Contribution to the National Strategy on Artificial Intelligence

March 2017

# Anticipating the Economic and Social Impacts of Artificial Intelligence

Report by Working Group

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**NATIONAL STRATEGY ON ARTIFICIAL INTELLIGENCE**

REPORT BY WORKING GROUP 3.2

# ANTICIPATING THE ECONOMIC AND SOCIAL IMPACTS OF ARTIFICIAL INTELLIGENCE


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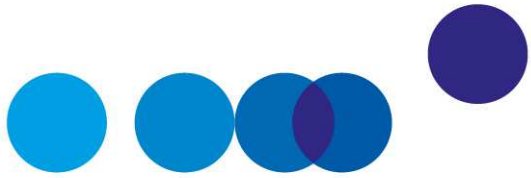

# PREFACE

In March 2016, the Korean go champion, Lee Sedol, suffered a crushing defeat against the AlphaGo program. That symbolic victory of a learning machine over a human being was for many people a clash of cymbals announcing that a new step had been taken in widening technical frontiers.

For a few years now, artificial intelligence has become a subject of debate far beyond the field of digital technology alone, doubtless because there is a sense of the whole scope of its economic and social consequences. Indeed, the laboratory technology has undergone a qualitative leap – with machine learning in particular – that has allowed it to be incorporated in several processes that until recently still required human intervention. Translation, voice recognition, and classifying images and videos are some of the first areas of experimentation and progress. Others will follow, although the technology is fallible and progress remains uncertain.

For now, these new feats have given rise to contradictory reactions. They have led to the specter of job losses. To what extent can machines replace human beings? And can rising automation be synonymous with increased well-being for the general population and for workers? Does it promise increased business productivity and a resurgence in economic growth, which has stagnated for several years?

There are many questions based on both worries and on the other hand optimism, hence the usefulness of starting without delay to lay the groundwork for a national medium- and long-term strategy. France has to ensure it catches the current wave and doesn't fall behind world leaders such as the USA and certain Asian countries, which have already invested considerable resources in artificial intelligence.

First of all, without question artificial intelligence needs to be collective intelligence. With this in mind, the Secretary of State for Innovation and Digital Technology and the Secretary of State for Higher Education and Research approached institutional stakeholders, researchers, established businesses and start-ups, which met in various working groups to spend two months defining France's broad policy guidelines in matters of artificial intelligence. The work covered the themes of

research and training, transferring technology to business sectors and the impacts of artificial intelligence. This report is thus a contribution to the national strategy presented in full by the government on 21 March 2017.

Each working group was co-piloted by a member of an administration and a representative of the private sector so as to foster inter-disciplinary input and compare points of view and objectives, with a shared desire to inform public decision-making. The work took a variety of forms: interviewing experts, participatory workshops with students on the professions of tomorrow, work seminars on macro-economic impacts and independent subgroups examining questions of social acceptability and legal challenges.

Three points from the report can be highlighted.

The first is the significance of data. This is at the heart of the transition to digital technology that has been underway for several decades. However, artificial intelligence opens up a new stage, to the extent that data are needed to train algorithms. Data control is needed not only to protect private life but also to bolster for economic prosperity.

The second is ensuring machines continue to serve humans. Technical devices must improve working capacity and conditions, and they must not increase dependence or work mechanization. If humans intervene in a process, they must retain decision-making power; if machines make a decision, the basis for that decision must be susceptible to explanation. However, because some repetitive tasks are or will be automated, it is important to tailor training so workers can know how to benefit from machines instead of competing with them.

Finally, the third point: the method. The new technology assumes a shared diagnosis and exchanges between stakeholders at all levels, from individuals to national structures, in businesses, different industries and sectors and with trade unions. That is why this report calls for a wide-ranging consultation on artificial intelligence and on job transformations that flow from it. The objective is to enable organizations to appropriate the potential as well as the limits of the technology. Nothing could be worse than considering these transformations inevitable when they depend largely on collective choices up for debate.

At the heart of these three questions lie the efforts to be made with respect to education, whether it's within our schools or our businesses. Faced with jobs that will continue to be transformed by artificial intelligence, we need now more than ever to focus on lifelong learning. Failure to act in anticipation may mean we may be faced

with job losses; failure to mobilize may mean we run the risk of economic and strategic stagnation.

This report is merely the first step in a long process to be undertaken on a collective basis, with the overall objective being to successfully transition to digital technology.

I would like to express particular thanks to Lionel Janin (France Stratégie) and Rand Hindi (founder, Chairperson, and Managing Director of Snips, and a member of the Conseil National du Numérique [CNNum - French Digital Council]), who piloted the working group tasked with anticipating the economic and social impacts of artificial intelligence, as well as Charly Berthet (CNNum), Julia Charrié (France Stratégie), Anne-Charlotte Cornut (CNNum) and François Levin (CNNum), who acted as the working group's rapporteurs.

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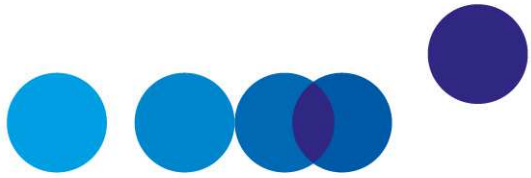
Commissioner General of France Stratégie



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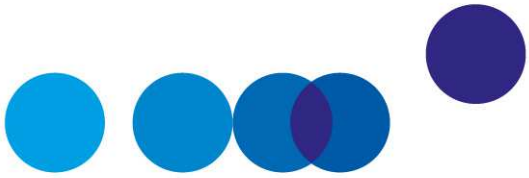


# SUMMARY


Artificial intelligence (AI) is a hot topic. It has a dynamic and a momentum that crystallize attention and energy, making it all the more urgent to take action sooner rather than later.

The recent attention is based on the spectacular progress made through R&D. This has led to sudden growth in tasks that can potentially be automated, leading society to reconsider the human element in the job market. We are moving from a polarized scenario where highly manual jobs on the one hand and skills-based jobs on the other seemed safe from automation to one where many more people are affected by AI. That is why the topic of a large number of jobs disappearing tends to monopolize debate and cloak all reasoning.

