Money *Leave(s)* Portugal: an Aesthetic Exploration of Public Investments

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***Abstract*—The field of Information Visualization has undergone major changes in the last decades due to the growing computational power and easier access to various technologies by a greater number of people. However, Information Visualization and its techniques literacy continue to be a knowledge associated to a reduced audience. In order to surpass this condition of Information Visualization, new practitioners have applied techniques from other areas, such as the arts, to develop visualizations that could transmit information in a more casual and accessible way to a larger number of people, weighing heavily on the artistic component. In this paper, we present a visualization that portrays information about public contracts held in Portugal, that despite being public data, is not analyzed or much less visualized by the majority. To do so we taken a casual representation approach with a strong aesthetics component in mind with the objective of promoting awareness about the dimension and distribution of the money applied daily throughout Portugal. We perform a phenomenological experiment to assess the effectiveness of our work in transmitting the information and evoking the desired insights. The experiment allowed us to collect distinct interpretations that could lead to further approaches and improvements in future iterations.**

***Keywords*-Casual Visualization; Data Aesthetics; Data Art;**

I. Introduction

Information Visualization (InfoVis) is the area responsible for analyzing and communicating data, transforming it into information and information into knowledge, aiming to amplify cognition through effective visual metaphors [1]–[3]. Throughout history, visualization models have proved to be notably important in understanding the most variable types of data in many fields of study. One of the main reasons behind the area's evolution was the parallel evolution of technology and its greater ease of access and use, thus leading to a more united and cooperative community between the diverse scientific fields of study [4]. However, at the same time, due to the increasingly large amount of data produced every day by ubiquitous systems, visualization tools must also explore new technologies and techniques to properly convey that same data to their target users, expanding its work universe in more appropriate and effective ways. The daily produced data comes from our everyday activities, whose processes of acquisition, treatment and provision of information are many times hidden from us or we are simply not aware of their existence.

There has been a growing awareness on this subject, leading several professionals, namely artists, to produce visualizations that make use of these sources of data to unveil the information contained in our society's practices. However, these practitioners are not taking an analytical perspective, but rather a more artistic and interventional motivation [5]. With this strategy, they intend to overcome some of the limitations in the scope of information communication in the traditional InfoVis area, which requires specialized literacy on visualization models that tend to represent information with some complexity. Thus, they intend to reach a wider audience in order to promote new insights and reflections about the data that otherwise would be impossible or very hard to achieve [6]. This recent practice originated an evolving subdomain in InfoVis: Casual Information Visualization.

"Casual InfoVis is the use of computer-mediated tools to depict personally meaningful information in visual ways that support everyday users in both everyday work and non-work situations" [7]

Casual Infovis can be separated from traditional InfoVis systems through four main factors [7]:

- **User Population**: encompassing a wider number of users from novices to experts in InfoVis;
- **Usage Pattern**: developing systems intended for usage that is momentary and repeatable over large periods of time;
- **Data type**: making use of data that is generally more personally interesting and relevant to target users;
- **Insight**: the main focus of the data visualization is not analytical, but rather to promote awareness, social, and reflective insights.

In this paper, we present a visualization system to portray information about public contracts held in Portugal, where we take a casual representation approach with a strong aesthetics component in mind. We aimed to reveal the monetary dimension of the contracts taking place every day, throughout Portugal and its diverse activity sectors, through a visual metaphor of the elements from which the money bills are made, the plants and their associated particularities such as growing, branching or mutations. For that purpose, we retrieved all the data regarding the public contracts held in Portugal for the year of 2020, available at the online portal

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website, Portal Base. We carried out a phenomenological experiment to understand if the visual approach taken would be able to transmit information and elicit the intended insights and at the same time collect different interpretations that could expand the work in future iterations.

The remainder of this paper is structured as follows. Next section covers an overview of related projects with similar communication and aesthetics perspectives. Section 3 presents the process of acquisition and processing of the used dataset and exposes the work motivation and main objectives. Section 4 presents the visualization structure and its main components. Section 5 details the user testing conducted through a phenomenological approach, and the analysis of the results. Section 6 concludes the paper by presenting the findings of our visualization and further improvements to consider in future work.

