Pursuing AI maturity in health

How São Paulo, Brazil built an AI solution for diagnosing COVID-19

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Executive summary

In 2020, the Broadband Commission on Sustainable Development published a roadmap for integrating AI solutions within health systems. The report lays out concrete actions that decision-makers and policymakers can facilitate to advance their country's readiness to deploy AI in health. These actions cover six areas:

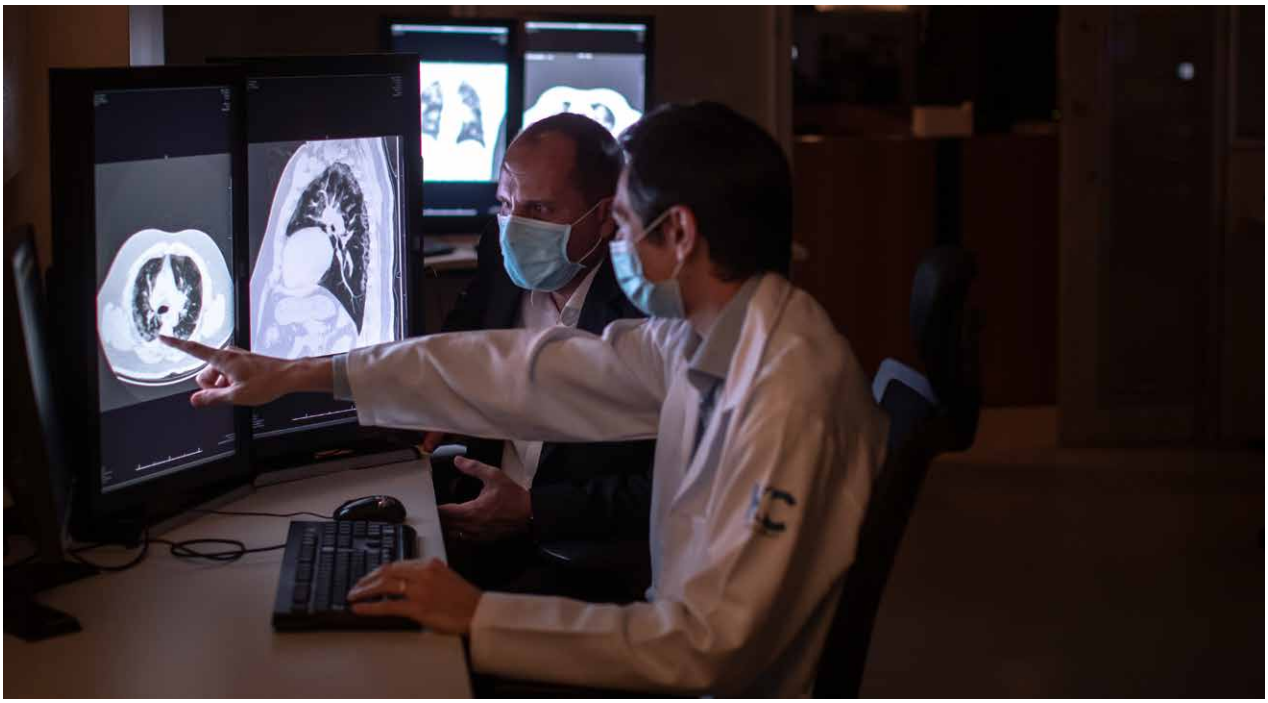
1. Upskilling people and the workforce's data science and AI capabilities
2. Building partnerships
3. Strengthening data and technology
4. Streamlining governance and regulations
5. Using needs-driven and human-centered design and integration processes
6. Creating and implementing business models that embrace innovation

As the COVID-19 pandemic began to impact Brazil in early 2020, the state of São Paulo soon experienced diagnostic bottlenecks. Recognizing the need to harness innovative technology to aid the pandemic response, the state government launched a new technology innovation hub, called IdeiaGov. Working with diverse partners from within and beyond Brazil, IdeiaGov solicited artificial intelligence (AI)-based solutions from Brazil's technology sector, which were put into use in clinical settings. In the process, the government learned that local technology firms were positioned to create AI solutions that were more finely tailored to local needs and at a lower price point than those offered by multinational tech companies.

Responding to a public challenge issued by IdeiaGov, three local tech firms developed AI tools to help diagnose COVID-19 by reading and interpreting lung images from patients affected by the disease. After testing and validation, these tools were put to use in clinical settings. At the time of this writing, they have been used to diagnose more than 25 000 patients with COVID-19 in São Paulo. Fifty hospitals are connected to the AI platform, of which 40 percent are public institutions.

São Paulo's integrated approach to local AI development and application exemplifies the AI roadmap described by the Broadband Commission for Sustainable Development. The state government and its partners not only created AI tools to meet an acute need. They also laid the foundation for a viable ecosystem for AI and technology innovation in Brazil.

IdeiaGov is now attracting funding from major investors, enabling expansion. The government is developing a workforce ready to leverage innovation for addressing critical social problems. And the health and care system is prepared to embrace innovation and advance on its path toward maturity for AI in health. Government agencies across Brazil, and even government agencies from other countries, are now asking the state government of São Paulo to share these best practices, which can serve as a model for other governments.



Introduction

Artificial intelligence (AI) has the power to transform health systems from being reactive to becoming proactive, predictive and even preventative. AI-powered solutions are part of growing number of medical tasks, supporting decision-making by identifying patterns, processing big data to facilitate insights, automating learnings and processes, and creating new efficiencies in the management of scarce resources. Countries facing shortages in qualified health professionals, plus a triple disease burden of infectious, chronic and nutrition-related diseases, can substantially benefit from AI. And yet these same countries often encounter the greatest challenges in developing and deploying the technology.

