Postgraduate Diploma

Computer Vision and Quantum Computing

tech global university

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Postgraduate Diploma
Computer Vision and Quantum Computing

- Modality: **online**
- Duration: **6 months**
- Certificate: **TECH Global University**
- Credits: **18 ECTS**
- Schedule: **at your own pace**
- Exams: **online**

Website: **www.techtitute.com/us/information-technology/postgraduate-diploma/postgraduate-diploma-computer-vision-quantum-computing**

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01

Introduction

Quantum computing has advanced rapidly in both theory and practice in recent years and with it the hope of potential impact on real applications. Unlike classical computing, whose basic unit is the Bit, quantum computers use *Qubits*. These generate subatomic particles, making the processing power many times higher and faster than classical computers, solving problems in a novel way and performing several operations at the same time. This 100% online degree will provide the engineer with specialized knowledge in Computer Vision and Quantum Computing, to generate competitive advantages in the industrial market.

If you are looking for professional excellence, join us and we'll help you achieve it”

Training and specializing in quantum computing is a winning bet. It is today and will undoubtedly be even more so in the future. A key area of interest and where quantum computing is proving to be most efficient is in the field of Machine Learning and its application in real proactive, predictive and prescriptive problems.

This Postgraduate Diploma analyzes in which situations a quantum advantage could be achieved in the context of advanced analytics and artificial intelligence for the engineering world. The goal is to show what benefits current and future quantum technologies can provide to machine learning, focusing on algorithms such as Kernel-based models, optimization and convolutional networks.

In addition, in this training the graduate will analyze the main case studies that exist for computer vision: classification, object detection, object identification, object tracking. In addition, through the Transfer Learning, resource, you will examine what network models are currently available to facilitate model training, applying this technique to your industrial project.

As it is a 100% online Postgraduate Diploma, the student is not conditioned by fixed schedules or the need to move to another physical location. Using a device with internet access, you will be able to consult the rich content that will help you acquire quantum computing techniques, to reach the elite in the computer industry. All of this, at any time of the day, combining, at your own pace, your work and personal life with your academic life.

This **Postgraduate Diploma in Computer Vision and Quantum Computing** contains the most complete and up-to-date scientific program on the market. The most important features include:

- The development of case studies presented by experts in Computer Vision and Quantum Computing
- The graphic, schematic and eminently practical contents, with which it is conceived, provide practical information on those disciplines that are essential for professional practice
- Practical exercises, where the self-evaluation process can be carried out to improve learning
- Its special emphasis on innovative methodologies
- Theoretical lessons, questions to the expert, debate forums on controversial topics, and individual reflection assignments
- Content that is accessible from any fixed or portable device with an Internet connection

You are looking at a qualification that will progressively and steadily lead you to the acquisition of the knowledge and competencies you need"

You will examine which network models are currently available, in order to facilitate the training of our model by applying the Transfer Learning technique"

Increase your skills in developing industry solutions with Machine Vision and set yourself up for success.

Training and specializing in Quantum Computing is a winning bet to boost your career.

The program's teaching staff includes professionals from sector who contribute their work experience to this training program, as well as renowned specialists from leading societies and prestigious universities.

The multimedia content, developed with the latest educational technology, will provide professionals with situated and contextual learning, i.e., a simulated environment that will provide immersive training, designed for training oneself in real situations.

This program is designed around Problem-Based Learning, whereby the professional must try to solve the different professional practice situations that arise during the academic year. For this purpose, the student will be assisted by an innovative interactive video system created by renowned and experienced experts.

