PhD Research Workshop in Computational / Artificial Intelligence

Sponsored by the Texas A&M Institute of Data Science

Tuesday 9/17/2019 to Friday 9/20/2019

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Due to limited space, attendance is by application only; see https://u.tamu.edu/tamids-wkshp-compai

Workshop Instructor Biography

Since my Ph.D. in Artificial Intelligence received from the University of London (2002) and Diploma of Imperial College London on Artificial Neural Networks (2002), I am teaching Computational Intelligence/Evolutionary Computation. I am the head of Computational Intelligence and Associate Professor (with habilitation) at University of Pernambuco-Brazil, where I have supervised over 100 students in the PhD, MSc and BSc final dissertations. My academic output is over 200 bibliographic products (e.g. articles, projects and books). Currently I hold four international appointments with: (i) Texas A&M (Adjunct Professor), (ii) Florida Tech (Graduate Faculty), (iii) University of Johannesburg (Visiting Professor), and (iv) University of Münster (Visiting Professor & Research Ambassador). My current research focuses are (1) Computational Intelligence (Evolutionary, Social and Hybrid Metaheuristics), (2) Complex and Stochastic Modeling/Simulation, and (3) Intelligent and Semiotic Decision Support Systems. In 2012 I visited at INRIA (Paris-Rocquencourt) as 'Professeur invité', in 2015 I was on sabbatical leave and Alexander von Humboldt Fellow at WWU Münster, Germany. For the past 16 years, I have been leading or Principal Investigator/Organizer of several projects/workshops funded by several international scientific agencies of various Countries. In 2014/15 was the president of the Brazilian Society of Computational Intelligence. And since 2013, I am chairing/steering several international conferences series like BRICS-CCI 2013(Recife-Brazil) & 2015(Beijing-China), and IEEE LA-CCI 2014 (Bariloche-Argentina), 2015(Curitiba-Brazil), 2016(Cartagena-Colombia), 2017(Arequipa-Peru), 2018(Guadalajara-Mexico), and 2019(Guayaquil-Ecuador). Currently I am visiting the Electrical and Computing Eng. Dept. of the University of Florida.

Foreword and Motivation

The World Economic Forum[1] – Davos (Switzerland), famous for global conjuncture analysis, often considered seminal by national governments and companies, in the 2016 edition had the overall theme "Mastering the Fourth Industrial Revolution". However, the main takeaway from Davos-2016 was clearly the seminal importance of Artificial Intelligence (AI) for the future of the already starting next revolution for humankind. The 2016 participants agreed that the current technological moment (encompassing a collection of disruptive technologies such as 'Internet of Things', 'big-data', 'cloud-computing', 'deep-learning' among others) is not only the beginning of the new revolution but they think that AI developments will be driving the whole process. This eye-opener message only gathered more and more momentum since then for researchers and practitioners. And it is my understanding that the ones who know and use properly intelligent methodologies/technologies are deemed to be the makers of tomorrow, in the dawn of this new human revolution.

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[1] Prestigious annual forum held in Davos-Switzerland that brings together political leaders, scholars and large corporations-investors for discussing and identifying macro-trends in world affairs and geopolitics.

Expected outcomes

That participating students will in four days increase their awareness of potentialities/risks associated to AI & CI in real world applications. Moreover, it is expected that the students get into contact with actual Computational Artificial Intelligent techniques at work, even though at introductory level.

Contents

- Intelligence, Artificial Intelligence, Computational Intelligence.
- Complex Problems and Computational Problem Classes.
- Cybernetics, Heuristic Search and Intelligent Agents Systems.
- Symbolic Approaches, theory and applications:
  - Expert Systems (Case and Rule based Systems).
  - Decision Support Trees.
  - Fuzzy Systems.
- Subsymbolic Approaches, theory and applications:
  - Artificial Neural Networks methods.
  - Evolutionary Computation methods.
  - Swarm Intelligence methods.
- Hand on practice on modeling and simulations using AI & CI

Key References

- Stuart J. Russell and Peter Norvig, Artificial Intelligence - A Modern Approach (3rd Ed.), 2016. Peason Educational Ltd.
- Andries P. Engelbrecht, Computational Intelligence: An Introduction, 2007. Wiley-Blackwell, an imprint of John Wiley & Sons Ltd.

