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WHAT'S IN A BOT? TRACING EPISTEMIC DIFFERENCES ACROSS EXPERT DISCOURSES

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Abstract: *Automated social social agents -bots – are increasingly central to digital environments, yet definitions of what constitutes a bot vary across expert communities. This article analyses how bots are conceptualised in academic and technological discourse by examining scholarly publications (Scopus) and developer discussions (Stack Overflow). Using computational methods, including keyword-in-context analysis and topic modelling, we trace epistemic differences in bot definitions across disciplines. Findings reveal structural discursive silos, with technical fields emphasising functional properties and social sciences focusing on sociotechnical entanglements. These definitional divergences have implications for research, regulation, and governance in an era of AI-driven automation.*

Keywords: *Social bots, discourse, expert communities, text analysis, AI.*

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INTRODUCTION AND AIM

The increased use and occurrence of automated social media accounts – bots – in online communication has given rise to an increased need to be able to distinguish bot accounts from other, human-driven user accounts. This is an issue of democracy and security, and research that maps and addresses issues related to bots is important and much needed. However, definitions of bots vary notoriously. What constitutes a bot is far from a fixed or universal concept which is broadly agreed upon. For example, different expert communities, ranging from scholars in fields such as computational social science to developers in tech industries, use different definitions and varying criteria, to classify and discuss bots.

Today, the playing field around automated opinion-making and computational propaganda is changing rapidly with the swift emergence of artificial intelligence tools that produce human-like language, and which make it increasingly harder to distinguish between bot-operated and human-operated accounts (Guglielmi, 2020; Monaco and Woolley, 2022). As content produced through AI generation has become increasingly difficult to distinguish from content created in and through human communication (Torusdağ, Kutlu, & Selcuk, 2021), the question of what constitutes a bot, and also how it should be identified, has become all the more complex. In academic and technological discourse, definitions of bots can range from instances of very straightforward rule-based automation, to extremely sophisticated AI-driven agents that can also be capable of dynamic interaction. This conceptual ambiguity around bots has an impact both on research approaches and technical implementations.

Because of these developments, the classification of bots has become an urgent challenge in a wide range of areas, for example, content moderation on online platforms (Binns et al., 2017; Ravazzi et al., 2022), political prognostication (Boichak et al., 2018; Brachten et al., 2017; Cantini et al., 2022), mitigating misinformation (Himelein-Wachowiak, et al., 2021; Lanius et al., 2021; Zhen et al., 2023), and preventing dangerous real-world consequences (Schuchard et al., 2019). However, the ways in which bots are defined or classified vary depending on different disciplinary perspectives, as well as different institutional priorities. For example, while tech developers quite often define bots based on functional and operational criteria, scholars in the humanities and social sciences will be more likely to approach bots as sociotechnical constructs that are, in turn, seen as embedded in broader socio-political dynamics. The fact that such divergent framings co-exist influences the way bots are studied, and also the broader societal discourses on automation and agency.

The aim of this article is to analyse how different epistemic communities formulate and apply definitions of bots and to critically examine how these definitions align with disciplinary assumptions, methodological choices, and broader societal concerns. We use computational methods to analyse how bots are conceptualized in expert discourse, drawing on scholarly publications (Scopus) and developer discussions (Stack Overflow). The study uses keyword-in-context (KWIC) analysis to analyse how bot definitions are articulated in context, and topic modelling to identify and compare dominant discursive themes across the different domains, revealing both points of overlap and divergence. By identifying key patterns in expert discourse, the study highlights the epistemic boundaries that shape understandings of botness. Ultimately, the article contributes to a critical discussion on how definitional differences influence research agendas, technological implementations, and broader debates on automation, agency, and politics.

BACKGROUND AND CONCEPTUAL FRAMEWORK

Social bots are a form of automation software that, through algorithms, are designed to mimic and potentially manipulate human behaviours (Keller & Klinger, 2019; Ferrara et al., 2019). In the social sciences and humanities, the existing scholarship on bots has a strong emphasis on socio-political consequences of the presence of bots in online discourse. Others have analysed which roles bots take up in online social networks (Seering et al., 2018). Such research is emphasising how bots are assigned different roles depending on the context in which they operate, and scholars have categorised bots as amplifiers, facilitators, gatekeepers, or disruptors, reflecting broader theoretical debates about automation, agency, and control in digital networks (Gorwa and Guilbeault, 2020; Fernqvist et al., 2018; Bulat and Hilbert, 2024; Doshi et al., 2024: Olanipekun, 2025).

In social science research, and more specifically also in the area of Critical AI Studies (Gorwa and Guilbeault, 2018; Woolley and Howard, 2018), bots tend to be framed as sociotechnical entities that are not merely technological artifacts, but which are entangled with, and influence, discourse and information ecosystems more broadly. This perspective highlights bots not only as source code or applications but as objects that are surrounded by political and epistemic – in other words, discursive – struggles. Bots can become a kind of 'empty signifier' (Wrangel, 2015) or 'nodal point' (Laclau & Mouffe, 1985) in relation to which different actors contest their meanings and roles in the digital society.

When interacting with users in social media feeds, it is seldom easy, and sometimes impossible, for both researchers and everyday users to assess if they are interacting with a human or not (Boshmaf et al., 2011; Ferrara et al., 2016; Howard, Kollanyi., and Woolley, 2016; Freitas et al., 2016). Further research has shown there is a political bot bias in the perception of online discourse (Schweitzer, Dobson and Waytz, 2024). This ambiguity may certainly be a challenge for everyday users of digital platforms and systems, but also for experts, as scholarly and technical communities may define bots in different ways. Some definitions, for example, may focus on functional elements such as automation or interactivity (Howard and Kollanyi, 2016), while others incorporate broader socio-technical definitions where bots are seen as embedded in human networks (Gorwa and Guilbeault, 2020). Additionally, as developments in generative AI continue, the boundary between automated and human-driven behaviour becomes increasingly blurred which, in turn, makes it more difficult to establish clear conceptual distinctions between different types of entities that are interacting online (Olanipekun, 2025).

