

# Online Knowledge Bases and Cultural Technology: Analyzing Production Networks in Korean Popular Music

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## Abstract

The meticulously internetworked structures of prominent K-pop groups and companies are a key aspect of “cultural technology,” the successful and sometimes controversial system for developing internationally appealing entertainment products pioneered by S.M. Entertainment, a K-pop firm, under the direction of its founder, Lee Soo-man. To examine the formation of “production networks” within Korean popular music over time, we applied network analysis techniques to records in online data archives describing ~4,800 individuals, groups, and companies associated with recent Korean popular music, especially K-pop. Network analyses focusing on specific time intervals can reveal prominent individuals, groups, and larger sub-networks in the Korean music scene during the global rise of K-pop over the past 20 years, shedding light on the comparative structures and scales of these production networks and their changes over time, as well as enabling comparisons between K-pop and more “independent” sub-fields of Korean popular music.

This study drew its data from large-scale public, moderated knowledge bases, specifically MusicBrainz, DBpedia, and Freebase. Automated methods for data extraction, rectification, and analysis were necessary given the expansive nature of the available information about K-pop. Records of specific artists, groups, and companies were extracted via queries to public REST APIs and SPARQL endpoints, and semantic relations as defined in the archives’ Resource Description Framework (RDF) ontologies were mined to build inter-entity connections such as group memberships, artist collaborations, distribution agreements, and recording contracts, as well as to assign date ranges and to restrict the network from growing beyond the immediate realm of Korean popular music. The existence of unique identifiers for entities in the

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knowledge bases was a crucial facilitator of this work, as was the presence of semantic relations enabling the correlation of entities across knowledge bases.

After assembling the data set, we applied network analysis techniques to extract relevant statistics about the resulting meta-network at regular time intervals. These statistics included total nodes and edges, diameter, clustering coefficient, number of connected components, average shortest path between nodes, and the average number of neighbor nodes. We also ranked the entities in the meta-network according to various centrality measures: node degree, betweenness centrality, closeness centrality, and eigenvector centrality. Software analyses for detecting prominent clusters of nodes aided in subsequent explorations of the structure of a given network.

The most noteworthy features we observed in the derived production networks of Korean popular music over time were its explosive growth in scale and interconnectedness from approximately 2005 to the present, and the extreme prominence of K-pop organizations—particularly S.M. Entertainment and its premiere idol groups—during this time. The high rankings of S.M.’s groups, especially in eigenvector centrality, were largely a result of the company’s practice of orchestrating collaborations and fabricating subgroups and “supergroups” among its artists, which could be characterized as a form of deliberate “network engineering” to boost its members’ prominence. The apparent resilience of non-idol Korean popular music performers in the age of K-pop was also noteworthy, indicating the flourishing of a largely “fringe” but nonetheless vibrant network of independent bands and labels, at least as signaled by contributors to online knowledge bases.

In the course of our research, we discovered that no single online source provides full or representative coverage of all genres and eras of Korean popular music. In fact, the datasets we considered exhibit marked biases for particular musical styles and time periods, with the preponderance of online data favoring recent artists and groups from the K-pop mainstream and, to a lesser degree, other forms of popular music from the 1990s and later. It is therefore important to note that the networks derived from these sources likely reflect the biases of their contributors, who on the whole tend to belong to the same youthful, internationalized demographics that were the primary target of K-pop’s limb of the “Korean Wave.” We did indeed confirm the existence of older genres and styles in a number of digital archives with limited computational access that cater to audiences who are less focused on K-pop; an exploration of these archives remains a possible subject of our future work. We also investigate but largely leave to further research the prospect of comparing the meta-networks of Korean popular music to those of other national and regional “scenes.”

# 文化科技與線上知識庫—— 韓流音樂之生產網絡分析

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## 摘 要

由當紅的韓國流行音樂團體和公司所構成的複雜且精細的交互網絡結構，可以視為「文化科技」的一個重要面向。雖然時有爭議、卻也是一個發展出具國際吸引力的娛樂產品的成功體系，其中由創始人李秀滿所領導的 S.M. 娛樂有限公司，更是帶動韓流席捲全球的先鋒。為了檢視韓國流行音樂產業的「生產網絡」如何形成，我們應用網絡分析技術，分析從線上資料庫所擷取的紀錄。其中的檔案清楚呈現大約 4,800 個與目前韓國流行音樂相關的藝人、團體、與公司等資料，特別是與「韓流」有關的偶像團體及經紀公司。網絡分析鎖定特定時間區間內中當紅藝人、團體、及其所形成更大的子網絡，有助於我們解讀韓國流行樂壇動態，以及過去 20 年韓流在全球崛起的現象。同時也可了解生產網絡規模、比較性結構，與經歷時間上的變化，進行韓國流行音樂與相對獨立的類型音樂之比較研究。

本研究所使用的大量資料，都是從 MusicBrainz、DBpedia 和 Freebase 等具規模的公開知識庫取得。基於韓流相關資訊快速增加的特性，使用自動化方法來進行資料擷取、修正、分析，自然有其必要性。我們藉由一些公開的具象狀態傳輸的應用程式介面（REST API）、以及可接受 SPARQL 協定的服務端點，從公開資料庫中針對特定的藝人、團體和公司進行查詢並擷取資料。然後依照資源描述架構（RDF）所定義的本體論，挖掘出檔案中的語意關係，以便建構出實體間的互相連結（如團體成員、合作藝人、分配約定與唱片合約等）；同時也可以指定日期區間，限制檢索條件，避免超出韓國流行音樂直接影響的範圍。為知識庫中的個別實體建立專屬標識碼是促成本研究成功的關鍵，即呈現跨知識庫中個別實體間的相關性。

蒐集彙整所需的資料之後，我們應用網絡分析技術來提取相關的統計資料，來找出固定時間區間的詮釋網絡。這些統計資料包括所有的節點和邊、直徑、群聚係

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數，連接組成元素的數量、節點間平均最短路徑，以及相鄰節點的平均數量等。我們也根據不同的網絡中心性的量度值：節點分離度、中介中心性、接近中心性、特徵向量中心等，並將詮釋網絡中的個體排序。輔以檢測突出的節點群集的程式分析，以便探索特定的網絡結構。

