

Computational Intelligence

Unit # 1 - Introduction

What do you expect in this course?

Definition

(Source: Wikipedia)

- Computational intelligence (CI) is a *set of Nature-inspired computational methodologies and approaches to address complex problems of the real world applications to which traditional methodologies and approaches are ineffective or infeasible.*

Information

- Text/Reference Books
 - L. N. de Castro, *Fundamentals of Natural Computing: Basic Concepts, Algorithms, and Applications*, 1 edition. Boca Raton: Chapman and Hall/CRC, 2006.
 - Andries Engelbrecht, *Computational Intelligence: An Introduction*, 2007
 - Gusz Eiben and Jim Smith, *Introduction to Evolutionary Computing*, 2007

Why nature-inspired?

**Indeed, in the creation of the heavens
and earth, and the alternation of the
night and the day are signs for those
of understanding.**

Surah Aa'l-e-Imran [189-90]



Why nature-inspired?

- Natural systems are good in dealing with complexity.
- We are aware of many sorts of complex natural systems—such as physical, chemical, biochemical, biological, and ethological systems—featuring many properties that we would really like to bring to our computational systems—such as **robustness**, **fault tolerance**, **self-repair**, and the like.

Nature Inspired Computing

- Computing inspired by nature
- Computing to simulate/emulate nature
- Computing using natural material

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IEEE Computational Intelligence Society's Scope

- The Field of Interest of the Society shall be *the theory, design, application, and development of biologically and linguistically motivated computational paradigms emphasizing neural networks, connectionist systems, genetic algorithms, evolutionary programming, fuzzy systems, and hybrid intelligent systems in which these paradigms are contained.*

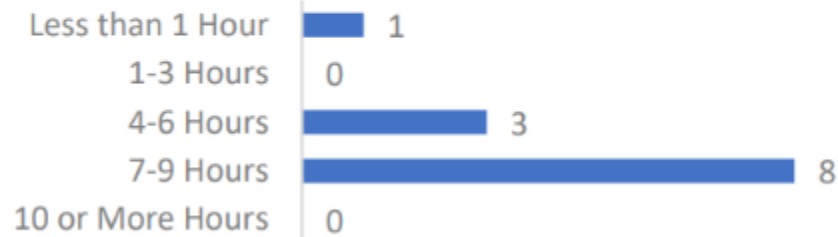
Course Outline

- Introduction
- Evolutionary Computing
 - Genetic Algorithms, Evolutionary Strategies
 - Evolutionary Programming
- Swarm Intelligence
 - Ant Colony Optimization, Particle Swarm Optimization
- Reinforcement Learning
- Fuzzy Logic
- Miscellaneous
 - Artificial Neural Networks
 - Artificial Immune Systems
 - Fractals

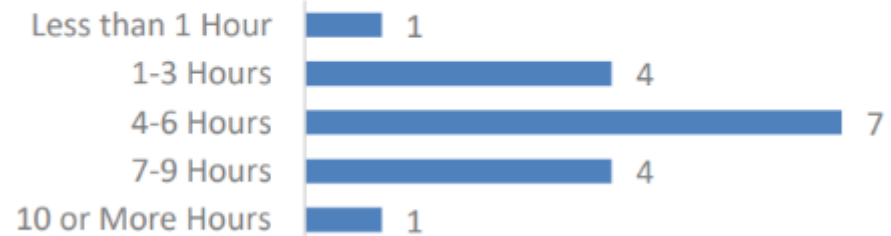
Syllabus Overview

Student Feedback: Work outside classroom

7. The average number of hours per week I spent outside of class preparing for this course were

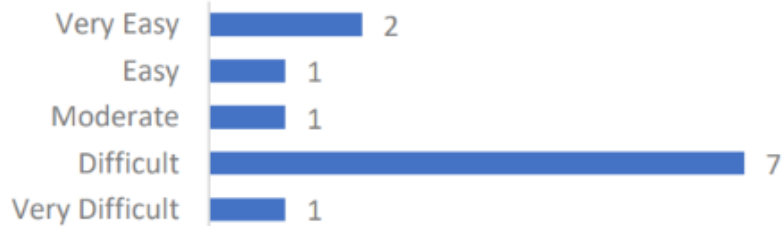


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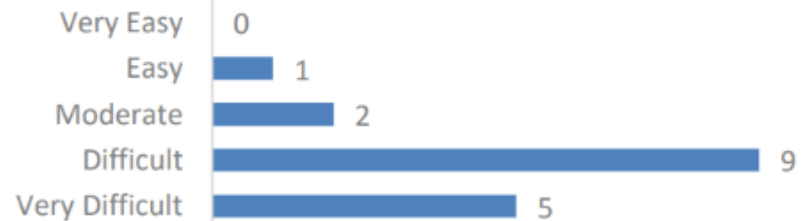