II. Related Work

Unlike analytically driven InfoVis, Casual Information Visualization can be translated as an encapsulation term for all InfoVis edge domains, combining concepts from ambient InfoVis systems [8], social InfoVis [9]–[13], and even artistic works [5], [14]–[18]. This mixture provides a broader medium, reachable also to the non-expert InfoVis users, acting therefore as an InfoVis domain expansion. The goals of different areas of casual visualization can be diverse: they can extend from purely artistic ends, with a strong aesthetic focus, to more exploratory and immersive interpretations to convey different types of data. King [19] presented a collection of several visualization works that fit different fields of Casual information, where many types of everyday data are displayed, each with different levels of readability, which depends on the visualization position in the spectrum between the conceptual space between InfoVis and art. A more comprehensive study on this subject was conducted by Lau and Moere [6], who introduced a model for a better understanding of these concerns about casual visualizations. The proposed model is based on the analysis of existing visualization techniques by their interpretative intent and data mapping inspiration, placing them in a domain defined by three factors: data, aesthetics and interaction and a two-dimensional space to correlate the mapping technique with the data focus behind the visualization's purpose.

Dawes' body of work focuses on producing artistic and informative forms about social activity, using data from online sources to promote pleasant and introspective reflection not only about ourselves but also about our society. The *Invisible Infrastructure* of Dawes [11] depicts the size of the U.S. economy across fourteen different industry sectors through a simple and engaging interactive visualization, with a strong aesthetics component, using only rectangles combined into spinning cubes. Their elements' visual properties swimmingly translate the data dynamics throughout time, with an appealing and effective way that requires no advanced visualization knowledge to understand it. Salavon [15] makes use of the "whole", displaying the entire data at once, to obtain an overwhelming effect in many of his strongly aesthetics-driven works. Some examples are collections of magazine covers, photos of portraits or cityscapes, movies screenshots, and the demographic evolution of all United States counties.

The *Dumpster* from Levin, Nigam and Feinberg [20] is an interactive online visualization that depicts a vision of the romantic lives of American teenagers, more precisely when one has *dumped* the other, achieved by presenting real texts extracted from many online blogs. The artists statement, similarly to our intentions with this work, refers to his attraction to the revelatory potential of InfoVis, seeking to provide new perspectives about ourselves and our culture and society. A similar work focused on the affective side of society is the *We Feel Fine* project from Harris and Kamvar [8] where the authors harvested human feelings from a large number of weblogs, allowing the user to perceive some insights, such as the happiest, sickest or loneliest cities in the world. They achieve these results through a simple interface based on a self-organizing particle system, where each particle represents a single feeling, and the particle visual properties (size, color, shape, opacity) depict other extracted aspects. *PeopleGarden* [13] creates a nice visual metaphor between the data and its representation. The authors propose a novel graphical representation of users based on their online interactions, depicting their social environment. They use a flower metaphor for representing an individual user, and a garden metaphor for combining the users on the online environment. The authors opt for an abstract view of the users' activity profiles, instead of the typical records of personal data, allowing them to obtain information about the users' activity and interactions in more artistic and visually appealing ways.

III. Project Framework

This section starts by exposing the motivation of our visualization, explaining afterward the source and composition of the dataset used for this work. Lastly, we present the visual approach adopted to achieve the desired goals.

A. Motivation and Main Goal

This visualization had the main purpose of representing the investments made in the country's varied activity sectors. We aimed to reveal the dimension and distribution of the contracts applied in these sectors, particularly the monetary volumes that were invested. We chose to use this data to raise awareness about one invisible pattern of our society regarding the administration of the money invested because despite being public and accessible to all, in reality, it tends to be ignored by the majority. This work seeks to translate this information in a simplistic and appealing way, posing as a piece mainly driven by an

aesthetic component, which can thus be appreciated by all types of audiences from which both aesthetic appraisal and analytical analysis may emerge. The resulting visualization was designed for a passive involvement of the audience, promoting both engaging reflections about the information being depicted, as well as the visualization piece itself, as an artistic communication piece. It was designed for large installations, such as large monitor murals or projections to provoke a more powerful overwhelming effect and facilitate the analysis of the leaves composition. Given that the central attribute of the dataset that we intended to highlight was the money employed throughout the country, we opted for a metaphorical approach to represent the physical object in our focus: the money bills. We focused on the plants of which the notes are made (cotton fiber and linen), more specifically, on their leaves' growing process, as a metaphor for the increasing total of the money invested in contracts day after day. The visual translation of our approach will be further discussed in the next section.