從所擷取出的韓國流行音樂生產網絡，我們觀察到 2005 年至今，除了規模上大幅成長，互相間的關聯也隨著時間增加，及韓流團體的優異表現（其中尤以 S.M. 娛樂公司及旗下當紅偶像團體特別顯著）。S.M. 娛樂有限公司所屬團體在網絡中心性（特別是特徵向量中心性）的高排名，其結果乃是這家公司不斷讓旗下藝人在子團與母團間來回進出的操作結果，因此我們可以將其認定為藉由「網絡工程」推波助瀾，來提高其成員重要性的一種型式。值得一提的是，韓國非偶像的流行音樂表演在韓流時代所展示的強大韌性，從大量的獨立樂團和唱片公司的蓬勃發展，現象顯示即使身處「邊緣」卻仍然充滿活力，至少我們能從線上知識庫中看得出來。

在我們的研究過程中，我們發現並沒有能提供涵蓋全部或代表韓國流行音樂流派和時代的單一線上資料庫。事實上我們選取的資料庫，呈現特定的音樂型態與時代，出現明顯的偏差。相較於 1990 年代以來的流行音樂形式，這些線上資料庫則往往偏好近期的韓流主流藝人與團體。尤其值得注意的是，從這些來源資料所擷取的網絡，常常反映了資料提供者的偏見。整體而言，往往就是年輕與國際化的族群，也就是「韓流」主要族群。從某些特定數位典藏資料庫（特別是極少能以自動化方式取用、針對不是太關注韓流音樂的使用者而設計的資料庫），我們的確證實了某些舊類型的存在。對這些檔案的探索，仍然是我們今後研究的可能議題。本文雖然也稍微探討韓流音樂與其他國家網絡或區域網絡的結構面比較，但這部分將留待未來繼續研究。

# 1. Introduction

On January 27, 2016, Lee Soo-man, founder of the prominent South Korean company S.M. Entertainment, announced the next phase of his firm's efforts to expand the scale and reach of its K-pop ventures, introducing a strategy which he dubbed "New Culture Technology." The core innovation of this strategy would be an international network of boy bands based in various countries, including Korea, Japan, and unspecified nations in Southeast Asia and Latin America. (Jackson, 2016) Compared to their Korea-based "idol" group predecessors, these networked boy bands, collectively named NCT, would feature more fluid memberships and localized operations, thereby fostering greater cultural and linguistic integration with their home regions. In Lee's estimation, these developments represented the next phase of S.M.'s vaunted and at times controversial "Cultural Technology" system of recruiting talent and producing internationally appealing entertainment products, (Seabrook, 2012) as well as the next phase of K-pop groups' contribution to the "Korean Wave" (*hallyu*)—the multi-pronged, government-backed strategy to develop and project aspects of Korean popular culture internationally as a form of economic and cultural "soft" power.<sup>1</sup>

Lee's announcement, as well as its coverage in the popular press, highlights the central role that network models play in the conceptualization of K-pop. Commentators immediately pointed out that the NCT concept represented only an incremental update to pre-existing strategies of artist/group inter-networking at S.M. as well as other K-pop companies, most notably its rival YG Entertainment. (Herman, 2016) Such techniques included the temporary division of larger groups into subgroups, the somewhat rarer aggregation of members from multiple groups into "supergroups" for special events, and the formation of dedicated subgroups targeted at specific foreign markets, such as S.M.'s Super Junior-M and EXO-M, both designed to appeal to audiences in China. Indeed, the meticulously fabricated and interconnected structures of K-pop's premiere idol groups—both within the bands and to their "labelmates" in the larger K-pop scene—is one of the genre's most salient features, forming a stark contrast to the ostensibly organic and impromptu organizations of groups in "independent" music scenes.

The characteristically "network-minded" nature of K-pop suggests network analysis as a productive analytical method for understanding aspects of the domain.<sup>2</sup> For this study,

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1 See Sangjoon Lee and Abé Mark Nornes, *Hallyu 2.0: The Korean Wave in the Age of Social Media* (2014), who note that the global popularity of K-pop can be viewed as a second Korean wave, distinguished from the international successes of Korean films and television dramas by its reliance on extended web technologies such as social networking and streaming media—a shift likely prompted in part by declines in sales of physical media formats.

2 We use the generally accepted definition of K-pop as the subset of Korean popular culture, traceable to the early 2000s, that highlights the visual appeal of so-called idol groups and features an international fan base,

we combine automated data mining techniques with network analysis to reveal relational structures among entities numbering in the many thousands. We focus on automated methods since assembling and studying the data manually would not be effective given the expansive nature of K-pop; non-automated approaches are more suited to the study of the dynamics of relatively small cultural fields (e.g., “subcultures”). To facilitate this study, we extracted relational structures from online archives for ~4,800 individuals, groups, and companies in K-pop and the broader scene of Korean popular music. We believe that the relationships between performers, groups, and music companies across the field of Korean popular music production extracted in this manner shed light on the comparative structures and scales of these “production networks” and their changes over time. This quantitative data in turn supports more qualitative assertions about Korean pop-cultural production, which recently has become an object of intense fascination for scholars, music critics, and the public internationally.

Recent developments in humanities scholarship, online technologies, and K-pop itself have made macroscopic methods such as network analysis possible. The international aspirations of K-pop and its resultantly transnational fandom communities have produced a wealth of data in online archives. These resources exist in Korean as well as in English, the “international language” of youth-oriented cultures in Asia and beyond. This internationalization trend has reinforced and, in turn, been reinforced by online technologies, which provide non-traditional channels of creating, mediating, spreading, and sharing knowledge about a scene’s performers and companies, unbounded by national borders. Indeed, it is no accident that K-pop, with its non-traditional channels of knowledge production and cultural affiliation, has been a natural “fit” for media studies scholars, who tend to be inclined toward primarily data-driven, audience- and fan-oriented research.<sup>3</sup> The application of a wide

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generous state support and promotion, new digital routes of mediation, and intimate connections to non-musical cultural commodities and forms of consumption. By contrast, we consider “Korean popular music” to indicate popular forms of music loosely organized around genres that cater to mostly domestic audiences. We acknowledge that any strict definition of these multifarious phenomena is likely to be problematic and that there are points of overlap and symbiosis between these two broadly defined categories. For further explorations of these distinctions, see *Korean Pop Music: Riding the Wave*, ed. Keith Howard (Dorset, UK: Global Oriental, 2006). See also Kyung Hyun Kim’s introduction to *The Korean Popular Culture Reader*, ed. Kyung Hyun Kim and Youngmin Choe (2014).

