

ML cube 

 spin off®
POLITECNICO DI MILANO

CASE STUDIES

COLLECTION

AI for decision making

2022

SUMMARY

AERODYNAMIC OPTIMIZATION	2
AERODYNAMIC FORCES ESTIMATION	3
AUTONOMOUS DRIVING	4
F1 RACING STRATEGY	5
SELF-DRIVING	6
MISSION PLANNING	7
PORTFOLIO OPTIMIZATION	8
PRICING & HEDGING	9
AUTOMATED TRADING	10
FINANCIAL RISK	11
CUSTOMER CHURN	12
PRICING OF ROOM TO RENT	13
AIRLINE TICKET PRICING	14
AIRLINE TICKET MARKET SEGMENTATION	15
DYNAMIC PRICING	16
RECOMMENDER SYSTEMS	17
AUTOMATIC CONTENT GENERATION	18
DEVELOPMENT OF INDICES FOR IMMUNOTHERAPY	19
DATA EXTRACTION FROM DOCUMENTS	20
IDENTITY MATCHING	21
PREDICTIVE MAINTENANCE	22
FAULT DETECTION AND DIAGNOSIS	23
ENERGY MANAGEMENT	24
EXHAUST GAS REDUCTION	25
PRODUCTION PLANNING	26
TURBINE REGULATION	27
PROPERTY VALUATION	28
BUSINESS FORECAST	29
ALLOCATION OF ADVERTISEMENTS IN THE METAVERSE	30
AUTOMATIC BIDDING	31
BUDGET OPTIMIZATION	32
TARGET OPTIMIZATION	33
TIMING OPTIMIZATION LAST-MILE DELIVERY	34
LAST-MILE DELIVERY OPTIMIZATION	35
WHO WE ARE, OUR VALUES, OUR MISSION	36
WHAT DO WE DO, OUR PRODUCTS	37
RESEARCH	38
EDUCATION	39
CONTACT US	40

Aerodynamic Optimization

CUSTOMER

Formula 1 racing team.

PROBLEM

Formula 1 requires constant research and innovation to compete at a high level. Every day, the research and development department designs several innovative solutions to improve the performance of the car's aerodynamic components. Prototypes are tested in a wind tunnel, where the team studies how the aerodynamic forces act on the car. It is of critical importance to know which configurations in the wind tunnel best represent real-life track performance in order to make the tests as representative as possible.

SOLUTION

Optimization algorithms were designed to define the best aerodynamic map (set of wind tunnel configurations) in terms of the available time for testing and how well they represent real track data. Improved accuracy of the wind-tunnel tests reduces the uncertainty in the estimate of lap time for a particular aerodynamic configuration.

RESULTS

The algorithms developed significantly improved the quality of wind tunnel tests. The generated aerodynamic maps resulted in a 75% reduction in the uncertainty of the lap time.

TECHNOLOGY

Supervised Learning - Optimization - Multi task learning - Matlab

[#windtunnel](#) [#optimization](#)

Aerodynamic Forces Estimation

CUSTOMER

Formula 1 racing team.

PROBLEM

F1 teams use sensors measuring several physical quantities to evaluate the on-track performance of their cars' aerodynamic designs. Mathematical models are used to estimate the aerodynamic forces acting on the car while it races around the track. The client required optimized sensor positioning, both to improve the quality of their data and make them more resistant to sensor failure.

SOLUTION

Optimization algorithms were created to improve the sensors' positions on the car ensuring that measurements were taken from the most effective positions, as well as making the sensors more resistant to damage or failure during racing. Artificial intelligence techniques were also used to improve the mathematical models which estimate aerodynamic forces. Transfer learning techniques were developed for the estimation of aerodynamic forces under various aerodynamic configurations.

RESULTS

By employing the sensor positioning algorithms and the new aerodynamic force estimation system, the sensors were significantly more robust to damage and resulted in a reduction of the estimation error from 2% to 0.5%. Transfer learning procedures allowed data from different aerodynamic configurations to be used with greater accuracy on new, previously unseen configurations.

TECHNOLOGY

Supervised Learning - Transfer Learning - Matlab

[#aerodynamic](#) [#estimation](#)

Autonomous Driving

CUSTOMER

Formula 1 racing team.

PROBLEM

In Formula 1, the research and development department constantly designs innovative solutions to improve all the car's aerodynamic components. It is essential to measure these components' on-track performance in order to determine whether their performance is in line with their specification. However, it is very expensive to physically test all prototypes on the track, which is why simulators are used for initial testing. The client asked for the development of an autonomous driving algorithm capable of finding the best on-track trajectory for each of the different aerodynamic configurations to test the proposed solutions in parallel.

SOLUTION

An autonomous driver was created based on Reinforcement Learning and Imitation Learning techniques. This driver drove with a style similar to F1 drivers, in order to produce realistic estimates of the quality of the prototypes. Imitation Learning techniques were devised which learned the driving styles of F1 competitors by analyzing their real-world driving data. Transfer Learning techniques were also designed to allow the autonomous driver to use previously acquired driving knowledge on different aerodynamic configurations.

