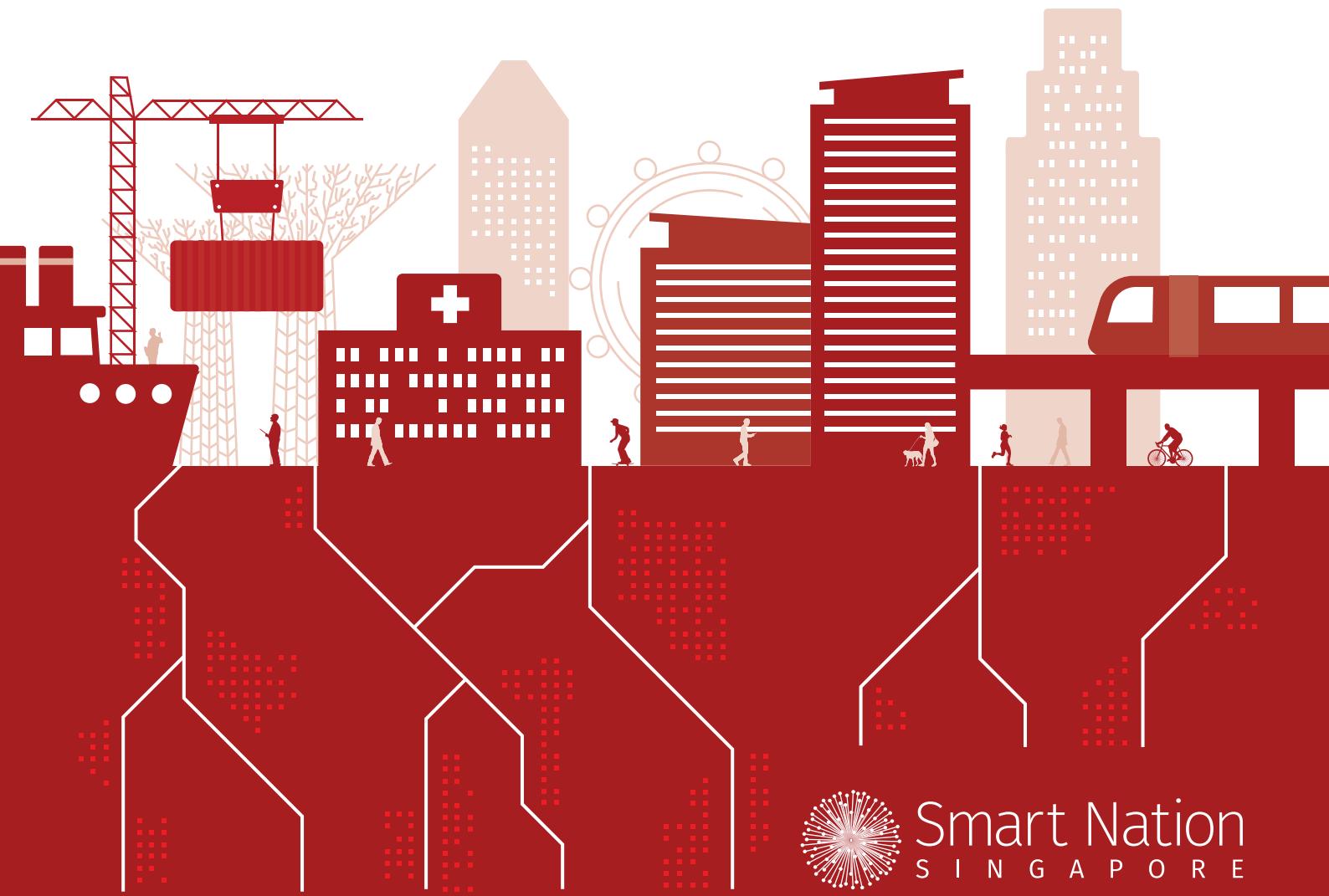


# NATIONAL ARTIFICIAL INTELLIGENCE STRATEGY

ADVANCING OUR SMART NATION JOURNEY



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NATIONAL ARTIFICIAL INTELLIGENCE STRATEGY

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# FOREWORD



The National AI Strategy is a key step in our Smart Nation journey. It spells out our plans to deepen our use of AI technologies to transform our economy, going beyond just adopting technology, to fundamentally rethinking business models and making deep changes to reap productivity gains and create new areas of growth.

## *Foreword by Mr Lee Hsien Loong, Prime Minister of Singapore*

Technological innovation has powered economic progress since the beginning of human history. Countries and cities that succeeded in exploiting technology have surged ahead and prospered; those that failed have languished and fallen behind. Our present era is no different. The emergence of new and disruptive digital technologies is re-ordering social and economic structures, and affecting the geopolitical landscape. To survive and thrive, Singapore must build up deep digital technology capabilities. This is why we launched the Smart Nation movement: to improve lives; to make Singapore a great place to live, work and play; and to stay relevant and competitive as an economy.

We have made progress. We are building a trusted, nationwide digital identity system using SingPass Mobile. E-payment is becoming more prevalent, benefiting businesses and consumers. Government services online are becoming more citizen and business-centric. At the backend, the Government has been building the basic digital infrastructure to share and use data securely, and to rapidly build and deploy digital applications and services.

But we have much more to do. Technology is constantly evolving. In particular, Artificial Intelligence (AI) has progressed dramatically, and will become a big part of our lives. For example, AI algorithms can pick out tumours from medical images more accurately than doctors.

They power ride hailing platforms like Grab and Uber. They optimise factory production lines. They work in the background of our smart-phone apps, like Apple's Siri or Spotify.

The National AI Strategy is a key step in our Smart Nation journey. It spells out our plans to deepen our use of AI technologies to transform our economy, going beyond just adopting technology, to fundamentally rethinking business models and making deep changes to reap productivity gains and create new areas of growth.

As a small country, Singapore lacks the scale of large markets and R&D ecosystems. But we can make up for this by building up AI research, and working together cohesively across Government, industry, and research, to develop and deploy AI solutions in key sectors. At the same time, we must also anticipate the social challenges that AI will create, by maintaining public trust and building capabilities to manage and govern AI technologies, and guarding against cybersecurity attacks and breaches to data privacy. We are confident that we will succeed in making Singapore a leading country in AI, and more broadly a Smart Nation for our citizens.

Lee Hsien Loong



# NATIONAL ARTIFICIAL INTELLIGENCE STRATEGY

**VISION**

By 2030, Singapore will be a leader in developing and deploying scalable, impactful AI solutions, in key sectors of high value and relevance to our citizens and businesses.

**NATIONAL AI PROJECTS**

We will embark on an initial tranche of 5 National AI Projects to deliver strong social and/or economic impact for Singapore and Singaporeans.



INTELLIGENT FREIGHT PLANNING



SEAMLESS & EFFICIENT MUNICIPAL SERVICES



CHRONIC DISEASE PREDICTION & MANAGEMENT



PERSONALISED EDUCATION THROUGH ADAPTIVE LEARNING & ASSESSMENT



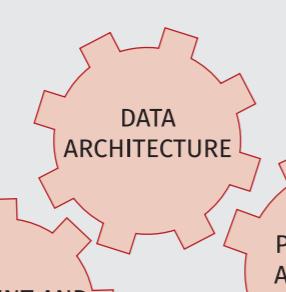
BORDER CLEARANCE OPERATIONS

**ECOSYSTEM ENABLERS**

To enjoy sustained benefits from AI, we will strengthen ecosystem enablers that drive AI innovation and adoption across the economy.



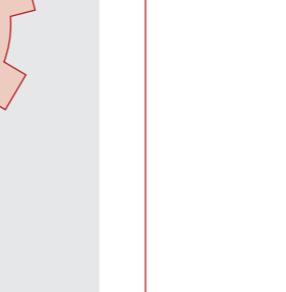
TRIPLE HELIX PARTNERSHIP  
RESEARCH COMMUNITY + INDUSTRY + GOVERNMENT



DATA ARCHITECTURE



INTERNATIONAL COLLABORATION



PROGRESSIVE AND TRUSTED ENVIRONMENT



AI TALENT AND EDUCATION

# EXECUTIVE SUMMARY

Singapore has a unique opportunity to harness digital disruption and propel ourselves onto a new growth trajectory to sustain our future national competitiveness and improve the lives of Singaporeans. We have made good progress through our Smart Nation movement, and have put in place the data and digital infrastructure to accelerate our whole-of-nation drive to transform our Government, economy, and society.

Artificial Intelligence (AI) represents the next frontier of technological opportunities. Often, the bottleneck to reaping the full benefits of AI is not in the readiness of the technology, but in our ability to redesign processes, systems, and regulation to deploy them. Singapore is well-positioned to do this at a national scale. We have made significant and early investments into AI research and are recognised as a global thought leader in AI ethics and governance. We are a global hub for digital and AI talent, with a vibrant tech startup ecosystem and a highly educated workforce that understands the value and potential of technology. Most importantly, we are able to bring Government, industry, and researchers together to work together on deploying AI solutions to address key national priorities.

## Vision

The National AI Strategy is a living document to place Singapore at the forefront in the development and deployment of scalable, impactful AI solutions, in sectors of high value and relevance to our citizens and businesses.

- Singapore will be a **global hub** for developing, test-bedding, deploying, and scaling AI solutions. This includes learning how to govern and manage the impact of AI.
- Government and businesses will use AI to **generate economic gains and improve lives**. AI will raise the Government's capability to deliver anticipatory and personalised services, and will also be a strong driver of growth in key sectors of Singapore's economy.
- Singaporeans will **understand** AI technologies and the benefits it can bring; our workforce will be equipped with the **necessary competencies** to participate in the AI economy.

To achieve this, we will focus on delivering National AI Projects and strengthening our AI ecosystem enablers.

## National AI Projects

We will embark on an initial tranche of 5 National AI Projects, to deliver strong social and/or economic impact for Singapore and Singaporeans. These projects will guide investment in AI research, generate lead demand to anchor talent and capabilities in Singapore, and guide how Singapore builds up its supporting digital infrastructure. We will continue to identify other high impact National AI Projects to pursue.

- **Intelligent Freight Planning** – to optimise the movement of freight to improve productivity for businesses and traffic efficiency.
- **Seamless and Efficient Municipal Services** – to make municipal services more responsive, reliable and timely.
- **Chronic Disease Prediction and Management** – to help prevent and better manage chronic diseases.
- **Personalised Education through Adaptive Learning and Assessment** – to help teachers to better customise and improve the learning experience for every student.
- **Border Clearance Operations** – to strengthen border security while improving traveller experience.

## Building the AI Ecosystem

Our National AI Projects will generate momentum for AI deployment and demonstrate the value of AI. To enjoy sustained benefits from AI, we will strengthen ecosystem enablers that drive AI innovation and adoption across the economy. Our strategy identifies 5 critical ecosystem enablers:

- **Triple Helix Partnership between the Research Community, Industry and Government** – enable the rapid commercialisation of fundamental AI research and deployment of AI solutions, through harnessing stakeholder synergies through collaboration.
- **AI Talent and Education** – address the shortfall in the quantity and quality of talent across the entire range of AI-related job roles.
- **Data Architecture** – enable quick and secure access to high-quality, cross-sectoral datasets.
- **Progressive and Trusted Environment** – strengthen trust in AI technologies to enable an environment for test-bedding, developing, and deploying AI solutions.
- **International Collaboration** – work with international partners to shape the international AI discourse and develop the other horizontal enablers.

## Working Together

We have established a National AI Office under the Smart Nation and Digital Government Office to set the national agenda for AI and partner the research community and industry to implement the National AI Strategy. The National AI Strategy requires a whole-of-nation effort, and we welcome ideas and contributions from individuals and companies to help deliver our AI vision for Singapore.



## WHY A NATIONAL AI STRATEGY?

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- What AI has to offer
- What we hope to achieve from a National Strategy
- Why we can succeed

## What AI has to offer

Artificial Intelligence (AI) is the capability to simulate intelligent, human-like behaviour in computers. The theory behind many of today's AI techniques has been around since the 1980s, but advances in computing power have now brought practical applications of AI within reach.

Machine learning, which includes techniques like neural networks and deep learning, has emerged as the primary enabler of this wave of AI progress. Machine learning algorithms improve their ability to perform a particular task by learning from data over time. This allows computers to adapt to unpredictable situations that defy codification by static rules. Such tasks include steering a car through traffic, or conversing with a customer to learn what she wants. On occasion, the computer may even adopt a novel solution not previously conceived by humans.

Thus, AI is a general purpose technology. It has applicability in any field, ranging from cancer diagnosis to urban planning and fraud detection. It also has the potential to offer breakthrough solutions that are incomparably better than existing approaches.

Like the advent of electricity, the potential impact of AI on society, economy, and Government cannot be understated. Any nation able to master this technology will be able to create tremendous social and economic value for its citizens. Societies that cannot adapt will fall behind.

The rise of applicable, deployable AI represents a golden opportunity for Singapore to open new frontiers of growth and transcend our geographical limits. For the nation, AI should transform national-level planning and significantly raise the quality of public goods like transport, education and healthcare. For the economy, AI should augment our workforce to raise productivity, and enable us to create valuable products and solutions for the Singapore market and beyond. For our people, AI should bring about greater convenience, safety and security, and most importantly, improve their lives.

## What we hope to achieve from a National Strategy

We need a national strategy to fully harness the benefits of AI. This strategy serves three purposes.

First, the strategy identifies areas to focus attention and resources at a national level. Singapore cannot be world leading on all fronts, and larger economies will continue to have significant advantages in certain fields of AI. We need to be deliberate about choosing where we should build our own world-class capabilities, and where we should tap on the advances made by others.

Second, the strategy sets out how Government, companies, and researchers can work together to realise positive impact from AI. Talent, data, regulation, and effective deployment are key elements needed to enable AI applications that serve society. We need a coherent plan that brings these elements together, across organisational boundaries.

Third, the strategy addresses areas where attention is needed to manage change and/or manage new forms of risks that arise when AI becomes more pervasive. These include workforce adaptation and the governance of decision making by machines. By being proactive in tackling these emerging issues, we will be better prepared and more confident as a nation to advance AI technologies.

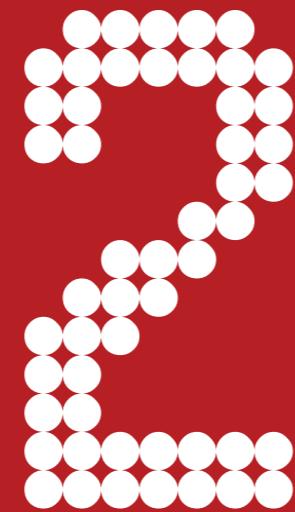
## Why we can succeed

First, we have consistently invested in ICT technologies, beginning with our National Computerisation effort in the 1980s. In recent years, we embarked on our Smart Nation journey to use digitalisation to transform our Government, economy and society. The build-up of our digital capabilities and infrastructure has given us a running start in developing and deploying AI.

Second, we have already made significant and early investments into AI, both in the public R&D ecosystem and the private sector. We are also a leading nation in AI ethics and governance. This provides a good base from which we can anchor world-leading capabilities in various niches of excellence and build a progressive and trusted environment for AI innovation.

Third and more broadly, we are a small, advanced country with a highly educated population that understands the value and potential of technology. We have the capability to organise and coordinate well across public and private institutions, and are able to make practical decisions, as a society, on the adoption of AI for social and economic good.

These factors should give us a measure of confidence in being able to use AI well to succeed as a nation, even if we are lacking in the sheer size and scale of other economies.



## VISION AND APPROACH

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## VISION

By 2030, Singapore will be a leader in developing and deploying scalable, impactful AI solutions, in key sectors of high value and relevance to our citizens and businesses.

