



THE STATS 250 E²COACH PROJECT: WHAT DID WE DO? WHAT DID WE LEARN?

Omar Chavez

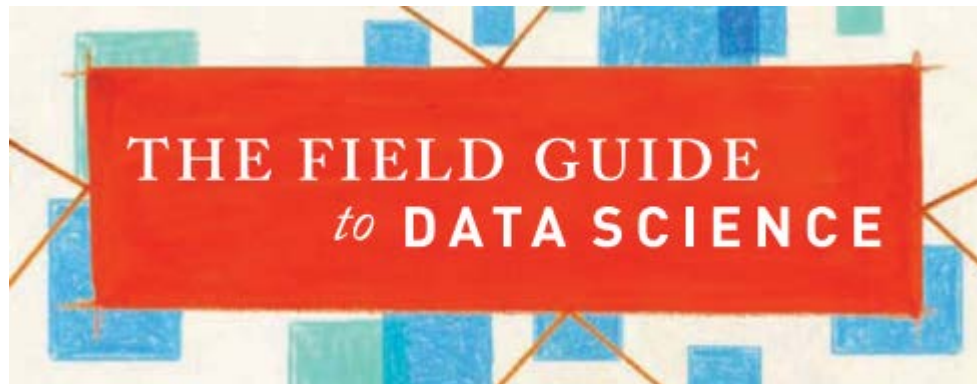
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Booz | Allen | Hamilton

»» FOREWORD

to personalized education,

Every aspect of our lives, from life-saving disease treatments, to national security, to economic stability and even the convenience of selecting a restaurant, can be improved by creating better data analytics through Data Science.

<http://www.boozallen.com/content/dam/boozallen/media/file/The-Field-Guide-to-Data-Science.pdf>

Talk Outline

- **About E²Coach**
 - What is it? How does it work?
 - Stats 250 Example Messages and Tools
 - Changes from F13 to W14
 - General Feedback
- **Data Analyses**

Estimating the Effect of E²Coach on Performance (F13/W14)
- **Current Status**
 - EZCoach
 - Sp14 No E²Coach Experiment → F14 E²Coach
- **Questions**

E²Coach

- E²Coach (**E**lectronic **E**xpert Coach) = web application that advises students through courses by *delivering personalized messages and normative data graphics*.
- Brings public health insights about **motivation and behavior change** to education.
- Implemented in large courses so **students can receive more individual attention**.

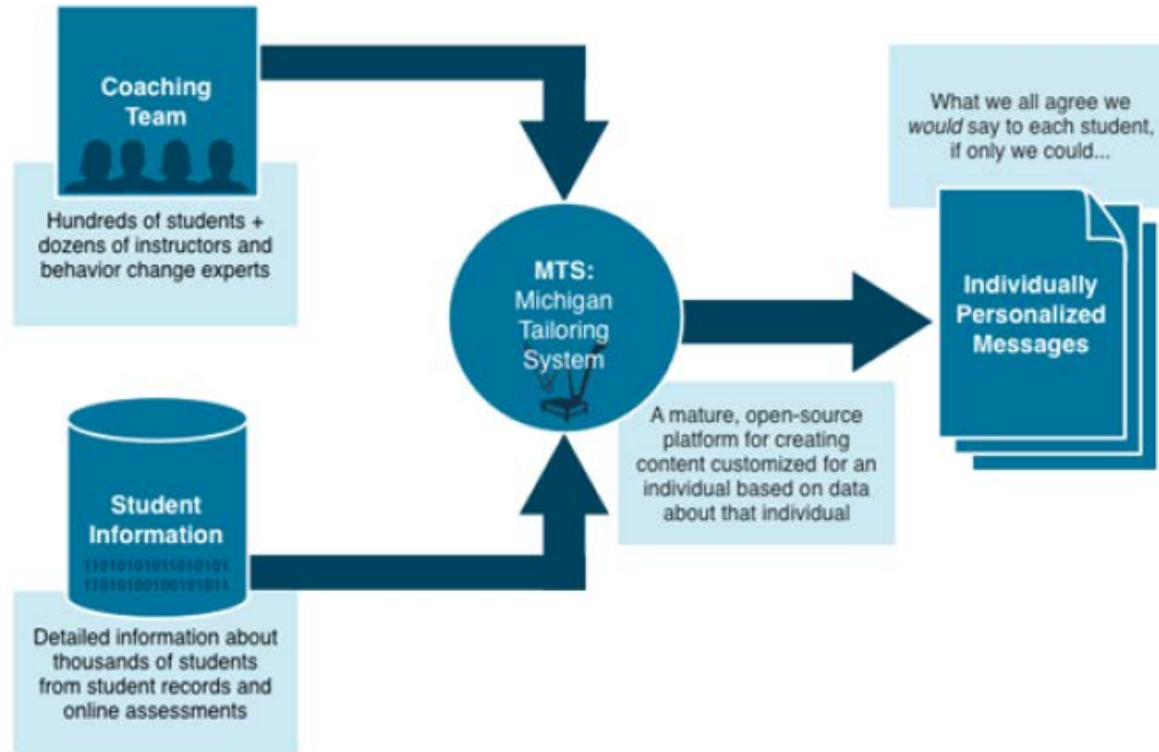
It allows us to say what we would like to say to each if they sat down with us for an expert coaching session.

E²Coach: Quick Video Intro




<http://youtu.be/0oxXjEfCLvc>

E²Coach: How does it work?



Key Stats E²Coach Team members:
Omar Chavez, Patricia Chen, Brenda Gunderson
Barsaa Mohapatra, Karen Nielsen, Eujain Ting, Jared Tritz



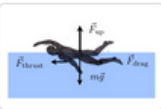

STEM Classes F13/W14



Coach Selector

COACHES LOGO

Explore our coached courses!

	Winter 2014 Stats 250 ACTIVE	Enter Coach
	Winter 2014 Chemistry 130 ACTIVE	Enter Coach
	Winter 2014 Physics 140, 240, 135, 235 ACTIVE	Enter Coach
	Winter 2014 MCDB 310 ACTIVE	Enter Coach

E2Coach helps you succeed in your courses by providing:

- Expert advice
- Advice from students like you
- Stats from your class
- Providing new opportunities in blended learning

The Stats 250 Class

- **Intro to Stats & Data Analysis**,
one term, 4-credit course in applied statistical methodology from analysis-of-data viewpoint.
- **3 hours of lecture, 1.5 hour computer lab** weekly
- Enrollments: **~1700 students/term**
- **Coordinated:** 6 lecture sections (~300 students),
~60 computer labs (30 students)
- **Mostly social-science sophomores**,
taking required course for major or a requirement.

E²Coach Participation

Fall 2013: 1701 Students	Winter 2014: 1735 Students
1386 (81.5%) Enrolled	1381 (79.6%) Enrolled

- Enrollment was **voluntary**
- **Two short surveys** to sign up
- **Promo video** shown in class to highlight purpose and **perks**

What do we tailor on?

- Knowledge of **course** and its structure
- Input from **gradebook**: HW scores, Lab Work, Exams
- Input from **students**
 - Desired and expected grades
 - Planned effort
 - Self-efficacy, confidence, approaches to course
 - Goals and interests
 - **Learning Styles Survey**
 - **Resources Used**
 - **Amount of Sleep**

Unique Data Gathered: Data on Learning Styles

Patrick, thank you for completing the Index of Learning Styles Survey!

Here are your results and some suggestions you might find useful to help you with your studies. We also wanted to point out that each scale of the survey is scored on a range between -11 and +11 with 0 being the balancing point between the two dimensions on the scale.

Active/Reflective Scale - You scored -5 on the Active/Reflective scale, indicating you have a moderate preference for the Active dimension of the scale and will learn more easily in a teaching environment which favors that dimension.

Sensing/Intuitive Scale - You scored -1 on the Sensing/Intuitive scale, indicating you are fairly well balanced on the two dimensions of this scale.

Visual/Verbal Scale - You scored -9 on the Visual/Verbal scale, indicating you have a very strong preference for the Visual dimension of the scale. You may have real difficulty learning in an environment which does not support this preference.

Sequential/Global Scale - You scored -9 on the Sequential/Global scale, indicating you have a very strong preference for the Sequential dimension of the scale. You may have real difficulty learning in an environment which does not support this preference.

Since you showed a preference for Active Learning, here are some ways you can help yourself: If you are an active learner in a

Learning Styles and Strategies by: Felder, R.M., and Soloman, B.A. (n.d.).
<http://www.ncsu.edu/felder-public/ILSdir/styles.htm>

Unique Data Gathered: Data on Resources Used

Reflecting on how you prepared for Exam 2.

Patrick, take a few minutes to reflect on how you studied for Exam 2.

Which resources did you specifically use to study for this Exam 2? (Select all that apply.)