B. Data Acquisition and Description

The visualization makes use of data available at http://www.base.gov.pt/, the public procurement online portal called Portal Base. The portal intends to disseminate public information about public contracts held in Portugal that are subject to the regime of the Public Contracts Code. Every day, since the beginning of 2020 (January 1st), we collected automatically all new public contracts inserted on the portal to update the visualization. Each entry of the data collected describes a contract, containing information about the contracting and contracted entities, the contract and procedure type, the contract subject negotiated (CPV)[1], the contract value allocated, its place of execution and some other details such as attached documents and observations.

IV. Data Visualization

This section describes the visualization structure. First, the main visual elements of the visualization, the leaves, are introduced. The leaf composition and its design and metaphor principles are described, followed by a detailed explanation of the principles behind the visualization structure and how the contract leaves are mapped.

A. Leaves

As said before, the main elements of our visualization were thought to represent the money involved in Portugal as the result of the multiple public contracts yield in all Portugal districts for the distinct activity sectors. To this end, we represent the money growth through the plant's growth, specifically, its leaf. A leaf translates the total amount

[1]The CPV establishes a single classification system for public procurement aimed at standardizing the references used by contracting authorities and entities to describe the subject of procurement contracts. More information about CPV can be found here: https://simap.ted.europa.eu/cpv

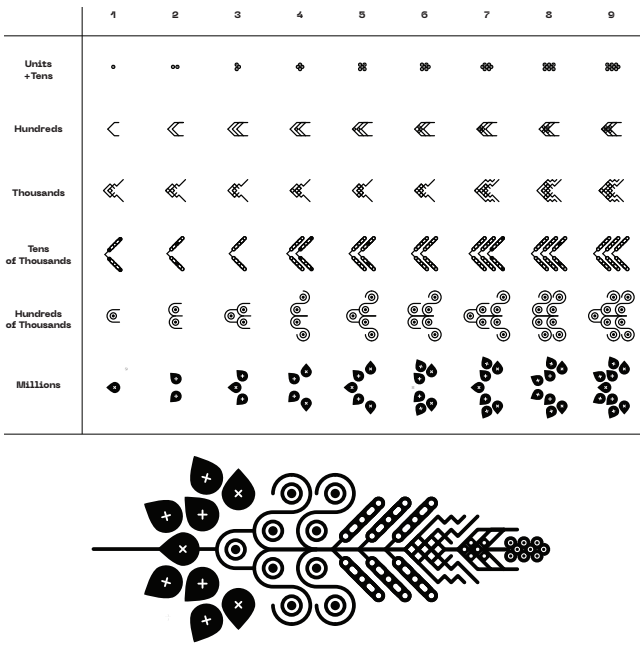

Figure 1. All *leaf* elements variations (top). Example of leaf representing the amount of 9999999€ (bottom)

invested in a given district for a given sector. The growth of this value is mapped to the growth of the leaf, with lower values having less visual prominence (smaller elements) and, in contrast, considerably higher values having more visual prominence (larger elements). This cumulative approach to represent the daily new data in favor of an incremental representation had to take into account the scalability of the visualization; otherwise, the visualization would become unreadable after several days of collecting data due to the increasing visual clutter generated by the leaves' overlaps. The total number is deconstructed, and a distinct element was created for each one of its digit positions. In the case of units and tens, the corresponding elements are combined through smaller internal filled circles and external stroked circles, respectively. The amount of elements for each digit position represents the corresponding digit value (e.g. the number 931 would be represented with 9 elements for the hundreds, 4 elements for the tens and 2 elements for the units). In the event of digit zero for a given position, no element of the corresponding position is represented. Figure 1 can be consulted for all possible combinations of all position elements and presents an example of a *leaf* representing the amount of 9999999€.

While the drawing of every leaf may result in visual clutter, the different types of leaves can still be identified when drawn together, keeping their legibility regardless of representing a low or high value. This is similar to plant fields, that regardless of their size when grown in a condensed place, manifest themselves as a whole. We intended to translate this visual phenomenon into the created

visualizations, so that the viewers, in their first interaction, would initially see it as a whole and only through exploration could the distinction between leaves be perceived.

