Applied Computational Intelligence

ESOF-4011

Dr. T. Akilan

takilan@lakeheadu.ca

Logistics

Class Name and Title	Days of Week	Start Time	End Time	Start Date	End Date
ESOF-4011-WA: Applied Computational Intelligence	TTH	05:30PM	07:00PM	Tuesday, January 12, 2021	Tuesday, April 13, 2021
ESOF-4011L-W1	M	01:00PM	02:30PM	Monday, January 18, 2021	Monday, April 5, 2021

- Final Date to Register (Add)–Friday, January 22, 2021
- Reading Week - February 15 to 19, 2021 → **Midterm exam: Feb. 23, 2021 (Tuesday)**
- Final Date to Withdraw (Drop)–Friday, March 12, 2021
- Examination Period - Friday April 16 - Sunday April 25, 2021

- All the materials for lectures, labs, assignments, projects, etc. will be posted on the main course website

Logistics Cont.

- Course Outline, Project, and Evaluation
- GA:
  - ✓ Robert H. - rhertel@lakeheadu.ca

Introduction to Computational Intelligence

Lecture 1

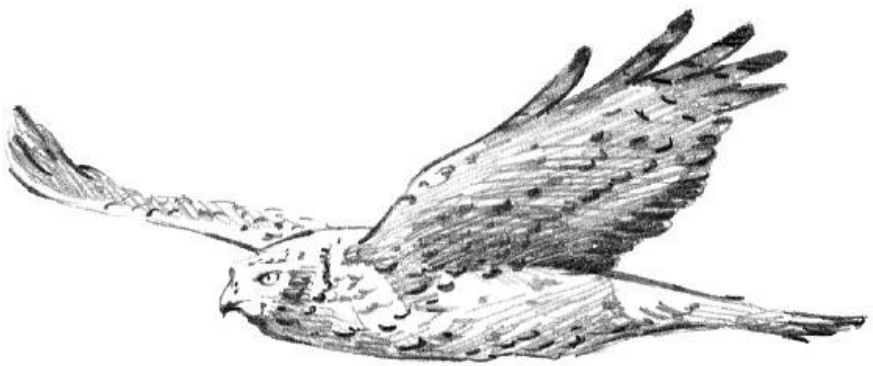
Outline

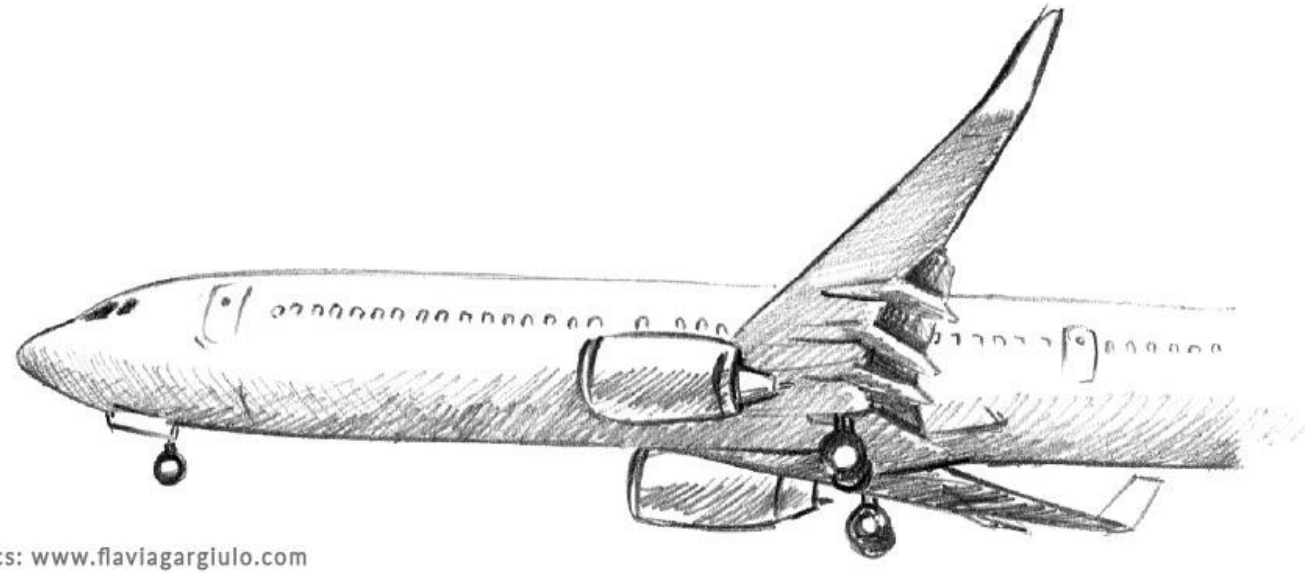
- Fundamental Definitions
- Computational Intelligence Paradigms
- Example Applications
- Summary
- Pop quiz