RESULTS

The autonomous driver developed by ML cube was able to drive on an F1 track with performance and style comparable to that of a human expert driver. In addition to delivering the same performance, the trajectory-finding algorithms were able to improve the lap time by about 2 percent.

TECHNOLOGY

Supervised Learning - Optimization - Multi task learning - Matlab

[#autonomousdriving](#) [#simulator](#)

F1 Racing Strategy

CUSTOMER

Formula 1 racing team.

PROBLEM

Pit-stop strategy is a key component for success in Formula 1 racing, offering significant strategic and performance opportunities during competition. The sequence of components fitted to the single-seater is not only chosen by the teams to purely optimize performance, but is also impacted by the driver's position on the track and the opponents' strategies. Making the correct strategic choices at the right time during the race is therefore crucial for F1 teams, which invest considerable resources in simulation and prediction systems.

SOLUTION

ML cube has developed an autonomous agent based on Monte-Carlo Tree Search methods, capable of deciding when to stop the car for a pit stop and which compound to fit it. Lap by lap, the agent considers the state of the race in real-time to determine the optimal strategy, assessing the driver's expected performance degradation, current position, and distance from their rivals.

RESULTS

Testing of the ML cube agent in an experimental setting (based on a race simulator of championships from 2014 to 2020), achieved better results than both existing state-of-the-art algorithms and real race strategies, improving race time and final placing in 70% of the cases analyzed.

TECHNOLOGY

Monte-Carlo Tree Search - Python

#strategy #planning

CASE STUDY

Self Driving

CUSTOMER

Multinational company specializing in systems for the automotive industry.

PROBLEM

Controlling an autonomous vehicle poses major challenges in terms of defining and achieving driving-related goals. For example, motorway driving and urban driving scenarios have different objectives, in both interactions with other vehicles and the desired driving style. Our solution aims to train an autonomous agent that meets human expectations, respects the Highway Code, ensures driving comfort, and reduces travel time.

SOLUTION

ML cube created Reinforcement Learning algorithms designed to make high-level tactical decisions (e.g. lane changing, overtaking, intersection entry) in a simulation environment. Particular attention was paid to the interpretability of the resulting algorithm to maximize the traceability of the decisions it made.

RESULTS

The algorithms were evaluated in terms of meeting driving objectives (e.g. reaching the destination in the shortest possible time), compliance with safety standards, and driving style. The developed solutions performed better than controllers designed by industry experts.

TECHNOLOGY

Reinforcement Learning - Interpretable AI - Python

[#autonomousdriving](#) [#interpretability](#)

Mission Planning

CUSTOMER

Company that builds missiles and other defense technologies.

PROBLEM

The simultaneous control of numerous aircrafts, some of which are piloted and others autonomous, requires a preliminary planning phase on the ground and the management of any unforeseen circumstances. This project's objective is to design solutions to manage the aircrafts autonomously, enabling cooperation between them and ensuring a rapid, efficient responses to unexpected or adverse conditions.

SOLUTION

ML cube developed a system based on Reinforcement Learning techniques involving both cooperative (managing aircrafts with the same global objective) and hierarchical (addressing the inherent complexity of the problem) approaches. The autonomous system was trained in a simulation environment and evaluated in real-world tests involving many such unexpected events.

RESULTS

The system's quality was assessed primarily by the degree to which the mission objectives were achieved and its ability to adopt effective alternative behavior to mitigate any unforeseen circumstances. The developed solution met the mission requirements in a wide range of environments and scenarios.

TECHNOLOGY

Reinforcement Learning - Cooperative Multi-agent AI - Python

[#autonomousdriving](#) [#interpretability](#)

Portfolio Optimization

CUSTOMER

Investment Bank.

PROBLEM

Portfolio optimization is one of the most important problems in finance. It encompasses finding the best risk/return profile for an investment portfolio. The performance of such an algorithm is typically measured by metrics related to cumulative gain and computational complexity. State-of-the-art solutions generally do not provide theoretical guarantees on performance and are often based on unrealistic assumptions (eg. not including transactional costs).

SOLUTION

A new portfolio optimization algorithm was designed to implicitly take transaction costs into account. The implemented solution was compared to other approaches available in the literature on four different real-world datasets on the following markets: New York Stock Exchange (NYSE), SP500, Toronto Stock Exchange (TSE) (all well-known benchmarks for portfolio optimization), and a financial dataset from the recent CoVid-19 crisis period, to explicitly analyze the algorithm's performance in periods of high volatility.

RESULTS

It was shown from a theoretical point of view that the algorithm has better performance both in terms of cumulative gain and computational efficiency. In experiments in real-life scenarios, the implemented algorithm performed considerably better than all other strategies which were found to perform worse once transactional costs were taken into account.

TECHNOLOGY

Supervised Learning - Decision Trees - C++

Pricing & Hedging

CUSTOMER

Investment Bank.

PROBLEM

Market makers, generally rely on the standard Black & Scholes model for option pricing and hedging. However, this method is based on several unrealistic assumptions such as assuming the hedge is cost-free and that the frequency of rebalancing is continuous. For this reason, the hedging process, which usually consists of buying or selling the option's underlying (delta hedging), must be adjusted according to the trader's experience to reduce risks and take account of hedging costs.

