

Summary of Proposal for Interdisciplinary Program in Cognitive Science

Preamble

Cognitive science is an interdisciplinary field that attempts to provide a framework to the various facets of the enquiry into the nature of the human mind. The field lies at the intersection of several other disciplines, including philosophy (knowledge representation, logic), psychology (basic human cognition, perception and performance), computer science (computational theory, artificial intelligence and robotics), linguistics (theories of language structure) and cognitive neuroscience (brain mechanisms for intelligent behavior). Typical research areas of cognitive science include reasoning and decision making, language comprehension and production, language acquisition, vision, attention, learning & memory, goal directed movement in complex environments and consciousness. In more recent times, Cognitive Science has also brought together various fields of engineering by providing insights about user (humans) behavior and cognitive processes to help in human-computer interface design and enhancing the usability of various products, i.e. usability engineering.

Cognitive science also studies behavioural deficits due to brain trauma, congenital or other reasons. Protocols for identification and rehabilitation form another important facet of this science.

Cognitive Science at IIT-Kanpur

As Cognitive Science is gaining prominence as an interdisciplinary field, around the world and in India, we propose the formation of an Inter-Disciplinary Program in Cognitive Science at IIT-Kanpur. The institute is in a good position to start a research program in cognitive science since several faculty (see participating departments and faculty below) based in different departments have research interests which are in this area. This will allow participating faculty and students to come together in a cooperative and focused research program in cognitive science. Given the growing popularity and demand of courses dedicated to study of cognitive science, there is every possibility that the IDP will gradually grow into a full department.

The Inter-disciplinary Program in Cognitive Science at IIT-Kanpur will seek to offer a Masters (MS) and a PhD Degree in Cognitive Science.

Prospects for Cognitive Science Graduates

Cognitive Science programs around the world are highly research oriented and that is why a lot of students pursuing a Masters' or a PhD in Cognitive Science choose to continue a research career in the field of cognitive sciences and allied disciplines. However, many jobs are also available for those who turn to industry after completing their respective degrees. Opportunities are available in the fields of cognitive computing, natural language processing, design, usability research, human factors, Human-Computer Interaction (HCI), cognitive and behavioural rehabilitation and advertising.

In the past, students specializing in cognitive science have secured placements in the fields of decision-making, game theory, neuro-economics, Human Computer Interaction, usability design, user experience, in some of the companies listed below:

- DRDO
- TCS
- NIELSON
- ITC
- DIPR
- Google
- Microsoft
- Persistence systems
- Hindustan Lever

One major strength of an IDP in Cognitive Science at IIT-Kanpur will be the participation from so many departments/disciplines at once. To the best of our knowledge only IIT Gandhinagar has a program in Cognitive Science. Given the number of participating faculty there is no program in the country with the degree of interdisciplinary breadth that our program will have. This would also place us in a position to get the best students interested in pursuing research in Cognitive Sciences in India.

Educational Objectives of the IDP in Cognitive Science

The IDP in Cognitive Science will encourage the students to:

- Acquire strong empirical and theoretical background in one or more areas of cognitive science.
- Inculcate analytical and technical skills to conduct and critically examine research.
- Develop ability to conduct original research in chosen area.
- Gain experience of participating in a collaborative lab-based community from varying backgrounds.
- Develop an application and innovation based perspective towards research to ensure greater societal and industrial impact.

Degrees Proposed

- MS (Cognitive Science)
- PhD (Cognitive Science)
- Integrated: (B.Tech. (X) + MS (Cognitive Science))

Program overview

MS in Cognitive Science

Given the interdisciplinary nature of cognitive science and the amount of emphasis on research, there will be two components in the MS Cognitive Science program, i.e. a course component and a research component. While the course component will allow the students to take a number of compulsory course and choose from a variety of electives, the research component will require students to complete a research thesis, under the supervision of one or more participating faculty, addressing a problem in the field of cognitive science using empirical, theoretical/computational, or a mixed approach.

