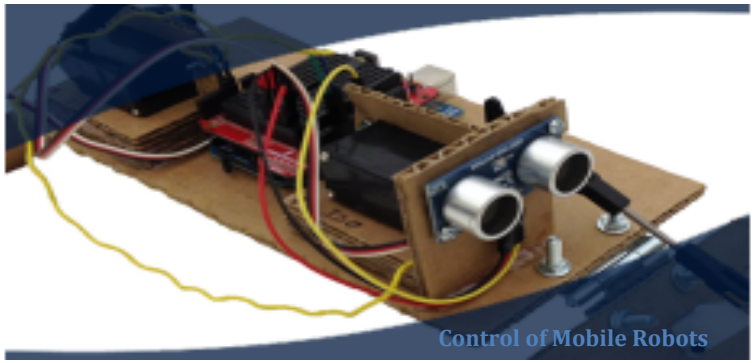
The Mechanics of a CPS(-ish) MOOC: The Good, The Bad, The Ugly

Magnus Egerstedt

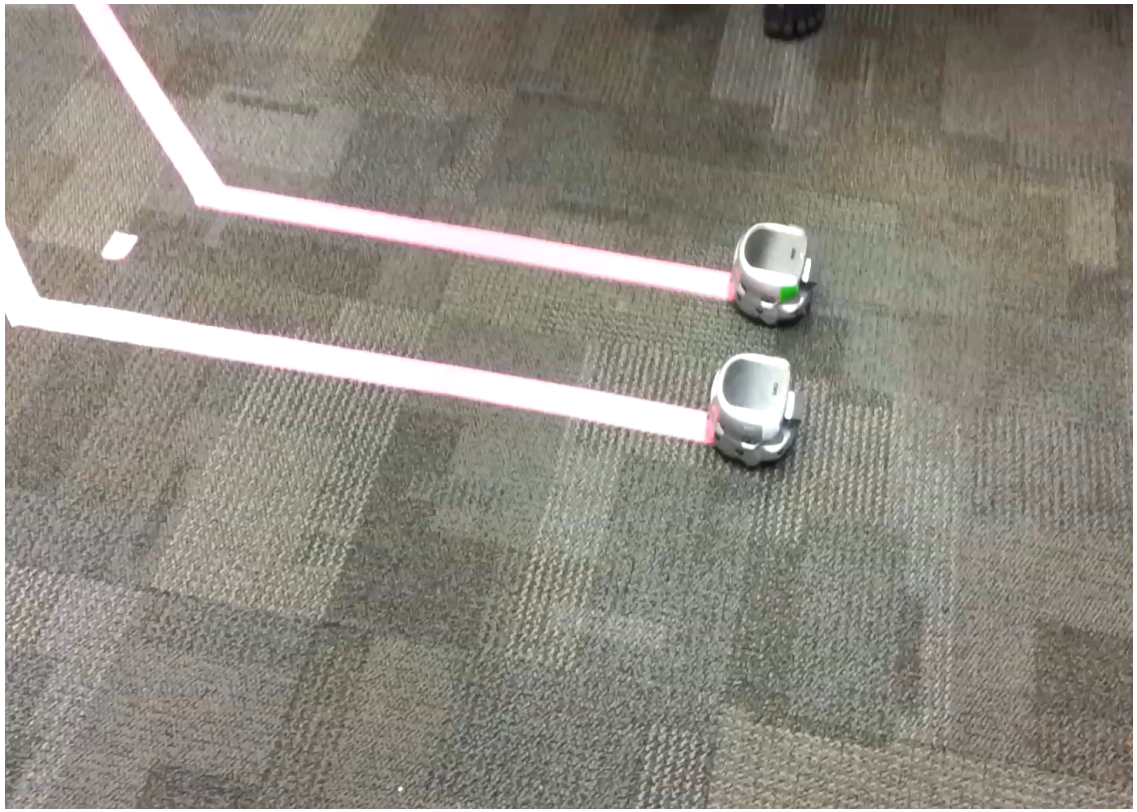
Electrical and Computer Engineering
Georgia Institute of Technology
www.ece.gatech.edu/~magnus



