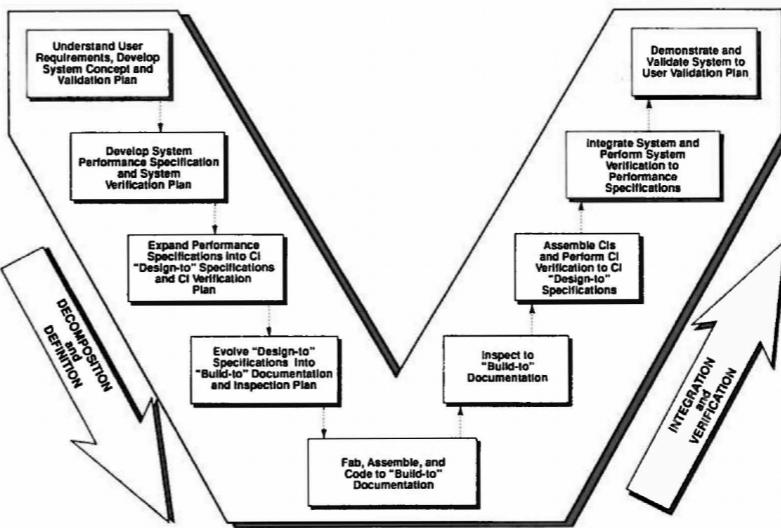
PAUL RALPH. THE TWO PARADIGMS OF SOFTWARE DEVELOPMENT RESEARCH. SCIENCE OF COMPUTER PROGRAMMING 156 (2018) 68-89

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One of the influential views in software engineering is rationalism.

# THE V-MODEL

"A new way of portraying the technical aspect of the project cycle clarifies the role and responsibility of systems engineering to a project. <...> In our approach, the technical aspect of the project cycle is envisioned as a "vee," starting with user needs on the upper left and ending with a user-validated system on the upper right."



## EMPIRICISM OR RATIONALISM?

K. FORSBERG, H. MOOZ, THE RELATIONSHIP OF SYSTEM ENGINEERING TO THE PROJECT CYCLE, ENGIN. MANAG. J. 4 (1992) 36-43.

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This is an example of a rational approach to software development. The article does not refer to any kind of observations and is based on the authors' idea how the things should be done.

# VIEWS ON SOFTWARE DEVELOPMENT

	Rationalism	Empiricism
<b>Methods</b>	Developers use methods.	Developers rarely use methods as intended if at all.
<b>Requirements</b>	Developers elicit requirements from the user.	Developers make sense of a problematic context.
<b>Success</b>	Success means delivering the required scope within the established budget and schedule.	Success is “a multidimensional variable comprising project efficiency, artefact quality, market performance and stakeholder impacts over time”.
<b>Design</b>	Design is a phase or part of development, temporally or conceptually situated between analysis and coding.	Design encompasses the entire development process from initiation to maintenance.
<b>Problems</b>	Development solves given problems.	There is no “the problem”, only a context that some actors view as problematic.
<b>Attitude</b>	How software <i>should</i> be developed (prescriptive)	How software <i>is being</i> developed (descriptive)

PAUL RALPH. THE TWO PARADIGMS OF SOFTWARE DEVELOPMENT RESEARCH. SCIENCE OF COMPUTER PROGRAMMING 156 (2018) 68-89

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break

what questions are meaningful/meaningless for empirical/rational

# QUESTIONS

- What is the **lower bound** of the combinatorial complexity of the fastest possible **comparison-based sorting** algorithm?

STEVE EASTERBROOK, JANICE SINGER, MARGARET-ANNE STOREY, DANIELA DAMIAN. SELECTING EMPIRICAL METHODS FOR SOFTWARE ENGINEERING RESEARCH.  
CHAPTER 11 IN GUIDE TO ADVANCED EMPIRICAL SOFTWARE ENGINEERING. SPRINGER 2008

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    - What is an effective way for teams to represent design knowledge to improve coordination?
      - This is not even about knowledge but about **design** (neither rationalism nor empiricism)
      - Next week: Lecture on Design Science

STEVE EASTERBROOK, JANICE SINGER, MARGARET-ANNE STOREY, DANIELA DAMIAN. SELECTING EMPIRICAL METHODS FOR SOFTWARE ENGINEERING RESEARCH.  
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## SIDE REMARK: TOOL BUILDERS

- Tend to **combine** two phases: design phase (based on rational or empirical arguments) and evaluation phase (empirical)



The image shows a screenshot of a Stack Overflow post. The title is "Conditional task with pg-promise". The post contains code related to reading values from tables and combining them. Below the code is a black rectangular box with a question mark icon and the text "EnTagRec++". To the right is a dark grey speech bubble containing the text "How effective is EnTagRec++?". At the bottom left is the reference "SHAOWEI WANG, DAVID LO, BOGDAN VASILESCU, ALEXANDER SEREBRENIK: ENTAGREC ++: AN ENHANCED TAG RECOMMENDATION SYSTEM FOR SOFTWARE INFORMATION SITES. EMPIR. SOFTW. ENG. 23(2): 800-832 (2018)".

Problem: tags on Stark Overflow are not up to date

Solution: a tool called EnTagRec++ (design)

Evaluation: effectiveness

# INDUSTRY NEEDS EMPIRICAL METHODS...

The screenshot shows a Mastodon instance with a yellow header bar. The main title is "INDUSTRY NEEDS EMPIRICAL METHODS...". Below it, there are several tweets:

- feenk** (@feenk) posted: "Because software is highly contextual. We can predict classes of problems, but we cannot predict the specific ones." (Replying to @aserebrenik)
- Tudor Girba** (@girba) posted: "Replies to @aserebrenik" (21h ago). "Because software is highly contextual. We can predict classes of problems, but we cannot predict the specific ones." (Replying to @aserebrenik)
- Jessica Joy Kerr** (@jessitron) posted: "Replies to @aserebrenik" (19h ago). "We constantly have to figure out what is happening, and what will happen if we make a change. How do we know it works? Is it working in production? Better or worse? This is what the #observability movement is about" (Replying to @aserebrenik)
- Jessica Joy Kerr** (@jessitron) posted: "... and that's just the parts about code. (New software engineers value those)" (Replying to @jessitron and @aserebrenik)
- Greg Wilson** (@gwilson@mastodon.social) posted: "@aserebrenik 1. To motivate adoption of better practices: in my experience, the evidence for the benefits of code review helped convince people to adopt it in the late 1990s/early 2000s. 2. To dispel myths: I frequently quote Prechelt's work on programmer productivity as a counter to claims about "10X" developers. 3. As part of creating a data-driven mindset for e.g. analyzing performance bottlenecks in distributed systems. (This isn't really SE, but the methods are allied.)" (Replying to @aserebrenik)
- Christine Gerpheide** (@phoxicle) posted: "Replies to @aserebrenik" (8h ago). "- Build tools to recognize when quality may be low or complex edge cases are likely. Eg code review tools.  
- Data to justify refactoring  
- Understand developer community behavior, identify problem areas (tech or organizational)  
- Why not to measure engineer performance by LOC" (Replying to @aserebrenik)

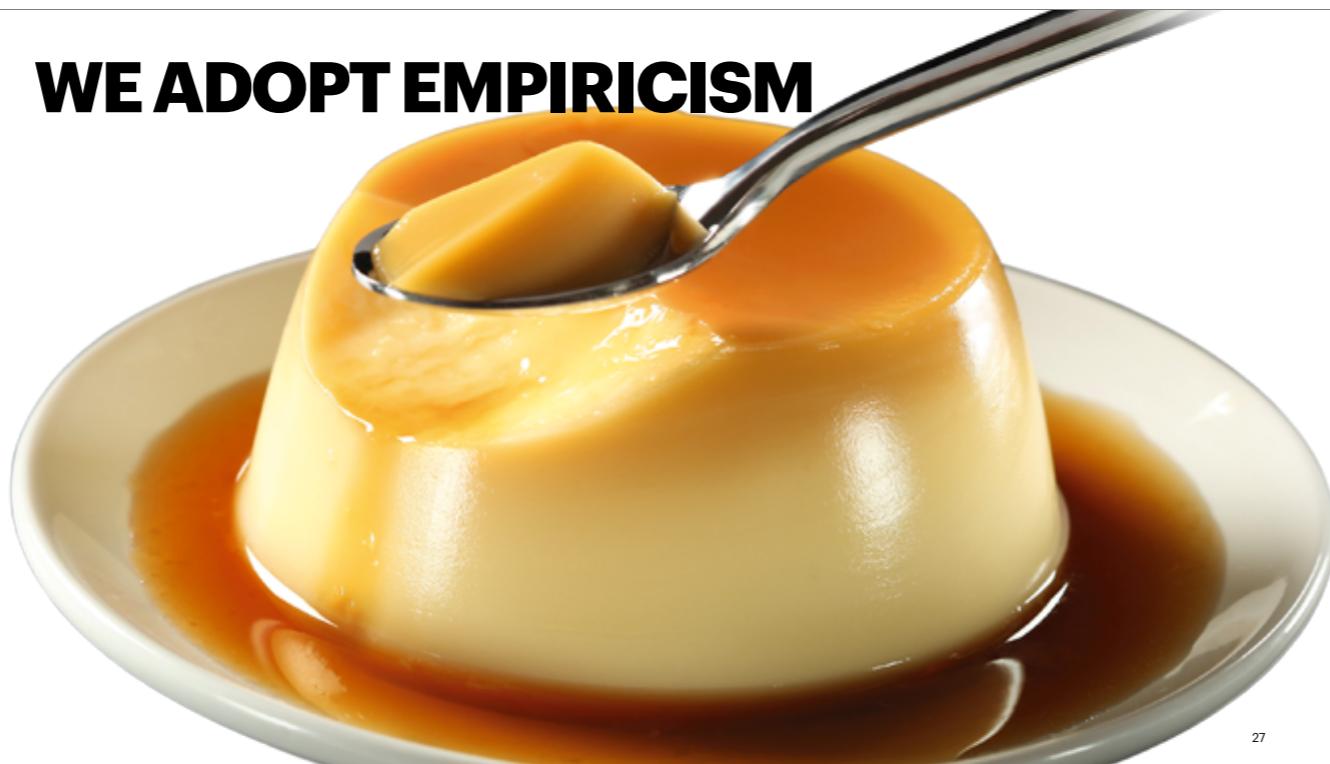
At the bottom right of the screenshot, the number "25" is visible.

