Executive Summary

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On February 16, 2020, the chairman of the Telem Forum appointed an inspection committee to examine the need for government intervention in order to accelerate the development of the field of artificial intelligence and data science. This paper describes the work of the committee and its recommendations.

In recent years, we have been facing a technological revolution, which is fueled by data collection on a large scale, the quantity of which is not known, and by a dramatic development in the ability to analyze and draw conclusions, while using advanced algorithms and new statistical methods. As will be shown below, "Moore's Law" which predicted, in the world of computers, a doubling of capacity every two years, is not valid, and the doubling of capacity is carried out every three-four months. The wide variety of applications, the rate of technological development, the impact on scientific research and on Israel's security, all of these require an in-depth examination of the opportunities facing the Government of Israel and the ways to realize these opportunities.

In light of the revolutionary effects of the field of artificial intelligence and data science on research and development in the fields industry, infrastructure, security, health, medicines and materials, and the expected expansion of these effects and their acceleration, many countries in the world decided to concentrate a special effort for promoting these fields. These countries include the US, EU, China, UK, Germany, Czech Republic, France, South Korea, Singapore and many other countries, which defined national plans with an investment of hundreds of millions to billions of dollars, to be spread over time periods of up to a decade. In a study conducted by the Tortoise Company, international comparisons were presented between 54 countries in 2019 and 62 countries in 2020. The countries were ranked according to their abilities in the field of artificial intelligence, based on seven aspects: talents, infrastructure, activity environment, research, development, government strategy and commercial. Although Israel was ranked 12th in 2019 and 5th in 2020, an examination of the specific indices shows an alarming gap between Israel's high ranking in research and development and

on the commercial side as compared to the low ranking in the required infrastructures and the government strategy that cloud over Israel's progress and its ability to establish its position in the field. Israel's notable backwardness in some of these key aspects, which is expressed, among other matters, in an acute gap in access to computing infrastructures and in the absence of a clear government strategy for making data accessible for the benefit of research and development, will end up significantly damaging even the aspects in which Israel has been successful stand out for good so far. Another worrisome sign is Israel's decline in rankings indicating innovation between 2019 and 2020 – with all implications thereof. In addition, in October 2020 a government preparedness report was published in the field of artificial intelligence by the Canadian IDRC center, which provided a comparison between all governments in the world. This report, which was ranked Israel in 20th place in the world, included a sharp criticism of Israel's gap and backwardness.

As part of the committee's work, many meetings were held, including with government officials and Telem members, security officials, industry figures, academic researchers and leading foreign experts in their field. Also, the committee reviewed various flagship programs applied in other countries. In particular, it is worthy to note the significant works done by the committees that preceded this committee: the work by the Budgeting and Planning Committee, the work of the sub-team of the National Initiative for Intelligent Systems on Computing Power and Quantum and other works.

As part of the committee's work, data science centers at universities were also examined. In the original planning, these centers were designated to also deal with artificial intelligence, but in practice, the main focus is on the application of tools and not on their creation. The projects operating in these centers are interdisciplinary in nature, and the administrative structure of the centers is also oriented to leading such issues. Since the purpose of the committee is to strengthen the core issues of artificial intelligence in the academy, the aforementioned administrative structure is not adapted to the promotion of the core field of artificial intelligence. The committee's recommendation is to establish a dedicated collaborative mechanism to promote the field of artificial intelligence.

At the end of the extensive work that was carried out, the committee's conclusion on this issue is unequivocal: there is a critical need for initiating a national program that will outline a systemic solution to promote research and development in the field of artificial intelligence and data science. The State of Israel has the potential and the opportunity to be a leading country in the field. The existence of a national program in the field of artificial intelligence and data science is essential to the resilience of the State of Israel and will contribute to the deepening of academic research, to expanding the industrial base, to creating significant economic opportunities and to dramatic advancement of Israeli security capabilities.

This document describes a national plan that focuses on the four aspects defined in the letter of appointment: infrastructure, human capital, regulation and data accessibility. In these aspects, the committee identified significant gaps that cut across all the fields of research and development in Israel. In the aspect of human capital in artificial intelligence, the committee identified a significant quantitative gap that begins already at the academy, and as a consequence also affects the industry and the defense system. The scope of the academic faculty in the core fields of artificial intelligence in Israel

and in the world is not sufficient for the training of the required human capital, both for the needs of the academy itself and for the needs of the other sectors. This means a significant gap between demand and supply, in all roles in the worlds of artificial intelligence. One of the main requirements for formation of the skills is related to the infrastructures required in the field. These infrastructures include computing capabilities and access to data, without which there is no possibility of acquiring the required skills. The global gap between supply and demand leads to difficulty in the preservation of the distinct persons in the field. Hence the lack of human capital in the field. In addition, the committee identified a significant gap in the field of central computing infrastructures. The lack of these infrastructures affects the inability to train and guide human capital in these fields. Also, in the absence of a guiding hand and enabling regulation, persons engaged in this field in Israel do not have sufficient access to data.

