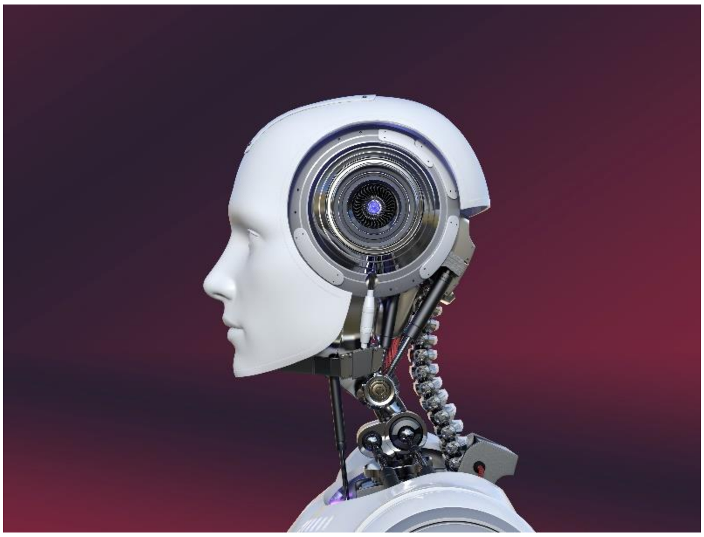
Quantum A Idea

# Real Estate Risk

# AI & Quantum Computing for Real Estate



**Material:**

- Presentations PDF
- Exercises in Excel
- R
- Python
- Jupyterlab
- Tensorflow

**Duration:** 36 h

**Price:** 7.900 €

## COURSE OBJECTIVE

Advanced course that uses classical artificial intelligence and quantum computing for property valuation, image classification, property status, rental valuation, market trend analysis and risk management in real estate.

A new wave of technological innovation, such as artificial intelligence (AI), is being applied today in various economic sectors, especially in recent years, due to improvements in hardware performance and the increase in the use of data. . Machine learning (ML) is a very powerful tool for collecting, analyzing and interpreting big data in order to predict results. It has been widely used in many sectors, including Real Estate. The use of ML in the real estate market can help improve decision making, reduce risk and increase efficiency in property valuation, management and investment.

The course explains ML models that, with historical data on previous real estate operations, can recognize patterns and relationships between multiple variables to predict how such parameters will affect the cost of an asset, thus speeding up the valuation of the property. Some variables that are taken into account are location, size, nearby services such as transportation, parking availability as well as the crime rate.
They also automatically categorize properties, ranking search results and suggesting comparable properties. ML can simplify real estate transactions. It can also help both buyers and sellers in the decision-making process.
ML algorithms can locate properties that are expected to appreciate in value or produce high rental income using historical data and recent market patterns. They can be used to analyze market trends, property data and economic indicators to assess the risk associated with investing in a particular property or market.

Analyzing data on occupancy rates, rental rates, and tenant behavior can be used to optimize property management operations such as rental pricing, lease renewal, collection of rents and maintenance scheduling.
Real estate websites and apps can use automated ML to recommend properties to consumers based on their interests, search histories, and activity.

About ML, a module on advanced data processing is presented, explaining, among other topics: sampling, exploratory analysis, detection of outliers, advanced segmentation techniques, feature engineering and classification algorithms.

During the course, ML and Deep Learning predictive models are shown such as: decision trees, neural networks, Bayesian networks, Support Vector Machine, ensemble model, etc. And as for neural networks, the feed forward, recurrent RNN, convolved CNN and Generative adversarial architectures are exposed. In addition, probabilistic machine learning models such as Gaussian processes and Bayesian neural networks have been included.

Computer vision is a form of artificial intelligence (AI) and machine learning that allows computers to extract meaningful information from images and automate actions based on that information, quickly and at scale.

During the course it is explained how computer vision can classify and evaluate interior and exterior images of properties (kitchen, living room, main bathroom, etc.). Amid the shortage of appraisers, investors, lenders, underwriters and online portals are turning to computer vision technologies to access accurate data on the condition of properties. Today, the most robust solutions use computer vision to analyze high-resolution aerial photographs and provide data on the condition of tens of millions of properties.

