Neural Networks and Genetic Programming
- Course Presentation -

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31/08/2020

"One of the central challenges of computer science is to get a computer to do what needs to be done, without telling it how to do it."

John Koza

"One of the central challenges of computer science is to get a computer to do what needs to be done, without telling it how to do it."

John Koza

Neural Network, Genetic Algorithm, Genetic Programming, Neuroevolution address this challenge, in some ways

History of artificial intelligence

Began in Antiquity

Modern AI began with the invention of programmable digital computer in the 40s.

Machine Intelligence

Having computers automatically solve problems is central to artificial intelligence and "machine intelligence" (Turing 1948)

Definition

Arthur Samuel, in his 1983 talk entitled "*AI: Where It Has Been and Where It is Going*" said that the main goal of machine learning and artificial intelligence is

"to get machines to exhibit behavior, which if done by humans, would be assumed to involve the use of intelligence."

Arthur Lee Samuel (1901 - 1990) was an American pioneer in computer gaming and artificial intelligence. He coined the term "machine learning" in 1959.

He authored the Alpha-Beta pruning algorithm

In this lecture…

… we will focus on *implementation aspects* of neural network, genetic algorithm, genetic programming, neuroevolution

This represents a small portion of what Artificial Intelligence is commonly associated with
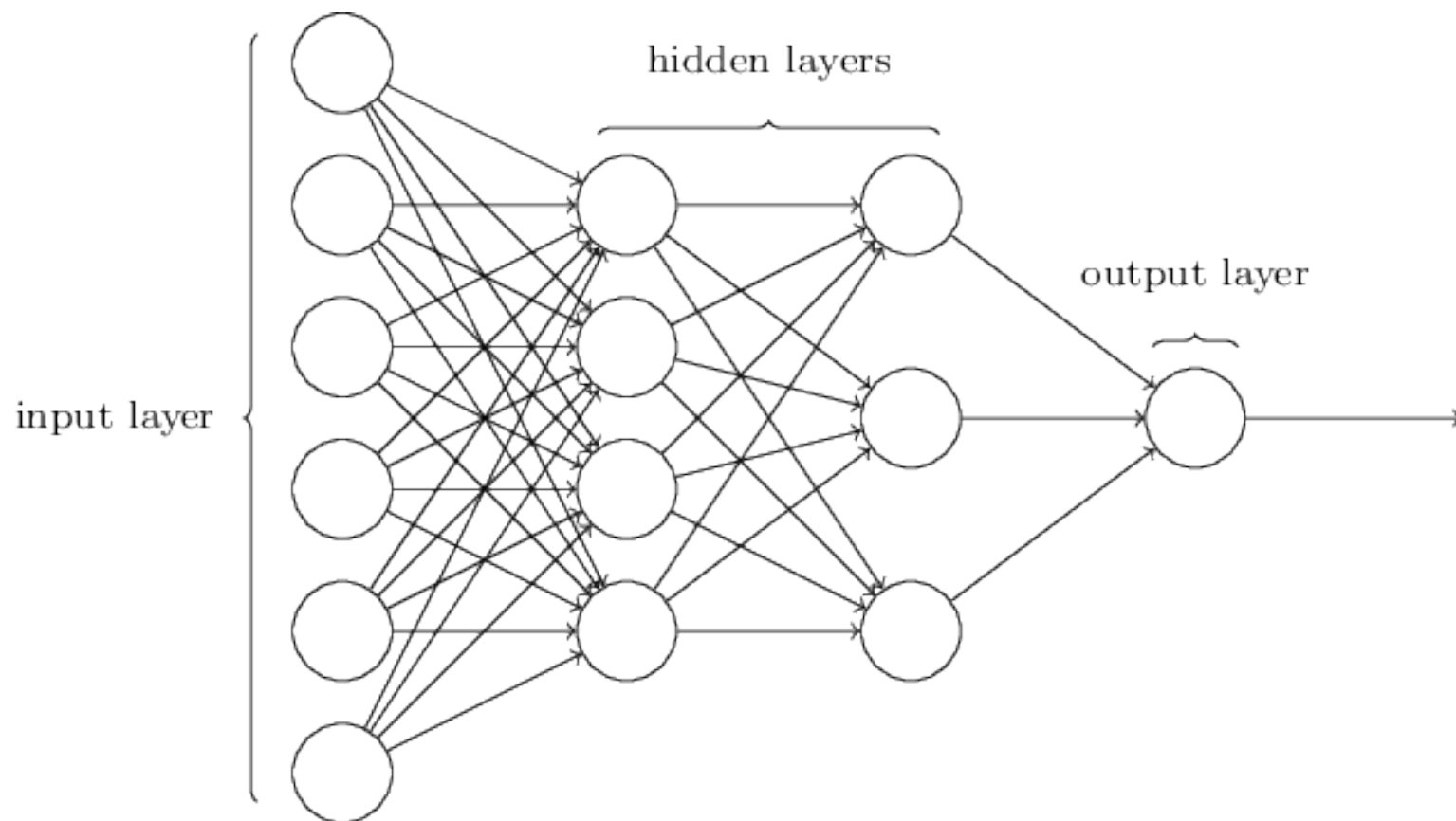
Why NN, GA / GP, Neuroevolution?