This report seeks to move away from a simplistic vision of AI, which focuses on massive job losses and the idea that it will change our lives regardless of what we do. Until now such an analysis has obscured seeing the positive impact of AI, such as productivity gains in businesses and improvements in the quality of services. It has also highlighted: the risk of losing economic independence; a lack of transformation in governance; the underestimated impacts on daily life, especially in the workplace; and the necessity of support the transition, in particular through training.

The aims of this report are threefold:

1. Clarify the acceptance of artificial intelligence and its incorporation into the means of production. It is mainly a case of machine learning: the ability of a software program to provide a high-quality reproduction of certain human aptitudes, provided that training data are available in sufficient amounts. These systems are used for voice recognition, image, sound and video classification, and word processing (e.g. automated translation).

2. Draw attention to what is essential: data. Value comes from data needed for learning much more than from the algorithm, which is developed openly (in open source). Consequently, businesses and public institutions must concentrate on

identifying data that is likely to be used and on making data available and possibly pooling data by maintaining control over the use that is made of the data or by benefiting from a fair return. Moreover, there must be in-depth discussions on free data circulation between geographical areas and business stakeholders.

3. Highlight the fact that it will be much more a matter of job transformation than of job losses. Planning the transformations will require the decision to be made as early as possible with the relevant stakeholders, in particular the professionals concerned. The aim is not to mechanize humans. Rather, it is to create value in work for everyone, harnessing AI to make people more efficient and more effective in their jobs. Public policies at the national and regional levels must be mobilized to build a positive vision of AI, which requires multiple ways of assessing and designing job transformations.

To achieve this, an essential tool is needed: training. In this sense, AI creates a need for professional training, which can then be used as a textbook case for the new visions of education and training that have been debated for many years in society: the importance of cross-disciplinary skills (soft skills) and digital literacy, which encompasses AI literacy. Such training involves general IT skills and mobilizing businesses and schools to get them to support initial training rather than on-the-job training.

If nothing is done to improve digital skills, there is a real risk of economic stagnation and a loss of independence, with a few large platforms gaining even more of a stranglehold over the economy. What's more, a lack of planning, low-quality support solutions, a compartmentalized approach and decisions made on the basis of cost alone would lead to significant job losses.

This report does not consider the highly unlikely scenario that all production will be automated. On the contrary, it focuses on the impact AI will have on jobs, with a view to rebuilding the social value of work.

More specifically, it is crucial to initiate a process of consultation to anticipate such impacts. Developing a forum whose material would be based on the different debates held across the country could be planned together with all employment stakeholders: Pôle Emploi (the French national employment center); the AFPA (Association for Adult Professional Training); regional, national, and European stakeholders; and the unions. It could then be applied in different sectors, in relevant thematic networks and at the regional level.

Initial training, businesses and the social and solidarity economy must all be part and parcel of an innovative training policy. This presupposes an assessment of sectors where AI is applied, especially refining approaches used in the public sector, including local governments (so-called smart cities and their environment policies, for example).

The CNNum and France Stratégie support the need for such a consultation. They are all committed to helping public policies anticipate the impact of digital transformations and analyzing their combined commercial, legal and social aspects. Though this report aims to take stock of the situation, the short period during which the work is planned means there will only be a few insights at this stage.

Over and above raising awareness, the CNNum is currently developing its analyses on job transition and deepening its proposals. The CNNum feels the value of human work must be protected and even enhanced in the face of technological change. At the same time, it must be reconciled in an innovative fashion with a competitive economy and improved well-being in an inclusive society.

For its part, France Stratégie intends to continue its work facilitating the public debate on AI – which is at the heart of the digital revolution – by giving priority to jobs and their spatial aspect. It will do this through collaboration with all levels of government, the social partners and stakeholders from civil society.

## Recommendations

| | Title | Description |
|---|---|---|
| 1 | Organize a consultation in order to anticipate the economic and social impacts of AI | In view of the transformations AI may initiate, the thought process on the economic and social impacts of AI cannot be done in a top-down manner. At all levels, it is a matter of considering the governance that would allow a dialogue to be organized and decisions to be taken that are able to transform our societies and our economies in order to anticipate the impacts of AI. A forum would be developed with all employment stakeholders (Pôle Emploi, the AFPA, regional, national and European stakeholders, and the unions).<br>Setting up the forum may help in answering the objectives of recommendations 3 (take human-machine complementarity into consideration), 4 (raise awareness of the value of data) and 5 (incorporate AI into businesses). |

| | | |
|---|---|---|
| 2 | Transform lifelong training | Aim for a wide-ranging transformation of lifelong training, in terms of the ratio of working to training time, the content and types of training. |
| 3 | Take human-machine complementarity into consideration | Measure the interchangeability of tasks in line with a bundle of technical and social criteria, taking account an economic context that goes beyond just business organization or the sector of activity:<br>- Is technology sufficiently advanced for this task to be automated?<br>- Does the task require cognitive abilities that are vertical (focused on a very specific task) or horizontal?<br>- Is it socially acceptable to automate this task?<br>- Does this task require emotional intelligence?<br>- Does this task require complex manual intervention? |
| 4 | Raise awareness of the value of data in training AI | Make organizations aware of the value of data as essential for training artificial-intelligence algorithms. |
| 5 | Incorporate AI into businesses | Encourage large and small businesses alike to develop and incorporate bricks of artificial intelligence, especially by bringing together stakeholders from various ecosystems around a thematic network. The latter would make the necessary data available in a controlled manner and would facilitate access to experimentation (e.g. for driverless cars). |
| 6 | Provide access to public data | Pursue and accentuate efforts relating to the access to public and parapublic data. |
| 7 | Circulate data | Explore the question of the free flow of data between geographical areas as well as between business stakeholders and define the conditions of dissemination. |

# INTRODUCTION

- **History** of artificial intelligence and of recent disruptions (deep learning); in spite of new high-impact applications, we are far from “general” AI; current software programs can only carry out very specific tasks.
- The current roll-out of AI **follows on from digital transformations that have been implemented for a number of years**; moreover, several questions raised by the latter are already being studied (private life and data management, ethics, acceptability and responsibility, ecological impacts in terms of data flows and data storage as well as using up resources).
- **Future transformations are far reaching, as are uncertainties.** The technology is one with significant potential and that is capable of greatly extending the field of what is possible.
- **Not everything is rosy.** Some points to watch need to be kept in mind: the risks of losing competitiveness, of dependence, and of increasing the focus of value on certain segments of the production chain.