Eligibility Criteria

- Bachelors or Masters Degree in Cognitive Science or related disciplines including Psychology, Neuroscience, Bio-sciences, Mathematics, Physics, Engineering, Medicine, etc.

Entrance Examination and Entitlement to Scholarship

Given that certain institutes like IIT-Gandhinagar, Centre of Behavioral Sciences, University of Allahabad are already holding nation-wide entrance examinations for intake of students, we could join with them to hold a Joint Entrance Examination in Cognitive Science, on the lines of the currently held JAM exam.

Students, who have qualified exams of national importance like the GATE, will be provided with scholarship obtained via the Government of India. Others coming just after bachelor's degree will have to self-finance their expenditure.

There is however a proposal to request DST to initially support students in the MS program with scholarship.

Requested Sanctioned Strength:

14 each year.

Program Format

The incoming students will be first required to take a minimum of 4 Core Courses during the first two semesters, which will allow them a uniform entry point into Cognitive Science. These core courses will equip the students with a firm grasp over the various topics and questions in cognitive science. Also, these courses will familiarize the students with methods and tools to conduct research in their chosen area of cognitive sciences.

At the end of the first semester, each student will be asked to choose one of the participating faculty as a project advisor. The participating faculty will conduct a project course for the student, which will familiarize the student with the advisor's research area. The project advisor will also help the student in choosing a research topic for the Master's Thesis. Also, the project advisor may guide the student in terms of choosing the right elective courses keeping the interests and thesis topic in mind.

Students will have to take a minimum of 3 Elective Courses, from a variety of electives offered by participating faculty. Elective courses can be taken according to credit load deemed optimal by the student and her/his advisor, in a fashion that fulfills the minimum credit requirement and does not exceed the maximum credit requirement.

During the third and fourth semesters students will be required to carry out a research project under the guidance of one of the participating faculty members, which will carry 24 credits per semester. The research project is expected to lead to a Master's Thesis. The Thesis supervisor may or may not be the same as the Project Advisor chosen by the student at the end of the 1st semester.

Additionally, in order to get students acquainted with the latest research in the various fields constituting cognitive science, there will be a compulsory reading group. Participation in the reading group will be treated as a Seminar course. Other requirements will be as per the PG manual for masters program.

Proposed Credit Structure

As per the PG Manual at IIT-Kanpur, a PG student can register for 45 credits in a semester, which leads to $45 \times 4 = 180$ credits. This will be the maximum number of credits allowed to a student in the MS Cognitive Science program. However, the prescribed credit scheme is as follows:

Courses:

4 Core Courses x 9 credits = 36 credits
3 Elective Courses x 9 credits = 27 credits
1 Project course x 9 credits = 9 credits
1 Seminar x 6 credits = 6 credits
Total = 78 credits

Thesis:

Two semester equivalent of thesis Work x 36 credits = 72 credits

Total = 78 + 72 = 150 credits.

Proposed Course Structure

Semester I

CGS 401: Cognitive Processes I (T + L)
CGS 408: Tools in Cognitive Science (T + L)
BSE 656A: Neurobiology (T)
Project/Elective 1 (Recommended)

Semester II

CGS 402: Cognitive Processes II (T + L)
Elective 2
Project/Elective 1
Seminar
Thesis I

Semester III

Elective 3
Thesis II

Semester IV

Thesis III

Doctoral Program (PhD)

The Doctoral Program in Cognitive Science will aim to provide the state-of-the-art training in Cognitive Science to prepare the students for careers as scientists and teachers who will make contributions to society in academic or applied settings. Students will be expected to gain expertise in scientific issues and experimental, theoretical, and/or computational methods across fields of Cognitive Science. Programs of study for PhD students will be highly individualized; decisions about research

and coursework will be made in close collaboration with a research advisor and graduate committee of each student. Students will be encouraged to collaborate with faculty members who are not their primary advisors.

