DATA CRAFTING: EXPLORING DATA THROUGH CRAFT AND PLAY

Creating New Perspectives of Data by Crafting Novel Visualizations with Unfamiliar Materials

Authors:
Nathalie Alexandra Vladis, Harvard Medical School, Harvard *
Aspen K. Hopkins, Computer Science & Artificial Intelligence Laboratory, MIT *
Arvind Satyanarayan, Computer Science & Artificial Intelligence Laboratory, MIT

Time:	Participants:	Facilitator for 20 people:	Goal:	Easiness facilitator:	Cost:
5h-6h	10-20	1 to 2	**Visualize Data Creatively**	★★★☆☆	★★☆☆☆

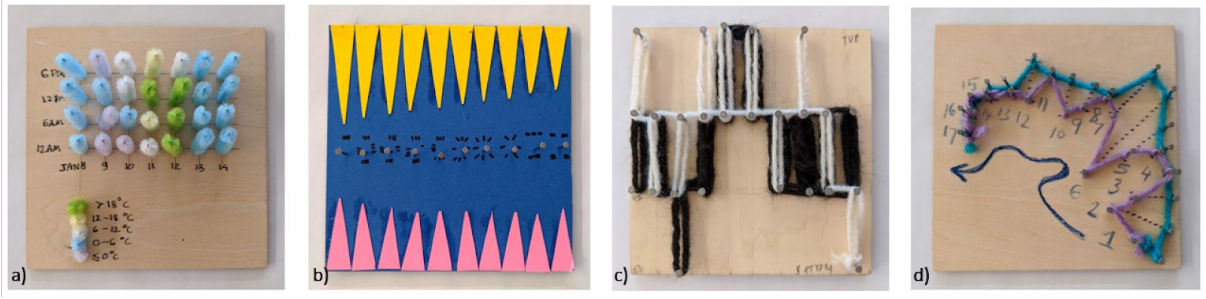

Figure 1: Example of productions. a) "Boston Weather with Pipe Cleaners" by Gaurav P. b) "Ten Hours in Boston" by Yue D. c) "Screen Time by Weather" by Artemisia L. d) "Highs and Lows" by Serena Booth.

Small abstract about the activity

In this full-day workshop, we introduced participants to novel, multi-sensory ways of exploring and visualizing their data through Data Crafting. Data Crafting—in which crafting by hand promotes and produces data communication—facilitates creativity through play; by emphasizing crafting, we sought to make data *approachable* and to build a space where experts can explore new facets of their data. Our participants thoroughly enjoyed being exposed to this new approach and shared that they were likely to apply what they learned to communicate their research, gain new perspectives on data, and build data literacy at home and in classrooms. Here, we provide instruction on how to recreate this workshop as well as strategies for adapting it to larger audiences and/or shorter sessions. Data Crafting activities can be applied across many domains and in many contexts, as shown by the diverse backgrounds of our participants. From graduate students and post-doctoral researchers to first year business undergraduates and journalism fellows, all participants benefited from attending.

* *First Authors*

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Introduction to Data Crafting:

While the value of play is scientifically grounded [2], the benefits of play *in the context of data* are underexplored. With few exceptions such as Huron et al.'s Constructive Visualization [10], literature in the space has focused on building data literacy in children [14, 15] with concepts of play limited to visual and tactile sensory experiences. This is surprising given the recent work by Kostelnick [13], Hopkins et al. [11], and Kennedy et al. [12], which highlight the rhetorical force of visualizations— a major reason behind why we find it difficult to fact check, debug, and critique them — and the low rates of data and visualization literacy. The perceived complexity of data maintained by the general populace combined with visualizations' rhetorical force creates a painful reality for the visualization community: data and its representations are unapproachable.

This is not unique to the general public; data experts struggle with beliefs that data is austere — perfect—making it difficult to play with and explore [11]. Those that work regularly with data (as analysts, teachers, researchers, or scientists) may only understand one facet of data and are thus limited in the ways they, the workers, can represent and engage with said data . In response to this difficulty, we facilitated a creative, hands-on play date with data to make data approachable for novices *and* to build a space where experts can explore new facets of their data.