- reviewed the **lecture notes**
- watched some **Blue Review** captured lectures
- reviewed past **required HW** problems
- reviewed past **recommended HW** problems
- tried some past exam questions on **Problem Roulette**
- spent some time practicing with **Name That Scenario**
- attended **office hours** during exam week
- reviewed some **lab materials** (ILPs)
- read some parts of the **textbook**
- discussed material with other students in the class (like **study group**)
- worked questions from the **practice exams** (from the lab workbook)

Unique Data Gathered: Data on Amount of Sleep

Sleep (Z-z-z-z) and Exam Performance

Take a look at these side-by-side boxplots created using the average amount of sleep data you have been providing on your weekly HW and exam 1 performance. **Do you see a shift?** How does the median exam 1 score change as you move from the group with less sleep to the group with more sleep?

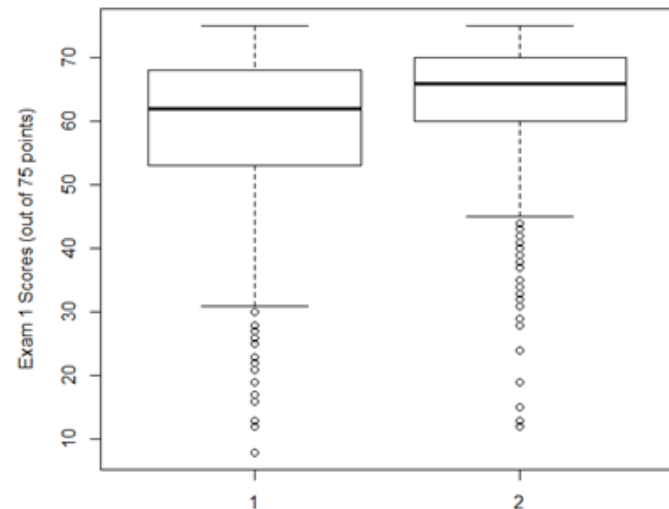
Based on your weekly self-reported data, you are averaging about **8.25** hours of sleep per night. Looking at the graph, what group are you in?

There are many things that factor into your performance on an exam, but studies have shown that getting adequate amount of sleep is important to enhance learning and performance on assessments. Check out this cool TED Talk on [Why do we sleep?](#) One idea: **Brain processing and memory consolidation.** *"If after you've tried to learn a task, and you sleep- deprive individuals, the ability to learn that task is smashed. ... Take Sleep Seriously ... If you have good sleep, it increases your concentration, attention, decision-making, creativity, social skills, health."*

Use what you've learned in this message to help guide your own studying ... and sleeping.



Comparison of Exam 1 Scores by Average Amount of Sleep
by Omar Chavez



Group 1: Less than 5.5 hours, Group 2: 5.5 hours or more

“Get Things Done” Lists



Stats 250: Fall 2013

COACHES

MESSAGES

STAFF VIEW

LOGOUT: KARENEN

Inbox [message](#)

- [Survey] Results of the ILS Survey
- [Survey] ILS Survey
- [Survey] Final E2Coach feedback
- [Final Exam] Results
- [Final Exam] Prep
- [Progress] Interested in More Stats?
- [Try it!] Name That Scenario
- [Try it!] Problem Roulette
- [Exam 2] Where do I stand now?
- [Exam 2] Reflection
- [Exam 2] Results
- [Exam 2] Prep
- [Exam 1] Where do I stand?
- [Exam 1] Reflection
- [Exam 1] Results
- [Exam 1] Prep
- [Progress] Prelabs
- [Progress] Lab Attendance
- [Progress] Office Hours
- [Progress] Homework
- [Welcome] Howdy!
- [Welcome] About E2Coach
- [Survey] Revisit Your Responses

Drew, here is what we have for you this week:

Week of 12/07 Get Things Done List:

- Last labs Mon-Wed, Dec 9 – 11: bring Lab 13 on Chi-Square Tests, a calculator, formula card/tables, and clicker. You will work on the last ILP, complete a learning style survey (for extra credit), and do a final check of your gradebook entries.
- Print and bring the final lecture review questions to your last lectures Mon-Wed, Dec 9-11. Plans are to capture the Tue 11:30 – 1 lecture review and post on Blue Review, solutions will be posted on ctools Wed, Dec 11 afternoon.
- Finish up that last required HW 10 on Chi-squared Tests before Thu, Dec 12 at 8 AM. Want more Chi-Square practice? – Try some recommended HW 10 questions – anytime. Solutions are provided.
- Print and bring the overall final exam review questions to the review on Thu, Dec 12, 10:15 AM in MLB AUD 3. Plans are to capture and post on Blue Review, solutions will be posted on ctools Thursday night.
- Spend 20 minutes today and go to Problem Roulette and select Topic 12 – Chi-Square Tests and work through 4 problems. Spend another 20 minutes and go to Name That Scenario and select Chi-Square Goodness of Fit, Homogeneity, Independence to practice identifying the three newest tests for addressing various research questions about categorical/discrete responses.
- Check your gradebook entries. Apart from HW 9 scores (available Sun 6 PM), HW 10 scores (available Thu 6 PM); all other scores should be checked, all questions must be addressed to your GSI by Fri, Dec 13, 5 pm. If you missed your last lab and attended a different lab, you must arrange to get your lab make up form to your GSI by Thu, Dec 12.
- Please take a few minutes and complete your online evaluations for stats 250 lecture and lab. Click on the “Evaluate This Class” link on the Stats 250 Ctools site for quick access. Your feedback is read and greatly appreciated – take time to do it in labs or any time before evaluations close.
- Read all 10 Guiding Principles from the end of Chapter 17. This is a great summary of some key concepts in our class!
- Come to take your Final Exam = Monday, December 16, 7:30-9:30 pm. Note the 7:30 start time (not 7:40 UM time) and check if your room is different than the semester exam room.
- Watch an interesting video on A Day without Statistics created by the Research Center for Statistics of the University of Geneva; entry to the ASA Video Contest for the International Year of Statistics 2013 – anytime.

Save My GTD List

Did you know...?

The University of Michigan has long been ranked in the TOP TEN statistics programs in the country. In 2010, it was ranked #4 by in the National Research Council. Check out more about the UM Statistics Department here. Check out the International Year of Statistics website, to get you Statistic of the Day, Statistical Quote or Word of the Week, even try an online quiz.

[Click here to visit Name That Scenario!](#)

[Click here to visit problem roulette!](#)



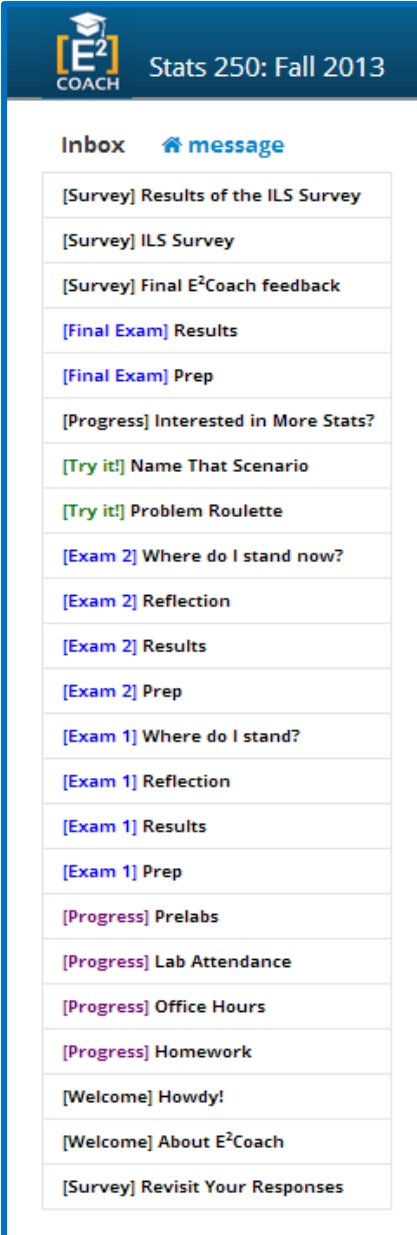
UMich STATS 250

[Today](#) [Week](#) [Month](#) [Agenda](#)

Monday, March 24
8:00am Prelab 7 due Before 8 A
Thursday, March 27
8:00am HW 7 due
Sunday, March 30
12:00pm Exam 2 Overall Review
Monday, March 31
8:00am Prelab 8 due Before 8 A
Thursday, April 3
8:00am HW 8 opens

Messages

- **Welcome**
 - Tips for class success
- **Progress**
- **Exam Related**
 - Preparation
 - Results
 - Reflection
- **Try It!**
 - Introduction of tools
- **Surveys**
 - Learning styles
 - Feedback



The screenshot shows the E2Coach interface for 'Stats 250: Fall 2013'. At the top, there is a blue header with the E2Coach logo and the course name. Below the header, the word 'Inbox' is displayed next to a 'message' icon. The main content is a list of messages, each with a colored label indicating its category: [Survey], [Final Exam], [Progress], [Try it!], [Exam 2], [Exam 1], and [Welcome]. The messages are listed in chronological order from top to bottom.

