COMP34212
Cognitive Robotics
Unit Handbook

Angelo Cangelosi
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1. Aim and Learning Outcomes

This unit aims to provide an in-depth understanding of the field of cognitive robotics. This will analyse the selection, use and combination of methods and approaches in robotics, in artificial intelligence and in psychology and neuroscience to design intelligent behaviour and cognitive skills in interactive robots.

At the end of this course you will be able to achieve the following learning outcomes:

1. Analyse the methods and software/hardware technologies for robotics research and applications
2. Understand how our psychology and neuroscience understanding of behaviour and intelligence informs the design of robotics models and applications
3. Compare, select and apply different machine learning methods for intelligent behaviour in robots
4. Discuss the state of the art in cognitive and intelligent robotics models, and how this informs the design of future robot applications
5. Discuss the role of ethics and responsible research and innovation in robotics

2. Delivery

The unit will consist of 14 1-hour lectures and 4 2-hour labs.

- The lectures will be in the *first 4 weeks* of term and the *last 3 weeks:*
  Mondays 9-10am in Simon_TH E
  Fridays 1-3pm in Simon_TH B
- The labs will be in *middle 4 weeks* of the term, with students choosing one session:
  Group A on Mondays 9-11am in Kilburn_1.8+1.10
  Group B on Fridays 1-3pm, in Kilburn_1.8+1.10
- Note that there will be *no lectures* during the 4 weeks of labs.

See Section 5 below for a detailed schedule of the dates and topics of the lectures and labs.

3. Teaching staff

Professor Angelo Cangelosi
Professor of Machine Learning and Robotics
Unit leader and lecturer
Department of Computer Science
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Web: UoM webpage / Google Scholar

The labs will be supported by GTAs from Cangelosi's group of PhD students and postdocs in the Cognitive Robotics Lab (CoRo Lab)

Angelo has *office hours* on Mondays 10-11am and after the lectures/labs.

4. Assessment

There are two components to the formal assessment.

4.1 Coursework (30%)

This will consist on a report on machine learning for robotics, integrating the practice of deep learning methods during the labs with the literature on learning in cognitive robotics.
The coursework is coded as "34212-Lab-S-Report" and submitted via **Blackboard**. The deadline for on **18 April 2024, 18:00**

4.2 Exam (70%)

There will be an exam held during the University's Spring exam period. We will provide you with guidance about what to prepare during the lectures, and there will be an exam review lecture in the last day of the term.

5. Lecture and Lab Schedule (see Blackboard for updates on this summary table)

WEEK	DATE	ACTIVITY	TOPIC
Week 1	29 January, 9am	Lecture 1 (Simon_TH E)	Introduction to cognitive robotics and sample lecture on language learning
	1 February, 12noon	Lecture 2 (Simon_TH B)	continues previous lecture
Week 2	5 February, 9am	Lecture 3	Robot definition, history and type of robots
	8 February, 12	Lecture 4	Actuators and sensors
Week 3	12 February, 9am	Lecture 5	Developmental robotics
	15 February, 12	Lecture 6	Navigation
Week 4	19 February, 9am	Lecture 7	Deep neural networks for robotics
	22 February, 12	Lecture 8	Robotics middleware
Week 5	26 February	Coursework specification release	
	26 February, 9-11pm 1 March , 1-3pm	Lab 1 Group A (Kilburn_1.8+1.10) Lab 1 Group B (Kilburn_1.8+1.10)	Lab 1 Keras for MLP
Week 6	4 March, 4-6pm 8 March , 1-3pm	Lab 2 Group A Lab 2 Group B	Lab 2 Keras for CNN
Week 7	11 March, 4-6pm 15 March , 1-3pm	Lab 3 Group A Lab 3 Group B	Lab 3 Keras for RNN
Week 8	8 April, 4-6pm 12 April, 1-3pm	Lab 4 Group A Lab 4 Group B	Lab 4 Pepper robot programming and demo
Week 9	15 April, 9am	Lecture 9	Manipulation.
	18 April, 12	Lecture 10	Evolutionary and swarm robotics
	18 April, 6pm	**Coursework deadline**	
Week 10	22 April, 9am	Lecture 11	Social robotics and human-robot interaction
	25 April, 12	Lecture 12	Robot tutors for education (guest lecturer Prof Belpaeme)
Week 11	29 April, 9am	Lecture 13 (pre-recorded videos)	Ethics for AI and robotics
	2 May, 12	**Lecture 14 EXAM REVIEW LECTURE**	**Review of lecture topics for exam preparation (see also past exam papers)**

6. Reading

Core reading

Cangelosi A., Asada M. (Eds.) (2022). Cognitive Robotics. Cambridge, MA: MIT Press (Open Access link)

Key chapters of this book will be made available in blackboard.

A set of additional articles and book chapters will be made available in Blackboard for each lecture. These will be important for the exam preparation.

Additional, optional reading

Cangelosi A., Schlesinger M. (2015). Developmental Robotics: From Babies to Robots. Cambridge, MA: MIT Press

Goodfellow, I., Bengio, Y., & Courville, A. (2016). Deep learning. MIT press.

For in-depth understanding of classical deep learning methods and good maths grounding. Official free online copy https://www.deeplearningbook.org

Vernon, D. (2014). Artificial cognitive systems: A primer. MIT Press.

For a theoretical analysis of cognitive systems/robots

Matarić, M. J., Maja, J., & Arkin, R. C. (2007). The robotics primer. MIT press.

For technical details on robot technologies (sensors, actuators, software)

Gulli, A., & Pal, S. (2017). Deep Learning with Keras. Packt Publishing Ltd.

For follow-up exercises on deep learning. The lab's Keras exercises have been adapted from this book and will be provided via Jupyter Notebook handouts in Blackboard.