Towards a Theoretical Approach for Analysing Music Recommender Systems as Sociotechnical Cultural Intermediaries

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ABSTRACT
As the rate and scale of Web-related digital data accumulation continue to outstrip all expectations so too we come to depend increasingly on a variety of technical tools to interrogate these data and to render them as an intelligible source of information. In response, on the one hand, a great deal of attention has been paid to the design of efficient and reliable mechanisms for big data analytics whilst, on the other hand, concerns are expressed about the rise of 'algorithmic society' whereby important decisions are made by intermediary computational agents of which the majority of the population has little knowledge, understanding or control. This paper aims to bridge these two debates working through the case of music recommender systems. Whilst not conventionally regarded as 'big data,' the enormous volume, variety and velocity of digital music available on the Web has seen the growth of recommender systems, which are increasingly embedded in our everyday music consumption through their attempts to help us identify the music we might want to consume. Combining Bourdieu's concept of cultural intermediaries with Actor-Network Theory's insistence on the relational ontology of human and non-human actors, we draw on empirical evidence from the computational and social science literature on recommender systems to argue that music recommender systems should be approached as a new form of sociotechnical cultural intermediary. In doing so, we aim to define a broader agenda for better understanding the underexplored social role of the computational tools designed to manage big data.

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1. INRODUCTION
In the age of digital music consumption, we are faced with an overwhelming amount content and choice combined with a growing number of online avenues through which we can access it. Record labels have licensed up to 40 million tracks to digital music providers [18], and with the rise of subscription and ad-supported music streaming services, such as Deezer, Spotify and Apple Music, we have legal access to this licensed music at relatively low cost. Meanwhile, online platforms for user-generated media, such as YouTube, Soundcloud, and Bandcamp, support the profusion of independent music production, which further contributes to the vast amount of content and choice found on the Web [17].

The overwhelming amount digital content makes the act of exploring and discovering new music beyond our known favourites challenging. In response to this, many digital music services provide automated recommendation services which identify content on our behalf. These systems exploit the growing volume, velocity and variety of digital data accumulated by digital music services about how we listen to music online. Indeed for digital music providers, recommendation is now understood as a key mechanism for generating value and distinction in the marketplace, as Universal Music executives explain: '… the main services all offer more than 30 million tracks and have a similar quality and approach. The value comes in what is being placed over the top. It's all about curation, recommendation and influence' (p. 21) [18].

These commercial practices date back to the early 2000s where the lack of content discovery mechanisms in early digital music

services, especially peer-to-peer (P2P) file sharing networks, saw the emergence of one of the first standalone, commercial music recommender service, LastFM. Since then, recommender systems have become central to the services offered by digital content providers. Apple was one of the first digital music download service to develop a recommender system, Genius, which was implemented in their 2008 iteration. In the streaming market, the use of recommender systems is now widespread, with recommendation offered by Pandora, Spotify (whose recommender system is driven by the Echo Nest), YouTube, and Apple Music amongst others.

The case of music recommender systems is an excellent example of the growing availability of complimentary tools designed to help us navigate the overwhelming volume and velocity of content being generated on the Web. Personalised recommendations offered by film streaming sites, such as Netflix, and item-to-item recommendations used by e-commerce sites, such as Amazon, are further instances of how big data and data analytics are driving personalisation and recommendation on the Web [3]. However, music recommendation is a particularly illustrative case because the global digital music marketplace is a highly competitive arena with an overwhelming amount of content and choice, whilst curation and recommendation is recognised by the industry as a mechanism for generating distinction and value within the marketplace [18].

These changes to the dynamics of digital music consumption create many opportunities and raise many questions for both the social and computer sciences. On the one hand with the growing importance of curation and recommendation to the services offered by digital music providers, there is an added incentive for computer scientists to continue contributing to the development of recommendation techniques, which the research community has been doing since the mid 1990s [15, 27, 32].

However on the other hand by exploiting data about who we are and what we do online, these computational systems aim to exercise influence over the culture that we consume: in short, they may come to shape our consumption behaviours and broader cultural tastes [4, 5, 29]. For instance, we might want to consider whether music recommender systems promote cultural omnivorousness and diversity in taste, or whether these systems homogenise our preferences and consumption behaviours. In doing so, we need to understand how recommendation systems negotiate social dimensions, such as class, gender and age, which are traditionally understood to affect tastes and the consumption of culture [33], and whether music recommender systems reproduce social structures in their modelling of consumption patterns, or whether, because of the scale at which they operate, they transcend these boundaries.