In 2020, the Broadband Commission on Sustainable Development published a roadmap for integrating AI solutions within health systems.[1] The roadmap identifies three phases that chart a course to "AI maturity:" exploring problems and AI solutions, activating AI solutions, and creating an integrated AI ecosystem. The report also lays out concrete actions that decision-makers and policymakers can facilitate that will advance their country's readiness to deploy AI in health. These actions cover six areas:

1. Upskilling people and the workforce's data science and AI capabilities
2. Building partnerships
3. Strengthening data and technology
4. Streamlining governance and regulations
5. Using needs-driven and human-centered design and integration processes
6. Creating and implementing business models that embrace innovation

The COVID-19 pandemic introduced a new sense of urgency to use digital technology powered by AI in health. A rapid rise in new cases in Brazil soon led to bottlenecks in diagnosis, depriving patients of care and placing major stress on the health system. To solve this problem, the state government of São Paulo, Brazil leveraged a new initiative they had been developing, which was designed to help public agencies procure innovative data and technology solutions.[2]

This case study describes how government officials, facing an emerging crisis, convened diverse partners to swiftly develop and deploy life-saving AI solutions. It describes how they applied the Broadband Commission roadmap toward AI maturity in health, and it provides lessons for developing AI solutions for challenges beyond COVID-19. The approaches laid out below cover all six of the roadmap's areas for AI maturity in health. They can serve as a model for governments that are designing their own integrated processes and programs for developing and applying AI technology for health.

Top 5 use cases for AI in health

A new report from the Broadband Commission Working Group on Digital and AI in Health identifies five use cases for how AI is addressing global and public health priorities, strengthening health systems, and improving outcomes for patients.

Targeting public health interventions through predictive analytics.

Optimizing drug discovery and design, personalized therapy, and trial design and execution.

Integrating into new and existing clinical workflows.

Interacting directly with patients, providing non-clinical therapies, information and advice.

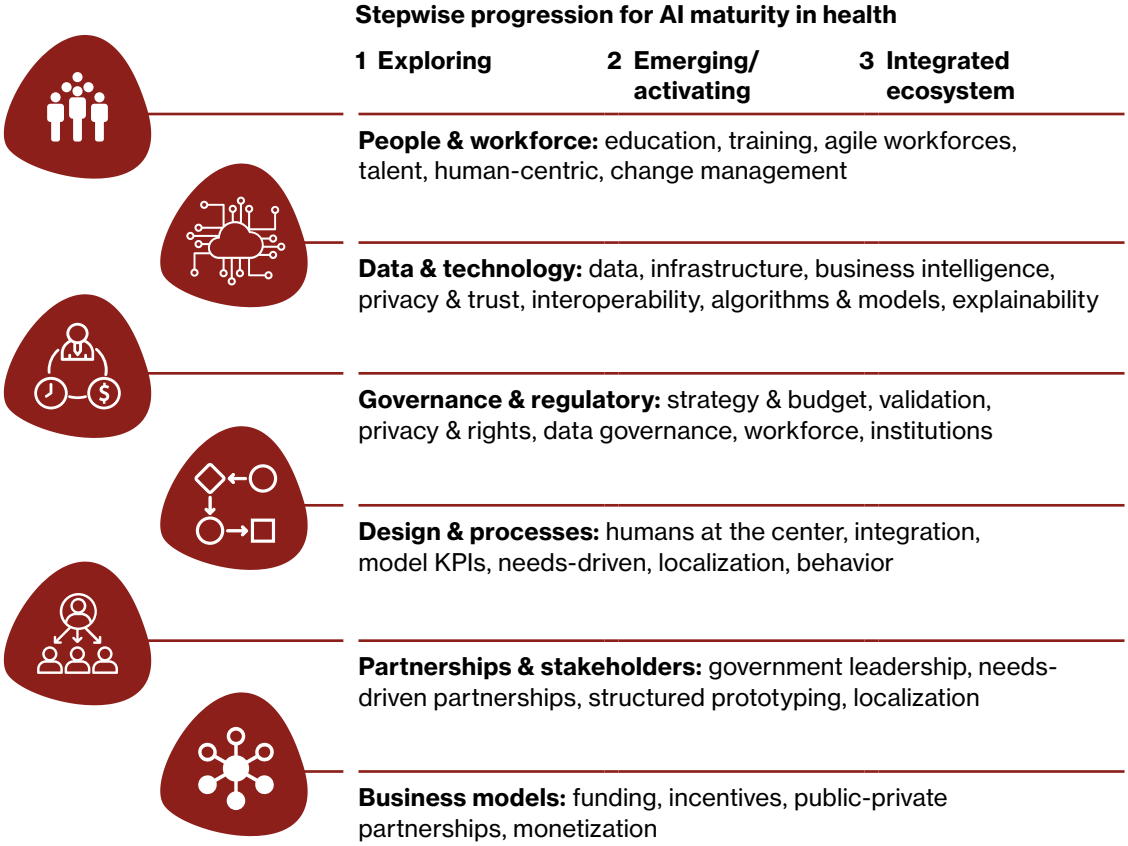
Optimizing back-end processes in healthcare.

Source: Broadband Commission for Sustainable Development. Reimagining global health through artificial intelligence: the roadmap to AI maturity. 2020.

[1] Broadband Commission for Sustainable Development. Reimagining global health through artificial intelligence: the roadmap to AI maturity. 2020. Available from: https://www.broadbandcommission.org/wp-content/uploads/2021/02/WGAIinHealth_Report2020.pdf

[2] Throughout this report, all mentions of 'São Paulo' refer to the state of São Paulo. Mentions of 'the government' refer to the government of the state of São Paulo unless otherwise stated.