Singaporeans will trust the use of AI in their lives. This confidence is borne out of a clear awareness of both the benefits and implications of the technology. Our workforce will have the necessary competencies to be part of the AI economy, and our engineers and entrepreneurs will innovate and create new AI solutions for the local and global markets.

Domestically, our private and public sectors will use AI decisively to generate economic gains and improve lives. Internationally, Singapore will be recognised as a global hub in innovating, piloting, test-bedding, deploying and scaling AI solutions for impact.

## APPROACH

### 1. Emphasise deployment

We will work jointly across public, private and research institutions to enable effective deployment of AI solutions. The objective of effective deployment will anchor our efforts in R&D, regulatory review, and capability development.

### 2. Focus on key sectors

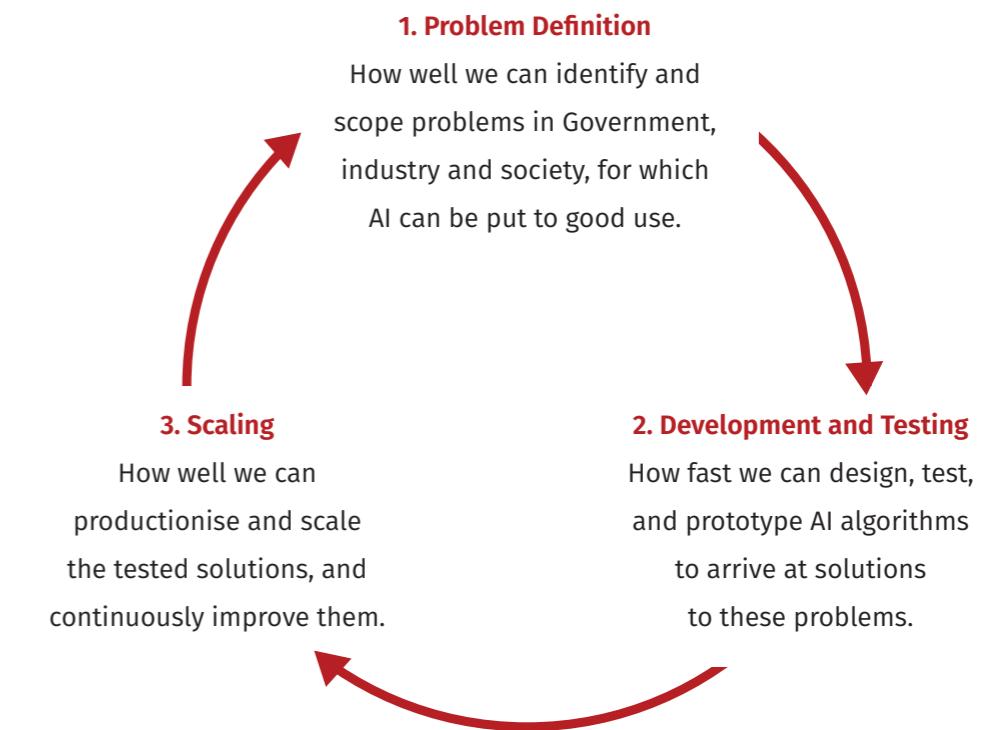
We will focus on driving AI deployment in key sectors with high social or economic value for Singapore, and for which we can build on existing strengths.

We have identified nine such sectors: Transport & Logistics, Manufacturing, Finance, Safety & Security, Cybersecurity, Smart Cities & Estates, Healthcare, Education and Government.

### 3. Strengthen the AI Deployment Loop

There are three aspects of effective deployment:

#### AI Deployment Loop



These three aspects mutually support one another in a virtuous cycle that we label the “AI deployment loop”.

Within each of the nine key sectors, we will identify and initiate impactful use cases to start collaborative AI projects. We call these the “National AI Projects”. Through these projects, we intend to create gains, draw lessons, and progressively tighten the feedback loop between problem definition, development/testing and scaling. In this way, we will be able to innovate on AI in cycles that will be increasingly shorter.

#### 4. Adopt a human-centric approach

First and foremost, we will focus on benefits to citizens and businesses, i.e. getting AI to serve human needs, rather than developing the technology for its own sake. This is aligned with our Smart Nation approach, and our focus on effective deployment in key sectors of high socio-economic value.

Second, we will be proactive in addressing the risks and governance issues that come with the increasing use of AI. In particular, we need to guard against the dilution of our societal and institutional responsibilities and accountabilities towards one another, even as we use AI more frequently to automate, detect, and predict.

Third, we will build an AI-ready population and workforce. At the societal level, as part of the overall promotion of digital literacy, we will raise awareness of AI, so that citizens are prepared for technological change, and are engaged in thinking about AI's benefits and implications for the nation's future. At the workforce level, we will prepare our professionals to adapt to new ways of working, in which workers are augmented by AI capabilities.

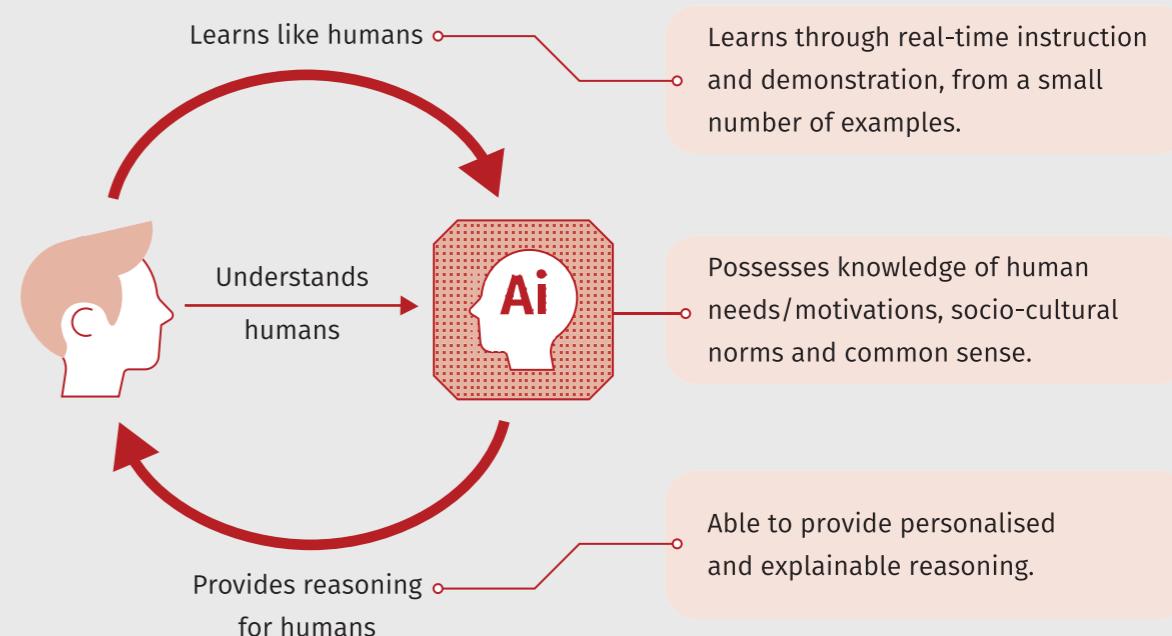
#### A\*STAR's Human-Centric AI R&D programme

Currently, AI systems often do not understand the context and complex nuances of human interactions; and humans do not fully understand why and how decisions are made by AI systems.

To advance human-centricity and understanding of AI, the Human-Centric AI Programme, led by the Agency for Science, Technology and Research (A\*STAR), brings together research groups across Singapore to develop AI technologies that learn like humans, understand humans, and can explain their inner workings to humans.

The team has started to create capabilities that enable robots to understand human interactions such as speech, gestures and touch. The team aims to make robots that can be "taught" by instruction and demonstration. This will allow robots to work collaboratively with humans without the need for specialised infrastructure or dedicated setup. The programme will also integrate social sciences, such as psychology and sociology, in the development of AI. This will allow AI systems to better understand culture and social norms (especially Asian cultures and norms) and human intentions.

#### Human-Centric AI Programme



# STRATEGY

The National AI Strategy consists of two components:

## National AI Projects

We will progressively identify National AI Projects in key sectors of high social and/or economic impact, and apply the AI deployment loop from problem definition to deployment. These projects will guide investment in AI research, generate lead demand to anchor talent and capabilities in Singapore, and guide how Singapore builds up its supporting digital infrastructure.

In Section 3, we have sketched out a portfolio of 5 National AI Projects in the areas of transport and logistics, smart cities and estates, healthcare, education and safety and security. Beyond these five projects, we will continue to identify future projects of similar impact level to pursue within the key sectors.

## AI Ecosystem Enablers

The National AI Projects will generate momentum for AI deployment and demonstrate the value of AI. To enjoy sustained benefits from AI, we will strengthen ecosystem enablers that drive AI innovation and adoption across the economy. In Section 4, we explain our plans to build up 5 critical ecosystem enablers: Triple Helix Partnership, AI Talent and Education, Data Architecture, Progressive and Trusted Environment, and International Collaboration.

### NATIONAL AI PROJECTS

We will embark on an initial tranche of 5 National AI Projects to deliver strong social and/or economic impact for Singapore and Singaporeans.



INTELLIGENT  
FREIGHT PLANNING



CHRONIC DISEASE  
PREDICTION &  
MANAGEMENT



BORDER CLEARANCE  
OPERATIONS



SEAMLESS & EFFICIENT  
MUNICIPAL SERVICES



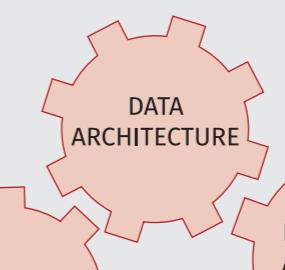
PERSONALISED EDUCATION  
THROUGH ADAPTIVE  
LEARNING & ASSESSMENT

### ECOSYSTEM ENABLERS

To enjoy sustained benefits from AI, we will strengthen ecosystem enablers that drive AI innovation and adoption across the economy.



TRIPLE HELIX  
PARTNERSHIP  
RESEARCH COMMUNITY  
+ INDUSTRY  
+ GOVERNMENT



DATA  
ARCHITECTURE



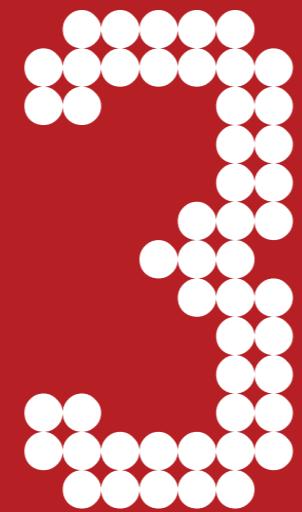
INTERNATIONAL  
COLLABORATION



AI TALENT AND  
EDUCATION



PROGRESSIVE  
AND TRUSTED  
ENVIRONMENT



## NATIONAL AI PROJECTS

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- Intelligent Freight Planning
- Seamless and Efficient Municipal Services
- Chronic Disease Prediction and Management
- Personalised Education through Adaptive Learning and Assessment
- Border Clearance Operations

# CREATING IMPACT THROUGH NATIONAL AI PROJECTS

The 5 National AI Projects address key national challenges for Singapore in transport and logistics, smart cities and estates, healthcare, education, and safety and security. Implementing them will require our research institutes, industry, and Government to work collectively to develop and deploy AI solutions.

## 1 TRANSPORT AND LOGISTICS

### Intelligent Freight Planning

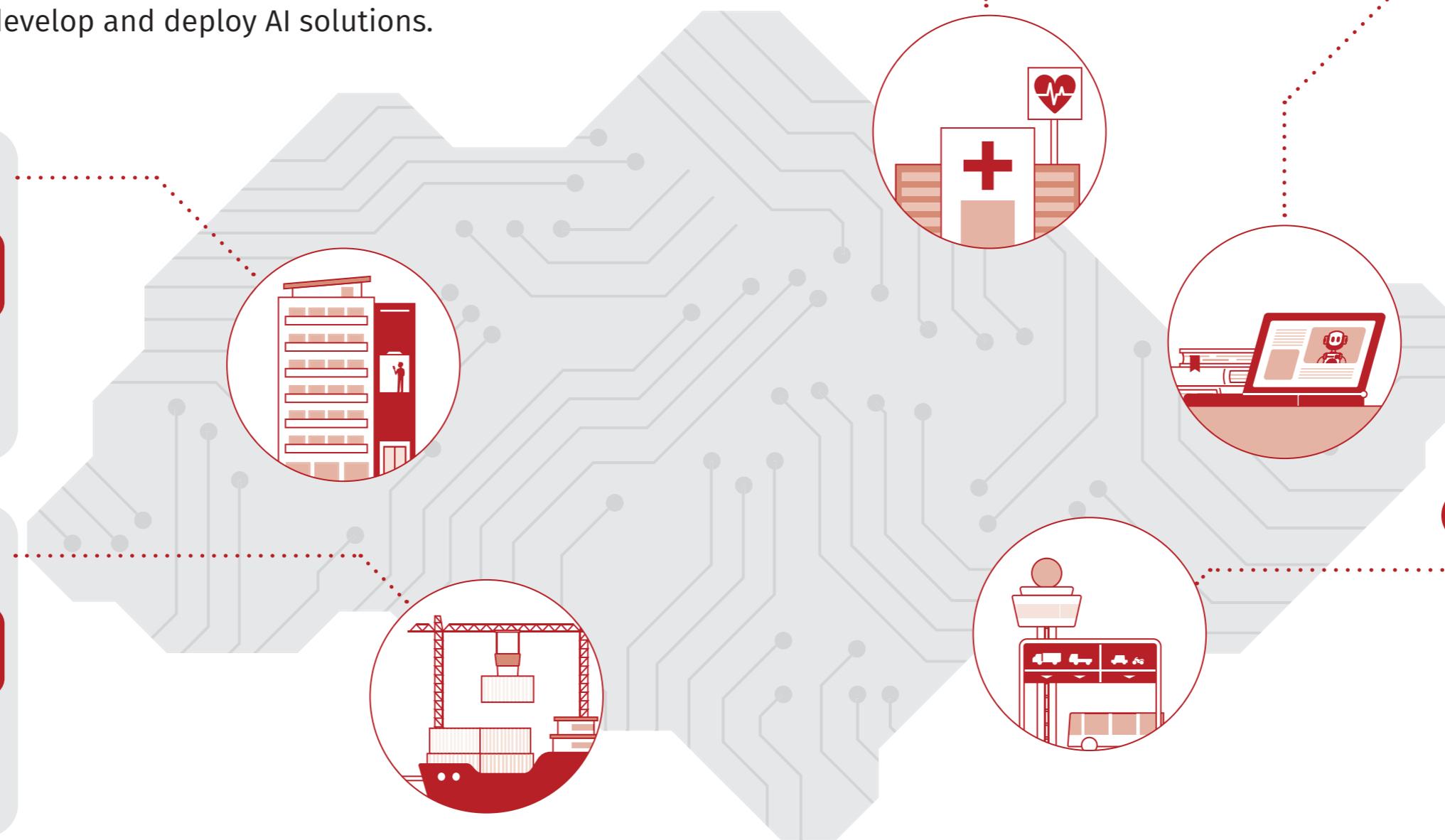
**AI TECHNOLOGIES:**  
Natural Language Processing,  
Computer Vision, Modelling  
and Simulation



## 2 SMART CITIES AND ESTATES

### Seamless and Efficient Municipal Services

**AI TECHNOLOGIES:**  
Natural Language Processing,  
Computer Vision, Modelling  
and Simulation



## 3 HEALTHCARE

### Chronic Disease Prediction and Management

**AI TECHNOLOGIES:**  
Machine Learning, Computer  
Vision, Explainable AI



## 4 EDUCATION

### Personalised Education through Adaptive Learning and Assessment

**AI TECHNOLOGIES:**  
Machine Learning, Natural  
Language Processing



## 5 SAFETY AND SECURITY

### Border Clearance Operations

**AI TECHNOLOGIES:**  
Machine Learning, Computer  
Vision, Cognitive Systems,  
Explainable AI



# 1. INTELLIGENT FREIGHT PLANNING

## Challenge

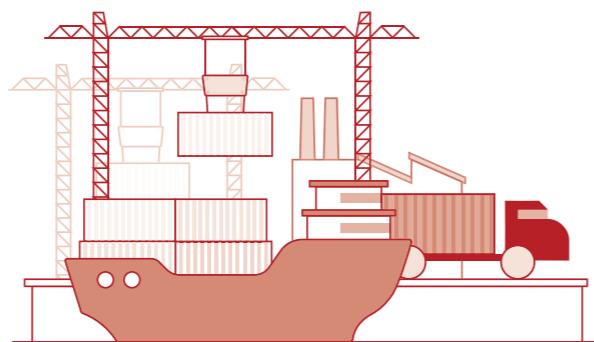
How can we optimise the movement of freight to improve productivity for businesses, and traffic efficiency?