The committee chose to analyze the issue by dividing it into seven layers: infrastructure and hardware, software tools, regulation and procedures for facilitating data sharing, data sharing tools, testing platforms for technological ventures, implementation and, finally, human capital training. These layers were examined in relation to the R&D needs and the unique characteristics of academia, industry, the public sector and the defense sector.

In recent years, economists have pointed to the ever-widening gap between the efficiency of the Israeli economy and efficiency of economies that are similar in size and level of development (referred to in the literature as the "benchmark countries"). Macroeconomic analysis of the sources of the productivity gap between Israel and the group of benchmark countries raises three main causes for the gap that are under the responsibility of the government: low level of public capital, in particular transportation and ICT infrastructures (communication and information technology), lack of human capital, especially of individuals who do not turn to academic studies and in the absence of alternative professional training, and a heavy regulatory and bureaucratic burden on the business sector .

For example, Sweden, which is characterized by an economy similar to the Israeli economy both in size and in absence of game-changing natural resources. It was found that its economy was at a level of efficiency similar to that of the Israeli economy until about 20 years ago. The state of affairs was changed by a reform carried out in government computerization. The goal of the reform was to make the government accessible to its businesses and citizens, in every field, through the computer. Digital management saves time, human errors and waste of budgetary resources. Use of artificial intelligence in government offices can make it easier to provide service to both businesses and individuals, for the entire process of reference and handling of the request vis-à-vis the office - from the stage verification of the personal details, while matching the correct form and process and providing response that is adapted to the questions and requests.

Additional issues that arose as part of the committee's work: ventures for national projects that will have a horizontal impact, such as NLP (natural language processing) abilities in Hebrew, common language requirements for the public-defense-government sector for the purpose of use and implementation, use of super-computerization alongside use of cloud, use of public cloud as compared to private cloud, use of open

source or closed source, maintaining security and data privacy, providing access to external databases to the cloud, the type of tools that will be provided on the infrastructure, planning of use of the resources, adapting the hardware to specific problems as a lever for overcoming the market failure, making capabilities accessible, the adaptation of the hardware and algorithms, the possibility of supplying additional hardware, the processing of the information in a centralized or decentralized manner, defining the ratio between CPU and GPU (Graphic Processing Unit, Central Unit Processing), as well as the option for different GPU types, separation of caches classified in hardware and cloud, provision of possibility for 'recycling' of old computerization through its conversion to educational or other institutions, and more.

Before submitting the draft report in August 2020, the committee was requested by the Ministry of Finance to examine ways for implementation of the program in the various government ministries. The committee chose to examine the assimilation in three different fields: employment, health and education. In this context, work was done by the committee the budget for which is not included in this report since it is assimilation activity that needs to be budgeted in coordination with the appropriate ministries. This work is not part of the full budget, with the exception of the pilot programs at the Innovation Authority that are noted in the report.

The recommended program includes, among others:

1. Establishing a central national infrastructure for research and accelerating the development of artificial intelligence, to contain large computerization power for the provision of holistic response to a large number of researchers and a variety of projects of various sizes. For example, projects that require substantial computerization power in order to train multi-parameter neural networks.
2. A very fast interface between the supercomputing center and the cloud infrastructure for the sake of speedy and broad data access.
3. The cloud services enable proximity to data and computing capabilities which are based on servers that include processors and accelerators. These capabilities are significant for solving calculation-intensive problems, and this report includes recommendations for the storage, calculation and network infrastructures required for this sake, as well as recommendations for establishing a team to operate and provide ongoing support in accordance with the needs of the users as defined above.
4. In addition, it is required to establish a development team for this infrastructure, which will be able to develop the shared artificial intelligence services, for the purpose of shortening the time and deployment in the development of artificial intelligence algorithms, as well as the team for accessibility of materials and operation for the purpose of creating verified and shared databases. This section was not priced at this stage.
5. Concentration of databases and calculation resources in one logical location, to enable efficient extraction, while allocating such resources in accordance with the various needs, assuming that there is a distribution in use along the timeline and provision of flexibility in SLA (Service Level Agreement), since the users need use of different intensities. Design of a data pool that will enable advanced research and perhaps even differentiation for start-up companies in Israel. The

concentration will enable the provision of effective support to users, efficiency and cost reduction in data storage contexts, flexibility in hardware upgrades, and will also facilitate cyber and physical security. The realization can be based on an external cloud infrastructure provider for immediate start-up, together with the establishment of the program for national infrastructure center and continued learning from experience. In this context, it would be prudent to consider connection to a number of cloud services for commercial reasons. This section was not priced at this time.

