Pins on the Map: Navigating the Ambiguous Landscape of Generativity in Digital Platform Ecosystems

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Abstract. Generativity is the main influencing mechanism for platform ecosystem evolution. As the literature on generativity grows, however, researchers have criticized that the concept itself remains rather fuzzy and ambiguous. Thus, the paper at hand aspires to make generativity more tangible. Based on a literature review, we uncover what is known about the nature, measurement, and management of generativity. Our results show that generativity is indeed still a somewhat elusive concept. While generativity is critical for the success of platform ecosystems, it also has negative effects. While there are valid approaches to measure generativity ex-post, leading indicators are still scarce. Lastly, while there are ways to manage generativity, the majority of the literature stresses its chaotic and serendipitous nature. By mapping the ambiguous landscape of generativity, we provide researchers and practitioners with a clearer understanding, further paving the way for generativity to become a valuable concept for understanding platform ecosystem evolution.

Keywords: Digital platform · Platform ecosystem · Generativity · Innovation

1 Introduction

As a major manifestation of e-business, digital platforms are centered on the premise of using the innovative capacities of a large ecosystem of actors outside the focal firm. Thus, they are often associated with generativity, defined as "a technology's overall capacity to produce unprompted change driven by large, varied, and uncoordinated audiences" [49, p. 1980]. Generativity has been identified as a major factor for platform ecosystem evolution, as complementors continuously develop new modules which in turn attract new customers [8].

As succinctly stated by Tiwana [41, p. 155] "the evolution of platform ecosystems is a journey [...]. In a journey, you need markers – pins on the map – [...] to decide whether you are indeed headed in the intended direction." Setting such

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markers, however, requires a clear understanding of where one wants to go, one's current position, and potential routes to reach the desired destination.

To date, the literature on generativity has been characterized by a rather vague application of the concept. As Eck and Uebernickel [10, p. 2] state in their literature review on generativity, "there is no consensus on what the nature of generativity is and how it manifests itself". Although they subsequently considerably advance our understanding of generativity by specifying it as a result of system design and evolution, there are still many questions remaining. Thus, even though generativity is one of the main mechanisms that drives platform ecosystem evolution, its still rather fuzzy and ambiguous nature renders it a difficult basis for tracking the platform ecosystem journey.

The paper at hand aspires to provide support in setting pins on the map by addressing the following research questions: (1) How much generativity is desirable in digital platform ecosystems? (2) Which indicators can be used to operationalize or measure generativity along ecosystem evolution? (3) How can generativity be managed? To answer these research questions, we systematically review the growing body of literature on generativity.

As answering all these questions in-depth in a workshop paper is a daring endeavor, we do not claim to answer them conclusively. In fact, our results show that there may be no definitive answer for any of these questions. While a certain amount of generativity is desirable, too much generativity can have negative consequences. While there have been interesting and valid approaches to measure generativity ex-post, leading indicators for generativity are still scarce. Lastly, while there are ways to manage generativity, it seems to be mostly regarded as an inherent characteristic that, if actively influenced at all, should primarily be restricted instead of facilitated.

Instead, our intention and contribution are twofold: First, we want to show that although it is widely used, generativity is still an elusive concept in several dimensions. Second, in this way we also render it less elusive by mapping the landscape of generativity and thus providing researchers and practitioners alike with a clearer understanding.

The remainder of the paper is structured as follows. First, we provide some theoretical background on digital platform ecosystems and how their evolution is driven by generativity. Subsequently, we describe the methodological foundations of our literature review. In Sect. 4, we present our results on navigating the ambiguous landscape of generativity along three questions: Where do I want to go? Where am I? How do I get there? To conclude our paper, we discuss fruitful avenues for future research and how our results contribute to the literature on the generativity of digital platform ecosystems.

2 The Generative Evolution of Digital Platform Ecosystems

Platforms are one of the main trajectories of digital innovation [47]. While pure transaction platforms only act as a market intermediary, many platforms also

perform the role of innovation platforms as "products, services, or technologies that [...] provide the foundation upon which outside firms [...] can provide their own complementary products, technologies, or services" [14, p. 418]. Digital platforms build on the premise that the functionality of digital products is somewhat decoupled from their physical form. As a consequence, their functionality can be extended after they have been physically "finished" [48]. To add functionalities, digital platforms usually rely on an ecosystem of third-party complementors. These complementors contribute to the platform by providing modular extensions that are compatible with the platform core. This enables platform owners to cover a heterogeneous market with varying customer needs while only offering a standardized core [44]. To describe the distributed innovation emerging in platform ecosystems, researchers refer to the notion of generativity.