Indeed, today the study of bots has become a research field in its own right (Subrahmanian et al., 2016; Gorwa and Guilbeault, 2020; Martini et al. 2021; Monaco and Woolley, 2022). However, as this type of research has expanded, it has also fragmented into different disciplines. Technical and computational research largely frames bots as software or algorithmic systems that can be optimised, detected, or mitigated (Aljabri et al., 2023; De Morais & Digiamp, 2021; Dialektakis et al., 2022; Torusdağ, 2022). On the other hand, scholars in the humanities and social sciences are to a much higher degree approaching bots as social, cultural, and political entities in analyses of, for example, issues of disinformation and manipulation (Woolley and Howard, 2018). Such diverging perspectives, especially when they are taken up in parallel in people's broader understandings of bots, may contribute to definitions of bots remaining field-specific rather than generic as they are shaped by different theoretical or epistemological assumptions or methodological priorities. This, in turn, can give rise to conceptual inconsistencies, where one and the same term – 'bot' – refers to fundamentally different entities depending on in which context it is discussed. This conceptual instability can, among other things, raise methodological concerns as studies that rely on different definitions may produce findings that are not directly comparable, which can further limit interdisciplinary dialogue.

Consequences of the instability of definitions of bots are particularly evident in the domain of bot detection, where the lack of clear definitional boundaries has long been a challenge. Two primary dilemmas are recurring in the literature for current bot detection methods: the ground-truth problem, which refers to the validity of results, and the impossibility of replication (Martini et al. 2021). The ground-truth problem refers to the uncertainty of the number of fully or partially automated accounts in the total population or a sample A, which can be compared to a manually or automatically coded sample B to validate the detection tool results. There is no ground-truth data available or attainable replication (Martini et al. 2021), and any detection method can only estimate automation by identifying accounts with similar or diverging patterns from typical human behaviour. The second challenge concerns replicability. Data quickly become outdated due to the constantly changing nature of social media. Accounts may be deleted, or their owners may remove followers or content, causing changes in displayed behaviour and network properties. Detection tools also evolve, so results achieved through newer versions are incomparable to older versions, making analyses time-sensitive and leading to different results if replication is attempted.

Considering the ground-truth problem and the impossibility of replication, results remain uncertain, making it difficult for researchers to confidently determine the number of automated accounts within a given sample. Different detection methods will yield different results, and specific methods may even generate varying outcomes when used at different points in time (Rauchfleisch & Kaiser, 2020). Studies have also shown that, with current techniques, threshold bot scores - even when applied conservatively – are subject to variance, resulting in false negatives (i.e., bots being classified as humans) and false positives (i.e., humans being classified as bots) (Rauchfleisch & Kaiser, 2020; Schuchard & Crooks, 2021; Martini et al., 2021).

On the one hand, the differing definitions discussed above can be argued to simply reflect natural, necessary, and expected variations across fields. Certainly, different definitions may be needed for specific purposes, such as developing field-specific methods, or devising strategies or tools to meet unique demands and challenges within different fields. On the other hand, however, the differences can also be seen as reflective of deeper epistemic divides. Problems may arise if the different origins or underlying assumptions of these definitions are not acknowledged or critically examined. It is against this background that this article examines how bots are conceptualised in scholarly and technical discourse. The analysis of both academic literature (via Scopus) and developer discussions (on Stack Overflow) maps different definitions, and further problematises what epistemic assumptions may underlie such differences. Importantly, rather than arguing for any single universal definition, the goal is to critically map discursive variations in order to identify points of convergence, divergence, or potential misalignment across domains and disciplines.

In terms of its broader conceptual framing, this article positions itself in the emerging research field of Critical AI Studies (Lindgren, 2023; Roberge & Castelle, 2021). The study, through its discursive perspective, approaches bots not as fixed technological artifacts, but rather as concepts that are shaped by different epistemic communities. Broadly speaking, we approach bots from the theoretical perspective of the social shaping of technology (Pinch & Bijker, 1984; Williams & Edge, 1996). Definitions of bots are not merely technical classifications but sociotechnical constructs. Differing framings in different contexts can be seen as illustrations of how technological and social dimensions of bots are co-produced rather than existing in opposition. Bots are socially shaped and are co-produced at the intersection of the social and the technical (Lindgren, 2023). The question then, is not simply what bots do, but how different expert communities discursively construct their meaning, where we can see an agent’s ‘botness’ as a fluid and contested category which can, in turn, be shaped by broader discourses about agency, authenticity, manipulation, and so on. The definitions used in any given case is reflective of deeper assumptions about what should be seen as analytically meaningful when studying bots.

For example, relying on a purely metrics-based approach when defining bots – such as posting frequency, time of activity, account creation dates, or follower counts (Kearney, 2018; Yang et al., 2020) – entails a reduction of the bot to a computational artifact. In contrast to that approach, it has been argued that the understanding of a bot must instead be ‘connected to its use, and its social and cultural contexts’ (Coeckelbergh, 2022, p.9). Thus, from a sociotechnical perspective, bots are more likely to be understood in terms of their relational, performative, and context-dependent characteristics rather than based on their merely technical attributes. While the metrics-oriented approach captures a straightforward kind of botness – ‘the likelihood of being a bot’ (Rizoiu et al., 2018, p. 300), or ‘the level of bot-like activity’ (Hui et al., 2019, p. 3) – there are also more far-reaching forms of botness. Bucher (2014), for example, sees botness as a more fluid and deeper-running property which has to do with the ‘personality’ of bots. This view clearly aligns better with the sociotechnical perspective, as it also highlights the ‘doing of botness’ (Bucher, 2014, p. 11) as a constructive process of meaning-making.

