



The WeBWoRKiR Project

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The Problem

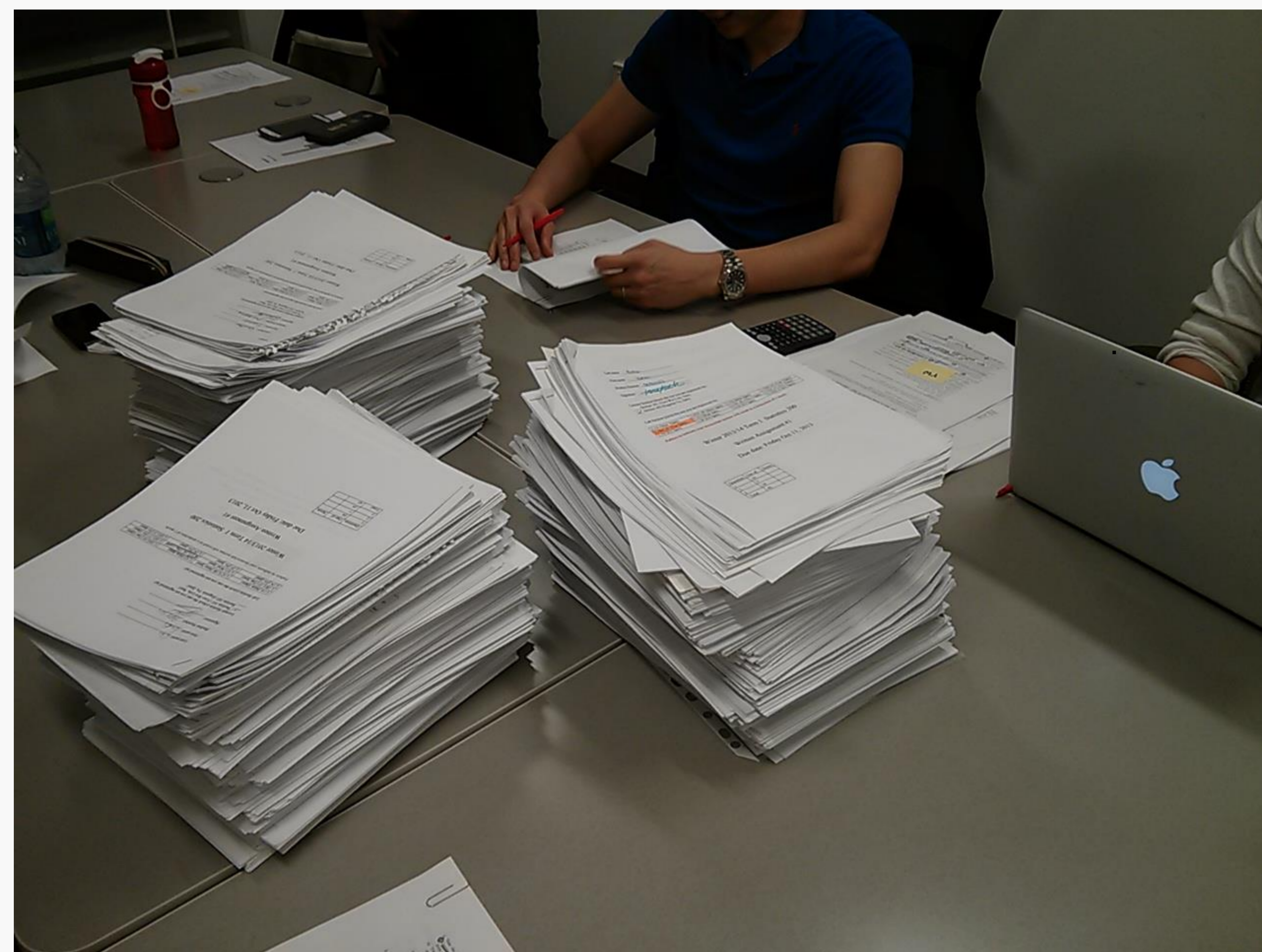
- Students require regular practice problems to apply concepts in a course. On certain STAT courses, students were requesting more regular homework assignments.
- Research suggests that only about 20% of students seriously attempt homework questions that are without credit.
- Traditional paper-based assignments require much time to grade, and feedback to students is not timely.
- All students received the same assignment, with the potential for plagiarism going undetected.
- Thousands of sheets of paper are expended on written assignments ...