Moving freight is a complex operation that involves many players such as port operators, freight forwarders, container depot operators, hauliers and third-party logistics service providers. Many processes in this sector are still highly manual, and use independently-operated systems that are not connected across the different parties in the chain. These result in inefficiencies in the transportation process and congestion around logistics nodes such as our ports and container depots, thus reducing the overall productivity of our trucks and drivers.

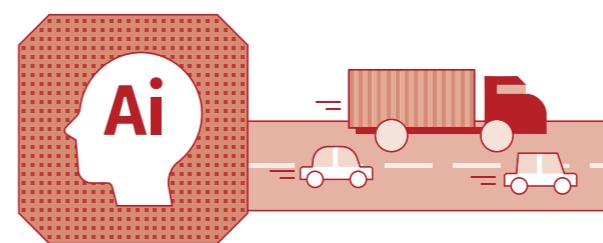
## Objective

Seamless and efficient freight movement, more productive companies and workers.

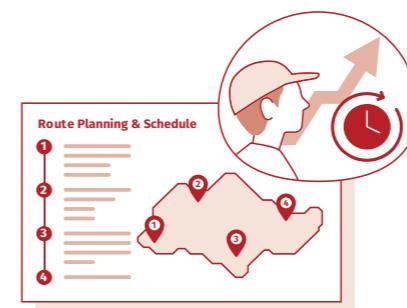
We aim to create a freight movement ecosystem where key parties leverage AI to share information and collaborate in an integrated manner, to enable more efficient freight and truck movement across Singapore.



**Pooling and dynamic assignment of trucking jobs.** Through the digitalisation of assets and the use of AI, jobs could potentially be pooled and dynamically assigned to trucks to ensure that trips are revenue generating both ways, instead of one-way. This would make each truck trip more productive, and improve asset utilisation and driver productivity for companies.



**Intelligent routing and scheduling of trucks.** AI could also be deployed to help companies better plan the routing and scheduling of their trucks to our ports and container depots, which will help to reduce waiting times and localised traffic congestion. This will enable companies to improve business margins and strengthen their business competitiveness. It will also create better and higher value-added jobs for workers in the industry.



**AI-enabled planning and modelling for better urban planning.** Data collected from the ecosystem will also enable Government to conduct data-driven policy reviews and do better urban planning to improve the overall efficiency of Singapore's logistics ecosystem.

## Key Benefits

- Businesses increase revenue through improving asset utilisation and job sharing.
- In-house transport planners are trained to use digital solutions to do smarter transport planning.
- Truck drivers can be more productive with less time spent waiting to complete a job.
- Businesses and the public benefit from less traffic congestion and a more efficient domestic logistics ecosystem.

## Our First Steps

We will need to strengthen data flows and connectivity between parties in the ecosystem, to create a foundation upon which to build intelligent applications. We will explore building a common and trusted data exchange platform to facilitate planning and optimisation of truck trips.

We will focus our initial efforts on piloting and deploying AI applications that facilitate planning and optimisation of truck trips to and from the sea gateway. In the longer term, we will scale the deployment of intelligent freight planning solutions to our air and land gateways.

## 2. SEAMLESS AND EFFICIENT MUNICIPAL SERVICES

### Challenge

How can municipal services be delivered to residents in a more responsive, reliable and timely manner?

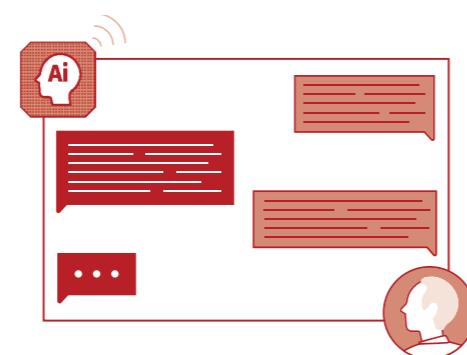
Municipal services are an essential part of daily life. From cleaning public spaces to maintaining roads and footpaths, 10 Government agencies and 16 Town Councils work tirelessly to ensure that Singapore residents enjoy a high<sup>1</sup> standard of municipal services.

Several of these services are high-volume and resource-intensive. While residents today help by informing us of municipal issues they face, we also need to undertake more pre-emptive inspections with the limited workforce we have, and better plan our living environment to prevent issues from arising in the first place.

At times, residents might find it challenging to provide agencies with sufficient information to follow up on their feedback. This lengthens the time taken to resolve the more than 1 million feedback cases that agencies receive each year. There is scope to employ AI to guide residents along the feedback process and eventually shorten case resolution time.

### Objective

More responsive, reliable, and timely neighbourhood services.



**Tell us once, just the way you see it.** Residents can report issues seamlessly, without the need to worry about which agency to report their feedback to, or how to describe the issue. An AI-powered chatbot can guide them along and get to the heart of the issue.



**Better-maintained estates.** Sensors and AI algorithms can be deployed in the neighbourhood, such as in lifts, to alert us to would-be faults before they occur, and help us pre-emptively address issues to minimise inconvenience to residents.



**Working with residents to improve the living environment.** AI can help us better understand how our residents, their families and the community are using various neighbourhood facilities. With this knowledge, we can then work towards the planning and building of facilities that best serve residents' needs.

### Key Benefits

- Residents can report municipal issues more efficiently and seamlessly.
- Resident can enjoy better-maintained estates, and more reliable municipal infrastructure and services without having to report them.
- Residents will enjoy facilities that will better serve their needs.

### Our First Steps

We will start with an AI-powered chatbot to guide residents when they report an issue. The chatbot will identify the correct agency to direct the issue to. It will also prompt residents for mandatory case details in real-time, thereby minimising the need for agencies to call them back for additional case information.

<sup>1</sup> More than 75% of residents are satisfied with the delivery of municipal services (Source: Municipal Services Survey 2018, conducted by the Municipal Services Office).

## 3. CHRONIC DISEASE PREDICTION AND MANAGEMENT

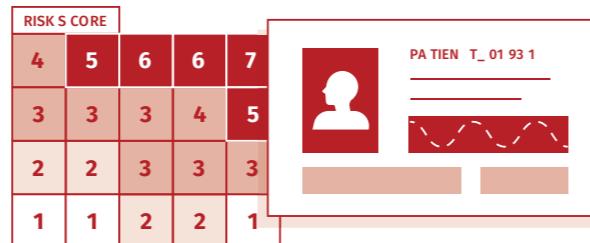
### Challenge

How can we help prevent and better manage chronic diseases such as diabetes, high blood pressure and high cholesterol, to reduce the risk of complications like heart disease, stroke and kidney failure?

Many Singaporeans have chronic diseases such as diabetes, hypertension and high blood cholesterol. They may be unaware that they have these conditions as the symptoms may not be noticeable early on. If not well controlled, these diseases can lead to serious complications such as heart attack, stroke, kidney failure and even death.

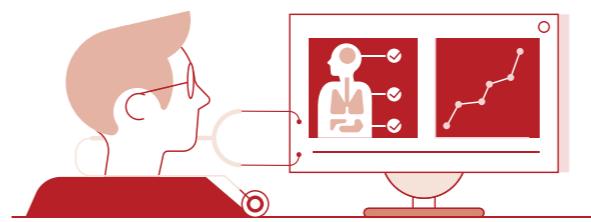
### Objective

Better control over chronic diseases such as diabetes, hypertension and high blood cholesterol.

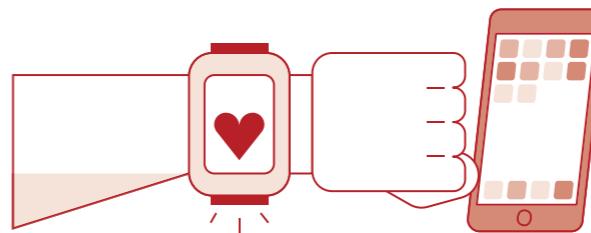


#### Personalised risk score for chronic diseases.

AI can be used to analyse clinical data, medical images, health behaviours and genomic data to create a personalised risk score for individuals. This score can help individuals to take appropriate preventive measures as well as receive earlier and more targeted interventions from their care teams.



**Clinical decision support for primary care doctors.** AI can be used to support primary care doctors and care teams in developing personalised care plans that take into account a patient's risk profile. As each care team may look after a large number of patients, AI can also assist in monitoring the progress of patients, and alert care teams to patients whose progress show cause for concern so that timely action can be taken.



**Empower patients to better manage their chronic diseases.** AI can make it easier for patients to self-manage their conditions. Patients can use AI to monitor their health status, and receive timely reminders to eat healthily, increase physical activities, take their medication and report for check-ups.

### Key Benefits

- Singaporeans will enjoy improved health outcomes, and will be empowered to better self-manage chronic diseases.
- Patients at higher risk of complications are identified earlier and provided with more intensive management and monitoring in the primary care setting, to reduce the likelihood of medical complications.
- Healthcare providers will be more productive and can better help patients control chronic disease conditions.

### Our First Steps

We will deploy the Singapore Eye LESioN Analyser (SELENA+), which analyses retinal photographs using a Deep Learning System to detect 3 major eye conditions: diabetic eye disease, glaucoma and age-related macular degeneration. SELENA+ can analyse retinal photographs as accurately and faster than human graders. This increases the productivity of human graders by up to 70 per cent, and allows them to dedicate more time to patients with complex cases. SELENA+'s capabilities in analysing retinal images will also be extended to develop a predictive risk assessment model for cardiovascular disease.

## 4. PERSONALISED EDUCATION THROUGH ADAPTIVE LEARNING AND ASSESSMENT

### Challenge

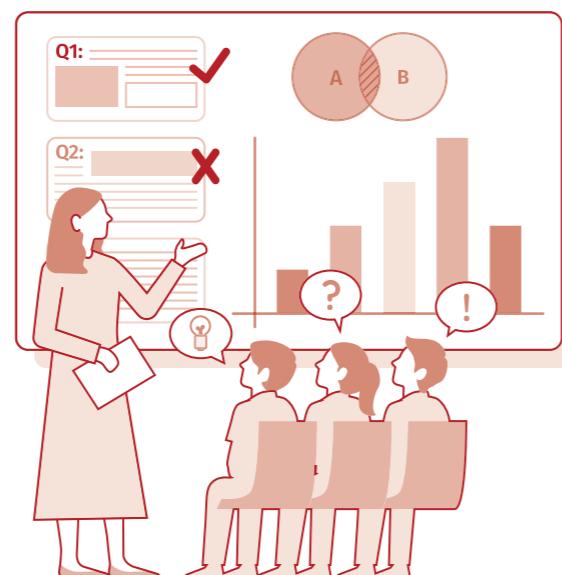
How can we help teachers to better customise and improve the learning experience for every student, particularly those with learning difficulties?

Different students have different learning needs, starting points and aptitudes for different subjects. They also have different strengths and interests. There is also a limit to how much teachers can customise the learning experience or provide continuous and detailed feedback for every student. Routine tasks also take up time that teachers could use to value-add to students' learning experiences.

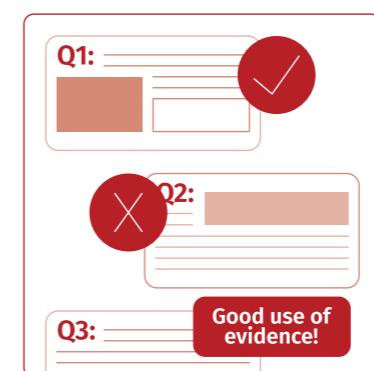
### Objective

More personalised learning and assessment for every student.

We will leverage AI through the Singapore Student Learning Space (SLS), an online learning platform for all students and teachers in the national school system, launched in May 2018.



Students' learning experiences with the SLS will be enhanced by an **AI-enabled Adaptive Learning System**. The adaptive learning system will use machine learning to enable it to tell how each student responds to learning materials and activities, and to recommend a step-by-step pathway customised for each learner.



Teachers will be able to assess students' work more efficiently and effectively with an **AI-enabled Automated Marking System**. The automated marking system will be able to assess open-ended student responses such as short-answer response questions and essays, and provide quick feedback to students' work.



We will also support students' holistic development through an **AI Learning Companion** that could motivate the student, keeping her engaged during challenging tasks, help the student reflect on her learning experience, and recommend further learning activities.

### Key Benefits

- Students will have a more personalised learning experience, tailored to their individual strengths and weaknesses.
- Teachers will spend less time on routine assessment tasks, and can guide students' learning more effectively through data-driven insights.
- In the long run, students of diverse learning needs, as well as low-progress learners, will be better supported, raising their achievement level.

### Our First Steps

We will pilot an AI-enabled automated marking system for English Language with selected primary and secondary schools in 2020.

We will also trial the adaptive learning system through the SLS for specific topics in the Mathematics curriculum, starting with upper primary and lower secondary levels. We will conduct a pilot with selected schools by 2022.

## 5. BORDER CLEARANCE OPERATIONS

### Challenge

How do we continue to strengthen border security while improving traveller experience?

The demand for secure and efficient immigration clearance is expected to grow amidst the heightened security climate and the anticipated increase in global travel and commerce. However, increasing security often comes at a price; from invasive body searches, to long queues at immigration checkpoints.

Singapore has long been a destination for business and leisure travel and a popular embarkation point for those wanting to explore the rest of Asia. To maintain Singapore's image as a welcoming and safe tourism and business destination, we need to continue to provide a fast and hassle-free immigration clearance experience for all our travellers, without compromising security. This will be especially challenging amidst our tightening resident labour force and space constraints.

### Objective

100% automated immigration clearance for all travellers.



We aim to deploy AI to achieve **100% automated immigration clearance** for all travellers, including first-time social visitors. Singaporeans and departing visitors will experience "Breeze-Through" immigration clearance, without the need to present their passports.



