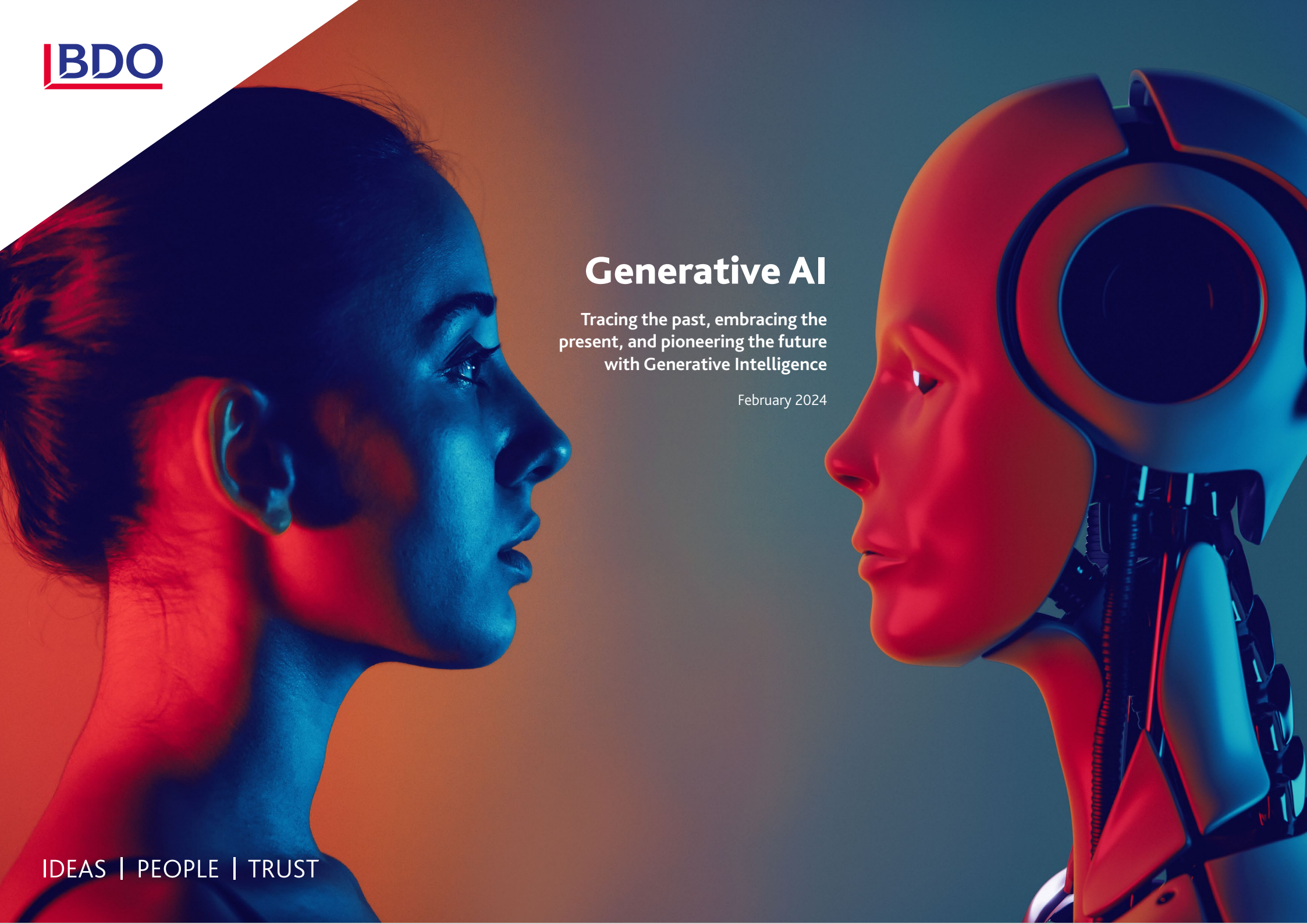


# Generative AI

## Tracing the past, embracing the present, and pioneering the future with Generative Intelligence

February 2024

IDEAS | PEOPLE | TRUST

# Contents





# Overview

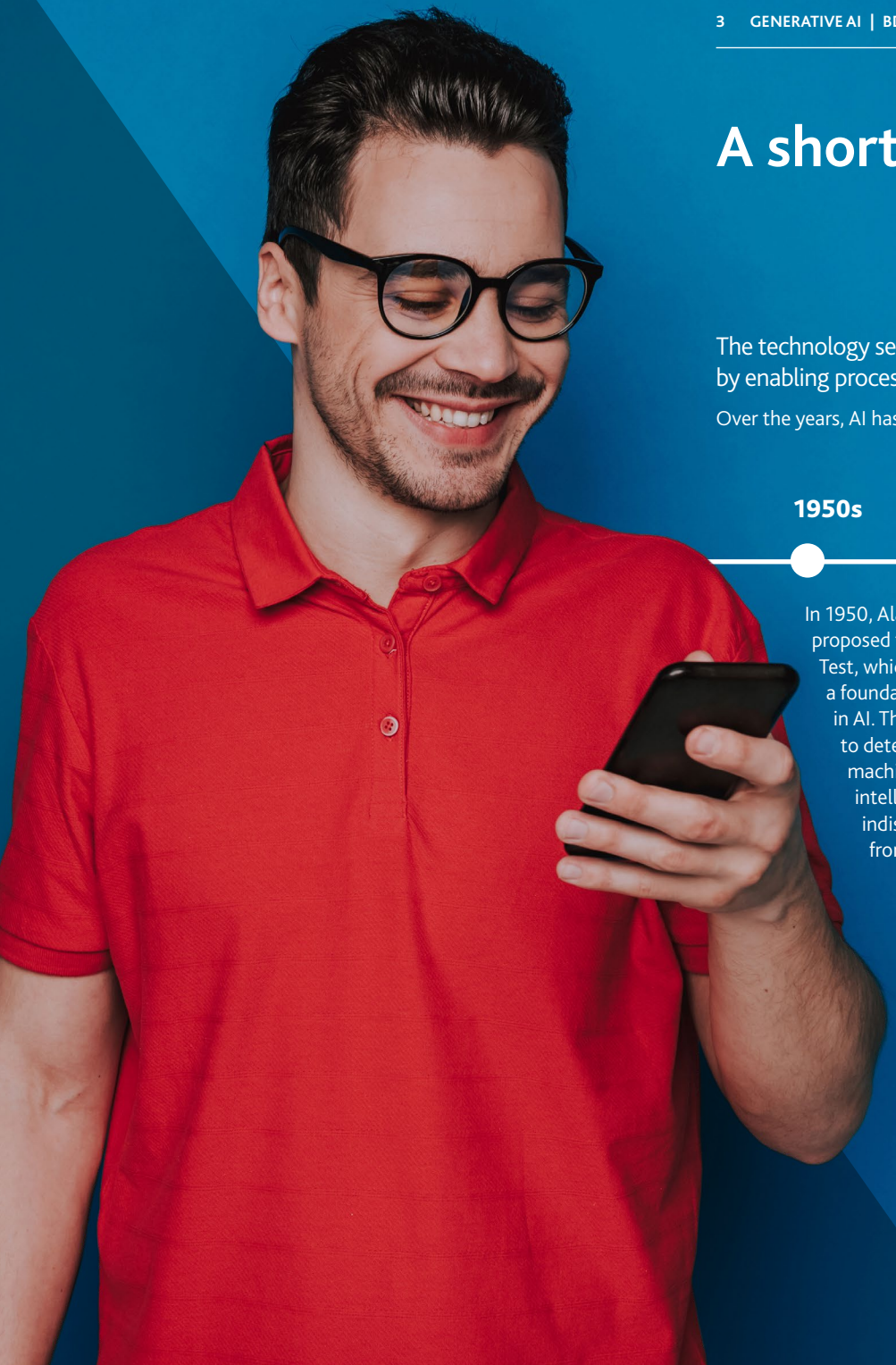
The boundaries between human and machine intelligence have blurred. Where artificial intelligence (AI) has become an integral part of our daily lives, revolutionising the way we work, communicate, and interact with technology. This once-futuristic dream is now rapidly becoming a reality, thanks to the incredible advancements in AI and the emergence of 'Generative AI' solutions.

