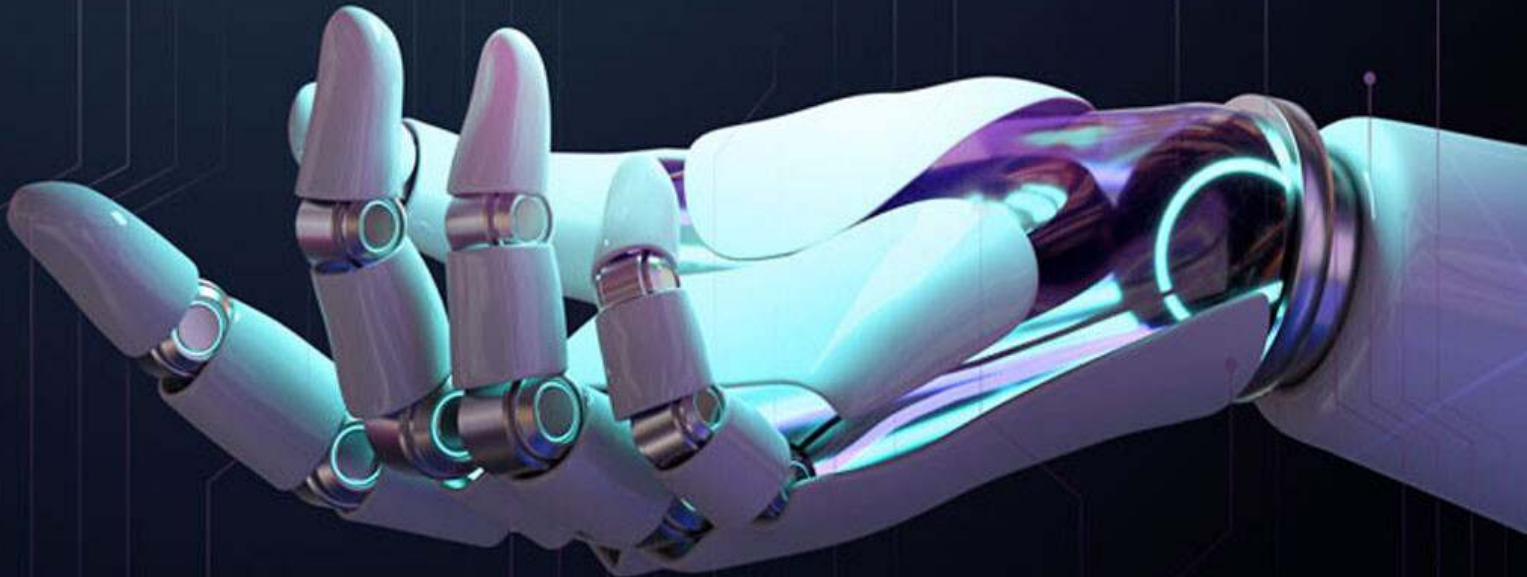
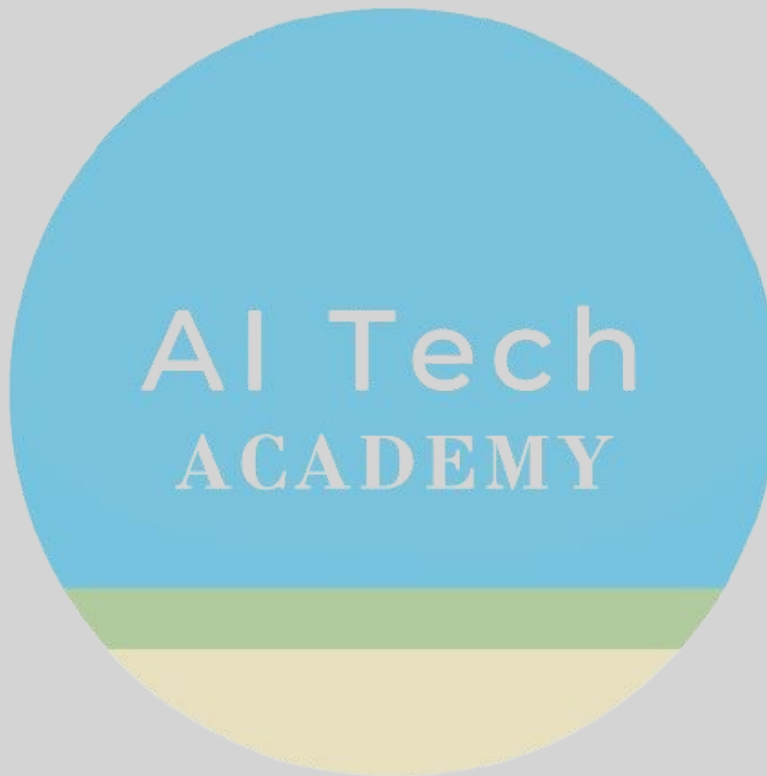


Artificial Intelligence for Property Business

Nasser Salem Abouzakhar





www.aitechacademy.co.uk



AI for Property Business





AI for Property Business

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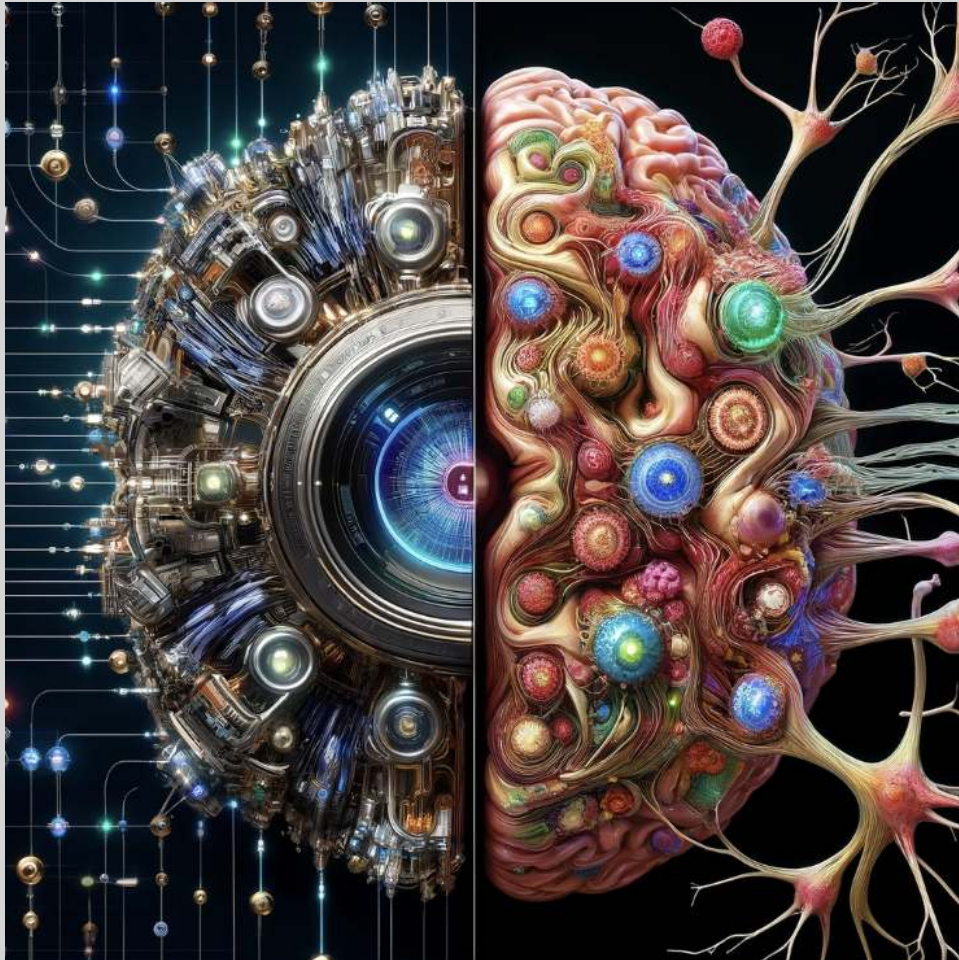
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Manchester

Dedication

To the innovative minds shaping property business with AI





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AI for Property Business



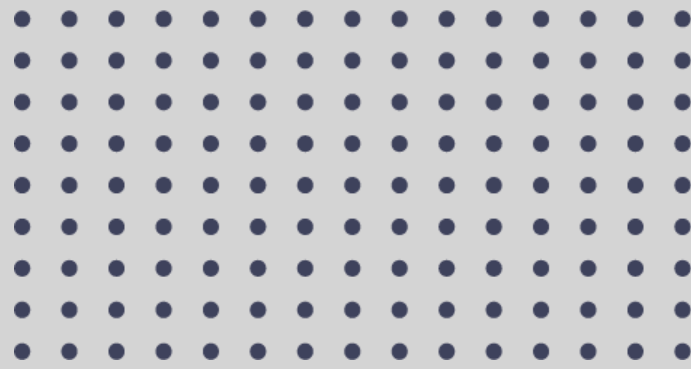


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AI for Property Business

Chapter One: Introduction



Chapter One

Introduction

Artificial Intelligence (AI) is a technology field impacting many global sectors and businesses quickly and daily. While the technology is still evolving, AI is a rapidly growing field comprising a range of techniques, making it capable of carrying out tasks such as predictive analytics, machine learning, natural language processing, and decision-making, among many other capabilities, some of which outperform humans. This chapter introduces AI, its benefits for society and businesses, its strengths and limitations and main features.

1. What is Artificial Intelligence?

With the support of machine learning techniques and predictive analytics, AI technologies can gather and analyse large amounts of data, like market conditions and sales data, to predict prices, allowing businesses and professionals to make informed decisions and minimise risks. We all agree that the Internet has fundamentally changed how we access and exchange information, communicate, and how businesses operate; AI is expected to transform our lives even more. AI has revolutionised how we perform many activities, manage business operations, predict and detect disease, develop marketing and sales strategies, etc.; the possibilities are endless. While the development of the Internet and the WWW (World Wide Web) era during the twenty-first century's first decade has reshaped many sectors and businesses, the emergence of AI after two decades presented a new wave of disruption.

AI is a collection of algorithms, tools and solution models that offer entrepreneurs a platform for managing, marketing, and systemising their SMEs and business operations. Recently, AI opened new venues for innovative activities and cost-effective solutions, saving time and money for start-ups and established enterprises. AI is essential for innovation and analysing extensive data from across areas of sectors and applications, offering effective predictive insights and developing efficient, cost-effective solutions for many industries; it undoubtedly will transform our lives. AI tools have been instrumental in finance, enabling new developments in FinTech financial stock market predictions and forecasting investment profits. AI has revolutionised cybersecurity mechanisms and become essential to many cyberintelligence technologies, intrusion detection systems, malware analysis tools, etc.

2. Benefits of AI Technology

Investing in AI requires proper planning and understanding of the risks and challenges of applying new technologies and tools. Therefore, entrepreneurs must acquire the necessary skills and build competent teams of experts to support them in maximising their returns and minimising risks. Recent advances in AI and entrepreneurship include planning and financing, analysing markets, and managing business processes and systems. The Internet has played a major role in changing the real estate business landscape. It made it easier to assess the property market, evaluate the demand and supply levels, develop effective sales and marketing strategies, search for properties to let, etc. Developing brains with competent cells for organisations and businesses to operate efficiently and effectively has become possible.





In the real estate industry, whether residential or commercial, the rapid use of AI offers opportunities and benefits to property investors, developers, estate agents, letting agents, tenants, technology service providers and product suppliers. Automated technological processes and components allow us to improve the management of our organisations and business activities and ensure the quality of operations services. For example, we could use sensors and IoT devices that are connected and can communicate with each other to help make informed decisions. It has become possible to utilise sensors in smart buildings or homes to monitor energy consumption, WiFi signal strengths, and tenants' usage behaviour and then collect the data for further analysis and optimisation of a building or home.

Smart technologies can provide businesses with different techniques and tools, such as IT systems, AI, and the web, to deliver their services. Having a data analytics platform and using Building Information Modelling (BIM) data for facility managers will help them carry out their duties and monitor the building's performance in terms of efficiency and effectiveness. This includes utilising and managing the property data, optimising the building's usage, and improving its efficiency and effectiveness over time, making the real estate industry more transparent and customer-friendly. In future, more data-driven decision-making and uncomplicated transactions will become the norm rather than the exception.

Advanced AI models like Generative AI (Gen AI), a subset of Neural Networks (NNs), can process and analyse data to generate new content or data such as natural language or video. This newly generated content is based on the patterns Gen AI recognised and similar to the data they were trained on; hence, the name Generative AI. Gen AI tools like chatbots and chatGPT use high-efficiency algorithms such as machine learning to evaluate product and service prices and reduce maintenance costs. For example, chatbots can initiate communication with potential clients, start the negotiation process to learn about their needs, get basic information about their situation, and filter out unqualified clients/applicants if necessary. Chatbot and ChatGPT use high-efficiency algorithms to assess markets, filter unqualified clients/applicants, evaluate product and service prices, and reduce maintenance costs.



AI models have radically disturbed many industries and sectors. They resolve complex problems, learn from their environment, and offer opportunities for entrepreneurs to innovate and develop intelligent solutions in a competitive market. However, this disruption presents new challenges for entrepreneurs in dealing with AI technologies and finding the right talents to support them in establishing their 'smart' businesses. According to Forbes, AI is expected to grow 37.3% from 2023 to 2030, reflecting the rising impact of AI technologies in optimising business operations. About 25% of businesses adopt AI to address labour shortages and offer compensation for the lack of qualified employees.

Furthermore, 77% of employees are concerned about losing their jobs because of the introduction of AI in 2024, showing a widespread concern among the majority of the workforce. However, AI is projected to introduce about 97 million new job opportunities, countering the job loss concerns. The impact of AI could reach 400 million workers worldwide, affecting around 15% of the global workforce.

3. AI for Business Leaders

AI is a general-purpose tool for supporting business leaders in resolving challenges and stimulating innovation within their firms and industries. It has become critical for small businesses and large corporations to manage their operations and maintain their competitive edge. This will have a positive impact on many sectors and stimulate economic growth, whether it is a service-led or product-centric approach.

Understanding how to integrate AI solutions and stay updated with AI advancement and intelligent technologies is essential. This should help businesses enhance the efficiency of their systems and processes and become more competitive and productive.

It is becoming increasingly vital for business leaders to develop strategies to adopt smart technologies, unlocking the potential of AI tools effectively to improve the quality of their business operations. AI can help them streamline and automate their business activities, saving them valuable time, effort, and resources. Moreover, AI can enhance their sales and marketing strategies to attract potential customers and boost conversion rates. Business leaders have to explore the power of AI to revolutionise their business operations and customer interactions, creating an efficient, responsive experience using effective systems such as AI agents.

Business leaders must know that all these activities imply a change in the business culture, business models, systems and processes, and technology infrastructure. Change is happening within many industries; therefore, business leaders must be ready for those transformations by leveraging the opportunities. This makes AI more challenging for business leaders to

- **Develop robust strategies for AI adoption:** This involves dealing with business challenges and making strategic decisions, assessing AI's strengths and limitations, and making informed decisions.
- **Motivate their colleagues and teams:** To investigate AI solutions and conduct practical experiments to select the right AI tools for specific business problems. Understanding the difference between AI algorithms helps all teams and business leaders communicate effectively, exchange technical information with non-technical colleagues and customers if needed, and be aware of the ethical issues associated with AI.
- **Manage cultural change:** This is to ease the process of integrating AI solution models, promote their benefits and any potential risks, and build trust and credibility among all technical teams and employees. This is always the case when deploying new systems or adopting new measures within an organisation.
- **Allocate the necessary resources:** This will support the development of the required know-how among technical teams and help build the technological infrastructure. Identifying priorities for all groups will ensure proper resource use and achieve optimum results.
- **Be realistic about AI capabilities and limitations:** This avoids being over-optimistic about AI outcomes. Take professional measures to address business problems and apply AI solutions appropriately.
- **Plan for the future:** To stay ahead of the game and remain competitive in an AI-driven global market.



Business managers have to help their leaders implement their strategies for integrating AI technologies into their operations and management activities, as follows:

- Identify AI opportunities for growth and increase productivity
- Identify AI's actual capabilities for improving the quality of current systems and business processes and value creation
- Derive business value from using AI

Companies need to address all these challenges and position themselves to develop long-term strategies and harness the benefits of integrating AI. To achieve the best results, they must manage the risks of incorporating AI technologies into their systems and business processes, such as allocating moderate financial resources for initial experiments and restricting the applications to one or two emerging AI technologies. Understanding how AI technologies are developed and implemented using current infrastructure to offer practical solutions can help business leaders make informed decisions. Developing a proper, clear plan with the technical team to resolve real-life problems within the company using AI and provide value to the business is essential.

AI is imperfect, and business leaders must be aware of its limitations. From basic computing, we learned that garbage in, garbage out; this applies to AI, i.e., incorrect or poor-quality data will produce faulty output. Data is critical for predictive analytics, recognising patterns, identifying anomalies, making decisions, and making valuable, accurate predictions. Access to big data is essential for AI models to function in training, testing, capturing complex relationships, and making proper decisions. To achieve that, AI uses intelligent algorithms and models like machine learning (ML), NNs, and Gen AI to perform tasks efficiently and effectively.