Originating in psychology as "a need to nurture and guide younger people and contribute to the next generation" [29], the concept has spread across various disciplines from linguistics, over architecture, to organization science [3], each time with a slightly different meaning but keeping a creation and evolution aspect. In the mid-2000s, it was introduced to the information systems field primarily by Avital and Te'eni [3], and Zittrain [49]. Following Zittrain [49, p. 1980], whose definition of generativity is by far the most widely cited, generativity is "a technology's overall capacity to produce unprompted change driven by large, varied, and uncoordinated audiences". Thus, generativity is vital for a platform's evolution and survival, as it allows for the adaptation to unanticipated changes in the environment [12].

Sparked by Zittrain's seminal definition, researchers' interest in the topic has flourished in the past decade. A large part of the discourse has taken place in the information systems literature and more specifically the literature on digital platform ecosystems. Despite or precisely because of its popularity, generativity remains a rather ambiguous concept, used by many researchers as "a nice shorthand label for a crucial and complicated thought" [36, p. 2758].

As a result, other researchers have already tried to clear the mist. Noting the increasing proliferation of generativity in information systems research, Eck et al. [9] analyze the different meanings assigned to the term. In a subsequent article, criticizing the fuzziness of the concept, Eck and Uebernickel [10] set out to provide a more clear-cut definition of generativity. Arguing that the ambiguity of the concept in information systems research is inter alia caused by the missing clarity of Zittrain's [49] definition, they scrutinize this definition to clarify it. Subsequently, they derive two perspectives on generativity: generativity as a consequence of a system's design, and generativity as a consequence of a system's evolution.

Despite these valuable efforts, generativity is still "conceived as a seemingly chaotic and anarchic environment" [20, p. 983]. Knowing that generativity can both be understood from a rather static design perspective and a dynamic evolutionary perspective still leaves some open questions: How much generativity is desirable? Is generativity always good? How can we measure generativity? How can we manage generativity? In this article, we will try to provide tentative

answers to these questions by reviewing extant literature on the generativity of digital platform ecosystems.

3 Method

To answer our research questions, we conducted a systematic literature review. According to Templier and Paré [39] our study can be characterized as a narrative review with the objective of summarizing the literature on the generativity of digital platform ecosystems. Nevertheless, as many literature reviews cannot reasonably be assigned to a single ideal type [26], it also entails elements of a descriptive review [34]. Therefore, while purely narrative reviews often rely on a subjective and non-systematic literature selection process, we conducted a systematic literature search as proposed by Webster and Watson [45].

We started our literature review by scanning the AIS Senior Scholar's Basket of Eight for papers with "generativity" in their title or abstract. This yielded 231[1] papers as a result, with 12 relevant papers remaining after a screening of first title and abstract, and later the full text.

Because of the low number of results and the generativity concept's origin outside the information systems discipline, we subsequently searched Scopus, again for papers with "generativity" in their title or abstract. This search resulted in an additional 1181 articles.

After screening the title and abstract, 15 papers remained from the basket and 71 papers from Scopus. At this point, we removed papers that discussed generativity in a different meaning (such as in developmental psychology) or in a setting with no connection to digital platforms. Consequently, the interdisciplinary nature of the concept led to the dismissal of a large number of articles at this stage. However, while we focused on generativity in digital platform ecosystems, we kept an open mind regarding papers addressing the generativity of digital technologies and infrastructures in a more general sense.

In the next step, we screened the full text of the remaining 86 papers to assess their relevance for our research questions. In this step, we removed 21 papers from our dataset, mostly because of an only tangential consideration of generativity. Based on a subsequent check for duplicates between our Basket and Scopus sets, we removed 3 papers. In the last step, a backward search identified 6 additional relevant papers, resulting in a final set of 68 papers for our analysis.

