

Technical Debt:

At the Intersection of Decades of Empirical Software Engineering Research



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Thesis



“It is only a little hyperbolic to call this a watershed moment for empirical [software engineering] study, where many areas of progress are coming to a head at the same time.”

Forrest Shull, Davide Falessi, Carolyn Seaman, Madeline Diep, and Lucas Layman. “Technical Debt: Showing the Way for Better Transfer of Empirical Results.” Forthcoming in “Future of Software Engineering” published in honor of the 60th birthday of Prof. Dr. H. Dieter Rombach, 2013.

Contributing Streams of Research

- ❧ Software aging and decay
- ❧ Risk management
- ❧ Qualitative methods and appreciation for context
- ❧ Software metrics
- ❧ Program analysis
- ❧ Software quality

Software Aging and Decay

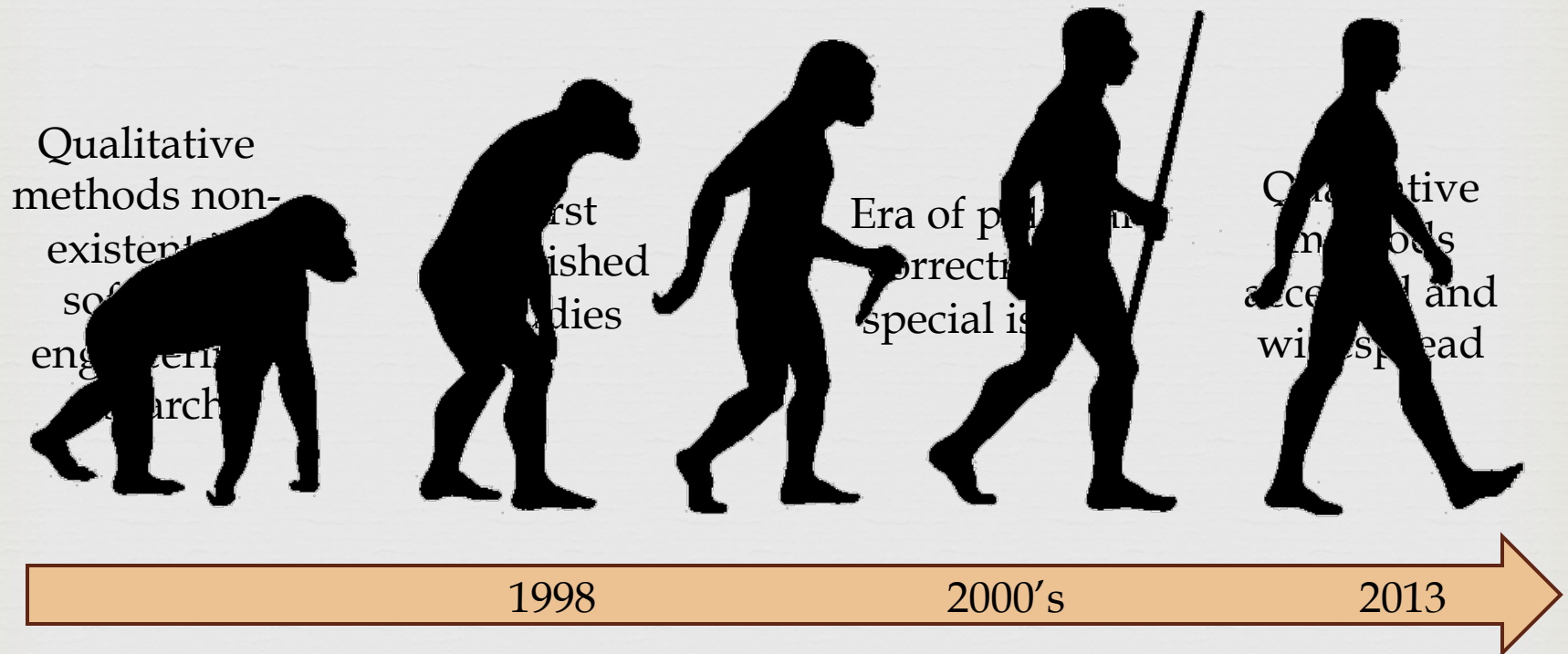
- ❧ Foundational
 - ❧ Technical Debt is in some ways just a restatement of these ideas
- ❧ Another metaphor
 - ❧ Like human aging
 - ❧ Changing the software becomes harder as it evolves
- ❧ Results
 - ❧ Inability to keep up
 - ❧ Reduced performance
 - ❧ Decreased quality
- ❧ Lehman's Law of Increasing Complexity:
 - ❧ Complexity increases unless work is done to maintain or reduce it

