



# SMARTSIM

DL SMART-AI

ARTIFICIAL INTELLIGENCE  
COURSE



DE LORENZO

# SMART SIMULATOR FOR LEARNING AI WITH PYTHON

The DL SMART-AI is a software that has been developed to teach artificial intelligence with Python in a unique and effective way.

With this software, students can improve their individual experience on studying artificial intelligence in practice.

Professors can explore this trainer to provide experiments to students with the following topics:

- ✓ **Optimization: Introduction, definition, time and cost problems;**
- ✓ **Classification: Neural networks, signal generation, TensorFlow, predictions and failure predicts;**
- ✓ **Reinforcement Learning: Introduction and comparative to modern control;**
- ✓ **Decision trees: Application on regression.**

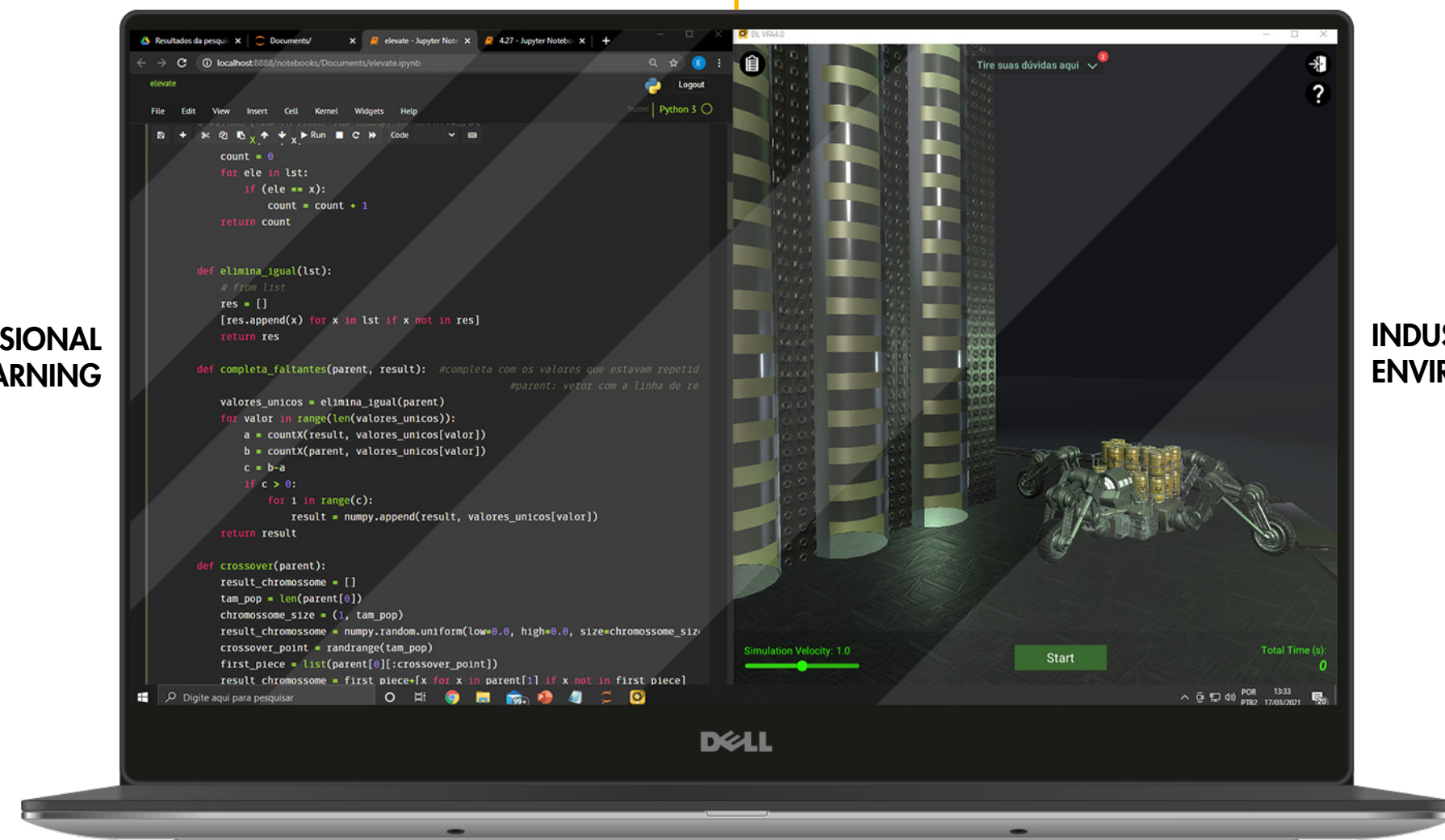
This software works integrated to a Python IDE (not included).