- 3 For a discussion on this issue, see the introduction to JungBong Choi and Roald Maliangkay, eds., *K-pop—The International Rise of the Korean Music Industry* (New York: Routledge, 2015), 1–18. For examples of such work, see Doobo Shim, “The Growth of Korean Cultural Industries and the Korean Wave,” in *East Asian Pop Culture: Analysing the Korean Wave*, ed. Beng Chua Huat and Koichi Iwabuchi (Hong Kong: Hong Kong University Press, 2008), 15–32. Also see Song Min, Yoo Kyung Jeong, and Ha Jin Kim, “Identifying the Topology of the K-pop Video Community on YouTube: A Combined Co-comment Analysis Approach,” *Journal of the Association for Information Science and Technology* (2015), doi: 10.1002/asi.23346. For a study focusing on matters of reception through an examination of fan-oriented digital platforms, see Eun-Young Jung, “Transnational Korea: A Critical Assessment of the Korean Wave in Asia and the United States,” *Southeast Review of Asian Studies* 31 (2009): 69–80, and “Playing the Race and Sexuality Cards in the Transnational Pop Game: Korean

range of techniques from the field of social network analysis enables the quantitative and visual consideration of the relationships that underlie the K-pop realm, allowing us to explore groups' and performers' interconnectedness. Including a temporal dimension allows the study of network dynamics, such as a consideration of whether and how network structures change over time. These observations can help support, refute, or complicate hypotheses regarding the production and marketing of K-pop, generating new insights about the history of K-pop as well as other forms of popular music in Korea.

An additional benefit of studying the network structures of music production is that it can complicate and, in some cases, deconstruct existing genre labels. As Stephen Epstein has noted, terms such as "indie" have lost a great deal of salience in Korean music in recent years, with the label now applied readily not only to aspiring K-pop performers who have not yet signed with a major label but also to independent-minded rock groups who nonetheless benefit from connections to large corporations and government funding. (Epstein, 2015; Shin, 2011; Tangherlini & Epstein, 2001)<sup>4</sup> This situation provides further motivation for examining network structures within the sphere of Korean popular music, suggesting that it may ultimately be more informative to consider an entity's position within a larger network rather than merely noting the labels conventionally assigned to it. Unexpected or anomalous links in the network can challenge the assumed separation between K-pop and "alternative" musical practices and styles.

The present study describes our experimental efforts to build and analyze a dynamic meta-network of Korean popular music by mining online data sources that contain large amounts of computationally actionable data about K-pop and other forms of Korean popular music. These efforts focus primarily on large-scale linked open data repositories using sophisticated identification schemes and relational ontologies, specifically MusicBrainz, DBpedia, and Freebase. We were able to construct a meta-network of individuals, groups, and record companies, extract relevant statistics, and highlight prominent entities within these networks by applying various network analytical methods. The most noteworthy features of the meta-network are its explosive growth in scale and interconnectedness from approximately 2005 to the present, and the extreme prominence of K-pop organizations—particularly S.M. Entertainment and its premiere idol groups—during this time. We also discovered that no single online source provides full or representative coverage of all genres and eras of Korean popular music. In fact, the datasets we considered exhibit marked biases for particular musical styles

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Music Videos for the U.S. Market," *Journal of Popular Music Studies* 22, no. 2 (2010): 219-236.

4 Stephen Epstein, "Us and Them: Korean Indie Rock in a K-pop World," *The Asia-Pacific Journal* 13, no. 46 (November 30, 2015). See also Hyunjoon Shin, "The Success of Hopelessness: The Evolution of Korean Indie Music," *Perfect Beat* 12, no. 2 (2011): 147-165, and *Our Nation: A Korean Punk Rock Community*, produced by Timothy Tangherlini and Stephen Epstein (New York: Filmmakers Library, 2001), DVD.



and time periods, with the preponderance of online data favoring recent artists and groups who constitute the K-pop mainstream and, to a lesser degree, other forms of popular music from the 1990s and later.<sup>5</sup>

## 2. Traversing K-pop

Social network analysis has been developed and applied widely in sociology for several decades. (Wasserman and Faust, 1994) More recently, researchers in the digital humanities have employed these methods to reveal noteworthy small- or large-scale patterns of social interactions in literary texts, correspondence networks, and other aspects of cultural production. (Moretti, 2011) In studies of recent music history, Nick Crossley's network-analytical examination of the role of personal networks in the formation of the early UK punk scene is a prime example of the type of a manually curated data analysis that we are attempting to "scale up" by harvesting data from crowd-sourced digital archives. (Crossley, 2008) In this work, Crossley suggests that examining personal networks within a cultural movement is fundamental to understanding its emergence, as well as the conflicts within it. The work of Trilcke, et al., which examines how the summary features of character interaction networks in German dramatic texts change over the course of more than a century in response to various literary trends, also was a notable inspiration for this project. (Trilcke, Fischer, and Kampkaspar, 2015)

A similarly influential related effort is the "Linked Jazz" project, led by researchers at the Pratt Institute School of Library Information Science, which employed automatic and crowd-sourced methods to encode information about interactions between jazz musicians. (Pattueli et al., 2013) The project developed techniques for visualizing these connections and for linking individual records to external authority lists and knowledge bases (including DBpedia and MusicBrainz) via a combination of automated linking and crowd-sourced verification. The entire dataset was made available via linked open data technologies. To date, however, the project has not focused on producing analytical studies, instead serving as an impressive demonstration of the potential of linked-data technologies to assemble large network datasets on cultural and historical topics.

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5 The biases of the examined archives became more apparent when we explored a few much smaller, more specialized, and therefore typically less "open" and interoperable digital archives of information about Korean music. For example, maniadb (<http://www.maniadb.com/>) constructs a history of Korean popular music that extends further back in time and espouses a standard of authenticity that rests on genre-specific originality, while the government- and recording industry-sponsored KPOP Archive (<http://k-pop.or.kr>) provides a highly curated set of data records extending to the 1950s, yet does not support integration with other data sources. See this chapter's "Further Work" section.



Applications of network analysis to multimodal music production networks, and particularly networks of East Asian popular music, are uncommon. One exception is recent work that constructed and analyzed networks of K-pop performers as linked by positive or negative comments on YouTube videos. (Min et al., 2015) Our project differs in that we are primarily interested in scrutinizing the structures of musical production networks as they change over time, although incorporating explicitly reception-based data into this research remains an option for subsequent work.