The concept of 'cultural intermediaries' was proposed by Pierre Bourdieu to describe the actors involved in the shaping of taste [6]. Initially intended to consider the activities of cultural critics, radio programmers, and advertising professionals in the 1960s, Bourdieu described how these actors drew on their 'feel for the game,' underpinned by deep cultural knowledge and expertise, to support the consumption of specific cultural products, such as food, music and fashion. In recognising some of the similarities with the work of cultural intermediaries, social scientists have begun to examine music recommender systems in cultural intermediary terms [4, 5, 29]. However, there are significant differences between music recommender systems and the conceptualisation of cultural intermediaries originally proposed by Bourdieu [6]. Where once the feel for the game was embodied in an individual, with a lifetime of experience, music recommender systems are complex sociotechnical systems made up of people, technologies, knowledge, data, algorithms and other heterogeneous actors. This raises questions about the dispersal of expertise and influence in music recommender systems and shifts our perspective from the occupational categories of the intermediary to the networked practices of intermediaries.

In particular given the sociotechnical make-up of music recommender systems, we need to consider who or what contribute to the expertise and authority underpinning music recommender systems' role as cultural intermediaries. As humans with embodied forms of knowledge, are the designers and engineers of music recommender system the only sources of expertise and authority, or are there ways in which technological actors contribute to and constrain music recommender systems' influence over the mediation of culture and the shaping of taste? Meanwhile, we need to consider whether these computational systems are external and more objective mediators of culture in comparison to human intermediaries who are socialised actors guided by subjectivity, or are there ways in which social values and norms pervade and regulate the actions of the technological components of a music recommender system?

Without addressing these types of questions, our accounts of how music recommender systems perform as cultural intermediaries and shape the formation of taste will be limited. We are at risk of producing accounts that privilege human agency and reduce technologies to mere artefacts, or fall into technologically deterministic accounts where music recommender systems are positioned as external and objective orchestrators of the consumption of culture. In doing so, we fail account for the fact that music recommender systems are sociotechnical systems dependent upon the contributions of different heterogeneous actors in order to function.

2. AIM & OUTLINE

In this paper we aim to consider if and how we can understand the cultural intermediary role of music recommender systems from a sociotechnical perspective, focusing in particular on how we might better account for the contributions made by both human and technological actors in music recommender system networks. In turn, this provides the foundation on which to empirically examine how cultural intermediaries' cultural match-making is performed differently by music recommender systems, and what impact this has upon the formation of taste.

In order to account for recommender systems' sociotechnicality (its interrelated mix of human and non-human components), we combine Bourdieu's theoretical perspectives on cultural intermediaries [6] with Actor-Network Theory's (ANT) insistence on the relational ontology of human and non-human actors [26, 27].

This paper will demonstrate how this kind of theoretical synthesis is possible and explain how it helps us to more appropriately analyse music recommender systems in cultural intermediary terms. In particular, we will highlight how this theoretical approach can help researchers to analyse how cultural knowledge and expertise is co-created by human and non-human actors, as well as how both humans and technologies can constrain and regulate recommender systems' 'feel for the game' in interpreting culture and taste.

In turn, we will 'test' our theoretical approach by applying it to the analysis of two recommendation techniques, collaborative filtering and content-based recommendation. Using our approach we will unpack how these techniques generate cultural knowledge and expertise, and how their 'feel for the game' in matching items with users is shaped by habitus and the constraints imposed by human and non-human actors. These recommendation techniques serve as compelling case studies because they are established techniques for generating recommendations, and they are widely deployed in the music recommendation domain [21]. In addition, the computer sciences have generated a wealth of empirical research into collaborative filtering and content-based recommender systems [1], and we can bridge these insights with the relevant social science research.

In what follows we develop our argument by introducing Bourdieu's concept of cultural intermediaries in more depth and we examine how this concept has been applied to music recommender systems. We identify the limitations in the existing literature and argue in favour of an approach to the study of music recommender systems which focuses upon the networked practices of intermediaries. We go on explain how synthesising Bourdieu with Actor-Network Theory (ANT) enables us to achieve this and leverage new insights into the cultural intermediary role of music recommender systems. After that, we demonstrate how this approach can be applied using the case studies of content-based and collaborative filtering recommendation.