We did not conduct a forward search because of two reasons. First, we already followed a rather broad search strategy by looking for papers mentioning "generativity" in their title and abstract in the entire Scopus database. Second, the seminal papers by Zittrain [49,50] have already been cited over 2 500 times, rendering a forward search rather complex and unfeasible. As our aim is to provide a representative and approximately comprehensive overview of the literature, this approach seemed appropriate.

[1] This number is rather high because the journal search engines sometimes used truncation automatically (e.g., leading to inclusion of "generate" or "generation") or only supported full text search.

We coded the final set of papers using the qualitative data analysis software MAXQDA. This allowed us to identify common themes across papers and define categories. While we primarily coded in a deductive manner based on our research questions, we also created new categories inductively to allow for uncovering (implicit) assumptions in the literature [26].

4 Mapping the Ambiguous Landscape of Generativity

4.1 Towards Generativity: Where Do I Want to Go?

Naturally, before setting out on a journey, one should determine the destination. In terms of generativity, even though it is characterized by "unanticipated" change, it might be worthwhile to determine the desired amount of generativity in the platform ecosystem. As discussed earlier, generativity is one of the main drivers of platform evolution. As such, it seems like generativity is a desirable or even necessary characteristic of digital platform ecosystems. However, the literature also discusses downsides of generativity as well as factors that need to be balanced with generativity.

Generally, generativity is viewed as something positive and even the main factor for the success of digital platforms [30]. Avital and Te'eni [3, p. 347], for example, explicitly refer to it as "a productive capacity that focuses on creating something that is beneficial and desirable". As an obvious positive effect, generativity increases innovation and extends the functionality of platforms [10,50]. This, in turn, increases the overall success of the platform ecosystem by triggering positive system reputation and network effects [8].

While generativity is thus imperative for successful digital platform ecosystems, more generativity is not necessarily better. Indeed, generativity comes with different pitfalls, as evident from many of the papers in our literature review. In their study of video game platforms, Cennamo and Santaló [8], for example, find evidence for a negative free-riding effect. In the early stages of platform ecosystem evolution, generativity ensures a steady flow of new games to satisfy diverse customer preferences. However, as the ecosystem matures and competition with other platforms increases, a tension arises between a positive reputation spillover effect and a negative free-rider effect. In this setting, a high number of high-quality contributions that increases overall platform reputation leads to reduced incentives for individuals to invest more resources into the development of complements, as they can "get away" with lower quality as well.

The resulting variance in complements is a negative effect of generativity frequently mentioned in literature. Nielsen and Hanseth [31], for example, state that the development of contributions by heterogeneous audiences can lead to a fragmented landscape of offerings. This fragmentation might result in customer insecurity and lower satisfaction because of low-quality complements [8]. In other cases, it can lead to modules that are not (fully) compatible with the platform core [30].

Based on these negative implications of generativity, researchers mention several tensions between generativity and other factors. A classic tension discussed in literature on platform ecosystems is the trade-off between autonomy and control [44]. This tension is also echoed in generativity literature [12]. As generativity is dependent on "uncoordinated audiences", complementor autonomy is necessarily a prerequisite for generativity. However, too little control can lead to the aforementioned negative results such as low-quality complements and fragmentation of the ecosystem [47].

This is closely related to balancing generativity and usability. While early adopters accept and even embrace complexity, mainstream users want products with a more confined set of functions that are easy to use. Therefore, usually, technologies follow a trajectory from complex, feature-driven architectures to simpler, more usability-driven designs [33]. To some extent, this clashes with the generativity of digital platforms. Having an ecosystem of heterogeneous actors developing complementary innovations will almost inevitably lead to a plethora of features. As Nielsen and Hanseth [31] discuss along the case of the iPhone, platform owners need to find ways to ensure high levels of generativity and usability at the same time.

A third balancing factor for generativity is standardization [16]. In contrast to the aforementioned ones, however, this trade-off is not focused on limiting potential negative effects of too much or uncontrolled generativity. Instead, it relates to the balancing act of standardizing IT infrastructure to the largest extent possible, while at the same time keeping generativity high. Standardization is desirable because it allows for the reuse of components, enabling economies of scale [40]. Standardization is also necessary for generativity, as it facilitates accessibility and adaptability as important prerequisites for generativity [50]. On the other hand, too much standardization can also stifle generativity [16,44]. Thus, the challenge in digital platform ecosystems is to balance standardization and generativity in such a way that one can reap the benefits of both.