### 3. Gathering K-pop: Data Collection Challenges

As with many “big data” studies, the initial phase involved extensive data gathering, entailing not only accessing data sources but also assessing the characteristics and potential biases of their sources, contributors, administrators, and data gathering and curation methods. Such scrutiny not only allowed us to guard against flawed or overly simplistic conclusions due to shortcomings in the underlying sources, but also provided important insight into the data resources in the context of humanistic inquiry.

After conducting a survey of English- and Korean-language online pop-culture data repositories, we chose to gather data first from open linked-data archives. Specifically, we used the MusicBrainz<sup>6</sup> open-source database of musicians, record labels and recordings; the Freebase general-purpose open knowledge base;<sup>7</sup> and both the English- and Korean-language versions of DBpedia, a knowledge base built primarily from data and relationships extracted from Wikipedia pages.<sup>8</sup> Although the contents of these sites are by no means immune to biases and errors (see Figure 1), they are fairly easily accessible via well-defined application programming interfaces (APIs), including the SPARQL semantic query language. Crucially, these sites also tend to assign one or more unique identifiers from official “authority” lists to each entity they contain. Generally, these identifiers are consistent across archives and thus make it possible to disambiguate entries in a fairly reliable fashion. In the absence of shared IDs, attempting to match entities based on non-unique names and other attributes would be quite challenging.

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6 <https://musicbrainz.org/>. We were able to download and run locally a virtual machine image containing the entire MusicBrainz database.

7 <http://www.freebase.com/>. Note that Freebase went into a “read-only” mode in mid-2015; the continued availability of its contents is presently in doubt, though its contents are purportedly being migrated to the Wikidata project (<https://www.wikidata.org/>) and also incorporated into the Google search engine’s Knowledge Graph to support semantically enhanced searching.

8 See <http://wiki.dbpedia.org/> and <http://ko.dbpedia.org/>. Our data harvesting from these resources’ data “endpoints,” as well as Freebase, followed many of the tenets of the “Linked Data Fragments” project at Ghent University (<http://linkeddatafragments.org/>): caching data locally to avoid making the same query multiple times, and breaking large, complex SPARQL queries into smaller, more manageable queries that often could be satisfied simply by parsing all available relations and attributes of a given artist or company record.

Extracting data from these linked-data resources was similar in practice to web crawling: we began each search with a “seed” group of target entities. In this case, our seed was all of the entries in MusicBrainz for artists, groups, and record labels associated with the region of interest (South Korea). We transferred these entries into a local Postgres database, noting names, group, label and sub-label relationships, and an artist’s gender, associated genres, number of official recordings, and earliest and latest dates of activity and group membership. We next used the unique identifiers discussed above to query these entities in Freebase, attempting to reconcile automatically potential data errors. We subsequently discovered new entries by following a given artist or label’s “group membership,” “related artist,” and “company association” linked-data relations, as defined in the Resource Description Framework (RDF) ontologies supported by Freebase.

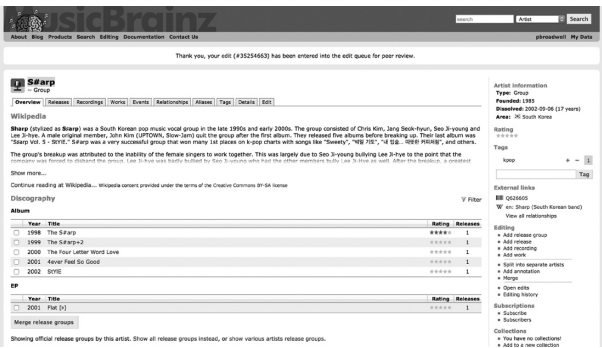


Figure 1 The record for the early K-pop idol group S#arp in MusicBrainz. The message at top notifies us that our suggested correction to the erroneous founding date for the group (1985) has been “entered into the edit queue for peer review.” The date was eventually corrected.

Crawling English and Korean DBpedia records proceeded in much the same manner as with Freebase, though we augmented the “seed” entities by adding those listed on an extensive set of DBpedia category lists (e.g., K-pop girl groups, Korean record labels). To reduce duplicate nodes and edges in the network, we correlated all discovered entities with those in Musicbrainz and Freebase by means of matching IDs (Musicbrainz ID, Freebase ID, Wikidata ID, DBpedia ID).<sup>9</sup>

9 Many artists had identifying data on other platforms and ontologies that we could potentially use for matching, but these were much less likely to be shared across the entire set of entities. Examples include VIAF, Allmusic, Discogs, Soundcloud, Facebook, Twitter, etc.

Korean DBpedia contributed as many new entities to the networks (~650 new artists) as Freebase and English DBpedia combined (see Table 1), suggesting the active participation of domestic Korean contributors in these archival sites. This is particularly likely considering that many automated linked-data extraction and knowledge-based generation “bots” are written first for Latin character sets and only ported to other scripts later, by which time many of the records in other languages have been entered by hand. (Kim, Weidl, Choi, and Auer, 2010)

One of the greatest benefits of linked-data resources, and of network analysis more generally, is the ability to discover significant and often unexpected connections between entities. Nevertheless, some degree of boundary enforcement is necessary in order to maintain a coherent dataset. Consequently, we only considered performers classified primarily as musicians, rather than actors or other entertainers. We also verified that all entities were strongly associated with South Korea. In the absence of straightforward nationality information, we utilized data linkages to infer this attribute from the nationalities of directly affiliated people or companies. These limiting steps had the effect of actively negating many linkages between the Korean popular music world and related cultural and international contexts: the “crossover” appearances of K-pop “idol” stars in television dramas, the distribution agreements between Korean record labels and overseas firms, and the frequent employment of foreign songwriters and music video directors. Yet, given the initial nature of this current study, these techniques were necessary to keep the scale manageable.

After accumulating enough data to surpass a basic threshold of representativeness, we constructed a meta-network of the artist-to-group, artist-to-artist, and artist-to-company relations we were able to derive from the data.<sup>10</sup> In addition to basic attributes including type (company, individual, group), gender, associated musical genres, and number of releases, we assigned discrete date ranges to the artist and company nodes to enable dynamic analysis of the network at various time “slices.”<sup>11</sup> We next used the open-source network analysis software packages Cytoscape (Shannon, et al., 2003) and Gephi (Bastian, et al., 2009) to examine the networks, with a specific focus on generating statistics and other attributes that would allow us to compare various “snapshots” of the development of particular production networks (such as that for idol K-pop) at regular intervals. Attributes that proved effective in revealing details about the network depicted by an online archive’s records in aggregate or pertaining to a specific point in time included simple counts of the nodes and edges in the network, the network’s diameter (the longest path across the network), the clustering coefficient, the

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10 The inclusion of composite entities such as music groups and recording companies as single “nodes” classifies our network as a “meta-network.”

