NATIONAL SPACE COUNCIL

USERS' ADVISORY GROUP

Space Data Ethics: The Next Frontier in Responsible Leadership

National Space Council Users' Advisory Group
Climate and Societal Benefits Subcommittee

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Recommendation on Space Data Ethics

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1. Purpose

This is a position paper in support of a recommendation to develop the principles of space data ethics, to be presented to the U.S. National Space Council (NSpC) at its next meeting by its Users' Advisory Group (UAG) subcommittee for climate and societal benefits.

Space data ethics is different from existing data ethics in its various forms, which include business-data ethics (e.g., protecting privacy[1]), research ethics (e.g., against falsifying data[2]), Artificial Intelligence (AI) ethics (e.g., guarding against machine-learned bias[3]), open-data ethics (e.g., for citizen science[4]), and others.

For instance, Earth Observation (EO) data from space doesn't typically raise the same concerns about individual privacy and harms that are central to data ethics, though in some cases it could (e.g., whether to reveal the location of uncontacted, indigenous tribes[5] in the Amazon, or other sensitive or competitive location-based data). Instead, space data ethics may both overlap *and* conflict with the various forms of existing data ethics given the wide-ranging applications of space data, from science to national security and more, as well as associated questions, such as data ownership and control.

To handle and share *space* data responsibly, work is urgently needed to **anticipate the possible harms**—which may be different from ordinary data-ethics failures—and **develop a new ethics framework specifically for space data**. To the best of our knowledge, no one else has identified or framed the problem this way or is conducting such a study, so this is a real opportunity to demonstrate responsible leadership.

This position paper only begins to lay out the justification for our recommendation and is *not a comprehensive discussion* itself, which would be part of the investigation recommended by the NSpC UAG subcommittee on climate and societal benefits.

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[1] https://hbr.org/2023/07/the-ethics-of-managing-peoples-data
[2] https://www.newyorker.com/magazine/2023/10/09/they-studied-dishonesty-was-their-work-a-lie
[3] https://www.whitehouse.gov/briefing-room/statements-releases/2023/07/21/fact-sheet-biden-harris-administration-secures-voluntary-commitments-from-leading-artificial-intelligence-companies-to-manage-the-risks-posed-by-ai/
[4] https://www.frontiersin.org/articles/10.3389/fclim.2021.637037/full
[5] https://www.smithsonianmag.com/smart-news/should-we-use-satellites-keep-eye-remote-amazonian-tribes-180953240/

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2. What is the problem?

Data is information, and information is power—and this power can be wielded responsibly or not. Power (and data) can also be shared equitably or hoarded. For nearly every week in the last 5-10 years, a curious researcher can find news reports about the **harms** that can arise from not attending to **data ethics**, such as AI bias in hiring or criminal sentencing. These are real problems that affect real lives.

But the principles and frameworks developed for data ethics, as generally understood now, appear ill-suited to guide our practices with respect to *space data*: information collected from various sources in outer space, such as satellites, telescopes, space probes, and so on; see section 3 for more detail. Space data, then, is typically a different, broader sort of data than what "regular" data ethics generally aims to oversee. **Therefore, "space data ethics" needs to be urgently studied as a novel or emerging domain, to ensure the U.S. and others are acting responsibly with space data.**

For instance, in data ethics, *data minimization* is a best practice, from collection to sharing to storage; this is meant to protect the privacy and sensitive personal information of individuals, among other reasons. While there still may be personal privacy concerns with some space data—such as communications intercepts and sensitive location or business data—for EO and other data, there may be good reason to *maximize* collection, especially if researchers don't know what they can learn from it (because it's a frontier of science) or what data they'll need in the future (e.g., to address climate change in new ways, or to leverage new technologies that become accessible).

As one more example, much of space data is also inherently *dual-use* in ways that "regular data" is usually not. For instance, tracking wildfire smoke from Canada across the U.S. can help forecast air quality and alert people to take precautions, in addition to better understanding weather patterns. But that information can also be weaponized by adversaries who want to know where to, say, strategically start the next wildfire (or release an airborne pathogen, or even detonate a nuclear bomb) *outside* of a target state's territory as an *indirect* attack with plausible deniability.