We do so through *Data Crafting,* a practice of data exploration and communication that emphasizes two key components: play and craft. We describe data crafting as either adjacent to or a subset of data physicalization, where the emphasis is not on a perfect, camera-ready object but rather on the process of doing — of playing with your hands, and experiencing with all five senses.

Unlike in data physicalization, the focus of data crafting is on *sensorial explorations without specific agenda*. This, we argue, is the critical element of play often missing in data physicalization. Play comes from curiosity, inquiry, and exploration [2], while craft acts as a form of individual agency via the creation of anything, regardless of material or technique [16]**.** Similarly, *data* crafting is a practice, a refinement of data comprehension and of construction that comes as an artifact of continuous, hands-on exploration and creativity. In this way, the limitations of expectation and norm are ignored and all senses are engaged. By using a variety of mediums — both traditional and not — in a space where imperfection is expected, we normalized exploration. Our workshop simultaneously encouraged novices and "made new" mundane notions for experienced practitioners by utilizing crafting materials and techniques. We describe our data crafting workshop in the following sections, then conclude with a reflection on recorded participant responses.

Preparation:

Preparation:	Activity	Post activity:
60 min	5-6 hours	10 min

Room Layout:

Prior to the workshop, we clustered desks and tables to accommodate small groups of three to four. Each group had easy access to crafting materials that were spread throughout the room and organized by

category (e.g. tools, threads, markers. etc). Optimally, data crafting activities need space for participants to spread out, which we achieved by having a larger room and plenty of chairs and tables.

Steps 1 through 3 helped us set the stage for the main Data Crafting capstone project which takes place in Step 4. Lunch and refreshments were provided. We frequently alloted time for short breaks between steps and during topic changes. The slides developed for this workshop are available in **our additional materials.**

Here are the workshop's learning objectives ranging from lower to higher levels in Bloom's taxonomy [1]:

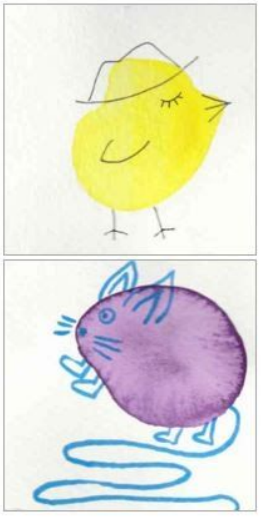
A. **Identify** the benefits of incorporating play and craft into our work, and the limitations of data encoding channels
B. **Describe** different types of data encodings used for data visualization/physicalization and how to navigate their associated trade-offs
C. **Discuss** the origins of crafting and **evaluate** the ways it can be used to represent information
D. **Create** a visualization from a public dataset through crafting

Activity:

Step 1 : Icebreaker and Introduction (30 min)

We started the workshop by introducing ourselves, our learning objectives, and the day's activities. Following the introduction, an icebreaker activity acted as a creative primer and allowed participants to get to know each other. We distributed watercolor blobs on cards, and participants had one minute to add features to their 'blob'. Once the minute was up, the cards were passed on to the participant sitting to their left who had another minute to write a one-sentence story about the transformed blob (30 minutes). Participants then shared their stories with the group along with a brief personal introduction.

Following the ice breaker, we shared a piece of paper and asked that each person use it to keep track of 1) how often they looked at their phone, 2) how often they scratched their nose, and 3) when they zoned out. We didn't explain what this dataset was to be used for until Step 3.



Caption: " A little chick is getting ready for a long day of work. He feels good in his new hat."

Caption: "A mouse has the longest tail in the world. It gets in the way most of the time, until one day that tail saved the day."

Figure 2: Icebreaker watercolor blobs and captions.

