



Quantifying Relevance in Art Exhibition Systems at the Turn of the Twentieth Century: A Case Study of a Cultural Network Approach

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This paper presents a digital humanities framework for the study of the art exhibition phenomena in Europe in the late nineteenth and first half of the twentieth centuries, which deploys a mixed-methods approach based upon the concept of relevance. This matter is examined from the perspective of art history; previous contributions are discussed, and the rationale for the proposed framework is specified. After modelling the exhibition phenomenon as a cultural network, the calculation of a relevance index is developed, and the defined attributes, values, and weights used in this method are thoroughly described. Finally, this conceptualization is tested on a case study of a dataset that comprises 2,845 solo exhibitions held in Barcelona (Spain) and surrounding municipalities between 1890 and 1938, setting grounds for improvement through future iterative work.

Cet article présente un cadre en humanités numériques pour l'étude du phénomène des expositions d'art en Europe à la fin du XIXe siècle et pendant la première moitié du XXe siècle, qui utilise une approche mixte fondée sur le concept de pertinence. Cette question est examinée du point de vue de l'histoire de l'art, les contributions précédentes sont discutées, et la justification du cadre proposé est précisée. Après avoir modélisé le phénomène des expositions comme un réseau culturel, le calcul d'un indice de pertinence est développé, et les attributs, valeurs et poids définis dans cette méthode sont décrits en détail. Enfin, cette conceptualisation est testée sur une étude de cas d'un ensemble de données comprenant 2 845 expositions individuelles organisées à Barcelone (Espagne) et dans les municipalités environnantes entre 1890 et 1938, jetant les bases d'améliorations grâce à des travaux itératifs futurs.



Introduction

This paper presents a digital humanities framework for the study of the art exhibition phenomena in Europe in the late nineteenth and first half of the twentieth centuries, which deploys a mixed-methods approach based upon the concept of relevance. This conceptualization has been developed and tested on a case study of a dataset produced within a project by Institut d'Estudis Catalans led by Francesc Fontbona, which comprises 2,845 solo exhibitions held in Barcelona and surrounding municipalities between 1890 and 1938 (Montmany Torrella, Navarro, and Tort 1999). Also, this contribution aims to provide means to model, reveal, and analyze the cultural networks that may underpin any exhibition system within our area and period of interest.

The predominant features and methodologies observed in earlier studies in this field (Vidal i Oliveras 1993; Miralles 2007; Bru i Turull and Fabregat Marín 2012; Vidal i Oliveras 2012; among others) have motivated this approach. Previous research on art exhibitions that fall within our area and time frame of interest is understandably partial, developed from a positivist stance and generally based upon archival sources and selected press minings, which become the foundation either of broad studies on this topic during an established time frame (Julián 1983; Ramón Navarro and Beltrán Catalán 2013; Escolano Martínez 2019; for instance) or of monographic approaches to determined exhibition agents throughout their entire lifespan or for a period of time (for example, Maragall i Noble 1975; Andrés Pàmies 2013; Fondevila Guinart 2018). Nevertheless, recent research—predominantly developed by multidisciplinary teams—has resorted to digital humanities and data analytics methods (Schich et al. 2014; Fraiberger et al. 2018; Rodríguez-Ortega, Suárez, and Varona 2020). Despite the fact that these new approaches have undoubtedly brought new perspectives to the discipline, they are usually driven and dominated by readily available data, which are notably balanced towards time frames from the second half of the twentieth century onwards.

We focus our efforts on a key moment in the history of art exhibition phenomena—that of their crystallization as market systems, free from the sway of academia (Rius Ulldemolins 2002, 154). Primary sources on this topic are being progressively digitized, thus paving the way for data-driven approaches like the one we present, which proposes a method to determine the relevance of the agents that participate in the art exhibition system of a given territory within this specific time frame. Our research goal is threefold: first, we seek to surface the interactions between these actors—artists, exhibition agents, and art critics—in order to observe co-exhibition relations, exhibitory paths, and long-lasting connections between actors over time. Second, we consider the concept of relevance regarding these characters and discuss the factors and

indicators used to determine relevance within our area of interest. Third, we analyze the aforementioned cultural network so as to detect patterns that reveal a gravitation of exhibitory events based upon the relevance of the agents involved. This circumstance intersects with the concept of consolidation regarding the individuals' professional trajectories, a matter that is also discussed. This approach allows us to draw a detailed map of the art exhibition phenomena in a given territory over a crucial period of time and to highlight interactions and patterns that have been overseen until present times.

Relevance in art history and in art exhibition systems

Even if not explicitly addressed, relevance is a core concept in art history as an academic discipline. We are absolutely aware of the blurred lines that bound notions such as relevance, value, reputation, and/or canon. Nevertheless, we consider it suitable for our purpose. It is strongly related to canon construction, a complex endeavour that is frequently questioned, debated, and revised. Relevance is one of the main principles used to assess which artists or artworks are worthwhile to devote research efforts to and, therefore, elaborate certain narratives about artistic phenomena. These processes relate to the dynamics of cultural memory, where the interaction and interdependence of actions such as forgetting and remembering determine the construction and evolution of canons and archives (Assmann 2010).

On the one hand, some concepts and factors used by art historians to determine relevance have indistinct boundaries and require remarkably erudite work. Among these, the notion of artistic quality is a key value to determine the relevance of an artist or an artwork; however, its ethereal nature sets grounds for gatekeeping, debate, and for the mutation of this understanding over time. Another example of these fine-grained components is the detection of influences, or quotes of a valued creator's hallmark both in contemporary and later artists' works, a skill only in the hands and the trained eyes of specialists. These dimensions by themselves do not bear negative connotations, but rather display some inherent features of art history as a scholarly discipline with a strong positivist component.

On the other hand, art historians also rely on objective factors when gauging relevance. These quantitative indicators usually support direct correlation statements about the relevance of an artist or their creative work. For instance, the amount and frequency of mentions of an artist or their work in contemporary written sources may be understood as a relevance indicator, despite the fact that previous research suggests that these data alone might render as a poorly reliable relevance factor (Layne 1997, 18–19). Similarly, the amount of later academic publications focused on or dealing extensively with an artist or their creations is also considered a relevance indicator, as

is the presence of a given artist's work in museums and collections, since both facts are closely related to canonization processes. Tangentially, data related to market value—selling prices of artworks in the artist's present and in current times—are also taken into account in relevance assessments. This has been especially common nowadays, once the art system has finalized its transformation into a scheme mostly ruled by the market laws.

More recently, especially with the proliferation of computational techniques in most fields of knowledge, there has been a growing interest in applying these to art history. This new scenario has led to an increased preference for quantifying concepts like artistic value or relevance. We will now discuss three contributions to this relatively new approach in the discipline, which acknowledge once again that one-size recipes, unsurprisingly, don't fit all. In this sense, we will conclude this section by elaborating on the reasons that posed a challenge to our attempts at making a direct implementation of the contributions made by previous research, and we will provide the first iteration of a method for determining relevance within the art exhibition system between the late nineteenth and first half of the twentieth centuries.

We have set the starting point for the discussion at the reflection about value-assigning processes in digital contexts (Rodríguez-Ortega 2018). Despite the fact that the chronological frame of the text—the post-digital realm—is out of our scope, the author makes a sociological reading of the main dynamics and driving forces at work in digital societies when these generate and transform the artistic canon: hypercanonization, social decanonization, and transcanonization. The sole consideration of this subject matter as a noteworthy topic in the recent past is yet another example of its recurrence in the field and the need for art historians to provide themselves with solid groundwork that may allow further progress of an inevitably erudite-bound discipline.

At around the same time that this paper was published, an attempt at quantifying reputation and success in art was also released (Fraiberger et al. 2018). Fraiberger and colleagues build their case upon a vast dataset with information about exhibitions, auction sales, and quotes from gallery sales that happened between 1980 and 2016 in 143 countries (Fraiberger et al. 2018, 825). The data are structured as a graph on which network analysis calculi are performed in order to reveal which factors affect success in the exhibitory system (Fraiberger et al. 2018, supplementary materials). This research demonstrates that the analyzed system is highly stratified and that the prestige of the institutions where an artist displays their work has undeniable impact on the individual's trajectory. The paper models a co-exhibition network—venues connected by weighted, directed edges that indicate the exhibitory path of an artist—and ranks these institutions based upon several reputation indicators that allow the

authors to evaluate and even forecast an artist's range of prestige. The results confirm the strong lock-in effect of the system, that is, the fact that artists who start their career in coveted institutions are more likely to develop a successful trajectory and that it will be significantly more challenging for artists who display their work in low-ranked institutions to develop a positive, upcoming professional trend in a ten-year time frame. Also, data underlines the looping nature of this lock-in effect, since both artists and institutions depend on each other's prestige to determine their own position in the ranks. Despite the fact that previous research addressed a significant amount of the key concepts discussed here from a different stance but leading to similar results and conclusions (Giuffrè 1999), Fraiberger and colleagues provide an approach that may be fully replicated in similar cases and offers solid arguments to leverage the contemporary exhibitory system at a larger scale.