Category	Message Title
[Survey]	Results of the ILS Survey
[Survey]	ILS Survey
[Survey]	Final E ² Coach feedback
[Final Exam]	Results
[Final Exam]	Prep
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[Exam 1]	Where do I stand?
[Exam 1]	Reflection
[Exam 1]	Results
[Exam 1]	Prep
[Progress]	Prelabs
[Progress]	Lab Attendance
[Progress]	Office Hours
[Progress]	Homework
[Welcome]	Howdy!
[Welcome]	About E ² Coach
[Survey]	Revisit Your Responses

Progress Messages - Advice

We see that you did the practice homework - great!

You scored well on this assignment. **Keep up the good work!** We have seen that students in the past start to lose points on later homeworks because they **forget to:**

- answer the question being asked
- always include units
- give a title and author for graphs
- show all your work (because good work with a wrong answer will probably still earn you some credit!)

Even though you plan to obtain a grade of an A or A+, you can still implement good homework techniques. Anna says,



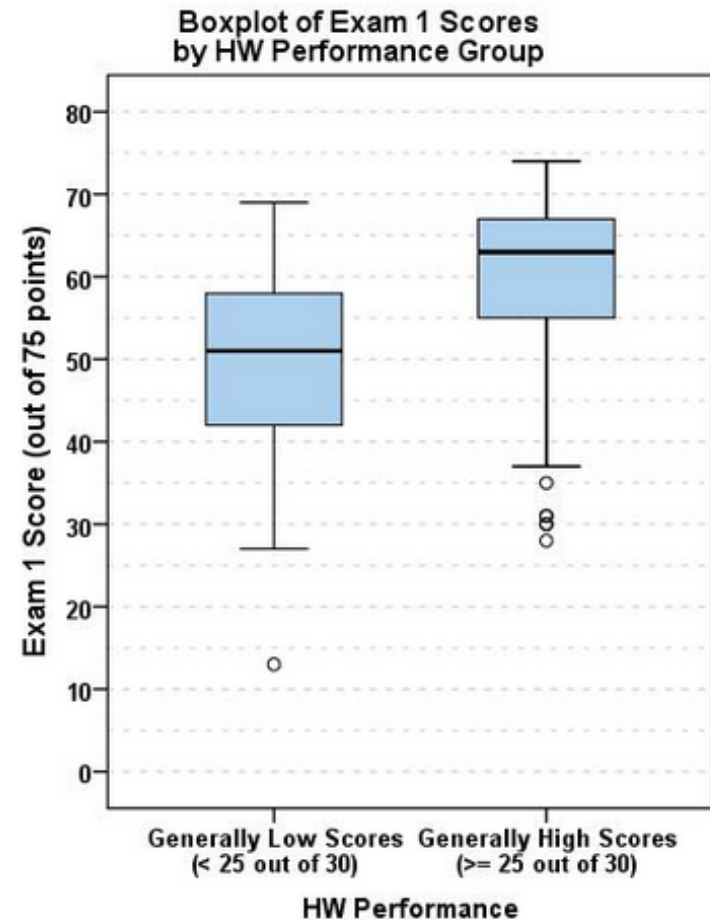
"I was very successful in this course, but if I had a "do-over," I would probably start my online homework assignments earlier so I wasn't as stressed about finishing them before the deadline."

Progress Messages - HW Data

Does homework really help? Using data from a previous semester, we have made the above side-by-side boxplots to show that students who score well on homework also score well on exam 1.

Research has shown that statistics is best learned by practicing. Homeworks often utilize past exam questions, so they are great preparation for your exams. Don't forget that the recommended homework is there for you to practice with also, since just the required homework is often not enough practice on its own. The solutions on the recommended homework are initially hidden for a reason - **try these problems out like required homework or exam questions before you look at the solutions!**

Using what you have learned so far in lab, use [this data set](#), which is a subset of the Fall 2012 grades used to make the side-by-side boxplots above. Try making a similar graph for final grades, or explore the data set for some informative practice of the techniques you've already learned!



Exam Messages - Reminders

Hi Drew, it is time to get ready for Exam 2!

What will you do today to start preparing for Exam 2? What will you do each day over this next week?
Be specific – [Click here for some examples to get you started.](#)

For Exam 2 room locations, review information, and material to be covered, [click here.](#)

There are **plenty of materials** available to help you anticipate what the exam will be like and prepare to give your best possible performance

Exam Reviews:

There will be a few reviews to give you more exposure to material on the upcoming exam. Print out the questions and try them out over this weekend!

- **Lecture Review:** Try out these review questions before class next week. (Mon-Thu, Nov 12-14).
- **Sunday Review:** Sun, Nov 10, 2:15 pm in MLB AUD 3. This review will be on Blue Review by Monday.

Study Materials

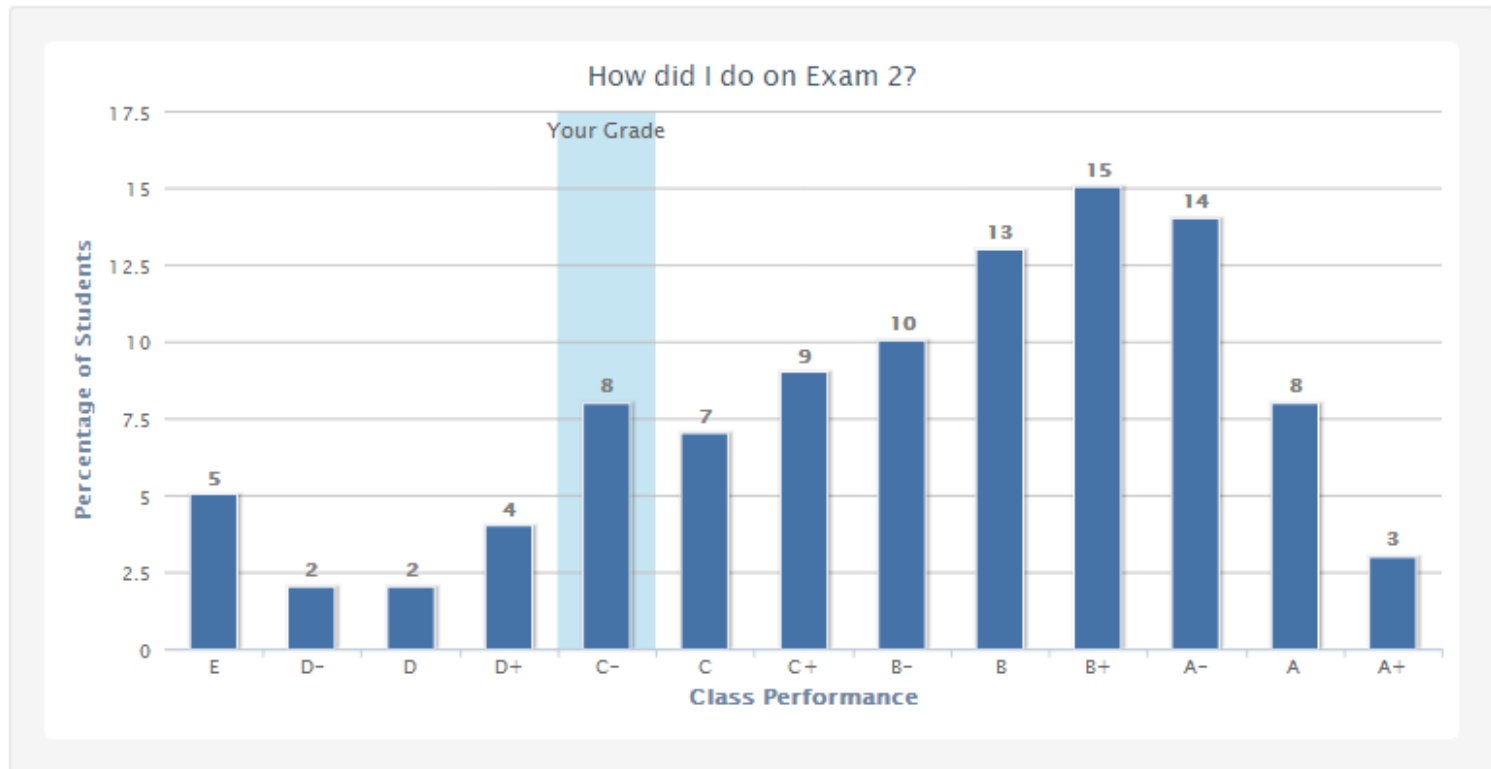
There are lots of places to go for study materials!

- Your own **Lecture Notes**
- Your **Lab Workbook** (Warm Ups, ILPs, Cool Downs, Example Exam Questions, Supplements 2, 5, 6, 7)
- **Blue Review Lectures**

Exam Results Messages

Congratulations on making it through Exam 2! We see that you scored a **50.0 out of 75 points** or **66.7 %**, which corresponds to a letter grade of a **C-**.

Here is where your exam grade falls in the class-wide distribution of exam grades.



Although you did not do as well on Exam 2 as you did on Exam 1, don't give up! Remember we have two methods to work out your final course grade. But there are some things you should do now to help get you on the right track! What can you do now?

Where do I Stand? Grade Prediction



Stats 250: Fall 2013

COACHES

MESSAGES

STAFF VIEW

LOGOUT: KARENEN

Inbox [message](#)

[Survey] Results of the ILS Survey

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[Exam 2] Where do I stand now?

