Rajeev Raizada: Teaching experience, approach, and goals

Much as I enjoy research, I have found teaching to be the most rewarding aspect of being a faculty member. I love the challenge of taking something that might seem intimidating and complicated, and trying to explain it as simply and clearly as I can. It's a great feeling when a student responds by sitting up in their seat, putting up their hand, and asking a question that shows that their interest has been piqued.

A person is very fortunate if they can find something that they enjoy doing, that they are good at doing, and that is useful. Teaching is certainly useful, and I know that I enjoy it. I believe that I can do it fairly well too, as I hope the evidence below attests.

My goals when teaching: to make the class engaging, interactive, and clear

Audience engagement: I try my best to make my teaching engaging. It doesn't matter how great your material is, if nobody is listening. As the teacher in front of the class, I need to be more interesting than whatever else is available on the students' phones and laptops: the entire internet, with its worlds of social media. I have only one advantage that Facebook friends and Instagram feeds lack: I am standing right there in the room with the students. I can ask them questions, and they can ask me questions in return. I can try to hook them in with a puzzle, or to present the information in the form of a story. I can't just hope to get the students' attention: I need to earn it.

Interactivity: To make a class interactive, asking questions is often not enough. Every teacher dreads the awkward silence that sometimes hangs in the air after asking a question to the class. For topics about which there may be a range of possible opinions, one method I sometimes use for changing that dynamic is the "turn to ask your neighbour what they think" technique, which can work well, as long as it is kept within a clearly delimited time window. When explaining speech and its constituent phonemes to a class, I enjoy running a real-time spectrogram analyser on my laptop so that the output is projected on the screen, and inviting students to speak into it so that they can immediately see the formants that they produce. I have also written several interactive Python tutorials about fMRI analysis, which students can run live in their web-browsers while I explain the ideas and the code (links given below).

Clarity: My guiding principle to make an explanation be clear is this: try hard **not** to sound clever. If an explanation sounds clever, then it is difficult to understand. But the whole point of explanation is to be as digestible and understandable as possible. So, the challenge is to take ideas that might be subtle or complex, and to find ways to make them concrete and intuitive. The grandmaster at this of course was Richard Feynman. We mere mortals can at least try our best in that direction.

Courses that I have taught, and my teaching evaluations

For a much more detailed overview, a zip file containing PDFs of my teaching evaluation comments and scores from multiple years can be downloaded **here**. Additional information and links can be found in the teaching section of my webpage, **here**.

- **BCS 265: Language and the brain.** This undergraduate class covers the neural processes and representations involved in language processing, and how they relate to linguistic behaviour. As part of the course, students find journal articles that they would like to present to the class, meet with me to go over their draft slides, and then give their presentation. Practicing how to convey the key points of a topic in an engaging manner is probably as important an aspect of this class as is the actual brain and language content.

Example syllabus, lecture slides, and readings: Downloadable **here**.

Typical enrollment: 20-30 students

Average evaluation score: 4.5 / 5

Representative comments:
- "great! really cared about students' understanding of the material and taught in very understandable ways"
- "Great and amazingly friendly teacher, this was one of the few classes I regretted missing when I was sick. A big thanks to the teacher."
- "I really liked how he used examples for certain concepts to make us understand the material better."

- **BCS 513: Introduction to fMRI.** The core focus of this class is on how fMRI can be used to ask questions about neural representations and cognitive and perceptual information processing. There is a particular emphasis on neural decoding and multivoxel pattern analysis methods. Part of the class involves hands-on computational work, analysing a publicly available fMRI dataset. This course is listed as a graduate class, but has often also been taken by interested undergrads.

  My course lectures on YouTube: Video of all the Spring 2014 lectures can be found in this **YouTube playlist**. To date, these videos have been viewed more than 23,000 times in total.

  Example syllabus, lecture slides, and readings: Downloadable **here**.

  Typical enrollment: Around 12-15 students.

  Average evaluation score: 4.4 / 5

  Representative comments:
  - "Very respectful of the students and very willing to explain and re-explain any topics at hand. He took every question and provided a clear answer. He made himself available for any student any time they needed extra assistance."
  - "The matlab tutorials were very interesting and useful."
  - "Very knowledgeable on the topic and is able to use very vivid and (I think) accurate example to explain complex problems."

- **BCS 508: Cognitive Neuroscience.** The aim of this class is to provide a general introduction to neuroscientific studies of various aspects of human cognition and perception, e.g. object-recognition, development, attention, language, vision, and so on. The course consists of lectures (by me, and also a variety of guest lecturers from across the university) and also seminar-type discussions led by the students. Typically taken by graduate students from the Brain & Cognitive Sciences department.