4. Strengths and Limitations of AI

AI is reshaping and disrupting the real estate sector, recently accelerating the adoption of many smart tools and technologies. Digital systems and processes have played a significant role in transforming the industry and enhancing real estate investment and management operations, including but not limited to finance, development, legal, asset management, etc. AI is an emerging trend in the real estate industry that provides a platform for enhancing the facility and property managers', tenants', and investors' experiences, improving the efficiency and effectiveness of the real estate business and market. AI technology offers many cost-effective solutions for investors, ensuring the growth of their investment portfolios, transparency, and staying current with market trends. Repetitive tasks that can be presented numerically can be easily performed by AI. Figure 1 shows the main features offered by AI solutions, as follows:

- **Data Analytics:** ability to analyse big data and learn of that data to perform interesting tasks
- **Effectiveness:** improve the quality of business operations
- **Cost Reduction:** keep business costs and expenses as minimal as possible
- **Efficiency:** ability to reduce the time required to complete business tasks and operational activities

AI is a multitasking technology that can deal with multiple activities simultaneously and effectively. AI helps analyse and process repetitive tasks such as marketing activities, filtering unqualified applicants, autofiling application forms, finding places, etc. Although there are similarities between humans and AI in making decisions, AI cannot solve all our problems simply because humans learn differently from AI. However, breaking a business problem into yes or no responses and using numerical data helps develop and offer many AI solutions to practical business problems. This implies human intervention to translate the context of the problem into a numerical language acceptable to AI.



Figure 1. Artificial Intelligence Features

AI helps provide cost-effective solutions and effective operations, which businesses need to improve the quality of their systems and processes, save money, and grow. AI can support customers by answering their questions and helping managers to become more efficient and effective. Many AI technologies and tools that offer quality solutions have become available and affordable, especially for SMEs and startups. Recently, Generated AI can mimic human creativity and intelligence; Gen AI creative artworks and quality written articles and poems have been close to human being creation. However, AI has already entered the monetary system and cryptocurrency.

Despite their benefits and rapid growth in recent years, the ability of AI to resemble humans produced excellent output and outperformed humans in many areas efficiently and cost-effectively. AI technologies can result in many problems, as follows:

- AI models are as good as the data used for training (garbage in, garbage out)
- Replace hundreds of millions of jobs worldwide.
- Many jobs will become obsolete.
- It could be costly to deploy, especially for the tools capable of simulating human intelligence.
- Future generations might be unable to use their brains effectively because of the adoption of AI in all aspects of their lives.
- It is almost impossible to incorporate vital human emotions and ethics into AI.

5. Structure of the book

This book is divided into six chapters: Introduction (this chapter), Introducing AI to Property Business, Machine Learning, Artificial Neural Networks (ANNs) and Deep Learning, Blockchain, and Generative AI (or Gen AI), as shown in Figure 2.



Figure 2. The book chapters



Chapter two introduces AI and the importance of investing in technology in the property business. The property business has improved significantly since the introduction of the Internet, and bringing many of the property business activities online has helped property investors and professionals manage their customers and investments. This chapter presents real-life examples of applying AI technology to property, such as price predictions and asset management. AI tools offer. An AI-based model for a real estate business comprising six primary services, Data analysis and strategy, finance, legal, property development, property management, and facility management, is introduced in this chapter.

Chapter three covers machine learning (ML), an AI algorithm capable of learning from training data using statistical methods to identify patterns within the data and make predictions. However, many algorithms, such as supervised learning, unsupervised learning, reinforcement learning, and others, are used for ML and applied to different business industries and applications. This chapter introduces some examples of using supervised learning ML for real estate business scenarios, like property price predictions.

Chapter four presents Artificial Neural Networks (ANNs) used in AI to learn from training data and reveal hidden relationships between multiple variables, showing cognitive abilities and quality computational tasks. ANNs are used for many property-related applications, such as analysing property historical data and features (for example, property location, size, amenities, air quality, expected yield, building characteristics, environmental factors or pollution levels, access to transportation) for forecasting property market supply and demand, predicting prices, etc. This helps property landlords, investors, property managers, and professionals better understand the market and make informed decisions. This chapter introduces DNNs, one type of ANN that can be learned through training from large data sets to identify complex patterns and relationships between data features. ANN real-life examples have been introduced, showing multiple property features and how their association can impact the estimation of buy-to-let residential property sale prices.

Chapter five covers Blockchain technology used to support many business activities, offering a decentralised open platform and robust marketplaces such as ledger services and mission-critical agreements. Incorporating AI with blockchain technology can support various property business activities, perform secured and transparent transactions, and collect and connect data in a geographically open environment. This chapter covers the main strengths of blockchain and its applications in the real estate business, including its robustness, transaction security, and ability to ensure the integrity of the document's content. These features of the blockchain can help property businesses and solicitors carry out trustworthy transactions and conveyancing services.

Chapter six discusses Generative AI (Gen AI), which uses machine learning and ANN algorithms to deliver real value to many industries, property businesses, and real-life applications. This chapter covers the main Gen AI models and types, including practical real estate business and development examples. A GPT-based AI-powered property consultant application developed by Anzar Property Group has been introduced, including some examples of using the application and ChatGPT. This should help property developers, landlords, and professionals resolve many business challenges, such as market analysis and assessment, property development and commercial conversion options.



6. Summary

AI algorithms and solution models offer businesses, property developers and investors a platform to improve the quality of their real estate business operations. AI can help property entrepreneurs manage and systemise their SMEs, opening new venues for efficient and effective business activities. Many AI tools are available, impacting worldwide industries and organisations and helping them grow and perform effectively. AI is becoming an essential tool for innovation across many sectors and business applications, transforming many people's lives; however, it has limitations like any other technology. This chapter presented AI and how it is helpful for businesses and society. It covered the strengths and limitations of AI. The structure of this book, including a brief description of each chapter, has been covered in this chapter.



AI for Property Business

Chapter Two: Introducing AI to Property Business



Chapter Two

Introducing AI to Property Business

With its intelligent features, the Internet has improved the real estate business regarding property market assessment, valuation, conveyancing, etc., but it has brought benefits and limitations. The Internet has limitations and cyber security challenges, threats, risks, and vulnerabilities. Bringing real estate businesses online helped interested customers check property prices, locations, and neighbourhoods. Many Internet and AI tools have become available to property businesses to speed up and simplify previously paid services that are often costly. Those tools cooperate to create an ecosystem that offers efficient and effective services to their customers. This chapter introduces the importance of investing in technology in the property business.

Examples of applying AI technology to real estate will be presented, including price estimation using information about its neighbourhood and nearby schools using various AI tools to enhance property business operations. AI tools can help property investors and professionals like estate agents, letting agents assess the property market and improve their customers' experience. The role of real estate businesses, such as asset management and buy-to-let companies, is to develop and use the opportunities AI tools offer. An AI-based model for a real estate business comprising six main services: Data analysis and strategy, Finance, Legal, Property Development, Property management, and Facility management has been introduced.

1. Investing in Technology

Property businesses are often concerned with providing their operations teams with different tools to deliver their services using smart web techniques, social media and IT systems. Automated technological processes and components allow us to improve our business activities and the quality of operations services. To achieve that, we are exploring different options to implement smart tools throughout all aspects of business. AI technology and online services are used to resolve some of the complex problems and challenges which are impacting businesses, as follows:

- Keep businesses operating effectively and capable of productively delivering their services to their customers.
- Monitor operations and more measurability of results and completed tasks.
- Ensure agility and accountability to minimise errors
- Speed up activities and workflow and improve service support
- Minimise wastage in effort and time and avoid the use of ad hoc measures
- Develop a dynamic and efficient business that is capable of resolving its problems and challenges and able to change
- Better satisfaction of business members and employees
- Reduce rental voids and blocks to the income flow
- Minimise the risks of human errors and make informed decisions





AI for Property Business

A successful property business is a profitable systemised enterprise using robust automated processes and tools. Digital marketing helps us understand how to use AI tools and social media to market properties and attract good tenants. After completing the refurbishment works for any property, it is often advertised on the rental market using various online platforms to find suitable tenants. Property accounting is vital, so we had to invest time and money to educate people and ensure that we did things right with the support of our accountants. Technology tools can support the business, such as Xero for accountancy and filing tax, Arthur to manage all properties and receive and record all tenants' enquiries, Google Cloud and drives are used to store all the business data and file management, Signable to sign tenancy agreements, etc remotely.

Figure 2.1 shows the main tools used by our family property company Anzar Property Investors Limited to support all four business activities: Operations and marketing, Finance and accounting, Investment and development, and IT management.



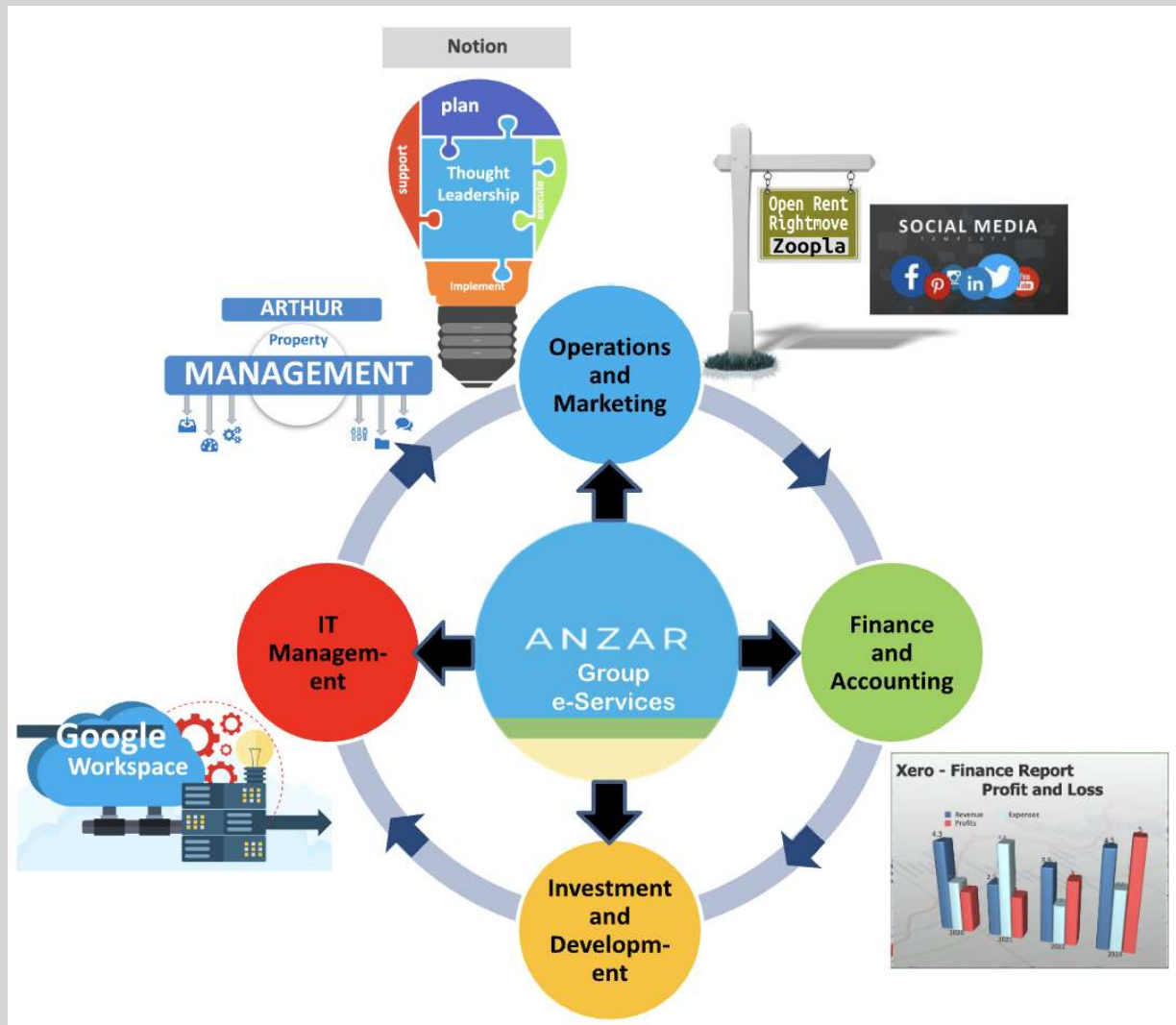


Figure 2.1. Main tools used by Anzar Property Investors Limited



The Internet has made it easy for potential tenants to view properties remotely, complete their applications, communicate with estate agents, and arrange online payments. The amount of work required by applicants and estate agents, as well as letting agents or asset management teams, has become more manageable. Web-based technologies like Google Maps have provided significant support to customers; they can easily get a full path to property locations and view property streets without travelling long distances to visit properties. Google Maps offers various features and customisation options, helping customers navigate paths and directions to reach their final destinations. In our family property business, for example, Xero accounting software operates with the Arthur Property Management tool, which can be linked to Signable, offering an online signature system, Fixflow for repairs reporting, and many other systems and processes. All those systems help reduce intensive labour tasks and work overhead and provide cost-effective solutions.

2. Applying AI to Property Business

AI uses intelligent algorithms which can help you estimate the value of your property and provide information about the potential selling price for your property, taking into account similar locally sold properties, the quality of your property and its neighbourhood, including local schools, crime rates, etc. AI can use big data and various resources to provide optimal figures quickly. As a property business, we use many AI techniques and smart tools to improve the efficiency and effectiveness of the business operations and enhance its performance, helping us to:

- find good deals online,
- get a virtual tour of the property for sale
- apply for a mortgage online
- advertise our properties for rent,
- find good tenants,
- allow tenants to report repairs,
- manage the property portfolio and current tenants, etc.

Many of these features and services were not possible ten years ago and were time-consuming and intensive. Today, you can look for a property and view it virtually; if you like it, you can offer your price, apply for a mortgage on the same website, and start purchasing the property on the same day. With such online services, advertising and selling a property has become much easier and faster. They simplify and expedite the communication between buyers and sellers, thus saving time for all parties involved.

AI uses simulation to design buildings, plan construction stages and estimate costs for a complete project life-cycle. Smart buildings are planned using smart 3D designs and developed with IoT technologies and sensors to monitor all activities and appliances in the developed properties. Many smart products have been offered to the real estate market. They are designed to obtain valuable data from the buildings and support property developers in managing their projects, facility managers, and property managers in managing their assets.



The real estate industry might have ignored many smart innovations and digital inventions and not adapted quickly to digitalisation and artificial intelligence. However, those emerging technologies create additional value for the buildings, property investment and finance sector, the development systems and processes, and the real estate ecosystem. Property developers and investors have to embrace AI smart technologies, make use of them as they gain a significant market share, and create value.



Property asset managers can be supported with various AI tools, such as online monitoring of property performance, making them aware of any issues, mitigating risk, and making informed decisions. Predictive Analytics can analyse the behaviour of the real estate market in terms of demand and supply, the occupancy rate, forecast financial and lending costs, rental income, etc. Big data and AI tools can be used to determine the best investment strategy, evaluate property location, and predict maintenance expenditures. AI auto search techniques provide information about the most suitable mortgage products and borrowing options offered by banks.

This speeds up the loan application process, eliminates intermediaries and unnecessary procedures, and minimises lending costs. Blockchain technology transforms real estate operations, offering a transparent and secure platform for managing and processing transactions. Blockchain is a decentralised network capable of immediately impacting the real estate industry, providing identity verification, authorisation and authentication services using personal digital keys. This technology can provide smart contracts, record secured transactions, transfer property titles, and reduce the risk of fraud.

AI tools like robots and 3D printing replace many traditional construction activities and building methods. This will change the property development process and how architecture and construction businesses operate in the future. Property developers must be aware of the changes happening in this sector and AI's role in the property development process, be prepared to adapt to available technologies and avoid unpleasant surprises. We are exploring different options to implement innovative tools throughout different aspects of business areas and applications. AI technology and online services resolve some complex problems and challenges impacting businesses:

- Keep businesses operating effectively and productively, delivering their services to their customers.
- Monitor operations and more measurability of results and completed tasks.
- Ensure agility and accountability to minimise errors
- Speed up activities and workflow and improve service support
- Minimise wastage in effort and time and avoid the use of ad hoc measures
- Develop a dynamic and efficient business that is capable of resolving its problems and challenges and able to change



AI for Property Business

- Better satisfaction of business members and employees
- Reduce rental voids and blocks to the income flow
- Minimise the risks of human errors and make informed decisions

A successful property business is a profitable systemised enterprise using robust automated processes and tools. Digital marketing helps us understand how to use AI tools and social media to market properties and attract good tenants. After completing the refurbishment works for any property, it is often advertised on the rental market using various online platforms to find suitable tenants. Property accounting is vital, so we had to invest time and money to educate people and ensure that we did things right with the support of our accountants.

Technology tools can support the business, such as Xero for accountancy and filing tax, Arthur to manage all properties and receive and record all tenants' enquiries, Google Cloud and drives are used to store all the business data and file management, Signable to sign tenancy agreements, etc remotely.





People tend to keep information about their financial situation private, including income and expenditure. However, the technology allowed many corporations to share such information and make it available and accessible through credit agencies like Experian, Equifax, and TransUnion in the UK. Credit reports contain information about our financial status, including debts such as mortgages, personal loans, credit cards, bank accounts, etc. Property businesses, estate agents, and letting agents need such information to assess their clients' financial status. The credit report provides a credit score and detailed information about our financial position, which financial institutions are currently reporting, and how our borrowing picture has changed recently. AI can extract such information faster, making it easier for property companies to conduct background checks, access their clients' financial information and credit history, and make informed decisions.

Investing in AI requires proper planning and understanding of the risks and challenges of applying new technologies and tools. Therefore, entrepreneurs must acquire the necessary skills and build competent teams of experts to support them in maximising their returns and minimising risks. Recent advances in AI and entrepreneurship include planning and financing, analysing markets, and managing business systems and processes. This book covers various AI-related topics and techniques that can be used to support businesses in general and real estate investment and management companies in particular, as follows:

- Apply AI tools and applications like chatbots and chatGPT in marketing, finance, real estate investing, asset management, etc.
- The role of AI in service sectors
- AI supported Entrepreneurial operations and characteristics of innovative entrepreneurs
- Risks and challenges facing entrepreneurs looking forward to applying AI to their SME operations
- AI techniques and systems property entrepreneurs should be familiar with
- Managing property business processes and systems using AI tools
- Predictive Analytics and Big data tools for AI-supported property businesses



3. AI-based Real Estate Business Model

Business processes, resources, and staff skills and abilities play a significant role in delivering quality service and achieving business goals. Real estate enterprises follow procedures to keep them running, generating revenues, and staying in business. However, they must develop strategic plans for their challenging operations and processes to deal with ongoing changes in the business landscape, economic issues, and technology. Property enterprises must ensure that critical processes and tenants are appropriately managed to ensure effectiveness and a positive impact on productivity. They need to explore many online services and implement different automated and cost-effective solutions to achieve that.

