

Above the Surface

Organizing the digitally processed archaeological finds of the north/southline

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ABSTRACT

1 INTRODUCTION

From 2003 to 2012 excavations took place for the creation of the North/South metro line in Amsterdam. At Damrak and Rokin, which are unlikely archaeological sites due to being in the city center, archaeologists had a chance to physically access the riverbed. During these excavations in the Amstel over 700,000 objects were preserved which resulted in the archaeological collection called 'Below the Surface'¹ commissioned by the Municipality of Amsterdam.

The collection has a great variety of objects, from tools over centuries old to credit cards recently lost which makes the collection a rare source of urban history. All objects are digitally processed (e.g. photographed, labeled, metadata added) and displayed on a front-end website at *belowthesurface.amsterdam*. This website shows an overview of all the objects and a detail page with metadata of a particular object but no further categorization or classifications. This research aims to further organize this collection of objects with a focus on grouping the items by *functional properties*, determining *cultural relevance*, and researching *object relationships*.

2 RELATED WORK - CHRIS

2.1 Below the Surface - Danny

2.2 Museum research - Desk Research - Chris

2.3 Antique collectors - Chris

2.4 Archaeologists - Chris

2.5 Academic Research - Chris

2.6 Machine Learning - Radu

3 METHODOLOGY - ABHILASH

3.1 Glushko 6 Questions - Abhilash and Chris

3.2 Data Dictionary and Metadata - Chris

3.3 Ontology - Chris

3.4 Data Model - Abhilash

3.5 Technical Implementation of the website

The website is a custom front-end mostly using web standards and open-source software and libraries. The assumption is that it will mainly be used in a desktop environment by the users to explore on larger screens so the website is not fully responsive and thus not mobile-optimized.

3.5.1 Front-end frameworks. The web application is created with the open-source front-end framework Svelte² and UI framework SvelteKit which allows the application to be built-in interface components, each chart is rendered separately making it more efficient to add functionality (e.g. add datasets, render different chart types) in the future but also makes the website performant when more data and charts are added. Svelte can be downloaded as a module (package) from NPM³ and uses the JavaScript back-end run-time Node.js⁴. For the charts the JavaScript charting library Chart.js⁵ is integrated into the components which allows charts to be rendered in HTML5 Canvas without much configuration.

3.5.2 Dataloading. The processed and transformed dataset was used as a primary data source of which subsets of the dataset in .csv format, roughly one per year chart and section, are converted to .json. These data files are loaded on page load of the browser. For this prototype, no back-end was set up and no database queries are being made. Any filter options and updating of the charts are more custom, it uses JavaScript utility functions to allow the data to be pre-processed and have only the data change. For the map page, an additional Chart.js Geo Plugin is used to render the Choropleth map. It uses a TopoJSON⁶ file to render the regions of the World.

3.6 Machine Learning Model

3.6.1 Data-set presentation. Below the surface provides a data-set[?] of all the objects resulting from the excavations. The data is provided in the form of a .csv file, with 139190 rows and 163 columns. Each row corresponds to an object. Describing each object is well outside of the scope of the purposes of this section, however, an explanation of the relevant columns is necessary. The following columns are relevant for the purposes of the ML model:

- *vondstnummer* - represents a unique inventory number, in the form of a string. Every object has a *vondstnummer*. Example: "NZC1.00001MTL001".
- *object* - a description of the contents of the object. Example: "sieve residue"
- *subcategorie* - a categorisation of the object material. Example: "metal: copper alloy"
- *objectdeel* - describes the object type morphologically (if it is part of a bigger object, a set, etc). Example: "fragment"
- *vlak_min* - Describes the minimum depth at which the object might have been found. Example: "-22.0"

¹<https://belowthesurface.amsterdam/en>

²<https://svelte.dev>

³<https://www.npmjs.com>

⁴<https://nodejs.org/>

⁵<https://www.chartjs.org>

⁶<https://github.com/topojson/topojson>

- `vlak_max` - Describes the maximum depth at which the object might have been found. Example: "-22.01"
- `begin_dat` - The beginning of the interval of the estimated year of the object. Example: "1675.0"
- `eind_dat` - End of the interval of the estimated year of the object. Example: "1725.0"
- `niveau1` - The category in which the object is placed. Example: "Communication & Exchange"

For the columns `object`, `subcategorie`, `objectdeel`, `vlak_min`, `vlak_max`, `begin_dat`, `eind_dat`, `niveau1` there are rows in the dataset in which one or more of these columns are blank.

The column `niveau1` can take the value of one of 12 pre-determined categories, as well as the value "Not classified". As previously mentioned, there are rows where this column is blank.

