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Creative Technologies: A Retrospective

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This paper undertakes an analysis of articles published in the area of Creative Technologies to inform the future development of the field. Articles were collated in a corpus and analysis conducted around keywords, content and authorship. The observations arising from the analysis is that there is some empirical evidence to support that Creative Technologies is an interdisciplinary field of research, with individuals having expertise across multiple domains having the potential to connect otherwise disparate disciplines. The results of the paper support some assertions around the nature of Creative Technologies, however it also suggests that more work is required to scope the field and change is required to secure a future for the Creative Technologies communities of practice.

Keywords: *Creative Technologies, Authorship Networks, Disciplinary Classification, Keyword Analysis, Bibliometrics.*

Introduction

Ka mua, ka muri is a Māori proverb that describes a person walking backwards into the future. It implies that the past is always clearly visible but there is at best imperfect information for the road ahead. It suggests that there is a need to look back for clues to the find the way forward, and to understand that the future comes out of the past but will not be identical to it. The purpose of this paper is therefore to critically analyse the past in order to inform the construction of a future for Creative Technologies.

It has been argued that Creative Technologies is at the heart of a creative revolution that is changing the world (Zagalo & Branco, 2015). At first glance "What is Creative Technologies?" appears a

simple question, but there is no universally held definition to help answer it (Connor et al., 2016). The definition provided by Wikipedia that Creative Technology "is a broadly interdisciplinary and transdisciplinary field combining computing, design, art and the humanities" (Wikipedia) provides some insight, but is both broad and generic. In the last fifteen years there has been a growth in degree programmes that adopt the term, yet many of these maintain their own distinct flavour that makes unification difficult. Within Creative Technologies, it appears that individuals tend to project their own experiences and requirements into the definitions they use (Connor et al., 2016) which results in a fluid and amorphous field. This has many advantages as well as potential drawbacks, not least of which is a lack of perceived credibility within academia.

This paper is a preliminary study that analyses research papers published in the field of Creative Technologies over the last five years to gain insight to the scope of the field. This builds upon and extends previous work that attempts to characterise Creative Technologies (Connor & Sosa Medina, 2018), which recognised that the lack of universal definition is a challenge for understanding the scope. By starting with a corpus of articles that have been published in a Creative Technologies journal, it aims to take a bottom up approach to identify what Creative Technologies is from a research perspective.

Background and Related Work

A historical review of creative technologies traces the usage of associated terms back to just after WWII (Connor, 2016). This review indicated that the growth of the field was initially slow; however, since the turn of the millennium there was an increase of interest. Despite this, there have been few attempts to deepen the understanding of what Creative Technologies is. Many attempts to discuss the field offer similar descriptions to that found on Wikipedia. For example, from a research perspective, Hugill reinforces the interdisciplinary nature of Creative Technologies and goes on to describe the activities of the Institute of Creative Technologies at DeMontfort as ranging across areas that include computational intelligence; digital writing; sonic art; pervasive media; digital heritage; interactivity in health; cultural visualisation; and the semantic web (Hugill, 2013).

In contrast, the Institute of Creative Technologies at the University of Southern California has a much narrower purpose, described as having a mission to focus on developing technologies for immersive virtual reality to be used in the creation of new virtual training applications for the US Army" (Korris,

2004). The USC Institute sits in partnership model but tied into a single purpose, whereas the DeMontfort institute would seem to be much freer in scope. These two examples are intended to provide different perspectives that highlight the diversity in both purpose and scope of research in Creative Technologies.

Different educational programmes also have variation in their stated purpose. For example, Mader and Eggink describe the goal of the Creative Technology programme at the University of Twente is: "to design products and applications that improve the quality of daily life in its manifold aspects" and also stating that "a paradigm of Creative Technology is to make use of existing technology in novel combinations – in contrast to developing new technology" (Mader & Eggink, 2014). In other work, Mader and Dertien argue that the field aims to use material and technologies in different ways than was intended (Mader & Dertien, 2014).

This perhaps provides some insight into the differences between Creative Technologies and the traditional disciplines. However, there is great diversity in academic programmes. For example, a programme at Auckland University of Technology is described as flexible and experimental, and founded on notions of play, community and interaction to promote divergent thinking and to break, blur or transcend normative disciplinary boundaries (Connor, Marks, & Walker, 2015). It is further described as training students to produce ideas, intellectual property and artefacts across a wide range of entrepreneurial creative industries contexts. The diversity of programmes in Creative Technology can further be made clear by considering programmes such as those by Universiti Malaysia Kelantan, who's programme is focused on multimedia and visual communication with the aim of combining of practical and theoretical knowledge in both technologies in animation production, with an entrepreneurship approach (Tarmizi, 2011).

There are some commonalities in these programmes, such as a design orientation, emphasis on media and entrepreneurial approaches. However, just as with research endeavours, there is a spectrum of breadth of purpose that can be further supported through analysis of institutional websites rather than research articles. The limited set of examples is enough to support the assertion that answering the question "What is Creative Technologies?" is not a simple task. Various opinions and viewpoints from blogs and websites provide further insight. For example, Flores answers the question directly with the statement "The short answer is a lot of things, depending on who you ask" before going on

to identify key elements as being motion sensors, large format display hardware, generative design tools, interactive screens and surfaces, virtual and augmented reality, and data platforms. Flores also argues that that Creative Technologists are "a critical bridge between developers and designers" (Flores, 2017).

Similarly, Avnet argues that Creative Technologists "understand the business of advertising, marketing, and branding, take a creative, strategic and people-centric view of how to connect people and brands, and understand the kinds of mediating technologies that can best be used to make those engaging experiences where the connection happens" (Avent, 2010). This view that Creative Technologists are connectors is quite pervasive with practitioners in this field. For example, Hammond draw parallels between creative technologies and the maker movement with the observation that these two communities help people to develop skills together and share knowledge across disciplines by connecting and working with likeminded individuals (Hammond, 2016).

This brief discussion of the literature is not exhaustive but is sufficient to suggest there is a need to further investigate the nature of Creative Technologies in three different dimensions. Firstly, is there any evidence to support the claim the field is inherently interdisciplinary in some way. Secondly, what topics or subjects constitute the field of Creative Technologies. Thirdly, is there any evidence that supports the commonly held view that Creative Technologists act as connectors between either other people, technologies or communities.