In the real estate business, entrepreneurial operations should meet the enterprise's objectives. This includes the business systems and processes designed to keep the business running and support the delivery of its services. The business management team must understand the business landscape and daily operations to deal effectively with ongoing changes. To achieve this, business leaders must develop strategic plans to optimise their systems and critical processes and ensure business continuity during challenging times. They have to develop creative ways and intelligent solutions to improve the quality of their service and operations, which are vital for the business. This will positively impact the enterprise regarding productivity, customer satisfaction, growth, and profitability.

AI has radically disturbed many industries and sectors, and the real estate sector is not an exception, offering opportunities to and allowing property business entrepreneurs and start-ups to innovate and develop smart solutions in a competitive market. However, this disruption presents new challenges for entrepreneurs in dealing with AI technologies and establishing their 'smart' businesses. AI tools such as machine learning can assess the property market, evaluate prices, and improve the customer experience. With the introduction of such tools, the role of real estate businesses such as asset management, buy-to-let companies, and letting agents or estate agents will develop and change. Figure 2.2 shows an AI-based model for a real estate business comprising six main services, as follows:

- **Data Analysis and Strategy:** Analysing the current property and letting markets, properties located at different geographical locations, and the demand and supply levels is essential in the real estate business. Applying AI mechanisms and its learning models can help perform market analysis and predict future changes to market behaviour.
- **Finance:** Offer digital mortgage brokering, providing access to capital and proposing different types of loans. Moreover, auto search tools for the best suitable mortgage products offer a comparison platform and options for borrowing beyond banks. This provides an efficient, transparent mortgage/loan application process that speeds up lending. Furthermore, it helps find and close the best deals faster, eliminating intermediaries and reducing costs.
- **Legal:** Blockchain technology is a platform capable of processing smart contracts and managing and signing property-related legal documents. Using the blockchain and smart contracts can improve the contract management process, speed up a transaction process, ensure transparency and avoid extra costs. The blockchain can transfer and record transactions and real estate titles and makes background checks on all entities involved. It is a decentralised system capable of verifying identities using the personal digital key to authenticate and authorise a smart contract or transaction. The blockchain conducts background checks for all participants to access the smart contract process and perform secured transactions, reducing the risk of tampering with contract documents, identity theft or fraud.



Figure 2.2. AI-based Real Estate Model

- **Property Development:** Digitally manage the development planning stage and develop the project life-cycle using smart tools such as Building Information Modelling (BIM). BIM can simulate the planning and development process and visualise all the milestones of construction projects. Smart simulation tools could be used to design buildings, estimate costs, and analyse them before construction. Moreover, smart buildings can be developed using smart 3D designs and printing services supported by data sensors and IoT devices at different construction site locations. This technology can ensure site safety and track people's movements.
- **Asset Management:** In real estate investment, asset management is about ensuring the growth and success of the investment through the property's income generation and capital appreciation. AI tools can be used to monitor the property's performance, stay current with market trends, make critical decisions, and mitigate risk on behalf of the investors, as shown in Figure 2.3. This includes two main activities.
 - **Property Management:** Online marketplaces are used to find potential tenants; chatbots filter unqualified applicants, assess those qualified ones, and select successful applicants. This helps property managers properly manage their property's occupancy using cost-effective solutions and supports potential tenants in overcoming geographical barriers. Autofilling applications for tenancy agreements using standard templates, extracting their content, and digitally signing contracts. The landlord does not have to be close to their property geographically. The tenancy agreement lifecycle is automated via the blockchain. Smart contracts are digitally written and signed by the property manager and the tenant. The contract can be signed securely by both parties and recorded online.
 - **Facility Management:** The facility manager can use smart tools and applications to monitor and optimise efficiency, control costs, regulate property usage, and report to the property owner in real time. This helps to optimise regular checks and routine maintenance, anticipate repairs, and respond to problems and breakdowns in the property. Furthermore, it reduces the workload of the facility manager. It ensures transparency and better communication to carry out management duties and minimise costs. AI enables buildings to become smart using sensors and IoT devices, collect data from various essential locations and facilities, and allow them to communicate and share data. This helps detect issues in property facilities and apparatus as early as possible, avoiding complete damage to facilities, unnecessary repairs, and additional costs. IoT devices and sensors can help facility managers optimise property facilities.



Figure 2.3. Asset managers access property reports remotely.

With the support of high-efficiency algorithms, there will also be a significant reduction in management time and maintenance costs. For example, certain AI technologies can significantly enhance property businesses, reduce the processing time of tenancy agreements and select the best tenants.

4. Summary

Many AI tools have become available to property businesses to create an ecosystem that offers efficient and effective services and simplifies different previously paid services. Applying AI technology to real estate can help investors and property professionals estimate prices using information from various online sources. AI tools offer smart solutions to enhance property business operations, assess the property market, and improve customer experience. This chapter introduced the importance of investing in technology in the property business. An AI-based model for a real estate business comprising six property-related services: Data analysis and strategy, Finance, Legal, Property Development, Property management, and Facility management has been presented.





AI for Property Business

Chapter Three: Machine Learning



Chapter Three

Machine Learning

Machine learning (ML) is an AI algorithm using statistical techniques to learn from training data to identify patterns and make accurate predictions and decisions. ML is used in many business sectors like real estate, education, and healthcare, offering innovative solutions to various industries' challenges. There are different ML algorithms with unique features and abilities, like supervised learning, unsupervised learning, semi-supervised learning, self-supervised learning, and reinforcement learning. ML requires transforming contextual data to numerical data format to perform its data analytics and predictions using specific thresholds to classify and make decisions. For example, in the property business, if you use data from a particular area or city as an input to an ML algorithm, the output results will only be valid for that area or city. This chapter focuses on supervised learning, showing real-life examples of property-related business scenarios such as property price predictions.

1. Introduction to Machine Learning

Machine learning (ML) is an area of AI concerned with learning from data patterns and analysis without predefined explicit instructions to carry out specific tasks using statistical algorithms. ML algorithms use statistical models to learn from data through training to discover patterns and relationships and make decisions or accurate predictions. The more data ML algorithms are exposed to, the more efficient and effective their results are. ML supports many industries, such as cybersecurity, healthcare and medicine, sales and marketing, manufacturing, speech recognition, and natural language processing, offering cost-effective solutions to various challenging problems. However, specific limitations and complications are associated with the training process when using biased data often gathered by human beings. Therefore, we have different ML algorithms with unique abilities that can be used for various applications. Figure 3.1 shows the main categories of ML algorithms, each with its strengths and limitations, as follows:

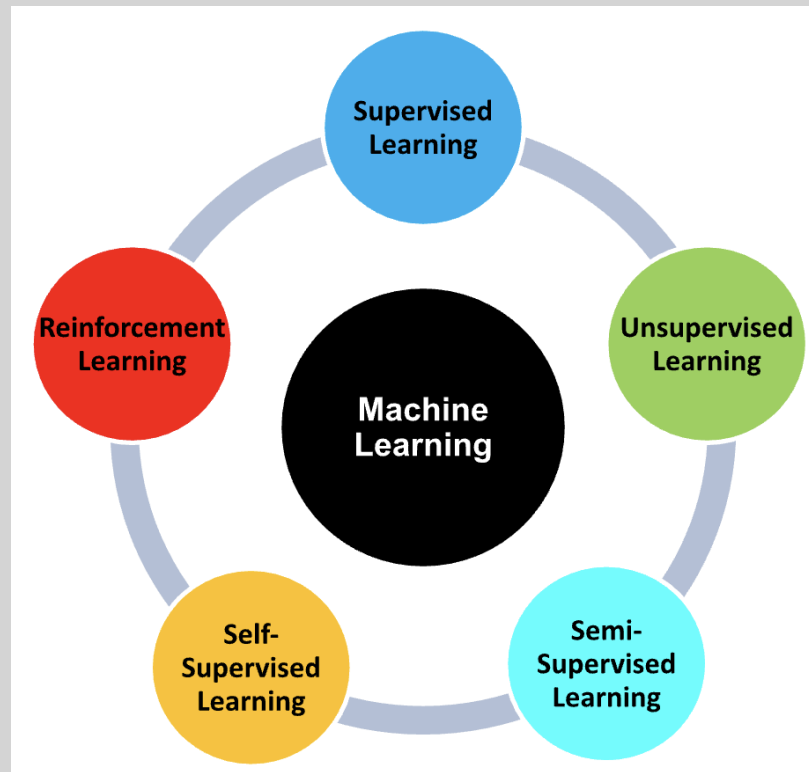


Figure 3.1. Main Categories of Machine Learning

- **Supervised learning:** This learning model uses labelled training data to discover relationships among data variables. Unseen data is used to make decisions or predictions. It is appropriate for applications where the target variable is known. Generally, it is divided into two types: classification and regression.
 - **Classification:** This supervised learning model uses a wide range of algorithms trained to predict the given data grouping and categories. Classification algorithms are evaluated using testing data to perform predictions, such as market or price predictions.
 - **Regression:** This statistical method of supervised learning can predict a numerical value based on the relationship between a dependent variable and a series of independent variables. Linear regression is the most commonly used method of this supervised learning, which develops an association between variables in the form of a linear relationship between two variables observed in the data using a straight line of best fit. The line shows how a change in one variable impacts a difference in the other.



- **Unsupervised Learning:** This algorithm uses unlabelled data to discover patterns with unspecific targets. It is about finding patterns in big data without guidance in learning.
- **Semi-supervised:** A partly supervised learning algorithm that combines supervised and unsupervised learning features to deal with data. It uses unlabeled and labelled datasets to support the learning process of an ML model to perform predictions and classifications.
- **Self-supervised Learning:** The algorithm model trains itself on unlabelled data, not big labelled data, but automatically produces labels to make predictions for applications such as natural language processing.
- **Reinforcement Learning:** An algorithm appropriate for applications where the environment's status allows the model to learn through trial and error to make optimal decisions. The model's agent learns from its own experiences based on a feedback system using a rewards and penalties approach for the agent's actions regarding reaching a predetermined target. Agents are encouraged to take good actions, follow good practices and accumulate rewards.

2. Machine Learning for Property Business

Depending on numerical data input rather than a context for predictive analytics and learning, ML requires transforming contextual data to numerical data format using specific thresholds for ML to operate and make decisions. The larger the data size, the better it is for the ML algorithm to function correctly. In the property business, for example, if you use data from a small neighbourhood as an input to an ML algorithm, the output results will only be valid for that neighbourhood. Developing an ML solution for such a small neighbourhood is not worthwhile because humans can analyse small amounts of data for such a neighbourhood within a limited area and population. They are, moreover, making it challenging to develop an effective ML algorithm due to restricted property sales activities and transactions.

Two factors play a role in the valuation of a property: firstly, the cost of the building and then the cost of the neighbourhood or surrounding environment. An expensive property in a costly area will have the wealthiest environment and likely be more expensive. Similarly, a poor, horrible property that looks cheap but is located in an expensive place with a very low crime rate, next to high-end restaurants, quality schools and a lovely park within a wealthy neighbourhood, will be valued at a higher price. Such an expensive environment will give the property extra features and selling points.



If you are investing in a family-friendly neighbourhood with a good lifestyle, consider the quality of schools in the area. Schools' quality tends to be an essential factor for families with children when they plan to move and search for a property to rent. The schools' success rate as numerical data reflects their quality, which can be used as one of the inputs for an ML algorithm to help families and investors make informed decisions. Therefore, the quality of contextual schools can be quantified and used by ML to provide helpful information to property investors, estate agents, and letting agents. To look at the average success rate of schools in each neighbourhood in a city, we have to collect this data over many years for each school, which is then compiled into a machine learning algorithm.

It is possible to keep track of all those environmental factors, including the quality of schools, crime rate, parks, etc., using an ML algorithm helping buyers and sellers to make informed decisions about whether or not to move forward with the property sale, an investor to buy or potential family tenants to rent. In the case of multiple schools, the ML algorithm should be able to calculate the average score; the same applies to crime statistics. ML can learn and understand your needs and help you select the right property at the right price and location. It can look at all the necessary factors and collected data and automatically analyse it, providing you with the right choice of property to buy or rent.

Machine learning tools will not replace humans entirely because of their limitations in understanding the full context and situations. For example, suppose a person is interested in letting one of your properties and only recently managed to clear their debts and increase their credit score but has had a bad credit history for many years. In that case, this will skew the results obtained from a machine learning algorithm, and you will miss such an opportunity. Human intervention with extra caution and analysis could have helped avoid such a mistake. Only those special AI techniques can interact with specific domains that can make sense of their environment.

Machine learning is helpful in many areas, mainly replacing repetitive tasks, but only some of the work and scenarios we all experience in real life. There are areas where we can rely entirely on machine learning, but there are other areas where we will continue to need human support because of their ability to understand context.

3. Supervised Learning for Property Price Prediction

A supervised learning algorithm can predict property prices using training labelled data with multiple input variables, such as property size, number of bedrooms, location, and tenure. The algorithm would be trained to learn the relationship between the input variables and the output target variable and, based on the training data, predict the price of an unseen property data. However, a large amount of labelled data is required to train the learning model effectively. Regression is a supervised learning method based on parametric algorithms that offer exciting insights into data structures and help us predict asset values.

Linear regression is the fundamental model that forms the principles of machine learning. It is a benchmark yet powerful method for developing supervised learning models. The two main types of linear regression models are:

- Simple linear regression
- Multiple linear regression

Simple linear regression is an algorithm model used to predict the value of a dependent variable based on an input independent variable. For example, it can help us analyse and understand the relationships between property price (dependent variable) and property size in sqm (independent variable), as shown in Figure 3.2 and Table 3.1, representing a sample data list of property sales in the Manchester M3 area.

Furthermore, using the regression line, the algorithm could predict a property's price based on its floor area. In other words, this method uses property size only to predict property prices.

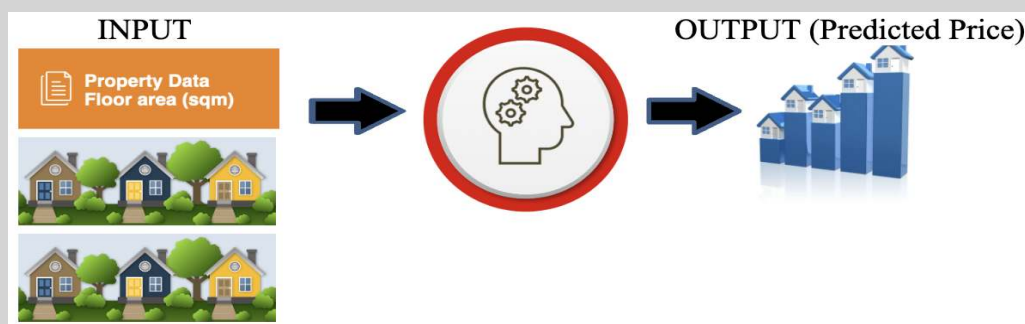


Figure 3.2. Simple Linear Regression



3.1. Scenario One: Property Price Prediction

In simple linear regression, we can use one independent variable to predict the dependent variable (target) to the observed data using the following model function. This formula helps find the best-fitting line using the optimal values of A and B. Notice that some predicted values are far from the actual dependent variable, the paid property price. However, overall, the model function keeps the difference between the predicted and actual values of the target variable as minimal as possible, as shown in Figure 3.3. Using one of the statistical analysis software can help quickly analyse the data and develop the regression model.

For example, the Analysis Toolpak in MS Excel spreadsheets can perform linear regression, create a predictive mode, and produce the intercept A and regression coefficient B values.

$$Y = A + B * X$$

$$\text{Prediction Model} = 15474.09105 + (3039.447999 * \text{Floor area})$$

Y is the dependent variable, the predicted value for any given value of the independent variable *X*.

A is the *y*-intercept representing the expected value of *Y*, i.e., the property price when the property size in sqm, *X*, equals zero.

B is the regression coefficient, which is the slope representing how much *Y* is expected to change in the property price as *X* increases.

X is the independent variable, the property floor area, which is expected to influence *Y*.

