Photo credit: Dave DiCello

17-803 Empirical Methods

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# Mixed Methods Research

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All methods have limitations. The strengths of one method can compensate the weaknesses of other methods.

# What Do We Mean by "Mixed Methods"?

▸ Studies that use two or more approaches to data collection or analysis to corroborate, complement and expand research findings (multi-methodology) or combine and integrate inductive research with deductive research (mixed methods), often but not necessarily relying on qualitative and/or quantitative data.

https://github.com/margaretstorey/mixed-methods/blob/main/mixed-methods.md

# Three familiar strategies

# Sequential Explanatory Strategy

QUANT ⟶ qual

▸ Collection and analysis of quantitative data <u>followed by</u> collection and analysis of qualitative data.

▸ Why?

   ▸ Use qualitative results to assist in explaining and interpreting the findings of a quantitative study.

QUANT
*Data
collection* ⟶ QUANT
*Data
analysis* ⟶ qual
*Data
collection* ⟶ qual
*Data
analysis* ⟶ Interpretation
of entire
analysis

# Sequential Exploratory Strategy

‣ Collection and analysis of qualitative data followed by collection and analysis of quantitative data.

‣ Why?

  ‣ Use quantitative data and results to assist in the interpretation of qualitative findings.

  ‣ Or, test elements of an emerging theory resulting from a qualitative study.

QUAL
*Data collection*  →  QUAL
*Data analysis*  →  quant
*Data collection*  →  quant
*Data analysis*  →  Interpretation of entire analysis

# Concurrent Triangulation Strategy

▸ Uses different methods concurrently, in an attempt to confirm, cross-validate, or corroborate findings.
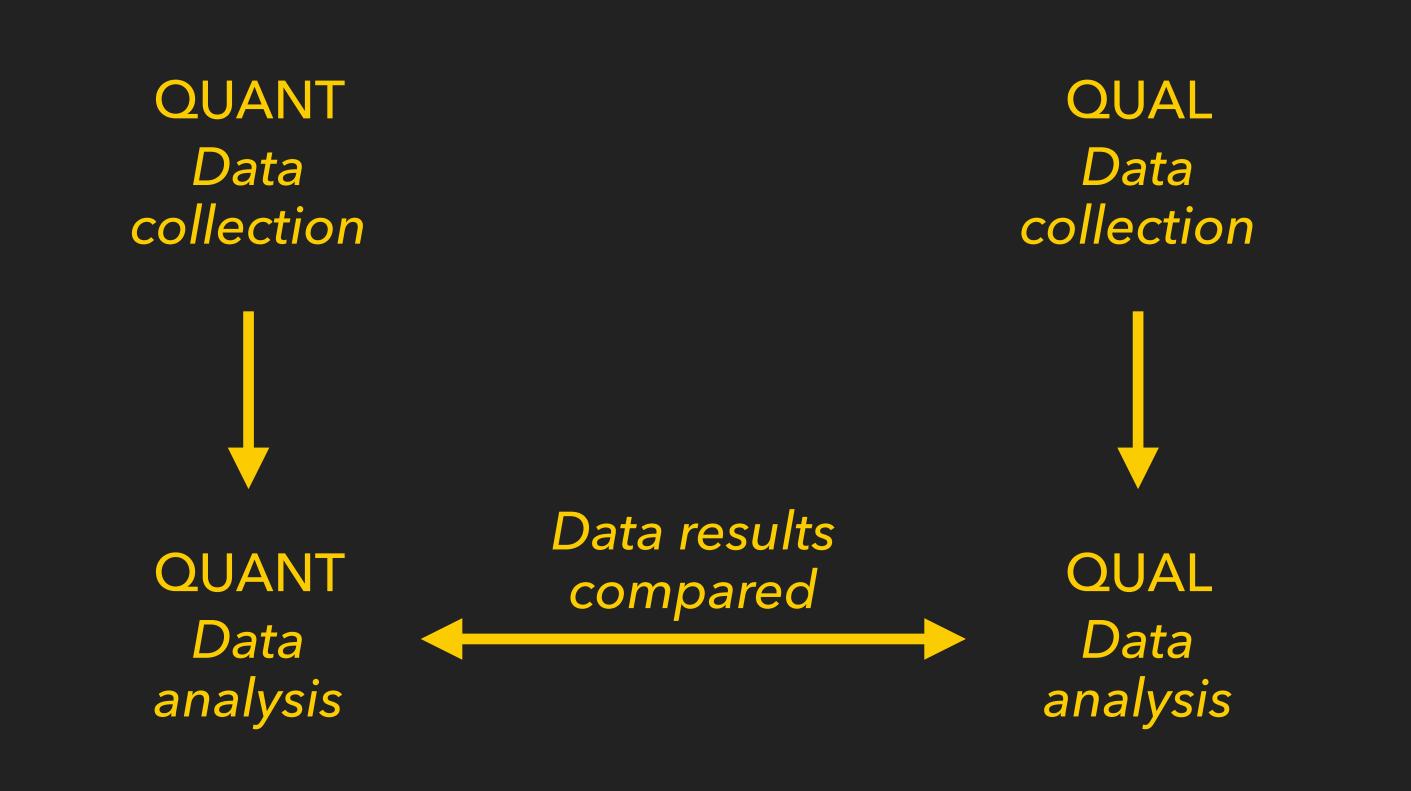
▸ Why?