[Exam 2] Reflection

[Exam 2] Results

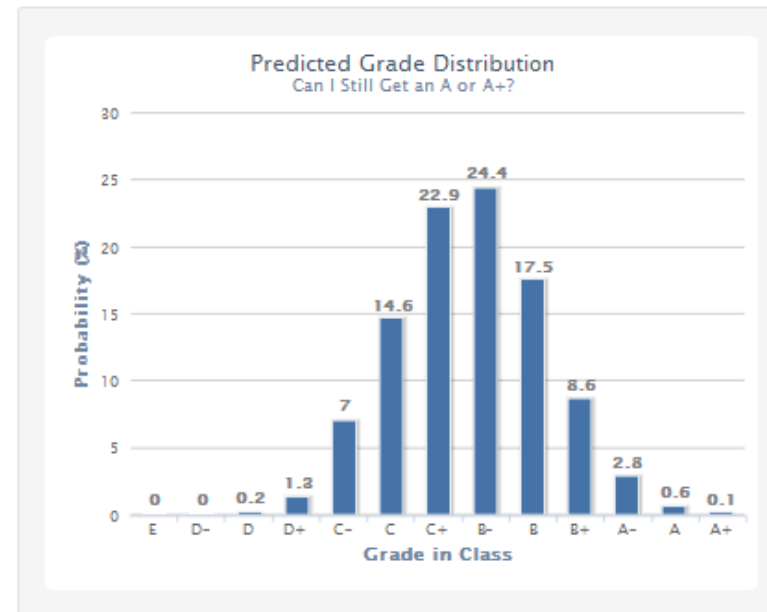
[Exam 2] Prep

[Exam 1] Where do I stand?

[Exam 1] Reflection

[Exam 1] Results

Drew, here are some tools to help you understand where you stand...

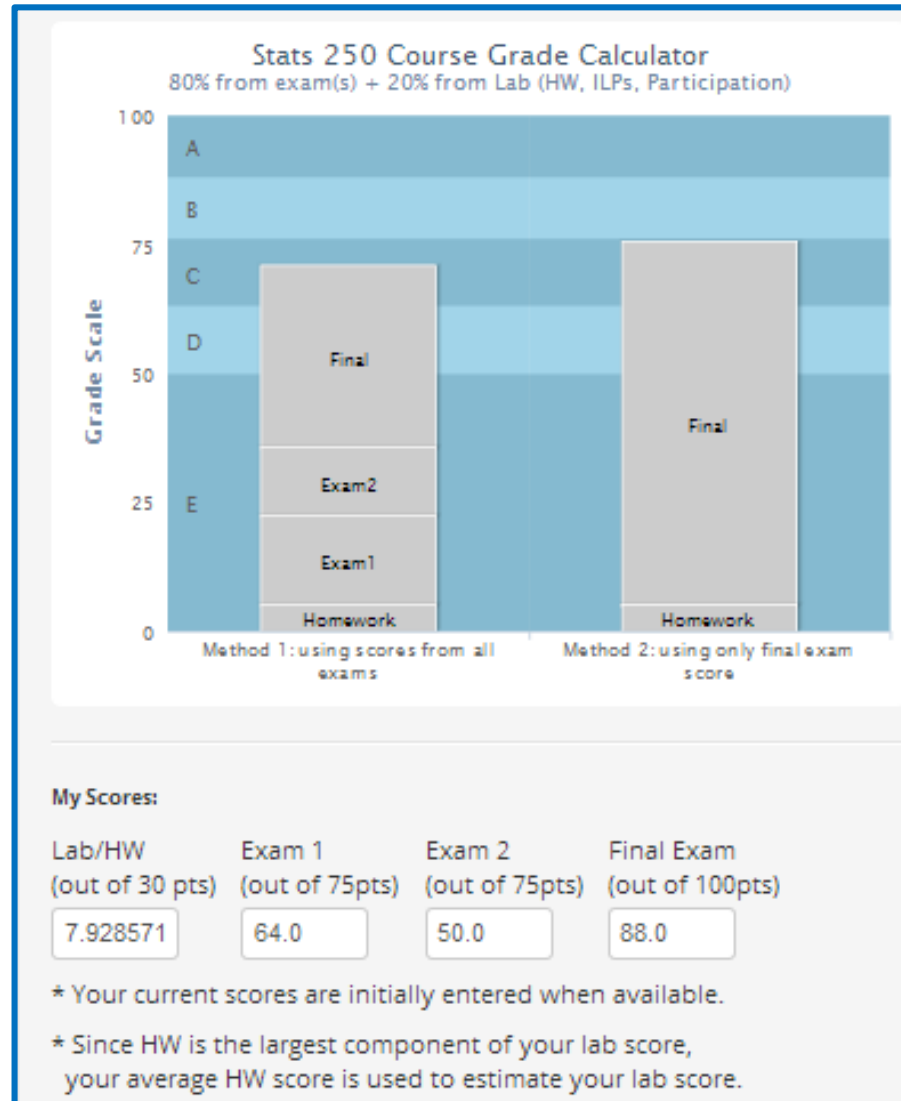


About your predicted grade distribution:

To get an idea of where you stand in the class we constructed a statistical model using historical student data. Based on how other students with similar performance as you have done up to this point in the semester, we are able to guess how you are likely to do. But because your exact grade is impossible to predict, we are only able to estimate the possible grade distribution. **A key point to take from this graph is that your grade thus far has NOT been determined. You should only use the prediction as an indication of where you may be at the end of the term if you do not change how you prepare and study for the class.**

About the Data: The data was collected from all the STATS 250 students who received a grade during the Winter 2013 Term. Because the grading scheme is exactly the same every semester, we can use the

Where do I Stand? Grade Calculator



Students Coach Themselves

After first exam, students were asked to take time to reflect on their study habits. **What would you do differently next time?**

E² COACH Stats 250: Fall 2013 COACHES MESSAGES

Inbox [message](#)

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- [Exam 1] Reflection

Reflecting on how you prepared for Exam 1

Take a few minutes to reflect on how you studied and got ready for Exam 1.
What would you do differently next time?
We'll remind you of what you said before your next exam.

The quotes from peers that you receive through E²Coach come from surveys like this one. May we use this quote, along with your first name and UMich photo, as the project grows?

no
 yes

Students Coach Themselves

What would you do differently next time?

presented advice back when time to study for exam 2

- ***Go to office hours!***
- *Ask ANY questions on ANY topic you are unsure of at all.*
- ***I want to do at least one stats problem every day.***
- *Spend more time on each problem the first time through.*
- ***I will start studying AT LEAST a week in advance.***
STOP WAITING UNTIL THE LAST MINUTE!
- ***I would like to set aside specific blocks of time for preparation in the two weeks prior to the exam.***

Try It! Tools for Practice

Name That Scenario

and

Problem Roulette

Stats 250: Fall 2013

COACHES MESSAGES STAFF VIEW LOGOUT: KARENEN

Inbox message

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Save My GTD List

download pdf of GTD list Dec 07
download pdf of GTD list Nov 25
download pdf of GTD list Nov 17
download pdf of GTD list Nov 10

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Click here to visit Name That Scenario!

NAME THAT SCENARIO

To practice recognizing when to apply concepts you will be presented with "real world scenarios" and you will identify which concept best applies.

To Start:

- Click on the "Go" button.
- Then click the "Next" button.

NAME

PROBATION

DATE

ADDRESS

Click here to visit problem roulette!

Problem Roulette

UMich STATS 250

Today Week Month Agenda

Monday, March 17
8:00am Prelab 6 due Before 8 A

Thursday, March 20
8:00am HW 6 due and HW 7 op

Monday, March 24
8:00am Prelab 7 due Before 8 A

Thursday, March 27
8:00am HW 7 due

Sunday, March 30
12:00pm Exam 2 Overall Review

Monday, March 31
8:00am Prelab 8 due Before 8 A

Thursday, April 1

Name That Scenario

Stats 250: Fall 2013

COACHES MESSAGES STAFF VIEW

NAME THAT SCENARIO

To practice recognizing when to apply concepts you will be presented with "real world scenarios" and asked to identify which concept best applies.

To Start:

1. Select at least two of the concepts from this list below.
2. Then click the "Begin" button.

PAIRED ✓

ONE-MEAN ✓

ANOVA

CHI-SQUARE-INDEPENDENT

CHI-SQUARE-GOODNESS-OF-FIT

Begin

Clear Selections

Select and practice these 5 statistical procedures to help you prepare for Exam 2!

Stats 250: Fall 2013

COACHES MESSAGES STAFF VIEW LOGOUT: BKG

NAME THAT SCENARIO

Correct : 1

Question 1 / 10

An insurance company currently believes their average claim is \$1,500. They are concerned their true mean is actually higher and they could potentially be losing money from this. They randomly select 40 claims and calculate a sample mean of \$1,727. Assuming that the standard deviation of claims is \$300, should the insurance company be concerned?

PAIRED

TWO-PROPORTION

ONE-PROPORTION

ONE-MEAN ✓

INDEPENDENT-T-TEST

Correct! Good Job :) You are given a sample mean (\$1,727) and a null value (\$1,500). There is a single population, all claims, and a single continuous variable, the claim payout. You can perform a one-sample t-test for the population mean.