Another conceptual and mathematical model to determine a relevance index for art institutions was presented shortly thereafter (Rodríguez-Ortega, Suárez, and Varona 2020). In this case, the research is focused on the connections between exhibitory institutions through artwork loans and defines a relevance index based upon the direction of these links. The authors are well aware of the limitations faced by this model and propose a pair of variables—the potential and the effective attention a given institution may receive (i.e., the city where it is located and the institution's visitor index, respectively)—that lead to an enhancement of the model and to an equation for calculating the impact index of a given art institution. Furthermore, a few additional parameters that may improve the suggested formula in future iterations are also noted. This proposed model has been tested on several subsets of data extracted from the Expofinder repository (Rodríguez-Ortega and Cruces Rodríguez 2019), which included information about art exhibitions held in Spain during the twentieth and twenty-first centuries.

After some consideration, we argue that the aforementioned proposals cannot be fully implemented in our research because of three main reasons. First, we consider that the features of the data on which the reviewed papers are based strongly impact the approach chosen by their authors. Since these projects focus on the art world of approximately the last half-century, a substantial amount of their data has been funnelled from various online sources. In our case, the internet is a mostly unsuitable point of supply, since online data pools rarely offer usable information about historical art events, and the sources we work with are barely digitized, thus forcing us to opt for an alternative approach in the early research stages. Second, and slightly related to the previously stated, since previous research is mainly focused on relatively recent events, these involve some elements—such as curators or new exhibitory venues—that

are not completely aligned with the roster of agents involved in the late nineteenth-century exhibition system. Last and also connected with this train of reasoning, part of the research that precedes us is built upon some data attributes that are impossible for us to replicate, such as sales prices, number of visitors, or exhibition venue surface areas, among others. Furthermore, some data attributes rely on tagging techniques. Despite the fact that this practice does not pose a problem, the chosen tagging criteria are prone to vary depending on the project, the available data, or the goals set by each researcher; thus, a cross-project implementation of tagging criteria may usually render as somewhat not fully feasible.

A proposal to determine relevance in the exhibition system from the late nineteenth to the mid-twentieth centuries

While understanding that recognition and prestige are volatile, partly intractable issues, we acknowledge that they maintain a certain dependence on objective factors over time, such as interactions with third parties, which are in turn the seed for any social network to develop (Marin and Wellman 2011). Therefore, it is possible to take a data-driven approach to this matter and go beyond pure erudition.

As previously stated, the shortcomings observed in the methods and models that precede us arise from issues that are particular to the chronological framework in which each study takes place. Hence, we have examined which are the main factors that affect or determine relevance within the late nineteenth and early twentieth-century exhibitory system and have developed a proposal for a method to surface this parameter based on cultural network analysis.

We consider the exhibitory system as a cultural network, a set of relationships between at least two agents which are mediated by cultural objects (Rodríguez-Ortega, Suárez, and Varona 2020, 1–3). In an exhibitory context, artworks are the obvious cultural objects mediating these connections, but other objects can also be considered, such as the exhibition brochures—especially the texts and data they trove—and the physical spaces where exhibitions take place.

The model

In order to elaborate our proposal, we first have modelled the exhibitory phenomenon of the late nineteenth and early twentieth centuries. To do so, we have taken into account the information about these type of events in the designated time frame, which is usually available in the written sources that have been preserved up to present day. This first approach is based upon exhibition brochures, since their closeness to art exhibitions

enables us to consider them as a primary source, despite their circumstantial nature. The best-case scenario is that of an exhibitory event for which at least a brochure was produced, is currently available, and offers information about the artist featured in the exhibition, the exhibition venue, its address, the exhibition dates, a list of artworks on display, and an introduction or commentary about the artist and/or the exhibition. The worst-case scenario is that of an exhibition for which data are fragmentary and available only through indirect sources, such as mentions in the printed press or in archival records such as correspondence or private journals. Naturally, the range of intermediate scenarios is quite wide, but our proposal is driven by the availability and the quality of the preserved sources. This first iteration of the model is based upon the best-case scenario described above, where data about an exhibitory event are extracted from preserved exhibition brochures.

There are three types of nodes in our model that represent, respectively, three types of agents in the studied domain (Latour 2005): artists, exhibitory agents, and art critics or commentators. In this first approach, both professional art critics and casual commentators are considered as the same node type, a particularity that will be subsequently clarified in further iterations of this proposal. Each node may interact with each other differently, establishing a set of relationships mediated by cultural artefacts, the exhibitions themselves. For example, an artist and an exhibitory agent may be related because the latter hosts an exhibition of artworks created by the former, an event that is documented by the exhibition brochure and that can be labelled using an ad hoc exhibition ID.

One might be tempted to consider the artwork as the cultural artefact that mediates the relationship between an artist and an agent, or use the artwork's ID extracted from a catalogue raisonnée as a value for this bond. However, only the work of a small share of artists of our time frame of interest (or any, actually) has been catalogued; most of the exhibitions held in this period did not offer a brochure with a list of works on display, and those that did so usually used ambiguous or generic artwork titles, which render this option as completely unfeasible (see also the insights in Bartosch et al. 2020, 427). Furthermore, the exhibition ID can be used to document relationships among all node types, thus avoiding unnecessary complexity in the proposed model. An example of other relationships that can be charted from direct sources such as exhibition brochures is the bond between an exhibitory agent and an art commentator (the agent promotes printing a brochure for the exhibition they host; a text signed by the critic is included in it) (**Figure 1**). In our regard, exhibition brochures are the most effective way to cohere the model presented in this section. On the one hand, they usually are the only tangible vestige of the events that focus our interest, which are ephemeral by

nature. On the other, exhibition brochures are a byproduct of these occasions to the extent that—with some exceptions—they will not be produced if exhibitions do not occur in the first place, whereas many artworks do exist regardless of whether they are publicly exhibited or not.

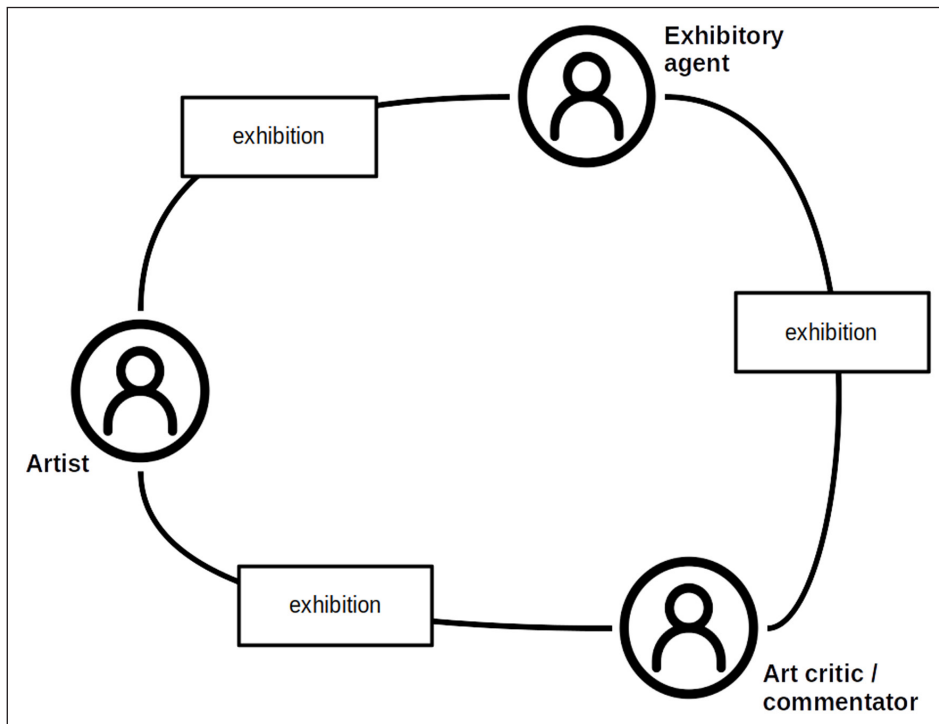


Figure 1: Cultural network diagram.