This study, rather than viewing botness as a static property, draws on the concept of digitally transformative processes (Lindgren, 2022) in its analysis of how definitions of bots differ and evolve across expert communities. Again, the meaning of 'bot' is not fixed but shifts as technologies change, and importantly also as different fields apply new conceptual frameworks. Such transformations reflect what Earl and Kimport (2011) describe as ‘model changes,’ where not only the superficial classification criteria but the fundamental understanding of what constitutes a bot, is altered. By mapping these definitional shifts, this article gives knowledge about tensions between competing perspectives and how they might contribute to shaping broader discussions on automation, agency, and technological governance.

DATA AND METHOD

As introduced above, the data used in this study consists of expert discourse on bots within two distinct domains: (1) scholarly research articles from the Scopus database, and (2) technical discussions from Stack Overflow, a widely used discussion forum for developers. The data collected from Scopus will give knowledge about how bots are discursively framed within academic literature, while the data from Stack Overflow will give insight into discourse on practical and technical aspects of bots, related to coding practices and real-world applications as discussed in a more applied context. Bringing textual data from these two domains together helps us get a comprehensive understanding of how bots are discussed and defined across different expert contexts, where the simultaneous focus on theory and practice will help us identify common themes, as well as divergences, in how bots are seen and used. First, a dataset was collected from Scopus by using the following search string:

```
TITLE ( "bot" OR "bots" ) AND PUBYEAR > 2013 AND PUBYEAR < 2025 AND (
LIMIT-TO ( SUBJAREA , "COMP" ) OR LIMIT-TO ( SUBJAREA , "SOCI" )) AND (
LIMIT-TO ( DOCTYPE , "cp" ) OR LIMIT-TO ( DOCTYPE , "ar" ) ) AND (
LIMIT-TO ( LANGUAGE , "English" ) )
```

This, in plain language, means that the Scopus data was collected by targeting scholarly publications that are explicitly engaging with the concept of bots by sampling only articles where the title (TITLE) contained either "bot" or "bots". This was to ensure a certain level of relevance to discourse directly centred around the term. Furthermore, to keep a focus on contemporary discourse only items with their publication year (PUBYEAR) falling within the time period of 2014 to 2024 were included. The selection was also refined by limiting the dataset to the two subject areas (SUBJAREA) of Computer Science (COMP) and Social Sciences (SOCI). The aim of this filtering was to ensure a certain degree of balance between technical perspectives, such as those relating to AI and automation, and social perspectives that may engage more with bots in relation to societal roles, interactions and cultural meanings. Additionally, we applied a further limitation to focus only on the two document types (DOCTYPE) of journal articles and conference papers. Finally, only English-language publications were included, both to ensure consistency in the computational text analysis to follow, as well as to enable comparisons with the Stack Overflow dataset, which is purely in English.

The full-text articles were downloaded and converted from pdf format to plain text (VikParuchuri, 2025) and then converted to lowercase. We tackled the methodological challenge of finding definitions of "bot" in these full-text sources by using a rule-based approach in combination with regular expressions (RegEx), which is a powerful tool for pattern matching in text (Thompson, 1968). We used a range of linguistic patterns commonly found in definitional statements, including “bot is,” “bots are,” “bot(s) mean(s),” “bot(s) function(s),” “bot(s) operate(s),” “bot(s) can,” “bot(s) will, and “bot(s) refer(s) to.” Note that these will by extension capture wordings such as "bot are defined as", "a bot can be said to", and so on. We also used phrasings referring to negations of bots, such as "bot(s) can't/cannot", "bot(s) isn't/is not (aren't/are not)" and "bot(s) don't/do not". The RegEx used to identify definitional statements was:[1]

```
\b(bot|bots)\s+(is|are|means?|functions?|operates?|can|will|refers?|can
not|can't|isn't|is not|aren't|are not|don't|do not)\b
```

As mentioned above, aside from these scholarly texts our data also included a subset collected from Stack Overflow (https://stackoverflow.com), which is a popular online community where developers and programmers ask and answer questions related to coding and software development (Barua et al., 2014). Full data from Stack Overflow is made publicly available through Google BigQuery, a cloud-based platform for analysing large datasets. (Fernandes & Bernardino, 2015). We ran an SQL query to extract posts from 2014-2024 across all of Stack Overflow, that matched either “bot” or “bots” (n=71,202) and then extracted definitional statements using the same RegEx as above. As shown in Table 1, the full dataset of bot definitions ended up having a size of 20,264 phrases.

Table 1. Number of retrieved documents and definition phrases across sources

Source	Timeframe	Articles/posts	Definition phrases Number (Phrases/document)
Scopus – social science	2014-2024	493	2,153 (4.3)
Scopus – computer science	2014-2024	1922	3,424 (1.8)
Stack Overflow	2014-2024	71,202	14,687 (0.21)
			20,264

KWIC Analysis

When analysing the data, we first did a concordance analysis. This approach, often used in the field of corpus linguistics, allows for looking at in which contexts, within a body of text, specific words or phrases are used. For the purpose of our analysis, we created a KWIC (Key Word in Context) concordance – an analysis where the "word-form under examination appears in the centre of each line" (Sinclair, 1991:33). This analytical step, carried out using the NLTK (Natural Language Toolkit) programming library (Bird et al., 2009), enabled us to see the specific textual context in which the word forms 'bot' and 'bots' occurred in our datasets. This, in turn, makes it possible to pick up on patterns of usage that might not be apparent through other types of analyses. The KWIC concordance, functioning as a first foundational step of our analysis, is also a form of collocation analysis (Chung, 2017) in the sense that it identifies words or phrases that appear often around our target words of 'bot' and 'bots', thereby giving an insight into the types of definition that this article analyses.