Continue

Receive Feedback! more than just correct or not ... includes guidance about how to "see" the correct answer.

Problem Roulette

Selections Problems My Summary

The links below serve randomly-chosen questions, one at a time, from banks



Statistics 250

Please select a topic to begin:

← Select Different Course Reset Selected Topics Use Selected Topics

Select All	Remaining Problems
<input type="checkbox"/>	44/44
<input type="checkbox"/>	20/20
<input type="checkbox"/>	15/15
<input type="checkbox"/>	40/40
<input type="checkbox"/>	80/80
<input type="checkbox"/>	14/14
<input type="checkbox"/>	27/27
<input type="checkbox"/>	27/27
<input type="checkbox"/>	24/24
<input type="checkbox"/>	21/21
<input type="checkbox"/>	34/34
<input type="checkbox"/>	33/33

← Select Different Course Reset Selected Topics Use Selected Topics

Selections **Problems** My Summary

Selected Topics/Remaining Problems: **3. Probability: 15 / 15**

A B

Submit or Skip

Stats 250 Exam 1 W13 Problem 6D

Attending Class: A professor wanted to investigate how class attendance affected a student's performance from his clicker questions to record whether students attended class regularly, sporadically, or not at all. The results are presented below.

	Attended regularly	Attended sporadically
Passed	120	45
Failed	5	15

Are the events "Passing the class" and "Attending class regularly" mutually exclusive?

A. Yes
B. No

Selections **Problems** My Summary

Selected Topics/Remaining Problems: **3. Probability: 15 / 15**

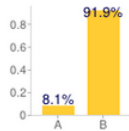
Next

Your time: 287 seconds Average user time: 106.6 seconds

Your answer: **A** Correct answer: B

Solution: [Stats 250 Exam 1 W13 Problem 6D](#)

Total Responses (N=651)



	Attended regularly	Attended sporadically	Did not attend class
Passed	120	45	2
Failed	5	15	13

Stats 250 Exam 1 W13 Problem 6D

Attending Class: A professor wanted to investigate how class attendance affected a student's performance from his clicker questions to record whether students attended class regularly, sporadically, or not at all. The results are presented below.

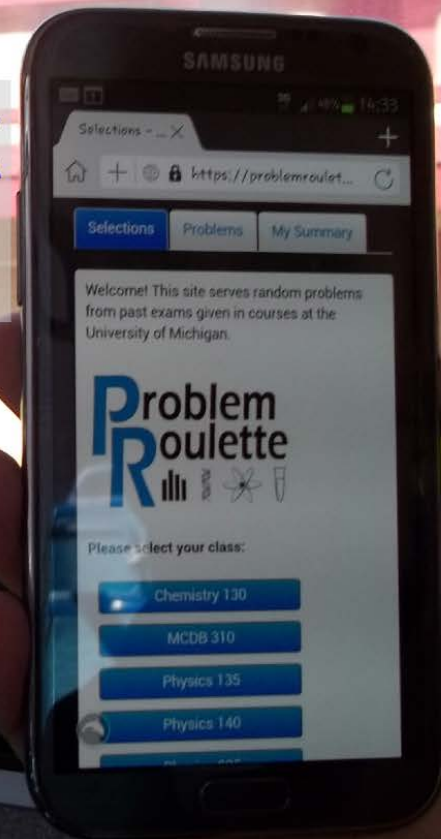
Are the events "Passing the class" and "Attending class regularly" mutually exclusive?

A. Yes
B. No

**Looking at Facebook
won't get you an A.**

Problem Roulette on the bus

<https://pr.lsa.umich.edu>



Contact: problemroulette@umich.edu

Students: What's the Best Thing about E²Coach?

- **Practice (Problem Roulette and Name That Scenario Applets)**

Problem Roulette and Name that Scenario were especially helpful for practice problems, and guiding my studying for the final exam in particular. Great review tools!

- **Grade Prediction**

I liked the grade updates to see my progress and how I needed to adjust my study habits. It was awesome to have information about how I was doing in the class automatically.

- **Reminders**

*I liked all the reminders to do certain tasks.
It kept me on track.*

What would you change? “nothing” or wanted “more.”

But ... Does E²Coach *Really* Help Students?

Changes from F13 to W14

- **Randomized controlled experiment** with respect to the tailoring level
- As students signed up for E²Coach, **alternated assignment to either HIGH or LOW tailoring level**
- All messages present **personalized information to HIGH, general information to LOW**

Progress Message: High

- *Personal name*
- *Report on their lab attendance*
- *Student advice matched by sex*
- *Own GSI sharing*

Lab Attendance Matters!

Hi **Holland**, according to our records looks like you have missed one or more of the lab sessions. **Here's why lab is important:**

Lab is an important part of this course. It is a place where you can practice applying the concepts taught in lecture and have helpful discussions with your peers and GSI. Material that is not covered in lecture will also be introduced during some labs.

You can learn from the In Lab Projects (ILPs) which will be a part of every lab. These assignments are designed to prepare you for the types of questions that will be asked on homework and exams, and to make you think critically about statistics.

Rachel says,



"You should make friends in your class - they will be a valuable resource."

Labs provide a perfect opportunity to **find those study partners**. The people you talk to before lab starts, or with whom you work on group activities, are faced with the same homework and exams as you! If you're looking to study with other people, try asking them if they are also interested in doing so.

Carolina says,



"The GSIs are incredibly helpful, and even sticking around after lab for just a few minutes can be very helpful to go over any quick questions you have about the homework."

Also, **lab attendance is required**. A missed lab will negatively impact your grade. It might not seem like a huge penalty when you're deciding between sleeping in and going to lab, but trust us - you'll want that point back at the end of the semester!

Your GSI **Mackenzie** says,

"If you know in advance that you will miss a lab, make plans to attend a different lab if possible. You will receive a lab makeup form like this, just return this form to me at the start of our next lab meeting for attendance credit. Now, if you miss lab because you are sick and unable to attend a different lab, let me know asap (not two weeks later). Then we can work out a makeup assignment to complete and bring to our next lab meeting."



Progress Message: Low

- *No name*
- *No reporting on lab attendance*
- *No student advice*
- *Lab make up form image and no reference to own GSI*

Lab Attendance Matters!

Here's why lab is important:

Lab is an important part of this course. It is a place where you can practice applying the concepts taught in lecture and have helpful discussions with your peers and GSI. Material that is not covered in lecture will also be introduced during some labs.

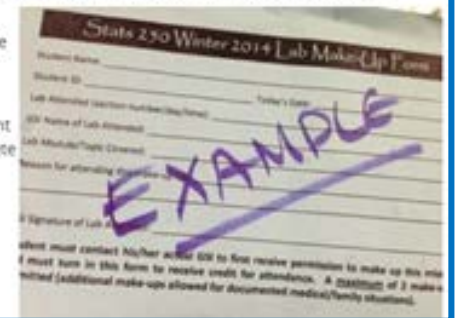
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Also, **lab attendance is required.** A missed lab will negatively impact your grade. It might not seem like a huge penalty when you're deciding between sleeping in and going to lab, but trust us - you'll want that point back at the end of the semester!

If you know in advance that you will **miss a lab**, make plans to attend a different lab if possible. You will receive a lab makeup form (like the one pictured). Return this form to your GSI at your next lab meeting for attendance credit.

If you missed lab because you were sick and unable to attend a different lab, contact your GSI. Then you will get a makeup assignment to complete and bring to your next lab meeting.



W14 Experiment Results and Thoughts

- High Tailor Group was compared to Low Tailor group
- Comparisons with like groups (based on usage level)
 - High Tailor / High Usage vs Low Tailor / High Usage
 - High Tailor / Med Usage vs Low Tailor / Med Usage**showed no significant difference in course grade**
- We were still **NEW** at this ...
 - still learning about what students are sensitive to ...
 - need more data

Analysis Outline

- Definitions
- Estimating the Average Treatment Effect
 - Comparisons with ECoach Registered Participants
 - Comparisons with Non Ecoach Registered Participants

Definitions

- Ecoach Registered Student
- Usage Ratio
- Low Group
- Medium Group
- High Group

- Propensity score
- Prognostic score
- Fullmatch
- Response Variable - Final Course Grade

Outline of Analysis: Estimating Average Treatment Effect

1. Identify a treatment group and a control group
2. Estimate propensity score
3. Estimate prognostic score
4. Create the dissimilarity matrix with the mahalanobis distance
5. Find a full match (with restrictions on the propensity score) using the R package, `optmatch` (Hansen and Klopfer)
6. Estimate average difference for the matched sets with $\alpha = 0.05$ using `xBalance` (Hansen, Bowers and Fredrickson)

Selecting Groups

We split students into **4 groups**:

1. **Non ECoach registered** students
2. **Low** group (bottom third usage ratio values)
3. **Medium** group (middle third usage ratio values)
4. **High** group (upper third of usage ratio values)