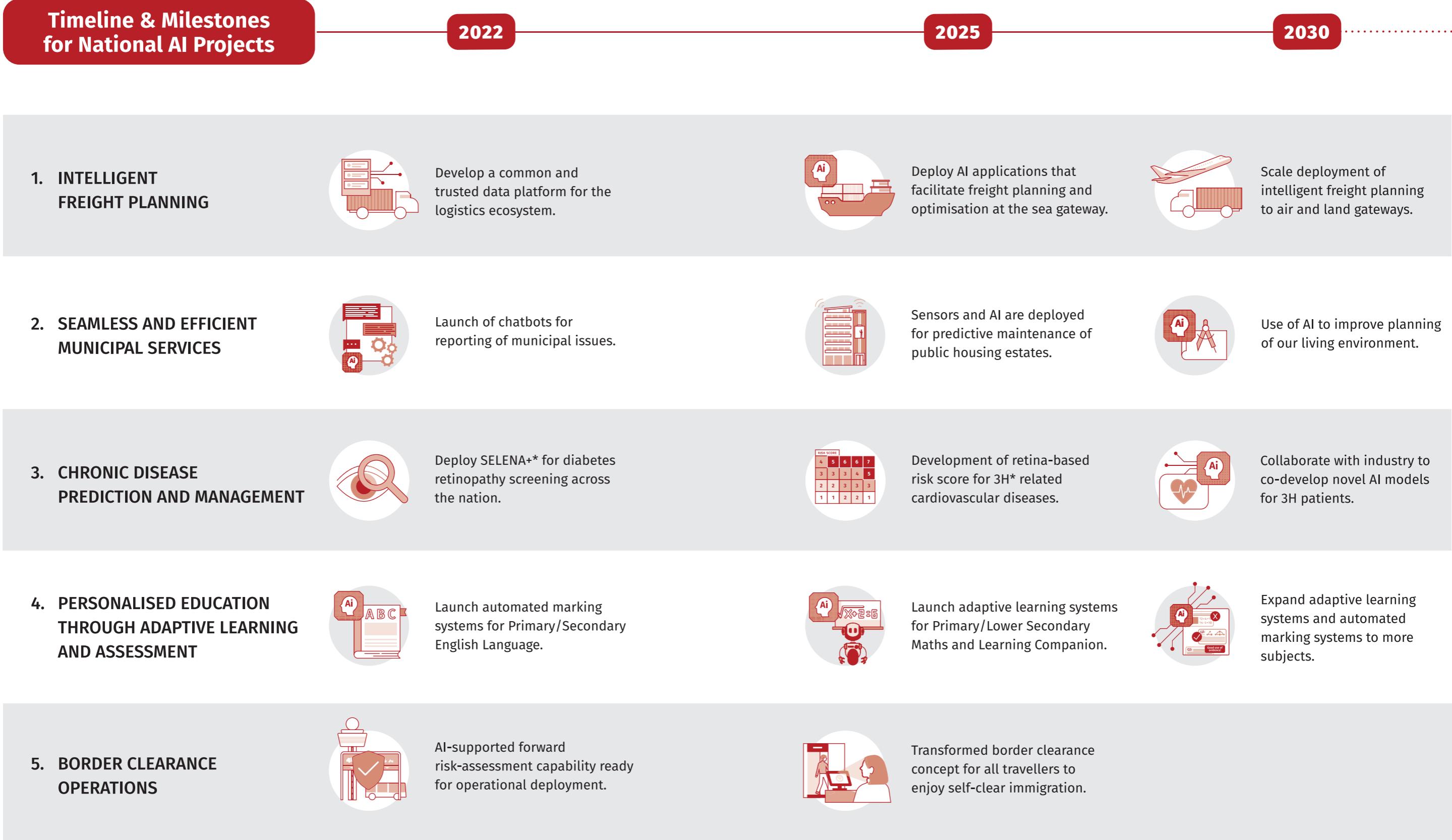
Even though our **border security will be enhanced**, for most travellers, these security measures will work quietly in the background, enabling them to experience the convenience of hassle-free international travel.

### Key Benefits

- Singaporeans and visitors will be empowered to process their own clearance through the automated immigration facilities, and enjoy a faster and more seamless travel experience.
- Singaporeans will enjoy greater safety and security through our strengthened border security.
- Immigration officers will achieve productivity gains and can focus on higher value work.

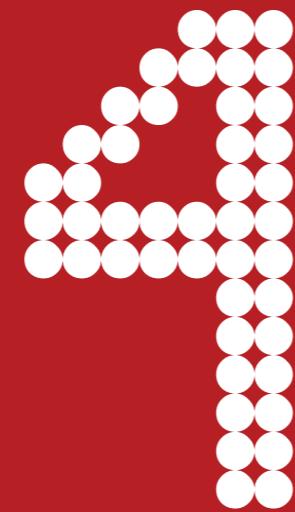
### Our First Steps

Singapore will explore using AI to assist immigration officers in evaluating the risk profile of travellers before they arrive at our checkpoints, and to tier the level of security screening accordingly. To enable this, we will collect and analyse data from various sources, including the Singapore Arrival Cards submitted by travellers and advance passenger information from airlines. We will also study how to redesign our immigration clearance process to enable all travellers to enjoy secure and seamless immigration clearance experience via automated clearance facilities.



\* SELENA+: Singapore Eye LESION Analyser

\* 3H: High glucose, High blood pressure, High cholesterol



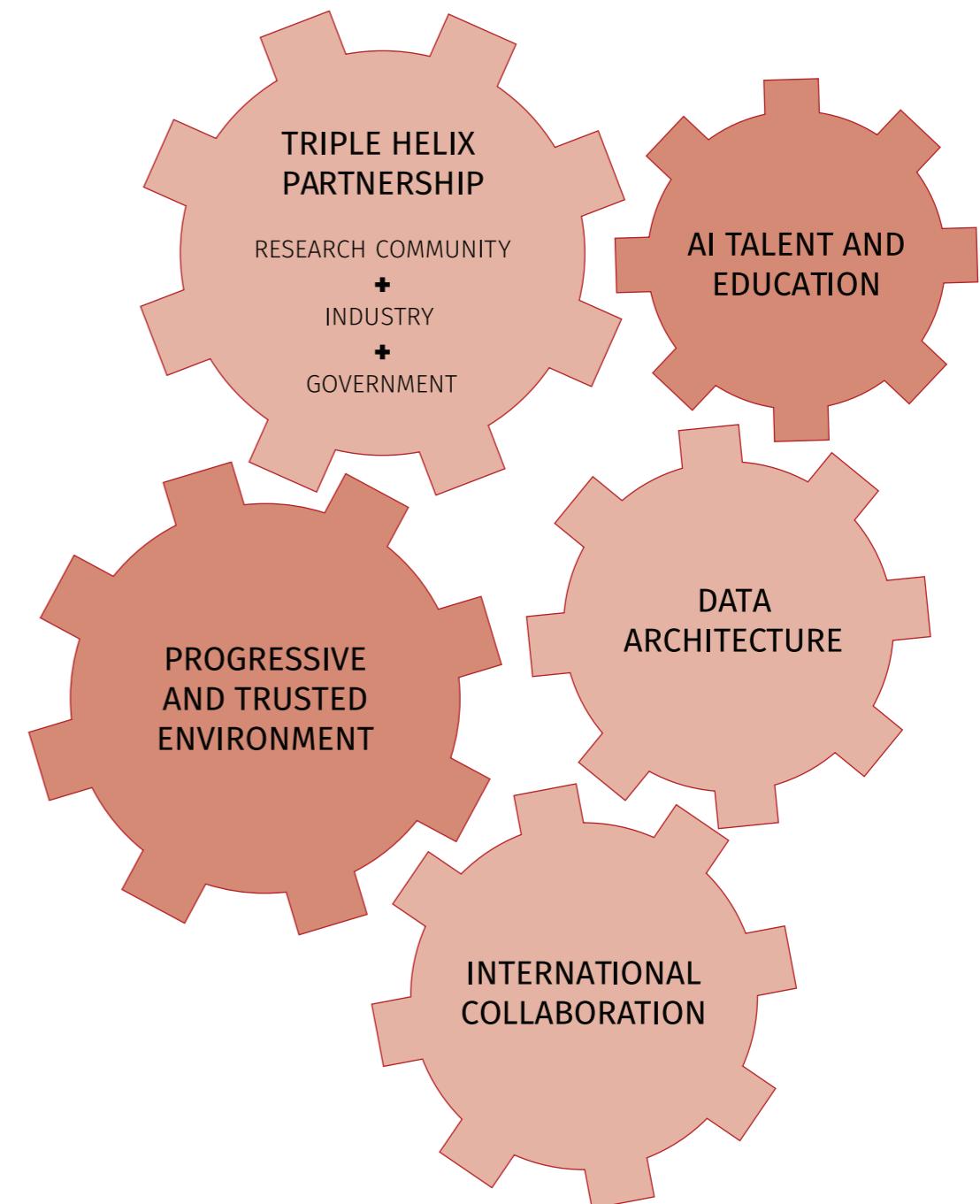
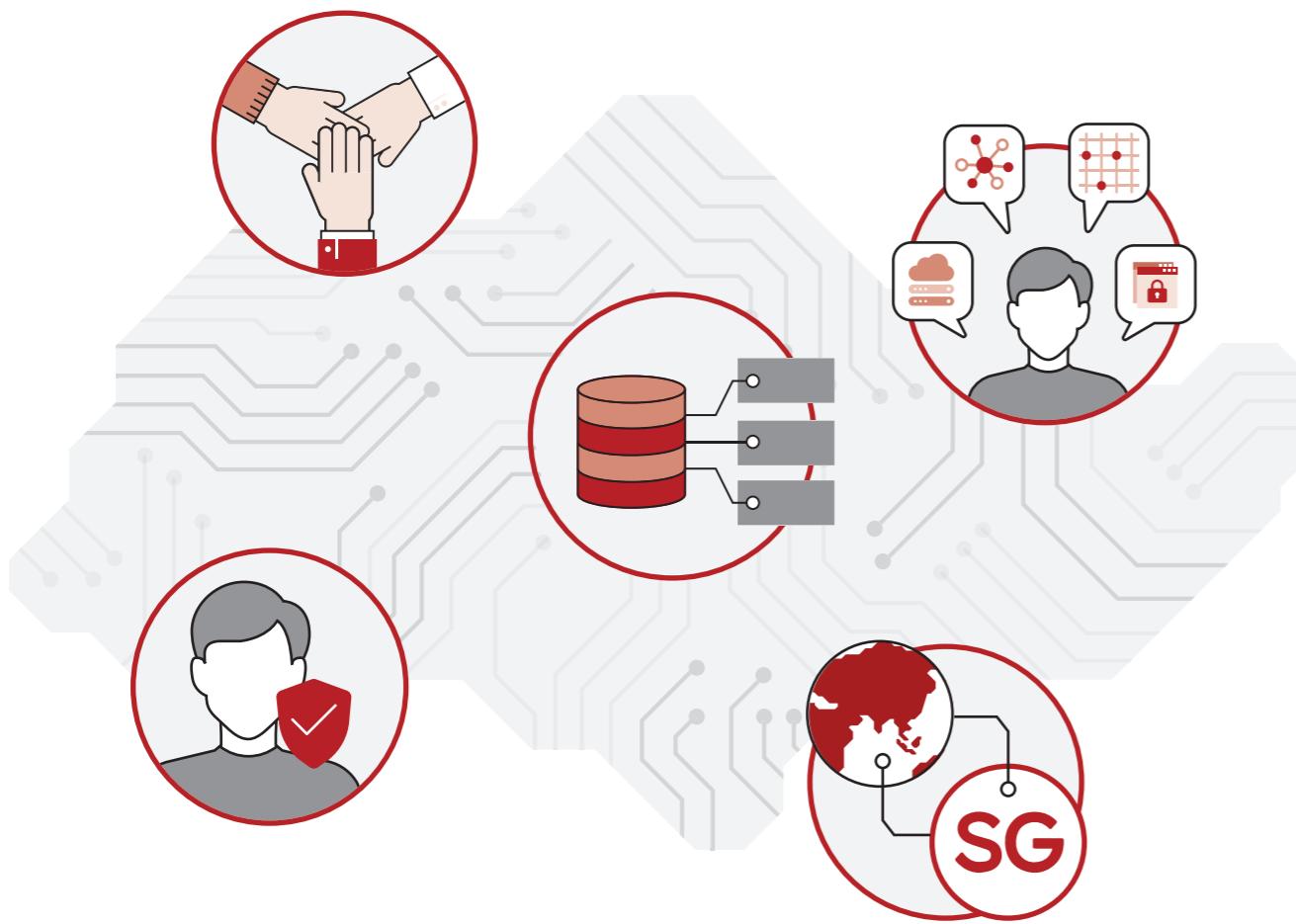
## BUILDING THE AI ECOSYSTEM

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- Triple Helix Partnership between the Research Community, Industry and Government
- AI Talent and Education
- Data Architecture
- Progressive and Trusted Environment
- International Collaboration

## THE ECOSYSTEM ENABLERS

Even as Singapore embarks on National AI Projects, we must build a vibrant and sustainable AI ecosystem to anchor AI innovation and adoption across the economy. We have identified five ecosystem enablers:



## ECOSYSTEM ENABLER 1

### TRIPLE HELIX PARTNERSHIP

– Research Community, Industry and Government

The research community, industry, and Government play important, interconnected roles to enable the development and deployment of AI solutions. It is critical for Singapore to enhance partnerships across these stakeholders to strengthen our collective capabilities and drive our overall national AI effort.

#### **Key Thrust 1.1 Deepen investments in AI-related R&D across the research ecosystem**

**Singapore has built substantive AI R&D capabilities from our early investments.** In 2019, Singapore ranked first in the world based on the impact of our AI scientific publications, according to Elsevier SciVal. Four of the ten most promising young AI researchers ranked by the Institute of Electrical and Electronics Engineers (IEEE) in 2018 are based in Singapore.

**We have already committed over S\$500m for AI-related research, innovation and enterprise activities under the RIE2020 Plan, and will invest more going forward.** Singapore will build on our strengths in AI R&D and continue to maintain a portfolio of AI R&D investments. This portfolio balances (a) game-changing fundamental research; (b) research that enables more widespread adoption of AI (e.g., explainable AI, “data-lite” AI, collaborative and human-centered AI, and digital trust technologies); and (c) applied research targeted at the needs of the nine key sectors.

Access to **supercomputing infrastructure** will also be an important driver of fundamental AI research. Over the next 5 years, Singapore will be investing S\$200m to upgrade both our supercomputing capability and network speed and quality. This will raise our supercomputing resources from 1 petaflop to 15-20 petaflops, to support high-end compute performance needs. Specifically for AI, the enhanced supercomputing platform will support the development and training of new AI algorithms and models.



#### **AI Singapore – Singapore’s national programme for AI**

Established by the National Research Foundation in 2017, AI Singapore (AISG) is a national programme for AI that brings together Singapore researchers and companies to jointly develop innovative AI solutions and grow a pipeline of AI talent for industry. AISG’s work is anchored on 3 key pillars: AI Research, AI Technology, and AI Innovation.



**AI Research** aims to build deep AI research capabilities in Singapore, invent the next generation of AI techniques/algorithms and position Singapore as a key player on the global stage.



**AI Technology** seeks to create significant economic and social impact by tackling national or global challenges using AI. AISG’s first Grand Challenge, launched in June 2018, was in healthcare.



**AI Innovation** focuses on accelerating industry’s adoption of AI technology through projects and talent development. Its programmes include the 100 Experiments Programme and the AI Apprenticeship Programme.

## Prof Ong Yew Soon – AI researcher in Singapore

Prof Ong Yew Soon is President's Chair Professor of Computer Science at the School of Computer Science and Engineering, Nanyang Technological University (NTU), Singapore, and the Chief AI Scientist at A\*STAR.

Prof Ong's contributions have helped propel NTU to be one of the leading computer science and engineering departments globally, especially in AI research.<sup>2</sup> He founded the Data Science and Artificial Intelligence Research Centre (DSAIR) at NTU. Prof Ong also established the first cognitive & AI corporate lab in Singapore – the S\$42.4 million Singtel Cognitive and Artificial Intelligence Lab for Enterprises (SCALE@NTU), where he currently serves as Director.

We interviewed him to find out more about his life as an AI researcher:

### 1. What made you decide to become an AI researcher?

I did my postgraduate study at the University of Southampton under the BAE-Rolls Royce University Technology Partnership research scholar programme. There, I became really curious about which were the most suitable optimisation solvers or algorithms for designing different forms of aircraft wing structures. This led to my PhD topic on "Artificial Intelligence Technologies in Complex Engineering Design", which explored and investigated state-of-the-art AI techniques to uncover new insights about optimisation solvers.