B. Structure

The visualization maps the contracts into a modular grid where each module represents a Portugal district. The layout of the modules, with a distribution of 3×6 (districts) + 2 (autonomous regions of the Azores and Madeira) is intended to resemble the geography of Portugal. The districts are arranged in order to approximate the relative position of each district in Portugal as closely as possible. An aesthetic decision was made to place the autonomous regions underneath the districts, to allow for a more homogeneous framing of the entire canvas data. In order to more easily distinguish the commercial area to which a given contract applies, the 45 established categories of CPV were grouped into 12 groups: (1) Health, (2) Food, (3) Commerce, (4) Communication, (5) Industry, (6) Transports, (7) Culture, (8) Construction, (9) Technology, (10) Education, (11) Consulting and (12) Society, which can then be further distinguished by the contract type of procedure [2]. There are five types of procedures, with different criteria and rules of application: (A) Open procedure, (B) Direct award, (C) Prior consultation, (D) Restricted procedure, (E) Framework Agreement.

The CPV grouping (1 to 12) and their further distinction per type of procedure (A to E) is applied to each grid module, and it is responsible for placing and representing the visual element that translates the amount employed in the contracts. The CPV groups are translated into 12 points, arranged in an alternating formation (2,3,2,3,2) from top left to bottom right. Taking the point of the corresponding CPV group as reference, the distinction between the types of procedures is made through the orientation in which its corresponding leaf is represented. Starting on the orientation of the vertical axis, in a radial layout, the five types are equally spaced lines arranged radially around the CPV group point. The overall structure of the visualization, namely the districts, the CPVs groups and the type of procedures placings are further explained in Fig. 2.

As stated previously, new contracts are collected and the visualization updated daily, and this update is reflected through two modes. At a given interval, the visualization changes between a cumulative view and a daily view, either representing the total of contracts since its initialization, or just the contracts collected for the present day. This interchange was devised to allow the user to perceive the daily increase of public contracts more easily. Two different states of the visualization can be seen in Fig. 3.

[2]More information about the different types of procedures can be found here: http://www.base.gov.pt/Base/en/FrequentlyAskedQuestions

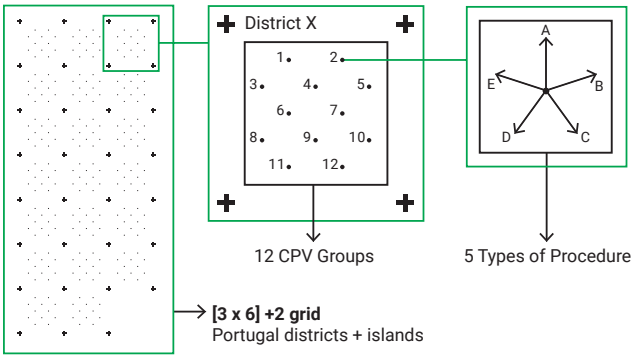

Figure 2. Visualization structure responsible for the contracts. The CPV Groups (1-12) and types of procedures (A-E) correspond to the same numbers and letters previously used

V. Visualization Analysis Experience

Since the visualization was conceived for a passive appreciation of the user (without interaction) and designed with a strong artistic perspective to instigate insights about the represented data, we conducted a test to understand how the participant explores and interprets the visualization. The process of interpretation and inference of what the visual communicates to the participant is precisely what we intended to collect with the test. More specifically, we wanted to know how this discovery process unfolds and how its reasoning narrative is constructed. Phenomenology, as "the study of experience from the perspective of the individual" [21], appears as an optimal approach to conduct our experiment, since our focus relies exactly on the participant's perspective and his/her process of understanding the visualization. We based our phenomenological methodology on the approach taken by Seiça, Martins, Roque and Cardoso [22] targeting their approach in understanding how their artifact was experienced as a phenomenon in order to discover meanings and common themes that participants may associate during the test. Their experience structure follows a method of interviewing that applies questions based on themes of experience contextualization, apprehension of the phenomenon and its clarification [23] that will be clarified further ahead. We adopted this same approach, as we did not necessarily intend to obtain an exact decoding of our visualization as an evaluation measure, but rather understand the distinct interpretations and associations the participants make of this same encoding. Our intention was to use this type of approach to observe the diverse learning processes of each participant, their insights and, consequently, discover new ways of applying the data and new possibilities for its visual codification.