Method

This paper undertakes a preliminary analysis of the three areas of inquiry outlined in the previous section by analysing the corpus of papers published in a single journal between the years of 2014 and 2019. The nature of the study is inspired by the work of Christensen and Ball (Christensen & Ball, 2019) who undertook an analysis of the papers published in the journal Design Studies by classifying the disciplinary backgrounds of authors using affiliation information. This method is extended in this paper, both by the inclusion of a more formal classification approach as well an analysis of the content of papers included in the corpus. The data collation and analysis methods are described in the following sections.

Data Collection

The papers published in the journal were collected based for all papers that were available online on the date of 31st December 2019, which resulted in 92 papers included in the study. The raw data extracted from the papers included the names and affiliations of the contributing authors, and keywords included in the papers. The authors list was checked to remove duplicates based on different names (e.g. John Smith and J. Smith) after checking that the names represented the same individual. In a small number of cases, the opposite was necessary, when a name was used in different papers that referred to different individuals, the names were disambiguated by expanding the first name. This resulted in a list of 274 unique contributors. Multiple affiliations, as a result of cross-appointment, were all included in the dataset. Keywords were extracted from all the papers without any preprocessing resulting in a list of 454 terms, of between one and seven words.

Geographic Data Processing

Author affiliations were examined to determine the geographical distribution of authorship. When cross-appointments resulted in affiliations in two different countries, these authors were counted twice resulting in the situation where the number of authors by country is greater than that the number of unique contributors.

Author Classification and Networks

The disciplinary classification of authors was made using the bepress Taxonomy of Disciplines (bepress, 2019). This is a three tiered, hierarchically organised taxonomy. The top tier of disciplines was modified to include two additional outcomes, that of Unclassified (where a decision could not definitively be made) and Multiple Classifications (where an author could arguably be placed in more than one discipline). In general, only the top two tiers of the taxonomy were used and those are reported in this paper.

A wide range of information was used to make each classification, rather than just the affiliation information used by Christensen and Ball (Christensen & Ball, 2019). These included inspecting institutional home pages, personal websites and blogs, LinkedIn profiles and publications information as provided mainly through institutional repositories, Google Scholar profiles, dblp and the ACM digital library. The main focus was to identify the range of research publications and to use this in the classification process. In many cases, inspecting both recent and historical publications

showed that an author's research focus produced a different classification than if it had been based on just their affiliation. Not all sources were used for all authors, and the decision was made to include information available up to the date of analysis rather than attempt to post-date the classification.

Keyword and Concept Analysis

The keyword analysis was originally intended to be a simple counting exercise. However, inspection of the keyword data indicated that such an analysis would be unlikely to provide any deep insight, therefore a clustering approach was undertaken. This involved the grouping of similar keywords to identify common themes, the limitations of which are discussed later. During this process, no attempt was made to refer back to the paper itself to determine the intended meaning of each term, each was taken at face value. In addition to the keyword analysis, each paper in the corpus was read and mapped into content areas of the journal.

Results

The analysis of the corpus of articles published in the journal are presented in this section. There are two broad areas of analysis, focusing on the authors and the paper content.

Geographical Distribution of Authors

Based on the affiliation of authors extracted from the corpus of articles, the geographical distribution of authors can be determined. In total, six authors were found to have institutional affiliations in different countries, with affiliation pairings of the UK and Portugal, Australia and New Zealand, Belgium and France, the UK and Nigeria, Nigeria and Portugal and Germany and France. These multiple inclusions only have a small impact on the overall data, which is presented in Figure 1.

Disciplinary Classification of Authors

The results of the classification of authors against the top tier of the bepress taxonomy of disciplines are shown in Figure 2, which also includes the additional labels of Unclassified and Multiple Classifications.

In total, there were 43 authors that could not be classified. In many cases, these were student authors for whom there was simply not enough data on which to base an informed decision. However, in a small number of cases, it was impossible to disambiguate an author based on their name and

institutional affiliation. This occurred when an institution had staff of the same name, but Google Scholar or LinkedIn profiles could not be confirmed as belonging to the paper author. The number of such cases was low, but it does emphasise the importance of using ORCID IDs or alternative methods of confirming authorship.

The most represented discipline areas are physical sciences, mathematics and engineering. However, these labels hide a wealth of diversity and therefore inspection of the second tier of classification is required. It is worth noting that the authors classified as having multiple discipline areas as well as those unable to be classified are dropped out from the data shown in Figure 3. The decision to not include authors with multiple classifications is based on that fact that such authors had potentially up to three, four or even five disciplinary areas.

The classification process at the second level is diverse, though it is dominated by Computer Sciences and Electrical and Computer Engineering. It is worth noting that these two disciplines have a very non-distinct boundary that may have resulted in some incorrect classifications between the two. For example, researchers focused on computer networking could easily be classified in either domain. An attempt was made to be consistent in such situations, for example an author who's focus was on algorithms used in networks would be classified in the Computer Sciences, in comparision someone develop networking technology would be classed in Electrical and Computer Engineering. Several other areas such as robotics and the development of interfaces also suffer from the potential for initial misclassification. A more formal use of the full taxonomy may result in fewer potential misclassifications.

Authorship Networks

In addition to classifying the discipline of authors, the co-authorship network for the papers in the corpus was generated. No author names are included in the authorship networks to preserves anonymity of the authors. As the objective is examining how the disciplinary classifications of authors play out in the writing of papers submitted to the journal, the author names have been replaced with their disciplinary classification.

The full co-authorship network was produced using VOSviewer (v1.6.14) and is shown in Figure 4. The size of an author node is proportional to the number of papers they have authored and the link

strength between authors increases with the number of joint publications and is denoted by a thicker line. The full network consists of 67 clusters mapping to the 92 papers in the corpus. Given the small size of the corpus, and the diversity of the published articles, it is not surprising that there is relatively little interconnection between authors of articles in the journal. Not all discipline classifications are displayed in the network to prevent overlapping labels in the figure. In some cases, these clusters are comprised of individuals all working in the same, or very closely related fields. In other cases, authors from disparate disciplines are working together. An example of each is shown in Figure 5.