Essentially, this is a matter of reflection: self-reflection, management etc. Understanding what works and what does not. I have asked on social media why would the industry need empirical methods.



Next Tuesday we will have guests from the industry

**WE ADOPT EMPIRICISM**



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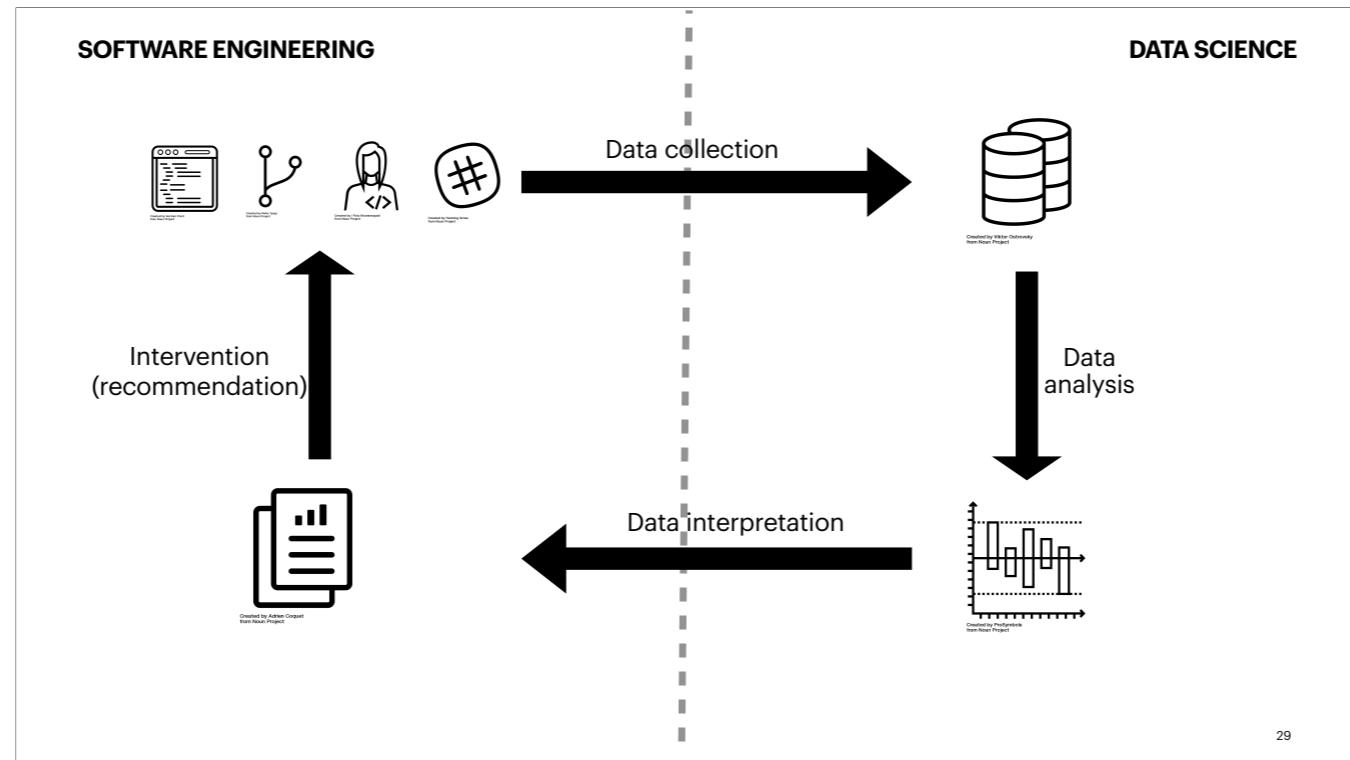
In this course we adopt empiricism. The proof of the pudding is in the eating

**WE ADOPT EMPIRICISM**

**ONLY BY TRYING THE PUDDING  
WE CAN UNDERSTAND  
HOW TO MAKE IT BETTER**

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In this course we adopt empiricism. The proof of the pudding is in the eating



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Empirical SE is an interplay between SE and Data Science

## SOFTWARE ENGINEERING

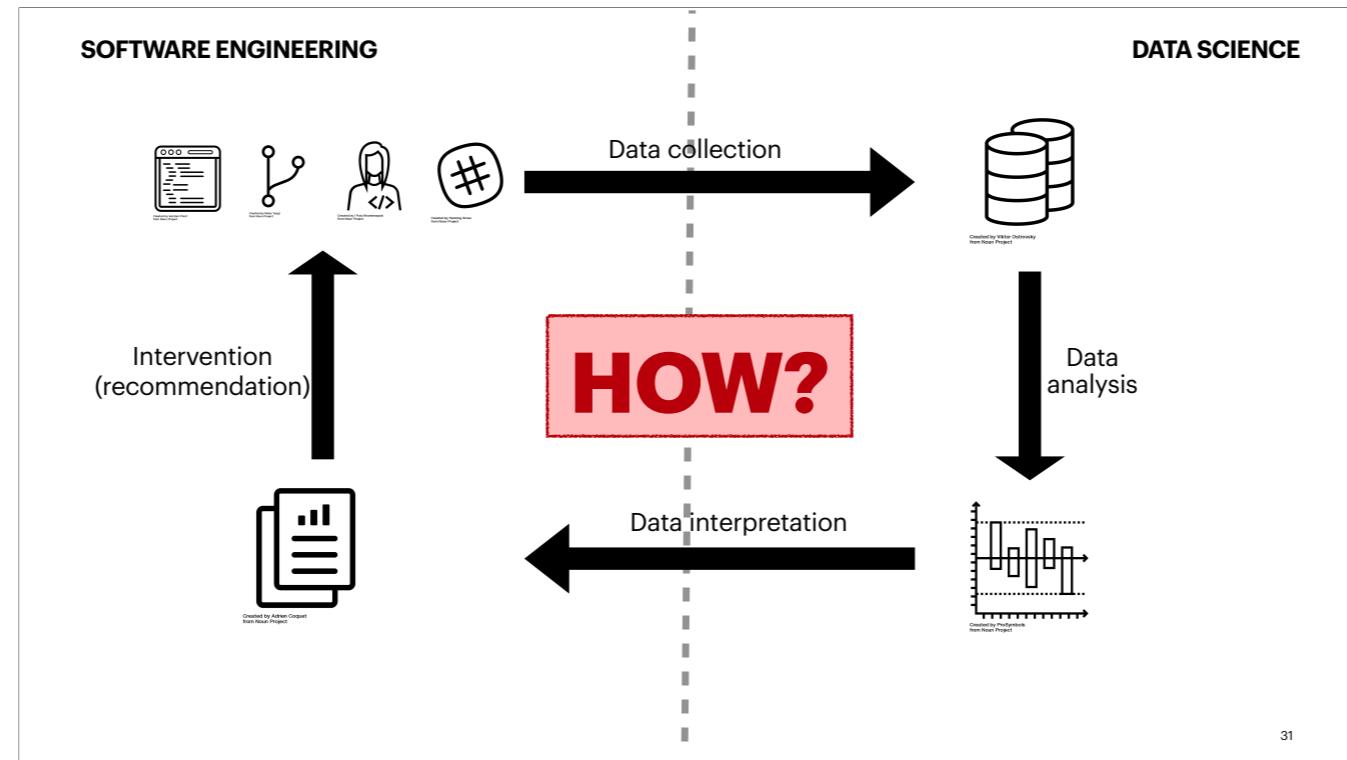
Obtain empirical evidence about what works in Software Engineering and what does not.

- How effective is modularisation?
- Does Test-Driven Development really work?
- Where do most software flaws come from?
- Are some programming languages make better programs than others?
- Why are my code reviews not finding defects?
- ...

## DATA SCIENCE

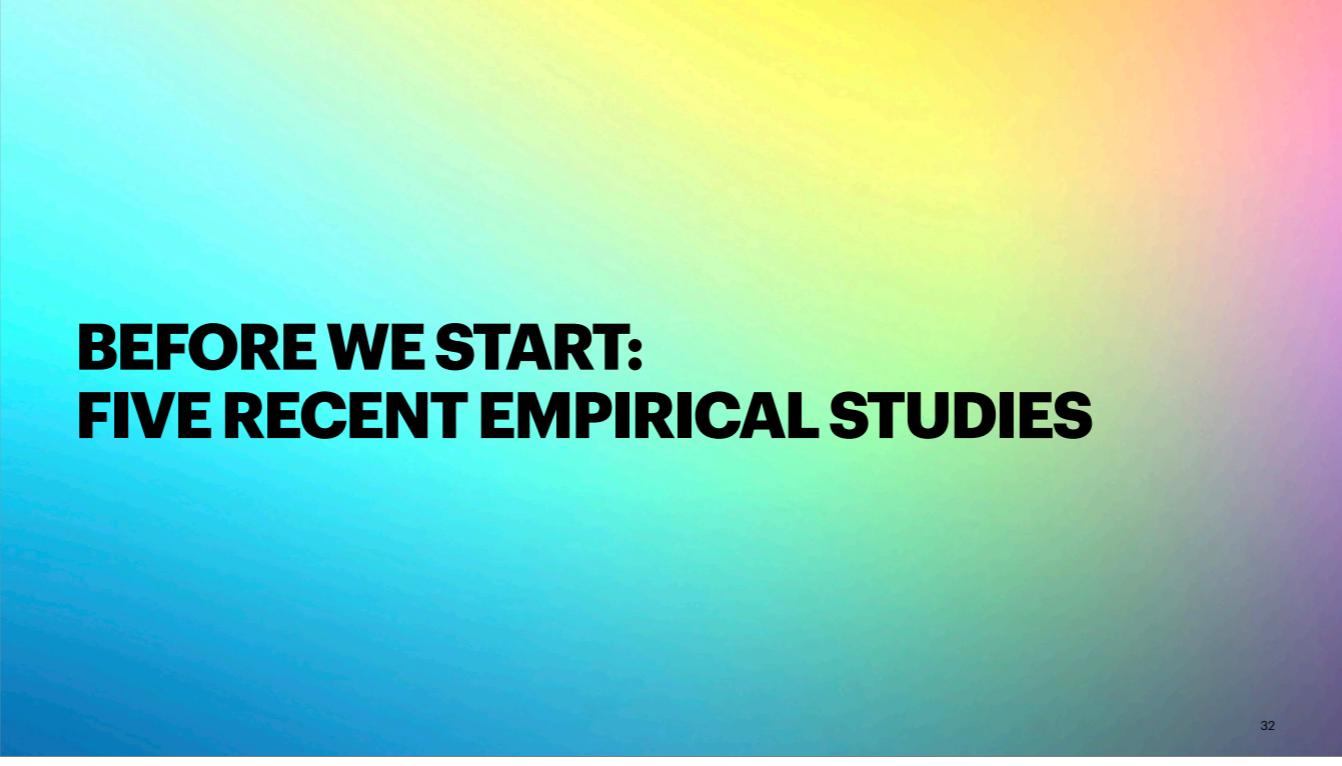
Design tools and techniques for data that is