The roadmap for AI maturity in health



Source: Broadband Commission for Sustainable Development. Reimagining global health through artificial intelligence: the roadmap to AI maturity. 2020.

Exploring solutions

Recognizing the need for modern technology to solve pressing public problems, in December 2004 Brazil passed a law to incentivize technological innovation in government.[3] Yet little progress resulted. Civil servants were not equipped to participate in the innovation process, nor were they empowered to procure innovative technology.

A 2016 law was meant to address this problem.[4] It allowed government agencies at national, state, and city levels to procure innovative technology, such as AI, without a public tender in certain circumstances. The law also provided clear procurement guidance. Even so, the underlying problem remained. Public officials still faced legal barriers and regulatory complexity in implementing the law. Furthermore, having never procured such technology before, most civil servants did not know how to assess their specific technology needs and then develop and procure effective solutions.

Brazil was not unique in this sense. Reviewing the capabilities of other governments, São Paulo's Science, Technology and Innovation (STI) branch, which sits within the Department of Economic Development, could not find any public sector model for procuring innovative solutions that it could replicate. So STI carefully mapped the steps and partners they would need for the entire process, from establishing supportive policies to developing, procuring and deploying innovative technologies.

This exercise led them to create IdeiaGov,[5] a new innovation hub designed to work with Brazilian tech companies to source and roll out innovative solutions for pressing problems. If successful at scale, IdeiaGov would also help advance Brazil's science and technology industry and develop São Paulo's economy.

IdeiaGov was initially conceived to address any challenge where innovative technology could apply, and it was set to launch in April 2020. But when the pandemic hit São Paulo in the months before, the government rapidly retooled IdeiaGov so that it could respond to the crisis. Operational timelines were accelerated, allowing solutions to be quickly tested and scaled. Pilot projects that would normally take a year or more were rescoped to conclude in as little as three months.

[3] Law no. 10.973/2004. Available from: https://www.dannemann.com.br/dsbim/uploads/imgFCKUpload/file/Law10973_2004.pdf
[4] Law no. 13.243/2016. Available from: https://stip.oecd.org/stip/policy-initiatives/2017%2Fdata%2FpolicyInitiatives%2F14098
[5] IdeiaGov [Internet]. São Paulo: Desenvolvimento Econômico; 2021 [cited 2021 Apr 13]. Available from: https://ideiagov.sp.gov.br/

Partnerships and stakeholders

Building a mature AI ecosystem requires a thorough understanding of the environmental conditions, as well as the systems and processes for developing and deploying AI solutions. This means governments need to work with a range of partners from academia, civil society, patient associations, not-for-profit organizations, industry, and funders.

As rates of COVID-19 continued climbing, the Department of Economic Development convened the Hospital das Clínicas of the Faculty of Medicine of the University of São Paulo (HCFMUSP, the state's teaching hospital), InovaHC (the hospital's innovation department), InRad HC (the hospital's radiology institute), the Institute for Technological Research (IPT), Associação Impact Hub Brasil, Instituto Tellus and the Novartis Foundation. The department also involved other government departments, particularly those critical for shaping policy, including the Department of Government and the State's Attorney General. Each brought unique knowledge and skills, plus expert networks that could be called upon to share knowledge and build capacity. Together, the partners initiated a plan to use the IdeiaGov hub for developing and implementing an AI solution that would help clinicians diagnose COVID-19, allowing patients to more quickly access treatment.

Partnership roles, responsibilities, and governance

São Paulo State Department of Economic Development, IdeiaGov	• Serve as focal point and coordination lead for the government • Liaise with other government agencies (such as the Attorney General, the Department of Health, the Department of Government) • Administer IdeiaGov
São Paulo State Department of Government	• Chair IdeiaGov's Steering Committee
São Paulo State Attorney General	• Provide legal guidance throughout the process • Serve on IdeiaGov's Steering Committee
Hospital das Clínicas of the Faculty of Medicine of the University of São Paulo (HCFMUSP)	• Oversee the AI algorithm development via the public challenge
Radiology Institute (InRad HC) **Innovation Nucleus (Inova HC)**	• Coordinate radiologists who guided algorithm development • Advance adoption of the AI tool within workflows • Coordinate the broader technology partnership to strengthen UHSP's data and AI strategy
Institute for Technological Research (IPT)	• Provide technological support for evaluating proposals
Associação Impact Hub Brasil (Brazilian branch of Impact Hub Network)[6]	• Hire and manage IdeiaGov's full time team • Manage the IdeiaGov platform • Assist departments with defining and preparing the public challenge
Novartis Foundation	• Provide funding • Provide strategic support and coordination • Link local partners with global AI in health experts and thought leaders
Tellus Institute	• Design, plan, and support the development of IdeiaGov
Innovation laboratory of the Inter-American Development Bank Group (IDB Lab)	• Provide funding for pilot projects

[6] Impact Hub Global Community [Internet]. Vienna: Impact Hub GmbH; [cited 2021 Apr 13]. Available from: https://impacthub.net/

Exploration design and process

In consultation with the medical and technical staff of the HCFMUSP, the partnership developed a framework for diagnosing COVID-19 using AI.

Ultimately, the goal was to develop a diagnostic tool that was superior to existing capabilities, and that would be useful for several different hospitals.