  ▸ "What people say" could be different than "what people do."
  ▸ Collecting data from multiple sources helps improve validity.
  ▸ By collecting qualitative and quantitative data simultaneously, each analysis can be adapted to explore emerging results from the other.

# Concurrent Triangulation Strategy

▶ Uses different methods concurrently, in an attempt to confirm, cross-validate, or corroborate findings.

QUANT
*Data collection*

QUAL
*Data collection*

QUANT
*Data analysis*

*Data results compared*

QUAL
*Data analysis*

# How I See You Projects

## Seq exploratory (qual -> quant)

- Maddy, Ecological restoration (interviews + social network analysis)
- Courtney, OSS dependencies (interviews + survey as validation)
- Paulo, ROS documentation (interviews + mining)
- Kush & Nikitha, Testing (survey needs + tool)

## Seq explanatory (quant -> qual)

- Ian, Rust packages (repo mining + interviews)
- Elijah, Gender in code (mining + qual analysis)
- Ao + Manisha, Bots (mining, qual analysis)
- Daniel, Breaking changes (mining, qual analysis)
- Chenyang, ML training (benchmark eval + user study)
- Vasu, Dependency manager (benchmark eval + user study)

## Concurrent triang. (quant + qual)

- Sam + Matt, Auto test generation with oracle
- Eli, Group biases?
- Jenny, Copilot with specify API prompts
- Charity, Taiwan (correlation + qual analysis of tweets)
- ?

# SIGSOFT standards project (draft)

https://github.com/margaretstorey/mixed-methods

# Essential

▸ **justifies** using multiple methodologies and/or methods

▸ provides a **purpose statement** that conveys the overarching multi or mixed method design intent (why)

▸ describes the **multi-methodology, multi-method** or **mixed method** design (what)

▸ describes **which phases** of the research study the different methods or methodologies are used in (when)

▸ describes how the design **aligns with the research question** or objective

▸ **integrates the findings** from all methods to address the research question/ objective

▸ acknowledges the **limitations** associated with integrating findings (e.g., samples that are drawn from different populations may introduce limitations when the findings are integrated)

# Desirable

▸ **defines** the multi-methodology or mixed method design used

▸ describes and justifies **sample reuse** (or no reuse, or partial reuse) across methods

▸ illustrates the research design using a **visual model** (diagram)

▸ indicates the use of multiple methods or mixed method design in the **title**

▸ (for mixed-methods) includes, in the **literature review**, a mixture of quantitative, qualitative, and mixed methods related work

▸ **distinguishes the additional value** from using a multi-methodology or mixed method design in terms of corroboration, complementarity, and expansion (breadth and depth)

# Desirable

▸ discusses **discrepancies and incongruent findings** from the use of multiple methods

▸ describes the main **philosophical, epistemological, and/or theoretical foundations** that the authors use and relate those to the planned use of multi or mixed methods in the study

▸ describes the **challenges** faced in the design and how those were or could be mitigated

▸ describes how the methods and their findings relate to one or more **theories or theoretical frameworks**

▸ describes **ethical issues** that may have been presented through the blend of multi- or mixed methods

# Antipatterns

‣ **Uninvited guest**: A research method is not clearly introduced in the paper introduction/methodology and makes an unexpected entrance in the discussion or limitations sections of the paper

‣ **Smoke and mirrors**: Overselling a study as a multi-methodology or mixed method design when one approach at best offers a token or anecdotal contribution to the research motivation or findings

