Lecture 1:
Transitioning from coursework to research

Jonathan P Williams

North Carolina State University

Fall 2024

Transitioning from coursework to research

After passing the qualifying exam:

  - $\rightarrow$ Developing your dissertation research is the most important aspect of your graduate studies

  - $\rightarrow$ Insofar as receiving passing grades, courses are no longer the highest priority

  - $\rightarrow$ Future employers will evaluate you based on the quality of your dissertation research

Note:

  While many people with a PhD degree in statistics are choosing to work in industry, the purpose of a PhD degree in statistics is to train you as a researcher

  A PhD is *not* a professional degree (e.g., Medical Doctor)

Transitioning from coursework to research

Timeline of next steps:

1. Narrow down your areas/types of potential research interest
   $\rightarrow$ Will overview areas later

2. Find 1-2 PhD advisors
   $\rightarrow$ Begin working on a first project
   $\rightarrow$ Might spend 6-12 months on background reading

3. Schedule written preliminary exam
   $\rightarrow$ Within $\approx$ 18 months of beginning research
   $\rightarrow$ Assemble your PhD committee
   $\rightarrow$ $\approx$ 5 faculty members, mostly from your department
   $\rightarrow$ Your advisor(s) are your PhD committee chair(s)

Transitioning from coursework to research

Timeline of next steps (continued):

4. Complete $\approx 75\%$ of dissertation research
   - $\rightarrow$ Schedule oral preliminary exam with committee
   - $\rightarrow$ Present what you have already accomplished
   - $\rightarrow$ Propose what the remaining 25% will look like

5. Complete $\approx 99\%$ of dissertation research
   - $\rightarrow$ Schedule oral final defense with committee
   - $\rightarrow$ Present your dissertation work
   - $\rightarrow$ Argue it is substantial enough to earn your PhD degree

6. Submit your dissertation manuscript to the university
   - $\rightarrow$ Ask senior students for the university-compliant .tex file

Transitioning from coursework to research

Types of statistics research:

- $\rightarrow$ Theoretical or mathematical statistics
- $\rightarrow$ Machine learning or statistical learning
- $\rightarrow$ Statistics methodology
- $\rightarrow$ Applied statistics
- $\rightarrow$ Computational statistics
- $\rightarrow$ Statistical software

Note:

This list does not include statistical applications or collaborative research published in domain science journals

Transitioning from coursework to research

Theoretical or mathematical statistics:

$\rightarrow$ Investigations of theoretical or mathematical properties of estimators or computational tools

$\rightarrow$ Formulations/justifications for a paradigm of statistical inference. E.g., frequentist, Bayesian, fiducial

$\rightarrow$ etc.

$\rightarrow$ No immediate applications necessary

Top journals include:

Annals of Statistics (AoS)
Bernoulli

Transitioning from coursework to research

Machine learning or statistical learning:

$\rightarrow$ Use data to train algorithms to perform tasks

$\rightarrow$ Particular emphasis on prediction problems/tasks

$\rightarrow$ Algorithm development

$\rightarrow$ Theoretical and empirical performance metrics/evalaution

$\rightarrow$ Unsupervised learning

Top journals include:

Journal of Machine Learning Research (JMLR)
Many prestigious conference proceedings (e.g., NeurIPS, ICML)

Transitioning from coursework to research

Statistics methodology (most common type):

$\rightarrow$ Propose a new estimator/approach for making inference on population quantity of interest

$\rightarrow$ Simulation study to investigate empirical properties of the proposed method

$\rightarrow$ Formulate and prove theorems to guarantee consistency or other optimality properties of the proposed method, under certain assumptions

$\rightarrow$ "Real data" implementations and proof of concept

Top journals include:

Journal of the Royal Statistical Society: Series B (JRSS B)
Journal of the American Stat Assoc: Theory and Methods
Biometrika

Transitioning from coursework to research

Applied statistics:

$\rightarrow$ Method development/evaluation motivated by a real data set and/or questions of interest with considerable practical relevance in some application

$\rightarrow$ Not necessarily methodologically novel

$\rightarrow$ Illustration of important aspects of existing methods

$\rightarrow$ Important case studies or comparisons

Top journals include:

Journal of the American Stat Assoc: Appl and Case Studies
Annals of Applied Statistics (AoAS)
Journal of the Royal Statistical Society: Series C (JRSS C)

Transitioning from coursework to research

Computational statistics:

$\rightarrow$ Algorithms for implementation of estimation routines

$\rightarrow$ Issues relating to computational efficiency versus statistical efficiency

$\rightarrow$ Theoretical properties of algorithmic convergence

Top journals include:

Journal of Computational and Graphical Statistics (JCGS)

Transitioning from coursework to research

Statistical software:

    $\rightarrow$ R package development

    $\rightarrow$ Open-source statistical software development, more generally

    $\rightarrow$ Demonstration/comparison of existing software

Top journals include:

  Journal of Statistical Software

Transitioning from coursework to research

Areas of statistics research:

. . . very many.

Here are the "major areas" of research in our department:

`https://statistics.sciences.ncsu.edu/research/`
`research-areas/`

Transitioning from coursework to research

Things to consider in choosing an advisor:

- $\rightarrow$ Type/area of research focus
  - $\rightarrow$ But be careful not to overemphasize this one...

- $\rightarrow$ Personal compatibility
  - $\rightarrow$ It is difficult to work with someone that you find difficult to interact with
  - $\rightarrow$ You'll meet $\approx$ weekly for the next 4 years
  - $\rightarrow$ You'll eventually need a strong letter of recommendation from them; so it's important they like you, as well

Transitioning from coursework to research

Things to consider in choosing an advisor (continued):

$\rightarrow$ Their work ethic and intensity of expectations
  $\rightarrow$ If you only want to work 30-40 hours per week, then you're never going to impress your advisor if she/he works around the clock
  $\rightarrow$ Look for an advisor with a likeminded attitude about work–life balance

$\rightarrow$ Feedback from current advisees
  $\rightarrow$ So long as $n > 1$, this is perhaps the best calibrated source of information for a glimpse into what your experience with a potential advisor might be like

Transitioning from coursework to research

Things to consider in choosing an advisor (continued):

→ Advisor's network
  → Do their students tend to get jobs in careers you are aiming for?
  → Some faculty send almost all students to industry
  → Some have better connections in academia or industry

→ Resources available from the potential advisor
  → Can they fund you as an RA?
  → Do they have funds for you to travel to present your research? (it's embarrassing that our department will only give you 700 USD to pay for 1 trip/year)
  → Do they work with collaborators in domain sciences of interest to you?

Transitioning from coursework to research

Things to consider in choosing an advisor (continued):

$\rightarrow$ Amount of interaction you need
  - $\rightarrow$ Some advisors meet with each student for 30 min/week
  - $\rightarrow$ Some advisors are willing to meet 4–5 hours/week
  - $\rightarrow$ In part, depends on how many other students are advised
    - $\rightarrow$ The number of students a faculty member chooses to advise in a given year gives an indication of how carefully they choose to think about research problems
    - $\rightarrow$ Also indicates how active the faculty member is

Transitioning from coursework to research

Things to consider in choosing an advisor (continued):

$\rightarrow$ You are exclusively your own best advocate for you
  $\rightarrow$ Don't expect that your advisor will make you aware of
    all that you need to be aware of
  $\rightarrow$ Don't expect your advisor to always be correct
  $\rightarrow$ Don't expect your advisor to always know best
  $\rightarrow$ But you need to be able to trust their judgement
  $\rightarrow$ Your advisor is as human as you are, proceed as such

Transitioning from coursework to research

Things to consider in choosing **to be an adult**:

- $\rightarrow$ Whatever choices you make:
    - $\rightarrow$ Sometimes you will have to work more hours in a day/week/month/year/etc. than you want to
    - $\rightarrow$ Oftentimes you will have to do work you don't want to
    - $\rightarrow$ Your work should be about more than how it benefits you; we live in a society
    - $\rightarrow$ Aiming for purpose, satisfaction, and fulfillment is more sustainable than aiming to feel happy, on any given day