02

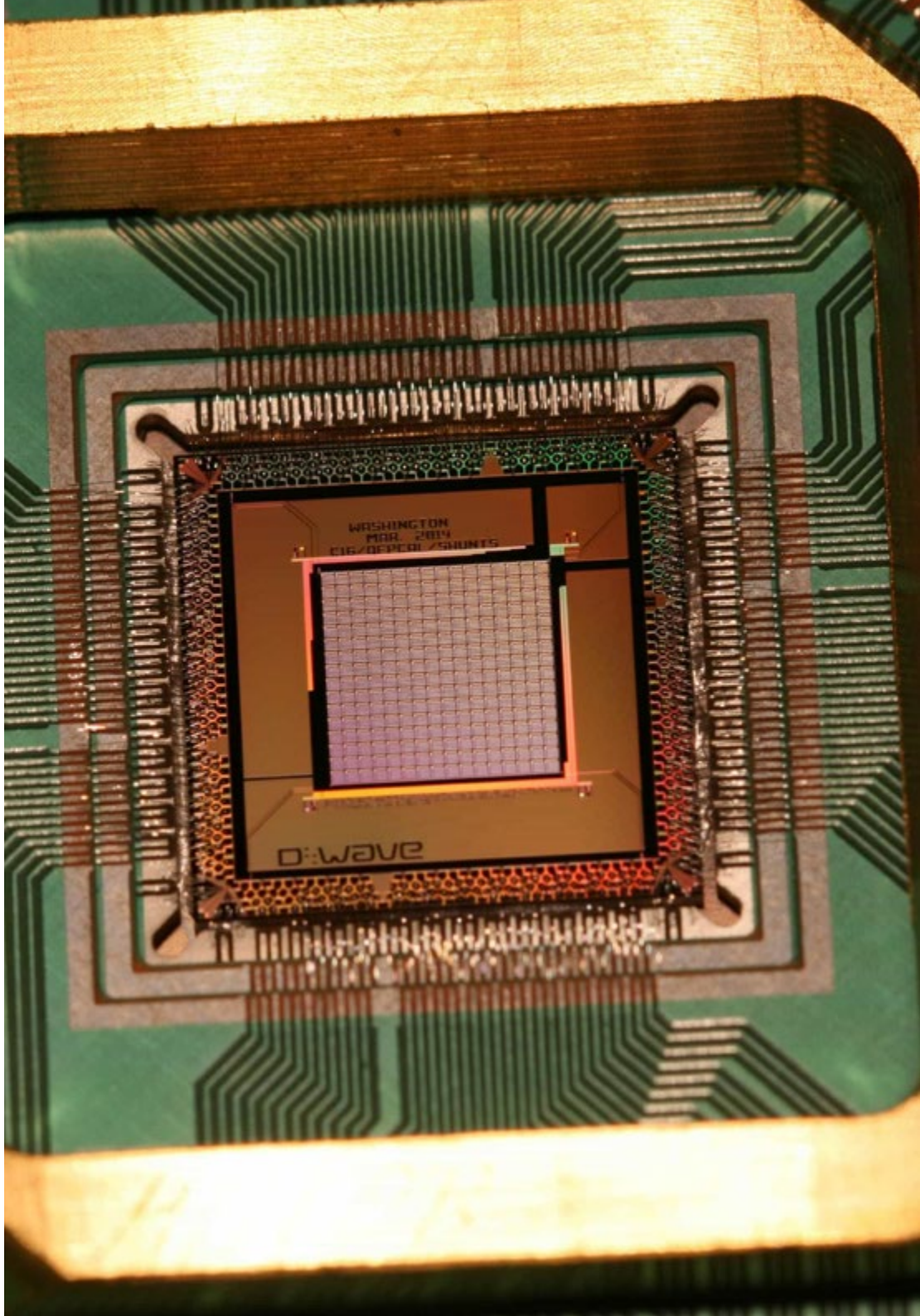
Objectives

The Postgraduate Diploma in Computer Vision and Quantum Computing is oriented toward approaching the subject from a practical point of view. In this way, a sense of security is generated in the engineer, which will allow him to be more effective in his daily practice. The direct application of the knowledge acquired in real projects is an added professional value that very few professionals specialized in Information and Communication Technologies can offer. This is precisely what makes this Postgraduate Diploma unique in the market, since the engineers who take it will be unique professionals in their sector.

Obtaining the right knowledge and advice will be essential in order to take advantage of the developments that are taking place and will take place in the coming years"

General Objectives

- Analyze how a computer is capable of identifying image
- Determine how the convolution layer works and how *Transfer Learning* works
- Identify the different types of algorithms mainly used in computer vision
- Demonstrate the differences between quantum computing and classical computing
- Analyze the mathematical foundations of quantum computing
- Determine the main quantum operators and develop operational quantum circuits
- Analyze the advantages of quantum computing in examples of quantum "type" problem solving
- Develop and demonstrate the advantages of quantum computing in application solving examples (games, examples, programs)
- Demonstrate the different types of projects achievable with classical Machine Learning techniques and the state of the art in quantum computing
- Develop the key concepts of quantum states, as a generalization of classical probability distributions, and thus to be able to describe quantum systems of many states
- Analyze how to encode classical information in quantum systems.
- Determine the concept of "Kernel Methods" used in classic *Machine Learning* algorithms
- Develop and implement learning algorithms for classical ML models in quantum models, such as PCA, SVM, neural networks, etc.
- Implement DL model learning algorithms on quantum models, such as GAN



Specific Objectives

Module 1. R&D+A.I. *Computer Vision*. Object Identification and Tracking

- Analyze what Computer Vision is
- Determine typical computer vision tasks
- Analyze, step by step, how convolution works and how transfer learning works Transfer Learning
- Identify what mechanisms we have available to create modified images from our own and have more training data
- Compile typical tasks that can be performed with Computer Vision
- Examine commercial Computer Vision case studies

Module 2. Quantum Computing. A New Model of Computing

- Analyze the need for quantum computing and identify the different types of quantum computers currently available
- Specify the fundamentals of quantum computing and its characteristics
- Examine the applications of quantum computing, advantages and disadvantages
- Determine the basic fundamentals of quantum algorithms and their internal mathematics
- Examine Hilbert space of dimension 2n, *n-Qubits,* states, quantum gates and their reversibility
- Demonstrating Quantum Teleportation
- Analyze Deutsch's Algorithm, Shor's Algorithm and Grover's Algorithm
- Develop examples of applications with quantum algorithms

Module 3. Quantum Machine Learning: the Artificial Intelligence (A.I) of the Future

- Analyze quantum computing paradigms relevant to machine learning.
- Examine the various ML algorithms available in quantum computing, both supervised and unsupervised
- Determine the different DL algorithms available in quantum computing
- Fundamentals of the use of the Quantum Fourier Transform in the integration of indicators for quantum ML models, as well as for feature selection
- Develop pure quantum algorithms for solving optimization problems.
- Generate specialized knowledge on hybrid algorithms (quantum computation and classical computation) to solve learning problems
- Implementing learning algorithms on quantum computers
- Establish the current status of QML and its immediate future

It addresses quantum computing, in an understandable, simple and friendly way, in order to get into what is undoubtedly the future in the coming years"

