Making the leap to an engaged classroom
- or -
What are all these white boards doing in 1005?

Jeff Fessler

2015-05-22 / 2017-04-07

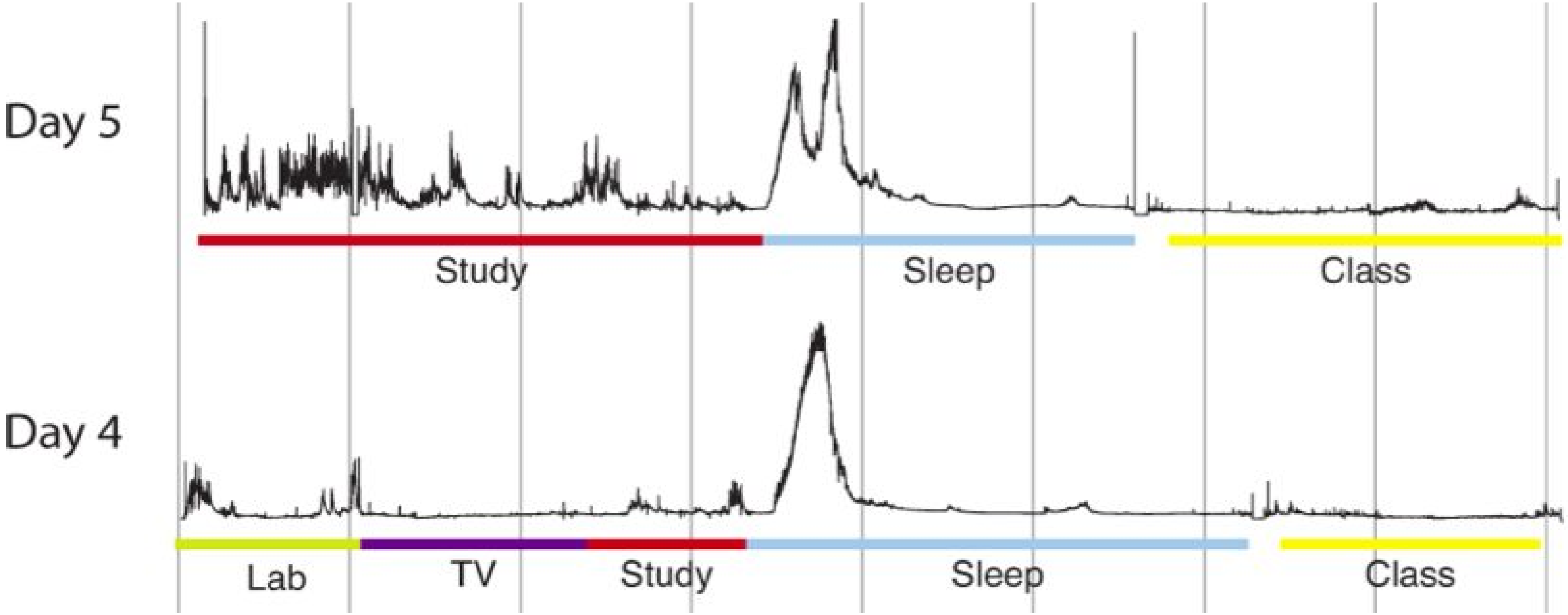
ELECTRICAL ENGINEERING &
COMPUTER SCIENCE
UNIVERSITY OF MICHIGAN

Background on W15 experiment

- Eric Mazur, Harvard Physics (peer instruction)
- Steve Yalisove, MSE 220
- Winter 2015 “experiment” sponsored by Brian Noble (ADUE) and Jennifer Linderman (ADGE)
- 5 volunteers, mentored by Steve:
  - Jay Guo (ECE)
  - Nancy Love (CEE)
  - Rachael Schmedlen (BME)
  - Ariella Shikanov (BME)
  - JF (ECE)
- My interest: interactive class / engaged learning, i.e., “flip” class

  but without becoming movie writer actor cameraman editor distributor...

Why engaged learning / flipped classroom / active learning?



M Poh, M Swenson, R **Picard**: A wearable sensor for unobtrusive, long-term assessment of electrodermal activity. IEEE Tr. on Biomed. Engin., 57(5):1243-52, May 2010.