Step 2 : Introduction to Play, Data, and Crafting (60 min)

During Step 2 of the preparation, we motivated Data Crafting by introducing the value of play and creativity, highlighting historic

Tools checklist:

[ ] 2 Hammers
[ ] 2 Hot Glue guns
[ ] 4 Rulers
[ ] 6 Pairs of Scissors

For presenting

[ ] Laptop
[ ] Projector

Materials checklist:

[ ] 40 Flat Wood Pieces
[ ] Box of Long Nails
[ ] Box of Short Nails
[ ] Bottle of Liquid Glue
[ ] Set of Markers
[ ] Set of Multicolored Yarn
[ ] Set of Embroidery Floss
[ ] Set of Embroidery Floss
[ ] Multicolored Pipe Cleaners

Tips for a large audience:

For a larger audience (>20), we recommend increasing the amount of materials and tools, especially glue guns. We also recommend that there is at least one facilitator per 10 participants.

Tips for a smaller time:

We had a flexible schedule for our workshop, however, it is possible to half the time it takes to do the activity by using these strategies:

- Choose a shorter icebreaker. You can just ask participants to give their name and share something about themselves
- Shorten Step 3 by choosing

contexts of crafting, and describing concepts of data visualization. For the section on play, we focussed on concepts from Mitchel Resnick's framework using projects, passions, peers and play for cultivating creativity [2]. Multi-sensory experiences are fundamental to play, thus to encourage multi-sensory thinking (critical also to data crafting), participants were asked to do a *sensory walkabout,* to observe the taste, smell, look, feel and sound of their environment. After ten minutes*,* each participant shared their most visceral or novel sensory encounter.

To teach data visualization principles, we described different types of encoding channels and the relative trade-offs associated with each, introducing expressiveness and effectiveness principles as tools for selecting appropriate encodings. We grounded these concepts using cartography, then compared encoding decisions for maps to those of line graphs and histograms. Ineffective visualizations were contrasted to effective visualizations, with key discussion questions such as "What does blue represent in a map, and why do we choose that color?" and "What is changing in this chart? What's confusing? Why might the visualization author use size instead of color in this context?" prompting participants to think deeply about how they map different types of data, such as categorical or ordinal, to their representation.

Finally, we tied these ideas back to multi-sensory experiences —while data visualization encodings are often empirically studied, there is much less work on alternative modalities. We ended Step 2 with the following question: how can we think about limitations and trade-offs when working with these different modalities?

Step 3 : Introduction to Data Crafting (90 minutes)

Step 3 focused on the process of creating a data visualization through craft, that is, Data Crafting. We began by presenting different types of projects in a variety of mediums, such as: sonification [3, 8], basket weaving [4], data scents, ancient knotting techniques [5], the Jacquard loom [9], and knitting [9]. We connected back to concepts taught in Step 2 by asking participants to identify the encodings used in the Data Crafts we presented.

We did two short activities, Data Scenting and Kitchen Jam Band, as part of this introduction. Data Scenting used the quantified self dataset that participants had been collecting. We used the collection process to highlight how data are not perfect, as no participant accurately recorded their data. Following this discussion, we encoded their dataset into a blend of scents (a process described under Data Scent Instructions). We revisited encoding effectiveness, and asked what worked and didn't work by mapping data to scent.

Kitchen Jam Band is a data sonification activity using various utensils, pots, and pans commonly found in a kitchen. The activity is short--only 20 minutes. By framing the activity as both a form of play and a way to work with data--Data Crafting--we found that participants naturally engaged more. Prior to the activity, we collected various statistics for the world for a given time frame, such as the number of planes that take off each minute, or how many people are born in a second. Each person was assigned a sound (ie hitting a pot, grinding the pepper, rubbing ladles together). Each sound is associated with an event type (births, deaths, etc) for a period of time, which was then associated with a distinctive metric rhythm. The piece was then played together and recorded. In later discussion, participants pointed out patterns they noticed in the sonification, and

- fewer examples, and skipping the smaller activities or the Case Study
- In Step 4, during the capstone, give a more restricted dataset to help participants narrow down ideas faster
- Finally, reducing the range of available materials reduces the amount of time participants experiment with different techniques

Data Scent Instructions:

1. Provide a variety of scented liquids. Strongly smelling oils can cause headaches and should be avoided or diluted.
2. For each of the three data columns, select an associated scent-- distinct smells are likely to stand out more
3. Count up the total for each column
4. Take the ratio between the total count and 16 drops of a scented liquid—the number of drops for each scent is reflects the relative ratio of an individual column to the total.
5. Combine the scents together.
6. Compare between people: can you tell what the composition is?