- Large
  - GitHub: 200M repositories, 83M users
  - Stack Overflow: 23M questions
- Diverse
  - Structured meta-data
  - Source code
  - Natural language texts (e.g., transcripts)
  - Schemes and diagrams
  - Videos (e.g., YouTube instructions)
- Publicly available
  - 128M public repositories on GitHub
- Rapidly evolving
  - Stack Overflow: 6-7K questions/day



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So how do we collect, analyse and interpret data and how do we design interventions? We will mostly focus on design, analysis and interpretation



## **BEFORE WE START: FIVE RECENT EMPIRICAL STUDIES**

**3.9** out of 5

105 Ratings

Click to Rate: Write a Review

App Support

Sort by Most Helpful

**Pas mal**   
Je viens juste de l'installer (Imac 2011). J'ai créé facilement une lettre type. Pas de problème avec les tableaux et les graphiques. Habituel à travailler sur des programmes de bureautique comme WORD ou plus professionnellement avec Microsoft Word et Microsoft Xpress, J'ai su rapidement trouver mes marques. L'interface est très intuitive et la navigation fait assez intuitivement après quelques minutes d'utilisation.

**Impossible d'ouvrir certains documents**   
Je ne sais pas ce qu'il se passe, mais lorsque je clique sur un document dans la liste des derniers documents, il n'ouvre plus les documents sur lesquels il pointe. Je réagis, le programme est ouvert, mais les documents ne s'ouvrent plus. C'est embêtant. J'en ai besoin de manière immédiate. Il y a une solution ?  
Est ce que c'est parce que mon mac os ne supporte pas les documents de pages ?

**Grosses améliorations à faire**   
Je travaille essentiellement avec des tableaux de texte et quelques images ! Une fois le texte ne passe pas sur la page suivante, une fois les rangées se désolidarisent, lorsqu'on change la taille d'un rang, celui-ci diminue, on ne peut même pas choisir combien de lignes il y a dans une ligne.

**Crash**   
Since the last update, I cannot create any new file!! Please, could you solve that problem fast? Thank you very much in advance.

**Plus possible de télécharger**   
Impossible d'avoir un lien de téléchargement pour Pages! Il faut nécessairement passer par Internet et l'utiliser Online?

**Study 1**

Sort by Most Helpful

**3.9** out of 5

105 Ratings 

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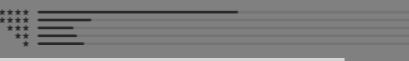
App Support Sort by Most Helpful

<b>Pas mal</b> ★★★★★ Je viens juste de l'installer (Imac 2011). J'ai créé facilement une lettre type. Pas de bug. Habituel à travailler sur des programmes de mise en page comme WORD ou plus professionnellement avec quark Xpress, J'ai su rapidement trouver mes marques. La mise en page se fait assez intuitivement après quelques minutes de prise <a href="#">more</a>	<b>Appropriate to make good looking documents with</b> ★★★★★ The first version of Pages were excellent. At version 5, it lost many useful features, but since that time it improved substantially. Assuming that it keeps improving, it is for sure worth buying. One could argue that it regained its two key advantages over competitors: 1) a lot easier than « pro » apps for what most people need and better aimed at producing nice documents <a href="#">more</a>	<b>Déçu de la 7, j'utilise toujours la version 4.3 !</b> ★★★★★ Dingue... 4 ans après la sortie de cette version de Pages, j'en suis resté à la version précédente (la 4.3 de Pages 09), principalement à cause du ravalement de façade. Plus puissante sur certains aspects, la version 7 souffre encore de certains manquants criants : - la gestion des styles - la gestion des tables des matières <a href="#">more</a>
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<b>Grosses améliorations à faire</b> ★★★★★ Je travaille essentiellement avec des tableaux de texte et quelle galerie ! Une fois le texte ne passe pas sur la page suivante, une fois les rangs se désolidarisent, lorsqu'on change la taille d'un rang celui d'autre diminue, on ne peut même pas choisir combien de	<b>Crash</b> ★★★★★ Since the last update, I cannot create any new file!! Please, could you solve that problem fast? Thank you very much in advance.	<b>Plus possible de télécharger</b> ★★★★★ Impossible d'avoir un lien de téléchargement pour Pages! Il faut nécessairement passer par Internet et l'utiliser Online?

1y ago Reikingham 2y ago becaphil 2y ago Benoit 2y ago Koda\_1993 2y ago xavez\_ 5 Sep Loulouch13 2y ago Geoffrey Degives 1y ago MichelZin 34

Who recognises this? (Belgian) apple app store. Reviews of one of the apps (actually it is Pages)

3.9 out of 5

Click to Rate: 

105 Ratings

## Why users give low ratings to an app?

**Pas mal**  2y ago becaphil

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**Impossible d'ouvrir certains documents**  2y ago Multiprise

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**Please fix Pages!!**  2y ago Koda\_1993

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Dingue... 4 ans après la sortie de cette version de Pages, j'en suis resté à la version précédente (la 4.3 de Pages 09), principalement à cause du ravalement de façade. Plus puissante sur certains aspects, la version 7 souffre encore de certains manquants criants : - la gestion des styles - la gestion des tables des matières [more](#)

**Thank you for this, Apple**  2y ago xavez...

If you can let go of your malformed Microsoft Word processing habits, this is a magnificent programme. Absolutely love it! I use Pages for so many things. From running my business, to typing day to day letters. This truly is the proverbial glass of water after crossing the Microsoft desert. Thank you, Apple! [more](#)

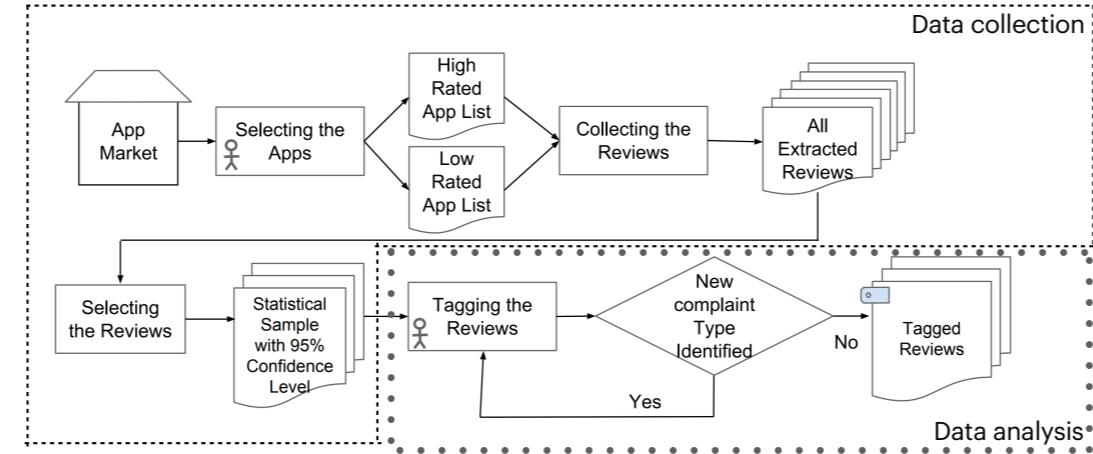
**Plus possible de télécharger**  1y ago MichelZin

Impossible d'avoir un lien de téléchargement pour Pages! Il faut nécessairement passer par Internet et l'utiliser Online?

35

Who recognises this? (Belgian) apple app store. Reviews of one of the apps (actually it is Pages)

# METHODOLOGY

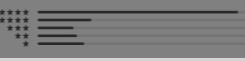


HAMMAD KHALID, EMAD SHIHAB, MEIYAPPAN NAGAPPAN, AHMED E. HASSAN: WHAT DO MOBILE APP USERS COMPLAIN ABOUT? IEEE SOFTWARE 32(3): 70-77 (2015)

36

We pick the 20 most popular iOS apps. High (>3.5 stars), low (3.5 stars or less). Collect all reviews. Select review with 1 or 2 stars, in total > 250K. Sample for manual analysis 6390 reviews (stratified, i.e., every app receives the correct sample of its reviews). Human figure represents manual steps.