3. THE CONCEPT OF CULTURAL INTERMEDIARIES

Cultural intermediaries is a conceptual term originally defined by Pierre Bourdieu to include '... all the occupations involving presentation and representation' (p. 359) of cultural goods and services [6]. They are the professional taste makers and 'vendors of symbolic goods' (p. 310-311), such as advertising and marketing material, magazine reviews and editorials, and lifestyle advice and pedagogy, located in the space between the fields of cultural production and consumption. They mediate cultural goods and ideas to new economic and social spheres, creating the conditions for consumers to identify their tastes in cultural goods.

In the 1960s when Bourdieu was writing, cultural intermediary occupations included the producers of cultural programmes in radio and television, advertising and marketing creatives, as well as press attachés, public relations officers, critics, museum curators and gallery directors. In addition to the occupations found in the market-orientated cultural industries, Bourdieu's concept of cultural intermediaries extends to the 'helping professions,' such as therapists, vocational coaches and counsellors, who similarly promote and shape 'lifestyle' choices [14].

The concept of cultural intermediaries emerges out of Bourdieu's broader theoretical framework, which is defined by the concepts of capital, habitus and field. Cultural intermediaries are contextualised actors operating within a field of relations, such as the literary field or field of popular music. Cultural intermediaries' authority in the field is based upon their accumulation of cultural capital combined with their position in the marketplace [29]. Capital refers to the forms of 'accumulated labour' (p. 241) that are valued as an asset in relation to the field, and capital can be divided into social (interpersonal networks), economic (wealth and financial assets), and cultural capital (valued experience and education) [7]. Cultural capital can be accumulated through the institutionalised pathways of higher education, as well as embodied through participation in cultural life, such as music critics attending concerts.

Meanwhile, cultural intermediaries' positioning and actions within the field are regulated by habitus. Habitus can be thought of as the system of structuring, structured dispositions constituted in practice [6]. This refers to the dialectic between structure and agency, the negotiation between individual agency and the historical norms and value that structure society which generate and organise individual and collective practices [8]. Habitus forms the basis for an intermediary's perception and appreciation of culture, their 'feel for the game,' and their schemes of perception and appreciation manifest in unconscious, unwilled avoidance behaviours [28].

Combining their expertise and 'feel for the game,' cultural intermediaries produce symbolic goods and services, such as marketing material, fashion and lifestyle magazines, or the production of radio and television programmes [6]. These symbolic goods and services result in the production and framing of symbolic value in relation to specific cultural activities [14]. The framing of symbolic value refers to the way in which these occupations 'forge a sense of identification' (p. 505) between the cultural product and its potential consumer [30]. This manifests in the imparting of forms of knowledge, expertise and skills in support of the consumption of specific cultural products, such as food, music and fashion.

4. MUSIC RECOMMENDER SYSTEMS AS CULTURAL INTERMEDIARIES

The social science research examining music recommender systems in cultural intermediary terms focusses upon how recommender systems are changing the process of 'cultural intermediation' and the work that cultural intermediaries do [4, 5, 29]. For example, Morris [29] argues that recommender systems '… shape taste and derive legitimacy in a different manner than cultural intermediaries' (p. 456). They mediate culture in a discrete and organisational fashion through the collecting of data about listening behaviour and musical content. In addition, their legitimacy to operate as cultural intermediaries is, in part, derived from both the '… cultural knowledge of those creating the databases and algorithms, but also on the size and scope of the databases and the efficacy of the algorithms themselves' (p. 456).

Morris' work illuminates some of the ways in which music recommender systems are changing the process of cultural intermediation and how cultural intermediaries' legitimacy might be derived in different ways. These insights are useful in

informing future research into how music recommender systems are shaping the formation of taste. For instance, it draws our attention to how cultural intermediation is performed more organisationally and we might want to consider whether these systems shape tastes in similarly categorical ways. However, Morris does not address how these changes to the process of cultural intermediation have materialised in the form described in this work and who and what have contributed to and enabled this.

By thinking in terms of the networked practices of intermediaries, we can unpack how these changes to the process of cultural intermediation materialise and who and what enable this change. For example by tracing the associations formed and the contributions made by different human and non-human actors, such as the decisions made by designers and engineers, the statistical models and the machine learning classification approaches, and the information filtering algorithms used, we can explain how the cultural intermediation performed by music recommender systems is more 'organisational' and in what specific ways. Meanwhile, Bourdieu's concept of habitus can help us to consider whether structural norms of the field are inscribed in this technology and how it shapes the organisational and 'objective' intermediation performed by music recommender systems, such as whether the clustering of users with similar listening behaviour reproduces class norms in musical taste.