## Quantum Computing

Quantum Machine Learning is the integration of quantum algorithms within Machine Learning programs. Machine learning algorithms are used to calculate large amounts of data, quantum machine learning uses qubits and quantum operations or specialized quantum systems to improve the speed of calculation and data storage performed by a program's algorithms. For example, some mathematical and numerical techniques from quantum physics are applicable to classical deep learning. A quantum neural network has computational capabilities to decrease the number of steps, the qubits used, and the computing time.

## WHO SHOULD ATTEND?

The Course is aimed at Real Estate professionals interested in developing powerful property image classification and valuation models using artificial intelligence and quantum computing.

For a better understanding of the topics, it is necessary that the participant have knowledge of statistics and mathematics.

## MACHINE LEARNING

### Module 1: Machine Learning

- Definition of Machine Learning
- Machine Learning Methodology
  - Data Storage
  - Abstraction
  - Generalization
  - Assessment
- Supervised Learning
- Unsupervised Learning
- Reinforcement Learning
- Deep learning
- Typology of Machine Learning algorithms
- Steps to Implement an Algorithm
  - information collection
  - Exploratory Analysis
  - Model Training
  - Model Evaluation
  - Model improvements
  - Machine Learning in consumer credit risk
- Machine Learning in credit scoring models
- Quantum Machine Learning

### Module 2: EDA Exploratory Analysis

- Data typology
- Transactional data
- Unstructured data embedded in text documents
- Social Media Data
- Data sources
- Data review
- Target definition
- Time horizon of the target variable
- Sampling
  - Random Sampling
  - Stratified Sampling
  - Rebalanced Sampling
- Exploratory Analysis:
  - histograms
  - Q Q Plot
  - Moment analysis
  - boxplot
- Treatment of Missing values
  - Multivariate Imputation Model
- Advanced Outlier detection and treatment techniques
  - Univariate technique: winsorized and trimming
  - Multivariate Technique: Mahalanobis Distance
- Exercise 1: EDA Exploratory Analysis

### Module 3: Feature Engineering

- Data Standardization
- Variable categorization
  - Equal Interval Binning
  - Equal Frequency Binning
  - Chi-Square Test
- Binary coding
- Binning
  - Kind of transformation
  - Univariate Analysis with Target variable
  - Variable Selection
  - Treatment of Continuous Variables
  - Treatment of Categorical Variables
  - Gini
  - Information Value
  - Optimization of continuous variables
  - Optimization of categorical variables
- Exercise 2: Detection and treatment of Advanced Outliers
- Exercise 3: Stratified and Random Sampling in R
- Exercise 4: Multivariate imputation model
- Exercise 5: Univariate analysis in percentiles in R
- Exercise 6: Continuous variable optimal univariate analysis in Excel
- Exercise 7: Estimation of the KS, Gini and IV of each variable in Excel
- Exercise 8: Feature Engineering of variables

## Unsupervised Learning

### Module 4: Unsupervised models

- Hierarchical Clusters
- K Means
- Standard algorithm
- Euclidean distance
- Principal Component Analysis (PCA)
- Advanced PCA Visualization
- Eigenvectors and Eigenvalues
- Exercise 9: Segmentation of the data with K-Means R

## Supervised Learning

### Module 5: Logistic Regression and LASSO Regression

- Econometric Models
  - Logit regression
  - probit regression
  - Piecewise Regression
  - survival models
- Machine Learning Models
  - Lasso Regression
  - Ridge Regression
- Model Risk in Logistic Regression
- Exercise 10: Lasso Logistic Regression in R
- Exercise 11: Ridge Regression in R

### Module 6: Trees, KNN and Naive Bayes

- Decision Trees
  - Modeling
  - Advantages and disadvantages
  - Recursion and Partitioning Processes
  - Recursive partitioning tree
  - Pruning Decision tree
  - Conditional inference tree
  - Tree display
  - Measurement of decision tree prediction
  - CHAID model
  - Model C5.0
- K-Nearest Neighbors KNN
  - Modeling
  - Advantages and disadvantages
  - Euclidean distance
  - Distance Manhattan
  - K value selection
- Probabilistic Model: Naive Bayes

