

Democratizing AI: From Theory to Practice

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Abstract

We are witnessing a movement towards *Democratizing AI*, with a wide variety of tools, platforms and data sources becoming accessible to more people. This movement is said to be fueling innovation, extending the capabilities of individuals and organizations, by making the creation and application of AI easier. However, beyond the hype, there is a need to understand what this trend means for various stakeholders. Through the lens of socio-political democracy, this chapter examines the democratization of AI. We find that the present state of the “AI Democracy” maps onto only one of three elements of a democracy. Current efforts focus primarily on providing people with the tools and technical infrastructure needed to participate in AI, but not in protecting their freedoms and access to social benefits, which are the other core elements of democracy. We discuss the possibilities for realizing a broader AI democracy, along with the anticipated challenges.

Keywords:

AI adoption, data maturity, democratization of AI, elements of democracy, social factors

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1. Introduction

1.1. Transformation, Revolution and AI

Technical innovations, such as electricity and steam engines, have been the drivers of economic growth and transformation for the last 250 years. Today, Artificial Intelligence (AI) - and in particular, *machine learning* - is considered to be the most important innovation of the modern era (Brynjolfsson and McAfee, 2017). The World Economic Forum (WEF) has described AI as being *the* key driver of the Fourth Industrial Revolution. AI has advanced significantly in the past decade, as a result of access to data, robust computing architectures (i.e., the rise in computer power, which drove the Third Industrial Revolution) and self-learning algorithms and specifically, advanced neural networks, or “deep learning”. Indeed, it is machine learning (ML) that the WEF cites as being responsible for the amplification of the scope and scale of AI’s deployment, across diverse sectors of society (World Economic Forum, 2021).

Technologists have detailed the changes brought about by AI within traditional sectors, such as manufacturing, as well as the service-oriented sectors (e.g., education, health) (Stone et al., 2016) that characterize most developed and developing economies today. Beyond the technological advances, experts are also trying to anticipate how these technologies will impact the way we live and work. Without a doubt, AI holds the promise of transforming society; the application of AI in developing innovative solutions for healthcare (e.g., the CARE initiative that applies AI to the design and optimization of new treatments against COVID-19 (Hurst, 2020)), as well as in the fight against climate change (Bibri, 2019), are two notable areas that stand to benefit humanity.

There is also recognition of the need to ensure that AI benefits *everyone*. AI has the potential to exacerbate social inequalities, if these technologies remain in the hands of the few. The European Commission (EC) has taken the view that “no one [should be] left behind in the digital transformation” and that everyone should have the opportunity to benefit from the Fourth Industrial Revolution (European Commission, 2018, p. 3). In light of the competition from other regions, but also to address the issue of between-country inequality, the EC laid out its approach for “AI for Europe,” which stresses the need to develop AI within Europe, at the same time putting human values at the center of its approach. Meanwhile, US-based think tank *AI Now* has characterized an “ethical crisis” within AI, citing issues such as the exploitation of users’ private data in research and development (R&D), primarily by industry and elite academic researchers (Crawford et al., 2019).

A recent trend, increasingly embraced in the sciences, as well as industry, is that of **Democratizing AI**. Its aim is to make AI more accessible, to more people. Consider the following quotes from business leaders:

It becomes a very unstable situation if you’ve got any incredibly powerful AI. You just don’t know who’s going to control that. It’s not that it will develop a will of its own right off

the bat, the concern is that someone may use it in a way that's bad... So we must have democratization of AI technology and make it widely available. And that's the reason that... [we] made OpenAI, to help spread out AI technology so it doesn't get concentrated in the hands of a few.

--Elon Musk, as quoted in (Su, 2017)

Our real mission is not about celebrating any of these big research breakthroughs, it's about democratizing AI so that every developer can build out these applications. That means having the best, world-class infrastructure for training and for inference."

--Satya Nadella, as quoted in (AlphaPeople, 2019)

But what does Democratizing AI entail? The term is often used differently across individuals (e.g., a casual user with a non-technical background versus a machine learning expert) and contexts. Thus, the goal of this chapter is to examine the present state of the "AI Democracy." We examine the trend towards democratizing AI through the lens of socio-political democracy, contrasting the theory or the "dream" of what this movement could mean, with the reality. Through this exploration, we shall consider the possibilities for realizing a broader AI democracy, being realistic about the anticipated benefits and challenges.

1.2 Real World Perspectives

To ground our discussion, we introduce three examples, as real world perspectives on democratizing AI. The intent is not to present views that are necessarily representative of a given sector, but to examine the promises and challenges of AI that organizations face. Specifically, we examine examples in which an "AI democracy" could be harnessed, for the purpose of creating innovative social or business solutions. We provide a brief introduction, returning to the examples later in the chapter.

Smarter Devon - Towards data-driven and evidence-led authority

Smarter Devon (Devon County Council, 2021a) is an initiative of the Devon County Council in the United Kingdom, aiming to "do what matters with data." The Council represents the largest local government authority in the South West of England, with nearly 800k residents. On a daily basis, it collects heterogeneous data sources concerning its operations and services, from roads and transport, to environmental issues, to health care and social services. Through Smarter Devon, the Council aims to equip its decision-makers with data-driven intelligence, towards a vision of "evidence-led authority."