03

Course Management

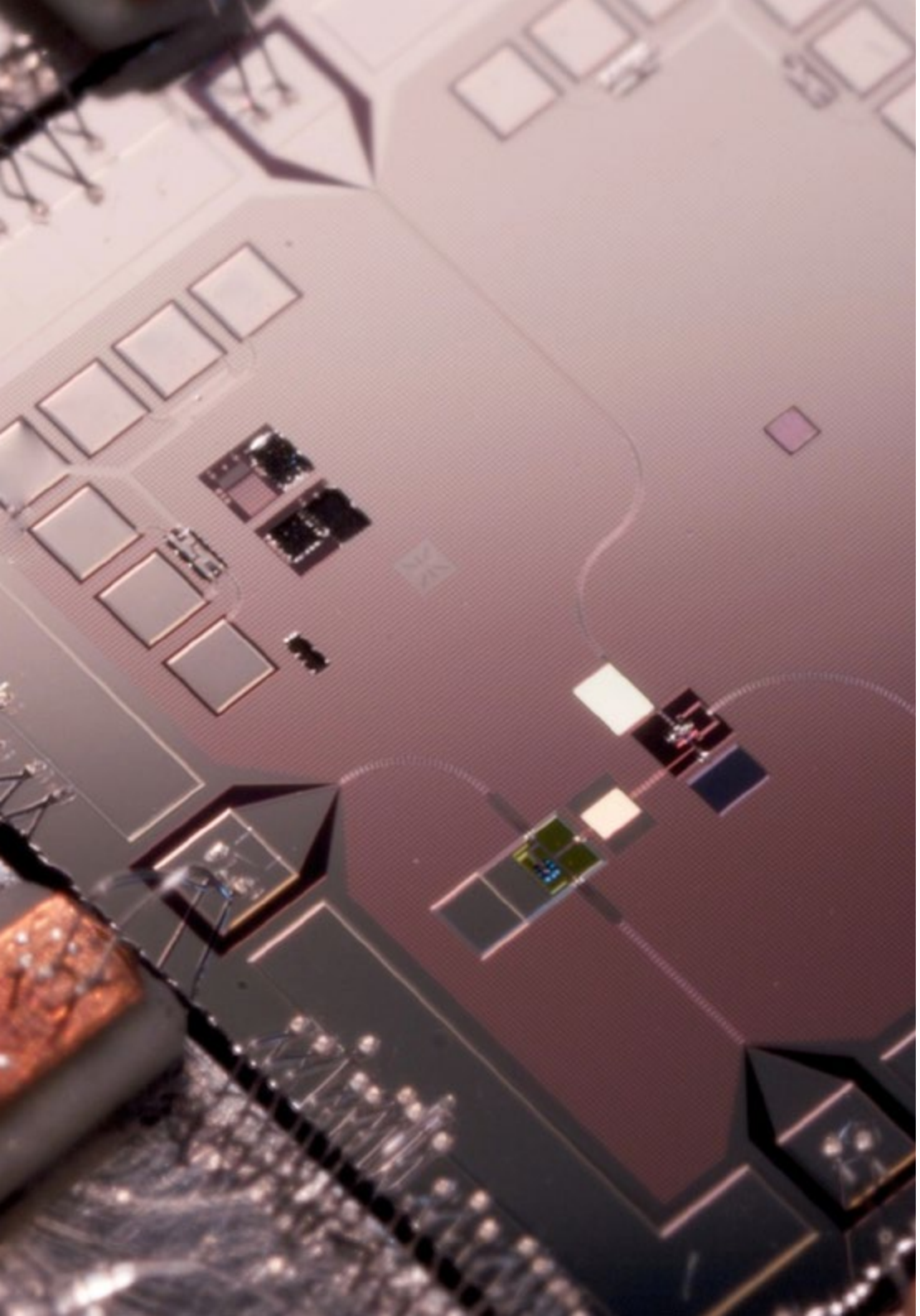
Highly qualified professionals from the engineering world, with several years of experience in the sector, have put together the best contents for the specialization of the graduate during his or her studies. The teachers of this Postgraduate Diploma will provide the keys and tools on Computer Vision and Quantum Computing, to turn the engineer into an expert in the most advanced technologies and of greater application in the present and future, to develop them in their field of work.

Engineers with extensive experience in the sector will guide you into the field of Machine Learning and its application in real proactive, predictive and prescriptive problems"

Management

Mr. Molina Molina, Jerónimo

- He is currently leading several relevant projects in the field of Artificial Intelligence.
- IA Engineer & Software Architect. NASSAT - Internet Satellite in Motion
- Sr. Consultant Hexa Ingenieros
- Expert in Artificial Intelligence based solutions
- He is currently leading several relevant projects in the field of Artificial Intelligence.
- Computer Engineer (Univ. Alicante)
- Postgraduate Diploma in Creation and Development of Companies (Bancaixa - FUNDEUN Alicante)
- Computer Engineer (Univ. Alicante)
- MBA-Executive (Foro Europeo Campus Empresarial)
- Master in Artificial Intelligence (Catholic University of Ávila)



Professors

Mr. Pi Morell, Oriol

- Degree in Technical Engineering in Computer Management from the Autonomous University of Madrid
- Master in Inteligencia Artificial
- Master's Degree in Business Administration. MBA
- Master in Information Systems Management
- Functional Analyst at en Fihoca, Atmira y Capgemini
- CDMON Product Owner of Hosting and mail

Dr. Moreno Fernández de Leceta, Aitor

- Head of the Artificial Intelligence Department at Ibermática
- Degree in Computer Engineering from the University of Deusto
- University Master's Degree in Advanced Artificial Intelligence (UNED)
- University Master's Degree in Advanced Artificial Intelligence (UNED)
- PhD. in Artificial Intelligence from the University of the Basque Country (UPV/EHU)
- Certificate in Computational Neuroscience" (University of Washington)
- Winner Bilbao Quantencomputer-Hackathon Autoridad emisora IBM
- Certificate in Computational Neuroscience" (University of Washington)
- Certificate “Quantum Computing: Theory to Simulation and Programming”

04

Structure and Content

Renowned engineers have selected the best didactic material and have gathered in three modules the latest advances in Computer Vision and Quantum Computing. Thus, this Postgraduate Diploma covers everything from the construction of convolutional neural networks, quantum circuits and classical Machine Learning algorithms, to the Transfer Learning concept and the programming of quantum computers, among others. To this end, this program delves into the scope of application of each technology in the world of engineering, understanding the competitive advantages they provide in the industrial sector.

Analyze in which situations a quantum advantage could be achieved in the context of advanced analytics and artificial intelligence in the industrial field"

Module 1. R&D+A.I. *Computer Vision*: Identification and Tracking of Objects

1.1. Computer Vision
- 1.1.1. *Computer Vision.*
- 1.1.2. Computational Vision
- 1.1.3. Interpretation of the Machines in an Image