A certain number of studies have drawn attention to massive job losses. Without taking a position on the relevance of those general thought processes on the redistribution of value, this report focuses more on the **necessary transformation of professions, especially human-machine complementarity**.

Image recognition, a remarkably efficient anti-spam filter, a music- and film-recommendation system, automated translation, video games with increasingly rich figures, psychedelic special effects, a machine victory over a human in the game of Go, and in poker a few weeks ago, a chatbot over the internet or at home, and automatic-driving software opening the way to driverless cars. Those are the achievements brought about by the recent and spectacular progress of artificial

intelligence (AI), especially machine-learning systems and statistical-learning systems.

The principles of artificial intelligence go back a long way (to the 1940s for neural networks, for example), a significant level was passed a few years ago under the triple push of the rise in computing power (which was especially enabled by graphics cards that were initially developed for video games), setting up immense databases of qualified images, videos, or sounds (thanks to the will of a few leading stakeholders, the work of researchers, and social networks), and progress in algorithms.

AI has certainly made spectacular progress, as is shown by the examples given above and regularly popularized in the media. For all that, current software programs carry out only very specific tasks, and often require immense volumes of learning data to reach a satisfactory result. We are still very far from so-called “general” or “strong” artificial intelligence, which is able to take account of context and to learn from a few examples.

## Continuities and discontinuities

Rolling out artificial intelligence in society, and in business in particular, follows more in the line of digital transformations that have been under way for a number of years. It also includes the progress made in robotics, virtual reality, and augmented reality, and it follows on from the data economy, dominated worldwide by American and Asian digital platforms, with France – and Europe, more generally – lagging behind.

In addition, AI raises standard questions that have already been studied several times. As an example, AI uses data to make personalized diagnoses, so it raises questions relating to personal data. The challenge is to be able to protect private life whilst taking advantage of AI’s potential, which presumes access to those data.

AI also raises new questions of ethics and acceptability. Responsibility lies with the designer of the algorithm, and there is also the impact of the data used for the learning process. Finally, AI raises the question of transparency in human-machine interactions, and the accountability of decisions taken by automated systems. A bank loan is refused, a driverless vehicle is involved in an accident: it must be possible to request an explanation of the way in which the decisions were taken, or even of determining areas in which humans must retain the final decision-making authority. It is a research subject that must be supported by the roll-out of technology (see the

box below, which summarizes appendix 1, “Artificial intelligence in search of acceptability and trust”[1]).

**The challenges of acceptability and trust in artificial intelligence**

**”Acceptability and trust” subgroup**

The nature of AI development is such that it considerably transforms the sphere of jobs and of work, leading in particular to the increase in AI systems in the work environment, the intensification of collaborations between humans and machines, the automation of the prediction function across industrial sectors, and the growing delegation to machines of tasks and activities previously carried out by humans. Those collaborations between humans and machines will take many forms. Some professions may be completely replaced by independent machines (e.g. drivers) whilst creating new supervisory tasks. Other professions will remain exclusively human, because replacing humans with AI will be considered unacceptable, inefficient, or not beneficial to society. In other and doubtless more numerous cases, forms of human-machine co-operation will emerge in work environments where AI will be a partner and an assistant rather than a replacement. Independent agents are already taking part in various types of negotiations and transactions (e.g. stock-exchange transactions), as well as interactions with users, businesses, and organizations. In the short term, there will be an even wider effect on professions that involve computing and those that follow a formally established procedure. New professions will also appear, such as those of designers, trainers, administrators (e.g. knowledge engineers) of data and information, AI supervisor and repairer, etc.

The members of the “Acceptability and trust” subgroup led a discussion on key concepts, of which the significance is likely to change under the effect of AI (responsibility, merit and value, and creativity) and the risks of using AI in some professional areas (emotional, physical, mimetic, teleological, and creative). Positive effects are real: time saved, taking over highly repetitive tasks or trivial procedural routines. However, there is a need to consider the risks, especially withdrawal, disempowerment, increased social disparities, etc. The result is a set of recommendations that especially concern the need

[1]The appendices can be downloaded from the France Stratégie web site: www.strategie.gouv.fr/publications/anticiper-impacts-economiques-sociaux-de-lintelligence-artificielle.

for experiments in the field and multidisciplinary studies. It will be crucial to make an effort as regards education and communication.

Why does AI draw so much attention from the general public and the media? Is it just a case of a bubble that will be burst? The expression “artificial intelligence” has an evocative power that is without a doubt a partial explanation for the fantasies that are associated with it.

## Far-reaching transformations and significant uncertainties

Two points to be highlighted to justify the special attention that the subject merits from public authorities, businesses, and civil society more generally:

- on the one hand, it is indeed a technology with very significant potential, one that is able to greatly widen the field of what is possible (going as far as driverless cars and automated script-writing or even film-making);
- on the other hand, there remain strong uncertainties over its effective roll-out and the manner in which it will be appropriated, especially in the world of work, as well as over the speed of future progress. All too often, the risk of massive job losses crushes any consideration of the practical incorporation of this technology.

Questions relating to a universal income, the legal personality of robots, and a possible tax on robots are raised in political debate[1]. This report takes no position on their relevance, but it specifies the diagnosis, identifies points to watch, and makes a few recommendations based on work being transformed rather than disappearing irreversibly.

**The legal challenges of artificial intelligence**

AI and the upheavals that it is likely to cause lead to a discussion on the legal challenges, especially protecting AI and the relevance of current mechanisms of liability. Based on that observation, the “Legal and regulatory challenges of AI” subgroup has led discussions and organized hearings on AI-related law, in order to collect observations from AI stakeholders ranging from SMEs to international groups, in respect of potential difficulties encountered in the

[1] The Delvaux Report, adopted by the European Parliament on 16 February 2017: “Recommendations to the Commission on Civil Law Rules on Robotics”.

matter, or, going the other way, legal solutions that are already being put into practice.