PYTHON PROGRAMMING  
TOOLS

POWERFUL  
3D SIMULATOR

PROFESSIONAL  
LEARNING

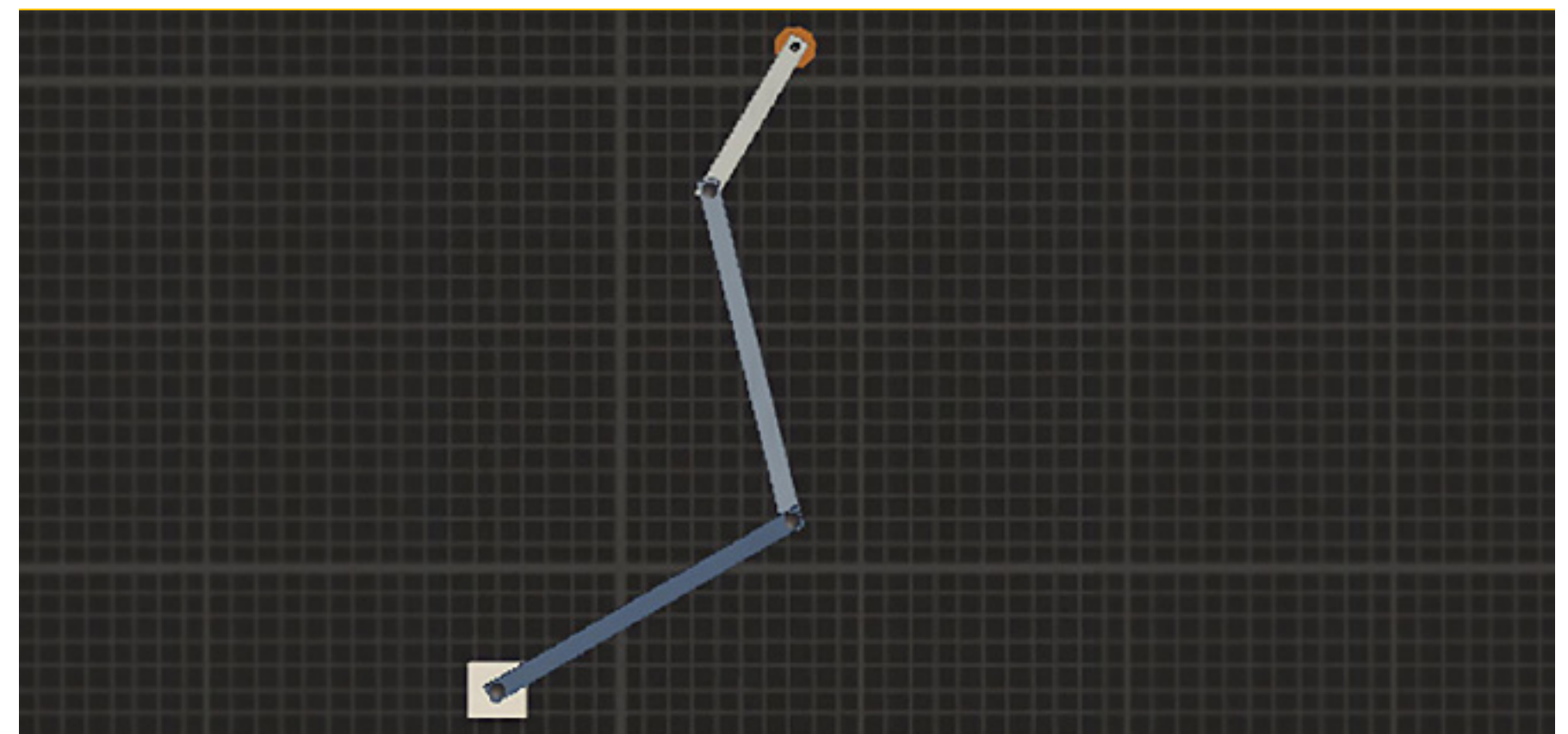
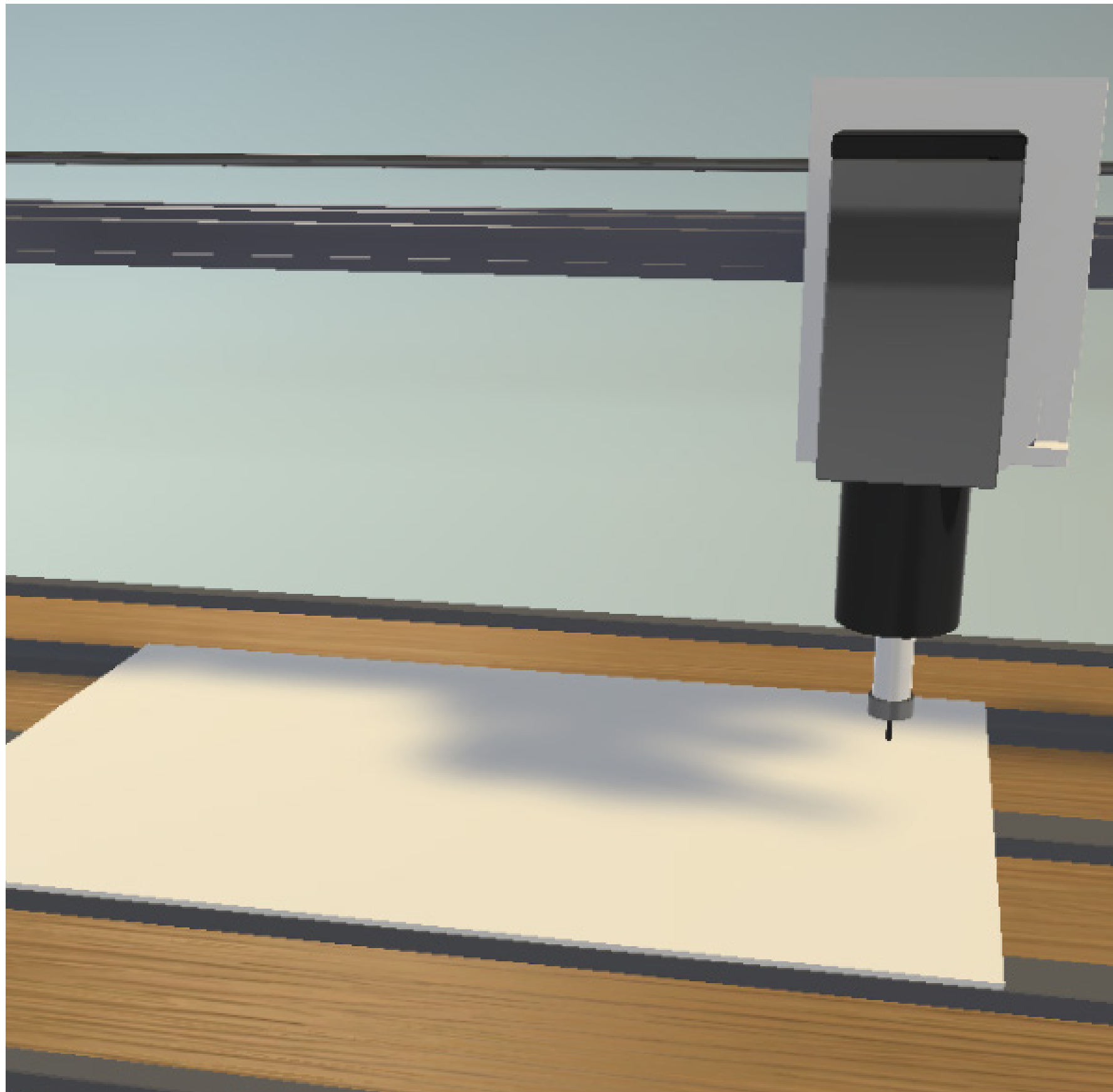
INDUSTRIAL REALISTIC  
ENVIRONMENTS