Mainly, three values can be used to express the relationships between nodes elicited from an exhibition brochure. The first is the exhibition ID, as stated above. This piece of data allows us to locate two or more nodes in a specific point in time and space. For example, two artists who participate in the same exhibition, an artist who displays their work in an event hosted by a given agent, a commentator who may sign a text in the exhibition brochure promoted by an agent, etc. The second value in our model is the mention, or information enclosed in an exhibition brochure. Thus, an artist may be connected to another one through a mention in an exhibition brochure by a critic, for example. The last value is a shared one, usually a third node used to join two other nodes. In this case, two agents might be related because they may have organized exhibitions of the same artist, or two art commentators may be connected because both have signed texts in exhibition brochures about the same individual artist, among other use cases (Figure 2).

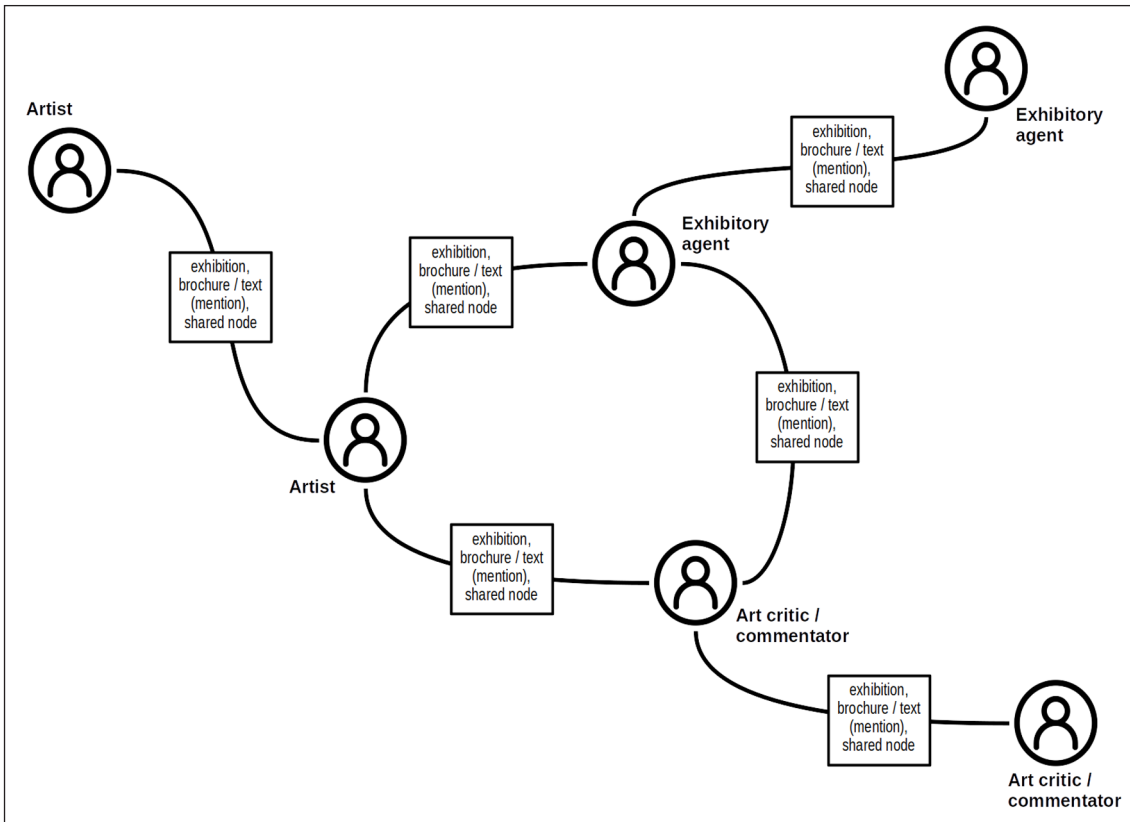


Figure 2: Expanded cultural network diagram.

These are the relationships that will be taken into account in this first iteration of our model. However, other connections have been identified but have been left aside for the moment because the information required to make them visible is unavailable at this stage of our project, and they entail an added complexity that cannot be currently undertaken. For example, an unmistakable relationship between an art critic and an exhibitory agent, mediated by the exhibition venue, happens when the first visits the exhibition organized by the second in a given venue. Similarly, an art critic and an artist can be connected through an artwork, since the first may interact with the object created by the second. Nonetheless, we are currently unable to document these relationships with the data available to us at present times. We cannot pinpoint an art critic at an exhibition venue or engaging with a given artwork unless a comment signed by them is published in the exhibition brochure, but we cannot deny a connatural particularity of the art exhibition phenomena: art critics visited exhibitions and often publicly shared their opinion beyond exhibition brochures. This matter is likely to be addressed once the available sources that include mentions to art exhibitions—the printed press, mainly—are mined at a scale, and tests such as sentiment analyses are performed.

Unfortunately, we do not have access to these data yet, but this kind of relationship needs to be taken into account in future iterations of this proposal.

Research questions

Other than the members of the network and the cultural objects that mediate the bonds among them, we are especially interested in deepening our understanding of the network structure and its dynamics. We are notably looking forward to surfacing co-exhibition networks and exhibitory paths. In our case, co-exhibition networks are produced by the coincidence of certain artists and exhibitory venues over time or by the coincidence of two or more artists in shared exhibitory events over time, independent of the venues where these take place. Exhibitory paths are determined by each artist's trajectory, as they may exhibit their works in just one or in various venues throughout their career. In this case, time is not strictly taken into account and only the total amount, the diversity, and the path sequence of the involved venues will be considered.

The repetition of coincidences among artists and/or venues over a time frame may indicate a higher relevance of the involved actors. Also, it may offer insight about successful partnerships or reveal a greater interest, both commercial and purely artistic, of certain actors. In turn, apart from using exhibitory paths to surface loyalties between artists and exhibitory agents or identifying artists with a rather changing venue record, the detection of common exhibitory paths may reveal professional itineraries with better prospects than others. Both indicators may allow us to observe and explain gravitational patterns, both at artist and venue scales.

Thus, after observing this first version of our model, several research questions arise, the most important of which are the following: (1) Which are the winning formulae for relevance for a given actor (artist, exhibitory agent, art critic) in the modelled network? Which factors determine these formulae, how do they interact, and how do they affect the relative position of each agent within the network? (2) Which gravitational patterns can be detected in the network? Are there any nodes that attract—concentrate, favour—bonds with third parties? Are there any repetitive patterns that may be read in terms of relevance? Which components play a decisive role in these behaviours and why? (3) How does the modelled system evolve over time? What is the impact of geographical components—such as venue location or distance to other venues or power centres—on this equation?

Attributes, values, and weights for a relevance index

We aim to address the challenge of detecting signs of relevance within an exhibitory system in a quantifiable manner. To do so, we have defined an index to measure the

relevance of an individual belonging to the cultural network described above. However, since the unclear nature of this concept has already been discussed, we deem it necessary to elaborate on the scaffolding that underpins this proposal.

In general terms, relevance implies importance or a special significance. In the context of art exhibitions in the late nineteenth and early twentieth centuries, relevance is not only related to the quality of the works an artist may produce and put on display or the public opinion they may raise. It also depends on each individual's—be it an artist, an exhibitory agent, or an art critic—trajectory within the system and on a nuanced understanding of prestige. This last concept derives from each individual's personal bonds, which provide us with several quantifiable attributes that can be understood as a proxy for prestige: the amount and diversity of connections among peers and counterparts, their strength (without ignoring the power of weak ties; Granovetter 1973), the cohesive power of certain individuals, or their bridging capability. The overall incidence of these attributes on an individual's relevance in the exhibitory system depends on their role (artist, exhibitory agent, art critic) and on the feedback loop of the relevance displayed by all the peers and counterparts that are at the end of each individual's bonds. Therefore, for example, an artist's relevance depends on the perceived quality of their artworks, their presence in specific artistic venues, their exhibitory trajectory, their incidence on peers and counterparts, and their peers and counterparts' incidence on themselves. The parameters we suggest to take into account in our proposal for a relevance index are grounded in these considerations (Table 1).

Parameter	Artist	Agent	Critic	Expression
Exhibition density	yes	yes	yes	Exhibitions / years active
Exhibition length	yes	yes	no	Average exhibition days
Amount of solo exhibitions	yes	yes	no	Solo exhibitions x 1
Amount of cohort exhibitions	yes	yes	no	Cohort exhibitions x 0.8
Agent type	yes	yes	yes	Art galleries x 1 Institutions x 0.8 Commercial businesses x 0.5 Societies x 0.4 Private spaces x 0.2

(Contd.)

