Automated Individualized Student Assessment

Stas Kolenikov

Department of Statistics
University of Missouri-Columbia

Stata DC conference 2009
Context

- **Stat 3500**: Intro to Probability and Statistics II, 14 sections
- **Audience**: sophomore/junior business students
- **Prerequisite**: Stat 2500, from basic probability to $t$-tests
- **Topics**: ANOVA, regression, rank statistics
- **Tools**: formula packet + tables, calculator, software package (at instructor’s discretion)
Automated Individualized Student Assessment system

Goals:
- help students learn statistics at their fingertips
- practice theoretical concepts with data
- familiarize students with Stata statistical software

Main idea: a simulated data set for each student × assignment

Advantages:
- interweaves learning statistical software and statistical methods
- equips students with modern computing tools
- forces students to work with and interpret statistical concepts
- simplifies academic honesty issues
Principles for good practices in education

- **Interaction with faculty**: it is easier for students to ask for help in the form of “This thing does not work here” than “I don’t understand this concept”

- **Interaction of students with one another**: slower learners can look over the shoulder of faster ones and get peer explanations of both the content and the software

- **Active learning**: students need to do their own work and interact with statistical software

- **Prompt feedback**: it takes an instructor 3 minutes to grade an assignment and post the results

- **Time on task**: there are make-up opportunities for early submissions

- **High expectations**: learn both the content and the software

- **Diversity of the ways of learning**: students can work on assignments on their own pace and in their preferred environment
Principles for good practices in education

- **Interaction with faculty**: it is easier for students to ask for help in the form of “This thing does not work here” than “I don’t understand this concept”

- **Interaction of students with one another**: slower learners can look over the shoulder of faster ones and get peer explanations of both the content and the software

- **Active learning**: students need to do their own work and interact with statistical software

- **Prompt feedback**: it takes an instructor 3 minutes to grade an assignment and post the results

- **Time on task**: there are make-up opportunities for early submissions

- **High expectations**: learn both the content and the software

- **Diversity of the ways of learning**: students can work on assignments on their own pace and in their preferred environment
Principles for good practices in education

- **Interaction with faculty**: it is easier for students to ask for help in the form of “This thing does not work here” than “I don’t understand this concept”

- **Interaction of students with one another**: slower learners can look over the shoulder of faster ones and get peer explanations of both the content and the software

- **Active learning**: students need to do their own work and interact with statistical software

- **Prompt feedback**: it takes an instructor 3 minutes to grade an assignment and post the results

- **Time on task**: there are make-up opportunities for early submissions

- **High expectations**: learn both the content and the software

- **Diversity of the ways of learning**: students can work on assignments on their own pace and in their preferred environment
Principles for good practices in education

- **Interaction with faculty**: it is easier for students to ask for help in the form of “This thing does not work here” than “I don’t understand this concept”

- **Interaction of students with one another**: slower learners can look over the shoulder of faster ones and get peer explanations of both the content and the software

- **Active learning**: students need to do their own work and interact with statistical software

- **Prompt feedback**: it takes an instructor 3 minutes to grade an assignment and post the results

- **Time on task**: there are make-up opportunities for early submissions

- **High expectations**: learn both the content and the software

- **Diversity of the ways of learning**: students can work on assignments on their own pace and in their preferred environment
Principles for good practices in education

- **Interaction with faculty**: it is easier for students to ask for help in the form of “This thing does not work here” than “I don’t understand this concept”

- **Interaction of students with one another**: slower learners can look over the shoulder of faster ones and get peer explanations of both the content and the software

- **Active learning**: students need to do their own work and interact with statistical software

- **Prompt feedback**: it takes an instructor 3 minutes to grade an assignment and post the results

- **Time on task**: there are make-up opportunities for early submissions

- **High expectations**: learn both the content and the software

- **Diversity of the ways of learning**: students can work on assignments on their own pace and in their preferred environment
Principles for good practices in education

- **Interaction with faculty**: it is easier for students to ask for help in the form of “This thing does not work here” than “I don’t understand this concept”
- **Interaction of students with one another**: slower learners can look over the shoulder of faster ones and get peer explanations of both the content and the software
- **Active learning**: students need to do their own work and interact with statistical software
- **Prompt feedback**: it takes an instructor 3 minutes to grade an assignment and post the results
- **Time on task**: there are make-up opportunities for early submissions
- **High expectations**: learn both the content and the software
- **Diversity of the ways of learning**: students can work on assignments on their own pace and in their preferred environment
Principles for good practices in education