PROFESSIONAL EXPERIENCE

REAL-LIFE SITUATIONS

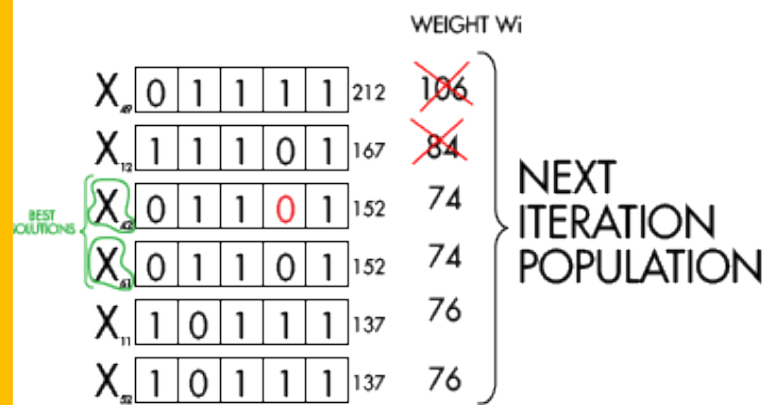
## 3D INDUSTRIAL ENVIRONMENTS TO PROVIDE **REAL PRACTICAL EXPERIENCE** TO STUDENTS