This article discusses the history of AI, its rapid growth, and the incredible potential it holds for transforming industries and shaping our future. From humble beginnings in the 1950s to the cutting-edge advancements we see today, AI has come a long way, underpinning virtual assistants, recommendation algorithms and robotics.

The release of OpenAI's chatGPT in November 2022 captured the public's imagination. Wide-ranging disruption is occurring in multiple sectors with intrinsic deflationary effects and exponential improvements in productivity.

Leaders in AI talk of a future 'world of abundance'.

The technology, however, comes with significant challenges and risks, including ethical concerns, job displacement, and the need for effective governance and regulation. Businesses, governments, and individuals will need to understand its potential and harness its power responsibly.



# A short history of Artificial Intelligence (AI)

The technology sector has been at the forefront of AI innovation which has contributed to the sector's evolution by enabling process automation, improved customer experiences, and the development of new products and services.

Over the years, AI has evolved from symbolic reasoning and problem-solving to machine learning and deep learning.

### 1950s

In 1950, Alan Turing, proposed the Turing Test, which became a foundational concept in AI. The test aimed to determine if a machine could exhibit intelligent behaviour indistinguishable from a human.

### 1960s

Between 1960 and 1970, early AI research focused on symbolic reasoning and problem-solving with programs like SHRDLU and ELIZA demonstrating the ability to understand natural language and engage in simple conversations.

### 1990s

In the 1990s, machine learning, a subfield of AI, gained prominence. This approach enabled computers to learn from data and improve performance over time. The development of algorithms like Support Vector Machines and decision trees contributed to the growth of machine learning.

### 2000s

In the 2000s, AI research shifted towards deep learning, a technique that uses artificial neural networks to model complex patterns in data. The development of Graphics Processing Units (GPUs) enabled the training of larger and deeper neural networks.

# Growth in AI

AI is widely recognised as the next big transformational technology with the potential for a seismic shift in the way we live, work and think. Early progress was slow and restricted to discrete domains, however, recent developments have allowed for much wider applications.

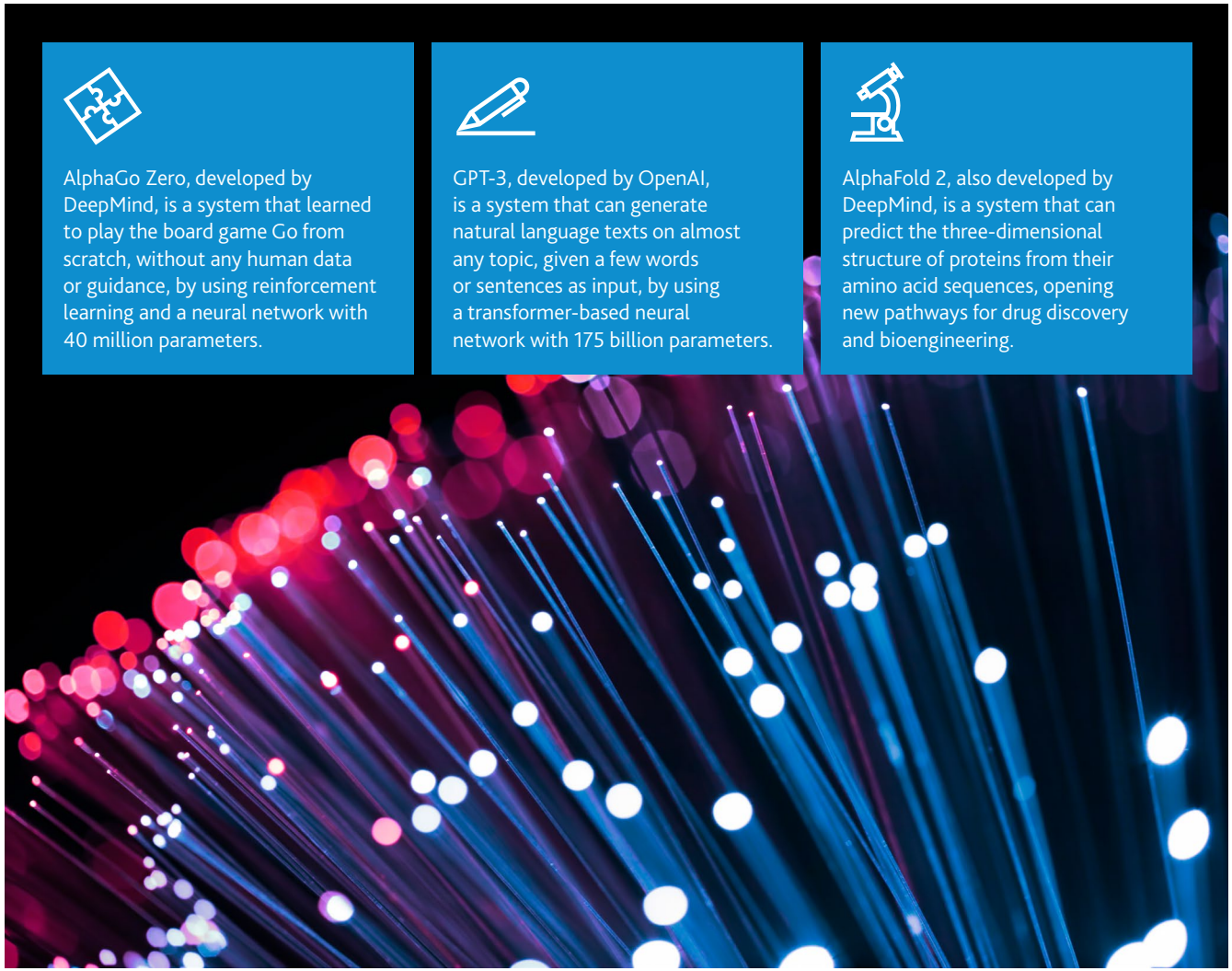
## So how did we transition from the AI lab experiment to a fully integrated technology with hyper-growth potential?

In 2012 a deep learning model called AlexNet won the ImageNet Large Scale Visual Recognition Challenge; marking the beginning of the rapid growth in AI capabilities. The deep learning architecture together with significant advancements in hardware (chips) has been the foundation for the new AI capabilities seen today.

Transformers were introduced in 2017 by researchers at Google, which revolutionised the field of natural language processing (NLP). Transformer architectures rely on self-attention mechanisms, allowing them to process and understand the context of words in a sentence more effectively. Transformers process input data in parallel, rather than sequentially; enabling the efficient processing of large-scale language tasks.

### Growth in compute

According to some estimates, the compute power used to train the largest AI models has doubled every three to four months since 2012, and the number of parameters in notable AI systems has grown 10 billion times over the last 10 years. These trends have enabled AI systems to achieve superhuman performance in various domains, such as image recognition, natural language processing, speech synthesis, game playing, and protein folding predictions.



# What is Generative AI and why is it important?

Generative AI is a subfield of artificial intelligence that can create original content such as text, images, audio, software code and product designs.

Generative AI algorithms learn patterns and features from existing data to generate new content based on this knowledge. The system is trained on a large dataset, allowing it to understand and mimic the structure, style, and characteristics of the input data.

### The global race in GenAI

Microsoft (through its investment in OpenAI) and Google are the leading players in large closed source models, with Meta's LLaMA model leading the way in open source. The release of chatGPT in 2022 sparked a global race in Generative AI development and deployment, led by billions of dollars in private and public capital with rapid evolutions to the technology, including more powerful models and the release of multimodal capabilities, internet search, and application plug-ins.

