# Online Supplements: A Tool for Confident Learning in Advanced Probability Theory

**BOLD FELLOWS**

**Sandya Lakkur** working with
**Dr. Robert Johnson**, Department of Biostatistics

## Course context

- **Course Title**: BIOS7361- Advanced Concepts in Probability and Real Analysis

- Required for PhD students in the biostatistics department, available to all students

- Generally small class sizes, < 6 students

- **Goal of course:** understand probability in a more formalized framework
  - E.g.- "Random variables are functions on a sample space for which inverse images of Borel sets are events" vs. "Random variables are functions mapping elements from a sample space to the real line"

- **Concepts covered**:
  - Random variables
  - Independence
  - Expectations
  - Limit theorems
  - Markov chains

## Problem to be solved

- **Problem**: course has a reputation for being difficult

- Students were invited to reflect on expectations of the course prior to taking it:
  - "I expect the material in the course will be quite difficult, based on discussion with fellow students who have taken the course."
  - "...I anticipate that the material will be reasonably difficult..."
  - "I imagine that the material will be difficult with a fair amount of work (10+ hours of homework)"
  - "I know that the material in the course won't be familiar, or come easily to me."

- **Goal:** use online supplemental material before course starts to assist with theoretical mindset transition
  - Theoretical mindset will be required throughout the course
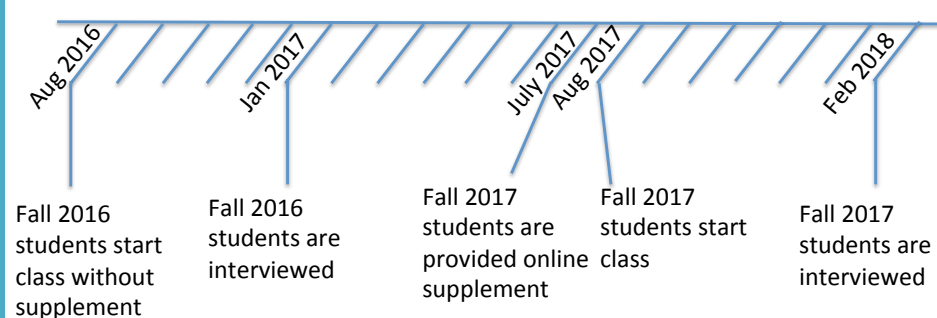
## Approach
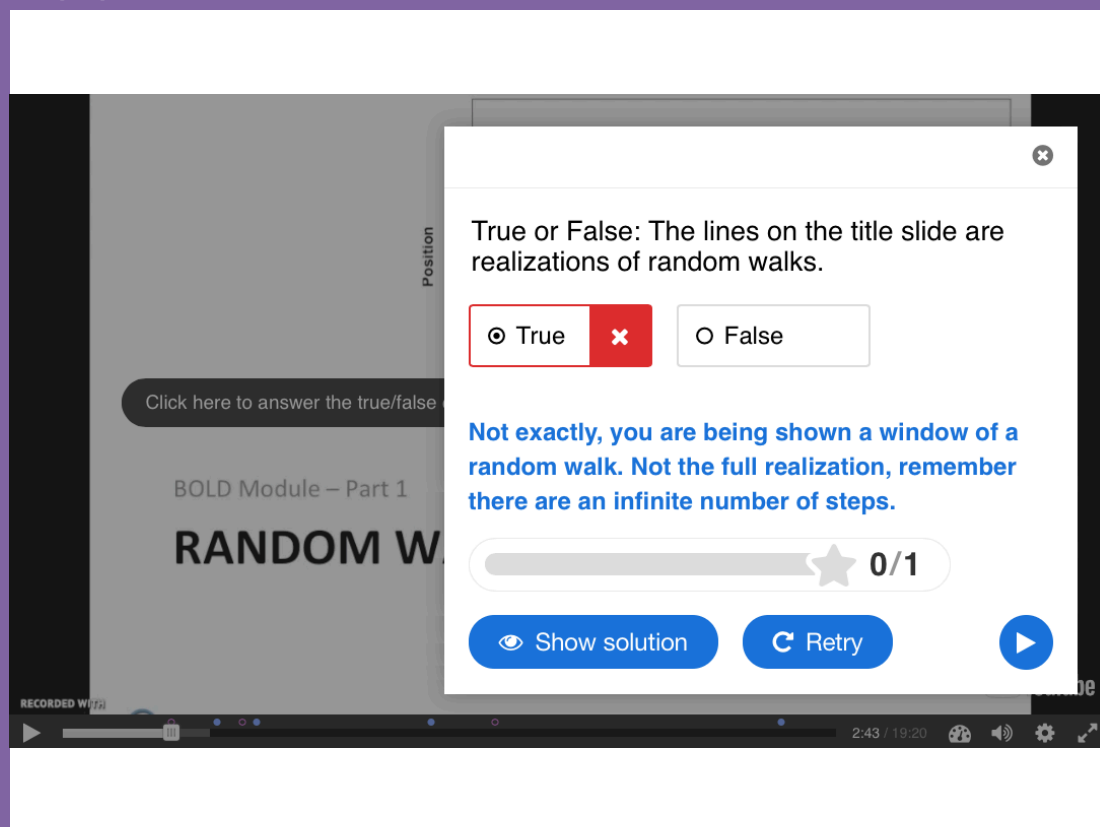