# EFFECTIVE LEARNING WITH GUIDANCE, REAL-LIFE PROJECTS, THEORY AND INSTRUCTIONS FROM BASIC TO ADVANCED

1

## POPULATION ADJUSTMENT

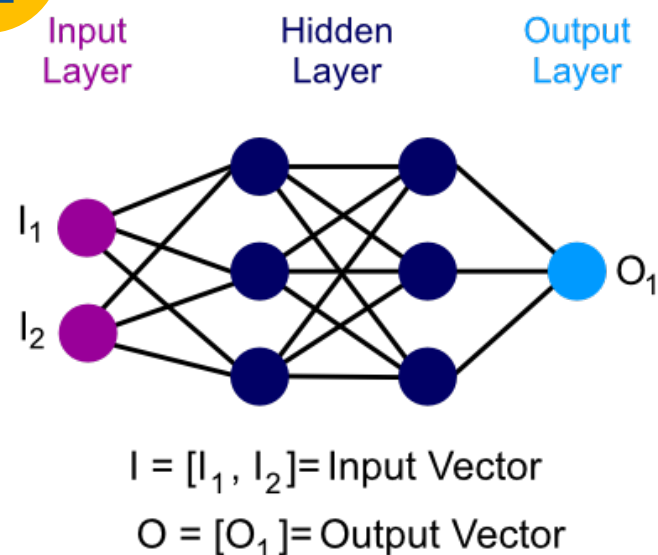


### OPTIMIZATION

**Goal:** Use genetic algorithm to resolve optimization problems, like the time problem or the cost one.

**AI concepts:** Introduction, genetic algorithm.

2

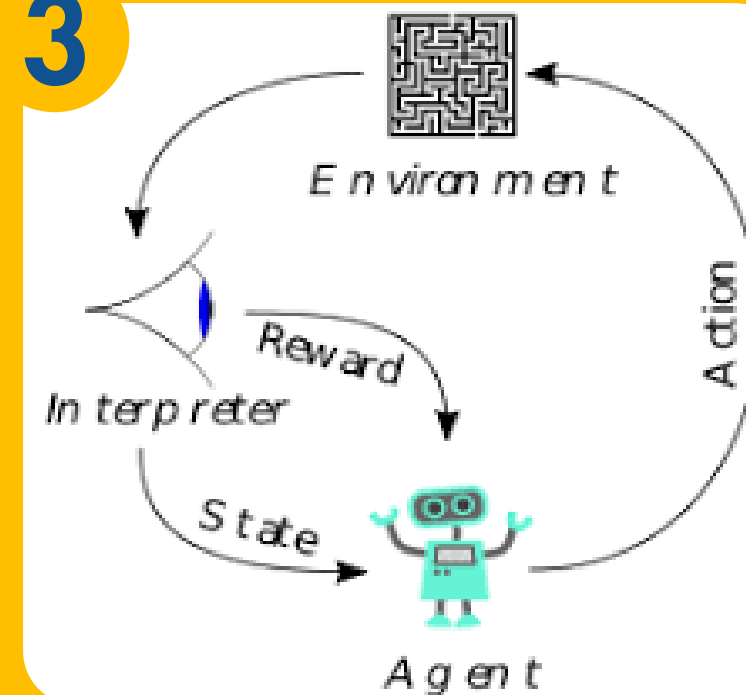


### CLASSIFICATION

**Goal:** Use neural networks to resolve classification problems.

**AI concepts:** Neural networks.

3

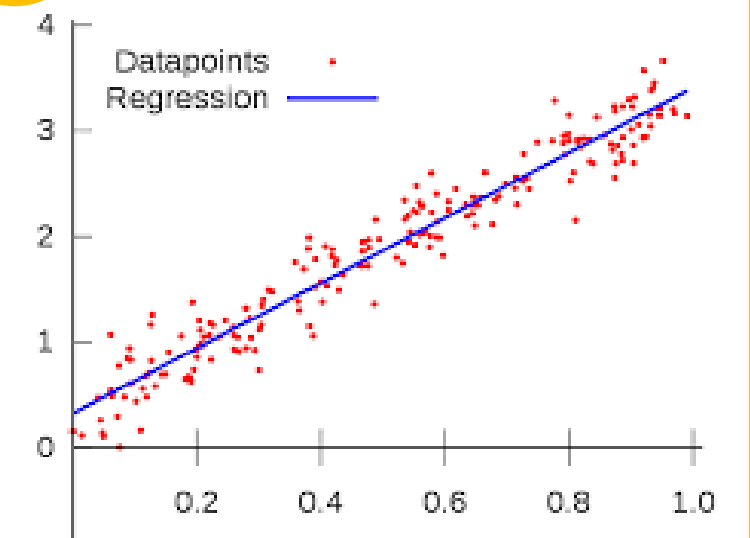


### REINFORCEMENT LEARNING

**Goal:** Use reinforcement learning to train a robot and a lead screw to reach a specific position.

**AI concepts:** Reinforcement learning.

4



### REGRESSION

**Goal:** Compare performances of decision tree and neural network algorithms in system modeling and predictions.

**AI concepts:** Decision trees.

# STUDENT CAN LEARN AND PRACTICE FROM BASIC TO ADVANCED AI TOPICS

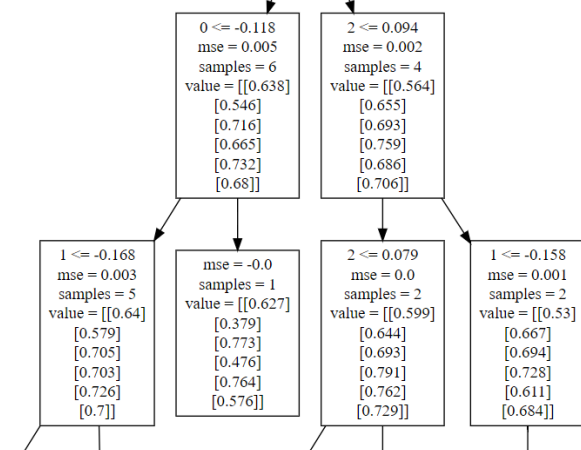
With the industrial 3D environments and also the built-in projects it's possible to develop solutions that evolve optimization, genetic algorithms, regression, neural networks and a lot more.

## PYTHON INSTRUCTIONS

```
def crossover(parent):
    result_chromosome = []
    tam_pop = len(parent[0])
    chromosome_size = (1, tam_pop)
    result_chromosome = numpy.random.uniform(low=0.0, high=0.0, size=chromosome_size)
    crossover_point = randrange(tam_pop)
    first_piece = list(parent[0][:crossover_point])
    result_chromosome = first_piece + [x for x in parent[1] if x not in first_piece]
    result_chromosome = numpy.asarray(result_chromosome)
    result_chromosome = completa_faltantes(parent[0], result_chromosome)
    return result_chromosome

def mutate(chromosome):
    chromosome = chromosome.astype(int) #transform a float array into a integer array
    lista = chromosome.tolist() # transform into list to use the function "sample"
    i, j = numpy.random.randint(low=0, high=len(chromosome), size=2) # choose two samples of the list (chromosome)
    lista[i], lista[j] = lista[j], lista[i]
    lista_saida = numpy.asarray(lista)
    return lista_saida
```

## DECISION TREE



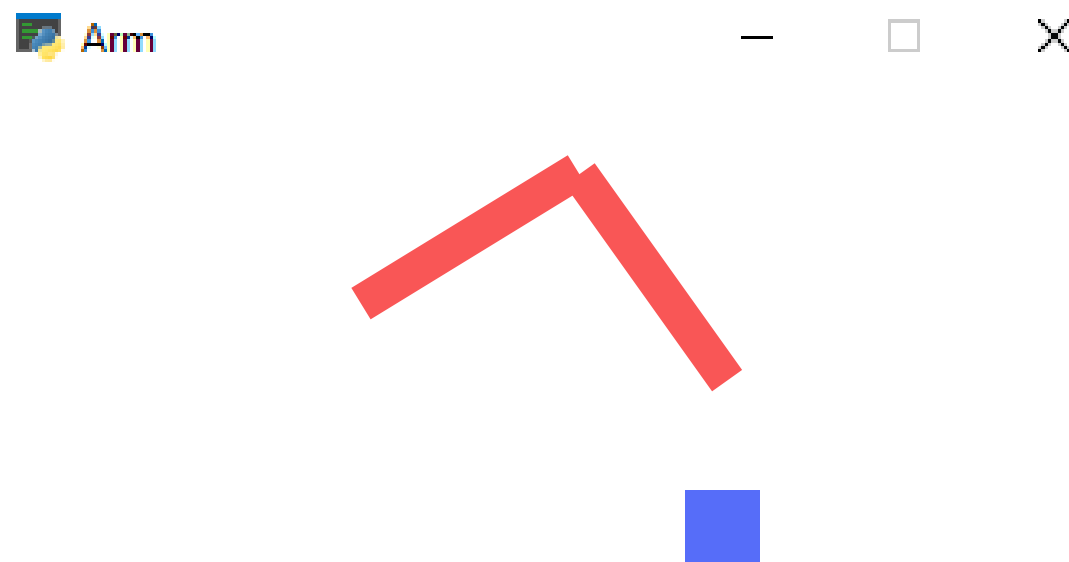
## PREDICTIONS

```
predictions = model.predict(testX)

predictions[10]
predictions[80]
predictions[50]
predictions[90]

array([9.9999940e-01, 1.9931608e-07, 1.7625602e-07, 2.5123788e-07],
      dtype=float32)
```

## VIRTUAL TRAINING ROBOT



## TRAINING

```
Epoch 2245/4000
1280/1280 [=====] - 1s 998us/step - loss: 0.1307 - accuracy: 0.9531 - val_loss: 0.1074 - val_accuracy: 0.9719
Epoch 02245: early stopping
Train: 0.972, Test: 0.972
```

## WHY IS IT A SMARTSIM?

## IT CONNECTS PROFESSOR, STUDENT AND SCHOOL

De Lorenzo's cloud server receives students activities and provides reports and analytics to professors and institutions. Besides, a student can start working at school and continue at home or vice-versa.