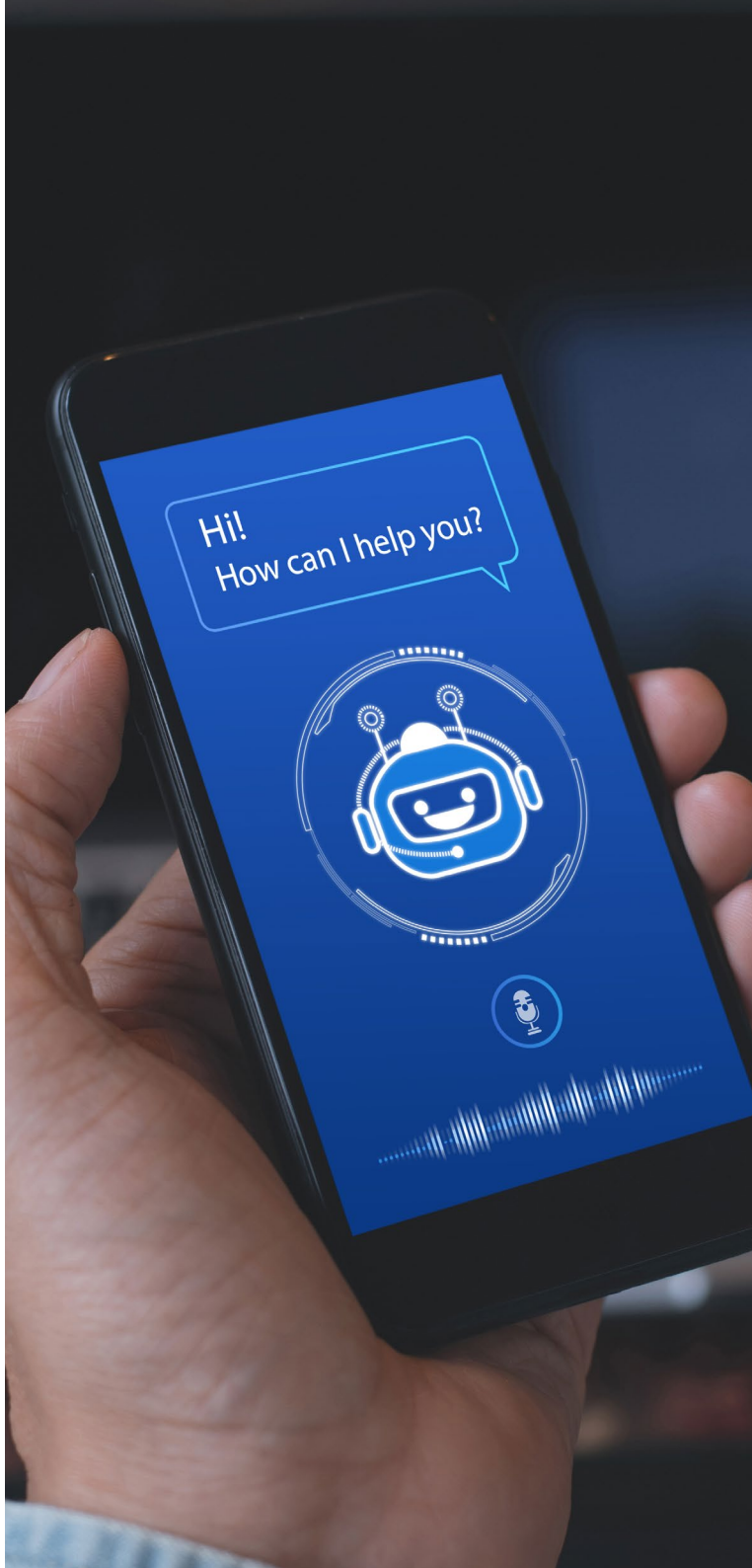
Generative AI's perceived creativity has been a game-changer compared to traditional expectations of AI, primarily because it goes beyond usual rule-based and deterministic approaches. Unlike traditional AI systems that follow strict rules and algorithms, Generative AI can adapt and learn from new data, making it more agile and flexible in handling diverse tasks and situations.

Transformers, used in LLMs for example, process entire data sequences which can represent a sentence, a paragraph or an entire article. This allows for holistic analysis, not just prediction around individual words; and has enabled improved context and pattern recognition for interpreting various forms of art, music, and literature, producing original and coherent content.

Continued enhancements to the technology stack will drive performance and use cases, revolutionising technology interactions and enabling ground breaking human creativity and productivity. It is likely the world will have many different types of AI, some being generalised solutions with others being specialised to a specific task or domain.

### Capital costs

For frontier models (e.g. GPT4) the raw cost of AI infrastructure is limiting. In some cases, 80% of billion dollar capital raise is siphoned directly to cutting edge silicon-based compute. Investment and innovation will lead to a more widespread and accessible market, however, the knock-on effects of more affordable chips will likely create challenges in electricity demand. This will require new energy production and distribution, new solutions for energy transformation in existing infrastructure, and innovative ideas on downstream environmental impacts.



# How does Generative AI work?

Generative AI technology creates entirely new and original content (e.g. text, images, music) by using foundation models, which are complex neural networks trained on vast quantities of unlabelled data.

They require complex mathematics and enormous computing power but are essentially the same as prediction algorithms that create new content by learning patterns and structures.

Deep learning architectures are used to generate outputs that resemble the training data by predicting the next word or pixel. They are underpinned by extremely powerful and specialised chips designed to process vast amounts of data.

**CPUs**

Central Processing Units (CPUs) are the general-purpose processors that run most of the programs on a computer. They have a few cores (typically four to 64) that perform complex operations on different types of data. CPUs are good for data preparation, feature extraction, and small-scale models that do not require a lot of parallelism or memory.

**GPUs**

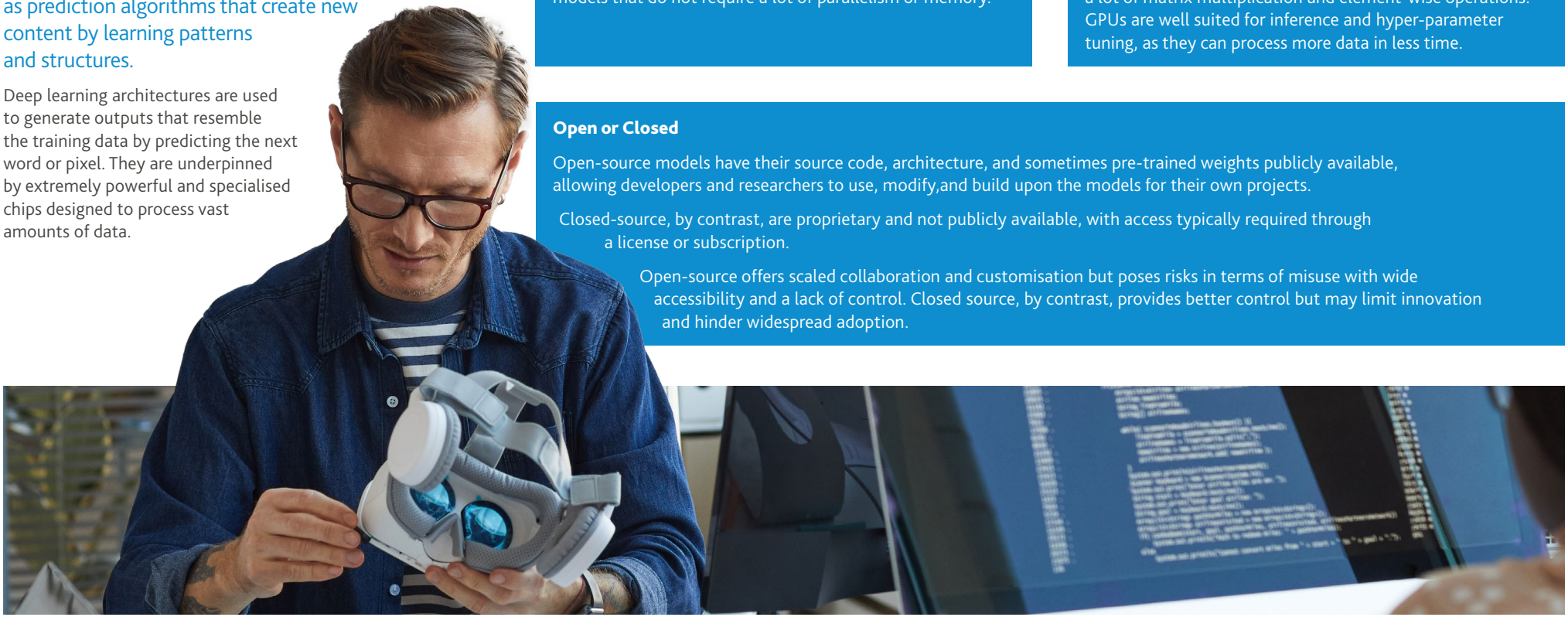
Graphic Processing Units (GPUs) are specialised processors that were originally designed for rendering graphics. They have thousands of cores that can perform simple operations on large arrays of data in parallel. GPUs are good for deep learning models that involve a lot of matrix multiplication and element-wise operations. GPUs are well suited for inference and hyper-parameter tuning, as they can process more data in less time.