Smarter Devon has been mapping out the Council's key "data and intelligence pipelines," (Devon County Council, 2021b) which detail the journey of the generation and collection of data concerning the Council's operations, to the generation of information based on that data, and then to the decision-making processes. Given the high volume of data collected across sources, automation is used in the curation process, as well as in the generation of intelligence - statistics and trends across time. The reports generated serve a number of purposes; for instance, they

are used to aid officials in assessing citizen needs and the commissioning of services. In addition, the standardized datasets are released as open data through the Council's GitHub.

Smarter Devon also aims to engage with partners outside the organization as well as with citizens. Example initiatives here include the organization of an annual "Smarter Devon Unconference," as well as a series of open lectures on Data Science. Such efforts are aimed at citizen empowerment, supporting this public organization's digital transformation.

Democratizing AI in Healthcare - Reusable models in diagnostic radiology

AI has brought significant advances to the field of diagnostic medical imagery. A recent meta-analysis found that deep learning algorithms are often as accurate as clinical radiologists in classifying diseases (Liu et al., 2019). Given such advances, as well as the Democratization of AI within the medical field, some have called for radical changes to the training of radiologists, putting AI at the core of the curriculum of future clinicians (Kobayashi et al., 2019).

A team of scientists at two sites described one way in which the Democratization of AI is changing clinical radiology at their institutions (Gupta et al., 2020). They take advantage of *transfer learning*, in developing models for a common use-case for diagnosing heart disease. Transfer learning is an ML technique that facilitates the reuse of existing models trained by others. Deep learning requires a huge volume of training examples (i.e., annotated images), which are expensive to generate. As many institutions struggle to generate such large datasets, due to insufficient human resources or equipment, this has traditionally been an obstacle for participation in model creation. Thus, transfer learning helps democratize the model building process, reducing the required resources to engage in AI / algorithmic decision support.

Clarifai - Democratizing AI in software development

Forbes explains that there are strong economic incentives for software developers to align themselves with the AI sector (Olson, 2019). About one in 12 European start-ups report using AI, and command between 15% to 50% more funding than other types of technology start-ups. Another survey of developers, who were not ML experts, shed light on the increased interest surrounding ML-based AI by software developers (Cai and Guo, 2019). Results revealed that developers often felt inspired to incorporate ML into their work, even when there was not an immediate need for it.

Responding to such needs, many companies are now offering AI as a Service, or "Cognitive Services." Clarifai (Clarifai, 2021a), a start-up company itself, specializes in computer vision solutions. Its initial offerings included image and video recognition services accessible via application programming interfaces (APIs), easy to use by anyone with basic programming skills. Recently, Clarifai's offerings have expanded to include a range of services spanning the AI lifecycle, enabling the development of machine-labeled training datasets, as well as tools for predictive model development and deployment.

Clarifai's featured use cases on its website include metadata generation, content moderation and visual search (Clarifai, 2021b). True to the spirit of democratizing AI, its clients include not

only Fortune 500 companies, but also, academic researchers and other start-ups. Another notable observation is Clarifai's emphasis on educating clients, enabling them to participate in the creation and use of AI. For instance, it offers free webinars, including the popular *AI 101 for Developers* (Clarifai, 2021c). Clarifai also publishes free e-books, such as *The Executive's Guide to AI Platform Adoption* (Clarifai, 2021d).

1.3 Structure of the Chapter

The chapter is structured as follows. In Section 2, we provide a working definition of AI, describe its applications and what it can do within the organization that adopts it. In Section 3, we discuss democratization - examining how people understand this term, and what it means in the context of AI. Section 4 considers the mechanics - how and what an organization might democratize, as well as the potential benefits for innovation - and the challenges. Finally, we sum up the broader picture in Section 5.

2. Artificial Intelligence (AI)

2.1. What is AI?

AI is a term that is used broadly, often without clear boundaries. We focus on **narrow AI**, implementations of ML algorithms, which address "everyday" problems. It is now extensively used in a range of consumer-facing information services and media, such as Web search, recommendation engines at eCommerce sites, or home assistants. Narrow AI differs from technologies of the past, in that it mimics human cognitive abilities. However, in contrast to General AI, it mimics a narrow range of abilities, in service of specific goals. The following examples illustrate the use of narrow AI within an organizational context:

- *Natural language processing* - e.g., chatbots that can automatically respond to customers' questions at an organizational website; call screening to route a given query to appropriate staff in a call center.
- *Algorithmic decision support* - e.g., helping human resource managers screen thousands of resumes submitted for a given position; screening for medical imagery, to support diagnosis.
- *Personalization algorithms* - e.g., digital personal assistants, which can learn employees' behaviors and preferences to automate repetitive tasks; eCommerce support, which can learn a shopper's preferences, to make intelligent recommendations.