3.9 out of 5

Click to Rate: 

**Why users give low ratings to an app?**

**Pas mal** ★★★★☆  
Je viens juste de l'installer (Imac 2011). J'ai créé facilement une lettre type. Pas de bug. Habituel à travailler sur des programmes de mise en page comme WORD ou plus professionnellement avec quark Xpress, J'ai su rapidement trouver mes marques. La mise en page se fait assez intuitivement après quelques minutes de prise [more](#)

**Impossible d'ouvrir certains documents** ★★★★☆  
Je ne sais pas qu'es pages n'ouvre plus les documents sur lesquels je clique. Ça réagit, le programme est ouvert, mais les documents ne s'ouvrent plus. C'est embêtant. J'en ai besoin de manière urgente et aucune solution ! Est ce que c'est parce que mon mac os ne peut pas aller [more](#)

**functional error**

**Please fix Pages!!** ★★★★☆  
Randomly Pages file. Sometimes after restarting the computer it works again, but not every time. Recently I've been unable to open any Pages files. The scenario was simple: In the morning I open a standard file to write into it and close it to go eating something. [more](#)

**functional error**

**Grosses améliorations à faire** ★★★★☆  
Je travaille essentiellement dans la galerie ! Une fois le texte ne passe pas sur la page suivante, une fois les rangs se désolidarisent, lorsqu'on change la taille d'un rang celui d'autre diminue... on ne peut même pas choisir combien de

**functional error**

**Crash** ★★★★☆  
Since the last update, my Pages has been crashing a lot. Could you solve this problem? It's really annoying. [more](#)

**app crashing**

**Plus possible de télécharger** ★★★★☆  
Impossible d'accéder à la version en ligne. Il faut nécessairement passer par Internet et l'utiliser Online? [more](#)

**feature removal**

**Déçu de la 7, j'utilise toujours la version 4.3 !** ★★★★☆  
Dingue... j'en suis resté à la version précédente (la 4.3 de Pages 09), principalement à cause du ravalement de façade. Plus puissante sur certains aspects, la version 7 souffre encore de certains manquants criants : - la gestion des styles - la gestion des tables des matières [more](#)

**feature request**

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**xavez\_**

most common type of complaints

## RESULTS: COMPLAINT TYPES

Complaint Type	Most frequent		Most impactful	
	Rank	Median (%)	Rank	1:2 star
Functional Error	1	26.68	7	2.1
Feature Request	2	15.13	12	1.28
App Crashing	3	10.51	4	2.85
Network Problem	4	7.39	6	2.25
Interface Design	5	3.44	10	1.5
Feature Removal	6	2.73	3	4.23
Hidden Cost	7	1.54	2	5.63
Compatibility	8	1.39	5	2.44
Privacy and Ethical	9	1.19	1	8.56
Unresponsive App	10	0.73	11	1.4
Uninteresting Content	11	0.29	9	1.5
Resource Heavy	12	0.28	8	2
Not specific	-	13.28	-	3.8

- **Most common:** functional error, feature request, app crashing, network problem
- **Most impactful:** privacy and ethics, feature removal, hidden cost, app crashing

HAMMAD KHALID, EMAD SHIHAB, MEIYAPPAN NAGAPPAN, AHMED E. HASSAN: WHAT DO MOBILE APP USERS COMPLAIN ABOUT? IEEE SOFTWARE 32(3): 70-77 (2015)

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explain ethics

unethical actions of the app developer (e.g., unethical business practices or selling the user's personal data)

example of privacy & ethical problem: an app that uses FB friends' list

# WHAT CAN DEVELOPERS DO?

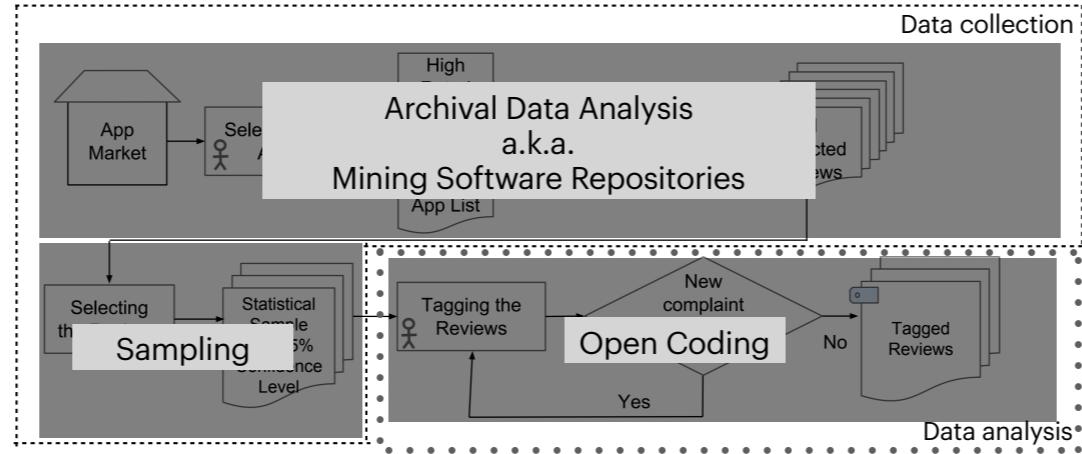
- **Most common:** functional error, feature request, app crashing, network problem
  - functional error, app crashing, network problem can be directly addressed by developers
  - feature request - strategy of app evolution, developers might influence it
- **Most impactful:** privacy and ethics, feature removal, hidden cost, app crashing
  - only app crashing can be directly addressed by developers
  - feature removal - strategy of app evolution, developers might influence it
  - privacy and ethics, hidden cost - value of the app itself, outside of developers' control
- **Focus on the most impactful complaints**

HAMMAD KHALID, EMAD SHIHAB, MEIYAPPAN NAGAPPAN, AHMED E. HASSAN: WHAT DO MOBILE APP USERS COMPLAIN ABOUT? IEEE SOFTWARE 32(3): 70-77 (2015)

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hidden cost - costs incurred by the functionality of a free app, for example purchase of game coins with real money

## WHICH DATA SCIENCE TECHNIQUES WERE USED?

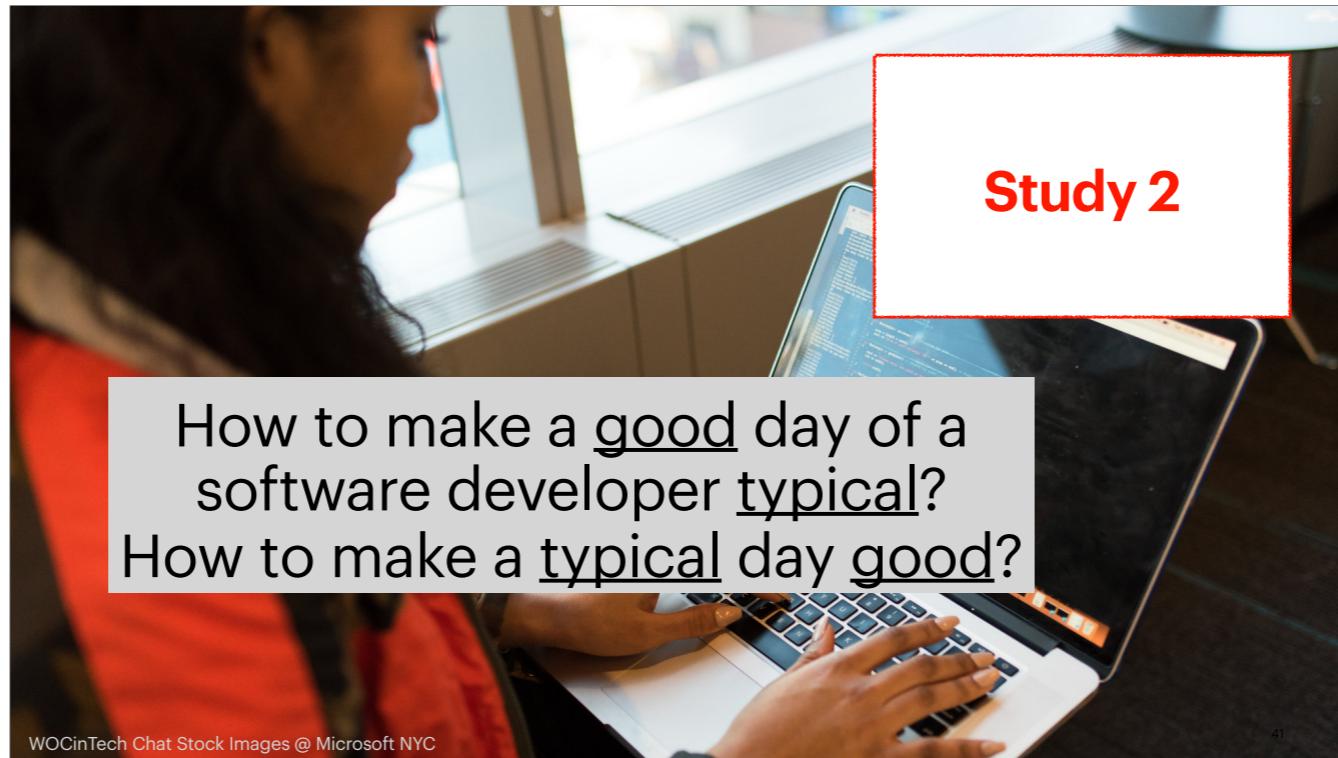


HAMMAD KHALID, EMAD SHIHAB, MEIYAPPAN NAGAPPAN, AHMED E. HASSAN: WHAT DO MOBILE APP USERS COMPLAIN ABOUT? IEEE SOFTWARE 32(3): 70-77 (2015)

40

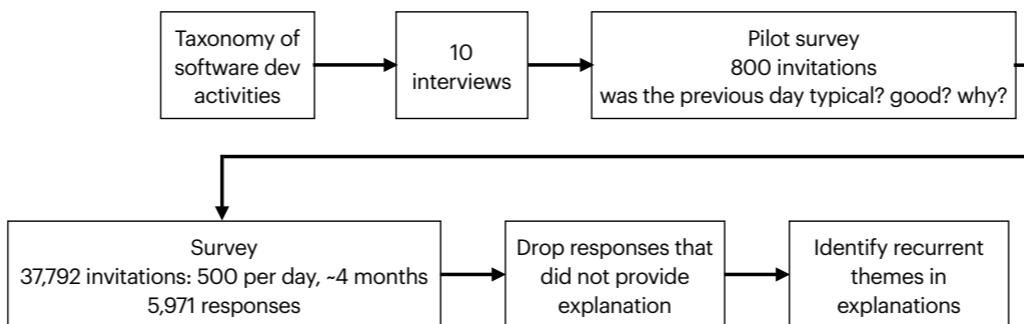
Sampling as a way of addressing too many reviews

Open coding is a form of qualitative analysis



Software development is a human activity and it is important for developers to be happy. Otherwise, both the software development process and software products lose quality (Graziotin et al.) This is a study of Microsoft. Microsoft would like to make developers happy, by making their typical days good and good days - typical.