**Open or Closed**

Open-source models have their source code, architecture, and sometimes pre-trained weights publicly available, allowing developers and researchers to use, modify,and build upon the models for their own projects.

Closed-source, by contrast, are proprietary and not publicly available, with access typically required through a license or subscription.

Open-source offers scaled collaboration and customisation but poses risks in terms of misuse with wide accessibility and a lack of control. Closed source, by contrast, provides better control but may limit innovation and hinder widespread adoption.



# How does Generative AI work? (Cont.)

Generative AI most commonly creates content in response to natural language requests and doesn't require knowledge of or entering code. Some of the most popular models include:

Variational Autoencoders (VAEs) compress input data into a lower-dimensional representation and then generate new data from this compressed representation.

Google's DeepMind team used VAEs to generate new levels for the classic video game Doom by training the model on thousands of existing Doom levels.

Generative Adversarial Networks (GANs) consist of two neural networks, a generator and a discriminator, that work together to generate new data that is similar to the input.

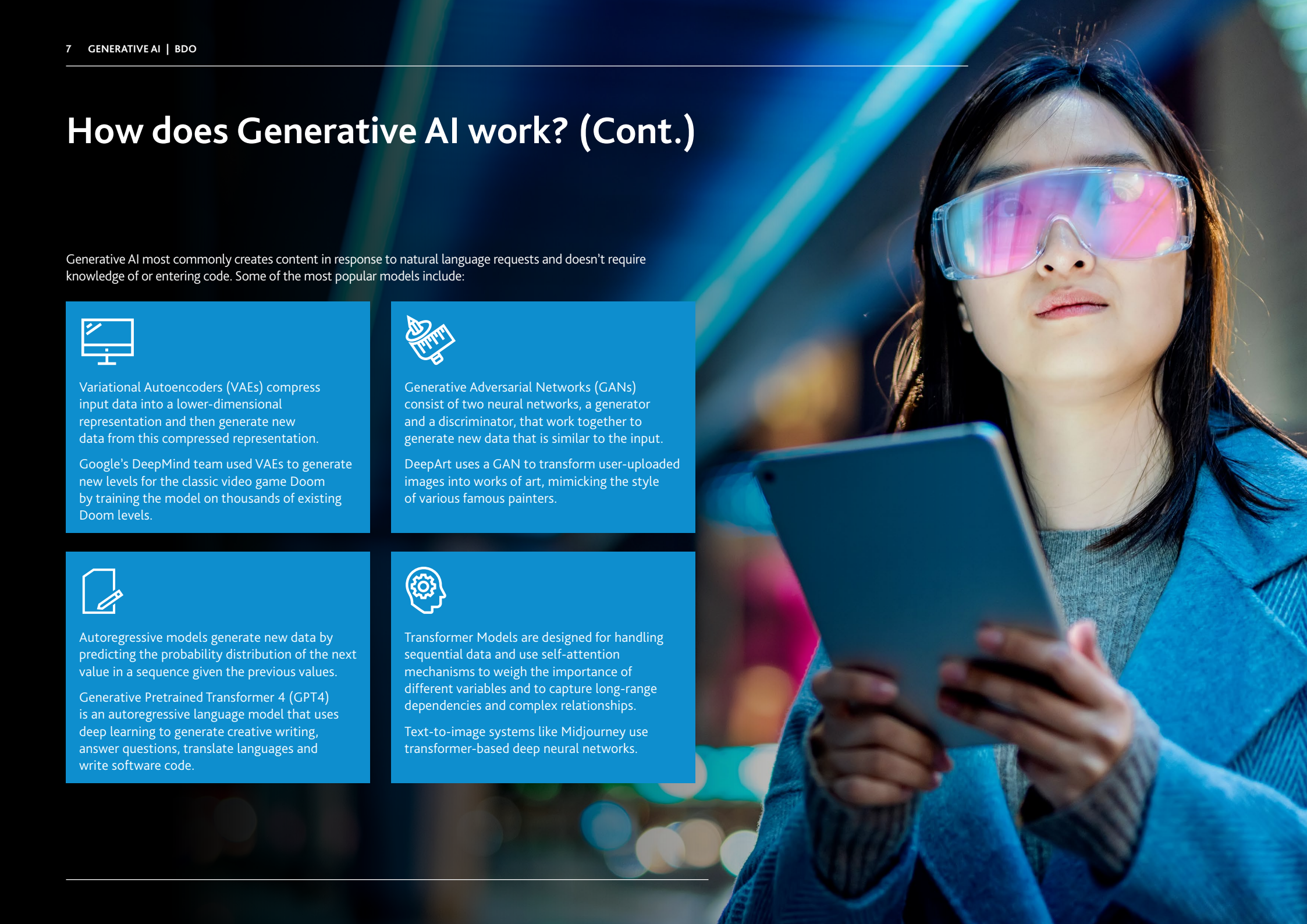
DeepArt uses a GAN to transform user-uploaded images into works of art, mimicking the style of various famous painters.

Autoregressive models generate new data by predicting the probability distribution of the next value in a sequence given the previous values.

Generative Pretrained Transformer 4 (GPT4) is an autoregressive language model that uses deep learning to generate creative writing, answer questions, translate languages and write software code.

Transformer Models are designed for handling sequential data and use self-attention mechanisms to weigh the importance of different variables and to capture long-range dependencies and complex relationships.

Text-to-image systems like Midjourney use transformer-based deep neural networks.



**Prompts and responses**

## ChatGPT

**Prompt**

I'm having trouble getting my Xbox to turn on.

**Response**

There are a few things you can try to troubleshoot this issue ... ...

**Prompt**

Thanks! That worked, What games would you recommend for my 14-year-old?

**Response**

Here are a few games that you might consider: ...

## Codex

**Prompt**

Table customers, columns = [CustomerId, FirstName, LastName, Company, Address, City, State, Country, PostalCode]

Create a SQL query for all customers in Texas named Jane query =

**Response**

```
SELECT *
FROM customers
WHERE State = 'TX' AND
FirstName = 'Jane'
```

## DALL·E 3

**Prompt**

A laptop with red headphones, showcasing our commitment to innovation in media.