The members of that subgroup agree on the fact that at this stage in the evolution of AI, there is no pressing need to rethink current legislative and regulatory frameworks. Current legal mechanisms and regimes, coupled with contractual flexibility, currently enable us to deal with technological changes by providing a satisfactory level of legal safety, except in particular cases. In addition, it has emerged from the discussions that, as with other leading-edge innovations, the law must not become an impediment to innovation. Moreover, France, and especially the European Union, which appears in all cases to be the appropriate level of intervention to avoid any competitive disadvantage, must allow time for technologies and business models linked to AI to reach a certain level of maturity before passing additional legislation where needed.

The subgroup specifically considered the challenges relating to algorithms, data, the responsibility of robots, and the protection of creations emerging from AI. Its discussions on those themes are attached to this report (see appendix 2).

AI enables productivity gains within organizations (anti-spam filter, automatic file processing, simple questions answered by an automated chatbot[1]), improvements in terms of processing quality (improvement of tumor detection[2]), but it does not escape existing questions on the effects of digital technology on well-being or on economic growth (see the debate between the partisans of a lasting slowdown of productivity gains, long-term stagnation – *The Rise and Fall of American Growth*, Robert Gordon, 2016 – and the partisans of future growth - *The Second Machine Age*, Erik Brynjolfsson and Andrew McAfee, 2014). Why do we observe a slowdown in productivity growth? Is it a case of a lack of investment in information and communication technologies (ICTs), insufficient appropriation by organizations, or a shortage of training? Will digital technology be content with replacing existing processes, and would there be a lack of new products comparable with those that ensured economic growth during previous industrial revolutions (aircraft and cars)?

[1]Software that is able to interact with humans through natural language (in writing or in speech) to answer simple questions.

[2] At the *Camelyon Grand Challenge for Metastatic Cancer Detection* held in 2016, the best results were obtained by teams in which humans and AI co-operated: 0.5% error rate for AI-assisted humans, 7.5% for AI alone, and 3.5% for humans alone.

Are we in a lasting situation of slow growth, or is it a temporary effect? The debate remains open, over and above the question of AI[1].

What is certain is that AI is a general-purpose technology; its working objects (images, sound, video, text, and natural languages) can be found in several activities, opening up opportunities for creating new products and increasing users' performances. Learning techniques can be disseminated from one sector to another through limited adaptations. Thus, investing in AI is likely to have a knock-on effect in several sectors, provided that AI receives additional investments to extract all its potential. Those additional investments are tangible, e.g. in the form of digital equipment, as well as intangible, especially in the form of data, software, know-how, skills, and organization. In addition, the business models based on the concept of a general-purpose technology show that the effects of technology replacement at work (job losses) can be more than compensated by improved competitiveness in some sectors, which increases their export potential (for example, see Germany, which is highly robotized but with more industry employees than France), by increases in buying power, which stimulates consumption, and by product innovation, which creates new markets, thus new jobs.

## Points to watch

However, that rosy scenario must, of course, be qualified. AI is one of the elements in the debate on the link between robotisation, automation, and jobs, which brings forth concern over a massive and swift disappearance of the latter. On that subject, the studies, of which a review was carried out in particular by the report published in January 2017 by the Conseil d'Orientation pour l'Emploi (COE – Employment Advisory Council)[2], recalled that jobs that can be automated are few in number (about ten percent, whether in the study by the OECD[3], by France Stratégie [4] or the work of the COE). Furthermore, the technical possibility that jobs can be automated does not mean that they will be, since that result depends on the business incentive to do so as well as on organizational and social choices. However, the same studies establish

[1]See the conference organized by the Banque de France and France Stratégie on that subject on 1st February 2017: "Productivity: a French enigma?"

[2] Conseil d'Orientation pour l'Emploi (2017), *Automatisation, numérisation et emploi*, 10 January

[3] Arntz M., Gregory T. and Zierahn U. (2016), "The risk of automation for jobs in OECD Countries: A comparative analysis", *OECD Social, Employment and Migration Working Papers*, no. 189, June

[4] Le Ru N. (2016), "L'effet de l'automatisation sur l'emploi : ce qu'on sait et ce qu'on ignore", *Analysis Note*, no. 49, France Stratégie, July.

the fact that several tasks (almost half) can be transformed. That is doubtless the appropriate reading of the Oxford Study (Frey and Osborne)[1] which contributed to the attention given to the subject.

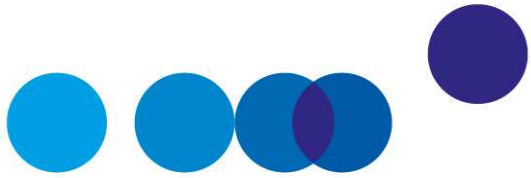
Moreover, AI is largely developed and marketed by large American and Asian digital platforms, which once again raises the question of the French and European lag in digital technology and the risk of prolonging current dependence. It is because there exists a danger of once again lagging behind in mastering and rolling out those technologies that the national strategy on artificial intelligence is particularly welcome. However, ultimately, it will have to enrich a European strategy on the question to be totally relevant, as is the case for several questions relating to digital technology (taxation, personal data, etc.).

Faced with such a transformation, the challenge of AI is that of disseminating technology in production processes, and of transforming jobs.

## Human-machine complementarity

Proper incorporation of AI involves identifying the contributions of that technology to improve work organization, offer new services, and create new jobs, by ensuring the implementation of human-machine complementarity. AI can eliminate repetitive tasks to enable people to concentrate on more interesting work; it can “increase” workers by providing them with a diagnostic tool that enriches their experience (augmented reality and medical pre-diagnosis that improves guidance for patients). However, such tools also carry the risk of transforming workers into mere de-skilled performers who follow machines’ instructions. Those possibilities depend on the conditions for rolling out and supporting the technology. To avoid alienation and proletarianisation, no automated system should be set up that exerts complete control over humans (otherwise, automate it in full); humans must retain the ability to resume control.