Less dramatically, business competitors can also weaponize data, capitalizing on asymmetric access. For instance, satellites are very useful in farm management, but that collected data isn't necessarily available to the farmer who often is *not* the owner of the land; yet third parties with greater resources could access that data to buy the land from under the famer.

If the U.S. wants to maintain its leadership in space affairs—including having the **moral authority** to attract, lead, and inspire allies—it must be careful and responsible in how it handles *space* data, just as it strives to do with personal data about its own citizens. But

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this will be problematic without first knowing what principles govern *space* data ethics, which already appear distinct from existing data ethics.

Indeed, the U.S. State Department has recently been promoting "**space data for the greater good of humanity**"[6], but what that means exactly is under-specified and bound to be controversial inasmuch as not all stakeholders will agree on what the "greater good" is. This is a similar problem as efforts in artificial intelligence that seek to promote "AI for humanity" or "AI for good" or "AI for people": which people? who gets to decide what the greater good is? who might the losers be here, i.e., what are the tradeoffs? As they say, the devil is in the details.

So, it's critical to quickly **fill that gap** by developing the principles and framework for space data ethics, since staggering amounts of space data are being captured and shared every day—data that is vital for science, agriculture, climate studies, commerce, civil society, national security, diplomacy, and more.

3. Why is data ethics important?

As the world is increasingly driven by data and technology, **data ethics**—or the ethical collection, processing, use, sharing, control, and storage of data—is essential, along with cybersecurity. For instance, in its various existing forms, data ethics[7] helps to safeguard individual privacy, promote fairness and equity, build trust and confidence, comply with laws and regulation, and much more.

This is more than about the accuracy and quality of the data, which clearly are essential, but it's also about *how that data is used and handled*. Not attending to data ethics has led to high-profile abuses and real-world harm to people (e.g., in biased decisions on hiring[8], bank lending[9], and criminal sentencing[10]), organizations (e.g., reputational

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[6] https://www.state.gov/the-i2u2-group-announces-joint-space-venture/
[7] https://www.scu.edu/ethics/focus-areas/technology-ethics/resources/an-introduction-to-data-ethics/
[8] https://www.reuters.com/article/us-amazon-com-jobs-automation-insight-idUSKCN1MK08G
[9] https://www.cnbc.com/2023/06/23/ai-has-a-discrimination-problem-in-banking-that-can-be-devastating.html
[10] https://www.propublica.org/article/machine-bias-risk-assessments-in-criminal-sentencing

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harm[11], loss of customers[12], decreasing employee morale[13]), and perhaps to democracy itself (e.g., Cambridge Analytica scandal[14]).

In 2023, the Hollywood strikes[15] were ultimately about the fair and responsible use of data, whether it's about the control of and reasonable compensation for actors' biometric data (e.g., to create AI versions of the actors that will work for free) or whether AI writers and their large language models were trained on ethically sourced data (e.g., without violating anyone's intellectual property rights).

In general, ethics promotes the things we humans care about: our well-being, values, principled decisions, integrity, accountability, fairness, justice, social cohesion, sustainability, and so on. Ethics, for instance, is the difference between a professional military and mercenaries. *Data* ethics, then, helps to promote the things we care about with respect to the digital fingerprints and footprints we inescapably leave behind in the online world but also offline, e.g., as captured by cameras, sensors, microphones, and other technologies embedded around us.

4. What is *space* data, and how is it different from other data?

"Space data" refers to the information collected from various sources in outer space, such as satellites, telescopes, space probes, and other such instruments. This includes satellite imagery, remote-sensing data, astronomical data, space weather data, space-based navigation and communications data, planetary exploration ethics (as distinct from the study of Earth), and more. The applications for space data are far-ranging and include scientific knowledge, environmental monitoring, agriculture, disaster response, mapping, urban planning, military planning, and so on.