Introduction to CI

- Computational Intelligence (CI) is the theory, design, application and development of **biologically and linguistically motivated computational** paradigms.

Image source:
https://cis.ieee.org/





Source: Designing Regenerative Cultures, 2016 - www.danielchristianwahl.com; Graphics: www.flaviagargiulo.com

Introduction to CI

- Computational Intelligence (CI) is the theory, design, application and development of **biologically and linguistically motivated computational** paradigms.

Image source: https://cis.ieee.org/

Video source: Boston Dynamics, Do You Love Me? - YouTube

CI Paradigm

Image source:
https://cis.ieee.org/

- Three main pillars of CI paradigm:
  - Neural Networks
  - Fuzzy Systems
  - Evolutionary Computation

- CI is an **evolving field** and at present in addition to the three main constituents.
  - Swarm intelligence, Fractals and Chaos Theory, Artificial immune systems, Ambient intelligence, artificial life, etc.
  - Recent explosion of research on Deep Learning (DL), particularly Deep Convolutional Neural Networks (DCNN).

Introduction to CI Cont.

- DL has become the core method for AI and the most successful AI systems are based on CI.
  - CI plays a major role in developing successful intelligent systems, including games and cognitive developmental systems.

- Computational intelligence systems usually incorporate hybrids of paradigms such as **artificial neural networks (ANN)**, **fuzzy systems**, and **evolutionary computation** (EC) **systems**, augmented with **knowledge elements**.

- **By the way, what is intelligence? What is ANN?**
  - Let's understand the basic definitions

Basic Definitions: What is Intelligence?

- Dictionary meaning →

- "**Intelligence**" is the capability of a system to adapt its behavior to meet its goals in a range of environments.
  - Ability to **perceive** and **act** in the world
    - ✓ **Reasoning**: proving theorems, medical diagnosis
    - ✓ **Planning**: take decisions
    - ✓ **Learning** and **Adaptation**: recommend movies, learn traffic patterns
    - ✓ **Understanding**: text, speech, visual scene