Simple to use and easy to adapt, at least in its simple form

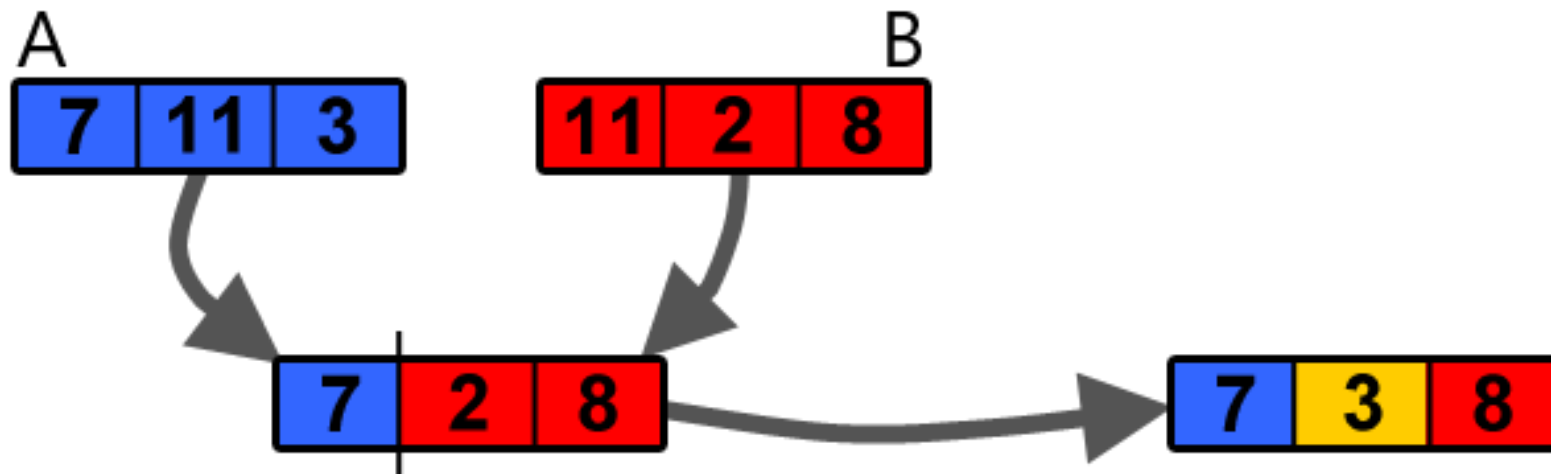Can be used to solve optimization and pattern-finding problems

