SYLLABUS

Neuromorphic Computing 7.5 credits D7064E

Neuromorf informationsbehandling

Course syllabus admitted: Autumn 2023 Sp 1 - Present

DECISION DATE
2023-02-15

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LULEÅ TEKNISKA UNIVERSITET

Neuromorphic Computing 7.5 credits D7064E

Neuromorf informationsbehandling

Second cycle, D7064E

Education level	Grade scale	Subject	Subject group (SCB)
Second cycle	G U 3 4 5	Datateknik	Computer Technology

Main field of study

Computer Science and Engineering

Entry requirements

Understanding of neural networks, e.g.D7046E Neural Networks and Learning Machines, 7.5 credits or similar. Basic Python programming knowledge, e.g. D0009E Introduction to Programming, 7.5 credits, D0028E Programming and Digitalisation, 7.5 credits, D0036E Programming for Machine Learning, 7.5 credits or similar.
Good knowledge of English equivalent to English 6.

Selection

The selection is based on 30-285 credits

Course Aim

After completion of the course, the student should be able to:

- Describe the basic principles of neuromorphic computing and how they differ from traditional computer architectures and computing paradigms, concerning the role of dynamic processes, co-localization of memory and processing, and sparse event-based processing of information.
- Describe information processing and encoding in the brain, including the physical and computational motivation for rate-based versus temporal coding, analog versus spiking behavior, event-based sensing and control, and differences between biology and implementations in technological artefacts.
- Give examples of state-of-the-art neuromorphic hardware systems and describe their properties and motivation, including ethical considerations.
- Demonstrate how spiking neural networks (SNNs) can be trained and validated with practical learning algorithms and explain how different choices of hyperparameters and models affect generalisation and test results.
- Describe when the use of SNNs rather than artificial neural networks (ANNs) is motivated, concerning energy-efficiency, latency, robustness, and learning characteristics.
- Develop and evaluate a spiking neural network (or hybrid SNN–ANN) architecture that addresses a particular machine learning, artificial intelligence, biosensing, prosthetics or robotics application.
- Formulate and implement variations of basic neuromorphic computing concepts introduced in the course material and assess the validity of the results.

Contents

This course is an advanced level introduction to neuromorphic computing, including event-based sensing and control, spiking neural network architectures and learning, dynamic neuromorphic processors, hybrid digital-neuromorphic architectures, and the basic organization of the human brain including some well-known biological neural circuits. The course introduces concepts and methods needed for further studies of advanced neuromorphic computing, for example in artificial intelligence, biosensing, prosthetics and robotics applications.

Realization

Each course occasion´s language and form is stated and appear on the course page on Luleå University of Technology's website.
Lectures, read and view self-study material, laboratory work in the form of computer exercises, self-assessment of learning with peer-review, and project work with oral presentation.
Projects can include the use of neuromorphic devices or simulations, as well as scientifically or industrially related problems and datasets.

Examination

If there is a decision on special educational support, in accordance with the Guideline Student's rights and obligations at Luleå University of Technology, an adapted or alternative form of examination can be provided.
Oral examination and written self-assessment with differentiated numerical grades as well as approved computer exercises and project assignments that are orally examined.

Unauthorized aids during exams and assessments

If a student, by using unauthorized aids, tries to mislead during an exam or when a study performance is to be assessed, disciplinary measures may be taken. The term “unauthorized aids” refers to aids that the teacher has not previously specified as permissible aids and that may assist in solving the examination task. This means that all aids not specified as permissible are prohibited. The Swedish version has interpretative precedence in the event of a conflict.

Course offered by

Department of Computer Science, Electrical and Space Engineering

Modules

Code	Description	Grade scale	Cr	Status	From period	Title
0001	Project work	U G#	2	Mandatory	A23	
0002	Computer exercises	U G#	2	Mandatory	A23	
0003	Self-assesment and oral exam	G U 3 4 5	3.5	Mandatory	A23	

Study guidance

Study guidance for the course is to be found in our learning platform Canvas before the course starts. Students applying for single subject courses get more information in the Welcome letter. You will find the learning platform via My LTU.

Syllabus established

by Robert Brännström 2023-02-15