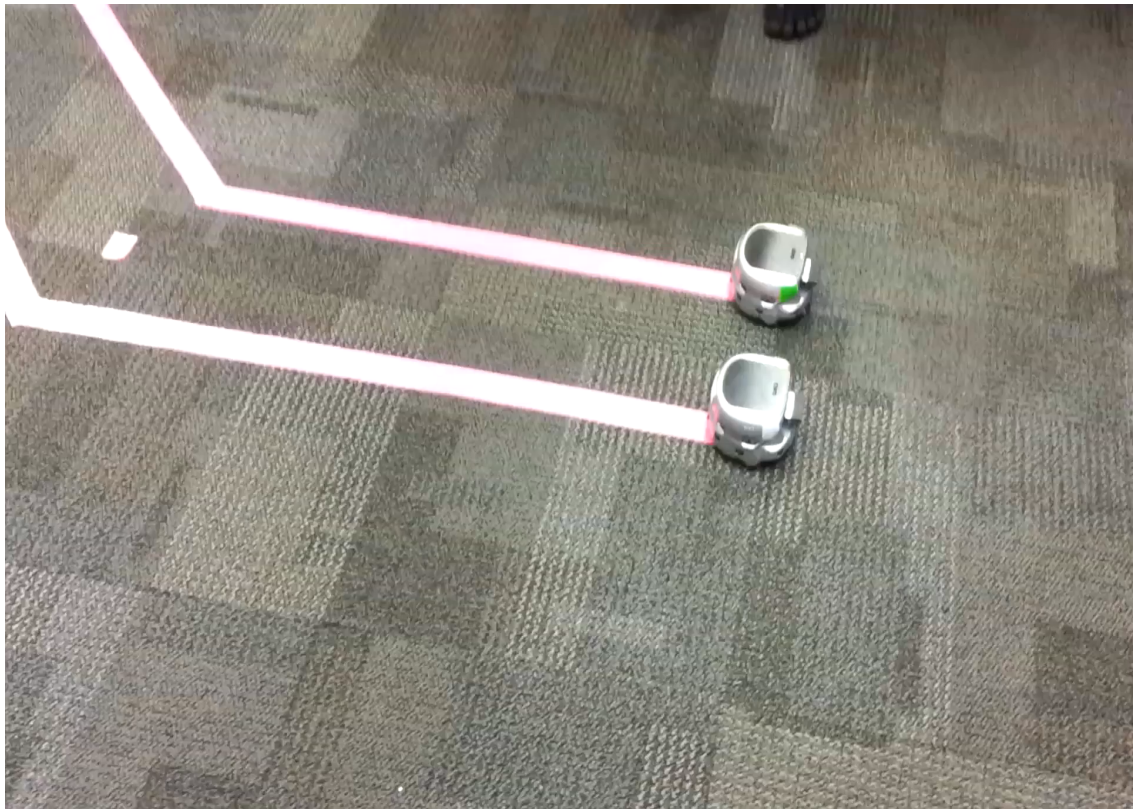
Where my troubles began:

$$\mathbf{U(s)} = \left(\mathbf{K_P} + \mathbf{K_D s} + \frac{\mathbf{K_I}}{\mathbf{s}}\right)\mathbf{E(s)}$$

Robots In the Classroom: GT-ECE4555



Robots In the Classroom: GT-ECE4555



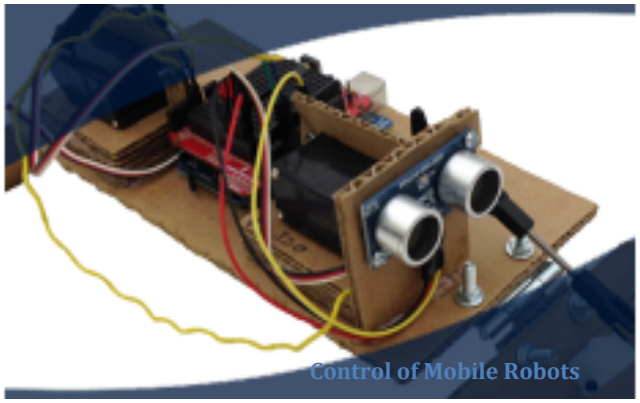
How to bridge the theory-practice gap in a *meaningful* way?

Flipped Classroom?