SOLUTION

A solution was implemented that would improve the trader's experience in containing both risk and hedging costs by developing a tool that would guarantee more accurate results than delta hedging. To this end, a Reinforcement Learning algorithm was designed to take transaction costs into account. This algorithm, through the control of a risk aversion parameter, can generate a range of solutions that offer the trader different trade-offs between risk and P&L.

RESULTS

The validation of the method on call options at the money, in contexts with annual volatility of 20% and market hedging costs on liquid assets, showed that:

- in the presence of higher hedging costs, a winning strategy seems to be to decrease risk aversion;
- it is possible to balance risk and return a priori by deciding the agent's level of risk aversion;
- agents can carry out effective hedging on different options or markets, thus generalising the learned strategy in new contexts.

TECHNOLOGY

NLP - Machine Learning - Python

#finance #deltahedging

Automated Trading

CUSTOMER

Investment Bank.

PROBLEM

Automated trading systems are steadily increasing their impact on financial markets, however, generating profitable strategies using solely historical data remains an ambitious goal. The possibility of developing an algorithm that can plan for an uncertain future without relying on economic or financial assumptions makes Reinforcement Learning an attractive alternative to classical approaches.

SOLUTION

The problem was addressed through the use of an algorithm called Multi-Objective Fitted Q-Iteration (MO-FQI). This algorithm makes it possible to transform a reinforcement learning problem into a sequence of simpler problems that can be solved using supervised learning techniques. The algorithm uses datasets containing features constructed solely from historical financial data. Specifically, the exchange rate series considered was the €/\$ exchange rate, with 1,230 observations per day.

RESULTS

The results, validated over several time intervals, showed that this strategy can indeed produce effective strategies, while allowing traders to select the most suitable trade-off between risk and P&L.

Tests have also shown that some simple patterns (such as market opening/closing times) are learned automatically, without any 'expert' explicitly providing this information to the algorithm. This type of approach has thus proven to be a useful tool for traders to discover new opportunities for making profit.

TECHNOLOGY

Reinforcement Learning - Supervised Learning - Python

[#finance](#) [#trading](#) [#forex](#)

Financial Risk

Model Optimization

CUSTOMER

Investment Bank.

PROBLEM

Complex parametric mathematical models are generally used to assess and manage the risk associated with interest rate derivatives. Setting parameters requires time-consuming procedures, but speed is typically of critical importance for banks. Interest rates affect the discounting of future cash flows and are a key element in modelling financial credits in general. The aim, therefore, is to use AI algorithms based on historical data to rapidly estimate near-optimal parameters.

SOLUTION

The approach was applied in a real-world framework, where the chosen financial model was the bifactor Gaussian model (G2++), calibrated to European swaption at the money, single-currency or multi-currency scenarios. The calibration of the model parameters takes place via a feed forward neural network based on the model considered, unlike previous approaches that learn the optimal calibration by imitating existing calibrators.

RESULTS

The main advantages lie in the independence from external calibrators and the reduction of calibration time. The implementation of the calibrator is optimised through various techniques and algorithms: by transferring computationally intensive tasks to an offline training process, and performing the evaluation online instead, this calibration can be performed in a significantly shorter time (reduction from several seconds to milliseconds).

TECHNOLOGY

Reinforcement Learning – Supervised Learning – Python

[#finance](#) [#pricing](#) [#otcderivatives](#)

Customer Churn

CUSTOMER

Asset Management Company.

PROBLEM

The digital services industry faces the problem of decreasing the churn rate through an automated and measurable process. It is important to understand the characteristics (demographic and behavioural) that influenced the historical churn rate and therefore be able to suggest changes and/or actions to be taken to reduce this in the future.

SOLUTION

We started by analyzing the historical data (comprising the entire customer journey) to locate patterns, and then created a behavioral model, through analysis of customer characteristics (trends, age, location, breakpoints, and completion rate), all communication between advisors and clients (date, frequency, content) and of the quantitative data (account movement, average account balance, historical and active investment typology, and the reasons for previous disinvestments).

RESULTS

The first result was a red-list of customers for whom immediate action should be taken; focusing marketing on this list of clients reduced the abandonment rate by about 30%. Furthermore, it then allowed improvements in onboarding, increasing the conversion rate from 14% to 42%. Finally, after placing customers in specific groups or "clusters", the algorithm could suggest specific, customized marketing and commercial strategies which would reduce the likelihood of abandonment of the product. The suggested commercial services were in the medium-term.

TECHNOLOGY

NLP – Machine Learning – Python

#finance #churnrate

Pricing of Rooms to Rent

CUSTOMER

Platform dedicated to the search of rooms to rent.

PROBLEM

The rental market is highly competitive and subject to significant variability depending on the season. Therefore, setting the price of a room to rent is a complex task that typically requires in-depth knowledge of the market and the area where the property is located.

SOLUTION

Explainable AI algorithms have been developed that can calculate the optimal price of a rented room to maximize profits in the short and long term and reduce the time properties remain unoccupied. These techniques look at property characteristics (location, sqm, floor, orientation, amenities, etc.) and market data to suggest the optimal price to the client.