There are 7 instances of a single author clusters in the corpus. The remaining 60 clusters can be investigated to determine to what extent there appears to be interdisciplinary collaboration. To do this consistently there is a need for guidelines on how to process networks. When a network contains an individual with multiple classifications then it is treated as an interdisciplinary collaboration. Individuals that are unclassified are ignored. Disciplines are also evaluated based on their similarity, so for example combinations of Electrical & Computer Engineering and Computer Sciences would not be considered interdisciplinary. Following these guidelines, 45 of the 60 clusters involve are potentially interdisciplinary in nature, representing 66 papers in the corpus.

In some cases, there is a distinct joining of smaller networks through a key author. In some cases, the authors across the joined networks have a common institution or location. In other cases, such obvious reasons to collaborate are not present. However, the main interest in these networks for this paper is to explore the disciplinary backgrounds of the authors in these joined networks. Two examples are given in Figure 6 and Figure 7. In addition, an overlay showing the authorship for each of the papers authored by this network has been added as coloured boxes. In both these examples, the connections between networks are made by individuals with some capacity to work in different discipline areas. This is normally demonstrated by several publications in different areas, for example art practice and computing sciences, or where publications demonstrate research that uses other knowledge bases to give a new twist to work within a discipline.

Keyword Analysis

In this section, the unit of analysis is changed to the papers in the corpus with a view of determining the actual scope of research in the area of Creative Technologies. This is conducted in two ways,

firstly looking at the keywords identified in the articles and then a more holistic evaluation of the content

As noted previously, a simple counting of keywords was unlikely to lead to much insight into the topic areas included in the scope of Creative Technologies. Of the 454 terms extracted from the corpus, only 33 terms were repeated in more than one paper. This situation could be changed by considering partial terms, for example the raw data includes “human computer interaction” as well as “multimodal human computer interaction” which could be argued as being similar enough to be treated as the same thing. However, such inclusion would have little impact as there are few similar terms. Indeed, there are cases where using partial terms is counterproductive. For example, “molecular communication” is a form of communication but has a specific meaning that might be lost by combining it with “communication”.

The vast majority of keywords are not repeated, though many have some degree of similarity, for example “face tracking” and “face direction”. Therefore, further analysis was conducted where keywords were clustered based on semantic similarity. No formal measures were used, instead the clustering was based on an informal interpretation of the keyword meaning. The limitations of this approach will be discussed later. This process resulted in 312 keywords being allocated to eighteen clusters, with a minimum number of four keywords required to form a cluster. The decision to use a minimum number of four terms to justify a cluster was based on a consideration of how similar keywords appeared in single papers. For example, many papers have two related keywords (e.g. “forward kinematics” and “inverse kinematics”). It was estimated that if the threshold for creating a cluster was lowered to two keywords, that eight clusters would be created of two keywords that were related to a single paper. If that threshold were raised to three keywords, only two such clusters would be made. However, in both cases there were no additional clusters that would emerge involving keywords from multiple papers.

In total, 142 keywords remained unclassified. These clusters and distribution of allocation are shown in Figure 8. The labels used for each cluster are chosen to be as descriptive as possible and represent the keywords embedded within them. It worth noting that 30% of the keywords do not to map into clusters.

Content Analysis

The aim of conducting an analysis of the content of papers is an alternative way to understand the scope of Creative Technologies. In this analysis, the stated scope of the journal has been rationalised into a set of terms that represent the intention of Creative Technologies. Examining this list of terms there is considerable alignment between the scope of the journal and the articles included in it based on the clustering of keywords shown in Figure 8, noting again though that there was a relatively large proportion of unclassified keywords. There is also potentially some bias in these terms as a result of the previous allocation of cluster labels.

The classification process for papers involved manually inspecting the content of all the papers included in the corpus and mapping against the merged scope list. As a result of the potential for a paper to be classified against more than one area, the sum of the classifications presented in Figure 9 exceeds the number of articles in the corpus. The classification process was based on a positive inclusion strategy, so in many cases a paper was classified against one or more of the merged topic areas, despite reservations around whether the content of the paper could truly be considered as an example of Creative Technologies. Examples would include papers that were clearly about well-defined topics, such as networking technology or software engineering.

Comparing the clustered keywords in Figure 8 and the journal scope areas defined in Figure 9, there are some differences that arise. For example, there are 38 keywords that have been clustered under the heading “Education” and yet is not explicitly listed in the journal scope. As a counter example, “Advertising” is listed in the journal scope and yet is not apparent in the keyword clusters. There is potential here to expand the include elements of education, though this needs to be done considering what defines education in the context of Creative Technologies.

An additional holistic analysis was carried out based on the colloquial expression “I know it when I see it”. There may not be an accepted definition of Creative Technologies, however it is possible to classify papers using a tacit understanding of the field in to one of three categories – either being, not being or maybe being a Creative Technologies article. The outcome of this classification was that 44% of the papers were not considered as Creative Technologies papers compared to 35% that were. The remaining 21% were open to interpretation, with the potential to maybe considered.

The limitations of the study, including the classification processes, will be presented in the next section. Notwithstanding these limitations, it is interesting to observe that many of the articles published in the journal are potentially not related to Creative Technologies. This may suggest that potential authors in this field are not clear what constitutes research in this field. More analysis is required to determine if these papers are those that could not have their keywords embedded in the clusters in Figure 8, though it needs to be considered a distinct possibility.

Discussion

The analysis in this paper explores three lines of inquiry in relation to Creative Technologies. The first was to identify whether there was any evidence to support the claim the field is inherently interdisciplinary. The second was to attempt to understand what topics or subjects constitute the field of Creative Technologies. Finally, it was intended to see whether the commonly held view that Creative Technologist act as connectors could be supported. However, none of these should be addressed without first considering the limitations of the research presented here.

Limitations and Threats to Validity

The main limitation of the work is the size of the corpus of articles used. The analysis has been conducted on just 92 papers over a five year period, with 274 authors. This can be compared with the study by of Christensen and Ball (Christensen & Ball, 2019) who analysed 1054 papers over a forty year period, with a total of 1514 authors. The small corpus itself is a restriction, as with small datasets it is possible to find patterns that do not really exist. However, this is also problematic given the assertion that at least some of the articles included in the journal simply don't fit. Arguably, a better approach would be to remove these articles prior to the analysis, however this would result in an even smaller dataset.

In addition to the limitations, there are also some threats to the validity. With regards internal validity, the fact that the analysis has been conducted by a single individual should be highlighted. The study has not utilised formal intra-rater strategies to ensure that all the judgements have been consistently made. This raises the possibility that some classifications are incorrect as a result of factors such as bias and fatigue. The study should be considered as a preliminary to provoke discussion and further work. Such further work will be discussed later but could utilise multiple evaluators with consideration of inter-rater agreement.