Pedagogical Methods

- Lectures will use data projector and whiteboard.
- All presented material will be also made available to the participants.
- Classroom exercises will heavily use actual problems of participants.

Pedagogical Expected Goals

- Attendance and active participation during all workshop day.
- Effective applicability of content on real world problems (desirably research).
- Effective applicability of content on attendee's own research.

Additional Possibilities for Interested Participants

- Activities planned will aim current and real research problems that can desirably be within the interest of participants. There is the possibility in selected cases that some MSc/BSc Students be recruited both in TAMU and in UPE to help on the implementation of some extensions to participants in the workshop.
- There is also the possibility that application papers may emerge out of the topics discussed in the workshop for selected-interested participants.

Intended Audience

- This Workshop is designed for advanced PhD students of TAMU.
- No previous knowledge is expected in Artificial / Computational Intelligence. In such case some suggested short-reading material will be desirable by the participants.
- Basic programing language skills (in any high-level one) could be handy, especially in cases the participants want to use some of the methods within their own research.

OVERVIEW

Session	Time	Topic(s)	[LUNCH: 60 min @ 12h30]
Day 1			
1	9h00-10h45	Introduction to the Workshop & Intelligence, Artificial Intelligence (AI), Computational Intelligence (CI) – *Lecture* + *BREAK(15min)*	
2	11h00-12h30	Complex Problems (their Classes), and AI/CI Key Concepts – *Lecture*	
3	13h30-14h45	Cybernetics, Heuristic Search, and Intelligent Agents – *Lecture* + *BREAK(15min)*	
4	15h00-17h00	AI/CI Concepts Applicability on Participants' Theses – *Exercise-1*	
Day 2			
5	9h00-10h45	Expert Systems (Case/Rule based Systems) – *Lecture* + *BREAK(15min)*	
6	11h00-12h30	Decision Tree & Fuzzy Systems – *Lecture*	
7	13h30-14h45	Artificial Neural Networks – *Lecture* + *BREAK(15min)*	
8	15h00-17h00	AI/CI Concepts Applicability on Participants' Theses – *Exercise-2*	
Day 3			
9	9h00-10h45	Evolutionary Computation (CEvo) – *Lecture* + *BREAK(15min)*	
10	11h00-12h30	Examples of Evolutionary Computation in Practical Problems - *Examples-1*	
11	13h30-14h45	Advanced topics on Potentialities associated to AI/CI - *Discussion-1* + *BREAK(15min)*	
12	15h00-17h00	AI/CI Concepts Applicability on Participants' Theses - *Exercise-3*	
Day 4			
13	9h00-10h45	Swarm Intelligence (S.I.) – *Lecture* + *BREAK(15min)*	
14	11h00-12h30	Examples of Swarm Intelligence in Practical Problems – *Examples-2*	
15	13h30-14h45	Advanced topics on Risks associated to AI/CI – *Discussion-2* + *BREAK(15min)*	
16	15h00-17h00	AI/CI Concepts Applicability on Participants' Theses – *Exercise-4*	

Detailed Programme

OVERAL PREPARATION

-Participants will be given some brief-reading directions on AI general concepts;
-Participants will be required to present a 15-minute individual presentation on AI/CI topics distributed randomly to the participants
-Participants will be required to present a 15-minute individual summary of their research, focusing on research questions, ideas, results so far, points that may need help from Artificial Intelligence.
-Brief reading on distributed material about the AI/CI Techniques to be discussed on Day-1.