- Somehow outsource the theory part
- Lots of hands-on projects
- MOOC?
  - Very few (none back in 2012) upper-level CPS-ish MOOCs
  - Senior GT students are the target audience

MOOC: Control of Mobile Robots

- Somehow outsource the theory part
- Lots of hands-on projects
- MOOC?
  - Very few (none back in 2012) upper-level CPS-ish MOOCs
  - Senior GT students are the target audience



- 40,000(Y1), 61,000*(Y2) students
- 7 weekly modules (8 sub-lectures each)
- Weekly quizzes (multiple choice)
- GT "Certification"
- **Flipped classroom (GT-ECE4555)**

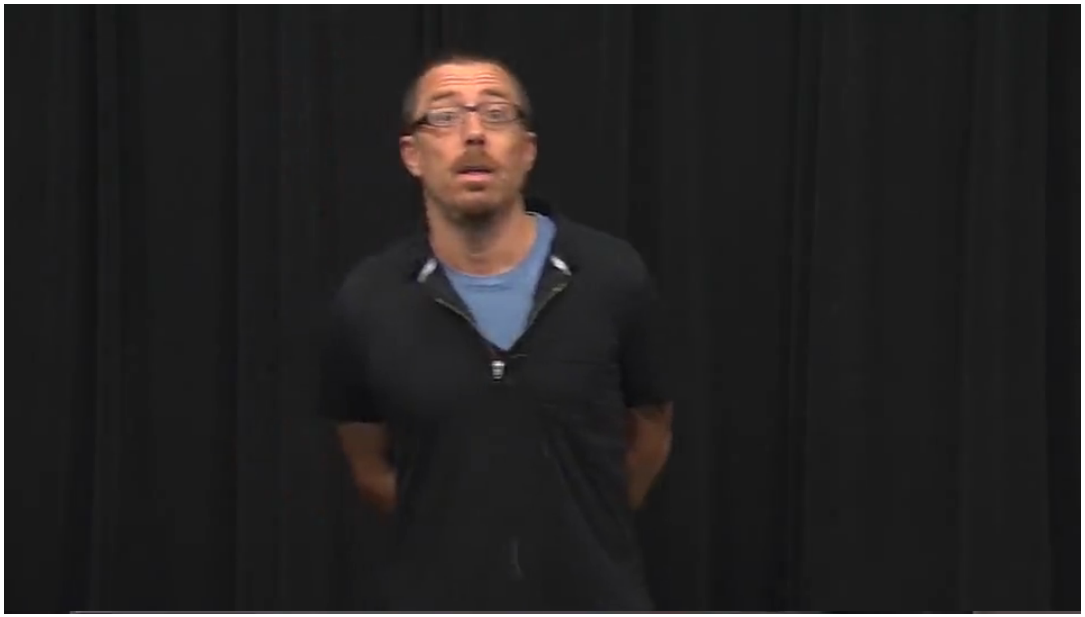
MOOC: Control of Mobile Robots

WEEK 1:

Introduction to Controls

WEEK 2:

Mobile Robots



WEEK 3:

Linear Systems

WEEK 4:

Control Design

WEEK 5:

Hybrid Systems

WEEK 6:

The Navigation Problem

WEEK 7:

Putting It All Together

Flipped Classroom

ECE4555 - Spring 2013

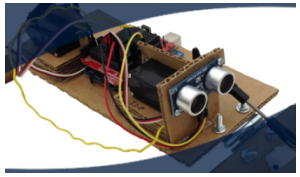
Embedded and Hybrid Control Systems

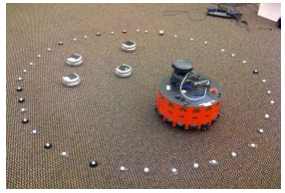
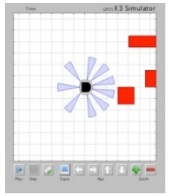
Magnus Egerstedt

Teaching Assistant: Jean-Pierre de la Croix

The emergence of increasingly complex engineering systems (so called embedded control systems), found for example in aircrafts, cars, robots, and manufacturing systems, where dedicated microcontrollers are combined according to a discrete switching logic, has provided new challenges in the areas of software development and control design. The objective of this course is to model, analyze, and control such systems, where continuous modes are linked together according to given transition rules. For this, a hybrid control theory is needed that combines ideas from computer science, such as automata theory and formal languages with classic as well as modern, state-space based control theory.