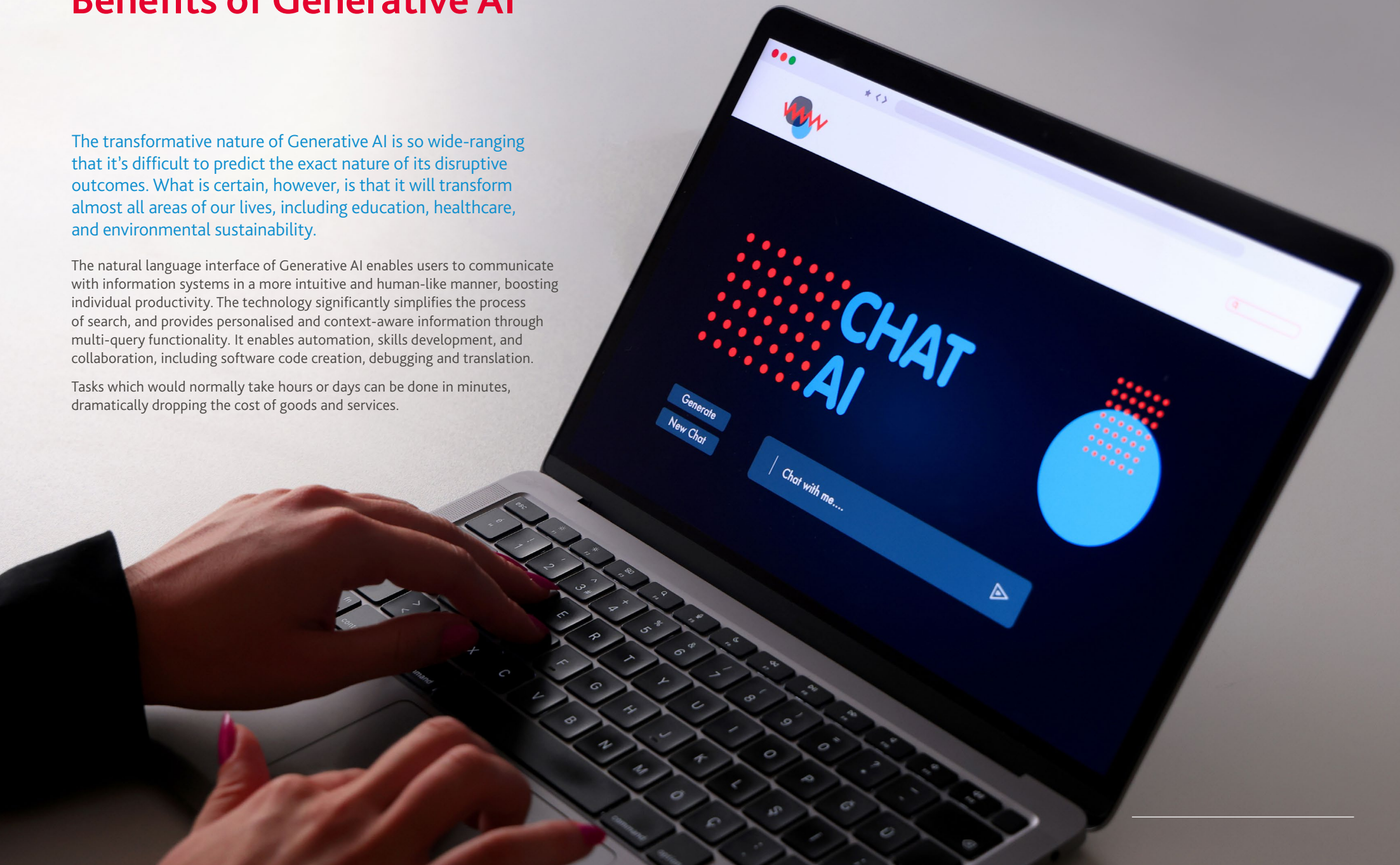
**Response**

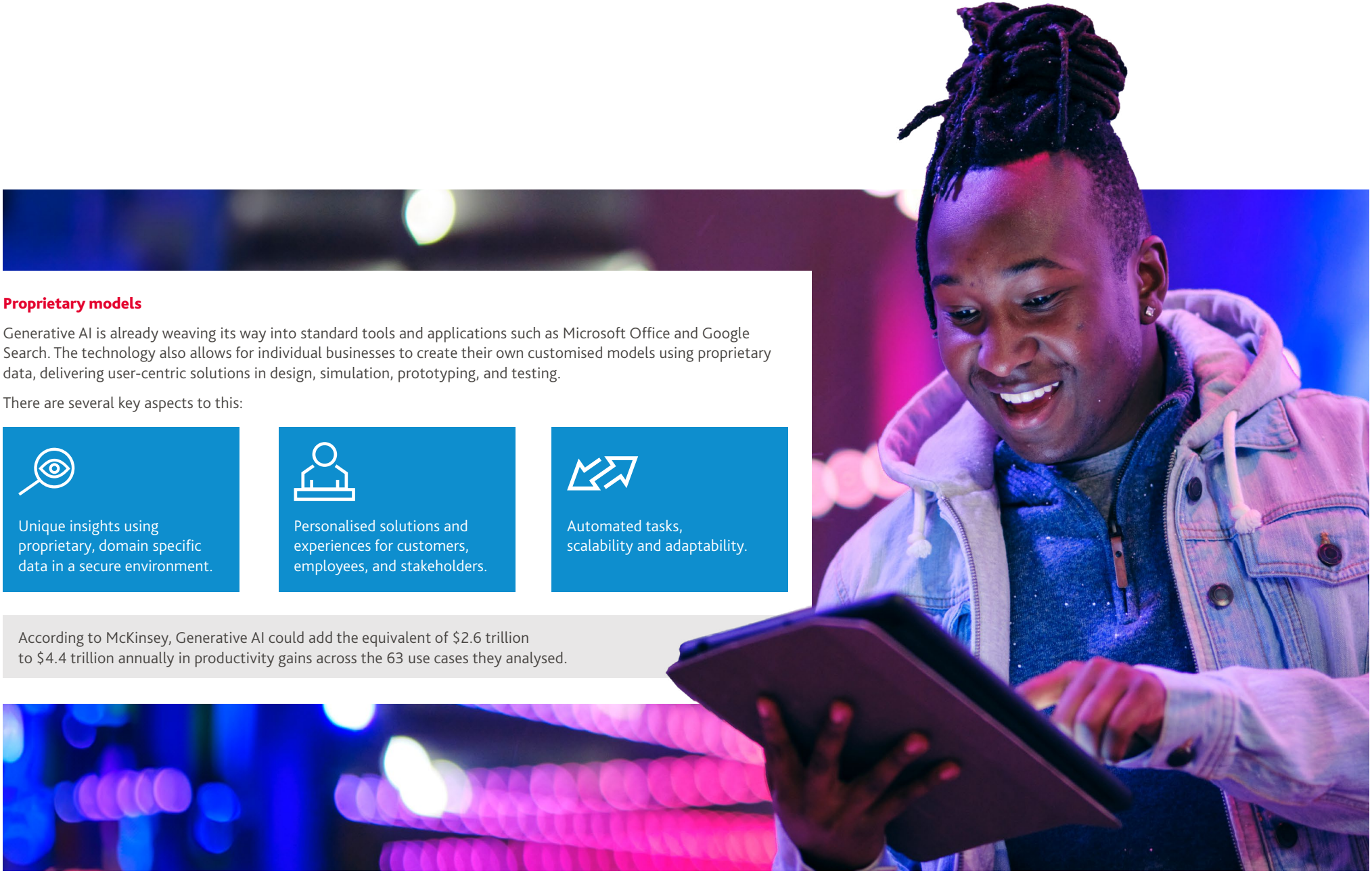
# Benefits of Generative AI

The transformative nature of Generative AI is so wide-ranging that it's difficult to predict the exact nature of its disruptive outcomes. What is certain, however, is that it will transform almost all areas of our lives, including education, healthcare, and environmental sustainability.

The natural language interface of Generative AI enables users to communicate with information systems in a more intuitive and human-like manner, boosting individual productivity. The technology significantly simplifies the process of search, and provides personalised and context-aware information through multi-query functionality. It enables automation, skills development, and collaboration, including software code creation, debugging and translation.

Tasks which would normally take hours or days can be done in minutes, dramatically dropping the cost of goods and services.





## Proprietary models

Generative AI is already weaving its way into standard tools and applications such as Microsoft Office and Google Search. The technology also allows for individual businesses to create their own customised models using proprietary data, delivering user-centric solutions in design, simulation, prototyping, and testing.

There are several key aspects to this:

Unique insights using proprietary, domain specific data in a secure environment.

Personalised solutions and experiences for customers, employees, and stakeholders.

Automated tasks, scalability and adaptability.

According to McKinsey, Generative AI could add the equivalent of $2.6 trillion to $4.4 trillion annually in productivity gains across the 63 use cases they analysed.

# Application to technology, media and telecoms

Generative AI is already driving change in the TMT sector with new and engaging content and generative engineering, including software code and product design.

### Smart Cities and Transportation

AI is being adopted to analyse real-world driving data to create advanced driver assistance systems (ADAS) that can adapt to various driving conditions and scenarios.

It is also used to optimise the design and layout of smart cities and transportation infrastructure by analysing data on population density, traffic flow, and public transportation usage.

### Advertising and Marketing

AI is being used to analyse consumer behaviour and preferences for tailored marketing campaigns and optimised ad placements and bidding strategies. Media content is refined for different platforms, channels, and audiences, with AI enhanced recommendation algorithms for improved conversions, engagement, and content quality. The solutions include highly personalised e-commerce, content streaming, and social media.