Student Feedback: Difficulty level

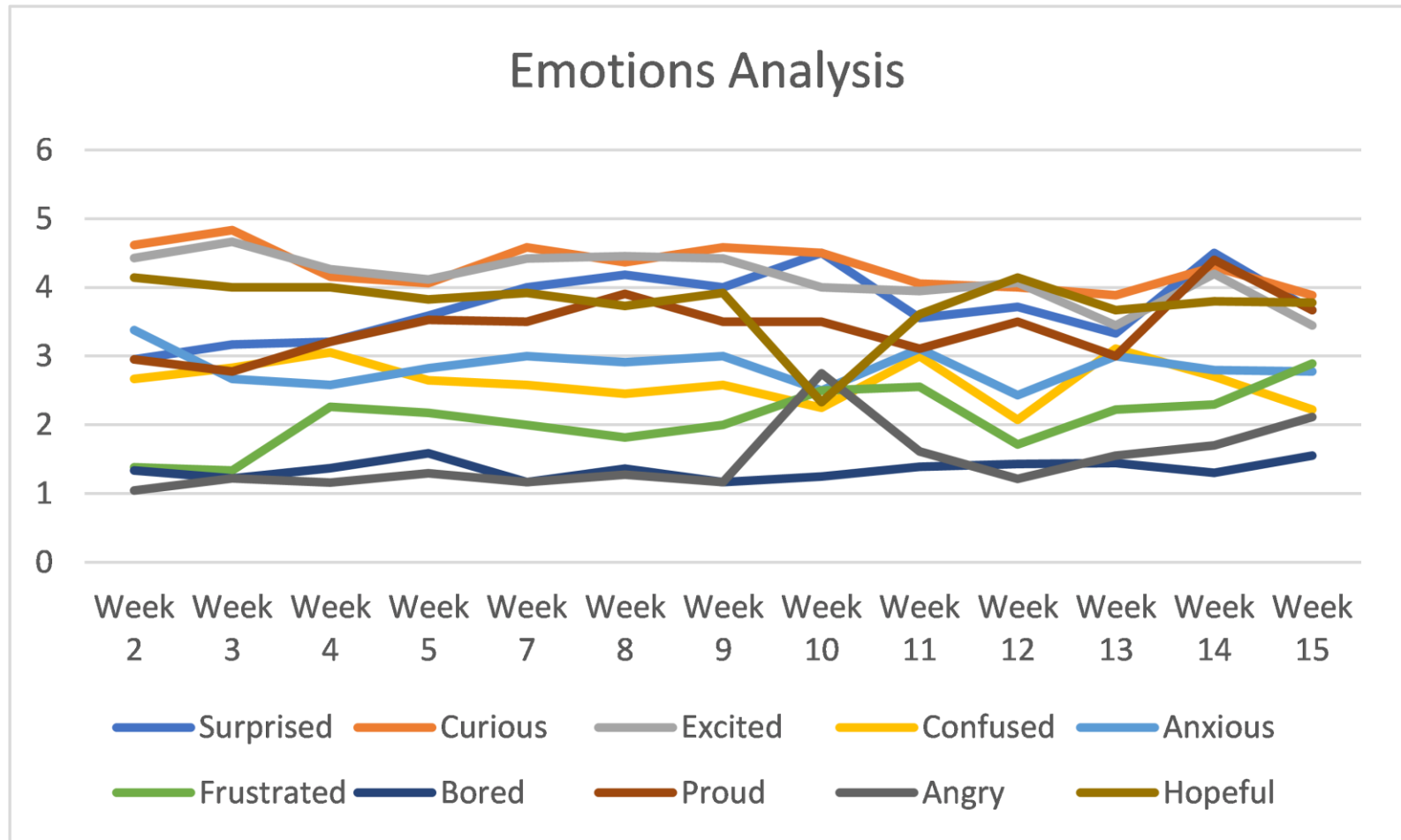
9. As part of the overall design, how would you rate the perceived difficulty (in terms of work hours & experience) for this course?



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Spring 2021



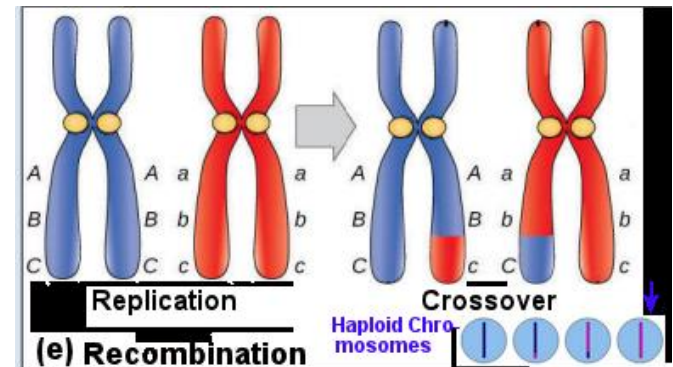
My Challenges

- Starting Project early
 - Here the problem matters more than the solution
- Teamwork assessment (in assignments)
- Managing time for presentations

Evolutionary Algorithm

(Source: Wikipedia)

- In artificial intelligence, an evolutionary algorithm (EA) is a parallel search scheme that is inspired by biological evolution.
- EAs have been used successfully for optimization problems in several fields.