Topic Modelling

Crucially, the KWIC mapping and analysis of definitions, while interesting in itself, also serves as the basis for moving on to a more refined computational analysis of more complex discursive patterns across all three discursive communities. In this step, we apply topic modelling to the full combined dataset to try to identify recurring themes, discursive overlaps, as well as points of divergence when it comes to how bots are framed across the different contexts. The point with this part of the analysis is to enable us to also move beyond the isolated domain-specific discourses analysed through KWIC, with the goal of tracing more complex discursive structures that shape expert discourses on bots. For example, this analytical strategy makes it possible to see if certain discursive patterns consistently exist across all three domains, and which distinct boundaries seem to persist.

For the topic modelling, we continued to rely on the concordance data that was extracted through the KWIC analysis, rather than using the entire full-text documents. Not including the full academic articles and discussion posts, but instead treating each KWIC context window as a separate document, ensured that the topic modelling focused specifically on how bots are defined and framed. In practice, then, this means that each document in the topic modelling corpus consisted of a short segment of text surrounding the term "bot" or "bots" drawn from one of the three datasets. The document set for the topic modelling thus matches the 'Definition phrases' column in Table 1, with a total of 20,264 documents.

Our topic model was trained using LDA (Blei 2003), which identifies topics in a text dataset by assigning words to topics based on their co-occurrence patterns. The training was done using the Gensim library for Python (Řehůřek & Sojka 2011), which provides a user-friendly implementation of the algorithm. When it came to choosing the number of topics to model – as LDA does not automatically determine the optimal number – we used a so-called elbow method based on coherence scores to guide our decision.

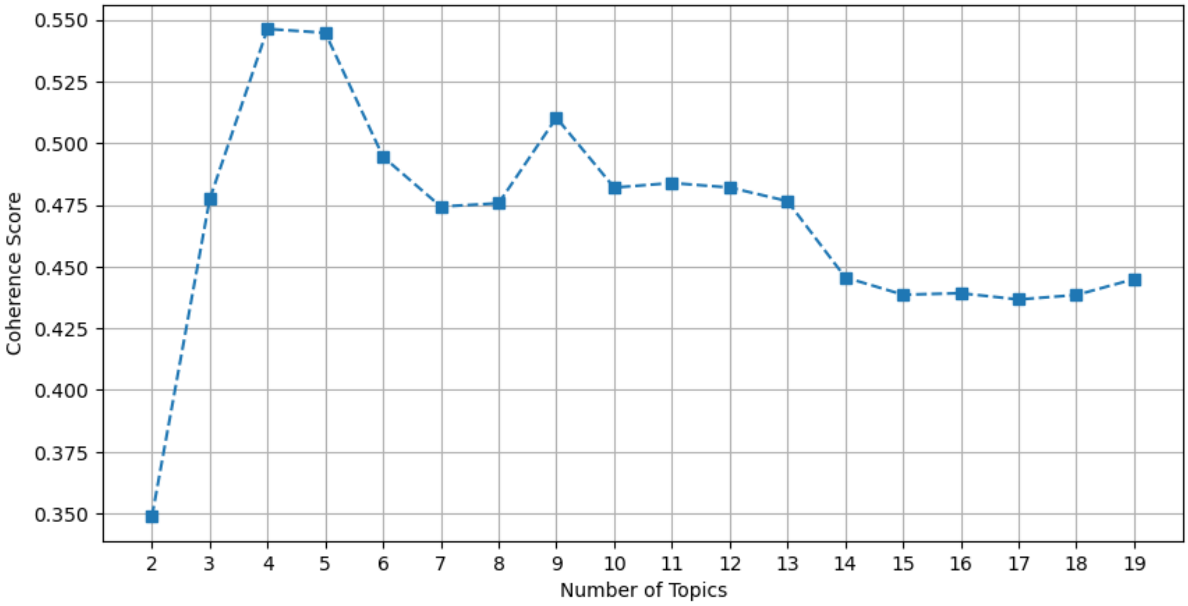

Figure 1. Coherence scores vs. number of topics (LDA model)

While training the model for 4-5 topics gives the highest coherence score, we chose to train the model for 9 topics, as using a too low number of topics is likely to merge thematic clusters that can be analytically meaningful. So, choosing to train the model for 9 topics is likely to strike a better balance between the coherence score of the model and the granularity and interpretability of the topics. The topics produced were manually labelled after qualitative assessment of key words associated with them and then plotted using the pyLDAvis tool (Mabey, 2018) to enable an analysis of the distribution of topics across the three discursive domains—computer science, developer discussions, and social science.

ANALYSIS

In the following sections, we first present the KWIC analysis of variations in how bots are defined in order to examine some broader discursive patterns around bots in the three analysed domains. After that, we use topic modelling to identify dominant discursive themes across the domains, and to further analyse how these themes cluster in relation to each another. This enables a mapping of the epistemic boundaries that shape bot discourse, highlighting both areas of overlap and points of divergence.

Computer Science: Bots as functional and technical entities

After carrying out the KWIC analysis, as described earlier, we made a qualitative assessment by manually reading through the concordance lists created based on each part of the dataset. First, we looked closer at how 'bot' and 'bots' were defined and described in the subcorpus from the computer science domain on Scopus. Table 2 lists 20 manually selected illustrative examples that are characteristic of this part of the discourse.