Table 3.1. Property floor area per sqm and price. Source: Source:
https://housemetric.co.uk/results?str_input=M3+3&order=1&imperial=F&page=1

Floor area	Price paid	Predicted price
55 sqm	£187,500	182643.731
56 sqm	£213,500	185683.179
57 sqm	£185,000	188722.627
59 sqm	£210,000	194801.523
60 sqm	£205,000	197840.971
61 sqm	£220,000	200880.419
61 sqm	£140,000	200880.419
61 sqm	£140,000	200880.419
64 sqm	£210,000	209998.763
68 sqm	£220,000	222156.555
69 sqm	£250,000	225196.003
75 sqm	£280,000	243432.691
77 sqm	£235,000	249511.587
77 sqm	£300,000	249511.587
78 sqm	£205,000	252551.035
81 sqm	£255,500	261669.379
85 sqm	£260,000	273827.171
85 sqm	£290,000	273827.171
85 sqm	£310,000	273827.171
87 sqm	£280,000	279906.067
92 sqm	£330,000	295103.307
97 sqm	£270,000	310300.547
110 sqm	£249,000	349813.371
118 sqm	£470,000	374128.955
154 sqm	£470,000	483549.083

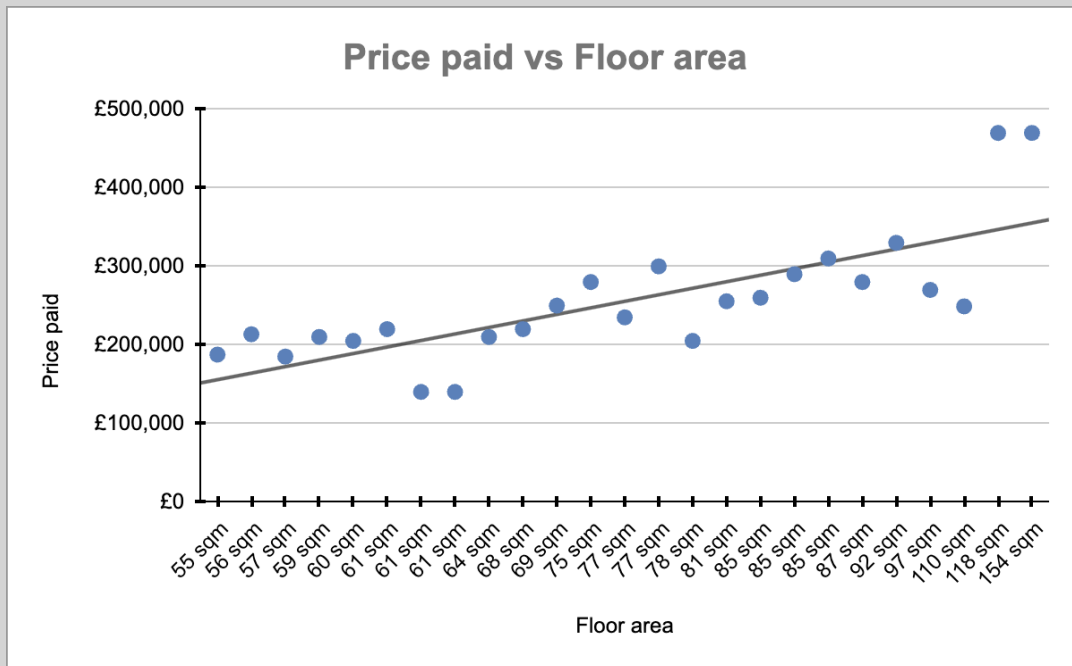


Figure 3.3. Regression analysis



3.2. Scenario Two: Property Price Prediction Using Multiple Independent Variables

The floor area is not the only factor influencing the property price; others can be used to develop a better learning model. In multiple linear regression, we can use more than one independent variable (features) to predict the property price (dependent variable or target) by adding the price per square meter and the number of bedrooms as two extra independent variables, as shown in Figure 3.4.

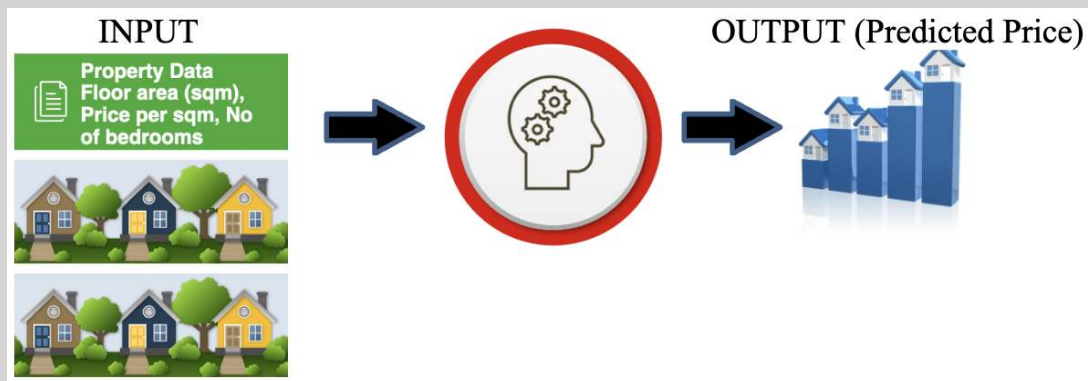


Figure 3.4. Multiple Linear Regression

Multiple linear regression is valuable for using labelled training datasets to perform predictions and decision-making. In multiple linear regression, we use multiple independent variables to predict the dependent variable (target) to the observed data using the following model function. This formula helps find the optimal A , B_1 , B_2 , and B_3 values based on the combination of independent factors. The Analysis Toolpak in MS Excel spreadsheets can perform multiple linear regression, develop a predictive mode, and produce the intercept A and regression coefficients B_1 , B_2 , and B_3 values.

$$Y = B_1 * X_1 + B_2 * X_2 + B_3 * X_3 + \dots + B_n * X_n + A$$

$$\text{Prediction Model} = (5059.156 * \text{Floor area}) + (119.057 * \text{Precise per sqm}) + (-44087.522 * \text{Number of rooms}) + (-397160.07 (\text{intercept}))$$

Y is the dependent variable, the predicted value for any given value of the independent variables X_1 , X_2 , and X_3 .

A is the y-intercept representing the expected value of Y , i.e., the property price when all X s equal zero.

B_1 , B_2 , and B_3 are the regression coefficients associated with each independent variable. They represent how much y is expected to change in the property price as X_1 , X_2 , and X_3 increase.

X_1 , X_2 , and X_3 are the independent variables, the property floor area, the price per sqm, and the number of rooms expected to influence Y .

The model finds the optimal values of the regression coefficients, keeping the predicted values not very different from the actual dependent variable, the property price paid, as shown in Table 3.2. The results show that the multiple regression is more accurate than the simple linear regression. The extra independent variables added have helped the prediction model produce better results. Overall, the model function keeps the difference between the predicted and actual values of the target variable as minimal as possible.



Table 3.2. Property has multiple independent variables and a dependent variable, 'Price paid'.

Data source: https://housemetric.co.uk/results?str_input=M3+3&order=1&imperial=F&page=1

Floor area (sqm)	£ per sqm	No of rooms	Price paid	Predicted price
55	£3,409	2	£187,500	£198,784
56	£3,812	2	£213,500	£251,823
57	£3,245	2	£185,000	£189,377
59	£3,559	2	£210,000	£236,879
60	£3,416	3	£205,000	£180,825
61	£3,606	3	£220,000	£208,505
61	£2,295	3	£140,000	£52,422
61	£2,295	3	£140,000	£52,422
64	£3,281	3	£210,000	£184,989
68	£3,235	3	£220,000	£199,749
69	£3,623	3	£250,000	£251,003
75	£3,733	3	£280,000	£294,454
77	£3,051	3	£235,000	£223,375
77	£3,896	3	£300,000	£323,978
78	£2,628	3	£205,000	£178,073
81	£3,154	3	£255,500	£255,875
85	£3,058	3	£260,000	£264,682
85	£3,411	3	£290,000	£306,709
85	£3,647	3	£310,000	£334,807
87	£3,218	3	£280,000	£293,849
92	£3,586	3	£330,000	£362,958
97	£2,783	3	£270,000	£292,651
110	£2,263	4	£249,000	£252,423
118	£3,983	4	£470,000	£497,674
154	£3,051	4	£470,000	£568,843
186	£5,107	4	£950,000	£975,517
187	£5,080	4	£950,000	£977,362
241	£6,224	4	£1,500,000	£1,386,757

This model helps find the hyperplane that keeps the difference between predicted and actual values of the target variable as minimal as possible. Using straightforward real-life property-related scenarios, and regardless of your knowledge of mathematics, you should be able to follow the logic behind regression. The goal is to help you understand how supervised learning works without getting into the details of complex machine-learning mathematics. Therefore, you will be equipped with the right skills and knowledge to determine the internal mathematical operations and the role of linear models in machine learning algorithms.

4. Logistic Regression

Logistic regression is a powerful statistical technique and supervised machine learning for classification, predicting a binary outcome and estimating its probability given one or more independent variables. It's an efficient analytic method for a classification problem using the sigmoid function to decide on one of two classes: yes/no, true/false, etc., as shown in Figure 3.5. The model parameters of logistic regression represent the weights for the data features. The learning algorithm and the gradient descent method tune the weights to classify the training data. The updated weights can be applied to unseen data to correctly estimate the probability of a particular class and achieve an excellent performance.



Figure 3.5 Logistic function (Sigmoid function)

Logistic regression uses the following logistic sigmoid function to model a binary outcome's probability, producing an output range between 0 and 1. The Sigmoid function is an activation function for perceptrons in the neural network, adding non-linearity in a learning model. Figure 3.6 shows the logistic function (or sigmoid function) with x input values ranging from -15 to 15, which have been transformed into probabilities between 0 and 1 (y -axis). This is how the logistic sigmoid function is mathematically defined:



$$f(x) = \frac{1}{1 + e^{-x}}$$

Where e is the base of the natural logarithm, also known as Euler's number, it is a constant equal to 2.71828, known as the base of the exponential function transforming x into a probability range between 0 and 1 of a given observation belonging to a specific class.

$$x = \theta_0 + \theta_1 * \text{data input}$$

x is the input that can take any real value to the sigmoid function, i.e. the score calculated using the data input and the coefficients, as follows:

θ_0 and θ_1

both terms represent the weights of the model that are learned during the training process.

θ_0

represents the intercept (or bias) term, the model's prediction, when all the input features are zero.

θ_1

represents the coefficient associated with the features of the input data. If it is positive, it means the higher the value of x and the data input. However, if it is negative, it means that x is lower and the data input. Figure 3.6 shows the results of training the logistic model output, with x input values ranging from -15 to 15 (x -axis) and the corresponding probabilities between 0 and 1 (y -axis).

When the value of x increases to positive infinity, then e to the power of $-x$ shrinks rapidly, approaching zero, and the predicted value of $f(x)$ will become 1. However, when the value of x decreases to negative infinity then e to the power of $-x$ grows rapidly, approaching infinity, and the predicted value of $f(x)$ becomes 0. When $x = 0$, $f(x)$ will be $\frac{1}{2}$.

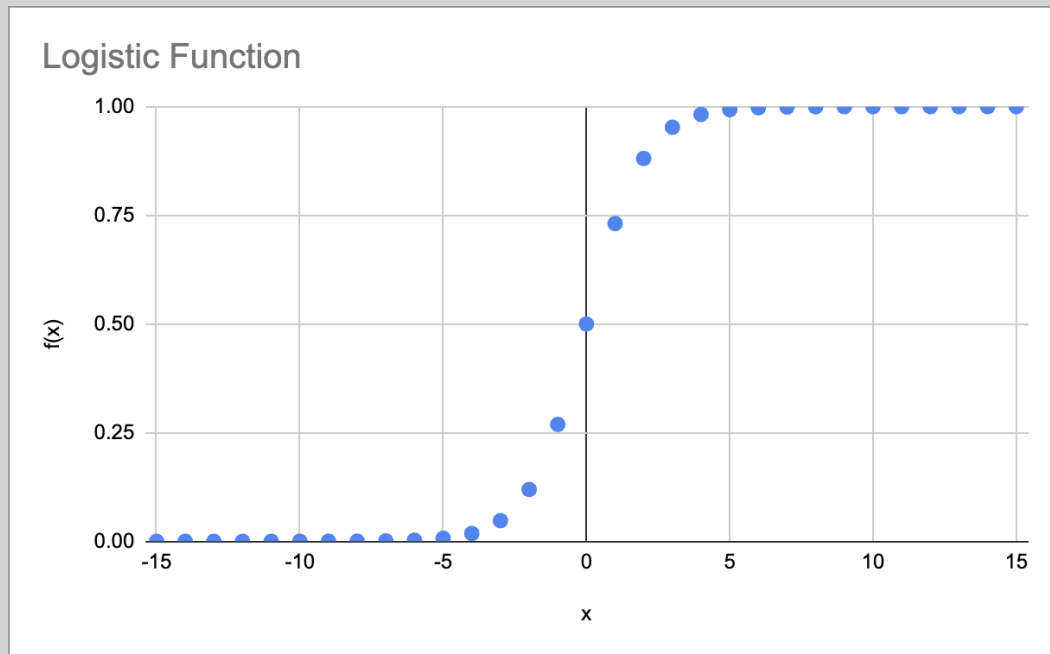


Figure 3.6. Logistic function for x input values -15 to 15

When the outcome of the sigmoid function is more than 0.5, you would classify that label as class 1 or positive class or true/yes, and when it is less than 0.5, you would classify it as a negative class or class 0 or false/no. The function determines which value to pass as output.

4.1. Scenario Three: Predicting Investment Decision

Suppose we want to know if a property investor will invest in a buy-to-let property or not for a price limit of £210,000 in Manchester, UK. Logistic regression can provide us with an answer by analysing data from previous investors with the same condition and budget limit. The learning model analyses the relationship between the property price and the likelihood of investing in a buy-to-let property. We want to predict if an investor will purchase buy-to-let property or not to buy based on property price. Logistic regression estimates the likelihood of the outcome using the sigmoid function, which transforms any input into a probabilistic value between 0 and 1. The sigmoid function models the weight assigned to the input. It calculates a score based on the input, which is then entered into the sigmoid function to output the probability of investment.

Logistic regression is different from linear regression. It uses a nonlinear function known as the sigmoid function, which outputs a probability value between 0 and 1. This value indicates the likelihood of an observation belonging to a specific class and decides whether the investor will buy, as shown in Figure 3.7.

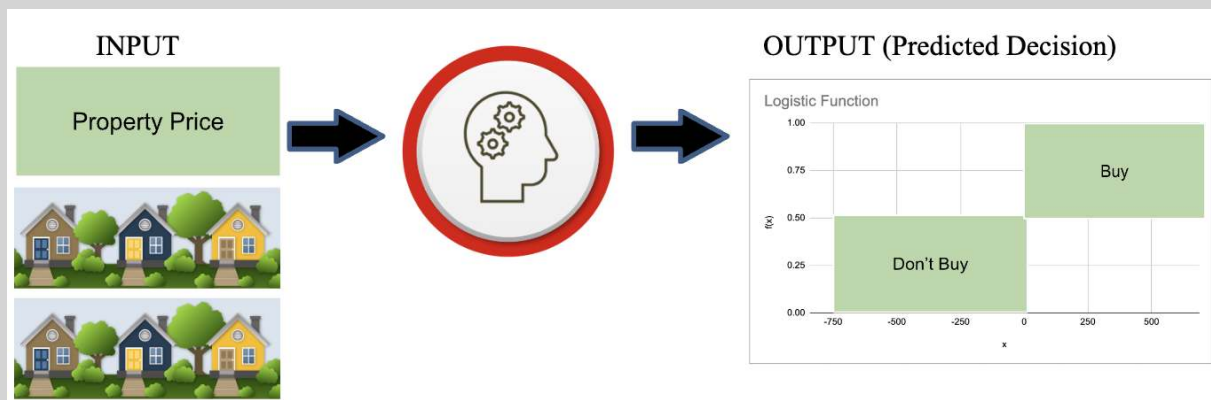


Figure 3.7. Logistic regression for investment decision

To calculate the probability of investment, we have to use the following logistic sigmoid function.

$$f(x) = \frac{1}{1 + e^{-x}}$$

x is the input that can take any real value to the sigmoid function, i.e. the score calculated using the input, i.e. property prices and the coefficients, as follows:

$$x = \theta_0 + \theta_1 * \text{Property Price}$$

If θ_1 is positive, it means the value of x is higher. In this case, investing in a high-priced buy-to-let is highly likely. However, if θ_1 is negative, it means that x is lower, which means the likelihood of investing in a low-price buy-to-let is highly likely. The results of training the model from data contain property sold prices and investment decisions yes (1) or no (0), including the values of both terms, the intercept and the price coefficient.





Training the model using historical data for property prices in Manchester determines the values of both coefficients. We can use a logistic regression tool or Google Sheets with the coefficients and input data to train the model in predicting the probability of an investor purchasing a buy-to-let property. This method uses gradient descent to iteratively adjust the coefficients' values to minimise the difference between the model's predicted values and the actual outcomes. The output should show the predictions for purchasing the investment property.

5. Summary

ML is one of the AI algorithms capable of learning exciting patterns in data sets, which makes ML helpful in making predictions and decisions. Multiple algorithms are categorised as machine learning models, such as supervised, unsupervised, semi-supervised, self-supervised, and reinforcement learning, and each has its own features and limitations. It is essential to transform contextual to numerical data format to enable ML models to function and carry out learning, predictive analytics and classification. An extensive training dataset helps ML models perform their learning tasks and operate effectively, especially in the property business. Developing an effective ML solution for a small neighbourhood is insufficient because it limits the learning abilities of ML models due to limited property sales activities. This chapter focused on supervised learning, presenting real-life scenarios of property business activities and ML models learning property price predictions.



AI for Property Business

Chapter Four: Artificial Neural Networks (ANNs) and Deep Learning



Chapter Four

Artificial Neural Networks (ANNs) and Deep Learning

ANN is an AI technique that is capable of learning, allowing the revealing of hidden relationships between multiple variables. It shows cognitive abilities with an acceptable level of performance in carrying out computational tasks for learning and forecasting. ANNs have been applied to property businesses to estimate property prices using a learning algorithm for input and output relationship modelling. Training data supports the ANNs' learning process, and testing data is used to develop a predictive modelling solution. Furthermore, different experimental works and research have been conducted to analyse the relationships between various real estate features and prices. In the property business, many key attributes, such as property location, size, amenities, air quality, expected yield, etc., play a role in determining the market value of a property, making the process of developing an ANN model.

Attributes like building characteristics, environmental factors or pollution levels, access to transportation, landscape, etc., and their impact on the property market can also be considered when developing ANN models. Such a modelling process helps analyse and simulate the relationships between those attributes and property prices, which supports various real estate business stakeholders in making informed decisions. ANN real-life examples have been presented, showing multiple property features and how their association can impact the estimation of buy-to-let residential property sale prices. A deep neural network (DNN) is one type of ANN with multiple layers, some of which are hidden for processing input data from the input layer. This chapter introduces DNNs, which can be learned through training from large data sets to identify complex patterns and learn relationships between data features.