Integrating R

- The R statistical software is a powerful open-source environment for statistical computing. R has been used extensively in undergraduate teaching at UBC.
- We have enhanced WeBWoRKiR to enable it to communicate with R.
- This integration allows WeBWoRKiR access to R's rich facilities for statistical data manipulation, analysis, and visualization, and hence permits the creation of probing and diverse problems in statistical science.
- Hundreds of questions have been coded in WeBWoRKiR that use R functionality.

WeBWoRKiR in Action

Questions have been created for use in STAT 200, 241/251, 300, 302, 305, 404, and SPPH 400. The screenshots that follow give an example of a question from STAT 300. As with most questions on the course, it features a case study that provides the basis for the simulated data.



Papers collected on a recent STAT 200 assignment

WeBWoRKiR

- Developed by the Mathematical Association of America, WeBWoRKiR is an open-source on-line homework system, incorporating thousands of questions in mathematics.
- WeBWoRKiR permits randomization in questions, allowing homework sets to be customized for each student.
- Grading is automated, students receive instant feedback on their answers and can be allowed multiple attempts at questions.
- Prior to our project, WeBWoRKiR contained very few questions in statistical science.
- Coded in the Perl language, WeBWoRKiR was not well suited for creating questions in probability and statistics.

WebWoRKiR : STAT300-101_2013W1 : HW03 : 2 [https://webwork.elearning.ubc.ca/webwork2/STAT300-101_2013W1/...](https://webwork.elearning.ubc.ca/webwork2/STAT300-101_2013W1/)

| Entered | Answer | Preview | Result |
|---------|--------|---------|-----------|
| 79.23 | 79.23 | | correct |
| 79.23 | 79.23 | | correct |
| 6.102 | 6.102 | | correct |
| B | B | | correct |
| 23.56 | 23.56 | | incorrect |

At least one of the answers above is NOT correct.

Students receive instant feedback on their answers.

Multiple attempts can be permitted for each question. Students are motivated to revisit incorrect responses.

WebWoRKiR : STAT300-101_2013W1 : HW03 : 2 [https://webwork.elearning.ubc.ca/webwork2/STAT300-101_2013W1/...](https://webwork.elearning.ubc.ca/webwork2/STAT300-101_2013W1/)

The Ricci v. DeStefano case in New Haven, CT (129 S. Ct. 2658, Sup. Court, 2009), involved a claim of "reverse" discrimination. Firefighters in the city took examinations to progress through the ranks. One test was for promotion to lieutenant, and at the time the city had eight such positions to fill. The city's charter required the fire department to appoint from the candidates with the best ten scores on the relevant examination. All the top ten scores were from white applicants. The district declined to certify the exam and did not promote any of the candidates, on the grounds that doing so would fail to promote sufficient visible minority candidates to an existing position.

It is of interest to investigate whether there appears to be a difference in the mean scores on the examination for the three identified racial groups: white, black, and Hispanic. Suppose the test score data were as displayed below:

| | Blacks | Hispanics | Whites |
|--------------|--------|-----------|--------|
| Sample size: | 19 | 15 | 43 |
| Mean: | 61.93 | 61.79 | 69.00 |
| S.D.: | 7.90 | 5.87 | 10.07 |

Hypothetical Lieutenant Exam Scores by Racial Group

Part a) Taking that the underlying assumptions of ANOVA hold and that the approach will be applied, what is the estimate of the common variance of the test scores for the three racial groups? (Give your answer to two decimal places.)

Part b) Complete the ANOVA table below, giving requested answers to two decimal places:

| Source of variation | df | SS | MS | F |
|---------------------|----|----------|----|------|
| Race | 2 | 966.8383 | | (ii) |
| Error | 74 | | | (i) |
| Total | 76 | | | |

Questions are devised by faculty members.

Data are generated in R and called into WeBWoRKiR. Each student has unique data.

Graphics can be created in R and imported into questions.

Students attempt questions based on their unique data set.

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Outcomes

- So far around 5500 students have used WeBWoRKiR on UBC STAT courses.
- Student feedback via mid-term surveys has been very positive:
 - on 200/241/251 around 90% either agreed or strongly agreed with the statement "The online WeBWoRKiR assignments were useful to your learning."
 - Comments include: "Good amount of questions - not too many but still reinforces learning", "Forces me to keep up with class", "I like it when I get immediate feedback on questions that require more than one part. This at least allows me to know where I went wrong in the question."
- Teaching assistants have been freed from tedious grading to work on other tasks, such as classroom support.
- Instructors report an increase in student engagement and performance.
- Other institutions are using the resources created, including Camosun College and University of Calgary.

Special Thanks

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