- Naive bayes
- Bayes' theorem
- Laplace estimator
- Classification with Naive Bayes
- Advantages and disadvantages

- Exercise 12: KNN and PCA

**Module 7: Support Vector Machine SVM**

- Support Vector Classification
- Support Vector Regression
- Optimal hyperplane
- Support Vectors
- Add costs
- Advantages and disadvantages
- SVM visualization
- Tuning SVM
- Kernel trick
- Exercise 14: Pricing con Support Vector Machine in R

**Module 8: Ensemble Learning**

- Classification and regression ensemble models
- Bagging
- Bagging trees
- Random Forest
- Boosting
- Adaboost
- Gradient Boosting Trees
- Xgboost
- Advantages and disadvantages
- Exercise 15: Pricing  Boosting in R
- Exercise 16: Pricing Bagging in R
- Exercise 17: Pricing Random Forest, R and Python
- Exercise 18: Pricing Gradient Boosting Trees

## DEEP LEARNING

**Module 9: Introduction to Deep Learning**

- Definition and concept of deep learning
- Why now the use of deep learning?
- Neural network architectures
- Feedforward network
- R deep learning
- Python deep learning
- Convolutional Neural Networks
- Use of deep learning in image classification
- Cost function
- Gradient descending optimization
- Use of deep learning
- How many hidden layers?
- How many neurons, 100, 1000?
- How many times and size of the batch size?
- What is the best activation function?
- Hardware, CPU, GPU and cloud environments
- Advantages and disadvantages of deep learning

**Module 10: Deep Learning Feed Forward Neural Networks**

- Single Layer Perceptron
- Multiple Layer Perceptron
- Neural network architectures
- Activation function
- sigmoidal
- Rectified linear unit (Relu)
- The U
- Selu
- Hyperbolic hypertangent
- Softmax
- Other
- Back propagation
- Directional derivatives
- Gradients
- Jacobians
- Chain rule
- Optimization and local and global minima
- Exercise 19: Pricing using Deep Learning Feed Forward

**Module 11: Deep Learning Convolutional Neural Networks CNN**

- CNN for pictures
- Design and architectures
- Convolution operation
- Descending gradient
- Filters
- Strider
- Padding
- Subsampling
- Pooling
- Fully connected
- Exercise 20: Pricing using deep learning CNN

**Module 12: Deep Learning Recurrent Neural Networks RNN**

- Natural Language Processing
- Natural Language Processing (NLP) text classification
- Long Term Short Term Memory (LSTM)
- Hopfield
- Bidirectional associative memory
- descending gradient
- Global optimization methods
- One-way and two-way models
- Deep Bidirectional Transformers for Language Understanding
- Exercise 21: Pricing using Deep Learning LSTM

**Module 14: Generative Adversarial Networks (GANs)**

- Generative Adversarial Networks (GANs)
- Fundamental components of the GANs
- GAN architectures
- Bidirectional GAN
- Training generative models
- Exercise 22: Pricing using GANs

**Module 15: Tuning Hyperparameters**

- Hyperparameterization
- Grid search
- Random search
- Bayesian Optimization
- Train test split ratio

- Learning rate in optimization algorithms (e.g. gradient descent)
- Selection of optimization algorithm (e.g., gradient descent, stochastic gradient descent, or Adam optimizer)
- Activation function selection in a (nn) layer neural network (e.g. Sigmoid, ReLU, Tanh)
- Selection of loss, cost and custom function
- Number of hidden layers in an NN
- Number of activation units in each layer
- The drop-out rate in nn (dropout probability)
- Number of iterations (epochs) in training a nn

**Module 16: Probabilistic Machine Learning**

- Introduction to probabilistic machine learning
- Gaussian models
- Bayesian Statistics
- Bayesian logistic regression
- Kernel family
- Gaussian processes