- Online supplement consists of:
  - Proof toolkit
  - Random walks section
  - Lim sup/lim inf section

- Types of resources
  - General descriptions of concepts
  - Guided practice problems
  - Video tutorials with in-video questions
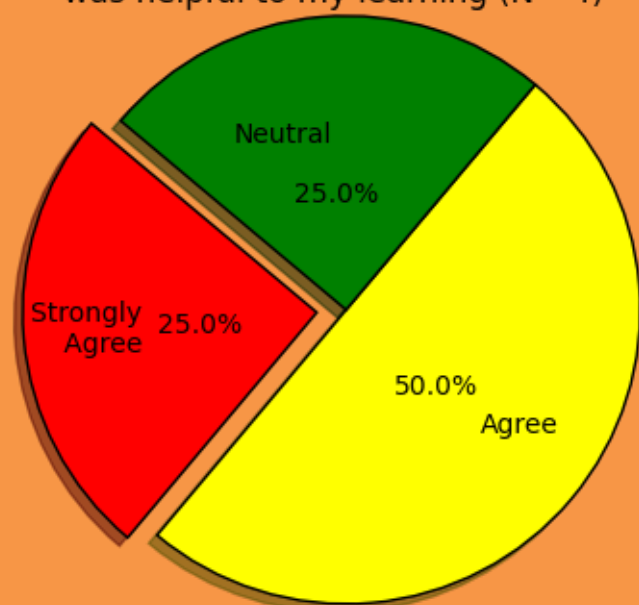  - R code illustrating examples

## Assessment



- Qualitative data
  - Transcribed interviews of Fall 2016 students (controls), and Fall 2017 students (exposure)

- Quantitative data
  - Likert-based evaluations of online supplement
  - Coding of transcribed interviews for key concepts and course reflections

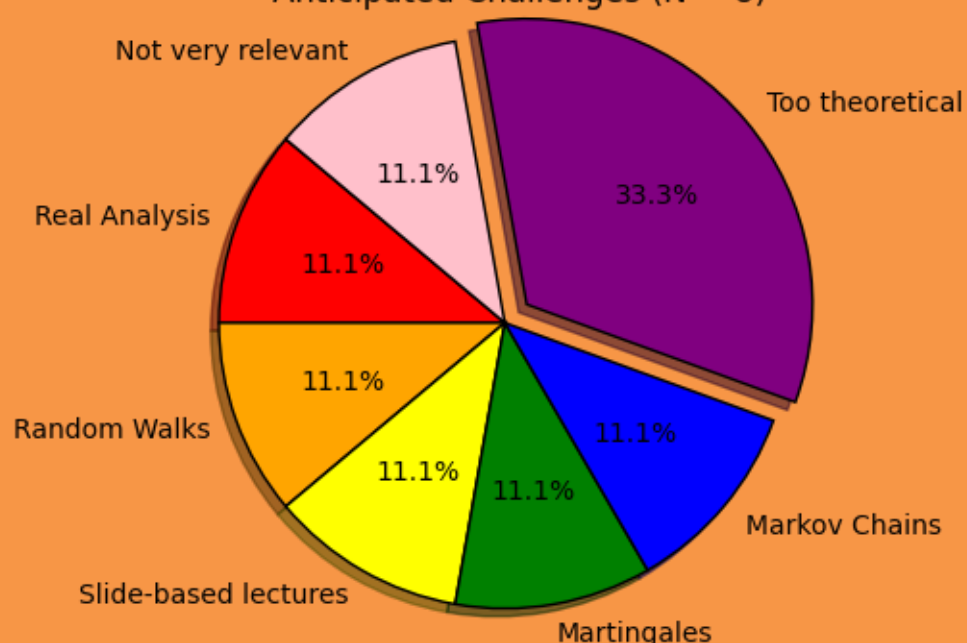- Coding scheme validated by two external coders