1. Introducing neural networks

Neural networks (NNs) operate like human brains, using perceptrons to perform calculations, keep errors as minimal as possible and make informed decisions. A perceptron represents a fundamental building block of a complex NN inspired by the human brain neuron, which processes electrical signals. Moreover, a perceptron represents a basic model of an advanced deep learning system. As a computational model, a perceptron is a mathematical unit for processing numerical values received as inputs from other perceptrons or sources, as shown in Figure 4.1. A perceptron can process and analyse data, apply weights to the inputs, and then output the result. It identifies patterns or detects anomalies within input data, such as text, and makes predictions or informed decisions. The principle operation of an NN is comprised of four steps.

1. Forward propagation: The process of feeding input data to a NN flowing from the input layer through the hidden layer(s) for processing and then to the output layer to generate an output.
2. Loss calculation: To calculate the error margin between the predicted and actual values
3. Backpropagation: The process of tuning the weights of a NN based on the error in the predicted output to improve the NN performance.
4. Update weights: A fundamental aspect of NN training that allows the NN to identify patterns and make accurate decisions, classifications, or predictions.

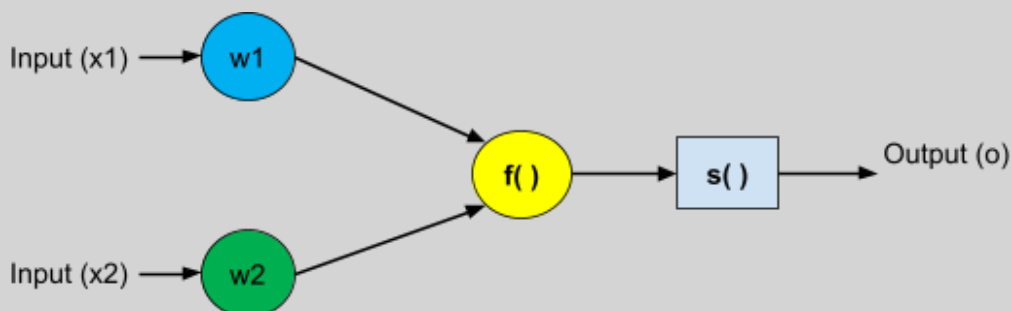


Figure 4.1. A Perceptron

The inputs to the perceptron could represent data features, which are typically numerical values derived from the data and to be processed by the perceptron. The input values operate like input signals to a human brain neuron. Each input value is associated with a weight, which determines the significance of the input or the link connecting the input to the perceptron. The weight is an adjustable parameter learned by the NN from the input data during training and used to optimise the network. The perceptron calculates a weighted sum of all the inputs using the following formula. The perceptron receives two inputs $(x1, x2)$ with their weights $(w1, w2)$. An activation function $s()$ is a step function to generate the final result. Finally, an activation function $s()$ is applied to this sum function $f()$. The step function maps a positive input value of $f()$, i.e. above a certain threshold to one and a negative value, i.e. below the threshold to zero.

$$f\left(\sum_{i=1}^n x_i * w_i\right) = (x1 * w1) + (x2 * w2)$$

The computed weights and activation function represent the combined significance of all the input signals and their influence on a human brain neuron and their decision-making. A NN without an activation function is just a linear regression model. The perceptron model is simple and only solves linearly separable problems, preventing it from dealing with real-life scenarios. Real-world applications involve complicated non-linear relationships in the data. The activation function $s()$ does the non-linear transformation to the inputs, making it suitable for learning more challenging scenarios and performing more complex computations and tasks.

In artificial neural networks (ANNs), each perceptron processes the incoming data and passes it on to the next layer of perceptrons in the network. The perceptrons are arranged in layers: input layer, hidden layer, and output layer, as shown in Figure 4.2. This allows the ANN to learn from the input data and identify any patterns to make predictions, classifications, or decisions.

The input layer is a bridge for the input data to access the ANN. The hidden layer stores and assesses the significance of each input to the output. Information about the importance of each input is stored in the hidden layer. The perceptrons in the hidden layer process and transform the input data as it accesses the ANN. The number of hidden layers and the number of perceptrons within each layer determines the complexity of the relationships an ANN can learn.

Depending on the kind of challenge being resolved by the ANN, the number of perceptrons in the output layer can be determined, and whether a single probability result is required for a single class or multi-class classification challenge. The ANN model is improved with the hidden layer because of the association of the inputs' significance in determining the output. Introducing extra hidden layers will determine the benefits the DNN can provide. In addition to the weights, each perceptron has a bias value b that shifts its output up or down, depending on the data or the ANN feedback, helping the network better fit the data and optimise.

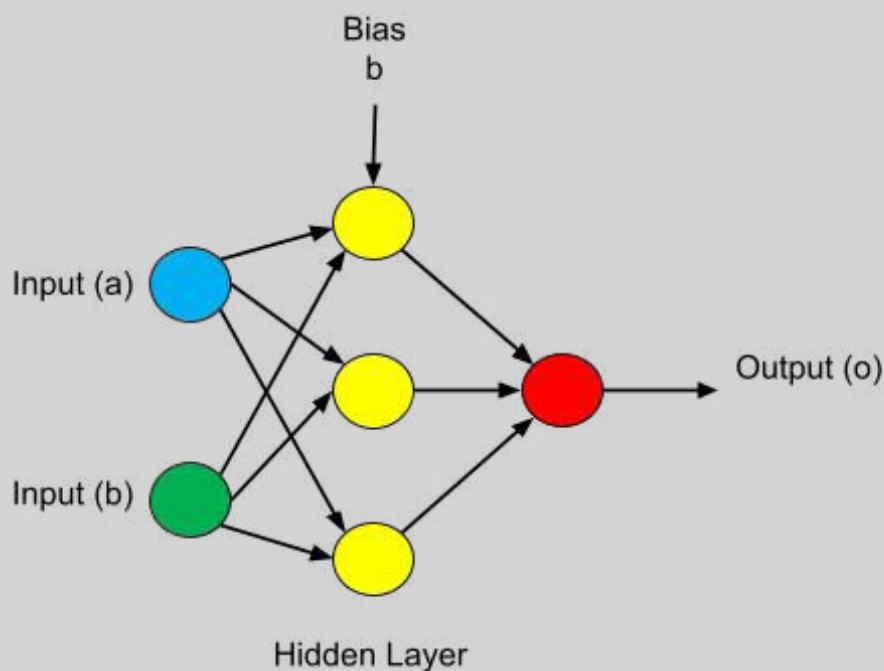


Figure 4.2. ANN with a hidden layer

The process of data flowing through the ANN moving from the input layer through the hidden layer(s) to the output layer is known as forward propagation. Training a perceptron is essential to learning to assign the weights for each input to produce the accurate output for any given data input. Keeping the difference between the predicted and correct outputs as minimal as possible helps the perceptron generate precise predictions. To achieve that, we use

- A loss function to measure the difference between how far the perceptron's predicted output is from the actual output
- An optimisation technique known as gradient descent is used to adjust the weights based on the loss function's slope. This helps identify how the weights must be adjusted to minimise errors in the perceptron's predictions.

An extension of the gradient descent algorithm is used: backpropagation, which calculates the gradient of the loss function concerning each weight and bias in the ANN and the gradient of the loss function for the output layer. The algorithm iteratively propagates the difference, i.e., the error, backwards through the ANN so that all the weights and biases can be updated accordingly, optimising the ANN's performance.

Despite its limitations, the perceptron is an essential building block for more advanced learning systems such as deep neural networks (DNNs). Mastering complex deep learning systems requires a good understanding of a single perceptron, which, when combined, operates together in a single ANN to identify and analyse patterns and relationships in data. A DNN incorporates multiple layers of interconnected perceptrons, allowing it to learn and represent complex non-linear relationships between variables.





2. ANN for Property Business

There are many business activities in the real estate industry and investment, especially when a decision-maker needs to select a deal among multiple business opportunities. This includes analysing property data, site viewing, analysing finances, etc. Many property data, including the owner's personal information and market analytics, have become available through AI technology efficiently and effectively. ANN can analyse property data like title deeds from the land registry, property features, location, sales transactions, etc. Moreover, it can correlate property facts such as location, size, market trends, and data from public sources with the data provided by the property owners. This helps improve the modelling process of ANNs to provide accurate estimates of properties with minimum errors.

2.1. Scenario Four: An Investment Deal Assessment

For instance, when investing in a buy-to-let property, an investor needs to get some data about the achievable yield and ROI before deciding. For example, if the buy-to-let property can achieve a yield of 14% or more and the ROI is 35% or more, it would be easy for the investor to accept the investment. So, the investor's brain begins questioning whether the yield is high enough and the ROI exceeds a specific percentage and then decides whether or not (yes or no) to buy the property. The investor's decision can then be taken for further analysis and to make a more complicated decision. In the case of the perceptron, the output is passed onto the next perceptron for further analysis and decision-making process; this new decision is passed onto the next perceptron, and so on, until it reaches the final perceptron. At this stage, we make the final decision about whether to go for this investment. So, the perceptron takes both inputs (x_1 , x_2) and provides a binary output (yes or no) using a threshold and a weighted sum; both determine the perceptron's decision (yes or no) for purchasing the buy-to-let property. The weighted sum determines how significant the input is to the output as follows:

The investor will only buy the investment property if:

x_1 - The achievable yield is more than 13%



x_2 - The achievable ROI is more than 34%

The perceptron decision can be represented with all possible input cases or vectors as follows:

$(1,0)$, $(0,1)$, $(1,1)$, and $(0,0)$.

In the first case $(1,0)$, the yield is more than 13%, and the ROI is below 35%

Let us use a weighted sum for each input, x_1 and x_2 . If yield is essential for the investor, we can give a weight of $w_1 = 3$. Whether or not the ROI can achieve 35% or more is less critical for the investor, so we give it a weight of $w_2 = 2$. The investor can have the following conditional function for the buy-to-let investment.

$$(x_1 * w_1) + (x_2 * w_2) = (x_1 * 3) + (x_2 * 2) > \text{some threshold output (o) that is 2.}$$

So, if $(x_1 * w_1) + (x_2 * w_2) - 2 > 0$, then the perceptron's output is yes (or 1), which implies buying the property.

Let us provide the input values to the vector equation. If the yield is more than 13% and the ROI is less than 35%, the inputs are $(1,0)$ based on the following calculation.

$$(1 * 3) + (0 * 2) - 2 \text{ is more than } 0$$

The output is yes for buying the investment property.

If the yield is less than 14% and the ROI is less than 35%, i.e. the inputs are $(0, 0)$, then based on the following calculations.

$$(0 * 3) + (0 * 2) - 2 \text{ is less than } 0$$

The output is not for buying the investment property.

2.2. Scenario Five: A Prospective Tenant Screening

Letting agents or property businesses may often have a list of tenants interested in renting their available properties, particularly in areas where demand for homes is high and supply is low. Deciding which prospective tenant to pick can depend on various factors, including their employability status, annual income, willingness to pay upfront, ability to provide a reference from the current landlord, etc. Most letting agents prioritise finding a reliable tenant who fits the criteria they are looking for, pays their rent on time and takes care of the property as their own. This implies a comprehensive check to determine which tenant passes the referencing process that best fits the property.

Understanding their circumstances helps achieve a hassle-free rental income and reduces the possibility of disputes. This process can help agents or landlords narrow their pool of prospective tenants and make a final decision. However, when there is a high demand for letting properties, there will be many prospective tenants' applications to process and analyse, which is labour-intensive and time-consuming. Deep learning algorithms can help deal with this matter, saving landlords and letting agents save time and money. Let us consider a real-life property business case of a buy-to-let property advertised for letting on an online platform. A deep learning model can predict whether a prospective tenant will be appropriate, as shown in Figure 4.3.



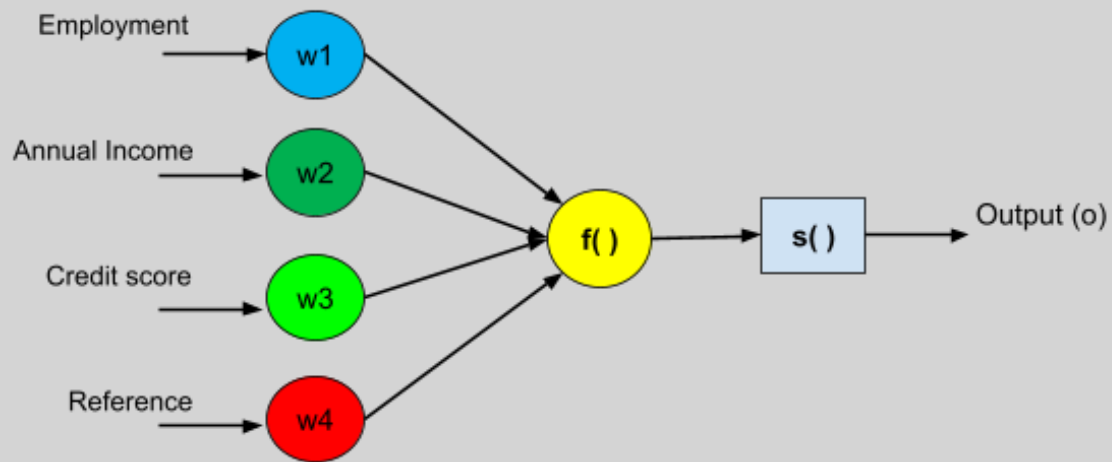


Figure 4.3. Multiple Input Example: Potential Tenant Assessment

Inputs: These are the prospective tenants' collected information the letting agent or landlord received about each applicant. This information might include employability status, annual income, credit score, reference letter from the current landlord, etc. The NN accepts this collected information as input features.



Weights: As part of the NN training process, the deep learning model learns the significance of each input and how much it influences the likelihood of paying rent on time. For example, the learning model might learn that annual income is a highly influential factor in determining the possibility of paying on time. This implies assigning a high weight to the annual income input data. If the model learned that the credit score input is less significant in determining the possibility of paying on time, it will be assigned a low weight. Therefore, learning and adjusting the weights is essential during training to keep prediction errors as minimal as possible.

Activation Function: The calculated result from the sum function $f()$ will be used as an input to the activation function to produce a value between zero and one. This value can be used as a probability figure to determine whether or not the prospective tenant will pay rent on time. In other words, if the output of the activation function is closer to one, then the learning model predicts a high probability of paying the rent on time. However, the learning model predicts a lower likelihood of paying on time if the output is closer to zero.

Considering this tenant screening scenario, the gradient descent will determine how to adjust the weights assigned to different tenant features like employability status or annual income to improve the perceptron's predictions. We use a learning rate parameter to control and decide the size of each step when adjusting the weights. During the optimisation process, the faster the adjustment process, the quicker the convergence rate. This way, the perceptron can improve its prediction abilities and more accurately solve its challenge.



2.3. Scenario Six: Predicting Property Prices

A database of property data and relevant attributes that can influence property prices needs to be produced. This data can be focused on specific types of property business strategies, such as buy-to-let, HMOs (Homes of Multiple Occupants), service accommodation, commercial properties, etc., used to train the ANN. The ANN contains one or more hidden layers, often with one perceptron at the last layer. The dataset comprises input data about properties collected from multiple sources, which is used to train the ANN. The property price represents the target output variable. The database can be divided into three subsets as follows:

- Training dataset:
- Testing dataset:
- Validation dataset:

The following list shows an example of dataset variables that can be considered for each property (Vincenza et al., 2014).

- Property asking price;
- The surface area of the property in square meters;
- Number of bedrooms at the property;
- Number of bathrooms on the property;
- In the case of a flat, the floor where the property is located in the building;
- The distance in kilometres to reach the CBD (Central Business District) from the property using the road network;
- The number of lines servicing the nearest bus stop;
- The time in minutes that it takes to reach the city CBD from the property;
- using the road network, considering congestion;
- A measure of the population density in a zone (inhabitants per area unit);
- The employability rate in the city
- The number of employed residents in a zone;
- The number of inhabitants in a zone.

It is essential to preprocess the training data in terms of cleaning, performing the necessary transformations, making the input data suitable for the network, and generating additional training data samples if required. This helps improve the network's performance and mitigate common challenges. As part of the training process, arranging perceptrons in layers, forward propagation of the processed data through the network, assessing the outputs, whether it is predictions, classifications, or decision-making, and compare them to the actual data labels, using backpropagation to adjust weights and biases, and eventually fine-tuning the whole neural network model. This process helps the network model to become more robust and capable of learning valuable patterns within the data and solving complex challenges in different domains.

3. Deep neural networks (DNN)

DNN is a type of ANN with multiple layers of preceptors for processing input data and providing an output. Each layer provides an input to the next layer with data to analyse and process. Deep learning is about developing and training an ANN to process and analyse large datasets, identify and learn complex patterns within data and make predictions and informed decisions. In DNNs, multiple hidden layers help in learning complex relationships and patterns. The output layer generates the predictions or classifications based on the previous layer's processed data.

Deep learning has recently demonstrated remarkable performance in many real-life scenarios and practical applications. Still, it may not be suitable for simple tasks with small datasets, considering its complex computations and expensive processes. Access to big data has helped develop deep learning algorithms and DNNs that have proven efficient and effective and perform remarkably well in processing such data, as follows:

- Develop relationships between large amounts of complex data features and a target output, allowing them to produce effective autonomous systems like self-driving cars.
- LLMs like OpenAI's GPT models are trained on large text files, enabling them to extract meaningful information and generate relevant content.