Framework for diagnosing and triaging COVID-19 patients based on lung images

Problem	What problem are we dealing with?	Large, rapidly increasing numbers of COVID-19 patients creating significant delays in diagnosis and treatment initiation
Analytical solution	How can we address the problem?	Use AI to aid diagnosis through analyzing lung images from chest X-Rays or CT scans
Users	Who might use the product?	Radiologists in São Paulo and across Brazil
Format	What's the best way for users to consume information?	Swiftly generated analytical report
Decisions	What types of decisions will the user make, based on the information delivered by the product?	Decisions related to patient's diagnosis, reported back to the treating physician
Input/Output	What are the main inputs and where do we find them? Once transformed, how will they be delivered as outputs?	Input: Chest X-Rays and CT scans provided by referring clinicians; patient data Output: Analytical report provided to radiologist
Threats and barriers	What are the main difficulties users might face that will need help from our team?	Radiologists must understand how to use the tool and trust its results The tool must be user-friendly and easy to integrate into workflows
Actions and rules	What actions can be taken to avoid risks? Does this imply any rules to ensure higher quality and avoid product bias?	The tool must be shown to work through appropriate testing and then receive regulatory approval The tool must be accompanied by clear instructions
Answers	What objective solution are we trying to develop?	Faster, accurate diagnosis of COVID-19
Success	How will we measure the success and adoption of this product?	Number of radiologists and hospitals adopting the tool Number of patients diagnosed and referred for treatment through use of the tool

Emerging solutions

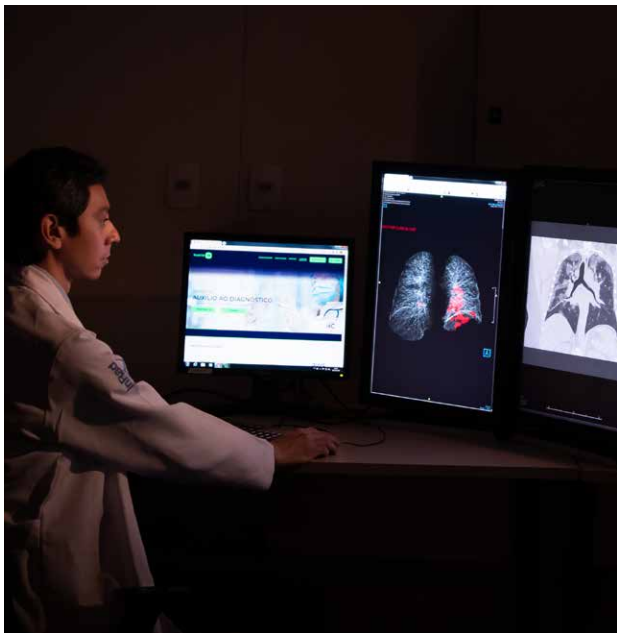
Data and technology

Polymerase chain reaction technology (PCR) is considered the gold standard for diagnosing COVID-19, as it is the only diagnostic test able to identify proteins unique to SARS-CoV-2. The test is not error-proof though, and it requires proper interpretation. Perhaps more importantly, the time needed to test PCR samples can make it hard to efficiently process large volumes of tests in resource-limited settings. This makes image-based testing, which is faster than PCR and allows for the application of AI, a good complementary tool. Physicians can use imagery to diagnose COVID-19 before receiving PCR results, which proved essential as PCR-performing labs were quickly overburdened.

A machine-learning algorithm is a set of coded instructions that the AI system uses to conduct its task, which is to reach a prediction, analytical outcome or recommendation based on input data. In this case, the AI needed to provide a reliable assessment of the likelihood and severity of COVID-19, based on its reading of radiological images of a patient's lungs.

Developing AI-supported image-based testing requires a large repository of data and images that machine-learning algorithms can read and learn from. Through RadVid-19, an HCFMUSP initiative supported by the Brazilian College of Radiology (CBR), Brazil has just such a repository for COVID-19. As of December 2020, RadVid-19 contained X-ray and CT images from more than 20 000 individuals.[7]

Initially, RadVid-19 had access to two AI algorithms, developed by Siemens and Huawei, that both could be used for diagnosing COVID-19 based on lung images. But there were two drawbacks. Accessing the algorithms was expensive. And because the algorithms were proprietary, their adaptability was limited. For these reasons, the partners decided to develop algorithms locally. This decision allowed the partnership to tailor new AI solutions to local needs, based on Brazilian data. It also meant engaging local innovators, data scientists and programmers, helping to foster a national AI ecosystem.