- **Interaction with faculty**: it is easier for students to ask for help in the form of “This thing does not work here” than “I don’t understand this concept”

- **Interaction of students with one another**: slower learners can look over the shoulder of faster ones and get peer explanations of both the content and the software

- **Active learning**: students need to do their own work and interact with statistical software

- **Prompt feedback**: it takes an instructor 3 minutes to grade an assignment and post the results

- **Time on task**: there are make-up opportunities for early submissions

- **High expectations**: learn both the content and the software

- **Diversity of the ways of learning**: students can work on assignments on their own pace and in their preferred environment
Principles for good practices in education

- **Interaction with faculty**: it is easier for students to ask for help in the form of “This thing does not work here” than “I don’t understand this concept”

- **Interaction of students with one another**: slower learners can look over the shoulder of faster ones and get peer explanations of both the content and the software

- **Active learning**: students need to do their own work and interact with statistical software

- **Prompt feedback**: it takes an instructor 3 minutes to grade an assignment and post the results

- **Time on task**: there are make-up opportunities for early submissions

- **High expectations**: learn both the content and the software

- **Diversity of the ways of learning**: students can work on assignments on their own pace and in their preferred environment
Work flow

Assign → Publish → Download → First analysis → First submission

First check

resubmit

accepted

Prelim result

improve

satisfactory

Second analysis → Second submission → Second check → accepted → Final result → Finish
Components

- **Data processing**: Stata package (ado file, 800 lines of code + help file)
- **Project/class files**: roster, grade book
- **Assignment level files**
  - Do files: data generation, key generation
  - Automated data files: results
  - Documentation files: HTML text of the assignment
- **Assignment × student level files**
  - Automated data files: raw data, answer key data
  - Student: answers (data or do-files)
Creating an assignment

Assignment on $t$-tests and confidence intervals:

1. What is the mean of variable $x$?
2. Test hypothesis that the mean of $x$ is equal to 2.7 against a two-sided alternative. Report the $p$-value.
3. Should the null hypothesis be retained or rejected at 5% level? Enter 1 if the null is rejected, and 0 if the null is retained.
4. Identify the confidence interval in the test output. Report the 90% confidence interval, with the Answer to Question 4 being the lower limit. . .
5. . . and the Answer to Question 5 being the upper limit.

- The text of the assignment is provided as an HTML or PDF file
- John Doe: an exemplary student with ID 99999
Student data files

Raw data to be used by the student: made available from the course website

set seed StudentID
set obs 20+floor( uniform() * 16 )
gen x = uniform() + uniform() + uniform() + uniform() + uniform() + uniform()

Answer keys: the analysis to be performed, results stored for later matching

In **Stata**, run:
aisa assign test2, replace
Student’s task: create and submit a data file with numeric answers in the format

<table>
<thead>
<tr>
<th>Question</th>
<th>Answer</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2.9988</td>
</tr>
<tr>
<td>2</td>
<td>0.0086</td>
</tr>
<tr>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>4</td>
<td>2.8177</td>
</tr>
<tr>
<td>5</td>
<td>3.1799</td>
</tr>
</tbody>
</table>

In **Stata**, show:

```
johndoe-test2-post.do
```
Grading an assignment

In **Stata**, show:

```plaintext
aisa check test2
aisa check test2 99999, replace verbose
aisa check test2 537909, replace verbose
aisa gradebook test2, nomissing
```

HTML file with the results is automatically generated:

- Student ID
- Score on the assignment
- Problems missed
Experience and challenges

- Interface with blackboard: a total mess
- Instructor time expense: $\sim 10$ min/question for development, $\sim 2–5$ min/student if something is wrong
- Learning curve: students have to learn basics of \texttt{Stata} first, then move on to statistics, then to work flow management in \texttt{Stata} with do-files
- Students’ technical problems: empty, incomplete, or raw data files submitted; interim files stored locally in the lab and lost
- Deeper concepts (such as interpretation of tests and graphics) still need to be assessed via written tests
- Graders become obsolete
Student reactions

- John Doe is everybody’s hero
- Office hours in computer lab are extremely helpful
- Stata assignments are closer to real life than paper-and-pencil homeworks
- Stata assignments are helpful for both learning the software and the content
- Flexibility and make-up opportunities are great
- Easy to get 100%