DAY 1

SESSION 1:

INTRODUCTION TO THE WORKSHOP &
INTELLIGENCE, ARTIFICIAL INTELLIGENCE (AI), AND COMPUTATIONAL
INTELLIGENCE (CI) – **LECTURE**

In this session the convenor will introduce the main objectives of the workshop and the rationale behind its organization. Participants will also introduce themselves and their work. They are encouraged to identify issues they are most interested in and their own expectations from the workshop. Participants will be encouraged to reflect on these issues based on their own experiences including in practical exercises throughout the workshop. In this session we also introduce and discuss the important concepts of Intelligence, Artificial Intelligence (AI), and Computational Intelligence (CI).

SESSION 2:

COMPLEX PROBLEMS (THEIR CLASSES), AND AI/CI KEY CONCEPTS – **LECTURE**

This session provides an overview on computable problems, briefly discusses issues of complexity associated to classes of problems (suitable for AI/CI computation) and carries on laying down other key AI/ CI concepts. A butterfly read on **Allan Turing's "Can Machines Think?"** seminal paper will be used as auxiliary means to clarify the concepts discussed.

SESSION 3:

CYBERNETICS, HEURISTIC SEARCH, AND INTELLIGENT AGENTS – **LECTURE**

This session provides an overview on Cybernetics, highlighting the need for feedback and learning, should performance and inductive abilities are to be incorporated. Comparisons among classic and heuristic searches will be used to exemplify why AI can be so useful and effective. The session concludes with the presentation of the Intelligent Agents perspective.

SESSION 4:

AI/CI CONCEPTS APPLICABILITY ON PARTICIPANTS' THESES – **EXERCISE-1**

In this practical session, participants are stimulated to point out which of the concepts discussed during day-1 lectures are of interest to their current research. They also should point out which aspects being pursued in their researches could improve should AI/CI is to be utilized. This session focusses on work that provides tips for practical use of the seen concepts.

DAY 2

PREPARATION

-Brief reading on distributed material about the AI/CI Techniques to be discussed on Day-2.

SESSION 5:

EXPERT SYSTEMS (CASE AND RULE BASED SYSTEMS) – **LECTURE**

This session provides an overview on the history of intelligent systems. The expert systems (Case and Rules based) are explained, compared and commented upon. A special attention is given to the dependency on the human specialist/knowledge engineer. Several set-ups and operation modes are to be commented upon. Cases of use, highlights and pitfalls are also to be explored.

SESSION 6:

DECISION TREE & FUZZY SYSTEMS – **LECTURE**

This session provides an overview on the very simple yet useful paradigm of Decision Trees (DT). The helpful aid and flexibility of Fuzzy for smoothing classifications is explained, compared to traditional approaches and commented upon. A special attention is given to hybrid systems. Cases of use, highlights and pitfalls of Decision Trees as well as hybridizations with Fuzzy are also to be explored.

SESSION 7:

ARTIFICIAL NEURAL NETWORKS – **LECTURE**

This session provides an overview on the very powerful and comprehensive set of techniques that compose the Artificial Neural Network paradigm. Their flexibility, computing power and various modalities of operation (for learning) are the number one topic of the session. A special attention is also given to the classes of problems to be curbed, e.g. prediction as well as classification. Cases of use, highlights and pitfalls of ANN are to be explored, especially because they can be readily use.

SESSION 8:

AI/CI CONCEPTS APPLICABILITY ON PARTICIPANTS' THESES – **EXERCISE-2**

In this practical session, participants are stimulated to point out which concepts discussed on the previous lectures (EXPERT SYSTEMS, DECISION TREE & FUZZY SYSTEMS, and ARTIFICIAL NEURAL NETWORKS) that are of interest to their current research. They also should point out which aspects currently being pursued in their research could improve should AI/CI is to be utilized. This session focusses on work that provides tips for practical use of the studied concepts. As well as for ANN, a pragmatically take will verse on the studied classic (Symbolic) approaches of AI. It is expected that some methodological or technological improvement may be found on the current research being pursued. Participants will be invited to present more details of their research, which are possibly prone to improvement by AI/CI.

DAY 3

PREPARATION

-Brief reading on distributed material about the AI/CI Techniques to be discussed on Day-3.