Risk Management



- ❧ Also foundational
 - ❧ Instances of Technical Debt constitute one type of software risk
- ❧ Risk Management cycle (identify, assess, manage) provides a template for managing Technical Debt
- ❧ Risk Assessment approaches (e.g., Risk exposure analysis) provides ways to quantifying Technical Debt
- ❧ Concept of utility loss provides a way to characterize the interest on Technical Debt

The Evolution of Qualitative Methods in SWE



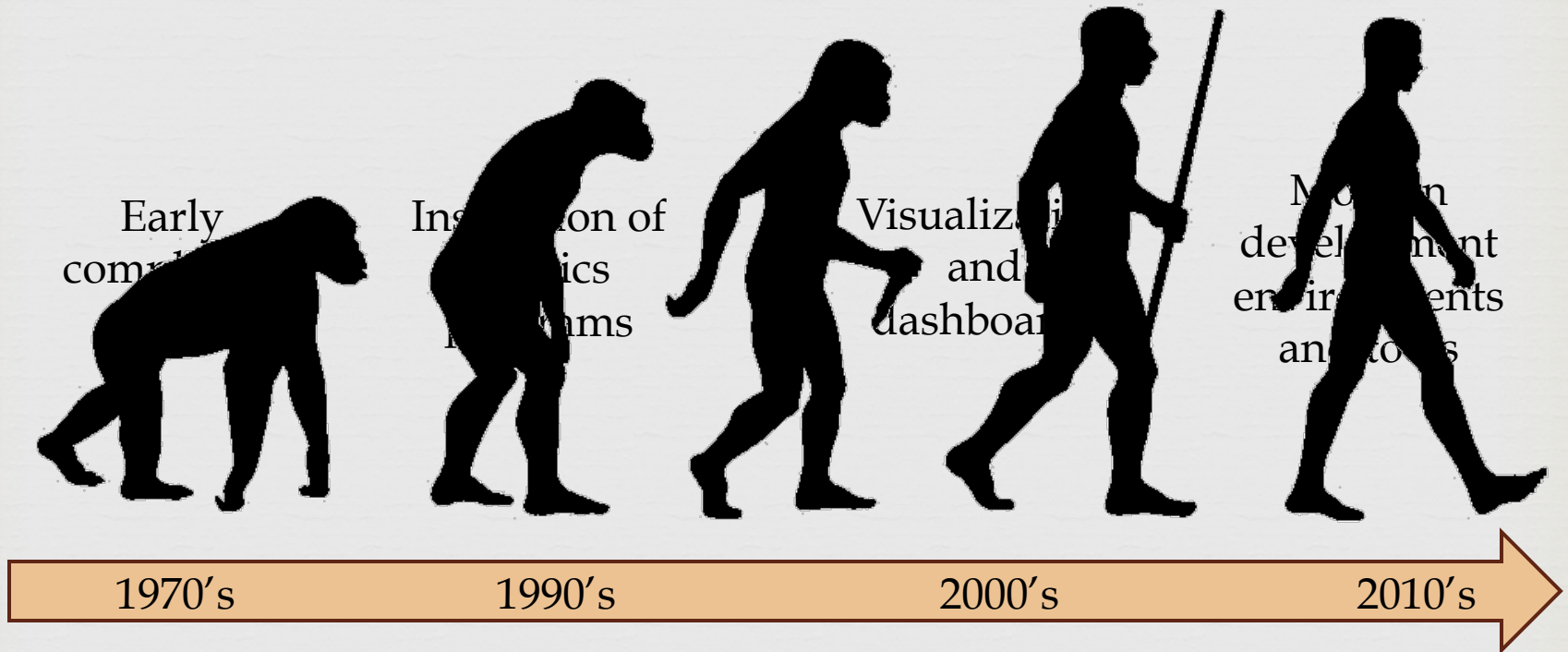
Current State of Qualitative Methods in SWE Research