# RESEARCH METHOD



ANDRÉ N. MEYER, EARL T. BARR, CHRISTIAN BIRD, THOMAS ZIMMERMANN: TODAY WAS A GOOD DAY: THE DAILY LIFE OF SOFTWARE DEVELOPERS. IEEE TRANSACTIONS ON SOFTWARE ENGINEERING, 2020

we conducted interviews with developers until the data saturation point was reached [45]. That is, once new interviews yield no additional information, further interviews will yield only marginal (if any) value. 7 saturations, went up to 10.

pilot the survey and identify any potential problems, we then sent the survey to 800 developers over the course of one week with an additional question asking if any aspect of the survey was difficult or confusing and soliciting general feedback.

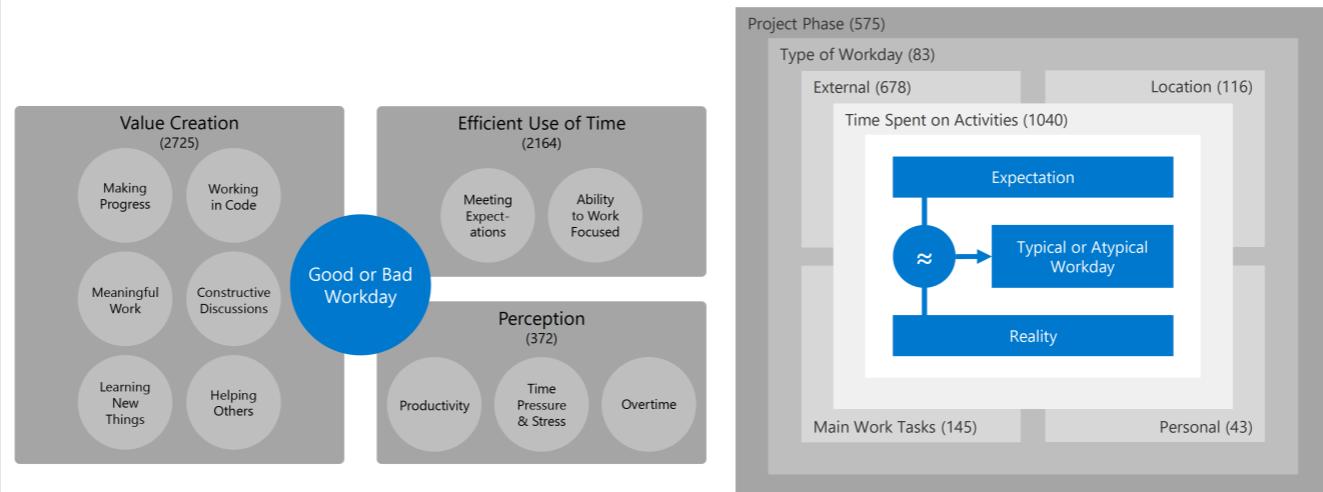
# RESULTS: GOOD DAY



ANDRÉ N. MEYER, EARL T. BARR, CHRISTIAN BIRD, THOMAS ZIMMERMANN: TODAY WAS A GOOD DAY: THE DAILY LIFE OF SOFTWARE DEVELOPERS. IEEE TRANSACTIONS ON SOFTWARE ENGINEERING, 2020

Fig. 1. Conceptual framework for good workdays. The 3 high-level factors are visualized as square layers; outer layers influence the inner layers.

# RESULTS: GOOD DAY      TYPICAL DAY



ANDRÉ N. MEYER, EARL T. BARR, CHRISTIAN BIRD, THOMAS ZIMMERMANN: TODAY WAS A GOOD DAY: THE DAILY LIFE OF SOFTWARE DEVELOPERS. IEEE TRANSACTIONS ON SOFTWARE ENGINEERING, 2020

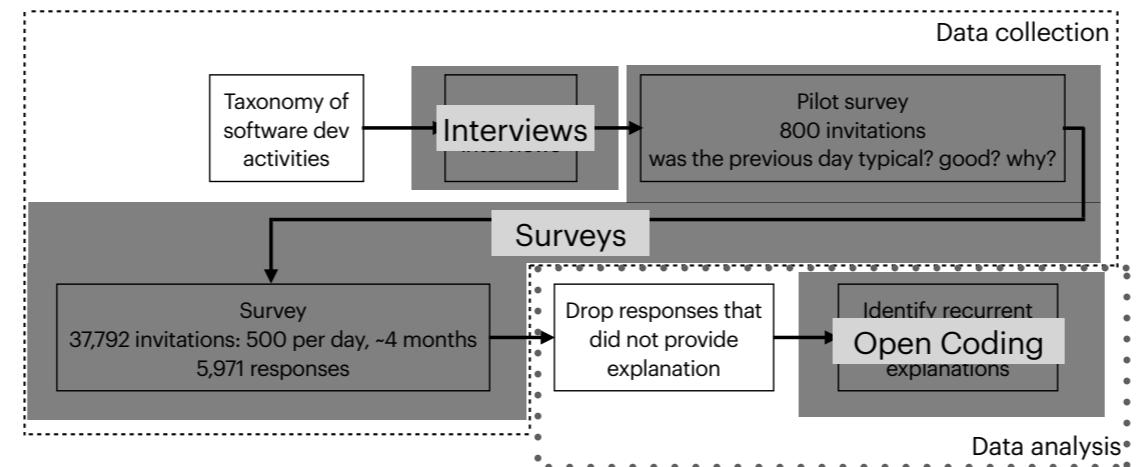
Fig. 2. Conceptual framework characterizing typical workdays. The main factors are visualized as layers; the outer layers influence all inner layers.

# WHAT CAN MANAGERS DO?

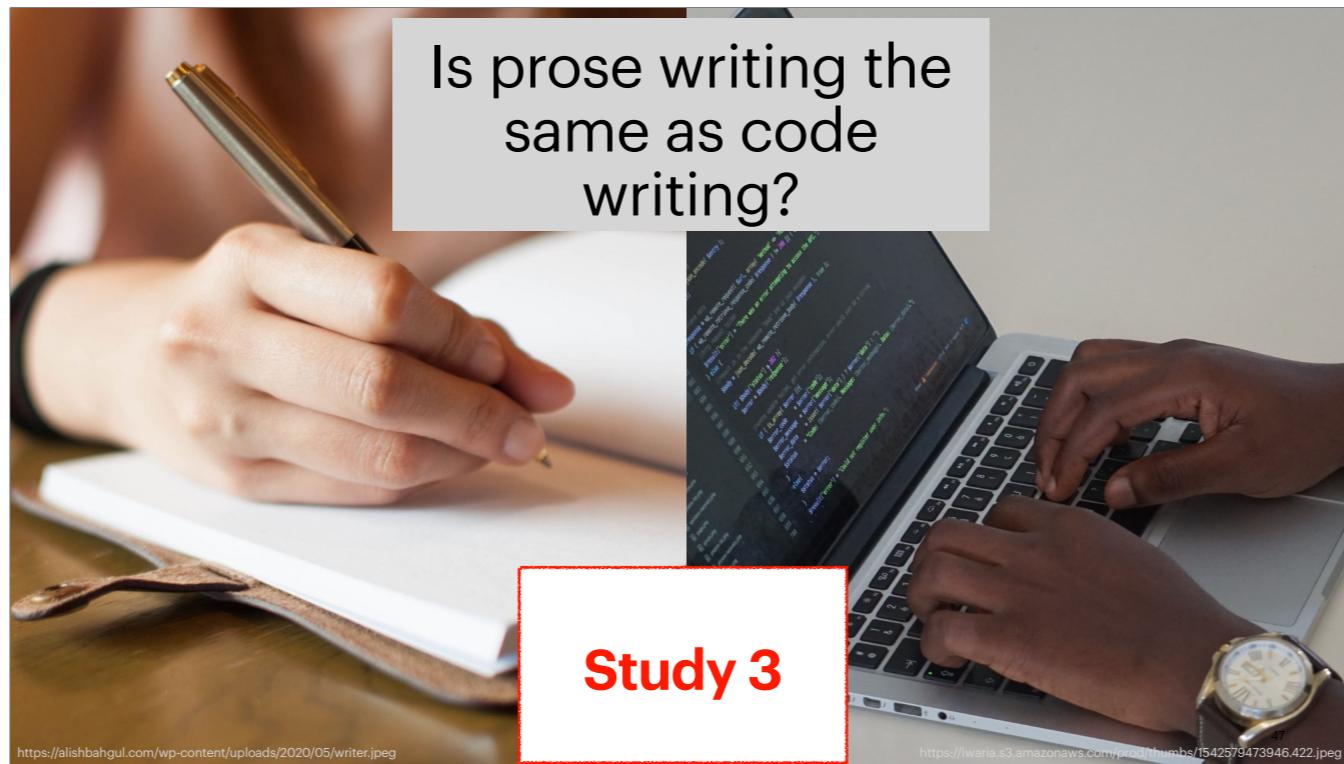
- **Make good days typical** (more routine)
  - minimise administrative tasks and infrastructure issues
  - reduce interruptions and meetings
- **Make atypical days good**
  - work from home when one needs a lot of focus and attention
  - no-meeting days
  - do a bit of coding during the planning phase
  - use slow time (e.g., project wrap-up) for side projects
- **Meetings are not necessarily evil**
  - during non-development phases they are good and (usually) productive