11 We consider the edges derived from these relations to be bidirectional and of equal weight. We reserve the creation of directional weighted graphs by weighting nodes according to the number of interactions between and among artists and companies, for example, for future work.

number of connected components, the average shortest path between nodes, and the average number of neighbors for nodes. Comparative rankings of prominent members of the networks based on various centrality metrics also helped to highlight potentially influential companies, groups, and individuals within the network as a whole or in particular sub-genres; these included node degree (number of connections), betweenness (the extent to which a node helps to “bridge” otherwise distant entities), closeness (how far the node is from all other nodes), and eigenvector centrality, in which a node has a higher score if it is closely connected to other high-ranking nodes. Software analyses for detecting prominent clusters of nodes also aided in subsequent explorations of the structure of a given network.

After assembling the raw dataset, we coded artist-to-group, artist-to-company, group-to-company and company-to-company relations in our database. We elected not to infer other classes of artist-to-artist relationships, such as collaborations and guest appearances on recordings, via artist-to-recording relations in the linked-data sources due to the unreliability of this data. We did, however, include such connections in the graph when they were explicitly coded via the “associated artist” relations in a knowledge base entry. We also experimented with “back-propagation” of the searches, e.g., seeding Freebase with new entities discovered in English and Korean DBpedia and then re-crawling the archive, but the gains from this tactic were minimal.

Determining the “active” dates for artists and labels was crucial for the generation of time-bounded network “snapshots,” although this task proved fairly difficult. Explicit “begin date” and “end date” fields were typically part of the knowledge base entries for artists and companies, but their values were often left empty. We employed a variety of methods to fill in missing dates, such as deriving them from the range of dates belonging to a company or an artist’s releases, making it thereby possible to construct a relatively reliable “flourished” date range between the earliest and latest dates found. In the absence of this information, we sometimes were able to infer an entity’s dates from the associated dates of linked group members and collaborators (for artists) and associated artists (for companies).

Table 1 A comparison of the linked-data sources for the K-pop meta-network, indicating how many artists and companies were unique to a given source, how many artist entries could be satisfactorily assigned a useful “active” date range, and also the types and numbers of links found.

| Nodes           | Artists         |                  | Companies       |                  |
|-----------------|-----------------|------------------|-----------------|------------------|
|                 | Total (w/dates) | Unique (w/dates) | Total           | Unique           |
| MusicBrainz     | 3065 (2401)     | 1583 (927)       | 388 (135)       | 323 (72)         |
| Freebase        | 2900 (2848)     | 621 (621)        | 119 (110)       | 0 (0)            |
| English DBpedia | 1252 (1235)     | 11 (11)          | 91 (91)         | 2 (2)            |
| Korean DBpedia  | 2617 (2533)     | 655 (614)        | 250 (182)       | 140 (81)         |
| All sources     | 5249 (4499)     |                  | 589 (270)       |                  |
| Links           | artist->artist  | group->artist    | company->artist | company->company |
| All sources     | 2122            | 2430             | 1586            | 214              |

#### 4. Analyzing K-pop: Network Analysis Results

Table 1 summarizes the artists, companies, and links we obtained for the K-pop meta-network from the linked-data sources described above. We were initially surprised to discover that the dataset’s overall historical range was quite limited, containing almost no data before 1970 and very few entities that were active prior to 1990 (Figure 2).

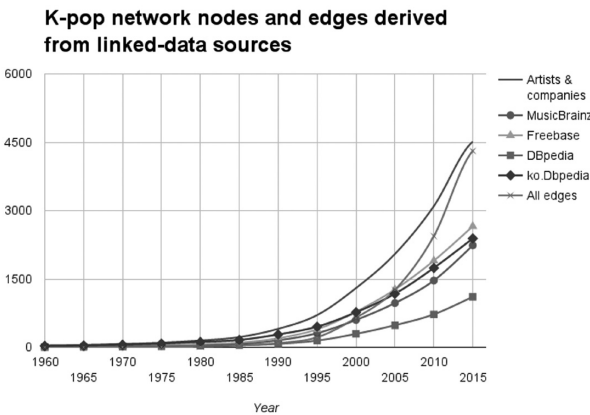


Figure 2 The total number of artist and company nodes and edges present in the K-pop network at each five-year “snapshot,” as well as the relative contributions of each of the linked-data sources to these totals.

The absence of data about Korean popular music from the 1980s and earlier suggests a likely bias in favor of recent K-pop among contributors to linked-data knowledge bases such as MusicBrainz, Freebase, and DBpedia. This suspicion prompted us to examine other

online repositories of data about Korean popular culture. These archives, some of which held historically extensive data, unfortunately tended to be difficult and sometimes impossible to correlate with the linked-data sources due to their eschewal of unique, canonical IDs for artists and companies; some are also not even truly “open” in terms of data accessibility.<sup>12</sup>

Despite the limited scope of time in the examined datasets, the results are intriguing and generative, primarily because they partially describe the advent of “idol” K-pop in the early 2000s and its affiliated entertainment companies. Figures 4 and 5 summarize the aggregate network statistics regarding the size of the K-pop meta-network and the connectivity of individual members, respectively, from the 1990s to the present. Both the size and the connectivity of the network evidence a notable increase in the rate of growth between 1995 and 2000, and an exponential rate of increase in the number of individuals, groups and companies in the network as well as the number of fully interlinked “components” in the years after 2000. The figures that describe the interconnectedness of the network—the clustering coefficient and average number of neighbors of each node—exhibit a more or less linear growth pattern after 2000, while the statistics that characterize whether the network is close-knit or dispersed reach an equilibrium point in 2005 near the archetypal “six degrees of separation” with an overall distance across the network of 12, suggesting that the network is more or less equally interconnected at all scales. Without conducting a more detailed interrogation of the data sources, it is difficult to determine whether these network characteristics are indications of wholesale changes to the underlying network of Korean music production during this era, or whether they are simply a consequence of the fact that contributors to online knowledge bases such as MusicBrainz and DBpedia have devoted more attention to cataloging K-pop artists and music from the years since 2000.