The platform includes a query and answer system that enables professors to support the students counting on a team of monitors. That means better support with less effort of the professors. The students can see questions asked by other colleagues too so that way if more than one student have the same doubt the professors answer will attend them all.

## New Question

Choose the Challenge or Tasks \*

Getting started

Question to \*

Team

Question Title \*

Type the title of your question.

Question Content \*

Type your question...

Attach Image

 Add image...

☐ Private question (visible only to teachers and instructors).

☐ Anonymous (display my name only for teachers and instructors).

Cancel

Submit

**COMPATIBLE WITH THE DL SMART-DASHBOARD (SOLD SEPARATELY)**

## PROFESSORS CAN FOLLOW STUDENTS PROGRESS

The professor can do and access everything the student can. Besides, he/she can also access the dashboard's portal. It includes interesting reports and analytics that help the professor to monitor the group in real time, as well as to identify students who are doing very well, as well as those who need help, who are not working at all and who seem to be "cheating".

## Tasks report

This is an important tool since it provides evidence of the activities a student worked on. That means the school has evidence of the practical activities the distance learner has done with detailed information about it.

| Curso                                     | Tarefa                                    | Timestamp              | IsDon |
|-------------------------------------------|-------------------------------------------|------------------------|-------|
| Scripts                                   | 1.1 - Abrindo uma tela modal              | 3/9/2020 6:33:37 PM    | False |
| Desenvolvimento de sistemas supervisórios | 2.6 - Implementar Gráficos                | 11/22/2019 7:14:00 PM  | False |
| Desenvolvimento de sistemas supervisórios | 2.5 - Montar interface principal          | 11/18/2019 5:04:15 PM  | True  |
| Desenvolvimento de sistemas supervisórios | 2.4 - Construindo os objetos da aplicação | 11/18/2019 4:28:54 PM  | True  |
| Desenvolvimento de sistemas supervisórios | 2.3 - Explorando Recursos                 | 11/15/2019 5:35:44 PM  | True  |
| Desenvolvimento de sistemas supervisórios | 2.2 - Conhecendo o Elipse E3              | 11/15/2019 5:10:00 PM  | True  |
| Desenvolvimento de sistemas supervisórios | 2.1 - Comunicação OPC                     | 11/14/2019 12:57:42 PM | True  |
| Desenvolvimento de sistemas supervisórios | 1.8 - Comandos pelo supervisório          | 11/14/2019 11:25:14 AM | True  |
| Desenvolvimento de sistemas supervisórios | 1.7 - Implementando alarmes               | 11/8/2019 7:33:30 PM   | True  |

## PROFESSOR CAN SEE WHICH STUDENTS ARE ON SCHEDULE

With this interface, the professor may choose which groups he/she wants to monitor, to verify who is on schedule, who is pending and so on. It is possible to define the expected progress percentage in relation to the tasks available in the course.