Deep learning algorithms are powerful tools that have the potential to support and help advance many industries. It has significantly developed useful, practical applications like virtual assistants, AI agents, natural language processing (NLP), and speech and facial recognition solution models for industries such as finance, real estate, cybersecurity, healthcare, etc., helping deliver interesting outcomes and efficient results.

4. Summary

ANN is one of the AI techniques capable of learning, showing cognitive abilities, and performing complex computations. ANN can reveal hidden relationships between multiple variables, making it useful for learning and predictive analytics. ANNs have demonstrated valuable applications in my business sectors, including real estate investment and finance.

For example, property training data is required to train ANN models to analyse relationships between real estate features, such as building characteristics, access to transport, and property prices, which helps market analysis and property price predictions. This allows property investors, professionals, and stakeholders to understand the market and make informed decisions.

This chapter introduced real-life scenarios showing how the association between different property features can impact real estate market predictions. DNN has been introduced, which contains multiple hidden layers to model a learning network with abilities to process and analyse input data.





AI for Property Business

Chapter Five: Blockchain



Chapter Five

Blockchain

Blockchain is an intelligent technology that supports many business applications and offers ledger services for efficient transactions. The blockchain represents a marketplace that collects and connects data in a decentralised database. It is a geographically open platform that records properties' title registers and ownerships, where data is validated and saved through the platform and made accessible to all interested parties and stakeholders. It provides a transparent, trustworthy, fast, and secure platform for businesses requiring mission-critical agreements. Incorporating AI with blockchain technology would help property businesses and the real estate sector in general, property legal matters, data management, and secured record-keeping. Once blockchain becomes accessible and affordable for property businesses, it improves the quality of conveyancing services. This chapter presents the concepts and principles of blockchain, including its features like robustness, security of transactions, and ensuring the integrity of the document's content.

1. Overview of Blockchain

The real estate business uses the blockchain (a ledger) to record all transactions. The blockchain was introduced to secure the timestamping of digital documents. Each document is signed with the current time and a link or a pointer (using hash functions) to the previous document. If the data in the previous document changes, the pointer automatically becomes invalid. A certificate is created for each document, including a hash pointer to the previous document's certificate and current time; all these items are signed together. Each certificate ensures the integrity of the previous document's contents, as shown in Figure 5.1. Each certificate fixes the entire history of documents and certificates, forming a linked timestamping; hence, the relative ordering of documents is reserved.

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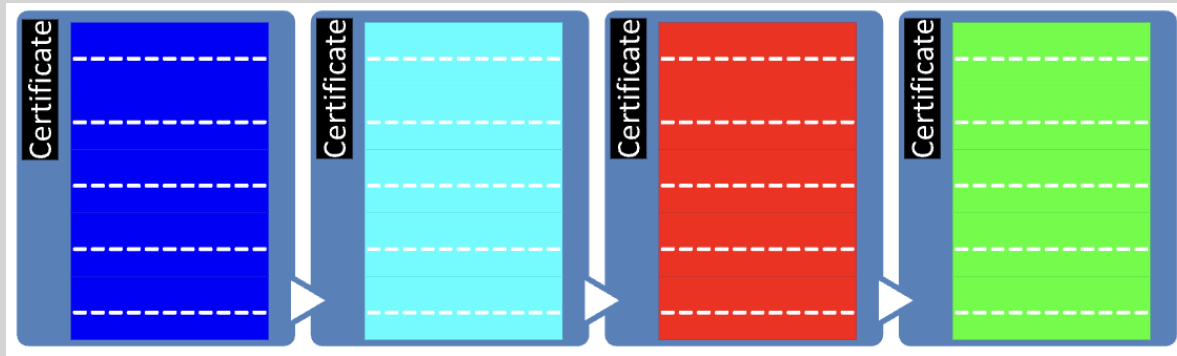


figure 5.1. Blockchain documents with linked certificates

Documents can be collected into blocks and linked in a chain in a tree structure, as shown in Figure 5.2. This structure reduces the time needed to verify that a particular document appears at a particular point. It also preserves the relative order of blocks and transactions, which are recorded and secured. The links represent the hash pointers from one document to the previous one, and so on.

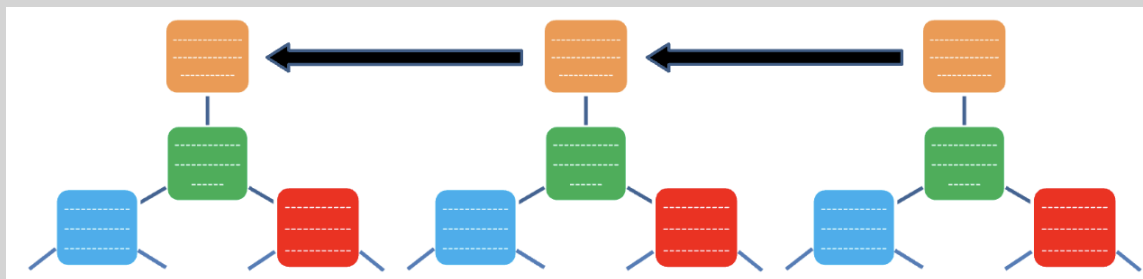


Figure 5.2. A chain of linked blocks

A hash pointer points to where a document is stored together with a cryptographic hash of the value of the data contained in the document at a particular time. Regular pointers provide a way to retrieve information. Hash pointers verify that the information has not been tampered with/changed. They can be used to build various data structures, such as a linked list or a binary search tree. The main properties of Hash Functions are:

- Any string of any size input
- Fixed-sized output
- Efficiently computable
- To be cryptographically secure:
 1. Collision resistance: A hash collision occurs when a is not equal to b , yet $H(a) = H(b)$, as shown in Figure 5.3. The hash function is considered collision-resistant if it is infeasible to identify a and b values.
 2. Hash Functions - Hiding: If the output of the function $f = H(a)$, there is no feasible way to determine the input a .

Regular pointers help retrieve information; however, hash pointers point to where data is located with a cryptographic hash code that represents the value of the data and verifies that the information has not been tampered with/changed. Hash pointers are used by blockchain technology to build a linked list data structure. These features of the blockchain and the use of hash pointers make it perfect for businesses to deal with contracts and legal agreements.

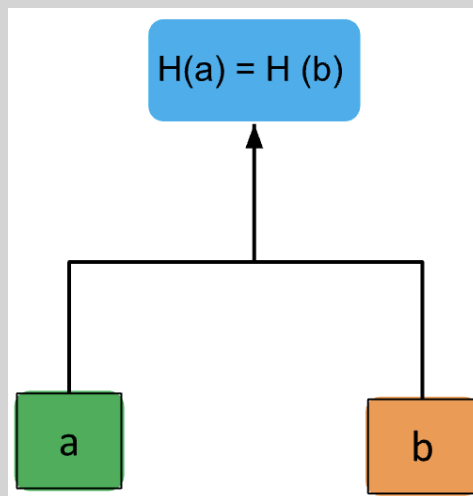


Figure 5.3. Hash collision



Producing a self-executing digital agreement is disrupting the traditional contract business model. For example, a property investor bought a buy-to-let property through their solicitor, who arranged the purchase and prepared the contract with the seller's solicitor to pay 50% of the agreed sale price upfront. The rest will be paid in twelve months' instalments starting from completion. With blockchain technology, the seller's and buyer's solicitors can set up a smart contract with the agreed arrangement in the next twelve months to monitor the monthly instalment payments. The smart contract automatically triggers an interest payment or the agreed penalty for the delayed period if the monthly payments are not received in time as agreed during the next twelve months. This system operates automatically per the agreement between both parties without confusion and ambiguity, delivering a trustworthy service and saving everybody time and effort.

Agreements are negotiated between parties (individuals legally binding contracts). With the support of secured pro blockchain technology arranges digital contracts and auto stages of the agreement lifecycle. The generated metadata information about each digital contract, including details of the agreement, start and end dates, agreed payments, etc. technology can autofill the relevant forms attached to the analyse the agreements' content using natural language



For example, when a tenancy agreement is about to end, both parties can be automatically alerted one month before to confirm any new arrangement. This would help the landlords avoid the hassle of using manual tools to monitor their tenancy agreements and offer better service to their tenants. Blockchain technology helps property businesses improve the quality of their services, providing practical and cost-effective solutions, streamlining the decision-making process and avoiding wasting time.

2. Cybersecurity challenges

As a ledger, the blockchain securely records all transactions using a secure timestamping of digital signatures for the relevant documents. Blockchain identifies when a document is produced and the order in which it is created using pointers and hash functions. This helps verify the value of the previous block and ensure it has not been tampered with. If an attacker tries to change the content anywhere in the block, it will result in an incorrect hash pointer in the following block. The stored head pointer will become inaccurate, the certificate becomes invalid, and we can use the head pointer to detect the tampering, as shown in Figure 5.4.

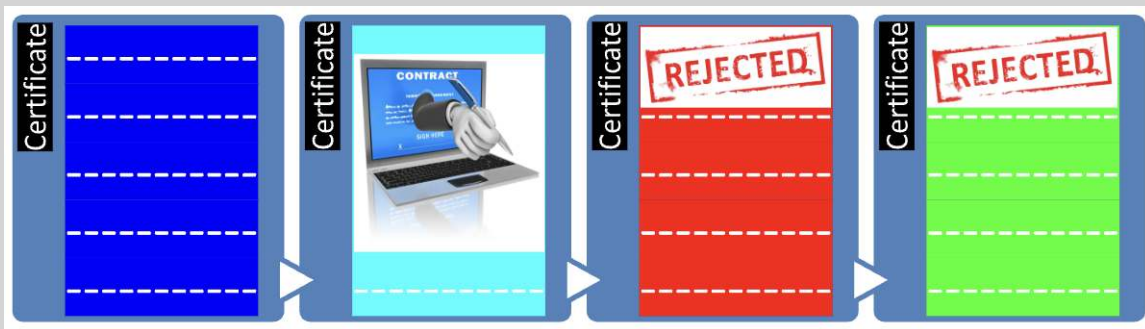


Figure 5.4. Tamper detection in a blockchain

In a tree structure blockchain, the documents can be collected and linked in a chain with a root node at the top of the tree, as shown in Figure 5.5. The data blocks are grouped in pairs, and the parent nodes contain the hash pointers for the data blocks. The hash pointers of the parent nodes are stored in their parent nodes, i.e. one level above and so on, up to the root node. The secured hash pointer (root node) at the tree's root can detect any changes to the data. The hash of each of the blocks is stored in a parent node. If an attacker tampers with some data block, the change will cause the hash pointer one level above not to match and then the next level up until the hash pointer at the tree's root detects the attack.

2.1. Digital Signatures

A digital signature is a digital analogue to a handwritten signature on paper and is used in many online applications. The main properties of a digital signature are as follows:

- Only one person can create their signature,
- Anyone who receives it can verify that it's valid and
- The signature is to be tied to a particular document only

Advantages:

- To sign the root hash pointer (protect the whole structure)
- This results in signing the entire blockchain



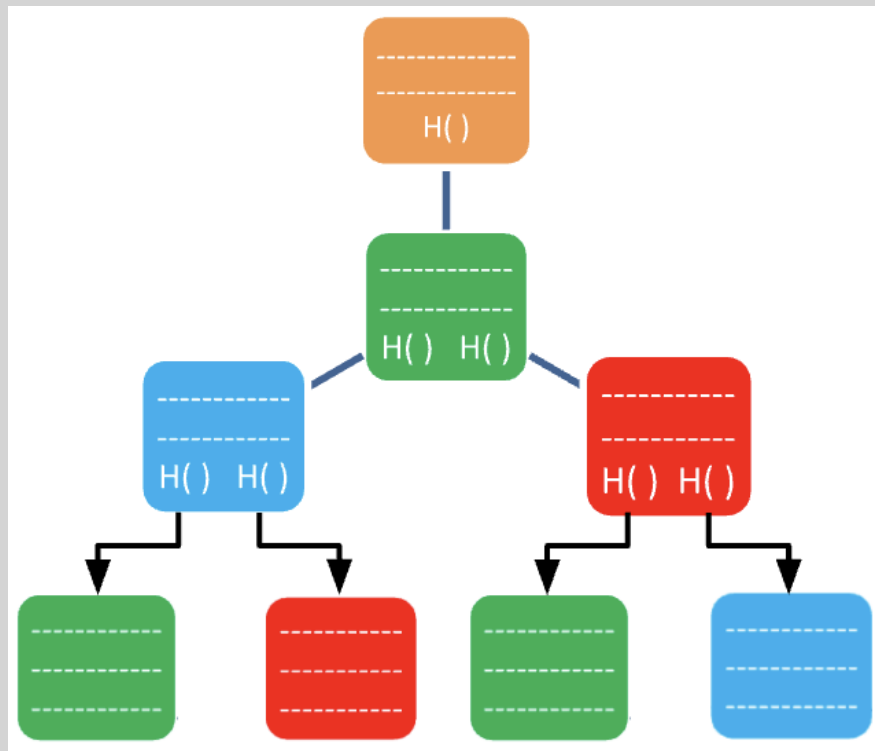


Figure 5.5. Tree structure blockchain

2.2. Digital Signature Algorithms

Three algorithms are used to create a digital signature, as follows:

1. Algorithm 1: Generate a key pair, the secret/private key PriK and public key PubK (PriK, PubK).
The private key PriK is used to sign a document or message and is kept private. The public key PubK is used for verification purposes and can be shared with others to verify your signature.
2. Algorithm 2: Sign a document or message using a private key, PriK, to produce a signature $\text{sig}(\text{PriK}, \text{message})$
3. Algorithm 3: Verify a signature for a document or message using a public key PubK, a signature, and the document or message as input, $\text{verify}(\text{PubK}, \text{message}, \text{sig}(\text{PriK}, \text{message}))$. The output is either true or false depending on the validity of the signature $\text{sig}(\text{PriK}, \text{message})$ and the public key PubK.

A public key is used to identify an individual in the system. For an individual to speak for the identity of PubK, they must know the corresponding private key, PriK. An identity (PubK, PriK) can be created using the generate Keys operation in the digital signature scheme. Since public keys are large, the hash of PubK can be used as the identity. It is a decentralised identity management system that replaces a central authority for registering individuals in a system. You can create multiple identities or become anonymous. It is just a hash of a public key. Over time, the created identity makes a series of statements known to others. P2P networks are close to being purely decentralised, where anyone can run and manage their blockchain.

3. Blockchain for Property Business

Blockchain and smart contracts offer fast and transparent processes for all transaction participants using automated payment systems. However, this requires digitising, automating, and securing the land registry and its records and processes and managing and tracking property titles using blockchain technology. This will automate the conveyancing process, making the real estate ecosystem more transparent and recording transactions. Furthermore, creating a permanent history of properties, eliminating unnecessary procedures, and soon changing how we buy, sell, and value properties. Moreover, tenancy agreements, mortgage registrations, and land title deeds are stored in a global, secure, decentralised ledger. Smart contracts do not require many days and weeks to settle like traditional contracts.

Property managers and letting agents can use an online service such as the DocuSign eSignature tool to get the tenant to sign the tenancy agreement. In 2018, DocuSign integrated its systems with the Ethereum blockchain to offer digital contracts and DocuSign agreements. In DocuSign digital contracts for tenancy agreements, the tenant should be able to set up their account and use this online service to sign future tenancy agreements. Using such a tool will speed up the signing and exchanging of contracts. Property businesses can show evidence of the tenancy agreement stored in a neutral environment. On a blockchain, no one owns the signed agreement. Still, the agreement can be checked against the evidence stored in the blockchain to verify integrity against the original DocuSign document.

DocuSign is an online digital signature platform that has used blockchain for many years as part of its digital offerings. DocuSign noticed this opportunity to offer blockchain-based digital agreements or smart contracts and leverage Ethereum blockchain technology across its platform. Blockchain technology allows organisations to access agreement evidence safely and verify integrity against the original DocuSign document and its agreement content. Once DocuSign completes a particular transaction, a one-way hashcode is computed and published on the Ethereum blockchain platform. The hashcode validates the completed transaction on the blockchain and records the evidence for the transaction.

DocuSign uses cryptographic hash fingerprints to validate the completed transaction(s) on the public blockchain and record evidence for each transaction. Validating digital contracts on the blockchain ledger improves the agreement's workflow and lifecycle using trusted 'self-executing contracts'. DocuSign has already set up its AI Labs to allow customers to get updated and learn about recent developments in this promising technology.

With AI support, e-signature tools can incorporate facial or voice recognition features to strengthen the security of online signature tools. This will positively impact the resilience of electronic signature agreements and minimise the risk of identity theft, fraud, and misuse.

AI algorithms can help identify unusual activities in real time, thus improving the authentication processes. All available AI tools and functions require proper attention because they can affect the progress of businesses and investments.



Property investors must have the skills to buy and sell, operate and manage real estate businesses, and use technology to deliver quality service. All such skills and activities help build a successful investment and keep the risk of failure minimal. AI is changing how many industries operate and how they manage their operations effectively with efficient client support. The transformation is enormous, leading to the disappearance of many traditional systems and jobs and the emergence of new opportunities requiring new skills.





4. Summary

Blockchain technology is a marketplace that can offer useful business solutions like ledger services connecting legal documents for efficient and secure transactions. The blockchain is an open platform that operates like a decentralised database that can collect, record, and validate legal documents such as title registers and property ownership. This chapter presents the concepts and principles of blockchain and its features like robustness, secured transactions, and the ability to offer smart contracts services and quality data management. This helps property businesses to carry out trustworthy and transparent transactions requiring critical agreements, eliminating unnecessary procedures and using a secured environment. This chapter introduced blockchain technology and how it performs a robust record-keeping process and management supported by secured online payment systems. Tenancy agreements, title deeds, and mortgage registrations are stored in a globally secured decentralised ledger. This allows property businesses to track property titles and quality conveyancing services that are affordable and accessible to property solicitors.