With regards external validity, the main concern is the use of a single journal as a source of data to determine the nature of Creative Technologies. Just as it appears that the journal includes articles that may not be Creative Technologies, it is safe to assume that articles that are in scope are also published elsewhere. Similar observations have been made in relation to conducting design authorship studies which included multiple sources (Ilhan & Oguz, 2019). This would include a number of conferences, books and other journals. Again, further work should consider establishing a larger corpus of articles from a broader range of sources.

The Field of Creative Technologies

The data presented in Figure 2 would suggest that the field of Creative Technologies is dominated by the Computer Sciences, however further analysis suggests that the field does contain a significant amount of collaboration across disciplines with 66 of the 92 papers in the corpus showing that some form of collaboration across disciplines. This can be compared with the findings of Christensen and Ball (Christensen & Ball, 2019) who identified that 24% of papers published between 2009 and 2018 in the journal Design Studies involved collaboration across disciplines. It is worth noting, however, that the extent to which that mixing of disciplines has occurred in practice has not been fully explored in this paper. The estimate of 71.7% in this analysis might be optimistic due to some of the assumptions made, however, it is likely that such an analysis would still reveal at least a comparable degree of collaboration across disciplines when compared to the design field.

There are 85 authors that have contributed to the journal associated with the Computer Sciences, but there are 65 authors that are active in more than one disciplinary area. Many of these authors are active in areas of the Computer Sciences, which suggests that this type of work is fundamental to the field of Creative Technologies. However, noting that some of the articles in the journal may be considered as not in scope for the journal, removing these from the analysis may change the distribution of affiliations and should be considered.

It is again worth comparing the findings with those of Christensen and Ball (Christensen & Ball, 2019) who identified a distribution of authors across different disciplines. A direct comparison is not possible due to different classification approaches. However, these authors also see large numbers of authors classified as working in engineering and technology (59.5%), with smaller numbers in the

arts, design & architecture (3.27%) as well as a minority in social and behavioural sciences (7.3%), business (5.4%), humanities and liberal arts (4.8%) and the natural sciences (0.7%). If the authors classified in this current study were reclassified into a single disciplinary area then a more direct comparison would be meaningful, however it would seem that there are certain patterns of similarity that would be interesting to explore. Again, more detailed analysis needs to be undertaken to explore this, but there is the potential that the mixing of disciplines doesn't produce interdisciplinary work as such. Instead, it produces a new or different way of doing things within a given disciplinary area.

Creative Technologies Topic Areas

The clustering of keywords produced a number of relatively generic labels that describe the scope of articles published in the journal. These labels would generally be considered to fall in the Wikipedia definition of Creative Technologies of "combining computing, design, art and the humanities" [5], but such definitions are so broad that they can become relatively meaningless.

Christensen and Ball (Christensen & Ball, 2019) did not explicitly research the scope of design in their paper, however they make several observations that are extrapolated from their analysis of disciplinary affiliations. One of these is that design research seems to be spreading across disciplines, which suggests that new topics or areas of interest emerge over time. Such observations are not limited to design, indeed many researchers have pointed out that topics and scope of research naturally change over time (Jo, Hopcroft, & Lagoze, 2011; Sidorova, Evangelopoulos, Valacich, & Ramakrishnan, 2008; Sordo, Ogihara, & Wuchty, 2015). Given that the scope of Creative Technologies is likely to change over time, and such change is likely to be as frequent as the change in technology itself, there is potential to consider ways of determining and defining scope that sits outside of the confines of particular topics or technologies.

It is also worth considering embracing the constant change as an advantage. The objects, systems and knowledge associated with Creative Technologies are constructs that can be recreated as new thoughts, technologies and approaches arise. This is a process of continuous creation characterised by ongoing transformations and reconfigurations. Such a field can be considered as an assemblage, defined as "the continuous movement of parts in a restless flux in which the separate identities of the parts give way to a mutual coming and going, uniting and separating" (Cooper, 1998).

The analysis of keywords and content suggests what Creative Technologies has been, however it provides no insight as to what it may become. In its current form, Creative Technologies has similarities with other interdisciplinary endeavours. For example, Gardner observed that most work in cognitive science was still taking place under the umbrella of one of the mother disciplines (Gardner, 1987), similarly areas such as tourism studies, tended to have researchers to approach it from within the specific boundaries of their main discipline (Echtner & Jamal, 1997). Tourism is an interesting example, as it seems that as field it has resisted the historical imperative of becoming a discipline and instead is considered an indiscipline (Korstanje, Mustelier, & Herrera, 2016; Tribe, 1997). Thinking about how to define the scope of Creative Technologies in a way to promote this development as an indiscipline may be a worthwhile endeavour. The aim would be to maintain connection with the disciplines, but at the same time to develop a unique identity.

Creative Technologists as Connectors

From the results presented, it is clear that in many cases individuals with ability to work across different disciplines also have the ability to connect others into teams. What is not clear is whether these individuals would consider themselves as Creative Technologists and whether this ability to connect is a core characteristic.

It has been suggested that "interdisciplinary academics should think of themselves as a tree: a researcher needs to have a main trunk of ideas, but also put out roots and branches that can connect to others" (Gewin, 2014). It has also been noted that "the very act of creation often involves the bringing together of previously unrelated ideas" (Koestler, 1964) and also observed that working across disciplines is both a way of finding new insights as well as finding errors in disciplinary thinking (Nissani, 1997). It is possible that the ability to connect is not a core function of Creative Technologies per se, but just an outcome of the interdisciplinary nature of the field. To get more insight, some form of comparative work with other relevant disciplines might be helpful.

Future Work

This paper has attempted to explore the field of Creative Technologies through an analysis of the articles published in a single journal. It was inspired by the work of Christensen and Ball [16] who undertook a similar analysis of the papers published in the journal Design Studies.

Further work may also draw inspiration from similar sources. For example, a bibliometric analysis of the papers in the journal may provide insight into the existing literature that is being drawn upon to further refine an understanding of Creative Technologies. Similar work has already been done in the area of design research (Chai & Xiao, 2012). Such a project may necessitate the extraction of exemplars of what is Creative Technologies research, an approach that has been utilised in other domains (Larsen & Levine, 2013).