Parameter	Artist	Agent	Critic	Expression
Amount of counterparts worked with	yes	yes	yes	Artist: amount of agents and critics worked with Agent: amount of artists and critics worked with Critic: amount of artists and agents worked with
Diversity of counterparts worked with	yes	yes	yes	Artist: unique agents and critics worked with / total unique agents and critics (197+278) Agent: unique artists and critics worked with / total unique artists and critics (1123+278) Critic: unique artists and agents worked with / total unique artists and agents (1123+197)
Amount of peers worked with	yes	no	yes	Artist: amount of artists worked with Critic: amount of critics worked with
Diversity of peers worked with	yes	no	yes	Artist: unique artists worked with / total unique artists (1123) Critic: unique critics worked with / total unique critics (278)
Exhibition brochures with text	yes	yes	yes	Amount of exhibition brochures with text
Weighted degree	yes	yes	yes	Average sum of the weights of each node's edges, normalized
Eigenvector centrality	yes	yes	yes	Normalized value
Betweenness centrality	yes	yes	no	Normalized value
PageRank	yes	yes	yes	Normalized value
Clustering coefficient	yes	yes	yes	Normalized value

Table 1: List of parameters selected as relevance indicators, stating whether they impact each node type and their expression.

Even though the relevance index needs to be calculated on a per-node typology basis, there are several attributes that are transverse signs of relevance. The most important is having participated in ≥ 2 exhibitions, a revealing threshold when it comes to gauging the interest raised by an individual's work. However, this criterion is not a *sine qua non*, as two main exceptions need to be taken into account: first, when an artist with several exhibitions under their belt has coincided in an exhibition with another individual with only one exhibitory event in their career; second, when an art critic that has signed several texts in exhibition brochures comments on an artist—and hence an agent may also be involved—with a single exhibition in their record. Exceptions that fall into these

two assumptions, despite not complying with the baseline rule, are also considered as valid data and will therefore be analyzed.

Another sign of relevance taken into account is the exhibition density in an individual's trajectory, a period not determined by their lifespan, but by the extreme dates of the exhibitions in which they have participated and for which a brochure has been preserved. Thus, the amount of exhibitions an individual has participated in is divided by the length of their career, expressed in the years elapsed between their first and last documented exhibitions. On top of this criterion, we consider that the presence of long-lasting exhibitions in an already long and dense trajectory is another clear indication of the relevance of an agent within the exhibitory system under scrutiny. Therefore, the average exhibition length (in days) is considered. Also, the amount of solo and cohort exhibitions of an individual's career has an impact on their relevance. While solo exhibitions are generally considered positive, cohort exhibitions are not harmful and should not be penalized. We have favoured the use of the term "cohort exhibitions" instead of "group exhibitions" since most of the coincidences of different artists in the same exhibitory event were driven by chance and were not planned, as proper group exhibitions would be. Hence a coefficient factor of 1 and 0.8 for solo and cohort exhibitions respectively has been determined as a value that casts these conditions in a fair manner.

Furthermore, the type of agent that promotes or hosts an exhibition has a significant impact on the overall relevance of an individual. Before deepening this explanation, we must acknowledge that the definition of exhibitory agent has been flexed, and, for the sake of our purpose in this paper and specifically of this criterion, there is a major overlap between the concepts of exhibitory agents and exhibitory venues. An exhibitory agent is a node of the network model described above that is physically located somewhere. This location, the exhibitory venue, is prone to change over time, a circumstance currently ignored, since it is beyond the scope of this paper and will be analyzed in future iterations of this proposal.

We have identified five categories of exhibitory agents: art galleries, institutions, commercial businesses, societies, and private spaces, and have given them coefficient factors ranged between 0.2 and 1 in order to highlight their different nature regarding relevance. Some examples of each category are as follows: Sala Parés, Galeries Dalmau, or Galeries Laietanes are clear cases of art galleries; spaces such as Ateneu Barcelonès, Acadèmia de Belles Arts de Sabadell, or Biblioteca Popular de Figueres are considered institutions; sites like Casa Guillermo Llibre (a confectionery shop), Hotel Ritz or Quatre Gats (an equivalent to a nowadays pub) are tagged as commercial

businesses; societies are groups of people with shared interests such as Centre Excursionista de Catalunya or Club Republicano; while instances of private spaces are Ramon Casas's studio or that of the Borrell brothers, among others. The distinction has been made according to the main pursuit of each agent and considering that there is a direct correlation between an agent's relevance within the artistic system, their main field of activity, and their potential audience outreach. Art galleries are the agents that confer most relevance to the other actors of the exhibitory system, since their main purpose is the public exhibition and sale of artworks; therefore, their coefficient value has been set to 1. Private spaces such as an artist's studio or a private salon are placed at the other end of the spectrum (and valued with a 0.2 coefficient), since these are not specifically devoted to outreach activities such as art exhibitions, and their potential audience is significantly smaller. Between both ends, agents devoted to the common good and therefore publicly respected, such as town halls, libraries, or theatres, may sporadically host art exhibitions, which provide remarkable relevance to affected artists and critics, this being the main reason why these agents bear a coefficient value of 0.8. Commercial businesses, that is, economic initiatives whose profit is other than art dealership, are at the centre of the spectrum and are calibrated at a 0.5 coefficient value, since they may host exhibitory events in their premises and provide artists and critics with a significant public exposure because of their main activity. This parameter places societies further away on the spectrum, since, despite their civic substrate (entities such as private clubs, hiking groups, or neighbourhood associations are considered in this category), their main activity is not related to art shows, and therefore the potential audience and public repercussion of the exhibitions they may host is way more modest than that of an event celebrated in a commercial setting. These entities receive the second-lowest coefficient factor of the range, established at 0.4. Nevertheless, it needs to be mentioned that a prominent diversity of exhibitory agents in an artist's career should not be detrimental to their relevance; what is especially considered is the presence of a meaningful amount of art galleries in the mix.

Coincidence with certain peers is a factor with a significant impact on an individual's trajectory, especially regarding artists and, to a lesser extent, art critics. Likewise, the amount and diversity of counterparts an individual has encountered throughout their career, expressed as the total sum of counterparts and the ratio of unique counterparts an actor has worked with, can also be interpreted in terms of relevance. In this case, a counterpart is any actor who meets two requirements. One, there is a tie between said actor and a node of interest; two, both individuals belong to different node categories. Hence, agents and critics are an artist's counterparts; agents and artists are a critic's

counterparts, and artists and critics are an agent's counterparts. To avoid excessive complexity in such an early stage of the project, both node types have been recast into the concept of "counterpart," leaving further inquiries about their individual incidence in the relevance index for future iterations of this research.

Therefore, we have defined two sets of two parameters each that respectively capture the amount and diversity of peers and the amount and diversity of counterparts each node has concurred with in their career. The amount of peers and counterparts is expressed by the total sum of these parameters per node category; the diversity of peers and counterparts is obtained by dividing the total count of unique peers and counterparts per node category by the sum of unique peers and counterparts respectively.

Exhibition brochures themselves may indicate relevance, especially if they include a text by an art critic. Although a significant amount of these texts may have been previously published elsewhere, especially in the printed press, and some others may not be strictly related to the exhibition or the exhibited artist (poems or famous quotations may fall into this category), in this occasion we will take into account only the amount of exhibition brochures featuring a signed text. This criterion may be significantly refined in further iterations of this proposal, especially once data from press minings are included in the dataset, the brochure texts have been transcribed, and a sentiment analysis has been performed.

All these signs of relevance converge towards the notion of centrality in network analysis. This concept still lacks an unambiguous definition from social network analysis as a discipline but is usually associated with importance, prominence, and prestige (Wasserman and Faust 1994, 169ss). Since we aim to obtain evidence related to this triad of concepts through network analysis methods, we have selected some statistical metrics that provide insights into an individual's connections and their ability to influence, attract, or repulse their neighbours. Moreover, each actor's weighted degree, eigenvector centrality, betweenness centrality, and PageRank yield pointers about their relationships with other nodes, their intensity, and their reach beyond the most immediate neighbouring nodes. On the other hand, an individual's clustering coefficient sheds a light on their influence on neighbouring actors and their ability to gather a cohort of individuals, a factor that can be clearly read in terms of relevance.

For the sake of simplicity in this first approach to the matter, the parameters listed in **Table 1** have been grouped into six categories: events, artists, agents, relationships, brochures, and graph metrics (**Table 2**). The value of each category per node is obtained by dividing the sum of the values of each selected parameter, which have been previously

normalized to a range between 0 and 10, by the number of parameters included in the category. Afterwards, the weight coefficient is applied to the result, according to the node type the data refers to.