In contrast to the application of *Data Science*, which typically involves a wide variety of data types (from structured to unstructured), practices (from data collection and pre-preparation) and operations (e.g., not only statistical prediction and decision-making, but also visualization), narrow AI is focused on addressing very specific business problems and processes, using ML, as illustrated in the examples. However, like Data Science, narrow AI enables an organization to take advantage of the data it has collected (e.g., concerning people, processes, and decisions).

We consider the full spectrum of data, techniques, and practices that surround the modern ML pipeline, in our examination of the trend towards Democratizing AI. We focus on applications within the organization, which are used to extend the capabilities of people and organizational processes; technologies such as robotics, autonomous vehicles and physical smart systems are beyond the scope of our current discussion.

2.2. Harnessing the Power of AI: Opportunities and Barriers to Adoption

AI has roots going back to the 1950s. However, AI R&D has gone through rises and falls, with the falls often referred to as an “AI Winter”. In such periods, funding, interest and confidence has been reduced, to be renewed years later. Currently, substantial increase in funding, development and deployment of AI across most areas of society, and a rise in commercial use, has seen an end to prior disillusionment. In fact, some are suggesting that the environment surrounding AI development has changed so much that it is leading to a new evolutionary stage in AI, called *AI 2.0* (Pan, 2016).

The use of ML is enabling computational intelligence to pervade all areas of business and society, driving innovation and bringing about digital transformation. In short, AI is enabling the vision of the data driven era and serves as a key driver of the Fourth Industrial Revolution. What are the benefits for business, and more generally, for society? It can mean changes in the ways organizations operate and how they create and deliver services and products. AI may also be used in ways not often considered, such as Microsoft’s *AI for Earth* initiative that tackles major societal issues, such as fighting climate change, tracking police work to avoid unfair targeting of citizens, or developing standards in healthcare to reduce inequalities in outcomes between social groups (Khullar, 2019).

Major consulting firms have introduced specialized services aimed at helping organizations harness the benefits of digitally-enabled transformation of processes and services, preparing them for AI’s impact on their workforces. The challenges are numerous and typically, non-trivial, in terms of the investment and adaptation required. The authors of a report by MIT Sloan and the Boston Consulting Group (Ransbotham et al., 2017) conducted a survey with around 3,000 business executives, managers and analysts from 112 countries and across 21 industries. The results showed that more than 80% of organizations saw AI as a strategic opportunity and around 72% of respondents expected large effects from AI in five years. The key reasons cited for businesses adopting AI included:

- Allowing organizations to obtain or sustain a competitive advantage (84%)
- Allowing movement into new markets (75%)
- Because new organizations using AI will enter their market (69%)
- Because competitors will use AI (69%)
- Pressures to reduce cost will require use of AI (63%)
- Suppliers will offer AI-driven products and solutions (61%)
- Customers will ask for an AI-driven offering (59%)

Despite the opportunities, the report found that only a quarter of all organizations surveyed had adopted AI technologies in their processes, products or services. There is a clear disparity between the expectation and action of organizations: four of five executives agree that AI is a strategic opportunity; however, only one in five had incorporated AI in some manner and only one in 20 had extensively incorporated AI into their offerings or processes. In looking into the barriers that prevent businesses from utilizing AI, the report cited the following:

- Being able to recruit people with the right technical skills
- Competing priorities for investment
- Security concerns
- Cultural resistance to AI approaches
- Limited IT capability
- Lack of leadership to support AI initiatives
- Unclear or no business case for AI applications

Barriers to adoption vary across sectors and by type of organization. For example, pioneers who are leading the way in the use of AI still struggle to recruit people with the right skills. On the other hand, some organizations have no solid business case for the use of AI, as well as lack support by management. What is clear is that despite all the promises of the benefits that AI can bring, the adoption of AI represents a huge change for most organizations.

3. Democratizing AI

We now examine the trend towards Democratizing AI. We begin by considering the social science perspective on the *nature of democracy*. We then use this lens to examine the current trends in the context of AI. Finally, we discuss how democratization of AI can be facilitated.

3.1. The Nature of Democracy

Social scientists often struggle to agree on a precise definition of *democracy*. Many attempts begin with the etymology of the word, and its Greek roots (consisting of “*δήμος*” (people) and “*κράτος*” (rule)). However, in reality there are numerous models of democracy around the world, with some claiming that no two democratic systems are the same (Council of Europe, 2017).

Despite this, members of the public have a relatively shared understanding of the core elements of democracy (Dalton et al., 2007). In a study that analyzed survey data collected across 49 nations, representing significant political and cultural diversity, researchers discovered three elements of the laypersons’ view of democracy.

	Political democracy	AI democracy	Related initiatives
1. Freedoms and liberties	The essential goals of democracy, which should be to protect individual rights, including freedom of speech.	Applications of AI should behave in a way that respects human rights and human agency.	Trustworthy AI FATE in AI
2. Institutions and procedures	The means to achieve the above goals. In a democracy, citizen participation is fundamental. Processes include rule by the people, free elections, majority rule, open and accountable government.	The participation of a range of stakeholders should be prioritized in the design, development and use of AI technology.	Democratizing AI
3. Social benefits	Ensuring the general welfare of all citizens, though e.g., provision of services. Some views emphasize that unless people's needs are met, democracy is meaningless.	The potentials of AI for social and economic benefits should be accessible to all.	AI for Social Good Human-Centered AI

Table 1: Relating the elements of democracy in a socio-political sense, to the context of AI.