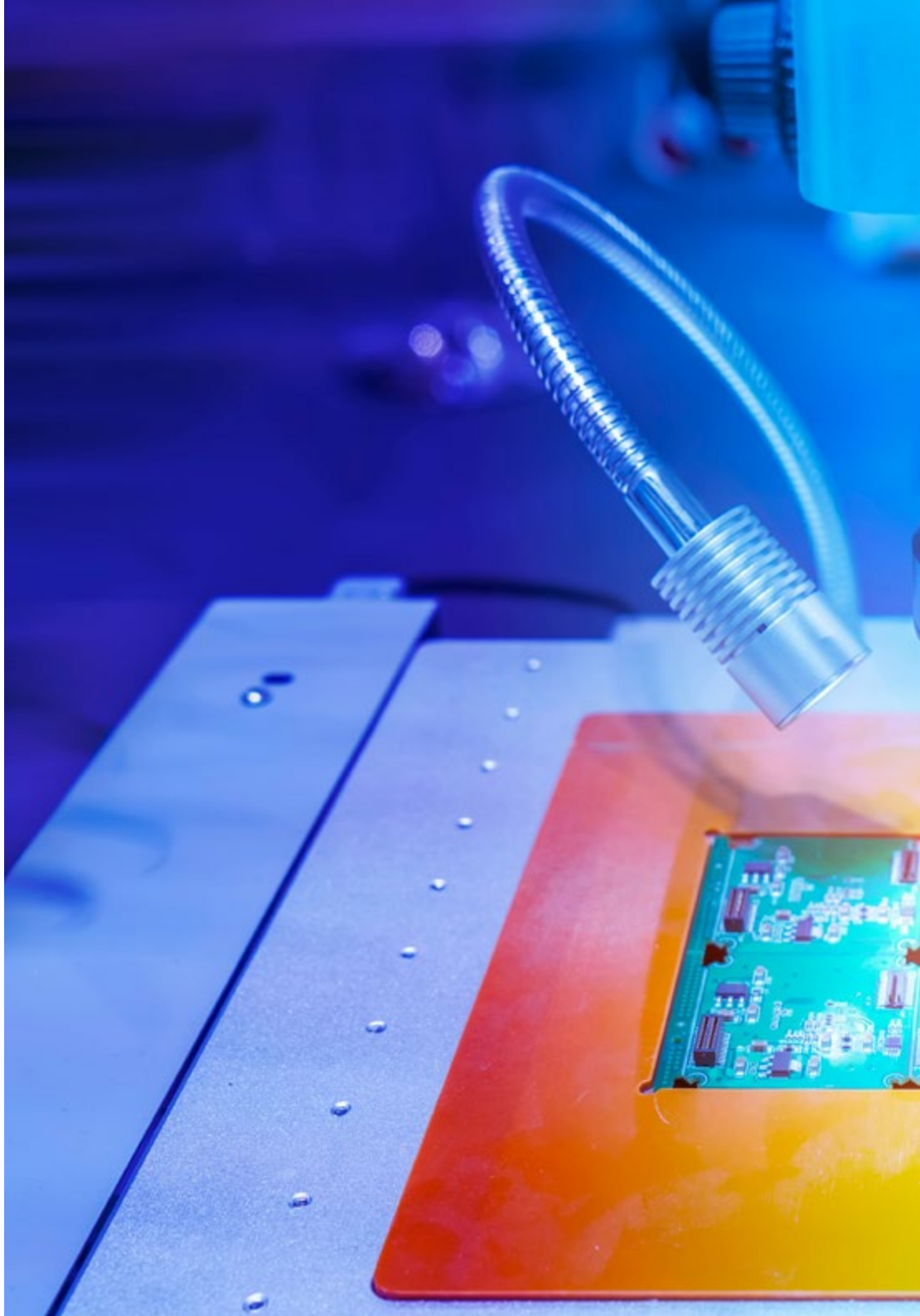
1.2. Activation Functions
- 1.2.1. Activation Functions
- 1.2.2. Sigmoid
- 1.2.3. ReLU
- 1.2.4. Hyperbolic Tangent
- 1.2.5. *Softmax*

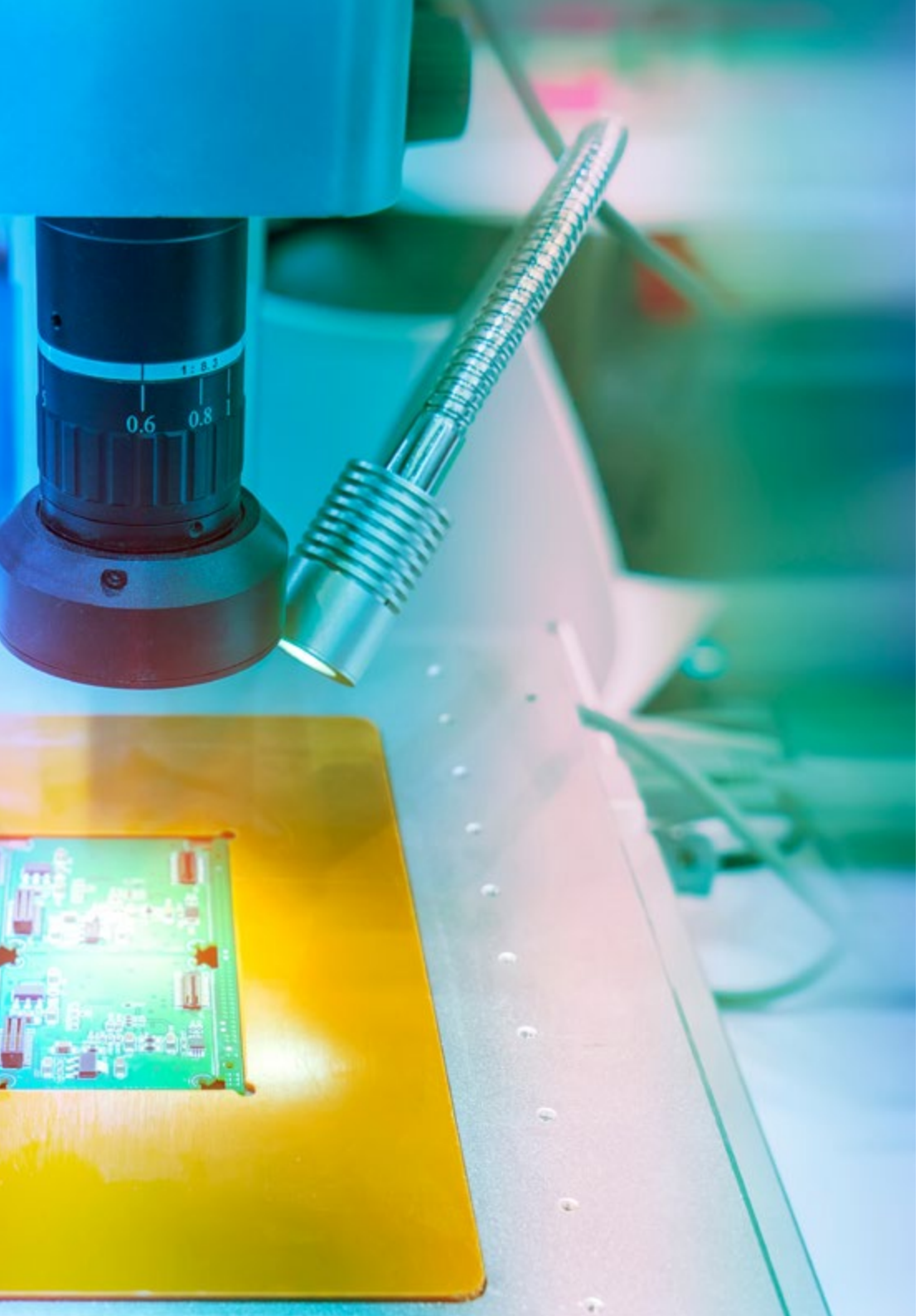
1.3. Construction of Convolutional Neural Networks
- 1.3.1. Convolution Operation
- 1.3.2. Capa ReLU
- 1.3.3. *Pooling*
- 1.3.4. *Flattering*
- 1.3.5. Full *Connection*