[1] Frey C. B. and Osborne M. A. (2017), "The future of employment: How susceptible are jobs to computerisation?", *Technological Forecasting and Social Change*, vol. 114, January , p. 254-280.



# ECONOMIC IMPACTS AND DISTRIBUTION OF VALUES

- Incorporating AI into our economies is a bearer of **significant productivity gains,** and it enables more value to be created.
- In open economies like ours, there is a **strong competitiveness challenge,** thus urgency over swiftly incorporating those innovations.
- Recent disruptions of artificial intelligence are the result of three factors coming together: access to big data, significant computing power, and sophisticated algorithms. Research and development relating machine-learning and deep-learning algorithms are largely based on an open-source mode; algorithms are available. **The challenge lies in access to data and to computing power**.
- **Risk of long-term dependence and loss of sovereignty**: In the long term, French and European businesses may be no more than consumers of software and of solutions developed externally.
- In that context of open research, **access to the data needed for algorithms thus becomes a competitive advantage**. Platforms enjoy a favorable position. The risk of value concentration.

AI can lead to a reinforcement of **territorial inequalities** – the advantage going to the metropolises –, which pick up more general approaches specific to the digital economy: production concentrated in urban centers, etc.

Incorporating artificial intelligence into the heart of our economics is a vector of significant productivity gains. As a technical innovation, it is an input for businesses in relation to their internal processes (management, logistics, customer service, assistant, etc.) as well as their production, whether of consumer goods (intelligent

objects, driverless vehicles, etc.) or of services (banking, insurance, legal, medical, etc.). Not incorporating those technologies would be a major risk of loss of competitiveness.

Nonetheless, it seems necessary to take three risks into account, in terms of economic dependence, sovereignty, and a possible strengthening of inequalities. In the current configuration of the digital economy, there is a significant risk that French businesses will be mere consumers of solutions developed abroad. The development of artificial intelligence may then widely strengthen the effects of platforming and of capturing value that are already features of the digital economy; that development requires means, in terms of data and of computing power, that are possessed by few stakeholders. Moreover, those technologies can serve as decision-support tools or even decision-making tools, so it is necessary to maintain the ability to determine their sense and content. Finally, disseminating those technologies can have a significant effect on increasing territorial and social inequalities, especially through concentrating value in some places.

## The challenge of international competitiveness

Artificial intelligence will be able to bring about productivity gains (see appendix 3, “Artificial intelligence and teaching general-purpose technologies”) as well as additional value to production. In an open economy like that of France, national production must swiftly incorporate that innovation to remain competitive in terms of price (productivity gains) as well as quality.

Like other innovations from the digital era, artificial intelligence is a bearer of radical changes in business sectors. France risks finding itself facing a transition conflict, with large businesses that do not have the strategic, logistical, and organizational means to effectively incorporate innovations, and that use institutional locks to slow down the development of new businesses that are more innovative. Ultimately, the businesses that have been able to develop in a favorable environment are the ones that, by entering the French market, contribute innovations and disruption. The transition can then be fairly brutal, with a massive win for clients thanks to light-touch dematerialized procedures, as was the case with Uber.

Recommendation: encourage large and small businesses alike to develop and incorporate bricks of artificial intelligence, especially by bringing together stakeholders from various ecosystems around a thematic network; the latter would

make the necessary data available in a controlled manner, and would facilitate access to experimentation (e.g. for driverless cars).

## Open-source neural networks

In June 2016, the magazine Wired prophesied “the end of code” by explaining that in the future, we would no longer program computers; we would “train” them as we train a dog[1]. From that point of view, machine learning – especially deep-learning techniques, based on neural networks – has, over the last few years, produced remarkable results that form a major break with what was already in existence. To reach that point, deep-learning algorithms need to combine powerful means of computing with access to big data.

Research and development relating to machine-learning and deep-learning algorithms are largely carried out in open-source mode. GitHub is a platform that makes programs available and where machine-learning projects are amongst the most active ones[2]. Those projects include *Tensor Flow*, which brings together machine-learning software projects by Google teams, and which has become the most popular directory on the platform[3]. France does not lag behind, since the *Scikit-learn library*[4], which brings together AI tools developed under open source and that are very widely used, was largely developed there. Similarly, Facebook, Microsoft, IBM, and Amazon have opted for an open-source model, thus making their work available to all. Even Apple, which is usually known for its extreme discretion, announced last December the opening up of its research into artificial intelligence[5]. Those businesses regularly share their research advances with the scientific community. Their researchers[6] also speak at conferences. Like their American counterparts, the Chinese giants of digital technology have also undertaken to open

[1]Wired, June 2016: www.wired.com/2016/05/the-end-of-code/.
[2] https://github.com/showcases/machine-learning.
[3] http://donnemartin.com/viz/pages/2015.
[4] http://scikit-learn.org.
[5] www.theverge.com/2016/12/6/13858354/apple-publishing-ai-research-siri-self-driving-cars.
[6]Nonetheless, that wide opening up of world research should be placed in context: it seems that contrary to Western research, Chinese research – currently the most active in the world! – forms a more distinct community. Language barriers lead to a form of asymmetry: Chinese researchers, who generally speak English, have access to work published in that language. Conversely, the English-speaking community finds it more difficult to have access to Chinese-speaking research.

up their artificial-intelligence algorithms. That is particularly the case with Baidu,[1] which has made its deep-learning tools available on an open-source basis.

## Risks of dependence and of platforming

Opening up algorithms enables the developer community to make progress on a complex technology that calls for collective mobilization. Nonetheless, only some stakeholders (Google, Amazon, IBM, etc.) with sufficient computing capacity are able to offer artificial-intelligence services to businesses, particularly cloud-hosted AI services.

Watson, the artificial intelligence developed by IBM, is rolled out in some businesses to help collaborators, who can ask it questions in natural language. At the law firm BakerHostetler, the law-specialist version of Watson, Ross, is used by the team working on bankruptcy cases. In another field, Alexa, Amazon's personal assistant, lies at the heart of households, and may become an entryway to essential clients for several services and businesses, which would thus become completely dependent on that intermediary.