Beer [5] further emphasises how these intermediary systems are more embedded and operate discretely as part of larger 'technological unconscious,' borrowing a term coined by Thrift [37] According to Beer [5], this notion refers to the active technological environments and infrastructures that '… operate without the knowledge of those upon whom they are taking an effect' (p. 990). Focusing upon the algorithms' role within the technological unconscious, Beer conceptualises these actors using Lash's [23] notion of 'post-hegemonic power,' arguing that they operate as a generative power from within through determining what to include and exclude in our cultural landscapes [5]. Beer discusses how this 'power through the algorithm' (p. 991) can be seen in the context of the social networking platform and music recommendation service, LastFM, where information about individuals' music preferences and attitudes is harvested in order to algorithmically shape auditory and cultural experiences.

Although Beer's work provides us with a means for conceptualising the way in which algorithms are embedded in a larger technological infrastructure and might discreetly exert power over our auditory and cultural experiences, it does not consider what the basis of the algorithms' power and authority might be and how different human and technological actors contribute to it. However by using Bourdieu's concept of cultural capital combined with thinking in terms of the networked practices of intermediaries, we can unpack this. As cultural intermediaries' authority over the mediation of culture and shaping of taste is underpinned by their accumulation of cultural capital, we need to understand what forms of cultural capital music recommender systems are in possession of and how it is accumulated. In order to address this, we can think in terms of the networked practices of intermediaries and consider how different heterogeneous actors contribute to the accumulation of music recommender systems' cultural capital.

Some progress has been made in examining music recommender systems as cultural intermediaries but we have highlighted some limitations in this work. In particular, this literature does not fully consider how both human and technological actors affect how music recommender systems perform as cultural intermediaries, which is an oversight given the sociotechnical make-up of these systems. In the next section, we explain how we can approach the study of music recommender systems in terms of the networked practices of intermediaries. In particular, we explain why Bourdieu's theories alone are not adept enough for analysing music recommender systems in this way and explain how Actor-Network Theory (ANT) enables us to accomplish this.

5. PROBLEMATISING BOURDIEU AND SOCIOTECHNICAL SYSTEMS

Although Bourdieu's theoretical framework might provide us with a way in which to unpack the substance of music recommender systems expertise and 'power from within' [5], through the concept of capital, and it might allow us to consider how the values and norms of the field structure the 'organisational' decisions made by music recommender systems [29], it does not enable us to consider how both human and technological actors contribute to and are affected by these. In particular, Bourdieu privileges human agency over the technological and his proposition that technology is an objectification of cultural capital is particularly problematic [28]. Whilst this helps Bourdieu explain how cultural consumption and taste is one of the drivers of social distinction and class domination [6], where our access to and grasp of technology is a reflection of our accumulation of economic and cultural capital, it is problematic because it demotes technology to symbolic projections of capital, and fails to engage with the specific sociomaterialities of technologies themselves.

In particular, this conceptualisation fails to consider how technologies enable and constrain action [2]. The form in which technologies - materialisations of human capital in Bourdieusian terms - take is shaped by the affordances and constraints of what it technologically possible at a given point in time. For example, the actions of a person developing a piece of software is affected by the constraints of programming languages and logic, as well the memory and processing capabilities of their computer hardware. Because of this, technology has agency to affect outcomes in the both the material world (how the software runs) and the social world (how the person designs it). This means that the way in which cultural intermediation is performed by music recommender systems is enabled and constrained by technological actors. Therefore, we need to be more attentive to the contributions of *both* human and technological actors when we are analysing music recommender systems as cultural intermediaries

By drawing upon ANT's insistence upon the relational ontology of human and non-human actors and combining this with Bourdieu's theoretical framework, we argue that we can successfully involve both human and technical actors in the study of music recommender systems as cultural intermediaries. We will now briefly outline the relevant features of ANT and explain how these can be combined with Bourdieu's theoretical perspective. We will then go on to apply this theoretical approach to our case studies of collaborative and content-based recommendation.

6. INVOLVING TECHNICAL ACTORS

Actor-Network Theory (ANT) proposes that society and technology are the effect – the outcomes – of networks of human and non-human actors which work together to make society form and function [25, 26]. Actors are also actor-networks, meaning every actor within a given actor-network can also be broken down into its constituent group of actors. There is a commitment to viewing society as being made of heterogeneous networks, and no methodological distinction between human and non-human actors is made.