Table 2. Computer science definitions of bots: qualitative selection of 20 KWIC examples

Left Context	KWIC	Right Context
terances 2 related work conversational bots	bots	are computer programs that provide natural l
media on the social media landscape social	bots	are defined as automated accounts designed t
lassification received march 17 2022 social	bots	are defined as computer algorithms that gene
thout being disclosed as pieces of software	bots	are defined as software designed to act in w
0 repositories in microsoft these developer	bots	are deployed in continuous delivery environm
with specific service platforms as a result	bots	are designed and optimized for these specifi
d at a faster rate ii related work the chat	bots	are developed by training the system based o
s we saw in the previous subsections sniper	bots	are developed to perform buy operations imme
s and needs in a more natural way while the	bot	can accurately understand and give an approp
ed work storey and zagalsky 11 propose that	bots	can act as conduits between users and servic
opinion spam messages or amplify propaganda	bots	can act as fake accounts eg for posting mess
signed for benign purposes for example chat	bots	can assist retailers in serving customers in
a multivocal literature review furthermore	bots	can help developers complete tasks related t
ption as well as potential ways that future	bots	can support different groups of moderators i
ial bots as per ferrara et al 2016 a social	bot	is a computer algorithm that automatically p
oaxes alternate narratives 1 introduction a	bot	is a computer application that is designed t
e game items in an economical manner a game	bot	is a computer program that plays games auton
ne of the most prominent today are bots 1 a	bot	is a computer program that simulates human a
ds for the users due to the bots high power	bots	will vote for posts even if other users do n

The examples are all indicative of the general patterns found when going through the concordance list. A general pattern here is that the computer science discourse on bots primarily defines them as automated software agents with a wide range of applications and uses in areas like social media automation, cybersecurity, and e-commerce. In terms of definitions, this part of the discourse certainly reflects the type of fluidity and ambiguity discussed in earlier parts of this article. However, and importantly, the fluidity hinted at in the computer science domain is more about the fact that there may be many different types of bots, rather than a more existential one. For example, ambiguity seems to exist when it comes to distinguishing between fully automated, semi-automated, and more human-controlled bot systems. This may, for example, be about moderation bots or trading bots that rely on human input to function in the intended way, or customer service bots that pass the more complex queries on to human operators.

Furthermore, in the computer science literature, bots are often defined in terms of whether they are benign or malicious, where benign bots tend to be associated with notions of efficient automation and productivity enhancements, while malicious bots are discursively linked to cyber threats, fraud, disinformation and political manipulation. In other words, different types of functional definitions are prominent in computer science definitions of bots. Such ways of approaching bots can be seen as reflecting a pragmatic engineering perspective, where bots tend to be defined simply by what they do, rather than on any pondering or reflection around any underlying nature or other, more philosophical or ontological considerations.

While this focus may be understandable and expected within its specific disciplinary context, there is still a risk in operating with definitions that are too strongly oriented towards pragmatism, neutrality, and problem-solving. Definitions that are overly functional may contribute to obscuring broader social and political stakes that may be involved in processes where bots are developed and deployed. Indeed, if one treats bots primarily as technical things and not as socially embedded entities, important concerns around, for example, accountability or any unintended consequences may be sidelined. So, by mapping out how bots tend to be defined in computer science, we can get some insight into what implicit assumptions may shape their technological development. From a discourse analysis perspective, definitions are not merely descriptive, but they actively contribute to shaping the social practices where we build, deploy, and govern bots.

Stack Overflow: Bots as practical implementations

Moving on with the KWIC analysis, we now turn to an analysis of how 'bot' and 'bots' are defined in the strongly developer-oriented discourse on Stack Overflow. This list consisted of 14,687 lines, with the discussion forum text excerpts being significantly messier and less structured than the scholarly articles. However, the strategy of sorting the list alphabetically on the word following after the KWIC was particularly helpful here as it enabled a more efficient qualitative scanning of the context in which 'bot' and 'bots' were appearing. Table 3 shows 20 illustrative examples of definitions and discursive context.

Table 3. Developer definitions of bots: qualitative selection of 20 KWIC examples

Left Context	KWIC	Right Context
.on whenever i test my form it works but the	bots	are finding a way to bypass the script i hav
.ng to solve this issue for quite awhile now	bots	are hitting my sites hard with invalid host
charlies ip 100038080 all of these	bots	are living in containers behind a nginx prox
very odd problem the problem is both of the	bot	are responding to postbacks button instantly
·ongyes i did itstrong what amaze me is that	bots	are scanning github for searching free api k
ıep pin this real life microsoft example the	bot	automatically comes up with a message and th
ıone transfer originurl styleurl codepre now	bot	can answer multiple requests but when it tea
ıtep pi know this would not be perfect and a	bot	can download the page and simulate the click
ıein progress and in which form so the teams	bot	can edit and overwrite the status is it poss
to bot but there is nothing available where	bot	can extract contents of pdf sent by user wil
ıbase to the twilio autopilot bot so that my	bot	can fetch data from the database and show it
.ng we want to be able to subscribetotone so	bot	can provide appropriate help during the meet
:s right away when they are released so this	bot	can purchase your desired items in an instan
ı the code for specific keywords so that the	bot	can respond accordingly and no i can not use
. lithe prefix is saved in a config file the	bot	can write to the file and save it for later
:python botpycode since py only denotes that	bot	is a python file i assumed this because when
ı your server implementing a code where that	bot	is able to be used as a normal useraccount a
ıotyour message contained a linkquot but the	bot	is not working i have tried a lot of differe
ıself with the administrators permission the	bot	will recognize and punish the memberstrongp
·eated and deployed a bot in microsoft teams	bot	works properly and responds when user talks

In comparison with the discourse of the computer science research literature, the discourse on Stack Overflow – dominated by programmers and developers – is even more pragmatic and focused on immediate problem-solving. This means that, while computer science definitions are largely engaged in functional definitions and classifications, the developer discussions are, unsurprisingly, not at all offering any explicit definitions of bots, but instead describe bots indirectly through their design, implementation, constraints, and behaviours in response to different commands. This, then, puts the focus on similarly functional definitions as in the computer science discourse, but largely also on activity-oriented definitions. This is because in the Stack Overflow subcorpus, bots are primarily defined in terms of tasks that they execute – particularly in relation to messaging, API interactions, and task automation – such as by 'finding', 'responding', 'scanning', 'downloading', 'purchasing', 'recognising', and so on (cf. Table 3). In spite of the overlaps, a difference between the computer science discourse and the discourse on Stack Overflow is that the former still largely defines bots as autonomous agents, while the latter tends to frame them as extensions of user commands, objects to shape and get to function, rather than as independent entities.