1.4. Convolution Process
- 1.4.1. Operation of a Convolution
- 1.4.2. Convolution Code
- 1.4.3. Convolution: Application

1.5. Transformations with Images
- 1.5.1. Transformations with Images
- 1.5.2. Advanced Transformations
- 1.5.3. Transformations with Images. Application
- 1.5.4. Transformations with Images. *Use Case*

1.6. Transfer Learning
- 1.6.1. Transfer Learning
- 1.6.2. Transfer Learning. Typology
- 1.6.3. Deep Networks to Apply *Transfer Learning*





1.7. Computer Vision. Use Case
- 1.7.1. Image Classification
- 1.7.2. Object Detection
- 1.7.3. Object Identification
- 1.7.4. Object Segmentation

1.8. Object Detection
- 1.8.1. Detection from Convolution
- 1.8.2. R-CNN, Selective Search
- 1.8.3. Rapid Detection with YOLO
- 1.8.4. Other Possible Solutions

1.9. GAN. Generative Adversarial Networks
- 1.9.1. Generative Adversarial Networks
- 1.9.2. Code for a GAN
- 1.9.3. GAN. Application

1.10. Application of Computer Vision Models
- 1.10.1. Content Organization
- 1.10.2. Visual Search Engines
- 1.10.3. Facial Recognition
- 1.10.4. Augmented Reality
- 1.10.5. Autonomous Driving
- 1.10.6. Fault Identification at each Assembly
- 1.10.7. Pest Identification
- 1.10.8. Health

Module 2. *Quantum Computing*. A New Model of Computing

2.1. Quantum Computing
- 2.1.1. Differences with Classical Computing
- 2.1.2. Need for Quantum Computing
- 2.1.3. Quantum Computers Available: Nature and Technology

2.2. Applications of Quantum Computing
- 2.2.1. Applications of Quantum Computing vs. Classical Computing
- 2.2.2. Contexts of Use
- 2.2.3. Application in Real Cases

2.3. Mathematical Foundations of Quantum Computing
- 2.3.1. Computational Complexity
- 2.3.2. Double Slit Experiment. Particles and Waves
- 2.3.3. Intertwining

2.4. Geometric Foundations of Quantum Computing
- 2.4.1. *Qubit* and Complex Two-Dimensional Hilbert Space
- 2.4.2. Dirac's General Formalism
- 2.4.3. *N-Qubits* States and Hilbert Space of Dimension 2n

2.5. Mathematical Fundamentals of Linear Algebra
- 2.5.1. The Domestic Product
- 2.5.2. Hermitian Operators
- 2.5.3. Eigenvalues and Eigenvectors

2.6. Quantum Circuits
- 2.6.1. Bell States and Pauli Matrices
- 2.6.2. Quantum Logic Gates
- 2.6.3. Quantum Control Gates

2.7. Quantum Algorithms
- 2.7.1. Reversible Quantum Gates
- 2.7.2. Quantum Fourier Transform
- 2.7.3. Quantum Teleportation

2.8. Algorithms Demonstrating Quantum Supremacy
- 2.8.1. Deutsch´s Algorithm
- 2.8.2. Shor´s Algorithm
- 2.8.3. Grover´s Algorithm

2.9. Quantum Computer Programming
- 2.9.1. My First Program on Qiskit (IBM)
- 2.9.2. My First Program on Ocean (Dwave)
- 2.9.3. My First Program on Cirq (Google)

2.10. Application on Quantum Computers
- 2.10.1. Creation of Logical Gates
  - 2.10.1.1. Creation of a Quantum Digital Adder
- 2.10.2. Creation of Quantum Games
- 2.10.3. Secret Key Communication between Bob and Alice

Module 3. Quantum Machine Learning: The Artificial Intelligence (A.I) of the Future

3.1. Classical Machine Learning Algorithms
- 3.1.1. Descriptive, Predictive, Proactive and Prescriptive Models
- 3.1.2. Supervised and Unsupervised Models
- 3.1.3. Feature Reduction, PCA, Covariance Matrix, SVM, Neural Networks
- 3.1.4. Optimization in ML: Gradient Descent

3.2. Classical Deep Learning Algorithms
- 3.2.1. Boltzmann Networks: the revolution in *Machine Learning*
- 3.2.2. Models of *Deep Learning*: CNN, LSTM, GAN
- 3.2.3. Encoder-Decoder Models
- 3.2.4. Signal Analysis Models: Fourier Analysis

3.3. Quantum Classifiers
- 3.3.1. Generation of a Quantum Classifier
- 3.3.2. Amplitude Coding of Data in Quantum States
- 3.3.3. Encoding of Data in Quantum States by Phase/Angle
- 3.3.4. High-Level Coding

3.4. Optimization Algorithms
- 3.4.1. Quantum Approximate Optimization Algorithm (QAOA)
- 3.4.2. Variational Quantum Eigensolvers (VQE)
- 3.4.3. Quadratic Unconstrained Binary Optimization (QUBO)

3.5. Optimization Algorithms Examples:
- 3.5.1. PCA with Quantum Circuits
- 3.5.2. Optimization of Stock Packages
- 3.5.3. Optimization of logistics routes

