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# Making sense of data in a Service Design education.

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## Abstract

Digital data has a considerable role in our everyday lives: we use publicly available data to find out about weather, traffic or pollution, we track ourselves and we release our private data to monitor our health and to get advices from our favourite apps, we relate on services that digest big amount of data to predict what will happen next.
In this era of "living services", what kind of data literacy is needed to equip a service designer? Is there a need to rethink of service design tools so that data will be explicitly taken into account in the design process? Is there a need to update service design curricula to embrace these challenges? All of these questions will be discussed through a specific case: a workshop on data exploration held at the Service Systems Design Master at Aalborg University in Copenhagen to investigate the role of data literacy in a service design university program.

KEYWORDS: Service Design education, data literacy, service design tools

## Introduction

Although Service Design can no longer be considered an "emerging discipline", Service Design educational programs are still not widespread and the different examples of these which can be found in Europe feature very specific identities. Various attempts have been made to map out the evolution of the discipline and analyse the multiple different definitions and dimensions of Service Design, distinguishing, for example, among the systemic and human experience approach (Nisula, 2012), or between an approach that tries to integrate practices and ideas from other fields and the one that works on the basic assumptions and methods in service design (Sangiorgi, 2009; Blomkvist, Holmlid & Segelström, 2010). In a recent document by the University of Arts London[1] service design research in UK has been

[1] http://ualresearchonline.arts.ac.uk/7712/1/Mapping-and-Devloping-SDR-in-the-UK.pdf

mapped out defining the different sectors, educational courses and modules in service design and emerging research themes within the discipline. The object of service design is also discussed as being at the core of the discipline (Blomkvist, Clatworthy, & Holmlid, 2016; Secomandi and Snelders, 2011), Lucy Kimbell highlights how the possible ways of conceptualizing the focus of design have specific implications for how we theorize about the field itself and how, we would like to argue, we teach it and prepare future service designers.

In a series of two workshops, held at the Service Design Conference in Finland in 2012 and in Lancaster in 2014, the competences and skills of "tomorrow's service designer" were discussed in order to attempt to define what an educational program should deliver for them. These competencies and skills ranged from conventional and contemporary design skills to business skills[2]. Among the contemporary design skills only one was related to technology "Technology - be able to create realistic concepts/design in real world", meaning the ability to understand and act upon the digital and physical environment within the service landscape. Several disciplines are borrowed from in Service Design education to develop this specific skill: Product-Service Systems, Interaction Design, Human-Computer Interaction and even Software Engineering are just a few examples of courses that are provided to service design students in different curricula across Europe to tackle the technical feasibility and context of the designed service. The data dimension is very often relegated to the gathering of qualitative insights from user research through interviews, focus groups, shadowing, cultural probes, contextual inquires, just to name a few of the techniques that allow the designer to better understand the context of use of a given artifact or service. However in the modern world, designers, and also service designers, need to be able to navigate into large digital datasets in their design process: we live in an era of "Living services" (Fjord, 2015) and designers need to update their skills and toolboxes in order to be able to manage this specific material that could inform the design process in addition to feeding the actual designed product/service.

The aim of this paper is to investigate how designers should be equipped to make sense of data in their design process and what kind of data literacy should be supported by service design educational programs in their curricula. In following sections, data literacy will be defined, the role of data in a service design process will then be explored. Following this, a workshop on data will be adopted as a use case to discuss possible approaches to data literacy in a service design education.

## In an era of living services: the role of data and data literacy

Economic production and distribution processes have become interconnected at an unprecedented rate and have spread across complex networks (Castells, 1996) simultaneously operating in a multiplicity of geographic, social, and cultural markets and contexts (Julien, 2007). A variety of services build upon continuously flowing streams of data, which are gathered, interpreted and processed to provide an offering that is adapted and tailored to the (oftentimes presumed) needs and wants of customers.
On the one hand, this phenomenon touches upon sensitive and alarming areas such as how this massive amounts of data allows for the tracking individuals, groups and even objects at