Note: Groups 2 - 4 are ECoach registered students

Selecting Groups

- **Who are the ECoach registered students?**
 - All students that completed the **required** ECoach Common Survey **and** also completed the **required** Stats specific Survey
 - These students **were** eligible to receive messages
- **Who are the Non ECoach registered students?**
 - The students that **did not** complete the two surveys
 - These students **were not** eligible to receive messages

Selecting Groups by messages read

- **Usage Ratio (UR)**

= (# opened by student i) / (# released to student i)

e.g. if Mike read 13 messages out of 23 that were released his UR = $13/23 = 0.565$

- Cutoff identified by quantile: $q_{1/3}$ and $q_{2/3}$

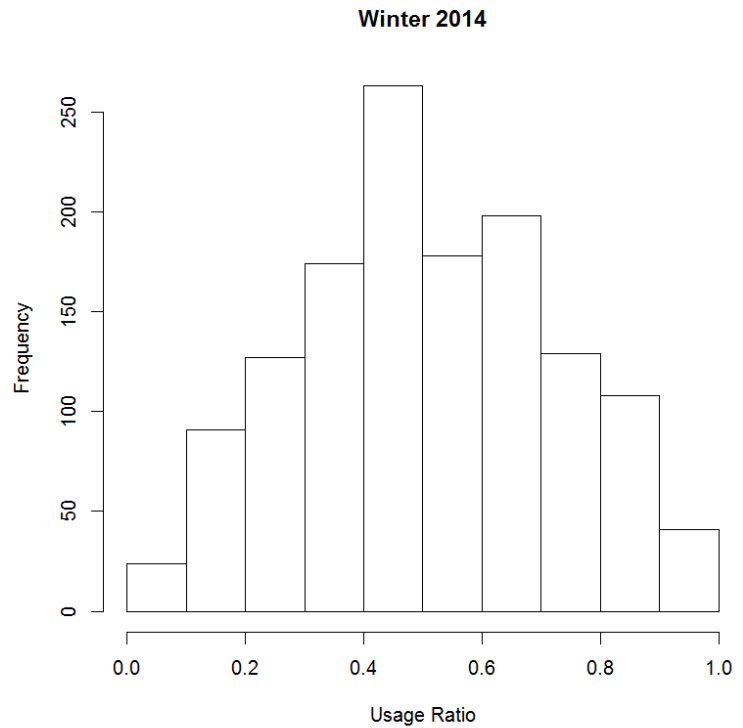
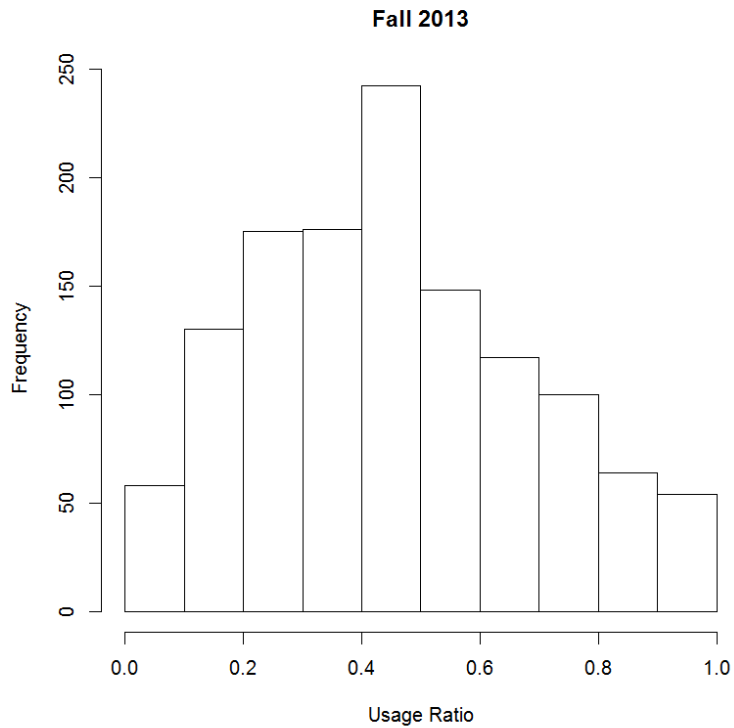
- **Fall 2013**

- Low User UR in $(0, 0.318]$
- Med User UR in $(0.318, 0.545]$
- High User UR in $(0.545, 1]$

- **Winter 2014**

- Low User UR in $(0, 0.409]$
- Med User UR in $(0.409, 0.615]$
- High User UR in $(0.615, 1]$

Distribution of Usage Ratios



Comparisons for Fall 2013 and Winter 2014

Treatment	Control
high	medium
high	low
high	non-registered
medium	low
medium	non-registered
low	non-registered

We could just do a two-sample t-test and be done -- right?

On to matching...

- General rule: want to **only use data that was available at the beginning** of the term (before treatment) or at least **could** have been known at beginning of term but was collected over term.
- Matching on variables that can be affected by treatment can cause **bias** in an estimate of treatment effect - in particular, if you are matching on a variable related to the outcome of interest. (Steiner, Cook, Shadish, Clark, 2010)
- Students that **register** give us **lots of data!**
- Students that **did not register** have **less** data - unfortunately...

On to matching...

Data available for **all** students:

- Academic Level
- Index of Learning Style Dimensions (Felder, R.M., and Soloman, B.A.)
 - Active/Reflective
 - Sensing/Intuitive
 - Visual/Verbal
 - Sequential/Global
- University of Michigan GPA
- Gender

On to matching...

Data available for ECoach registered Students =
Data available for all students + more!

- Goal Grade
- Confidence in Academic Ability
- Subject Interest
- Confidence in Ability to Achieve Goal Grade
- Expected Frequency of OH Attendance
- Expected to have a study partner (yes or no)
- Major Declared
- Number of Semesters Completed
- Age
- Is student employed (FT, PT, no)
- Involved in Greek Life (yes or no)
- Involved in Sports (yes or no)
- Involved in Religious Activities (yes or no)
- Involved in Research (yes or no)
- Involved in Volunteering (yes or no)
- Involved in Music/Art (yes or no)
- Involved in Other Activities (yes or no)
- Post College Plans (job, grad school etc)
- Highest Level of Parent Education
- High School Cummulative GPA
- College (Nursing, LSA, Engineering, etc)
- Time_expectation for class
- Major

On to matching...

- Rather than match on covariates directly we collapse data into two scalars that we estimate based on observed data
 - **Propensity Score** – estimate of the probability an experimental unit (in this case a student) will elect to be part of the treatment group
 - **Prognostic Score** - Similar to propensity score but rather than estimate the probability of treatment assignment, it is an estimate of the outcome of interest (Final Course Grade)
- We found **propensity scores use the same information differently than do the prognostic scores**
...more about this in a few slides

Propensity Scores

- Suppose **subject T_i** is a member of the treatment group with **response $g(T_i)$** (Final Course Grade), and **subject C_j** is a member of the control group with **response $g(C_j)$** (also Final Course Grade)
- Both **T_i** and **C_j** have the same **propensity** score **$\text{prop}(x)$**
- Also assume there are no confounding variables
- Under these assumptions, **$E[g(T_i) - g(C_j)]$** is an **unbiased estimate** of the treatment effect that is, the **average difference**, $g(T_i) - g(C_j)$, is unbiased
- We **used the largest complete set of variables available** for both treatment and control groups

Propensity Score - how to calculate them...

1. Identify the **treatment** and **control** groups to compare.
2. **Label** treatment observations 1 or "T" and control observations with 0 or "C" - this is not explicitly in the data. We must make this designation.
3. **Build a model that estimates the probability a particular subject falls in the treatment group.**
We used Random Forest classifier but logistic regression also popular.
4. The estimated probabilities are the **Propensity Scores**.

Prognostic Scores

Prognostic Scores are somewhat similar to propensity scores with a few key differences. Just as before:

- Suppose **subject T_i** is a member of the treatment group with **response $g(T_i)$** (final course grade), **C_j** is a member of the control group with **response $g(C_j)$** (also final course grade)
- Both **T_i** and **C_j** have the same **prognostic score $\text{prog}(x)$**
- Also assume there are no confounding variables
- Under these assumptions, **$E[g(T_i) - g(C_j)]$** is also an **unbiased estimate** of the treatment effect

Prognostic Scores - How to calculate them...

- Rather than use both treatment and control subjects to model the response, **we use only the control group to model the response, $g(C_j|X)$.**
- **Use model built with data from control group to predict $g(T_i|X)$ for all the members of the treatment group.**
- Set of predicted response values are the **Prognostic Scores**

Information used by the propensity and prognostic score - *variable importance*

Propensity Score	Prognostic Score
<ul style="list-style-type: none">● Learning Style scores (all four dimensions)● Gender● Number of Office Hours Expected to Attend During the semester● Time expected to spend studying for the class at the beginning of the semester	<ul style="list-style-type: none">● Goal Grade● Confidence in One's Ability to be Academically Successful● Active/Reflexive and Visual/Verbal● GPA

Still working on getting a good matching...

