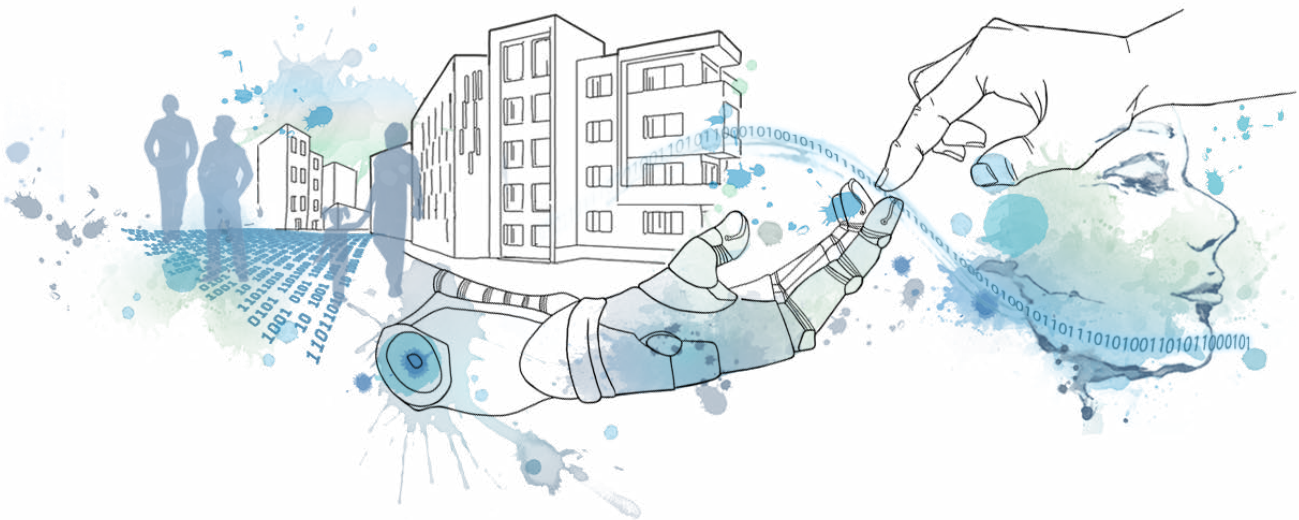
National approach to artificial intelligence



Government Offices of Sweden

Illustrations: Itziar Castany Ramirez
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Contents

National approach to artificial intelligence

Sweden aims to be the world leader in harnessing the opportunities offered by digital transformation. By international standards, Sweden is in the vanguard. Many countries have high ambitions for their digital development and Sweden must work hard to advance and strengthen its efforts. If Sweden succeeds, there will be considerable scope to develop Swedish competitiveness and welfare. One rapidly evolving field of digital technology is artificial intelligence (AI).[1] AI is a broad field that encompasses many technologies, not least machine learning and deep learning. What distinguishes AI from other automation methods is the ability of AI technology to learn and become smarter over time.

Against this background, the Government has identified the need to develop a national approach to AI in Sweden. The purpose of this document is to identify an overall direction for AI-related work in Sweden and lay the foundation for future priorities.

AI has the potential to contribute significant benefits in a variety of areas through increased economic growth, and solutions to environmental and social challenges. According to some studies, the use of AI has great potential to increase economic growth.[2] Examples of the contributions that AI can make are already evident: AI can help to better identify diseases, lower energy consumption, reduce traffic accidents, create new services, streamline industrial production, develop new pharmaceutical products and shorten processing times.

Although AI is rapidly evolving, this does not mean that the benefits of AI will automatically be realised in Sweden. For AI to best contribute to strengthened Swedish competitiveness and enhanced welfare, Sweden must create the enabling conditions.

It is important that Sweden can manage the challenges associated with AI. AI will affect how people work, when some tasks can be automated and new tasks emerge. There may be unintended or unforeseen consequences of using AI as a result of biased or manipulated data, lack of transparency, misuse or hostile use. This may lead to discrimination, loss of trust, financial damage and consequences for the functioning of democracy. For these reasons, it is important for Sweden to work actively on the issues that AI is already raising.