[2] https://tomorrowsservicedesigners.wordpress.com/

an unprecedented level of granularity (Ciuccarelli, Lupi & Simeone 2014), or how algorithms processing these huge quantities of data are increasingly regulating our lives (O'Neil, 2016). On the other hand, big (and, especially, open) data are seen as an instrument to better understand our lives and the inner dynamics of organizations and societies (Ratti and Claudel, 2016) and to build more inclusive services and government processes (Townsend, 2013).
While keeping a critical eye on these emerging issues, data can be considered a resource, which comes with a set of already configured practices, particularly if we refer to the technical procedures that allow any user to exploit it, but it is still lacking design practices that could enable social innovation through more participatory and bottom up approaches. These practices could empower a community of users not limited to public authorities, large corporations or data experts.
While analysing the reasons behind the current challenges faced by open data, Kalampokis and colleagues pointed out that "gaining access to raw data, placing it into a meaningful context, and extracting valuable information is extremely difficult" (Kalampokis, 2013, p. 99). Among the barriers and the myths of open data, Janssen and colleagues illustrate how "some data requires the use of statistical techniques, a deep understanding of the underlying data, and an understanding of the types of (causal) relationships. This is knowledge that is not available to everyone and might require considerable time and effort to achieve" (Janssen, 2012, p. 265).
Data literacy is then crucial to support new practices around data, providing the designers, and even the citizens, with the necessary means to understand and use data which would enable them to think critically about social and political issues and to identify problems and propose meaningful solutions. Data literacy has been defined in many different ways, according to the domains in which the data was used: engineering, information science, journalism, just to name a few, have different perspectives on the skills that are needed to manage data. The focus can vary from highly technical skills related to collecting and managing quantitative data in order to conduct scientific research into the mechanics of finding and managing data or the ability to consume for knowledge, produce coherently and think critically about data. We will use a definition that takes into account these diversities and that refers to data literacy as "the ability to collect, manage, evaluate, and apply data, in a critical manner" (Ridsdale, 2015). This definition fits particularly well the framework for data literacy instruction proposed by Calzada and Marzal (2013). The authors define five "data actions" that need specific competencies and skills to be accomplished.

These data actions can be briefly summarized as follows:

- Understanding data -- what is data? what is it's role in society, how is data generated and by whom?
- Finding and/or obtaining data -- what are the data sources? how to evaluate and select them?
- Reading, interpreting and evaluating data -- what are the different formats in which data can be presented and represented? How to critically evaluate data?
- Managing data -- how to better prepare a data set to be ready for reuse? what is the function of metadata?
- Using data -- how to prepare data for the analysis phase? how to synthesize from data? how to represent data?

All these data actions can be performed at different levels with different outcomes. In a Service Design perspective this translation process is also important to understand "the value, structures and relationships of specific data sets" (Prendiville, 2017) and allow the designer to move one step further the statistical analysis and to adopt a user-centred approach to data.

## Making sense of data in a (service) design process

Foulounneau et al. (2014) claim that data can play different roles in a service design process:

1. the service can be based on data;
2. the service can use data as a resource;
3. the service is validated or enriched with data, but the data is not directly used or visible in the service.

In the first case, data is at the core of the service concept: the service can not work without a specific dataset that is frequently visualized through the service or used in combination with other ones in order to provide new meaning to data. The data research, in this case, begins at a very early stage of the design process when the designer is still ideating and exploring opportunities. In the second case, data is used to verify the feasibility of a service: the data intervention happens at an advanced stage of the design process, during what Foulounneau and colleagues define as the *maturation stage*. Finally, in the last one, data is used to validate the service in a late phase of the design process, to verify a business model or to check the validity of other datasets used in the service itself.

Towards operationalizing data literacy for the field of design and empowerment, D'Ignazio (2017) has laid down strategies on teaching "creative data literacy", such as working with data that the learners can relate to. Any mainstream data expert tool (e.g., R) contains sample datasets for learning, but these are most often highly domain specific (e.g., a car catalogue from 1974 with details) or highly generic. For service design students to learn about data, a relevant dataset would need to relate to service specific characteristics, or to be relevant for a specific step in the design process. As an alternative approach, Hill et al. (2017) approach the teaching of data literacy for novices via their four-days long "democratizing data science" workshops, through getting them engaged with programming. In their approach, they teach programming as a foundational skill for working with data (and thus, programming is tought specifically for data operations), and then have the participants follow an actual data science workflow. Throughout the process, the participants learn how to use code to capture data from online resources, and to visualize data to provide answers.

The approaches proposed by D'Ignazio and Hill et al. are specific to empowering people without data skills. However, understanding what approaches would be appropriate for designers for acquiring data skills that can be applied to the design process is still in its infancy. The initial aim of our study was to focus on data used at the core of the service concept, investigating how a data exploration in the ideation phase can be facilitated with novice designers who have limited, or no, experience with data. In this phase, the designers are often exploring a problem space that they would like to complement with additional data capture and analysis. Most likely they will need to follow the five data actions mentioned in the previous paragraph using specific methods and tools in order to gather the insights that will be communicated or used in the design process. As our use case clearly shows, the students used the data exploration workshop to refine their research question, mainly gathering insights from behavioural or thick data.