Applications in *software engineering, software testing, gaming, image processing, signal processing, data clustering, …*
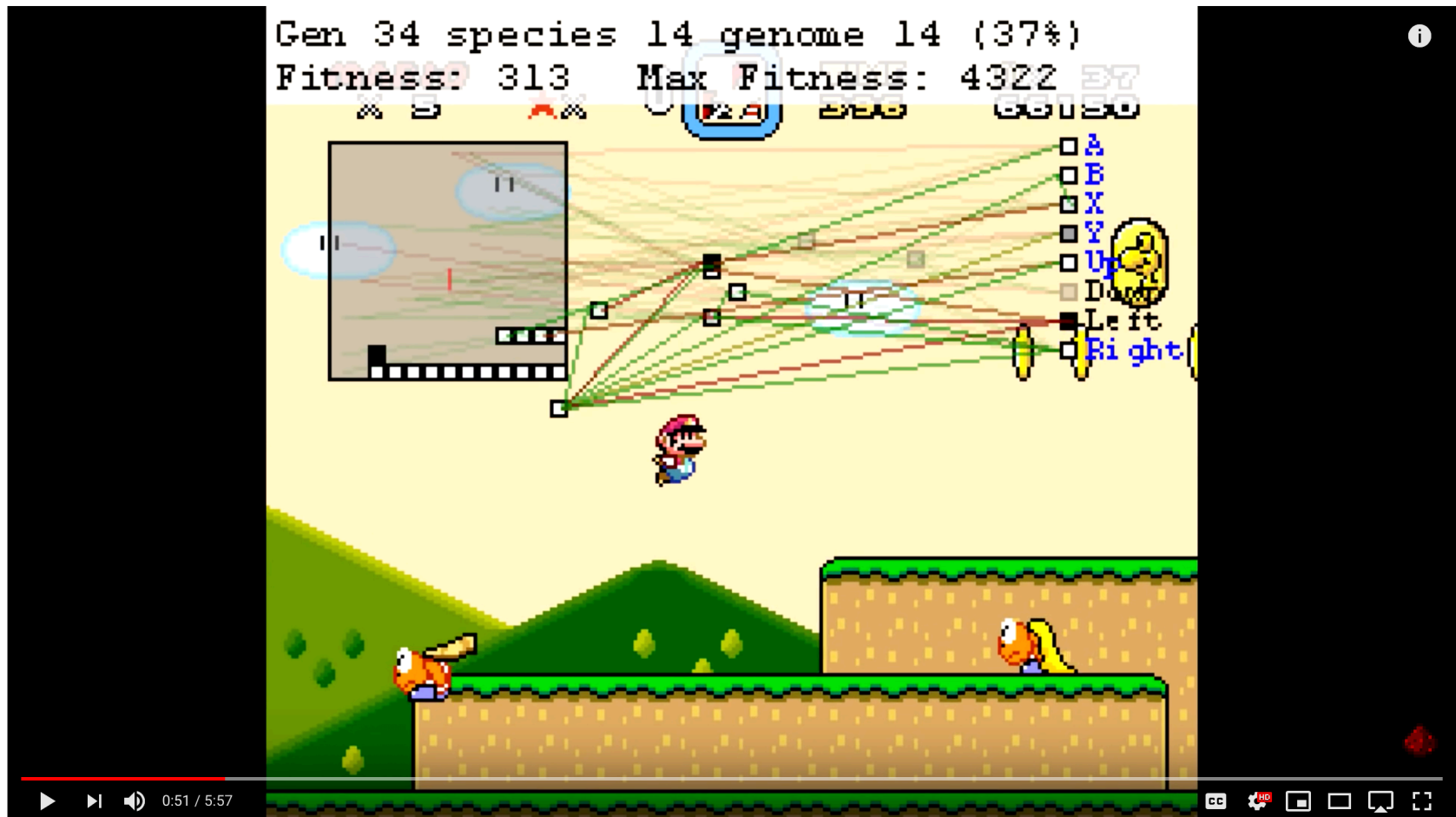
input layer

hidden layers

output layer

Crossover

Mutation

A

7 11 3

B

11 2 8

7 2 8

7 3 8

Marl/O - Machine Learning for Video Games

8,663,500 views

https://www.youtube.com/watch?v=qv6UVOQ0F44

Objectives of this lecture

Explore the design and implementation of

Neural network

Genetic algorithm & programming

Neuroevolution

Evaluate our implementations

Study applications to solve relevant problems

Objectives of this lecture

Emphasizes on the *implementation of AI technique*.

This means that at the end of the semester, *you will have designed and implemented your own IA engine*.

You will have solved some specific problems using Neural Networks and Genetic Programming

Programming?

You will have *to program* this semester

You will therefore have to *apply good programming* practices (testing, versioning, benchmarking, …)

No restriction on the programming language to use

This lecture

… is not about using TensorFlow, Keras, PyTorch

They are super cool frameworks, but they are *mostly black boxes (i.e., very unlikely that one day you look at their source code)*

This lecture is about opening these blacks boxes and tweaking inside

The whole point of CC5114 is to not use existing libraries

Also, TensorFlow, Keras, PyTorch cannot express evolutionary algorithms

Formalities

Régimen de clases

2-3 horas semanal

Semi-flipped classroom

Bring your laptop in class

You will need it to concretize your ideas and solve some challenging problems

Evaluations

4 Tareas

Semi-flipped classroom

We will cover some theoretical aspects about NN, GA, GP, Neuroevolution, but this will have an applicative focus

We will mostly do project during the semester

Projects will be mostly done during classroom

If you prefer to attend the theoretical part, and finish at home, it is absolutely fine