Hence, those businesses are able to place themselves at the heart of a business and as an interface between a business and its clients. They can thus reproduce the models of digital platforms like Booking, AirBnB, and Uber, which have been able to capture a significant share of a market's value by positioning themselves as essential intermediaries. That platforming phenomenon, which is typical of the development of the digital economy, thus causes major risks in terms of dependence by business stakeholders. The advent of artificial intelligence would thus lead to even greater concentration of economic value – which may entail negative social consequences (e.g. lower tax revenues). The dependence of the economy on artificial-intelligence developed abroad can also lead to a loss of sovereignty when the rules governing technological advances are largely outside national control. Once innovations have been established and rolled out abroad, it becomes very difficult to weaken their functioning or to determine other rules for governing them.

**The industrial impact of artificial intelligence:**
**the example of driverless vehicles**

[1] www.theverge.com/2016/9/1/12725804/baidu-machine-learning-open-source-paddle.

From 2010 onwards, media coverage of driverless-vehicle projects borne by digital-technology businesses like Google, Apple, Tesla, and Uber has highlighted technological advances relating to artificial intelligence in the car-manufacturing sector. The horizon for rolling out driverless cars is drawing closer, with the first non-experimental use planned for 2020, and large-scale dissemination envisaged for 2030 and beyond.

Fitting vehicles with artificial intelligence for autonomous driving raises the question of sharing value with car manufacturers. Software could increase from 40% to 70% of a vehicle's added value by ten years from now. Will car manufacturers who rely on their know-how in terms of design and engines to maintain their brand image be able to develop artificial intelligence that offers sufficiently high performance, or will they have to incorporate external software that may become new intermediaries between them and their clients? Over and above their ability to develop artificial intelligence, will consumers be inclined to buy a vehicle fitted with the manufacturer's software, or one fitted with software from a digital-technology company?

Based on a balance of forces that will come into being, i.e. the brand that will impose itself as that of the vehicle, value-sharing will be either to the advantage of the car manufacturer, or to the advantage of the artificial-intelligence supplier.

Over and above that battle of the vehicles, we need to prepare for the entire business organization of road transport to be called into question: the impact on insurance, driving licenses, mechanics, and transport companies, a potential transition from a system in which households own their vehicles to one of "à la carte car hire", and complementarity between current forms of public transport and driverless vehicles[1]

## Access to data becomes a competitive advantage

In a context of largely open research and development into artificial intelligence, the question raised is less that of access to algorithms than of access to data to train them. The latter then become a crucial element in developing those self-learning machines: without a sufficient mass of data, deep-learning algorithms may not achieve satisfactory error rates. In the matter of deep learning, the more a machine is

[1] Janin L., Nemri M. and Raynard C. (2016), "La voiture sans chauffeur, bientôt une réalité", *Analysis Note*, no. 47, France stratégie, April.

trained, the more relevant it becomes. Thus, a poor-quality algorithm, if trained, may be better than a good algorithm.

Within organizations, businesses, and administrations, the challenges and significance of big data seem increasingly understood and assimilated. What is much less so is the crucial importance of raw data in matters of artificial intelligence. Taken in large numbers, those data, even if unrefined, can be used to train machines to detect correlations, and use them in the medium and long term to take decisions. Indeed, organizations with access to large databases possess a crucial asset.

Recommendation: make organizations aware of the value of data as essential resources for training artificial-intelligence algorithms.

It is undeniable that the giants of digital technology – whether from China, Russia, or the USA –, whose success is largely explained by their data-collection capacity, thanks in particular to significant market size, start off with a certain advantage in the world race in artificial intelligence. That may increase the risks of economic dependence and of inequalities in terms of balance of power generally, and economic value in particular. Hence, it is entirely in the interests of the giants of digital technology to open up machine-learning algorithms, to capitalize on the logic of open innovation whilst keeping control of the assets that are the key to it. Those large businesses are currently entering into partnerships with research bodies to enrich algorithms with data and improve them, but those businesses are careful not to open up all their data. They thus keep control of their strategic asset, of which they determine any conditions of access and terms of use.

**The consequences of AI development on the outsourcing market**

Incorporating AI into production processes leads to value chains being modified. Various effects can be identified. At international level, it is possible that processes that had been outsourced to countries with low labor costs will be bought back in-house as soon as they can be carried out by AI. That process does not imperil jobs in developed countries, because it had already been outsourced. However, it may present a threat to some countries that rely solely on poorly-qualified labor specializing in repetitive cognitive tasks. That process is clearly at work in some banking activities and in call centers.

Another process is also at work with the development of micro-task platforms, such as Amazon Mechanical Turk or Foule Factory. On those platforms,

artificial-intelligence developers use workers to train algorithms *via* tasks that involve labeling, cleaning databases, image recognition, etc.

## France and Europe must be aware of their assets

The question of access to data risks becoming even more urgent in line with the emergence of artificial intelligence that is less and less limited to specific tasks (so-called weak artificial intelligence), i.e. artificial intelligence that is able to learn new tasks or acquire new abilities by transfer or even "capillarity". For example, DQN, an algorithm developed by DeepMind (Google), is able to understand the rules of various games in which it is has never been trained, based on its training in a specific game. A genuinely semi-strong intelligence[1] is not expected to emerge for several decades, so the abilities of artificial intelligence tend to flatten out, and, from that point of view, the large platform enjoys a favorable position. The diversification of their activity as well as the dynamism of acquisitions and of the partnerships that they enter into lead platforms to amass information covering several sectors, which is conducive to horizontality, i.e. the ability to carry out various tasks. The richness of a datum is due in great measure to its potential for being cross-linked to other data.

In that world competition, assets are not lacking in France and Europe. In France, for example, the medical-administrative health databases are enriched each year by 1.2 billion treatment forms, 500 million medical procedures, and 11 million hospital admissions. Other data, such as legal data, may benefit from being opened up more widely.

Recommendation: pursue and accentuate efforts relating to access to public and parapublic data.