3.6. Quantum Kernels Machine Learning
- 3.6.1. Variational Quantum Classifiers. QKA
- 3.6.2. Quantum Kernels Machine Learning
- 3.6.3. Classification Based on Quantum Kernel
- 3.6.4. Clustering Based on Quantum Kernel

3.7. Quantum Neural Networks
- 3.7.1. Classical Neural Networks and Perceptron
- 3.7.2. Quantum Neural Networks and Perceptron
- 3.7.3. Quantum Convolutional Neural Networks

3.8. Advanced *Deep Learning* (DL) Algorithms
- 3.8.1. Quantum Boltzmann Machines
- 3.8.2. General Adversarial Networks
- 3.8.3. Quantum Fourier Transformation, Quantum Phase Estimation and Quantum Matrix

3.9. Machine Learning Use Case
- 3.9.1. Experimentation with VQC (Variational Quantum Classifier)
- 3.9.2. Experimentation with *Quantum Neural Networks*
- 3.9.3. Experimentation with qGANS

3.10. Quantum Computing and Artificial Intelligence
- 3.10.1. Quantum Capacity in ML Models
- 3.10.2. Quantum *Knowledge Graphs*
- 3.10.3. The future of Quantum Artificial Intelligence

You will be up to date on the latest advances in Computer Vision and Quantum Computing in the engineering field"

05

Methodology

This academic program offers students a different way of learning. Our methodology uses a cyclical learning approach: **Relearning.**

This teaching system is used, for example, in the most prestigious medical schools in the world, and major publications such as the **New England Journal of Medicine** have considered it to be one of the most effective.

Discover Relearning, a system that abandons conventional linear learning, to take you through cyclical teaching systems: a way of learning that has proven to be extremely effective, especially in subjects that require memorization"

At TECH we use the Case Method

Our program offers a revolutionary method of skills and knowledge development. Our goal is to strengthen skills in a changing, competitive, and highly demanding environment.

At TECH, you will experience a way of learning that is shaking the foundations of traditional universities around the world"

We are the first online university to combine Harvard Business School case studies with a 100% online learning system based on repetition.

The student will learn, through collaborative activities and real cases, how to solve complex situations in real business environments.

A learning method that is different and innovative

This intensive Engineering program at TECH Global University prepares you to face all the challenges in this field, both nationally and internationally. We are committed to promoting your personal and professional growth, the best way to strive for success, that is why at TECH Global University you will use Harvard *case studies*, with which we have a strategic agreement that allows us, to offer you material from the best university in the world.

> *Our program prepares you to face new challenges in uncertain environments and achieve success in your career"*

The case method is the most widely used learning system by the best faculties in the world. The case method was developed in 1912 so that law students would not only learn the law based on theoretical content. It consisted of presenting students with real-life, complex situations for them to make informed decisions and value judgments on how to resolve them. In 1924, Harvard adopted it as a standard teaching method.

What should a professional do in a given situation? This is the question that you are presented with in the case method, an action-oriented learning method. Throughout the program, the studies will be presented with multiple real cases. They will have to combine all their knowledge and research, and argue and defend their ideas and decisions.

Relearning Methodology

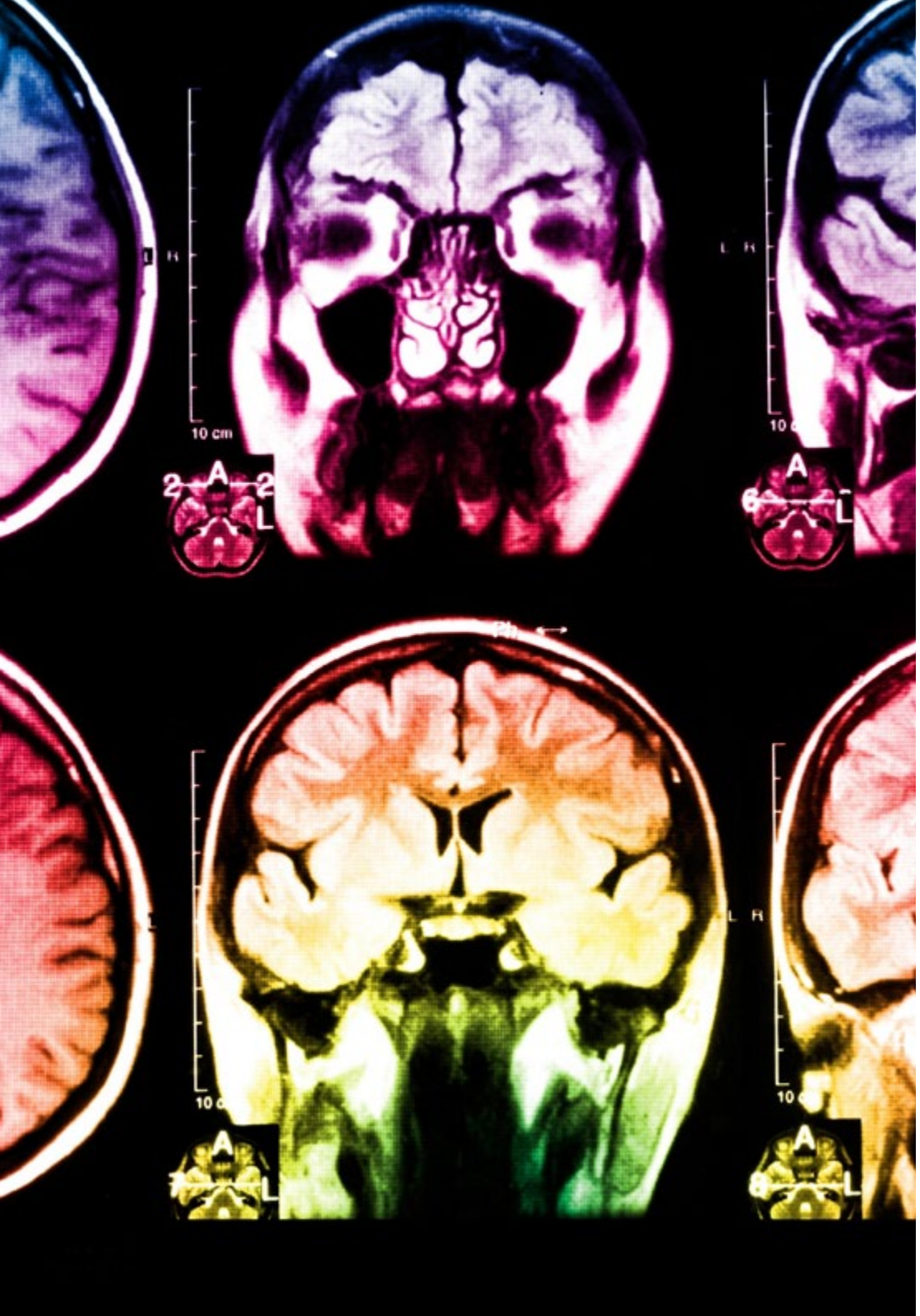
TECH is the first university in the world to combine Harvard University *case studies*with a 100% online learning system based on repetition, which combines 8 different didactic elements in each lesson.