It is also important to consider the future of Creative Technologies as a field. In many regards, it has parallels with the field of design which has gone through a process of first looking for disciplinary credibility (Cross, 2006) and more recently trying to establish itself without disciplinary siloing (Bremner & Rodgers, 2013). Framing Creative Technologies as a field, whether it is a discipline or not, can draw from examining additional other areas that have experienced relatively new emergence in comparison to the established disciplines to guide innovation in Creative Technologies.

Conclusion

This paper has conducted an analysis of Creative Technologies articles to examine three line of inquiry, whether Creative Technologies is inherently interdisciplinary, what topics constitute Creative Technologies, and finally whether is there evidence that suggests that Creative Technologists act as connectors between either people, technologies or communities.

In that regard, there is clear evidence that Creative Technologies is interdisciplinary in nature. However, there is no clear indication of what would be considered in scope of the field. Further work is needed to reframe Creative Technologies for the future. Finally, while there is some evidence which suggests that certain individuals act as connectors between disciplines, it is suggested that this is an outcome of those individuals interdisciplinarity rather than inherently related to Creative Technologies.

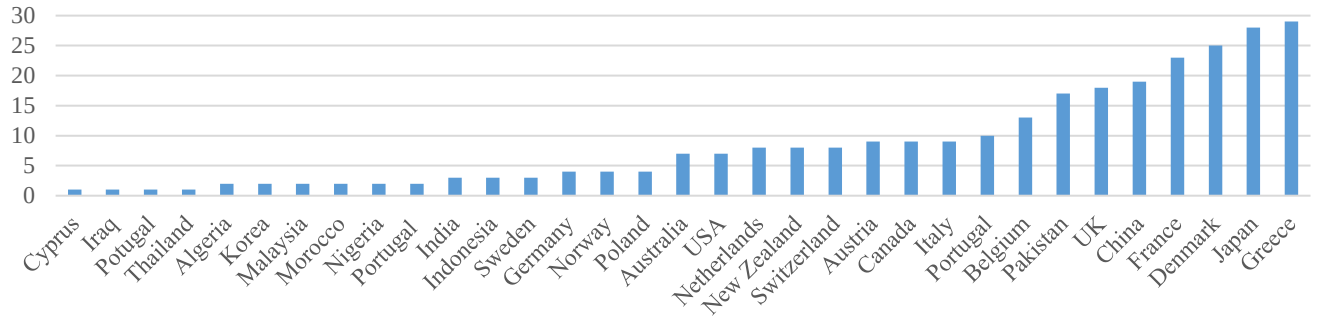


Figure 1. Authors by Country

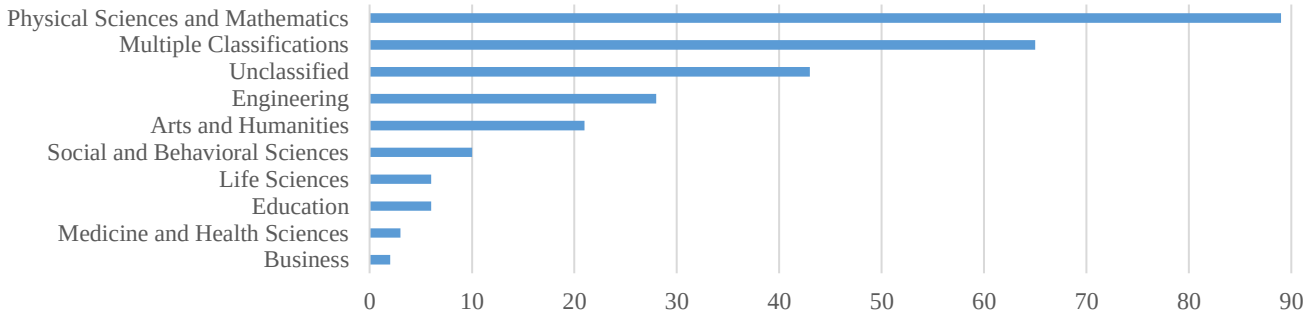


Figure 2**.** Authors by Top Level Discipline

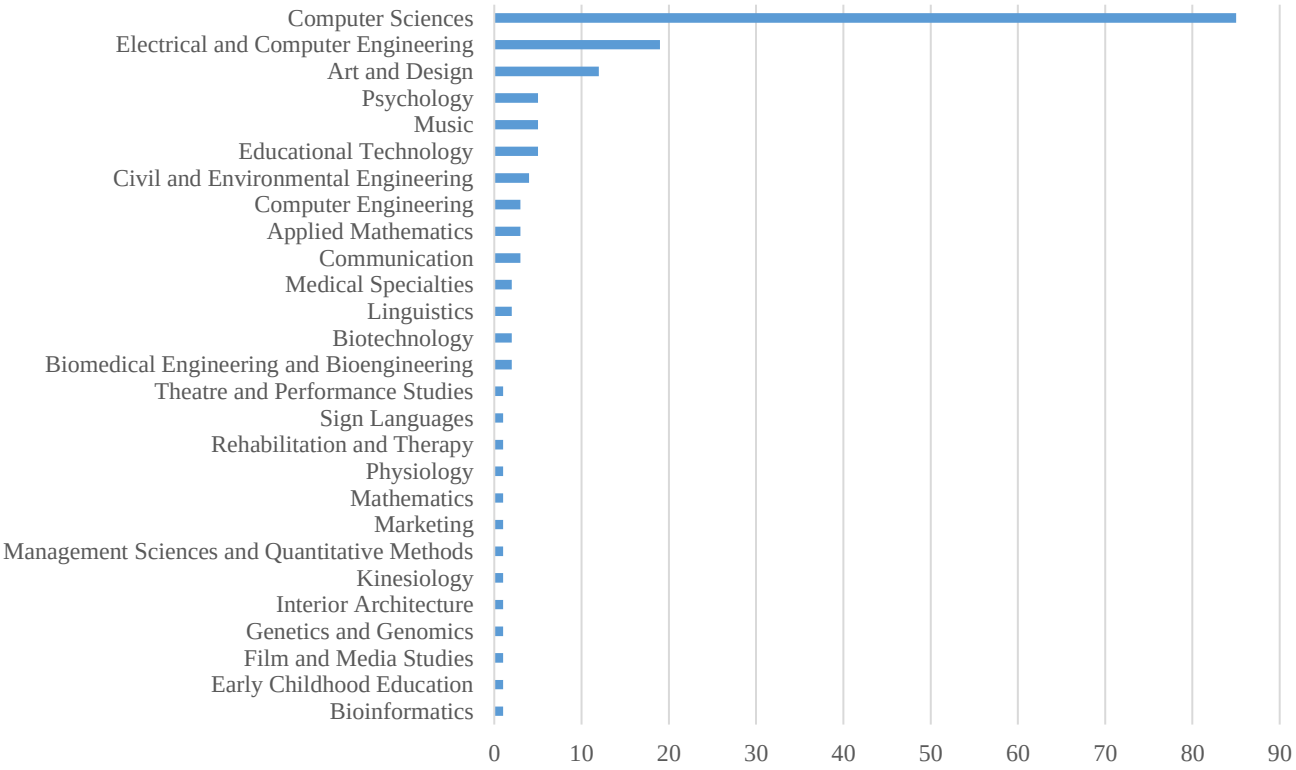


Figure 3. Authors by Second Level Discipline

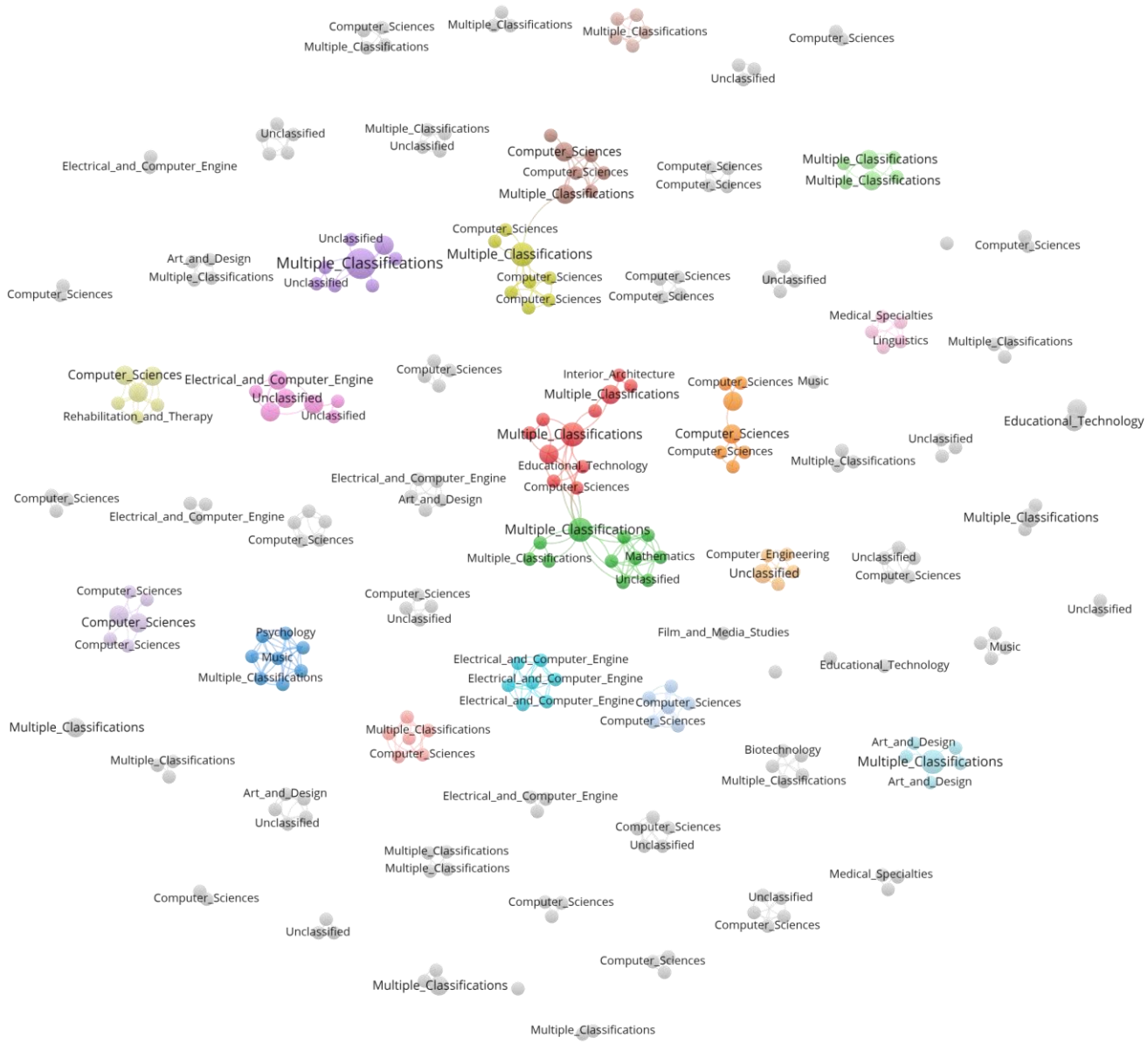
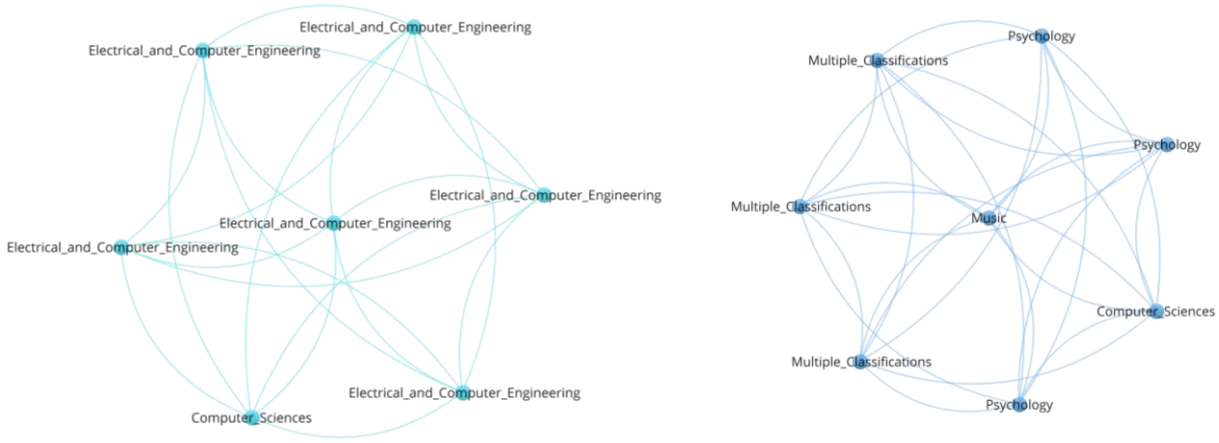