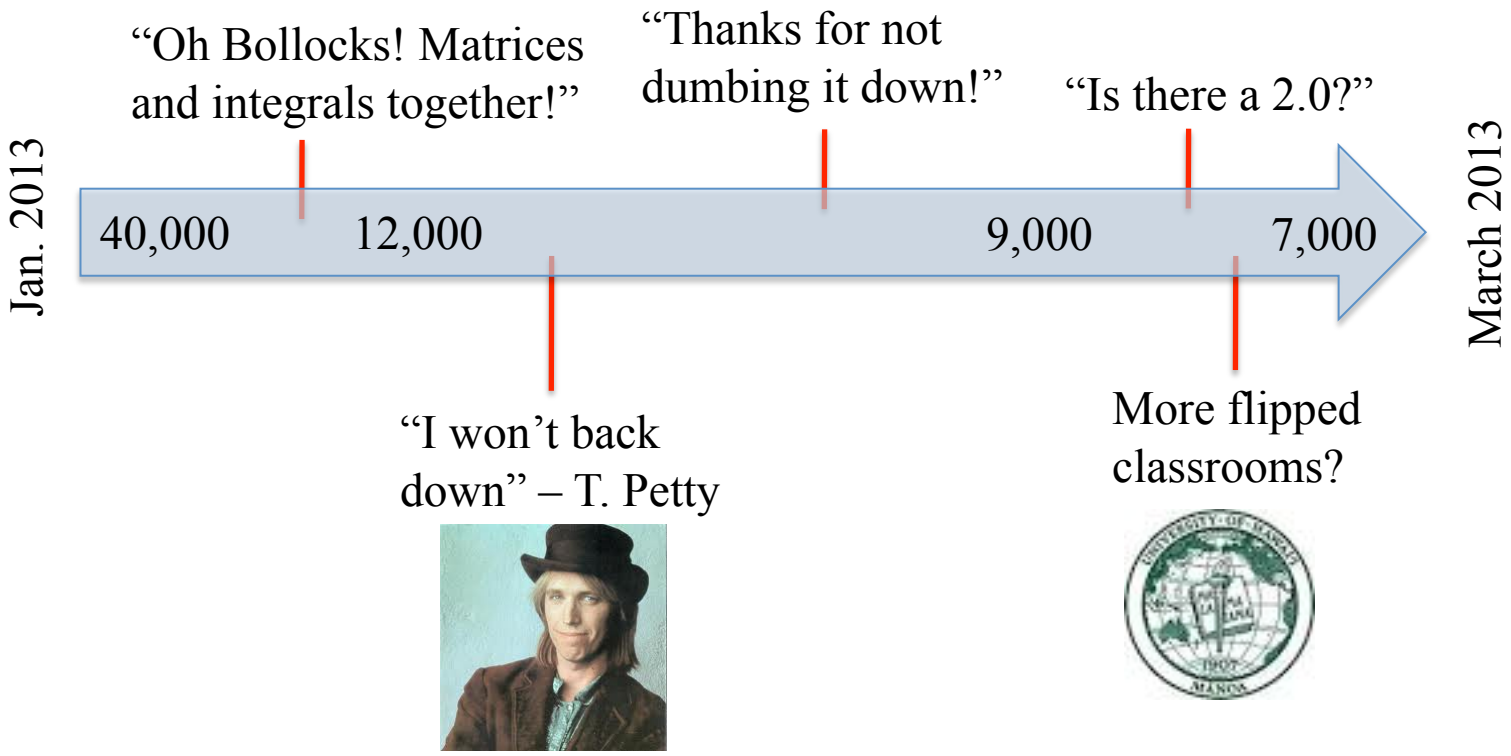
The driving application in this class will be control of mobile robots through a number of in-class projects, focusing on how to make mobile robots navigate cluttered and unknown environments in an autonomous manner.