Table 2 lists the highest-ranking nodes (record/management companies, solo artists, and groups) in the K-pop network at five-year intervals, as determined by network “centrality” measures. Each metric quantifies a different notion of “importance” within the network, though none is definitive and they are not directly comparable. Even so, the table highlights several noteworthy attributes of the network, including the increasing prominence of “idol” K-pop, indicated by the sudden rise around the turn of the century of S.M. Entertainment and, to a lesser degree, YG, JYP, and Mnet/CJ, and their signature groups (H.O.T., Shinhwa, and TVXQ/DBSK/Tohoshinki at first, then Super Junior and SHINee) although the venerable LOEN Entertainment (formerly Seoul Records) continues to occupy a central position. Additional observations include the rising profiles of K-pop talent agencies Cube Entertainment and WOOLLIM Entertainment (which became a subsidiary of S.M. in 2013). Indeed, in many cases, a closer analysis of the network is necessary to uncover the extent to

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12 See the “Further Work” section of this chapter.

which seemingly discrete entities are in fact components of a large conglomerate or cooperative. For example, Cube Entertainment has distribution arrangements with both WOOLLIM Entertainment and Universal Music Korea, as well as the music division of CJ E&M, which is also known as Mnet Media. These links are discoverable via direct examination of the network connections (see Figure 3 for representative visualizations) but are not immediately apparent from summary results like Table 2.



Figure 3 Sequential “snapshots” of the meta-network of Korean popular music artists (blue and violet circles), groups (grey hexagons), and recording companies (yellow squares) derived from online knowledge bases (MusicBrainz, DBpedia, and Freebase) at 5-year intervals: 2000 (upper left), 2005 (upper right), 2010 (lower left), and 2015 (lower right). Labels are sized proportionately to a node’s degree (number of connections). Individual features are difficult to observe at this resolution, but the progressive growth of a central “component” dominated by entertainment companies including S.M. Entertainment, LOEN Entertainment, and YG Entertainment is apparent even from this “distant” perspective.

The intensely connected yet also somewhat insular organization of the S.M. Entertainment “family” is highlighted in Table 2 via its consistent top rankings in closeness, degree, and eigenvector centrality after 1995, as well as the high rankings of its flagship groups (SNSD/Girls’ Generation, EXO, SHINee). The company and many of its artists and subsidiaries also constitute the majority of entities in the largest and most tightly coupled cluster detected in the network by the Cytoscape network analysis software suite (see Figure 6). Again, although it is difficult to deny the conventional wisdom that S.M. has been a dominant



force in Korean popular music since its introduction of the first high-profile boy and girl “idol” groups, H.O.T. and S.E.S. in 1996 and 1997, the network discussed here cannot provide definitive quantification of this prominence without further inspection of the underlying biases of the data sources. In particular, it is important not to underestimate the possibility that S.M.’s international and youth appeal has produced a disproportionately high representation of its groups in online knowledge bases, whose contributors may also tend to be young and international. Even so, the dominance of S.M. within the network is no doubt an indication of *some* kind of prominence. It is also noteworthy that the high rankings of the company and its idol groups according to network centrality measures, especially eigenvector centrality, are largely a result of the company’s practice of orchestrating enmeshed collaborations within the “family”—for example, combining multiple high-profile S.M. idol groups into the ephemeral “supergroup” SMTOWN for special concert tours, and selecting individual members from several groups for participation in specialized ensembles such as S.M. THE BALLAD. Indeed, this strategy and its effect on the meta-network is so conspicuous that it could be characterized as a form of deliberate “network engineering” to boost its members’ prominence.

The apparent resilience of non-idol Korean popular music performers throughout the time frame covered by Table 2 is also noteworthy. The early statistical prominence of Korean rock and metal bands such as Boohwal, Sinawe, and Sanullim is partly due to the sparseness of the network data for the 1990s. Not surprisingly, these groups disappear from the top rankings along with the solo ballad singers of the 1980s and 1990s with the advent of idol K-pop groups and the influx of new data records about them. Yet in the mid-2000s, the non-idol Korean rock and punk bands Vassline and No Brain appear in the top betweenness rankings, and further examination of their peripheral but still highly interconnected position in the network suggests that they have retained a considerable degree of currency, at least as signaled by contributors to online knowledge bases. Notably, these groups appear to be embedded in a largely “fringe” but nonetheless vibrant network of independent bands and labels, such as Roxtamuzik & Live and GMC Records.<sup>13</sup> This phenomenon also supports the observation, explored in detail by Tangherlini and Epstein, that the attention that the rise of K-pop drew to Korean popular music in general was beneficial for other “independent” genres as well, including, possibly, the “old-fashioned” genre of *trot*<sup>14</sup> and the pop ballads of the 1980s, as well as Korean rock, indie, punk, and others. This simultaneous process of obscurity and elevation, in which (in one interpretation) a rising *hallyu* lifted all boats, is reflected in the characteristics of the online data that documents this phenomenon.<sup>15</sup>

13 록스타뮤직엔라이브 .

14 트로트 ; t'eurot'eu.

15 See Epstein 2015 for a discussion of Korean “indie” groups’ awareness of their ability to benefit from a “bait-and-switch” approach to programming that packages K-pop and Korean indie performances into the same events.

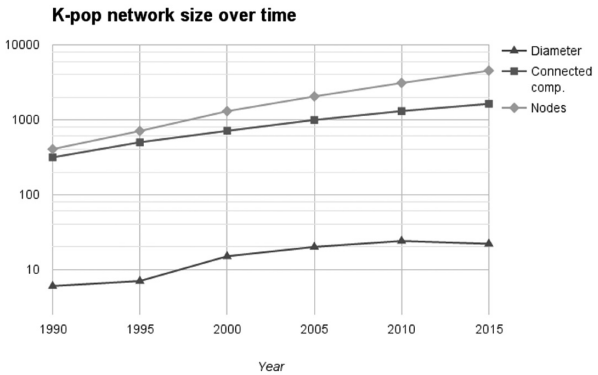


Figure 4 Network statistics over time related to the size of the K-pop meta-network at five-year intervals since 1990. Note the logarithmic scale of the vertical axis. The values of the different statistics are not directly comparable, but presenting them in the same graph highlights the concurrent, prodigious growth of the number of connected components and overall number of nodes through the idol K-pop era. The overall distance across the network, however, reaches a stable point between 2000 and 2005, indicating that from this time, the network is growing progressively more complex and interconnected, rather than far-flung and disconnected.