In a democracy, *freedoms and liberties* should be protected, such as the right to speak freely. In other words, this first element consists of the essential goals of a political democracy. In contrast, the second element consists of the *institutions and procedures*, which are necessary to achieve the goals of freedom and liberty. Here, citizen participation is stressed; all citizens should enjoy representation in an open and accountable government. Finally, the third element of democracy consists of the *social benefits* that citizens expect to receive from a democratic state. Here, there is also the notion that unless basic needs are met, democracy will be meaningless and difficult to sustain.

We also apply each element of democracy to the case of AI, to explore what an “AI democracy” might mean. Taking the first element, we arrive at the notion that AI should behave in a manner that is consistent with human rights and agency. With respect to institutions and procedures, an AI democracy would prioritize stakeholder participation in the design, development and application of AI. Finally, the benefits brought about through digital transformation should be accessible to all. Again, this is what we might envision for an AI democracy if we extrapolate from theory; given the known challenges of AI adoption, the reality is likely to differ.

The last column of Table 1 details related initiatives. The belief that AI should be developed and used in a manner that respects human rights, is reflected in current initiatives; here, we mention but a few. *Trustworthy AI*, as envisioned by the EC, is AI that is lawful, ethical and robust from a

technical and social point of view (European Commission, 2019). These systems are trustworthy because they respect human freedoms and diversity. There are now many research communities working in the area of FATE (fairness, accountability, transparency and ethics) in AI. For instance, the Association for Computing Machinery's FAccT (ACM FAccT, 2021) brings together researchers and practitioners not only from the computer and information sciences, but also, law, the social sciences as humanities, to promote the development of more ethical socio-technical systems. Furthermore, Microsoft's FATE group (Microsoft, 2021b) is an example of the growing number of research groups that place human values and freedoms at the heart of R&D efforts.

Facilitating access to participation in the design, development and use of AI, is the primary concern of the Democratization of AI. This area is directly related to the second element of democracy, as it concerns the means of achieving positive outcomes and benefits. One challenge is that not everyone wants to participate in AI in the same way. Likewise, not everyone (individuals, organizations, or even nations) has the same level of "AI readiness."

Finally, initiatives such as "AI for Social Good" (Tomašev et al., 2020) and "Human-Centered AI" (Stanford University, 2021) are aligned with the third element of democracy. AI for Social Good concerns the *application* of AI to problems of major concern to humanity. Thus, a focus is on creating teams that have significant ML, as well as domain, expertise. Many working in this area focus on solving problems related to the United Nations' Sustainable Development Goals (United Nations, 2021).

3.2. Big Tech's Role in Democratizing AI

Democratizing AI depends in large part on the efforts of tech giants. Over the years, the big tech industry has been accumulating the key resources necessary for developing state-of-the-art AI; beyond datasets and computing power, they also have been accumulating top talent. According to the Stanford AI Index Report for 2019, industry hired over 60% of all PhD graduates in 2018 (Perrault, 2019). Similarly, AI professors are increasingly leaving academia for industry (Metz, 2019). Many tech giants have emphasized the democratization of AI, but what do they mean?

Table 2 analyzes a sample of statements by four large companies. What can be observed is that, from their perspective, Democratizing AI is primarily about providing people and organizations with AI capabilities, through computing platforms, tools, and services. In other words, big tech initiatives relate to the second element of democracy - the institutions and procedures that allow participation in AI.

Amazon	<p>“...AI ML is still in the very, very early days, sort of tying yourself to one particular framework as an organization or an enterprise or a startup, etc. may not be the best thing to do. We have what we call AI services, which are a set of capabilities that allows an organization to take advantage of AI/ML, without knowing much about AI/ML. We are trying to democratize AI.”</p> <p>(Madhusudan Shekar, Head, Digital Innovation, Amazon Internet Services) quoted in (Srikanth, 2019)</p>
Google	<p>“AI is empowerment, and we want to democratize that power for everyone and every business—from retail to agriculture, education to healthcare. AI is no longer a niche in the tech world—it's the differentiator for businesses in every industry. And we're committed to delivering the tools that will revolutionize them.”</p> <p>(Fei-Fei Li, Chief Scientist, Google AI) (Li, 2018)</p>
IBM	<p>“Data is what fuels digital transformation, AI unlocks the value of that data, and hybrid multicloud is the platform to democratize the data.” (IBM, 2021)</p>
Microsoft	<p>“For every person and every organization.”</p> <p>“We're building the world's most powerful AI supercomputer and making it available to anyone, via the cloud, to enable all to harness its power and tackle AI challenges, large and small.” (Microsoft, 2021a)</p>

Table 2: Four Big Tech companies' statements on Democratizing AI.