AI for Property Business



Chapter Six: Generative AI





Chapter Six

Generative AI

Generative AI or Gen AI has significantly impacted many impressive real-life applications, delivering real value to many sectors, including finance, real estate, business management, research and development (R&D) projects, and entrepreneurial operations. Gen AI uses machine learning and neural network algorithms trained using big data text, images, audio and video. This chapter introduces the main Gen AI types and covers real-life examples of applying Gen AI techniques to property business problems. It presents a GPT-based AI-powered property consultant application developed by Anzar Property Group. The application uses GPT to help property developers, investors, and professionals, offering solutions to business challenges such as property design and conversion options. If necessary, the user prompts the application, which responds with options for possible solutions like design solutions or converting office buildings or commercial properties to multiple residential flats and houses.

1. Introduction to Gen AI

Although Gen AI is considered by many as a game changer that is capable of showing interesting creativity and the ability to deliver real value in research and development (R&D), entrepreneurial operations and innovation, there is potential for more impressive content generation, design works, and scientific research. This offers good support to entrepreneurs and various enterprises across various industries to gain significant operational support; however, Gen AI needs to catch up in producing original ideas and content that human creative authors can make. Gen AI models are large algorithms trained on human intelligence using massive datasets, growing Internet content, and its expansion. These intelligent models can be tailored to specific sectors like education, finance, real estate, etc., offering disruptive applications across many industries.

Gen AI tools allow companies to provide high-quality services or develop enhanced products, opening new markets and clients. However, businesses must build pilot projects and plan for testing Gen AI tools and their impact, which implies a lot of learning and education and making informed decisions. This should help them gain the necessary knowledge and build their understanding of how to deal with this extraordinary technology. It should also equip them with the right skills that will support them in achieving their business goals and objectives. Gen AI focuses on two major categories, Generative AI and Discriminative AI, as follows:

- Generative AI models analyse data to learn probability distributions of sub-categories within a dataset, which makes them capable of generating content similar to the training data. They offer content generation, create personalised content such as text, images, sound, and videos, and transform text into images or video, making Gen AI a significant model for producing creative content such as ChatGPT.
- Discriminative AI models are about summarisation and predictive analytics. They are based on ANN models that can classify data by identifying features. They offer exciting applications like speech recognition and analytics, AI-powered applications, document summarisation, chatbots, etc. Such smart tools can be trained on previous customer communications and interactions, creating exciting applications that support many businesses and organisations and offer quality customer service.

2. Gen AI Models

Gen AI models are well-trained algorithms that encompass machine learning models capable of identifying patterns in data and then using this knowledge to generate new content (e.g., text, video, images, audio, code) resembling human-like produced content. This requires access to an extensive training dataset to achieve the necessary level of learning and ability to identify patterns. For instance, if we want a model capable of generating new property designs, we have to feed it a large dataset of property data, including many images of different designs. Over time, the model should understand how to generate a new property design. There are four models of Gen AI, each with its approach to generating content, as shown in Figure 6.1 below.

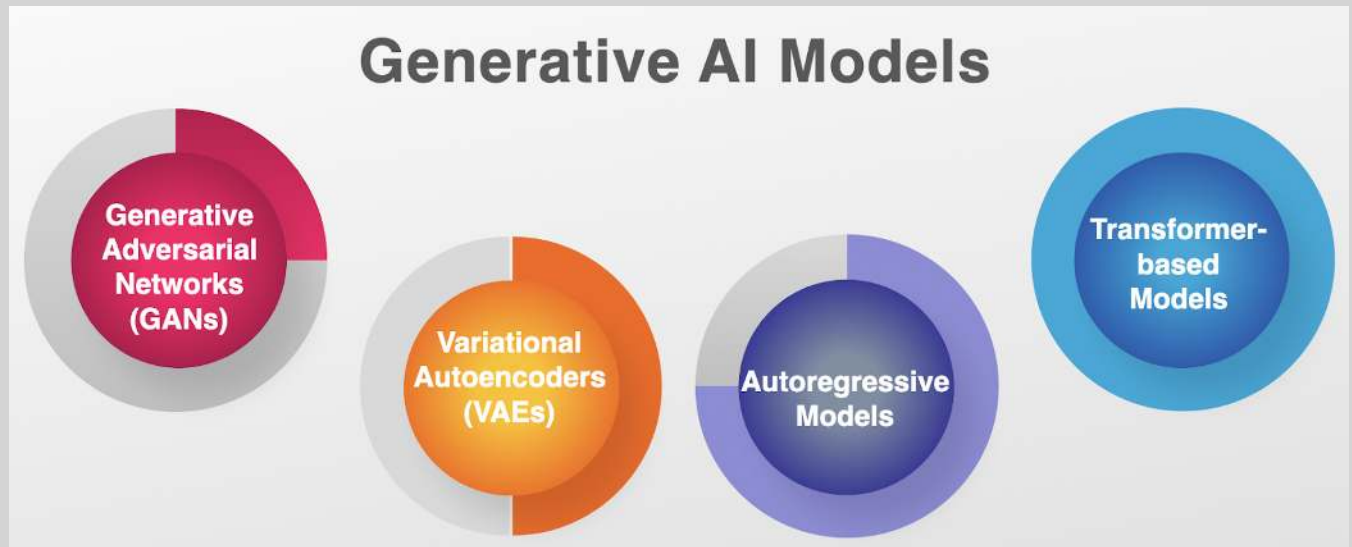


Figure 6.1. Gen AI Models

Generative Adversarial Networks (GANs):

GANs consist of Gen AI models, the generator and the discriminator, operating against each other competitively to generate highly realistic content. The generator's task is to produce new content to make it as realistic as possible, while the discriminator's job is to compare the generated content with a real one and try to identify any mismatch between them. This forces the generator to produce as realistic content as possible and avoid fine-tuning the content to win the competition.

Variational Autoencoders (VAEs):

VAEs consist of two generative components: an encoder and a decoder. The encoder's task is to learn the probability distribution of the input data, such as an image, sound, or video and then convert it into a more straightforward latent data representation while preserving the essential relevant information that represents the input data's critical characteristics. The decoder takes the newly produced representation, removes the irrelevant information and regenerates a convincing replica of the original input that is not necessarily 100% the same or creates new content for a different image, sound, or video.

Autoregressive Models:

Autoregressive models generate data based on some aspects of previously generated data. They refer to what was generated before to decide on what content to generate next. They use predictive analytics to learn the probability distribution of the following data elements and their context to create new output, such as a new sentence or image, using the context of the previous sentence or image as a reference. This makes autoregressive models appropriate for text generation applications, significantly impacting this area like Generative Pre-trained Transformer (GPT).

Transformer-based Models:

Transformer-based models can learn patterns and relationships between data features in sequential data, where the order of data, such as sentences, is essential. Such sequences help these models learn the data context and respond to user prompts. Large datasets, such as online wikis, e-books, videos, etc., are often used to train Transformer-based models. They are used in natural language processing applications like text generation, summarisation, and translation.

Encoders and decoders are part of the transformer architecture. They perform data representation and segmentation to learn the context of the input data using Feed-forward NNs. This allows the model to decide the essential weights for the input data to understand the relationships and dependencies between different parts of the content, including single words. The decoder converts the segmented input data and uses Feed-forward NNs to create the output content.





3. Gen AI Types

Gen AI has become an attractive tool for business intelligence, market assessment, and property legal matters, using online accessible data repository platforms to extract valuable information. For instance, property investors and developers became aware of the power of Gen AI and started using it to analyse the real estate market and for evaluation and assessment purposes. OpenAI tools such as ChatGPT use a large language model (LLM) designed to respond to user questions efficiently. LLM is an AI algorithm that uses deep neural network (DNN) learning techniques to process and summarise big data and predict new content. It is closely connected to Gen AI and designed to help generate content. This makes LLM capable of predicting the best output response textually or verbally to text-based queries or input questions. Different types of Gen AI (Abdullahi, 2024) (Almeida, 2024) can be distinguished based on the input and output content type, as shown in Figure 6.2 below.

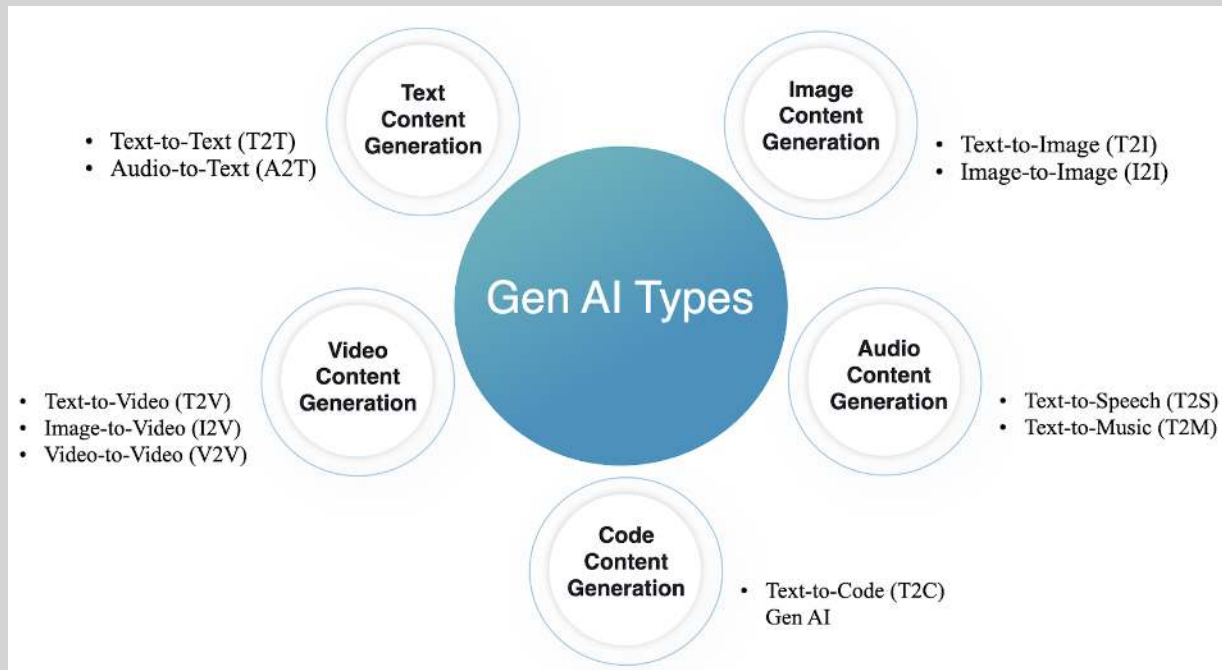


Figure 6.2. Gen AI Types

Text Content Generation: Text AI generators are trained on large amounts of text from different sources, such as websites, e-books, and publications, to identify patterns and relationships between features in natural language. This makes them capable of generating new text such as reports, blogs, poetry, etc. There are two categories of text content generation, as follows:

- Text-to-Text (T2T) Gen AI
- Audio-to-Text (A2T) Gen AI

Image Content Generation: This type of Gen AI analyses image datasets and their text descriptions and learns their features and concepts to create new images. There are two categories of image content generation, as follows:

- Text-to-Image (T2I) Gen AI
- Image-to-Image (I2I) Gen AI

Audio Content Generation: Audio AI generators can analyse sounds and their metadata from different audio genres and associated text or song lyrics to learn features and patterns. There are two categories of audio content generation, as follows:

- Text-to-Speech (T2S) Gen AI
- Text-to-Music (T2M) Gen AI

Video Content Generation: These generators can analyse visual, sound, and text content to learn how to generate new videos and apply effects if necessary. There are three categories of video content generation, as follows:

- Text-to-Video (T2V) Gen AI
- Image-to-Video (I2V) Gen AI
- Video-to-Video (V2V) Gen AI

Code Content Generation: These AI generators are trained from large, accessible code datasets for different programming languages. This helps identify patterns and language structure and then write or develop program code to perform various tasks, whether for producing new programs or debugging purposes. There is only one category of code content generation, as follows:

- Text-to-Code (T2C) Gen AI

4. Gen AI Tools

Many Gen AI tools are currently available for businesses to help them with their operations and business challenges. These tools use LLM models trained on extensive data to learn how to generate human-like content, such as predicting the highly likely word to follow a previous one in T2T Gen AI. Figure 6.3 shows six tools: OpenAI's ChatGPT, Google's Gemini, Inflection's Pi, Anthropic's Claude, Microsoft's Copilot, and Adobe's Firefly (Kothari, 2024). Table 6.1 shows a brief comparison between all these tools.



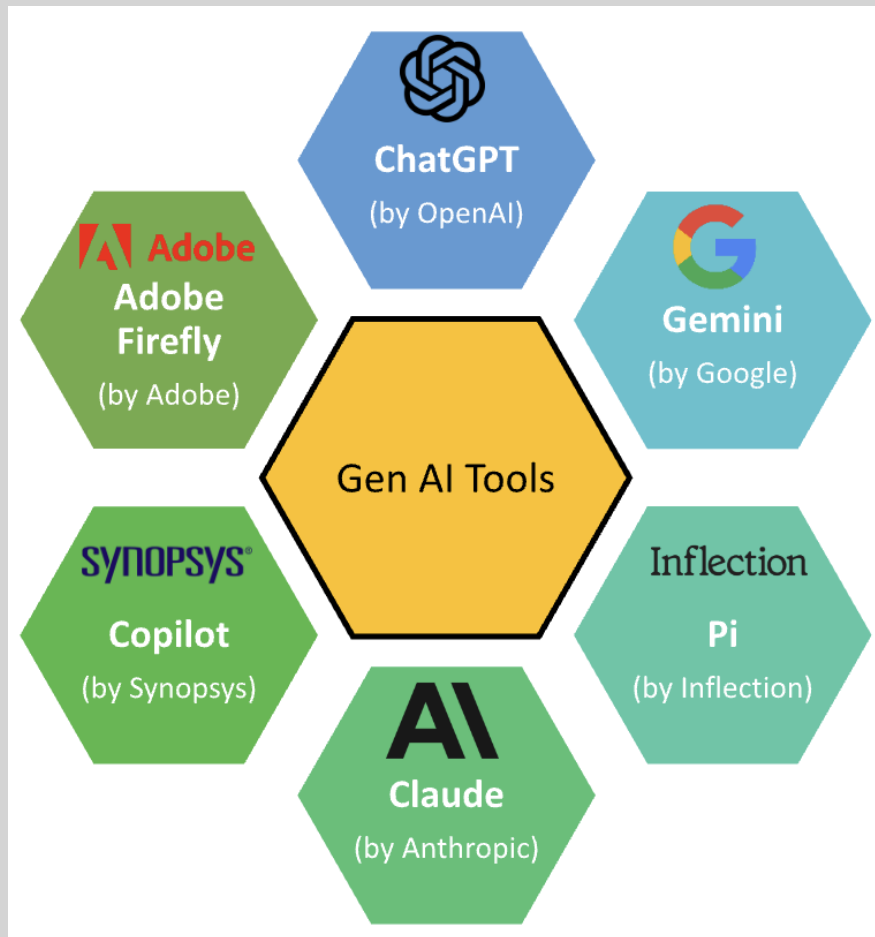


Figure 6.3. Gen AI Tools

These tools use a large language model (LLM) to respond efficiently to user questions and use many resources to gather information, such as published research papers and articles, technical reports, social media, programming code, and online communications. These resources and LLM allow these tools to respond to users and offer helpful content using human-like smart AI functionalities. Therefore, communicating with Gen AI tools is essential to getting a helpful output or response to your query, such as an exciting image, useful video, or article. However, you must provide the Gen AI tool with the correct input or prompt, use the right words, structure requests correctly, and communicate clearly to receive the perfect response and desired information (Patel, 2024).


Table 6.1. A Brief Comparison Between Gen AI Tools

Tool	Model	Code generation	Context window	Message limit
ChatGPT	GPT 4+ & Turbo	Yes	32k & 128k	40-80 per 3h
Gemini	Gemini Ultra	Yes	1 m	~ Limitless
Pi	Inflection-2.5	No	?	?
Claude	Claude 3 Opus	Yes	200k	100 per 8h
Copilot	GPT 4+	Yes	?	100 per day
Adobe Firtto efly	Diffusion	Yes	1k	?


4.1. Scenario Seven: Interacting with Gen AI GPT Models

Prompts instruct or ask ChatGPT or Google Gemini a question to generate a response in text, images, or both. ChatGPT can respond to customers' questions or queries, providing helpful information and efficient support, offering customers a superior experience and satisfaction. ChatGPT is a large AI-based natural language processing model, and its name ChatGPT combines 'Chat', which uses the AI chat feature used by chatbots, and 'GPT', which stands for Generative Pre-trained Transformer, an LLM.

Property investors and developers became aware of Gen AI's power and started using it to analyse the real estate market and for evaluation and assessment purposes. I asked ChatGPT two prompts about the current property market in England. The questions concerned the best areas to invest in buy-to-let properties in England. I couldn't disagree with ChatGPT; the response is shown in Figure 6.4.


You

Where are the best areas in England to invest in buy-to-let properties?


ChatGPT

Choosing the best areas for buy-to-let properties depends on various factors, including rental yields, demand for rental properties, economic growth, and local market conditions. As of my last update in January 2022, here are some areas in England that were often considered promising for buy-to-let investments:

- Manchester:** The city has a strong rental demand, particularly from a large student population and young professionals. Areas like the city center, Salford Quays, and Didsbury have been popular among investors.
- Liverpool:** With regeneration projects and a growing economy, Liverpool has become a hotspot for buy-to-let investors. Areas like the city center, Baltic Triangle, and Kensington have seen increased interest.
- Birmingham:** The city's economic growth, redevelopment projects, and a high demand for rental properties make it an attractive option for buy-to-let investors. Areas such as the city center, Digbeth, and Edgbaston are often considered.
- Leeds:** A vibrant city with a large student population, Leeds has been a popular choice for buy-to-let investments. Areas like the city center, Headingley, and Hyde Park are frequently targeted by investors.
- Sheffield:** The city's affordable property prices and growing student population make it appealing for buy-to-let investors. Areas such as the city center, Ecclesall Road, and Crookes are commonly considered.
- Nottingham:** With a significant student population and affordable property prices, Nottingham has been attractive for buy-to-let investments. Areas like the city center, Lenton, and Beeston are popular choices.