Category	Parameters	% weight artists	% weight agents	% weight critics
Events	Exhibition density Exhibition length	20	25	30
Artists	Amount of solo exhibitions Amount of cohort exhibitions	20	5	n/a
Agents	Agent type	10	25	30
Relationships	Amount of counterparts worked with Diversity of counterparts worked with Amount of peers worked with Diversity of peers worked with	25	20	25
Brochures	Amount of exhibition brochures with text	10	5	5
Graph metrics	Weighted degree Eigenvector centrality Betweenness centrality PageRank Clustering coefficient	15	20	10

Table 2: List of categories, stating which parameters constitute each one and the weight coefficient determined for each category and node type.

As previously stated, the relevance index needs to be calculated on a per-node basis, since each category has a different incidence in the overall result depending on the node type under scrutiny. In the case of artists, the weight distribution among categories is fairly balanced. We consider that their relevance is most influenced by the ties that may bond these artists with third parties, either peers or counterparts. This category is closely followed by the events an artist participates in and their features (solo or cohort exhibitions). Categories such as the agent type, the amount of brochures with text, and the graph metrics are considered to be slightly less determinant in the overall result. Besides, the weight distribution among categories for calculating a relevance index for agents and critics is quite differentiated. The relevance of the former is most affected by their category as exhibitory agents and the events they host or promote, followed closely by the category devoted to relationships with third parties and graph metrics. The amount of brochures with text and the features of the exhibitions an agent may promote or host are considered to have the least influence in the overall calculation of

their relevance index. Finally, in the case of critics, we consider their relevance to be strongly determined by the events they participate in, the type of agents they collaborate with, and the relationships with third parties built around their professional activity. As with agents, the amount of brochures with text and the graph metrics are considered secondary, and the features of the exhibitions they participate in (solo or cohort events) are not considered in the calculation.

The generic equation for a relevance index (R_i) is as follows (**Equation 1**):

$$R_i = \sum_{j=1}^{j=6} (W_j V_{ij})$$

$0 \leq R_i \leq 10$
 $0 \leq i \leq n$; n being the number of nodes (items) in the dataset
 W = weight according to node type (artist, agent, art critic)
 $j \subseteq \{\text{events, artists, agents, relationships, brochures, graph metrics}\}$

Equation 1 can also be expressed as follows:

$$R_i = (W_{ev} \times V_{ev}) + (W_{ar} \times V_{ar}) + (W_{ag} + V_{ag}) + (W_{re} \times V_{re}) + (W_{br} \times V_{br}) + (W_{gr} \times V_{gr})$$

Where: W : Weight given to a certain category per node type; V : Value of a certain category. Each category is denoted by the first two letters of its name, so ev stands for events, ar for artists, ag for agents, re for relationships, br for brochures, and gr for graph metrics. The expected result is a value between 0 and 10.

Case study: Dataset description

The data used to test our proposal has been manually collected and processed from a catalogue of solo exhibition brochures published in Barcelona in 1999 (Montmany Torrella, Navarro, and Tort 1999). In turn, this repertoire expands a previous cataloguing project carried out in 1982, focused on a collection of 1,325 exhibition leaflets preserved in Biblioteca de Catalunya (Catalonia's National Library, Barcelona), which exclusively advertised painting and sculpture exhibitions held in Barcelona until 1936 (the year the Spanish Civil War broke out). This primal core was subsequently enlarged between 1996 and 1999 with the cataloguing of solo exhibition brochures preserved both in Biblioteca de Catalunya and in other public archives and institutions in Barcelona. The documents compiled in this iteration describe solo exhibitory events of any artistic discipline that took place in any Catalan municipality before the end of January 1939 (the date of the fall of Catalonia and the start of the Republican retreat in the final stages of the Spanish Civil War, generally considered a more determining turning point in Catalan

contemporary history than the war's outbreak). Therefore, the catalogue offered—at the time of publication—a compilation of all the solo art exhibitions celebrated in Catalonia whose brochure is preserved in a public archive or institution in Barcelona, since the first documented instances to late January 1939 (Montmany Torrella, Navarro, and Tort 1999, 11–12).

At this point, in order to fully comprehend and thus properly process the data gathered in this publication, some clarification needs to be provided. Solo exhibitions are commonly understood as events involving one agent that displays their artistic work in a specific venue, which in turn is managed by a specific agent. However, in this case, the concept has been flexed by the authors of the catalogue, and events where up to three agents concurrently display their work in the same venue are considered solo exhibitions. This is the main reason that drove us to consider these events as cohort exhibitions and to treat them differently from solo exhibitions. Also, this already wide definition is momentarily broadened to include those—exceptional—cases when more than three agents perform an exhibitory event at the same time and venue, and they are explicitly mentioned on the front page of the exhibition brochure (Montmany Torrella, Navarro, and Tort 1999, 12). Furthermore, as the catalogue exists only in the form of a printed book and one of its *raison d'être* is to ease discoverability, the events are listed in alphabetical order by the surname of each participant. Consequently, they are referenced as many times as participants involved (Montmany Torrella, Navarro, and Tort 1999, 12), while a chronological index is also provided. Nonetheless, some omissions have been detected in both compilations, even though this particularity did not have a direct effect on our purposes.

The published catalogue lists 3,022 events, a figure that rises up to 3,059 if all omissions are taken into account. The description of each event includes a numerical ID; the full name of the artist(s) involved; the exhibition venue and the municipality where it was located (in those cases where it was outside Barcelona, since this location is the default value); an incipit of the exhibition brochure, including the opening and closing dates if known; a bibliographical description of the document; an indication of whether it includes a list of the displayed works; the title and author(s) of the text(s) that may accompany the leaflet; and the list of institutions where an instance of the brochure is preserved (**Figure 3**). The number at the top left is the exhibition ID; the artist holding the exhibition is named in the first line, and the exhibitory agent that hosts the event in the second. In italics is the incipit of the exhibition brochure, followed by a short bibliographic description of the document. The art critics who sign a text in the exhibition brochure are listed in the second- and third-last lines; the last line is for the acronyms of the institutions where a copy of the brochure is preserved.

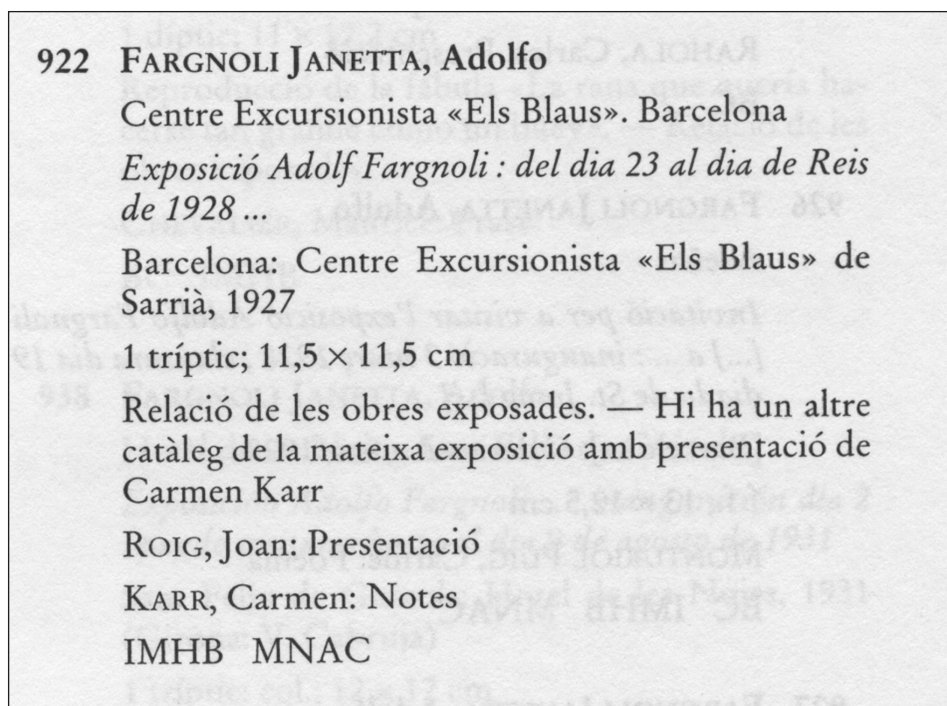


Figure 3: Catalogue record sample.

Data processing

The catalogue has been manually mined and the obtained data has undergone several processing and feature engineering stages. Uncertain exhibition dates, for example, have been refined by locating the events in the printed press and capturing the opening and closing dates mentioned there. Not stating the year in which the exhibitions were held, or even stating the days and months in ways that currently may look quite impractical (using days of the week as a reference, especially when stating closing dates) was standard practice in this period. Likewise, not stating the address of the exhibition venues was also frequent, since they were considered common knowledge and this information was usually disregarded, with the ensuing difficulties for current time research.