RESULTS

The developed algorithms were validated by a team of real estate experts who found the algorithms' predictions to be so accurate that it is now regularly used to support real estate agents in setting room prices. The test, carried out over nine months on a set of several hundred rooms, showed an 11% increase in revenue.

TECHNOLOGY

Explainable AI - Python - scikit-learn - C#

#pricing #rents

Airline Ticket Pricing

CUSTOMER

Booking platform for airline tickets.

PROBLEM

The airfare market for online travel agencies requires that the prices of airline tickets adapt to many factors affecting customer demand, such as the route and the time of year in which the booking is made. Computing the most profitable price for a single route also requires a careful analysis of competitors' pricing, to ensure the suggested price is competitive with the market. When there is a large number of routes under consideration, this would require an infeasible amount of human time.

SOLUTION

To solve this problem sequential decision algorithms (specifically Multi-Armed Bandit) were developed which automatically maximize profit and dynamically evaluate whether different pricing strategies may be better. These techniques, developed specifically for airline ticket pricing, can automatically update pricing in real-time, and are scalable over an arbitrary number of routes.

RESULTS

The system handled a turnover of €1M of airline ticket sales over 3 months, with an associated 30% increase in revenue for some of the routes using this automatic pricing system.

TECHNOLOGY

Multi-Armed Bandit -Python

[#dynamicpricing](#) [#flighttickets](#)

Airline Ticket Market Segmentation

CUSTOMER

Booking platform for airline tickets.

PROBLEM

Learning optimal pricing strategies within very large catalogs, such as that of an online travel agency with thousands of different routes, and converging to the optimal pricing strategy takes a long time. However, implementing the same policy for all tickets belonging to a certain category, e.g. all flights departing from Milan, can lead to the choice of sub-optimal strategies and, consequently, substantially reduce revenue. The problem then becomes a trade-off between pricing each flight differently and having a single price for all available tickets.

SOLUTION

Using decision trees specifically developed for the online learning task, the market was segmented into sub-categories based on the quantity of data collected and the homogeneity of user behavior within the sub-category. These structures also serve as a tool to assess the business characteristics within the different market segments.

RESULTS

The trees were used for the pricing of more than 10% of the company's business, leading to the use of automatic pricing techniques being extended to all the countries covered by the airline. In addition, interpreting the different mechanisms in each section of the business brought about a deeper understanding of the dynamics present in the different countries where the company operated.

TECHNOLOGY

Decision Trees - C++ - Python

[#marketsegementation](#) [#interpretabletree](#)

CASE STUDY

Dynamic Pricing

for E-commerce

CUSTOMER

E-commerce of consumer products.

PROBLEM

The pricing of products within e-commerce can be a complex problem. This is because an e-commerce store often has a large number of products in its catalogue and defining a price for each one is cumbersome and not always possible due to exogenous factors. The client asked for an estimation algorithm capable of automatically evaluating the optimal price of their products, starting from transactional data.

SOLUTION

An online Dynamic Pricing algorithm based on Multi-Armed Bandit was developed, capable of adapting to market changes and understanding variations in customer purchasing patterns. The underlying mathematical models take into account the type of products considered and the business dynamics to which they are subject.

RESULTS

The proposed Online Learning algorithms have increased the overall profit on priced products by more than 50%. The model adapts to changes and can handle seasonal trends. Discounts based on the number of selected products are also proposed in an optimized manner, leading to an increase in the average number of product units added to carts by customers.

TECHNOLOGY

Online Learning - Multi-Armed Bandit - Python

[#ecommerce](#) [#pricing](#)

Recommender Systems

CUSTOMER

E-commerce.

PROBLEM

One of the main factors determining the success of an e-commerce company is the quality of the user experience throughout all stages of the customer journey. Suggesting to the user, from a catalog of thousands of products, those that might be of interest to him/her is a crucial element of building loyalty and increasing the value of a customer's shopping cart.

SOLUTION

Recommender algorithms have been developed to process past orders, browsing data, purchasing habits, and user characteristics to predict how users will evaluate a particular product. These methods make it possible to suggest products related to those already in the shopping cart and more akin to the user's purchasing habits.

RESULTS

The employment of the recommender system in the e-commerce, led to an increase in the average value of each shopping cart, resulting in a 9% increase in net margin over a 9-month period with a catalogue of more than 20,000 products.

TECHNOLOGY

Recommender systems - Python

#e-commerce

Automatic Content Generator

CUSTOMER

Online Newspaper.

PROBLEM

The client's goal is to increase traffic to their website through automatic content creation. The primary requirement is to generate web pages with SEO-optimised content, taking into consideration the analysis of a set of keywords stemming from examining the industry's users' searches.

SOLUTION

A pipeline was implemented for the automatic generation of articles, in particular biographies, using web sources as starting point. The first part of the solution consists of an intelligent scraping algorithm, which is capable of searching and selecting online sources and subdividing them into paragraphs relevant to the topic. Then, by using NLP algorithms, these paragraphs are summarised to obtain a biographical card with information organically arranged according to a template (e.g. according to a timeline).

RESULTS

Hundreds of biographical entries have been created, each telling the story of the person under consideration. The information present in the entries is relevant to the selected sources and is well organized on the page. The generated text is fluent and almost indistinguishable from content written by humans, yielding enormous efficiency gains compared to writing articles by hand.