### 2. What is something exciting that you are researching now?

One of my coolest work has been developing IntelliK, an AI platform that enables creative people to develop AI-powered digital games and gamified Apps without any programming skills. More broadly, my research interest is now in AI Research for Society, which looks at how AI can contribute towards sustainability as well as supporting people with special needs.

There are five unique cornerstones, or AI.Rs, of AI Research for Society:

- i) Rationalisability – to interpret and logically explain the workings on deep neural network models.
- ii) Resilience – to be able to retain high predictive accuracy for AI models even in the face of adversarial attacks.

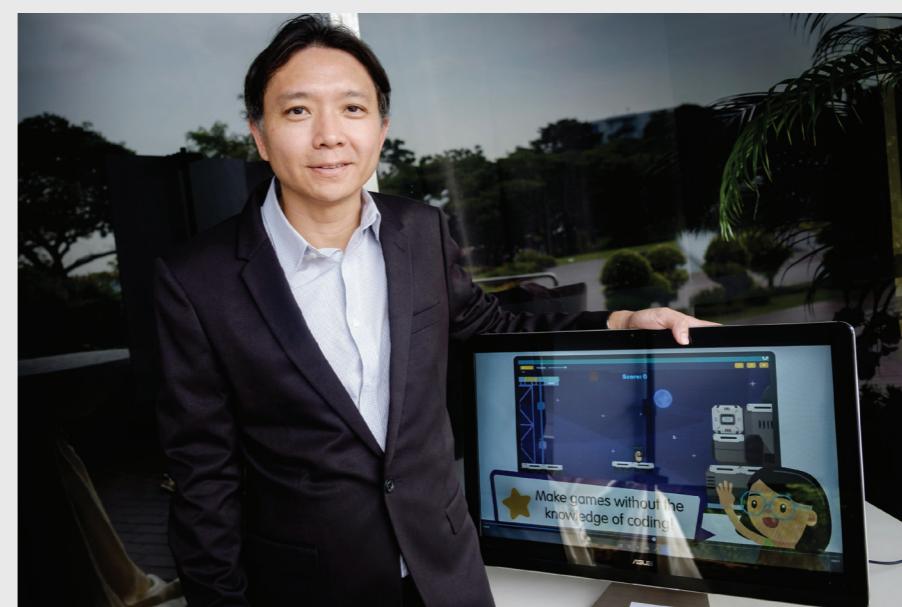
- iii) Reproducibility – to enable others to reproduce the same output from AI models.
- iv) Realism – to introduce a human element into AI.
- v) Responsibility – to build ethics and ethnics into AI and AI for benefiting society.

### 3. What is your favourite part about conducting AI research in Singapore?

First, there are many existing digital systems in Singapore that generate significant amounts of data. This provides opportunities for researchers to customise AI algorithms to analyse the variety of datasets, develop human-centric AI models, test-bed and optimise them, so that solutions may be quickly adapted by companies.

Second, Singapore has also set up tech platforms that bring together a consortia of partners from different parts of the value chain where system level integration is required. This allows researchers to collaborate with industry on effective implementation of AI systems.

Third, as a small but well-connected digital nation with a heterogeneous population, Singapore presents vast opportunities for researchers to leverage our datasets and develop algorithms that contribute towards Smart Nation, Healthcare, Finance and Insurance, and many other areas that are critical for Singapore's economy and society.



Prof Ong Yew Soon designed IntelliK to create AI-powered digital games and gamified Apps without the need to know coding.

<sup>2</sup> NTU was ranked 1st in Asia for Computer Science and Engineering by the Academic Ranking of World Universities, 4th by the US News Global University Ranking and listed as one of the Top 3 universities in AI research globally by The World University Ranking.

## Key Thrust 1.2 Drive partnerships between the research community and industry

Research collaborations with industry will enable the research community to sharpen their focus on societal/market needs and gain access to relevant data. Industry also benefits from research innovations that they can incorporate into their products and services, and from access to the pipeline of research talent. Such public-private partnerships can also support the commercialisation of AI technologies.

We have made a good start in driving partnerships between research and industry. There are currently more than 15 AI public-private partnerships and joint labs in Singapore. We will continue to attract and anchor AI R&D and product teams from leading global and local technology companies in Singapore, and encourage them to partner with our research institutions and Institutes of Higher Learning to establish joint labs and invest in training programs.

### Singtel-NTU AI Lab

Singtel has partnered with NTU and the National Research Foundation (NRF) to establish the Singtel Cognitive and Artificial Intelligence Lab for Enterprises (SCALE@NTU) to develop applications for use in the areas of public safety, smart urban infrastructure, transportation, healthcare and manufacturing. Under the collaboration, Singtel's subsidiary NCS has developed next-generation products & platforms to tackle the challenges faced by cities. These include innovations in the areas of advanced machine learning and AI algorithms for intelligent transport, IoT, robotics, computer vision and audio analytics.

One key development is in the area of multimodal sensation with vision and speech intelligence to understand customer behaviour & emotion and to assist human-machine interaction. Our research and development in deep learning technologies have been applied to robotics and IoT capabilities for dynamic optimisation and planning. For the healthcare industry, a potential application would include non-invasive tracking and monitoring of patients and their vital signs. In the case of Smart Urban Infrastructure industries, the work focuses on applying edge intelligence through visual and video analytics for a safer and more effective workplace. These capabilities have been pursued in various Proof of Concepts to bring across the benefits to our customers.

### IMDA-SUTD Partnership in Smart Estates

To support our Built Environment sectoral transformation efforts under the Smart Estates Initiative, Infocomm Media Development Authority (IMDA) and the Singapore University of Technology and Design (SUTD) are launching a new research-industry-Government collaboration to leverage AI applications to achieve greater effectiveness and efficiency in designing and managing Smart Estates in Singapore and the region.

Applications of AI in Smart Estates could provide benefits such as manpower and cost savings in estate management, improved urban sustainability, and better planning and design.

There are already ongoing trials to use AI to improve estate management:

1. Energy and utility management, fault detection, and predictive maintenance for building facilities.
2. Automated surveillance monitoring and detection of safety and security.
3. Unmanned retail concept store offering personalised shopping experience.

The IMDA-SUTD partnership will further advance Smart Estates development through a multi-faceted effort over the next 2 years:

INNOVATION	DATA	TALENT
We will bring together estate owners, technology providers, and researchers to co-develop innovative AI applications, with co-funding support from IMDA, with the aim of scaling up deployment locally and overseas.	We will work with data owners to pilot AI toolsets through a Data Lake for Smart Estates. The Data Lake will facilitate AI development and experimentation by researchers, students, and AI companies.	We will support technology companies co-developing AI applications in Smart Estates to train fresh or mid-career AI professionals through a combination of courses and on-the-job training.

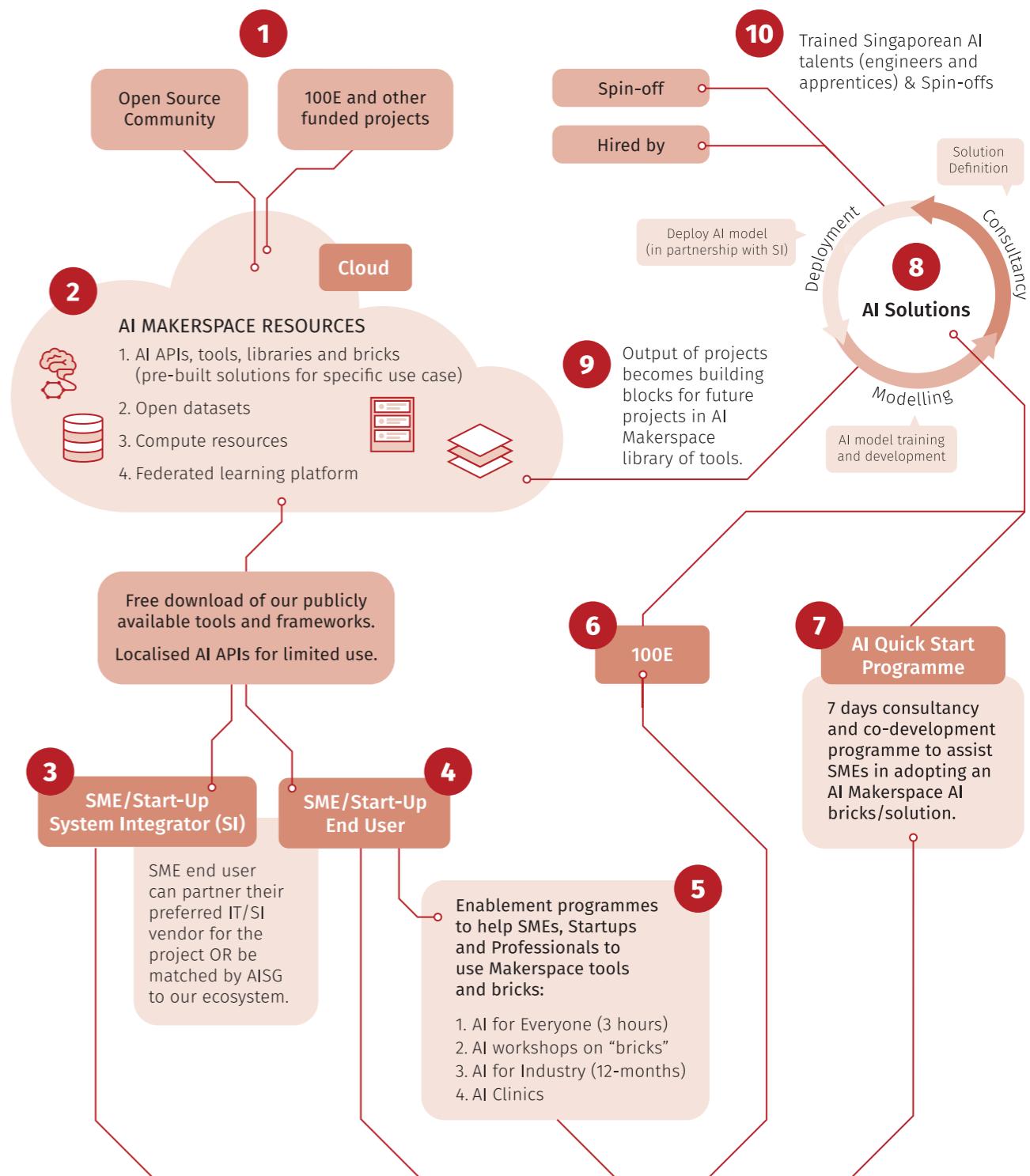


### Key Thrust 1.3 Accelerate AI adoption in companies

Companies must develop the organisational capacity to deploy AI solutions if they are to realise the full, transformative value that the technology can bring to their businesses. This requires investing in digital infrastructure and engineering capabilities, as well as fostering an innovative culture. To assist companies in doing so, Singapore will make more resources available for them to adopt AI solutions and develop AI-related applications:

- Industry digital transformation and AI deployment plans.** As part of the SMEs Go Digital programme, SMEs can leverage the sector-specific Industry Digital Plans, which provide a step-by-step guide on the digital solutions to adopt at each stage of a company's growth. The programme aims to curate more AI-enabled solutions to benefit businesses in various industries as they embark on their digital transformation journey.
- AI Singapore's 100 Experiments programme.** The 100 Experiments (100E) programme supports companies in deploying AI in a co-investment model by providing them with access to talent from AISG's AI Apprenticeship Programme. AISG has undertaken more than 38 AI projects with company partners, of which 10 have had AI deployed into production.
- The AI Makerspace** is a new national platform developed by AI Singapore to support SMEs and start-ups to jumpstart their AI journey. It provides access to resources for AI experimentation such as off-the-shelf, pre-built AI solutions ('Bricks'), curated datasets from industry and Government, cutting-edge AI libraries and tools, and supercomputing resources. AI Makerspace will also aim to grow local companies to be able to deliver these solutions to our SMEs over the next 2-3 years.

### AI Makerspace



- Accreditation@SGDigital and SG:D Spark programmes help companies identify and engage quality Singapore-based AI solution providers and start-ups. These programmes give buyers the assurance of reliable digital and AI solutions when working with these companies and startups, allowing for a more streamlined approach to integrating digital solutions. At the same time, both the Accreditation@SGD and SG:D Spark programmes help grow and scale promising and innovative Singapore-based startups and companies.
- Through the **Tech Depot on SME Portal**, local SMEs can access “Ready-to-Go” AI solutions developed by A\*STAR to enhance their productivity and expand their business. Companies can also gain access to a broader range of AI expertise in A\*STAR to grow their own AI capabilities by leveraging **A\*STAR’s T-UP programme**.
- IMDA’s Digital Services Lab provides a suite of tools to help companies develop AI solutions and leverage AI technologies. This includes the National Speech Corpus and the Intelligent Sensing Toolbox. This suite of tools, developed to address the needs in the services sectors, is continually being expanded and is made easily accessible for companies through platforms such as the AI Makerspace.

## From 100 Experiments to Scaling Startups

### *Automatic Assessment of Chronic Wounds in Diabetic and Elderly Patients*

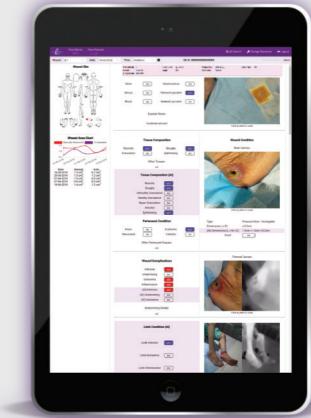
Chronic wounds are a common clinical problem in hospitals. AI Singapore worked with a local start-up, Kronikare, to develop a Computer Vision system on an AI-driven mobile and web platform to capture, analyse and diagnose chronic wound conditions. This enables healthcare institutions to better triage patients and allocate resources for wound management, resulting in improved patient outcomes in terms of early detection and faster intervention for major wound complications.

Following the successful Proof of Concept study with AI Singapore, Integrated Health Information Systems (IHIS) facilitated the scaling, validation, regulatory approval, and planned deployment of Kronikare’s solution. The Health Sciences Authority (HSA) provided scientific and regulatory advice and the device underwent HSA’s priority review scheme to obtain regulatory approval.

Kronikare has now deployed its scanner in St Andrew’s Community Hospital and a nursing home at Kwong Wai Shiu Hospital. It has also completed operational trials at Changi General Hospital with promising results. IHIS continues to work with companies like Kronikare to support the integration of the results into the clinical Electronic Medical Record systems.



A nurse can use Kronikare Wound Scanner to capture an image of the wound for full assessment and documentation under 30 seconds at a patient’s bedside.



Uploaded data vectors are automatically compiled into medical reports for monitoring wound progress and prioritising serious cases using a tablet.