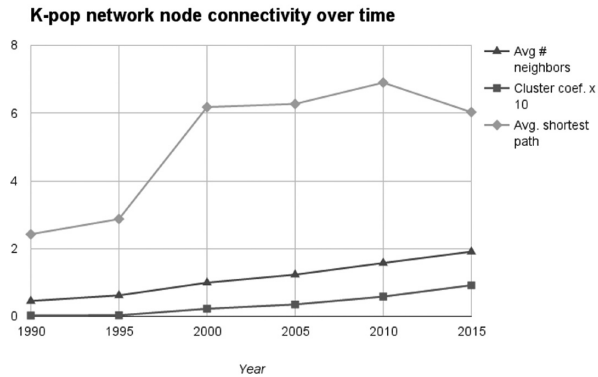


Figure 5 Statistics describing the average connectedness of artists and companies in the K-pop meta-network at five-year intervals since 1990. The values of the different statistics are not directly comparable, but their juxtaposition here highlights the gradual increase in the number of immediate neighbors and cluster memberships of a given node, as well as an arrestment and even slight decline in the average degree of separation between any two nodes, suggesting that the network has become increasingly interconnected since 2000.

Table 2 The highest-ranking companies (in bold) and artists in the K-pop meta-network according to various network “centrality” metrics, at five-year intervals.

| Year                        | 1990            | 1995             | 2000            | 2005               | 2010              | 2015             |
|-----------------------------|-----------------|------------------|-----------------|--------------------|-------------------|------------------|
| Degree Centrality Rank      |                 |                  |                 |                    |                   |                  |
| 1                           | Ens. Jong...    | LOEN Ent.        | S.M.Ent.        | S.M.Ent.           | S.M.Ent.          | S.M.Ent.         |
| 2                           | Boohwal         | soundTeMP        | SidusHQ         | LOEN Ent.          | LOEN Ent.         | LOEN Ent.        |
| 3                           | 위대한 탄생          | Ens. Jong...     | LOEN Ent.       | YG Ent.            | YG Ent.           | YG Ent.          |
| 4                           | LOEN Ent.       | Two Two          | M-Flo           | SidusHQ            | Mnet Media        | JYP Ent.         |
| 5                           | 들국화             | BooBooBand       | YG Ent.         | M-Flo              | JYP Ent.          | S.I.D-Sound      |
| 6                           | Sinawe          | Seo Taiji & Boys | No Brain        | No Brain           | SidusHQ           | Cube Ent.        |
| Betweenness Centrality Rank |                 |                  |                 |                    |                   |                  |
| 1                           | LOEN Ent.       | LOEN Ent.        | LOEN Ent.       | LOEN Ent.          | LOEN Ent.         | LOEN Ent.        |
| 2                           | Boohwal         | CRASH            | Universal       | S.M.Ent.           | Universal         | Universal        |
| 3                           | Sinawe          | Seo Taiji & Boys | S.M.Ent.        | Universal          | Park Jung-hyun    | S.M.Ent.         |
| 4                           | 들국화             | 들국화              | SidusHQ         | WOOLLIM Ent.       | GMC Records       | CJ E&M           |
| 5                           | Sanullim        | kt music         | Crazy Ken Band  | YB                 | Mnet Media        | Kim, Sang-Woo    |
| 6                           | kt music        | Jungle Ent.      | kt music        | YG Ent.            | Vassline          | Huckleberry Finn |
| Closeness Centrality Rank   |                 |                  |                 |                    |                   |                  |
| 1                           | LOEN Ent.       | LOEN Ent.        | LOEN Ent.       | LOEN Ent.          | LOEN Ent.         | LOEN Ent.        |
| 2                           | Boohwal         | CRASH            | Universal       | WOOLLIM Ent.       | Universal         | INFINITE         |
| 3                           | Sinawe          | 들국화              | Park Jung-hyun  | S.M.Ent.           | Mnet Media        | Universal Music  |
| 4                           | 들국화             | Jungle Ent.      | SK Telecom      | Universal          | WOOLLIM Ent.      | WOOLLIM Ent.     |
| 5                           | Sanullim        | Sanullim         | Lee, Seung Chul | Fluxus Music       | MBK Ent.          | JYP Ent.         |
| 6                           | Kim, Jong Seo   | Lee, Sun Hee     | JYP Ent.        | Clazziquai Project | Fluxus Music      | Apink            |
| Eigenvector Centrality Rank |                 |                  |                 |                    |                   |                  |
| 1                           | Boohwal         | Two Two          | S.M.Ent.        | S.M.Ent.           | S.M.Ent.          | S.M.Ent.         |
| 2                           | Sinawe          | Kim Ji Hoon      | SMTOWN          | Shinhwa            | Super Junior      | Super Junior     |
| 3                           | Kim, Jong Seo   | Hwang Hye-young  | Shinhwa         | Tohoshinki         | Girls' Generation | EXO              |
| 4                           | kt music        | Oh Ji Hoon       | Eric            | BoA                | Shinhwa           | SNSD             |
| 5                           | Lee, Seung Chul | Yoo Hyun Jae     | S.E.S.          | Junjin             | SHINee            | SHINee           |
| 6                           | Chae Je Min     | Kim Joon         | Kim Min-jong    | TRAX               | Tohoshinki        | Shinhwa          |



Concerns about the biases of our data sources led us to investigate a handful of much smaller and generally less computationally “open” digital archives of information about Korean popular music.<sup>17</sup> Among these, the most promising for further study is maniadb, a largely Korean-language site that features a collection of more than 200,000 crowd-sourced discographies and biographical sketches of musical artists from Korea and several other East Asian countries. Mainstream K-pop artists are not absent from this roster, but the contributors’ true musical sympathies are reflected in the overall makeup of the site’s artist entries as well as the concert and album reviews on the site, which indicate a determination on the part of its creators and contributors to defend and champion an older lineage of South Korean popular music in contradistinction to the hegemony of K-pop.<sup>18</sup> Correspondingly, the volume of Korean artists catalogued in maniadb from each decade of the twentieth century, though impressively extensive throughout (especially in comparison to the paucity of records from prior to 1990 in the linked-data sources described above), increases sharply in the 1990s (see Figure 8).