Figure 4. Authorship Network



(a) Single Discipline (b) Multiple Disciplines

Figure 5. Comparison of Author Networks

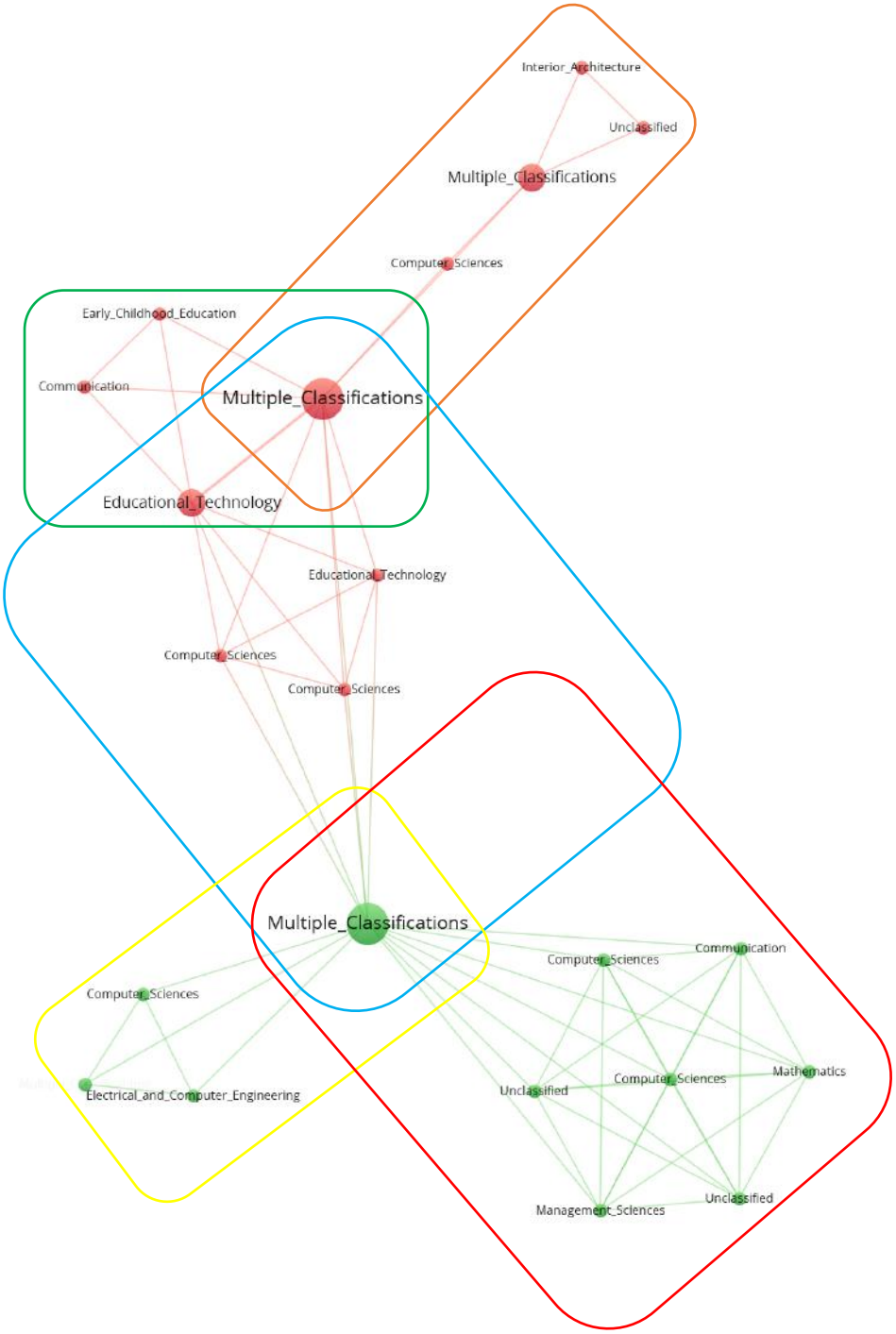


Figure 6. First Joined Network

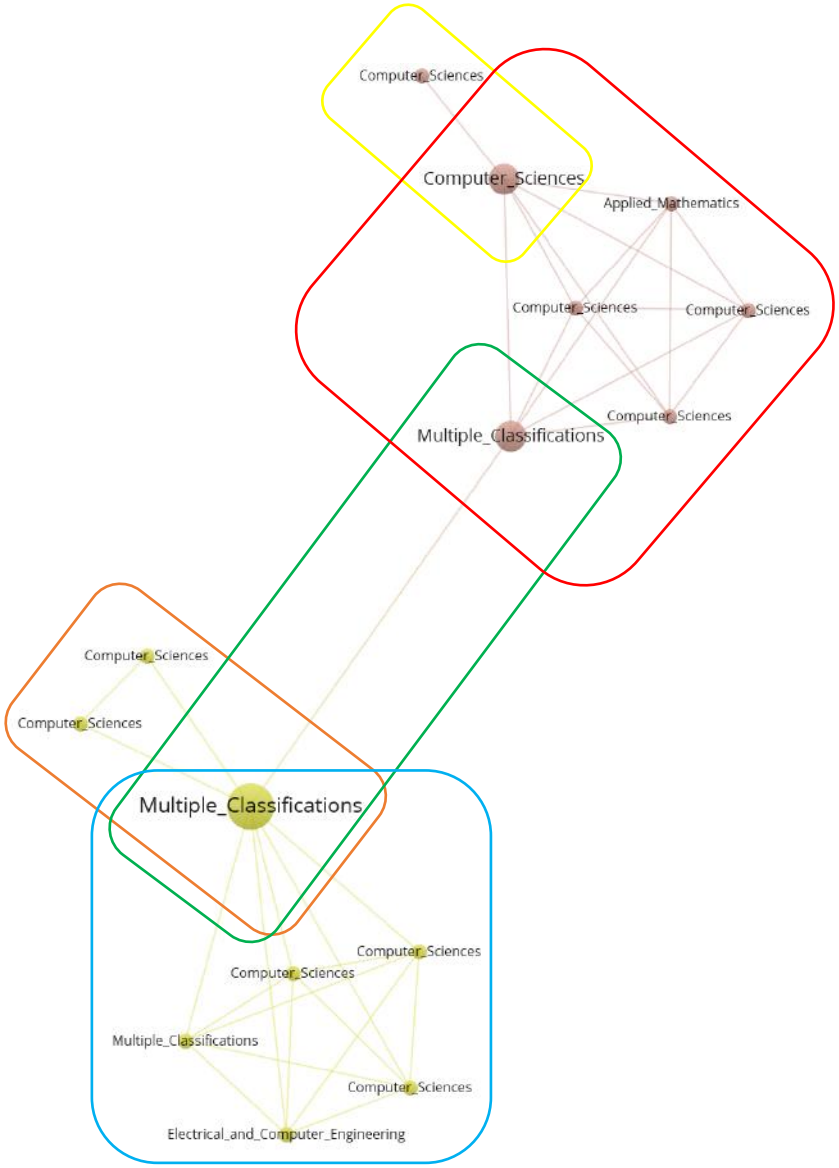