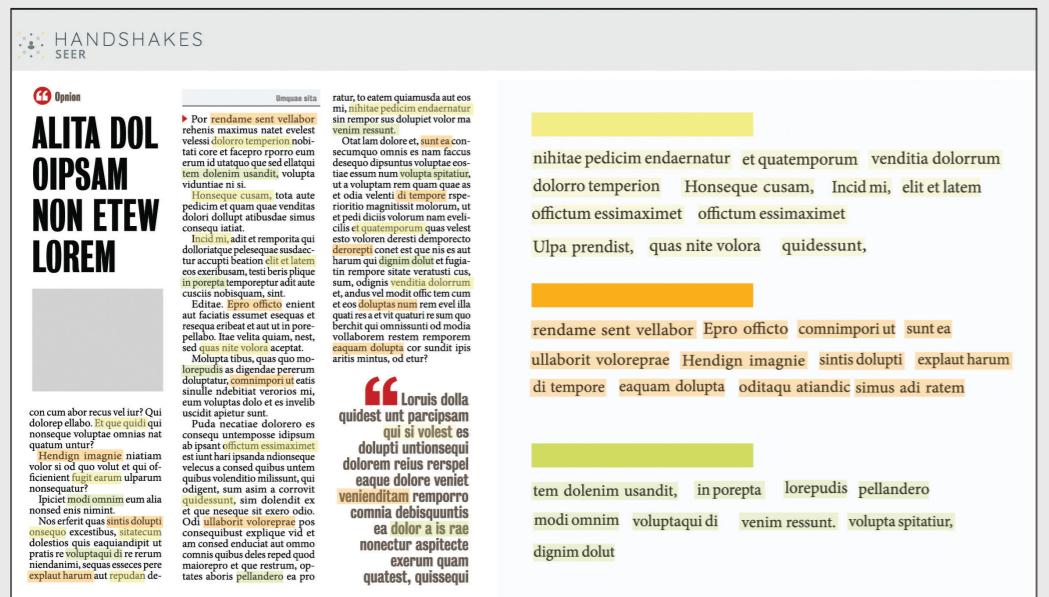
## DC Frontiers – a local SG:D Accredited AI company

DC Frontiers Pte Ltd is a local SG:D Accredited data analytics and AI technology startup. Founded in 2011, DC Frontiers offers a suite of corporate intelligence solutions to give organisations greater visibility over risks.

Their award-winning Machine Learning technology is known as Handshakes SEER. It utilises proprietary Natural Language Processing and Machine Learning to transform voluminous amounts of unstructured data into a reliable, contextualised data source for corporations, regulators and financial institutions.

SEER technology can be applied to emails, customer feedback, news and more. In fact, Singapore Press Holdings (SPH) is working with DC Frontiers to tailor content recommendations for readers based on their unique consumption habits and personal attributes. Apart from improving the reader experience, this has also successfully automated SPH's content curation process, which was previously a manual task.

To date, DC Frontiers has secured S\$16 million worth of funds to further drive product development efforts, which includes AI research and the expansion of its data coverage across more parts of ASEAN and Asia – beyond Singapore, Malaysia and Hong Kong.



DC Frontiers' award-winning AI technology is known as Handshakes SEER. It is not only able to pick up keywords, but more intelligently – context. This can be applied to news, customer feedback, emails and more.

## Key Thrust 1.4 Establish AI innovation testbeds

Singapore's regulators will work with companies to facilitate the deployment and testing of new ideas through AI innovation testbeds. A key initiative is the Punggol Digital District, a living test bed for deploying and integrating new technologies into the everyday lives of citizens.

### Punggol Digital District (PDD)

A greenfield project developed and masterplanned by JTC Corporation, PDD offers the opportunity to fundamentally review how technology can transform what it means to work, learn, live and play in a smart district. It will showcase concepts on future living, and provide companies opportunities for test-bedding technologies such as AI.

PDD will house an **Open Digital Platform** that will integrate various technology verticals including facilities management systems, district cooling system, autonomous goods delivery systems, and security systems. The data gathered from the platform can be used by companies to test-bed new innovations and district managers to provide personalised and anticipatory services, and deliver energy and manpower savings by optimising operations and resource consumption within the district.

The **co-location of the Singapore Institute of Technology (SIT) and JTC Business Park** will facilitate close collaboration between the digital industry and academia.



Artist's impression of PDD

## ECOSYSTEM ENABLER 2

# AI TALENT AND EDUCATION

Talent is both the foundation of, and critical bottleneck for, realising Singapore's AI vision. We need a range of multidisciplinary talent (AI, digital, business domain) to develop and deploy AI solutions to the key sectors:

- Research and Development – **AI researchers/scientists** with relevant industry or corporate research and development experience;
- Data Engineering – **Data engineers/technicians** with experience in using data to continually develop and improve AI solutions;
- Product Development – **AI engineers/translators/developers** who can design and build user-centric products to drive large-scale adoption; and
- Implementation – **Application developers, infrastructure engineers/developers and systems integrators** with experience in building and operating large-scale machine learning systems.

Singapore will track the supply and demand of AI talent and manpower to identify shortfalls and guide manpower strategy and talent initiatives. We will also make a concerted push to strengthen AI training for Singaporeans and attract AI talent to Singapore.

### Key Thrust 2.1 Train more Singaporeans for high-quality AI jobs

Singapore will establish more local talent pipelines to increase the quantity and quality of our AI workforce in the longer-term. We will do so by creating AI conversion programmes and corporate-backed AI academies to upskill the latent pool of STEM and digital workers into higher-value AI-related job roles.

- **Post-graduate Scholarships.** The Singapore Government currently works with companies such as Alibaba, Nvidia, Senstime, and Grab to provide full-time postgraduate students with industry-relevant training in preparation for R&D roles in industry. We will establish more of such partnerships to train more AI PhDs with industry experience.
- **AI Apprenticeship Programme (AIAP).** The AIAP is a full-time 9-month programme by AI Singapore to groom AI engineers for industry. Apprentices will work on real-world industry projects, from scoping problem statements to deploying models. AI Singapore has produced 60 engineers to date, and plans to train up to 500 Singaporean AI engineers over the next 5 years.
- **TechSkills Accelerator (TeSA)** offers various programmes to support ICT and non-ICT professionals to upgrade and acquire new skills for the digital economy.
  - TeSA collaborates with companies on job placement programmes, where fresh and mid-level professionals will undergo structured learning courses and on-the-job training to acquire skills and competencies in AI.
  - To support conversion of non-ICT professionals and upskilling of tech professionals, TeSA supports full-time bootcamp or mentorship & coaching opportunities offered by global education providers and established academic institutions.
  - For tech professionals who aspire to upskill/reskill through short-form training, TeSA also funds professional development courses in AI.
  - Underpinning these programmes is the Skills Framework for ICT, a reference guide of in-demand job roles and their required skills, to help individuals and employers plan career pathways and facilitate hiring. The framework will be updated with AI-related skills and job roles.
- To further help Singaporeans understand the fundamentals and applications of AI, be it in their workplace or daily lives, SkillsFuture Singapore has partnered with major technology partners, to enhance the **SkillsFuture for Digital Workplace** programme with the inclusion of relevant AI content.

## Goh Yong Liang – a Grab post-graduate scholar

The Grab-NUS AI lab was officially launched on 18 July 2018 to develop and nurture local AI talent. NUS post-doctoral research scientists and PhD students can work with Grab's data and apply their AI expertise to create smart urban transportation solutions for Singapore and Southeast Asia. Grab has since successfully recruited 5 AI PhD graduates from the NUS School of computing and Institute of Data Science.

Goh Yong Liang joined Grab in 2019 under the post-graduate scholarship programme.

We interviewed him to find out why he chose to pursue an AI PhD.

### **1. Why are you interested in AI?**

With the increased footfall of digital services, companies are starting to collect more high-quality data. AI, to me, is a tool to create standalone digital products, and I hope to acquire the knowledge to build them.

### **2. What made you decide to pursue a PhD in AI, and how does this link to your career aspirations?**

While working as a data scientist for three and a half years, I was constantly looking for avenues to further my technical knowledge. The Grab post-graduate scholarship opportunity came up and this felt like a great opportunity to invest my time in work that could have major impact. I felt that to effectively lead a technical team, I first have to establish a strong foundation in the field, and a PhD offers that opportunity.



### **3. Why did you choose an industry post-graduate programme instead of an academic PhD programme?**

I chose the industry post-graduate scholarship as it allowed me to work on problems that are relevant to industry. At the same time, I have always aspired to translate research work to tangible products, and the programme enabled this.

## Shirlene Liew – an AI Apprentice's journey

A mechanical engineer by training, Shirlene worked on science policy and industry development in a Government agency after graduation. She first encountered data analytics when she furthered her studies in healthcare systems and operations. That was when she became proficient in the programming language R, and also picked up some Python. She took 2 years off to be a full-time mother after the birth of her daughter, and chanced upon the AI apprenticeship programme from AI Singapore's website when she was ready to re-enter the workforce.

Under the AI Apprenticeship Programme, Shirlene had the opportunity to work for a health-tech client and helped to develop models for fraud detection in healthcare images. Although there were times when she found the AI equations and concepts to be daunting, her personal interest in healthcare, and the supportive learning environment in the apprenticeship programme, helped her through the challenges and made her journey a positive experience.

Shirlene believes that to grow in a field, it is important to be part of a community, and keeps in touch with her peers. She now works as a product manager with a data security AI start-up.



## SkillsFuture Singapore partners IBM Singapore to train AI talent

On 4 Oct 2019, SkillsFuture Singapore (SSG) announced a partnership with IBM Singapore to launch a suite of programmes in AI. The programmes will help our workers build deep knowledge and capabilities in AI and boost the implementation of relevant AI solutions within local enterprises.

IBM is one of the first major technology partners to deliver industry-led AI training programmes for Singaporeans. Through this partnership, IBM and SSG aim to train 2,500 Singaporeans in AI and emerging skills within the next three years. The focus will be on helping individuals apply and contribute to their work-related projects with the most up-to-date AI resources and networks.

SSG and IBM have also incorporated AI content into the curriculum of the SkillsFuture for Digital Workplace programme. This will help Singaporeans understand the fundamentals of AI technology, and how they can apply AI in their workplaces and daily lives.

## Key Thrust 2.2 Teach basic computing skills and computational thinking to all

As AI becomes more accessible and prevalent, Singapore will need to develop AI-ready individuals who can understand and apply AI in their respective domains. We will layer the teaching of computer science across all learners' journeys, with the aim of developing "bilingual individuals" who can apply computer science and AI concepts in their respective domains. Students should learn basic foundational concepts to spark their interest in AI at an early age. Later on, they should develop basic AI competencies and literacy, and have further opportunities to deep-dive into AI applications during higher education.

- **Develop AI-ready graduates.** We will encourage our Institutes of Higher Learning to introduce domain-specific AI courses, to ensure that our undergraduates understand how to apply AI to their areas of expertise and are able to leverage AI tools in their work.
- **AI for Industry.** We will train 25,000 professionals in basic AI coding and implementation by 2025.
- **AI for Everyone, AI for Kids and AI for Students.** We will scale AI literacy courses to 100,000 adult Singaporeans and school-going children by 2025.

## Key Thrust 2.3 Attract top-tier global AI talent

In addition to grooming our local talent pool, Singapore must remain open to top-tier AI talent from around the world. These talents will help bring cutting-edge technology to Singapore, develop our local capabilities by mentoring budding AI researchers and engineers, and grow our global talent networks.

- **Tech@SG Programme for Technology Companies.** The Economic Development Board (EDB) and Enterprise Singapore (ESG) will pilot a programme with fast-growing technology companies to facilitate Employment Pass applications for their core team members, which may include professionals equipped with deep technical skills in frontier areas such as AI. This will help companies tap on skilled global talent to strengthen their tech capabilities and scale quickly.

## ECOSYSTEM ENabler 3

# DATA ARCHITECTURE

Data is the foundation that anchors AI collaboration between Government, industry, and research. Despite Singapore's small size, we have natural comparative advantages in data. We can leverage our unique common identifiers to curate rich, cross-sectoral datasets. Our heterogeneous, multi-ethnic population gives us an edge in developing exportable AI solutions in sectors such as healthcare, because AI algorithms trained on Singapore's population could potentially be scalable across Asia.

Singapore's key value proposition to global companies and talent lies in our ability to provide timely and secure access to rich, high quality datasets. We must manage our data as strategic national assets and establish an ecosystem to acquire, clean, fuse, and distribute data across the public and private sectors. At the same time, we must proactively build institutional capabilities to manage and govern data, to protect against cyberattacks, safeguard our citizens' data privacy, and ensure that data is used for the public good. We will continually study industry and global best practices to identify new and innovative ways of safeguarding data, while facilitating its effective usage. This will include enhancing our policies, legislation, technical safeguards, and organisational structures, as well as keeping abreast of and adopting frontier data security technologies.

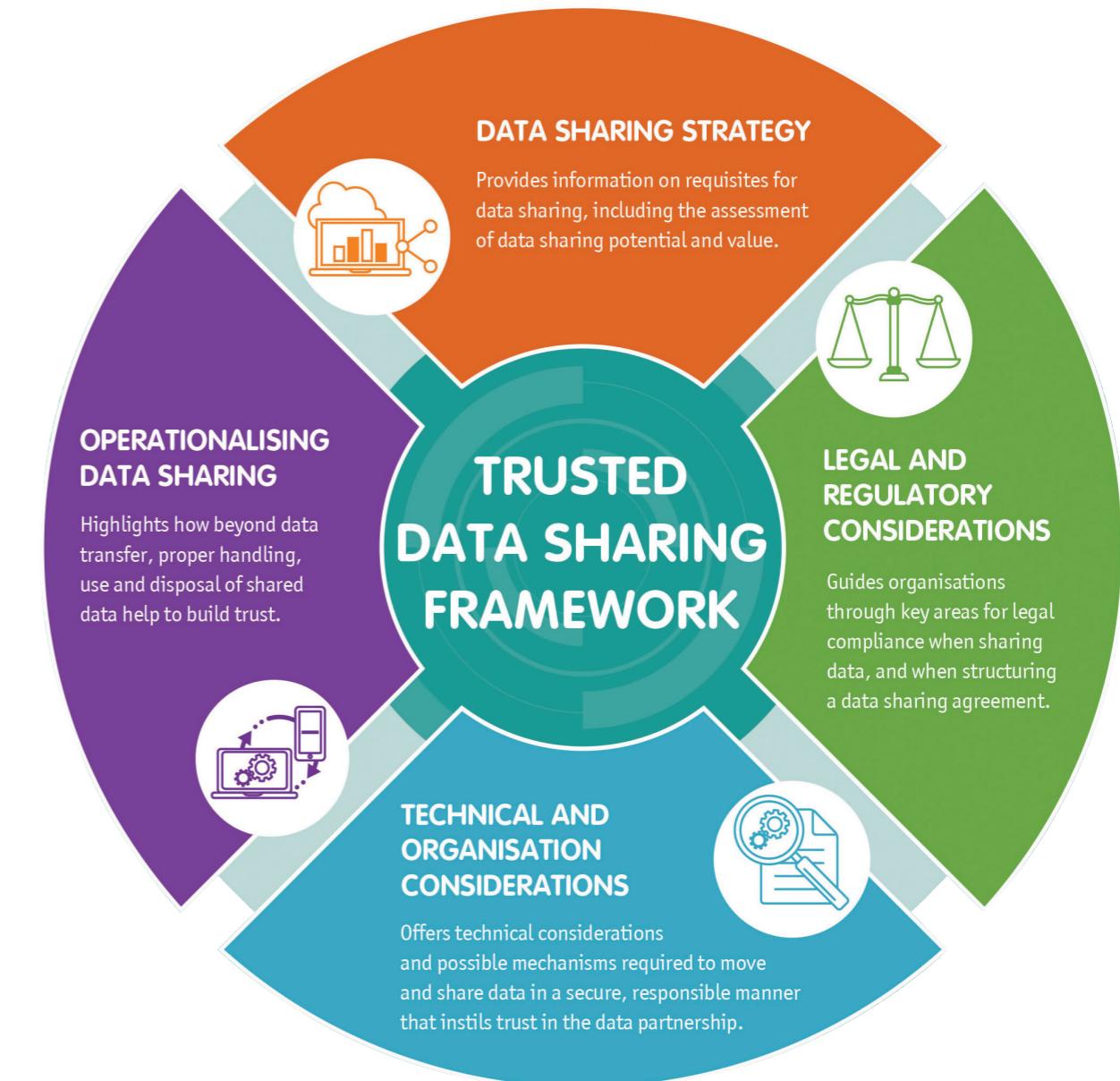
We will begin by consolidating the data assets required for each of the National AI Projects, and put in place the necessary data sharing frameworks and legislation to enable companies to share and exploit data securely.