Nonetheless, it is not a case of focusing only on public or parapublic data, but also, in the longer term, to initiate a discussion on the ways of sharing value between private stakeholders. In that sense, the CNNum has tackled the question of the free circulation of data at international and European level, from a point of view of transfer between territories as well as between business stakeholders.

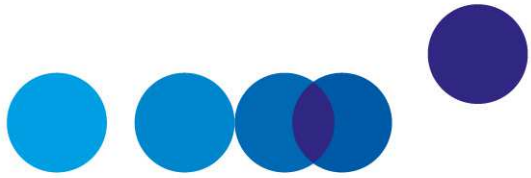
[1] A distinction is made between weak artificial intelligence, which is capable of reproducing a specific task (that is the intelligence rolled out at present), semi-strong AI, which is able to carry out more general tasks by understanding context (a research subject), and strong AI, which equals or even exceeds human intelligence (and currently lies in the realm of science fiction).

Recommendation: deepen the question of the free circulation of data between geographical areas as well as between business stakeholders, and define its conditions.

## Territorial inequalities at the national level

At national level, AI raises the same questions of advantage to metropolises and territorial inequalities as those raised by the economic development of the last few years[1]. Digitization brings the risk that production activities become concentrated in urban centers of sufficient size to benefit from network externalities, especially for AI production, because the latter assumes that production factors are brought together that are located mainly in metropolises (human capital, R & D, physical capital, and ecosystem). However, as regards the use of services permitted by an AI, the expected gains can be spread across the territory. To do so, its services must be disseminated in the territories, ensuring that they are accessible to the greatest number of people.

[1] Lainé F. (2017), "Dynamique de l'emploi et des métiers : quelle fracture territoriale ? ", *Analysis Note* no. 53, February, France stratégie.



# HUMAN-MACHINE COMPLEMENTARITY

- Thinking in terms of tasks rather than professions enables us to think of job transformation rather than job losses.
- In order to grasp these transformations, there is an urgent need to define the governance that enables such impacts to be anticipated, especially with respect to three key points:

– Measuring job loss as well as job transformation, thus assessing interchangeable skills against a bundle of criteria:

*– Is technology sufficiently advanced for this task to be automated?*

*– Does the task require cognitive abilities that are vertical (focused on a very specific task) or horizontal?*

*-Is it socially acceptable to automate this task?*

*- Does this task need recourse to emotional intelligence?*

*- Does this task need complex manual intervention?*

– Determining the skills that remain to the advantage of humans may not be enough. It is necessary to consider human-machine complementarity at the level of individuals and of organizations.

- Based on the determination of which skills are not interchangeable, **an in-depth reform of lifelong training** must be carried out, in terms of temporality, content and structures.

The development of AI will also have an impact on individuals' working conditions and on the structures of organizations. Macro-economic studies focus particularly on the question of interchangeability of machines with respect to human work. Of course, it would be out of the question to sweep aside the scenario of an irreversible reduction

in job numbers. However, and even if that does not encumber parallel discussions on the way in which value is redistributed, we feel it necessary to consider the transformation of professions rather than acknowledge that irreversible decrease. That scenario is based on ongoing-task reasoning. However, as we learn from the COE report, which takes a task-based rather than a profession-based approach, a certain number of tasks will be automated whereas others will not be, those in which human beings have the comparative advantage. According to the COE, on the basis of that task-based approach, half of existing jobs may see their content significantly or deeply transformed, and less than 10% of jobs contain weaknesses that may threaten their existence. That means we can start from the finding that professions will be largely transformed rather than destroyed. That finding can be based on the lessons drawn from previous industrial revolutions, which – sometimes with a difficult transition period – saw new jobs appear to replace those that were lost. In addition, the effectiveness of an algorithm associated with human beings is much more significant than that of an algorithm alone. AI handles repetitive tasks, and human beings can focus on the richer tasks. For those two reasons, it seems necessary to consider the notion of human-machine complementarity. How can we organize ourselves to conduct those discussions in a collective manner?

## Organize governance with a view to anticipating those transformations

The discussion on the economic and social impacts of AI cannot be done in a top-down fashion, in view of the transformations that it may initiate. At all levels, it is a matter of defining the governance that structures a dialogue and the decision-making needed to anticipate the impacts of AI, and to consider the spread of productivity gains that digital technology allows.

By way of example, five levels could be initially targeted: national level, regional level, the employment area, the branch, and the business. At each of those levels, preliminary work to identify the network of relevant stakeholders would be carried out, to organize a consultation and the participatory construction of tailored projects.

A digital platform in the form of a national consultation with all employment stakeholders, Pôle Emploi, the AFPA, as well as regional, national and European stakeholders, and unions, would be set up to that end.

Three priority subjects would form the subject of the national consultation:

- The complementarity between skills that can be automated and those that cannot be automated, in view to determining interchangeable human skills and controlling the transition
- Identifying the virtuous modes of complementarity that can be long-lasting and do not create additional alienation at an individual and collective level
- Root-and-branch reconsideration of all types of lifelong training in light of the complementarity referred to above

## What skills are interchangeable?

Several studies have tried to define human skills that do not currently seem interchangeable with AI (see appendix 1, “Artificial intelligence in search of acceptability and trust”). Skills that cover an dimension that involves emotion and relationships, some physical skills that require accuracy, and, above all, abilities relating to general analysis (flexibility, ability to adapt, and problem-solving ability) seem *a priori* to be more effectively accomplished by humans.

More specifically, it is a matter of urgency to measure the interchangeability of tasks in accordance with a bundle of technical *and* social criteria, and, taking account of an economic context that goes beyond just the organization of the business or the sector of activity:

- Is technology sufficiently advanced for this task to be automated?
- Does the task require cognitive abilities that are vertical (focused on a very specific task) or horizontal[1] ?
- Is it socially acceptable to automate this task?
- Does this task need recourse to emotional intelligence?
- Does this task need complex manual intervention?