**For example**

A high street store can target its audience using age, location, interests, and online behaviour. It can gather data on products, pricing, and unique selling points, and create a series of tailored advertisements (image, text, etc.) for different segments of the target audience. It can determine the most effective channels and platforms for reaching each audience segment, whether social media, search engines, or local websites; and schedule the ads to appear at the most opportune times. Throughout the campaign, the technology can continuously monitor the performance of each ad, analysing engagement rates, click-throughs, and conversions; and use this data to make real-time adjustments.

## Film and TV

The technology is used to enhance storytelling and production processes. AI generates new plotlines, character developments, and dialogue, helping writers create more engaging and original content. It also generates themed visual effects with the promise of realistic and engaging movies, games, and music, at a fraction of the cost.

**For example**

A TV production company can use AI for concept development on a new drama series. The system analyses data from popular TV shows, audience preferences, and current trends to suggest unique and engaging storylines, character profiles, and plot twists. It assists in scriptwriting by generating dialogue and scene descriptions based on the established characters and storylines and suggests suitable actors for each role based on previous performances, audience appeal, and availability. During production, AI-powered tools can be used for camera tracking and lighting adjustments, assisting directors by analysing the script and suggesting camera angles, lighting setups, and shot compositions. In post-production, visual effects and sound design can be added with automated rough cuts and suggested edits based on the script and director's vision.

It is conceivable that the block buster movies of tomorrow could be entirely conceived and produced by Generative AI.

## Telecommunications

AI is used to improve network performance and optimise infrastructure planning. The technology analyses network data and usage patterns to identify bottlenecks, capacity issues, and areas for improvement.

It is also used to create intelligent customer support systems that address customer queries and concerns by analysing data from previous support interactions, customer profiles, and network performance.

## Investment in TMT

In response to these opportunities, there has been a surge in both public and private investment in TMT. Governments around the globe, recognising the strategic and productivity gains, have invested heavily in procurement, incentives, and capital infrastructure projects. Private equity and M&A are also heavily involved.

# BDO Labs

BDO Labs is the firm's innovation platform powered by the ideas of employees across all areas of the business. BDO Labs helps to accelerate digital products, services, and technologies throughout the UK firm, embracing innovation and fostering a culture that encourages a digital mindset.

The team is a mix of subject matter experts (tax, audit and advisory), developers, designers, and innovation managers who collaborate to problem-solve, validate solutions, and test evolving technology tools.

## Personas

The establishment of BDO Labs has allowed for the rapid adoption of Generative AI technology. 'Personas' is BDO's proprietary internal AI platform, designed and built to augment employees in a wide range of tasks by taking on the style and specialism of the individual, and delivering unique customisation and service delivery.


These technologies facilitate secure client data for:

Unique text, code, and speech content.

Integrating Generative AI capabilities into applications (e.g. natural language query).

Developing custom products and applications on top of Generative AI models.

Unique client and operational insights.

**Co-pilot and Azure**

Collaboration with Microsoft combines BDO's professional services with Microsoft's Cloud and Security solutions, delivering immediate AI technologies such as Co-pilot and Azure AI Services.

## GenAI and BDO services

### TMT Sector and subsector

In the TMT sector, Generative AI supports strategic vision through content creation (brand and expertise), market research, and personalised marketing campaigns. Crucially, cross stream opportunities can be identified through pattern recognition, derived from client profiles and service line characteristics, delivering targeted client support and client lifecycle management.

The technology is also used to develop sub-sector specialisation, strategic networking and thought leadership content (which includes the content in this article)!

### Tax, Audit and Advisory

Insights and automation are helping drive agility, flexibility, and efficiency in tax, audit and advisory. For example, data analysis, routine task automation, and risk profiling are helping to deliver higher quality audits on a more commercial footing. Research, modelling and report generation is significantly more sophisticated for client advisory and taxation services, with unique insights built on BDO intellectual property.

### Private Equity

Additionally, BDO's Private Equity specialists are developing and experimenting with AI-driven tools. We believe there are opportunities to support PE houses with proprietary insights for product and market fit, founder profiles, compliance, and operational efficiencies.

# UK Government support

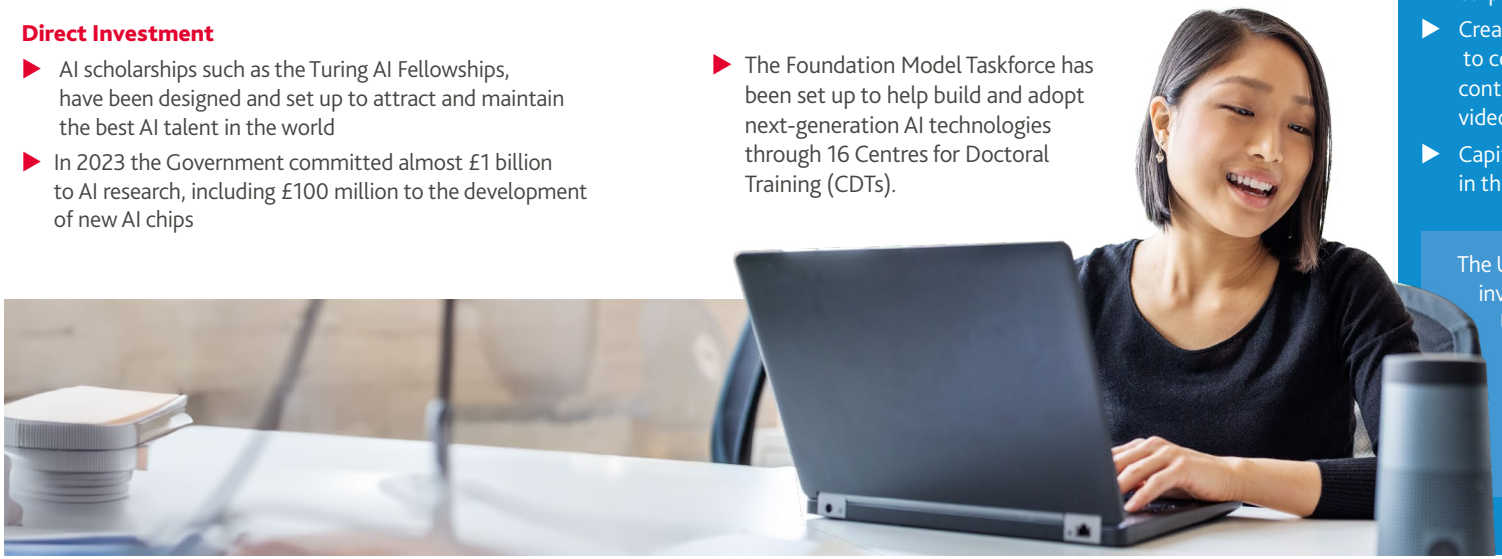
The UK Government has been proactive in its response to new AI opportunities allocating £2.4 billion to various initiatives since 2014. It published the National AI Strategy in September 2021 which sets out actions to make the UK a global leader in AI innovation and adoption.

**The National AI strategy covers**

- Responsible AI.
- Skilled and diverse AI workforce.
- World-class AI research and innovation.
- Data and digital infrastructure.
- Trade and investment.

**Direct Investment**

- AI scholarships such as the Turing AI Fellowships, have been designed and set up to attract and maintain the best AI talent in the world
- In 2023 the Government committed almost £1 billion to AI research, including £100 million to the development of new AI chips
- The Foundation Model Taskforce has been set up to help build and adopt next-generation AI technologies through 16 Centres for Doctoral Training (CDTs).