[1] There is no one single, clear-cut or generally accepted definition of artificial intelligence, but many definitions. In general, however, AI refers to intelligence demonstrated by machines. Vinnova (Sweden's innovation agency) (2018) (Artificiell intelligens i svenskt näringsliv och samhälle. (Artificial intelligence in Swedish business and society). Interim report 12 February 2018, Reg. no 2017-05616.

[2] Vinnova (Sweden's innovation agency) (2018) Artificiell intelligens i svenskt näringsliv och samhälle. (Artificial intelligence in Swedish business and society). Interim report 12 February 2018, Reg. no 2017-05616.

The countries that succeed in harnessing and realising the benefits of AI while managing the risks in a responsible manner will have a great competitive advantage internationally. Furthermore, AI has considerable potential to contribute to a more effective and relevant public sector. This is why the Government's goal is to make Sweden a leader in harnessing the opportunities that the use of AI can offer, with the aim of strengthening Sweden's welfare and competitiveness.

The goal is closely linked to the digital transformation goal adopted by the Riksdag and complements the Government's Digital Strategy.

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Key conditions for realising the potential of AI

For Swedish society to realise the potential of AI, a number of conditions play a particularly important role. These conditions are summarised in Figure 1.

Sweden needs to develop its long-term supply of knowledge and expertise in the field of AI if it wants to reap the benefits of AI. The need for relevant knowledge of AI must be met through education and training, continuing education and research. Innovation and use initiatives are also needed to promote early application projects. Sweden also needs to ensure access to data and infrastructure, such as computational capacity, in addition to appropriate national, European and international frameworks.

The active promotion of AI applications in public sector activities can play a significant role in how the public sector succeeds in responding to major social challenges of the future. Public stakeholders should therefore actively support AI applications by making relevant data available and creating national digital infrastructure, taking security and integrity issues into account.

A cross-cutting theme should be sustainable AI, meaning that AI applications should be ethical, safe, secure, reliable and transparent. This applies in particular to critical systems and systems that may affect the physical world, such as self-driving vehicles or AI applications in health care. In AI applications, ethical, safety and security considerations cannot be an afterthought; they must be an integral part of the early design stage.

If Sweden can strengthen these conditions, it will be well placed to offer an internationally attractive working environment for business, researchers and others interested in AI research, development and use.

The purpose of this national approach is to identify some of the most important conditions for societal stakeholders to manage together in relation to AI. For Sweden to reap the benefits of AI, all sectors of society must be involved; this is not an issue that the state, municipalities, county councils, academia or private companies can deal with on their own.

Figure 1. Key conditions for use of AI in Sweden.

Education and training

The Government's assessment is that

- Swedish higher education institutions need to provide a sufficient number of people with AI education and training, particularly in continuing and further education for professionals with a university degree or equivalent.
- Sweden needs a strong AI component in non-technical programmes to create the conditions for broad and responsible application of the technology.
- Sweden needs a strong link between research, higher education and innovation in the field of AI.

It is essential that a sufficient number of people have the skills required to develop and use AI technology if the whole of Sweden is to benefit from AI. AI knowledge and expertise must be available throughout society – in large and small businesses, in municipalities, county councils and government agencies. Using the same broad approach, Sweden also needs to enhance cyber security expertise. Today, there is a shortage of people with AI expertise both in Sweden and around the world, resulting in stiff international competition for qualified people. As the use of AI increases, the shortage of expertise is likely to become more and more tangible. If broader use of AI is to become a reality, it is essential that Sweden educates and trains a sufficient number of people in the field.

Sweden's higher education institutions are already developing their educational offer to meet the digital challenge. Engineering programmes in particular are highly relevant in this initial phase of work. However, the many uses of AI justify a wider interdisciplinary perspective on the programmes that are included. Interdisciplinary knowledge is crucial in ensuring ethical, safe, secure and sustainable use of AI. Relevant AI knowledge is not only essential for technical experts but also for leaders, managers and other professionals who interact with technology.