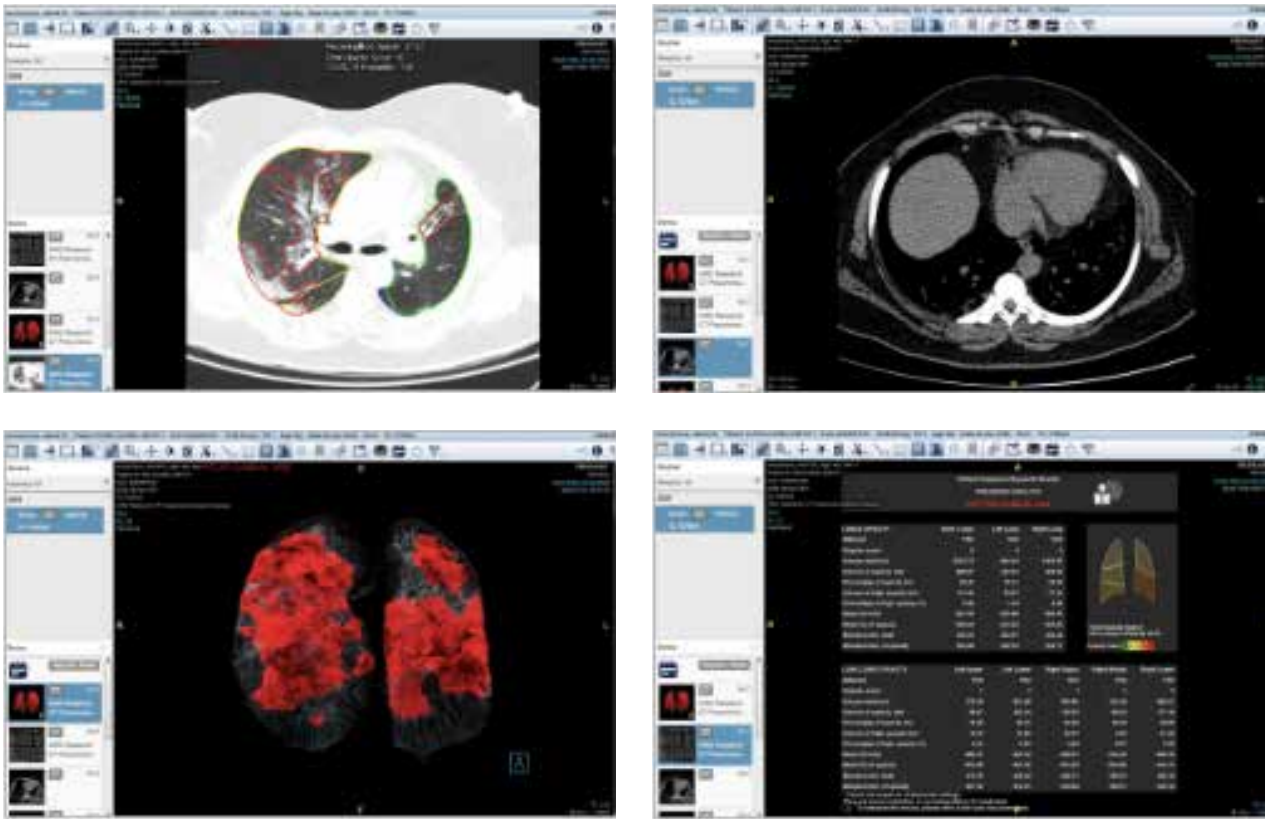
Solutions design and process

The goal was to recruit local tech innovators to design machine-learning algorithms that could identify typical effects of COVID-19 on lung tissue, based on AI analysis of chest X-rays and CT scans. After analyzing the state of COVID-19 diagnosis in São Paulo, the partners established a six-step process to evaluate and select machine-learning algorithms for testing and further development:[8]

1. Explore and define the problem
2. Identify solution requirements
3. Issue a public challenge for tech companies to submit algorithms
4. Promote the public challenge
5. Select algorithms for pilot testing
6. Pilot test three algorithms

The São Paulo State Department of Economic Development managed the public challenge through IdeiaGov. After a systematic evaluation, the partners' evaluation committee selected algorithms from three Brazilian tech firms: NeuralMind, Visibilia, and Otawa Health. These algorithms are open-source and are available on GitHub.[9, 10, 11]

[7] RadVid-19 is made possible through the voluntary collaboration of Brazilian radiologists and is open for AI use. All images are de-identified and anonymized to protect patient privacy, and HCFMUSP manages access rights to the repository.
[8] See Appendix 1 for details.
[9] Gitlab. Challenge Project ID: 22956958 [Internet]. [cited 2021 Apr 13]. Available from: https://gitlab.com/nm-miclab-public/challenge
[10] Github. Visibilia/IA-for-fully-automatic-COVID-19-detection [Internet]. [cited 2021 Apr 13]. Available from: https://github.com/visibilia/IA-for-fully-automatic-COVID-19-detection
[11] Github. klaus-otawa/Artificial-Neural-Networks-DL [Internet]. [cited 2021 Apr 13]. Available from: https://github.com/klaus-otawa/Artificial-Neural-Networks-DL



Examples of analyzed lung images with RadVid-19

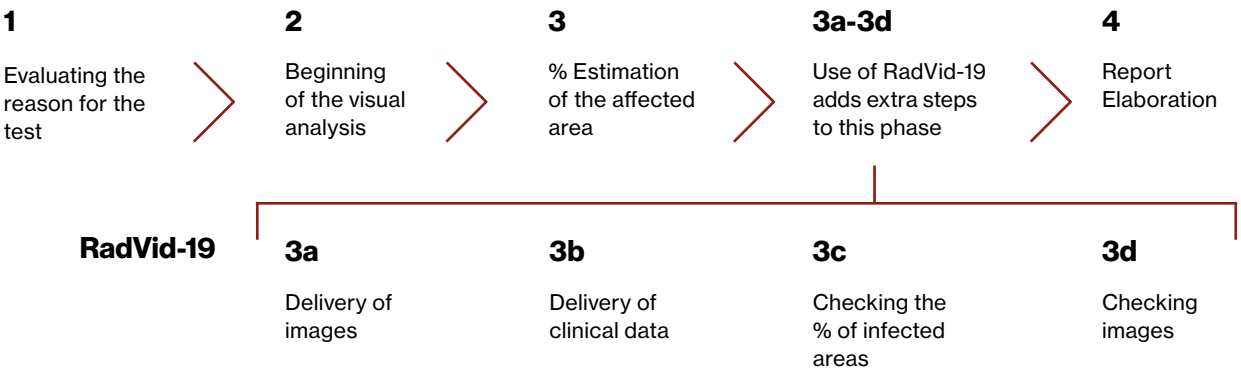
Adopting AI solutions: People and workforce considerations

Earning users' trust in the tool and ensuring a positive user experience are both essential for seeing AI tools adopted in clinical practice. By using a user-centric design approach focused on the clinicians' experiences and needs, the operational team began identifying any barriers that could prevent the adoption and use of AI in practice. They analyzed national and international COVID-19 guidelines to see how to best support the use of medical imagery for diagnosis. Interviews with Brazilian physicians revealed that they were already using image tests to screen patients for COVID-19 prior to or in the absence of other diagnostic tests.