Swarm Intelligence

- The collective behavior that emerges from a group of social insects has been dubbed *Swarm Intelligence*.

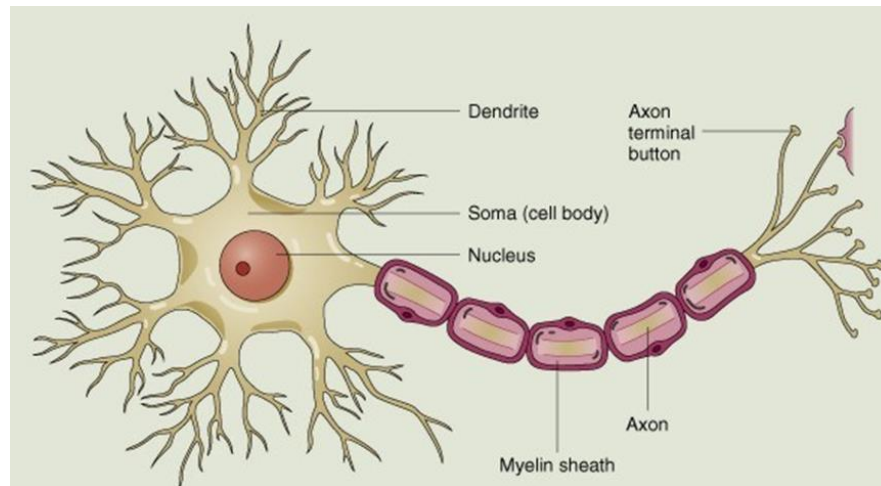


Examples



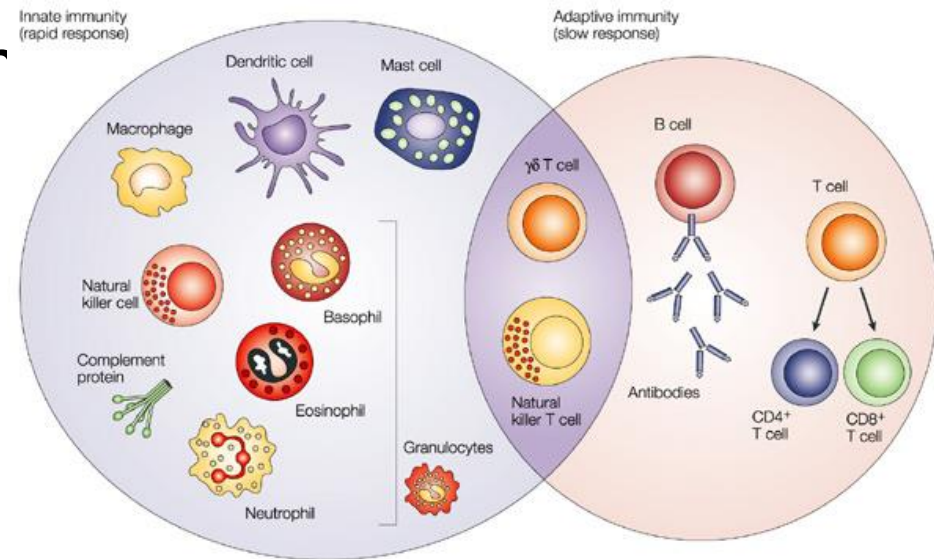
Artificial Neural Networks

- Artificial Neural networks are biologically motivated computing structures that are conceptually modeled after the brain.



Artificial Immune System

- Artificial Immune Systems (AIS) are a class of computationally intelligent systems inspired by the principles and processes of the biological immune system. The algorithms typically exploit the immune system's characteristics of learn to solve a problem.



Reinforcement Learning

- An RL agent learns by interacting with its environment and observing the results of these interactions. This mimics the fundamental way in which humans (and animals alike) learn.

Reinforcements



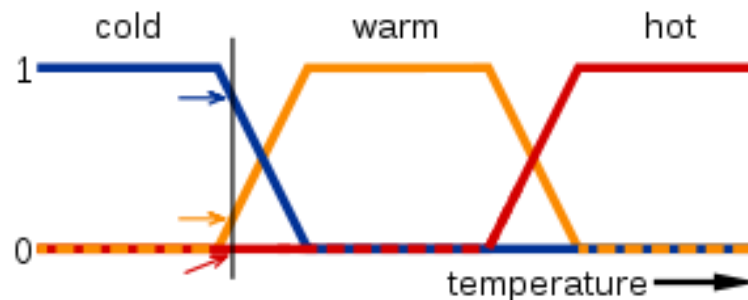
positive rewards
for desirable behavior

negative rewards
for undesirable behavior



Fuzzy Logic

- **Fuzzy logic** is a form of reasoning that is approximate rather than fixed and exact.
 - For example,
 - When you are at 10 meters from the junction start braking at 50% pedal level.
- Can be rephrased as:
- When you are near the junction, start braking slowly.



Thanks