As well as bringing non-human actors into the frame of reference, ANT is super-symmetric, meaning no actor, human or non-human, is privileged *a priori* over others, and actors exist in heterogeneous networks, not hierarchical orders [36]. This allows ANT to consider technologies as actants, rather than artefacts, and it can help expose the way in which technology enables and constrains action.

At first glance, it may seem that combining Bourdieu and Actor-Network Theory will end up in 'conceptual negation' due to the some of the fundamental differences between these two conceptual standpoints [31]. There are several privileged concepts in Bourdieu's framework, such as capital and habitus, which, for some, do not sit well with ANT. For example, Callon, one of the early proponents of ANT, states his opposition to Bourdieu's understanding of power, which Callon argues is not an accumulation of capital, as Bourdieu understands it, but an effect of heterogeneous networks [10], and Latour similarly argues that power is not a property of humans, but a chain of associations between human and non-human actors [25].

However despite some of their differences, there are precedents for combining Bourdieu and ANT and scholars have recognised the potential gains to be made by combining these approaches. For example, Halford and Savage [16] note in their reconceptualisation of digital social inequality that the presumed opposition between Bourdieu and ANT is typically based upon the emphasis of particular features in each but that common ground can be found between them. Halford and Savage identify the performative qualities of Bourdieu's framework and Actor-Network Theory as one bridge between these two perspectives. Performativity is understood in relation to Butler's [9] theories on gender identity and it refers to the way in which structure and relations between things, such as gender, come about through performing and doing, rather existing as a pre-determined order.

The performativity of ANT manifests in the way in which materiality is actively constructed through the formation and translation of associations amongst heterogeneous actor-networks; things only exist if these associations are actively maintained. Meanwhile, the performativity of Bourdieu's theoretical framework manifests in the notion of 'practice,' where the structures of society (for example, class divisions) and symbolic meaning come about through practice, and these are sustained through habitus and the regulation of practice [8]. And the same applies for capital: '[capital] only exists and only produces its effects in the field in which it is produced and reproduced' (p. 108) [6].

The performative qualities of ANT and Bourdieu can be usefully combined to attend to how music recommender systems are performatively constructed and stabilised as an actor-network, and how this performativity is both a product, and producer of, a music recommender system's positioning as a cultural intermediary. In doing so, we are able to better account for the contributions made by technical actors to the process of cultural intermediation, and these contributions are considered, in principle, on an equal footing to the actions of human actors in a music recommender system.

Meanwhile, ANT is often criticised for failing to consider the cultural context in which actors operate and make decisions [48]. For example in relation to music recommender systems, pedagogic traditions of computer science, the notions of trust and technical judgement amongst engineers, and the culturally institutionalised schemas for analysis and perceiving musical content, may be overlooked by ANT. However, Bourdieu's theoretical framework has been identified as a way in which to help overcome this criticism made of ANT, allowing us to bring the cultural context and subjective forces back into the fold. For example, Prior [31] notes how ANT allows one to recognise the interrelations between human and non-human actors in socio-technical systems, and Bourdieu allows one to acknowledge how sociotechnical systems accrue symbolic validity in the field of relations.

7. A THEORETICAL APPROACH TO SOCIOTECHNICAL CULTURAL INTERMEDIARIES

This paper has presented a high-level understanding of how we can synthesis Bourdieu's theoretical framework with ANT, but we will now focus upon how these two theoretical perspectives can be synthesised for the specific purposes of examining how music recommender systems accumulate cultural capital, and how the actions of these systems are regulated by the structural norms of the field.

As part of this synthesis, we discuss the cases of collaborative filtering and content-based recommendation and we highlight how we can analyse these types of recommender systems in cultural intermediary terms. Collaborative filtering and content-based recommendation are foundational techniques widely deployed in music recommendation [21]. Collaborative filtering takes user ratings in order to generate recommendation lists based upon the predicted likelihood of a user rating a new item based upon the rating behaviour of similar users [19]. 'Rating' is a generic term used in recommender system vernacular to refer to some kind of transaction between a 'user' and an 'item.' Meanwhile in content-based recommendation, correlations between the objective characteristics of items and users' preferences serve as the basis for recommendations. In order to achieve this, item profiles containing characteristic information about a piece of music have to be constructed. Groups of similar items of music are identified by evaluating the overlap between item features [19].