# Results

## The online module in general was helpful to my learning (N =4)



- Neutral 25.0%
- Strongly Agree 25.0%
- Agree 50.0%

## Anticipated Challenges (N = 8)



- Not very relevant 11.1%
- Too theoretical 33.3%
- Real Analysis 11.1%
- Random Walks 11.1%
- Slide-based lectures 11.1%
- Martingales 11.1%
- Markov Chains 11.1%

## Modifications to course (N = 8)



- Increase length of class 18.2%
- General supplementary material 18.2%
- Programming 18.2%
- Exit sessions 18.2%
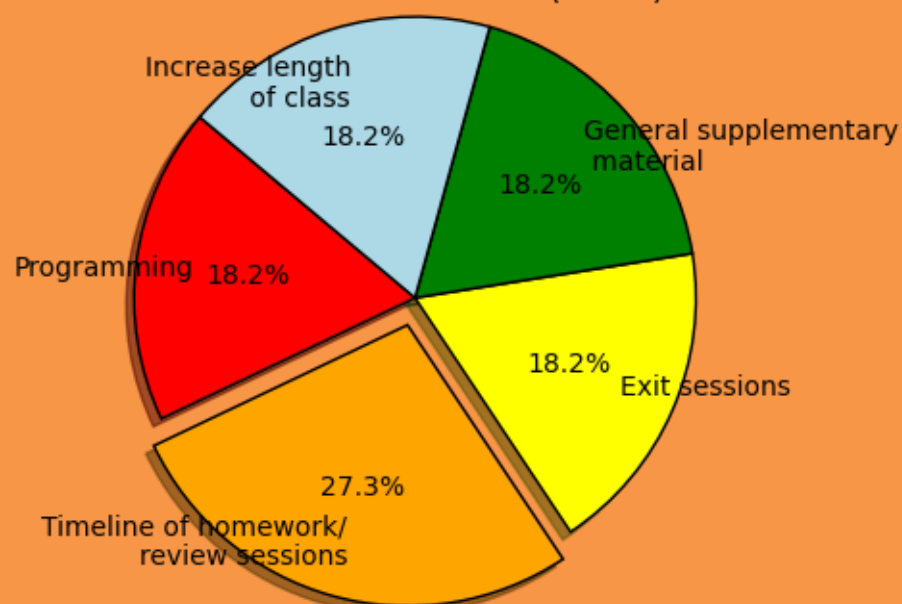- Timeline of homework/review sessions 27.3%

- None of the students felt supplementary material did not help learning

- Students used module for an average of 5.5 hours

- All students agreed the three main supplementary components (proof toolkit, random walks section, lim inf/lim sup section) were very helpful to their learning

- 3 out of 4 students agreed that the online supplement was at least moderately helpful with understanding real analysis

- All students agreed that the online supplement was at least moderately helpful with becoming more familiar with proofs

- Validation of coding scheme: there was a  TO FILL (TO FILL) agreement between two individual validators

- Course may benefit from additional supplementary material, beyond what was included in this investigation's online supplement

- Future investigations may benefit from assessments that contribute to course grade to encourage more interaction with supplement

- General consensus that course proceeds quickly, and homework deadlines should change