- After computing both the prognostic and propensity scores, every observation in the treatment and control groups has an ordered pair associated with it
 $(prop(x), prog(x))$
- We then use R packages, `optmatch`, to create a full matching between members of treatment and control group
- ***But wait!*** propensity scores are in $(0,1)$ and our prognostic scores are roughly in $(65,97)$ - **how to deal with this imbalance in the scale?**

Computing Distance

- optmatch computes a Mahalanobis distance rather than Euclidean distance between observations
- **Definition:** Let X_1 and X_2 be two random vectors, then the **Mahalanobis Distance** between X_1 and X_2 , denoted $d(X_1, X_2)$ is:

$$d(X_1, X_2) = ((X_1 - X_2)^T S^{-1} (X_1 - X_2))^{1/2}$$

where S is the covariance matrix of the components of X .

- Recall that in our case, X_1 and X_2 would be 2 component vectors:
(prop(x), prog(x))

Saving the Distance Information

The dissimilarity information is then saved in a matrix as follows:

Suppose we have n treatment and m control observations, then the “*dissimilarity matrix*” we use is an $n \times m$ matrix whose i, j^{th} entry contains the *mahalanobis* distance between **treatment observation i** and **control observation j** .

Dissimilarity Matrix

...	Control Unit j	...
Treatment Unit i	$d(x_i, x_j)$...
...

Full Match

- *Informal Definition:* **full match** is a matching method whereby a sample is subdivided "...into a collection of matched sets consisting either of a treated subject and any positive number of controls **or** a control subject and any positive number of treated persons." (Hansen 2004)
- *Characteristics of full match:* "Among matching techniques for **observational studies**, full matching is in principle the best, in the sense that its alignment of comparable treated and control subjects is as good as that of any alternate method, and potentially much better. "(Hansen 2004)

For details see "Optimal full matching and related designs via network flows"
(Hansen 2006)

Results: ECoach Registered Students Only

Semester	Comparison	estimated difference	p-value	95% Confidence Interval	sample size	n omitted from match
Fall 13	High - Low	2.89**	7.6e-5	(1.48, 4.32)	H = 409 L = 445	H = 1 L = 25
Fall 13	High - Med.	1.268*	0.015	(0.25, 2.32)	H = 409 M = 410	H = 3 M = 10
Fall 13	Med. - Low	1.21*	0.061	(-0.05, 2.48)	H = 410 M = 445	M = 4 L = 12

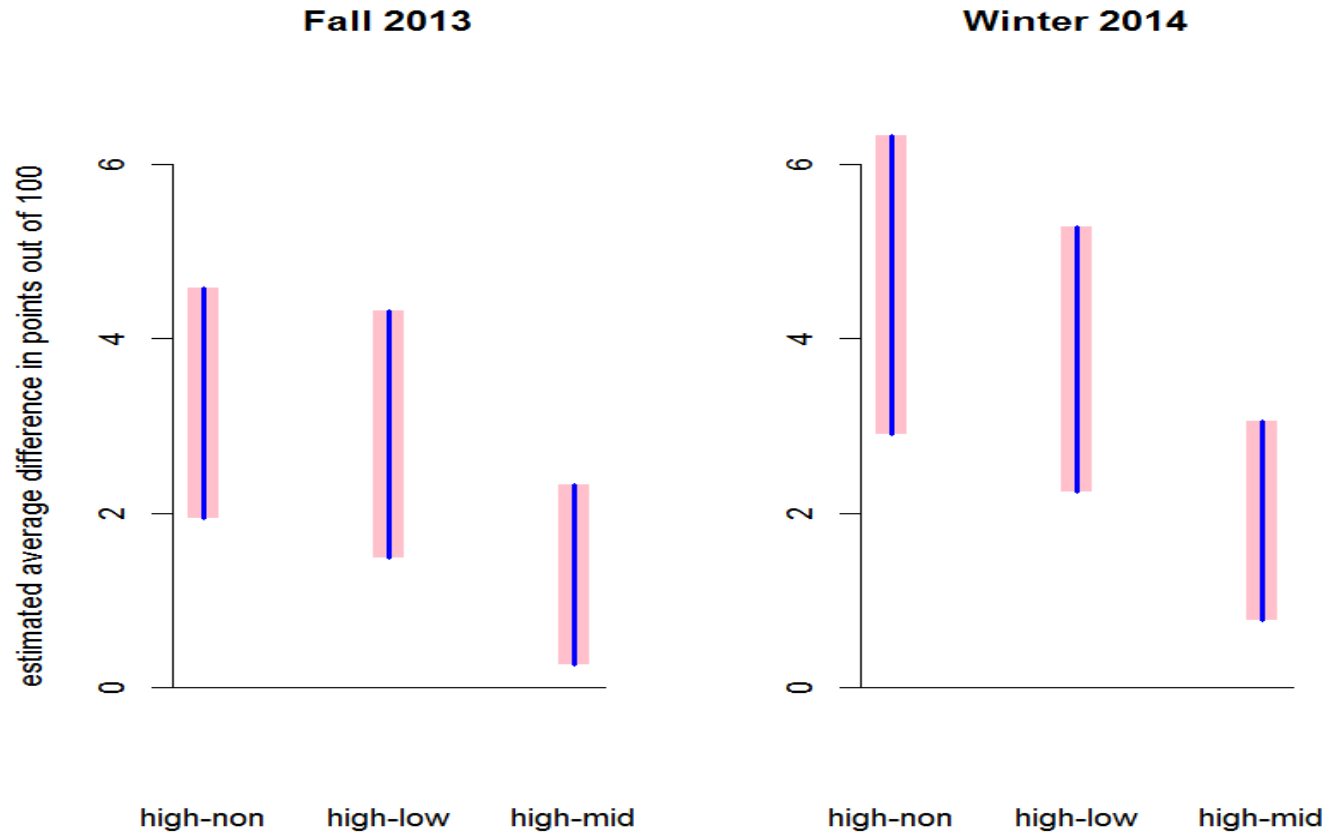
Winter 14	High - Low	3.77*	2.3e-6	(2.24, 5.29)	H = 429 L = 455	H = 0 L = 55
Winter 14	High - Med.	1.92*	0.0012	(0.77, 3.06)	H = 429 M = 449	H = 7 M = 16
Winter 14	Med. - Low	1.62**	0.0614	(-0.33, 2.82)	M = 449 L = 455	M = 4 L = 29

Results: ECoach Users vs. Non-Registered Students

Semester	Comparison	estimated difference	p-value	95% Confidence Interval	sample size	n omitted from match
Fall 13	High - Non	3.26*	2.7e-6	(1.94,4.58)	H = 336 Non = 303	H = 2 Non = 1
Fall 13	Med - Non	2.54*	8.9e-5	(1.29,3.78)	M = 381 Non = 303	M = 3 Non = 2
Fall 13	Low - Non	0.62*	0.36	(-0.70, 1.94)	L = 470 Non = 303	L = 0 Non = 0

Winter 14	High - Non	4.62*	3.8e-7	(2.90,6.34)	H = 432 Non = 312	H = 5 Non = 7
Winter 14	Med - Non	2.33*	0.01	(0.56,4.09)	M = 439 Non = 312	M = 0 Non = 8
Winter 14	Low - Non	0.83*	0.407	(-1.14, 2.79)	L = 450 Non = 312	L = 0 Non = 0

95% Confidence Intervals for Average Improvement in Final %



Meet Samantha ~ an average student

- **Samantha** is an average student that exists in two universes
- **Universe 1:** Samantha is taking STATS 250 during W14 term **BUT** in universe 1 there is no ECoach
- **Universe 2:** She is also taking STATS 250 but Ecoach exists and she is *totally excited* about receiving messages from Dr. Gunderson and reading other students testimonials. Her **Usage Ratio** = **0.85** (read 85% of released messages)
- **Universe 1:** expected grade is 89.4% (**an A-**)
- **Universe 2:** would expect her to score
~ $89.4 + 4.62 = 94.02\%$ on average (**an A**)
- **Better to be in Universe 2 in her case!**

Sp14: No E²Coach, but Interesting Experiment ...

- Ran a controlled experiment to test an intervention developed by **Patricia Chen** (UM Psychology PhD Student)
- Intervention gets students to **choose strategically among available class resources to plan their exam preparation**
- Total number of participants in study = 137
- Out of 100 percentage points, students in Treatment Group scored an **average of 3.7 percentage points higher** than students in the Control Group ($M_t = 87.9\%$ vs. $M_c = 84.2\%$), $t(df = 132) = 2.48, p = .0145$, and a 95% CI of (0.749, 6.67)
- Basis for expanded work in current F14 using EZCoach

F14: EZCoach +



- Get Things Done >
- Exam 1 Prep
- Pre-exam 1 Survey
- [Progress] Lab Attendance
- [Progress] Homework
- Problem Roulette
- Prelabs
- Office Hours
- Review: Common Survey
- Review: Stats Survey
- Howdy
- Welcome Message

Hello Brenda ~ Here is your Get Things Done (GTD) List for the week ...