It's important to conduct thorough research and stay updated on the latest market trends before making any investment decisions. Consider factors such as local amenities, transportation links, employment opportunities, and the overall economic climate. Additionally, changes in government policies and regulations can impact the buy-to-let market, so it's advisable to seek advice from real estate professionals and financial experts.

Figure 6.4. ChatGPT's response to the best areas in England to invest in buy-to-let

Getting the best of Gen AI tools requires a proper understanding of how to instruct “prompt” those innovative tools to generate the results you are aiming for. It is not always guaranteed to receive the desired output; it is just about increasing the opportunity to get the desired results. Regardless of the content of your prompt, the way you structure and frame it would significantly improve the generated response and results. In other words, the quality of your prompt determines the quality of the tool’s response. The better you write and frame your prompt, the better the output. Examples of valuable prompts will be introduced in the following sections, illustrating some techniques you must be aware of to produce well-framed prompts for Gen AIs.

5. Gen AI Property Applications

Gen AI has radically disturbed many industries and sectors, offering property businesses opportunities to effectively manage their portfolios and deploy smart solutions. Gen AI techniques and tools can offer support and assess the property market, and improve the business leaders and customer experience. With the use of such techniques, the role of property businesses such as asset management and buy-to-let companies will definitely change and progress. This technology offers endless resources using GPT models such as chatbots, consultancy service, etc. This section introduces two real-life examples of GPT applications.





5.1. Chatbots

Although email communications helped speed up the transmission of applications, AI has only recently improved processing them. The main problem is that there needs to be more time to check and analyse every single application unless we use intelligent methods to deal with and process those applications. In the property business, it is essential to efficiently manage potential tenants' or buyers' applications, especially when dealing with tens or hundreds of applicants who want to live in high-demand areas. Those applicants who do not meet your criteria in terms of background information such as income, credit score or history can be filtered out to improve the efficiency of the application management process. Chatbots have different applications in customer support, management, sales and marketing, investment, etc. Property businesses can use chatbots to filter unqualified property buyers or tenants.

The Internet, combined with AI, can help manage this task effectively and efficiently. A chatbot can be assigned to support the person in charge of this activity and help carry out this work. Managing the initial conversation and interview with applicants interested in renting a particular property is essential. A chatbot shown in Figure 6.5 can filter unqualified applicants of property potential tenants or buyers using predefined criteria based on a specific algorithm. They can initiate online communication with potential tenants visiting the business website, ask them particular questions, and based on the responses they receive, they can rank those potential tenants or buyers and provide a short list of top applicants to the property landlord or asset manager in charge to select the best applicant.

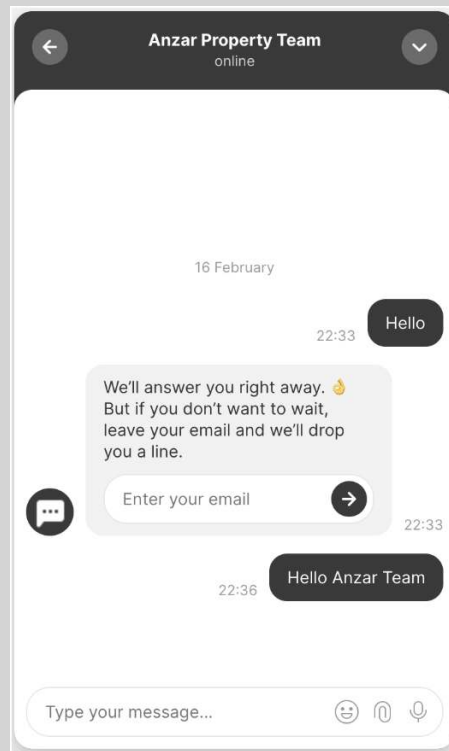


Figure 6.5. A chatbot interacting with a customer

Chatbots can use a transcript of questions, often letting agents prepare to ask their prospective applicants. Right after the client accesses the property business or letting agent website, they get notified by a chat box produced by a chatbot to initiate conversation. This chat box allows the prospective customer to ask questions and receive responses from the chatbot. This automated system of initiating communication and identifying the best applicants can save you time, cost, and effort in reviewing and analysing many applications manually. Ultimately, the asset management team, estate agent or letting agent would leave the hard work for the chatbot and focus on their primary job of growing the business. This process of interviewing and selecting the best applicant can be used to sell properties or any product or service. Knowing what a client wants is crucial for the sales team's success.



5.2. AI-Powered Property Consultant

We developed a Gen AI application using a GPT, an ANN model that uses the Transformer Gen AI model, which can learn the context of the input data using feed-forward NNs, deciding the weights of the input data to determine the relationships between different parts of the input content. It is commonly used in natural language processing and AI applications like ChatGPT. The developed application is a GPT-based AI-powered property Consultant using ChatGPT to support property investors and professionals. Figure 6.6 shows four prompt options and an input field, allowing property developers, investors and professionals to use the application for various services. The application is designed to help them analyse properties, property locations and markets and obtain information about converting large properties into multiple flats and houses, as follows:

- Analyse any property market using SWOT (Strengths, Weaknesses, Opportunities, and Threats) and PESTEL (Political, Economic, Social, Technological, Environmental, and Legal) analysis.
- Identify supply and demand for residential properties in any city or country.
- Get information about a property use class and building conversion options.
- Design options for property conversion, such as commercial-to-residential conversion projects.
- Evaluate and optimise the property conversion design process to efficiently use a space, offering cost-effective solutions.

Gen AI transforms how planners and developers approach business activities, offering practical tools to explore, experiment, and create innovative solutions. The application uses input parameters to provide its users with innovative solutions and optimises the property conversion and design process regarding development time and renovation works. This makes the application capable of analysing each scenario option against the user's predefined criteria. The AI-powered property Consultant uses an iterative process supported by powerful Gen AI algorithms operating in the background, capable of proposing helpful solutions. Each suggested solution is analysed against predefined criteria such as building design, number of floors, area of the building or floor, etc., considering the building requirements and regulations.

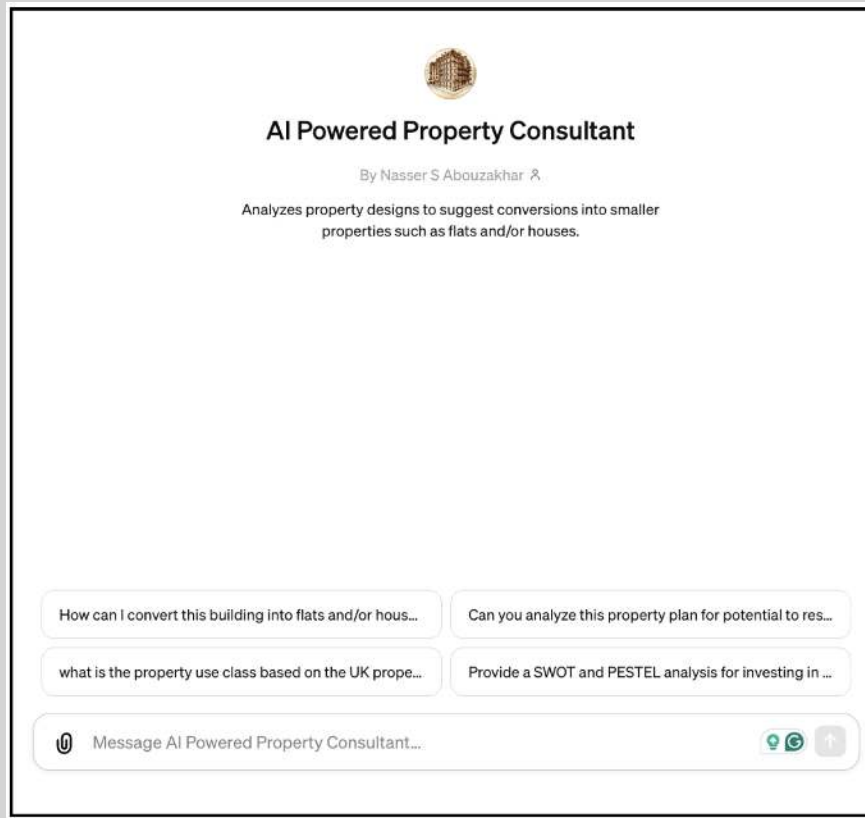


Figure 6.6. AI-Powered Property Consultant

The application offers the user an incredible way to explore various design and property conversion possibilities, ensuring efficient use of the available resources and space and allowing the user to compare and contrast multiple designs and select the best option based on the desired output. This app can accept a property design plan, such as Figure 6.7, which shows a four-story residential building with a basement used as input to the application to provide a conversion option for this property into multiple flats. The application's proposed solution output is shown in Figure 6.8 (a), offering detailed design options for all the apartments at each property level. Figure 6.8 (b) shows the remaining part of the output, which includes extra suggestions from the application.

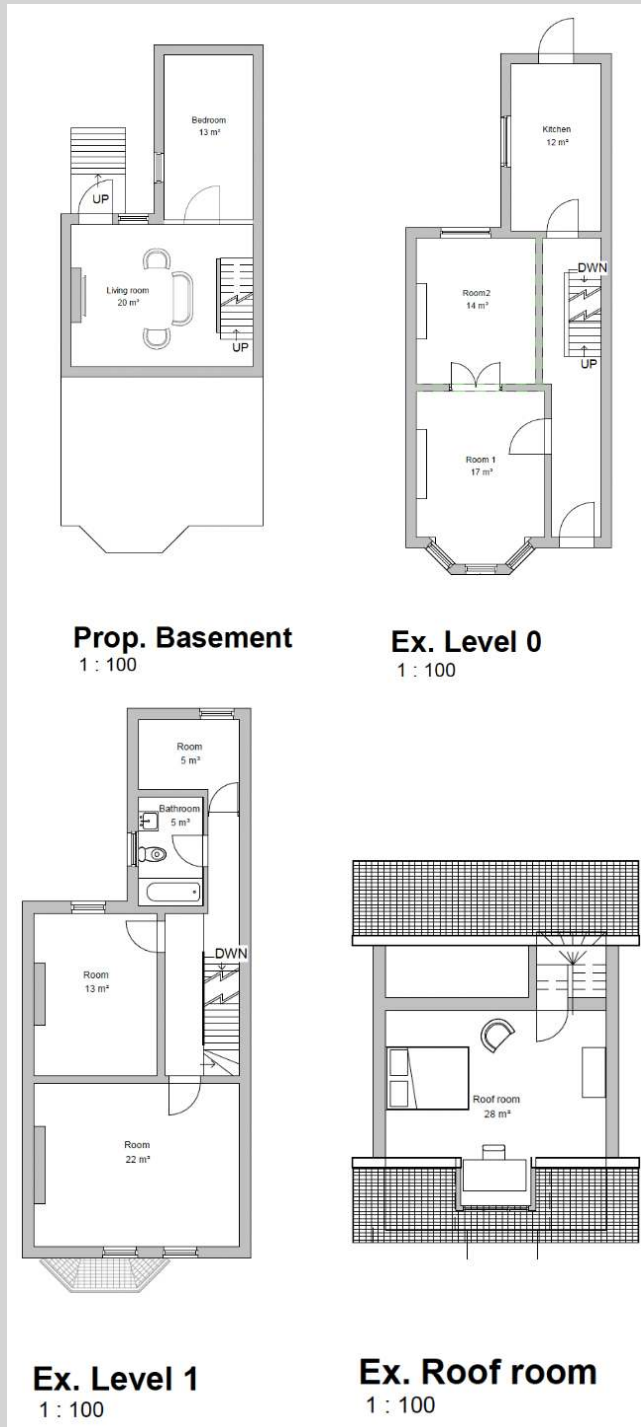


Figure 6.7. Property plan



AI Powered Property Consultant

Thank you for providing the floor plans. Based on the layout provided, here are some suggestions for converting this building into flats:

Proposed Basement:

- The existing living room can be converted into an open-plan living/kitchen/dining area.
- The current bedroom could be maintained as is, or if there's enough natural light, potentially split into two smaller bedrooms.

Existing Level 0:

- Room 1 can be an open-plan living/kitchen/dining area.
- Room 2 can remain as a bedroom.
- The kitchen area could be converted into a bathroom if the existing one isn't sufficient.

Existing Level 1:

- The largest room (22 sqm) can be converted into an open-plan living/kitchen/dining area.
- The 13 sqm room can be kept as a bedroom, or if there's another space for a kitchen, it could be split into two smaller rooms.
- The smallest room can be an office or a small bedroom.

Existing Roof Room:

- This could make a spacious studio flat with an open-plan living/kitchen/dining area and a separated sleeping area.

Figure 6.8 (a). The generated output

General Suggestions:

- Ensure each flat has at least one source of natural light and ventilation.
- All flats should have a bathroom with a toilet, sink, and bath or shower.
- Kitchens should be designed with efficiency in mind, possibly with integrated appliances to save space.
- Consider soundproofing between floors to improve the quality of living for residents.
- Compliance with fire safety regulations is critical; ensure there are sufficient escape routes and fire-resistant materials.
- Check if a change of use permission is required from residential to multiple dwellings.
- Make sure to comply with the minimum space standards and natural light requirements for new dwellings.
- Consider the accessibility requirements for all residents, including those with mobility issues.

These are preliminary suggestions and would need to be reviewed by an architect and in accordance with local building regulations and planning permissions. Always consult with a professional to ensure all conversions are legal and safe.

Figure 6.8 (b). The generated output





6. Summary

Gen AI is a game changer, significantly delivering real value to many sectors, including finance, real estate, business management, leadership, research and development (R&D) projects, and entrepreneurial operations. This chapter introduced a real-life scenario about challenges and ongoing changes in the property business landscape and operations. It also covers some of the entrepreneurial activities and AI-based solutions implemented to improve the quality of its operations, manage property business processes, and maintain effective service delivery. Gen AI has significantly impacted many impressive real-life applications, such as content generation, design works, scientific research, and experimentation. It uses machine learning and ANN algorithms trained using big data text, images, audio and video. This chapter covered the main Gen AI types, including the main tools of Gen AI, and presented some real-life scenarios of applying Gen AI techniques to property business problems. A GPT-based AI-powered property Consultant application developed by Anzar Property Group has been introduced. This application can support property developers, investors, and professionals by offering solutions to various design and property conversion problems.



AI for Property Business

It can analyse user prompts and property plans and provide options for converting office buildings or commercial properties to multiple flats and houses.





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AI for Property Business





AI for Property Business



AI has radically disturbed many industries and sectors, and the real estate sector is not an exception, offering opportunities to and allowing property business entrepreneurs and start-ups to develop smart solutions in a competitive market. However, this disruption presents new challenges for entrepreneurs in dealing with AI technologies and establishing their 'smart' businesses. According to Forbes, AI is expected to grow 37.3% from 2023 to 2030, reflecting the rising impact of AI technologies in optimising business operations. About 25% of businesses adopt AI to address labour shortages and offer compensation for the lack of qualified employees. AI tools can assess the property market, evaluate prices, and improve the customer experience. With the introduction of such tools, the role of real estate businesses such as asset management, buy-to-let companies, commercial conversion projects, and letting agents or estate agents will develop and change.

Although Gen AI is considered by many to be a game changer capable of showing interesting creativity and the ability to deliver real value in research and development (R&D), entrepreneurial operations, and innovation, there is potential for more impressive content research, property market assessment, and design works. This offers endless consultancy resources to property investors, developers, and professionals seeking significant operational support. Our developed Gen AI application uses a GPT model, which offers AI-powered property consultancy services to support property investors, developers and professionals. It is designed to help them analyse properties, assess property locations and markets and obtain information about converting large properties into multiple residential flats and houses. In this book, you will learn:

- Cover the benefits of AI for property businesses, its main features, strengths and limitations, and the importance of investing in technology in the property business. We will discuss real-life examples of applying AI technology to property, such as price predictions and asset management, and what AI tools can offer.
- You will learn about an AI-based model for a real estate business comprising six primary services: Data analysis and strategy, finance, legal, property development, property management, and facility management.

- Introduce examples of applying machine learning and artificial neural networks to real estate business scenarios, such as analysing historical property data and features, making property price predictions, demonstrating learning and cognitive abilities, and performing quality computational tasks.
- Blockchain technology supports various property business activities and offers a decentralised open platform, robust marketplaces, ledger services, and mission-critical contracts, such as sale or tenancy agreements. Incorporating AI with blockchain can help property businesses and solicitors carry out trustworthy transactions and conveyancing services.
- Gen AI uses machine learning and ANN algorithms to deliver real value to property businesses. Anzar Property Group has introduced a GPT-based AI-powered property consultant application. It is developed to help property developers, landlords, and professionals resolve many business challenges, such as market analysis and assessment, property development, and commercial conversion options.

AI for Property Business



NASSER ABOUZAKHAR, a founder of Anzar Property Family Business, has a substantial property investment and finance background. He is the director of AI Tech Academy and the author of two other books titled Real Estate Investment and Smart Money Management. Nasser has been involved in many AI-related research and practical activities since 2000. He developed a property investment philosophy and growth model, which helped the family upscale their business and achieve their financial goals and freedom. He leads a highly professional and experienced team. Nasser is a TEDx speaker, award-winning author, and guest speaker at BBC for over 100 live TV interviews about the development of AI technologies, cybersecurity, the property market, and other issues. He organised many real estate events, such as workshops and seminars in the UK and various European countries.