As an extension of its alternative-music evangelism and communitarian spirit, the maniadb site offers a data API, exposing its formidable contents for automated searching and linking, facilitated via local unique identifiers for each artist and recording. Another consequence of this “do-it-yourself” mentality, however, is that the entity IDs are endemic only to maniadb, and the database entries do not contain references to canonical IDs such as MusicBrainz authority strings. We were able to ingest the full contents of maniadb’s artist records into a self-contained database and use them to build a dynamic social network of its contents, incorporating more than 20,000 solo artists and groups, but we could not incorporate this data into the network created from the linked-data sources described above due to the lack of shared identifiers. Nor could we consistently link the artists in the maniadb network to record companies because the dataset does not provide unique IDs for record companies.<sup>19</sup> Despite these shortcomings, a networked-data history from maniadb would provide an alternative to the K-pop-centered, temporally limited data narrative analyzed in the present study.

17 The full list of additional sites we studied consists of Generasia Wiki (<http://www.generasia.com/wiki/>); NamuWiki (나무위키 – “Tree Wiki” – <https://namu.wiki/>); maniadb (<http://www.maniadb.com/>); and the KPOP Archive (<http://k-pop.or.kr/>).

18 The degree to which maniadb subscribes to this ideology is tellingly established via reviews that lash out against the image-conscious, hyper-commercial aspects of K-pop, as well as in positive reviews of Korean artists whose styles first flourished in the 1980s and 1990s, just prior to the advent of idol K-pop.

19 Moreover, inconsistencies in naming the record companies tend to produce multiple duplicate nodes for each company, which are quite difficult to detect and merge.

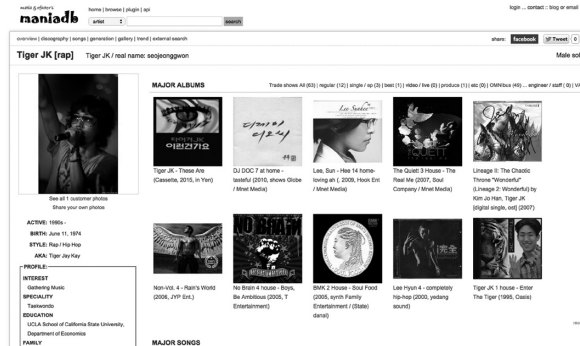


Figure 7 A page from maniadb; note the link to the data API in the top menu

For the purposes of comparison and situating the K-pop meta-network in a broader context, we also repeated the linked data-mining steps described above to build a separate dynamic network focused on the history of Japanese popular music for the past century. As this was a preliminary effort, we elected not to extract data from Japanese DBpedia, which would have required further assistance from domain experts. Even lacking contributions from Japanese DBpedia, however, the J-pop meta-network we derived from MusicBrainz, Freebase, and English DBpedia was several times larger and more historically extensive than the K-pop network (see Figure 8). The entries on Japanese musicians in MusicBrainz alone numbered more than 27,500, compared to 3,065 musicians in the K-pop dataset. This difference, and the presence of records for thousands of Japanese popular music artists active as far back as the 1950s, indicates that the paucity of historical records in the K-pop linked-data network is a legitimate phenomenon. We speculate that it may reflect to some degree the smaller overall scale of the Korean popular music industry throughout history, especially relative to the sprawling and diverse Japanese music industry, as well as a likely attenuated level of interest in earlier Korean popular music history among contributors to linked-data archives—particularly in comparison to contributors to J-pop-related records in the same digital archives. Note, however, that the number of Korean popular music artists in the separate maniadb data set reaches parity with the J-pop sources in 1970 and maintains roughly equal numbers to the present, a phenomenon that calls for future study.

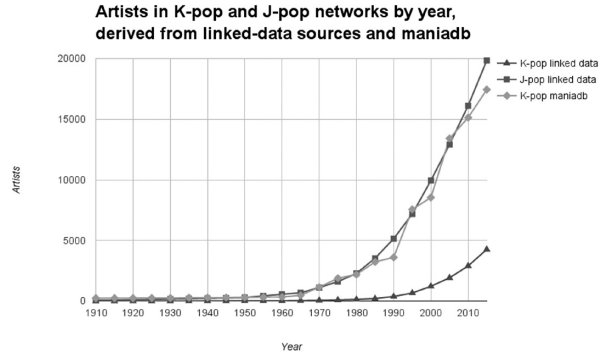


Figure 8 Artists present in the K-pop and J-pop meta-networks at 5-year intervals as extracted from online linked-data sources, in addition to corresponding counts of the historical Korean artist records available via maniadb.com’s data API.

Finally, it may be possible to explore our preliminary consideration of J-pop through the concept of “New Culture Technology” summarized in the introduction. The network-oriented focus of Korean music industry commentators is once again apparent in their observations that S.M.’s plan to embed NCT’s flexible sub-groups in specific localities, domestic or abroad, bears a strong resemblance to the model of large-scale girl “idol” groups in Japanese popular music, best exemplified by producer Akimoto Yasushi’s flagship group AKB48. (Jung, 2016) Such groups also feature multiple large interconnected “teams” with rotating memberships based at a dedicated venue. Since late 2011, this model has spread far beyond its domestic environs, with the formation of foreign franchises in locations such as Jakarta (JKT48) and Shanghai (SNH48), which feature local performers singing J-pop numbers in their native languages. (Ho, 2015) The recent development of sophisticated statistical techniques for comparing the structures of multiple distinct social networks to each other may eventually make it possible to quantify the extent to which the network structure of S.M.’s “NCT” meta-boy band actually resembles the large-scale girl groups of Japanese idol pop, as well as its predecessors in Korea.<sup>20</sup>

## 6. Conclusion

The research process and results presented above narrate an experimental effort to explore the production networks of an increasingly internationalized yet region-oriented cultural phenomenon, specifically Korean popular music, by harvesting, analyzing, and

<sup>20</sup> A promising technique for arbitrary network comparison is described in M. Berlingiero, D. Koutra, T. Eliassi-Rad, C. Faloutsos, “NetSimile: An Effective and Scalable Network Similarity Approach,” *The 2012 NIPS Workshop on Social Network and Social Media Analysis: Methods, Models and Applications*, Lake Tahoe, NV, December 2012.



simultaneously critiquing data made available via online data archives. The results of our dynamic meta-network analysis present intriguing new perspectives on recent K-pop history, as well as suggesting that the limitations and biases of available linked-data sources reflect the preoccupations and genre preferences of their contributors, who themselves represent subsets of both domestic and international audiences.

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