“attention-grabbing stimuli and attention-demanding tasks ... evoke increased EDA responses”

New annotation tool: “NB” (Nota bene)

- http://nb.mit.edu (created in 2009 with UM’s Mark Ackerman)

  Zyto, Karger, Ackerman, Mahajan (2012): Successful classroom deployment of a social document annotation system
- free, open source annotation tool (*Q: heard of it? used it?*)
  - UM server now: https://nb.engin.umich.edu

Principles:

- cf writing notes in the margin of a book
- Many questions can be answered by other students
- Learning by teaching (peer instruction)
- provides context, unlike traditional online forums

(live demo - hopefully) Student view on next slide...

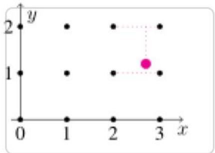
Jeff Fessler Help

© J. Fessler, February 12, 2015, 22:39 (student version) page 9 8.9

(one page of 640)

2D linear or bilinear interpolation

For **bilinear interpolation** of 2D samples, roughly speaking one first does **linear interpolation** along x, and then linear interpolation along y, (or vice versa.)
More precisely, the procedure is to find the four nearest sample locations, interpolate the top and bottom pair along x, and then interpolate the resulting two points along y. This figure illustrates the process graphically for the case $\Delta_X = \Delta_Y = 1$.



Clearly this process is (integer) shift invariant, so we can determine its interpolation kernel by interpolating the 2D Kronecker impulse $\delta_2[n,m]$. For a point (x,y) that is within the unit square $[0,1]\times[0,1]$, one can verify that the interpolation kernel is $(1-x)(1-y)$. Considering the symmetries of the problem, for locations (x,y) within the square $[-1,1]\times[-1,1]$ the interpolation kernel is $(1-|x|)(1-|y|)$. Otherwise the kernel is zero, *i.e.*,

$$h(x,y) = \begin{cases} (1-|x|)(1-|y|), & |x|<2,\ |y|<2 \\ 0, & \text{otherwise.} \end{cases}$$

In other words, bilinear interpolation is equivalent to using (8.1) or (8.2) with the following interpolation kernel: [RQ$_0$]

$$h(x,y) = \boxed{??}$$

An alternative way to view bilinear interpolation is as follows. For any point (x,y), we find the four nearest sample points, and fit to those four points a polynomial of the form

$$\alpha_0 + \alpha_1 x + \alpha_2 y + \alpha_3 xy. \tag{8.9}$$

Then we evaluate that polynomial at the desired (x,y) location.

Example. Consider a point (x,y) that is within the unit square $[0,1]\times[0,1]$. Then the four nearest samples are $g_d[0,0]$, $g_d[1,0]$, $g_d[0,1]$, $g_d[1,1]$. To fit the polynomial we set up 4 equations in 4 unknowns:

$$\underbrace{\begin{bmatrix} 1 & 0 & 0 & 0 \\ 1 & 1 & 0 & 0 \\ 1 & 0 & 1 & 0 \\ 1 & 1 & 1 & 1 \end{bmatrix}}_{[\,1 \;\; x \;\; y \;\; xy\,]} \begin{bmatrix} \alpha_0 \\ \alpha_1 \\ \alpha_2 \\ \alpha_3 \end{bmatrix} = \begin{bmatrix} g_d[0,0] \\ g_d[1,0] \\ g_d[0,1] \\ g_d[1,1] \end{bmatrix}.$$

page 9

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Solving for the coefficients and substituting into the polynomial and simplifying yields

43 threads me 14 ★ 1 ? 0

2 for this function, what if the delta_x is not equal to 1 in 8.4…
2 Is this a convention? Can samples to the left be used inst…

5 threads on page 9

4 ★ I don't think I'm understanding this figure, how can some …
2 Is this the case for bi linear interpolation only?
3 How can we verify that the interpolation kernel is (1-x)(1-y…
2 Why should we consider the symmetries of the problem h…
3 Since only locations (x,y) within the square [-1,1] X [-1,1] …

4 threads on page 12

3 How is this defined? I see how, once we have our points, …
1 It also looks like it's not separable, so it violates another o…

? + 0 - replies requested

Why should we consider the symmetries of the problem here? And it says we should consider location (x, y) within [-1, 1]*[-1, 1] to deal with the symmetries of the problem. But in (8.2), it seems that we want to recover ga(x, y) when 0<=x<=N-1 and 0<=y<=M-1. Why we consider location out of this region here?
Yu Chen – 16 Feb, 02:35PM EST