## A use case: a workshop on open data for tourism

This workshop was conducted within the Distributed Systems course of the Service Systems Design Master at Aalborg University in Copenhagen. 26 students from the second semester of a Master in Service Design participated working in work groups of 4-5 people each. The workshop ran for three consecutive days and was intended as a hands-on learning activity to teach data skills and tools to students, who were invited to tinker with data while working on a specific design problem. The overall aim of the workshop was to see how design students

could adopt a data-driven inquiry and build upon newly-acquired skills in data analysis to complement their research and design process. The workshop approach was based on problem-based learning; we wanted to minimize the frontal education as much as possible, and had the students figure out working with data on their own, supported by constant facilitator presence and assistance as needed. The workshop's learning goal was to prepare the students to use end-user data tools (tools that do not require programming), that can provide flexibility and can address reasonable complexity.
Prior to the workshop, the students attended one introductory lecture on theoretical and methodological approaches to working with data. The students already had an average level familiarity with spreadsheets software (e.g., Excel, Sheets), and with typical visualization techniques (e.g., charts, graphs), these being basic technical literacy, but we also refreshed their tacit knowledge with two homework assignments one week before the workshop.

In the Service Systems Design Master's program, the students are invited to work on a problem-based learning approach and each semester they receive a brief for a design project that they would have to carry out in groups. The workshop was an occasion for the students to keep working on this semester-long project by looking at it through the angle of data analysis and visualization. The theme of the semester-long project was tourism in a Nordic capital.

Throughout the workshop, the students worked towards generating tangible outcomes (like gained insights and concepts), which were then captured and shared during mid-term and final presentations to show progress and results. We kept observational notes to document the students' processes throughout the workshop. The students' materials, their reflection sheets and the observational notes have been processed following an open coding procedure to identify patterns, key issues and challenges. The workshop was followed by a questionnaire sent to the participants to collect immediate data about the learning goals and reflections on the impact of the workshop on their future projects.

## Procedure

Prior to the workshop, the participants received two homework assignments to familiarize with data capturing, analysis and visualization methods. First, the participants were instructed to scrape a specified webpage (i.e., their university library's search-page), and second, they were instructed to visually explore a sample dataset from RAWGraphs (an online visualization tool that we recommended for the workshop) and extract three insights from it.
The three-day workshop started with a basic introduction on the data workflow and the tools provided (the participants worked on their own computers) and a debriefing of the homeworks. The workshop went on with the **Activity 1** (Question definition), where the participant groups needed to define research questions based on their semester project. **Activity 2** (Data collection) kept exploring the previously defined research questions, and the students were invited to capture potentially relevant data in relation to the research questions. The task of **Activity 3** (Data transformation) was to clean, prepare and transform the captured dataset. The workshop ended with **Activity 4** (Data exploration), when the participant groups had to analyse the dataset, produce suitable visualizations and prepare a presentation to share with the other groups. The participant groups could iterate from Activity 1 (Question definition) to Activity 4 (Data exploration), if necessary.
An overview of the setup and methodology of the workshop can be found in Table 1.

| | |
|---|---|
| **Our interest in running the workshop** | We wanted to investigate how designers should be equipped to make sense of data in their design process and what kind of data literacy should be supported by service design education in their curricula. In particular, we wanted to explore how design students adopt a data- |

| | |
|---|---|
| | driven workflow as a complementary technique for their research phase? |
| **Settings** | The workshop took place in the format of a three-day format on consecutive days. Prior to the workshop, there was a homework to familiarize participants with some of the tools. The theme of the workshop was related to the semester-long project that the students had to work on. |
| **Participants** | First year Master's design students (n=26, 20 female, 6 male) from Service Design. Students worked in groups of 4-5. |
| **Apparatus**<br>*Dataset*<br><br>*Software Tools* | <br>No provided dataset (the participants captured data as part of the study).<br><br>WebScraper[3], Microsoft Excel, Google Sheets[4], RAWGraphs[5], OpenRefine[6], Carto[7] |
| **Procedures**<br>*Prior the workshop*<br><br>*3-days workshop*<br><br><br><br><br><br><br><br><br><br><br><br>*Follow up* | <br>Homework a week before the workshop to scrape a webpage (with Web-Scraper), and extract one insight from the Titanic dataset with RAWGraphs.<br><br>Basic introduction presentation about data processing and tools and debriefing on the sensitizing task.<br>**Activity 1 (Question definition):** Related to the semester project, defining three research questions to be answered with data.<br>**Activity 2 (Data collection):** Capture data (by scraping or downloading) for the questions from Activity 1.<br>**Activity 3 (Data transformation):** clean, prepare, transform the captured data from Activity 2.<br>**Activity 4 (Data exploration):** Make sense of the dataset from Activity 3 by analysis or visualization. Conclude on three main insights gained. Iterate from Activity 1, if necessary. Prepare a presentation about the process and the insights.<br><br>Survey regarding learning goals, individual reflections and impact of the learning on participants' future work. |
| **Research Data** | Content analysis of presentations from Activity 4, observational notes throughout the workshop, post-workshop survey and observations. |