Big tech companies are clearly in a position to provide technologies that support the democratization of AI. In addition, there is an academic discourse on Democratizing AI. For instance, some researchers have envisioned a new paradigm for AI R&D, in which the public's participation will be facilitated (Moreau et al., 2019). This specific proposal advocates using natural language technologies as a means to encourage the participation of the public, given that language is a natural means of interaction for most human adults. Other researchers have focused on developing tools to support the democratization process, emphasizing education and training for the public (Van Brummelen, 2019).

The academic efforts towards democratizing AI are happening on a smaller scale as compared to the efforts of the big tech companies. In this sense, we might draw parallels between the big tech companies and the utility companies. Like the water or electricity companies of a given region, the big tech companies are positioned to provide the basic resources needed by others to facilitate - on a large scale - the development, deployment and use of innovative social and business solutions.

3.3 Democratization in Practice

Next, we examine the more practical aspects of the Democratization of AI. There is no “one size fits all” approach for an organization interested in democratizing its AI. In fact, democratizing AI has been described as a spectrum (Rao, 2020). At one end, an organization may simply provide

open access to datasets. However, various resources may be democratized, which require different levels of sophistication and time to implement, as described in Table 3.

What an organization can democratize also depends on who their target users are. For instance, casual users, who do not have a technical background related to ML, may seek to answer questions through simple data analyses and visualizations, facilitated by the democratization of data and computing. In contrast, more technical users, who have some programming skills and an interest in modeling, might also take advantage of algorithms. However, only expert users would be likely to benefit from the services at the farther end of the spectrum. Thus, democratization depends not only on the assets that an organization is willing to share, but also the profile of the potential consumers and/or contributors they wish to serve.

	Description	Examples
Data	Providing access to datasets; providing a means to explore and visualize data	Smart Devon's COVID-19 dashboard, implemented with Microsoft Power BI Data sharing and access to open and public datasets (e.g., UCI ML repository, data.gov.uk).
Computing and storage	Providing access to computing infrastructure and storage	Amazon Web Service's on-demand cloud computing services, featuring 175+ services, including computing, storage, networking, database, analytics, IoT tools, etc. Google's Tensor Processing Unit (TPU) and NVIDIA's DGX-1 offer powerful hardware built specifically for machine learning.
Algorithms	Facilitating the use and / or development of ML algorithms, including deep learning	Google's Tensorflow, Amazon's Sagemaker Neo, Theano, Keras, H2O.ai, Uber's Ludwig, spaCy, Apache Spark and MLib, PyTorch. Ready-to-use Cognitive Services.
Model development	Facilitating the end-to-end model development process, including training, development and testing, and deployment	Automated ML (AutoML), self-service analytics and ML (e.g. Azure ML, Data Robot)

Marketplace	Providing access to a full range of services for the use, exchange and monetization of ML components (data, algorithms, models) and their outcomes	Kaggle, Algorithmia, Microsoft Azure ML Community,
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Table 3: Examples of AI-related resources that can be democratized, in increasing order of sophistication.

The spectrum in Table 3 starts with access to the raw material required to train intelligent systems and drive transformation - data. Historically, it was only the large companies or academics who had access to large datasets. However, there are multitudes of datasets representing all kinds of problems now available for experimentation, training machine learning and education purposes (see Table 4). This has in part been driven by the requirements of public research funding to (where possible) make data publicly available and shared widely.

Type	Description	Example Resources
Repositories	Curated training datasets to facilitate various machine learning tasks. Primarily of interest to researchers and ML practitioners.	UCI Machine Learning repository: https://archive.ics.uci.edu/ml/datasets.php
		Kaggle datasets: https://www.kaggle.com/datasets
		BigML datasets: https://bigml.com/gallery/datasets
		OpenML: https://www.openml.org/
		Awesome datasets on GitHub: https://GitHub.com/awesomedata/awesome-public-datasets
Government data	Open Data released by governments, to facilitate transparency but also reuse. Of interest to various stakeholders (citizens, developers, analysts).	UK Government open data: https://data.gov.uk/
		US Government open data: https://www.data.gov/
Dataset search engines	Search engine specific designed to enable people to locate existing datasets. Primarily of interest to researchers, analysts and ML practitioners.	Google Dataset search: https://toolbox.google.com/datasetsearch
		DataCite search engine: https://search.datacite.org/

Table 4: Example available data - repositories or collections, open public data and dataset search engines.

However, it is more than just access to data that is enabling the democratization of AI. Big tech companies are providing access to on-demand computing and storage services via the cloud, e.g., Amazon Web Services (AWS), Google Cloud Platform and Microsoft Azure. This alleviates the need for individuals and companies to develop and manage their own infrastructure, which is costly and requires specialist skills, and instead provides flexible, affordable and state-of-the-art compute resources and AI services. In addition, complex algorithms and tasks can require vast amounts of computing power that go way beyond the capabilities of traditional hardware devices. Specialist chipsets for ML tasks, such as Google's Tensor Processing Unit (TPU) and NVIDIA's DGX-1, have become more affordable and readily available.