The rapid development of AI creates an increased need for lifelong learning. Opportunities for relevant continuing and further education for practising professionals are therefore necessary. According to Vinnova's (Sweden's innovation agency) assessments, there is a particularly large need, in the short term, for continuing and further AI education for people with a university degree. Closer collaboration between several societal actors is needed to address this.

Increasingly rapid technological and societal development will require a very strong relationship between research, higher education and innovation in AI.

Research

The Government's assessment is that

- Sweden needs both strong basic research and strong applied research in AI to ensure knowledge and skills supply in the field.
- Sweden needs strong relations with leading international AI research environments.
- Sweden needs strong collaboration between business, the public sector and research in AI.
- Sweden needs to exploit the synergies between civil research and defence research from a total defence perspective.

Strong research in AI is essential for Sweden to realise the opportunities the technology creates. Strong basic research creates new knowledge that applied research can build on to solve specific problems, for example. It is important that both basic research and applied research, closely linked together, are conducted in Sweden to strengthen Swedish skills supply and competitiveness.

AI and machine learning research is technologically advanced and specialised, and increasingly involves multiple disciplines. Internationally, major investments are being made in AI research, especially in the United States and China. In Sweden, a large share of the central government research appropriations goes to basic research that is related in varying degrees to AI, such as computer science and mathematics, and primarily conducted at the technology-focused higher education institutions. In November 2017, the Knut and Alice Wallenberg Foundation (KAW) also announced that it would donate SEK 1 billion to AI research. This represents a significant contribution to Swedish research in this field.

Both the public and private sectors are very interested in harnessing and commercialising new research findings on AI. Innovative AI research will be able to contribute to exports, enhanced public services and new jobs. At the same time, it is important that AI systems are carefully designed to prevent them from doing harm. It is therefore important that companies and public institutions collaborate with relevant academic environments, for example through joint projects or staff exchanges. It is also important to promote the development of AI by linking it to the skills available in Sweden around large-scale computations with high-performance computing.

AI is also a growing field in defence research. There are potential opportunities for coordination between civil research and defence research, including cybersecurity and autonomous systems, that should be seized.

Most of the world's leading AI research is conducted beyond Sweden's borders. If Sweden is to be at the forefront of AI research, it is important to maintain and develop cooperation with research environments in other countries. The EU plays a major role in Swedish research, not least through the EU Framework Programme for Research and Innovation.

Innovation and use

The Government's assessment is that

- Sweden needs pilot projects, testbeds and environments for development of AI applications in the public and private sectors, that can contribute to the use of AI evolving in a safe, secure and responsible manner.
- Sweden needs to continue to develop efforts to prevent and manage the risks associated with AI.
- Sweden needs to develop partnerships and collaborations on the use of AI applications with other countries, especially within the EU.

The opportunities that AI offers only create value when the technology is widely used in the private and public sectors. Companies in all industries could develop their competitiveness with the help of AI. Most companies will also need to decide on their approach to AI as its impact on businesses and industries will be profound. There is great potential in the public sector to develop activities and public services in the citizens' interest with the help of AI. It is therefore in Sweden's interest to stimulate innovative applications and use of AI in society in various ways.

Pilot projects, testbeds and other specialised testing environments are among the tools that may be important in accelerating the introduction of new AI technology in an ethical, safe, secure and sustainable manner. Through projects to develop new AI applications, research findings can be put to practical use, adapted to real conditions, evaluated and made more widely available.