Based on these findings, the team developed a workflow for including lung images in the diagnostic decision-making process. They found that radiologists were likely to experience stress and uncertainty when they did not clearly understand the parameters for using a new technology. Radiologists were also likely to use the AI tool differently based on their level of experience. More experienced radiologists were likely to use the AI's interpretation of lung images as a check on their own interpretation, while less experienced radiologists were likely to use the AI's interpretation as a baseline. Consulting with physicians and radiologists, the team designed a workflow in which the algorithm would augment radiologists' performance by refining their interpretation of lung images, particularly the nature and extent of infection observed in each patient.

In this workflow, physicians provided two pieces of information for the AI to analyze: the radiological images and the patient's clinical data, including the results of PCR tests. Powered by the algorithm, the AI "reads" the lung images combined with the clinical data. It then rapidly produces a report of its reading that can be compared to the radiologist's own visual analysis.

Including AI image analytics in the diagnostic decision-making process

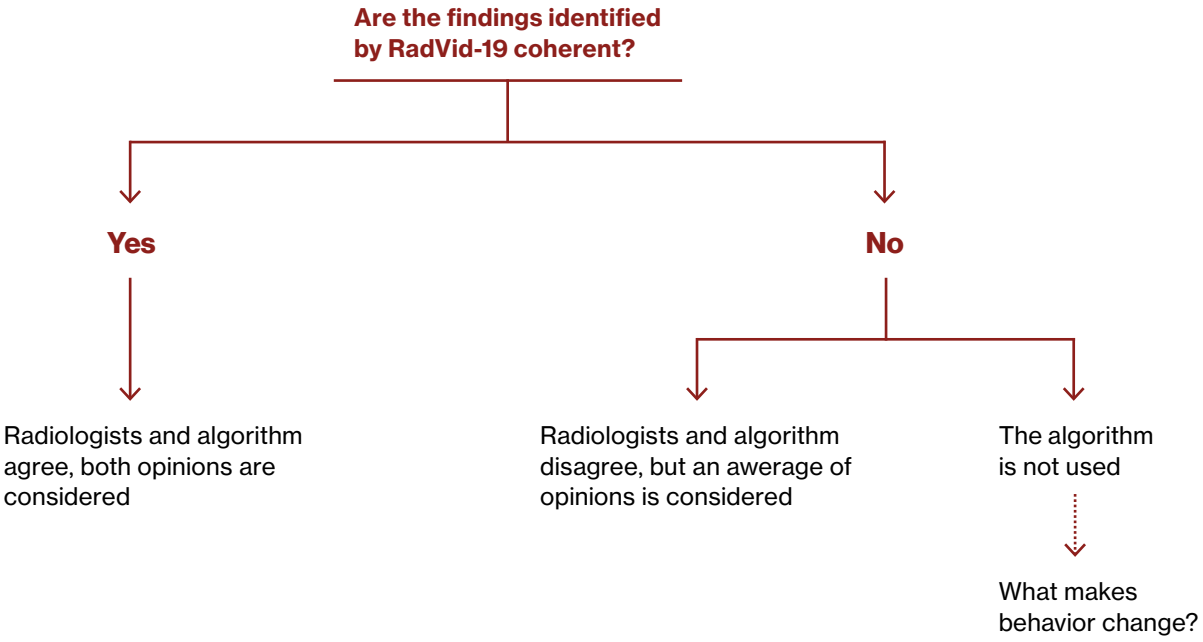


Whenever the AI and the radiologist interpret images differently, the physician must decide whether to disregard the radiologist's report, to disregard the AI, or to "average" the two findings. To support this decision-making, the operational team searched the literature and found common factors that affect one's confidence in using AI, including user expertise, perceived objectivity of the task, and potential consequences of using the AI.

Using this insight, they consulted with radiologists to refine the workflow, working to eliminate barriers for usage, ranging from the demands on the users, bandwidth problems, difficulties transferring and receiving images, security issues with the transfer of images to external IT networks, to difficulties interpreting the reports produced by the AI algorithm.

To further aid users, the team produced a digital user manual along with 15 videos featuring physicians from the RadVid-19 management team. These provided step-by-step instructions, clarified policies, explained the tool's benefits, and addressed common concerns raised in prior interviews with end users.

Decision-making tree for physicians using the AI tool



Creating an integrated AI ecosystem

IdeiaGov governance and regulatory considerations

IdeiaGov is governed by appropriate committees at all levels. Its Task Force Against COVID-19 involves a group of experts in innovation, public policy, and health. These experts collectively design public challenges related to the pandemic and oversee the registration and selection process. Their decisions are informed by an Expert Committee, comprised of technical, operational, and business specialists who evaluate potential solutions. A Review Committee chooses the solutions that will be pilot tested. A Steering Committee that includes representatives from government is responsible for granting final approvals for public challenges and for adopting technology solutions that are validated through testing.

IdeiaGov's business model and InovaHC future prospects

IdeiaGov's business model is intended to ensure sustainability for both its programs and the adoption of innovative technology. With approximately 15 full-time IdeiaGov staff, the state government now has the capacity to use a systematic, validated process to scope and procure innovative technology that is fit for purpose. With support from the IdeiaGov team and external partners, public managers from any state agency can now use this process for developing and procuring innovative technology.[12] IdeiaGov has begun applying the process to solve a range of problems beyond the health system, including in basic education, technical vocational education and training, and national statistics. Government agencies across Brazil, and even government agencies from other countries, are now asking the state government of São Paulo to share these best practices. IdeiaGov has also joined the Civtech Alliance, an international network of government and civilian technology programs spanning 16 countries.[13]

At the same time, InovaHC (the innovation department within HCFMUSP) and its partners are working to expand access to the AI diagnostic tool across Brazil, with the aim of making it available to all health facilities, also in remote areas. Looking beyond the pandemic, the new AI platform will be used to assist in the diagnosis of other diseases that rely on imaging, including breast, prostate, or other cancers. Now branded as Órbia, the platform is hosted by the Hospital das Clinicas and is equipped to carry out future data competitions and challenges.