Figure 7. Second Joined Network

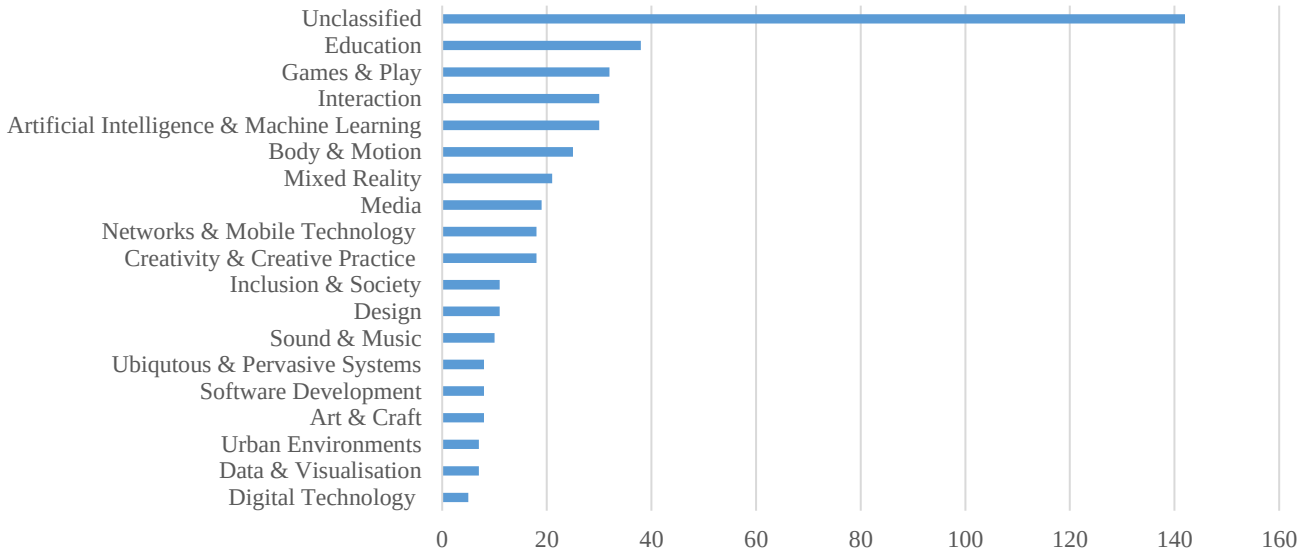


Figure 8. Clustered Keywords

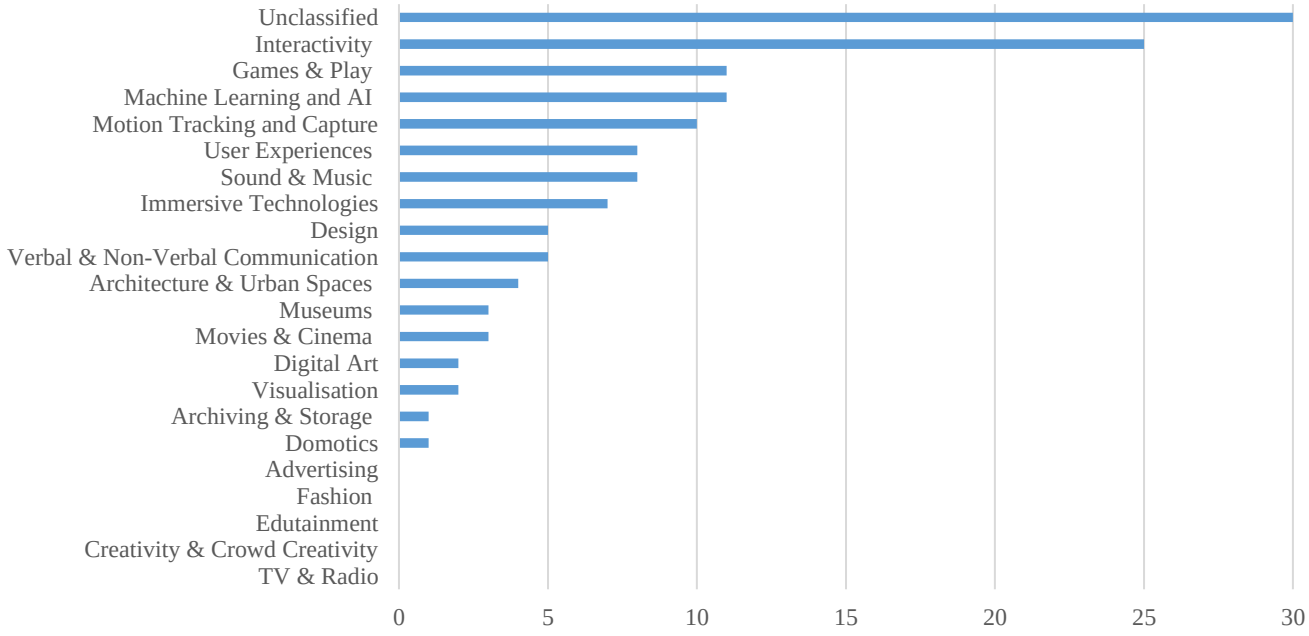


Figure 9. Classification of Papers to Journal Scope

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