Fairhall lab

Computational neuroscience at the University of Washington

Pursuing computational neuroscience

Posted by *fairhalllab* on *June 14, 2013*
Posted in: Uncategorized. 4 Comments
Many people have been in touch with questions about how to pursue further education or careers in computational neuroscience. With the BRAIN initiative in the news and a number of companies launching into neural technologies, this is certainly an area of current opportunity. I wanted to give some perspective on possible trajectories, as the field is very diverse, spanning academic study in quantitative approaches to systems neurophysiology to robotics and industrial engineering.

Graduate programs

It is not necessary to join a graduate program in computational neuroscience. Indeed, I am not strongly in favor of such programs and here at UW we have chosen not to go that route: I believe that computational neuroscience is the quintessential interdisciplinary program, and it is important to master at least one discipline. So I tend to favor basing oneself in a home department that provides the core skill set and knowledge base you seek: neurobiology, computer science, physics, statistics, electrical engineering, bioengineering or mathematics, but doing so in a place with opportunity and proven track record of cross-departmental collaborations and openness to interdisciplinary thesis projects. That way, you will ensure that your core coursework is a strong preparation for one academic discipline, but that you have the chance to take a variety of electives that allow you to get a broad training in other areas, and that your interdisciplinary research will be fairly and helpfully guided and evaluated.

Where? Top-tier examples of institutions in the US that provide such an environment (in no particular order) include the University of Washington (http://compneuro.washington.edu/) (naturally!), Berkeley, UCSD, Columbia, NYU, Carnegie-Mellon/Pitt, Princeton, MIT, the University of Chicago, U. Penn, UT Austin, Northwestern. Other notable options include Duke, UT Houston, UC Davis, Brandeis, Yale, Stanford, Caltech and USC, which has an impressive retinal prosthetics group. It is important to be aware that entry into graduate programs at all of these institutions is highly competitive. As an example, the University of Washington's Neurobiology and Behavior graduate program received nearly 300 applications this year for an anticipated class of 10, and only around 30 students from an excellent applicant pool were interviewed. So it is important not to fixate only on top programs, but to look carefully at some other places where you can find at least two or three researchers who are working in areas that interest you. You might be able to develop a novel collaboration between faculty who have not worked together before. Very few institutions have a

"computational neuroscience" program. You should look to see which graduate programs (eg. Neurobiology and Behavior (http://depts.washington.edu/behneuro/academics/index.shtml), Computer Science and Engineering (http://www.cs.washington.edu/prospective_students/grad/), Applied Math (http://depts.washington.edu/amath/studies/)) host the faculty whose work interests you, and where you will be able to do the coursework and research you have in mind: there may be multiple options. Also be careful to tailor your choice of institution and program to the direction that you are motivated by, whether that be delving into the basic mathematics of chaotic neural networks, probing decision-making behavior and/or circuitry in primates or rodents, working closely with clinical applications or developing devices. All of these require rather distinct training.

Internationally, there are centers of excellence in many countries, and this area has recently received an enormous stimulus in Europe in the form of support for Henry Markram's brain simulation consortium, centered in Switzerland. In terms of clusters of individual labs doing high quality systems neuroscience with theory components, Germany, Great Britain and Israel have perhaps the most extensive offerings. Germany boasts the network of Bernstein Centers for Computational Neuroscience and many Max-Planck centers have been trailblazers in systems neuroscience, particularly in invertebrates (e.g. Tuebingen). Britain has a long-standing tradition of quantitative approaches to biology and the support of the Wellcome Trust for systems neuroscience; there are particularly vibrant groups at UCL (including the Gatsby Institute), Cambridge, Oxford and Edinburgh. Israel has the Weizmann Institute and Hebrew University with very strong programs, and good ones also at Ben Gurion and the Technion; the Weizmann accepts foreign students although a better all-round option for a stint in Israel may be for a postdoc. I'll also randomly identify a few other places that I know have interactive theory/experimental groups: Ecole Normale Superieure in Paris, ETH in Zurich, the Champalimaud center in Lisbon. But again, there are many places where high quality work is going on at lower concentrations that would be fine choices.

Getting into graduate school. The admissions process focuses less on the specifics of your undergraduate training, reflecting the diverse backgrounds that are appropriate for neuroscience, but on high academic performance and interesting and productive research or work experience. Research experiences tend to be favored over work experience with the assumption that these reveal more of your independence and creativity, so if you are applying out of a work situation, your statement and letters should emphasize and give specific examples of these qualities.