In the end, it is difficult to determine a universal answer to the question of the desired amount of generativity. As often, the sweet spot seems to be somewhere in the middle. Generativity is without doubt necessary for a platform ecosystem to thrive. However, too much generativity can lead to fragmented ecosystems with patchy complement quality and customer insecurity.

4.2 Measuring Generativity: Where Am I?

As mentioned earlier, for the most part, "generativity is conceived as a seemingly chaotic and anarchic environment" [20, p. 983]. At the same time, it is something that needs to be delicately balanced with other factors. However, doing so requires indicators concerning the level of generativity in the platform ecosystem. Therefore, we scanned the identified literature for lagging and also potential leading indicators of generativity that could help assess generativity and subsequently guide the evolution of digital platform ecosystems.

Lagging indicators look backwards in time and serve to tell whether a platform ecosystem has thus far been generative. Consequently, they represent the

results of generativity. In line with the criticized ambiguity, the results of generativity are often referred to on a rather high level. Zittrain's [49] original definition refers to "unprompted change". In the information systems literature on digital platform ecosystems, this change has been equated with innovation [30,46]. On a lower level, this innovation is often specified as new services [31,43] or applications [23,43].

Eck et al. [9, p. 13] criticize this equation of generativity and innovation, stating that "unanticipated outcomes do not have to be innovations, there might be other worthwhile ends to be considered". While other manifestations of generativity are mentioned in the literature, they also remain rather vague. Examples include "new outputs, structures or behaviors" [27, p. 54] or "new supplementary modules, organizational structures, and work practices" [22, p. 2010]. However, the innovation aspect is present in these examples as well, as all authors mention that the created "things" are usually new.

Most of these lagging indicators are rather vague in nature. Thus, our results are in line with Le Masson et al. [25, p. 7] who found that generativity "is usually hardly quantified". However, there are also a few papers that attempt to operationalize the measurement of generativity in empirical studies.

Andersen and Bogusz [2] study the evolution of a blockchain-based infrastructure over several years. To analyze the generative evolution of the blockchain infrastructure, they rely on forking events, that is, splitting off source code to pursue an independent line of development, as an operationalization. Interestingly, Fürstenau et al. [13] follow a similar approach. Their object of interest is the digital web-shop platform of Otto, a German e-commerce company. To study the generativity-driven evolution of the platform, they also rely on forking in the platform's GitHub repository. Cennamo and Santaló [8] apply a more straightforward and intuitive approach in their study of generativity-related tensions in platform ecosystems. Their study relies on longitudinal data from the U.S. video game industry. To determine the degree of generativity, they use the number and diversity of games launched in a certain month for a certain platform. This is in line with Nikou et al. [32] who suggest the variety of complements as an appropriate indicator.

Hein et al. [18] again employ two different criteria to measure generativity. To assess the amount of generativity, they use complementors' autonomy and the degree of knowledge sharing as indicators. In turn, to operationalize autonomy they analyze the number of complementors and whether their relationship with the platform owner is characterized by tight or loose coupling. For the assessment of knowledge sharing they rely on the number of active GitHub repositories. Um et al. [42] study the evolution of the WordPress platform. In their approach inspired by network biology, they indicate the number of complementary plugins as a measure for generativity.

What becomes obvious from these examples is that generativity, of course, cannot be measured directly. Instead, researchers employ different proxies. While some of those, such as the variety of complements, might be relatively easy to determine, others, for example knowledge sharing, might themselves again

require proxies for measurement. Additionally, all presented studies and indicators focus on an ex-post determination of generativity. With the exception of the measures used by Hein et al. [18], none of the criteria can be used as leading indicators for generativity. Overall, it seems difficult to exactly determine a system's generativity. Interestingly, the generativity of some kinds of digital platforms might be easier to determine as there are digital traces for many actions, such as in the case of repositories like GitHub.

4.3 Managing Generativity: How Do I Get There?

Sticking to the navigation analogy, after having found out where one wants to go and having defined one's current position, the last step is to figure out how to reach the desired destination. With regard to generativity, this refers to influencing the amount of generativity in a given platform ecosystem.