The manual mining process allowed us to locate and correct several typing mistakes and refine the available information in successive data-wrangling rounds. First of all, duplicate events were purged while keeping track of the ID numbers that pointed to the same event, merging their data, and solving any detected inconsistencies. This list of 2,845 unique events was subsequently processed in order to obtain a roster of 1,123 artists and an account of exhibitions held by each individual. Artists identified both by their pseudonym and their real name in different exhibitions—such as Joan Baptista Acher, a.k.a. Alfons Vila Franquesa, a.k.a. Shum—have not been merged and regarded

as the same individual, since we consider that the separate use of these identities at different times obeys some reason that is currently unknown to us. A similar course of action has been taken with the list of commentators compiled in the repertoire. Data were manually mined and processed so as to obtain a list of 278 people—without merging individuals such as Feliu Elias, who signed texts in brochures using both his real name and the alias of Joan Sacs—who wrote introductory texts or comments in 416 unique exhibition brochures.

This was followed by an intensive processing of the data concerning exhibition venues, deployed in two directions, since it became necessary to differentiate between agents and venues. The former are the businesses that promote, organize, and publicize exhibitory events in their establishments, while the latter are the physical spaces where exhibitions take place, which in turn might vary their location over time. Some exhibition agents may be located in only one venue over their lifespan; others—usually renowned, though there is no direct correlation in this fact—may change locations over time, a circumstance that needs to be tracked in order to perform more precise analyses on the particularities of these actors within the exhibitory system.

We therefore refined the list of exhibition venues so as to obtain a list of 164 agents and a list of 197 venues. Information about the venues, which was originally reduced to the municipality where they could be found, was enlarged by incorporating the physical address of each venue (extracted from press sources), the address coordinates, the time frame in which each venue could be found at each address, and the number of exhibitions held in each of these spaces, divided between real solo exhibitions and events with two or more concurrent participants. Regarding the list of agents, we took into account the number of locations held by each one over time and the total amount of exhibitions—solo and those held by two or more concurrent participants—organized in all the premises occupied by each agent. Also, 131 coincidences in space and time among artists have been detected, yielding a total of 303 individuals (262 unique actors), which concurred in 164 exhibitory events.

However, dealing with missing data has been unavoidable, even though it has not been a critical issue. Missing values in this dataset boil down to two attributes: the dates and the venue where an exhibition took place. Uncertain exhibition dates prevent us from obtaining the average exhibition length for a given event, and the lack of an explicit mention of the venue where an exhibition took place makes it impossible to determine the agent type involved in it. Therefore, a statistic replacement of these missing values has been performed, once the data valid for the purposes of this paper—individuals who have participated in ≥ 2 exhibitions, plus exceptions—have been extracted from the general dataset.

Regarding the uncertain exhibition dates, valid data have been filtered by node type, yielding 33 missing values for 700 exhibitions participated by artists (4.7%) and 33 missing values for 142 exhibitions participated by agents (23.23%). The average exhibition length per node type is obtained (13.51 days for artists; 14.37 days for agents) and added in lieu of the missing values. Since the average exhibition length is not taken into account in the equation for a relevance index for critics, these data are not processed for this type of node, as they were not gathered in the first place.

Only a single case of missing data concerning the venue where an exhibition took place has been detected. In order to obtain a statistic replacement for this value, we have determined the weighted average of the agent types present in the subset of valid data (46 art galleries, 50 institutions, 24 commercial businesses, 11 associations, and 10 private venues), which yielded a result of 0.58. Therefore, the unknown venue is considered an unnamed commercial business and its value as an agent type is set at 0.5.

Data limitations and bias

In a similar way as mentioned in the introduction, this dataset and by extension the research performed on it have three main biases and limitations. However, we consider that these do not prevent the data from being coherent enough and from constituting a sufficiently representative sample to test the model presented in this paper.

First, the gathered and processed data offers a snapshot dated back to 1999. The number of solo exhibition brochures that fall within our area and time frame of interest might have been augmented due to the discovery or contribution of new specimens to the public collections that were mined in 1999 in the search of these documents, not to mention that some of them have changed locations or have been incorporated into other institutions. It is the case of the then known as general library of Museu Nacional d'Art de Catalunya (MNAC) and of Centre de Documentació de l'Art Contemporani Alexandre Cirici (CEDAC). The former moved from the old convent of Sant Agustí—relatively close to the ancient museum's site in Barcelona's Parc de la Ciutadella—to Museu Nacional d'Art de Catalunya's current location up in Parc de Montjuïc; while the latter is currently being preserved in Museu d'Art Contemporani de Barcelona's (MACBA) study centre, also known as Centre d'Estudis i Documentació.

Second, our domain of action is defined by a rather random circumstance, that of the survival until present times of such frail items as exhibition brochures, which were not conceived as long-lasting documents. Furthermore, we are unable to determine the initial amount of exhibition brochures produced within our area and time frame of interest, in the same way as the reasons that determine which of these have been

preserved until present times are inscrutable. Therefore, our proposal for a method to determine relevance in the context of art exhibition phenomena will be strongly affected by the existence of brochures that give account of an exhibitory event, a circumstance that will be corrected in future iterations of this research.

Third, Barcelona is over-represented in the dataset. This particularity is understandably due to the fact that—despite Barcelona already being the largest and most important city in Catalonia in the late nineteenth century—the catalogue used as a starting point for this research only prospects public collections located in the municipality of Barcelona, a circumstance that raises the odds of the brochures found in these to provide details about exhibitions held in that very same location. However, the aforementioned catalogue provides us with a noticeable amount of exceptions, and there is also clear evidence (Solé i Martí 2015; Solé i Martí 2019; Bassegoda i Hugas 2022) of exhibitory events and venues located in other parts of the country in the same period. These data will progressively be added to the dataset as part of a systematic collection process that aims to cover as much of Catalan territory as possible and therefore gradually normalize the deviations stated above.

Case study: Validation and discussion

Equation 1 was applied on a per-node type basis to the subset of data considered valid for our purposes—individuals who have participated in ≥ 2 exhibitions, plus exceptions. This subset consists of 1,118 nodes (700 artists, 141 agents, and 277 critics), all of which display a relevance index (R_i) between 0 and 10.

Galleries Laietanes, a renowned exhibition agent from Barcelona, bears the absolute highest R_i of the subset (8.6639); while the absolute lowest R_i is that of Casa-Estudio (0.0315), an artist's private house and studio, also located in Barcelona. In terms of node typologies, the artists with the highest and lowest R_i are Adolfo Fargnoli (5.9356) and Josep Maria Recoder (0.2950); while the extreme R_i values for critics are 7.5359 for Rafael Benet and 0.3917 for J. D. (Jaume dels Domenys, pseudonym of Alfons Maseras Galtés).

The distribution of the results is as anticipated: a rather small amount of cases display a high R_i , and the vast majority of observations have a somewhat modest value. However, disparity in the overall distribution is more pronounced than expected. The overall average is 1.1306 (with a standard deviation of 0.7822), while the median and the mode are 0.8571 and 0.6737 respectively. The R_i of 401 individuals (35.86% of the analyzed subset) is under the mode, while the 717 remaining observations are over the mode. Among these, 268 cases (23.97%) display a R_i between the mode and 0.999; the R_i of 309 individuals (27.63%) is

between 1 and 1.999; there are 106 (9.48%) cases with an R_i between 2 and 2.999; 25 cases (2.23%) with an R_i between 3 and 3.999, and 9 individuals (0.8%) bear a R_i higher than 4. Among these, the R_i of 4 of them is above the centre of the range of expected results, which is 5 (Table 3).

Relevance index (R_i)	Overall count	Relative frequency overall (%)	Agents	Relative frequency in agents (%)	Artists	Relative frequency in artists (%)	Critics	Relative frequency in critics (%)
0-0.999	669	59.8389	15	10.6382	419	59.8571	235	84.8375
1-1.999	309	27.6386	32	22.6950	250	35.7142	27	9.7472
2-2.999	106	9.4812	71	50.3546	28	4	7	2.5270
3-3.999	25	2.2361	20	14.1843	1	0.1428	4	1.4440
4-4.999	5	0.4472	1	0.7092	1	0.1428	3	1.0830
≥ 5	4	0.3577	2	1.4184	1	0.1428	1	0.3610

Table 3: Frequency R_i distribution overall and by node type.