‣ **Selling your soul**: Employing an additional method to appeal to a methodological purist during the review process that does not contribute substantively to the research findings

‣ **Integration failure**: Poor integration of findings from all methods used

# Antipatterns

▸ **Limitation shirker**: Failure to discuss limitations from all methods used or from their integration

▸ **Missing the mark**: Misalignment of multi- or mixed method design with the research question/objective

▸ **Cargo cult research**: Using methods where the research team lacks expertise in those methods, but hopes they work

▸ **Design by committee**: Failure to agree on a crisp research question/objective (may be induced by different epistemological perspectives or use of heterogeneous methods)

# Antipatterns

‣ **Golden hammer**: relying on superficial, typically quantitative analysis of rich qualitative data

‣ **Sample contamination**: a mixed method sequential design where the same participants are used in multiple, sequential methods without accounting for potential contamination from earlier method(s) to later ones.

‣ **Ignoring the writing on the wall**: In a mixed method sequential design, failing to use findings from an earlier study when forming an instrument for a study in a later phase of the research

# Invalid Criticisms

▸ The method(ologie)s **do not contribute equally** (a non-equal design) or the minor method is limited (e.g. few participants).

▸ The mixed- or multi-method approach **isn't necessary** (when it is beneficial)

▸ The method(ologie)s have **different philosophical foundations** or are otherwise incompatible

▸ In an unequal design, the **wrong method is dominant** (this is a study design choice not a flaw)

▸ The method(ologie)s have **inconsistent findings**

# Remember the Final Report?

▸ https://docs.google.com/document/d/1NC9oxJcG6-50yi3ILLIogRrJMupyFLvFNTfThO7JAv4/edit

The **final deliverable**, due at the end of the semester, is a **report** that looks like a mature research proposal / emerging results research paper. That is, the write-up has an abstract, an introduction, a background/theory section if applicable, a thorough literature review identifying an important knowledge gap, clear motivation for the research questions and/or hypotheses, a detailed description of the overall study design (which methods are used for which parts, how they are mixed, etc), a detailed description of individual research methods (e.g., for a quantitative analysis, what data will be collected, how it will be preprocessed and aggregated, how it will be analyzed, etc), a summary and discussion of the preliminary results, and a discussion of future work remaining (e.g., maybe you've already conducted and analyzed some small-scale interviews, so you present the emerging themes from that analysis; you've also designed a survey instrument to test some of the interview findings on a larger scale, but you didn't deploy that survey yet).

# Examples

# Greiler et al, 2012: Interviews -> Survey

## Greiler, M., Van Deursen, A., & Storey, M. A. (2012, June). Test Confessions: a Study of Testing Practices for Plug-in Systems. In 2012 34th International Conference on Software Engineering (ICSE) (Pp. 244-254). IEEE.

▸ "In practice, the systems assembled from plug-ins are widely used, achieving levels of reliability that permit successful adoption."

   ▸ How do they do it?

▸ Exploratory study:

   ▸ "instead of starting out with preset hypotheses on how testing is or should be done, we aimed to discover how testing is actually performed, why testing is performed in a certain way, and what test-related problems the community is facing."

   ▸ "Therefore, we used grounded theory to conduct and analyze open interviews (lasting 1-2 hours) with 25 senior practitioners and thought leaders from the Eclipse community regarding their test practices."

# Greiler, M., Van Deursen, A., & Storey, M. A. (2012, June). Test Confessions: a Study of Testing Practices for Plug-in Systems. In 2012 34th International Conference on Software Engineering (ICSE) (Pp. 244–254). IEEE.

▸ "Our results show …

▸ "Based on our results, we identified barriers which hinder integration testing practices for plug-in systems …

▸ "We challenged our outcomes through a separate structured survey, in which 151 professionals expressed their (dis)agreement with specific outcomes of our study.

▸ "We used the findings to propose a series of recommendations (at the technical as well as the organizational level) to improve plug-in testing, community involvement, and the transfer of research results in the area of integration testing.

# Mamykina et al, 2011:
# Statistical data analysis -> Interviews

# Mamykina, L., Manoim, B., Mittal, M., Hripcsak, G., & Hartmann, B. (2011). Design Lessons From the Fastest Q&a Site in the West. In Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (Pp. 2857–2866). ACM.

▸ RQ: Why is Stack Overflow successful?