In 8.2 we considered the samples (n,m) to be within [0:N-1 , 0:M-1] and not x ,y. In fact, precisely when x/delta_x, y/delta_y is not in this range, we have to extrapolate the values as mentioned in page 8.7.
Considering range [-1, 1] X [-1, 1] enables us to define the shape of the kernal (tri(x) in 1D example)
Shweta Khushu – 17 Feb, 12:46AM EST

NB: Instructor view (pdf download)

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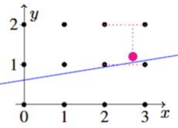

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How can we verify that the interpolation kernel is (1-x)(1-y)? Are we using the equation 8.2? If so, what is our g_d[n,m] and g_a(x,y) in this situation? Is g_d[n,m]=delta[n,m], and g_a(x,y) is the picture in the right above corner? Can someone illustrate how we get the h(x,y)=(1-x)(1-y)?

In 1D, the kernel is tri(x). When consider x in [0, 1], the kernel is h(x)=(1-x). In 2D, when consider location (x, y) in [0, 1]*[0, 1], the kernel should be h(x, y)=(1-x)(1-y). That's what I think about how it comes from.

Just to add to that, tri(x) corresponds to the x range: [-1 1]

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Since only locations (x,y) within the square [-1,1] X [-1,1] are considered, shouldn't it be |x| <= 1, |y| <=1 ?

Right, I also think the 2s should be replaced by 1s.

JF: oops, you are right!

Format - engagement before class

- Students read (detailed) course notes before each class
  - Annotate notes (4-5 per assignment) before class using NB
  - Answer short “reading questions” (RQ) before class

    (initially used Google forms, later used CTools, then Canvas...)

    (4 points if attempted, 5 points if correct - learning not assessment)
  - RQ always included “what part was most interesting/confusing”

- Prof reviews student annotations and RQ answers before class

- Students prepare individual HW solutions prior to Thu class

Format - in class (Tuesday)

- Short overview of main points
- Discuss main points of confusion
- Discuss RQ where “too many” were incorrect
- No wasted time on the points they all get

- In class group work using white boards
  - Aerial instructor view is helpful (flat classroom)

Format - in class (Thursday)

- Shorter version of Tuesday format (less reading)
- Group work on HW problems
  - Focus is on *learning*, not assessment
  - Prof. checks individual HW for completeness, not correctness
  - Graded based on effort and honesty, not accuracy
  - Students self correct their errors
  - Solutions shown as each group finishes a problem (if needed)
  - Individual short self-reflection turned in next day
  - No incentive to copy or cheat on HW

Exams

- Part evening in class, part take-home
- Group solutions the next day
  - Emphasis on learning again (immediate feedback)
  - Exam solutions posted at end of that class
  - 75% score individual exam work
  - 25% score group exam work
  - Average boost in score only 5%
  - Not sure if that was worth entire class period
- scores comparable to past years...

Course evaluation feedback

I was skeptical about the 'engaged learning' thing; however, after the one full day of lecture we had, while very good, I concluded that group-work was far more useful and engaging than sitting in a chair staring at the front of the room.

The assigned reading helped me prepare for lecture. I liked the adjustment that was made midway through the semester for Professor Fessler to explicitly highlight the key topics in lecture.

I found the group work (as well as annotations) guided by the instructor to be particularly helpful in gaining a deeper understanding of the material.

The "big picture" can be communicated much more easily in a lecture than a reading. I think a bit of a hybrid of hands on and lecturing - similar to what happened towards the end of the class - worked well.

Course feedback continued

I couldn't be happier with this engaged method. Sure, it is a lot more work than the average engineering lecture-based course. However, rather than semi-learning material throughout the term and cramming at the end for a final (in which I will likely forget some of the material later), I am really gaining a deep understanding of everything presented each time we meet and know that I will understand/maintain the material from this course much better than with a traditional teaching method.

This class was a lot of work. Far more than either of my other 3-credit classes this semester. The workload was really more appropriate for a 4-credit class, and adding a 4th credit would mean an extra hour of lecture, so it would really be a win-win. I'm sure it's a bureaucratic nightmare to get the credit level changed, but it might be worth looking into.