The majority of the literature treats generativity as an inherent capability of digital platform ecosystems, making achieving generativity rather easy. This serendipitous nature of generativity is already noticeable in Zittrain's [49, p. 1980] seminal definition of generativity as "a technology's overall capacity to produce unprompted change driven by large, varied, and uncoordinated audiences". It suggests that generativity is a characteristic of a certain system or technology. A majority of the literature building on this definition thus adopts this perspective, leading to the overall impression that once certain conditions are fulfilled, generativity "evolves endogenously, without prior planning or central control" [46, p. 3].

Taking a more detailed look, there are several characteristics that make a technology or phenomenon generative. Zittrain [50] mentions capacity for leverage, adaptability, ease of mastery, and accessibility. With regard to digital technologies, there are additional characteristics that facilitate generativity. These include modularity [43], openness [21,37], standardization [16] and incompleteness [38]. All of these characteristics reflect the layered modular architecture of digital innovation as described by Yoo et al. [48]. Not surprisingly, many of these characteristics can be found in digital platforms, illuminating why generativity is for the most part implicitly regarded as an inherent capability.

Consequently, based on this notion of generativity as something that spreads somewhat automatically, the main challenge does not seem to be to foster generativity, but to restrict it. This is in line with the large part of literature focusing on generativity-related trade-offs discussed earlier. To restrict generativity, platform owners can employ different measures. By exerting control over interfaces and access to the ecosystem, they can determine who can interact with the platform in which way [15,30]. Additionally, platform owners can control type and quality of complements ex-post by checking them against a standard policy [8].

These approaches to influence generativity interestingly rely primarily on governing actors' interaction with the platform. This points toward an aspect of generativity that goes beyond a platform's or technology's generative properties. While on the one hand a certain generative potential is ascribed to technologies and systems based on their design, on the other hand, generativity (especially

in digital platforms) is always closely linked to evolutionary dynamics, i.e. how generative a technology really is will only show after the ecosystem has interacted with it for a certain amount of time [1,10,38].

This interaction of users with a generative technology or platform as the key factor for realization of its generative potential is a recurring theme in literature [1,9,10,50]. Thus, importantly, generativity is a socio-technical phenomenon and needs to be understood and analyzed accordingly [30]. As a consequence, besides technical characteristics of the platform, there are also features of the ecosystem such as the frequently mentioned heterogeneity of actors [5,9,20,24,30,47] that have a positive influence on generativity.

In conclusion, our analysis of the literature indicates that while the two perspectives of generativity as a consequence of system design, and as a consequence of system evolution proposed by Eck and Uebernickel [10] are reflected in the approaches to manage generativity, they are employed in different ways. While the facilitation of generativity primarily focuses on the creation of generative characteristics at the point of system design, the restriction of generativity is centered around controlling platform ecosystem evolution. Broadly speaking, there seems to be an implicit assumption that once a system is designed "generatively", the main task is to restrict generativity and not foster it.

From a different perspective, according to Blaschke and Brosius [6, p. 2] "generativity can only be stimulated (not directly managed) by control mechanisms that appropriately bound participant behavior without excessively constraining a desired level of generativity". While this might initially sound somewhat contradicting, it makes sense in light of the abovementioned insights from literature. "Control" in terms of generativity does not necessarily mean restricting the amount of generativity in a platform ecosystem. Similarly, "stimulate" does not necessarily refer to increasing the amount of generativity. Instead, both stimulation and control refer to channeling a platform ecosystem's generativity in the desired direction. The result is a "continuous process of developers as protagonists seeking to engage in generative acts [...] and an opposing platform owner as antagonist [...] accepting or rejecting generative attempts" [11, p. 272].

5 Discussion

Generativity is a concept frequently used in platform ecosystems research. This is not surprising, given the domains and cases most frequently studied. Many studies focus on mobile platforms [4,15] or video game platforms [7,8]. These platforms come relatively close to the prerequisites for generativity proposed by Zittrain [50] such as adaptability, ease of mastery, and accessibility [9]. This might be one of the main reasons for the implicit assumption that generativity is an inherent characteristic of digital platform ecosystems. However, while this might be true for many or even most of the digital platforms studied to date, it may not be valid as a general rule.