## Model Validation

**Module 17: Validation of traditional and Machine Learning models**

- Model validation
- Validation of machine learning models
- Regulatory validation of machine learning models in Europe
- Out of Sample and Out of time validation
- Checking p-values in regressions
- R squared, MSE, MAD
- Waste diagnosis
- Goodness of Fit Test
- Multicollinearity
- Binary case confusion matrix
- K-Fold Cross Validation
- Model diagnosis
- Exercise 27: Advanced regression validation
- Exercise 28: Regression Diagnosis
- Exercise 29: K-Fold Cross Validation in R

## Auto Machine Learning and XAI

**Module 18: Automation of ML**

- What is modeling automation?
- That is automated
- Automation of machine learning processes
- Optimizers and Evaluators
- Modeling Automation Workflow Components
- Summary
- Indicted
- Feature engineering
- Model generation
- Assessment
- Hyperparameter optimization
- Global evaluation of modeling automation
- Implementation of modeling automation in banking
- Technological requirements
- Available tools

- Number of clusters in a clustering task
- Kernel or filter size in convolutional layers
- Pooling size
- Batch size
- Exercise 23: Optimization Pricing Xboosting, Random forest and SVM
- Exercise 24: Optimized Pricing Deep Learning
  DEEP LEARNING

## Probabilistic Machine Learning

- Gaussian processes for regression
- Hidden Markov Model
- Markov chain Monte Carlo (MCMC)
- Metropolis Hastings algorithm
- Machine Learning Probabilistic Model
- Bayesian Boosting
- Bayesian Neural Networks
- Exercise 25: Gaussian process for regression
- Exercise 26: Pricing model using Bayesian Neural Networks

- Benefits and possible ROI estimation
- Main Issues
- Genetic algorithms
- Exercise 30: Automation of the modeling, optimization and validation of pricing models

## Explainable Artificial Intelligence

**Module 19: Explainable Artificial Intelligence XAI**

- Interpretability problem
- Machine learning models
- 1. The challenge of interpreting the results,
- 2. The challenge of ensuring that management functions adequately understand the models, and
- 3. The challenge of justifying the results to supervisors
- Black Box Models vs. Transparent and Interpretable Algorithms
- interpretability tools
- Shap, Shapley Additive explanations
- Global Explanations
- Dependency Plot
- Decision Plot
- Local Explanations Waterfall Plot
- Lime, agnostic explanations of the local interpretable model
- Explainer Dashboard
- Other advanced tools
- Exercise 31: XAI interpretability of pricing

## Quantum Computing

**Module 20: Quantum computing and algorithms**

Objective: Quantum computing applies quantum mechanical phenomena. On a small scale, physical matter exhibits properties of both particles and waves, and quantum computing takes advantage of this behavior using specialized hardware. The basic unit of information in quantum computing is the qubit, similar to the bit in traditional digital electronics. Unlike a classical bit, a qubit can exist in a superposition of its two "basic" states, meaning that it is in both states simultaneously.

- Future of quantum computing in insurance
- Is it necessary to know quantum mechanics?
- QIS Hardware and Apps
- quantum operations
- Qubit representation
- Measurement
- Overlap
- matrix multiplication
- Qubit operations
- Multiple Quantum Circuits
- Entanglement
- Deutsch Algorithm
- Quantum Fourier transform and search algorithms
- Hybrid quantum-classical algorithms
- Quantum annealing, simulation and optimization of algorithms
- Quantum machine learning algorithms
- Exercise 32: Quantum operations multi-exercises

**Module 21: Introduction to quantum mechanics**

- Quantum mechanical theory
- Wave function
- Schrodinger's equation
- Statistical interpretation
- Probability
- Standardization
- Impulse
- The uncertainty principle
- Mathematical Tools of Quantum Mechanics
- Hilbert space and wave functions
- The linear vector space
- Hilbert's space
- Dimension and bases of a Vector Space
- Integrable square functions: wave functions
- Dirac notation
- Operators
- General definitions
- Hermitian adjunct
- Projection operators
- Commutator algebra
- Uncertainty relationship between two operators
- Operator Functions
- Inverse and Unitary Operators
- Eigenvalues and Eigenvectors of an operator
- Infinitesimal and finite unit transformations
- Matrices and Wave Mechanics
- Matrix mechanics
- Wave Mechanics
- Exercise 33: Quantum mechanics multi-exercises

