Beliefs and decisions: of minds and machines

CEU SUMMER UNIVERSITY

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Statement of purpose

The course focuses on a truly cross-disciplinary issue: how beliefs and decisions are represented and made in our brain and how modern artificial intelligence is constructing machines that achieve similar goals. This is a topic discussed in a wide range of scientific fields as different as mathematics, sociology, economics, biology, psychology, computer science, psychiatry and education sciences. In addition, the topic has contributions to such distant areas as anthropology, history, cultural evolution, the study of consciousness and various forms of arts. True to this cross-disciplinarity, the course will attempt to investigate this complex topic from many different viewpoints thereby providing a critical analysis of reigning dogmas and emerging new results in a number of related but very different fields, such machine learning, control of movement, representations of uncertainty, visual development, and neuroeconomics.

The field of probabilistic computations and decision making straddles the boundaries of traditional disciplines and bears on subjects, such as aesthetic or moral decisions, or evaluating economic options, that appeal to a general audience. Yet, a thorough understanding of these issues should also include formal approaches. Therefore, the course will demonstrate the rich interactions between mathematics / computer science and neuroscience / cognitive science. The motivation is to draw the attention to the direct relevance that highly formal, and mathematically rigourous approaches can have for such seemingly informal and easily popularised issues as how beliefs and decisions are represented and made in our brains. The course thus brings together researchers from disciplines ranging from machine learning to cognitive science, including theoretical as well as experimental sub-fields.

The design of the course stresses highly interactive forms of teaching where apart from the standard lecture format, the faculty will be encouraged to have open discussions about the relevant issues amongst each other as well as with students, there will open debate sessions, and opportunities for hand-on experience with various experimental tools exploring related questions. This should demonstrate the link between the high level concepts presented and various ways of exploring these concepts empirically.

Pre-requisites for participants

Course participants will be expected to have at least started their graduate studies and have backgrounds in one of the related disciplines: either the psychological sciences / neuroscience, or in mathematics / computer science, broadly defined. The course will also be appropriate for post-docs and junior faculty. Although not required, some working knowledge of general issues in the areas of perception, memory, probability theory, statistics, and neural networks will be useful.

Assessment and expected outcomes

Course participants will be evaluated on the strength of their participation in course discussions and debates. They will also be evaluated on the strength of their group projects.

In addition to the group project and presentation, all course instructors will be available for one-on-one meetings with participants. Course faculty will encourage participants to use these meetings as opportunities to familiarise themselves with their research areas. Course faculty will be available to read and evaluate final proposals, and provide guidance in how they can be further developed.

By the end of the course, participants should have acquired a working knowledge of some of the basic concepts and debates in probabilistic inference, learning, and decision making, and have gained a better understanding how the brain works and how this process could be modelled. In addition, they will gain some practice in moving from these theories to developing research designs and new hypotheses as well as devising ways in which these could be tested with empirical material.