▸ "We first conducted a statistical data analysis of the entire SO corpus to understand usage patterns. We investigated answer time, user types, suitability for different question types, and possible extensions of the SO model to other domains.

▸ "To ground this aggregate view in concrete user experiences, we also conducted a qualitative interview study with users and the design team.

# Mamykina, L., Manoim, B., Mittal, M., Hripcsak, G., & Hartmann, B. (2011). Design Lessons From the Fastest Q&a Site in the West. In Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (Pp. 2857–2866). ACM.

▸ How well does Stack Overflow perform? (Quant)

   ▸ Hundreds of Thousands, but not Millions of Users

   ▸ 92.6% of Questions are Answered; Most Multiple Times

   ▸ Answers are Fast: First Answers in 11 Minutes, Accepted Answers in 21 Minutes (Medians)

   ▸ Most Answer Activity Takes Place in the First Hours

   ▸ …

## Mamykina, L., Manoim, B., Mittal, M., Hripcsak, G., & Hartmann, B. (2011). Design Lessons From the Fastest Q&a Site in the West. In Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (Pp. 2857–2866). ACM.

▸ "In the previous section we discussed the patterns of questions and answers that emerged on SO over time. This analysis showed SO to be largely successful in accomplishing its primary goal: giving software developers fast, informative answers to their questions. To better understand the driving factors behind these patterns we conducted a qualitative study of the community…

  ▸ Improving on Forums through Productive Competition

  ▸ Credibility in the Community

  ▸ Evolutionary Approach to Design

# Watt et al, 2015:
# Survey + Interviews

## Watt, M. H., Myers, B., Towe, S. L., & Meade, C. S. (2015). The Mental Health Experiences and Needs of Methamphetamine Users in Cape Town: a Mixed–Methods Study. South African Medical Journal, 105(8), 685–688.

▸ "Despite the potential impact of untreated mental disorders on treatment seeking and outcomes, there has been little research on how methamphetamine users experience symptoms of psychological distress.

▸ "The results presented here come from a mixed-methods study that included a cross-sectional survey of 360 current methamphetamine users and in-depth interviews (IDIs) with a subset of 30 participants. Data collection was completed between May and October 2013 in Delft, a township on the Cape Flats, Western Cape.

## Watt, M. H., Myers, B., Towe, S. L., & Meade, C. S. (2015). The Mental Health Experiences and Needs of Methamphetamine Users in Cape Town: a Mixed-Methods Study. South African Medical Journal, 105(8), 685-688.

▸ "Analysis was conducted using a concurrent triangulation strategy, whereby qualitative and quantitative data contributed equally to the analysis and were used for cross-validation.

▸ "For the quantitative analysis, descriptive statistics were used to characterise the mental health symptoms, needs and treatment-seeking behaviour of the sample.

▸ "For the qualitative analysis, audio recordings of the interviews were transcribed and translated into English. Narrative memos were written to organise the content of the transcripts, make connections across the transcript content, and begin to achieve meaningful insights into the data.

▸ "The quantitative and qualitative data were then combined to provide a full picture of the mental health experiences and needs of the population.

# Credits

▸ Graphics: Dave DiCello photography (cover)

▸ Margaret-Anne Storey (University of Victoria). Multi-Methodology and Mixed Methods Research. Supplement to the SIGSOFT Standards. https://github.com/margaretstorey/mixed-methods

▸ Creswell, John W., V. L. Plano Clark, Michelle L. Gutmann, and William E. Hanson. "An expanded typology for classifying mixed methods research into designs." A. Tashakkori y C. Teddlie, Handbook of mixed methods in social and behavioral research (2003): 209-240.

▸ Easterbrook, Steve, Janice Singer, Margaret-Anne Storey, and Daniela Damian. "Selecting empirical methods for software engineering research." In Guide to advanced empirical software engineering, pp. 285-311. Springer, London, 2008.

▸ Johnson, R. & Onwuegbuzie, Anthony & Turner, Lisa. (2007). Toward a Definition of Mixed Methods Research. Journal of Mixed Methods Research, 1, 112-133. Journal of Mixed Methods Research. 1. 112 -133. 10.1177/1558689806298224.

▸ Venkatesh, V., Brown, S. A., & Bala, H. (2013). Bridging the qualitative-quantitative divide: Guidelines for conducting mixed methods research in information systems. MIS Quarterly, 21-54.