Already, key differences can be seen between space data and "regular data" or the everyday kind of data that's collected by businesses and other organizations, which more typically tracks *individual* behavior and characteristics, and which is the kind of data that "traditional" or existing data ethics (i.e., data ethics as we generally know it now, in its various forms) seeks to govern.

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[11] https://cmr.berkeley.edu/2022/01/the-reputational-risks-of-ai
[12] https://www.informationweek.com/big-data/the-cost-of-ai-bias-lower-revenue-lost-customers
[13] https://www.fastcompany.com/90762918/ai-can-hurt-worker-morale-when-managers-dont-have-these-specific-skills
[14] https://www.reuters.com/legal/facebook-parent-meta-pay-725-mln-settle-lawsuit-relating-cambridge-analytica-2022-12-23/
[15] https://apnews.com/article/artificial-intelligence-hollywood-strikes-explained-writers-actors-e872bd63ab52c3ea9f7d6e825240a202

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While space data can be about individual people—such as satellite surveillance that follows a suspected terrorist and intercepts his space-enabled communications, or to help a particular farmer manage the land more productively with precision agriculture—it's generally easier, less expensive, and better (e.g., higher-resolution) to track individuals with technologies on Earth, such as ordinary mobile phones, internet click-histories, and surveillance cameras. Space data, then, is more often about *phenomena at a broader scale*, such as monitoring water levels, forest fires, migration patterns, traffic congestion, areas of interest on land or sea, military troop movements, and so on.

5. Is existing data ethics enough for *space* data ethics?

If "regular data" is generally different from space data—e.g., they may have different data subjects, different purposes, and different risks—then it makes sense that data ethics aimed at regular data may *not* be capable of addressing the unique or different considerations associated with space data more broadly.

As it's understood today in its various forms, data ethics is generally aimed at protecting the human subjects about which data is collected—which means that data ethics tends to prioritize protection of the autonomy, privacy, and other interests of individuals, especially as failing to protect these things can result in serious harm or worse to people. In contrast, space data isn't nearly as focused on individuals (though it sometimes can be) or even people in general, which again can be better tracked by Earth-based data sources. So, there is a difference in the **subjects of data collection** between a typical data ethics framework and space data ethics. (Where space data implicates personal and sensitive data of individuals or their property, a typical data ethics framework could still apply.)

Therefore, the **purposes** or **uses** of data are also generally different between data ethics in general and space data ethics, as are the **interests at stake**. For instance, online browsing data is commonly used for targeted advertising and recommender algorithms (e.g., Netflix, YouTube, Spotify, Amazon, etc.), while space data is more often used for scientific, national security, land-use management, and other purposes. Commercial purposes raise a special challenge in as much as a profit-motive can conflict with ethical values, which is a primary concern of data ethics in general.

Of course, space data can also be used for advertising and other commercial purposes (e.g., weather-based marketing[16]), but again it's more often about things of other

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[16] https://www.ibm.com/watson-advertising/thought-leadership/complete-guide-weather-triggered-advertising

economic interest, such as natural resources, crop yields, weather forecasts, and other things that directly or indirectly affect business. Thus, space data ethics likely does not have such an emphasis on protecting individual subjects (e.g., with EO data, where the data isn't so much about individuals) and so will be motivated by different principles and priorities.

The **risks** are likewise different between the two. Where data ethics in general is designed to guard against harm to individuals—especially with respect to privacy, autonomy, and discrimination—space data isn't typically about individuals and thus not aimed at the same kind of risks. But there is real risk with space data, particularly if much of space data is *inherently dual-use*. For instance, weather tracking and predictions can help farmers, first-responders, and other people plan for their future; but could that data also be exploited for politics (e.g., in strategically timing a military attack) and for profit (e.g., information asymmetry in water/land negotiations, as well as in competition among farmers and landowners)? Refugee migration patterns, as seen from space[17], can help with coordinating humanitarian efforts; but is it really a good idea to make all such data open and accessible, even to authoritarian governments seeking to persecute the same refugees (or political enemies on the run)?

