Lectures

It is when students want to learn, that learning happens as a side effect of their interest. Unfortunately, students often lose track of why they want to learn what we want to teach. Especially with complex mathematical topics that may appear abstract and pointless. I believe that constantly reminding them why is one of the main tasks of a teacher. Luckily, practical examples are perfect for this. They can help gain the students’ interest by connecting abstract topics with down-to-earth, appealing applications.

With this in mind, I like to start each topic with an engaging and intuitive story. Fortunately, engineering offers an endless source of those. And since I believe in examples, here is one. Suppose NASA asks you to determine whether two meteorites — one that fell in Roswell, New Mexico, and one that fell in Chelyabinsk, Russia — came from the same asteroid in space. How would you do this? We could model the densities of each meteorite as gaussian random variables, and use a likelihood ratio test to determine whether they have the same mean. And voila! Hopefully at this point students can relate to hypothesis testing and find it interesting.

However, interest and big pictures can fade away. Especially because most topics cannot be covered in a single class. Therefore, I think it is crucial to connect the ideas in consecutive classes. To this end, at the beginning of each class I like to briefly remind my students of our goal, where we stopped last time, and what we are going to cover today. This allows us to dive deeper into what would otherwise seem like incomprehensible equations and theorems, without losing touch with the big picture. Remember how NASA wants us to determine whether two meteorites came from the same asteroid? We are already thinking about using a likelihood ratio test. But is this the best way? What does it even mean to be best here? Today we will study these questions, and we will learn Neyman-Pearson’s Lemma, which tells us in what sense the likelihood ratio test is the best. Similarly, at the end of each class I like to remind students of our goal, what was covered today, and what we plan to do in the next class.

Homeworks

There is a lot of time between today and the next class. And that is a good thing. Ideas can take some time to sink in. Students often have to play and experiment with concepts before fully understanding them. They say: if you want to understand something, write about it. I would rephrase: if you want to understand something, code it up. Wilks’ theorem says that if NASA gets a lot of samples (meteorites), our likelihood ratio test will behave like a $\chi^2$ random variable. One can easily try this out with a few lines of code, and see Wilks’ theorem in action. We are fortunate to teach and learn at a time when computers, the Internet, and high-level programming (e.g., Matlab) offer endless opportunities to solidify knowledge with simple experiments.

Projects

Learning is about acquiring knowledge. The purpose of classes and homework is to spread the knowledge that mankind has gained over years, centuries, millenniums. But there are things that nobody knows... yet. Students play a decisive role in extending our knowledge. Class projects are tremendous opportunities to explore and apply ideas. I would not like my students to accumulate vast amounts of knowledge, without knowing what to do with it. So when it comes to projects, I give students the choice to either apply ideas from class to a problem in another field, or propose an idea to solve an open problem from class. Or both. For example, recently a dentist was accused of spreading a disease between his patients. Maybe you can use the same NASA likelihood ratio test to determine whether the infections of different patients came from the same place.

They say good problems fight back. So not all ideas will pan out. But that is fine. Negative results provide knowledge too. They tell us which paths do not lead to the answer so that we try others. That is precisely what research is about. Search for an answer here. If the answer is not here, search somewhere else: re-search. Maybe you find that because of the way diseases mutate, the NASA approach cannot be used in the dentist case. This would be an example of a negative result. But that does not mean it is useless. Maybe the prosecutor will try to convict the dentist using a likelihood ratio test. You could prove him wrong.

Acquiring knowledge bestows the responsibility of doing something with it. For better or worse, no man is an island. Whether to disseminate knowledge (as teachers) or to apply it (as engineers) or to extend it (as researchers), at some point students will inevitably have to interact with broad audiences. These interactions will demand their ability to convey ideas clearly. Presentations help develop essential communication skills. Therefore, one significant part of my project assignments involves giving a short talk explaining their findings. You need to convince the jury why the likelihood ratio test cannot be used in the dentist case.

http://danielpimentel.github.io
Evaluation

One fundamental part of teaching is evaluating performance. Homework and exams give reasonable estimators of how well students are learning. They can give an idea of the students’ weaknesses and what needs to be strengthened. The converse, however, is usually left aside: how well is the teacher teaching? To answer this, I apply two anonymous surveys to assess my performance at the first and second thirds of the semester. This allows me to improve my teaching, adapt my strategies to be more effective, and find out which topics my students find most interesting. Because in the end, I strongly believe that learning — and teaching — should be fun.

Teaching Experience

As an undergraduate student, I taught high-school math and physics to adult students. When I started graduate school I assisted introductory electronics for undergraduates. Later on, I was teaching assistant of introductory signals and systems courses. In the last years of my graduate studies I was teaching assistant of graduate-level courses, like pattern recognition, machine learning, estimation, detection, and statistical learning theory. I was honored with the College of Engineering Teaching Award.

Teaching Interests

My favorite undergraduate-level topics include signals and systems, probability, and, of course, linear algebra. I would also like to teach graduate-level topics like detection and estimation, analysis, probability, information theory, and seminar classes centered around linear algebra with missing data and machine learning.

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