### Key Thrust 3.1 Establish frameworks for public-private data collaboration

We will enhance our regulatory and policy frameworks to provide greater clarity on the scope, governance, and technical safeguards for data sharing across the public and private sectors. This will encourage organisations to share and use data more pervasively for legitimate use cases, and help anchor public-private data collaboration and innovation.

- **Private Sector Data Sharing Framework.** IMDA has published the Trusted Data Sharing Framework to guide companies in establishing data sharing partnerships with each other. The Framework articulates the key legal, regulatory, and technical considerations and safeguards that each organisation should take into account, and provides sample legal clauses and templates to draft data sharing agreements.

### Trusted Data Sharing Framework



- Public-Private Data Sharing Framework.** As the nation's custodian of personal and administrative data, the Government holds a data resource that many companies find valuable. The Government can help drive cross-sectoral data sharing and innovation by curating, cleaning, and providing the private sector with access to Government datasets. The envisaged Public-Private Data Sharing Framework will facilitate the sharing of Government data with non-Government entities (NGEs) and key commercial partners, by defining the scope, type, granularity, and safeguards (people, process, and technical) of Government data that can be shared with the private sector. As a start, we will work closely with the domain agency leads to develop this Framework to support the implementation of the National AI Projects. We will develop a similar framework for NGEs and companies to share data with Government agencies.

### Key Thrust 3.2 Establish trusted data intermediaries for public-private data exchange

The Government will identify organisations to serve as trusted data intermediaries for data fusion and distribution. These trusted entities could be situated in either the private or public sector, depending on the sector, type of data, and where the majority of data are sited.

- Define and promulgate common data standards to ensure data interoperability.** To facilitate data fusion, the Government will work with companies in key sectors to define and promulgate a set of common data standards for the sector (e.g. standards for health records across restructured hospitals, private GPs and research institutes).
- Curate and publish a meta-data catalogue of public-private datasets required to implement the National AI Projects.** We will also work with the trusted data intermediaries to define common data standard and technical safeguards to anonymise, secure, and provide companies and researchers with access to these data. This will help facilitate data discovery and anchor data and AI collaboration between Government agencies, industry, and researchers.

### Government Data Architecture (GDA)

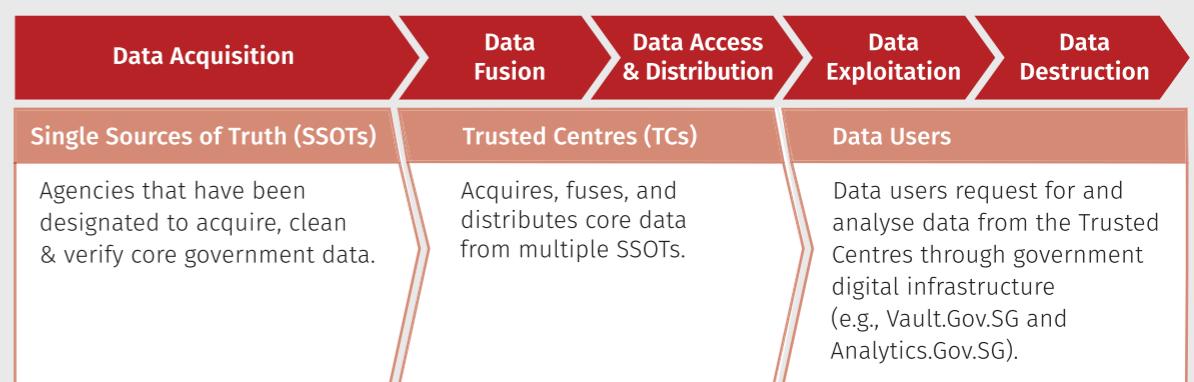
In June 2018, Singapore's Smart Nation and Digital Government Office launched a Government Data Strategy that sets out action plans to manage data as a strategic asset and deepen the Government's use of data by 2023.

The GDA is a key thrust of the Government Data Strategy, and aims to enable secure data sharing between Government agencies within 7 working days. It is centred on the Government putting in place the organisational structures, technical systems, and processes and capabilities to manage and use data across its lifecycle, from problem statement definition to exploitation.

The Government has done a stocktake of its data assets and identified an initial tranche of core datasets that are highly relevant for policy, planning, operations, and service delivery. It has established common definitions and standards and assigned agencies to serve as Single Sources of Truth to maintain, clean, and distribute these core Government datasets. It has also organised these core data assets around four Trusted Centres (Individuals, Businesses, Geospatial, and Sensors), which are tasked with fusing and distributing these datasets. In addition, it has built central digital infrastructure for public officers to securely use data and protect the identity of individuals while leveraging analytics to improve policies and services. Vault.Gov.SG is a one-stop shopping portal for discovering and requesting access to core Government datasets, and Analytics.Gov.SG provides a secure virtual environment with commonly-used tools for data analytics.

The GDA will be operationalised in phases, beginning from Oct 2019. At the same time, we are also preparing for the future, to extend the use of data as a strategic asset at the national level and to apply digital technologies such as AI to enrich the value of our data assets.

#### Overview of Government Data Architecture



## ECOSYSTEM ENABLER 4

# PROGRESSIVE AND TRUSTED ENVIRONMENT

Singapore's governance and regulatory regime must strike the right balance between fostering technology and business innovation, while safeguarding citizens' interests.

### Key Thrust 4.1 Establish citizens' trust on the responsible use of AI

Singapore has established **an industry-led Advisory Council on the Ethical Use of AI and Data**. The Council advises the Government on issues arising from the commercial deployment of AI that may require policy or regulatory attention, and industry on the responsible development and deployment of AI.

In January 2019, Singapore published Asia's first **Model AI Governance Framework** that provides detailed and readily implementable guidance to private sector organisations to address key ethical and governance issues when deploying AI solutions.

As AI developments move beyond the confines of a research lab into our daily life, Singapore must guide and shape how AI will interact with citizens, institutions and society. We will:

- develop sector-specific AI governance frameworks, including codes of practice and professional codes of conduct for different sectors and application contexts;
- curate technical solutions that enable explainable AI that industry can use to augment their AI models;
- develop training and certification in AI ethics and governance for professionals managing AI solutions and implementing AI projects, which will be overseen by Singapore Computer Society's newly formed AI Ethics and Governance Steering Committee; and
- publish assessment guides for organisations to assess the alignment of their AI governance processes with the Model AI Governance Framework.

Singapore will also apply multidisciplinary and human-centered approaches to study the systemic risks and long-term impact of AI, and develop potential solutions to address them. Risk assessment in AI development should not be narrowly confined to the engineering disciplines, but also include sociologists, ethicists, economists, lawyers and policy makers. Today, Singapore's universities are actively studying the societal implications of AI, and we will tap on their expertise.

- The Singapore Management University's Centre for AI and Data Governance will explore potential options to address longer-term issues as AI becomes more pervasive.
- The Singapore University of Technology and Design's Lee Kuan Yew Centre for Innovative Cities is collaborating with local think-tank Live with AI and AI company DataRobot to research AI's impact on jobs.

Singapore's balanced approach to AI ethics and governance has attracted international attention. Singapore has been invited to take part in influential international fora such as the Organisation for Economic Co-operation and Development (OECD) Expert Group on AI and the European Commission's High-Level Expert Group on AI. In April 2019, Singapore's work on AI Governance and Ethics won the top award at the prestigious World Summit on the Information Society (WSIS) Prizes in the category of "Ethical Dimensions of the Information Society". In November 2019, Singapore was invited to present its human-centric approach to AI at the Paris Peace Forum.

## Veritas – an implementation framework for AI governance in the finance sector

Artificial Intelligence and Data Analytics (AIDA) driven decisions, without proper governance and accountability structures, may potentially erode the fabric of financial services. For these reasons, the Monetary Authority of Singapore (MAS) worked with the financial industry to co-create a set of principles to guide the responsible use of AIDA in financial services. Centred around trust, the principles consist of four key pillars – Fairness, Ethics, Accountability and Transparency (FEAT) and were released in 2018. The principles have established a standard across the financial sector in Singapore and various jurisdictions have adopted similar principles to guide the adoption of AIDA.

Nevertheless, the practical implementation of the FEAT principles remains challenging for the industry. This is to be expected – translating philosophical concepts into mathematical and scientific language is a daunting exercise. These challenges have curtailed the adoption of AIDA in the industry. To overcome these challenges and accelerate AIDA adoption in the financial industry, MAS is collaborating with multiple parties to create a standardised modular implementation framework of the FEAT principles, called Veritas.

We envisage that Veritas will comprise tools for institutions to validate their models against the FEAT principles. Veritas will be applicable to different business lines, different principles as well as differing regulatory and legal regimes. The goal is to produce the world's first framework that financial institutions can use to evaluate their governance of AIDA.

## SMU's Centre for AI and Data Governance

The Research Programme on Governance of AI and Data Use was setup at Singapore Management University (SMU) School of Law in 2018 with funding for S\$4.5m over five years. It complements other technical R&D initiatives in Singapore and aims to achieve the following:

1. Promote cutting edge thinking and practices in AI and data policies and regulations;
2. Inform AI and data policy and regulation formulation in Singapore through research publications and stakeholder engagement activities; and
3. Establish Singapore as the global thought leader in AI and data policies and regulations.

The research agenda for the initial 5 years includes:

1. AI & Society: Understand issues that bear on most members of the public, such as attitudes towards AI and data protection.
2. AI & Business: Examine issues relevant to the corporate sector as a whole, such as intellectual property and trade.
3. AI in Specific Industries: Focus on three specific domains, namely autonomous vehicles, dispute resolution, and the financial industry.

IMDA supports the Research Programme by engaging local and international stakeholders to partner the Centre to conduct industry-relevant research on AI ethics and governance.



On 24 September 2018, Singapore Management University launched the Centre for AI and Data Governance (CAIDG). Front L-R: Prof Goh Yihan, Prof Lily Kong, SMS Janil Puthucheary, Mr Yeong Zee Kin

## Live with AI, SUTD Lee Kuan Yew Centre for Innovative Cities and DataRobot's joint research on AI and work

### INTRODUCTION TO LIVE WITH AI

Live with AI is a non-profit foundation based in Singapore, which believes that AI will impact our society positively and contribute to accelerating human development. The foundation gathers thought leaders, decision-makers, and international researchers to lead working groups and research projects. Its 2019 report covers 3 pillars: (i) AI & Work; (ii) AI & Healthcare; and (iii) AI & Society.

### AI & WORK

In 2019 the Live with AI community, in partnership with the Lee Kuan Yew Centre for Innovative Cities and DataRobot, researched the impact AI has on multiple tasks within jobs, in order to better understand the workforce disruption and potential scenarios which may happen in different industries. The findings were as follows:

#### 1. AI won't simply replace Humans

The AI revolution will not only create jobs for computer specialists. Thanks to the principle of comparative advantage, AI-enhanced human roles will emerge as well.

#### 2. AI and Work: Equal to the Task

AI disrupts jobs task by task and not job by job. All workers can take advantage of this to disrupt disruption. We can use tasks to better track technology impact, chart clearer pathways between jobs, and improve work prospects for people.

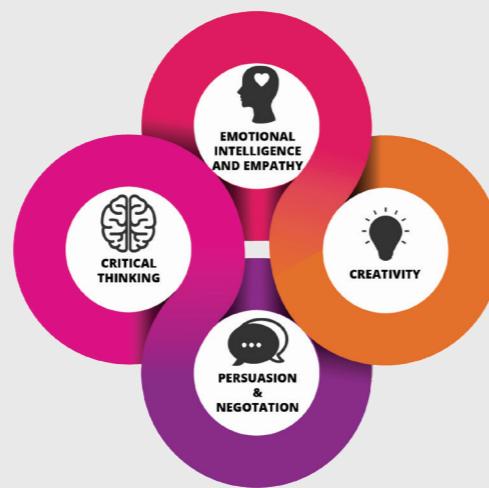
#### 3. How to Work with AI: Strengthening your Human Skills

To get prepared for the AI revolution, employees must focus on enhancing their innately human skills.

#### 4. Automation Needs You to Think More about Humans, Not Less

Taking into account the “human cause” in an automation journey means augmenting a task that satisfies the worker, not replacing it.

### Strengthen Your Human Skills



## Key Thrust 4.2 Provide a top-class IP regime and accelerated patent initiatives for AI

AI companies seeking to grow and expand internationally will need to develop a clear intangible asset (IA) and intellectual property (IP) strategy. To support companies, the Intellectual Property Office of Singapore (IPOS) has launched a new enterprise engagement arm, IPOS International, to provide them with **customised IA solutions and programmes**.

We will **review Singapore's IP legislation** to ensure that our laws support the development and commercialisation of new AI technologies. Having clear legislation will provide certainty for AI innovators in commercialising new products and services.

IPOS has also introduced the **Accelerated Initiative for Artificial Intelligence (AI<sup>2</sup>)**, the world's fastest patent-acceleration programme<sup>3</sup> that grants applicants an AI patent within six months. A new **ASPEC-AIM** (Acceleration for Industry 4.0 Infrastructure and Manufacturing) initiative by the ASEAN IP offices also allows applicants to fast-track patent applications for key emerging technologies in the region.

<sup>3</sup> Average pendency times between first office action and final decision range between 9.2mths to 95.1mth.

Source: WIPO World Intellectual Property Indicators 2018

## Alibaba granted AI patent within three months

In June 2019, IPOS received an application for an AI invention by Alibaba Group Holdings Limited (Alibaba) via its online application portal (IP2SG), which included a separate application for eligibility under the AI<sup>2</sup> scheme. The application fulfilled the requisite conditions under the scheme and was eligible for fast-track examination. The assigned patent examiner conducted extensive global searches to ensure the patentability of the AI invention. Given the well-drafted patent specification, the examiner was able to issue a positive search and examination report, subsequently leading to the expedited grant of the patent within three months.

Complementing Singapore's efforts in supporting enterprises to accelerate their go-to-market strategy, Dr Benjamin Bai, Vice President and Chief IP Counsel of Ant Financial, Alibaba said: "Companies looking to implement AI solutions globally have grown exponentially. Against this backdrop, the speed at which a patent can be granted is critical. Singapore plays a pivotal role as it facilitates our entry into markets of our interest rapidly. We applaud the efficiency and speed of Singapore's IP office, and look forward to filing more patent applications in Singapore under this initiative."



Ms Sharmaine Wu, Director, Registries of Patents, Designs and Plant Varieties, IPOS presents the patent grant certificate to Dr Benjamin Bai, Vice President and Chief IP Counsel, Ant Financial, Alibaba.

## ECOSYSTEM ENABLER 5

# INTERNATIONAL COLLABORATION

International collaboration is essential for driving sustainable development of AI. Singapore has a meaningful role to play to support this global effort. We will continue to be an open and neutral platform where international researchers and businesses can work together.

### Key Thrust 5.1 Contribute to global standards for AI-related policies and guidelines

Singapore will strive to be a useful contributor and thought leader in setting AI-related policies and standards. We will collaborate with influential industry advocates to apply these principles in industry, and work closely with key international organisations and standard-setting organisations such as the World Economic Forum (WEF), the OECD, the International Organisation for Standardisation (ISO), and the International Electrotechnical Commission (IEC) to participate in the standards setting and norm-shaping processes actively.

## Collaboration with the WEF on the Model AI Governance Framework

Singapore collaborated with the WEF Centre for the Fourth Industrial Revolution (C4IR) to enhance the Model AI Governance Framework and to promote its adoption. To this end, the C4IR has been conducting industry workshops in San Francisco to solicit input, feedback, and obtain use cases from companies within its network.

The output of these workshops will be incorporated into the Model AI Governance Framework to provide organisations implementing AI solutions useful examples and practices on responsible use of AI.