This focus on direct functionality and execution highlights a key distinction: while both domains analysed this far are centering on what bots *do*, the developer discourse places even less emphasis on conceptual clarity or categorisation. This is not to say that these discursive fields should be expected to, or required to, engage deeply in theoretical discussions around defining bots. Nonetheless, the analysis thus far of the first two cases illustrates how disciplinary and professional priorities tied to different domains shape how bots are discursively understood. Each domain is, more or less implicitly, embedding its own specific assumptions of what a bot is and does into its language and practice. After having analysed the two more technical and applied domains, we turn not to the final part of the KWIC analysis focusing on how bots are defined in the social sciences.

Social Science: Bots as socio-technical and contested constructs

The third and final part of the KWIC analysis is focused on how 'bot' and 'bots' are defined and discussed in social science discourse. In comparison with the two previously analysed cases, this one reflects a quite different epistemic orientation that is much more focused on contextual meaning. Table 4 shows 20 qualitatively chosen examples that illustrate broader patterns in this discourse. It should be stressed here, again, that while these differences align clearly with expectations and activities in the domains analysed, the mapping carried out through KWIC will form the basis for a more refined computational analysis of bot definitions across all three discursive communities through topic modelling.

Table 4. Social science definitions of bots: qualitative selection of 20 KWIC examples

Left Context	KWIC	Right Context
ound and literature review terminologically	bots	are a dazzling phenomenon and describe a bro
n fig 3b it turns out that most noncredible	bots	are also parasitic on rightleaning celebrity
parkland events we can conclude that social	bots	are an explicit subpopulation of actors in o
l reasoning myside bias introduction social	bots	are artificial agents that infiltrate social
ns underexplored whether manipulated social	bots	are as active as humans in climate change di
ed humans more frequently then conservative	bots	are better at being perceived as humans poli
mation flows more than just tools wikipedia	bots	are both sociotechnical agents engaging with
rch projects have made it clear that social	bots	are by no means a merely technical phenomeno
ing across different languages in wikipedia	bots	are governed differently in different langua
hear any different voices especially if the	bots	are highly skilled at disguising themselves
amic interactions in sociotechnical systems	bots	are imbued with technical agency and a uniqu
our study and the egbf study is that for us	bots	are inextricably linked to their developers
sanction asian issues in many topics social	bots	are not significantly different from humans
working in the it industry highlighted how	bots	can manipulate public opinion by disseminati
nes wrote the question is no longer whether	bots	can pass as human but how social interaction
20 as budnikova os babenkova note that chat	bots	can radically change the nature of human int
bots in journalism the definition of social	bots	is contested and varies among research field
hen et al 2008 describe this as the ratio a	bot	is mistaken for a human player this is
tives but how the expressive power of these	bots	is symbiotic with the fact their outputs pro
discovered the behavior patterns of social	bots	will change constantly in the future and thi

When analysing the third part of the data, covering social science discourse on bots, we found an orientation that was clearly different from that of the two others. While, in the previous domains, bots were predominantly framed in terms of either their functionality or their technical properties, the social science discourse to a much larger extent defines bots as parts of broader sociotechnical systems. One of the most central themes in these texts is the idea that bots are not to be seen as merely neutral tools or simply automated agents, but instead as entities the meaning, impact, and role of which are shaped by their interactions with human intentions, institutional structures, and political contexts. This discursive theme is, for example, evident in relation to those definitions that link bots to political influence and to the manipulation of public opinion (e.g., "bots can manipulate public opinion by disseminating a large number of messages"), as well as in statements that emphasise their entanglement with human agency (e.g., "bots are inextricably linked to their developers rather than autonomous agents").

A recurring feature in this discourse is the explicit contestation of bot definitions. Rather than assuming a clear-cut functional classification, social science texts tend to problematize what a bot is and how it is perceived. This is particularly visible in the statement "the definition of social bots is contested and varies among research fields", which highlights the interdisciplinary tensions around conceptualizing bots. Similarly, the notion that "bots are by no means a merely technical phenomenon but change sociotechnical systems" reinforces the idea that bot classification cannot be disentangled from their broader social and cultural implications.

Another clear contrast to the other two domains is the emphasis her on the ambiguity of bot identification. A significant number of examples are highlighting how bots blur the boundaries between automated agency and human agency. There are for example wordings such as "bots are a dazzling phenomenon and describe a broad array of applications", and "bots are not significantly different from humans, however, from the social science perspective, they […]". Overall, then, there is a recurring concern in social science discourse with the misrecognition of bots, and that bots can be strategically disguised in online interactions. Indeed, as discussed above, concerns relating to deception, disinformation, and strategic uses of bots are not entirely unique to social science discourse, as such themes also appear in the computer science literature. This is especially true in relation to discussions of malicious bots. A key difference, still, is that these issues are framed in quite different ways in the two domains. In computer science discourse, these aspects tend to be approached through a more functional lens (detection, classification, mitigation), while in social science discourse the very process of defining bots is construed as inherently problematic, and deeply shaped by sociotechnical entanglement and broader power dynamics. Furthermore, in the social science discourse, there is often an emphasis on the fluid and evolving nature of bots (e.g., "bots will change constantly in the future and this evolution will […]". This focus on transformation and instability stands in contrast to the, by comparison, relatively stable functional and practical definitions in the technical fields.

In sum, then, the KWIC analysis of all three domains highlights one fundamental discursive contrast when it comes to the definition and understanding of bots across the areas. While computer science and developer communities primarily define bots in terms of technical properties, functionalities, and immediate implementations, social science discourse to a larger extent problematises such definitions. It does this by emphasising the sociotechnical entanglements that shape how bots are understood. This difference can be seen as reflecting a broader concern with the ways in which technology is embedded in political, institutional, and cultural contexts. Overall, the KWIC analysis shows how definitions of bots are not neutral descriptions that are universal across fields, but that they rather are a form of discursive markers that reflect and shape which aspects or interpretations of bots are prioritised in different settings. While such differences may seem unproblematic from a directly practical point of view – of course, a developer will have a more practical focus than a sociologist – they still become significant in relation to things such as interdisciplinary dialogues or policy discussions. In such settings, competing assumptions about what a bot *is* and *does* can lead to misalignments in theoretical debates, and methodological strategies, as well as have broader societal implications. Now, to investigate this pattern further and to try to identify discursive patterns across domains, we turn to topic modelling as a complementary approach to map the terrain of bot discourse.