TECHNOLOGY

Natural Language Processing – Deep Learning – Python

#textgeneration

Development of Indices for Immunotherapy

CUSTOMER

National Hospital.

PROBLEM

The tools (indices) available to date for assessing whether an immunotherapy treatment will be effective for a lung cancer patient do not guarantee adequate accuracy. There are several reasons for this inefficacy. First, the indices used are based on clinical studies on single markers and do not take into account the interactions between the complex microenvironment formed by the tumor and the surrounding organs to assess the efficacy of the treatment. Second, these indices do not consider individual patient characteristics, e.g. age or previous diseases, which could be crucial for the efficacy of immunotherapy.

SOLUTION

The application of Supervised Learning techniques on data from cancer patients makes it possible to select the best therapy based on the factors that are most likely to result in a successful outcome for the patient. The technique assesses the relevance of each factor and proposes the immunotherapy treatment which is the most likely to be effective, based on the database of medical records of patients treated in the past.

RESULTS

The developed method was able to improve the predictive capabilities, in terms of accuracy, by more than 15% compared to traditional techniques used by medical practitioners. Furthermore, these models confirmed the need for preliminary examinations of patients which proved to be informative for predicting the effectiveness of the therapy.

TECHNOLOGY

Supervised Learning - Matlab

#precisionmedicine #healthcare

Data Extraction from Documents

CUSTOMER

Traditional bank.

PROBLEM

The process of creating an application file for the granting of loans and mortgages to businesses and individuals necessitates collecting a large quantity of information from various documents.

Additionally, manually inputting them into a management system requires considerable human effort, consuming time and resources.

Automating these processes makes it possible to minimize the amount of time required to deal with a file.

SOLUTION

The developed system is capable of automatically extracting the required fields from a set of documents containing a large collection of digital files and scans of structured and unstructured documents. The system uses image processing, OCR, and NLP techniques to extract information from the documents. Moreover, it is also able to fill in the required fields either directly in the client's database, or graphically on the form using bots.

RESULTS

The system can extract the required information from the documents. It specifies its confidence and applies corrections based on language models to optimize the output. This minimizes the operator's verification time while increasing the number of files processed.

TECHNOLOGY

NLP - OCR - Python - OpenCV

#images #documents

CASE STUDY

Identity Matching

Intelligent database search

CUSTOMER

Insurance company.

PROBLEM

Databases of multinational companies may contain ambiguities arising from the discrepant entry of the same source information by operators in different subsidiaries. An example is the identity ambiguity generated by the incomplete or incorrect entry of people's names.

By disambiguating values entered in databases, the data access is simplified, the flow of information through the system is made more efficient and the risk of errors for both automated systems and human operators is reduced.

SOLUTION

A system that can disambiguate fields in a database was developed. It is based on different features related to errors commonly made during entry. The system combines spelling correction rules with a language model capable of generating the phonetic representation of words, to assess the similarity of the sounds of two different spellings of the same word.

RESULTS

The developed system can disambiguate the results of a search performed on the database, providing a measure of the strength of the match based on a customized score for each feature considered. This allows the search results to be expanded without confusing the user or worsening the relevance of the results.

TECHNOLOGY

NLP - Python

[#database](#) [#search](#)

Predictive Maintenance

CUSTOMER

Multinational manufacturing industry.

PROBLEM

Industry is increasingly moving towards the automation of production processes using intelligent machinery. However, this innovative process has its risks, since new production lines need to be constantly monitored to prevent faulty products or breakdowns. The customer asked for the development of artificial intelligence systems that can predict failures and modify the parameters of the machinery to avoid producing defective parts.

SOLUTION

Intensive scientific research has been carried out to create new algorithms for autonomous machine management, not only in production but also for small maintenance operations, to avoid defective units. The designed algorithms monitor the different production stages, predicting whether the produced unit will be defective, and what defect it will have. Moreover, Reinforcement Learning algorithms were applied to autonomously adjust machinery configuration parameters to reduce production risks.

RESULTS

The designed algorithms, field-tested in plant, were demonstrated to be highly effective. the fully automated experimental production

TECHNOLOGY

Reinforcement Learning – Supervised Learning – Python

#industry4.0 #defect-unit-detection

Fault Detection and Diagnosis

CUSTOMER

Italian Energy Research Centre.

PROBLEM

Photovoltaic systems are becoming increasingly popular and more widely used as a renewable energy source for the transition in electricity production. Solar panels can suffer a considerable number of failures due to constant exposure to the elements, resulting in corrosion of the devices' electrical components. In addition to stopping electricity production, a failure can also be dangerous by short circuits resulting in fires or other electrical problems.

SOLUTION

Artificial Intelligence algorithms have been developed which, by analysing electrical and atmospheric data, are able to identify the presence of faults, their nature and intensity to reduce the time between the occurrence of a fault and its resolution by a technician. Fault diagnosis allows the maintenance technician to know what repair measures need to be taken in advance, thus considerably reducing time and costs. The developed solution is applicable on different models and photovoltaic systems, making it easily scalable and extendable to many different environments.