Non-interchangeable skills must be developed (see below, the part relating to training). Nonetheless, that development, if it is necessary, is not enough to ensure virtuous complementarity between humans and artificial intelligence. Several factors influence the terms of that complementarity, mainly work organization. The introduction of artificial intelligence can have negative impacts at individual and

[1]That vertical / horizontal distinction refers back to the distinction between weak AI and strong AI developed on page 9

collective level. Some risks are described in appendix 1, “Artificial intelligence in search of acceptability and trust”.

## Human-machine complementarity

Also required is defining the principles of complementarity that enable the acceptability and appropriation of AI to be guaranteed, a long-lasting dissemination of its contributions, and protection against systemic risks that it can carry within it.

Moreover, at individual level, daily work with AI, beyond its many assets, can also present social and psychological risks. The concentration of the ability to analyze and of intelligence in new AI tools contains the risk of leading to “proletarianisation”[1] of an even greater number of workers, in the sense of depriving them of their knowledge that gives value to their skills. Delegating an increasing number of tasks to AI is also likely to lead to withdrawal and disempowerment amongst workers, due to the impoverishment of interpersonal relationships as well as increased delegation of decision-making.

At the level of organizations, the dissemination of technologies linked to AI must be grasped in terms of cognitive risks, especially the potential growth in the propensity to “functional stupidity”. Massive introduction of AI into organizations may encourage obedience, conformity, and predictability of behavior. Disseminating AI leads to automation of an even greater number of repetitive tasks and activities, but it can, at the same time, contribute to delegating decision-making and encouraging organizational contexts that reduce the mobilization of cognitive abilities. It may thus encourage a lack of reflexivity by individuals and by the organization, as well as a lack of justification for decisions. By optimizing all tasks, it may reduce or even annihilate the ability to innovate. Such situations would then lead to the development of systemic risks, which would threaten economic and social structures in addition to the organization.

**Practical case: the example of the call center**

The case of the profession of call-center operator is interesting, for it shows the ambivalence of automation within organizations.

[1] To re-state the idea developed by Bernard Stiegler in his work *La Société Automatique*, Fayard, 2015.

**a. Scenario in which workers are "enhanced" by AI.**

- Automation of the simplest calls: 80% of calls are automated.
- Operators concentrate on the remaining 20% of calls, those that are more complex and that enable commercial and relationship skills to be developed.
- For the remaining 20% of calls, operators are helped by AI; they can use semantic search engines that enable information to be found very quickly, and, once again, concentrate on the client relationship.

**b. Scenario in which workers are subordinate to AI**

- Artificial intelligence analyses customer calls and offers operators a script for interactions, with operators merely reading aloud the answers offered by the machine. Those answers are optimized on the basis of the analysis of all other previous interactions.
- Operators thus become vocal and emotional supports in almost automatic response to artificial intelligence.

## Learning in a world of artificial intelligence

In view of the objective of virtuous complementarity between AI and workers, training plays an essential role: developing cross-cutting skills in creativity, adaptability, and problem-solving ability makes it necessary to have a significant reform of lifelong learning, even if the latter is not solely linked to job-market changes caused by artificial intelligence. Vocational training is regularly criticized for its modes of functioning and its effectiveness. Furthermore, the requirement for decompartmentalization between initial training and lifelong learning, in view of the difficulty in anticipating the activities and professions of tomorrow, has already been defended in a certain number of works, especially those of the CNNum on the digital transformation of higher education and research[1]. Nonetheless, the massive upheavals that the job market will experience due to the development of AI raise the question of lifelong learning with a fresh acuity. **By speeding up the obsolescence of skills acquired during initial training, artificial intelligence raises the question of the increase in time for ongoing training and the modification of its content and structures.** The link between the fact of having undergone initial

[1]See the CNNum's works on the digital transformation of higher education and research: Référentiel de transformation numérique de l'Enseignement supé rieur et de la Recherche, 19 December 2016.

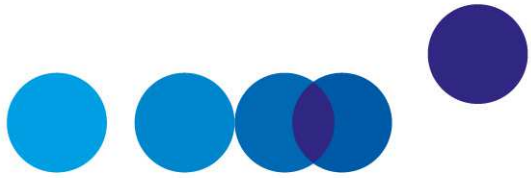
training and that of having worked in the related profession for your entire life is clearly one to be brought into question, whence the objective of lifelong training that can truly support transitions, both within a profession as well as towards professions and sectors of the future.

**The current ratio between working time and training time may not match the requirement for the constant renewal of skills.** That is why we must consider extending the time used for ongoing training, to give each person the chance to acquire the new technical and non-technical skills that individuals will need in a world of artificial intelligence. That extension of training time must go together with setting up a more significant level of continuity between initial training and ongoing training. **The professions that are potentially the most affected by automation could be the priority target of a policy on preventive training.**

Next comes the modification of training content. The challenge of initial and ongoing training consists of finding the balance between acquiring knowledge and skills in line with society's current requirements, and the need to prepare for a future of which we know at least that it requires everyone to have a critical mind and an ability to learn how to learn. The development of artificial intelligence reinforces that fact. It must permit the acquisition of technical skills that are specific to it so that the sector's labor requirements can be satisfied, and it must also develop general qualities of adaptability, creativity, and a critical mind. Ultimately, those skills alone will enable individuals to develop their complementarity with machines. That means that in addition to training that is specific to artificial intelligence, the question must be raised of refocusing ongoing training on generalist training, enabling the development of cross-cutting skills of adaptability and creativity. The development of those skills requires reinventing modes of training (training in context, in post, and in design) and the connection with knowledge itself, through practices that involve sharing, networking, experimentation, projects, etc.

In the end, the transformation of lifelong-training structures is inevitable. In view of the increased need for every worker to be able to be trained according to those requirements, existing entities are neither sufficient nor suitable. The role of universities in delivering lifelong training may thus become increasingly emphasized, to ensure that everyone receives high-quality training. Pôle Emploi would change to take on a preventive function. Finally, arrangements for informal training (third places, *fablabs*, *makerspaces*, etc.) and for experimentation with new educational practices must be fully incorporated into the development of lifelong-training structures.

Recommendation: aim at a wide-ranging transformation of lifelong training, in terms of the working time / training time ratio, content, and modes of training, as well as bearer structures.



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