Moreover, insofar as data of any kind is increasingly processed by **AI or machine learning**, there will exist a risk of misclassification with *all* such data, given technological limits. For instance, in AI data ethics, mislabeling a person as a "high-risk offender" or "high-risk borrower" based on factors indirectly correlated with race or ethnicity could seriously disadvantage the individual or worse. In space ethics, mislabeling Earth observations can similarly create unwarranted bias to harmful effects, e.g., mislabeling a populated area as a "slum" or "refugee camp" could cause it to be unduly stigmatized and even targeted for eradication. Still, the risks appear to be of different kinds, even if both are caused by AI misclassification.

6. What are examples of the tension between the two ethical regimes?

As starting examples of how the differences can manifest between data ethics and space data ethics:

A key principle in data ethics is to **minimize data collection**[18] to only what is needed for an intended and legitimate purpose, such as to recommend movies and other content to digital consumers. For that purpose, the data collector doesn't need to collect, say, social

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[17] https://www.migrationdataportal.org/data-sources/satellite-data
[18] https://gdpr-info.eu/art-5-gdpr/

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security numbers or other sensitive personal information to achieve the intended goal; nor should it seek out intimate details of a person's life, such as sexual preferences and partners, especially if the data subject had not consented to it or if the data isn't very relevant to a purpose. Over-collecting data not only puts such sensitive details of one's life at unnecessary risk of a data leak or breach—which could then be used against the person or in identity theft—but it also could violate reasonable privacy expectations and harm human dignity.

But in space data ethics, insofar as much of the data could be for the promotion of knowledge and science, researchers don't know what they don't know and therefore what kinds of data they should collect in order to know; so, there is a plausible justification to *over-collect* space data in the hopes of finding something useful in there. Such data-fishing expeditions about the natural world may be reasonable in the pursuit of new knowledge, but much harder to defend when it's about personal and location data of human subjects. Still, there may be reason to limit space data collection, such as to conserve computing energy and storage given the massive amounts of data that's generated every minute. Some space data could still raise privacy concerns both for individuals and at scale for certain groups, such as indigenous tribes that haven't consented to being monitored or refugee camps that are politically vulnerable.

Another related principle in data ethics is to **minimize data sharing**[19] to only the legitimate parties that need the data, or at least with enough transparency to the data subjects for their informed consent. This helps to install a firewall to limit the damage in case an organization's data about users/customers is stolen or accessed without authorization; if an organization isn't holding on to sensitive or unnecessary personal data of its users/customers, then that data can't be stolen.
But in space data ethics, insofar as much of the data's use is for humanitarian or socially beneficial purposes—e.g., improving crop yields, forecasting weather, monitoring disasters—it seems that data sharing can help to accelerate or spread those benefits: sharing is caring. Indeed, the (non-legally binding) 1986 United Nations General Assembly resolution "Principles Relating to Remote Sensing of the Earth from Outer Space"[20] encourages maximal data sharing among nations; for instance, a State with a remote-sensing program "shall, moreover, make available any other relevant information to the **greatest extent feasible and practicable** to any other State, particularly any developing country that is affected by the program, at its request" (emphasis added.)

Further, in the emerging domain of space ethics, benefit-sharing[21] is recognized as an important value and practice, especially among nations for the sake of diplomacy and

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[19] https://www.whitehouse.gov/ostp/ai-bill-of-rights/data-privacy-2/
[20] https://www.unoosa.org/oosa/en/ourwork/spacelaw/principles/remote-sensing-principles.html
[21] https://www.unoosa.org/oosa/en/ourwork/spacelaw/principles/space-benefits-declaration.html

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more, even if it's currently unclear how exactly that benefit-sharing should work. But there are dual-use and other risks associated with **open** space data that is broadly accessible globally. For instance, if made open-sourced, data about the Moon, asteroids, and other planets could prematurely open the floodgates for the next "gold rush" before it can be managed to avoid indiscriminate, wholesale exploitation and irreversible damage. Likewise, data about new archeological sites on Earth (e.g., "lost cities"[22]) could invite tomb raiders and tourists to exploit those sites before they can be properly secured.