Eligibility Criteria

- a) Master's Degree (or equivalent) in any branch of Engineering or Medicine.
- b) Bachelors Degree in any branch of Engineering/Medicine.
- c) Master's Degree in Psychology, Philosophy, Linguistics, Cognitive Science, Biosciences, Mathematics, Physics or Chemistry.

All students in categories (b) and (c) should have obtained percentage marks (or equivalent) in the qualifying examination greater than equal to the minimum as currently laid down for different categories by the Senate. All such students must also have a valid GATE/NET or other score as specified by the institute.

Entrance Examination and Scholarship

All students

Requested Sanctioned Strength:

30 (at any given time)

Course Structure

The course component of the doctoral program will require the students to take a minimum of 4 core courses, which will be common to the Masters Program. The students will be advised to take these courses as they are offered in the Masters Program. In addition, the students will be advised to take Elective Courses as per the credit requirements, deemed optimal by the Thesis Supervisor. Moreover, in each semester after the second semester students will be required to do a seminar which discusses advances in one of the core subject areas of cognitive science (this is item 1d below). The seminar course will be graded as satisfactory or unsatisfactory and no letter grades will be awarded. Students who have background deficits will be required to do extra courses as suggested by the program adviser (also see remedial courses below). Other requirements will be as per the current requirements for PhD students in the PG manual.

The thesis, which will be an original contribution in the area of cognitive science, will be done with at least one supervisor who is a participating faculty member in the inter-disciplinary program and possibly joint supervisors from other departments based on expertise.

Faculty:

The faculty resources in terms of individuals in parent departments exist. However, we require the following help from the parent departments:

- a. Formal recognition of teaching, research and administrative load in the interdisciplinary program while assigning load in the parent department.
- b. To strengthen the program we need recruitment of faculty in the parent department who can also participate in the cognitive science program. The institute should be willing to raise sanctioned strengths where needed. The program currently requires faculty in the areas mentioned below:
 - i. Artificial intelligence, machine learning, computational cognitive modeling, human computer interaction (CSE, EE).
 - ii. Experimental cognitive psychology, computational and cognitive linguistics, philosophy of cognitive science (parent HSS Psychology, Linguistics/English, philosophy).
 - iii. Cognitive and computational neuroscience (BSBE)

Currently, the participating departments include - CSE, HSS (Psychology and Linguistics), EE, BSBE and the following faculty are interested:

- BSBE: Drs Nitin Gupta (NG), Jonaki Sen (JS)
- CSE: Harish Karnick (HK), Nisheeth Srivastava(NS).

- EE: Dr. Tanaya Guha (TG)
- HSS (Philosophy): Drs A V Ravishankar Sarma (AVRS), Vineet Sahu (VS)
- HSS (Linguistics): Dr. Achla Raina (AR).
- HSS (Psychology): Drs Ark Verma (AV), Devpriya Kumar (DK), Shikha Dixit (SD).

Support required from the Institute:

Laboratories: The following are needed to be able to support the basic experimental component. These facilities can be created by adding equipment to already existing facilities in the parent department.

Cognitive Science Lab (Parent lab in HSS - cognitive psychology).

Additional equipment required: 5

- i. Remote eye tracking system.
- ii. EEG at least 128 electrodes.
- iii. TMS system with localizer
- iv. High-end workstations for psychophysics experiment and data analysis
- v. Dedicated laboratories for conducting experiments using above-mentioned equipment's.
- vi. Dedicated seating/working space for masters and PhD students
- vii. Scholarship for MS students without GATE/NET
- viii. Journal/Book Purchase budget for Cognitive Science IDP

Note: Some of the above equipment will be procured through project funding. CSRI has already funded two projects in this area. The above is an initial list. Other faculty in Design and Mechatronics may join in once the program starts.

The cognitive science group has strong connections with all the other main cognitive science centers in the country and the group here expects to collaborate strongly with the groups in the existing centers.