- ❧ Empirical software engineering researchers can now add a host of qualitative methods to their empirical toolkit
- ❧ Many good examples of qualitative studies are available in the literature (e.g. in special issues)
- ❧ Many experts who are highly experienced
- ❧ Starting to look at qualitative synthesis of studies (e.g. in the context of SLRs)
- ❧ **Bottom line:** We now have the tools and expertise available to fully investigate questions of human behavior and context

Qualitative Methods and Context in TD Research

- ❧ Technical Debt related concepts are context-specific
- ❧ A project's Technical Debt strategy should be based on goals and “pain points”
- ❧ Context factors can be elicited in a number of ways
- ❧ We need qualitative methods to ensure capture of all relevant factors
- ❧ Qualitative work in Technical Debt research one of the reasons for its relevance to practice
- ❧ **Bottom line:** We can't study TD properly without qualitative methods, and until recently we didn't as a community know how to use qualitative methods effectively

The Evolution of Software Metrics



McCabe, 1976

Halstead, 1970

Basili et al., 1994

Gaudin, 2009

Schumacher et al., 2010

Bohnet and Döllner, 2011

Snipes et al., 2011

Current State of Software Metrics



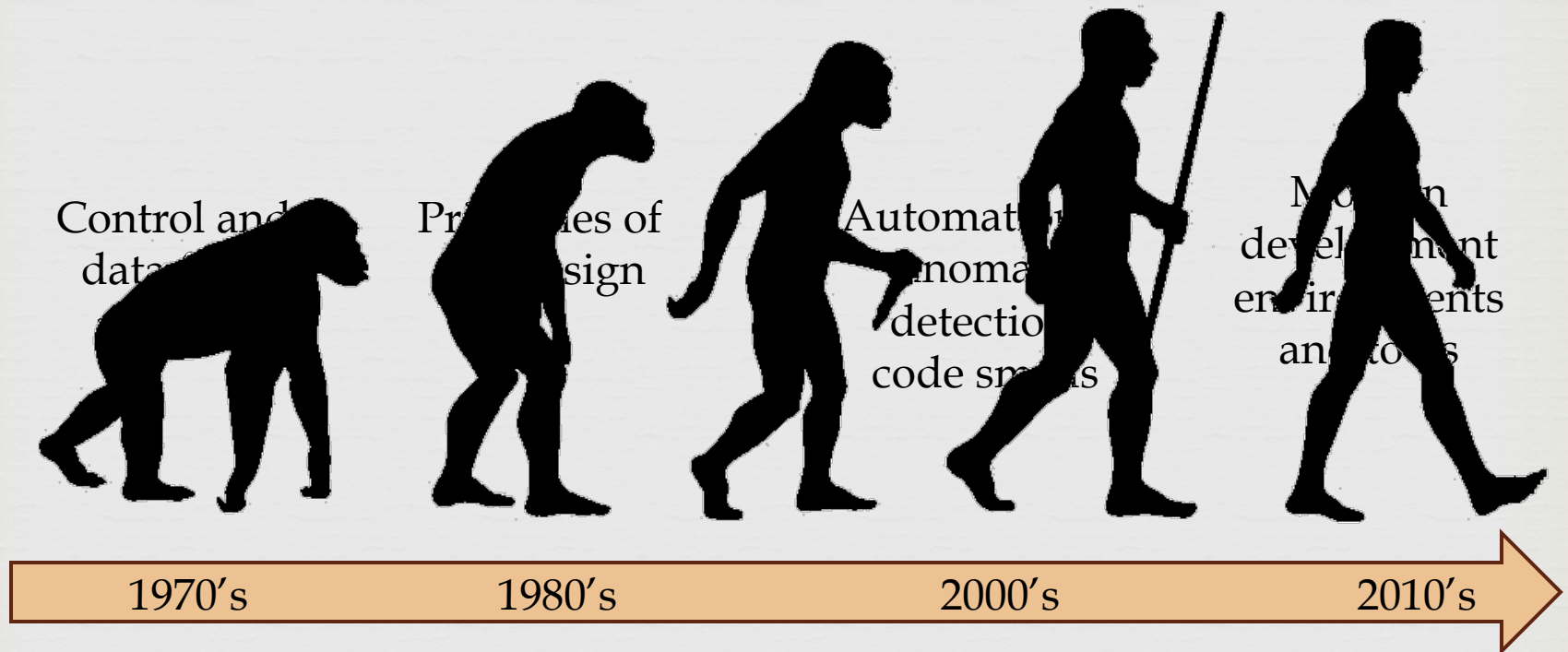
- ❧ Adoption of software metrics in industry is still spotty
 - ❧ Especially in small and medium organizations
- ❧ Many large development organizations are “data-rich” environments
- ❧ Metrics no longer have to be “added on” at the end of the process – better integration is possible
- ❧ **Bottom line:** Tools are available to integrate data collection, analysis, and visualization into the software development process