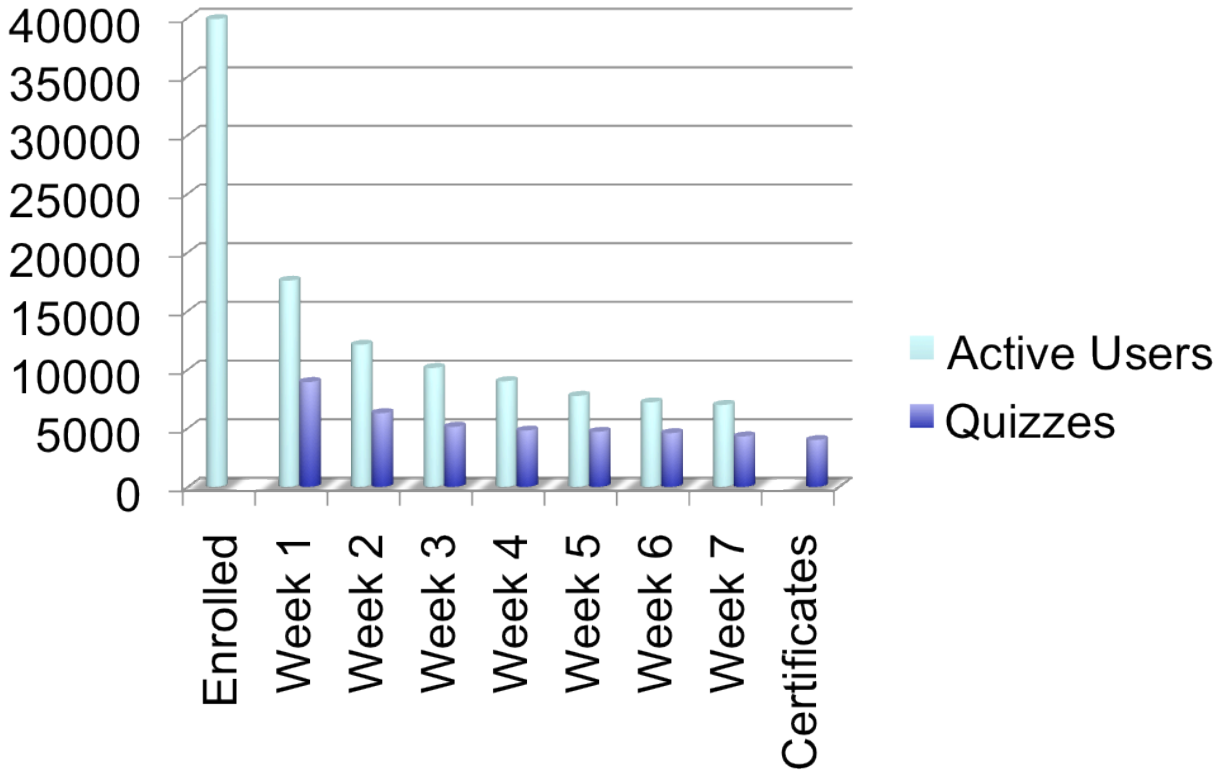



WARNING: This is not a regular class. Instead, we will be attempting a so-called *flipped classroom* by following two distinctly different modes of operation. The first and third phases of the class will look more or less like a traditional class, while the second phase will constitute the flipped classroom. What this means is that you will be asked to prepare material on your own - by taking my online course on "Control of Mobile Robots" and then we will work on robots in the classroom. To complete this course, you must also attend the online course as well as do the weekly assignments in that course, available at **https://www.coursera.org/#course/conrob**.