Beyond Discursive Boundaries: Topic modelling across domains

Now moving on to the analysis of overall discursive patterns in bot definitions across all three domains, we will use the trained LDA model to assess how topics are distributed across them. First, we shall have a look at which topics were identified and how they can be related to the patterns found in the KWIC analysis.

Table 5 shows top keywords in the nine identified topics in the full dataset, including the definition phrases from all three domains. These topics have then been qualitatively labelled based on their thematic content.

Table 5. Identified topics in bot definitions across domains

Topic #	Keywords	Label
0	trying, command, error, reply, execute, fail	**Execution and errors in bot commands**
1	social, political, news, account, network, influence	**Bots and sociopolitical influence**
2	interact, task, game, player, automation, control	**Bots in interactive and automated systems**
3	message, send, user, server, request, response	**Messaging and communication bots**
4	function, run, process, framework, implement, system	**Bot functionality and system implementation**
5	role, response, user, message, engagement, moderation	**Bots in moderation and user engagement**
6	human, activity, interaction, behaviour, perception, agency	**Human-bot interaction and agency**
7	const, codepre, def, await, script, method	**Bot programming**
8	wikipedia, account, edit, rule, governance, verification	**Bots in knowledge management and governance**

When it comes to the distribution of topics across the three domains – computer science, social science, and developer discourse – Figure 2 indicates that there is some variation in the concentration of topics within each domain. The numbers in the heatmap state the proportion of documents within a given domain for which the topic in question was the dominant one, where a darker shade means a high prevalence. For example, the topic *Political and social* is particularly dominant in the social science discourse (0.48), but also in the computer science discourse (0.42), but nearly totally invisible in the developer discourse (0.01). As a contrast, *Messaging and communication* is very much present in developer discourse (0.47), but much less so in the two other ones. Furthermore, the figure shows that some topics (for example, *Human-bot interaction* and *Functionality and implementation*) are more evenly distributed across the discursive domains, suggesting that they are more relevant to all of them.

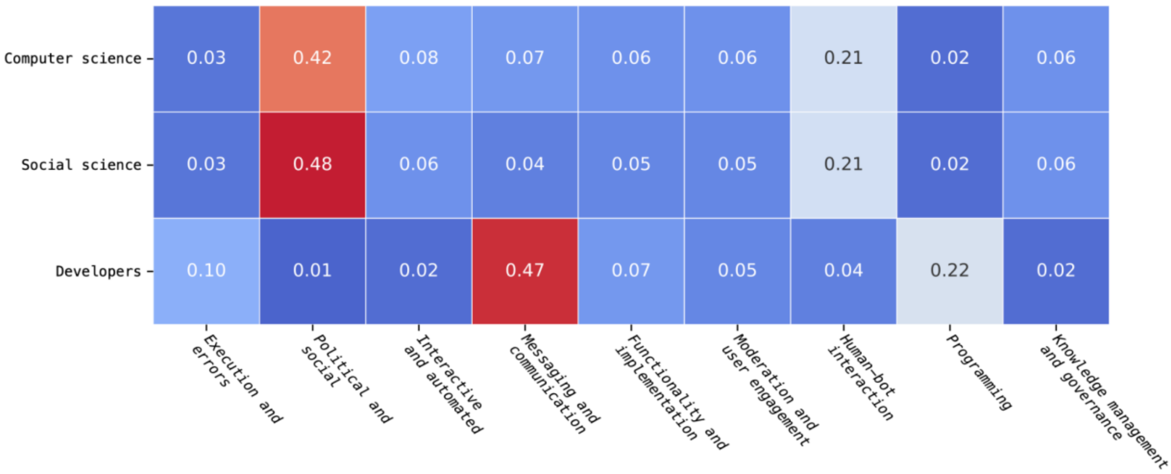

Figure 2. Distributions of topics in bot discourse across domains

Figure 3 shows the mapping, done with pyLDAvis, of the positions of topics in a two-dimensional space based on their relationships and similarities. The axis names PC1 and PC2 simply refer to "Principal Component 1" (dimension 1) and "Principal Component 2" (dimension 2) resulting from the reduction of the multidimensional LDA model to 2D, implemented in pyLDAvis. The interpretation of the map should thus focus on how the topics are positioned relative to each other rather than on their absolute positions on the plot. The main task of the plot is simply to give a picture of the overall structure and distribution of topics within the dataset, highlighting how closely or distantly related they are to one another. The sizes of the circles in the plot represent the relative prevalence of each topic. In other words, a larger circle indicates that a topic appears more frequently across the documents, which can be interpreted in terms of them being more dominant in shaping the overall discourse on bots.