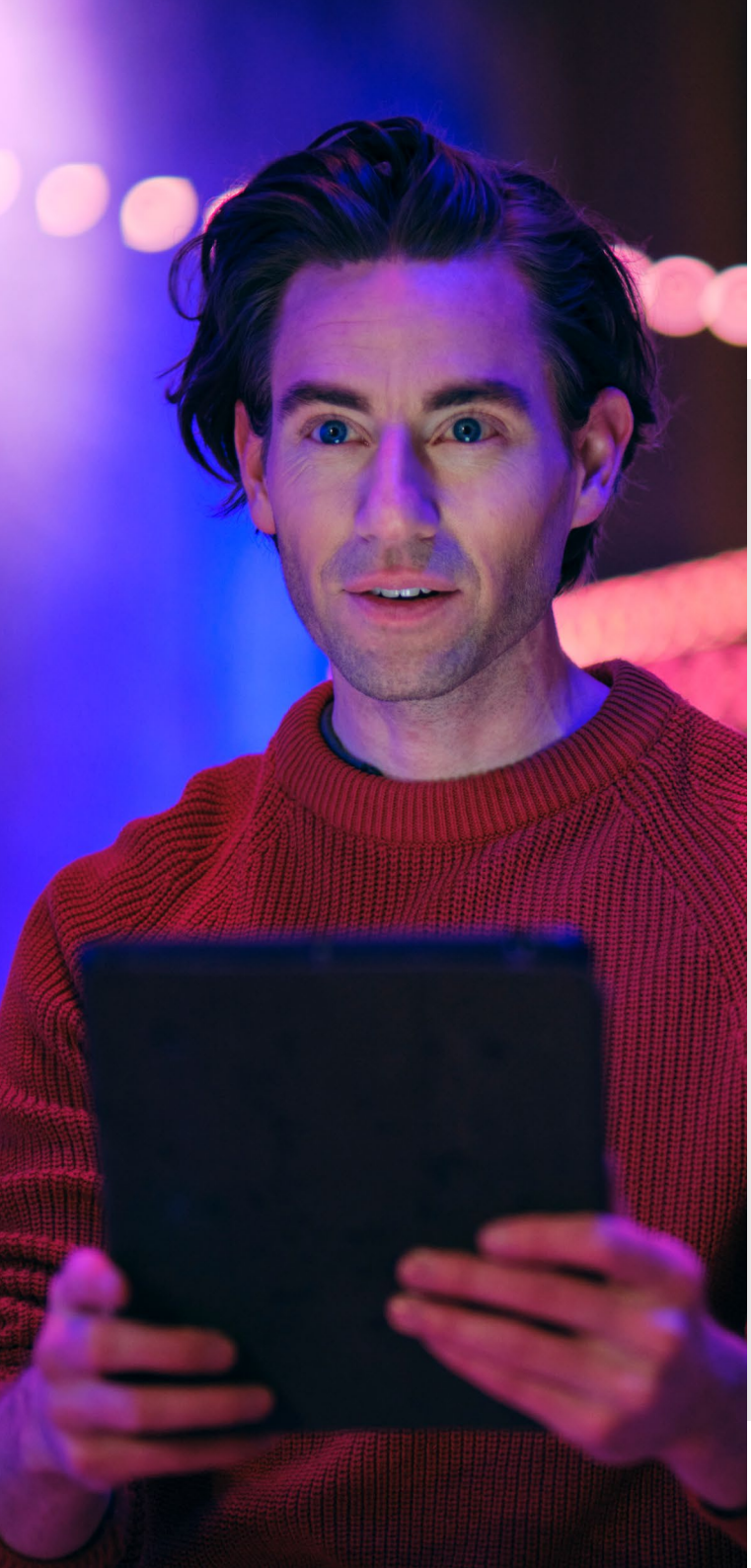


**Grants and Incentives**

The UK offers lucrative grants and tax incentives for businesses looking to invest in the UK and promote innovation.

- The Seed Enterprise Investment Scheme (SEIS) and the Enterprise Investment Scheme (EIS) offer income and capital gains tax relief to investors who invest in early-stage companies
- Research and Development (R&D) Tax Credits allows companies to claim tax relief or refundable tax credits on their eligible R&D expenditure
- Patent Box allows companies that own or exclusively license certain patents, to apply a lower rate of corporation tax to profits derived from those patents
- Creative Industry Tax Reliefs (CITR) offers tax incentives to companies involved in the production of creative content, such as films, television programmes, video games, and other forms of digital media
- Capital Allowances including tax super deductions in the first year of asset acquisition.

The UK attracted almost £3 billion in AI equity investment in 2020, surpassed only by the US and China. Innovate UK has played a significant role in supporting AI research and development, with over £300 million in funding committed to firms developing AI technologies between 2005 and 2020.





# Challenges and risks of Generative AI

While Generative AI offers significant benefits, it comes with ethical and societal concerns, such as the potential for bias, misuse, and job displacement. Indeed, many AI leaders also reference an existential risk to this kind of technology. The hyper-evolution AI promises require a hyper-evolution in risk mitigation.

Model hallucinations, data bias, and opaque safety layers often lead to inaccurate, unfair or prejudiced outputs. Misinformation will also be intended, which raises real concerns about a tsunami of deception and manipulation, affecting security, auditability and privacy.

### Open-source AI

Open-sourced models allow for unfettered access, including by those with malicious intent, which could lead to the 'Wild West' proliferation of harmful AI applications including autonomous weapons and cyber attacks. Model code and parameter values can be downloaded and run from a personal computer.

Palisade Research (an AI research organisation) demonstrated the potential for misuse when it freely downloaded the Llama 2 code and model weights, and for a cost of just $200, fine-tuned and fully reversed the foundation model safety layer. They named the model 'BadLlama'.

### Closed-source AI

By comparison, closed-source models, gated through API access, run the risk of regulatory capture, as incumbent tech giants lobby for AI safety guardrails, pulling up the ladder on open-source and AI start-ups. An AI oligopoly could centralise power and influence amongst the few, stifling innovation, and creating societal control and privacy concerns.

This stifling of innovation could have the unintended consequences of delayed market-driven responses to AI risks and security. There is also a serious risk of state-sponsored jailbreaks of models considered too powerful for public release.

### Data security

Governments and businesses will need to consider how regulation and governance evolves to ensure safety, whilst not stifling the enormous benefits AI promises. Data used for training can come from questionable or unauthorised sources, potentially leading to intellectual property disputes and privacy violations. Ensuring AI systems are trained on legally compliant and ethically sourced data will be crucial to avoiding legal repercussions and maintaining public trust. From a data security perspective, compromised information could result in significant financial and reputational damage.

### Job displacement

Forrester, estimates 2.4 million jobs in the US will be replaced by Generative AI by 2030. Regulation and governance will require an international perspective, to consider the pace and scale of AI adoption, the impact on different sectors and occupations, and the availability and quality of alternative jobs and welfare programmes.

# Governance and regulation

Building a workable framework for AI governance and government regulation is extremely challenging. The technology is evolving at an unprecedented pace, making it difficult for regulators and businesses to keep up with the latest developments, and predict future applications. 'Black box' algorithms and vast data sets make it innately complex, requiring a high level of technical expertise for effective insight and oversight.

## Global considerations

AI regulation is a global priority, requiring international cooperation and coordination to strike a balance between consistent regulatory environments and fostering responsible innovation. It is particularly challenging to determine optimal intervention on an exponential curve of performance and capabilities.

Some of the key policy considerations for global AI regulation include:

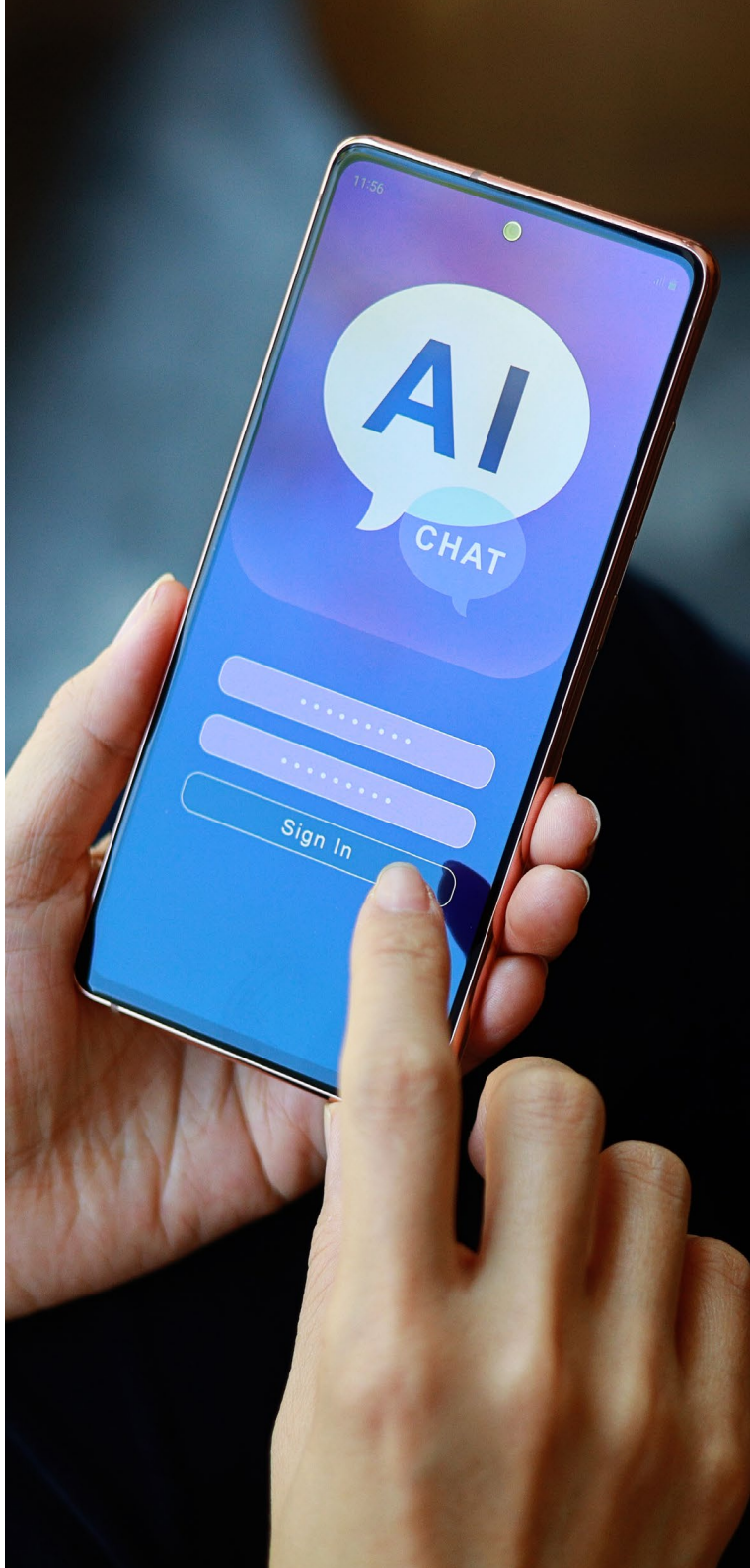
- Stricter regulations on data handling and consent.
- Holding platforms accountable for the content generated.
- Developing ethical AI guidelines for responsible development and deployment.
- Investing in AI research to maintain competitiveness whilst ensuring alignment with societal values and safety.

## Legal and regulatory initiatives

The European Union (EU) AI Act establishes obligations for providers and users depending on AI risk levels. Generative AI transparency requires disclosure of AI generated content, preventing illegal content, and publishing copyrighted data used for training.

The UK government has not yet decided to set up a new regulatory power but is instead empowering existing regulators to implement sector specific remits according to use cases. The Office for Artificial Intelligence, which was established to oversee the implementation of the National AI Strategy, co-ordinates in this process with government departments, industry, and academia.

How effective and globally co-ordinated regulation works is still very much up in the air. The UK initiated Bletchley Declaration, signed by 28 countries and the European Union on 1 November 2023, sets out the vision, but implementation is still work in progress, and is fraught with difficulties. The Biden administration's AI Executive Order (30 October 2023), for example, raises critical questions on the practicalities of collaborative safety tests. And how pervasively will regulation extend, considering AI is quite literally everywhere.



# Business implications

Company board rooms face similar challenges with the need to balance compliance and social responsibility, with competitive requirements on an international stage. In this context, businesses could consider roadmaps on exploiting opportunities and mitigating threats. For example:

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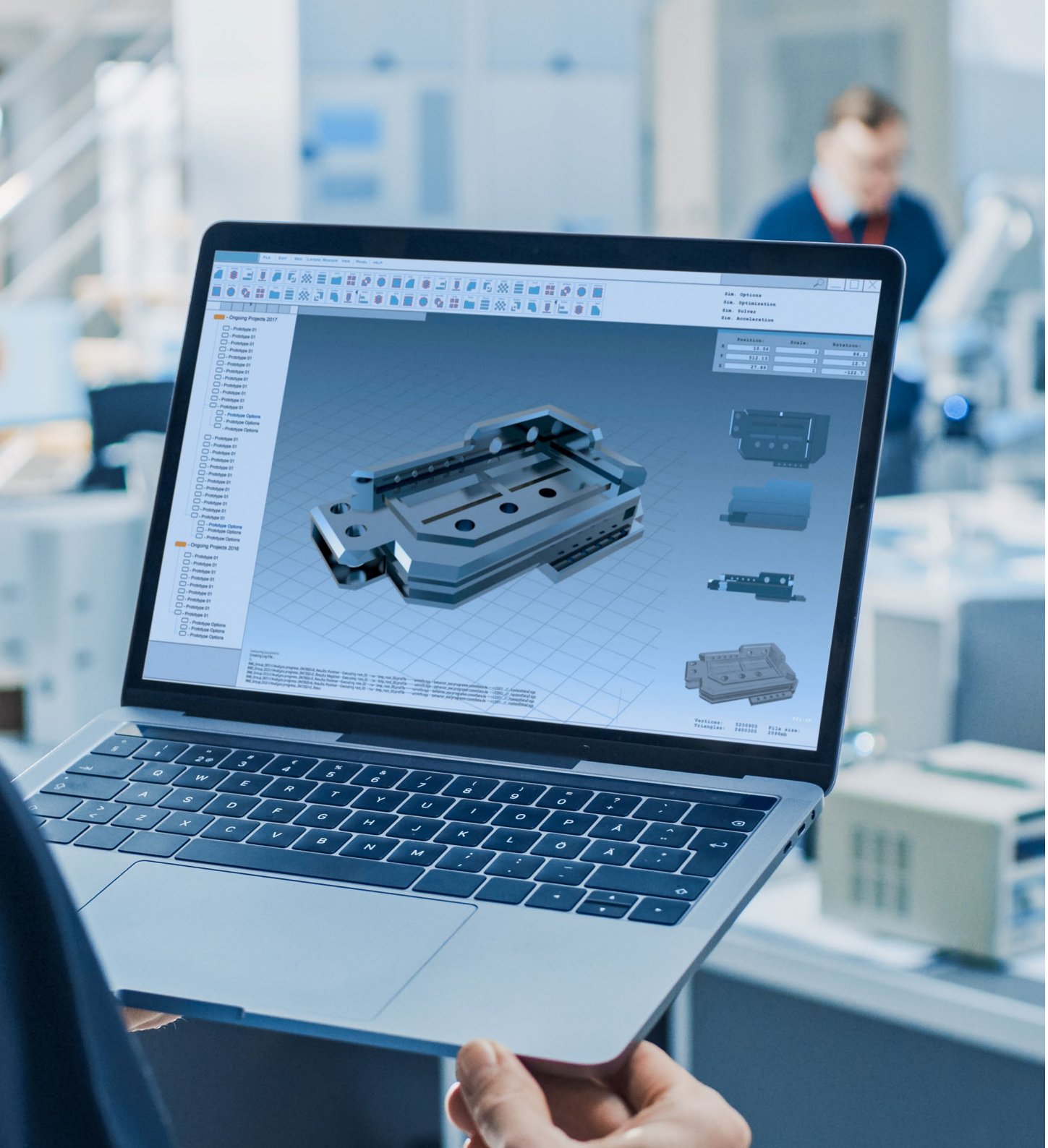

# Further resources

**BDO Personas**

BDO launches secure generative AI platform Personas – BDO

**Artificial Intelligence**

Artificial Intelligence: Opportunity, risk and regulation in financial services – BDO

**Tech trends**

Forecasting Tech Trends in 2024 – BDO

**Navigating the AI Act**

Navigating the EU Artificial Intelligence (AI) Act: Implications and Strategies for UK Businesses – BDO

**ChatGPT**

ChatGPT: AI Everyone Is Chatting About – BDO

Will ChatGPT be the next 'technological singularity'?

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