

Tools and Tips for Statistical Research

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- How do we start? (Where do we get the ideas?)
- How do I find what has already been done?
- How do I show that my new method works or that it is better than existing methods?
- What are the available tools?

What is research?



- **OECD (2015)**

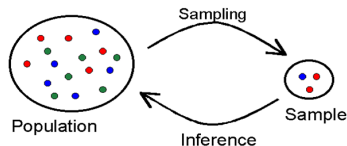
Research comprises "**creative and systematic work** undertaken **to increase the stock of knowledge**, including knowledge of humans, culture and society, and the use of this stock of knowledge to devise new applications."

- **Merriam-Webster**

Research is "investigation or experimentation aimed at

- ① the discovery and interpretation of facts,
- ② revision of accepted theories or laws in the light of new facts, or
- ③ practical application of such new or revised theories or laws."

Topics in Statistical Research



- Estimation
- Inference
- Sampling

- Computation
 - Visualization
 - Optimization
- Application (New Discovery)

ASA Sections and Interest Groups:

<https://www.amstat.org/asa/membership/Sections-and-Interest-Groups.aspx>

JSM 2018 Program Booklet:

<http://ww2.amstat.org/meetings/jsm/2018/pdfs/JSM2018-SessionBooklet.pdf>

Outline of A Paper

- 1 Abstract
- 2 Introduction
 - Motivation/Contribution: *Where do we get an idea?*
 - Literature Review: *How do I find what has already been done?*
- 3 Methodology
- 4 Simulation: *How does a method perform?*
- 5 Real data analysis
- 6 Results/Conclusion/Discussion

Where do we get an idea?

Anywhere!

- Dropping off kids at childcare center



Emmanuel Candès
Stanford University



Terrance Tao
UCLA

- Talking to strangers at a bar



Amy Willis
University of Washington

Where do we get an idea?

- From a professor
- From a class
- Reading paper
- Colloquium/Conference talks
- Networking events in conferences

- Subscribe to the E-Mail Alerting Service of **Arxiv**:
<https://arxiv.org/help/subscribe>



Literature Review

- Build background knowledge
- Understand what's been done and what hasn't been done
- Obtain motivation/contribution of the method we propose
- Can develop/improve method from literature

How do I find what has already been done?

When we are new to a field:

- Find a textbook
- Find a review paper
- Follow the citations

Resources:

- Google Scholar: <https://scholar.google.com/>
- WMU library: <https://wmich.edu/library>

Reference management tools:

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

Zotero vs Mendeley

	Zotero	Mendeley
OS compatibility	Windows/Mac/Linux	Windows/Mac/Linux
Web plug-in	Chrome, Firefox, Safari	Chrome, Firefox, Safari, Internet Explorer
Cloud Sync	Yes	Yes
Storage	<ul style="list-style-type: none">● Free for 300MB● \$20/year for 2GB● \$60/year for 6GB● \$120/year for Unlimited	<ul style="list-style-type: none">● 2GB Free● \$55/year for 5 GB● \$110/year for 10 GB● \$165/year for Unlimited

After literature review, now what?

- Develop the methodology.
(Model, Theorems, Computation, ... etc.)
- Check if the method works as expected.
- Compare with other methods from the literature review.
⇒ Simulation
- Apply the method to real data.
- Summarize results.
- Re-emphasize the contribution and state the limitation of the method.
- Provide possible future research topics.

- Simulation is often used to assess the performance of a proposed model.
- We generate data under controlled settings (under known truth) and see how the model performs under such settings.
- We can check whether the model performs as expected.
- Simulation will also give us some insights to how the model will perform for real data.
- We can compare different models using simulation, and show the proposed method is better performing than the methods from literature.

- Showing convergence of an estimator:

For simple linear regression $y = \beta_0 + \beta_1 x + \epsilon$,

$$\|\hat{\beta}_1 - \beta_1\|^2 = O_p(n^{-1}).$$

- Comparing two tests (Check type I error and power):
t test vs. Wilcoxon signed-rank test

A few more resources

- Overleaf (Online LaTeX Editor): <https://www.overleaf.com/>
- Evernote (Note taking app): <https://evernote.com/>



drawn by Frits Ahlefeldt

Thank you