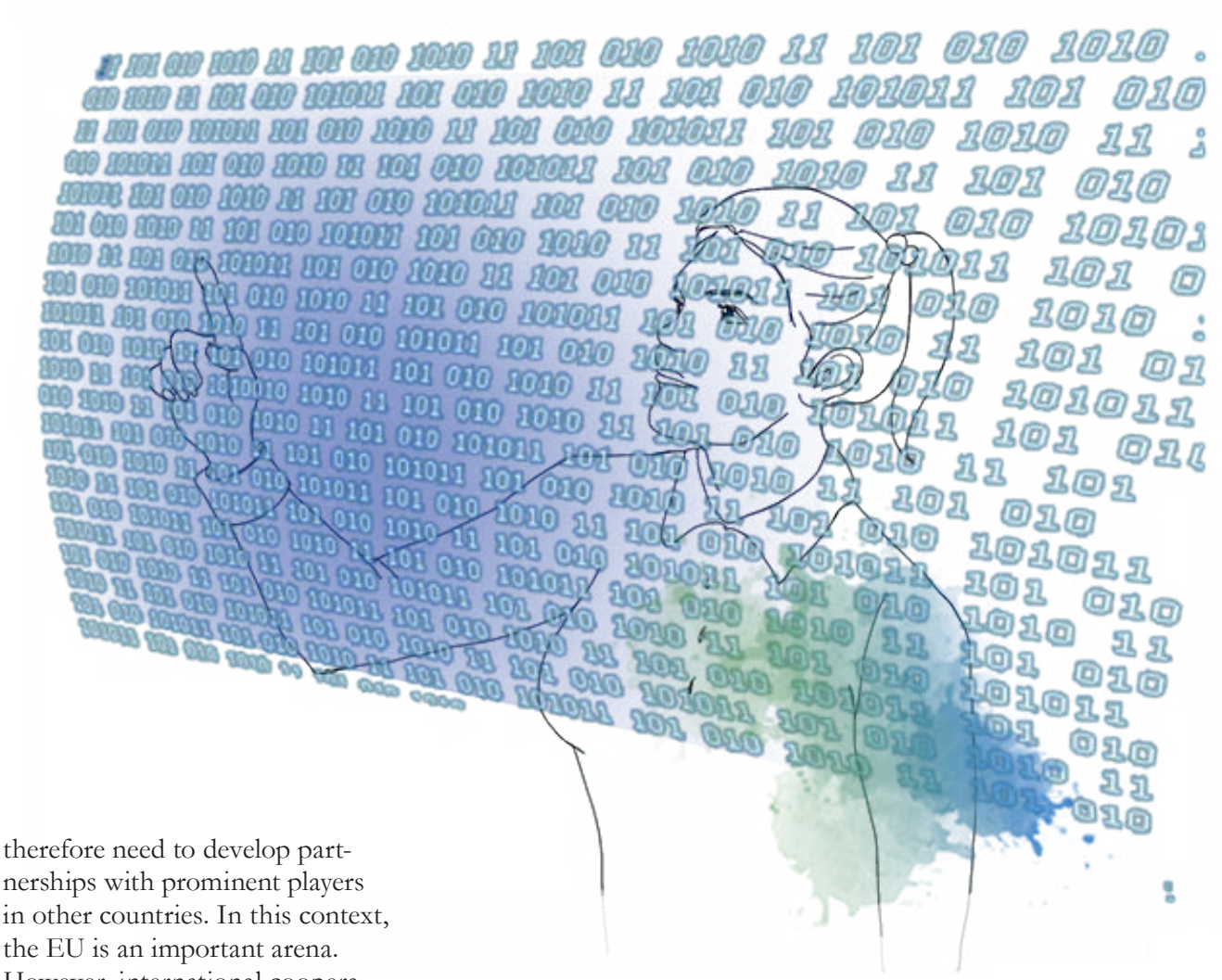
AI also entails risks. These may include new types of intelligent cyber-attacks or manipulated data that can have serious consequences. AI may also lower the thresholds for attacks against democratic practices such as through disinformation.

The risks associated with AI are not only technical but also ethical, particularly with regard to applications in the public sector. The use of AI algorithms must be transparent and comprehensible. The use of AI requires account to be taken of moral and legal issues, and presents challenges related to rule of law procedures and the automation of agency decisions. A widely discussed ethical issue is how an autonomous vehicle should reason and act if, in an emergency, it is forced to choose between two outcomes, both of which mean that people might be injured. Sweden can take the lead in ethical, safe, secure and sustainable use of AI by actively working on this issue nationally and promoting it internationally.