Tips for fun:

The icebreaker was a great way to create a fun environment as the shapes ended up looking very funny. This helped us set a great ambience that lasted until the end of the workshop. We also made sure to present some examples of Data Crafts that did not work well (e.g. we shared one of our own failed sonifications that ended up in a cacofonie) to encourage a sense of experimentation and humor to the process.

References and Online resources:

[1] Bloom, B.S. (Ed.) (1956). Taxonomy of Educational Objectives: The Classification of Educational Goals. Handbook I. Cognitive Domain. New York: David McKay Company, Inc.

[2] Resnick, M. (2017). Lifelong

highlighted the novelty of the activity as a creative outlet to *hear* patterns rather than see them.

Following the presentation, co-organizer Nathalie Vladis described her process when creating a data craft via a Case Study of her Temperature Quilt originally made for the 2016 DataX exhibition [6] at the University of Edinburgh. Most participants did not have any experience with data physicalization prior to this workshop. The goal of this case study was to provide workshop participants with a framework they can use to create their data craft project.

This process encompassed the following steps:

1. Finding a dataset of interest if one is not already provided
2. Cleaning the dataset
3. Deciding on which crafting techniques will be more appropriate based on the dataset and access to materials
4. Selecting visual encodings based on data attributes and crafting techniques
5. Gathering materials
6. Prototyping the project by making a miniature or a sketch
7. Creating the data craft

Figure 3: Feel the Heat: A Temperature Quilt by Nathalie Vladis. We used that project as a Case Study.

Step 4 : Data Crafting Project (120 to 180 min)

After the case study presented in Step 3, we provided students with a link to a website where they could access Boston's past weather data [7] as well as a wide variety of crafting materials including multicolored threads, yarns, papers and markers. We also provided participants with tools such as hammers, nails of different sizes, scissors and flat wood pieces. The instruction was: "Create a data craft based on historic Boston weather data of your choice. You can combine the weather data with other datasets of your choice". We gave participants the option to work in groups or individually. Examples of productions are shown in Figure 1.

Step 5 : Presentations and Survey (30min)

Participants had a chance to present their work and get feedback from their colleagues. After presenting, participants filled in a survey about their Data Crafting process. We asked them to share their impressions, insights and challenges they faced. We describe the outcomes of the survey in Reflections and Conclusions.

Step 6: Conclusion (10 min)

In Step 6, we wrapped up the activity by giving participants feedback on each Data Craft, as well as insights we gathered by

Kindergarten: Cultivating Creativity through Projects, Passions, Peers, and Play. MIT Press.

[3] The Higgs Boson Song: A Sonification of the ATLAS Dataset by Domenico Vicinanza (https://youtu.be/KjHvGyPlcT4)

[4] The Weather Artist: Chasing Storms with Sculpture (https://youtu.be/1ES4Ds7ApQw)

[5] Threads That Speak: How the Inca Used Strings to Communicate (https://youtu.be/AmPyz1kCbOw)

[6] DataX Exhibition Ressources, University of Edinburgh (http://data-x.blogs.edina.ac.uk/abou)

[7] Time and Date Website (https://www.timeanddate.com/weather/usa/boston)

[8] Rhapsody in Grey: Using Brain Wave Data to Convert a Seizure to Song (https://vimeo.com/121042482)

[9] List of Physical Visualizations (http://dataphys.org/list/)

[10] Huron, Samuel, et al. "Constructive visualization." *Proceedings of the 2014 Conference on Designing Interactive Systems*. 2014.

[11] Hopkins, A. K., Correll, M., & Satyanarayan, A. (2020, June). VisuaLint: Sketchy In Situ Annotations of Chart Construction Errors. In *Computer Graphics Forum* (Vol. 39, No. 3, pp. 219-228).