7.1 The Delegation of Capital Accumulation

The first part of our theoretical synthesis combines Bourdieu's emphasis on cultural capital as the accumulation of labour, with ANT's attention to how labour is delegated amongst human and non-human actors in particular networks. The purpose of this

section is provide a means for unpacking how a music recommender systems' cultural capital might be accumulated by both human and technological actors.

If according to Bourdieu capital is the accumulation of labour, we can draw upon ANT to think about how labour is dispersed in a sociotechnical system in a super-symmetric fashion. 'Delegation' is a notion introduced by Latour, an ANT theorist, and it helps explain how labour is distributed amongst an actor-network [24]. Delegation of work reflects a '… transformation of a major effort into a minor one' (p. 154) meaning work is delegated to a non-human in the actor-network because the effort required for humans to achieve it is greater, and the same applies for when work is delegated to human actors. Therefore, the recommender system's deployable cultural knowledge – its cultural capital – is a product of its delegated labour, where both human and non-human actors co-constitute its cultivation.

As part of applying this theoretical approach, we would first need to identify what music recommender systems' cultural capital is: in other words, what valued cultural assets does a music recommender system possess. This would involve finding out why we trust music recommender systems to help us discover music, or why do digital music services implement them. With these insights to hand, we can apply this theoretical approach in order to unpack how different human and technological actors contribute to the accumulation of this cultural capital.

This paper will now apply this part of the theoretical approach to the case studies of collaborative filtering and content-based recommendation. We hypothesise that music recommender systems' cultural capital takes the form of their knowledge the overlap in users' tastes, as well as their content-based knowledge and the relationships between different styles of music.

7.1.1 How Do Music Recommender Systems Delegate Capital Accumulation?

The information domain of a collaborative filtering recommender system consists of users and ratings. Collaborative filtering works by generating and comparing ratings of different users in order to find content that a given user is likely to rate [19]. Firstly, human actors (users) contribute insights into their tastes through the rating of items, a process which is guided by their subjective outlooks (habitus) and familiarity with culture (cultural capital). Common examples of ratings include like/dislike, numerical scales, purchases, as well as implicit feedback such as viewing and listening behaviour. For example, YouTube's recommendation system combines data implicit ratings (view counts) with explicit ratings ('liked,' rated, or added to playlists) [12].

At the same time, the recording of user ratings is enabled by the contribution of non-human actors, such as the user interfaces and ranking systems (for example, 'like' buttons or star ratings) and the databases storing the information needed to construct taste profiles. Furthermore with this information to hand, mathematical actors, such as the cosine similarity metric or the 'Pearson *r* algorithm' traditionally used in collaborative filtering [35], calculate the similarity between the ranking behaviour of two or more user profiles, allowing the system to predict how a user might rate an unseen item. This knowledge of user similarity and predicted ratings serves as the basis for generating recommendations using the collaborative filtering technique [19], and the constitution of its cultural capital as we understand it in this hypothetical scenario. The labour required for a human actor to achieve this at the scale required of a commercial recommender system is greater than delegating it to a mathematical actor.

Meanwhile, content-based recommendation works by creating item profiles, which contain characteristic information about an item, and comparing this to the preferences of users. There are a variety of ways in which item profiles can be constructed. In some systems, the task of producing music metadata is delegated to human actors. For example, LastFM use user-generated tag clouds to produce rich artist and track metadata [22]. However even in the case of LastFM non-human actors are often implicated in the compiling of user-generated metadata. For example, some systems cluster tags together in order to support navigation and discovery. Tag similarity is typically determined by measuring tag co-occurrence. In order to achieve this, mathematical actors, such as Jaccard, Overlap, Dice and Cosine distance similarity measures, are used to calculate tag similarity [22].

Other systems, such as the Echo Nest (the recommender system owned and used by Spotify) rely upon more computationally driven approaches to music metadata generation, using music information retrieval (MIR) techniques in order to extract content descriptors [21]. For example, services such as the Echo Nest analyse audio signal behaviour in order to identify features such as tempo, mode and timbre, and they also scrape Web pages, such as recognised music blogs, and apply natural language processing techniques to identify key terms [38]. The MIR process requires computers to perform signal processing and analysis, but also relies upon human actors to determine the schema with which content is described as well as produce the content of the Web pages which are scraped in the first place. With this kind of knowledge about items, content-based recommender systems identify the items that a user likes and compares the profiles of these items with other profiles in order to generate 'similar' content. The process of identifying similar items can equally be treated as the outcome of the labour of a range of human and non-human actors.