Course feedback continued

- essentially no change to Q1/Q2 scores
- much more written feedback than usual

- lowest median:

239 The amount of work required was appropriate for the credit received. 4 8 2 5 0 3.81

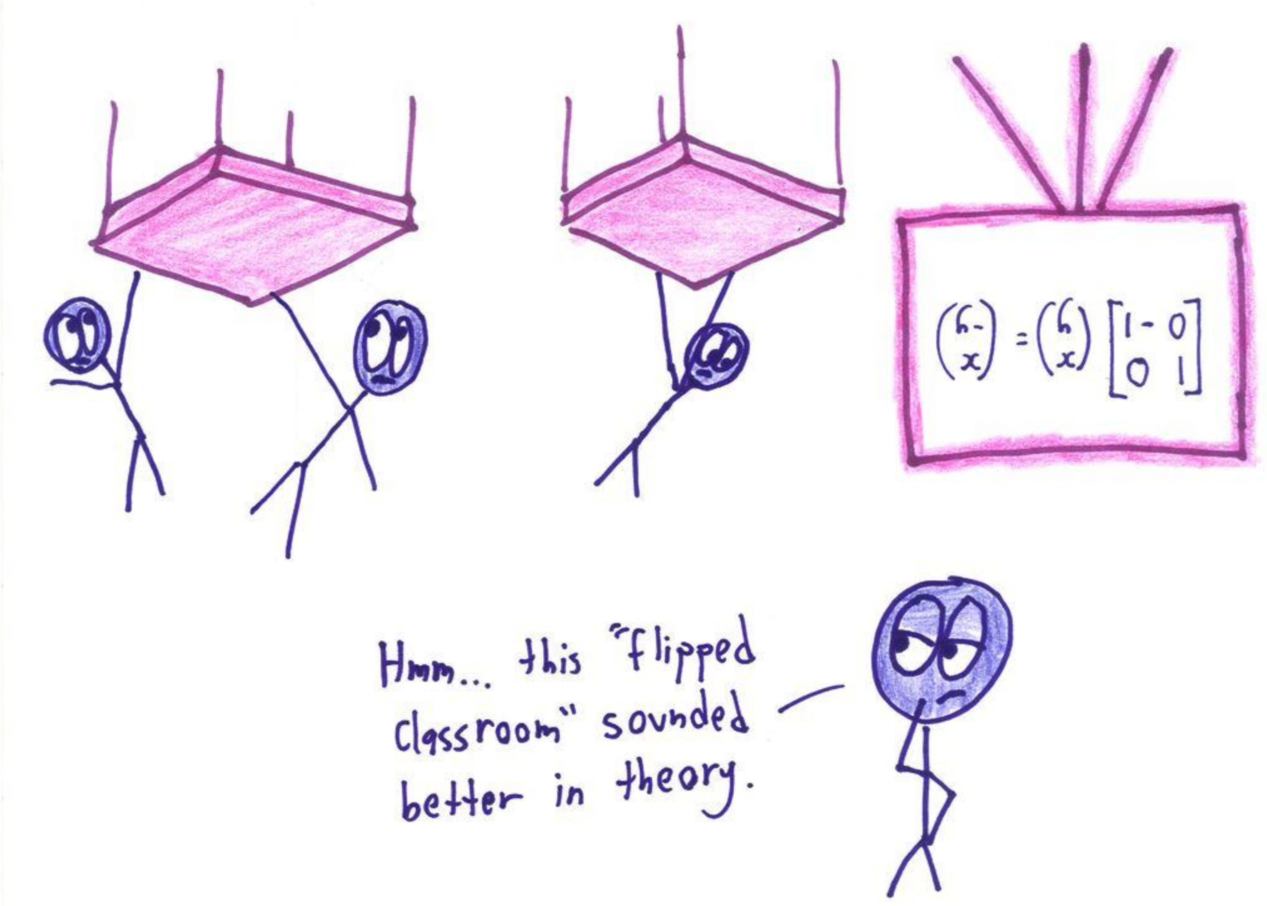
- (Despite this gripe the overall course evaluations for Q1 and Q2 were high.)

Take aways

- I will do this again in 556 (with refinements)
- It was much more interesting than lecturing
- Top students “help teach” in group work
- Numerous errors in notes corrected
- Many higher-level concepts debated too in NB
- Auto-grading of NB annotations on horizon

    http://perusall.com

- Unsure how to scale to large classes / terraced rooms
    - I might use NB even with traditional lecture



https://mathwithbaddrawings.files.wordpress.com/2017/04/20160725083200_00044.jpg