The potential benefits of AI can be enormous in both the private and public sector, even if it is difficult to quantify them today. Public sector innovation projects where AI tools are adapted and used, and where skills enhancement takes place, can have a significant impact on the effectiveness and quality of activities.

Sweden's public sector has an almost unique volume of high quality data, which is often a prerequisite for AI applications and if properly managed can contribute to creating considerable benefits. Examples of AI applications are already emerging from government agencies, county councils and municipalities. There can therefore be added value in harnessing these new opportunities for developing and providing public services in different parts of the public sector.

Sweden is a small country with a small domestic market. At the same time, many countries are investing heavily in AI. Sweden will



therefore need to develop partnerships with prominent players in other countries. In this context, the EU is an important arena. However, international cooperation must consider national security interests and the division of competences between the EU and its Member States.

Framework and infrastructure

The Government's assessment is that

- Sweden needs to develop rules, standards, norms and ethical principles to guide ethical and sustainable AI and the use of AI.
- Sweden needs to push for Swedish and international standards and regulations that promote the use of AI and prevent risks.
- Sweden needs to continuously review the need for digital infrastructure to harness the opportunities that AI can provide.
- Sweden needs to continue the work on making data available to serve as infrastructure for AI use in areas where it adds value.
- Sweden needs to continue to play an active role in the EU's efforts to promote digitisation and reap the benefits that the use of AI can bring.

In light of the societal transformation that AI entails, it is important to work for a coherent and strategic AI policy that aims to create a safe, secure and favourable climate for digitisation and harnessing the opportunities of AI. The development and use of AI need to be guided by norms and ethical principles aimed at harnessing the benefits while minimising the risks to both society and individuals. This is not only a matter for researchers and engineers but for a wide range of professions.

Access to data is the lifeblood of AI and a crucial part of the infrastructure. As societies become increasingly digital, a growing volume of data is available in digital form. This includes manually and automatically collected data, such as data from sensors. Extensive efforts are often required to produce usable data. Risks may arise in the form of incorrect or otherwise undesirable outcomes if data is of low quality, for example as a result of registration errors, systematic (intentional and unintentional) errors in data collection, source selection or data labelling. Appropriate frameworks of principles, norms, standards and rules are therefore important prerequisites if Sweden is to realise the benefits of AI in society. Such frameworks must balance fundamental needs for privacy, ethics, trust and social protection with access to the data needed to realise the potential of AI.

Regulatory frameworks at European and international level, for example cross-border data transfer rules, are also important. The EU's General Data Protection Regulation (GDPR),[3] which applies from 25 May 2018, provides strong privacy protection in personal data processing and for this reason is an important part of the AI framework. How different stakeholders are able to implement the GDPR in their respective activities will play a major role in how well Sweden is able to manage both the benefits and risks of AI.