In addition to computing infrastructure, access to state-of-the-art frameworks for machine learning, especially the development of neural models, has been critical in democratizing AI. The open sourcing by big tech companies is driving innovation, as anyone can instantly access the capabilities of tools that have been developed through decades of R&D. Some of the most notable open source frameworks include Google's TensorFlow, Amazon's MXNet and Facebook's Torch. These are providing standardization for ML development and in addition, being open source allows organizations to develop and sell their own applications built upon them. Many of these frameworks are powering AI applications used by millions of users and therefore represent a level of maturity and production-readiness that is typically far beyond most open source software.

Next in the spectrum of Table 3 comes model development. There has been a rapid rise in the availability of self-service applications for developing AI applications, often aimed at the "citizen data scientist" or non-expert user. Many of these applications provide drag-and-drop frameworks making AI development possible for those without specialized training. For example, DataRobot² provides a platform for analytics and ML. As a part of Microsoft's Azure Machine Learning offering, the Designer interface offers access to the required components and resources to develop and deploy ML applications through a simple graphical user interface where ML pipelines can be easily created and deployed. Amazon and Google have also rolled out similar platforms. These are all built on top of powerful and scalable compute infrastructure that make developing applications at (Big Data) scale possible, even by those with limited data science expertise.

Last in Table 3 comes marketplace - access for everyone to the full range of services for use and exchange and, where applicable, monetization of ML components. Examples of such marketplaces might include Kaggle³, which provides organizations with a way of eliciting the input from Data Scientists to tackle problems in the context of a competition. Kaggle also provides a marketplace for sharing expertise and ideas, as well as a repository for datasets and

² <https://www.datarobot.com/>

³ <https://www.kaggle.com/>

codebases. Other marketplaces, such as Algorithmia⁴, allow one to search for and download algorithms for specific purposes, e.g., face recognition. As many companies might not have the required scientific expertise in-house then access to such marketplaces allows buying in solutions. Even with in-house expertise, purchasing solutions or components can substantially speed up the development process.

The result of all this is that the world of AI and ML is no longer restricted to the echelons of academia and corporate research centers, but is now accessible to everyone. In addition to the aspects shown in Table 3, a recent study (Di Fiori, 2018) suggests that decision-making authority must also be democratized - from leadership positions to nearly every employee within a company. This will be the only way that intelligence can actually make a difference: if it is applied at the right time, which often arrives faster than a board can enact a decision.

3.4 Realizing the Broader Democratization of AI

One conclusion is that the Democratization of AI to date, maps neatly onto one of the three elements of a socio-political democracy. The current movement primarily emphasizes the provision of the infrastructure and means that people need to participate in the creation and use of AI. Here, we consider what might be required to fully realize the democratization of AI, considering all three elements of a democracy.

3.4.1 Protecting Human Freedoms and Liberties

The key outcome from a political democracy is the *protection of human freedoms and liberties*. As presented in Table 1, while there are other initiatives that are closely related to this goal, these are still somewhat disjoint from the efforts towards democratizing AI. It is worth noting that some legislation at the intergovernmental level relates to this first element of democracy. For instance, the European Union's Right to be Forgotten, and more recently, the General Data Protection Regulation, aim to protect the rights of individuals from potentially harmful behaviors of algorithmic processes.

At a *national level*, many countries have published strategies for AI. The Organisation for Economic Co-operation and Development's AI Policy Observatory maintains a list of national policies and other stakeholder initiatives.⁵ Ethical principles that guide a nation's development and use of AI are typically articulated in these policy documents, although not the technical and social mechanisms for protecting human rights. There has also been the establishment of independent bodies, such as the Algorithmic Justice League⁶, a movement that seeks to raise awareness about the impacts of AI, and the AI Now Institute⁷ - a research institute studying the social implications of AI.

⁴ <https://algorithmia.com/>

⁵ <https://oecd.ai/countries-and-initiatives>

⁶ <https://www.ajl.org/>

⁷ <https://ainowinstitute.org/>

The National AI Strategic Vision for Greece (Ziouvelou et al., 2020), is an interesting case, in that it focuses specifically on the Democratization of AI. The document explains that Greece aims to innovate on the core European values and moral ideals of democracy. It then lays out four key enablers: data infrastructures, supporting infrastructures, funding and investment, and culture. Noting that in addition to being a political process, democracy is also a system of fundamental rights, the strategy places the protection of human rights and freedoms at its core.

3.4.2 Social and Economic Benefits

People anticipate *social and economic benefits* from democracy; they expect that their basic needs will be met. Thus, one can reflect upon how such benefits could also be provided in an AI democracy. From the analysis presented, one might pose the following question: in an AI democracy, who are the citizens? Do we observe different classes of citizens?

While the democratization of AI focuses on enabling people to participate in AI, this does not mean that everyone necessarily wants to participate fully. Just as in a political democracy, some citizens are less engaged, and some may even be apathetic. As the adoption of AI spreads, leaders - at the organizational, national, and international levels - must take steps to ensure that AI is indeed used to benefit everyone. Initiatives such as AI for Good, which aims to apply AI to the 17 Sustainable Development Goals put forward by the United Nations, will become increasingly important. Unless people see that AI is being used for the common good, they might become disenchanted with the AI democracy.