**Module 22: Introduction to quantum error correction**

- Error correction
- From reversible classical error correction to simple quantum error correction
- The quantum error correction criterion
- The distance of a quantum error correction code
- Content of the quantum error correction criterion and the quantum Hamming bound criterion
- Digitization of quantum noise
- Classic linear codes
- Calderbank, Shor and Steane codes
- Stabilizer Quantum Error Correction Codes
- Exercise 34: Noise Model, Repetition Code and quantum circuit

**Module 23: Quantum Computing II**

- Quantum programming
- Solution Providers
- IBM Quantum Qiskit
- Amazon Braket
- PennyLane
- cCrq
- Quantum Development Kit (QDK)
- Quantum clouds
- Microsoft Quantum
- Qiskit
- Main Algorithms
- Grover's algorithm
- Deutsch–Jozsa algorithm
- Fourier transform algorithm
- Shor's algorithm
- Quantum annealers
- D-Wave implementation
- Qiskit Implementation
- Exercise 35: Quantum Circuits, Grover Algorithm Simulation, Fourier Transform and Shor

**Module 24: Quantum Machine Learning**

- Quantum Machine Learning
- Hybrid models
- Quantum Principal Component Analysis
- Q means vs. K means
- Variational Quantum Classifiers
- Variational quantum classifiers
- Quantum Neural Network
- Quantum Convolutional Neural Network
- Quantum Long Short Memory LSTM
- Quantum Support Vector Machine (QSVC)
- Exercise 36: Quantum Support Vector Machine

**Module 25: Tensor Networks for Machine Learning**

- What are tensor networks?
- Quantum Entanglement
- Tensor networks in machine learning
- Tensor networks in unsupervised models
- Tensor networks in SVM
- Tensor networks in NN
- NN tensioning
- Application of tensor networks in credit scoring models
- Exercise 37: Neural Network using tensor networks

**Quantum AI Appraisal and Rental Model**

**Module 26: Real estate Pricing using AI and quantum computing**

- Real Estate Situation in Europe and Spain

- Real Estate Situation in the United States
- Real Estate Situation in Latin America
- Key factors
- Construction material costs
- Energy costs
- Inflation and interest rates
- Housing demand
- Housing construction
- Housing prices
- Impact of Covid-19 on housing construction
- Increase in material prices
- Shortage of qualified labor
- Analysis of classic Real Estate pricing models
- Analysis of variables to model the price
- Inflation adjusted price
- Gross area of residential property
- Age of residential property
- Building structure
- Property floor level
- Parking availability
- Distance to train station
- Distance to nearest public transport
- Location
- Crime rate
- Feature Engineering
- ML models
- Support Vector Machine Regression
- Neural Networks Feed Forward
- Convolutional Neural Network CNN
- Quantum ML models
- Qubit and Quantum States
- Quantum circuits
- Quantum k means
- Support Vector Quantum Machine
- Quantum Neural Networks
- Variational Quantum Regressor (VQR)
- Exercise 38: Variational Quantum Regressor ( VQR ) for pricing model
- Exercise 39: Quantum Support Vector Machine and classical SVM for pricing model
- Exercise 40: Quantum feed forward Neural Networks and classical NN for pricing model
- Exercise 41: Classical CNN for pricing model

**Module 27: ML model for price estimation per m2 and habitability classification model**

- Fair price modeling
- Buy, sell or rent strategies
- Strategies for real estate companies
- Location through GPS coordinates
- Habitability rating
- Feature engineering
- Price Regression Models
- Random Forest
- Adaptive Boosting
- Gradient Boosting
- Dense Neural Network
- Classification Models
- Random Forest
- Gradient Boosting
- Deep Learning Feed Forward
- Deep Learning CNN
- Model XAI
- Model validation
- Model diagnosis
- Analysis of results
- Exercise 42: Pricing using machine regression and deep learning models
- Exercise 43: Modeling habitability with deep and machine learning classification models