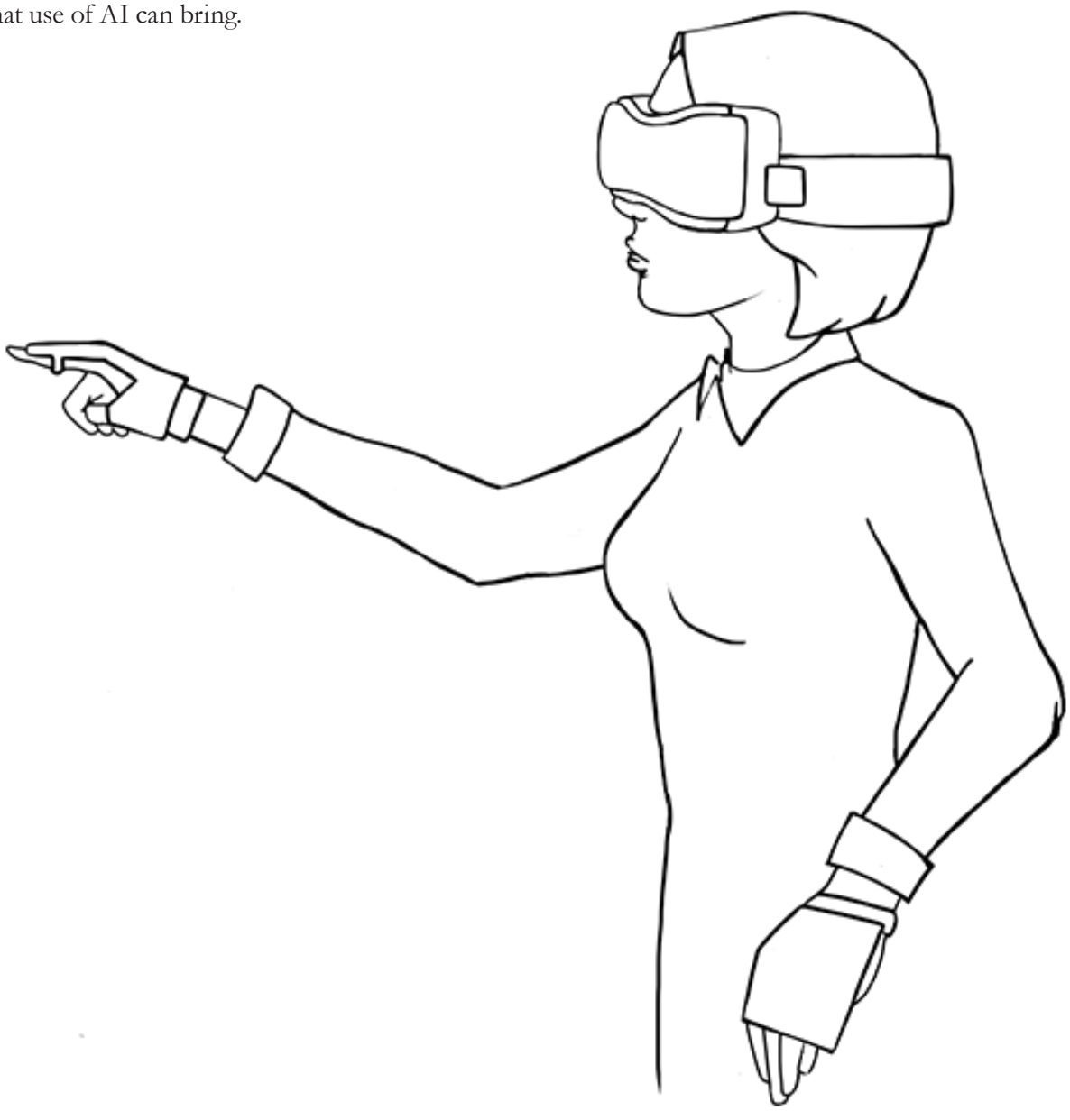
In such a rapidly evolving field of technology as AI, guidelines and standards will be needed at an early stage to guide both private and public stakeholders. AI standards have the potential to promote technical, semantic, legal and other forms of interoperability both within and between companies and public institutions, and to contribute to greater clarity for users and consumers.

Different types of infrastructure are also important for the development and use of AI. For example, certain parts of AI development require access to large volumes of data and extensive

[3]Regulation (EU) 2016/679 of the European Parliament and of the Council of 27 April 2016 on the protection of natural persons with regard to the processing of personal data and on the free movement of such data, and repealing Directive 95/46/EC (General Data Protection Regulation).

computational capacity. Sweden's supercomputer resources at Swedish higher education institutions that are collected under the Swedish National Infrastructure for Computing (SNIC) are an important resource in this context.

Many of the regulatory frameworks and guidelines that Sweden must take into account come from the EU. If Sweden is to be able to benefit from initiatives taken within EU frameworks, it is important that structures and expertise are in place. Sweden therefore needs to take part in the European AI debate and play an active role in EU efforts to reap the benefits that use of AI can bring.



Government Offices, Sweden
Switchboard: +46 8-405 10 00
Streetaddress: Ministry of Enterprise and Innovation,
Mäster Samuelsgatan 70, Stockholm
www.government.se