  Example syllabus, lecture slides, and readings: Downloadable **here**.

  Typical enrollment: Around 10 students.

  Average evaluation score: 3.8 / 5

  Representative comments:
  - "Very good at making sure that students feel comfortable and providing feedback and suggestions for the project."
  - "Tone down the hand-holding. It's more appropriate for an undergraduate course rather than a graduate course." [Note: I hope this quote shows that I am not *solely* selecting the

purely positive comments. For the fullest picture, please download the zip file of multiple years' comments and scores, **here**.]

- **BCS 310: Senior Seminar.** This is a "professional development" class, taken by final-year undergraduates in the Brain & Cognitive Sciences major. Topics covered include finding, critiquing and giving a presentation on a news media article about neuroscience, being especially on the look out for over-simplifications or exaggerations. A large part of the class addresses topics related to seeking a job or a place in graduate school. For example, I guided the students in developing and presenting a one-minute "elevator pitch" about their interests, experience and goals. We also worked on making a simple academic webpage for each student, aimed at digestibly conveying that same core information at a glance, and practiced how to e.mail professors to inquire about possible openings in their labs.

  Example syllabus, lecture slides, and readings: Downloadable **here**.

  Typical enrollment: Around 25 students.

  Average evaluation score: 4.2 / 5

  Example websites made by students as part of class: These are shared here with the students' permission: http://mharata.wix.com/online-resume, http://adfriedman6.wix.com/resume

  Representative comments:
  - "Raj made this class very engaging and worked hard to try and help anyone who was still looking for a job feel like it wasn't the end of the world. He's a very caring and thoughtful guy and I really appreciated this class."
  - "I got to learn practical, real world applications of the things I have learned the past four years. Making my own website is something I did not even think to do until this class which I find extremely helpful now and in the future."

Interactive code tutorials for statistics, fMRI analysis, and neural networks

Being able to code is an extremely useful and sought-after skill. It is also a rigorous intellectual exercise, and is a crucial skill for many aspects of science.

In my experience, the best way to understand how code works is to play around with running and modifying it. Over the years, I have written several computational tutorials, written with the aim of being as clear and understandable as possible. I have used them in my teaching, and have posted them online so that others can freely use them too. They have indeed been used for teaching at several different universities (links below).

Most of my tutorials have been written in Matlab, which for many years has been a leading language for scientific computing. More recently, I have started writing tutorials in Python, which is rapidly overtaking Matlab in popularity, not only within academic science but even more so in industry.

- **Interactive statistics tutorials, in Python and Matlab**
  My webpage containing these tutorials is **here**. A YouTube video illustrating the interactive programs in action can be found **here**. These tutorials have been used for teaching at U.Mass Boston, **here**.

- **Python and Matlab for fMRI, General Linear Model and pattern-based analysis**
  Webpage with these tutorials is **here**. Used for teaching at the Univ. of Arizona, **here** and the

Univ. of Gent, **here**. A YouTube video of me presenting these tutorials to a class can be found **here**.

- **Matlab for neural networks**
  Webpage with these tutorials is **here**. The page includes tutorial code implementing and explaining the backpropagation algorithm, which is the core tool used for training deep neural networks.

Examples of additional courses that I would be interested to teach

- Data science, using Python programming
  - Pattern recognition algorithms that we interact with in daily life
  - Data visualisation
  - Always try a simple approach first: linear regression
  - Generalisation, cross-validation, over-fitting, under-fitting
  - Regularisation, logistic regression, support vector machines
  - Backpropagation, deep neural networks, and some popular toolboxes
  - Practical exercise: take some real data, and try to make predictions from it
- Statistics and research methods
  - What is the aim of an experiment?
  - What is a control condition? What is an experimental confound?
  - Why use randomised designs? Why use double-blinded designs?
  - The reproducibility crisis and p-hacking
  - Steps out of the crisis: pre-registration, cross-validation
  - Practical exercise: run a simple behavioural experiment
- Cognitive psychology
  - Make learning stick: retrieval practice, spacing, interleaving, semantic elaboration
  - Attention: why people don't take in more than one thing at a time
  - Working memory: don't try to stuff too much into your head at once
  - Declarative memory: what did you have for breakfast this morning?
  - Non-declarative memory: can you describe how you ride a bike?
  - Language: how do you know what I'm saying to you?
- Neuroscience and society
  - Neural decoding: is it mind-reading? (Spoiler: no)
  - Can neuroscience create an accurate lie-detector?
  - Environmental effects on neural development
  - Brain-computer interfaces
  - Can neuroscience lead to cognitive enhancement?
  - Neuroscience, the law, and criminal responsibility