Tareas

Tarea 1

Design, Implementation, Application of a Neural Network
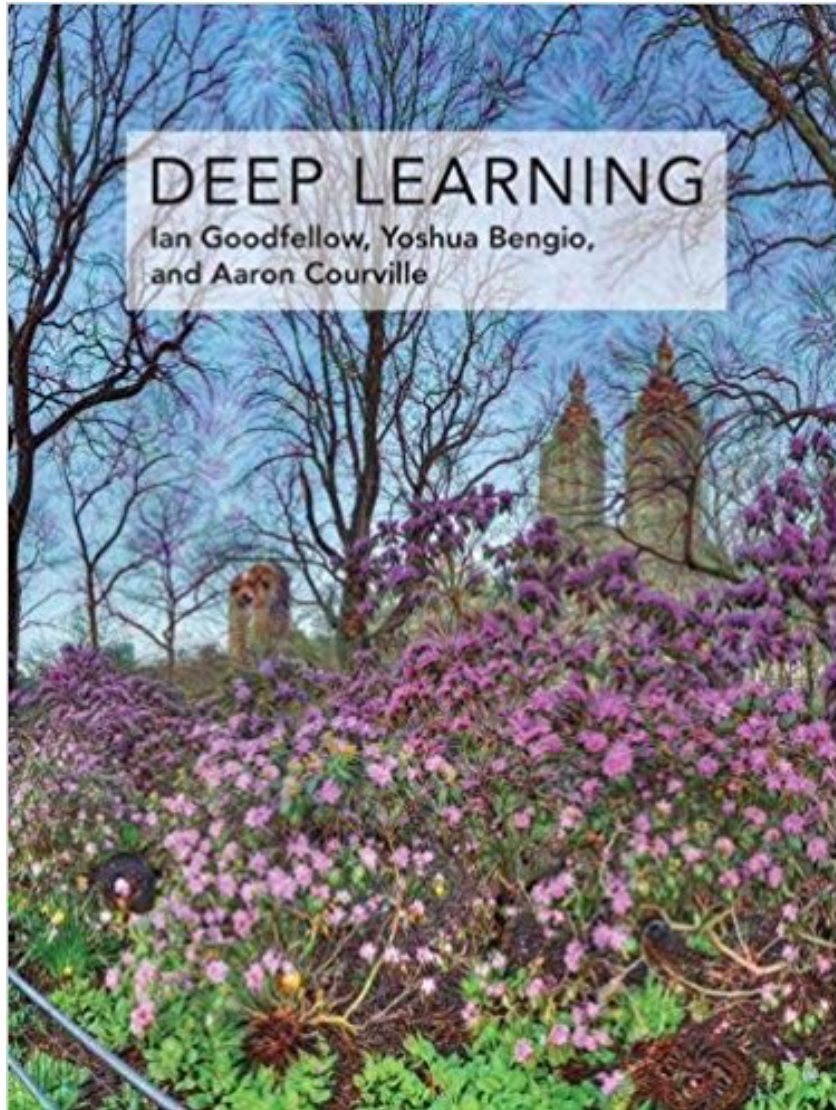
Tarea 2

Design, Implementation, Application of a Genetic Algorithm engine

Tarea 3

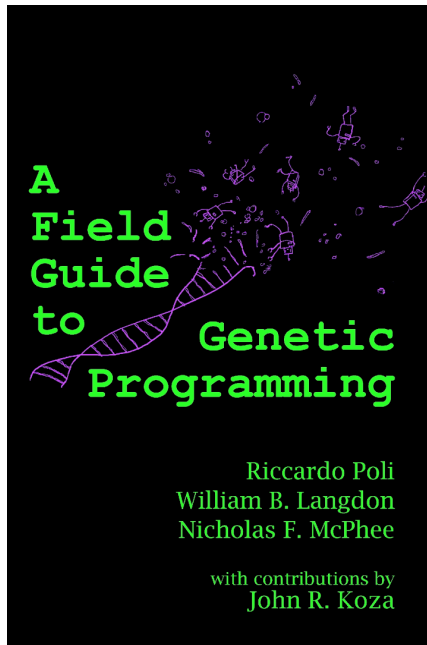Design, Implementation, Application of a Genetic Programming engine

Tarea 4

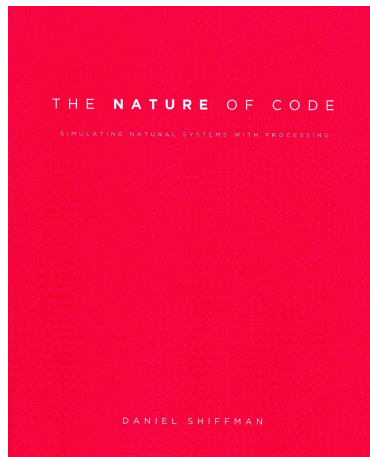Design, Implementation, Application of a Neuroevolution engine

Deep Learning
by Ian Goodfellow

A reference, but does not consider
implementation details

A
Field
Guide
to
Genetic
Programming

Riccardo Poli
William B. Langdon
Nicholas F. McPhee

with contributions by
John R. Koza

http://www.gp-field-guide.org.uk

THE NATURE OF CODE

SIMULATING NATURAL SYSTEMS WITH PROCESSING

DANIEL SHIFFMAN

Daniel Shiffman
http://natureofcode.com

What to read

Neural Networks and Deep Learning by Michael Nielsen, 2017. *http://neuralnetworksanddeeplearning.com*

Intelligent Machinery, A Heretical Theory. A. M. Turing 1951. https://doi.org/10.1093/philmat/4.3.256

Work of John Koza: http://www.genetic-programming.com

See you on Wednesday, with your Laptop!