3.6.2 Objectives. Our objective is to create a machine-learning model that will complete the missing data for the "niveau1" column. This means that our model will predict a value in the `niveau1` column, for the rows where currently that column is blank or has the value "Not classified". The prediction will be based on the values in the `object`, `subcategorie`, `objectdeel`, `vlak_min`, `vlak_max`, `begin_dat`, `eind_dat`, `niveau1` columns, which will act like input to the machine-learning model.

3.6.3 Deliverables. In order to achieve our objectives, the following files are delivered:

- `process_dataset.py` - a simple python script that takes the original 163 column .csv files and consolidates it into another .csv files that only contains the columns of interest. The name of this .csv file is "selected_dataset.csv"
- `machine_learning.py` - this python script is the backbone of the machine-learning process. It is a more-complex script that does the following steps:
 - Loads the "selected_dataset.csv" dataset
 - Preprocess the data (completes the values with 0 or placeholders here they are blank", etc)
 - Converts text strings to vectors
 - Splits the data into unlabeled and labelled data based on the values in the "niveau1" column
 - Splits the labelled data using a training, testing, and validation split
 - Builds the ML model
 - Compiles the model
 - Trains the model
 - Tests the model
 - Predicts the values of `niveau1` for the unlabelled data
 - Saves the updated dataset into a file named `predicted_dataset.csv`
- `predicted_dataset.csv` - a file containing the dataset in `selected_dataset.csv`, but with the column `selected_dataset.csv` fully completed.

3.6.4 Model description.

4 RESULTS - ABHILASH

4.1 Website - Camilla and Danny

The original website has a lot of individual objects and detailed metadata about properties. The aim of the website was mainly to

summarise the collection to allow the before-mentioned users to explore the broad dataset and find interesting patterns.

The design is based on the branding of the original below the surface projects and follows standard information and visual design principles.

4.1.1 Overview summary page. Create a storytelling kind of page with 5 sections. HIER ENUMERATE ALLE SECTIES MET CHART TYPES

4.1.2 Collection detail subset. Based on the categories of the summary page a user can create a subset of the collection.

4.2 Machine Learning Model - Radu

4.3 Dataset - Abhilash

4.4 Ontology and Data Dictionary - Chris

5 CONCLUSION - CAMILLA

6 DISCUSSION - CAMILLA

6.1 Reflection

7 FUTURE WORK - CAMILLA

7.0.1 Website. Additional visualization features and filter options need to be added to the website in the next iteration of the website. Currently, the website only visualizes broad categories but there are more subcategories in the dataset that the user might be able to click on to get more detailed views and overlays. From a user experience point of view, further usability testing needs to be done to validate the User Experience (UX) and User Interface (UI) of the prototype website. Direct feedback from the users would further validate the workings of the website and uncover hidden interface and interaction problems. From a technical perspective, the website currently relies on exported data that is then loaded into the web visualization. A further enhancement for the website, and to make it more dynamic, is to have the dataset exposed through a Query-like API (e.g. GraphQL ⁷) with an underlying 'headless' database (e.g. MongoDB ⁸) in which the website is able to fetch up-to-date collection real-time data. This also allows for more performant and dynamic filter options on the 'create a subset page' through the use of a back-end.

8 CONTRIBUTION OF AUTHORS

- *Abhilash*: did stuff
- *Camilla*: did stuff
- *Chris*: did stuff
- *Radu*: did stuff
- *Danny*: programmed the website and visualizations (front-end development) as well as conceptualized the interface interactions (interaction design) and look and feel (visual design).

9 ACKNOWLEDGEMENTS

We thank lecturer dr. V.O. Degeler (University of Amsterdam) for providing guidance and assistance during the project and MsC. A.

⁷<https://graphql.org/>

⁸<https://www.mongodb.com/>

Fleck (University of Amsterdam) who provided valuable feedback and answered our questions during the seminars which helped us further expand our research.

10 APPENDIX

10.1 Hosted source code

The source code of the web-based visualization, Python notebooks of the machine learning model and datasets used are hosted on GitHub using the MIT License. Under the *uvaio* username we have several code repositories:

- (1) Notebooks: Source Code for the Jupyter Notebooks for data processing and machine learning. <https://github.com/uvaio/notebooks>
- (2) Website: Source Code for the custom front-end website and interface. <https://github.com/uvaio/website>
- (3) Datasets: The processed and modeled datasets and the ontology. <https://github.com/uvaio/datasets>

10.2 Live version

A live demo version of the front-end website and visualization (desktop only) is hosted on Netlify and can be viewed using the following link <https://uvaio.netlify.app>

10.3 Website screenshots

Shown in Figures 1 and 2.