[12] Kennedy H., Hill R. L., Aiello G., Allen W. The work that visualisation conventions do. Information, Communication & Society 19, 6 (2016), 715–735. 2, 3.

[13] Kostelnick, C. The visual rhetoric of data displays: The conundrum of clarity. IEEE Transactions on Professional Communication 51, 1 (2008), 116–130.

[14] Bishop, F., Zagermann, J., Pfeil, U., Sanderson, G., Reiterer, H., & Hinrichs, U. (2019).

circulating around the room during the activity. We also opened the floor for discussion--some individuals had questions about personal projects, and we spent this time sharing additional resources and events with those interested.

Construct-A-Vis: exploring the free-form visualization processes of children. *IEEE Transactions on Visualization and Computer Graphics*, *26*(1), 451-460.

[15] Alper, B., Riche, N. H., Chevalier, F., Boy, J., & Sezgin, M. (2017, May). Visualization literacy at elementary school. In *Proceedings of the 2017 CHI Conference on Human Factors in Computing Systems* (pp. 5485-5497).

[16] Adamson, G. (2010). *The craft reader*. Berg.

Survey Overview

We asked participants to fill out a survey at the end of their presentations. Here are some example of questions we asked participants to elaborate on:

- Describe your process and materials
- What did you enjoy most about the activity?
- What challenges did you encounter?
- What did you do upon encountering a challenge?
- Did crafting affect the way you connected with the data?
- Are you likely to use any of the strategies we discovered today in your work or other aspects of your life?

Reflection & Conclusion

The motivation for organizing this workshop was to expose participants to new ways of thinking about and representing data. Data Crafting not only makes data more tangible for the researcher, but may also help audiences establish stronger connections to the phenomena described by the data. Participants commonly described Data Crafting as helpful to gaining a better sense of quantities and proportions. For example, participants reported that having to cut many different lengths of thread to represent temperature changes helped them get a better grasp of the variability in the data from day to day or week to week. This visceralization from the additional tactile experience ultimately led to a deeper understanding of their data--a difficult task to accomplish in other contexts.

In relation to our first and second learning objectives (A & B), participants told us that the imprecise nature of the materials forced them to think more creatively about communicating concepts such as time and proximity. This imprecision came with a new sense of freedom, and as a result one participant chose to combine the Boston dataset with data from her phone about her daily screen time (Figure 1.C). She told us this was not something that she would likely do in a traditional data visualization setting as it would

have required considerable time just to clean and format the data. From this, we concluded that operating in the Data Crafting framework made it easier for workshop attendees to ask novel questions.

The most common challenge reported during the workshop and in the survey pertained to the Data Crafting planning process. As we were working on our final learning objective (D), many participants were enthusiastic about creating their artifact and did not spend enough time thinking about how they will represent their variables and how much material they will need. As a consequence, some teams had to stop halfway through the Data Crafting project to redesign their piece. This reflects the iterative cycle of both data collection and visualization authorship.

All participants reported that they were keen to use the strategies in their work, mainly as a data exploration tool before engaging in their traditional data analysis and visualization workflows. Some participants said they would use the skills taught in the workshop for communicating their research more effectively to lay audiences in public outreach events. A handful expressed interest in replicating our activities with their children as a method of teaching data literacy. Taken together, these reports are a good demonstration of our third learning objective (C), as participants were able to evaluate different ways of using Data Crafts in their professional and personal lives.

Overall, as organizers, we were thrilled to see how open participants were able to use the techniques and framework we presented during the workshop. Our attendees were diverse, ranging from artists, community members, undergraduate business students, journalism fellows, graduate students, professors, and postdoctoral machine learning researchers. During the activities, the buzz of excitement and conversation filled the room. We were not only impressed with the productions (examples shown in Figure 1) but also with the flexibility and adaptability participants showed as they engaged with unfamiliar tools and materials. Most importantly, everyone left the room with plans for future Data Crafting projects and collaborations.

Credits & Acknowledgment :

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