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# The Role of Automation in Undergraduate Computer Science Education

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# Article: The Role of Automation in Undergraduate Computer Science

- Background:
  - Grading is a very time-consuming element of teaching
  - Automated grading has advantages
    - Students can submit programs online where they are automatically graded
    - Students receive relatively fast feedback
    - Students can submit multiple times, can make corrections and, ideally, better learn concepts
- Objective: Look at effect of automatic grading on learning and other outcomes

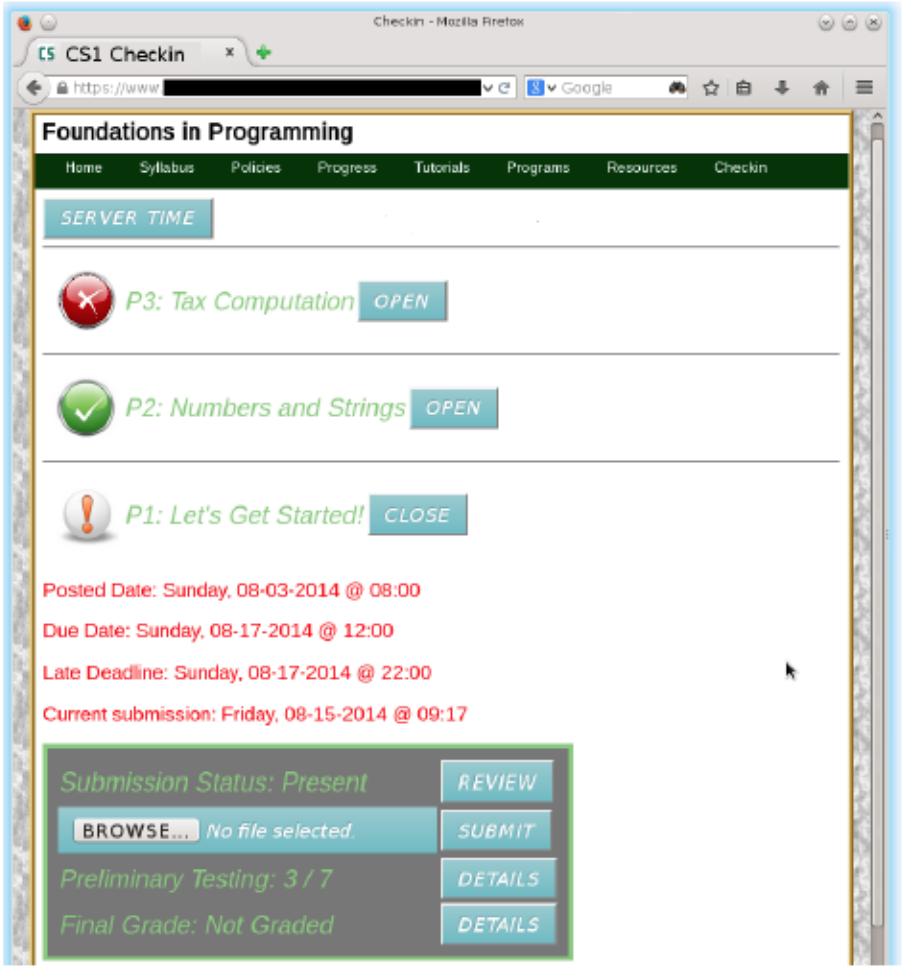


Figure 3: Automated Program Grading Interface.

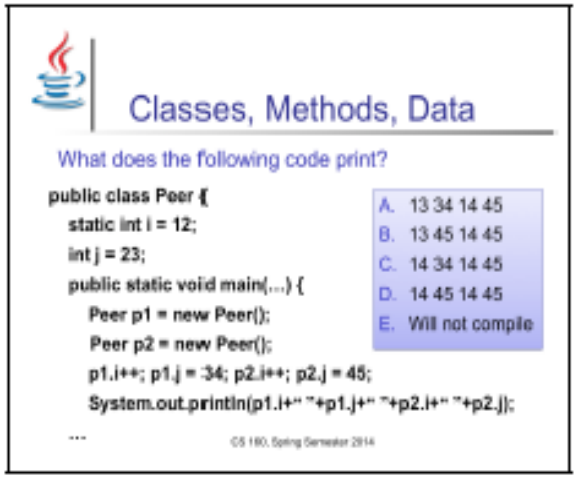


Figure 4: Peer Instruction Example Question.

| Semester | Zeros Included | Mean | Median | Sample Size | Stddev | Variance | Increase | Statistical Significance |
|---|---|---|---|---|---|---|---|---|
| Spring 2013 | Yes | 66.1 | 71.0 | 234 | 20.3 | 410.4 | +0.0% | base semester |
| Spring 2013 | No | 68.5 | 71.0 | 234 | 16.2 | 264.0 | +0.0% | base semester |
| Fall 2013 | Yes | 70.3 | 76.3 | 252 | 24.1 | 582.7 | +6.4% | $t = 2.07$<br>$p = 0.0388$ |
| Fall 2013 | No | 75.7 | 79.0 | 252 | 14.7 | 216.3 | +10.6% | $t = 5.04$<br>$p < 0.0001$ |
| Spring 2014 | Yes | 73.9 | 78.0 | 232 | 20.5 | 422.3 | +11.8% | $t = 4.11$<br>$p < 0.0001$ |
| Spring 2014 | No | 77.6 | 78.0 | 232 | 12.5 | 156.8 | +13.3% | $t = 6.63$<br>$p < 0.0001$ |

Figure 5: Analysis of Exam Scores.

# Conclusions

- Article contributions: the combined adoption of new pedagogic techniques (automated grading + peer instruction)
  - improves the average final exam scores and overall grade.
  - decreases the student withdrawal rate.
  - improves student attendance.

- Limitations
  - Autmoated grading and peer instruction are confounded
  - Are students just better over time (uncontrolled extraneous variable)?

- Additional observations
  - Automated grading has an unforgiving nature
  - Some students throw submissions at automated grading

# Project idea: development of an automated tool for learning *R* programming

# *R* programming and *swirl*

- *R* (http://www.r-project.org) is a free environment for statistical computing and graphics
- *R* is an interpreted language
- Many *packages* are available for specialized analyses (http://cran.r-project.org/web/packages/)
- Swirl (http://swirlstats.com) is a package where you can "learn R, in R."
  - Questions are hard-coded
  - This makes *swirl* appropriate for learning but not for practice and/or assessment

# Proposed project

- Develop a swirl-based package that generates template-based problems to help students practice *R* programming and data analysis concepts

- Question templates that use random variable names and/or values:

  - Question: Create a vector named 'x' that stores the values 3 and 11.
  - Solution: x = c(3,11)

- Improvement: values in red above are randomly generated each time.

# Questions:

1. What is the best way to learn a new programming language?

2. Does anyone have experience creating R packages (how do you do this)?

3. How do I implement random number generation

   Question: Create a vector named 'x' that stores the values **a** and **b** (where a and b are values in [1,20])

   Solution: x = c(**a**, **b**)