A. Methodology

The test was conducted using a 10-page PDF document containing the visualization states for the first 10

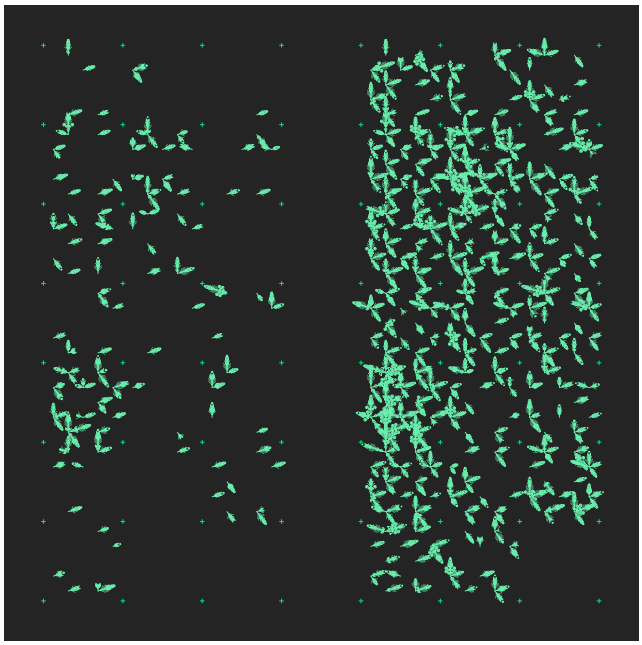

Figure 3. Visualization screenshot presenting all contracts at the 1st and 10th of January

days of 2020, where each page represents a day [3]. For the purpose of perceiving the size of daily contracts collected and added each day to the visualization, the days chosen presents the following distribution: 467+878+429+5+0+630+373+406+338+331, with a total of 3857 contracts for the 10 days. Although a caption and additional information would be provided in the real context for which the visualization was designed, for the tests all this information was omitted so that we could obtain the most varied possible interpretations, which could lead to new interesting approaches to undertake in future iterations of this work, as well as to detect possible issues with the adopted visual encoding. The days were displayed in the cumulative mode, as we wanted to focus mainly on the perception of the leaves' growth, and not so much on the perception of the values represented by them. Due to social limitations at the time [4], the tests were conducted online by video conference, providing the PDF previously for the test to be carried out in their personal computers. The participants' screen was shared and recorded, so we could follow their exploratory process of the visualization and document it for further analysis. We selected participants from different backgrounds and levels of expertise in visualization to improve the chances of obtaining a more diversified set of insights. Individually, eight participants were submitted

[3]PDF available at https://deiucpt-my.sharepoint.com/:f:/g/personal/pedros_student_dei_uc_pt/EooqePPVwIxKr4tzF9WNBCIByKJgg1KnfqTQHBFNcR-3Hg?e=DSPFKb

[4]Facing the social limitations imposed in order to mitigate the COVID-19 virus propagation.

Table I
PERSONAL DATA OF THE TEST PARTICIPANTS

Age	Gender	Background	VI Knowledge
29	F	Multimedia Design	Advanced
26	F	Nursing	Reduced
26	F	Multimedia Design	Intermediate
29	M	Computer Science	Reduced-Intermediate
27	M	Multimedia Design	Intermediate-Advanced
25	F	Pharmacy	Reduced
26	M	Biomedical Engineering	Intermediate
27	M	Social Communication	Intermediate

to the test (50% male and 50% female) with ages within 26 and 29 years (See Table. I). This total was established since feedback started to converge and new insights stopped emerging.