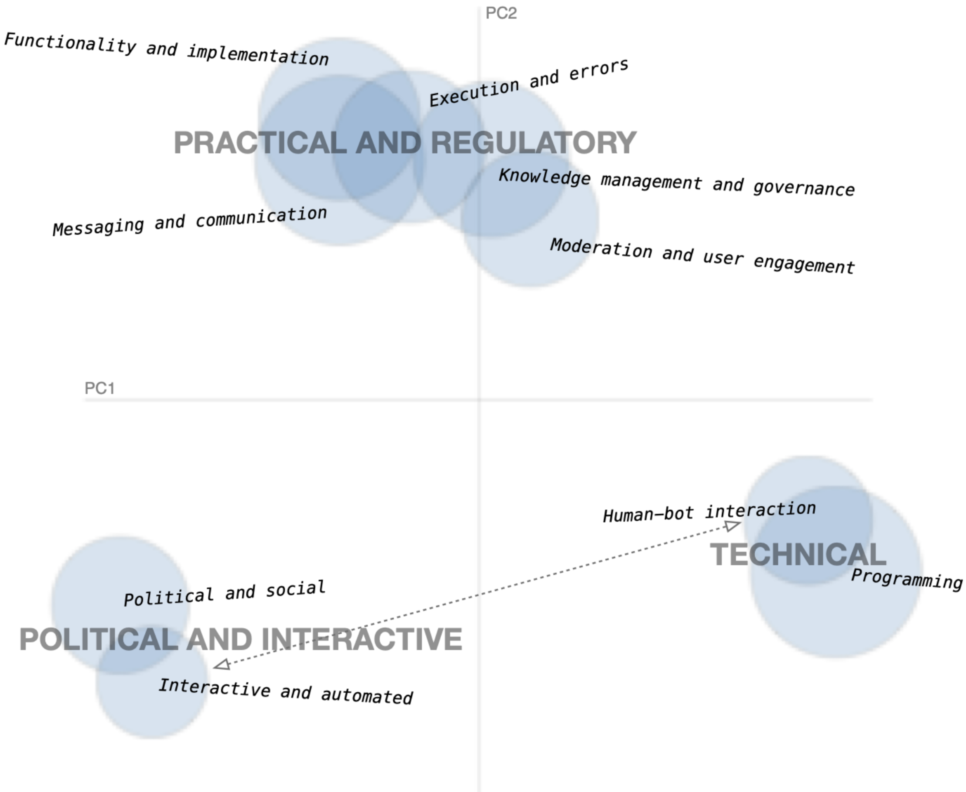

Figure 3. Spatial relationships among identified topics

Looking first at clusters and proximity, one of the most significant findings in the plot relates to the largest group of topics where f*unctionality and implementation*; *execution and errors*; *knowledge management and governance*; *messaging and communication*; and, *moderation and user engagement* appear close together. This means that these aspects of bot discourse and bot definitions are tightly interlinked and that they can be said to form a core discursive space where discussions around technical implementation, governance, and moderation frequently intersect with each other. Overall, then, this cluster highlights that technical and social aspects can appear together when speaking of bots.

However, only some dimensions of 'the social' seem to be addressed. For example, issues of moderation, messaging, and governance are integrated here, while broader sociopolitical concerns are absent. The main discursive space does not extend naturally to more critical debates such as those found in the cluster on *political and social* dimensions. Instead (see, the lower left corner of Figure 3), these appear to form part of a more distant and separate cluster. Together with the topic on *interactive and automated* aspects of bots, this cluster suggests that there is a more far-reaching rift in bot-related discourse between the practical and regulatory aspects in one space and the political and interactive in another. Furthermore, in the lower right corner of the plot is an overlapping cluster of *human-bot interaction* and *programming*, indicating that the programming topic, likely largely driven by the Stack Overflow dataset, overlaps with many of the key terms in the *human-bot interaction* topic, but that this overlap still does not bridge into neither the more practical and regulatory discourse, nor to the socio-political one. The pattern that is the most difficult to interpret here relates to the positioning of the two topics on interaction (see the dotted arrow in the plot). The positioning of these topics could potentially reflect that the notion of interaction is ambiguous and operates at different levels of meaning across discourses.

CONCLUSION

This article makes two key contributions, where the first one is purely empirical in the sense that it has shown, using KWIC analysis, both that bots are defined differently in different fields, and what these different definitions look like. This insight is expected in the sense that it confirms the likely hypothesis that experts in different areas will define bots based on conventions in their respective domains. The second contribution, made through topic modelling, is more novel as it concretely shows that, when bot definitions from different domains are analysed together, the definitional difference found clearly align with discursive silos that are unlikely to intersect. In other words, the mapping in Figure 3, reveals that bot discourse is not only shaped by domain-specific priorities (cf. KWIC analyses), but that it is also structurally separated into different conceptual clusters. The key difference here, simply put, is that while the KWIC analysis showed *what* the definitional differences look like between domains, the topic modelling and Figure 3 reveal *how* these differences are structured in relation to each other. The key conclusion then is that bot discourse is not only characterised by varying terminologies or different choices of focus but that it is fundamentally fragmented into separate and distinct epistemic spaces with minimal overlap.

This fragmentation has serious implications. First, it shows that while discussions of governance and regulation acknowledge both technical and social aspects, they still do so in a way that excludes any broader political and ideological perspectives. Second, it raises questions about whether policy and design frameworks have the vocabulary for fully taking the socio-political dimensions of bots into account. Finally, the isolation of programming discourse – even if possibly strengthened by the particular character of the selected dataset – can to some degree be said to imply that technical implementations of bots is in many cases treated as a neutral or apolitical process. Taken together, these findings highlight that there is a need for more integrative approaches in research and policy, both to bots in particular and to AI and automation more broadly. The discursive silos can limit interdisciplinary engagement in these areas, indicating that we need more integrative approaches to make sure that issues of automated agency in society are not just shaped within isolated domains but informed by a broad spectrum of perspectives and expertise.

ENDNOTES

1. The regular expression \b(bot|bots)\b ensures that "bot" or "bots" are matched as whole words. The \s+ component guarantees that a space follows these terms. The parenthesis (…) groups various verb variations, covering definitional statements such as "is," "are," "means?," "functions?," "operates?," and "refers?," where s? allows for singular and plural forms (e.g., "means" or "mean"). It also includes descriptors of bots' capabilities like "can" and "will," as well as negations such as "cannot," "can't," "isn't," "is not," "aren't," "are not," "don't," and "do not." The \b word boundary, finally, prevents partial matches, ensuring, for instance, that "can" is detected correctly without also matching unrelated words like "candy."

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