THE UNIVERSITY OF WESTERN ONTARIO
FACULTY OF ENGINEERING
DEPARTMENT OF ELECTRICAL AND COMPUTER ENGINEERING

ECE 9067: *Cooperative Distributed Systems Engineering: Technologies &Applications*
COURSE OUTLINE –SUMMER 2021

DESCRIPTION & OBJECTIVES:

This course provides a graduate-level introduction to the wide area in *Cooperative Distributed Computing* (CDS) and its evolution to *Collaborative Intelligence Smart Space (CISS)* in the context of *Artificial General Intelligence (AGI).*

Cooperative Distributed Computing is a computation paradigm in which an application setting is modeled as a society of "intelligent" entities/agents (might include human, computers, robots, devices, equipment, sensors, etc.) that are able to exercise some degree of "*authority*" and "*autonomy*" in sharing their knowledge and capabilities. In *artificial intelligence (AI)*, most of the recent breakthroughs have been constrained to the classical setting of individual agents operating in highly constrained environments. However, in the practical world many applications, range from everyday-life settings, to business-driven settings, to mission-driven settings, exhibit cognitive problems with "*collective/collaborative intelligence*" that "*emerges"* from individuals and groups of "*intelligent*" entities. As such it should be natural to think of it in the context of the evolution of *Cooperative Distributed Computing* into *Collaborative Intelligence Smart Space* where the individual agents exhibit aspects of *Artificial General Intelligence*.

The course emphasizes both the theoretical and practical aspects. The learning approach will be hands-on project-based. The theoretical component includes lectures, discussion sessions, and literature review and technical reaction based on reference books and papers within the context of the project.

The practical component includes the application of the principles and technologies to design and build a solution for the problem(s) identified in the project.

- The essential challenge of each project is the **problems or the issues of the project's setting** are **not effectively solvable unless** *modeled as a society of "intelligent" entities/agents (might include human, computers, sensors, etc.) that are able to exercise some degree of "authority" and "autonomy" in sharing their knowledge and capabilities*.
- The core computation principle is that the **"correct" solutions** related to the problems are ***collectively emerge*** through the individuals' (agents) that autonomously determine and coordinate their actions among themselves.

In addition to the hands-on experience, students will examine how theoretical concepts are actually realized by studying several applications of cooperative distributed systems in various domains.

PREREQUISITES:

- Computer Science Fundamentals, with emphasis on Object-Oriented
- Algorithms & Data Structures
- Software Systems Design
- Introductory Artificial Intelligence

COURSE SCHEDULE:

Lectures 3 hrs/week

TOPICS

- **Cooperative Distributed systems** (CDS)
  - The Evolution of Computation
  - CDS Model for Open & Decentralized Environment
  - Coordination & Cooperation as Computational Concepts
  - Architecture and Design Concepts for CDS
- **Collaborative Intelligent Smart Space**
  - Intelligence and Universal Intelligence
  - Semantics: Ontological-views of Conceptualization
  - Principles of General Artificial Intelligence
  - Principles of Collective Intelligences
- **Computing Paradigms & Technologies**
  - Agent-Oriented (AO) Computing
  - Smart-Object (SO) Paradigm
  - Supporting Technologies
- **Application Areas/Projects**
  - The specific applications may vary based on the students' area of interest, but are directly related to
    - Smart Space based Applications
    - Internet of Things based Applications
    - Mobile & Ubiquitous Computing based Applications
- **Future Directions for**
  - Smart-Objects & Cooperative Distributed Systems

SPECIFIC LEARNING OBJECTIVES

Upon the completion of the course, student should:

- gain a picture of contemporary thinking about new form of computation and especially AO and SO including principles and theory, common practices, and application areas, current and emerging;
- develop some concrete accomplishments in the CDS arena through a project;
- gain experience and confidence in understanding a new and rapidly evolving technology.

REFERENCE TEXTS:

[1] **Course notes**,

[2] **Papers and supplementary Reading** list of recent research publications

[3] **Artificial Intelligence: A Modern Approach** 2/E, Stuart Russell and Peter Norvig, ISBN: 0-13-790395-2, 2002.

[4] **Artificial General Intelligence**, Ben Goertzel, Cassio Pennachin (Eds), Springer-Verlag Berlin Heidelberg 2007

[5] **An Introduction to Multiagent Systems**, Michael Wooldridge, John Wiley & Sons (Chichester, England). ISBN 0 47149691X, 2002

[6] **Transactions on Computational Collective Intelligence**, Springer Nature Switzerland AG. ISSN: 1611-3349

[7] **Handbook on Ontologies**, 2/E, Steffen Staab and Rudi Studer, Springer Publishing Company, ISBN:3540709991 9783540709992

EVALUATION:

The approximate weight for each component is shown below. Note that these are maxim; if less than the stated number is given, the rest of the marks will be pro-rated.

Project-based Deliverables:

- (20%) Team formation, Project Description & Literature Review
  - Problem description
    - Domain Application: Motivation & Analysis
    - Technical challenges within the context of CDS
  - Literature Review
    - Application based solutions
    - Technical solutions for the identified challenges identified in the proposal.
- (30%) Proposed Solution of Domain Application as CDS
  - Technical Analysis & Design Report
- (30%) Solution Implementation & Demo
- (10%) Final Project Report
- (10%) Peer-Review of other Team(s) Projects

ⓘ In accordance with the policy of the University, the grade assigned to all written and oral work presented in English shall take into account syntax, diction, grammar and spelling. In addition, in the professional life of an engineer, the manner in which oral and written communications are presented is extremely important. An engineering student must develop these skills as an integral part of the undergraduate program. To encourage the student to do so, the grades assigned to all written and oral work will take into account all aspects of presentation including conciseness, organization, neatness, use of headings, and the preparation and use of tables and figures.

ATTENDANCE:

Any student who, in the opinion of the instructor is absent too frequently from class or laboratory periods in any course, will be reported to the Dean (after due warning has been given). On the recommendation of the Department concerned, and with the permission of the Dean, the student will be debarred from taking the regular examination in the course.

CHEATING:

University policy states that cheating is a scholastic offence. The commission of a scholastic offence is attended by academic penalties, which may include expulsion from the program. If you are caught cheating, there will be no second warning.

PLAGIARISM:

Students must write their essays and assignments in their own words. Whenever students take an idea, or a passage of text from another author, they must acknowledge their debt both by using quotation marks where appropriate and by proper referencing such as footnotes or citations. Plagiarism is a major academic offence (see Scholastic Offence Policy in the Western Academic Calendar).

PLAGIARISM CHECKING:

The University of Western Ontario uses software for plagiarism checking. Students may be required to submit their written work in electronic form for plagiarism checking.

COURSE INSTRUCTOR:

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