RESULTS

The algorithms were tested on a fault facility over a period of one year, during which the faults of interest were artificially generated on three different types of photovoltaic systems. The proposed solution showed 99% accuracy in identifying faults and their nature. Furthermore, the use of different brands and electrical components of photovoltaic panels demonstrated the reliability of the algorithms when dealing with different electrical specifications.

TECHNOLOGY

Supervised Learning - Python

CASE STUDY

Energy Management

for smart-grids

CUSTOMER

Energy Research Centre.

PROBLEM

In a smart-grid network, there are home storage systems that can compensate for shortfalls in energy generation from renewable sources and absorb the surplus. The customer asked for a controller that optimised the use of these storage systems by deciding how much energy to absorb and how much to feed into the grid.

SOLUTION

A controller based on Reinforcement Learning techniques was realized for energy management within a home network, which decides when it is best to exchange energy with the grid or with the home storage system.

RESULTS

The designed controller, capable of simulating the storage system by using an electrochemical model, resulted in savings of more than 20 percent compared to controllers typically used for such problems.

TECHNOLOGY

Reinforcement Learning - Python

[#smart-grids](#) [#energy](#)

Exhaust Gas Reduction

CUSTOMER

Energy infrastructure companies.

PROBLEM

The transport of methane gas requires a complex infrastructure of pipelines and gas turbines. Regulations impose emission limits for NOx and CO to protect the environment, and companies must provide emission forecasts for the plants. The client asked for the development of Machine Learning techniques to estimate NOx and CO emissions from field measurements of turbines.

SOLUTION

Techniques for selecting the most meaningful information from the acquisition systems and artificial intelligence algorithms for estimating emissions have been developed. These algorithms are compatible with different types of turbines.

RESULTS

The selection of the most relevant information allowed us to understand exactly what was causing the increase in emissions and therefore design courses of action to reduce them while complying with emission regulations.

TECHNOLOGY

Multi task learning - Feature Selection - Supervised Learning - Python

#green #gaspipeline

Production Planning

CUSTOMER

Engineering manufacturing company.

PROBLEM

It is of paramount importance for companies to keep production facilities running smoothly to avoid lost revenue opportunities due to downtime or overcrowded production. Scheduling and demand forecasting techniques are used for this purpose. The introduction of artificial intelligence in these two fields has been requested to improve them.

SOLUTION

Artificial intelligence algorithms were developed to estimate the demand for raw materials required to meet customers' demand. Production planning algorithms were designed in conjunction with demand forecast algorithms for short- and medium-term production planning.

RESULTS

The accuracy of the demand forecast algorithms has optimized the management of raw materials in the warehouse and improved the efficiency of production facilities.

TECHNOLOGY

Forecast - Supervised Learning - Planning - Python

[#demandforecast](#) [#scheduling](#)

Turbine Regulation

CUSTOMER

Energy services company.

PROBLEM

Regulating the operation of a gas turbine is generally conducted through the use of classical control techniques, specifically PID controllers. Although effective, these control systems are not suitable for dealing with aging phenomena in the system and ensuring safe operating conditions when dealing with the wide range of phenomena that can occur at the plant. The aim is to overcome these limitations through AI-based approaches.

SOLUTION

Reinforcement Learning algorithms were designed, both to calibrate the parameters of PID controllers, and also to produce new controllers capable of demonstrating behavior robust to system variations and guaranteeing specific safety conditions, whilst avoiding the occurrence of operating conditions that could damage the system.

RESULTS

The algorithmic solution was tested on a system simulator. The results obtained significantly improved the performance compared to that achievable with PID controllers and completely avoided system malfunctions that could damage the system.

TECHNOLOGY

Reinforcement Learning - PID

#gasturbines #pid

Property Valuation

CUSTOMER

Real estate SGR.

PROBLEM

Evaluating an investment property is a task that requires in-depth knowledge of several dimensions: the market, the type of real estate transaction, the characteristics of the area and the property, etc. As the number of properties to be evaluated increases, it becomes increasingly complex to provide accurate estimates, especially if the properties are located in areas never previously analyzed.

SOLUTION

Explainable AI algorithms have been developed that can provide a valuation of a property that can be used by advisors to evaluate investment opportunities. The model receives as input historical data, scraping data, market data, and property features. The interpretable output indicates the valuation of the property and the contribution of each feature in defining that value.

RESULTS

Algorithms have been successfully introduced into real estate valuation processes bringing significant benefits both in terms of estimation accuracy and savings in the time required to perform an evaluation.

TECHNOLOGY

Explainable AI – Scraping – Python – scikit-learn – C#

[#valuation](#) [#realestate](#)

Business Forecast

CUSTOMER

Multinational medical device company.

PROBLEM

In a multinational company, strategic planning is a very complex task given the number of customers, the number of shops, and the variability between countries. Sales forecasting is one of the most important and valuable tools for making informed and functional decisions. In addition, the number of is needed to understand the right operations to maximize sales potential.

SOLUTION

Advanced sales forecasting algorithms have been designed by learning from customer behavior. The implemented simulation tool was able to test different business scenarios (cost of devices, marketing expenditure, trial period length) and identify the best strategy.