Distributions vary among node types, and therefore the descriptive statistics values per node type are less disperse (Table 4). The R_i distribution of both artists and critics is noticeably asymmetric and skewed to the lower end of values, while the R_i distribution of agents presents a more normal curve. For instance, 419 artists and 235 critics (59.85% and 84.83% of their respective cohorts) display a R_i below 1, while only 15 agents (10.63% of the cohort) bear such a small R_i . On the other hand, the majority of agents (71 individuals, 50.35% of the cohort) display a R_i between 2 and 2.999, whereas only 28 artists and 7 critics (4% and 2.52% of their cohorts respectively) fall in this range of results (Figure 4). This succinct approach to the results from a descriptive statistics point of view reveals the consistency of the method presented in this paper, notwithstanding it is at a preliminary and perfectible stage.

Node type	Average R_i	Median R_i	Mode R_i	Min R_i	Max R_i	Standard deviation
agent	2.23	2.26	2.25	0.03	8.66	1.08
artist	0.99	0.88	0.6	0.3	6.35	0.51
critic	0.92	0.67	0.67	0.4	7.54	0.74
all node types	1.13	0.86	0.67	0.03	8.66	0.79

Table 4: R_i descriptive statistics overall and by node type.

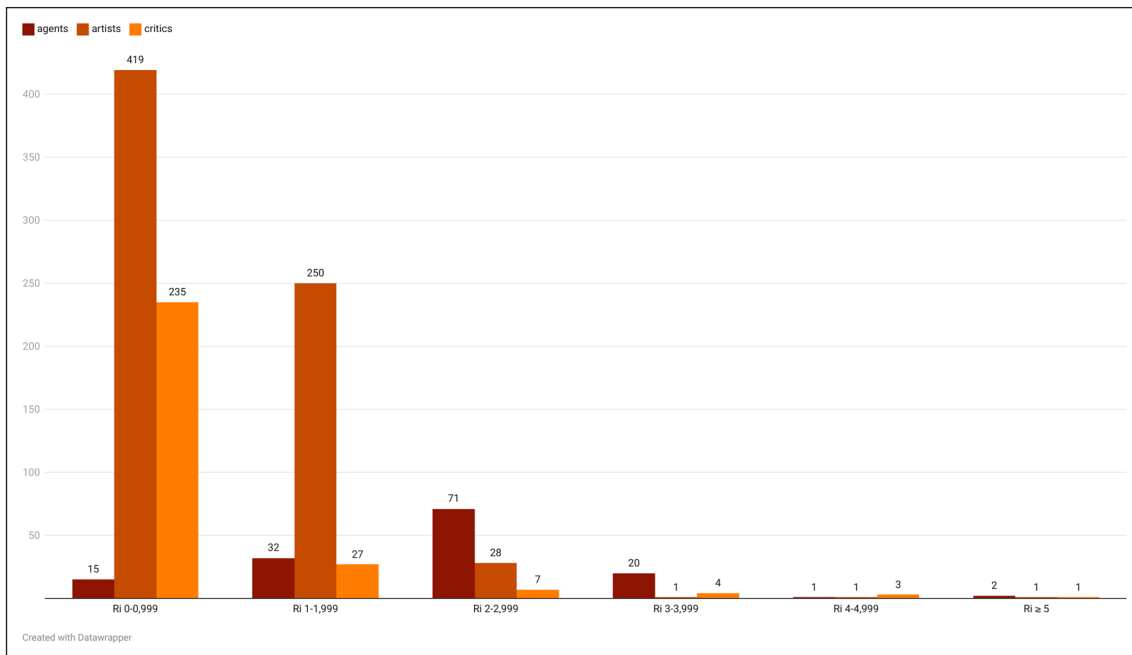


Figure 4: *Ri* distribution frequencies by node type.

As **Figure 4** already suggests, when the overall results of **Equation 1** are ranked by *Ri*, the top positions are mainly filled by exhibitory agents, while critics and artists plunge rather abruptly into the lower ranks. For instance, among the 25 actors with the highest *Ri* values (**Table 5**), there are 15 exhibitory agents, 7 art critics and 3 artists (10.63%, 2.52%, and 0.42% of their cohorts, respectively).

We deem it reasonable that agents dominate the highest *Ri* ranks. They constitute the smallest cohort in the overall analyzed population (141 out of 1,118 individuals, 12.61% of the total), a circumstance that favours their already critical role within the exhibitory ecosystem, that of facilitating the public display of artworks and therefore making their creators known both by art critics and the general public. However, the dearth of exhibitory agents—or lack of relevant enough ones—in a system based upon art exhibitions poses a serious threat to its survival as a whole. Their scarcity is both a risk for stagnation and an opportunity to increase their own relevance and influence on their counterparts; thus, it is sensible that exhibitory agents with a high *Ri* are more common than other actor types. Still, the apparently low ratio of exhibitory agents in the analyzed dataset seems to fall within a safe threshold, at least from an exploratory perspective.

On the other hand, it is also understandable that artists are rare among the individuals with the highest *Ri*. Most of the analyzed population (700 individuals out of

1,118, 62.61% of the total) are artists; therefore, an excess presence of these in the top ranks would suffocate the system and thwart the role performed by exhibitory agents and art critics, that of orientating the general public by the means of the exhibitions they decide to host or the comments they publish. Moreover, a cultural network based upon art exhibitions as the one modelled in this paper would be meaningless without a significant population of artists—even irrelevant ones. It would eventually self-extinguish due to the absence of new artworks, the cultural objects that ultimately underpin this set of relationships.

Node ID	Node type	Relevance index (<i>R_i</i>)
Laietanes	agent	8.6639
Rafael Benet Vancells (crític)	critic	7.5859
Parés	agent	5.9971
Adolfo Fagnoli Janetta	artist	5.9356
Joaquim Folch i Torres	critic	4.6977
Josep Maria de Sucre	critic	4.2699
Joan Mates	critic	4.2361
Ramon Casas Carbó	artist	4.2026
Dalmau	agent	4.1967
Syra	agent	3.8121
Joan Sacs	critic	3.7657
Pinacoteca	agent	3.7194
Carles Capdevila	critic	3.5518
Busquets	agent	3.5509
Forja Catalana	agent	3.5269
Santiago Rusiñol Prats	artist	3.4114
Areñas	agent	3.3754
Barcino	agent	3.3747
Camarín	agent	3.3154
Serra	agent	3.2713
Costa	agent	3.2457
Malmedé	agent	3.2363
Marian Burguès Serra (crític)	critic	3.2171
Faianç Català	agent	3.1776
Salón de Arte Moderno	agent	3.1655

Table 5: Top 25 actors according to their *R_i*.

Finally, it seems fair that almost one-third of the top *Ri* bearers are art critics, especially if we take into account that they constitute approximately a quarter of the overall analyzed population (277 out of 1,118 individuals, 24.77% of the total) and that their role in the exhibitory system is not as determining or fundamental as that of their counterparts. The lack—or even absence—of art critics in an exhibitory ecosystem may not suddenly put its continuity at peril, but the presence of a core group of highly relevant art critics, as pointed out by **Table 5**, is key to ensure the health of the network's dynamics.

Besides, the list of actors with the highest *Ri* echoes—to some extent—the Catalan artistic canon of the late nineteenth and early twentieth centuries. No unknown characters are found in **Table 5**, and those present in the roster are familiar not only to the average Catalan art historian, but also to minimally informed citizens. As expected, the deeper into the list one may dive, the obscurer the names of the individuals that may be found, especially in the case of artists and, to a lesser extent, art critics. Regarding women, the first occurrences—the ceramists Amèrica Cardunets and Euda Solé, who concurred in several exhibitions—share an *Ri* of 2.1414 and are placed in the 122nd and 123rd positions of the overall ranking, equivalent to positions 19th and 20th of their cohort. The first woman art critic is Margarita Nelken, bearing a 0.8837 *Ri* and placed in the 523rd position overall, 52nd of her cohort.

However, some cases—notably Adolfo Fargnoli—currently give the impression to be outliers due to being over-represented in the analyzed dataset. In a similar manner, some notable absences due to under-representation have been detected and should also be treated with caution. A clear example is that of Romà Bonet Sintes, a.k.a. Bon, an illustrator and cartoonist known for holding a rather large amount of travelling exhibitions with his partner, Antònia Trenchs. Knowledge about these events has been extracted from documentary sources but not from exhibition brochures, which were not even produced, or have not been preserved to present times. Therefore, neither Bonet nor Trenchs are to be found among the *Ri* list but will eventually enter it in further iterations, once data from the printed press are added to the analysed dataset. Other unanticipated results may be those of some highly respected artists, undoubtedly prominent in most Western art canons, such as Salvador Dalí, Pablo Picasso, or Joan Miró, for example. Since their presence in the analyzed dataset is discreet (they respectively participated in 4, 2, and 1 exhibitions, without many interactions with third parties), the resulting *Ri* (0.8984, 0.8002, and 0.5323) drags them down to the depths of the ranks, to the 510th, 600th, and 1032nd positions overall (334th, 385th, and 627th of their cohort, which consists of 700 individuals). Cases like these lead us to believe that the results will self-adjust once more diverse data (in geographical, chronological, and actor terms) are consolidated into the analyzed dataset.