We enhance Harvard *case studies* with the best 100% online teaching method: Relearning.

In 2019, we obtained the best learning results of all online universities in the world.

At TECH, you will learn using a cutting-edge methodology designed to train the executives of the future. This method, at the forefront of international teaching, is called Relearning.

Our university is the only university in the world authorized to employ this successful method. In 2019, we managed to improve our students' overall satisfaction levels (teaching quality, quality of materials, course structure, objectives...) based on the best online university indicators.



In our program, learning is not a linear process, but rather a spiral (learn, unlearn, forget, and re-learn). Therefore, we combine each of these elements concentrically. This methodology has trained more than 650,000 university graduates with unprecedented success in fields as diverse as biochemistry, genetics, surgery, international law, management skills, sports science, philosophy, law, engineering, journalism, history, and financial markets and instruments. All this in a highly demanding environment, where the students have a strong socio-economic profile and an average age of 43.5 years.

Relearning will allow you to learn with less effort and better performance, involving you more in your training, developing a critical mindset, defending arguments, and contrasting opinions: a direct equation for success.

From the latest scientific evidence in the field of neuroscience, not only do we know how to organize information, ideas, images and memories, but we know that the place and context where we have learned something is fundamental for us to be able to remember it and store it in the hippocampus, to retain it in our long-term memory.

In this way, and in what is called neurocognitive context-dependent e-learning, the different elements in our program are connected to the context where the individual carries out their professional activity.

This program offers the best educational material, prepared with professionals in mind:

Study Material

All teaching material is produced by the specialists who teach the course, specifically for the course, so that the teaching content is highly specific and precise.

These contents are then applied to the audiovisual format, to create the TECH online working method. All this, with the latest techniques that offer high quality pieces in each and every one of the materials that are made available to the student.

Classes

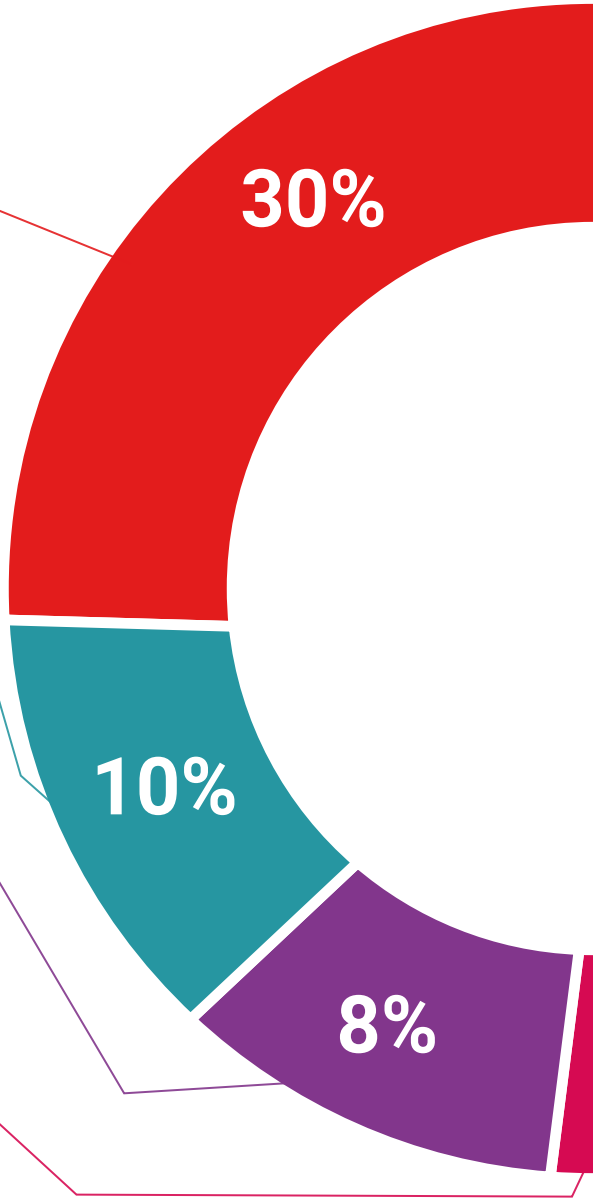
There is scientific evidence suggesting that observing third-party experts can be useful. Learning from an Expert strengthens knowledge and memory, and generates confidence in future difficult decisions.