These represent some of the ways in which music recommender systems delegate the accumulation of cultural capital amongst human and non-human actors. The second part of our theoretical synthesis combines Bourdieu's emphasis upon how structural norms and value regulate practice through habitus with ANT's consideration for how technological affordances and constrains regulate action. The aim of this section is to provide a framework for examining how structural norms and values might pervade and regulate the actions of music recommender systems.

7.2 The Distribution of Regulated Practice

In Latour's discussion of the delegation of labour, he picks up upon an interesting feature which relates to the regulation of human and non-human action [24]. Latour notes how, through delegation, non-human actors take on the '… selective attitudes of those who engineered them' (p.158), which results in the prescription of certain actions and effects. At the same time due to super-symmetry, technology also regulates the action of those

who form associations with it, and Latour borrows a concept from Akrich [2], known as 'prescription,' to explain this effect. Akrich argues that machines have been delegated ethics, values and duties and these are relentlessly, due to their mechanistic qualities, and silently prescribed back to the human.

To use technology, then, one has to act in a certain way in accordance with technology's design and engineering, and this design and engineering is the effect of the delegation of labour. Latour describes this process as a 'distribution of competences' [24].

The habitus effect of the distribution of competences is significant because habitus guides the work of cultural intermediaries and the accumulation of cultural capital. Habitus forms the basis for the perception and appreciation of culture, its 'feel for the game,' and this manifests in unconscious, unwilled avoidance strategies, such as the '… avoidance of "bad company" or "unsuitable books"' (p. 61) [6]. It regulates the cultivation of knowledge and the accumulation of cultural capital, which in turn, affects how individuals perform as cultural intermediaries.

Latour's notion of the 'distribution of competences' is useful for thinking about how habitus is distributed in sociotechnical systems and how this comes to regulate human and non-human actions. We can then use this as a basis for explaining how music recommender systems reinforce or deviate from the structural norms of the field and we can consider what impact this 'feel for the game' has upon the shaping of taste, such as whether it reinforces the gendering of musical tastes.

This paper will now examine how the distribution of competences manifests in collaborative filtering and content-based recommender systems and how this relates to Bourdieu's notion of habitus.

7.2.1 How Are the Actions of Music Recommender Systems Regulated?

In collaborative filtering recommendation, the designers and engineers' habitus will guide the decisions in determining behaviour of the information filtering algorithms. For example, it is possible to constrain collaborative filtering algorithms to treat rankings in particular ways. In designing the Ringo music recommender system, Shardanand and Maes [35] created a 'constrained Pearson *r* algorithm' which was designed to increase the correlation co-efficient when two users either both rate an item positively or both negatively. On the one hand, this highlight how selective attitudes can be inscribed in the technology, whilst on the other hand, these decisions have been constrained by what can be expressed in programming languages and logic.

In the case of content-based recommendation, the distribution of competences and the regulatory effects of habitus also affect the classification of content. For example, the social tagging system of LastFM is regulated by habitus in the forms of users' notions of what constitutes a genre and how genres and artists are related to one another – their 'classificatory imagination' (p. 998), as Beer [5] describes it. This knowledge is affected by the norms of the field, which have been internalised by the habitus, as well as one's knowledge and familiarity with different styles of music [33]. Using user-generated tags, it is possible to use genre folksonomies to create genre hierarchies by measuring tag frequencies and tag similarity [22]. In affecting how genres and their relationships are defined, these structural norms have the potential to pervade the system, regulating how content is classified and, therefore, how recommendations are generated.

Returning to the use of music information retrieval and signal processing techniques for content-based recommendation, constraints are also imposed upon the system by both human and non-human actors. MIR methods are built around the relationship between the behaviour of the audio signal and musical characteristics this behaviour represents [11, 34]. For example, the subjective notion of 'emotive' can be paired with a set of machine-readable spectrographs to allow a machine to bring semantic meaning to the features it extracts [38]. The signal processor, as a non-human actor, introduces constraints in the form of the features of the audio signal it can analyse (typically, signal frequency, amplitude, bandwidth, evolution and on-set detection) [11, 34]. The computer scientist, as a human actor, shapes the way in which music is classified by determining the high-level, subjective semantics of the audio content [20]. The computer scientists' notion of what constitutes 'emotive' and how it relates to music is shaped by the norms of the musical field and the ways in which music and emotion have historically been associated.