**Module 28: Rental Predictive Model**

- Situation of rental supply and demand in Spain and Latin America
- New Housing Law in Spain
- Rental price limits
- Protection against evictions
- New definition of great owner
- Stressed area
- Number of bedrooms, hallway, kitchen
- Rental of Houses/Apartments/Flats
- Size of houses/apartments/flats
- Floors located on which Floor and Total Number of Floors
- Builded surface.
- Location of the area: Location of the Houses/Apartments/Flats.
- City where the houses/apartments/flats are located.
- Condition of the furniture of the houses/apartments/flats, whether furnished, semi-furnished or unfurnished.
- Type of tenant preferred by the owner or agent.
- Rental modeling
- Random Forest
- Adaptive Boosting
- Gradient Boosting
- Dense Neural Network
- Exercise 44: Rental models using machine regression and deep learning models

## Real Estate Pricing Model with Time Series

**Module 29: Deep Learning models for real estate pricing and macroeconomic projections**

- Time series model to predict house prices
- Macroeconomic variables that impact Real Estate
- Time series models
- Data exploration and analysis
- Feature engineering and data preprocessing
- Model development and training
- Model performance and evaluation
- Model prediction
- Trading strategies with forecasting models
- Multivariate Models
- VAR Autoregressive Vector Models
- ARCH models
- GARCH models
- GARCH Models Multivariate Copulas
- VEC Error Correction Vector Model
- Johansen's method
- Machine Learning Models
- Supported Vector Machine
- Neural network
- Forecasting market time series yields

- NN and SVM algorithms for performance forecasting
- Forecasting volatility NN vs. Garch
- Development and validation base
- Deep learning
- Recurrent Neural Networks RNN
- Elman's Neural Network
- Jordan Neural Network
- Basic structure of RNN
- Long short term memory LSTM
- Temporary windows
- Development and validation sample
- Regression
- Sequence modeling
- Quantum Deep Learning
- Exercise 45: Charge-off model with VAR and VEC
- Exercise 46: Forecasting financial series and Bayesian LSTM indices in Python
- Exercise 47: Forecasting using Multivariate RNN LSTM in Python
- Exercise 48: Forecasting using Quantum LSTM

## Real Estate Image Classification

**Module 30: Image Classification**

- Multiclass image classification
- Collection of images such as bedrooms, living room, kitchen, etc.
- Verification of properties
- Classification of images in Real Estate
- Problem Statement
- Deep Learning Problem Formulation
- Project and Data Source
- Image Dataset
- Evaluation Metric
- Exploratory Data Analysis
- Image Preprocessing
- Model Training
- Productionizing
- Image Classification: Data-driven Approach
- Convolutional Neural Networks
- Data and the Loss preprocessing,
- Hyperparameters
- Train/val/test splits
- L1/L2 distances
- Hyperparameter search
- Optimization: Stochastic Gradient Descent
- Optimization landscapes
- Black Box Landscapes
- Local search
- Learning rate
- Weight initialization,
- Batch normalization
- Regularization (L2/dropout)
- Loss functions
- Gradient checks
- Health checks
- Hyperparameter optimization
- Architectures
- Convolution / Pooling Layers
- Spatial arrangement,
- Layer patterns,
- Layer sizing patterns
- AlexNet/ZFNet/VGGNet
- Convolutional Neural Networks tSNE embeddings
- Deconvnets
- Data gradients
- Fooling ConvNets
- Human comparisons Transfer Learning and
- Fine-tuning Convolutional Neural Networks
- Exercise 49: Convolutional Neural Networks for classification of image collection such as bedrooms, living room, kitchen, etc.
- Exercise 50: Convolutional Neural Networks for Real Estate Verification Classification

## Quantum Real Estate Pricing

**Module 31: Quantum Real Estate Pricing**

- Quantum modeling of real estate prices
- Quantum physics
- Quantum probability
- Quantum computing
- Simulate a quantum system
- Classic Monte Carlo simulation
- Quantum Monte Carlo
- Encode Monte Carlo problem
- Amplitude Estimation
- Acceleration by applying the amplitude estimation algorithm
- Exercise 51: Quantum Monte Carlo Simulation vs. Classical Monte Carlo Simulation to estimate the price in Real Estate

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