And just because space data may be open doesn't mean everyone will have **equal access** to it or equal capabilities in understanding the data, and this information asymmetry can put vulnerable stakeholders at greater risk. For instance, if energy companies have more resources to access and understand EO data, they can put Native American tribal nations at a serious disadvantage when it comes to negotiating water rights and forest management. Or if one farm can access and understand EO data about the productivity of other farms, that may create a competitive disadvantage for those other farmers.

As a final and related example, data ethics typically requires compliance with applicable laws and regulations. For instance, surveillance by uncrewed aerial vehicles (UAVs) or drones could be subject to the **laws of a territory**[23] if it's done within their airspace; but space-based intelligence, surveillance, and reconnaissance (ISR) arguably transcends[24] those laws because outer space itself transcends those territories and their legal jurisdictions. Outer space is recognized as a global common, thus sovereign autonomy (beyond control of a state's own space objects) has different weight in space data ethics, including sovereign control of data concerning their territories.

In contrast, data ethics in general typically demands that data subjects have some level of control over the data[25] collected about them, such as prescribed by the General Data Protection Regulation (GDPR[26]) in Europe and the California Consumer Privacy Act (CCPA[27]) in the U.S. And it's very unclear whether, and to what extent, states or individuals would have a corresponding general right to *delete* the space data about them, such as satellite images from over their territory, at least beyond perhaps obscuring faces, license plate numbers, and other familiar measures to protect individual privacy.

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[22] https://www.smithsonianmag.com/science-nature/lost-cities-of-the-amazon-discovered-from-the-air-180980142/
[23] https://worldpopulationreview.com/state-rankings/drone-laws-by-state
[24] https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3649792
[25] https://www.whitehouse.gov/ostp/ai-bill-of-rights/data-privacy-2/
[26] https://gdpr-info.eu/
[27] https://oag.ca.gov/privacy/ccpa

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States could claim, for example, national-security interests in demanding the deletion of satellite images over their military installations or the deletion of location-data about their sensitive space assets (e.g., spy satellites). But given customary international norms and laws around ISR and espionage[28], do those demands have much/any legal or moral force by themselves? Further, such national-security demands are in tension with the pressing need for better space situational awareness (SSA), i.e., more awareness of where space assets are to avoid collisions and other interference, irrespective of who owns the assets or what they are.

Domestic privacy laws can also create tensions with respect to, for instance, the Native American tribal nations and farmers mentioned earlier, who don't have the same access or ability to understand EO data as their competitors or negotiating parties do. Could those vulnerable stakeholders demand "shutter control"[29,30] of domestic satellite cameras (to not take photos), or limits on domestic sharing of data about their territories, or to know the identity of those requesting their data (and what data exactly) to level the competitive playing field? That is, how should we balance their privacy and commercial interests with the public good in *domestically* sharing EO and other space data, even if such data sharing by other nations cannot be controlled?

There are undoubtedly more examples and scenarios to uncover, e.g., related to the dual-use nature of space data, but already there's reason to believe that data ethics, as it exists now, is not enough for space data ethics.

7. Recommendation on space data ethics

If plans for space data collection, processing, use, sharing, control, and storage are to be **responsible and grounded in ethics,** then space data ethics must be recognized as distinct from traditional data ethics or data ethics in general, and its principles need to be identified and clarified.

Therefore, it is our recommendation to convene a study to develop a framework for space data ethics. The recommendation will be formally presented to the NSpC at its next meeting, by the UAG subcommittee on climate and societal benefits.