4. The Democratization of AI and Innovation

We now return to the examples introduced in Section 1. In revisiting them, we consider the following questions: i) What is being democratized, and for whom? ii) What are the potential benefits for social and/or business innovation? iii) What are the potential risks? iv) Is the example primarily about tools and procedures, or are other elements of democracy emphasized?

4.1 Smarter Devon

The Smarter Devon initiative is primarily focused on democratizing data and analytics, in service of decision-making for the public good. The stakeholders taken into consideration include information technology personnel within Devon County Council, decision-makers and those involved in policy-making, and finally, members of the public - individuals and other organizations. Through the Smarter Devon project and other initiatives, significant effort is going into developing the technical foundations and processes to effectively manage and govern data, for example, centralizing data collection and management, having effective data access protocols in place, cataloguing data sources and assessing data quality.

While Smarter Devon incorporates some automation into its data collection and curation processes, the widespread use (and subsequent democratization) of AI has not been fully

realized. The current focus is on facilitating access to data both within the organization (i.e., between departments, which may be responsible for different operations, but for whom sharing relevant data can be beneficial) and with those outside the organization. It has adopted open data practices; for instance, standardized and anonymized datasets are offered via the Council's GitHub, engaging developers and/or analysts who have the relevant technical skills.

For citizens more generally, who may or may not have a technical background, the Council's website enables interaction with public data. For instance, its COVID-19 dashboard⁸, built with Microsoft's Power BI, features statistics of interest, but also allows the user to visualize trends over time and geographical area. The Council also organizes educational lectures and workshops, as a means of engagement but also in an effort to work towards data maturity in the broader community.

Smarter Devon is an initiative that uses data democratization for social innovation. At its heart is the provision of the necessary data and infrastructure, leading the community's decision-makers to exercise "evidence-led authority." However, with its use of data visualization tools, coupled by public education initiatives, Smarter Devon is also focused on explanation and storytelling - it aims to raise awareness of the trends surrounding the operations and services of the areas served by the Council. Finally, the risks of the Council's current democratization strategies are minimal. To date, the focus is on sharing open data, placing emphasis on personal data protection. Despite the many practical and financial challenges faced within local government, the work within Devon County Council demonstrates many elements of successful digital transformation and innovative practice.

4.2 Democratizing AI in Healthcare - Reusable Models in Diagnostic Radiology

There is excitement surrounding the use of algorithmic support for diagnostic medical imagery, given the capabilities of deep learning. The particular example introduced concerns the adoption of transfer learning in the creation of predictive diagnostic models. This is an interesting case, as what is actually being democratized is the algorithm, although the barrier that this solution addresses is that of data.

As reported in (Gupta et al., 2020), as compared to general computer vision models, which detect "everyday objects" in an input image, greater expertise is required to generate a corpus of radiological images, for the purpose of training algorithmic models. Indeed, general-purpose datasets, such as ImageNet, often recruit crowdworkers, who typically do not have specialized training, to annotate images (Su et al., 2012), a strategy that clearly cannot be employed in diagnostic imaging. Further complicating matters, institutions may use different imaging equipment and tools that do not lend themselves to curating a training dataset.

With the use of transfer learning, an institution may take advantage of a pre-trained model, provided by another institution. Using this technique, an analyst does not initiate the training

⁸ <https://www.devon.gov.uk/coronavirus-advice-in-devon/coronavirus-data/>

process from a random point, but rather, starts with the weights of a previous model. Thus, transfer learning can be used by specialists (i.e., stakeholders with specialist ML training) to bring about several potential benefits for the organization. First, the amount of required training data is significantly reduced, saving time and expense. However, another added benefit is that the local institution can participate in the model training process. It can incorporate the data collected locally (i.e., from its own patients) into the processes of training and testing the model.

One potential risk of this approach is that, while in transfer learning, a previously-trained model is shared for reuse, the process is still opaque. Deep learning techniques more generally, are black boxes - they cannot be easily interpreted by users. Thus, institutions must take extra caution in this high-stakes domain.

4.3 Clarifai - Democratizing AI in Software Development

Clarifai provides a range of services that support the AI lifecycle. Its target users are power users (e.g., developers, who have solid programming skills, but not necessarily ML expertise), as well as specialist developers trained in ML. Clarifai democratizes algorithms, facilitating the use of its own models as well as the training and development of custom models.

Clarifai's services allow developers and analysts to create innovative products and services themselves, without having to invest heavily in the infrastructure or human resources required to exploit state-of-the-art computer vision techniques. Given its solid performance and ease of use, Clarifai's image tagging services have also become popular with socio-technical researchers, many of whom want to study human communication behaviors within social media and the Web on a large scale (Kyriakou et al., 2019).

Clarifai's services are also based on deep learning; thus, one issue is the lack of interpretability of the models. Particularly when analyzing images of people, computer vision is known to display socially biased behaviors; for instance, they are more prone to error on recognizing the gender of people of color, as compared to whites, and may produce output promoting stereotypes (Barlas et al., 2021). For developers who may be using the pre-trained models and/or do not have training in ML, this could present serious ethical and liability issues.