RESULTS

The algorithms provide an overview that allows a better understanding of the business dynamics within the company. The predictive algorithms have proven to be effective across different countries by accurately estimating device sales.

TECHNOLOGY

Supervised Learning - Planning - Python

[#sales-forecast](#) [#sales-funnel](#) [#what-if-analysis](#)

Allocation Of Advertisements In The Metaverse

CUSTOMER

Metaverse platform.

PROBLEM

The development of algorithms for advert allocation and related economic mechanisms plays a key role in digital marketing. Most of the state-of-the solutions are focused on online advertising in commonly used environments, such as websites and smartphone applications. However, in recent years, new environments are emerging into which the online advertising sector will expand, such as the metaverse. This new scenario poses great challenges from a technological point of view, as it presents new features compared to classical scenarios (e.g. the space component).

SOLUTION

User interaction in the metaverse inherently has a spatial component. For this reason, the advert allocation problem can be modeled as an optimization problem on a graph and solved by adapting classical algorithms on graphs. Parallel to the allocation algorithm, the development of tools to define the pricing of the adverts is of crucial importance since the adverts' costs are closely related to their spatial positioning.

RESULTS

Graph-based algorithms have been developed that can efficiently allocate advertisements in the metaverse, capable of scaling up to large real-world scenarios.

TECHNOLOGY

Optimization - Python

[#digitaladvertising](#) [#metaverse](#)

Automatic Bidding

CUSTOMER

Advertising platform for hotels.

PROBLEM

Managing a hotel advertising campaign is a very complex task that requires the optimization of many variables on different platforms. As the number of adverts and keywords grows, it becomes impossible for a human to simultaneously manage the bid value for each keyword of each campaign on all platforms.

SOLUTION

Online Machine Learning algorithms were designed to process campaign metrics (impressions, clicks, conversion) and define the optimal bid to be set on each keyword. The goal of the algorithm is to maximize the overall profit generated across all platforms.

RESULTS

The impact of the algorithms was evaluated on two main KPIs: profit and time saved. On the first pilot test, a 16% increase in profit and a reduction in the working time of more than 30% were recorded.

TECHNOLOGY

Online Learning- Python - scikit learn - Google Ads - Facebook Ads

#advertising #bidding

CASE STUDY

Budget Optimization

CUSTOMER

Media agency.

PROBLEM

One of the most important tasks marketers have to perform when managing an advertising campaign is budget optimization. Typically, the marketer has to manage a monthly budget for each client to be distributed daily over a set (typically tens or hundreds) of advertising campaigns directed at different targets using different channels.

SOLUTION

A solution was developed based on Online Machine Learning techniques that, given a set of campaigns belonging to different advertising channels, optimally distributes the budget to maximise revenue while respecting the ROI and the spending constraints imposed by the client.

RESULTS

The algorithms developed achieved considerable results in terms of both ROI and time saved. In a 6-month test campaign with an advertising budget of over 100k, a 32% increase in ROI was recorded.

TECHNOLOGY

Gaussian Process – Python – scikit learn – Google Ads – Facebook Ads

[#advertising](#) [#budget](#)

CASE STUDY

Target Optimization

CUSTOMER

Media agency.

PROBLEM

During the management phase of a campaign, the advertiser has to define the audience segments to be targeted by the advertisement. First, they must identify which users are most likely to purchase after clicking on an ad. In addition, they have to ensure that the targeted audience is sufficiently large to guarantee the expenditure and turnover agreed with the client.

SOLUTION

An algorithm based on Machine Learning techniques was designed that optimizes the targeting of an advertising campaign. This algorithm analyses historical data of existing campaigns and customer pages and returns a set of new campaigns aimed at the optimal target group.

RESULTS

The algorithms were tested on advertising campaigns of a large company operating in the financial sector for 6 months. The targeting optimization suggested by the algorithm resulted in a 13% increase in ROI.

TECHNOLOGY

Gaussian process - Python - scikit learn - Google Ads - Facebook Ads

#advertising #target

Timing Optimization Last-Mile Delivery

CUSTOMER

Last Mile Logistics Company.

PROBLEM

A delivery company gives its customers the option to choose the time slot in which they want the goods to be delivered. Each time slot has a certain availability of delivery drivers. The goal of the implemented algorithm is to learn the expected demands and propose delivery slots so that the load is distributed correctly according to the number of available drivers.

SOLUTION

An algorithm based on Reinforcement Learning methods was implemented in order to define an order to present the time slots in. The algorithm proposes the optimal time slots for the company, and also offers the possibility of increasing the delivery price in the time slots that are considered inconvenient for the company, so as to incentivise some slots while disincentivising others.

RESULTS

The proposed Reinforcement Learning algorithms resulted in a better allocation of the delivery personnel. The number of delivery people allocated but not used, or not available but requested, was reduced by 70 percent compared to the strategy that was previously being used.

TECHNOLOGY

Reinforcement Learning - Python

#allocation #delivery

Last-Mile Delivery Optimization

CUSTOMER

Last Mile Logistics Company.

PROBLEM

A delivery company has a given number of drivers available to deliver multiple orders within the same city in a given time slot. The task is to optimize the routes to minimize the number of delivery staff needed to deliver all the products on time.