SESSION 9:

EVOLUTIONARY COMPUTATION (CEVO) – **LECTURE**

This session starts discussing the theory of evolution which inspired Evolutionary Computation. The session will also provide a comprehensive overview on six evolutionary computational approaches (GENETIC ALGORITHMS, GENETIC PROGRAMING, EVOLUTIONARY STRATEGIES, DIFFERENTIAL EVOLUTION, CO-EVOLUTION, CULTURAL ALGORITHMS). All techniques are explained, compared and commented upon, aiming practical use.

SESSION 10:

EXAMPLES OF EVOLUTIONARY COMPUTATION IN PRACTICAL PROBLEMS – **EXAMPLES-1**

In this session several examples of CEvo applications are provided so that the participants can have a clear idea on the modelling and simulation aspects of every tackled problem. After every example presented the key concepts and mechanisms used are to be discussed so that they can be re-used on the participants' own research.

SESSION 11:

ADVANCED TOPICS ON POTENTIALITIES ASSOCIATED TO AI/CI - **DISCUSSION-1**

Given the high impact that can be evoked by current AI/IC techniques, this session will delve into wide discussions about the likely hidden POTENTIALS that can be produced & foreseen in the near future by new AI/CI techniques or novel applications.

SESSION 12:

AI/CI CONCEPTS APPLICABILITY ON PARTICIPANTS' THESES - **EXERCISE-3**

In this third practical session, participants are stimulated to point out which concepts discussed on the previous lectures of the day (versing on EVOLUTIONARY COMPUTATION) that are of interest to their current research. They also should point out which aspects currently being pursued in their research could improve should CEvo is to be utilized. This session focusses on work that provides tips for practical use of the studied concepts. Here a more pragmatically take will verse on Sub-Symbolic approaches of AI, hence, CI. It is expected that some methodological or technological improvement may be found on the current research being pursued. Participants will be invited to present more details of their research, which are possibly prone to improvement by CI, in special, by CEvo.

DAY 4

PREPARATION

-Brief reading on distributed material about the AI/CI Techniques to be discussed on Day-4.

SESSION 13:

SWARM INTELLIGENCE (S.I.) – **LECTURE**

This session starts discussing the concept of Population based algorithms, inspired by gregarious species. The session will also provide a comprehensive overview on three swarm intelligent approaches (ANT COLONY OPTIMIZATION, PARTICLE SWARM OTIMIZATION, FISH SCHOOL SEARCH). All techniques are explained, compared and commented upon, aiming practical use.

SESSION 14:

EXAMPLES OF SWARM INTELLIGENCE IN PRACTICAL PROBLEMS – **EXAMPLES-2**

In this session several examples of S.I. applications are provided so that the participants can have a clear idea on the modelling and simulation aspects of every tackled problem. After every example presented the key concepts and mechanisms used are to be discussed so that they can be re-used on the participants' own research.

SESSION 15:

ADVANCED TOPICS ON RISKS ASSOCIATED TO AI/CI - **DISCUSSION-2**

Given the high impact that can be evoked by current AI/IC techniques, this session will delve into a wide discussions about the likely hidden RISKS that can be produced & foreseen in the near future by new AI/CI techniques or novel applications.

SESSION 16:

AI/CI CONCEPTS APPLICABILITY ON PARTICIPANTS' THESES - **EXERCISE-4**

In this final practical session, participants are stimulated to point out which concepts discussed on the previous lectures of the day (versing on SWARM INTELLIGENCE) are of interest to their current research. They also should point out which aspects currently being pursued in their research could improve should S.I. is to be utilized. This session focusses on work that provides tips for practical use of the studied concepts. Again, a pragmatically take will verse on Sub-Symbolic approaches of AI. It is expected that some methodological or technological improvement also may emerge upon the current research being pursued. Participants will be invited to present more details of their research, which a possibly prone to improvement by CI, in special, by S.I. In the end of the session, final conclusions will be drawn and the workshop will be closed.