Lessons learned

- Local technology firms are positioned to create solutions that are finely tailored to local needs, at a price point that might be lower than the one offered by large technology companies. These local firms are often more willing than multinational corporations to highly adapt and customize their solutions.
- The AI diagnostic tool for COVID-19 supported radiologists in different ways. Specialists with many years of experience used the AI-generated reports to augment their own capacity and make their own radiology readings faster and more accurate. Less experienced radiologists were more likely to start their diagnostic process with the AI output reports.
- When gathering and nurturing partnerships, it is important to bring together partners who themselves have robust networks of experts who can be enrolled to remediate capacity gaps where needed.
- Establishing the capacity to procure and adopt innovative technology is not simply a technical challenge – it is also a political one. Building and operationalizing IdeiaGov required collaborating with nearly a dozen government agencies. Engaging all relevant government agencies early and along the entire journey is critical for success.
- The COVID-19 crisis made it feasible to efficiently develop, validate, and adopt new AI solutions for health in São Paulo, Brazil. All partners were fully committed, while the state created flexibilities that enabled action. To solve other pressing challenges, it will now be critical to translate this collaboration into action for many other scenarios.

[12] See Appendix 2 for details.
[13] Civtech Alliance. IdeiaGov [Internet]. [cited 2021 Apr 13]. Available from: https://www.civtechalliance.org/ideiagov

Conclusion

With IdeiaGov, São Paulo has established a process for working with private and public partners to rapidly develop, test and procure innovative technologies, such as AI solutions. In so doing, it has laid the foundation for a viable ecosystem for AI and technology innovation in Brazil. São Paulo's integrated approach to local AI development and application exemplifies the six areas for AI maturity in health described by the Broadband Commission for Sustainable Development. This experience can serve as a model for other governments.

At the time of this writing, the AI platform developed in São Paulo has been used to diagnose more than 25 000 patients with COVID-19. Fifty hospitals are connected to the platform, of which 40 percent are public institutions.

IdeiaGov has facilitated the implementation of innovative solutions from 17 Brazilian tech companies selected from 180 applicants through eight public challenges. It is now attracting funding from major investors, enabling expansion. In addition, the government is developing a workforce ready to leverage innovation for addressing critical problems, while the health and care system is now prepared to embrace innovation and advance on its path toward maturity for AI in health. As Marcos Bego, Chief Innovation Officer at the University Hospital São Paulo, describes the new AI capabilities: "Our hope is that we will use it on a large scale. We have the infrastructure now."

Acknowledgements

This case study, funded by the Novartis Foundation, describes the results of a collaborative effort between the São Paulo State Department of Economic Development, Science, Technology and Innovation (SDE), Hospital das Clínicas of the Faculty of Medicine of the University of São Paulo (HCFMUSP) and its Radiology Institute (InRad HC), the Tellus Institute and the Novartis Foundation. We thank Paul Jensen and Phil Coticelli for the writing support. A special thanks goes to the authors of the case study and their contributions, reviews, and comments:

- **Ann Aerts**, Novartis Foundation
- **Marco Bego**, Executive Director, Chief Innovation Office – INRAD – Instituto de Radiologia HCFMUSP
- **Johannes Boch**, Novartis Foundation
- **Suellen Carvalho**, Government Innovation Lead, Instituto Tellus
- **Germano Guimarães**, Co-Founder and CEO, Instituto Tellus
- **Bruno Kunzler**, Data Evaluation Lead, Instituto Tellus
- **João Arthur Reis**, Technical Director at the Subsecretary of Science, Technology and Innovation; Current affiliation: Project Lead for Data Policy, C4IR Brasil, Affilated WEF Center
- **Marcos Vinícius Souza**, Subsecretary of Science, Technology and Innovation at the Secretary of Economic Development of the State of São Paulo; Current affiliation: President of the Board, IPT – Institute for Technological Research

Additionally we thank all members of the participating organizations and would like to acknowledge the work of the Service Designers (Aline D`Unhão, Daniel Valle, Fernando Esperandio, Lara Pessoa, Esther Leblanc, Ariel Macena), the team from InovaHC (Giovanni Cerri, Claudia da Costa Leite, Ivisen Lourenço, Marcelo Felix, Bruno Aragão, Diogo Edelmuth, Cleiton Caldeira, Renata Arruda, Alexandre Siegmann, Valdiramos Lima), the IdeaGov Taskforce (Ana Calçado (Wylinka), Alex Avallone (IPT) , Bruno Martinelli (Impact Hub), Beatriz Miranda (IPT), Felipe Massami Maruyama (Impact Hub), Ingrid Silva (Impact Hub), Kika Gianesi (Impact Hub), Kerollayne Candida (Impact Hub), Priscila Sant'anna (Impact Hub)), the Attorneys' Office of the State of São Paulo (Rafael Fassio) and the Graphic Designers (Aline Aliste, Rodrigo Sallai).

References

- Pictures p 1, p 7: Sao Paulo – Brazi – A portrait of Marco Bego, engineer and Executive Director Chief at InRad. Photo by Jonne Roriz/Getty Images/Novartis
- Pictures p 2, p 11: Sao Paulo – Brazil – Image of a doctor Marcio Sawamura with Marco Bego, engineer and Executive Director Chief at InRad hospital. Photo by Jonne Roriz/Getty Images/Novartis

Appendix 1:

Implementing IdeiaGov's public challenge for AI algorithms to support COVID-19 diagnosis

1. Initial exploration and problem definition

Two overlapping problems were defined: to support the development and deployment of machine-learning algorithms (including the design of processes to integrate innovations into existing workflows), and to develop algorithms assisting health professionals in diagnosing COVID-19 based on lung images (chest X-Rays and CT scans).