These represent some of the ways in which habitus regulates the actions of the different human and non-human actors that comprise a music recommender system. In cultural intermediary terms, the constraints of these human and non-human actors affect how it derives its 'feel for the game' in making sense of the cultural field.

8. CONCLUSION

This paper has presented a theoretical approach which aims to better account for music recommender systems' as cultural intermediaries. In order to achieve this, our theoretical approach has combined Bourdieu's theories of cultural capital and habitus with Latour's notion of distributed labour and competences.

This approach enabled us to examine in detail how the cultural capital needed to perform as a cultural intermediary can be accumulation through the labour of both human and technological actors, and how the structural norms and values that are internalised through habitus pervade and regulate the behaviour of music recommender systems. This allowed us to explain the basis of music recommender systems' expertise and authority, and how these systems are contextualised within a structured field of relations rather than operating as a kind of objective 'higher order.' The case studies of collaborative filtering and content-based recommendation systems were used to demonstrate this. We highlighted some of the ways in which knowledge of culture and taste is co-created by a range of human and non-human actors associated with these types of recommendation techniques, as well as how both humans and technologies can constrain and regulate the actions of recommender systems in a habitus-like fashion.

In future research, we will go on to empirically examine how music recommender systems' impact upon the way in which cultural intermediation is performed and how this shapes tastes

and influence perceptions toward music. This will include an examination of whether recommender systems promote cultural omnivorousness and the diversification of taste, whether these systems breakdown divisions and homogenise taste, or whether they reinforce existing tastes for particular styles of music. Alternatively, we could examine how music recommender systems are shaping the role of music in everyday life [13]. For instance, we might ask whether music recommender systems are changing how and what music we associate with emotional contexts, such as relaxation or sadness, or whether they are changing how music is used as part of specific activities, such as exercising or at social events. This is of particular relevance given digital music services' innovation in the use of context-aware recommendation and the curation of content around specific moods and activities, such as exercising, studying and entertaining.

This research would be underpinned by the theoretical approach presented here and it will allow us to examine how different human and non-human actors contribute to these specific social effects. Focussing upon the question concerning music's role in everyday life, we can examine how music recommender systems' cultural capital is operationalised in shaping the consumers' perception of the relevance of particular styles of music to particular emotional and activity-related contexts, and consider how the regulatory effects of habitus and technological constraints guide this outcome. For instance, we can consider how this outcome is affected by the data users' provide about the types of music they like to listen to and the devices recording where and when music is listened to; music content analysis and the generation of metadata, such as measures of a song's loudness, energy, speed and timbre; and the decisions made by designers and engineers in determining how to represent and model context. This would allow us to more fully unpack how the sociotechnical composition of music recommender systems impacts upon the role of music in everyday life.

Methodologically, these insights could be leveraged through qualitative research. This could begin with focus groups and interviews with music recommender system users in order to ascertain the impact music recommender systems have upon individuals' perceptions of their own tastes, or music's role in their everyday lives. This would include a consideration for the ways in which the systems' knowledge and expertise (cultural capital) in match-making music and taste is valued by listeners and on what ground they deemed trustworthy and credible; what motives their use of music recommender systems; and how reflexively aware users are of the data which they provide about their listening activities. Alternatively, more longitudinal qualitative insights could be gained through diary-keeping exercises, where participants are invited to reflect upon their engagement with recommender systems and digital music services and consider how it has affected their listening behaviour and perception of music.

Meanwhile in order to help triangulate how the contributions of different human and non-human actors affect these outcomes, 'supply-side' ethnographic research and expert informant interviews with designers and engineers, combined with insights from the secondary computer science literature, could be employed. This would include questions regarding how the data provided by users is used; what effect different algorithmic techniques and modelling decisions have upon the generation of recommendations; and how human and non-human actors constrain the design and implementation of music recommender systems. This fieldwork would be especially useful for trying to understand how human actors, such as designers and engineers, inscribe values in the technology through habitus, and how technology enables and constrains this inscription. Using the theoretical approach presented in this paper, we can then go on to bridge these insights with those generated in the other qualitative research.

These suggestions for future research point to some of the important questions regarding our changing understanding of what it means to be a cultural intermediary and the impact they are having upon the shaping of taste. These suggestions also highlight the contributions that our theoretical approach can make. With a more refined understanding of what it means to be a cultural intermediary, we can continue to use the concept as a lens through which to examine the changing dynamics of cultural consumption encountered in the era of big data and data analytics.

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