Software Metrics and Technical Debt



- ❧ The relationship between software metrics and Technical Debt is complex and subject to further research
- ❧ Not evident that modules with “worse” indicators have “real” debt
- ❧ Code smell definitions try to get at the complicated relationship
- ❧ In practice, TD management often begins with monitoring metrics
- ❧ **Bottom line:** Simple views of metrics are not sufficient; we need easy ways to combine and visualize custom-fit combinations and relationships between different metrics

The Evolution of Program Analysis



Kildall, 1973
Jones, 1981
Rentsch, 1982
Booch, 1986
Ball and Rajamani, 2002
Munro, 2005
Bohnet and Döllner, 2011
Snipes et al., 2011

Current State of Program Analysis

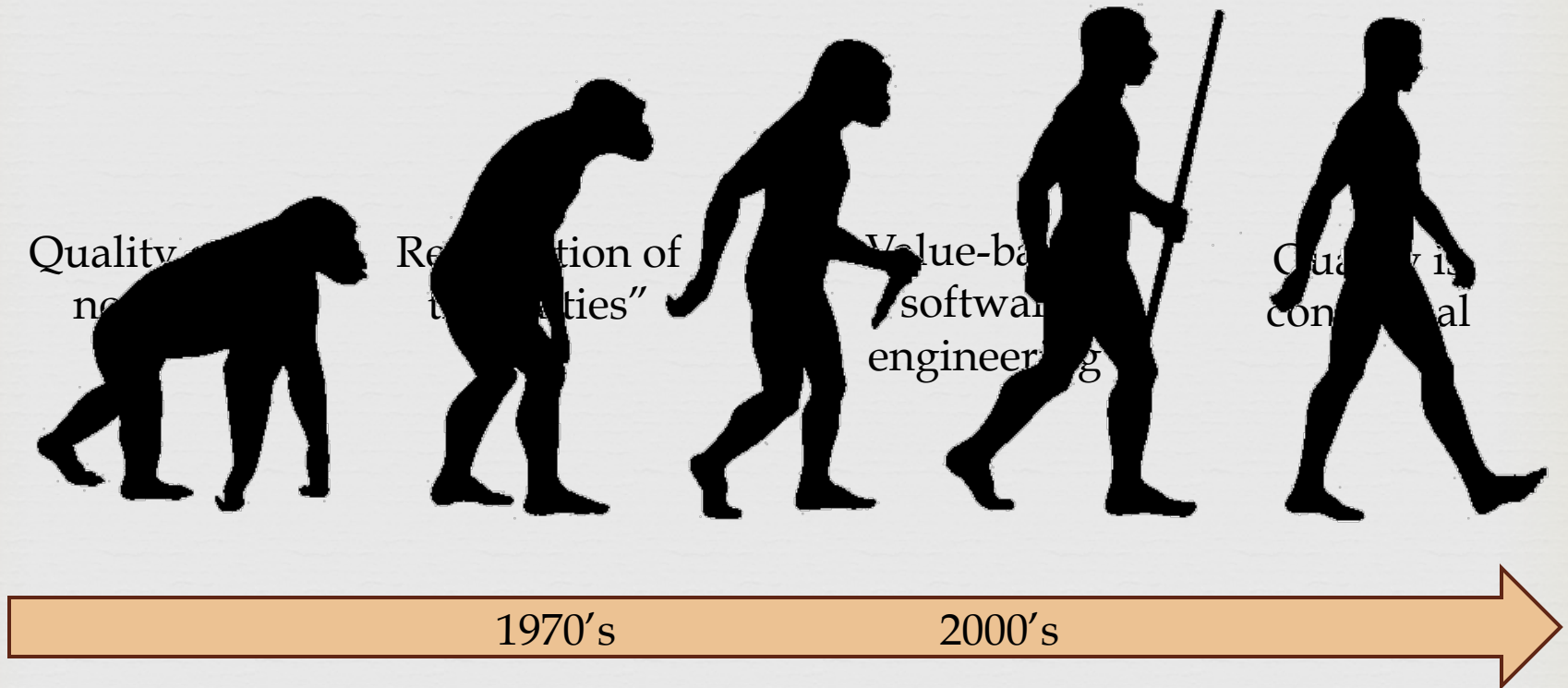
- ❧ A plethora of tools available
- ❧ Easy to use
- ❧ Some cases in which program analysis is integrated into the build process
 - ❧ Even quantitative thresholds for an acceptable number of “issues”
- ❧ Generate mountains of information
- ❧ **Bottom line:** the challenge is to make sense of the analysis results – what’s important?

Program Analysis and Technical Debt



- ❧ Like software metrics, the relationship between program analysis and Technical Debt is complex
- ❧ Anomaly detection through program analysis (e.g. code smells, ASA “warnings”, etc.)
 - ❧ Not clear what anomalies constitute debt
 - ❧ Tools don’t usually convey information about the value or importance of the anomaly
- ❧ Program analysis provides the building blocks for techniques that look at higher-level (e.g. architectural) issues
- ❧ **Bottom line:** Modern program analysis techniques provide tools only facilitate identification of debt, they need more support to identify and evaluate instances of “real” debt

The Evolution of Software Quality



Current State of Software Quality

- ❧ Organizations still struggle to define quality in a meaningful way
- ❧ Maturity of understanding of quality varies
- ❧ Organizations who manage quality successfully have tied their quality indicators to business goals and desired outcomes
- ❧ **Bottom line:** Quality management is goal-driven