2. Solution requirements

Two indices were created to evaluate tech companies submitting algorithms following the public challenge, as well as the algorithms themselves. The business maturity index classified participating tech companies based on their experience developing data solutions. The algorithm performance index classified algorithms based on established metrics for assessing machine learning applications.

3. Issuing a public challenge

The AI technology was sourced through a public challenge initiated by the government through IdeiaGov. For tech companies to submit any machine-learning solution, they first had to register for the public challenge on an online platform called Prosas. Through the platform, participants were asked questions to classify them on the business maturity index.

For the public challenge, each participating tech company was required to create a machine-learning training algorithm using a subset of the x-ray and CT scan images on RadVid-19. Companies were asked to use those images to develop algorithms to assist radiologists in identifying lesion patterns typical in people affected by COVID-19.

Each algorithm was subjected to two tests: a classification test and a segmentation one, to ensure that the algorithms could be generalized. Participants were required to share the algorithms' code for audit, in order to verify ownership of the algorithm, ensure transparency, and deter fraud. Tech companies were selected using uniform criteria: online registration and data retrieval through a common form, provision of data for training and testing, the two-step test, and the algorithm audit.

4. Promoting the public challenge

The public challenge was promoted through the partners' social media channels, a mailing to relevant organizations, the news media, and a webinar. This promotion yielded 19 valid registrations.

5. Selecting algorithms for pilot testing

In the first selection phase, submissions were screened solely on the algorithm performance index. In the second phase, remaining participants were assessed on the business maturity index and their submitted code. Participants' reports were shared with the project's evaluation committee – a multidisciplinary group of technical, operational, and business specialists. Three participants were selected: NeuralMind, Visibilia, and Otawa Health.

6. Pilot testing three algorithms

For testing the three algorithms, it was essential to establish connectivity between the tech companies' technology infrastructure and the RadVid-19 infrastructure. Connections were made between the HCFMUSP's IT systems and each company's system, enabling the transfer of radiological images and data. Once these connections were established, the algorithms were re-trained using additional images and deployed in a semi-controlled environment where only the project team had access to the algorithms. Algorithm performance was monitored, the business model through which they could be deployed in real-world settings was defined, and final recommendations were made for further development.

Appendix 2:

IdeiaGov's business model

1. Establish the vision

a. Public leaders from any government department can propose problems that need to be solved, in line with the state's strategic priorities.
b. With mediation provided by IdeiaGov, public managers define their objectives, draw synergies with public policy priorities, map out their stakeholder groups, and identify potential buyers of solutions within the government.
c. IdeiaGov facilitates consultation with government agencies and stakeholders as needed and helps to identify potential funding sources, whether from the state budget or from private investors.

2. Create lines of communication

a. IdeiaGov helps the initiating department define the specific problems they need to solve, map out the partners who can help solve those problems, and reach cooperative agreements with those partners.
b. The Department of Economic Development establishes working relationships with essential partners from other government departments, while IdeiaGov initiates contacts with validation partners, sources of funding, and legal partners.
c. Together, all these partners identify and enroll others who can contribute to the solution.
d. IdeiaGov hosts discussion workshops to establish processes and clarify objectives.
e. IdeiaGov and the validation partners design the public challenge, define the model, selection criteria, legal conditions for hiring, and other aspects, with input from legal and technical partners. The partners work together to identify reviewers and other individuals to implement the public challenge.

3. Opening and management of the public challenge for solutions

a. The partnership develops the materials needed to open the public challenge, writing notices, legal text, and other necessary forms, with approval of the state Attorney General. They establish the review committee including staff from the state Department of Economic Development, the initiating departments or agencies, and the validation partners.
b. IdeiaGov and other relevant government departments develop the communications strategy for the public challenge with involvement from state communications leads.
c. IdeiaGov opens the public challenge and manages registrations. Depending on the response, the partners can modify the communications strategy and extend the registration period.
d. The partners conduct a "knockout stage," eliminating registrants that fail to meet minimum business maturity or other criteria. Remaining participants move on to the review phase.
e. The review committee assesses proposals based on their technical, operational, and business model viability.
f. The selection committee, comprised of IdeiaGov, technical and validation partners, and staff from the initiating government departments or agencies, selects the most promising proposals for validation.

4. Develop solutions

a. IdeiaGov, in collaboration with validation and technical partners, closely assesses proposed solutions and the companies that submit them. Through this validation process, some solutions go directly to pilot testing, while others might need to undergo further technical validation before piloting. Various partners contribute to pilot design.
b. IdeiaGov and validation partners evaluate the outcomes of pilot testing, with input from technical partners if needed.
c. Solutions that achieve proof of concept through pilot testing can be further developed to scale through an agreement with the state, and potentially with other funding partners. Legal partners help construct agreements.
d. IdeiaGov, with validation and technical partners, develops plans for replicating solutions, identifying goals, objectives and key performance indicators. Legal partners help to develop legal and institutional models for implementation.

5. Achieving and monitoring impact

a. IdeiaGov establishes connections between the tech companies that have developed solutions and potential buyers and investors. All partners can participate in this process by activating their networks.
b. After finding buyers and investors, IdeiaGov acts as the legal facilitator through the conclusion of contracting agreements.
c. IdeiaGov develops studies used to measure and evaluate impact, then reports findings to the initiating government agency or department.