Curso

Multiple selections

#0 P 17,18,19 A

Grupo

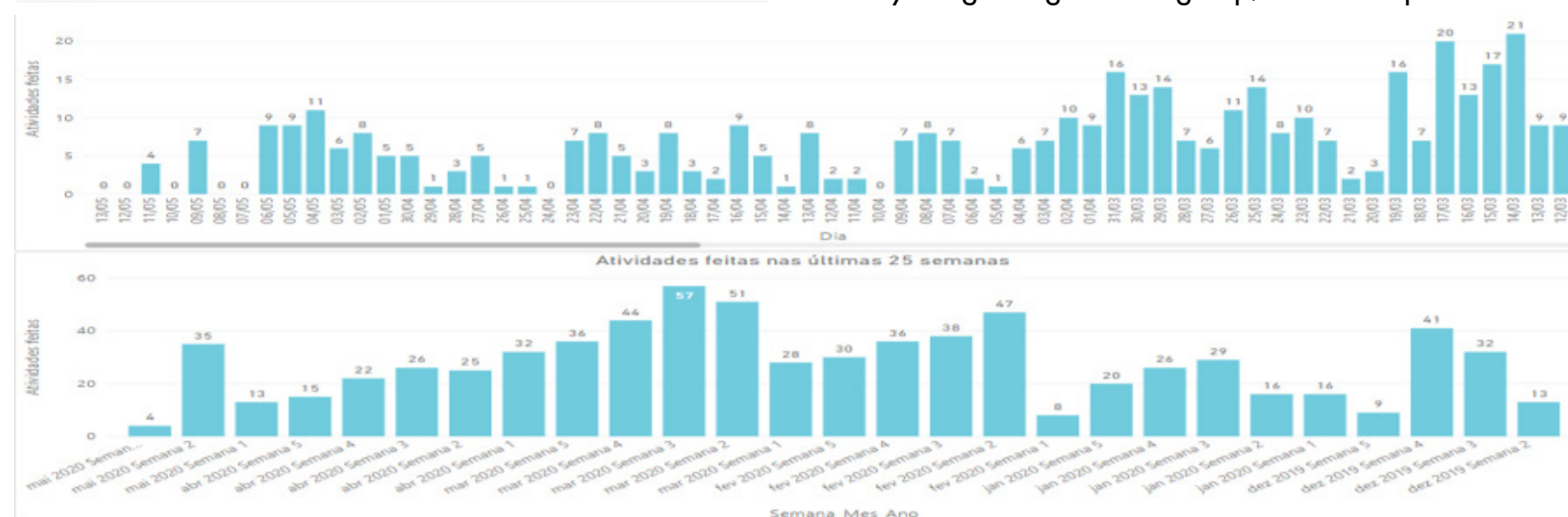
% Aprobación

70

| Curso      |                   | Control de Procesos |                   | Visión Artificial |  |
|------------|-------------------|---------------------|-------------------|-------------------|--|
| Aluno      | Atividades feitas | Minimo atividades   | Atividades feitas | Minimo atividades |  |
| anonymized | 12                | 27                  |                   |                   |  |
| anonymized | 39                | 27                  | 7                 | 5                 |  |
| anonymized | 39                | 27                  | 7                 | 5                 |  |
| anonymized | 39                | 27                  | 7                 | 5                 |  |
| anonymized | 39                | 27                  | 7                 | 5                 |  |
| anonymized | 39                | 27                  | 7                 | 5                 |  |
| anonymized | 1                 | 27                  | 7                 | 5                 |  |
| anonymized | 30                | 27                  | 1                 | 5                 |  |
| anonymized | 11                | 27                  | 7                 | 5                 |  |
| anonymized | 27                | 27                  |                   |                   |  |
| anonymized | 12                | 27                  | 7                 | 5                 |  |
| anonymized | 9                 | 27                  | 7                 | 5                 |  |
| anonymized | 39                | 27                  | 7                 | 5                 |  |
| anonymized | 39                | 27                  | 7                 | 5                 |  |
| anonymized | 39                | 27                  | 7                 | 5                 |  |
| anonymized | 39                | 27                  | 7                 | 5                 |  |
| anonymized | 39                | 27                  | 7                 | 5                 |  |
| anonymized | 39                | 27                  | 7                 | 5                 |  |
| anonymized | 39                | 27                  | 7                 | 5                 |  |
| anonymized | 36                | 27                  | 7                 | 5                 |  |
| Total      | 39                | 27                  | 7                 | 5                 |  |

## RHYTHM

This other dashboard shows the number of activities the students did daily and weekly. The professor may decide to verify it regarding a whole group/class or a specific student.



### EFFORT/TASK DEDICATED TIME

If the professor selects a student, he/she may verify how much time the student took to develop and deliver each task of the course.

| Tempo por tarefa                                  |                   |
|---------------------------------------------------|-------------------|
| Tarefa                                            | Duracao Total (h) |
| Controlador ON-OFF - Forno                        | 4.33              |
| Estudando a Planta - Forno                        | 4.08              |
| Controlador PI - Forno                            | 3.14              |
| Resposta transiente e estacionária - Forno        | 2.50              |
| Estudando a planta - Fuso                         | 2.45              |
| Métodos de Ziegler-Nichols(Malha Fechada) - Forno | 2.35              |
| Controlador PD - Forno                            | 1.99              |
| Controlador ON-OFF - Válvula                      | 1.88              |
| PID Siemens - Forno                               | 1.63              |
| Controlador Proporcional - Forno                  | 1.44              |
| Controlador PI - Válvula                          | 1.42              |
| Métodos de Ziegler-Nichols(Malha Aberta) - Forno  | 1.29              |
| Estudando a planta - Válvula                      | 1.22              |

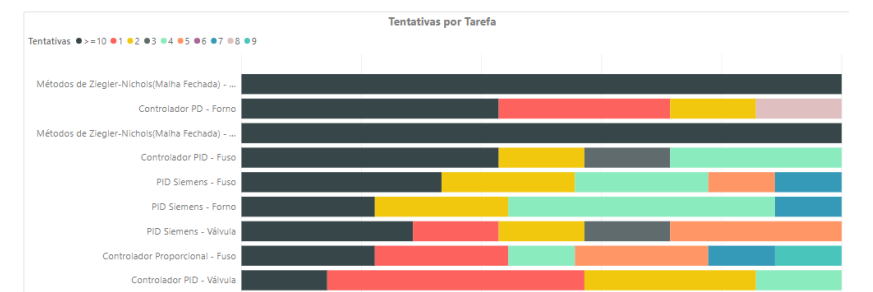
## PROGRESS VS TIME TAKEN

It is also possible to verify the distribution of the dedicated time with relation to the number of tasks done by each student at any period of time. That helps to identify who is doing well, who may need help, who is doing nothing and who is trying to cheat.



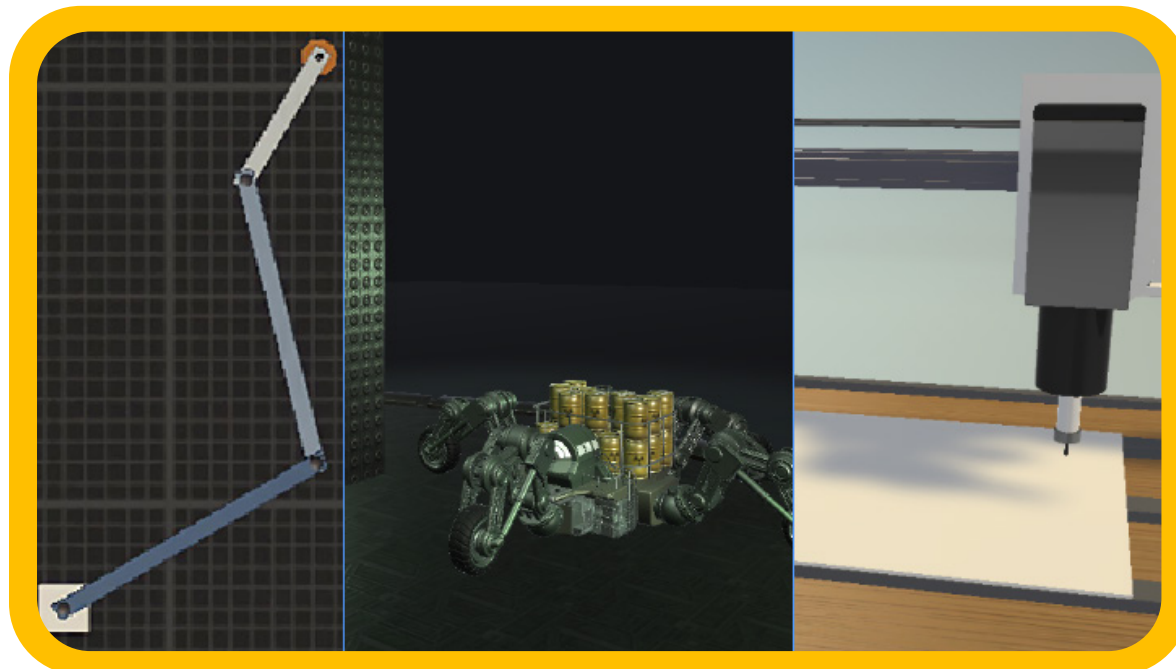
## TRIALS PER TASK

This chart helps the teacher to understand which task may be the most difficult and which one may be the easiest in order to adjust the deadlines.