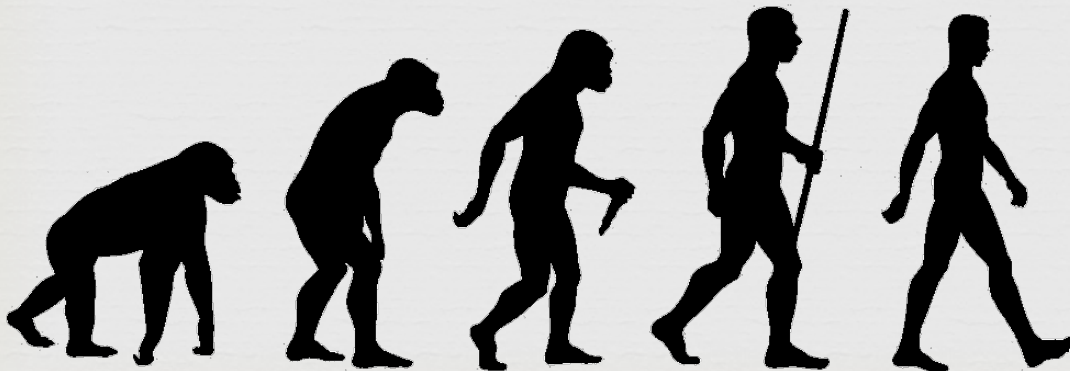
Software Quality and Technical Debt

- ❧ Technical Debt is primarily concerned with the maintainability aspect of quality
- ❧ But most other “ilities” feed into maintainability
- ❧ The debt-related concepts of principal and interest are directly tied to the idea of value
 - ❧ The idea that quality contributes to value, not just function
- ❧ **Bottom line:** We now understand that quality means different things in different times and places, and it is this understanding that is crucial for the study of Technical Debt

Persistent Problems in Empirical Software Engineering



Technology
Transfer



Evolution of the
Discipline

Technology Transfer



- ❧ Too few empirical software engineering researchers get to see their ideas put into practice
- ❧ Our research too often does not start from a real problem or a real context
- ❧ Our research too often is described in terms that are not relevant for practitioners
- ❧ We're not good salespeople
- ❧ Requirements of publication and practice are not always in harmony

Technology Transfer and Technical Debt



- ❧ The Technical Debt metaphor
 - ❧ Gives us a vocabulary that both researchers and practitioners understand
 - ❧ Is a problem that practitioners care about
 - ❧ Forces researchers to view the problem from a practice point of view
- ❧ Applying Technical Debt research in practice starts with identifying the project's sources of “pain”
- ❧ Thus, research in this area by necessity is grounded in practice

Evolution of the Discipline

- ❧ Software engineering research has long suffered from an inability to build on previous results
- ❧ Too often suffers from a lack of grounding in prior literature
- ❧ Previous slides show successes in individual areas
- ❧ But we need to get better at
 - ❧ applying findings in one area to solve problems in another
 - ❧ combining diverse solutions to address a multi-faceted problem
 - ❧ see the relationships between different areas

Evolution of SWE and Technical Debt

- ❧ Technical Debt is a multi-faceted problem
- ❧ Addressing it effectively in practice relies on solutions from:
 - ❧ Software evolution
 - ❧ Risk Management
 - ❧ Qualitative assessment of context
 - ❧ Software metrics
 - ❧ Program analysis
 - ❧ Software quality
- ❧ Here's our chance to appreciate and use results from outside our own corners of the field

Recap



❧ Technical Debt

- ❧ Is a metaphor that describes a real problem in software engineering practice
- ❧ Requires solutions from a variety of different areas in empirical software engineering that have evolved over the last few decades
- ❧ Requires solutions that are only now possible because of the level of evolution of these contributing areas
- ❧ Provides the potential for addressing some long-term problems in the empirical software engineering research community

Call to Action



- ❧ Do more research on Technical Debt, **BUT**
 - ❧ Don't lose the industry focus
 - ❧ Keep talking to practitioners
 - ❧ Learn the vocabulary
 - ❧ Listen to where the pain is
 - ❧ Don't reinvent the wheel
 - ❧ Read the literature
 - ❧ Adapt solutions
 - ❧ Collaborate

“Watershed”?



“It is only a little hyperbolic to call this a watershed moment for empirical [software engineering] study, where many areas of progress are coming to a head at the same time.”

- ❧ Are we at a historical moment in empirical software engineering research?
- ❧ Will everything be fundamentally different from now on?
- ❧ We have the right problem, we have a history of research providing at least the beginnings of the right solutions.
- ❧ It could be....

Thank you!



Questions?

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