As the "platformization" affects more and more branches of the economy [35], platforms emerge that do not unanimously fulfill these criteria. A phenomenon

that is increasingly attracting the attention of researchers in information systems, for example, are Industrial Internet of Things (IIoT) platforms [17,19]. These platforms collect data from a heterogeneous set of industrial assets and machines and provide it to third parties for the development and sales of industrial applications. Thus, they are a major trajectory of industrial firms' increasing move towards e-business [28]. Such technologically more complex platforms may not be characterized by ease of mastery. Similarly, the ecosystems around them will not resemble "large, varied, and uncoordinated" [49, p. 1980] audiences, but may be more closed business-to-business networks with distinct governance. To provide meaningful analyses of the evolution of such platform ecosystems, we need to move away from regarding every digital platform as being inherently generative.

In line with this change of perspective, we need to increasingly identify means to deliberately foster generativity. This needs to go beyond designing static properties of systems to ensuring ecosystem interaction along the lifecycle. The literature currently focuses on passive characteristics and not active measures. This means, to some extent, setting the stage for generativity primarily in the beginning of the life cycle and then letting it play out. This notion of the serendipitous nature of generativity is somewhat problematic, as "we cannot simply assume that systems continue to evolve generatively on the sole basis of their generative history" [10, p. 4].

Adopting a more proactive perspective on generativity also includes defining more specific measures to assess the generativity of digital platform ecosystems. As our results show, generativity is often equated with innovation. As a consequence, a platform ecosystem is regarded as generative if it can produce a high number or variety of complements. However, this clashes to some extent with the ambiguous nature of generativity as being desired on the one hand, and detrimental at some point. As Cennamo and Santaló [8, p. 618] put it, "not all complements are created equal". Some complements might be more valuable for the platform ecosystem than others that might even have a negative impact. Researchers should therefore aim for more clearly specified indicators of generativity. This will not only allow for a more precise application of the concept, but also aid in the abovementioned design of mechanisms to facilitate generativity. Otherwise, as Eck and Uebernickel [10, p. 2] put it, "there is no point trying to design 'for generativity' or 'towards generativity' because we do not know which design objectives to aim for".

6 Conclusion

In this paper, we attempted to map the ambiguous landscape of generativity in digital platform ecosystems along three questions: (1) How much generativity is desirable in digital platform ecosystems? (2) Which indicators can be used to operationalize or measure generativity along ecosystem evolution? (3) How can generativity be managed? Our analysis shows that, despite the valuable efforts by Eck and Uebernickel [10], and Eck et al. [9], the literature on generativity

still seems to suffer from the concept's character as "a nice shorthand label for a crucial and complicated thought" [36, p. 2758]. While generativity is critical for the success of platform ecosystems, it also has negative effects. While there are valid approaches to measure generativity ex-post, leading indicators are still scarce. Lastly, while there are ways to manage generativity, its seemingly chaotic and serendipitous nature leads to a focus on restriction rather than facilitation.

However, the aim of this paper is not necessarily to criticize this ambiguity, as it is to some extent part of the nature of generativity itself. "Unprompted change driven by large, varied, and uncoordinated audiences" [49, p. 1980] can perhaps by definition not be planned, measured and managed precisely. Still, while the generativity-driven evolutionary journey of different platform ecosystems will be unique, it still needs to be restricted and facilitated, and thus channeled in the right direction [41]. This requires a clear understanding of the desired level of generativity, the current level of generativity, and appropriate mechanisms to reconcile the both. In other words, it requires pins on the map that guide the platform evolution. The paper at hand provides help in setting such pins as it explores what we know about the means to measure and manage generativity.

Thus, by mapping the ambiguous landscape of generativity, our study contributes to the literature on the generativity of digital platform ecosystems by providing a clearer understanding of the nature of generativity. While this does not resolve the ambiguity inherent to the concept, it allows for a more precise handling by both researchers and practitioners. When studying generativity in different empirical contexts, researchers can build on our insights to more clearly specify their underlying assumptions and preconceptions regarding the concept. Practitioners, on the other hand, can use this study as a guideline regarding the assessment and management of generativity as their platforms evolve. Especially as domains are seized by platformization that may not be inherently generative, such as the IIoT, it will be vital to actively manage generativity.

Of course, as a limitation, this workshop paper can only provide tentative answers to the three research questions. Still, it can serve as a starting point for further exploration and clarification. This clarification is necessary in order for generativity to remain a valuable concept for research on digital platform ecosystems.

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