# SUMMARY OF FEATURES

## IT'S A 3D SIMULATOR



## IT HAS BUILT-IN PROJECTS

Artificial Intelligence

### NEURAL NETWORK TRAINING

As we already know how to use a neural network in Tensorflow, we will comment only on the changes that need to be made to solve a regression problem.

Open the program "Neural Network - State Machine"

We will use the same network that we use, but with some modifications, we modify the number of neurons in the input, which must be equal to the number of input variables of our problem, which are 4, and the number of output neurons, for the number of engines that we want to control, which are 2.

We also changed the function of activating the output to sigmoid, as our output must be between 0 and 1. Note that the output will not be exact, but a poorly trained network will give for example 0.4 whenever it is 0 and 0.6 whenever it is 1. Now a better trained network, it will give for example 0.1 whenever it is 0 and 0.9 whenever it is 1. As we already have our truth table with all possible known states, we will not need a test group, because we will never it will be possible to find values different from these.

Another thing we need to change is the metric for Mean Squared Error (MSE) and Mean Absolute Error (MAE), which are good metrics for regression.

It is very important that you identify and understand the changes that we have made! See how our model looks:

## THE PROJECTS INCLUDE GUIDANCE

Change the activation function of the output layer to the linear function. Because we want our output to be an integer that will tell the position of the joint.

Train the network and see the output errors, if it doesn't look good, change the hyperparameters.

Did it look good? Use the predict function to predict some values.

## + CONTENTS AND SUPPORT MATERIALS, SO THEY CAN LEARN BY THEMSELVES

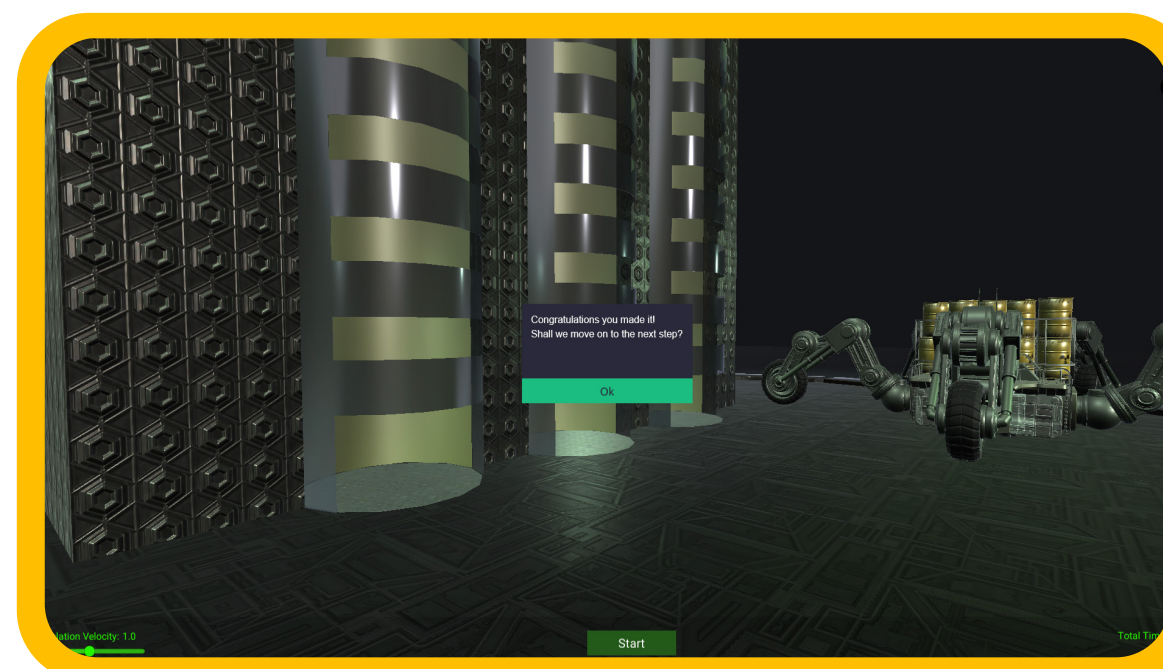
Let's study a little bit about GA before we continue. For that, you can take a look at the video below and, if you want to complement, see also the links:

Video 1: [https://www.youtube.com/watch?v=FYF6IS\\_BHKA](https://www.youtube.com/watch?v=FYF6IS_BHKA)