Recapitulation and future work

After having offered a data-based perspective on the concept of relevance in art history and having noted that its definition is far from precise, we consider that several of its features can be objectivized. Therefore, this traditionally etheric notion can be approached from a quantitative point of view so as to perform clearer analyses that, in turn, are easier to share and replicate. Our focus has been set to the art exhibition system from the late nineteenth to the mid-twentieth centuries, a time frame whose singularities—especially the reception of art exhibitions and the role performed by exhibitory agents and art critics—cannot be completely homologated to those of current exhibition systems. Moreover, its historical component shall not be ignored and the substantial information on this topic is directly conditioned by the completeness and quality of the available documentary sources, which are, at best, only partly digitized. Nonetheless, setting aside a completely erudite manner to favour a data-driven approach to these documents has furnished new opportunities to better understand the art exhibition phenomenon, such as those concerning the bonds among the actors that constitute this ecosystem.

Usually, relevance is understood to imply importance or special significance. The factors and indicators considered to affect relevance in our area of interest orbit around events (art exhibitions), their features, and the relationships among the individuals involved in said events. A number of quantifiable features have been selected in order to obtain a collection of values that, together, provide us with a nuanced proxy for each individual's relevance in the art exhibition system of the turn of the twentieth century. Still, it has to be noted that not all the selected parameters have a direct incidence on each individual that participates in the system and that their incidence is not equal across all the studied population.

A proposal for an index to measure relevance (R_i) has been elaborated based upon these criteria and circumstances (**Equation 1**) and tested in a case study modelled as a cultural network where artists, exhibitory agents, and art critics mutually interact in a compilation of relationships mediated by art exhibitions. **Equation 1** has been applied to all the individuals that constitute the analyzed network in order to facilitate node comparisons and further research by avoiding multimodal and overly complex scenarios, at least in such early stages of the project.

The relevance index presented and validated above is definitely not the winning formula longed for in research question 1, but a first attempt. As already mentioned, the parameters and the weights used in **Equation 1** need to be perfected and adapted to the features of new data subject to be analyzed in the future, such as the information that may be extracted from the printed press or the results of sentiment analyses run on these, on the exhibition brochures, and on other printed documents. The possibility of

making these adaptations paves the way for adjusting the relevance index calculation to different contexts and scenarios, which leads us to think that our proposal is not another one-size recipe.

In any case, the obtained results are both fair and balanced, though somewhat stratified and skewed to the lower end of the expected range. The evidence suggests that well-known, canonized individuals (both in art practice and criticism), and specialized exhibitory agents are to be found among the most prominent R_i ranks. Among these, the latter are the most valued actors of the ecosystem. Artists are to be found throughout the spectrum of results, though they mostly constitute its left tail, and only a minority is located among the most relevant individuals. In a similar manner, art critics are revealed as apparently secondary, non-critical characters. The rationale for these findings connects with the model proposed in this paper: its node typologies are not evenly distributed; it would be meaningless otherwise. Also, feedback among actors in this type of network is unavoidable and has an effect on the position of each individual in the whole ecosystem, which does not exclusively depend on oneself and their attributes, but also on their relationships with third parties (**Figure 5**). Finally, in an art exhibition system progressively dominated by market laws, as the one discussed in this paper, exhibitory agents become the most necessary partners for both artists and art critics to thrive. Since many of these agents are completely devoted or close to trading activities, and they also form a scarce cohort, they are the best positioned actors in this new scenario. This privileged position facilitates gravitational patterns both between peers and counterparts, inasmuch as many exhibitory agents are the connecting node between two other nodes that elseways would not be related. This matter, intended to be fully addressed through research question 2, requires further work, especially in terms of network analysis, which ended up being beyond the scope of this paper.

Similarly, research question 3 proved to be over-ambitious for this first approach to the topic. Still, the prospect ahead of this inquiry is highly stimulating, and multiple paths to follow have opened up. Future work to improve the proposed framework will be approached in an iterative way and will advance in two main directions. On the one hand, data available for analysis will be enlarged by incorporating information sourced from exhibition brochures from our area of interest preserved in other collections and archives. Besides, evidence mined from other documentary sources—personal archives and periodicals—will be added to the dataset, in the hope of reducing biases, tempering, and upholding those results that currently may be considered as outliers. Indeed, all the gathered information will be accessible without restrictions in order to replicate the results and advance research in this matter. On the other hand, the method suggested in **Equation 1** to assess relevance will be subject to revision, especially regarding the

weights and values determined for each parameter. Likewise, these criteria are prone to be altered once data obtained from new source typologies are merged into the working dataset. Notably, those under the “brochures” category may be diversified and necessarily make room for, at least, sentiment analyses.

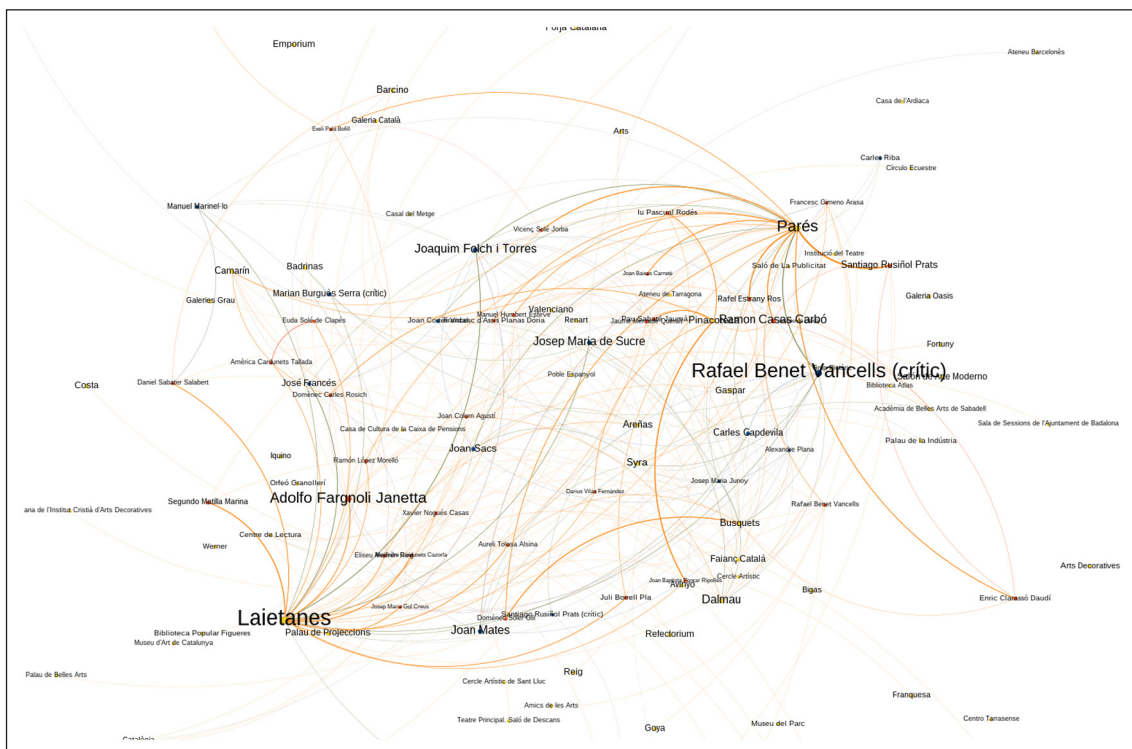


Figure 5: Partial visualization of the exhibitory system (node $R_i > 1$) as a network with a random layout. The size of the nodes and labels is proportional to their R_i ; yellow nodes are exhibitory agents, blue nodes are art critics, and red nodes are artists. The edge colour is the combination of the connected nodes' colours, and its thickness is proportional to their weight.

Although we do not aspire to transform art history into an aseptic, numerical discipline, we argue that its scholarship can benefit from companions such as the one presented in this paper. Quantifying procedures in the humanities are still viewed with suspicion, considered as something completely alien to traditional researchers, and sometimes even seen as a threat. The method to determine relevance in art exhibition systems proposed above, conceived as an approach that may be easily adapted to different time and space coordinates, shall be understood as a compromise proposal, something halfway between pure erudition and algorithmic knowledge which, after all, may contribute to strengthen this area of knowledge.

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Competing interests

The author has no competing interests to declare.

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