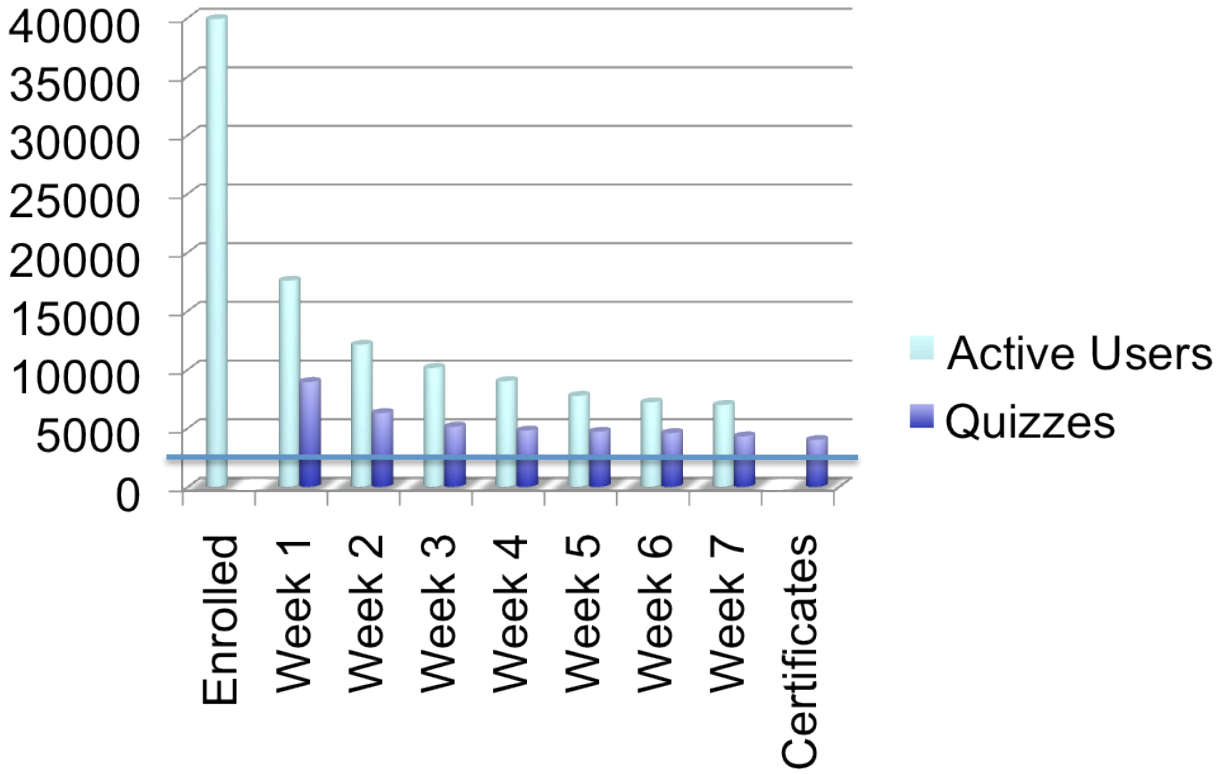
MOOC (Y1) Chronology



Participants

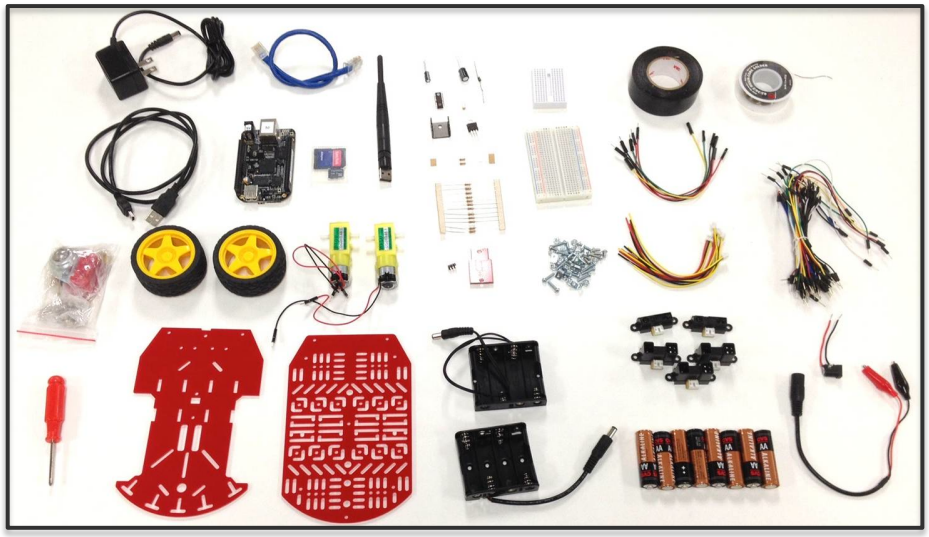


Participants



Year 2

- Bridging the theory-practice gap on a massive scale?
- *Price* vs *performance* vs number of *solder joints* vs *parts availability* vs ease of mapping *algorithms to code*?



- Solution: The **QuickBot**!
- Diff. drive, 4 IR, WiFi, optical encoders, BeagleBone Black/Arduino
- Cost: $160-$200 (Next year: Free?)
- Optional part of the MOOC

QuickBots! (Thousands of them…)

The Good, The Bad, The Ugly

- 40,000 is different from 40
- An incredible time-sink (3x before & during, workload models, studio time, support staff)
- CPS education is tricky (prereqs?, assignments?, labs?, multi-disciplinary?…)
- Internet people are mean (protect the TAs)
+ Appetite for serious CPS content (modules?)
+ Flipped classrooms
+ Incredibly rewarding
+ Continuing education
+ ***MOOCs are still mysterious in general and w.r.t. CPS in particular! We can be leaders!***