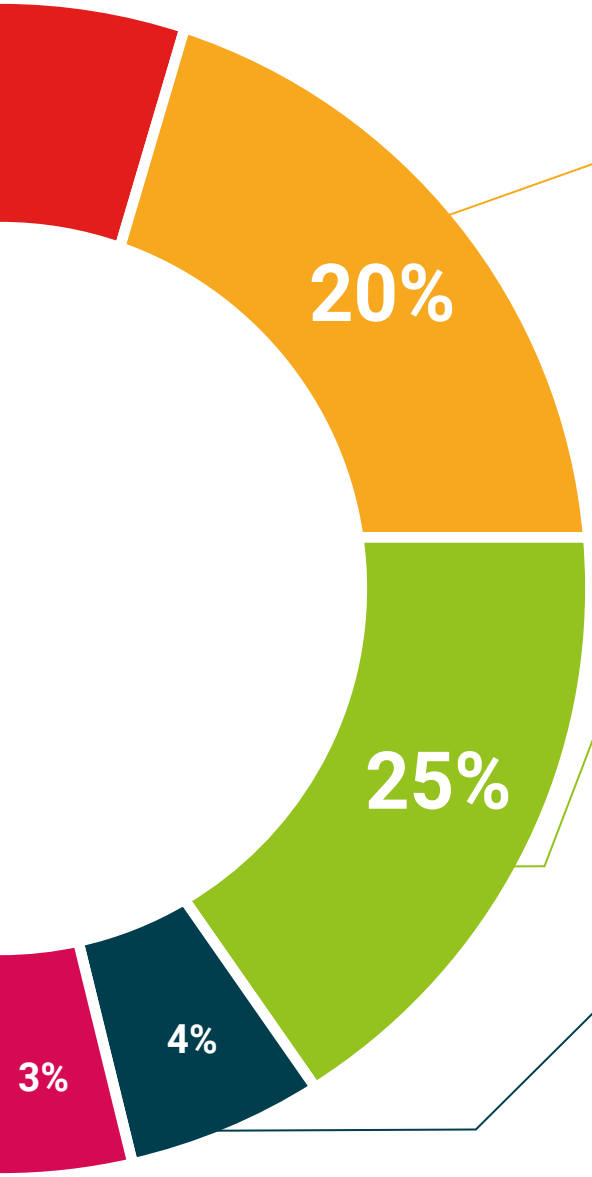
Practising Skills and Abilities

They will carry out activities to develop specific competencies and skills in each thematic area. Exercises and activities to acquire and develop the skills and abilities that a specialist needs to develop in the context of the globalization we live in.

Additional Reading

Recent articles, consensus documents and international guidelines, among others. In TECH's virtual library, students will have access to everything they need to complete their course.





Case Studies

They will complete a selection of the best case studies in the field used at Harvard. Cases that are presented, analyzed, and supervised by the best senior management specialists in the world.

Interactive Summaries

The TECH team presents the contents attractively and dynamically in multimedia lessons that include audio, videos, images, diagrams, and concept maps in order to reinforce knowledge.

This exclusive multimedia content presentation training Exclusive system was awarded by Microsoft as a "European Success Story".

Testing & Retesting

We periodically evaluate and re-evaluate students' knowledge throughout the program, through assessment and self-assessment activities and exercises: so that they can see how they are achieving your goals.

06

Certificate

The Postgraduate Diploma in the Computer Vision and Quantum Computing guarantees, in addition to the most rigorous and up-to-date training, access to a Postgraduate Diploma qualification issued by TECH Global University.

Successfully complete this training program and receive your university certificate without travel or laborious paperwork"

This program will allow you to obtain your **Postgraduate Diploma in Computer Vision and Quantum Computing** endorsed by **TECH Global University**, the world's largest online university.

TECH Global University is an official European University publicly recognized by the Government of Andorra (***official bulletin***). Andorra is part of the European Higher Education Area (EHEA) since 2003. The EHEA is an initiative promoted by the European Union that aims to organize the international training framework and harmonize the higher education systems of the member countries of this space. The project promotes common values, the implementation of collaborative tools and strengthening its quality assurance mechanisms to enhance collaboration and mobility among students, researchers and academics.

This **TECH Global University** title is a European program of continuing education and professional updating that guarantees the acquisition of competencies in its area of knowledge, providing a high curricular value to the student who completes the program.

Title: **Postgraduate Diploma in Computer Vision and Quantum Computing**

Modality: **online**

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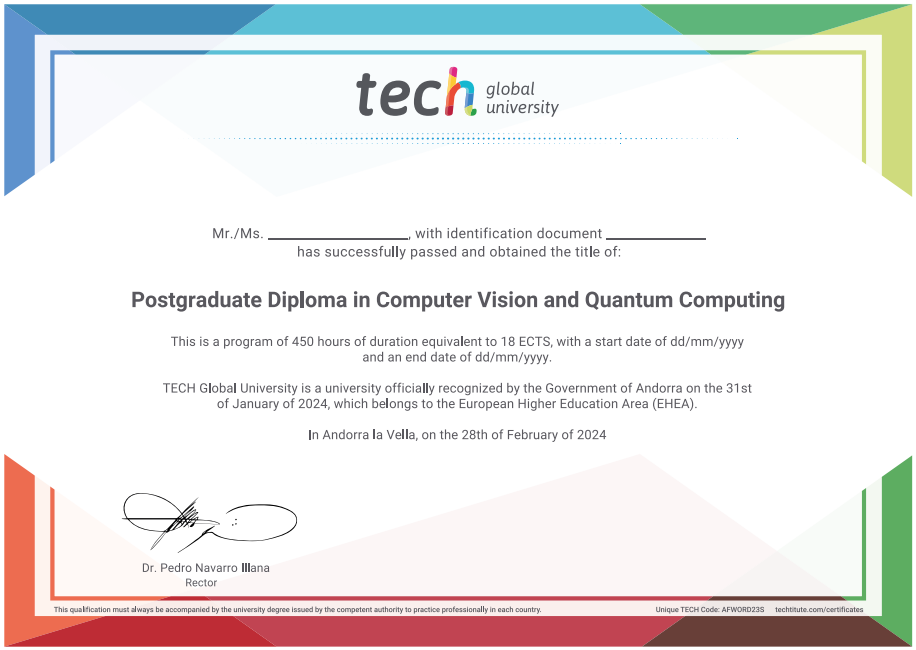
Accreditation: **18 ECTS**


tech global university

Mr./Ms. _____, with identification document _____
has successfully passed and obtained the title of:

Postgraduate Diploma in Computer Vision and Quantum Computing

This is a program of 450 hours of duration equivalent to 18 ECTS, with a start date of dd/mm/yyyy and an end date of dd/mm/yyyy.

TECH Global University is a university officially recognized by the Government of Andorra on the 31st of January of 2024, which belongs to the European Higher Education Area (EHEA).

In Andorra la Vella, on the 28th of February of 2024

Dr. Pedro Navarro Illana
Rector

This qualification must always be accompanied by the university degree issued by the competent authority to practice professionally in each country. Unique TECH Code: AFWORD23S techtitute.com/certificates

*Apostille Convention. In the event that the student wishes to have their paper diploma issued with an apostille, TECH Global University will make the necessary arrangements to obtain it, at an additional cost.

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