5. Conclusion

Figure 1 summarizes the broader democratization of AI, from theory to practice. The theory provides the key elements of democracy that must be considered as we move forward; however, theory alone is not enough. Much of the existing focus has been on what to democratize and how. This has certainly helped to bring AI into the hands of more people and beyond the privileged few. However, realizing democratization also involves careful thinking about the following - leadership, strategy and governance; ethics; education of stakeholders; and promoting AI for good.

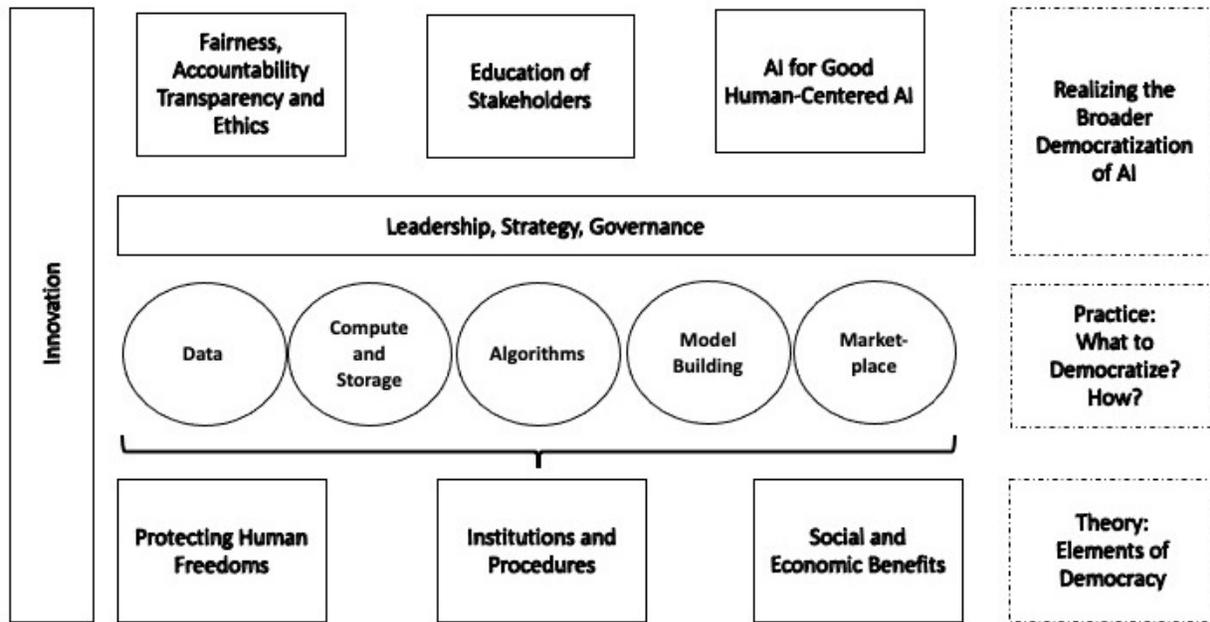


Figure 1: Realizing the broader democratization of AI.

Leadership needs to be data and AI literate to successfully utilize AI technologies. Organizations and governments need to develop effective strategies that align with other strategic plans (e.g., data strategies and organizational goals) and provide clear guidance on the use of AI. Consideration must be given to the governance of AI and appropriate access to data. Although the desire to give everyone access to data is appealing in theory, the reality is that it will not always be appropriate for everyone to have access to all data (even with suitable levels of obfuscation). Leadership must also develop effective methods of change management for introducing AI technologies and practices into the organization to ensure the right cultural fit and integration into legacy systems, processes and workplaces.

Recent attention is being given to the aspects of AI centred around ethics and transparency; such efforts have demonstrated that just because we can solve tasks using AI doesn't always imply that we should. This requires the establishment of appropriate bodies to regulate and govern AI. For example, in the UK, the Centre of Data Ethics and Innovation (CEDI) was created in 2019. CEDI is an independent expert committee, led by a board of specialists, set up and tasked by the government to advise on maximizing the benefits of new technologies, such as AI. In the US, bodies such as the Algorithmic Justice League and AI Now are monitoring the use of AI and its impact on society, raising awareness of potential harms, and providing a mechanism whereby citizens can raise cases of inequalities produced by AI technologies.

Providing everyone with access to AI tools and technologies is certainly a key element of democratization; however, this must be accompanied by appropriate education and training. This goes beyond simply knowing how to use tools and encompasses learning elements of theory and practice. Effective communication to stakeholders with diverse backgrounds and needs will also be necessary to ensure people are able to understand concepts and ensure that

good practices are developed and followed. Providing resources through open access will help to reduce barriers and more equitable access to knowledge.

As well as the business benefits, democratization should also result in social and economic benefits. Having a human-centred approach to AI will ensure that developments and use are not driven by technology vendors, but rather, are focused on people and society. Looking at applications of AI that address major global challenges facing society will benefit those most in need, and also ensure that everyone can benefit from today's digital transformation. The result of this will be innovation: in developing new AI technologies, applications and services to being able to innovate in creating new ways of managing and realizing the true potential of AI in society.

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