Model AI Governance workshop conducted in San Francisco with 40+ CTOs and tech leaders from around the world on 1 August 2019 in collaboration with World Economic Forum Centre for the Fourth Industrial Revolution.

## Key Thrust 5.2 Collaborate on multi-national AI projects

Many AI projects during their testing phase will need to test their products internationally for external validation; Singapore can play a role in bringing together an international network of multi-site test beds for AI solutions, starting with the 5 National AI Projects.

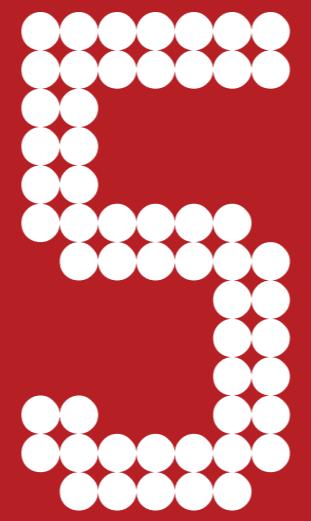
## International Collaboration in AI research by AI Singapore

AI Singapore has established ties with many countries to catalyse joint AI research pursuits.

An example is the AI partnership between Singapore and France, which aims to advance innovation and research in areas of mutual interest to achieve world-class scientific and technical results, leading to new and innovative technologies. In July 2018, AI Singapore, the French Institute for Research in Computer Science and Automation (INRIA), the French National Centre for Scientific Research (CNRS), and the French Institute of Health and Medical Research (INSERM) signed a Memorandum of Understanding on research collaboration in five focus areas: AI in Healthcare, Explainable AI, Federated and Distributed Learning, Natural Language Processing and Privacy, Trust & Accountability in AI and Data Sharing.



The MOU on AI cooperation was signed in July 2018 in the presence of Singapore's Minister for Trade and Industry Mr Chan Chun Sing, France's Minister for Higher Education, Research and Innovation Frédérique Vidal, Deputy Chief of Mission, Embassy of Singapore in Paris Karen Ong, CEO of Inserm Yves Levy, CEO of INRIA Bruno Sportisse and CEO of CNRS Antoine Petit.



WORKING  
TOGETHER

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# ORGANISING OURSELVES FOR SUSTAINABLE SUCCESS

We have established a **National AI Office** under the Smart Nation and Digital Government Office. The National AI Office will set the national agenda for AI and catalyse efforts across research, industry, and Government stakeholders to work on national AI priorities.

The National AI Strategy requires a whole-of-nation effort, with Singaporeans, businesses, researchers and the Government working closely together. Singapore will also need to work with international partners to advance the deployment of AI in Singapore.

**1. National AI Projects.** We have announced a first tranche of five National AI Projects centred on key challenges. We invite researchers, companies, and individuals to propose solutions, or to suggest new National AI Projects.

**2. Transform your business with AI.** No matter the size of your company, you can begin your AI transformation journey today by building up your technological capabilities and digital infrastructure. There are many avenues where companies can receive support from the Government. If you are a company that is already adopting AI, take part in data sharing initiatives to promote greater use of AI, and contribute to a trusted environment by adopting AI governance initiatives.

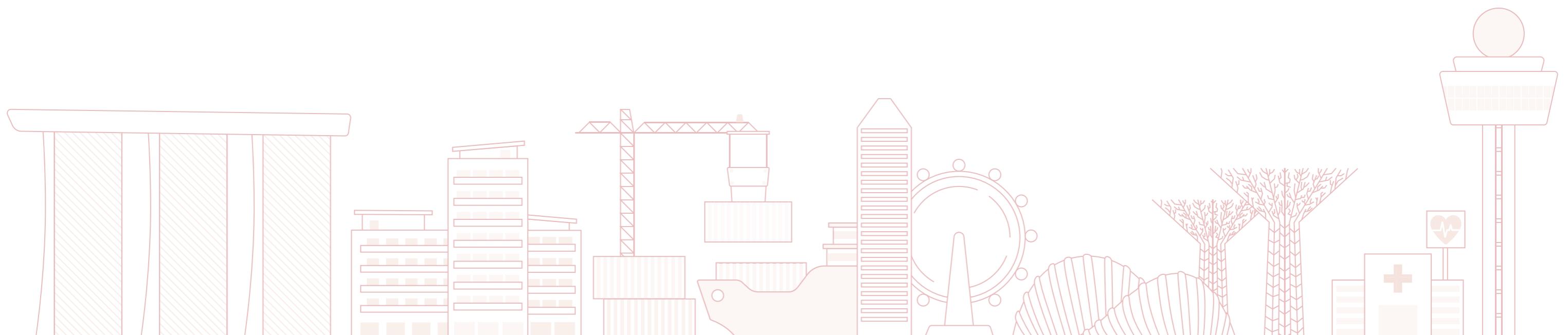
**3. Participate in Singapore's AI ecosystem.** As we transform our key sectors through AI, there will be an abundance of opportunities for businesses to research, develop and deploy AI solutions in Singapore for the region. Both local and international investors can consider establishing an AI team in Singapore, and leveraging Singapore's research ecosystem to enhance and validate new AI methodologies.

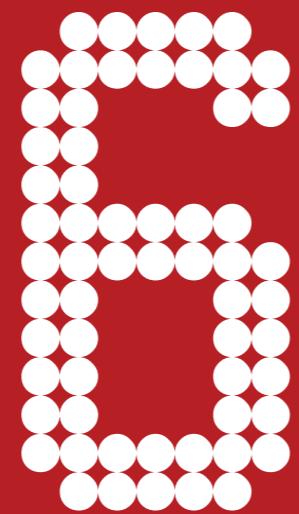
**4. Learn about AI.** Given that AI can be applied to any field, it will be important for workers to understand how AI can be applied in their respective domains. Find out about the opportunities for you to learn the skills necessary to participate in the AI economy.

For more information on how to be involved in the National AI Strategy, visit [go.gov.sg/AIStrategy](http://go.gov.sg/AIStrategy)

## Conclusion

We will develop and implement the National AI Strategy iteratively, to respond to the rapidly changing technology landscape and to seize new opportunities. The 5 National AI Projects and 5 ecosystem enablers are but a first step in our multi-year AI journey. We will continue to embark on more National AI Projects and adjust the enablers as we learn through implementation. This is a whole-of-nation effort, and we welcome ideas and action from individuals and companies to help deliver our AI vision for Singapore. Let us work together to build a Smart Nation, to improve lives and make Singapore an outstanding place to live, work and play.





WHAT THE  
EXPERTS SAY

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## WHAT THE EXPERTS SAY



### Mr Andreas Ebert

*Worldwide National Technology Officer, Microsoft Corporation*

With computers capable of understanding humans for the first time, the world is at an inflection point – with implications extending beyond technology into economy and national development. Already a global thought leader on AI ethics and governance, the publication of the National AI Strategy is evidence that Singapore is taking a holistic and inclusive approach on how the nation can be a fast adopter of best-in-class technology that is empowered by a focus on building national capabilities. When you underpin all of these with trust, through Singapore's Trusted Data Sharing Framework and international digital economy agreements, this geographically little island nation is excellently positioned to play a leading role in facilitating cross border data flows that will realize AI applications and services to improve people's lives and local businesses. Microsoft is committed to the success of Singapore's AI and data journey, and we look forward to contributing to the implementation of the Strategy.



### Dr Andrew Ng

*CEO and Founder, Landing AI*

The world has caught on to the power of artificial intelligence, but we have still barely scratched the surface. To move the world forward, we will need millions more AI engineers. We also need to educate our leaders across government, businesses and academia so they can build AI solutions that bring positive change to their communities.

Having grown up in Singapore, I've seen firsthand its excellent educational system, which gives students a strong foundation in math and science, as well as its international connections and ability to attract ideas and talent from around the world. Singapore already has a strong foundation on top of which to build AI. The National Artificial Intelligence Strategy outlines several important, actionable steps that build on these strengths. These include:

- **Thoughtful regulations.** Singapore has an opportunity to enact thoughtful regulations that allow for innovation and experimentation while protecting citizens' safety. Sound regulations empower Singaporean AI engineers to work on cutting-edge problems that can immediately benefit their community.

- **Human-centric approach.** Singapore is simultaneously training talent to work on major technological developments and investing resources in retraining and education programs. Building social programs and technology in parallel, Singapore can prepare its citizens for changes and transitions in an AI-powered future.
- **Sectoral transformation.** Singapore's AI Strategy focuses on several use cases that can immediately benefit the nation. These use cases – spanning healthcare, manufacturing, logistics, security, education and more – will merge Singapore's engineering talent together with real companies in order to develop more impactful real-world solutions.

Silicon Valley and Beijing have been global leaders in AI research and developing AI-first startups. But Singapore's vision lies in becoming a leader in developing and deploying scalable, impactful AI solutions in key sectors by 2030. I commend Singapore for leading the way in globalizing and democratizing the next wave of artificial intelligence.

Singapore has all the pieces needed to become a regional AI hub. To everyone working on building this vision, I say: Majulah Singapura!



### Professor Ho Teck Hua

*Executive Chairman, AI Singapore*

*Senior Deputy President and Provost, and Tan Chin Tuan Centennial Professor,  
National University of Singapore*

The Singapore government has always been deliberate in envisioning, planning, and executing its Smart Nation initiatives.

The National Artificial Intelligence Strategy (NAIS) maps out a bold and concrete plan to develop and deploy digital and AI technologies across economic sectors. The NAIS identifies powerful use cases that have the potential to transform industry and improve the lives of people in Singapore. AI has the power to amplify human potential and multiply our productivity. It will create many new and exciting jobs and power the growth of our digital economy.

AI Singapore is excited to be a key implementer of the NAIS. We will champion deep research and technology translation, accelerate AI adoption by industry, and develop a strong pipeline of AI talent. We will help to build a strong and vibrant AI Ecosystem, to attract global AI talent and companies, and to make Singapore a leading hub for AI.



### **Professor Isaac Ben Israel**

*Chairman, Israel Space Agency*

*Director, Blavatnik Cyber Research Centre, Tel-Aviv University*

*Co-chair, Israel National Task Force for AI*

The dominant technology of our century is computer technology, and its latest application is AI.

AI is impacting nearly every facet of our lives, with machine learning becoming more capable and improving efficiencies in daily life. Thus, understanding and developing AI is key for the future of our world.

Singapore has all the ingredients to be, within a decade or so, a world leader in this emerging technology.

Actually, Singapore has some relative advantages that promise an excellent start: educated people and highly developed education system, knowledge based economy and effective government.

With the right strategy, AI can transform national-level planning and significantly raise the quality of public goods like transport, education and healthcare, raise productivity, and enable the creation of valuable products and solutions for the Singapore market and beyond, and overall improving significantly the lives of Singaporeans.

Altogether, Singapore took today a huge step ahead, leading the way to a more efficient future.



### **Mr Jean Francois Gagné**

*Co-Founder and CEO, Element AI*

The pace of change in the field of AI is dramatic and being an inspiring leader is the only way to unlock transformative value for society. Singapore is becoming a leader in AI, with its increased focus and investments across its burgeoning AI ecosystem which is supported by its sound governance and regulatory frameworks.

The National AI Strategy (NAIS) is an ideal starting point from which the public and private sectors can rally behind key national initiatives and ensure that AI initiatives improve the lives of Singaporeans. Element AI is a strong advocate of using human-centric principles that are ethical, transparent and trustworthy for the design, deployment and adoption of AI.

Element AI is strongly committed to partnering with Singapore in its mandate to develop a nation driven by innovation between government, academia and industry. Our role as a member of this ecosystem is to bring world-class research and technology to ensure the NAIS delivers sustainable growth and positive impact from AI, both at a national level and across the region.



### **Mr Jeff Zhang**

*Chief Technology Officer, Alibaba Group*

*President, Alibaba Cloud Intelligence*

The launch of the National AI Strategy further affirms our decision to work closely with Singapore to build its digital economy. Singapore has consistently demonstrated its foresight and tenacity to fulfil the nation's objectives, as demonstrated in its strong talent base and world-leading research institutions. This is what first drew us to set up Alibaba Cloud's international headquarters and Alibaba Cloud's first overseas research institute in Singapore. We have subsequently embarked on partnerships with A\*STAR, the National University of Singapore and the Nanyang Technological University to expand AI ecosystems across advanced manufacturing, fintech, retail, tourism and smart city management under the Smart Nation initiative. With the launch of the National AI Strategy, Singapore is well placed to harness the transformative potential of AI and data intelligence to empower industry across sectors.



### **Dr Richard Socher**

*Chief Scientist, Salesforce*

Singapore is a regional and global leader when it comes to AI. Singapore's National AI Strategy (NAIS) will help propel Singapore to continue to harness AI effectively and develop these skills and capabilities locally.

This is evidenced in Salesforce's Research Asia hub in Singapore, our first outside the United States to develop AI talent and the AI ecosystem. A deliberate decision, based on Singapore's AI focus and capability.

I congratulate the Government of Singapore on the NAIS, a forward-looking vision to steer Singapore to the forefront of AI.



### **Professor Tang Xiao'ou**

*Founder, SenseTime*

*Professor, Chinese University of Hong Kong*

The National AI Strategy (NAIS) is the turnkey to drive whole-of-nation AI innovation and adoption, and to build long-term industry trust through responsible AI governance in Singapore. It is an ambitious plan that will position Singapore as a leading AI hub in the region.

The NAIS will further empower SenseTime, an AI technology platform company, to establish our Singapore base as a living lab to test and scale innovative AI solutions for the global stage, and to facilitate international collaboration.

We are confident in further contributing to Singapore's AI ecosystem and the empowerment of Singapore's various strategic industries. The NAIS' concrete talent development plan, in particular, aligns with our commitment to harness the local talent pool to strengthen our core capabilities in Singapore and beyond.



### **V.K. Rajah, SC**

*Chairman, Advisory Council on the Ethical Use of AI and Data*

The launch of the National AI Strategy is timely. In the near future, AI is likely to pervasively affect and influence all aspects of our lives in many ways. As a society, we must be alive to its benefits and potential pitfalls. Trust is crucial to the adoption of AI, and building trust is a multi-stakeholder effort involving public, private and people sectors.

Singapore has shown thought leadership in developing a human-centric approach to AI governance that balances the need for innovation and consumer protection. Our voluntary Model AI Governance Framework was the first national framework in Asia that provides practical guidance to organisations on how to implement AI responsibly. This is just the start of a never ending journey. We need to continue to identify and address the ethical concerns that AI brings. The Advisory Council on the Ethical Use of AI and Data fully supports this national effort to create an enabling environment for our businesses and citizens.



### **Dr Yan Shuicheng**

*Chief Technology Officer, Yitu Tech*

In the past decade, Singapore's AI researchers have made fruitful contributions to fundamental AI research. Their accomplishments have been recognised by the international AI research community, with frequent awards in flagship AI competitions and many high-impact AI publications. Now, it is time for us to take a step forward and consider how to transform these AI research capabilities into actual impact and value for our society and economy. To realise such a transformation, building an AI ecosystem is very crucial, as is identifying the proper business scenarios that would benefit from AI. The 5 national AI projects and 5 ecosystem enablers proposed in the National AI Strategy (NAIS) will generate great momentum for the transformation process.

Beyond nurturing AI talents, how to attract and anchor these AI talents is an even bigger challenge. It is believed that the best way to do so is to incubate more fast-growing local startups. When more Singapore-based startups are internationally recognised, even more AI talents would be willing to join them and relocate to work in Singapore, thus gradually forming a strong and healthy talent community. The NAIS provides great opportunities for incubating fast-growing local startups through offering help in building the different key AI ecosystem enablers, including talents, data, business scenarios, and global collaborations. I am excited by the opportunities ahead and am confident that Singapore will be a leading player in AI.

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