SOLUTION

An algorithm based on optimization heuristics was realized to jointly optimize all orders, using the delivery addresses, to minimize the number of delivery personnel required. The solution also takes into account the constraints on the volume and weight that can be transported by each driver.

RESULTS

The joint optimization of deliveries has enabled the company to significantly reduce its personnel costs and so increase its competitiveness. The created models can consider last-minute deliveries to be added to the schedule without modifying the other deliveries, by inserting the additional deliveries most efficiently.

TECHNOLOGY

Optimization heuristics - Python

#optimization #delivery

WHO WE ARE

ML cube S.r.l. is a spin-off of University Research and an innovative company that provides **cutting-edge solutions** for the optimization of **Machine Learning** and **life cycle management systems**. It is the result of specific research lines in the fields of Artificial Intelligence, Reinforcement Learning and Optimization, conducted by a brilliant team from the **Politecnico di Milano**.

ML cube was born as an initiative of **Kayrhos S.r.l.**, a management consulting company, with which it achieves a synergistic combination of **scientific excellence** and **managerial competence**, so as to be able to face the new challenges of the AI market.



OUR VALUES

We believe that **Artificial Intelligence** will be part of our lives and will design business models for any type of company, becoming an integral part of every product and service.

In this challenge, we want to play a **key role** by creating innovative and reliable AI tools with high and long-lasting performance.

OUR MISSION

We support our customers in the **growth** of their core business through artificial intelligence solutions.

We have experience in developing **custom Machine Learning solutions** for startups, medium and large companies.

WHAT DO WE DO



OUR PRODUCTS



ML CUBE PLATFORM

MACHINE LEARNING MODEL LIFECYCLE OPTIMIZATION.

ML cube Platform is an innovative B2B product for real-time optimization of the life cycle of Machine Learning models, in order to prevent their obsolescence. It is offered in SaaS mode and provides monitoring, performance analysis, maintenance management (re-training, adaptation, decommissioning) capabilities for production systems in different application domains.



AD CUBE

ONLINE ADVERTISING CROSS-CHANNEL CAMPAIGN OPTIMIZATION.

With a simple and intuitive interface, AD cube supports marketers in the most important decisions for their business by suggesting the best investment strategies and changes to be made to advertising campaigns to maximize their performance thanks to the power of proprietary AI algorithms.



PRICE CUBE

E-COMMERCE AND THE MARKETPLACE PRICING OPTIMIZATION.

Price Cube is a Dynamic Pricing system for online sales and which consists in modifying the prices shown to users in real time. It acquires data from various sources in real-time to update its predictive models, recalculate the price and exploit all sales opportunities. The algorithms thus make it possible to increase revenue by adapting to market condition and user behavior without additional costs.

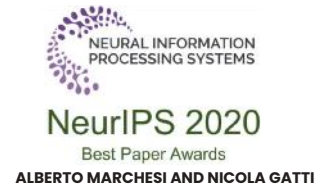
RESEARCH

40% of the Team carries out scientific research, numerous publications, citations and awards, participation in ambitious European projects with relevant public and private institutions.

PRESTIGIOUS AWARDS

340+

Articles published in major conferences on artificial intelligence



5300+

Scientific quotes

INTERNATIONAL CONFERENCES



RESEARCH COMMUNITY



EDUCATION

The path starts from the C-level to progressively involve the entire company organization, maturing awareness and skills at every level. The training sessions are articulated and structured through useful and original work frameworks for each phase of the activity, from conception to proof of concept up to Deployment in production. The framework is developed on the application of a series of methodological tools to support the governance and de-risking of AI projects. The nature of these, in fact, deeply differentiates them from software projects, and places them in an intermediate space between business and IT. Alias, a field of application that too many companies are not yet familiar with.

MODULI DI BUSINESS

Starting from the C-Level up to involving the company Subject-matter experts, we bring out the awareness of how AI helps to make better decisions, reduce costs by automating repetitive activities, can be used in design and go-to-market of new products and services.

- 1. AI, MARKET TRENDS, AND NATIONAL STRATEGIES**
Introduction to AI to clarify its evolution (failures and successes), new paradigms, market forecasts, players and government strategies, practical implications, risk levels, rules for adoption.
- 2. OPPORTUNITIES AND METHODOLOGIES**
What is AI and what is not. Therefore, provide clear metrics for self-assessment of Teams, Datasets, Processes and Projects to get to analyze the main cases of success and failure in the specific sector of the company.
- 3. AI FOR BUSINESS INNOVATION** Let's discuss and explore together how AI can be applicable and the maturity of the techniques that can be adopted. We proceed through Design Thinking sessions, with preliminary collection of KPIs and data, evaluation and presentation of results.

MODULI TECNICI

The goal is to present algorithms and techniques, experimenting together with the development of simple algorithms and on the main popular languages.

- 1. Module 1T:** Machine Learning
- 2. Module 2T:** Online ML
- 3. Module 3T:** Reinforcement Learning
- 4. Module 4T:** Deep Learning
- 5. Module 5T:** Explainable Learning
- 6. Module 6T:** Computer Vision
- 7. Module 7T:** NLP
- 8. Module 8T:** Python, AWS, Azure, etc


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