Courses and Summer Schools

Of course there is our Coursera course (https://class.coursera.org/compneuro-001/class/index), which we are likely to run regularly. There are also some excellent summer schools which can afford a quick boot-up in the area. One of my favorites (as I attended it and also directed it for five years) is the MBL course, Methods in Computational Neuroscience (http://hermes.mbl.edu/education/courses/special_topics/mcn.html). This is a very selective course aimed at graduate students and postdocs which takes one through the mathematical methods that underlie many contemporary approaches to problems in systems neuroscience. Other options are the Okinawa course run through OIST, and Cold Spring Harbor Labs has initiated what seems to be an annual course in China. CHSL has a highly regarded Computer Vision course that counts as alumni and faculty many of the top researchers in vision neuroscience. There are also several European courses including through the Bernstein Center: watch the compneuro mailing list (http://neuroinf.org/mailman/listinfo/comp-neuro) for opportunities.

Industry

A few companies are working on fundamental neural research with the hopes that this will lead to useful devices. One such company is Brain Corporation, in San Diego, which is building a model of the retina with a long-term view to modeling the entire brain. The Allen Institute for Brain Science, in

Seattle, has also embarked on a long-term project to solve the problem of coding in the visual system using a combination of high-throughput electrophysiology, anatomy and modeling. The Redwood Center for Neuroscience, in Berkeley, was also initiated as an academic/industrial collaboration to transfer fundamental brain algorithms to device design. IBM Alameda (http://www.ibm.com/smarterplanet/us/en/business_analytics/article/cognitive_computing.html)has an ongoing project to replicate cognition in a brain model.

A much larger number of companies are entering the field of neural prosthetics and brain-computer interfaces. One way to locate such opportunities is to look for university-based centers which have industrial affiliations and partnerships; their websites can direct you to those companies. One example is UW's Center for Sensorimotor Neural Engineering (http://www.csne-erc.org/), an NSF-funded Engineering Research Center. There are perhaps a dozen comparable centers across the US. These companies may offer internships and other ways to gain experience and refine your understanding of the qualifications you require.

Thanks to information provided by our Coursera students, edited to add the following:

Gerick Lee posted FENS' **map of neuroscience programs in Europe (http://www.fens.org/nens/map.php)** and particularly recommends the NSC (http://www.nsc.uzh.ch/)program in Zurich and the GSN program in Munich: "Great, great people at both institutions."
Allar Kasick adds some sites where one can search for studentships:
1. a portal for academic positions in the UK. (www.jobs.ac.uk) This includes paid studentships for Masters (53 of them, at the moment of writing) and PhDs (588).
2. http://www.prospects.ac.uk/search_courses.htm (http://www.prospects.ac.uk/search_courses.htm) allows to search all (funded and not funded) postgraduate courses in the UK. The keyword for "neuroscience" returned 233 courses, 104 if filtered for MSc
and a comparison of institutions: – The UK University League Table by the Guardia (http://www.guardian.co.uk/education/table/2012/may/21/university-league-table-2013)n

- "UK tuition fees for postgraduate courses (if you fund them yourself) are usually about £9,000-£11,000 a year for EU and about twice that for non-EU students, but there is a lot of variability in the cost, more so than for undergraduate courses. When you look for funding, then the University is one option, but depending on where you are from, there may be additional opportunities for sponsorship."

Please feel free to add links and information about other programs in the comments!

4 comments on "Pursuing computational neuroscience"

caltanner on August 9, 2013 at 11:56 pm said:
This summary and your coursera course have been incredibly helpful to me, thank you!

Reply
treestanding on January 16, 2014 at 11:20 pm said:
This is very helpful, thank you. Do you have any advice for someone with a PhD in theoretical physics (currently a professor) to switch over? Thanks!

Reply

Padma on February 22, 2014 at 2:22 pm said:

Of the ones that I have read so far I have found this summary to be most unbiased. It is helpful. How would an anesthesiologist [not licenced in USA] switch over? Look forward to hearing fom you. Thanks

Reply

Schauna on August 11, 2014 at 10:14 am said:

What are your suggestions for someone in an electrophysiology lab as a grad student, wanting to work in computational neuroscience?

Reply

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