ANDRÉ N. MEYER, EARL T. BARR, CHRISTIAN BIRD, THOMAS ZIMMERMANN: TODAY WAS A GOOD DAY: THE DAILY LIFE OF SOFTWARE DEVELOPERS. IEEE TRANSACTIONS ON SOFTWARE ENGINEERING, 2020

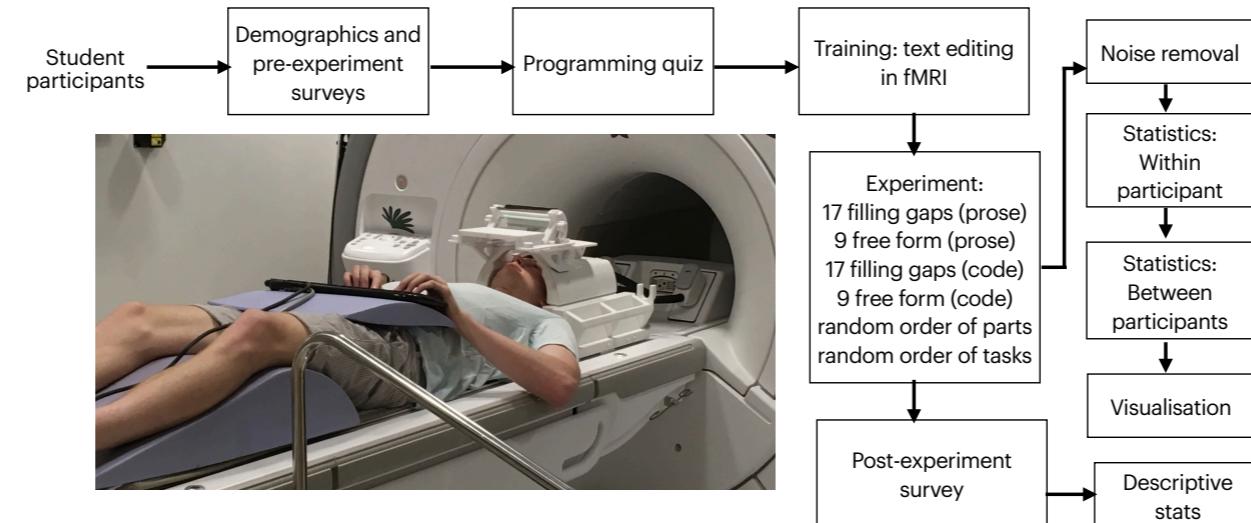
## WHICH DATA SCIENCE TECHNIQUES DID THEY USE?



ANDRÉ N. MEYER, EARL T. BARR, CHRISTIAN BIRD, THOMAS ZIMMERMANN: TODAY WAS A GOOD DAY: THE DAILY LIFE OF SOFTWARE DEVELOPERS. IEEE TRANSACTIONS ON SOFTWARE ENGINEERING, 2020



# RESEARCH METHOD



RYAN KRUEGER, YU HUANG, XINYU LIU, TYLER SANTANDER, WESTLEY WEIMER, KEVIN LEACH. NEUROLOGICAL DIVIDE - AN FMRI STUDY OF PROSE AND CODE WRITING. INT CONF SOFTWARE ENGINEERING 2020

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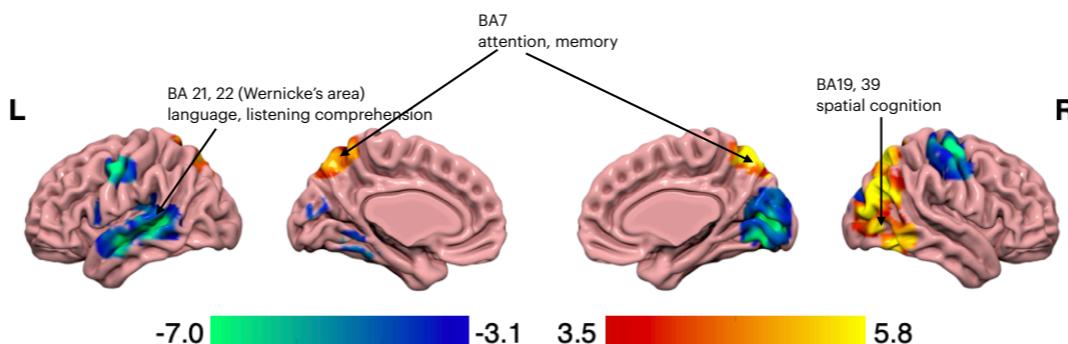
fMRI - functional magnetic resonance imaging

we collected basic demographic data (sex, gender, age, cumulative GPA, and years of experience) and socioeconomic status (SES) data + three standard psychological measurement surveys: Positive and Negative Affect Scale (PANAS, emotional health), Autism Spectrum Disorder (ASD), and Need for Cognition (NFC, inclination for effortful cognition)

programming quiz - knowledge of C/C++

## RESULTS: FREE FORM

- Cold: more prose than code
- Hot: more code than prose



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### BA Brodmann area HEMISPHERE

The authors visualise results of statistical analysis using heat-based representation. Free-form prose writing involves areas associated with language. Coding involves areas associated with attention, memory, planning, and spatial ability.

(1) and (2) are left hemisphere, (3) and (4) are right hemisphere

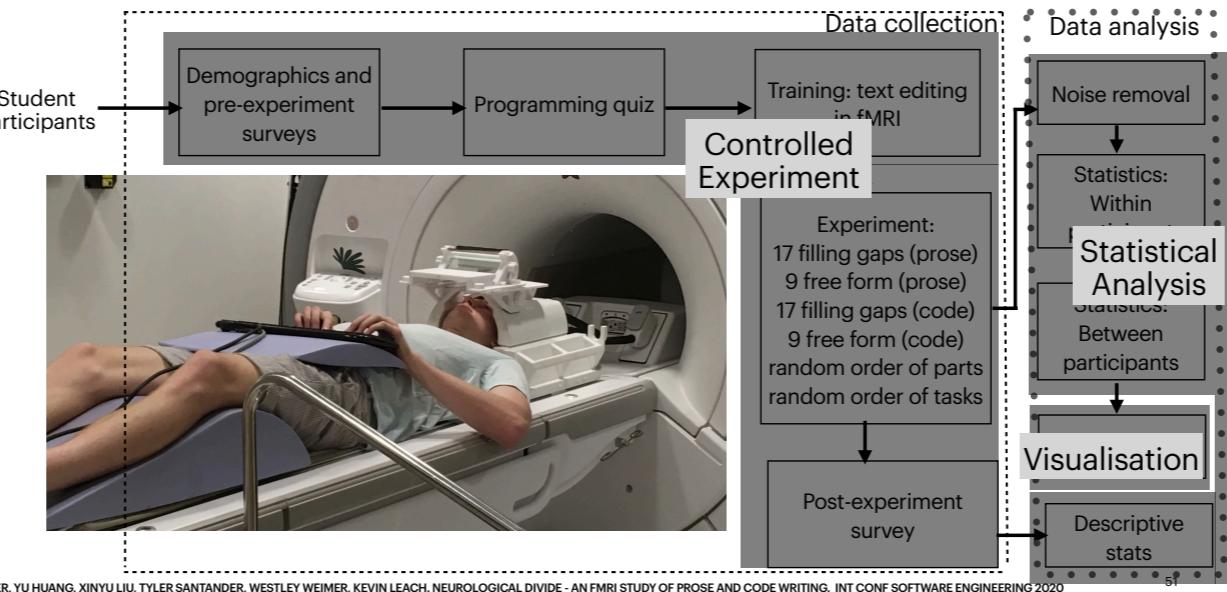
Areas are merely examples, there are more in the paper

## WHAT DOES THIS MEAN FOR RESEARCHERS?

- The **brain** does not treat code writing and prose writing as similar
  - Free-form prose writing involves areas associated with language. Coding involves areas associated with attention, memory, planning, and spatial ability.
  - Filling gaps in code requires more activity in areas associated with careful top-down control, planning, and categorisation.
- However, 38.5% **respondents report similarities** between writing code and writing prose
- **Self-reporting is unreliable!** Surveys need to be augmented with objective data analysis.