6. Human capital training for supercomputers and information centers, which will provide services not only to the center but also to the general ecosystem, the establishment of a knowledge center and a link between data and technology.
7. Promotion and focusing of human capital by recruiting faculty members, building academic curricula and in the industry and other trainings, providing scholarships and additional incentives, as well as:
    A. Providing opportunities for graduate students to work while forming ties between research and work in industry.
    B. Granting scholarships to outstanding research students (about 1000 doctoral and master students), at a cost of NIS 100,000 per student per year (and a total of 100 million NIS per year). Based on scholarships of Budgeting and Planning Committee in data science, but with a focus on core areas of artificial intelligence, additional budget, and the possibility of a direct budgeting mechanism for researchers.
    C. Providing research grants to renew computational infrastructure for academic researchers in artificial intelligence, possibility of integration with the use of cloud services. Up to an amount of 150 thousand dollars per grant. Competitive process with an emphasis on excellence, which can be combined with data science. 30 grants will be awarded every year, a total cost of 22.5 million dollars for 5 years.
    D. Creating chairs for Israeli artificial intelligence researchers who are leaders in Israel and the world. Distribution of three grants each year (which are divided into an initial grant, a consolidation grant and an advanced grant). One million dollars per grant, a total cost of 15 million dollars for 5 years.
8. State support for industrial R&D for the purpose of creating a competitive advantage in the Israeli economy. Distribution of the resources within the industries is carried out according to the nature of the research - the development of artificial intelligence capabilities in relation to its application in various fields, and according to the characteristics of the companies - those dealing with hardware or software infrastructure and applications compared to those that develop artificial intelligence and are required to have calculation infrastructures and data for training and validating the developed abilities.
9. Investment in the development of NLP corpuses and tools for the Hebrew and Arabic languages for the industry and the needs of the public sector.
10. Investment in establishing international collaborations.

11. Defining a fixed budget for the purpose of upgrading the hardware according to the needs and the technological advancement, to ensure support and for future innovations.
12. Defining one government regulator, such as the CBS, as having responsibility for mapping, storage, availability, licensing and accessibility to data available for research and development. This step enables a solution to the problem of difficulty in accessibility for the data, subject to the international standards and the Israeli law for the protection of privacy, while complying with aspects of privacy and information security.
13. Implementing the use of artificial intelligence in government ministries.
14. Implementing the use of artificial intelligence in the fields of security and industry.
15. Expanding the training and application of artificial intelligence in other fields of research in the academy besides the core fields.
16. Developing smart tools for use by the center's clients and providing support in their adaptation.
17. Encouraging research and development to promote the artificial intelligence industry and transfer knowledge from the academia to the industry.

We were required to implement the program, since if such a national plan is not implemented, already in years in the near future, the State of Israel will find itself in a scientific, technological and economic gap that may be unbridgeable, and scientific and technological dependence that will be a hindrance on national resilience. The meaning of building capabilities in artificial intelligence is speeding up and streamlining all the fields we refer to in this work and improving our national resilience. Israel lags behind other countries worldwide and the meaning of the delay is a structured inferiority and relative deterioration in relation to other foreign countries and players, which will continue to advance at a fast pace and push Israel from areas of activity that are expanding, in critical areas of science, economy, industry, defense, health, education and employment with high productivity. The State of Israel cannot afford to be in such a situation.

This report describes the full plan that was approved as part of the committee's work. Due to the special situation in the Israeli market, which includes a postponement in the approval of the state budget, at this stage a partial budget was defined for a limited period. This budget will be the first pulse for the entire program. The definition of this partial budget was done separately from the receipt of approval for the full plan, which will be broadly budgeted later. The first pulse budget includes only the investment in supercomputing, natural language processing and the partial advancement of the academic program. This pulse was done in coordination with the Budgets Division at the Ministry of Finance, in order to immediately start the activity. Supercomputing is a moving target that is entering the technological mainstream very quickly. Therefore, supercomputing has become more available and convenient to purchase, also in a service model starting from the scope required in the first pulse. However, the full budget required is also detailed.

The total budget required for the implementation of the recommended plan is 5.26 billion NIS, of which approximately 1.15 billion will be allocated to the Israeli academy, about 1.09 will be directed to industrial activity, about 1.08 - to activity in

the defense system (the two latter have significant mutual generic cooperation of about 80% in the industry and about 95% in defense), about 1.90 - will be used to establish the national infrastructures (of which 1.08 for supercomputer, including maintenance and update of infrastructure for 5 years, and about 0.86 for cloud services). The proposed budget is presented in Appendix 1. Additional appendices of the report are the committee's appointment letter (Appendix 2), table summarizing the industry and security needs (Appendix 3), cost estimation of cloud databases for COVID-19 research, written in collaboration with Professor Oren Korland (Appendix 4), an appendix that briefly summarizes the work that was made on the subject of assimilation (Appendix 5), and an appendix that details updates on the subject of super-computerization (Appendix 6). Another appendix, regarding clusters of academic courses, will be enclosed to the report further on as Appendix 7.

In conclusion, the field of artificial intelligence and data science is a growing field with a high potential for impact on diverse fields, which has been in accelerated development in recent years. Israel has a strategic need and dramatic potential thereof for the preservation and strengthening of national, security, academic and business resilience. Since the field requires diverse human infrastructure the training of which takes a long time and there are already a number of leading players therein, concentrated effort is required for maximizing the potential of the field. To this end, the committee is honored to present below its proposal for a national program that combines all potential partners, in order to establish local capacity and competitive status in the international arena.