As a position paper, the above discussion merely presents an initial case for a study and is itself not a comprehensive investigation of how the two ethical regimes are different,

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[28] https://www.justsecurity.org/85486/a-right-to-spy-the-legality-and-morality-of-espionage
[29] https://www.wired.com/story/how-the-government-controls-sensitive-satellite-data/
[30] https://breakingdefense.com/2022/04/how-us-intel-worked-with-commercial-satellite-firms-to-reveal-ukraine-info/

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nor does it anticipate a full range of possible harms that might arise with space data. That is all work left to be done. Again, some space data, such as about individuals, may already be addressed by existing frameworks; that will need to be determined as well.

Inasmuch as data ethics is researched primarily by academic scholars, the **National Academies** would be a natural organization to lead this effort in the U.S. Other organizations, such as NASA, may also be reasonable homes, only if they are able to access the wide range of fields that may need to be considered in building a framework for space data ethics. For instance, the cognate or relevant fields may include the following:

- Data ethics
- AI ethics
- Geospatial/location ethics
- Surveillance ethics
- Intelligence/espionage ethics
- Research ethics (especially on dual-use)
- Climate/environmental ethics
- Agricultural ethics
- Space ethics (including benefit/data sharing)
- Free/open data ethics
- Citizen-science ethics
- Privacy law
- International law
- Corporate law
- Other domains

As key stakeholders, both producers and consumers of space data (e.g., National Geospatial-Intelligence Agency, National Reconnaissance Office, Planet, Maxar, etc., as along with relevant professions, such as farmers), as well as civil-society stakeholders (e.g., civil rights groups, climate action non-governmental organizations, etc.) should also be invited to the study, especially as they can share real-world practices and existing norms or thinking around handling and managing space data.

The National Science Foundation (NSF) may also be a reasonable home, if those sponsored projects can engage with the full range of cognate fields above. But there are advantages in having a central, coordinated effort by a "neutral" organization such as the National Academies—with convening power to build a broad coalition of relevant experts—than to have this work distributed or even replicated across universities and other organizations as NSF-funded projects.

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On the other hand, if diverse views on space data ethics are desired first, then it may make sense to distribute this work across organizations—e.g., as NSF grants—and even international geographies to arrive at a consensus or convergence. Either way, it would be welcomed to see more researchers as well as stakeholders attending to the emerging subject, especially in space-faring nations that are positioned to generate and share space data.

To the extent that this work is urgent—since vast amounts of space data is being handled and shared *every day*—this NSpC UAG subcommittee recommends starting with a **one-year study** that convenes a series of working meetings with relevant experts, e.g., AI ethics, surveillance ethics, climate ethics, etc. That study would culminate in an **initial list of principles** for space data ethics, or at least a discussion of when the principles might apply, what the tradeoffs might be, etc.

A *definitive* list of principles would require more time and care, especially to engage more experts and stakeholders *globally*. We'd estimate it would take 3-5 years to do it properly, depending on resources, judging how long it has taken for a thoughtful list of principles to be developed in *AI ethics* in recent years (starting around 2017[31]), which are still evolving and being refined even now[32].

If this recommendation were to be accepted by the NSpC, the UAG subcommittee on climate and societal benefits would be available and prepared to work with the lead organization—whether it's the National Academies or otherwise—on developing a workplan with more specificity and structure. The above is only a very broad sketch of the outline.

Given the urgency of this subject and the time it may take for the lead organization to formally convene the recommended study, it may also be a good idea to kick off this work with a preliminary workshop. This workshop would include a range of diverse experts to better identify and organize the key issues and risks at stake, as well as to provide input in developing the workplan.

Because space data cuts across many different disciplines and interests, it has extraordinarily broad value but, at the same time, raises new complexity for responsible oversight. Our national values and ethical principles are a source of strength, not weakness; and acting responsibly with respect to space data—and data is the *life-blood* of the information age—is our next test of those commitments, as well as an opportunity for moral leadership as the U.S. presses farther into space, the final frontier.

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[31] https://alanwinfield.blogspot.com/2017/12/a-round-up-of-robotics-and-ai-ethics.html
[32] https://medium.com/@svallor_10030/edinburgh-declaration-on-responsibility-for-responsible-ai-1a98ed2e328b

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