rename

## WHICH DATA SCIENCE TECHNIQUES DID THEY USE?



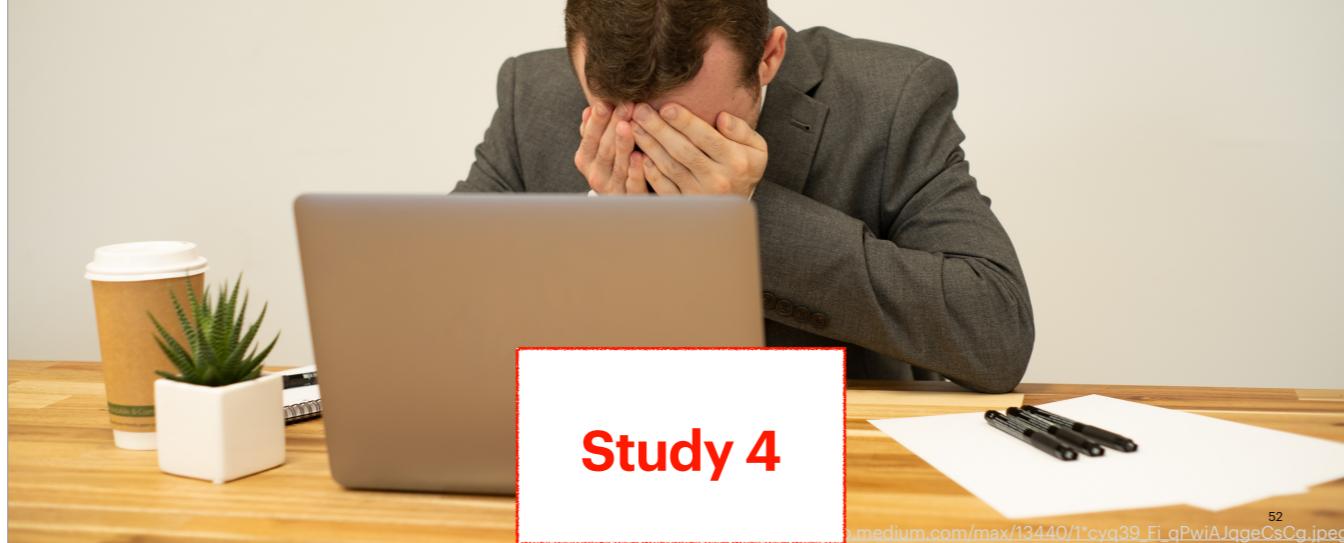
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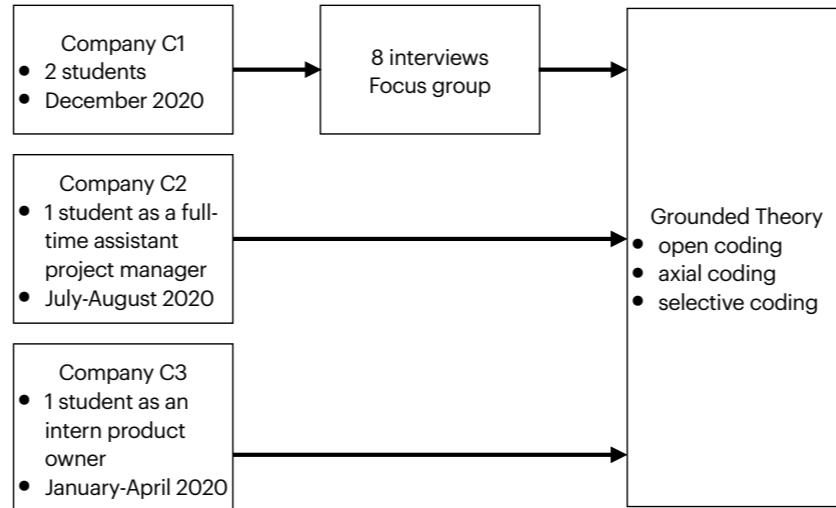
programming quiz - knowledge of C/C++

## What issues do these software teams have when adopting DevOps and microservices?



**DevOps** is a set of practices that combines software development (Dev) and IT operations (Ops). It aims to shorten the systems development life cycle and provide continuous delivery with high software quality. A **microservice** architecture – a variant of the SOA structural style – is an architectural pattern that arranges an application as a collection of loosely-coupled, fine-grained services, communicating through lightweight protocols.

# RESEARCH METHOD



XIN ZHOU, HUANG HUANG, HE ZHANG, XIN HUANG, DONG SHAO, CHENXING ZHONG: A CROSS-COMPANY ETHNOGRAPHIC STUDY ON SOFTWARE TEAMS FOR DEVOPS AND MICROSERVICES: ORGANIZATION, BENEFITS, AND ISSUES. ICSE (SEIP) 2022:1-10

## ISSUES IN ADOPTING DEVOPS AND MICROSERVICES?

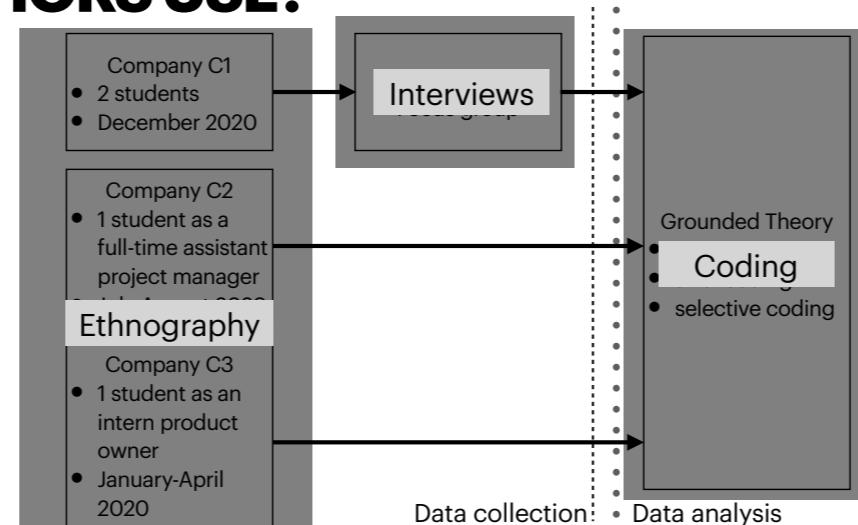
- Implementation is often **fragmentary**, disconnecting planning and Dev, Dev and Ops, sometimes due to **department boundaries**
- **Abuse of technology** because it is perceived as fancy
- **Recommendations** for practitioners:
  - establish more connections between different phases of the DevOps project
  - reconsider appropriateness of architectural choices

XIN ZHOU, HUANG HUANG, HE ZHANG, XIN HUANG, DONG SHAO, CHENXING ZHONG: A CROSS-COMPANY ETHNOGRAPHIC STUDY ON SOFTWARE TEAMS FOR DEVOPS AND MICROSERVICES: ORGANIZATION, BENEFITS, AND ISSUES. ICSE (SEIP) 2022:1-10

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First, software organizations are keen to improve DevOps pipelines (automation, security, etc.), but may have less interest in other essentials (e.g., cross-stream communications) that DevOps advocates for the holistic improvement. The complete DevOps pipeline was detached into several segments that are barely connected to each other (Figure 6). The first chasm is between planning and coding. Although C2 builds an association between JIRA and GitLab, the correlation between requirements and code in the pipeline is elusive. The self-developed project management system in C3 has little to no connection with the code repository. Another chasm is between operations and others. For example, operational issues could only be resolved in weekly operations meetings in C3. Moreover, the operations of the Internet infrastructure produced in C1 and C2 are independent from their development. This chasm raises questions about whether DevOps is indeed adopted in organizations because of the separation of ‘Dev’ and ‘Ops’.

# WHICH DATA SCIENCE TECHNIQUES DID THE AUTHORS USE?



XIN ZHOU, HUANG HUANG, HE ZHANG, XIN HUANG, DONG SHAO, CHENXING ZHONG: A CROSS-COMPANY ETHNOGRAPHIC STUDY ON SOFTWARE TEAMS FOR DEVOPS AND MICROSERVICES: ORGANIZATION, BENEFITS, AND ISSUES. ICSE (SEIP) 2022:1-10

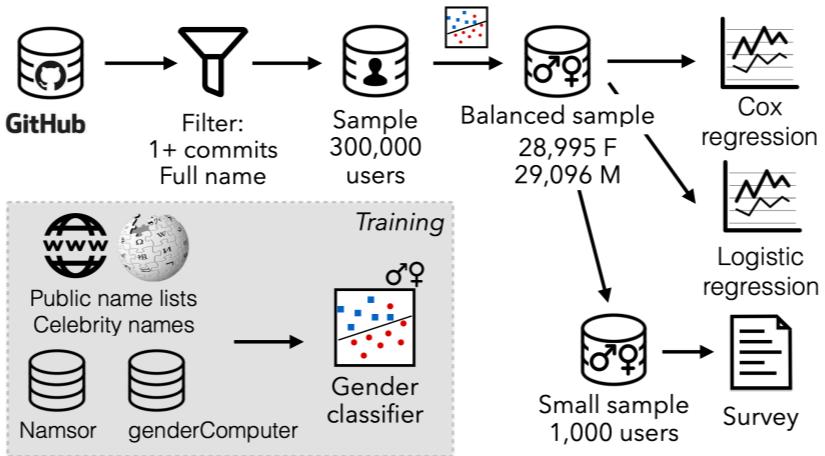
55

Not common in SE: expensive. Refer to Samar Jameel's thesis



OSS

# RESEARCH METHOD



HUILIAN SOPHIE QIU, ALEXANDER NOLTE, ANITA BROWN, ALEXANDER SEREBRENIK, BOGDAN VASILESCU. GOING FARTHER TOGETHER - THE IMPACT OF SOCIAL CAPITAL ON SUSTAINED PARTICIPATION IN OPEN SOURCE. INT CONF SOFTWARE ENGINEERING 2019

# RESULTS OF STATISTICAL ANALYSIS

TABLE III: Regression models for early-stage disengagement ( $N = 29,235$  users; 140,441 data rows) and later-stage disengagement ( $N = 26,299$  users; 143,984 data rows).