Link 8: <https://conteudo.icmc.usp.br/pessoas/andre/research/genetic/>

Link 9: <https://www.nce.ufrj.br/GINAPE/VIDA/alggenet.htm>

## IT AUTOMATICALLY CHECKS STUDENT ACTIVITIES TO LET THEM MOVE ON, LIKE IN GAME



## PROFESSORS CAN MONITOR STUDENTS, AND VERIFY WHICH POINT THEY NEED HELP (Option available with Dashboard)

Student Progress

INSTITUTION NAME

Group: Group 1 Course: Machine Automation with Codesys User: Student 1

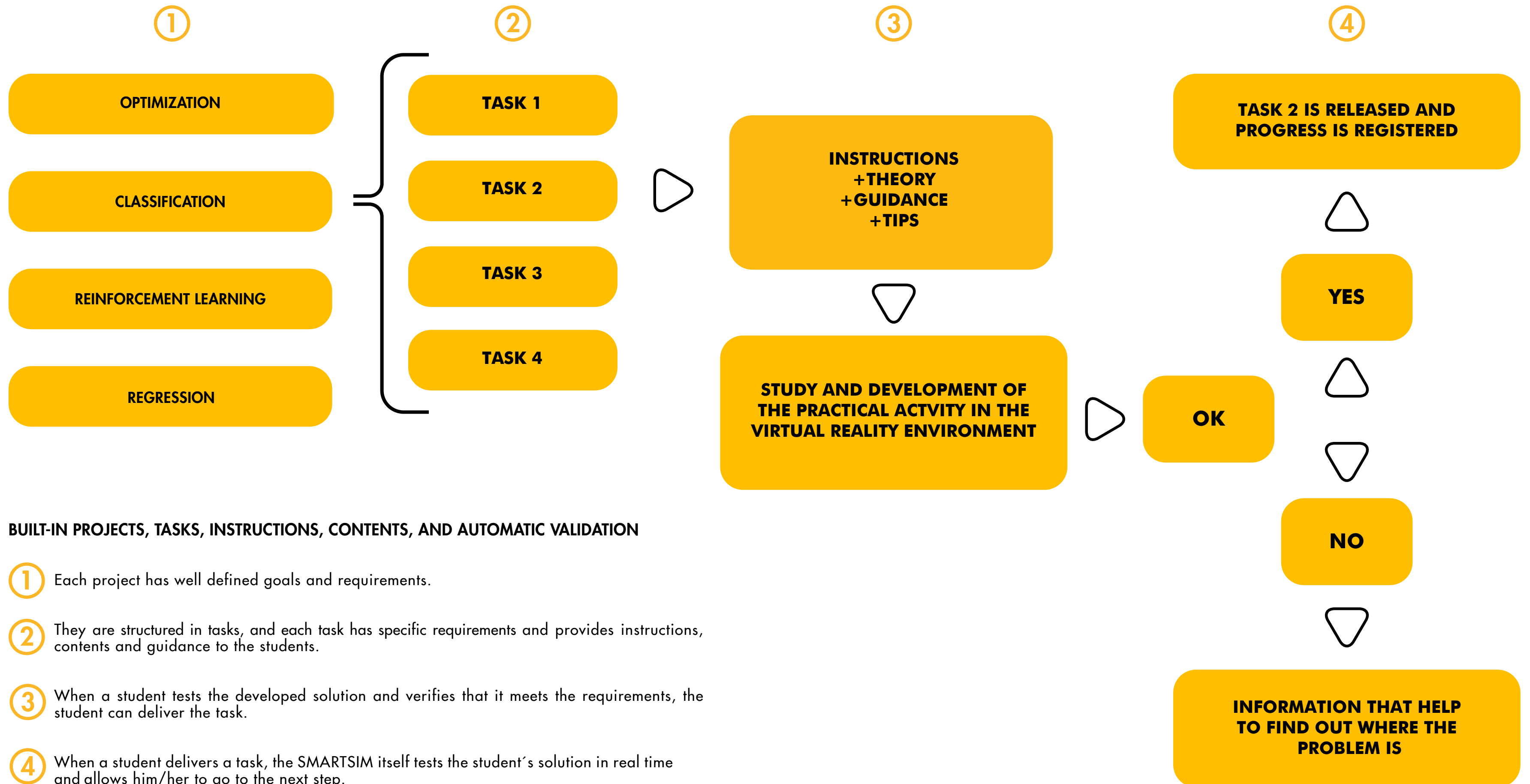
User Progress (POLI)

| Student    | Progress |
|------------|----------|
| Student 1  | 100%     |
| Student 2  | 100%     |
| Student 3  | 100%     |
| Student 4  | 100%     |
| Student 5  | 100%     |
| Student 6  | 100%     |
| Student 7  | 100%     |
| Student 8  | 100%     |
| Student 9  | 100%     |
| Student 10 | 100%     |

User Activities

| Timestamp    | Tasks → Task Description            |
|--------------|-------------------------------------|
| Aug 26, 2019 | 1.1 - Breaking the inertia          |
| Aug 26, 2019 | 1.2 - Interlocking with endswitches |
| Aug 26, 2019 | 1.3 - Retentive command             |
| Aug 26, 2019 | 1.4 - Adding other interlocks       |
| Aug 26, 2019 | 1.5 - Using the remote button       |
| Aug 26, 2019 | 2.1 - Manual operation              |
| Aug 27, 2019 | 2.2 - Simultaneous commands         |
| Aug 27, 2019 | 2.3 - Adding water                  |
| Aug 27, 2019 | 2.4 - Adjusting the conveyors       |
| Aug 27, 2019 | 3.1 - Dosing station                |
| Aug 30, 2019 | 3.2 - Mixing station                |
| Sep 3, 2019  | 3.3 - Filling the recipient         |

# HOW ARE BUILT-IN PROJECTS STRUCTURED?



# SYSTEM REQUIREMENTS

ORDER CODES

DL SMART-AI

ARTIFICIAL INTELLIGENCE COURSE

DL SMART-DASHBOARD

CLASSROOM MANAGEMENT DASHBOARD FOR SMARTSIMS

IMPORTANT NOTE:

THIS PRODUTS DOES NOT INCLUDE ANY THIRD PARTY SOFTWARES. TO OUR KNOWLEDGE, ANACONDA PYTHON CAN BE FREE DOWNLOADED AT ANACONDA WEBSITE.

MINIMUM REQUIREMENTS

OPERATIONAL SYSTEM

64-BIT WINDOWNS 10

DIRECTX VERSION

DIRECTX 11

PROCESSOR

INTEL i5 9400F OR AMD RYZEN 5 3600

MEMORY

8GB

GHRAPHIC CARD

STORAGE

HDD (1GB)

RECOMMENDED REQUIREMENTS

OPERATIONAL SYSTEM

64-BIT WINDOWNS 10 PRO

DIRECTX VERSION

DIRECTX 12

PROCESSOR

INTEL i7 9700 OR AMD RYZEN 7 3700X

MEMORY

16 GB

GHRAPHIC CARD

NVIDIA GTX 1050 TI 4GB OR RX 550 4GB

STORAGE

HDD (1GB)