Stats 250 GTD List for Oct 4 - 10 [Optional Download](#)

- Watch the short video for the [Confidence Interval Prelab](#) then **complete** the [Prelab Assignment](#). Use the simulation to answer the questions, submit your 1-2 sentence summary for each question – before **Mon, Oct 6, 8 AM**. If you have trouble getting the simulation to run, check out this [video](#) that shows one way to get it to work.
- Bring a printed copy of the [Lab 5 pages](#) about hypothesis testing, your clicker, and copy of the [\(yellow\) formula card](#) to lab **Mon-Wed, Oct 6-8**.
- Login to your online HW tool at [lecturebook.com](#). to work on the **required HW 3 questions** -- all entered answers automatically submitted for you **Thu, Oct 9, 8 AM**. Note: Q8(d) requires uploading a picture of a p-value – sketch a picture by hand and take a picture or use that `prob()` function or `pval()` function. Remember you also have some **recommended HW 3 questions and solutions** to review anytime.
- HW General Tips ... plan ahead!** Save HW work often. After you logout, go back in and check all looks ok. Print questions with your answers to pdf as back up of work. There are 7 days for each HW. If question requires SPSS or upload, work on it early (technical issues the evening before HW is due is not valid excuse for not completing it). **Lecturebook technical support: support@lecturebook.com**.
- Review that **cool p-value function** under [R Tutorials](#) on canvas. The **pval()** function is a mini-program created in [R](#) that automatically calculates an exact p-value, as well as draw a very nice plot of that p-value for a variety of tests, the first option being for a large sample Z test for a population proportion p. You can use it to create the nice picture to upload for HW 3 Question 8(d)-- [sometime this week](#) .
- Reviewing material and have a question?** Stop by the Stats 250 office hours in the SLC (1720 Chem) – Sun 1-4, Mon 9-5, Tue 9 am-10 pm, Wed 9-9, Thu 9-2:30, Fri 10-2. Be sure to check the canvas HOME page for **updated hours for Exam 1 week (Oct 13-16)**.
- Watch the short video for the [Type I and Type II Errors Prelab](#) then **complete** the [Prelab Assignment](#). Use the simulation to answer the questions – before **Mon, Oct 13, 8 AM**.
- Exam 1: Thu, Oct 16, 6:10 – 7:40 PM** -- [Room and Review Details](#) are posted on canvas. Remember you have old exams for practice in your lab workbook and [video solutions](#) on canvas; finally check out the [Exam Cover Instructions](#) [anytime before the exam](#).
- Try creating your one 1-page "**Almost Everything about ____**" chapter/topic summary sheets. An example is on canvas (in Files, under Exam and Review Info) called [Almost Everything Example](#) - [anytime before the exam](#).
- Statistics in the News: Check out this NYTimes article** called **The Odds, Continually Updated** which talks about how a Long Island fisherman owes his life to a field known as Bayesian statistics, a set of rules for using new data to continuously update beliefs or existing knowledge - [anytime](#).

F14: EZCoach + Canvas +

M Pilot canvas As: Test Student Log

Courses ▾ Grades Calendar

STATS 250 Fall 2014

Home **Intr Stat&Data Anlys**

Announcements
Modules
Assignments
Grades **16**
Files
BlueReview
Pages
People

View Course Stream

Recent Feedback

- Homework #2
0 out of 30
- Time Plots and QQ Plots P
0 out of 2
- Practice Homework
10 out of 10

13 more ...

Statistics 250 F14

Introduction to Statistics and Data Analysis

Exam 1 = Thu, Oct 16, 6:10-7:40 PM (Stat 250 F14 Exam 1 Info [updated.pdf](#))

Office Hours		
Instructor	Times	Location
Dr. Gunderson	Week of Oct 6: Th 10-11:30, 1-2:30	445A WH
Dr. Miller	Week of Oct 6: Th 11am-2pm	427 WH
Dr. Romero	M 10-11am, M 4:10 - 5:10pm, W 4:10-5:10pm	443 WH
Dr. Venable	MW 11:10am-12:10pm, Tu 4:10-5:10pm	270 WH
GSIs	Su 1-4pm, M 9am-5pm, T/W 9am-10pm, Th 9am-2pm, F 10am-2pm Full GSI Office Hour Listing Week of Fall Break Office Hours	1720 CHEM (SLC)

[Department of Statistics Tutor List](#)

Links to Common Resources

- [Prelab Tutorials](#)
- [Practice Exams](#)
- [Problem Roulette](#)
- [LectureBook](#)
LectureBook Homework Tool
- [open.michigan](#)
Open Michigan
- [Virtual Sites](#)
Virtual Sites (for accessing SPSS)
- [R Tutorials](#)
- [Lab Make-Up Form](#)
- [Formula Card](#)
- [GSI Lab Schedule](#)
- [YouTube](#)
Stats 250 YouTube
- [EZCoach](#)
- [Dr. Miller's HyFlex Lectures](#)

F14: EZCoach + Canvas + Expanded Experiment (from Spring)



[Get Things Done](#)

[Exam 1 Prep](#)

[Pre-exam 1 Survey](#) >

[\[Progress\] Lab Attendance](#)

[\[Progress\] Homework](#)

[Problem Roulette](#)

[Prelabs](#)

[Office Hours](#)

[Review: Common Survey](#)

[Review: Stats Survey](#)

[Howdy](#)

[Welcome Message](#)

Student Learning Project Pre-Exam 1 Survey

Graduate students Patricia Chen and Omar Chavez, along with Dr. Brenda Gunderson, are conducting a study to understand student learning in Statistics 250. As a current Stats 250 student, you are invited to participate in this research study.

Before and after each of your exams, we will make available short online questionnaires. Each survey will take approximately 10 minutes. Doing each survey will count for 1 extra credit point, for a total of 6 possible points that will go towards your homework total. You can participate in any and all surveys, and there will be no penalties for choosing not to participate. Alternatively, you can write an 12-page paper for the same 6 extra credit points. If you choose the paper option, please contact Dr. Gunderson for more details. You may only choose either the surveys or the paper for your extra credit, but not both.

There are no anticipated risks or benefits to participants in this study. This study seeks to gather information that may ultimately be useful in advising students on how to study and prepare successfully for exams in Statistics. You may ask questions about this study at any time. You may also refuse to participate in this study, discontinue at any time, or not answer questions without any consequences. Participation or non-participation in this study will, in no way, affect your academic standing or record.

Participation in the study is voluntary. You may refuse to participate in the entire study or in any part of the study. You are free to withdraw at any time without any negative effect on your relations with the University of Michigan or with any other participating institutions or agencies. You may skip any question that you feel uncomfortable answering.

Any inquiries about this study should be directed to Patricia Chen (patchen@umich.edu), Department of Psychology, University of Michigan, 3232 East Hall, 530 Church Street, Ann Arbor, Michigan, 48109-1043. Alternatively, you may contact Dr. Brenda Gunderson at bkg@umich.edu.

Note: Please only use the forward and back buttons on the web page during the survey, DO NOT use the back button on your keyboard because it interferes with the response process. This survey should only be taken on computers or laptops and NOT via cell phone due to past issues with submitting responses via cell phones.

If you consent to participate in this survey, please start the survey by clicking on the next page.

[Begin](#)

THE FIELD GUIDE to DATA SCIENCE

Booz | Allen | Hamilton



Steven Mills
(@stevndmills)

Data Science, like life, is not linear. It's complex, intertwined, and can be beautiful. Success requires the support of your friends and colleagues.

Requires a team



Peter Guerra
(@petruguerra)

Data Science is the most fascinating blend of art and math and code and sweat and tears. It can take you to the highest heights and the lowest depths in an instant, but it is the only way we will be able to understand and describe the why.

**Art + Math + Code
+ Sweat + Tears**



Drew Farris
(@drewfarris)

Don't forget to play. Play with tools, play with data, and play with algorithms. You just might discover something that will help you solve that next nagging problem.

Don't forget to Play!

The Stats 250 E²Coach Story

References

1. Ben B. Hansen; The prognostic analogue of the propensity score; *Biometrika* (2008) 95 (2): 481- 488 doi:10.1093/biomet/asn004
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4. The Consequences of Adjustment for a Concomitant Variable That Has Been Affected by the Treatment by Paul R. Rosenbaum *Journal of the Royal Statistical Society. Series A (General)*, Vol 147, No 5 (1984), 656-666
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6. Can Nonrandomized Experiments Yield Accurate Answers? A Randomized Experiment Comparing Random and Nonrandom Assignments. William R. SHADISH, M. H. CLARK, and Peter M. STEINER; *Journal of the American Statistical Association*, December 2008, Vol. 103, No. 484.
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8. Full matching in an observational study of coaching for the SAT. Hansen, Ben *Journal of the American Statistical Association* (2004), 99(467): 609-618.
9. Optimal full matching and related designs via network flows. Ben B. Hansen and Stephanie Olsen Klopfer, *Journal of Computational and Graphical Statistics*, 2006 *JCGS* 15 609-627.
10. Felder, R.M., and Soloman, B.A. (n.d.). *Index of Learning Styles*. Retrieved from <http://www.ncsu.edu/felder-public/ILSpage.html>

The Stats 250 E²Coach Story

Thank you! Questions?

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Omar Chavez
odchavez@umich.edu