Table 1: Setup and methodology overview

[3] WebScraper: http://webscraper.io/
[4] Google Sheets: http://sheets.google.com
[5] RAWGraphs: http://rawgraphs.io/
[6] OpenRefine: http://openrefine.org/
[7] Carto: http://www.carto.com/

### Results

Prior to the study, the participants received two homework assignments. The task to visually explore a dataset (to be done individually) was done by all participants, while the task of scraping a webpage (to be done as a group) was only carried out by half of the groups. During the debriefing, the participants reported difficulty in extracting interesting findings from the sample dataset without having some background knowledge and not knowing what would be interesting about this dataset.

During the workshop, the groups started with Activity 1 (Question definition): they first considered their project and defined some initial research questions to be answered with data. The groups then followed to Activity 2 (Data collection). They engaged in capturing data from online resources, primarily by scraping and downloading existing datasets (i.e., open data). The scraping process was initially daunting for participants without extensive programming skills. Nevertheless, by the end of the process most participants managed to develop non-trivial scrapers, that could tackle pagination and similarly advanced techniques. All scraping was done using browser extensions.
The groups ended up by capturing data on tourism, primarily by scraping publicly accessible data from social media and websites that focus on elements of tourism (such as community reviews). All teams scraped data from various social tourism platforms (Tripadvisor, etc.) and some teams from social media (e.g., Twitter and Instagram).
In the next step, the participant groups worked on Activity 3 (Data transformation). The main needs of data cleaning were to eliminate inconsistencies, hidden characters, encoding errors and similar string operations. As a significant portion of the participant groups' captured data was location-specific (e.g., addresses), some groups used OpenRefine - an open source application for data cleanup and transformation - to enrich their datasets with Global Positioning System (GPS) coordinates. This was accomplished by following an OpenRefine recipe that called an external API with the address input to enrich the data with GPS coordinates. The participant groups finished the study with Activity 4 (Data exploration). The groups explored their dataset with visualizations produced through data visualization and mapping tools, such as RAWGraphs and Carto.
Throughout the three day workshop all groups went through several iterations from Activity 1 (Question definition) to Activity 4 (Data exploration). In the end, all the groups managed to develop valuable insights for their semester project. As an example of the kind of research questions the teams attempted to answer, one team focused on how seasons influence tourism. When they found that the correlation of seasonality and tourism is probably low for their target group, they decided to focus on comparing the target city with similar cities, based on weather and other predictors. This was a process that allowed the group to explore, stretch and expand their research questions.
In the following section, the outcome of the workshop will be discussed reflecting on the service design educational perspective and opening up to other crucial aspects related to data that should be considered while designing for services.

## Discussion

As previously mentioned, the participants of the workshop were second semester Service Design students who had successfully completed their first semester courses in Programming, User Experience and Product-Service Systems design. All the students were familiar with qualitative data, ethnographic research and methods, co-design methods, and in general, with adopting a user centered perspective through all their studies.
One of the goals of the workshop was to have students realize that the ethnographic research they are familiar with in their work could be supported by data analysis in the design

of services, and to find out what other kind of skills and knowledge the students should then acquire through the program and how.