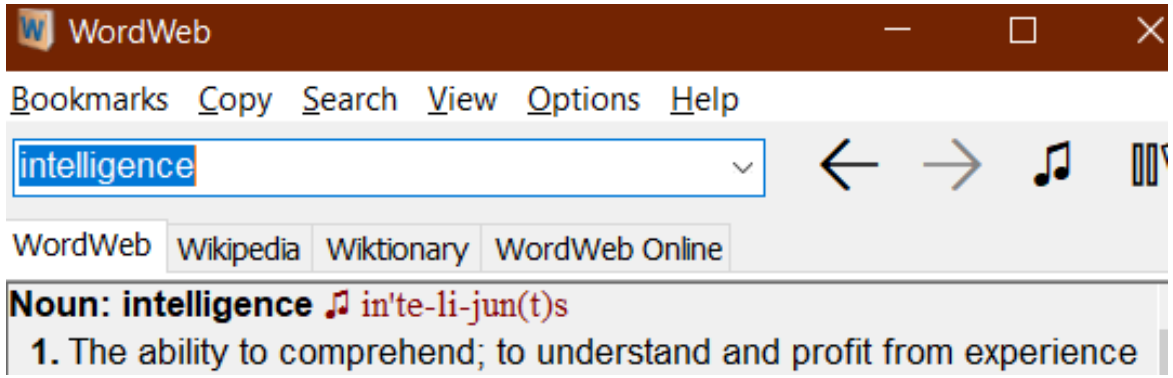
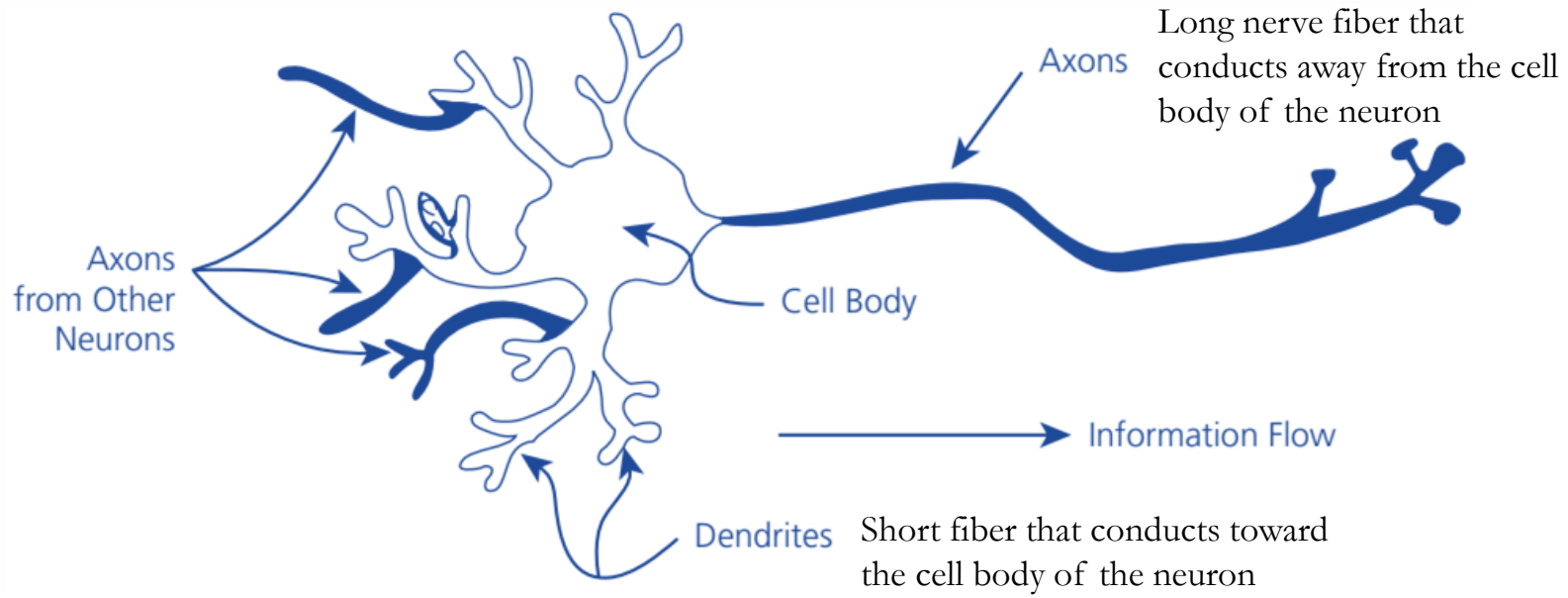


Image source: Andrew D., Artificial Intelligence for Investing, https://blogs.cfainstitute.org/,

Basic definitions: ANN

- An **artificial neural network** is an analysis paradigm that is roughly **modeled after** the massively parallel **structure of the human brain**.
  - The term **neural network** refers to a network or circuit of **biological neurons**

- ANN includes:
  - Feedforward NNs
  - Recurrent NNs
  - Self-organizing NN
  - Deep learning
  - CNN
  - …



Conceptual diagram of a neuron (Computational Intelligence : Concepts to Implementations)

Basic definitions Cont.

- **Fuzzy Systems (FS):**
  - Do real-world problems have definite response ?
    - ✓ "real world" are fuzzy.
    - ✓ E.g., "It is kind of foggy outside now, but it should be fairly sunny before too long".
      - ➢ It incorporates three fuzzy concepts: "kind of," "fairly," and "before too long."
  - **Source of inspiration** – **human language** and **linguistic imprecision**
  - **Model** - solves uncertain problems based on a **generalization of conventional logic** enabling "approximate reasoning."
    - ✓ Conventional logic - **crisp logic (**two-valued**)**, an element either is or is not a member of the set.
  - **Properties** - imprecision, approximation, or vagueness.
  - **Operations** - equality, containment, complementation, intersection, and union.
  - **Extensions** - fuzzy sets and systems, fuzzy clustering and classification, fuzzy controllers, linguistic summarization, fuzzy neural networks, type 2 fuzzy sets and systems, etc.