Participants were free to explore the entire PDF without any restrictions. In order to collect as much information as possible, the participants were invited to actively share their thoughts and exploration rationale behind all their actions. We assumed an impartial posture prompted by the phenomenological method, discarding a preconceived mindset about the visualization to be compliant to collect new and different interpretations [24]. At the same time, we did not want to provide any types of cues that could introduce bias in the participants' insights. With these principles in mind, the tests were performed under the following conditions:

- The participants had no knowledge about the visualization. The only information provided at the beginning of the test to participants was that the visualization represents data regarding public procurement celebrated in Portugal in 2020. All extra information about its visual elements and their meanings was omitted to prevent participants from providing biased interpretations;
- Participants were free to explore the entire PDF without any restrictions. In order to collect as much information as possible, participants were invited to actively share their thoughts and exploration rationale behind all their actions;
- Following Bevan's methodology [23] on how to retrieve the phenomenon apprehension by the participant, if participants felt blocked as the test progressed and could not provide additional information, questions were asked to further explore the visual aspects they had mentioned earlier, always using the terms used in their observations.
- Near its final phase, in the sense of clarifying the phenomenon [23], new hints were provided to lead the participant to reflect and relate their previous observations from different perspectives. Hints could focus on the leaves composition and orientation or in the spatial arrangement and disposition of the districts;
- The test was concluded as we realized that the participant was unable to provide more information either on his/her own initiative or in response to the questions raised throughout the test. Lastly, the visual encodings

Table II
VISUAL ENCODINGS ADDRESSED (WITH CORRECT ENCODING) AND CORRESPONDING ASSUMPTIONS PROVIDED BY THE PARTICIPANTS

Spatial Mapping Portugal conceptual map A - Portugal (5) B - Unknown (1) C - Cartesian axis (2) D - Small Multiples (1) **Modules** Districts A - Distritcs (4) B - Companies (1) C - Axis Section (2) D - Geographic Regions (2) E - Month working days (1) F - Sector/Public Tender (1) **PDF Pages** Time A - Weeks (6) B - Days (1) C - Unknown (1)	**Leaf Composition** Total amount A - Size = money (6) B - Set of contracts (4) C - Single contract (2) D - Elements = contract details (7) E - Size = contract evolution (1) F - Type of contract (2) **Leaf Position** CPV sector A - Region (5) B - Company (4) C - Contract (1) D - Cartesian axis E - Sector (1) **Visual Approach** Visual Metaphor A - Contracts made on paper (1) B - Analogy with leaves' particularities (growth, branches, variety) (7)	**Leaf Orientation** Type of contract A - Contract Intervention sector (3) B - Relationship within contracts (2) C - Unknown (3) D - Contract changes (1) E - Geo. Direction of contracted entity (1) F - Type of contract (2) **Leaf Evolution** Addition of new contracts' amounts A - Addition of new contracts (5) B - Unknown (3) C - Contract duration (1)

of the visualization were revealed, and a final discussion was held to better understand the participant's difficulties in decoding them.

B. Results

After all the tests were performed, the recordings of each participant were analyzed to gather all the visual encodings that were addressed. All the topics covered and their different interpretations can be seen in Table II.

Regarding spatial mapping, most participants understood the conceptual map of Portugal with ease when they noticed the relative positions of the leaves, which led them to assume that the denser areas could represent the two largest Portuguese cities, Lisbon and Porto. A significant issue that led to misinterpretations regarding this assumption was the absence of data in the last module, and mainly the necessity of additional distinctions between the modules representing the autonomous regions and those representing Continental Portugal. Those who did not recognize Portugal presumed that the map could represent a Cartesian axis in its entirety where time and geographical position were recurrent variables hypothesized for the axes. One participant assumed a small multiples representation with equal variables for the axes. One of the main reasons pointed out by the participants for these assumptions was the delimiters referring to markings or distances generally used in these types of graphics. Since the interpretation of the modules was closely linked to the interpretation behind their spatial mapping, the assumptions were consistent according to the previous understanding. All participants who recognized Portugal assumed each module as a district and island or a geographic region depending, respectively, on whether they distinguished Continental Portugal from the islands or not. Some participants perceived them as being companies or activity sectors of the contracts. They also considered month days or working days given the number of module delimiters (31) or the number of modules (20). The majority of the participants who interpreted the visualization as the map of Portugal also interpreted the leaves' points of origin within each module with higher precision to the geographic localization of where the contracts were yielded. Another common assumption was that each point represented a company and that the orientation of its leaves could represent either the type of contract yield, the activity sector or the geographic direction of the contracted company. One participant perceived each point as a contract and its branches through the multiple leaves as changes to that same contract. Another participant detected an apparent set of predefined modular positions for the leaves origin. Although three participants could not present a reason for the leaves' orientation, the remaining participants understood a relationship between these sets of leaves due to their aggregation at the same point, being even mentioned explicitly by two participants. In addition, half of the participants noticed the existence of five predefined possible orientations for the leaves, arguing that otherwise the leaves' orientation could be adjusted to avoid some overlaps. As for the composition of the leaves, every participant recognized them as leaves, flowers or petals. While six participants interpreted their size as a representation of the money involved, no participant interpreted that each digit of this value was translated into a distinct set of elements. Instead, they assumed that the different elements and their variations represented additional details about the contracts (e.g. number of clauses, number of companies involved, number of workers, etc.). Two participants assumed that the distinctive compositions depicted different types of contracts. Half of the participants took into account scalability issues in the representation of the number of contracts and therefore assumed that a leaf could represent a set of contracts. Only two participants expressed that a single contract was associated with a leaf, in which one of them further assumed that its size would represent the evolution of the process, that is, its stage of completion. All participants intuitively understood that each page of the document represented different time periods, but only one interpreted that each page represented a day, while most others interpreted each page as representing 1 week. This may be mainly because of two factors: the lack of notion regarding the dimension of public contracts carried out in Portugal (one of the reasons for this work) and the leaf aggregation factor not being taken into consideration. Most participants interpreted the leaves' changes as the addition of new contracts to the existing ones, referring an accumulative approach, evidenced by the increasing density throughout the pages. Nonetheless, three participants could not give a reason for this evolution. A participant questioned the evolution of the leaves, namely the possibility of a leaf occupying two modules, which created doubt on whether it was intentional or not.