The initial struggles for the participants were, firstly, to become familiar with the computational thinking that data capture and data manipulation require. These activities at the level of the workshop (and design students) only require basic programming skills (and more of computational thinking), but at the beginning of the workshop they found it hard to make the connections to their previous programming experience. However, after a few iterations of a trial-and-error process it became much easier for them, partly by becoming familiar with a "data mindset" as well as getting familiar with the tooling and the capabilities. Throughout the iterations they both refined their leading research question, that informed what data to capture, as well as their data capture technique, that informed what complexity they would address. In this process, they continuously improved their understanding of what were the addressable and non-addressable questions, and iteratively eliminated the non-addressable ones. This data-driven inquiry process, and the very act of continuously tinkering with data helped them in refining the orientation of their project. With every iteration, their understanding of the potential of employing data techniques increased. Since the workshop lasted three days, the participants had a sufficient amount of time to carry out various iterations. In the end, all the groups succeeded in understanding how a data-driven approach can help in identifying and answering relevant research questions. To succeed, the students needed to incorporate a computational-thinking heavy "data mindset", which was intertwined with their designerly framing processes.

During the workshop we also observed that participants used data techniques to seek inspiration from data; tinkering with data was approached as a generative design technique. For example, one of the groups analyzed social media hashtags for a specific neighborhood, and looked specifically into the less common descriptors of the neighborhood, such as slang and subcultural terminology. They accessed knowledge that otherwise would have been hard to gain from user interviews. They used their findings not to quantify how popular such hashtags are compared to the most frequent ones, but to explore a phenomenon that they would hardly have access to otherwise. This is a creative way of using data, and one where the human abductive sense-making is necessary to create the right connections (Kolko, 2009; Dorst, 2011). It is worth noting that the kind of data the students extracted from a critical planning of their data search was quite different from the statistical data or the public data now available in public repositories. The combination of public data and this kind of data can in fact provide a much more "live" picture of events, trends, or social phenomena. Abductive reasoning from data is a point of departure for the traditional usage of data, which is to deduct or induct conclusions from a dataset throughout analysis (Wong and Thomas, 2009).
We assume that students can be trained to such designerly sense-making from digital data the same way as they are trained to extract meaning out of insights gathered from contextual and qualitative studies. The (service) design process could then move technically driven and abstracted data ideas to human-scale service offerings, and while future research is necessary to validate this in detail we can argue that service design education should start considering specific interventions or even full courses on data literacy for designers in their curricula.

The workshop was a limited (in terms of time and perspective) experimentation within a Master's program, but proved that service designers with basic knowledge on programming can make sense of and use data as one of the materials they have to work with in the design process. It also gave some insights regarding the software and tools that should be used to support these teaching sessions.
The challenges that data poses to service designers, however, are more complex than the ones that are simply related to transforming a dataset or capturing data through scraping online resources. Prendiville et al (2017) discuss the role of service design in making sense

of data through processes of translation, visualization and persuasion to turn the abstract and intangible nature of data into human-centred services with social and economic value. The authors claim that one of the critical aspects that should be addressed by service designers concerns the transformation of data (something highly technical that we all produce every day, though letting others to exploit it) into something that can be understood and consumed by broader communities, possibly making the general public a proactive agent in data formation and use. In other words the question is to use data as a new kind of resource for service design. In particular when focusing on publicly available data -- open data -- it can be regarded as a new commons (Ostrom, 1990), with new communities of users and new practices. The question of open data as a new commons (Morelli et al., 2017; Seravalli, 2014) is also currently under discussion in the design community and the role of service designers to empower citizens in making use of data and to co-create more explicit value propositions for all the different stakeholders has to be further analyzed.
A completely new, and almost unexplored, chapter should then be open regarding the tools that could support the designer intervention in the "non expert" empowering process. Can the service design toolbox be modified or adapted to add the data level earlier in the design process?

## Conclusions

This paper discusses the relevance of data literacy in education, in a logical domain that crosses two perspectives.
The first perspective focuses on the rising relevance of data in the design of new services. The ever growing number of services that use data and/or produce data requires that service design education include teaching activities that equip the students with the tools needed to understand, analyse and transform data as well as design with this data informing the process at every step.
The second perspective focuses on the increasing the availability of data and the opportunity to use it as a resource, or even, when the data are publicly available, as a commons. The use of shared resources requires that a set of practices (and in particular design practices) for data usage are consolidated and that a community of users has access to this resource and can understand, figure out, and make proposals regarding how this large amount of data can be used.
The intersection of those two perspective creates a new working area, in which it is important to define new operative tools and practices, so that a higher level of data literacy can create, as a consequence, a higher integration of data into the design of services.
The two perspectives are strongly connected, the case presented in this paper though addresses the first one, as it is a contribution to the definition of new teaching activities for service design to work with data. However, at the same time it creates the conditions for a wider use of data that will eventually create new practices and new communities around this new resource.

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