	Early-stage (GLM)		Later-stage (Cox)	
	response: Disengaged = 1		response: Disengaged = 1	
	Coeffs (Err.)	LR Chisq	Coeffs (Err.)	LR Chisq
(Intercept)	1.61 (0.07)***			
Followers	0.61 (0.02)***	990.53***	0.70 (0.02)***	394.39***
Stars	0.89 (0.02)***	45.18***	0.86 (0.02)***	103.26***
Commits to date	0.63 (0.01)***	1635.38***	0.64 (0.02)***	718.15***
Is major contrib.	0.77 (0.05)***	29.05***	0.63 (0.06)***	62.96***
Is repo owner	0.56 (0.03)***	363.80***	0.51 (0.04)***	310.35***
Niche width	0.47 (0.05)***	244.20***	0.54 (0.05)***	132.70***
Is female	1.27 (0.03)***	68.79***	1.32 (0.04)***	59.96***
Team familiarity	0.84 (0.08)*	4.83*	0.79 (0.09)**	13.22***
Rec. cohesion	0.85 (0.04)***	30.77***	0.86 (0.04)***	28.46***
Share newcomers	1.07 (0.04)	3.37	0.78 (0.04)***	35.70***
Lang. heterogen.	0.70 (0.11)**	44.44***	0.63 (0.14)***	44.43***
Lang. heter.:Female	0.73 (0.15)*	4.36*	0.69 (0.18)*	4.30*
Female:Team fam.	1.09 (0.11)		1.05 (0.17)	
Female:Cohesion	1.02 (0.05)		1.01 (0.04)	

\*\*\*  $p < 0.001$ , \*\*  $p < 0.01$ , \*  $p < 0.05$

HUILIAN SOPHIE QIU, ALEXANDER NOLTE, ANITA BROWN, ALEXANDER SEREBRENIK, BOGDAN VASILESCU. GOING FARTHER TOGETHER - THE IMPACT OF SOCIAL CAPITAL ON SUSTAINED PARTICIPATION IN OPEN SOURCE. INT CONF SOFTWARE ENGINEERING 2019

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Early - logistic regression for contributors who disengage within their first three months of activity

Late - a Cox regression for contributors who disengage later

Interpretation: if the coefficient  $< 1$  then “more X less likely to disengage”, if the coefficient  $> 1$  “more X more likely to disengage”

More popular (i.e., followers), active (i.e., commits to date) and versatile (i.e., niche width) developers are less likely to disengage. Similarly, project owners, major contributors and contributors to highly starred projects are less likely to disengage. Moreover, as expected, female contributors are at higher risk of disengagement than males.

Contributing to projects where team members are more familiar pairwise with each other from prior collaborations (Team familiarity), or projects where cliques of three or more developers recur from prior projects (Recurring cohesion), is associated with decreased risk of disengagement.

The variables related to team diversity also have statistically significant effects. Heterogeneity in the programming language

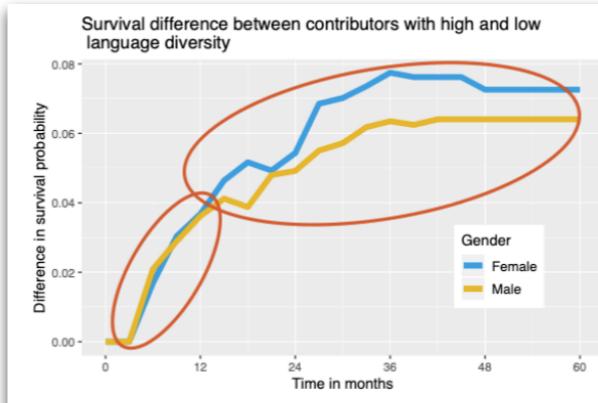
backgrounds of project team members is associated with decreased risk of disengagement both short and long term. Moreover, language heterogeneity has a statistically significant interaction with gender: women are more likely to disengage when language heterogeneity is low. Contributing to projects with high turnover (Share of newcomers) is associated with higher risk of disengagement after the first three months.

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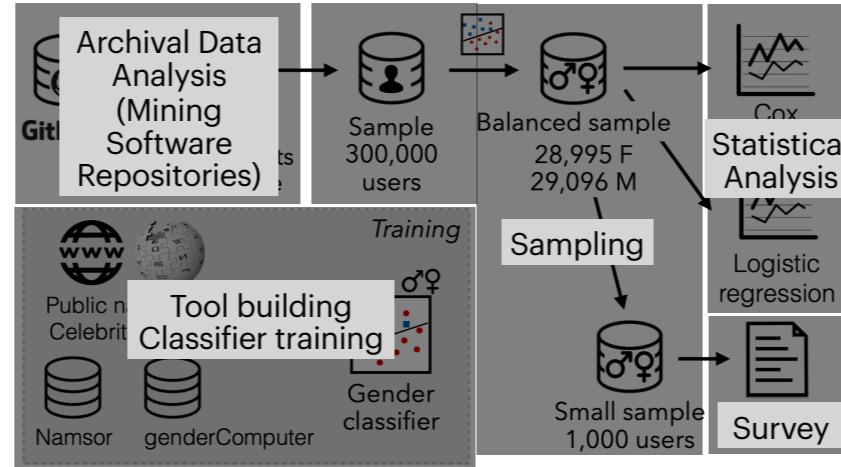
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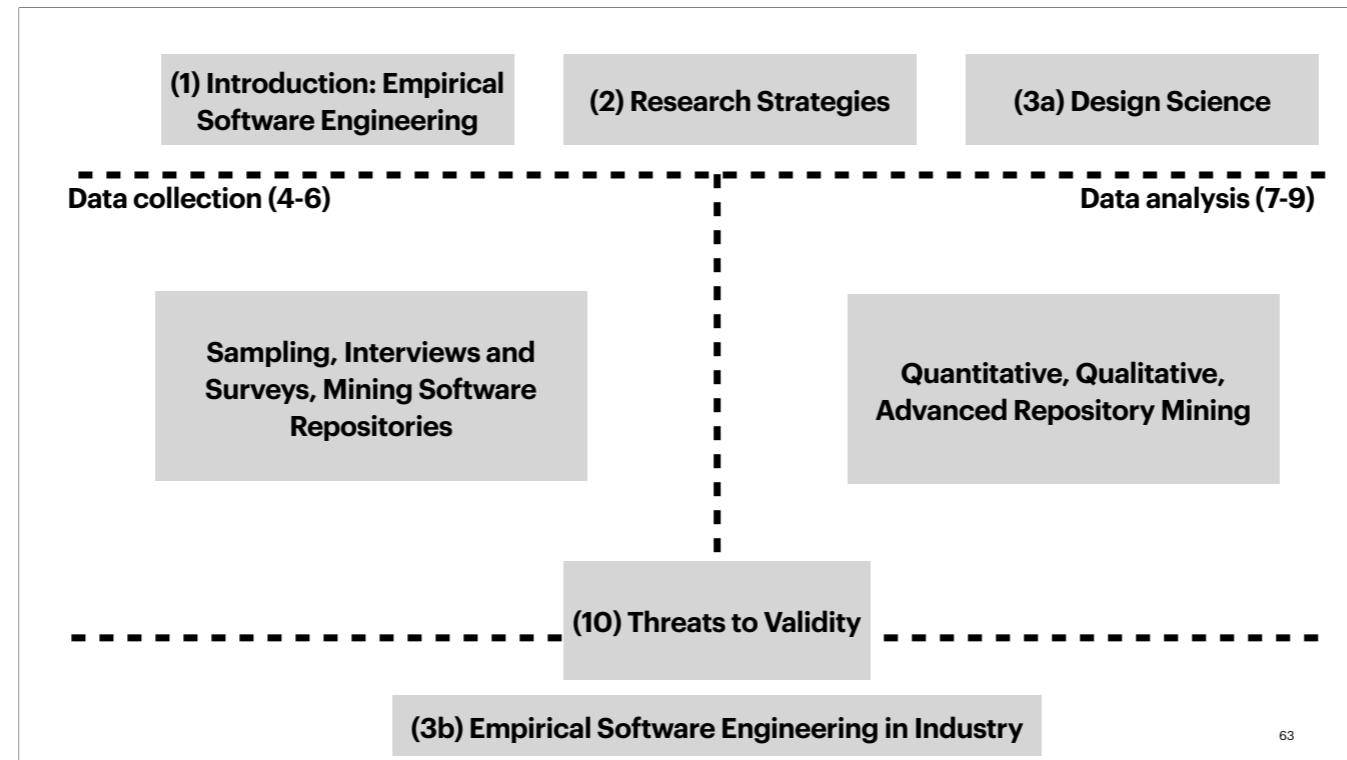
# SUMMARY OF THE STUDIES

	<b>App reviews</b>	<b>Good day/ Typical day</b>	<b>Code and prose</b>	<b>DevOps and microservices</b>	<b>Gender and GitHub</b>
<b>Data source</b>	Apple app store	Experiences of developers	Brain activity of developers	Communication and development	GitHub
<b>Data collection</b>	Archival data analysis (Repository mining), sampling	Interviews, surveys	Controlled experiment, post-experiment survey	Ethnography, interviews	Archival data analysis (Repository mining), sampling, survey
<b>Data analysis</b>	Open coding	Open coding	Statistical analysis, visualisation	Ground Theory	Statistical analysis, machine learning
<b>Beneficiaries</b>	Developers	Managers	Researchers	Architects	Developers, women in particular
<b>Recommendation</b>	Focus on the most impactful complaints	Make good days typical and atypical days good	Surveys should be augmented with objective measures	Reconsider appropriateness of the solution and add connections	Join projects that use different programming languages

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Data source	Apple app store	Experiences of developers	Brain activity of developers	Communication and development	GitHub
Data collection	Archival data analysis (Repository mining), sampling	Interviews, surveys	Controlled experiment, post- experiment survey	Ethnography, interviews	Archival data analysis (Repository mining), sampling, survey
Data analysis	Open coding		Statistical analysis	Content analysis	Statistical analysis, machine learning
Beneficiaries	Developers			Developers with mental disorders	Developers, women in particular
Recommendation	Focus on the most impactful complaints	and atypical days good	augmented with objective measures	the solution and add connections	Join projects that use different programming languages

So many methods...  
Which one to choose?  
Next lecture...



Plus three workshops and a coffee-hour

## **EMPIRICAL PEOPLE@CS**

- **Software engineering:** Serebrenik, Chaudron, Cleophas, Krüger, Nolte, Ochoa
  - **PhD students:** Cassee, van den Haak, Mohayeji, Paganini, Rukmono
  - **Security:** Allodi, Zannone
  - **Databases:** Fletcher

# **SUMMARY**

- Empirical Methods in Software Engineering
  - **empiricism** vs. rationalism: observation vs. intuition/reason as a source of knowledge
  - **research**: not all questions are meaningful in all paradigms!
  - **practice**: we need to understand what works/what does not
    - evidence-based medicine, reproducibility crisis in psychology, ...
- **Data collection**: repository mining, interviews, surveys, controlled experiment, ethnography...
- **Data analysis**: statistical analysis, visualisation, open coding, machine learning, ...