C. Discussion

As a final question, participants were asked why we took this visual approach, and their answers were similar to our own reasons, revealing that our visual concept has also been understood. As further feedback, the participants also appreciated the shapes of the leaves and the overall visualization. One participant further stated that his relatability to the elements of nature helped him better interpret the visualization and the relationship between its elements. A recurring suggestion was to better distinguish between the districts and the islands, albeit the boundaries of the modules have been successful in helping to associate the leaves to the corresponding locations. The main interpretation of the leaves elements portraying additional details of the contracts leads us to think of new approaches for future iterations of this work. Another suggestion on that note was to use color and the leaf's own stem to represent other variables. The overall composition can be improved in order to reduce overlapping issues, as mentioned before, through some adjustments to the leaves sizes, the modules dimensions or the CPVs modular grid positions.

VI. Conclusion and Future Work

We presented a visualization approach that shows the money involved in public contracts carried out in Portugal since 2020. The resulting visualization was designed for a passive involvement of its audience, which through its simplistic and appealing way intended to promote both engaging reflections about the information being depicted and the visualization piece itself. The goal of this visualization was to promote awareness about the dimension and distribution of the money applied daily throughout the country. We chose to use this data to reveal an invisible pattern of our society, which, despite being public and accessible data to all, in reality, is ignored by the majority, and when it is not, basic overviews of the data do not provide enough information in order to obtain significant insights. This same data was centralized and mapped in our visualization in a single piece. The money invested in the contracts is divided by execution district and, in turn, by the corresponding sector of activity. This way, both local analysis (e.g. by district or activity sector) and global analysis of the data could be performed in order to obtain different types of assessments. This was verified through the study conducted, where it was demonstrated that through the visualization approach, users were able to extract information both at local and global levels, being able to easily indicate the value translated by a leaf but also promptly indicate the district or sector with more money involved. We applied a phenomenological approach to evaluate the visualization ability to foster its desired purposes, conducting a series of interviews to assess the users' perception. The participants' insights showed that the visual approach taken proved to be intuitive, considering the lack of context that was provided to them, and also unveil new paths to take in future iterations. Future work may involve adapting the visualization to integrate user interaction, presenting itself more as an exploration tool. This adaption may require the creation of a proper interface that could provide ways to perform even more local and focused analysis, namely allowing the users to specify the region and temporal window that they wish to visualize, leading the visualization to adapt accordingly. Allowing further interactions with the visualization leaves could be used to provide more details about their associated contracts, where additional information present in the retrieved dataset, discarded in this work, could also be presented to the user. Regarding the visualization elements itself, the leaf design can also be improved to be more readable for reduced dimensions as well as to accommodate higher values.

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