REFERENCES

- [1] DatasetBelow [n. d.]. Bellow the surface dataset. https://statics.belowthesurface.amsterdam/downloadbare-datasets/Downloadtabel_EN.csv. Accessed: 2023-10-08.

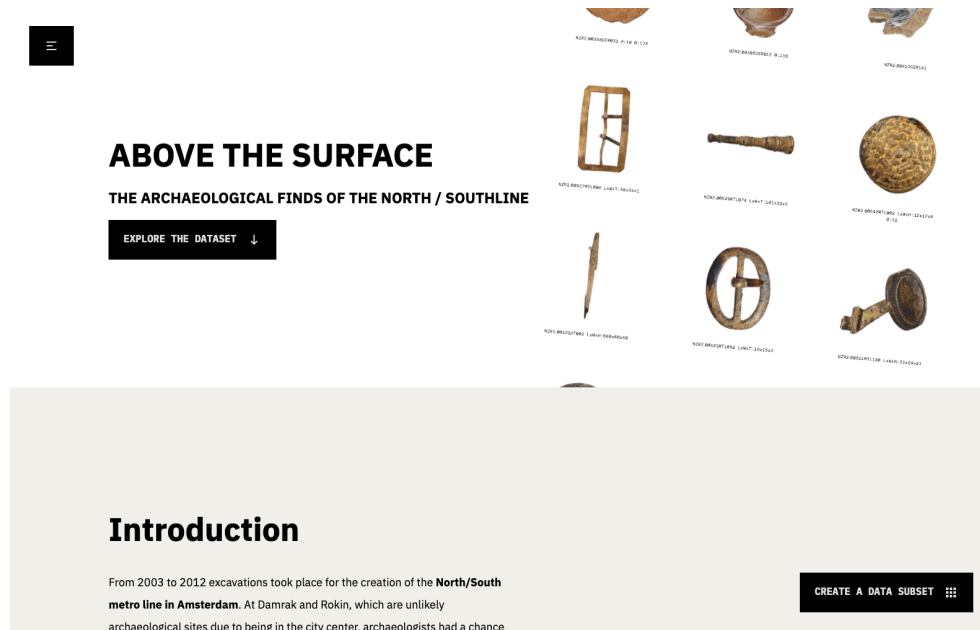


Figure 1: Screenshot of the 'overview landing page' of the website

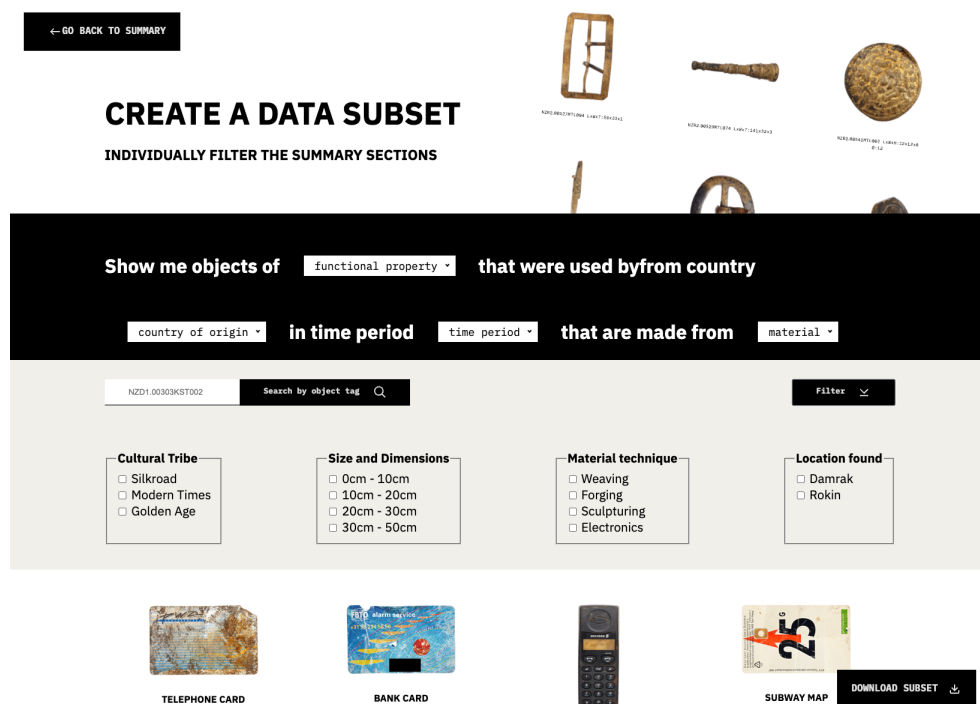


Figure 2: Screenshot of the detail 'create a subset' page of the website